Section 2

June 2015

Drift Creek Storage Project Reconnaissance Investigation

Report III

East Valley Water District
Willamette Basin, Marion County Oregon

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As Provided To:
Oregon Water Resources Department- Water Conservation, Reuse and Storage Grant Program.

DRIFT CREEK
HYDROLOGIC REPORT UPDATE #4

(Based on Oct. 2008- Sep. 2014 Data)

JUNE 2015

Proposed Drift Creek Reservoir Site at S.E. Fox and S.E. Victor Point Junction

Report Prepared for

East Valley Water District
Mt. Angel, OR

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EXECUTIVE SUMMARY

1. This report pertains to a proposed irrigation project initiated by East Valley Water District (EVWD) at a site located on Drift Creek, a tributary of the Pudding River, at the junction of Victor Road and Fox Road. It is the fifth of its kind and uses stream flow data collected during the last six water years (October 2008 – September 2014) to review the hydrologic records at the site and help support the feasibility of the project under a wide range of possible runoff conditions – e.g., how the proposed reservoir would be operated, given its physical size, the expected inflow, the required downstream releases, the projected irrigation needs, etc.

2. The first half of the report deals with basic hydrologic analysis. It documents the availability and characteristics of hydrologic data collected at nearby streams and how those data correlate with data gathered at the project site. It also helps identify the shape and runoff volume of representative (low, average and high) hydrologic flow years.

3. New Oct. 2012- Sep. 2014 stream flow data available for the analysis documented in this report covers all the stations discussed in the previous reports, except for the Lower Drift Creek gauge at Hibbard Road. To date, stream flow data collected at the Hibbard Road station for that period are still in a coded format.

4. Stream flow data described in the previous (third) hydrology addendum released in October 2012 supported the classification of 2008 - 09 as a dry water year; 2009 - 10 as a slightly below average year, and 2010 - 11 as a high water year. This classification data remains practically unchanged, with the additional water years 2011-12 ranked as "high", and 2012-13 and 2013-14 ranked as "slightly below average".

5. Based on updated flow duration curves, stream flows during the reservoir release season, between spring and fall, are expected to increase from the current 25 cfs average to about 50 cfs during 50 percent of the time. This increase could have some impacts on bank erosion for the creek downstream from the dam.

6. Strong statistical correlation exists between the stream flows at the proposed project site and some of nearby streams (including the Lower Drift Creek) throughout the six water years. This is especially true for the Pudding River stations at Aurora and Woodburn, which also have the longest period of stream flow records of all the stations under review and, thus, become the primary focus of the hydrologic analysis.

7. The close relationship between Upper Drift Creek and Pudding River stream flow data allows for the extension of the 6-year (2008 - 2014) hydrologic actual records at the project site to a longer time span covering a wider range of runoff conditions, through the use of regression equations. Based on an updated runoff volume frequency curve using those extended numbers, the expectation for an October-April runoff volume of 12,000 acre-feet (AF) to be available for annual reservoir refill purposes continues to look reasonably good.

8. A comparison between two completely independent sets of data, the regression-based predictions using 2008-11 data and the 2011-14 observed stream flows at the proposed project site, is also provided. The results reflecting a reasonable close relationship between projected and actual stream flows during those years support the continued use of current statistical tools to extend stream flow records.

9. A sequential mass curve was prepared using the 2008-2014 observed stream flow data at Upper Drift Creek for double-checking the storage required to provide a given yield. This tool will be mostly helpful for future use in testing storage availability under detailed irrigation withdrawal scenarios.

10. The rainfall-runoff model approach was also explored as another tool to predict discharges in response to precipitation. This approach requires representative rainfall amounts over the basin, a requirement that a unique index station like Salem Airport cannot always meets. The six (2008-2014) years of stream flow data recorded so far were caused by rainfall; snowmelt, which usually created design floods in the region, has not been a major factor. Additional hydrologic data would further enhance the validity of the conclusions reached on project operations during high runoff conditions triggered by snowmelt.

11. While regression-based discharge predictions using Pudding River discharges are slightly more accurate than those obtained via rainfall-runoff modeling, both prediction tools still deserve further evaluation because of their complementary application potential. Rainfall-runoff modeling is also an absolute need when dealing with Probable Maximum Precipitation and Probable Maximum Flood, and real-time flood predictions.

12. Water availability tables posted on the Internet by Oregon Water Resources Department (OWRD) contain several categories of stream flow data needed to calculate net water availability, for each month of the year and the 50% and 80% exceedance frequencies. For Drift Creek, the information includes (1) natural stream flows for Drift Creek at its junction with Pudding River, (2) consumptive uses and storages, and (3) in-stream flow requirements. Data sets (2) and (3) are directly related to Drift Creek and, as such, were used to define if, when and how much of the incoming natural inflow can be stored in Drift Creek Reservoir. Since most recently updated consumptive uses and storages data now also include the monthly flows requested by EVWD; they should be treated differently in future model studies.

13. OWRD has no immediate plans to update current natural stream flows shown for Drift Creek, nor to add any other exceedance frequencies. To estimate monthly stream flows for the 90% and 95% exceedance frequencies, that appear to be of interest to the Project Team, a simplified procedure was used based on monthly flow duration curves of 2008-2014 observed daily flow data and necessary adjustments to match OWRD 80% exceedance monthly flows.

14. The second part of the report deals with potential reservoir operational scenarios using a daily time step reservoir model. Model input includes variable initial pool elevations, expected

runoff conditions, reservoir volume, outlet capacities, projected irrigation needs, and downstream release criteria to meet existing in-stream requirements. All the model runs have been updated to reflect the 677' elevation used as normal operating water surface elevation for the reservoir, per the Murray-Smith & Associates (MSA) Report. The water surface will be controlled at that elevation (which corresponds to the spillway crest elevation), using the automated outlet structure tower.

15. Modeling of daily reservoir operation covers two groups of stream flows. The first group consists of estimated representative flow years (low 1935-1936, average 1933-1934 and high 1947-1948 flow years) based on Pudding River near Aurora data. Reservoir refill during those years was assumed to start from an empty reservoir, at Elevation 620 feet msl. The second group refers to the more recent data covering the October 2002 – September 2014 period, which includes 6 years (2002 – 2008) of synthesized flow data and 6 years (2008- 2014) of actual flow data. October 2002 was the month the Pudding River gauge near Aurora was re-operated after several years of inactivity. The 2002-2008 inflow data to the project were developed through a regression equation, and the 2008-2014 inflow data are actually observed stream flows at the project site. Reservoir operation during those years starts from an empty reservoir on 1 October 2002 and extends from that day through a continuous, multi-year model simulation.

16. In the multi-year continuous model simulation, two basic reservoir operation criteria were tested. The first criteria affects the allowed contribution of the local inflow below the reservoir site in meeting water rights at the mouth of Drift Creek, assuming either 0 percent contribution or 100% contribution. The second criteria involves greater daily irrigation release requirements (new base volumes of 10,000 and 12,000 AF were added to the original volume of 8,000 AF). Pre- and post-project flow duration curves were developed for those three cases. The impacts of those two operating criteria were found to have limited negative impacts on the annual reservoir refill. Impacts of increased April- September discharges on bank erosion and mud flats need further, more specialized analyses.

17. Multi-year model simulation suggests that actual reservoir refill does not start exactly at the adopted start date because other in-stream requirements (e.g., minimum flows, water rights, flushing flows, etc.) also control the refill operation. In earlier model runs, the start date for the refill was not used as a direct check prior to allowing the reservoir to store any or all of the inflows. This was not as date-specific as current specified in the OWRD draft water use permit dated July 22, 2014, which specifies November 1 and April 30 as the start and end dates of the allowable reservoir refill. The July 2014 draft permit also specifies that all live flows must be released during May through October. Based on past exploratory model runs, both of those new, more date-specific provisions have not caused any significant impacts on reservoir refill and/or reservoir releases. Future hydrologic model runs will have to treat those new requirements exactly as stated in the draft permit. Downstream senior water rights will also be evaluated to determine if there is any need to add them to the model regarding the refill season (November – April). This likely will not be a necessary model revision.

18. Multi-year model simulation also highlights the role of the initial reservoir pool elevation at the start of the annual refill operation. Due to the relative sizes of the reservoir and the runoff, during a high runoff water year like 2010-2011, it appears that the project would fill even if it

started from empty on October 1 and had to meet 100 percent of the in-stream flow required at the mouth (without any local inflow credit).

19. A similar observation applies to the upper bound elevation, UL. When UL had to be changed from 680' to 677' to be compatible with the elevation previously used in the MSA's PMF study, the 3 foot elevation difference appears to have limited impact on final reservoir refill.

20. Post-project stream flows are predicted to significantly increase during the reservoir release season, from May through September of each year, from about 24 cfs up to as much as 60 cfs or higher. These increase would likely impact stream bank erosion and sediment deposition in the river reached downstream from the dam.

21. Evaporation losses during the 2008-2014 period are predicted to be negligible due to the relatively small size (about 310 acres) of the reservoir storage area subject to evaporation.

22. Impacts of climate changes to the flow regime of Drift Creek was also evaluated based on trend line analysis of long-term (1893-2014) precipitation and (1893-2014) air temperature data recorded at Salem, and on Pudding River (1928-2014) stream flow recorded at Aurora. Slightly warmer air temperature and slightly greater runoff trends were identified, but data are still missing to allow for more accurate and more detailed explanations for Drift Creek hydrographs shifts. Many of the climate changes signs seem to call for a wetter and warmer summer in the next 20 to 40 years. Results of a region climate change study conducted by a tri-agency work group were used to project the range of changes in Drift Creek's monthly stream flow in 2020 and 2040.

23. The appendix contains selected stream flow data mentioned in this report and the previous updates. A sample detailed listing of the reservoir model output is also provided based on the 2008-2009 water year. Other data used in the analysis are also available for the records.

24. The hydrologic analysis and the results described in this report are part of the usual process to support the feasibility of the proposed project. As stated earlier, provisions of the draft water use permit issued on July 22, 2014 will be modeled as called for in the draft. Additional tasks may be required in the near future to examine new information, explore other possible what-if conditions, develop more specific data needed for special engineering or economic studies, and to further enhance the conclusions reached. Tasks like dam-break analysis to delineate potential emergency flooding areas, downstream river bank erosion, etc. would be expected.

DRIFT CREEK SITE "A" NEAR SILVERTON, OREGON

DRIFT CREEK HYDROLOGIC REPORT

(UPDATE #4)

1. Introduction

This technical report is an update of the October 2012 report on hydrologic data collected on Drift Creek and nearby streams as part of a feasibility study of the Drift Creek irrigation project proposed by East Valley Water District (EVWD). The primary objective of the hydrologic analysis is to continue to evaluate the relationship between Drift Creek and other streams in terms of discharges, watershed characteristics, rainfall-runoff distribution, and to determine how best to use that information to develop the expected project inflow covering as long a period (and, thereby, as many runoff conditions) as possible. The report is a self-contained document based on five years of collected stream flow data covering the October 2008 – September 2013 period (instead of just the three years, October 2008 – September 2011, covered in the previous report, and updates the expected runoff yield at the proposed project site. It provides an indication of the accuracy of the regression-based predictions by comparing predicted vs. observed stream flows for the October 2011 – September 2103 period. The report also continues to re-evaluate the daily operation of the reservoir under several plausible scenarios controlled by reservoir inflow, mandatory release requirements, irrigation needs, etc. to help solidify an acceptable release strategy.

2. Project Background

EVWD is planning to build a reservoir to store the runoff of Drift Creek, a tributary of the Pudding River, to meet irrigation needs in that area. An application was submitted on February 21, 2013 to the Oregon Water Resources Department (OWRD) for the following water use permit:

- Amount of Water: 12,000 acre feet (AF)
- Use of Water: storage for irrigation and flow augmentation
- Appropriation season: October 1 through April 30

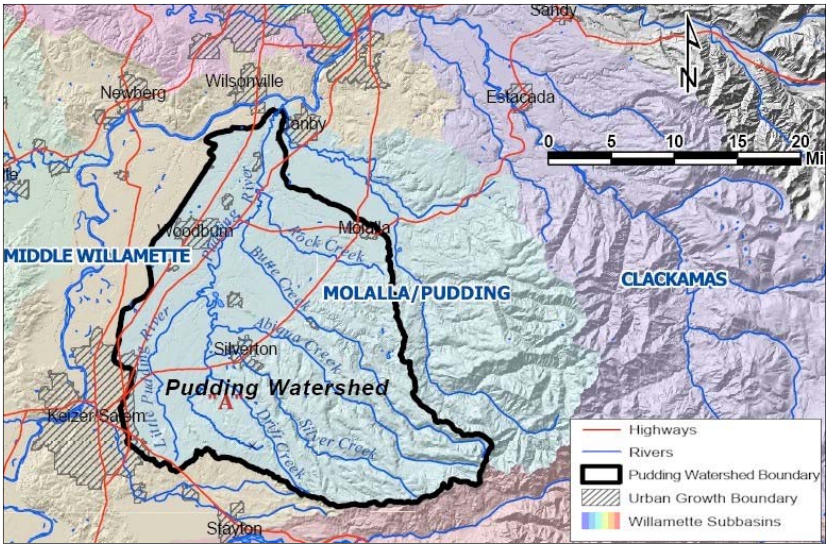
In response to the application and following the normal approval process, a proposed final order with OWRD recommendations to issue with conditions a draft permit was released on July 22, 2014. However, EVWD may not begin construction of the reservoir until the Department approves the engineering plans and specifications.

The proposed project site is located on Drift Creek, near the junction of Victor Road and Fox Road, south of Silverton. See Figure 1. It controls a drainage area of 15.4 square miles and has physically the potential of storing up to 12,000 AF of water.

The actual volume of water that could be stored in the reservoir each year, prior to the start of the irrigation season, depends on the Drift Creek run-off and the in-stream flow requirements during the preceding October through April reservoir refill period. This critical data needed for the assessment of the project's feasibility must be as reliable as possible and of sufficient length to provide a good picture of the long-term runoff conditions. It is usually provided by stream flows measurements at the project site, and/or reconstituted flows based on the observed data at comparable nearby streams with good records.

Up until 2008, Drift Creek was a stream with no recorded flow data. Actual, continuous daily stream flow measurements on the creek were only initiated in April 2008 by Marion Soil and Water Conservation District (Marion Co. SWCD). This occurred at two gauging sites. The first gauge was located at the project site, and referred to as "Upper Drift Creek Gauge" or "Victor Road Gauge". The second gauge was at lower stream location, at the Hibbard Road bridge-crossing near the confluence of Drift Creek with Pudding River, controlling a drainage area of 24.8 square miles. Stream gauging was conducted at the upper site by a contractor to EVWD, and at the lower site by a Marion SWCD flow monitoring specialist.

Figure 1. Vicinity Map



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The first hydrologic yield analysis report was prepared in February 2007 to provide estimates of the October through April run-off volume that could be expected at the proposed project site. At the time, no observed stream flow data were available for Drift Creek. As a result, the report only provided a review of existing hydro-meteorological records at nearby streams, and development of synthesized mean monthly discharges at various probability levels of occurrence. The report recommended discharge measurements on the creek to enhance the reliability of the runoff volume estimates.

Following the subsequent stream flow gauging during October 2008-September 2009, Update #1 examined the significance of the newly collected runoff data --a hydrologic year with low Drift Creek runoff-- on the previously estimated runoff volumes. It took into account the OWRD water availability data and irrigation and fisheries water rights listed for Drift Creek at the mouth. Daily stream flows were then developed for the dry year, average year, and wet year at the project site. A reservoir routing model was also set up to test how the runoff would be stored at and released from the project every day during those years to meet the required water rights and ecological flow triggers.

The February 2011 report, Update #2, was a direct continuation of the June 2010 report, focusing on stream flows data collected on Drift Creek and other near-by streams, using October 2009-September 2010 data. Data for this average flow year added a higher flow range to the previous year's data. The 2011 report updated earlier findings and strengthened the capabilities of the analytical tools used to generate historical runoff data and simulate the operation of the proposed reservoir. At that point, records for a low flow and an average flow year have been recorded.

The September 2012 report, Update #3, reviewed the runoff-yield analysis with one more year of stream flow data (Oct. 2008 – Sept. 2011 vs. Oct. 2008 – Sept. 2010). The October 2010 – September 2011 hydrologic year was an above average flow year for Drift Creek, and further extended the range of stream flows recorded so far on that stream.

The current October 2014 report, Update #4, is similar in many ways to the previous reports, except that it includes two additional years of stream flow records (instead of just one year), for a total of five years –from October 2008 through September 2013. The scope and format of the current study update include the following specific tasks:

1. Collect/retrieve stream flows and precipitation data for the October 2011 – September 2014 period;
2. Analyze stream flow data at Drift Creek and selected nearby streams for that six-year period, with particular reference to runoff magnitude, timing and correlation between the various sites, based on daily, monthly and statistical frequency data;
3. Update regression equations for daily and monthly stream flows;
4. Review prediction capabilities of Upper Drift Creek stream flows using (1) regression equations linking daily flows of Pudding River at Aurora with daily flows of Drift Creek at Victor Road, and (2) a rainfall-runoff model using daily precipitation at Salem Airport to develop Upper Drift Creek daily stream flows;
5. Compare predicted vs. observed October 2011 – September 2014 using the regression equations based on October 2008 – September 2011;
6. Update ranking and hydrographs of representative low, average and high runoff years;
7. Update the statistical frequency curve for the October – April runoff volume;
8. Develop inflow data for the 2002 – 2014 period and perform daily time-step modeling of daily reservoir operation for that period, assuming different levels of irrigation withdrawal levels and different schedules; and
9. Prepare report on findings and recommendations for future actions.

The tasks listed above are essentially the same as those included in the Grant Program application submitted to the Oregon Water Resource Department by East Valley Water District on 11/1/2013.

Additional tasks were performed in February 2015 at the request of the Project Manager involving the multi-year time step reservoir model simulations. The first new task required using the same reservoir upper bound elevation of 687 feet mean sea level (msl). as that used in the Murray-Smith's PMF Routing completed in May 2011 (instead of El. 680). This was to ensure full compatibility between reservoir data used during all study phases of Drift Creek Project. The second task affected the proposed irrigation daily releases, which so far were based on assumed full reservoir storage volume (FRSV) of 8,000 AF reached at the start of the reservoir release season. Two new FRSVs values, 10000 and 12000 AF, were used to specify higher irrigation releases and determine the impacts on those higher irrigation releases on the water surface and annual bank exposure.

3. Hydro-Met Data Available

3.1 Hydrologic Data

At the start of the Drift Creek hydrologic study in 2007, although there were no recorded stream flows at the project site itself, some gauging stations of relevance to the project did exist, as listed in Table 3.1. At that time, the longest stream gage records belong to Pudding River at Aurora with a combined total of 49 years of data, followed by Pudding River near Mt. Angel (28 years), Silver Creek at Silverton (16 years), Zollner Creek near Mt. Angel (13 years), Little Abiqua Creek near Scotts Mills (12 years), and Pudding River near Woodburn (9 years). Some of the periods of records overlap each other, but no stream gauge has records that span the entire 1928 - 2005 period uninterrupted.

Table 3.1 Stream Gages, Drainage Areas and Period of Available Records in 2007

Agency	Site Number	Site Name, Drainage Area, Record Period
USGS	14200300	Silver Creek At Silverton, OR F=47.9 sq. mi. (10/1963 - 09/1979)
USGS	14200400	Little Abiqua Creek Near Scotts Mills, OR F=9.81 sq. mi. (7/1993-9/2004)
USGS	14201000	Pudding River Near Mt. Angel, OR F=203 sq. mi. (10/1939-3/1966)
USGS	14201300	Zollner Creek Near Mt. Angel, OR F=15.0 sq. mi. (7/1993-9/2011 and 5/2012-9/2007)
USGS	14201340	Pudding River Near Woodburn, OR F=314 sq. mi. (10/1997-9/2007)
USGS	14202000	Pudding River Near Aurora, OR F=479 sq. mi., (10/1928-9/1964, 7/1993-9/1997 and 10/2002-9/2007)

Table 3.2 contains the monthly averages of the historical stream flows recorded at the various gauging stations as posted on the Internet at the start of this study. Pertinent monthly

values for each year of record are provided in the Appendix. All discharge values are expressed in cubic feet per second (cfs).

Table 3.2 Monthly Flow Averages Available at the Start of the Hydrologic Study (2007)

Sta.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
(1)	526	336	324	226	136	64	25	17	31	46	274	498
(2)	78	76	59	40	28	15	5.8	3.5	4	12	44	80
(3)	55	49	33	14	7.1	3	0.79	0.44	0.841	6.4	36	61
(4)	1,560	1,470	1,140	845	539	237	76	31	44	246	915	1,430
(5)	1,800	1,640	1,360	896	614	310	81	33	48	172	667	1,670
(6)	2,710	2,700	2,100	1,570	889	420	150	68	90	341	1,410	2,430

Stations:
(1): Silver Cr; 1963-68 and 1970-79;
(2): L. Abiqua nr Scotts Mills; 1993-2007
(3): Zollner nr. Mt Angel; 1993-2007;
(4): Pudding nr. Mt Angel; 1939-66
(5): Pudding nr. Woodburn; 1997-2007
(6): Pudding at Aurora 1928-64; 1993-97, and 2002-2007

Table 3.3 shows a diagram of the years when the other streams of interest were (or are) under stream gauging programs. Blue-shaded boxes refer to years of stream flow gauging activity.

Table 3.3 Records Length of Available Stream Flow Data in October 2007

N	Year	Pudding	Pudding	Pudding	Zollner	Silver	Abiqua	Butte
		Aurora	Woodb.	Mt. Angel	Mt. Angel	Silverton	Scotts M.	Monitor
1	1928	10/1928						
2	1929	x						
3	1930	x						
4	1931	x						
5	1932	x						
6	1933	x						
7	1934	x						
8	1935	x						
9	1936	x						x
10	1937	x						x
11	1938	x						x
12	1939	x		10/1939				x
13	1940	x		x				x
14	1941	x		x				x
15	1942	x		x				x
16	1943	x		x				x

17	1944	x		x				x
18	1945	x		x				x
19	1946	x		x				x
20	1947	x		x				x
21	1948	x		x				x
22	1949	x		x				x
23	1950	x		x				x
24	1951	x		x				x
25	1952	x		x				x
26	1953	x		x				x
27	1954	x		x				x
28	1955	x		x				x
29	1956	x		x				x
30	1957	x		x				x
31	1958	x		x				x
32	1959	x		x				x
33	1960	x		x				x
34	1961	x		x				x
35	1962	x		x				x
36	1963	x		x		10/1963		x
37	1964	09/1964		x		x		x
38	1965			x		x		x
39	1966			03/1966		x		x
40	1967					x		x
41	1968					09/1968		x
42	1969							x
43	1970					10/1970		x
44	1971					x		x
45	1972					x		x
46	1973					x		x
47	1974					x		x
48	1975					x		x
49	1976					x		x
50	1977					x		x
51	1978					x		x
52	1979					10/1979		x
53	1980							x
54	1981							x
55	1982							x
56	1983							x

57	1984							x
58	1985							x
59	1986							
60	1987							
61	1988							
62	1989							
63	1990							
64	1991							
65	1992							
66	1993	07/1993			07/1993		07/1993	
67	1994	x			x		x	
68	1995	x			x		x	
69	1996	x			x		x	
70	1997	09/1997	10/1997		x		x	
71	1998		x		x		x	
72	1999		x		x		x	
73	2000		x		x		x	
74	2001		x		x		x	
75	2002	10/2002	x		x		x	
76	2003	x	x		x		x	
77	2004	x	x		x		09/2004	
78	2005	x	x		x			
79	2006	x	x		x			
80	2007	x	x		x			

N	Year	Pudding Aurora	Pudding Woodb.	Pudding Mt. Angel	Zollner Mt. Angel	Silver Silverton	Abiqua/ Scotts Mills	Butte Monitor
Years in Operation		48	11	28	15	16	12	49

3.2 Meteorological Data

Daily precipitation (rainfall and snow) and air temperature were recorded at the Salem WSO Station near the airport from 1892 to 2012. See data on Tables 3.4 and 3.5 retrieved from the website hosted by Western Regional Climate Center, at: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?or7500. Data more recent than March 2013 are currently not yet posted on that website, but can be retrieved from the National Weather Service Forecast Office, Portland, Oregon, as "Preliminary Monthly Climate Data" at http://www.nws.noaa.gov/climate/index.php?wfo=pqr

Table 3.4 Precipitation at Salem Airport, OR (1892 to 2012)

	in.	in.		in.		1-day Maximum		Total snowfall		
	Mean	High	Year	Low	Year	in.	Date	Mean "	High "	Year
JAN	6.11	15.40	1953	0.24	1985	3.86	18/1911	2.9	32.8	1950
FEB	4.72	13.01	1996	0.34	1920	2.99	06/1985	1.6	25.2	1937
MAR	4.14	10.13	1894	0.59	1911	2.55	31/1943	0.4	10.9	1951
APR	2.57	7.68	1937	0.39	1939	2.21	13/1937	0	0.1	1972
MAY	2.07	5.56	1998	0.05	1992	1.76	17/1991	0	0	1906
JUN	1.32	4.61	1937	0.00	1918	1.63	06/1985	0	0	1915
JULY	0.39	2.72	1916	0.00	1893	1.80	18/1987	0	0	1898
AUG	0.52	4.17	1968	0.00	1894	1.14	31/1971	0	0	1906
SEP	1.53	4.84	1914	0.00	1975	2.11	05/1911	0	0	1906
OCT	3.21	11.17	1947	0.00	1895	2.71	31/1994	0.1	5	1935
NOV	6.12	16.99	1896	0.48	1936	3.60	08/1896	0.3	6.1	1977
DEC	6.69	17.54	1933	1.26	1976	4.30	06/1933	1.8	23	1919
Annual	39.38	66.96	1996	23.74	1985	4.30	12/06/33	7.1	33.5	1950
Winter	17.51	30.32	1956	4.97	1977	4.30	12/06/33	6.3	34.9	1969
Spring	8.78	16.05	1894	3.00	1924	2.55	03/31/43	0.4	10.9	1951
Summer	2.23	7.20	1983	0.21	1919	1.80	07/18/87	0	0	1915
Fall	10.86	21.25	1950	2.18	1936	3.60	11/08/61	0.3	6.1	1977

M/D/YR

According to the records listed above, the October-April snow precipitations in excess of 10 inches (snowy conditions) were somewhat infrequent. They occurred in the following 15 years: 1928, 1929, 1936, 1942, 1949, 1955, 1956, 1959, 1961, 1967, 1968, 1970, 1972, 1985 and 1992.

For the 30-year (1971-2000) period, the Salem WSO Station recorded October-April rainfall amounts in excess of 40 inches (average years) in 1931, 1932, 1937, 1942, 1947, 1950, 1955, 1960, 1970, 1973, 1981, 1982, 1994, 1995, 1996, 1998 and 2005. The same station recorded October-April rainfall amounts less than 20 inches (very dry years) in 1976 (11.57”), 2000 (16.89”), and 2004 (18.22”). For comparison purposes, data shown in Tables 3.6 through 3.10 are more directly related to the 30-year (1971-2000) period, instead of the entire 119-year (1892-2012) period.

Table 3.5 Air temperature at Salem WSO Airport, OR From 1892 to 2012

	Monthly Averages			Daily E				Monthly Extremes			
	Max	Min	Mean	High	Date	Low	Date	Highest	Year	Lowest	Year
	(F)	(F)	(F)	(F)		(F)		(F)		(F)	
JAN	46	33.4	39.7	68	07/1896	-10	31/1950	46.9	1953	27.4	1930
FEB	50.6	34.8	42.7	72	28/1968	-4	Mar-50	48.6	1991	34.7	1989
MAR	55.5	36.8	46.2	80	29/1923	12	Jan-71	52.3	1926	40.9	1951
APR	61.2	39.5	50.4	93	28/1926	23	13/1968	59.3	1926	44.6	1967
MAY	67.7	44.2	55.9	100	28/1983	25	Jan-54	61	1928	51.4	1962
JUN	73.8	49	61.4	105	22/1992	32	06/1899	67	1926	56.8	1976
JULY	81.8	52	66.9	108	23/1927	35	03/1899	72	1941	61.9	1963
AUG	81.7	51.9	66.8	108	Sep-81	30	30/1920	71.6	1967	62	1899
SEP	75.5	48	61.8	104	Feb-88	26	25/1934	66.6	2011	56.6	1893
OCT	64.2	42.5	53.3	93	Feb-70	19	27/1919	59.6	1901	46	1919
NOV	52.6	37.9	45.3	74	Mar-10	9	15/1955	51.1	1995	37.3	1985
DEC	46.7	34.8	40.7	72	Sep-29	-12	Aug-72	47.9	1917	33.2	1985
Annual	63.1	42.1	52.6	108	1.9E+07	-12	12/08/72	55.8	1926	49.8	1893
Winter	47.8	34.3	41.1	72	1.9E+07	-12	12/08/72	44.7	1958	35.9	1949
Spring	61.5	40.2	50.8	100	2E+07	12	03/01/71	56.6	1926	46.6	1955
Summer	79.1	51	65	108	1.9E+07	30	08/30/20	68.8	1958	60.9	1954
Fall	64.1	42.8	53.5	104	2E+07	9	11/15/55	56	1995	48.9	1985
							M/D/Y				

Table 3.6 Precipitation Monthly Averages (1971-2000)

Stations	ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Salem WSO Airport	7500	5.8	5.1	4.2	2.8	2.1	1.5	0.6	0.7	1.4	3	6.39	6.46	40
Silver Creek Falls	7809	9.9	9.4	8.8	7	5	3.5	1.3	1.3	2.8	5.4	11.3	10.6	76.1
Silverton	7823	6.5	5.6	5	3.8	3	2.1	0.9	1	1.9	3.6	7.16	7.07	47.5

Table 3.7 Average number of Days with Selected Precipitation Amounts
Salem WSO Airport, 1971-2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
>.01"	17	16	17	14	11	8	3	4	7	11	18	18	144
>.10"	12	12	11	8	6	4	2	2	4	7	13	13	92.9
>.50"	4	3	2	1	1	1	0	0	1	2	4	5	24.7
>1.00"	1	1	0	0	0	0	0	0	0	0	1	2	6.1

Table 3.8 Monthly and Annual Average Temperatures 30-year average (1971-2000)
Salem WSO Airport (degrees F)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean max	47.0	51.2	56.3	61.1	67.5	74.0	81.5	81.9	76.6	64.5	52.4	46.4	63.4
Mean min	33.5	34.7	36.6	38.8	43.6	48.4	52.0	52.1	47.7	41.3	37.9	33.9	41.7
Mean temp	40.3	43.0	46.5	50.0	55.6	61.2	66.8	67.0	62.2	52.9	45.2	40.2	52.6
Extreme max	65	71	77	85	100	105	103	108	104	92	71	68	108
Extreme min	6	-1	12	26	28	32	38	36	26	23	11	-12	-12

Mean number of days

Max >90	0	0	0	0	0.4	1.5	5.9	5.8	2.5	0.1	0	0	16.0
Min >32	13.4	10.5	8.1	4.4	0.6	0	0	0	0.1	2.4	7.3	13.0	59.9
Max <32	0.8	0.2	0	0	0	0	0	0	0	0	0.2	1.1	2.3
Min <0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.2

Table 3.9 Snowfall, Monthly and Annual 30-year Averages (1971-2000), inches

Name	Station ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Salem WSO Airport	7500	1.3	2.1	0.1	0	0	0	0	0	0	0	0.4	2.0	6.0
Silver Creek Falls	7809	3.0	3.4	1.7	0.4	0	0	0	0	0	0	1.3	2.2	14.3
Silverton	7823	1.0	1.3	0	0	0	0	0	0	0	0	0.3	1.3	3.2

Table 3.10 Monthly and Annual Average Heating Degree Days (base 65°F), 1971-2000

Name	Number	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Salem WSO Airport	7500	769	623	576	451	301	140	39	35	116	376	596	771	4790
Silver Creek Falls	7809	844	711	700	564	410	244	121	124	218	480	702	863	5997
Silverton	7823	780	623	566	441	292	150	50	42	117	356	594	787	4795

Precipitation data recorded at Salem for the more recent October 2008 – September 2014 period are listed by water year in Tables 3.11 (daily values) and 3.12 (monthly values). Monthly average precipitation data for the longer 1892-2012 period are provided in Appendix. During the last six years, no snowfall was recorded at Salem Airport.

Table 3.11. Daily Precipitation Data at Salem Airport, 2008-2014

```
Oct08,0.00,0.00,0.31,0.10,0.03,0.01,0.02,0.00,0.03,0.00,0.00,0.00,0.00,0.00,0.00
      0.01,0.00,0.07,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.37
Nov08,0.05,0.20,0.84,0.10,0.18,0.14,0.02,0.26,0.01,0.02,0.64,0.59,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.45,0.04,0.00,0.00,0.00,0.04,0.00,0.01,0.00,0.00,0.03
Dec08,0.23,0.08,0.00,0.00,0.00,0.00,0.22,0.00,0.00,0.00,0.00,0.52,0.12,0.25,0.00
      0.00,0.22,0.12,0.03,0.88,0.68,0.47,0.00,0.47,0.09,0.16,0.27,0.18,0.84,0.09,0.10
Jan09,1.32,0.64,0.00,0.26,0.09,0.14,0.27,0.46,0.00,0.00,0.05,0.01,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.04,0.14,0.00,0.13,0.01,0.00,0.00,0.00
Feb09,0.00,0.00,0.00,0.00,0.04,0.40,0.00,0.00,0.03,0.13,0.13,0.02,0.02,0.00,0.08
      0.00,0.10,0.00,0.00,0.00,0.00,0.17,0.65,0.21,0.56,0.36,0.00,0.00
Mar09,0.21,0.50,0.12,0.00,0.07,0.00,0.08,0.07,0.04,0.00,0.00,0.00,0.00,0.58,0.62
      0.14,0.07,0.00,0.00,0.00,0.08,0.02,0.06,0.00,0.05,0.00,0.00,0.27,0.00,0.00,0.05
Apr09,0.13,0.16,0.03,0.00,0.00,0.00,0.00,0.02,0.14,0.00,0.00,0.37,0.17,0.01,0.00
      0.00,0.07,0.00,0.00,0.00,0.00,0.00,0.01,0.00,0.00,0.00,0.04,0.19,0.00,0.00
May09,0.24,0.35,0.15,0.80,0.06,0.59,0.06,0.00,0.00,0.01,0.00,0.02,0.45,0.02,0.00
      0.00,0.00,0.17,0.12,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Jun09,0.00,0.00,0.02,0.56,0.35,0.00,0.00,0.00,0.00,0.00,0.05,0.05,0.27,0.01,0.00
      0.00,0.00,0.03,0.00,0.01,0.04,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Jul09,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.68,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Aug09,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.09,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.03,0.00,0.00,0.05,0.00,0.00,0.00
Sep09,0.00,0.00,0.00,0.00,0.53,0.22,0.09,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.13,0.00,0.00,0.06,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.15,0.02
Oct09,0.00,0.06,0.00,0.08,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.40,0.38,0.03
      0.00,0.41,0.00,0.00,0.00,0.17,0.00,0.30,0.00,0.01,0.52,0.03,0.05,0.08,0,0.09
Nov09,0.00,0.00,0.00,0.00,0.21,0.78,0.85,0.64,0.41,0.21,0.42,0.54,0.35,0.00,0.08
      0.01,0.71,0.18,0.10,0.79,0.26,0.49,0.00,0.00,0.00,0.86,0.12,0.00,0.00,0.01
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Dec09,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.11,0.00,0.65,1.78
      0.55,0.09,0.00,0.07,0.49,0.38,0.07,0.00,0.00,0.00,0.00,0.02,0.00,0.37,0.33,1.23
Jan10,0.54,0.00,0.00,0.07,0.93,0.20,0.00,0.37,0.04,0.00,0.03,0.58,0.25,0.00,0.88
      0.23,0.42,0.00,0.00,0.07,0.00,0.18,0.00,0.78,0.12,0.07,0.00,0.00,0.00,0.08,0.01
Feb10,0.24,0.07,0.15,0.13,0.00,0.21,0.00,0.00,0.00,0.08,0.49,0.36,0.02,0.36,0.19
      0.04,0.00,0.00,0.00,0.00,0.00,0.00,0.78,0.25,0.10,0.60,0.00,0.00
Mar10,0.00,0.12,0.00,0.02,0.00,0.00,0.14,0.05,0.06,0.01,0.76,0.28,0.00,0.00,0.00
      0.00,0.01,0.00,0.00,0.00,0.11,0.00,0.00,0.25,0.62,0.51,0.00,1.00,1.06,0.14,0.00
Apr10,0.00,0.91,0.22,0.10,0.23,0.13,0.06,0.18,0.00,0.04,0.11,0.02,0.02,0.76,0.07
      0.00,0.00,0.00,0.07,0.10,0.00,0.00,0.00,0.00,0.00,0.69,0.44,0.14,0.04,0.02
May10,0.00,0.00,0.26,0.01,0.18,0.00,0.00,0.00,0.04,0.06,0.00,0.00,0.00,0.00,0.00
      0.00,0.33,0.14,0.34,0.37,0.96,0.10,0.04,0.00,0.18,0.22,0.00,0.00,0.00,0.03,0.21
Jun10,0.09,1.03,0.55,0.42,0.00,0.18,0.00,0.09,0.14,0.06,0.00,0.00,0.00,0.00,0.01
      0.01,0.00,0.00,0.00,0.06,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Jul10,0.02,0.02,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Aug10,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.02,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.18,0.00
Sep10,0.00,0.00,0.00,0.00,0.00,0.00,0.18,0.12,0.00,0.00,0.00,0.00,0.00,0.00,0.27
      0.07,0.04,1.05,0.15,0.01,0.00,0.00,0.03,0.00,0.00,0.15,0.00,0.00,0.00,0.00
Oct10,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.02,0.40,0.83,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.01,0.86,0.69,0.67,0.17,0.00,0.39,0.00,0.91,0.27
Nov10,0.16,0.00,0.00,0.00,0.00,1.05,0.15,0.11,0.66,0.07,0.02,0.00,0.08,0.01,0.00
      0.16,0.92,0.41,0.10,0.23,0.18,0.37,0.00,0.00,0.00,0.34,0.04,0.12,0.04,1.22
Dec10,0.33,0.00,0.00,0.00,0.00,0.05,0.15,1.18,1.12,0.14,0.77,0.22,0.34,0.59,0.15
      0.00,0.00,0.49,0.12,0.41,0.00,0.00,0.00,0.02,0.14,0.69,1.10,1.70,0.24,0.00,0.00
Jan11,0.00,0.00,0.00,0.00,0.08,0.00,0.04,0.06,0.04,0.00,0.08,0.34,0.63,0.00,0.72
      0.62,0.02,0.41,0.00,0.00,0.18,0.00,0.00,0.00,0.00,0.00,0.00,0.01,0.02,0.00,0.00
Feb11,0.00,0.00,0.00,0.02,0.04,0.05,0.11,0.00,0.00,0.00,0.00,0.51,0.07,0.46,0.60
      0.09,0.01,0.34,0.00,0.00,0.00,0.05,0.17,0.02,0.00,0.00,0.10,1.67
Mar11,0.55,0.14,0.18,0.30,0.01,0.00,0.06,0.14,0.34,0.89,0.00,0.10,0.72,0.70,0.54
      0.87,0.05,0.11,0.01,0.03,0.03,0.00,0.04,0.10,0.24,0.17,0.27,0.07,0.48,0.02,0.00
Apr11,0.15,0.05,0.00,0.17,0.06,0.22,0.09,0.00,0.00,0.30,0.04,0.00,0.22,0.26,0.63
      0.09,0.00,0.02,0.00,0.00,0.00,0.00,0.00,0.27,0.84,0.11,0.13,0.17,0.28,0.05
May11,0.00,0.07,0.00,0.00,0.02,0.23,0.02,0.19,0.00,0.00,0.34,0.00,0.00,0.00,0.19
      0.01,0.31,0.00,0.00,0.00,0.00,0.00,0.08,0.00,0.41,0.33,0.23,0.06,0.01,0.64,0.26
Jun11,0.29,0.23,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.15,0.07,0.00,0.00
      0.00,0.00,0.11,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.02,0.11,0.00,0.00
Jul11,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.13,0.00,0.00,0.00
      0.21,0.40,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Aug11,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.11,0.00,0.00,0.00,0.00,0.00
Sep11,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.02,0.06,0.00,0.00,0.00,0.00,0.00,0.16,0.05,0.06,0.00,0.00,0.00
Oct11,0.32,0.13,0.24,0.31,0.01,0.00,0.03,0.00,0.07,0.25,0.36,0.04,0.03,0.06,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.08,0.05,0.12,0.05
Nov11,0.00,0.26,0.00,0.00,0.21,0.02,0.04,0.02,0.00,0.00,0.14,0.10,0.00,0.09,0.00
      0.52,0.66,0.44,0.11,0.00,0.63,1.01,0.69,0.53,0.00,0.00,0.45,0.00,0.01,0.03
Dec11,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.01,0.00,0.00,0.00,0.00,0.00,0.00,0.08,0.07,0.38,1.19,0.71,0.77,0.00
Jan12,0.00,0.10,0.00,0.35,0.04,0.05,0.00,0.00,0.21,0.03,0.00,0.00,0.00,0.20,0.04
      0.13,2.18,2.47,2.13,0.65,0.15,0.19,0.00,0.77,0.04,0.08,0.00,0.00,0.50,0.00,0.01
Feb12,0.05,0.00,0.00,0.00,0.00,0.00,0.03,0.54,0.11,0.14,0.00,0.12,0.10,0.11,0.00
      0.06,0.13,0.06,0.15,0.17,0.01,0.28,0.00,0.31,0.17,0.08,0.00,0.47,1.05
Mar12,0.21,0.00,0.00,0.00,0.38,0.03,0.00,0.00,0.00,0.26,0.31,1.26,0.45,0.69,0.93
      0.48,0.07,0.00,0.07,0.63,1.27,0.07,0.00,0.00,0.07,0.01,0.16,0.15,0.81,1.13,0.54
Apr12,0.24,0.00,0.27,0.08,0.19,0.00,0.00,0.00,0.00,0.13,0.15,0.06,0.10,0.00,0.11
      0.38,0.11,0.13,0.40,0.00,0.00,0.00,0.00,0.00,0.17,0.35,0.03,0.00,0.07,0.11
May12,0.02,0.21,0.50,0.13,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.07,0.57,0.27,0.01,0.27,0.26,0.00,0.00,0.00,0.00,0.00,0.00
Jun12,0.09,0.00,0.08,0.30,0.00,0.00,0.47,0.17,0.00,0.00,0.00,0.14,0.00,0.00,0.00
      0.00,0.00,0.00,0.01,0.00,0.00,0.22,0.22,0.06,0.14,0.02,0.00,0.00,0.00,0.28
Jul12,0.04,0.02,0.01,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.08,0.00
Aug12,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Sep12,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.02,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.01,0.00,0.01,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Oct12,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.96,0.02,0.67,0.80
      0.22,0.00,0.06,0.20,0.08,0.15,0.31,0.15,0.09,0.01,0.00,0.48,1.16,0.12,0.18,0.28
Nov12,0.30,0.19,0.14,0.00,0.00,0.02,0.01,0.02,0.27,0.00,0.21,0.59,0.00,0.05,0.00
```

```
      0.00,1.22,0.75,1.92,1.12,0.51,0.00,0.57,0.15,0.00,0.00,0.00,0.02,0.26,0.60
Dec12,0.74,0.58,0.32,0.93,0.00,0.03,0.07,0.10,0.02,0.00,0.24,0.00,0.00,0.23,0.29
      0.53,0.36,0.04,0.03,1.09,0.12,0.20,0.63,0.05,0.77,0.01,0.01,0.00,0.01,0.00,0.00
Jan13,0.00,0.00,0.00,0.00,0.01,0.09,0.11,0.00,0.29,0.03,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.23,0.23,0.11,0.27,0.14,0.07,0.02,0.03,0.00
Feb13,0.00,0.00,0.00,0.00,0.12,0.10,0.13,0.00,0.07,0.00,0.00,0.00,0.00,0.00,0.00
      0.01,0.00,0.05,0.00,0.12,0.02,0.45,0.07,0.01,0.20,0.00,0.00,0.06
Mar13,0.00,0.00,0.00,0.00,0.00,0.30,0.32,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.24,0.00,0.00,0.68,0.56,0.03,0.01,0.00,0.00,0.00,0.04,0.02,0.01,0.00,0.00,0.00
Apr13,0.00,0.00,0.00,0.16,0.49,0.62,0.20,0.02,0.00,0.14,0.00,0.03,0.11,0.24,0.00
      0.00,0.00,0.05,0.28,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.05,0.00
May13,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.02,0.00,0.00,0.14
      0.10,0.00,0.05,0.04,0.00,0.73,0.19,0.25,0.01,0.24,0.04,0.59,0.24,0.19,0.02,0.00
Jun13,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.22,0.00,0.00
      0.00,0.00,0.02,0.16,0.01,0.00,0.00,0.11,0.02,0.33,0.15,0.00,0.00,0.00,0.00
Jul13,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Aug13,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.02,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.02,0.00,0.00,0.07,0.03,0.00,0.04,0.17,0.00,0.00
Sep13,0.00,0.00,0.00,0.00,0.18,0.52,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.10,0.05,0.22,0.36,0.40,0.01,0,0.18,1.33,1.64,0.42
Oct13,0.19,0.22,0.00,0.00,0.00,0.00,0.03,0.09,0.00,0.00,0.00,0.04,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Nov13,0.03,0.39,0.07,0.08,0.05,0.27,0.43,0.02,0.00,0.00,0.00,0.23,0.00,0.00,0.04
      0.03,0.01,0.44,0.59,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Dec13,0.49,0.35,0.00,0.00,0.00,0.03,0.00,0.00,0.00,0.00,0.00,0.11,0.02,0.00,0.09
      0.00,0.00,0.05,0.00,0.08,0.01,0.00,0.04,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Jan14,0.00,0.00,0.08,0.00,0.00,0.01,0.16,0.37,0.20,0.00,0.57,0.40,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.06,0.28,0.08,0.04,0.01
Feb14,0.01,0.00,0.00,0.02,0.00,0.22,0.54,0.45,0.01,0.11,0.79,0.52,0.36,0.76,0.86
      0.10,0.67,0.74,0.23,0.20,0.00,0.00,0.03,0.22,0.00,0.00,0.17,0.00
Mar14,0.07,0.34,0.40,0.01,1.46,0.51,0.00,0.74,0.22,0.01,0.00,0.00,0.00,0.22,0.00
      0.51,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.26,0.55,0.33,1.08,0.45,0.10,0.06
Apr14,0.02,0.00,0.17,0.01,0.08,0.00,0.00,0.03,0.01,0.00,0.00,0.00,0.00,0.00,0.01
      0.00,0.41,0.00,0.04,0.00,0.19,0.20,0.63,0.42,0.07,0.14,0.28,0.00,0.00,0.00
May14,0.00,0.00,0.31,0.07,0.05,0.00,0.00,0.59,0.46,0.04,0.00,0.00,0.00,0.00,0.00
      0.00,0.02,0.36,0.00,0.00,0.00,0.00,0.06,0.00,0.00,0.00,0.05,0.05,0.01,0.00,0.00
Jun14,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.08,0.00,0.00,0.03
      0.15,0.00,0.00,0.00,0.04,0.00,0.00,0.00,0.00,0.00,0.07,0.27,0.00,0.00,0.00
Jul14,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.06,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.11,0.26,0.03,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Aug14,0.15,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.13,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.07,0.00
Sep14,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
      0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.47,0.57,0.08,0.00,0.00,0.00,0.04,0.03
```

Table 3.12 Monthly Average Precipitations at Salem Airport, 2008-2014

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Ann.
2008-09	0.95	3.62	6.02	3.56	2.9	3.03	1.34	3.04	1.39	0.68	0.17	1.20	27.9
2009-10	2.61	8.02	6.14	5.85	4.07	5.14	4.35	3.47	2.64	0.04	0.2	2.07	44.6
2010-11	5.22	6.44	9.95	3.25	4.31	7.16	4.15	3.40	0.98	0.74	0.11	0.35	46.06
2011-12	2.15	5.96	3.21	10.32	4.14	9.98	3.08	2.31	2.20	0.07	0.00	0.04	43.46
2012-13	5.94	8.92	7.40	1.63	1.41	2.21	2.39	2.85	1.02	0.00	0.35	5.41	39.53
2013-14	0.57	2.68	1.27	2.26	7.01	7.32	2.71	2.07	0.64	0.46	0.35	1.19	28.53
2008-14	*2.91*	*5.94*	*5.67*	*4.48*	*3.97*	*5.81*	*3.00*	*2.86*	*1.48*	*0.33*	*0.20*	*1.71*	*38.35*
1892-2012	*3.21*	*6.12*	*6.69*	*6.11*	*4.72*	*4.14*	*2.57*	*2.07*	*1.32*	*0.39*	*0.52*	*1.53*	*39.39*

Figure 3.1 is a plot of the monthly average precipitations and the cumulative precipitation amounts for the October 2008 – September 2014 period. Based on that plot, it appears that 2010-11 was the wettest of the six years, and 2008-09 the driest year.

Figure 3.1 Plot of Monthly Average Precipitation and Cumulative Amount

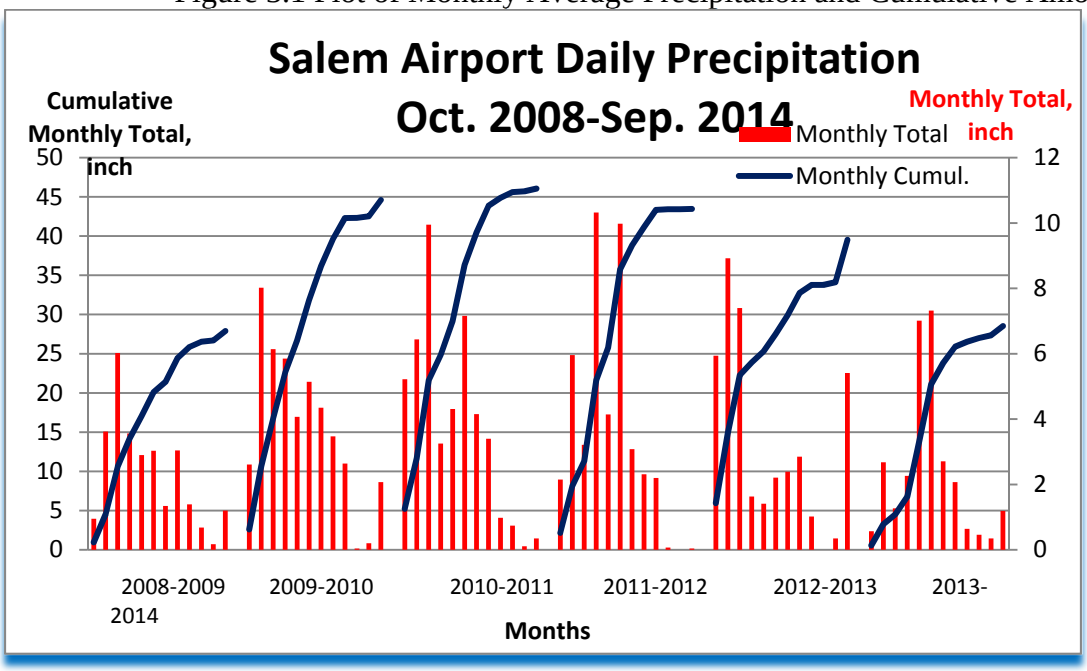
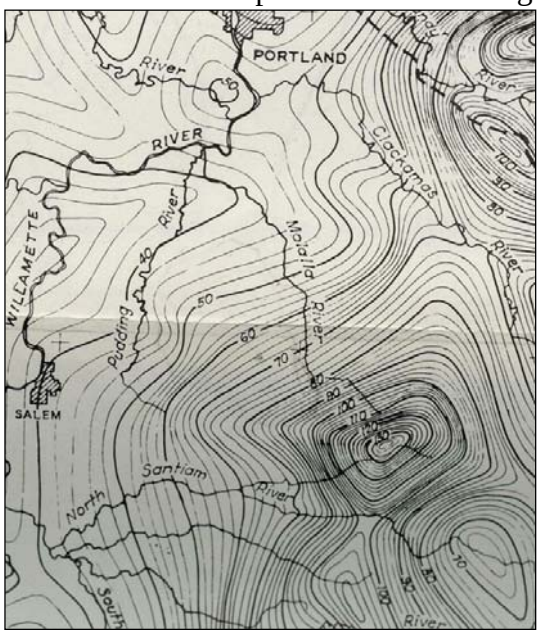


Figure 3.2 shows a map of normal annual precipitation over the Pudding River basin as excerpted from the U.S. Corps of Engineers report, "Procedure for Determination of Maximum Annual Flood Peak and Volume Frequencies for Portland District", dated February 1969. Based on the isohyets shown on that map and the 1971-2000 average precipitation data listed in Table 3.6, Salem records about 40 inches of rain per year. As expected, this precipitation amount is a lot less than the rainfall over the Drift Creek watershed, which is located on much higher ground than Salem and receives as much as 120 inches of rainfall at its headwaters.

Figure 3.2 Normal Annual Precipitation over Pudding River Basin



4. Drift Creek's 2008-2014 Observed Stream Flows

Starting in 2008, Drift Creek's stream flow data were recorded both at the project site (Victor Road) and the Hibbard Rd. gauge located further downstream. The observed flow data at the project site (Upper Drift Creek) are listed below for each of the five hydrologic years (HY). Table 4.1 refers to HY 2008-09; Table 4.2 to HY 2009-10, Table 4.3 to HY2010-11, Table 4.4 to HY2011-12, Table 4.5 to HY2012-13 and Table 4.6 to HY2013-14. Corresponding stream flow data, at the lower Hibbard Rd. gauge, when available, are provided in the Appendix. When possible, runoff hydrographs are plotted together each year for the two stations for direct comparison purposes, with separate plots for daily and monthly flows. See Figures 4. 1, 4.2, 4.3, 4.4, 4.5, 4.6 and 4.7.

4.1 HY 2008-09

Stream flow data and related information (see Table 4.1 and Figures 4.1 and 4.2) were discussed in Report Update #1 and included the following:

- Daily stream flow data collected by Marion Soil and Water Conservation District (Marion SWCD) at two Drift Creek gauges: Victor Point (project site) and Hibbard Rd. (lower station below the project site). Those data were provided by Marion SWCD,
- Daily stream flow data collected by the U.S. Geological Survey (USGS) at six sites on the Pudding River and nearby streams. USGS data were retrieved via the Internet from pertinent websites,
- Ecological and flushing flows prepared by Ellis Ecological Service in March 2010; and
- Revised OWRD's Drift Creek flow availability data made available in April 2010.
-

Table 4.1 Observed Flows (in cfs) of Drift Creek at Victor Rd., HY **2008-09**

DATE	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2008	2008	2008	2009	2009	2009	2009	2009	2009	2009	2009	2009
1	0.50	0.65	17.00	275.00	22.00	91.00	60.00	22.00	11.00	3.00	0.23	0.16
2	0.50	0.70	19.00	500.00	21.00	92.00	81.00	39.00	10.00	2.70	0.23	0.17
3	1.00	1.00	20.00	267.00	21.00	86.00	80.00	39.00	9.80	2.30	0.23	0.19
4	5.00	6.00	19.00	181.00	20.00	74.00	72.00	40.00	10.00	2.00	0.22	0.19
5	4.00	5.00	19.00	173.00	19.00	77.00	64.00	70.00	13.00	2.00	0.23	0.49
6	3.80	3.30	17.00	159.00	23.00	71.00	56.00	98.00	12.00	1.80	0.25	0.90
7	3.50	3.50	17.00	161.00	23.00	65.00	51.00	128.00	11.00	1.70	0.28	0.85
8	3.50	3.00	19.00	198.00	22.00	62.00	46.00	108.00	10.00	1.60	0.35	0.40
9	4.00	3.50	17.00	163.00	22.00	60.00	44.00	89.00	9.30	1.70	0.42	0.29
10	3.00	4.00	16.00	132.00	22.00	58.00	45.00	75.00	8.80	1.80	0.34	0.30
11	2.80	5.00	15.00	115.00	25.00	54.00	38.00	65.00	8.70	1.80	0.30	0.29
12	2.60	22.00	17.00	96.00	24.00	50.00	35.00	59.00	8.40	2.00	0.39	0.27
13	2.50	130.00	26.00	84.00	25.00	46.00	44.00	53.00	7.90	3.00	0.50	0.25
14	2.30	85.00	23.00	73.00	24.00	46.00	42.00	66.00	7.50	2.80	0.35	0.25

15	2.10	54.00	19.00	65.00	24.00	80.00	39.00	54.00	7.20	2.10	0.30	0.73
16	2.00	40.00	17.00	57.00	23.00	92.00	35.00	46.00	6.80	1.60	0.29	3.70
17	1.60	34.00	17.00	50.00	23.00	84.00	35.00	40.00	6.50	1.20	0.26	1.70
18	1.80	28.00	28.00	44.00	22.00	73.00	33.00	36.00	6.20	0.92	0.20	0.83
19	1.30	23.00	25.00	39.00	21.00	66.00	30.00	37.00	6.20	0.78	0.18	0.43
20	1.00	24.00	24.00	35.00	20.00	60.00	27.00	33.00	6.00	0.73	0.17	0.32
21	1.00	25.00	33.00	32.00	19.00	54.00	25.00	29.00	5.80	0.66	0.15	0.27
22	1.20	24.00	60.00	30.00	19.00	62.00	24.00	26.00	5.10	0.63	0.15	0.23
23	0.80	23.00	50.00	28.00	24.00	59.00	23.00	24.00	4.70	0.57	0.15	0.21
24	0.70	22.00	40.00	26.00	71.00	54.00	22.00	22.00	4.40	0.51	0.14	0.20
25	0.60	21.00	50.00	27.00	126.00	61.00	21.00	21.00	4.00	0.40	0.13	0.19
26	0.55	20.00	55.00	25.00	156.00	59.00	20.00	19.00	4.00	0.35	0.13	0.18
27	0.60	20.00	110.00	24.00	123.00	54.00	20.00	18.00	3.50	0.31	0.13	0.17
28	0.60	19.00	200.00	27.00	106.00	56.00	27.00	16.00	3.20	0.29	0.13	0.17
29	0.60	18.00	215.00	25.00		68.00	29.00	15.00	3.20	0.26	0.15	0.18
30	0.55	17.00	160.00	24.00		66.00	24.00	14.00	3.10	0.25	0.16	0.22
31	0.60		130.00	23.00		63.00		11.00		0.24	0.17	
COUNT	31	30	31	31	28	31	30	31	30	31	31	30
AVE, cfs	1.83	22.82	48.19	101.87	38.93	65.90	39.73	45.55	7.24	1.35	0.24	0.49
VOL, AF	112	1358	2963	6262	2161	4051	2364	2800	431	83	14	29
MONTH	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
	2008	**2008**	**2008**	**2009**	**2009**	**2009**	**2009**	**2009**	**2009**	**2009**	**2009**	**2009**

Annual Oct. 2008-Sep.09 runoff volume= 22,629 AF

Figure 4.1 Hydrographs for HY **2008-09** Upper Drift Creek Daily Flows

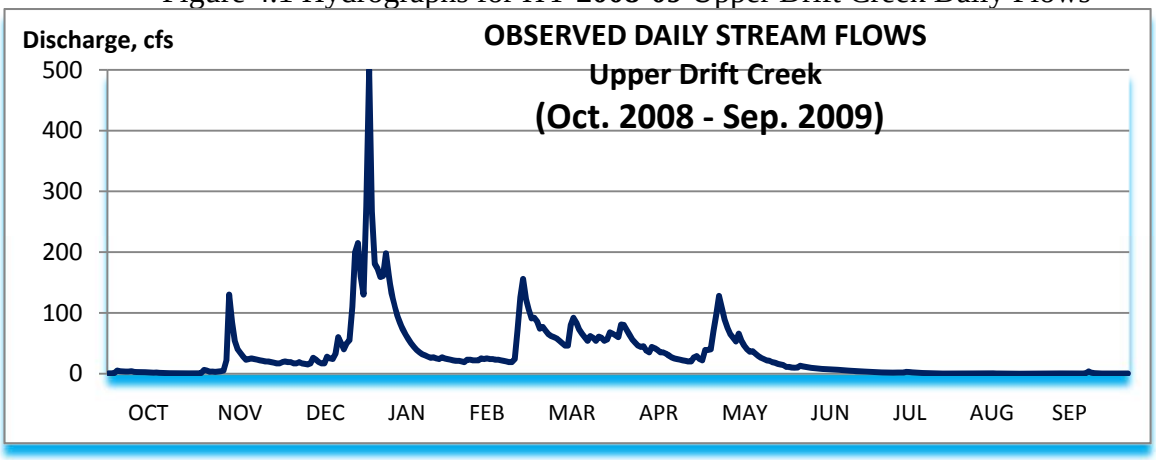
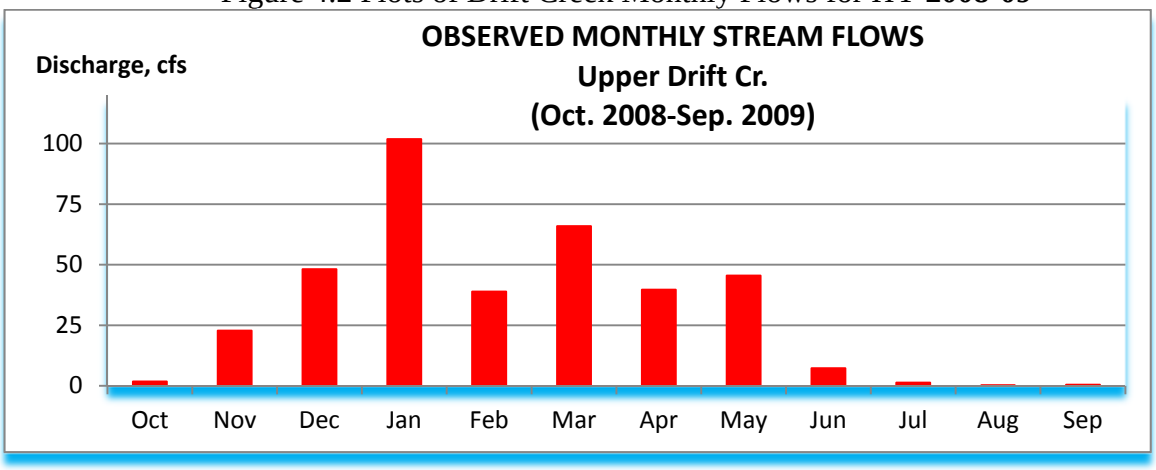


Figure 4.2 Plots of Drift Creek Monthly Flows for HY **2008-09**



4.2 HY 2009-10

Stream flows data for the 2009-10 hydrologic year (see Table 4.2 and Figures 4.3 and 4.4) were discussed in Report Update #2 and included the following:

- Daily stream flow data collected at the project site (Victor Point) by a contractor to EVWD (and provided via Ellis Ecological Service).
- Daily stream flow data at Hibbard Rd. below the project site collected by Marion SWCD. The District team also provided daily stream flows they recorded for Silver Creek at Silverton, Abiqua Creek above Gallon House Bridge, and Butte Creek at Monitor.
-
- Daily stream flow data collected by USGS for the Pudding River near Woodburn and near Aurora. USGS data were retrieved via the Internet.

The full 2009-2010 stream flow data at the project site (Victor Point) were collected, except for short gaps during the 1-4 October 2009 and 7-16 November 2009 periods. Those gaps were later filled with corresponding data for the lower site with selected drainage-based correction factors.

Table 4.2 Observed Flows (in cfs) of Drift Creek at Victor Rd., HY **2009-10**

DATE	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2009	2009	2009	2010	2010	2010	2010	2010	2010	2010	2010	2010
1	0.70	10.79	54.39	187.27	45.19	51.35	171.98	70.85	68.46	14.77	3.19	1.00
2	0.70	8.59	48.26	165.74	45.43	47.56	166.41	62.56	136.61	15.78	3.03	1.32
3	0.70	6.66	41.19	132.53	44.04	44.84	181.37	63.13	195.20	15.30	2.80	1.12
4	0.70	5.42	35.61	113.88	44.32	42.01	162.35	56.63	218.07	13.73	2.71	0.77
5	0.79	4.78	31.07	130.90	43.94	37.53	142.77	52.36	174.99	13.06	2.65	0.51
6	5.78	5.08	27.47	191.81	40.61	34.17	129.91	47.98	143.78	12.24	2.40	0.43
7	2.87	36.28	24.13	157.00	38.22	31.81	113.09	43.37	127.85	11.35	2.11	1.13

8	1.42	55.48	21.00	132.48	35.25	35.16	112.58	39.85	100.15	10.54	2.05	2.24
9	0.67	52.93	18.39	124.22	33.35	30.86	92.67	36.46	90.73	9.99	2.60	1.98
10	0.30	46.11	17.07	104.58	31.71	30.79	86.88	38.71	101.39	9.27	2.31	1.51
11	0.14	51.62	16.81	91.60	32.79	32.37	79.64	34.80	106.54	8.93	2.23	1.20
12	0.05	70.48	17.13	99.40	39.27	61.17	74.54	31.07	90.62	8.43	1.96	0.93
13	0.01	66.70	17.46	97.79	45.29	83.26	68.17	28.35	77.12	8.15	1.60	0.76
14	0.41	62.52	16.84	90.21	55.18	72.85	63.26	26.15	67.57	7.40	1.25	0.65
15	0.95	50.95	55.29	91.97	63.16	64.35	99.46	24.13	61.91	6.73	1.05	4.38
16	0.85	41.70	114.32	155.85	68.98	57.41	85.35	22.61	56.13	6.46	0.99	3.89
17	0.91	65.84	103.93	155.43	64.85	52.17	74.17	25.01	48.52	6.12	0.81	2.88
18	2.26	60.65	89.10	143.91	59.67	46.22	65.93	29.70	40.54	6.04	0.61	4.27
19	1.72	52.80	82.03	122.95	54.35	41.64	59.30	29.28	33.76	6.00	0.72	9.06
20	1.07	54.80	80.05	104.39	49.01	37.87	55.28	27.45	32.08	6.06	0.78	8.42
21	1.06	67.07	119.79	91.33	43.59	40.14	60.96	28.51	30.63	5.70	0.69	7.00
22	1.35	79.67	135.69	81.97	38.99	43.58	50.16	53.49	25.78	5.42	0.65	4.66
23	2.09	71.38	110.51	73.89	36.92	37.75	45.01	54.12	25.48	5.12	0.56	3.51
24	4.89	59.61	93.72	70.91	46.62	34.79	43.31	51.45	23.87	4.83	0.44	3.15
25	3.68	50.82	81.40	93.90	50.28	43.75	39.20	51.19	20.65	4.56	0.33	2.76
26	6.11	51.31	70.00	83.75	56.25	94.43	37.25	81.95	18.78	4.26	0.31	2.60
27	10.53	108.69	60.92	73.38	61.95	96.52	62.12	86.80	17.54	3.89	0.51	2.80
28	6.52	89.71	53.72	63.59	55.78	93.94	89.32	75.31	16.39	3.81	0.40	2.42
29	5.80	74.28	48.54	59.02		232.61	94.04	68.72	15.39	3.83	0.24	2.10
30	10.91	62.44	62.75	54.70		263.37	82.19	60.16	14.59	3.64	0.30	1.86
31	12.15		100.94	50.00		215.25		68.22		3.51	0.54	
COUNT	31	30	31	31	28	31	30	31	30	31	31	30
AVE, cfs	2.84	50.84	59.66	109.37	47.32	68.76	89.62	47.43	72.70	7.90	1.38	2.71
VOL, AF	175	3024	3668	6723	2627	4227	5332	2916	4325	486	85	161
MONTH	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
	2009	**2009**	**2009**	**2010**	**2010**	**2010**	**2010**	**2010**	**2010**	**2010**	**2010**	

Annual Oct. 2009-Sep.10 runoff volume= 33,749 AF

Figure 4.3 Hydrographs for HY **2009-10** Drift Creek Daily Flows

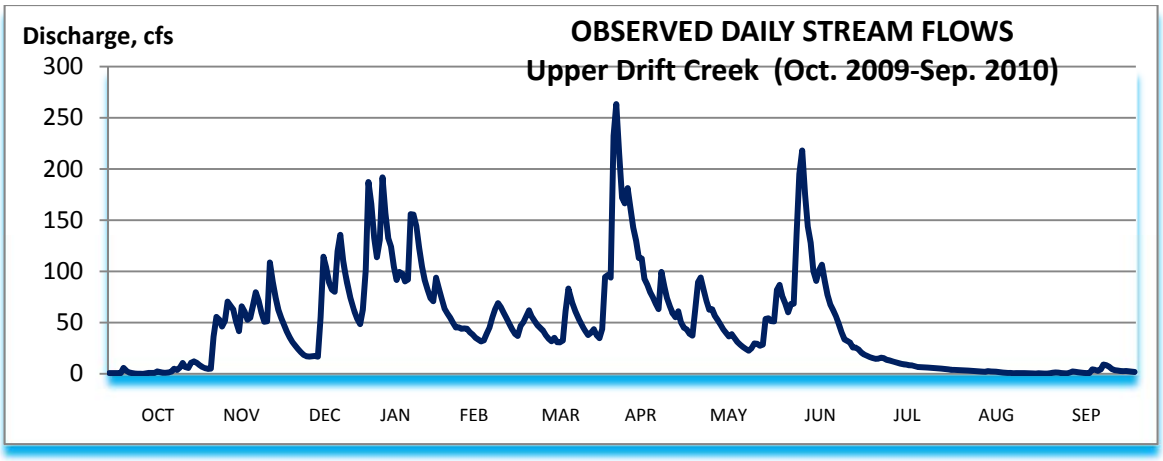
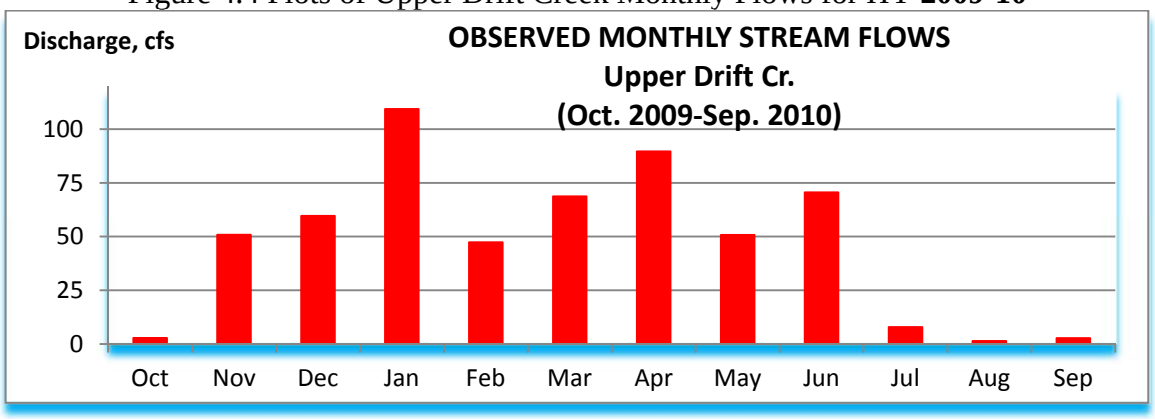


Figure 4.4 Plots of Upper Drift Creek Monthly Flows for HY **2009-10**



4.3 HY 2010-11

Stream flow data for the 2010-11 hydrologic year discussed in Report Update #3 include the following:

- Daily stream flow data collected at the project site (Victor Point) by a contractor to EVWD (and provided via Ellis Ecological Service).
- Daily stream flow data collected at Hibbard Rd. gage below the project site by Marion SWCD. The District made "provisional" data available in late April 2012, along with daily stream flow they recorded for Silver Creek at Silverton, Abiqua Creek above Gallon House Bridge, Butte Creek at Monitor, and Zollner Creek near Mt. Angel. Updated 2008-2009 stream flows data for Abiqua Creek were also received.
- Daily stream flow data collected by USGS for the Pudding River near Woodburn and near Aurora were available as usual through the Internet. Some minor changes were noticed between data posted in mid-January and mid-April 2012.

In general the 2010-11 flow meter readings for Drift Creek were within the level of accuracy generally expected for this type of discharge measurement and this relatively small size of catchment area. Data readings in August and September yielded flows slightly higher at the

upper gauge than those recorded at the lower gauge of the creek. This difference involved flows of less than 0.1 cfs that last only a few days, and could be caused by irrigation withdrawal between the two stations.

Table 4.3 Observed Flows (in cfs) of Drift Creek at Victor Rd., HY **2010-11**

DATE	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2010	2010	2010	2011	2011	2011	2011	2011	2011	2011	2011	2011
1	0.93	27.76	150.98	107.95	33.98	197.32	98.27	66.94	58.42	16.74	4.51	1.56
2	0.89	65.17	146.27	91.19	30.72	177.45	104.75	62.00	57.30	13.55	4.09	1.45
3	0.87	52.99	117.08	78.10	28.21	147.41	89.55	56.02	52.73	11.88	4.76	1.34
4	0.85	41.19	97.92	68.02	26.29	131.63	81.81	50.39	46.85	10.96	3.76	1.13
5	0.70	33.72	82.74	61.75	25.39	125.27	86.61	46.05	41.84	10.09	3.51	1.01
6	0.58	32.08	72.05	56.90	24.27	105.42	80.34	43.75	39.17	9.23	3.43	0.66
7	0.48	93.07	62.73	51.46	24.09	92.36	86.91	47.76	35.83	8.84	3.55	0.55
8	0.49	76.55	70.85	52.29	23.23	82.51	82.17	46.90	32.91	8.78	3.64	0.56
9	1.34	72.60	112.46	49.88	24.34	76.97	74.60	49.48	29.38	8.23	3.69	0.69
10	10.27	88.34	161.50	46.57	23.58	121.70	69.10	44.48	26.93	8.03	3.89	0.70
11	12.07	73.01	150.43	42.96	22.57	120.77	75.56	43.92	25.32	8.17	3.14	0.66
12	7.36	64.54	149.68	48.52	21.81	104.77	70.82	47.69	23.32	8.93	2.69	0.72
13	5.38	54.87	216.24	79.27	28.92	103.92	69.17	42.48	24.53	9.65	2.55	0.80
14	4.34	56.06	254.46	97.22	28.09	121.83	68.74	40.20	21.52	8.70	2.90	0.99
15	3.66	54.18	199.07	95.98	56.26	114.71	82.27	44.97	19.45	7.71	2.88	1.10
16	3.31	59.11	157.15	250.04	77.59	130.45	123.00	53.75	17.62	8.31	2.60	1.18
17	2.95	56.68	129.72	302.76	67.17	141.44	130.35	49.46	17.76	11.94	2.34	1.14
18	2.68	147.34	125.35	217.56	60.02	130.18	110.06	43.82	17.88	13.12	2.19	0.98
19	2.45	137.00	112.07	203.90	58.04	121.67	92.64	37.15	16.48	11.37	2.04	1.39
20	2.29	125.47	102.02	153.15	52.18	106.88	78.28	34.01	16.94	10.55	1.72	1.52
21	2.19	104.50	89.26	130.74	47.81	98.89	70.35	31.41	15.67	8.91	1.55	1.20
22	4.66	107.28	77.25	114.96	44.88	90.87	62.51	29.68	14.86	8.36	1.67	1.07
23	6.54	121.10	67.60	97.94	44.00	80.86	55.49	27.57	15.04	7.47	1.65	0.89
24	13.30	99.00	59.93	85.55	44.94	79.09	51.56	25.55	14.21	6.84	1.50	0.73
25	18.51	80.73	54.81	74.58	42.47	76.00	64.36	28.32	13.39	6.37	1.45	0.90
26	23.92	75.48	61.51	66.05	39.01	90.95	63.94	28.72	12.86	6.13	2.79	1.41
27	20.36	101.56	70.77	58.64	37.81	89.78	63.28	42.19	12.31	5.70	2.02	4.04
28	19.53	90.63	148.98	52.69	79.31	89.38	66.73	62.67	13.15	5.40	1.67	3.95
29	21.88	79.97	245.75	47.35		105.84	78.25	63.70	13.04	5.01	1.69	2.78
30	18.34	84.46	164.79	42.39		117.06	73.58	57.14	13.88	4.78	1.78	2.75
31	28.39		129.61	37.93		104.72		54.31		4.75	1.62	
COUNT	31	30	31	31	28	31	30	31	30	31	31	30
AVE, cfs	7.79	78.55	123.90	95.62	39.89	112.20	80.17	45.24	25.35	8.86	2.69	1.33

VOL, AF	479	4673	7617	5878	2215	6897	4769	2781	1508	544	165	79
MONTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2010	2010	2010	2011	2011	2011	2011	2011	2011	2011	2011	2011

Annual (Oct. 2010-Sep. 2011) runoff volume= 37,606 AF

Figure 4.5 Hydrographs for HY **2010-11** Drift Creek Daily Flows

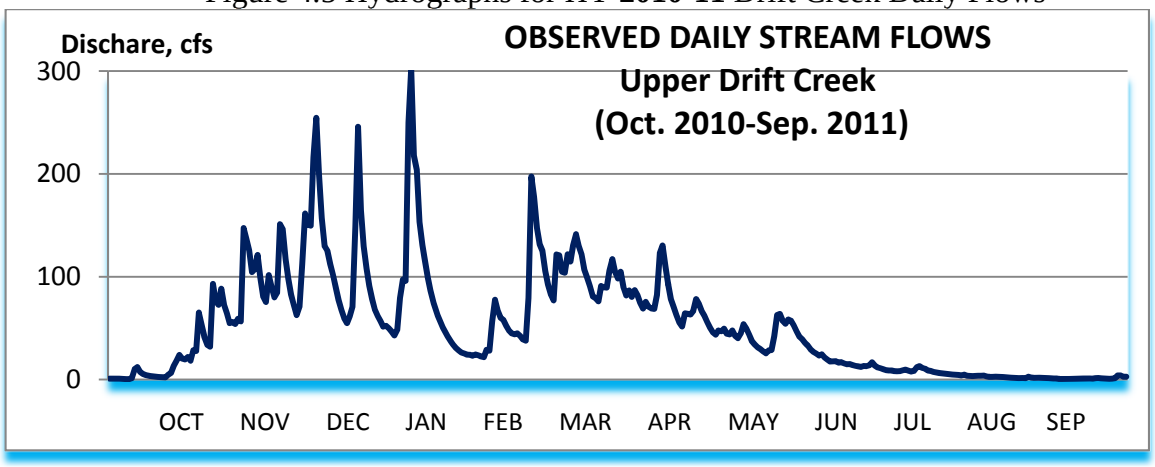
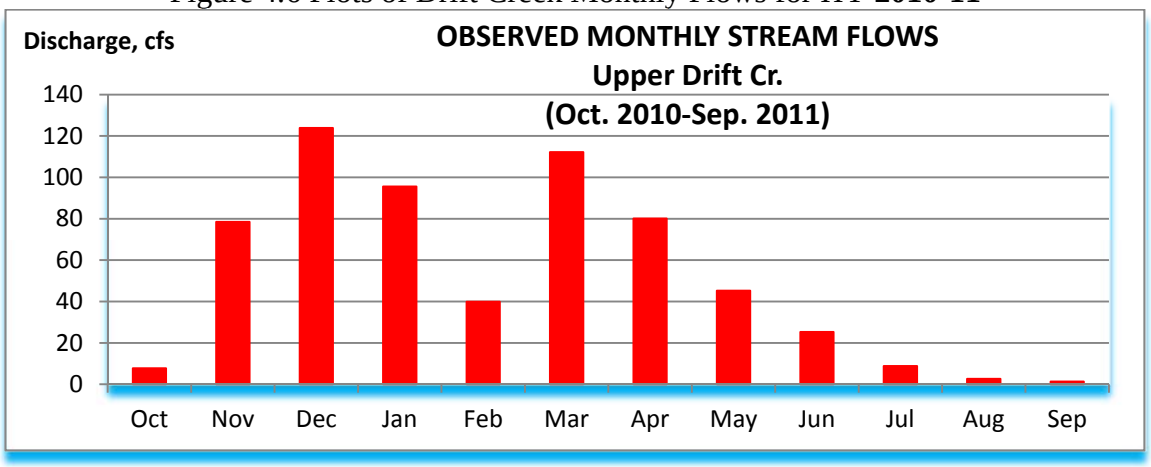


Figure 4.6 Plots of Drift Creek Monthly Flows for HY **2010-11**



4.4 HY 2011-12

Stream flow data for the 2011-12 hydrologic year were collected at the project site (Victor Point) by a contractor to EVWD, and later made available by Ellis Ecological Service. On the other hand, the daily stream flow data collected at the lower Hibbard Rd. gauge below the project site by Marion SWCD has been put on hold while the District Board reviewed the Stream flow Program and weighed whether to continue the program or not. As a result, those data are still not available in readable format at this time and, therefore, not included in the current hydrologic analysis.

Daily stream flow data collected by USGS for the Pudding River near Woodburn and near Aurora were available as usual through the Internet. However, as shown in Table 3.3, no data are available for the Pudding River nr. Mt. Angel, Silver Cr. nr. Silverton, and Albiqua Cr. nr. Scott Mills.

The 2011-12 flow meter readings for Upper Drift Creek went well, with only minor gaps during the 10/01/11 – 12/31/11 and 2/09/12 – 3/17/12 periods. Missing data for those two periods were reconstituted through the use of regression equations that correlate daily flows of Pudding River near Aurora and Upper Drift Creek for the same hydrologic year. The highest daily discharge for the 2011-12 hydrologic year (and also for the 6 years of records, October 2008-September 2013) initially was 809 cfs occurring on January 19, 2012. The wettest month for this water year was January 2012.

Slight revisions were made later, in October 2014, by Stillwater Sciences as reflected in Table 4.4. The annual runoff volume for 2011-12 has been updated to 36,178 AF.

Table 4.4 Observed Flows (in cfs) of Drift Creek at Victor Rd., HY **2011-12**

DATE	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2011	2011	2011	2012	2012	2012	2012	2012	2012	2012	2012	2012
1	1.80	9.75	58.40	136.07	90.72	93.37	233.97	67.05	18.78	14.01	3.69	1.06
2	2.72	8.39	51.91	106.17	79.80	104.02	187.98	65.56	18.76	13.15	3.47	0.98
3	4.03	14.76	45.76	91.88	72.60	88.31	163.40	74.76	17.21	12.78	3.27	0.95
4	6.33	14.10	40.58	78.75	65.93	77.71	159.95	76.32	19.65	11.81	2.99	0.87
5	6.55	11.94	35.89	81.18	59.62	72.51	150.60	76.01	45.07	10.70	2.82	0.65
6	5.58	11.80	31.68	71.08	54.12	75.63	124.75	70.28	34.13	9.37	2.67	0.40
7	4.50	11.04	27.96	64.24	49.25	77.02	108.06	64.37	33.80	8.58	2.54	0.36
8	4.46	10.94	25.17	57.43	46.63	70.06	93.09	58.10	37.08	8.14	2.43	0.34
9	3.86	10.46	24.17	52.03	54.49	63.74	80.95	51.84	49.87	7.58	2.45	0.57
10	4.07	9.87	22.68	51.10	60.20	59.13	73.02	45.70	45.11	7.08	2.41	0.63
11	9.72	9.63	21.67	44.71	63.39	60.55	69.68	40.89	38.90	6.74	2.26	0.54
12	8.88	12.68	18.89	40.12	70.41	74.59	62.97	36.20	35.86	6.43	2.05	0.49
13	6.57	14.69	17.73	36.28	65.15	108.62	56.29	31.74	34.61	6.18	1.89	0.40
14	5.60	17.64	16.72	34.51	60.20	161.28	49.73	28.03	28.30	5.93	1.69	0.31
15	5.45	18.07	16.83	36.15	55.56	167.97	43.72	24.60	23.40	5.87	1.63	0.26
16	5.05	17.74	16.27	32.55	51.61	201.90	55.83	23.71	22.61	6.12	1.58	0.25
17	4.83	43.59	15.32	39.79	48.73	252.18	55.95	22.00	20.80	5.76	1.43	0.23
18	4.22	67.75	15.13	205.75	50.53	195.68	62.38	20.63	19.90	5.65	1.36	0.23
19	3.96	72.31	14.87	808.62	58.42	165.53	68.03	19.38	19.01	5.61	1.69	0.29
20	3.83	61.11	14.01	342.00	58.77	184.46	75.65	18.65	17.79	5.47	1.58	0.42
21	3.65	52.26	13.56	327.25	62.32	261.65	69.53	20.79	16.38	5.73	1.40	0.62
22	3.49	76.57	12.98	242.50	74.94	237.99	63.38	28.56	15.51	5.47	1.25	1.09
23	3.41	93.71	12.50	205.46	92.70	203.23	56.07	26.09	18.87	5.52	1.09	1.48

24	3.27	107.40	12.02	192.30	95.05	186.13	48.75	29.60	18.74	5.22	0.98	1.56
25	3.13	95.88	11.89	204.22	89.67	163.62	46.37	43.48	16.43	4.78	0.94	1.56
26	3.07	79.18	12.00	171.59	87.29	141.99	66.68	34.50	16.07	4.49	1.12	1.63
27	2.91	73.03	12.27	140.72	79.09	124.99	68.69	28.35	14.74	4.52	1.12	1.61
28	2.76	88.82	49.60	123.71	71.81	111.85	64.17	23.96	13.40	4.83	1.12	1.57
29	3.71	73.83	121.21	111.88	69.01	110.03	58.80	23.27	12.59	4.53	1.09	1.35
30	6.14	66.94	249.25	119.60		272.33	66.61	21.35	12.38	4.35	1.06	1.38
31	12.25		195.25	98.69		314.63		19.78		4.01	1.06	
COUNT	31	30	31	31	29	31	30	31	30	31	31	30
AVE, cfs	4.83	41.86	39.81	140.27	66.83	144.60	86.17	39.21	24.52	6.98	1.87	0.80
VOL, AF	297	2490	2447	8623	3843	8889	5126	2410	1459	429	115	48
MONTH	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
	2011	**2011**	**2011**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**	**2012**

Annual Oct. 2011-Sep.12 runoff volume= 36,178 AF

Figure 4.7 Hydrographs for HY **2011-12** Upper Drift Creek Daily Flows

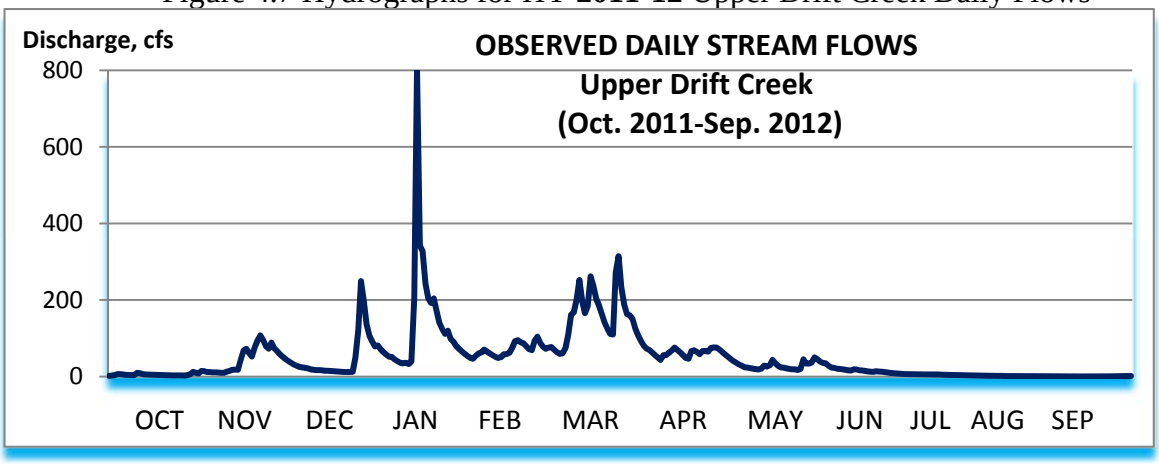
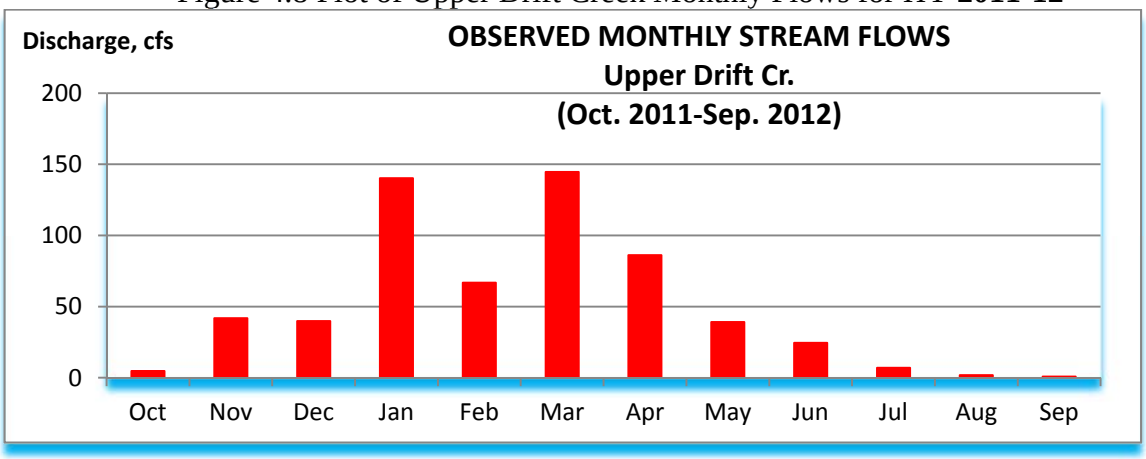


Figure 4.8 Plot of Upper Drift Creek Monthly Flows for HY **2011-12**



4.5 HY 2012-13

Stream flow data for the 2012-13 hydrologic year were collected at the project site (Victor Point) by a contractor to EVWD, and made available by Ellis Ecological Service. As mentioned earlier, the daily stream flow data collected at the lower Hibbard Rd. gauge below the project site by Marion SWCD are not available as of mid-October 2014 and, therefore, not included in the analysis documented in this report update #4.

Daily stream flow data collected by USGS for the Pudding River near Woodburn and near Aurora were available through the Internet but, like in the previous water year, no data are available for the Pudding River nr. Mt. Angel, Silver Cr. nr. Silverton, and Albiqua Cr. nr. Scott Mills.

The 2012-13 flow meter readings for Upper Drift Creek showed a minor gap between 8/06/13 and 8/17/13. Missing data for that 12-day period were reconstituted through the use of regression equations that correlate daily flows of Pudding River near Aurora and Upper Drift Creek for the same hydrologic year.

Table 4.5 Observed Flows (in cfs) of Drift Creek at Victor Rd., HY **2012-13**

DATE	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2012	2012	2012	2013	2013	2013	2013	2013	2013	2013	2013	2013
1	2.03	40.72	97.97	67.67	143.61	46.07	23.02	17.69	42.50	10.78	2.15	1.08
2	1.95	40.21	143.66	59.44	121.15	43.50	21.61	16.76	36.81	9.98	2.61	1.05
3	1.92	42.08	141.51	52.59	102.24	42.11	19.43	15.73	31.86	9.28	2.53	1.17
4	1.85	40.44	178.28	47.87	87.76	38.73	19.24	14.82	27.49	8.66	2.07	1.03
5	1.78	35.02	181.20	43.58	79.73	37.26	19.78	13.91	23.87	7.84	1.93	3.14
6	1.61	30.52	141.43	40.17	73.63	45.40	34.42	13.33	20.76	7.47	3.51	23.75
7	1.58	29.64	125.95	41.62	68.67	50.61	50.35	12.90	18.19	7.25	3.22	14.50
8	1.59	26.63	111.14	41.41	62.23	45.69	49.34	12.55	17.15	6.98	3.08	9.74
9	1.70	23.90	101.09	46.90	55.45	41.54	44.09	12.20	17.17	6.56	3.03	7.58
10	1.72	25.33	89.00	63.22	50.94	37.72	41.76	11.43	16.00	6.21	2.98	6.22
11	1.80	25.61	85.72	62.21	46.32	35.50	39.41	10.89	15.29	5.89	3.08	5.22
12	2.67	38.17	98.58	56.13	45.40	33.49	36.26	10.67	14.78	5.63	3.22	4.61
13	6.13	47.86	85.66	50.93	41.50	30.70	38.72	11.32	16.30	5.40	3.22	4.28
14	5.98	43.91	78.82	46.37	37.89	26.13	35.92	10.74	15.24	5.03	3.17	4.18
15	10.89	39.18	73.43	43.06	35.16	24.24	35.70	10.44	13.06	4.67	3.03	4.02
16	17.61	35.25	80.94	39.86	33.54	25.73	32.89	11.20	12.04	4.58	2.93	4.14
17	12.42	44.06	108.52	37.05	32.40	31.71	30.28	12.24	11.43	4.97	3.17	3.99
18	11.02	95.11	111.59	34.55	30.19	27.18	28.18	10.18	12.38	4.67	1.09	6.57
19	8.21	152.95	102.25	32.05	29.20	25.77	33.53	11.54	13.41	4.18	1.13	9.08
20	9.43	364.40	148.92	29.75	27.98	49.17	33.81	10.53	14.94	3.96	1.14	5.88
21	9.19	328.25	160.18	27.65	30.04	56.51	30.69	12.47	16.52	3.79	0.90	4.67

22	9.94	230.55	138.54	25.95	35.05	52.63	28.55	23.38	13.76	3.63	0.83	4.83
23	12.60	175.09	140.80	25.88	54.63	48.36	26.19	29.80	13.42	3.37	1.35	7.88
24	14.21	218.49	161.01	27.13	52.45	44.18	24.21	40.66	17.32	3.12	1.69	11.15
25	16.63	164.96	162.39	46.67	54.46	40.81	22.40	35.88	16.44	2.81	1.74	16.86
26	14.46	133.15	174.77	60.62	51.95	37.97	20.71	33.83	17.92	2.48	2.09	15.29
27	14.24	108.97	142.90	69.87	46.46	34.82	19.05	42.88	16.83	2.24	1.77	12.33
28	32.91	90.71	123.61	107.25	44.39	31.88	17.60	61.00	14.45	2.19	1.60	15.62
29	63.04	81.26	105.14	210.04		29.22	17.92	65.12	12.92	2.22	1.58	69.21
30	48.69	74.71	90.73	207.69		26.66	17.33	59.32	11.71	2.22	1.58	109.21
31	39.84		79.96	183.62		24.64		50.08		2.20	1.30	
COUNT	31	30	31	31	28	31	30	31	30	31	31	30
AVE, cfs	12.25	94.24	121.47	62.22	56.23	37.16	29.75	22.76	18.07	5.17	2.22	12.94
VOL, AF	753	5606	7467	3825	3122	2312	1770	1399	1075	318	136	770
MONTH	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
	2012	**2012**	**2012**	**2013**	**2013**	**2013**	**2013**	**2013**	**2013**	**2013**	**2013**	**2013**

Annual Oct. 2012-Sep.13 runoff volume= 28,553 AF

Figure 4.9 Hydrograph of HY **2012-13** Upper Drift Creek Daily Flows

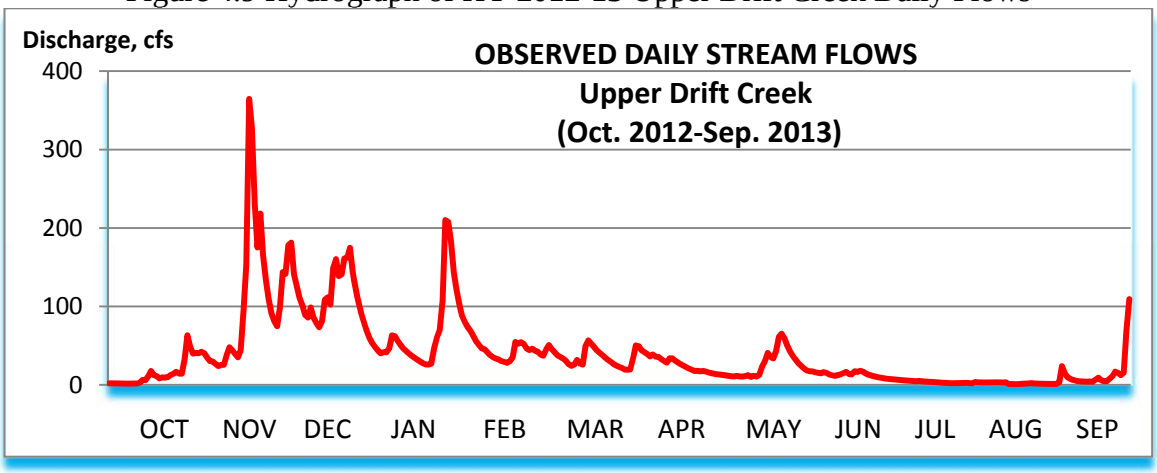
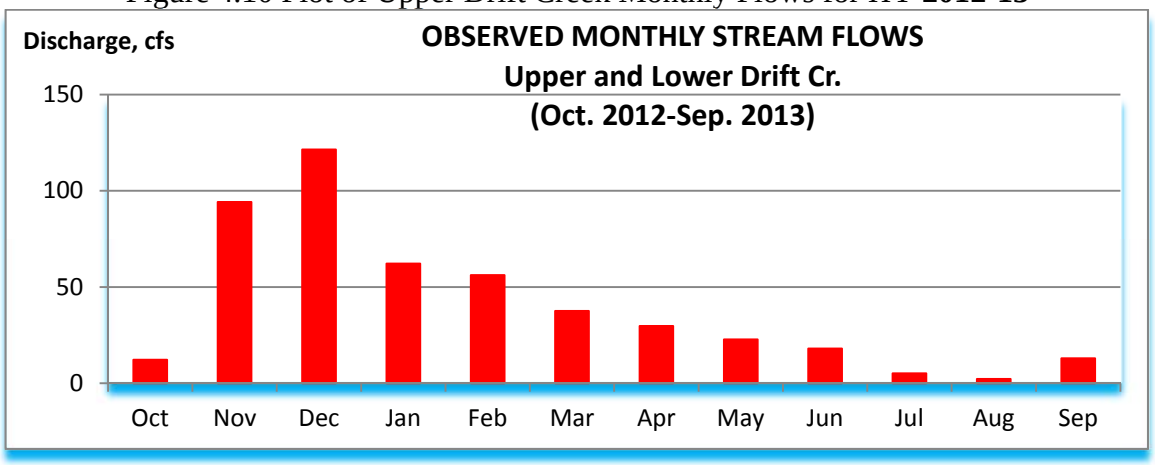


Figure 4.10 Plot of Upper Drift Creek Monthly Flows for HY **2012-13**



4.6 HY 2013-14

Stream flow data for the 2013-14 hydrologic year were collected at the project site (Victor Point) by Stillwater Sciences, a contractor to EVWD. Provisional data were received in early October 2014, followed by final data one week later. Data gap between January 9, 2014 and January 23, 2014 were filled using regression formulae linking daily flows of Pudding River at Aurora and Upper Drift Creek for the same water year. October 2013 started with higher discharges than usual, but those discharges quickly dropped a couple of weeks later.

Table 4.6 Observed Flows (in cfs) of Drift Creek at Victor Rd., HY **2013-14**

DATE	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	2013	2013	2013	2014	2014	2014	2014	2014	2014	2014	2014	2014
1	96.34	11.01	20.55	21.60	34.02	59.52	102.06	57.08	11.77	7.73	0.75	1.04
2	85.87	17.57	83.23	20.42	31.64	76.97	83.02	50.13	11.18	6.31	0.81	0.84
3	70.45	22.71	78.44	23.71	28.94	108.07	73.56	44.99	11.49	3.72	0.66	0.84
4	56.48	21.82	64.42	21.79	26.76	112.98	76.95	48.28	11.09	3.23	0.62	0.75
5	46.18	24.75	54.43	20.19	24.53	143.84	72.56	42.89	10.40	3.39	0.55	0.62
6	37.79	34.67	47.22	19.25	23.23	214.80	80.38	36.86	9.66	5.05	0.47	0.42
7	33.64	49.06	41.01	19.53	24.01	166.53	72.73	31.14	9.15	5.58	0.35	0.30
8	33.95	56.60	35.47	23.27	24.73	136.19	64.90	31.61	8.71	5.17	0.45	0.20
9	39.54	50.60	31.61	*26.12*	32.58	189.68	59.21	62.31	8.30	3.92	0.45	0.26
10	32.29	44.53	27.59	*39.55*	48.43	152.83	52.06	76.09	7.85	2.86	0.47	0.26
11	27.39	38.42	24.04	*49.60*	141.99	123.79	45.91	67.03	7.49	2.70	0.46	0.18
12	23.46	44.75	24.05	*72.18*	225.28	104.29	40.99	57.63	7.64	2.22	0.44	0.12
13	22.99	46.86	29.41	*95.01*	211.02	87.10	37.97	49.41	9.14	2.58	0.62	0.07
14	21.09	41.96	25.62	*102.72*	281.20	81.03	32.77	42.52	8.85	2.60	0.55	0.06
15	19.53	38.30	24.59	*92.32*	293.23	71.15	28.21	36.78	8.45	2.41	0.55	0.05
16	18.35	42.53	23.42	*78.22*	275.75	63.24	25.37	32.01	8.79	1.38	0.63	0.16

17	17.23	38.95	22.49	*64.94*	221.22	84.22	27.47	28.04	8.97	0.98	0.76	0.16
18	16.27	36.02	21.80	*54.52*	220.53	70.13	30.07	30.96	8.42	1.80	0.50	0.21
19	15.48	55.54	21.29	*47.17*	221.26	62.33	24.54	40.80	7.58	1.95	0.38	0.25
20	14.72	67.42	20.29	*41.54*	212.60	55.32	24.27	29.69	7.17	1.69	0.26	0.18
21	14.02	58.88	25.51	*37.57*	183.14	49.49	22.48	24.75	6.74	2.79	0.25	0.11
22	13.42	51.71	27.03	*34.07*	146.96	43.82	29.88	22.39	6.26	3.05	0.31	0.22
23	12.87	46.38	29.34	*31.26*	123.21	38.62	49.38	20.98	5.89	3.66	0.42	2.81
24	12.41	41.63	39.27	25.40	106.95	34.04	108.76	19.80	5.72	3.60	0.36	2.71
25	12.26	36.70	37.66	24.52	84.26	32.73	121.93	18.46	5.85	3.17	0.37	2.70
26	11.81	32.24	34.72	22.61	73.63	37.46	98.39	17.18	7.22	2.67	0.34	1.78
27	12.69	28.93	31.82	21.44	67.86	66.47	97.50	15.68	11.93	2.34	0.22	1.40
28	16.12	24.72	28.40	21.51	60.97	112.03	84.35	14.90	11.76	1.67	0.26	1.12
29	13.09	20.42	25.01	31.92		173.18	73.82	14.83	9.89	1.15	0.68	1.31
30	11.91	18.92	24.49	31.14		147.83	64.70	13.32	9.51	1.00	1.25	1.37
31	11.22		23.00	34.39		119.96		12.38		0.90	1.12	
COUNT	31	30	31	31	28	31	30	31	30	31	31	30
AVE, cfs	28.09	38.15	33.78	40.31	123.21	97.41	60.21	35.19	8.76	3.01	0.53	0.75
VOL, AF	1727	2270	2077	2478	6841	5988	3582	2163	521	185	32	45
MONTH	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
	2013	**2013**	**2013**	**2014**	**2014**	**2014**	**2014**	**2014**	**2014**	**2014**	**2014**	**2014**

Annual Oct. 2013-Sep.14 runoff volume= 27,908 AF

Figure 4.11 Hydrograph of HY **2013-14** Upper Drift Creek Daily Flows

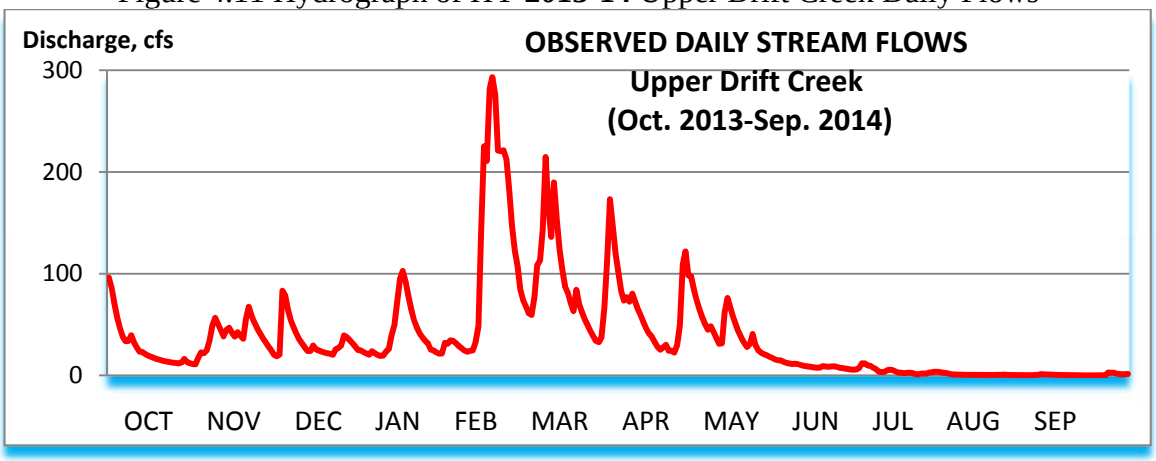
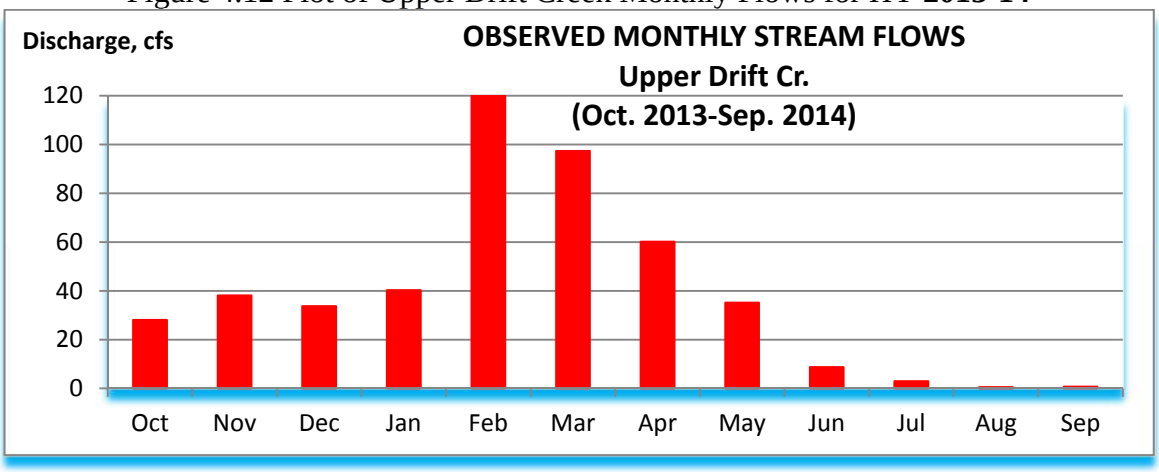


Figure 4.12 Plot of Upper Drift Creek Monthly Flows for HY **2013-14**



4.7 Comparison of HY 2008-14 Observed Stream Flow Data

The hydrographs for Upper Drift Creek's daily flows are shown for all six water years in Figure 4.13. Highest discharges are most prominent during December through March. The highest daily peak discharge of 809 cfs was recorded on January 19, 2012 followed by a daily peak discharge of close to 500 cfs on January 9, 2009.

Monthly flow variations during the six water years are listed in Table 4.7 and illustrated in Figure 4.14 on a month-by-month basis, and in Figure 4.15 on a year-by-year basis. During the raining season, the highest monthly flows occurred mostly during December through March, and the lowest monthly flows during July through September. The driest month for all 6 water years occurred in August 2009 (0.24 cfs monthly average), and the wettest month was March 2012 (144.60 cfs monthly average).

Figure 4.13 Hydrograph of HY 2008-14 Drift Creek Daily Flows

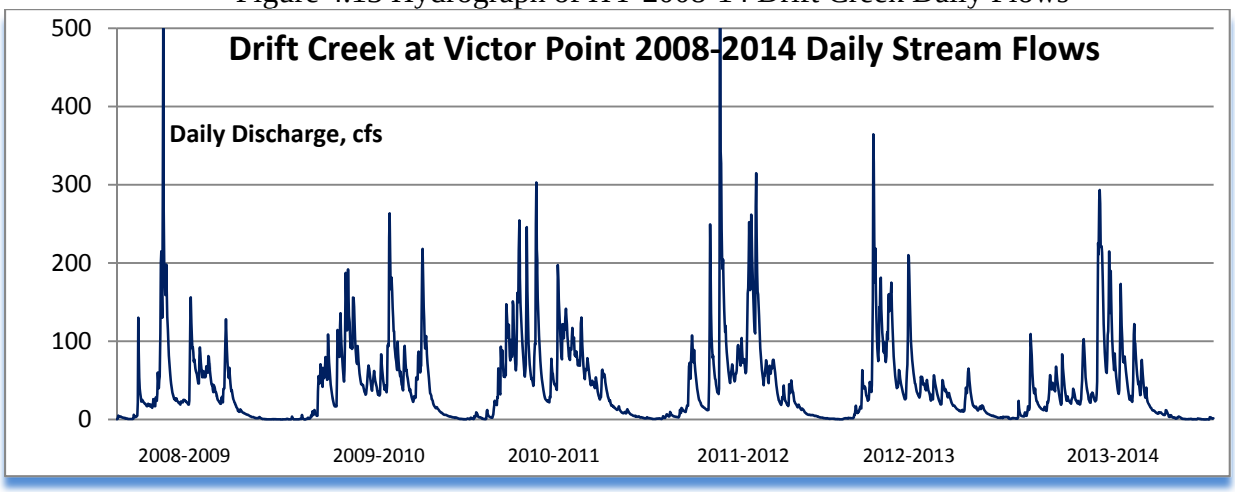


Table 4.7 Summary of HY 2008-14 Upper Drift Creek **Monthly** Flow, cfs

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Oct08-Sep09	1.83	22.82	48.19	101.87	38.93	65.90	39.73	45.55	7.24	1.35	0.24	0.49
Oct09-Sep10	2.84	50.84	59.66	109.37	47.32	68.76	89.62	47.43	72.70	7.90	1.38	2.71
Oct10-Sep11	7.79	78.55	123.90	95.62	39.89	112.20	80.17	45.24	25.35	8.86	2.69	1.33
Oct11-Sep12	4.83	41.86	39.81	140.27	66.83	144.60	86.17	39.21	24.52	6.98	1.87	0.80
Oct12-Sep13	12.25	94.24	121.47	62.22	56.23	37.61	29.75	22.76	18.07	5.17	2.22	12.94
Oct13-Sep14	28.09	38.15	33.78	40.31	123.21	97.41	60.21	35.19	8.76	3.01	0.53	0.75

Figure 4.14 Hydrograph of HY **2008-14** Drift Creek Monthly Flows (month-by-month)

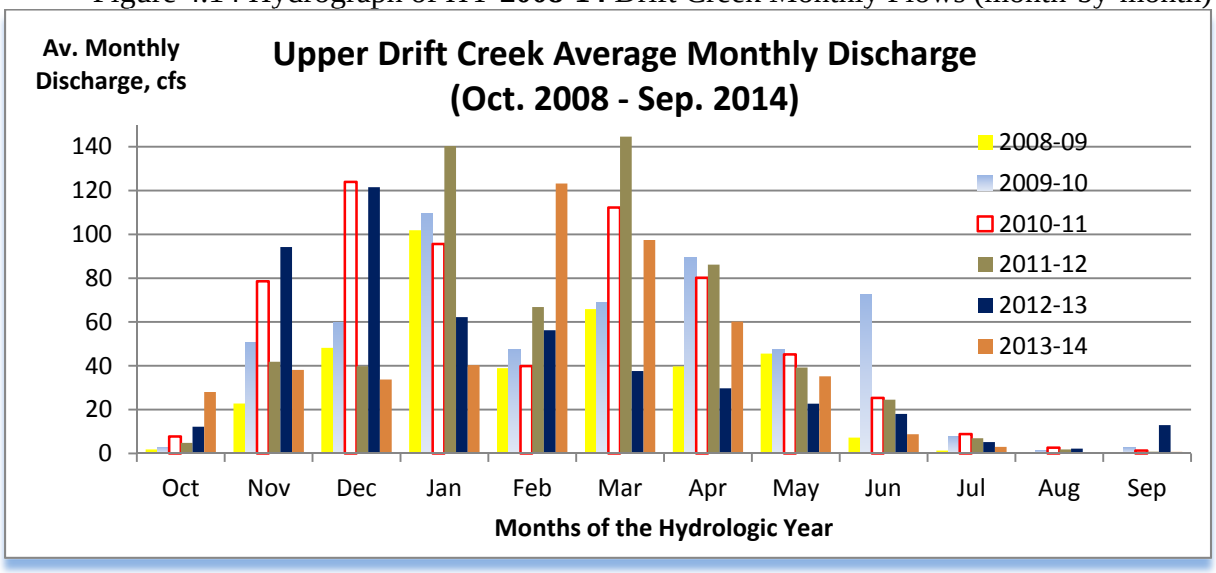
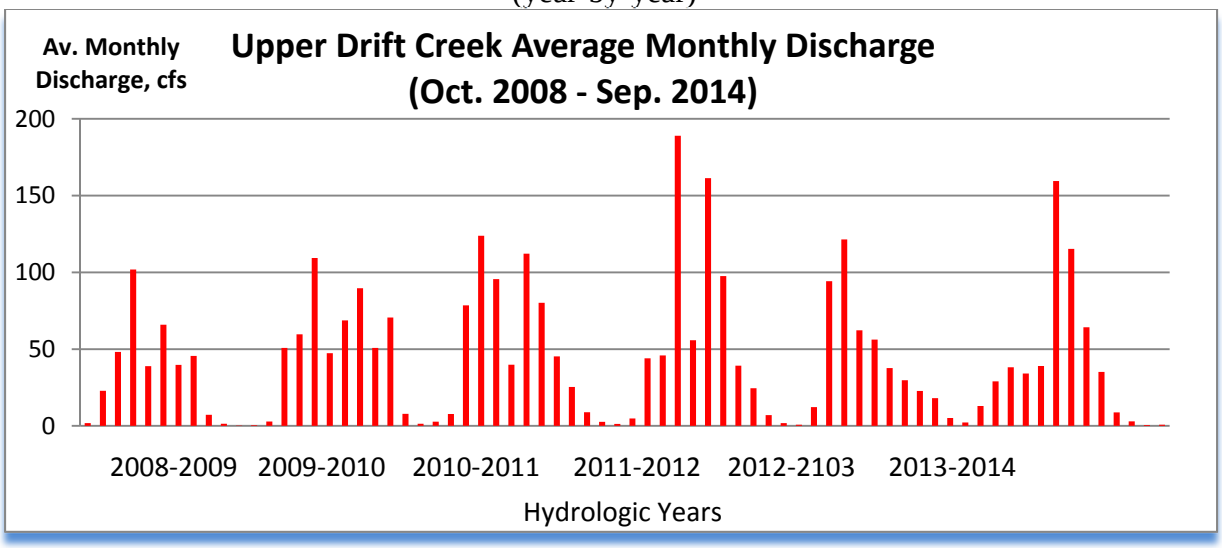
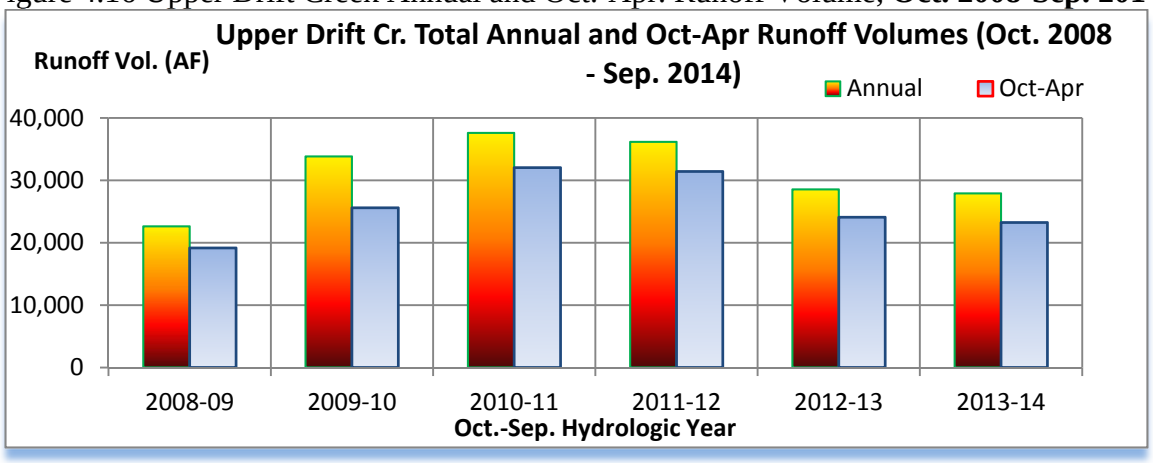


Figure 4.15 Hydrograph of HY **2008-14** Drift Creek Monthly Flows (year-by-year)



The runoff for both the hydrologic year and the October-April season in each of the six flow years is plotted in Figure 4.16.

Figure 4.16 Upper Drift Creek Annual and Oct.-Apr. Runoff Volume, **Oct. 2008-Sep. 2014**



The cumulative monthly runoff volumes for Upper Creek are listed in Table 4.8, and illustrated in Figure 4.17. Corresponding volumes for the October - April period are also listed/illustrated.

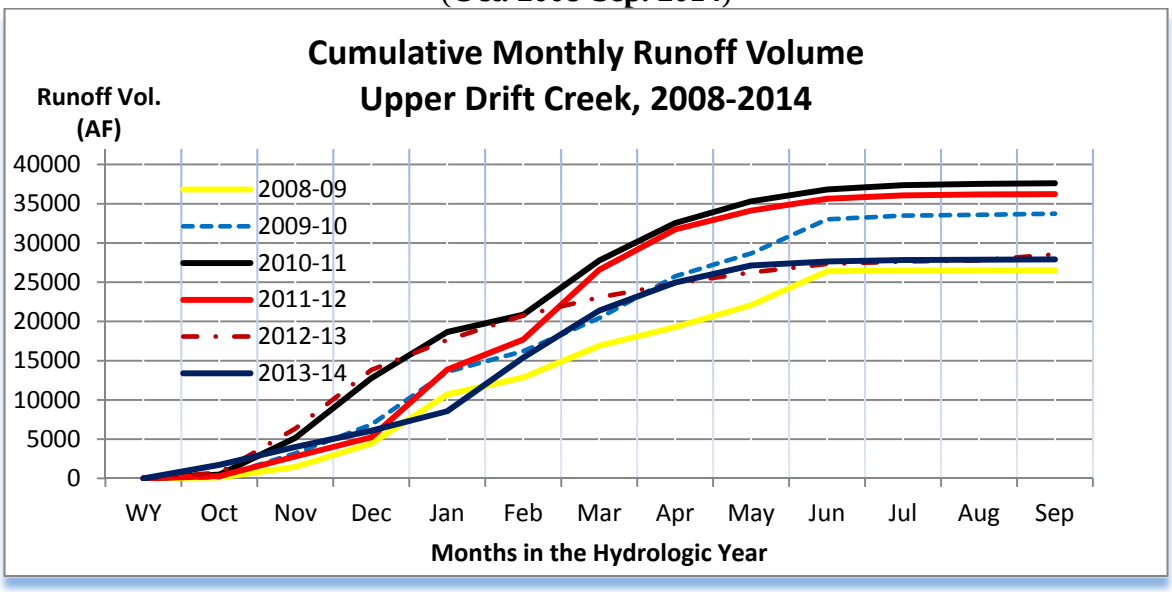
Over the last six years, the annual runoff volume ranges from 22,629 AF to 37,606 AF, with largest volume occurring during the October 2010 – September 2011 water year. It appears that 2009-10, 2010-11, and 2011-12 were high flow years; 2012-13 and 2013-14 were close to average runoff years; and 2008-09, a low flow year. The six year average annual runoff was 31,117 AF.

Based on the six 2008-2014 water years of records, the average runoff volume for the October – April projected reservoir refill period is 25,928 AF. The runoff volume of 20,000 AF would only be closely missed by one year (out of 6).

Table 4.8 Upper Drift Creek's Annual Runoff Volume

Water Year	Oct. - Sept. Volume, AF	Ranking		Oct. – Apr. Volume, AF	Ranking
Oct08-Sep09	22,629	6		19,159	6
Oct09-Sep10	33,749	3		25,601	3
Oct10-Sep11	37,606	1		32,049	1
Oct11-Sep12	36,178	2		31,419	2
Oct12-Sep13	28,553	4		24,102	4
Oct13-Sep14	27,908	5		23,235	5
Oct08-Sep14 Average	31,117			25,928	

Figure 4.17 Upper Drift Creek Cumulative Monthly Runoff
(**Oct. 2008-Sep. 2014**)



It should be noted that runoff in the Drift Creek basin was primarily driven by rainfall -- no detectable snowmelt impact —during all six water years (2008-2014). This is to be expected for most runoff years, since most of Drift Creek watershed lies below elevation 2000 feet. It also appears that rainfall recorded at the Salem Airport reasonably matches the shape of the Upper Drift's hydrographs, especially the timing of most of the peak discharges.

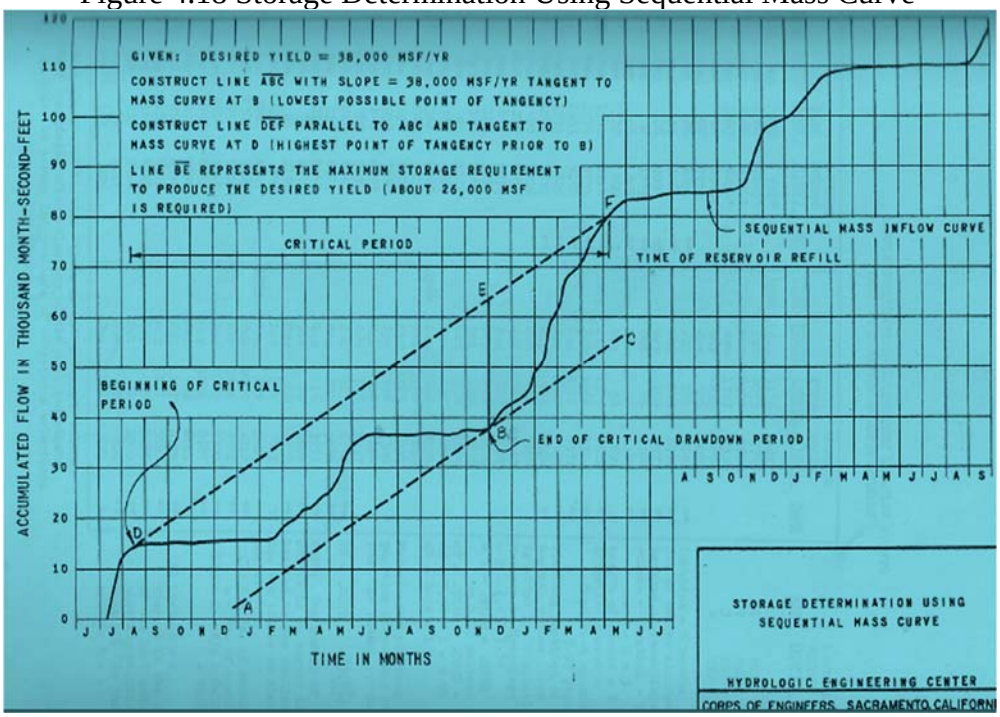
The availability of the Oct. 2008 – Sep. 2014 stream flow data should justify the removal of Drift Creek from the list of ungauged watersheds. These data provide a real picture of how the runoff is shaped during the six hydrologic years, including how the timing of its peak discharge is related to the peak rainfall recorded at Salem. However, these measurements still only reflect six of the many possible runoff conditions that could take place in the basin. Any practical conclusions reached so far would be more applicable to years with rainfall-runoff conditions similar to those years. Flow records pertaining to historical heavy precipitation and/or snowfall are still absent.

4.8 Sequential Mass Curve for Upper Drift Creek

A potentially useful piece of information to help estimate the storage required to provide a given yield is the sequential mass curve --also referred to as Rippl's curve. As stated in the Reservoir Storage Yield Procedures Manual prepared by the US Army Corps of Engineers Hydrologic Engineering Center in May 1967, "*the mass curve in month-cfs units is constructed by accumulating the inflows throughout the period of record and plotting the cumulative inflow versus the sequential time. The desired yield can be represented by a straight line with a slope equal to the desired yield rate in units corresponding to the flow units... The desired yield must include the average evaporation, and the net yield (yield remaining after evaporation) must represent the average demand for water during the critical period*".

The Corps of Engineers instructions further added, "*After the mass curve is drawn, lines are constructed parallel to the desired yield line and tangent to the mass curve at each low point and at the highest preceding tangent point. The vertical difference between these two lines represents the storage required to provide the desired yield during the time period between the two tangent points. The maximum difference in the period of records is often used to determine the required storage*". See Figure 4.18.

Figure 4.18 Storage Determination Using Sequential Mass Curve



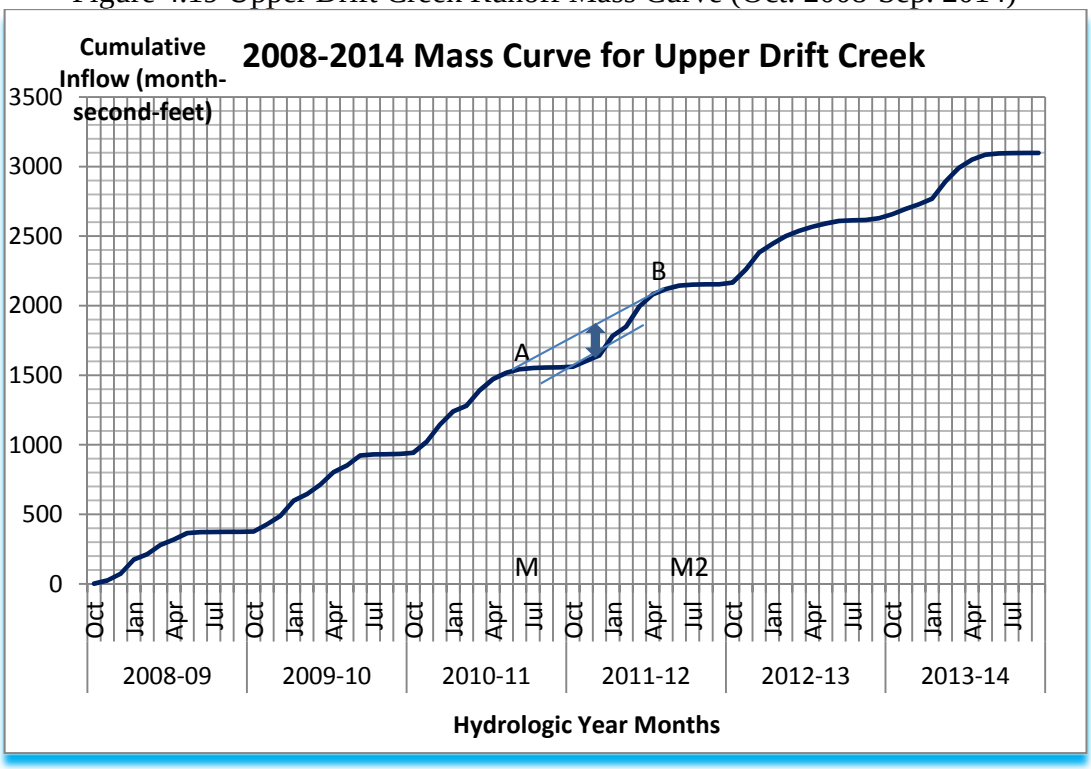
Sequential mass curve data developed per the above instructions for Upper Drift Creek station using the latest October 2008 - September 2014 stream flow records are listed in Table 4.9, and the corresponding mass curve plot is illustrated in Figure 4.19.

Table 4.9 Mass Curve for Oct. 2008 - Sep. 2014 Period, in month-second-feet

HY=	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Oct.	1.8	377.0	942.5	1561.1	2166.3	2657.1
Nov.	24.6	427.8	1021.0	1603.0	2260.5	2695.2
Dec.	72.8	487.5	1144.9	1642.8	2382.0	2729.0
Jan.	174.7	596.9	1240.6	1783.1	2444.2	2769.3
Feb.	213.6	644.2	1280.5	1849.9	2500.5	2892.5
Mar,	279.5	712.9	1392.6	1994.5	2538.1	2989.9
Apr.	319.3	802.6	1472.8	2080.7	2567.8	3050.1
May	364.8	850.0	1518.1	2119.9	2590.6	3085.3
Jun.	372.1	922.7	1543.4	2144.4	2608.6	3094.1
Jul.	373.4	930.6	1552.3	2151.4	2613.8	3097.1

Aug.	373.7	932.0	1555.0	2153.2	2616.0	3097.6
Sep.	374.2	934.7	1556.3	2154.1	2629.0	3098.4

Figure 4.19 Upper Drift Creek Runoff Mass Curve (Oct. 2008-Sep. 2014)



The slope of the mass curve at any point on the graph represents the flow rate at that instant. By connecting two points, A at month M1 and B at month M2, by a straight line, the slope of that line represents the average rate of flow that can be maintained between M1 and M2 if adequate storage is available at the reservoir.

The following material excerpted from the 2014 Guidelines issued by the Pennsylvania Department of Environmental Protection provides additional information on the mass curve and its possible applications in the future, if and when the need for such a tool arises to test the feasibility of special irrigation withdrawal scenarios.

"*Typically, a sag in the mass curve occurs during late summer and early fall base flow periods. A demand or draft rate (straight line for a constant draft rate) is superimposed on the runoff curve at a tangential point showing the rate at which water is withdrawn for [a given] use... Where the runoff (mass) curve is steeper than the draft line, the natural stream flow is at a higher rate of supply than the rate of draft. Consequently, some of the stream flow is available for storage or it will spill if the reservoir is already full. Where the mass curve has a flatter slope than the draft line, water will be withdrawn from storage in order to maintain the required rate of draft. The storage required to supply a given demand or draft rate is therefore the maximum intercept between the demand or draft line and the mass curve....The critical duration is defined*

as the length of time between the start of drawdown (tangent point of draft line) until the maximum drawdown is reached (maximum intercept) and recovery begins. The higher the demand or draft rate, the greater the drawdown and storage required, and the greater the critical duration before recovery and refill can begin. Therefore, based on Rippl mass diagram, steps taken towards water conservation early on in a drought occurrence can save significant amounts of reservoir storage and promote a much earlier recovery from the effects of the drought.

4.9 Correlation between Upper and Lower Drift Creek Stream Flows

To date, stream flow data for Lower Drift Creek are only available for the three HY's 2008-09, 2009-10 and 2010-11. Data collection, originally conducted by Marion County Soil and Water Conservation Service, was taken over by USGS in May 2014. Unfortunately, as of mid-November 2014, the most recent three years have only raw, unanalyzed data, which prevented any updates for HY's 2011-12, 2012-13 and 2013-14. Therefore, data, text, tables and graphics shown below are basically the same as the material presented in the 2012 report update #3.

Figure 4.20 Hydrographs of Drift Creek Daily Stream Flows, **2008-2011**

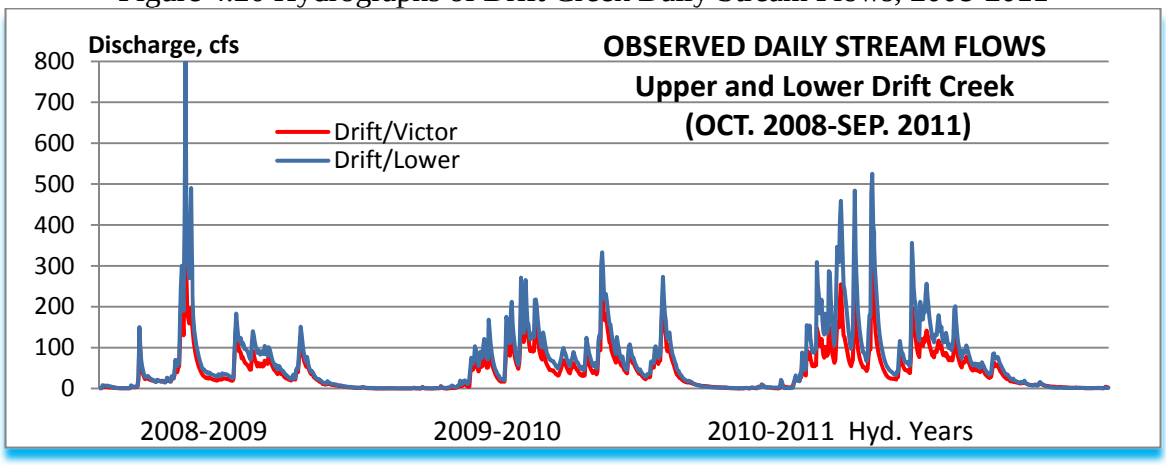


Figure 4.21 Hydrographs of Drift Creek Monthly Flows, **2008-2011**

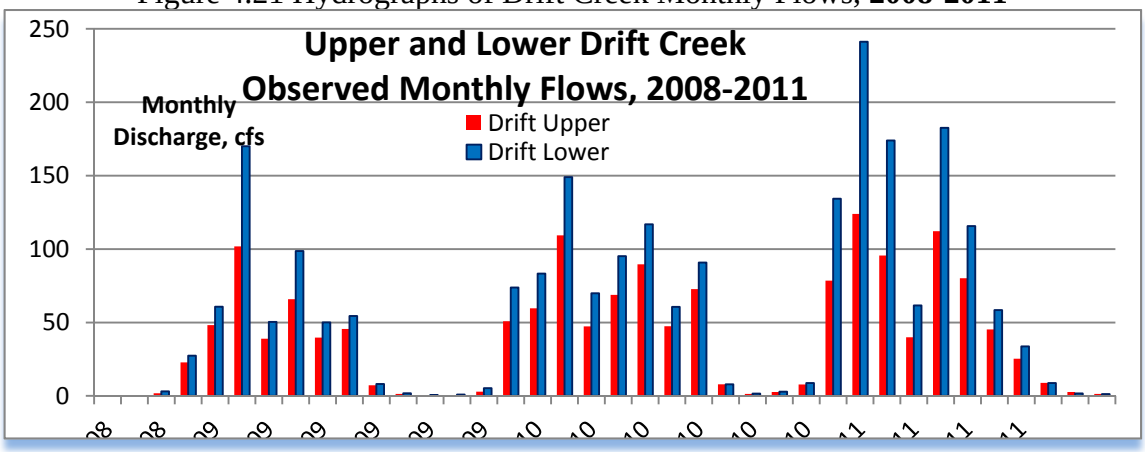


Table 4.9 provides a summary of monthly flow data at both the upper and lower gauging stations for the three HY's, including the monthly runoff volume ratio of the upper station over the lower station.

There is a strong correlation between both the daily and the monthly flow data at the two gauging stations in all three HY's. See Figures 4.22 through 4.25 for daily flows and Figures 4.26 through 4.29 for monthly flows. Table 4.10 presents a summary of the polynomial regression equations and the correlation factor R^2 linking Lower Drift Cr. (X) to Upper Drift Cr. (Y).

Table 4.9 Monthly Flows Data at Upper and Lower Drift Cr. (**2008-2011**)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Upper Drift												
2008-09	1.83	22.82	48.19	101.87	38.93	65.90	39.73	45.55	7.24	1.35	0.24	0.49
2009-10	2.84	50.84	59.66	109.37	47.32	68.76	89.62	47.43	72.70	7.90	1.38	2.71
2010-11	7.79	78.55	123.90	95.62	39.89	112.20	80.17	45.24	25.35	8.86	2.69	1.33
Lower Drift												
2008-09	3.08	27.38	60.77	170.00	50.39	98.68	50.07	54.45	8.15	1.83	0.59	0.88
2009-10	5.32	73.87	83.32	149.00	69.93	95.16	116.90	60.64	90.79	7.87	1.59	2.87
2010-11	8.82	134.30	241.26	174.00	61.64	182.58	115.67	58.48	33.77	8.73	1.73	1.27
Ratio Up/Lower												
2008-09	0.59	0.83	0.79	0.60	0.77	0.67	0.79	0.84	0.89	0.74	0.40	0.56
2009-10	0.53	0.69	0.72	0.73	0.68	0.72	0.77	0.78	0.80	1.00	0.87	0.95
2010-11	0.88	0.58	0.51	0.55	0.65	0.61	0.69	0.77	0.75	1.01	1.56	1.05

Correlation results for daily and monthly data are presented separately in the following paragraphs for better clarity.

Daily Flows

Figure 4.22 Upper and Lower Drift Cr. Daily Flow Correlation, HY **2008-09**

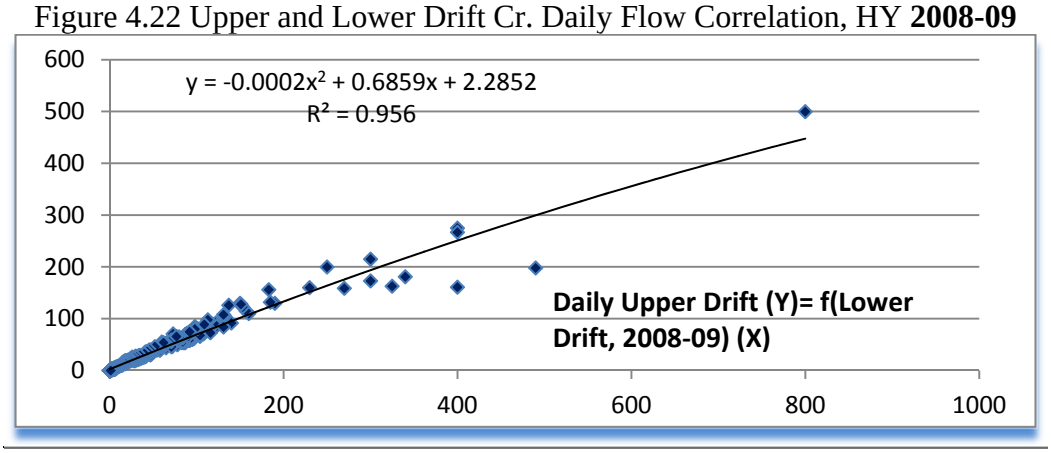


Figure 4.23 Upper and Lower Drift Cr. Daily Flow Correlation, HY **2009-10**

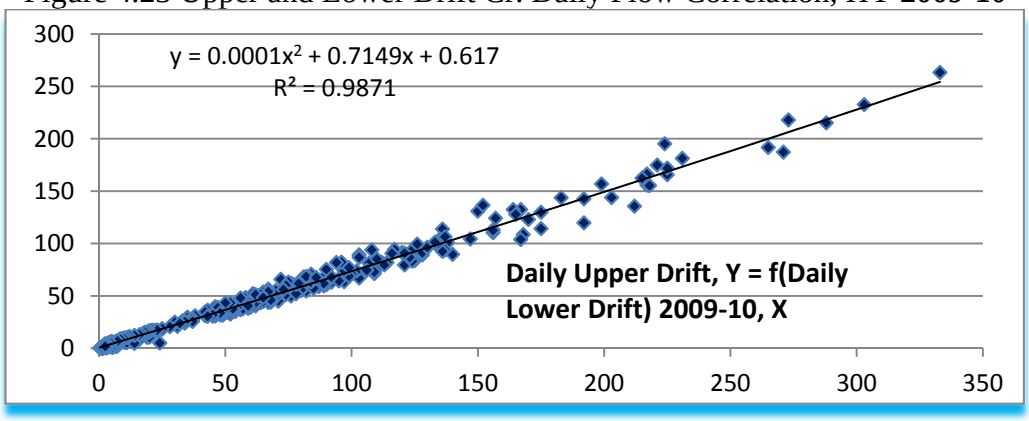


Figure 4.24 Upper and Lower Drift Cr. Daily Flow Correlation, HY **2010-11**

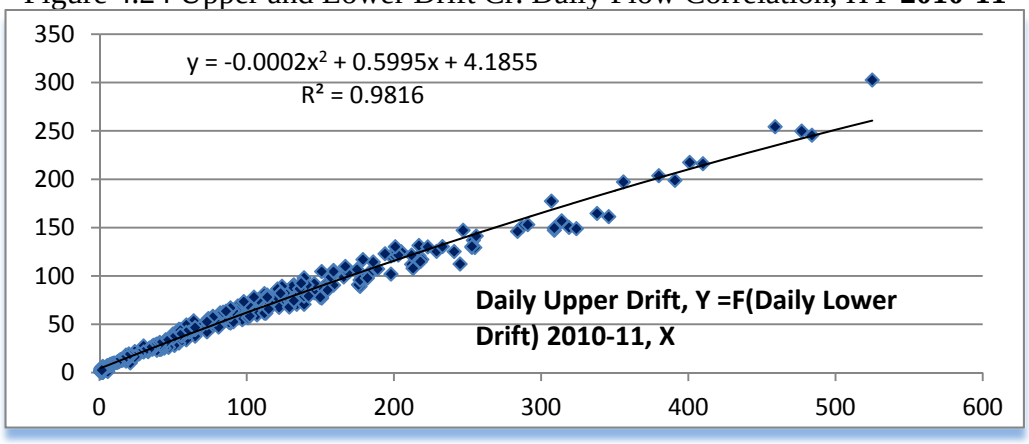
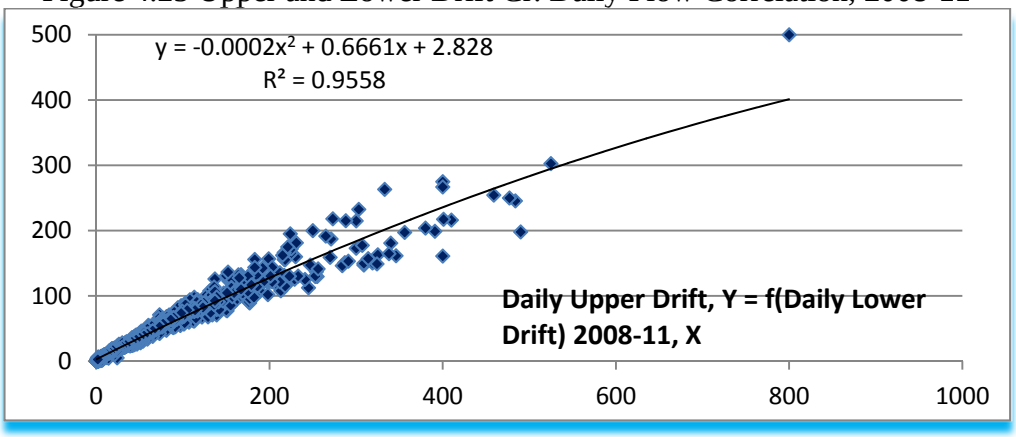


Figure 4.25 Upper and Lower Drift Cr. Daily Flow Correlation, **2008-11**



Monthly Flows

Figure 4.26 Upper and Lower Drift Cr. Monthly Flow Correlation, HY **2008-09**

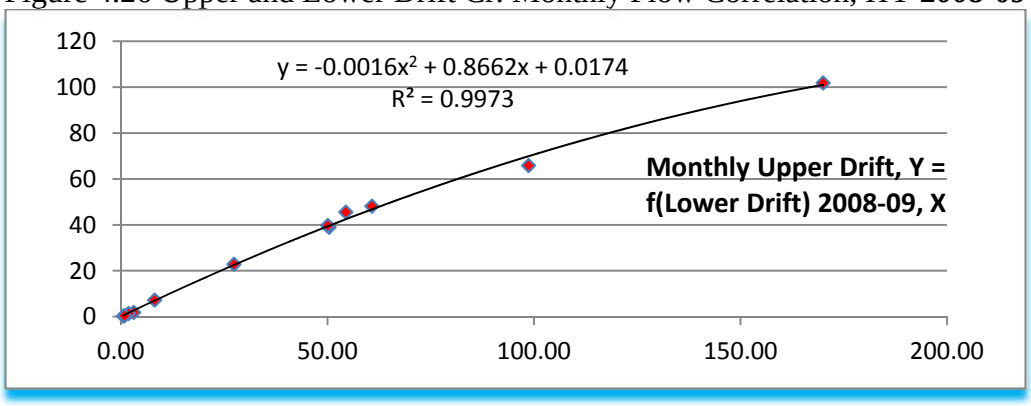


Figure 4.27 Upper and Lower Drift Cr. Monthly Flow Correlation, HY **2009-10**

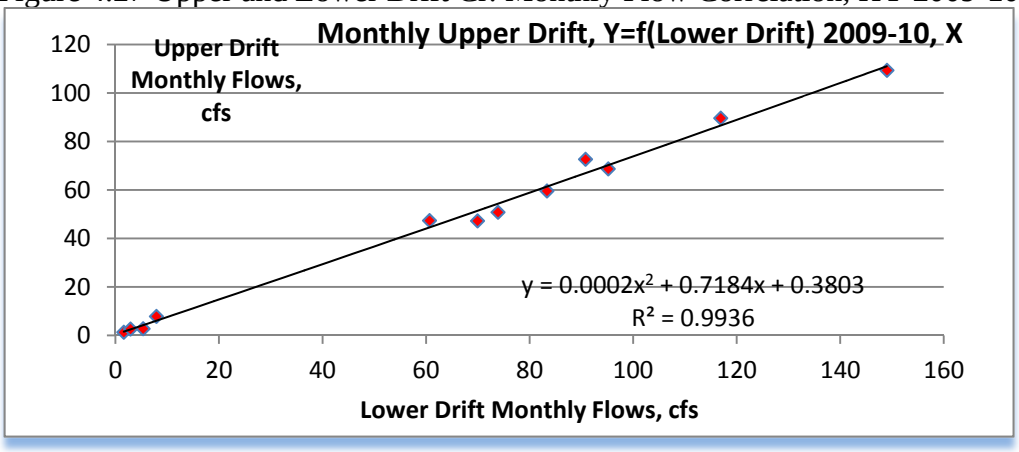


Figure 4.28 Upper and Lower Drift Cr. Monthly Flow Correlation, HY **2010-11**

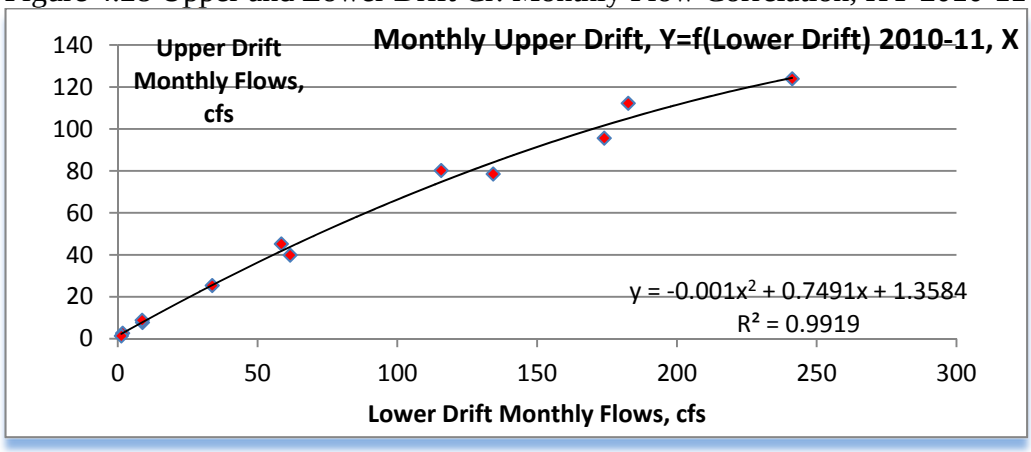


Figure 4.29 Upper and Lower Drift Cr. Monthly Flow Correlation, **2008-11**

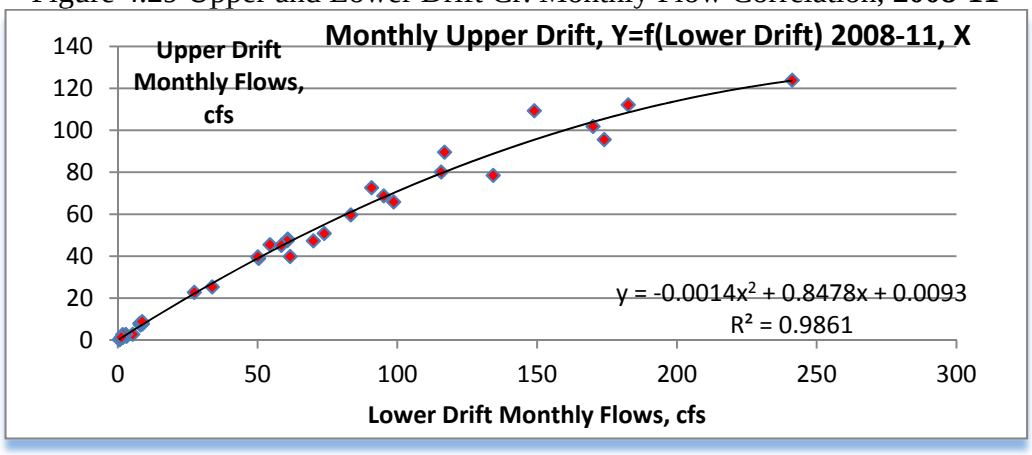


Table 4.10 Regression Equations Linking Lower Drift (X) to Upper Drift (Y)

Daily Flows	Regression Equation	R^2
2008-09	Y= -0.0002*X^2+0.6859*X+2.2852	0.956
2009-10	Y= -0.0001*X^2+0.7149*X+0.617	0.9871
2010-11	Y= -0.0002*X^2+0.599*X+4.1855	0.9861
2008-11	*Y= -0.0002*X^2+0.6661*X+2.828*	*0.9558*
Monthly Flows		
2008-09	Y= -0.0016*X^2+0.8661*X+0.00174	0.9973
2009-10	Y= 0.0002*X^2+0.7184*X+0.3803	0.9936
2010-11	Y= -0.001*X^2+0.7491*X+1.35840	0.9919
2008-10	*Y= -0.0014*X^2+0.8478*X+0.0093*	*0.9861*

Stream flow data recorded to date at both the upper and the lower gauging stations have been instrumental in firming up runoff estimates for Drift Creek. The two recording stations are the two nearest stations available on Drift Creek and, as such, provided the most reliable means to cross-check the stream flow readings. They also play a back-up role for one another, in case recordings at one of the stations are missing due to high flood events, equipment failures, and other unusual/unexpected circumstances. Flow records at those two sites should also provide a firmer basis for OWRD to revise their water availability data for the 50% and 80% exceedance frequencies at the mouth of Drift Creek.

5. Stream Flows at Nearby Streams

To provide the big picture of the runoff conditions that prevail in the region, stream flow data recorded at the following streams/gauging stations were analyzed: Pudding River at Aurora and at Woodburn, Silver Creek at Silverton, Abiqua Creek above Gallon House Bridge, Butte Creek at Monitor, and Zollner Creek near Mt. Angel. The needed data were available at all those stations between October 1, 2008 and September 30, 2011.

For the post-October 2011 period and as of October 19, 2014, the full stream flow data are only available on the USGS website for Upper Drift, Pudding River at Aurora and Woodburn,

and Zollner Creek but are very limited or even non-existent for the other streams. Lower Drift and Silver Creek only have stream flow data from June 22, 2014 to October 19, 2014; Silver Creek has stream flow data for the same 2014 period (with gaps between August 15-26); Butte Creek has stream flow data from January 24, 2014 to October 19, 2014; Abiqua Creek only has gage height data from June 22, 2014 to October 19, 2014; and Lower Drift only has stream flow data from May 20, 2014 to October 19, 2014 posted on the Internet.

Table 5.1 lists the monthly flow data that are available during the October 2008 – September 2014 period.

Table 5.1 2008-2014 Monthly Flows at Drift Cr. and Nearby Streams (when available), cfs

Streams	Pudding	Pudding	Drift	Drift	Silver	Lo.Abiqua	Butte	Zollner
Gauges=	Woodburn	Aurora	Upper	Lower	Silverton	GH Bridge	Monitor	Mt. Angel
Sq.Mi.	314	479	15.8	24.8	47.9	75.7	58.7	15
Area Ratio	20.39	31.1	1	1.57	3.11	4.79	3.715	0.97
Oct08	74.16	132.58	1.83	3.08	25.71	37.29	31.45	0.90
Nov08	556.73	767.80	22.82	27.38	217.60	315.63	160.10	4.93
Dec08	821.84	1110.10	48.19	60.77	199.65	514.00	237.23	31.03
Jan09	2237.45	3281.81	101.87	170.00	413.52	883.23	578.74	58.67
Feb09	562.86	830.07	38.93	50.39	164.00	203.89	149.04	11.28
Mar09	1146.90	1810.32	65.90	98.68	345.00	458.77	318.00	26.29
Apr09	727.00	1174.83	39.73	50.07	222.30	313.27	238.90	8.99
May09	710.03	1117.77	45.55	54.45	215.48	295.32	223.68	10.47
Jun09	148.20	247.27	7.24	8.15	19.79	57.83	32.94	1.19
Jul09	38.97	57.84	1.35	1.83	15.74	11.68	5.00	0.34
Aug09	15.62	21.65	0.24	0.59	8.61	5.06	2.09	0.26
Sep09	20.23	36.93	0.49	0.88	6.72	12.49	5.58	0.25
Av 08-09	591.0	886.4	31.18	44.0	154.8	260.4	166.0	13.0
Vol Ratio	18.95	28.42	1.00	1.41	4.96	8.35	5.32	0.45
Vol, AF	427,771	641,582	22,629	31,880	112,077	188,487	120,131	9,407
Oct-Apr V	370,748	551,076	19,159	27,847	95,757	165,120	103,653	8,585
Oct09	61.19	99.84	2.84	5.32	22.04	58.90	19.33	0.97
Nov09	777.67	1179.60	50.84	73.87	222.97	343.93	226.80	24.43
Dec09	1007.00	1508.16	59.66	83.32	233.06	368.65	253.58	34.09
Jan10	1954.71	2843.55	109.37	149.00	429.39	628.65	412.16	71.42
Feb10	834.46	1287.64	47.32	69.93	189.46	292.00	177.11	30.14
Mar10	992.10	1452.06	68.76	95.16	298.29	408.39	298.84	24.18
Apr10	1432.77	2252.33	89.62	116.90	383.37	491.87	379.13	26.29
May10	663.55	1076.85	47.43	60.64	202.33	321.21	215.70	9.44
Jun10	1100.64	1676.93	72.70	90.79	306.61	402.57	310.18	24.31

Jul10	126.58	183.74	7.90	7.87	36.68	54.39	24.20	1.04
Aug10	42.39	49.32	1.38	1.59	15.05	12.09	5.41	0.69
Sep10	64.17	90.07	2.71	2.87	38.73	21.97	16.06	1.10
Av 09-10	753.1	1138.7	46.63	63.0	197.8	283.3	194.6	20.6
Vol. Ratio	16.09	24.33	1.00	1.35	4.23	6.05	4.16	0.44
Vol, AF	545,117	824,216	33,749	45,571	143,168	205,055	140,852	14,921
Oct-Apr V	424,646	638,574	25,601	35,690	107,005	155,967	106,365	12,664
Oct10	181.81	275.90	7.79	8.82	53.52	85.81	48.13	8.40
Nov10	1211.53	1857.27	78.55	134.30	310.70	456.73	298.37	45.40
Dec10	2720.65	4140.97	123.90	241.26	665.00	911.61	689.10	95.94
Jan11	2150.13	3344.19	95.62	174.00	506.39	675.74	498.29	51.68
Feb11	624.43	1109.64	39.89	61.64	152.57	235.21	154.75	18.85
Mar11	2233.87	3538.71	112.20	182.58	519.48	697.65	536.19	75.32
Apr11	1535.73	2467.00	80.17	115.67	424.00	589.67	425.67	32.26
May11	712.52	1184.65	45.24	58.48	202.81	342.29	253.77	8.13
Jun11	465.90	798.17	25.35	33.77	127.67	204.83	175.97	4.66
Jul11	133.19	207.94	8.86	8.73	39.81	50.45	33.61	1.75
Aug11	51.23	83.94	2.69	1.73	19.23	17.48	7.85	0.57
Sep11	31.70	50.60	1.33	1.27	17.63	12.11	7.02	0.61
Av 10-11	1009.6	1595.4	51.80	85.5	254.4	358.1	262.0	28.8
Vol. Ratio	19.49	30.80	1.00	1.65	4.91	6.91	5.06	0.56
Vol, AF	730,765	1,154,752	37,606	61,908	184,151	259,175	189,612	20,844
Oct-Apr V	646,026	1,013,493	32,049	55,586	159,411	221,051	160,577	19,372
Oct11	92.16	107.26	4.83					3.83
Nov11	668.87	950.13	41.86					24.83
Dec11	594.65	829.58	39.81					25.66
Jan12	3331.71	4723.16	140.27					119.13
Feb12	1419.69	1944.48	66.83					33.57
Mar12	2843.23	4085.48	144.60					115.65
Apr12	2175.67	3065.67	86.17					40.04
May12	777.03	1056.06	39.21					7.60
Jun12	451.43	596.03	24.52					3.54
Jul12	150.26	203.71	6.98					1.67
Aug12	39.52	66.74	1.87					31.01
Sep12	27.83	49.87	0.80					0.99
Av 11-12	1047.94	1473.88	49.81					31.60
Vol. Ratio	21.04	29.59	1.00					0.63
Vol, AF	760,573	1,069,775	36,178					22,936
Oct-Apr V	672,675	949,805	31,419					21,800

Oct12	258.52	307.19	12.25					8.65
Nov12	1894.40	2568.30	94.24					84.07
Dec12	2443.23	3330.97	121.47					96.81
Jan13	1090.48	1439.52	62.22					27.68
Feb13	1030.82	1441.75	56.23					15.96
Mar13	856.61	1221.77	37.61					13.43
Apr13	711.47	1028.83	29.75					8.99
May13	451.48	615.84	22.76					5.64
Jun13	338.73	455.93	18.07					2.83
Jul13	75.13	106.29	5.17					0.64
Aug13	22.71	32.74	2.22					0.32
Sep13	168.80	203.03	12.94					6.91
Av 12-13	776.46	1059.55	39.58					22.68
Vol. Ratio	19.62	26.77	1.00					0.57
Vol, AF	561,998	766,897	28,553					16,417
Oct-Apr V	498,036	681,291	24,102					14,900
Oct13	489.68	664.23	28.09					7.37
Nov13	600.43	844.30	38.15					13.85
Dec13	657.90	910.30	33.78					11.01
Jan14	732.10	1040.74	40.31					14.88
Feb14	2423.43	3492.25	123.21				615.68	85.64
Mar14	2040.16	2885.16	97.41				531.68	61.19
Apr14	1175.27	1640.40	60.21				290.00	12.88
May14	685.35	997.35	35.19				194.52	10.68
Jun14	162.70	253.93	8.76	10.54			43.07	1.20
Jul14	74.55	116.52	3.01	3.49	1.16		15.26	1.05
Aug14	19.77	32.74	0.53	0.56	0.90		4.35	0.84
Sep14	23.07	34.13	0.75	0.59	0.87		6.36	1.84
Av 13-14	746.26	1059.37	39.12					18.11
Vol. Ratio	19.07	27.08	1.000					0.46
Vol, AF	540,139	766,767	31,117					13,106
Oct-Apr V	481,159	679,144	25,928					11,699
Streams	Pudding	Pudding	Drift	Drift	Silver	Lo.Abiqua	Butte	Zollner
Gauges=	Woodburn	Aurora	Upper	Lower	Silverton	GH Bridge	Monitor	Mt. Angel

Figure 5.1 shows the hydrographs of the daily flows at all stations, while Figures 5.2, 5.2a, 5.2b and 5.2c focus on the smaller streams. The hydrologic years covered in each figure depend on data availability.

Figure 5.1 Daily Flow Hydrographs for All Streams, **2008-11**

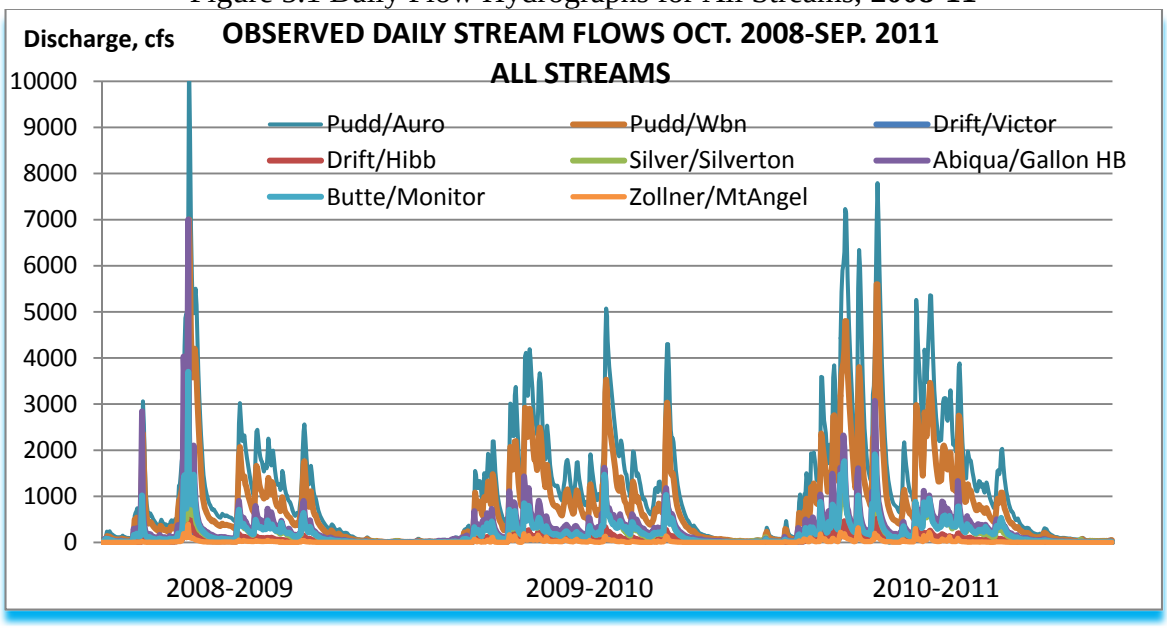


Figure 5.2 Daily Flow Hydrographs for Selected Streams, **2008-11**

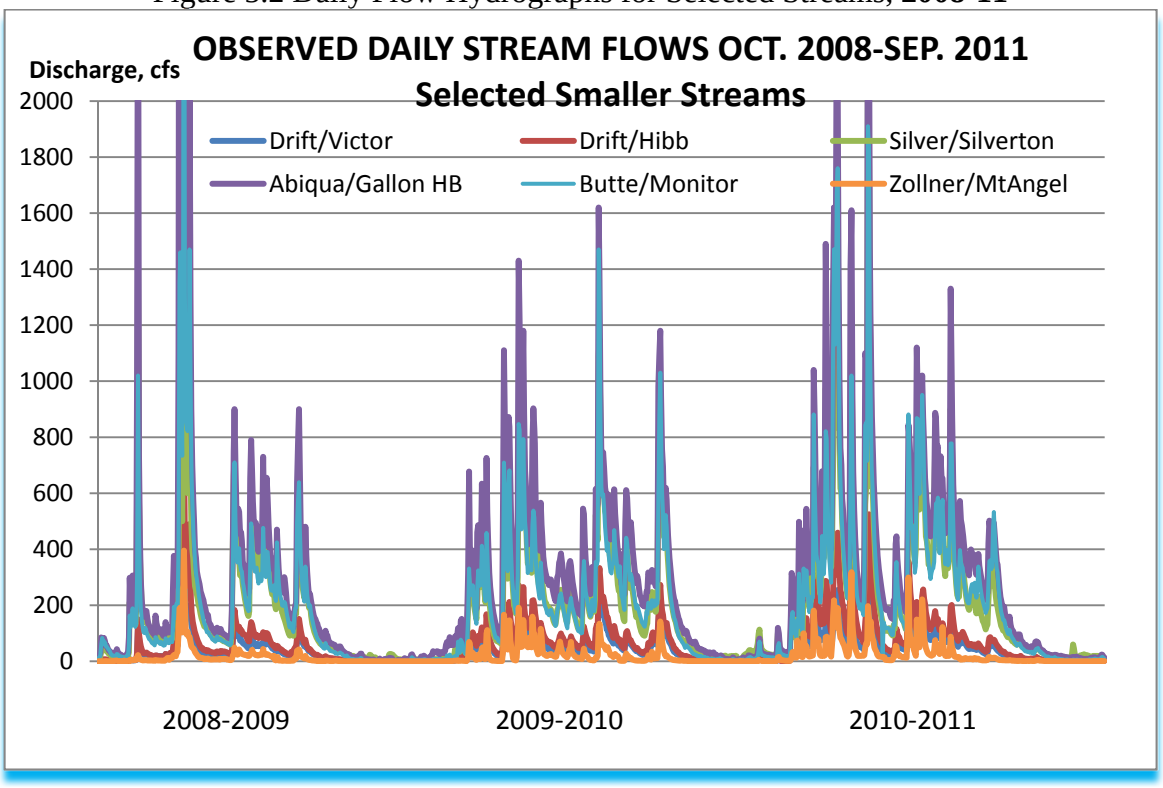


Figure 5.2a Daily Flow Hydrographs for Smaller Streams, **2008-09**

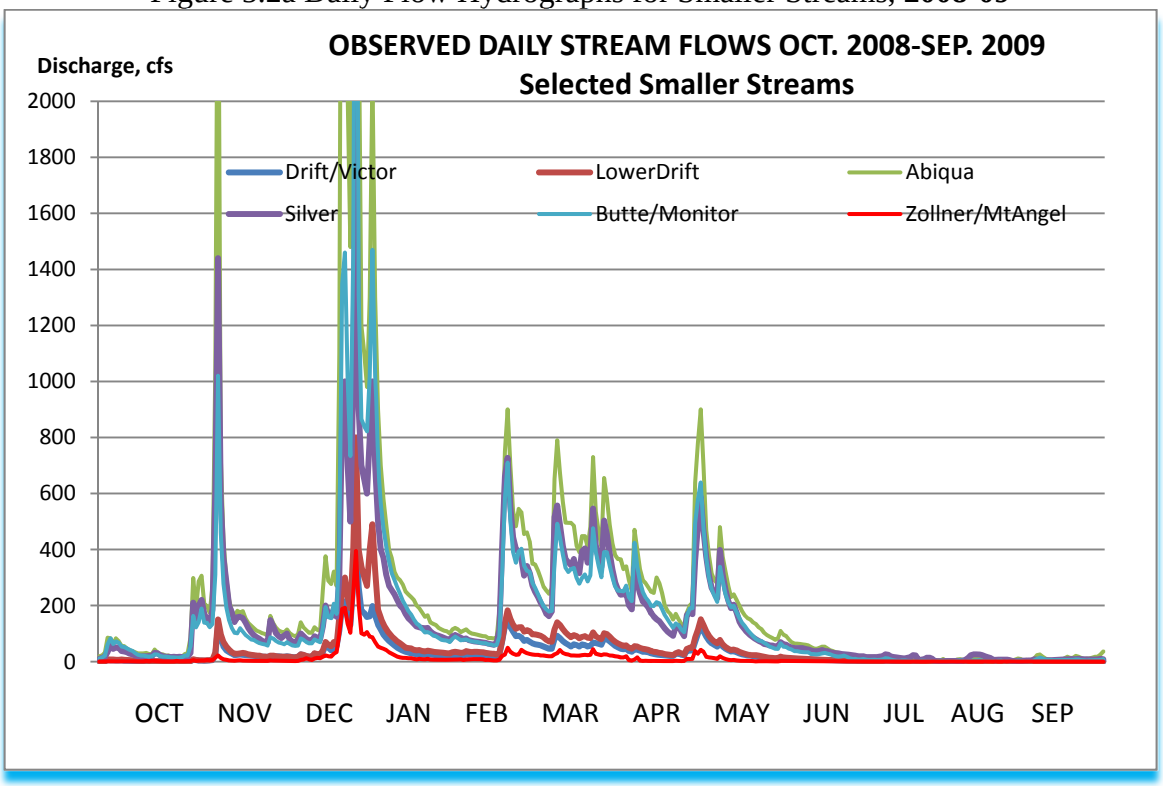


Figure 5.2b Daily Flow Hydrographs for Smaller Streams, **2009-10**

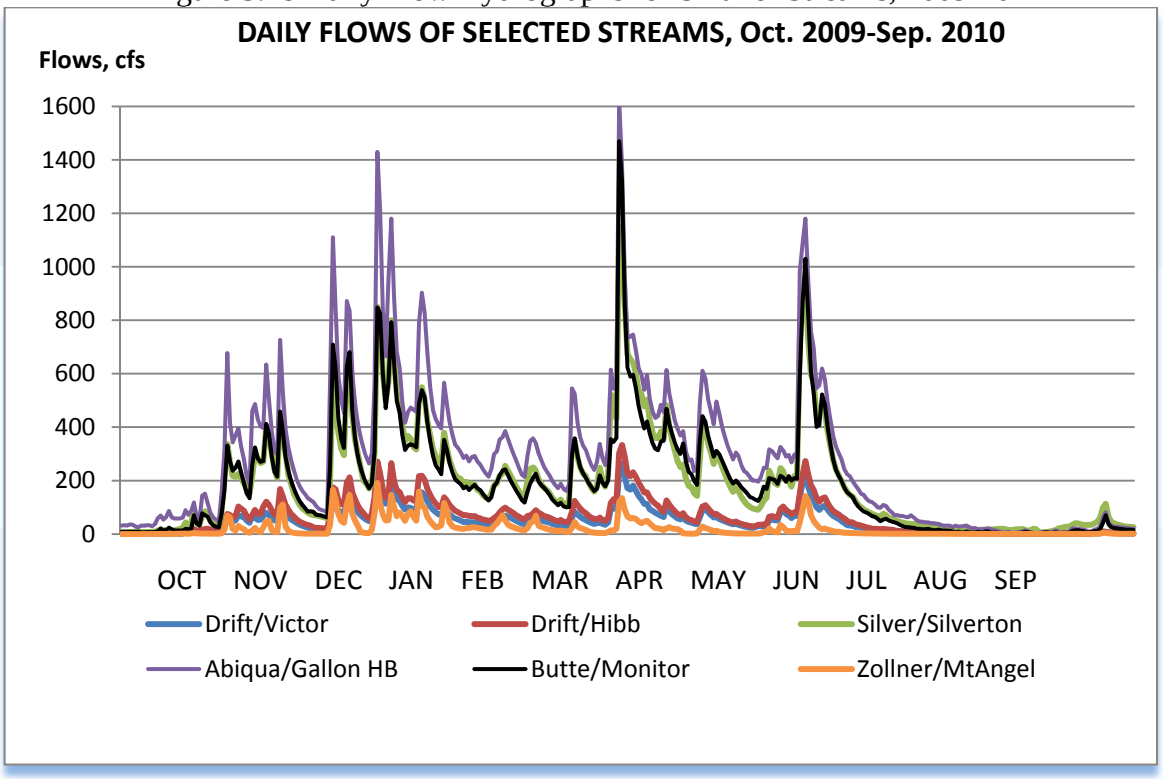
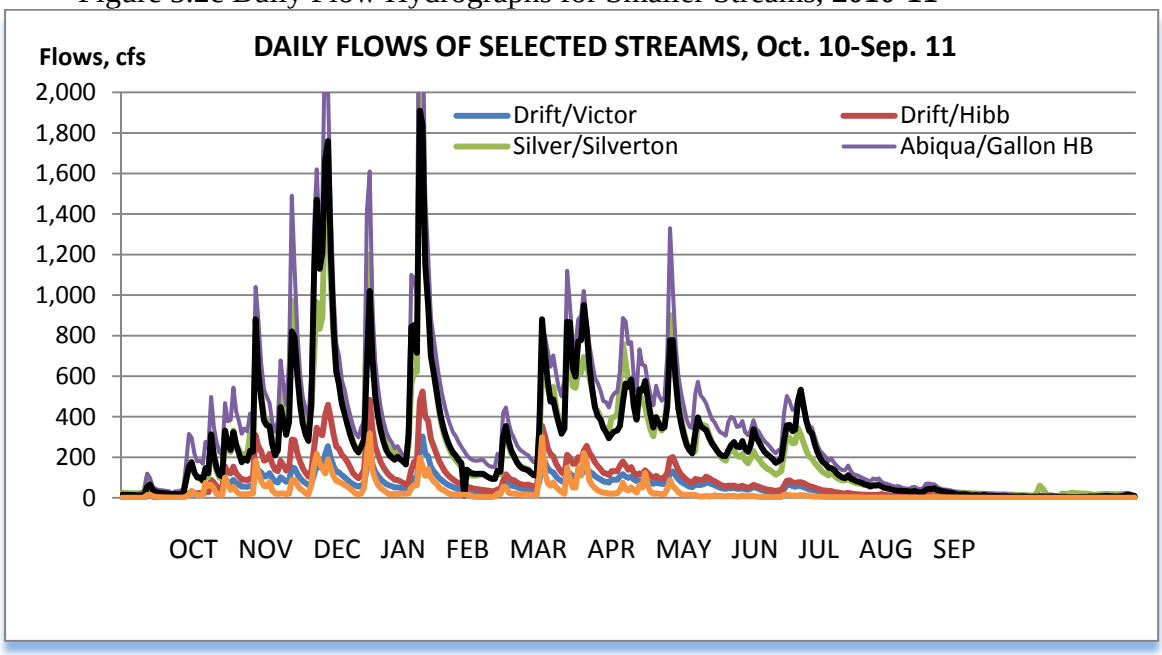


Figure 5.2c Daily Flow Hydrographs for Smaller Streams, **2010-11**



Figures 5.3 through 5.8 provide a closer, one-on-one comparison between Drift Creek flows and the flows at other nearby streams covering the three (2008-11) or six (2008-14) hydrologic years, depending on data availability.

Figure 5.3 Daily Flow Hydrograph of Upper Drift and Pudding @ Aurora, **2008-14**

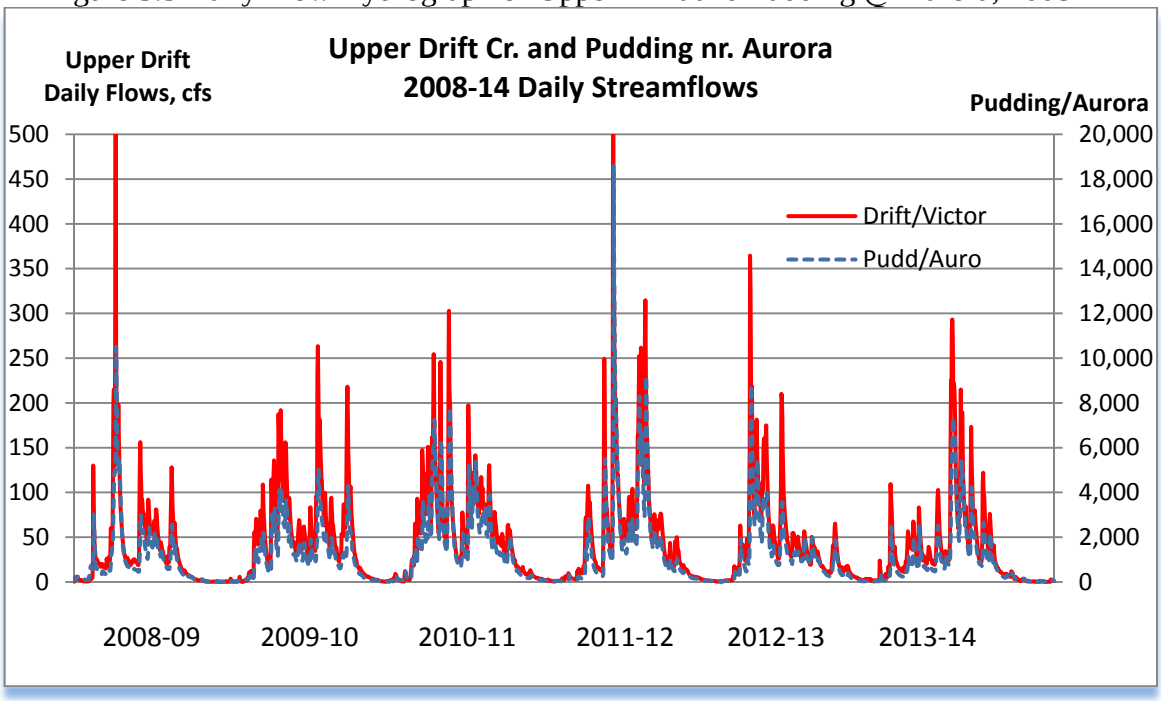


Figure 5.4 Daily Flow Hydrograph of Upper Drift and Pudding @ Woodburn **2008-14**

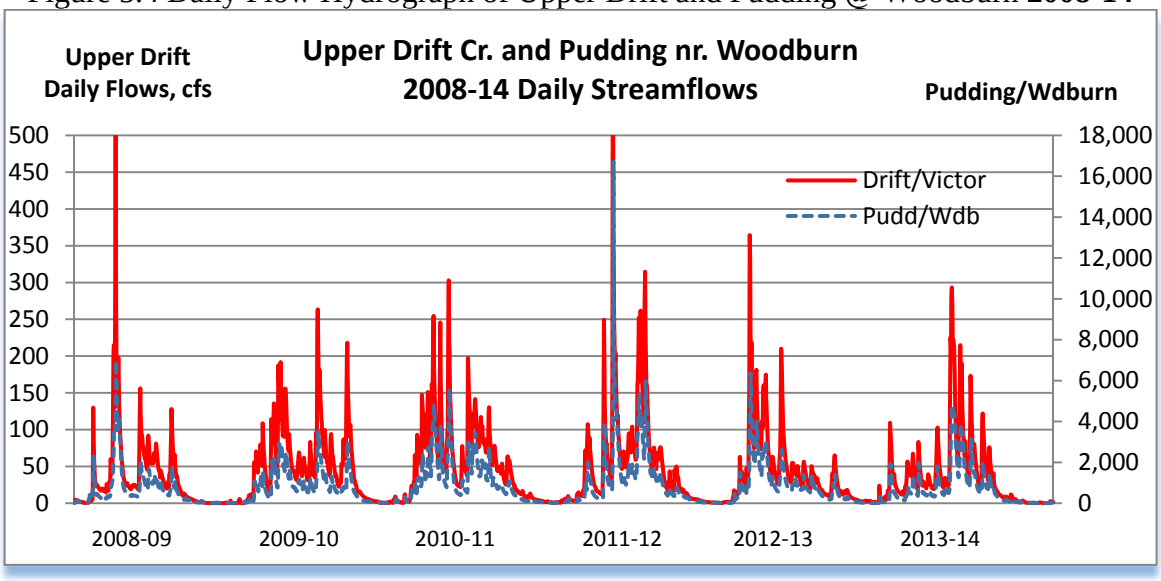


Figure 5.5 Daily Flow Hydrograph of Upper Drift and Silver Cr. @ Silverton, **2008-11**

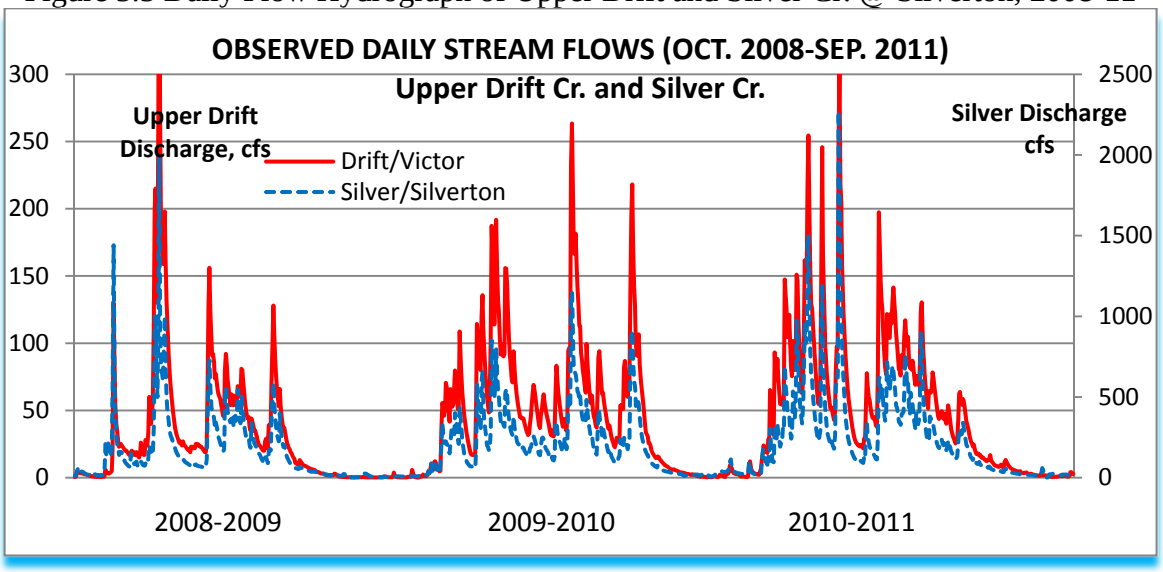


Figure 5.6 Daily Flow Hydrograph of Upper Drift and Abiqua @ Gallon House Bridge **2008-11**

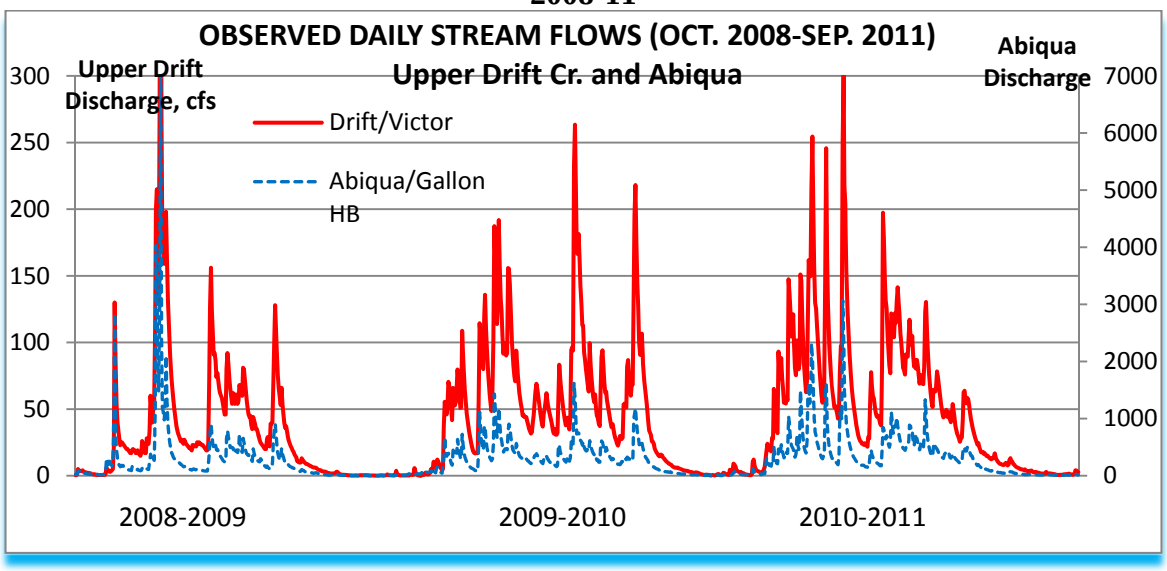


Figure 5.7 Daily Flow Hydrograph of Upper Drift and Butte @ Monitor **2008-11**

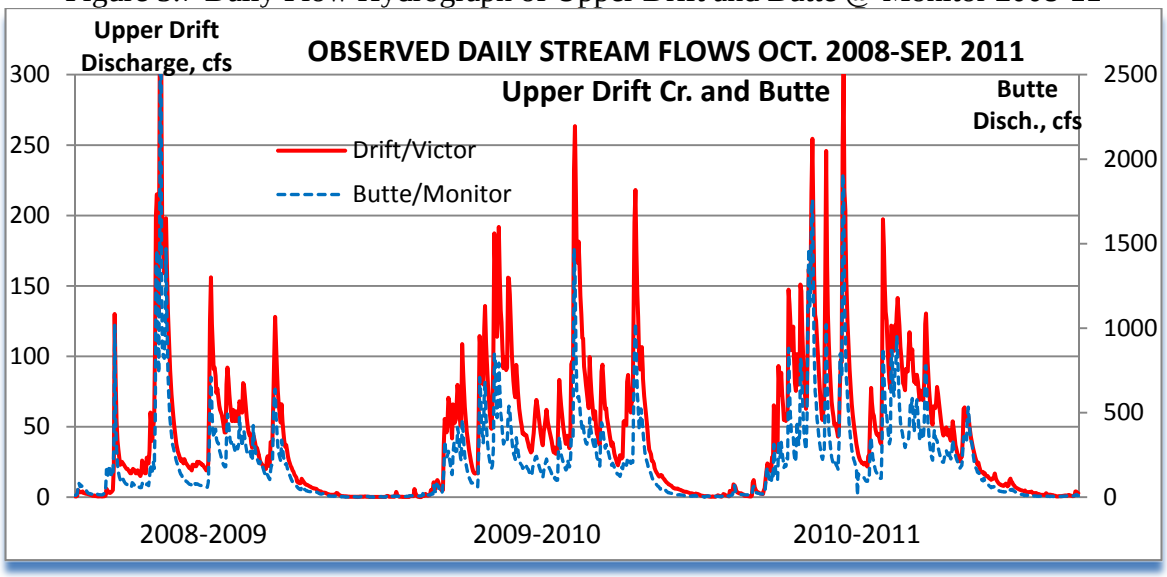
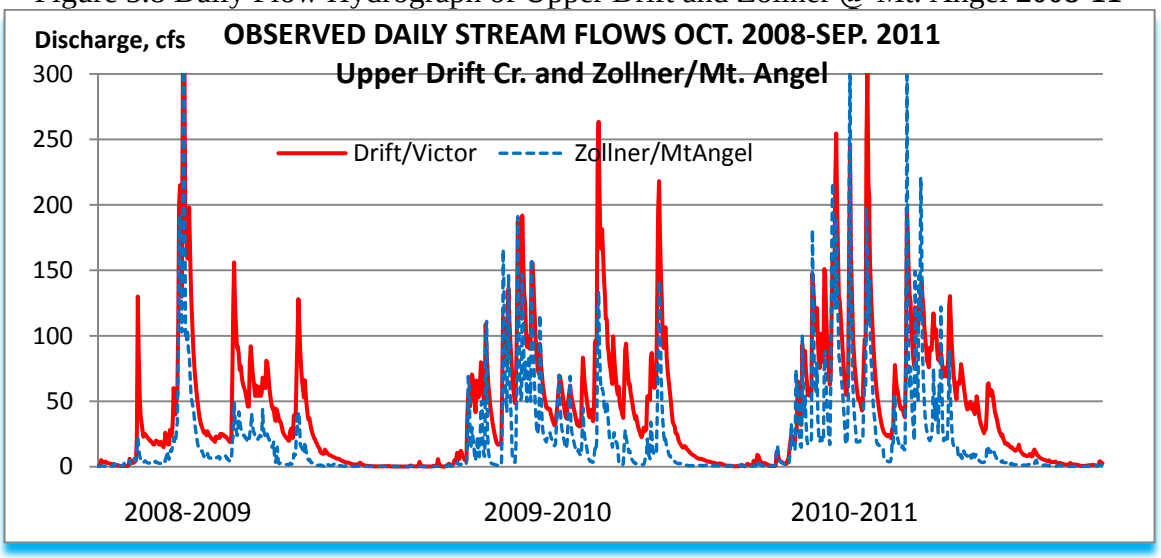


Figure 5.8 Daily Flow Hydrograph of Upper Drift and Zollner @ Mt. Angel **2008-11**



Figures 5.9 through 5.14 provide the same type of runoff information on a **monthly** basis. The plots also include the runoff volume ratios of the streams involved.

Figure 5.9 Plots of Monthly Flows of Upper Drift and Pudding @ Aurora **2008-14**

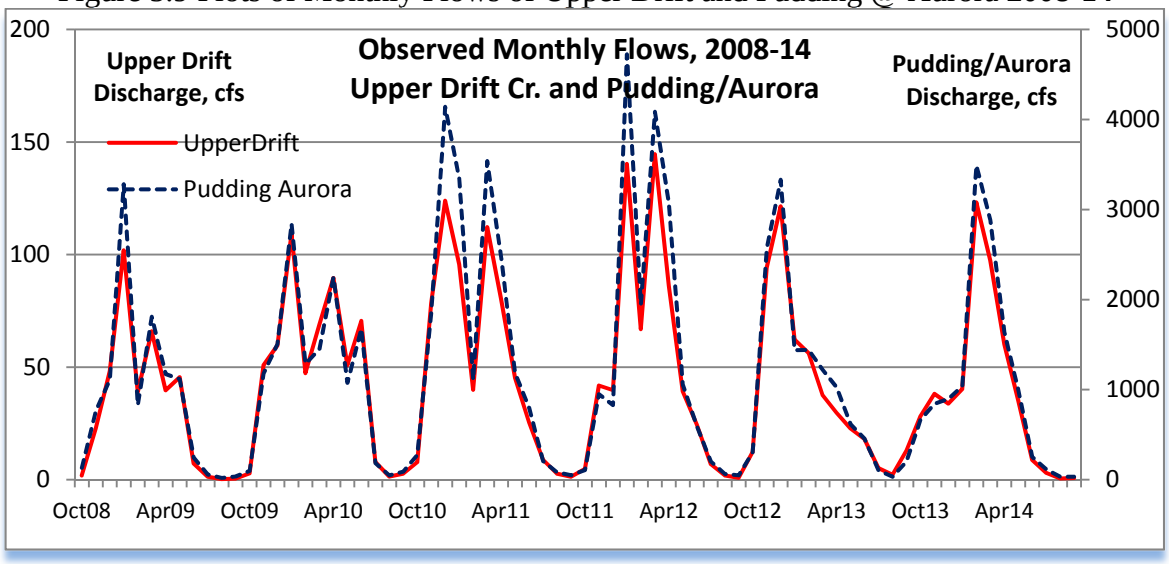


Figure 5.10 Plots of Monthly Flows of Upper Drift and Pudding @ Woodburn **2008-14**

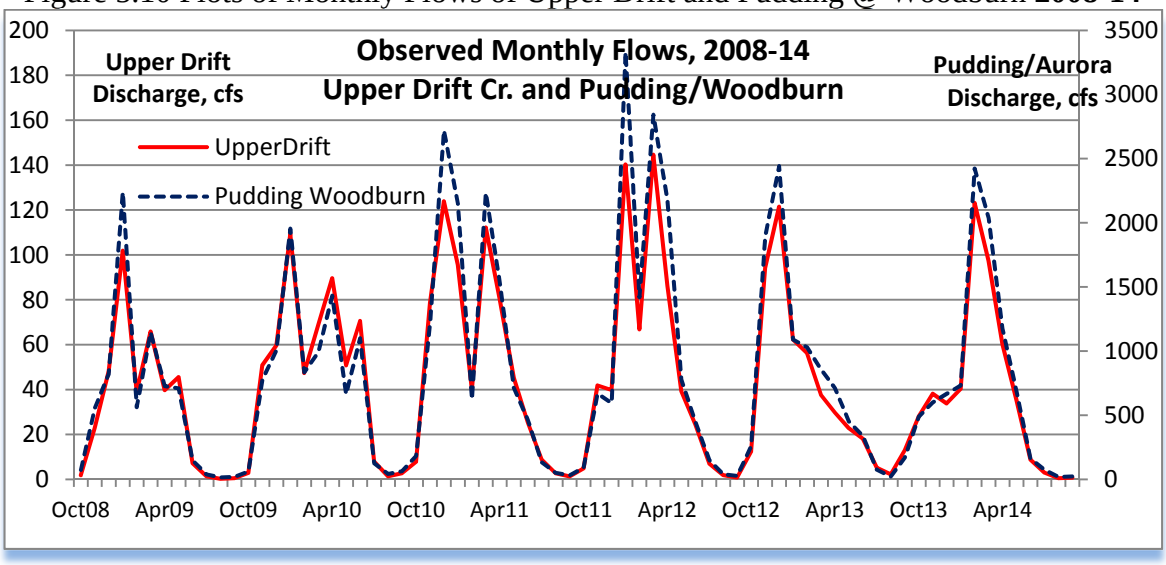


Figure 5.11 Plots of Monthly Flows of Upper Drift and Silver @ Silverton **2008-11**

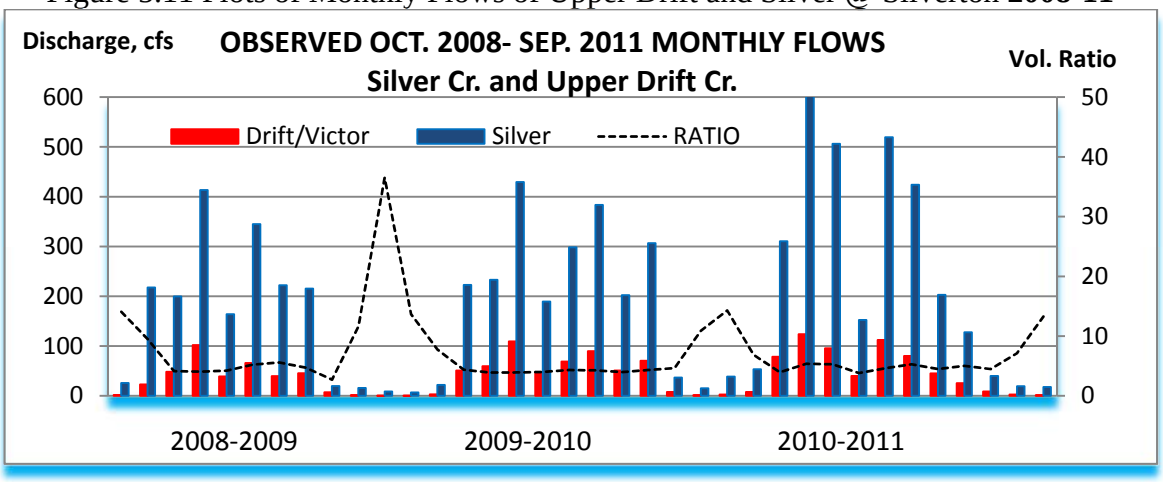


Figure 5.12 Plots of Monthly Flows of Upper Drift and Abiqua @ G. H. Bridge **2008-11**

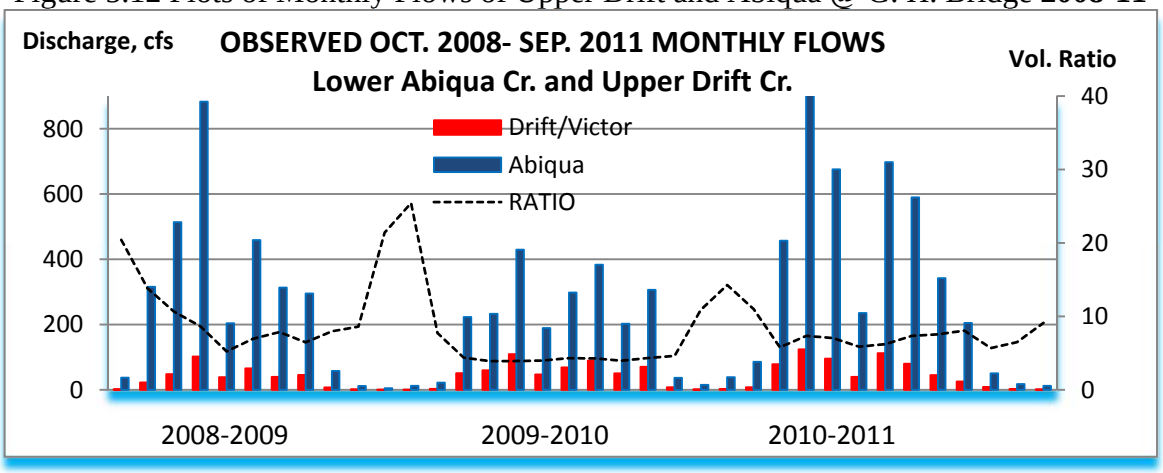


Figure 5.13 Plots of Monthly Flows of Upper Drift and Butte @ Monitor **2008-11**

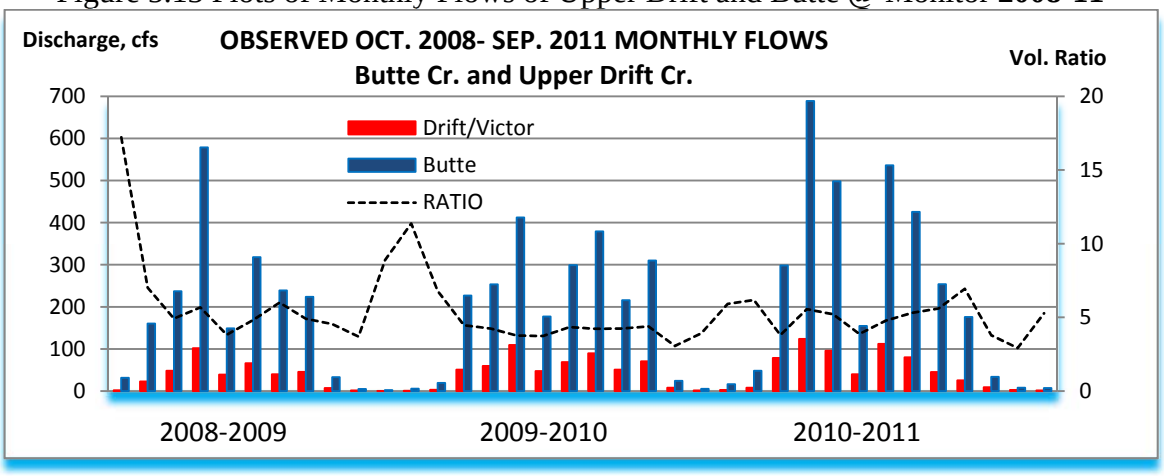
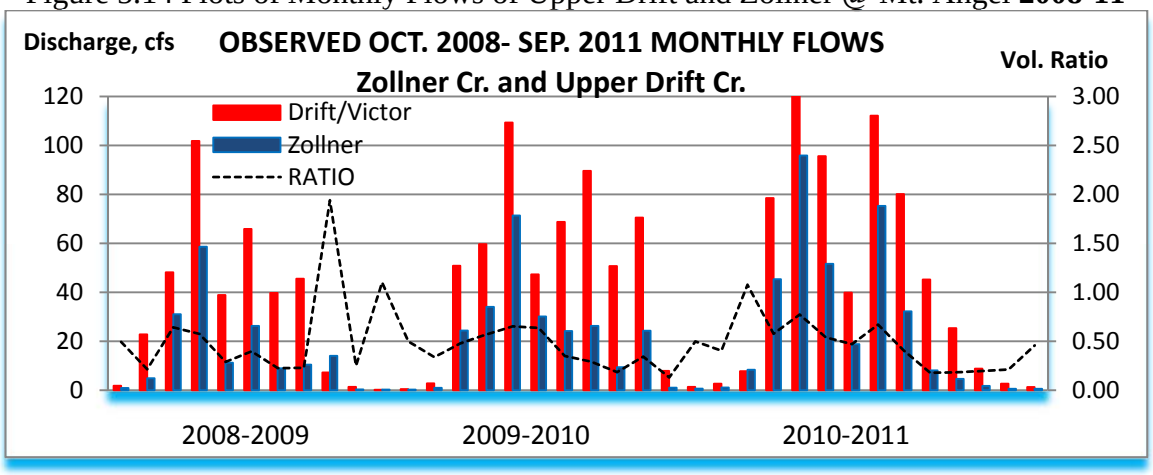


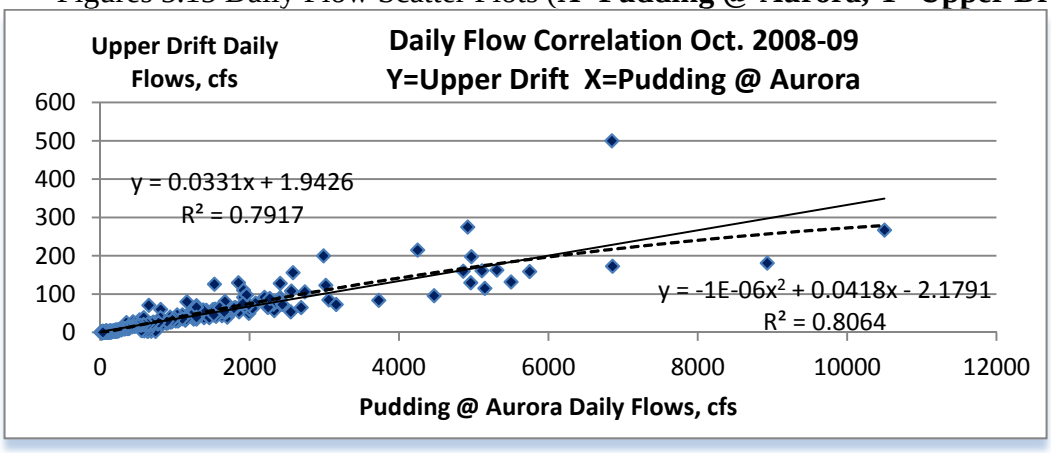
Figure 5.14 Plots of Monthly Flows of Upper Drift and Zollner @ Mt. Angel **2008-11**

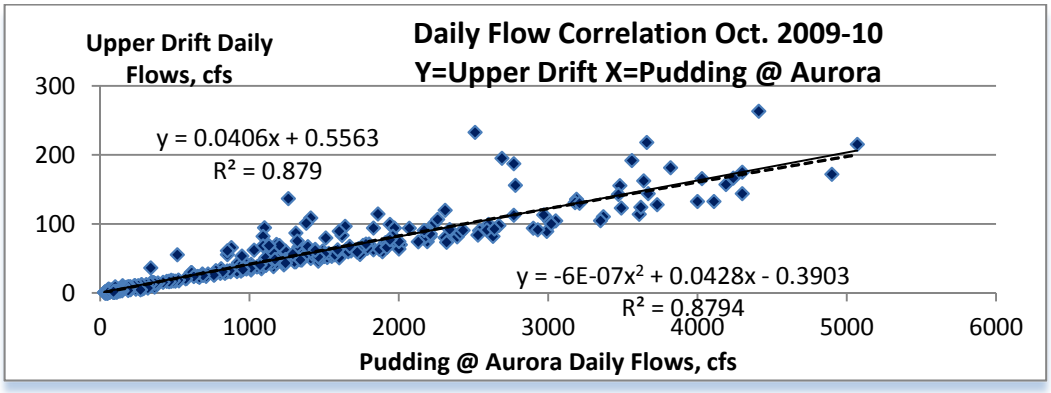


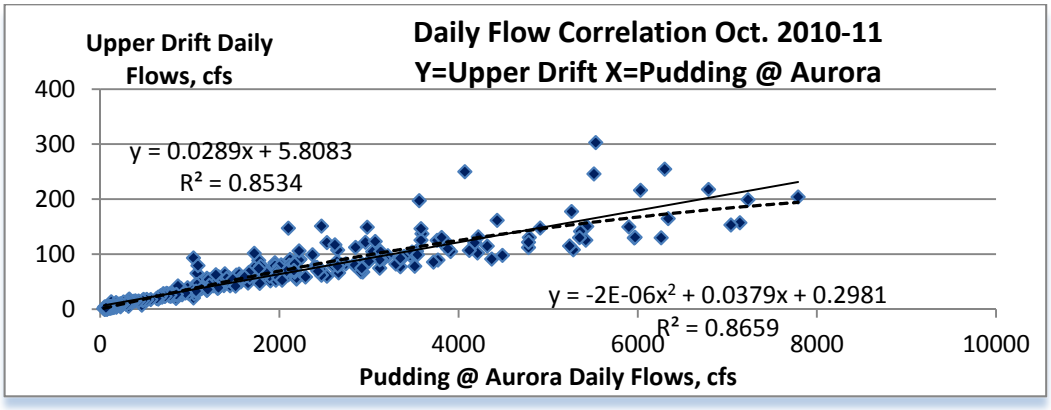
To provide the level of correlation between Upper Drift Creek flows and the corresponding flows at other streams, graphical scatter plots were performed. Those scatter plots define the polynomial regression equations relating the two parameters (X=Drift Creek flows vs. Y=corresponding flows from the other stream), as well as the correlation indicator, R^2. These plots were done separately for daily and monthly flows, and are shown in Figures 5.15 through 5.20 (daily flows) and Figures 5.21 through 5.26 (monthly flows). Each figure includes the plots for any and all hydrologic years (2008-14) depending on data availability.

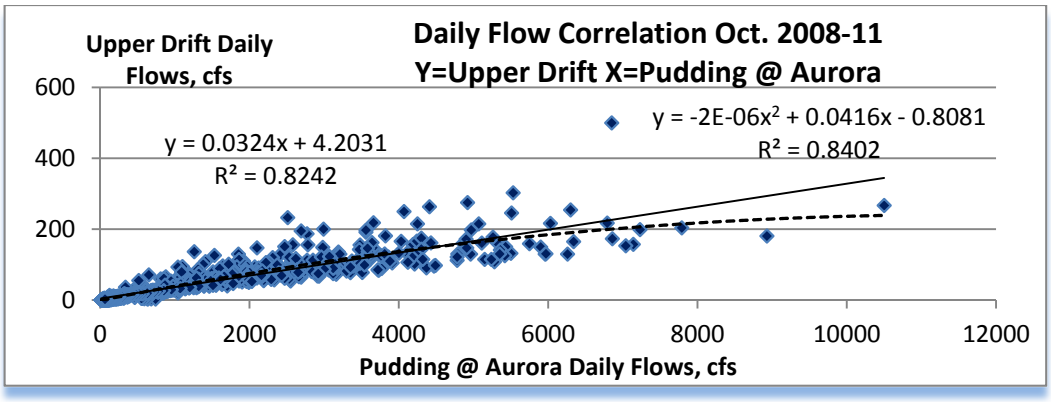
Note that some of the results may not match exactly those shown in previous report updates as some of the data used before had been modified later by the flow data collectors. Both the linear and order 2 polynomial trend/regression options are used to see which option yields the highest R^2 value.

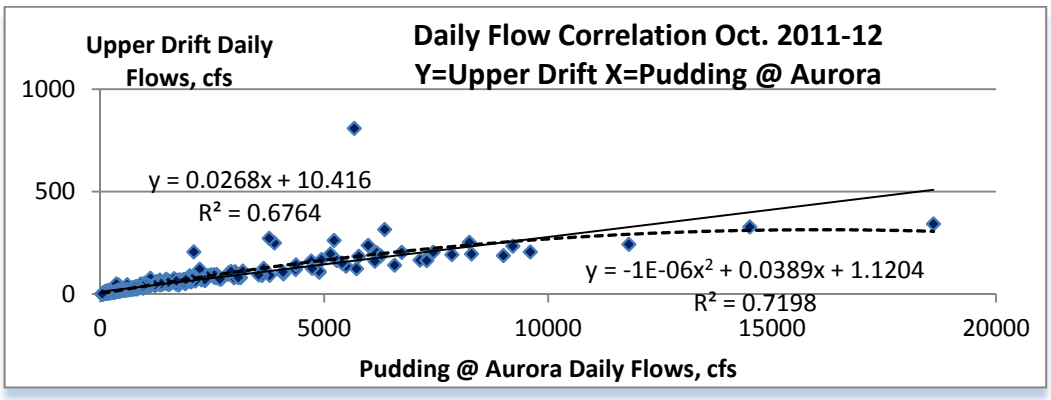
Figures 5.15 Daily Flow Scatter Plots (**X=Pudding @ Aurora, Y=Upper Drift**)

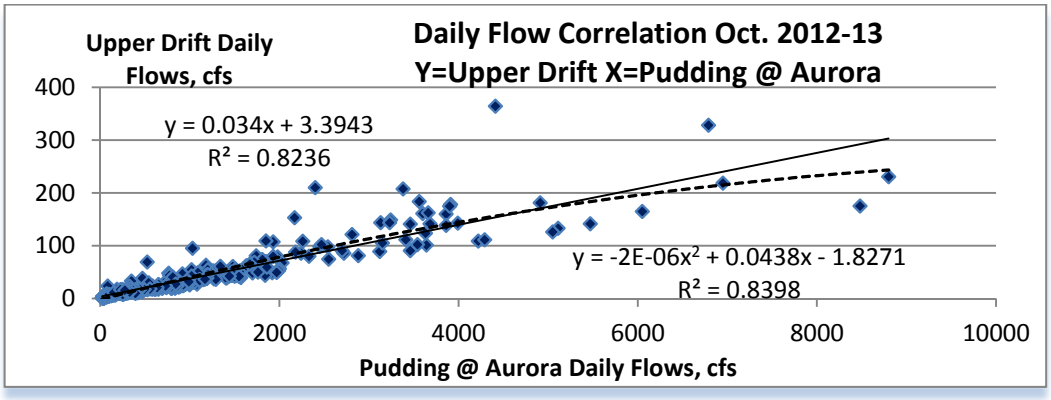


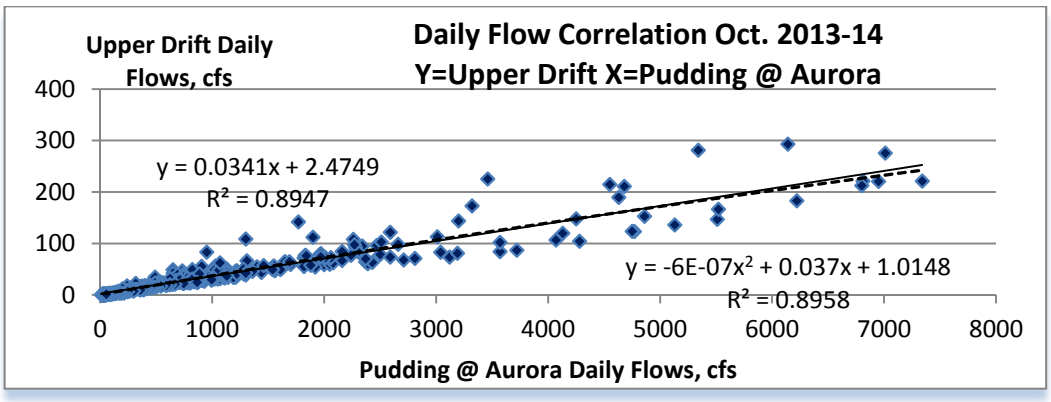


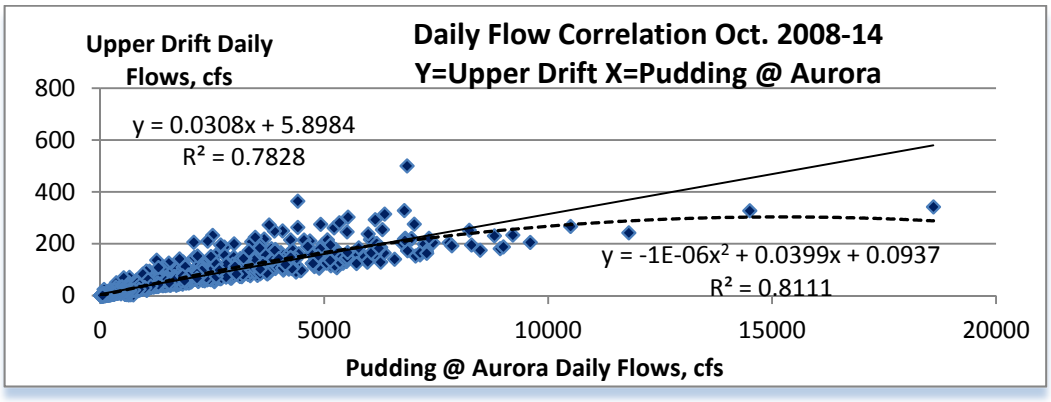



Daily Flow Correlation Oct. 2008-11
Y=Upper Drift X=Pudding @ Aurora
Upper Drift Daily Flows, cfs
y = 0.0324x + 4.2031
R² = 0.8242
y = -2E-06x² + 0.0416x - 0.8081
R² = 0.8402
0
200
400
600
0
2000
4000
6000
8000
10000
12000
Pudding @ Aurora Daily Flows, cfs

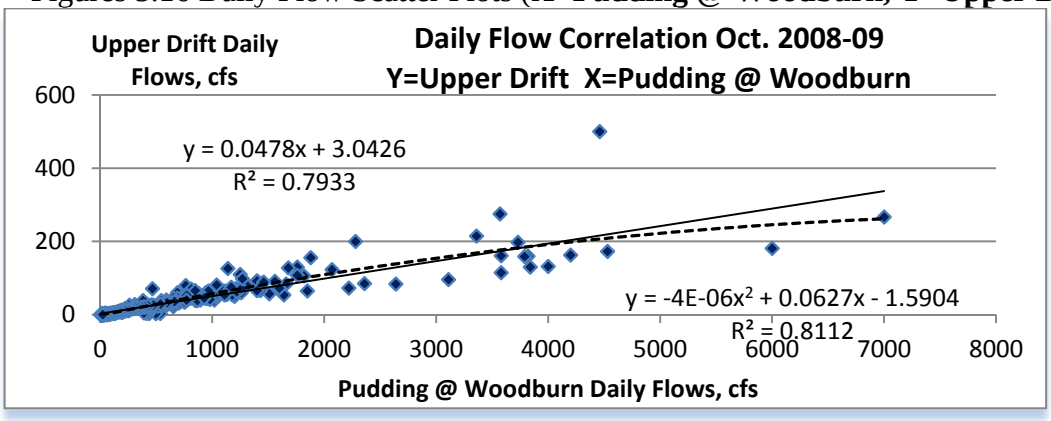

Daily Flow Correlation Oct. 2011-12
Y=Upper Drift X=Pudding @ Aurora
Upper Drift Daily Flows, cfs
y = 0.0268x + 10.416
R² = 0.6764
y = -1E-06x² + 0.0389x + 1.1204
R² = 0.7198
0
500
1000
0
5000
10000
15000
20000
Pudding @ Aurora Daily Flows, cfs

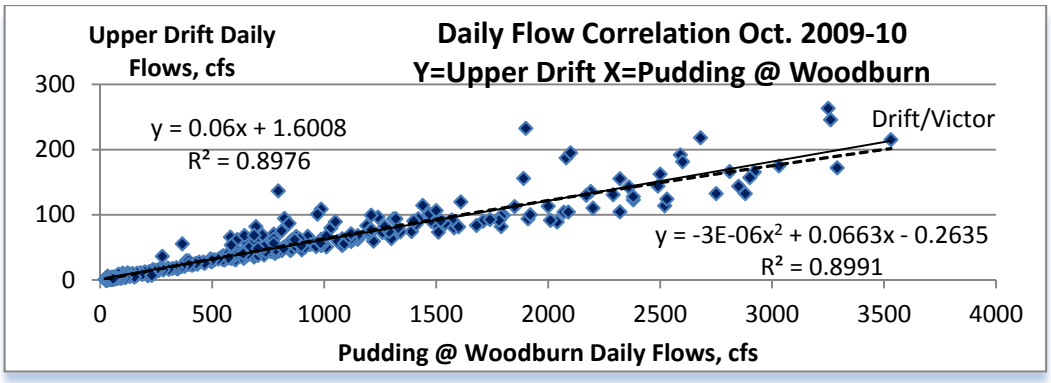

Daily Flow Correlation Oct. 2012-13
Y=Upper Drift X=Pudding @ Aurora
Upper Drift Daily Flows, cfs
y = 0.034x + 3.3943
R² = 0.8236
y = -2E-06x² + 0.0438x - 1.8271
R² = 0.8398
0
100
200
300
400
0
2000
4000
6000
8000
10000
Pudding @ Aurora Daily Flows, cfs

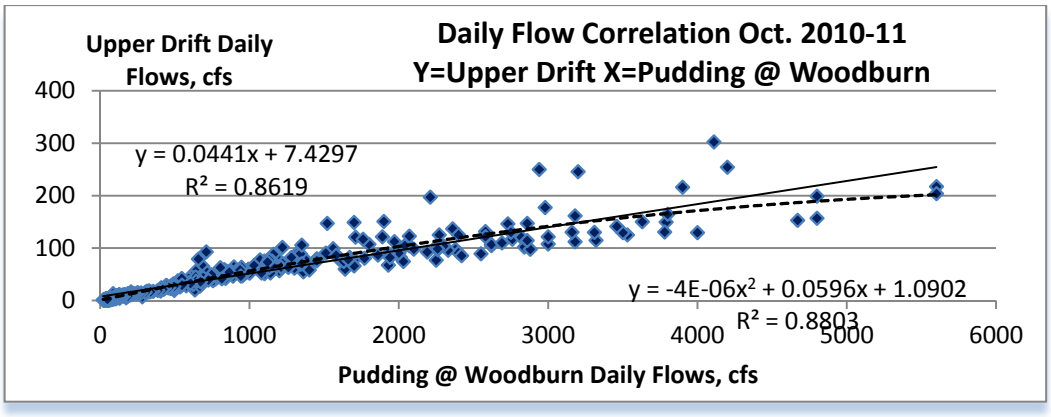

Daily Flow Correlation Oct. 2013-14
Y=Upper Drift X=Pudding @ Aurora
Upper Drift Daily Flows, cfs
y = 0.0341x + 2.4749
R² = 0.8947
y = -6E-07x² + 0.037x + 1.0148
R² = 0.8958
0
100
200
300
400
0
1000
2000
3000
4000
5000
6000
7000
8000
Pudding @ Aurora Daily Flows, cfs

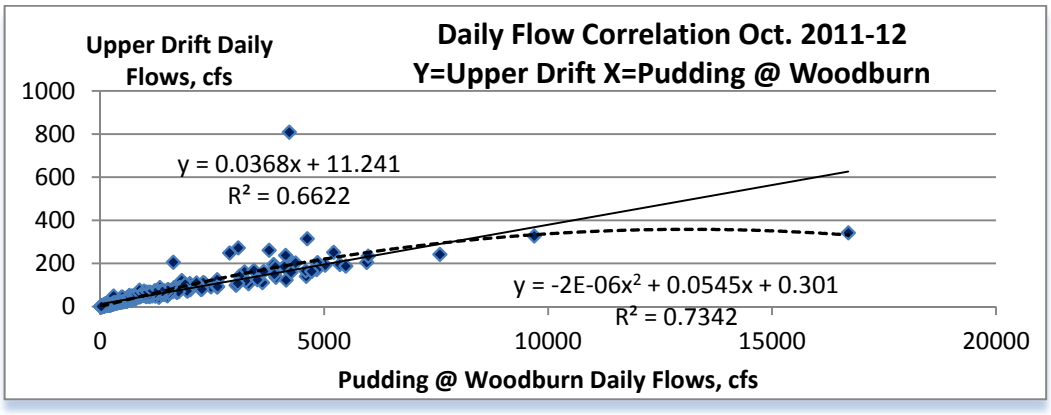


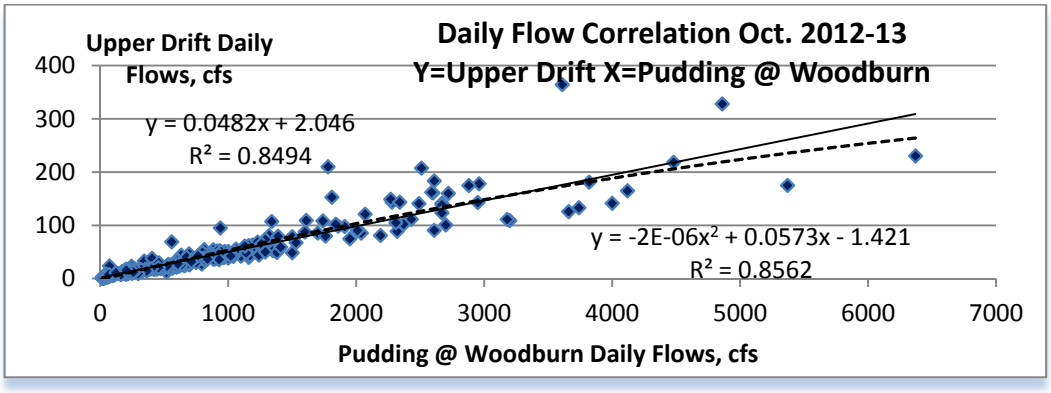
Figures 5.16 Daily Flow Scatter Plots (**X=Pudding @ Woodburn, Y=Upper Drift)**

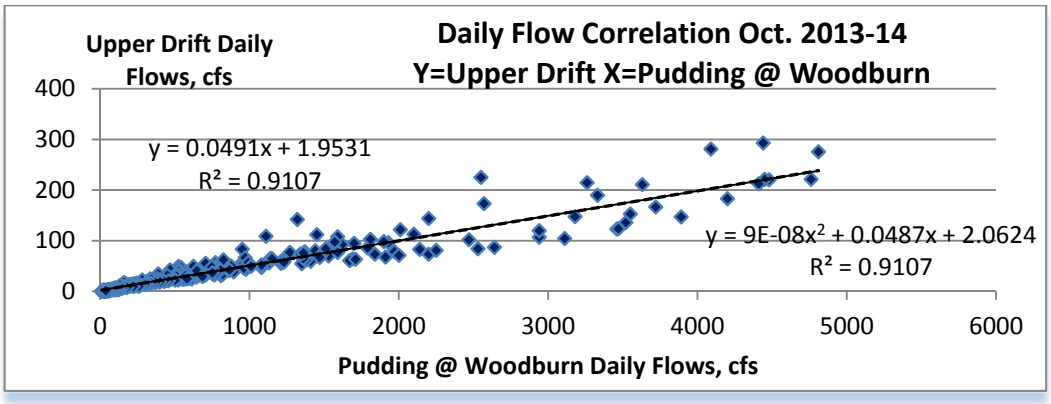


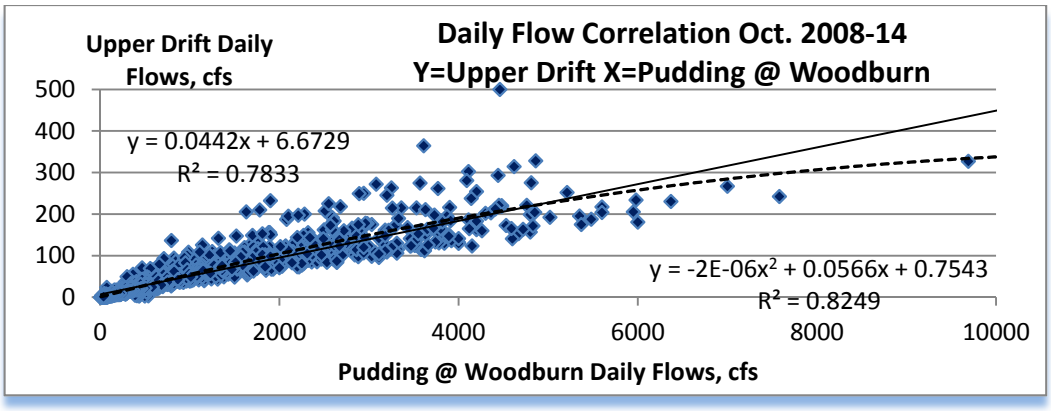



Daily Flow Correlation Oct. 2010-11
Y=Upper Drift X=Pudding @ Woodburn
Upper Drift Daily Flows, cfs
y = 0.0441x + 7.4297
R² = 0.8619
y = -4E-06x² + 0.0596x + 1.0902
R² = 0.8803
Pudding @ Woodburn Daily Flows, cfs

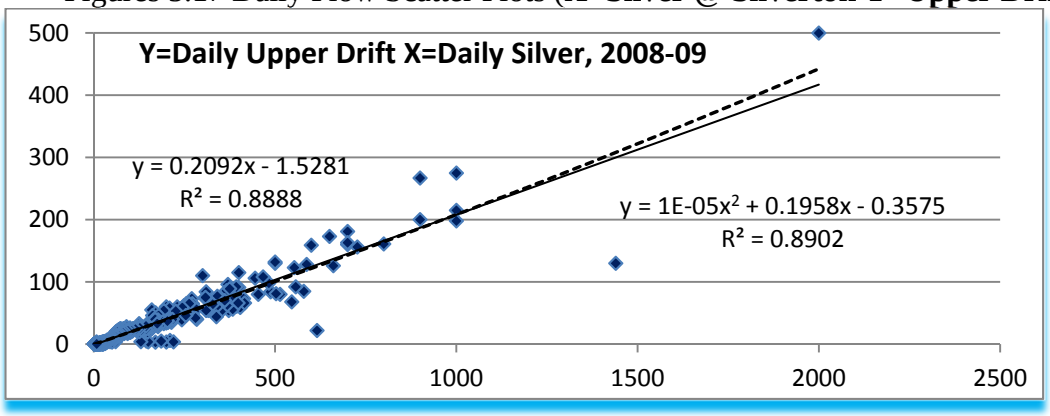

Daily Flow Correlation Oct. 2011-12
Y=Upper Drift X=Pudding @ Woodburn
Upper Drift Daily Flows, cfs
y = 0.0368x + 11.241
R² = 0.6622
y = -2E-06x² + 0.0545x + 0.301
R² = 0.7342
Pudding @ Woodburn Daily Flows, cfs

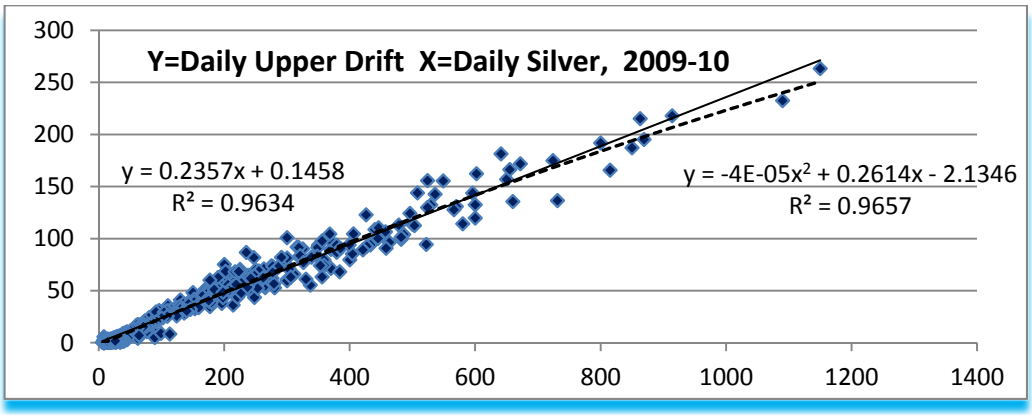

Daily Flow Correlation Oct. 2012-13
Y=Upper Drift X=Pudding @ Woodburn
Upper Drift Daily Flows, cfs
y = 0.0482x + 2.046
R² = 0.8494
y = -2E-06x² + 0.0573x - 1.421
R² = 0.8562
Pudding @ Woodburn Daily Flows, cfs

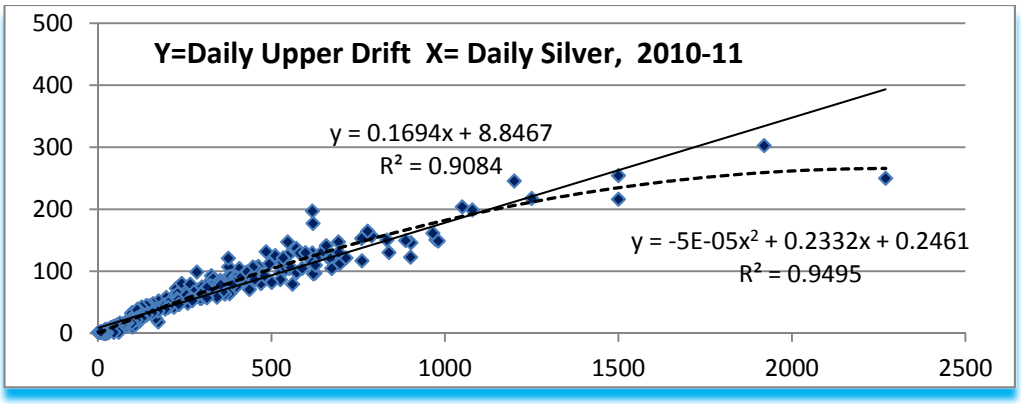

Daily Flow Correlation Oct. 2013-14
Y=Upper Drift X=Pudding @ Woodburn
Upper Drift Daily Flows, cfs
y = 0.0491x + 1.9531
R² = 0.9107
y = 9E-08x² + 0.0487x + 2.0624
R² = 0.9107
Pudding @ Woodburn Daily Flows, cfs

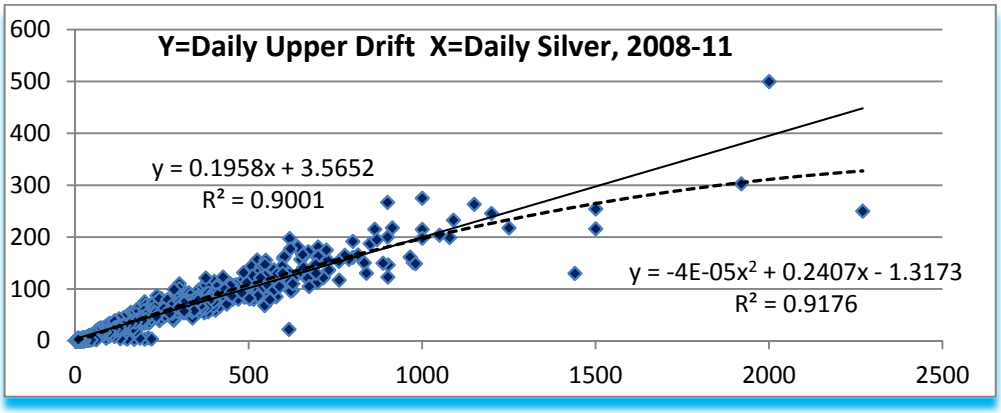


Figures 5.17 Daily Flow Scatter Plots (**X=Silver @ Silverton Y=Upper Drift)**

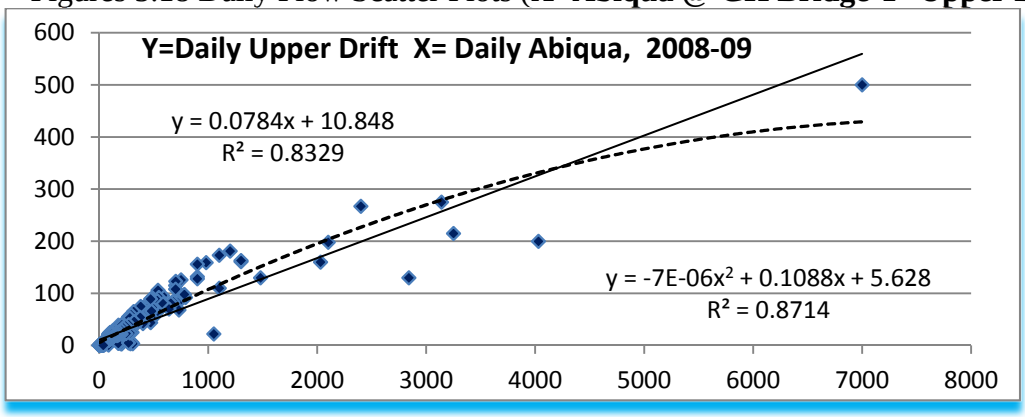


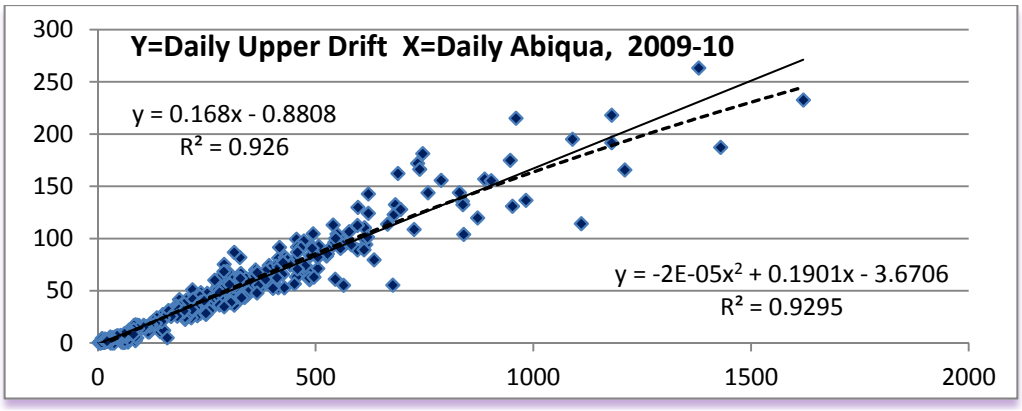


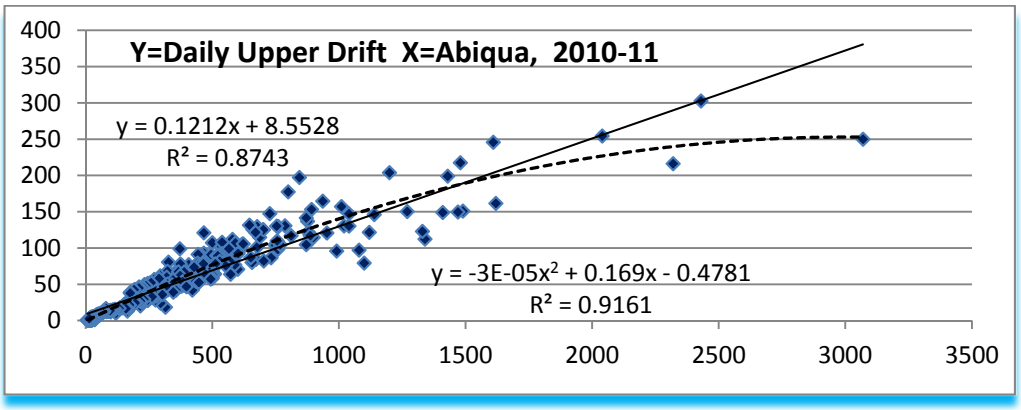


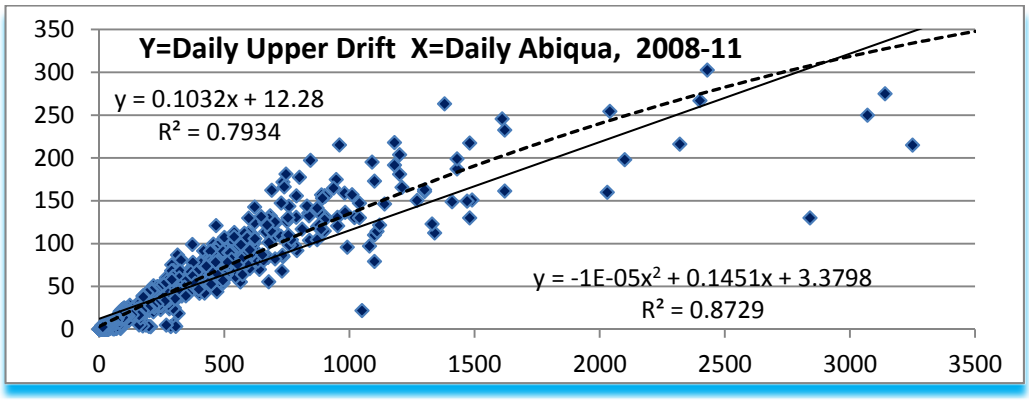


Figures 5.18 Daily Flow Scatter Plots (**X=Abiqua @ GH Bridge Y=Upper Drift)**

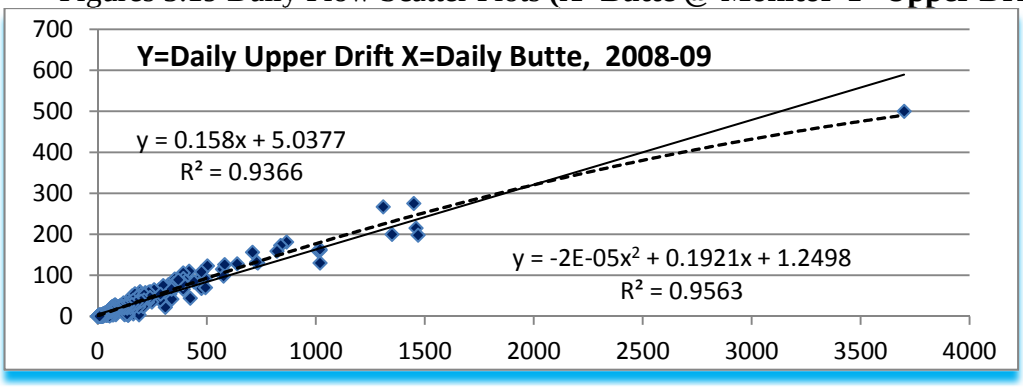


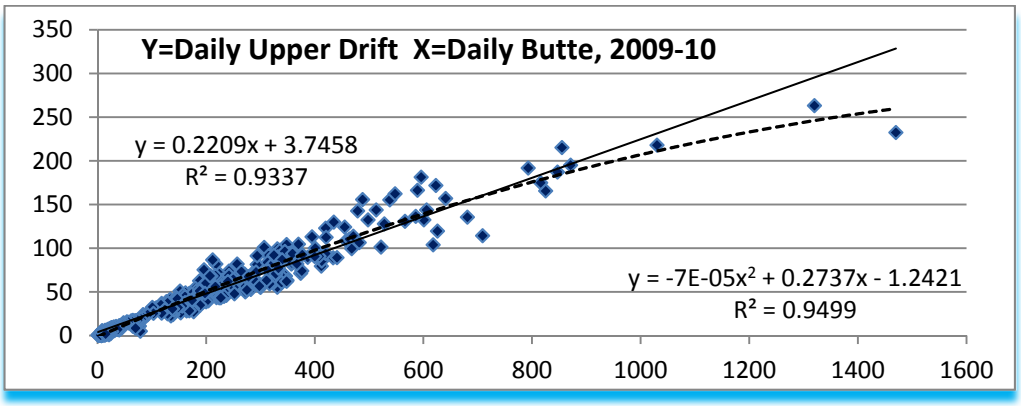


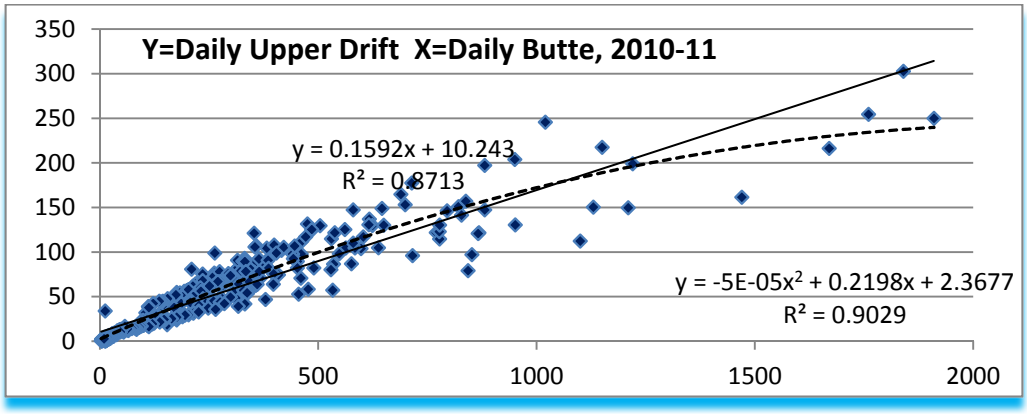


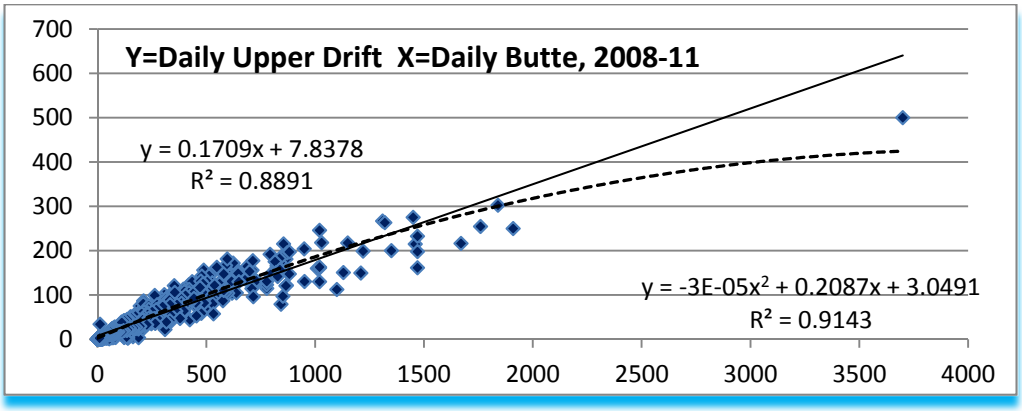


Figures 5.19 Daily Flow Scatter Plots **(X=Butte @ Monitor Y=Upper Drift)**

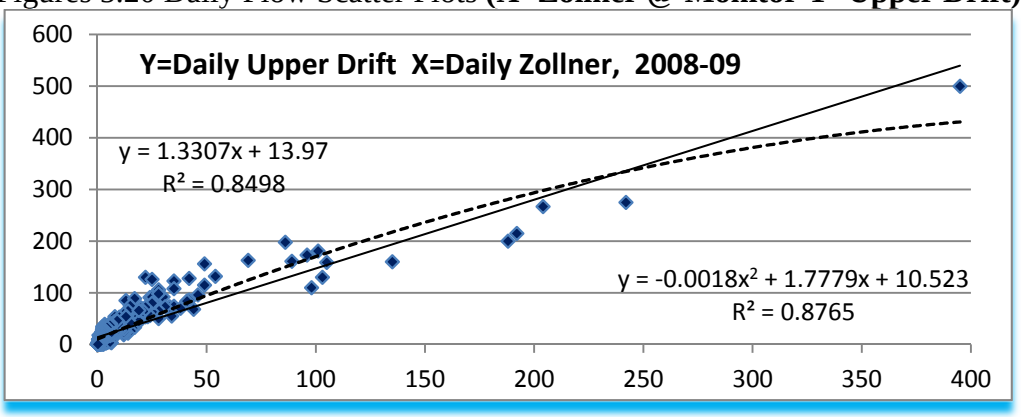


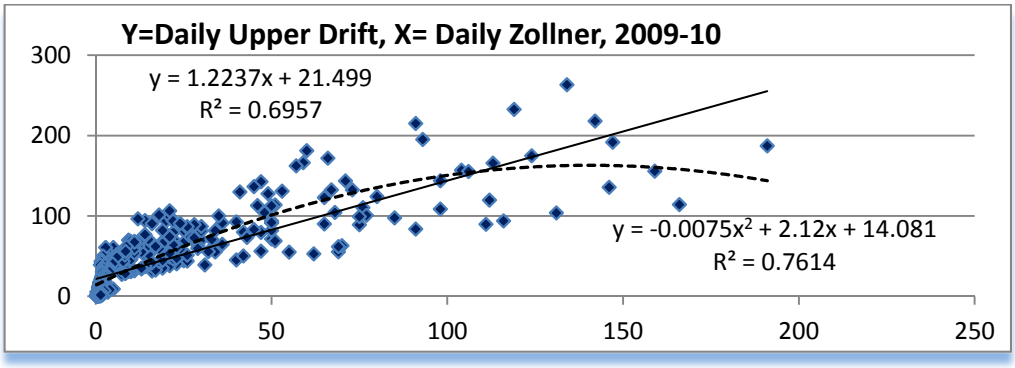

Y=Daily Upper Drift X=Daily Butte, 2009-10
y = 0.2209x + 3.7458
R² = 0.9337
y = -7E-05x² + 0.2737x - 1.2421
R² = 0.9499
350
300
250
200
150
100
50
0
0
200
400
600
800
1000
1200
1400
1600

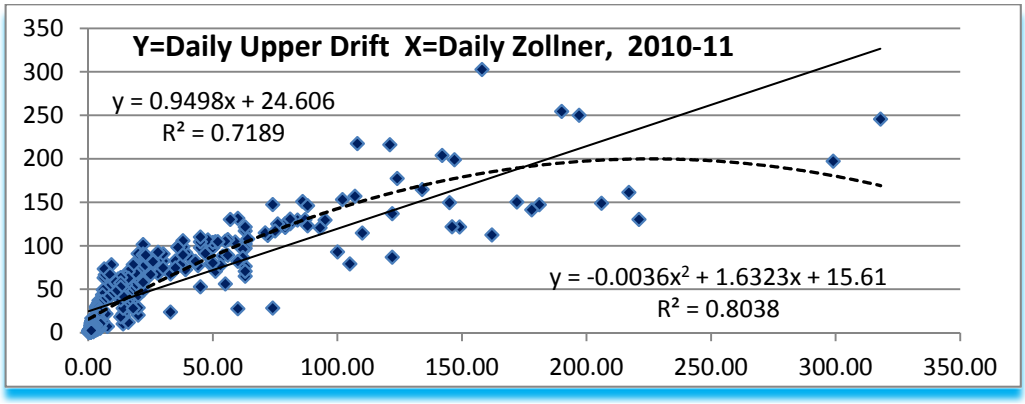

Y=Daily Upper Drift X=Daily Butte, 2010-11
y = 0.1592x + 10.243
R² = 0.8713
y = -5E-05x² + 0.2198x + 2.3677
R² = 0.9029
350
300
250
200
150
100
50
0
0
500
1000
1500
2000

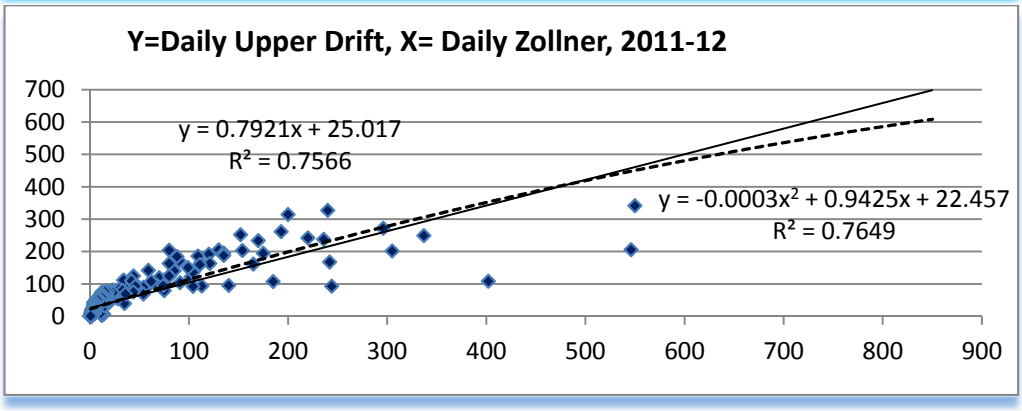

Y=Daily Upper Drift X=Daily Butte, 2008-11
y = 0.1709x + 7.8378
R² = 0.8891
y = -3E-05x² + 0.2087x + 3.0491
R² = 0.9143
700
600
500
400
300
200
100
0
0
500
1000
1500
2000
2500
3000
3500
4000

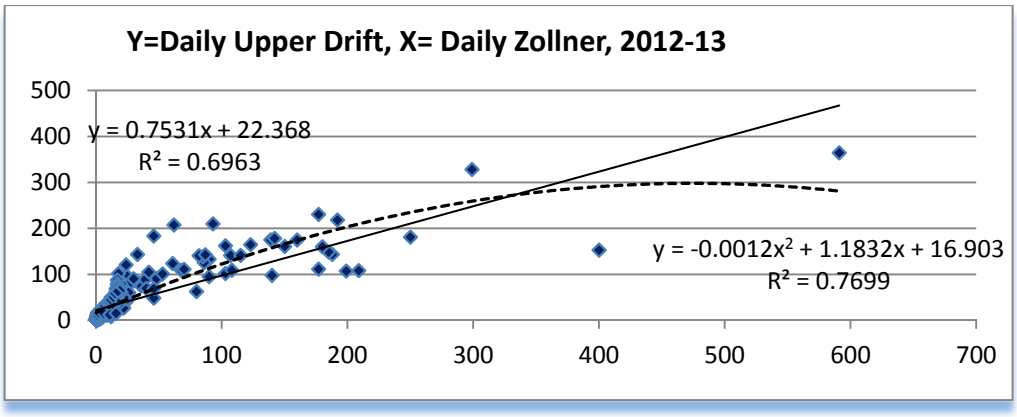
Figures 5.20 Daily Flow Scatter Plots **(X=Zollner @ Monitor Y=Upper Drift)**

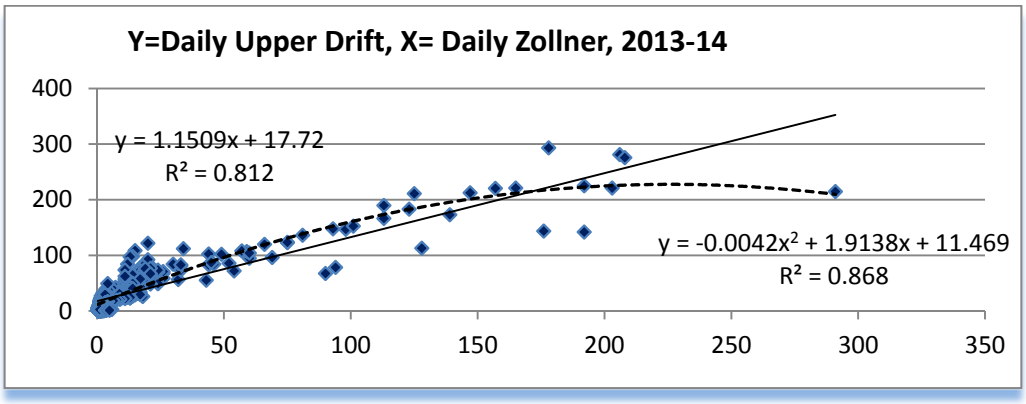


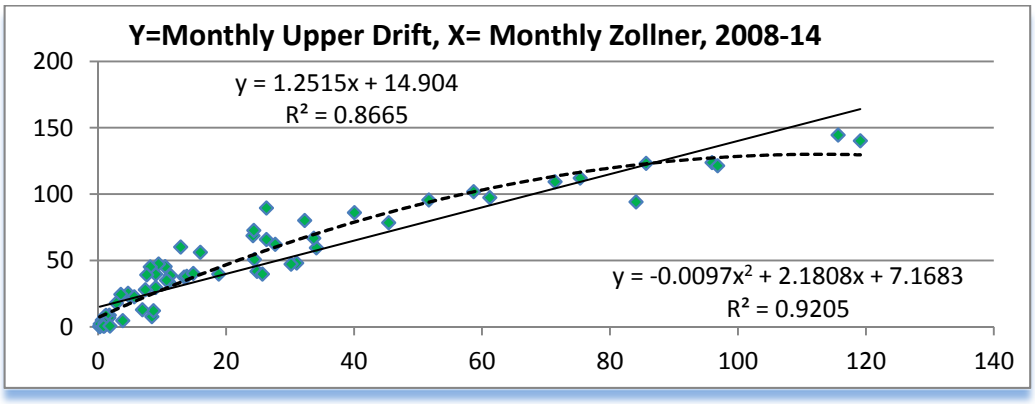




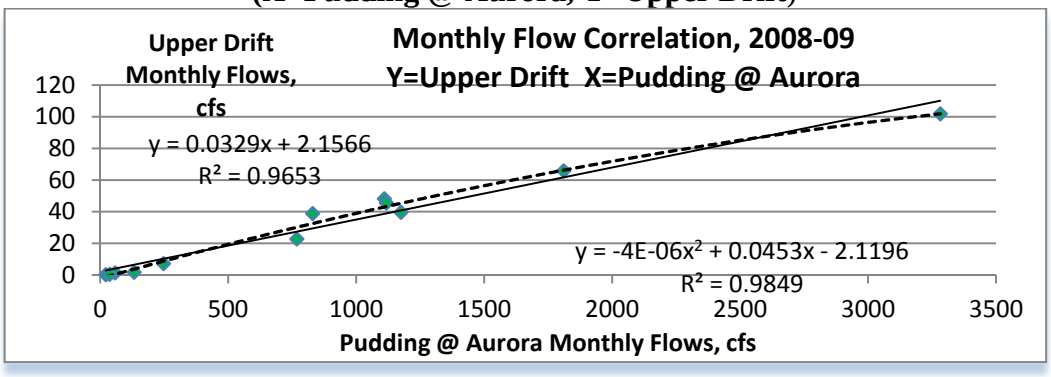


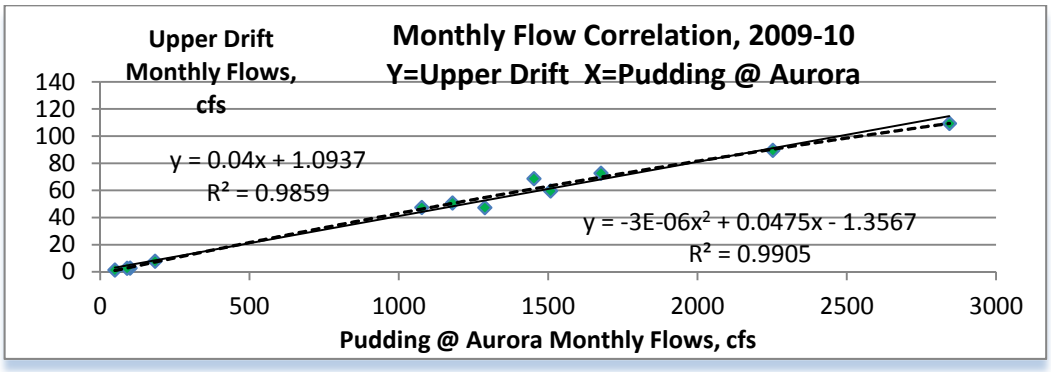

Y=Daily Upper Drift, X= Daily Zollner, 2012-13
y = 0.7531x + 22.368
R² = 0.6963
y = -0.0012x² + 1.1832x + 16.903
R² = 0.7699
500
400
300
200
100
0
0
100
200
300
400
500
600
700

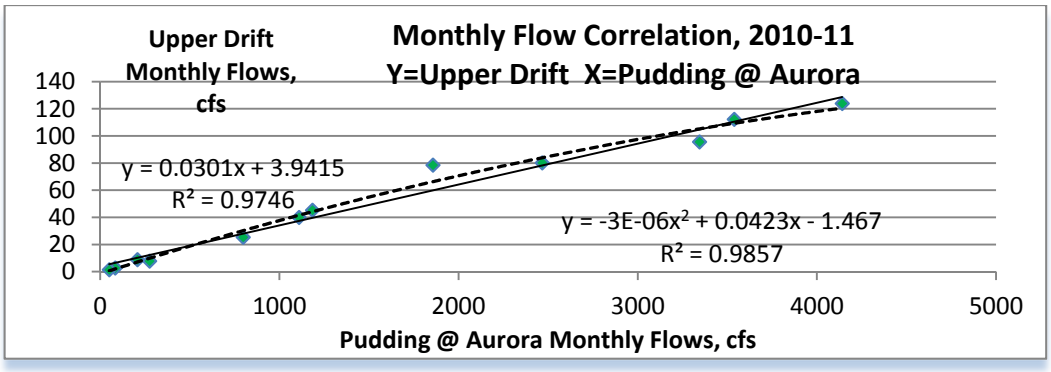

Y=Daily Upper Drift, X= Daily Zollner, 2013-14
y = 1.1509x + 17.72
R² = 0.812
y = -0.0042x² + 1.9138x + 11.469
R² = 0.868
400
300
200
100
0
0
50
100
150
200
250
300
350

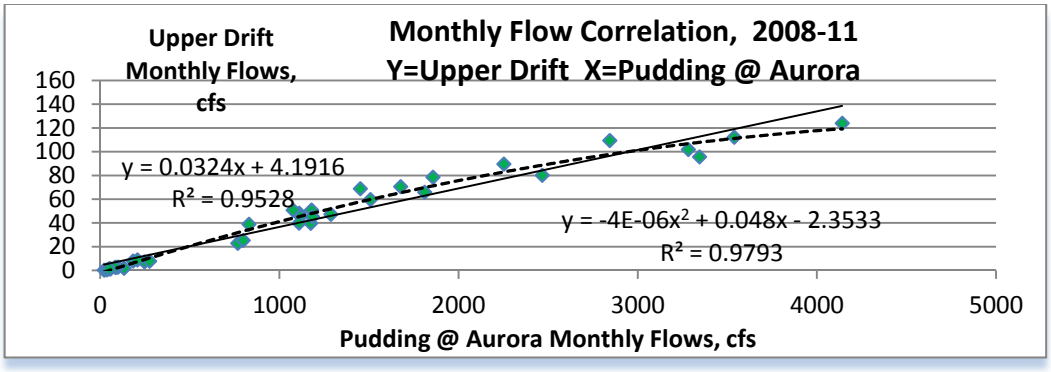

Y=Monthly Upper Drift, X= Monthly Zollner, 2008-14
y = 1.2515x + 14.904
R² = 0.8665
y = -0.0097x² + 2.1808x + 7.1683
R² = 0.9205
200
150
100
50
0
0
20
40
60
80
100
120
140

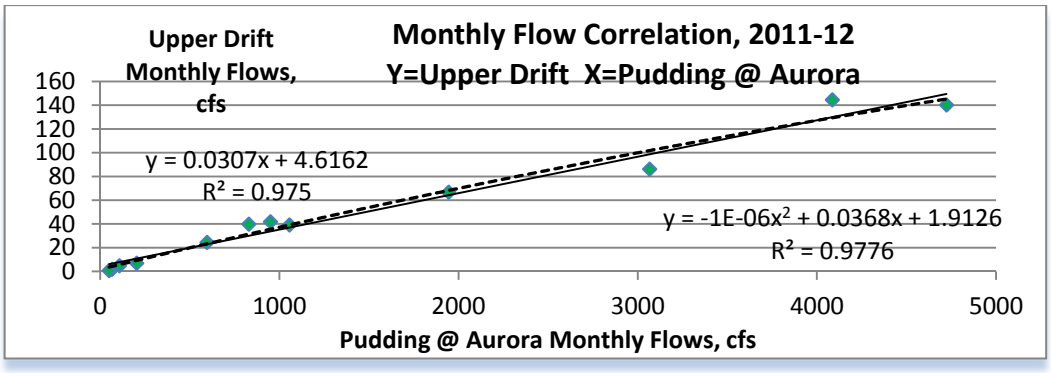
Figures 5.21 **Monthly** Flow Scatter Plots
(X=Pudding @ Aurora, Y=Upper Drift)

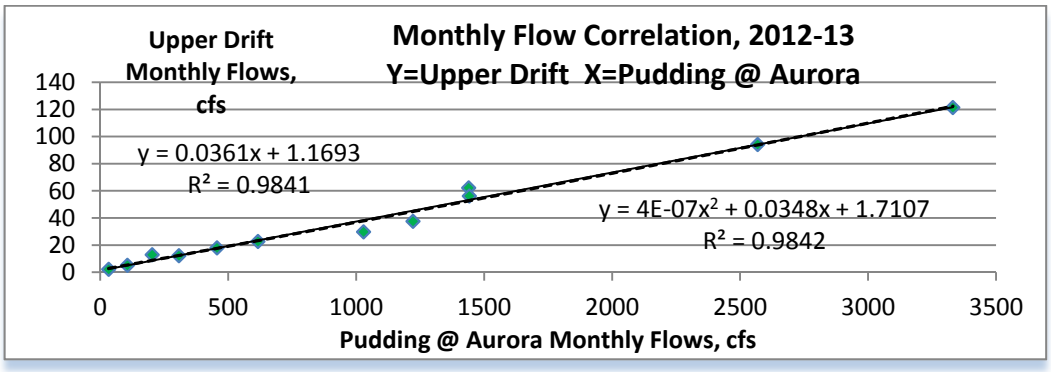


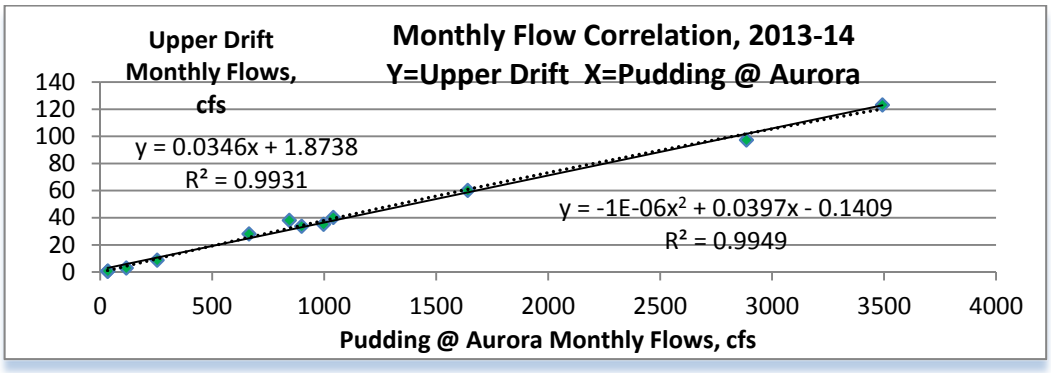


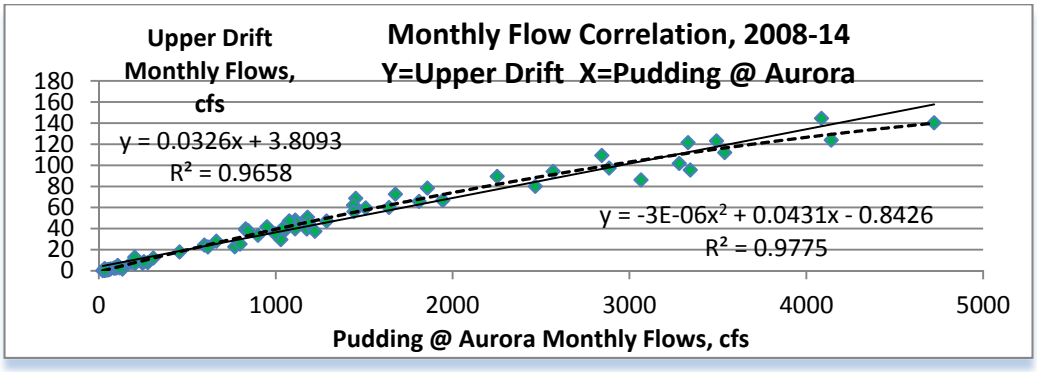




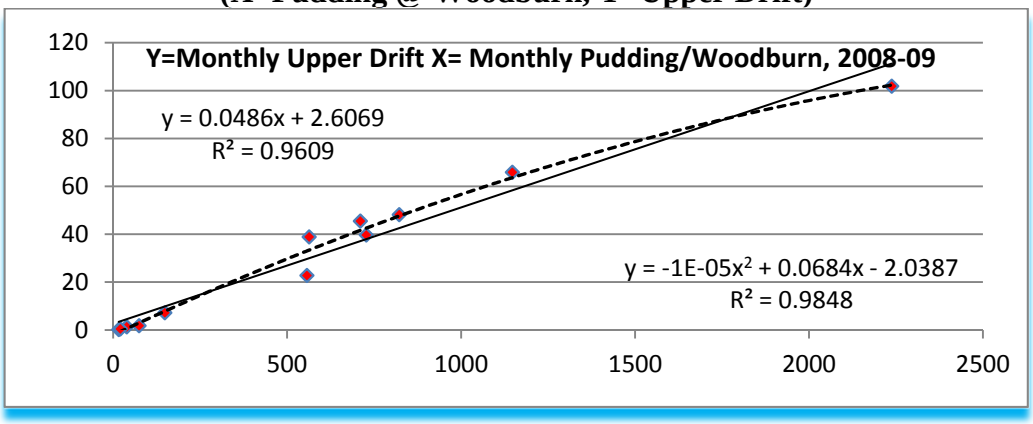

Monthly Flow Correlation, 2011-12
Y=Upper Drift X=Pudding @ Aurora
Upper Drift Monthly Flows, cfs
y = 0.0307x + 4.6162
R² = 0.975
y = -1E-06x² + 0.0368x + 1.9126
R² = 0.9776
Pudding @ Aurora Monthly Flows, cfs

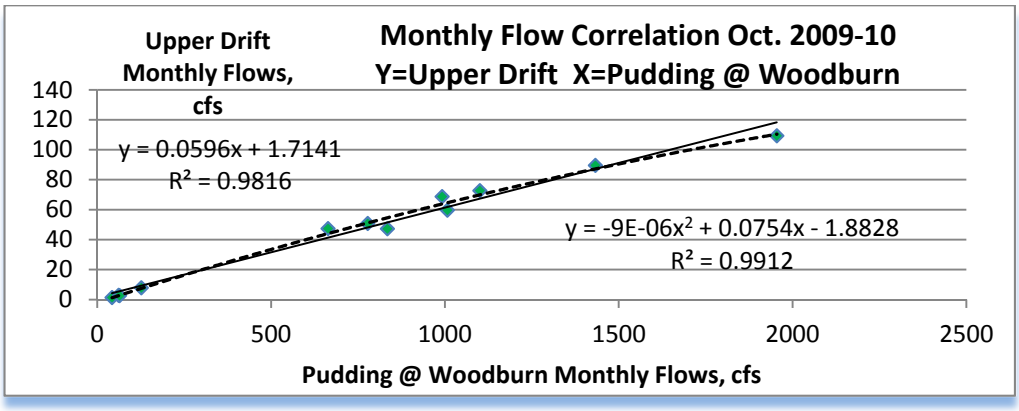

Monthly Flow Correlation, 2012-13
Y=Upper Drift X=Pudding @ Aurora
Upper Drift Monthly Flows, cfs
y = 0.0361x + 1.1693
R² = 0.9841
y = 4E-07x² + 0.0348x + 1.7107
R² = 0.9842
Pudding @ Aurora Monthly Flows, cfs

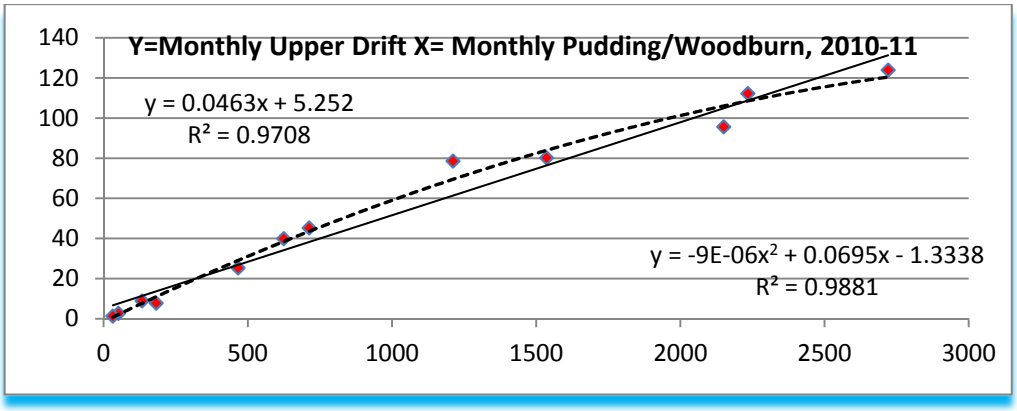

Monthly Flow Correlation, 2013-14
Y=Upper Drift X=Pudding @ Aurora
Upper Drift Monthly Flows, cfs
y = 0.0346x + 1.8738
R² = 0.9931
y = -1E-06x² + 0.0397x - 0.1409
R² = 0.9949
Pudding @ Aurora Monthly Flows, cfs

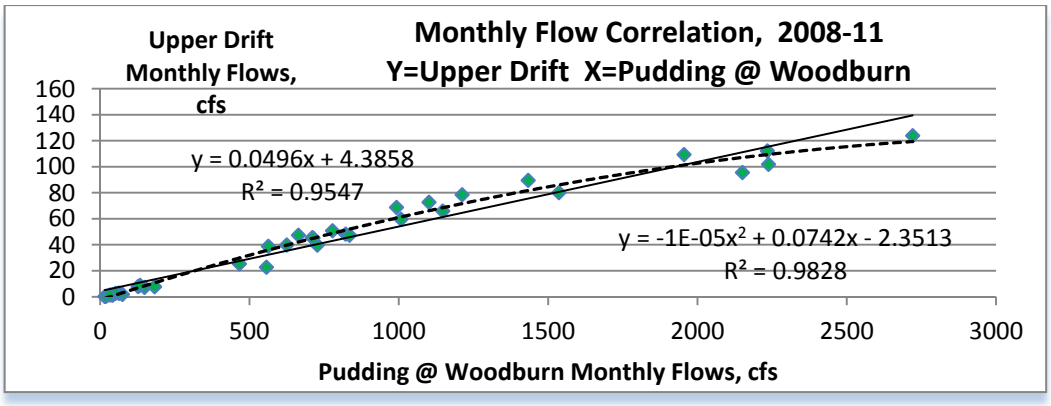

Monthly Flow Correlation, 2008-14
Y=Upper Drift X=Pudding @ Aurora
Upper Drift Monthly Flows, cfs
y = 0.0326x + 3.8093
R² = 0.9658
y = -3E-06x² + 0.0431x - 0.8426
R² = 0.9775
Pudding @ Aurora Monthly Flows, cfs

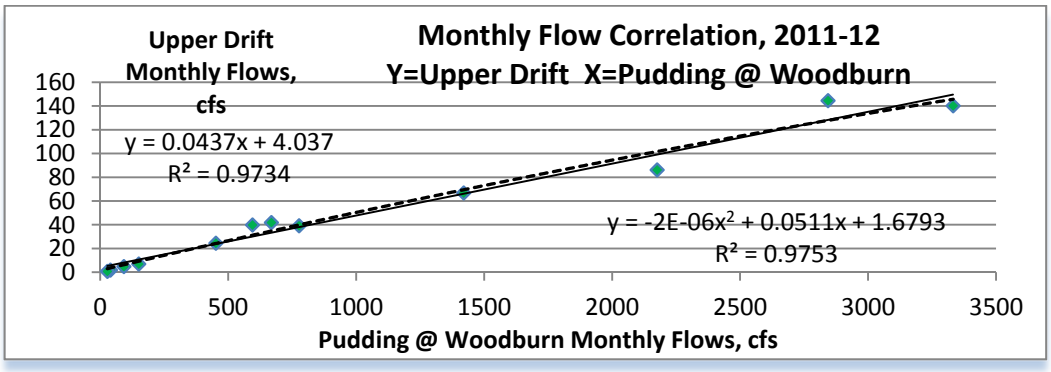
Figures 5.22 **Monthly** Flow Scatter Plots
(X=Pudding @ Woodburn, Y=Upper Drift)

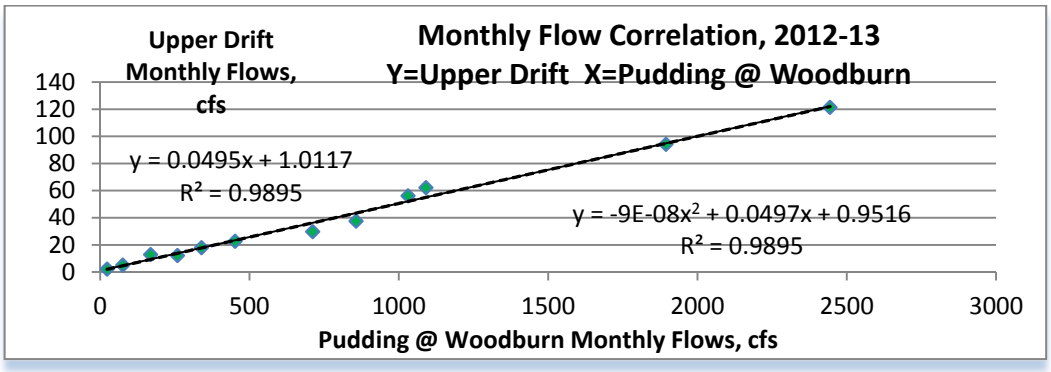


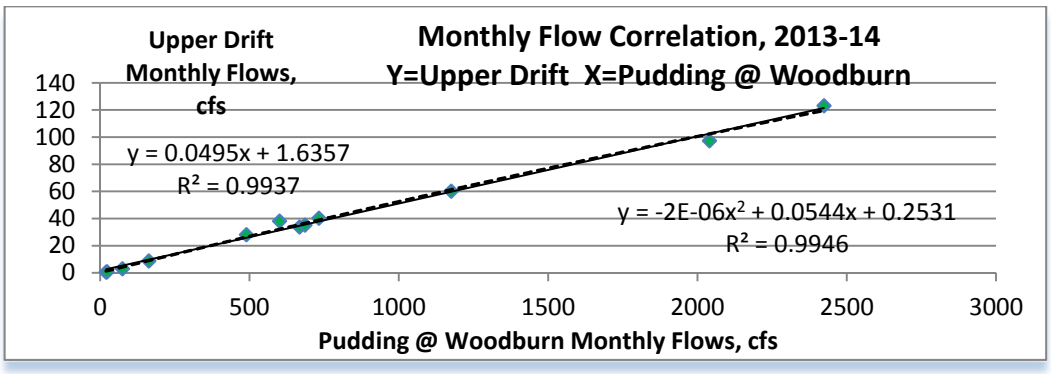


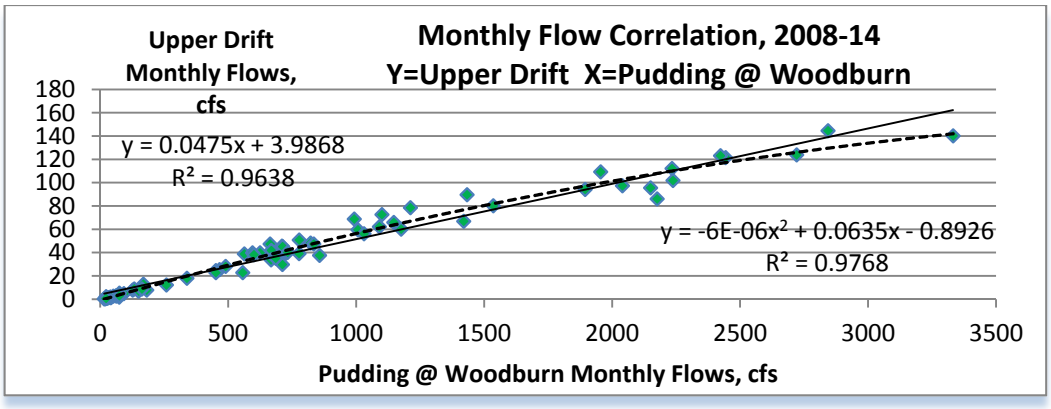



Monthly Flow Correlation, 2008-11
Y=Upper Drift X=Pudding @ Woodburn
Upper Drift Monthly Flows, cfs
y = 0.0496x + 4.3858
R² = 0.9547
y = -1E-05x² + 0.0742x - 2.3513
R² = 0.9828
0
20
40
60
80
100
120
140
160
0
500
1000
1500
2000
2500
3000
Pudding @ Woodburn Monthly Flows, cfs

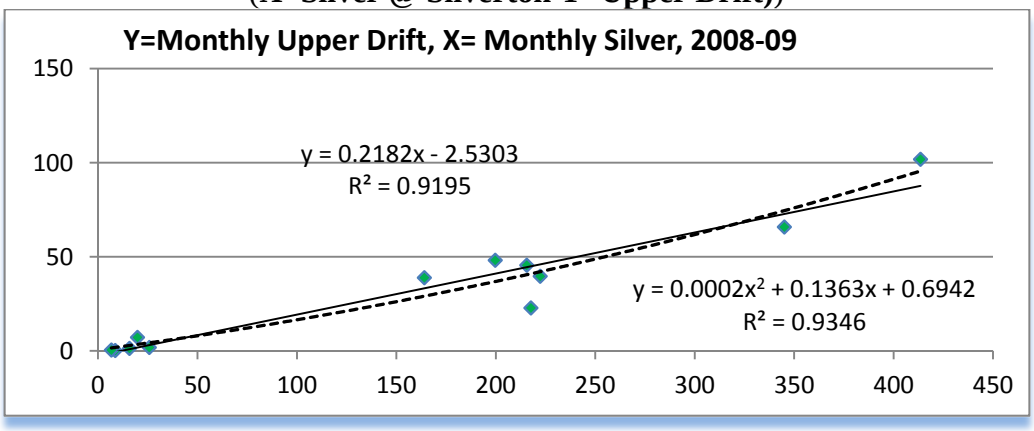

Monthly Flow Correlation, 2011-12
Y=Upper Drift X=Pudding @ Woodburn
Upper Drift Monthly Flows, cfs
y = 0.0437x + 4.037
R² = 0.9734
y = -2E-06x² + 0.0511x + 1.6793
R² = 0.9753
0
20
40
60
80
100
120
140
160
0
500
1000
1500
2000
2500
3000
3500
Pudding @ Woodburn Monthly Flows, cfs

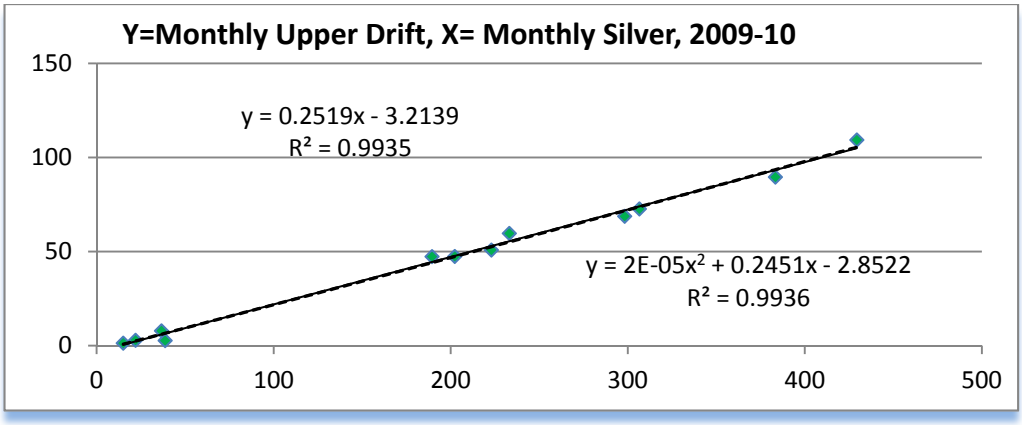

Monthly Flow Correlation, 2012-13
Y=Upper Drift X=Pudding @ Woodburn
Upper Drift Monthly Flows, cfs
y = 0.0495x + 1.0117
R² = 0.9895
y = -9E-08x² + 0.0497x + 0.9516
R² = 0.9895
0
20
40
60
80
100
120
140
0
500
1000
1500
2000
2500
3000
Pudding @ Woodburn Monthly Flows, cfs

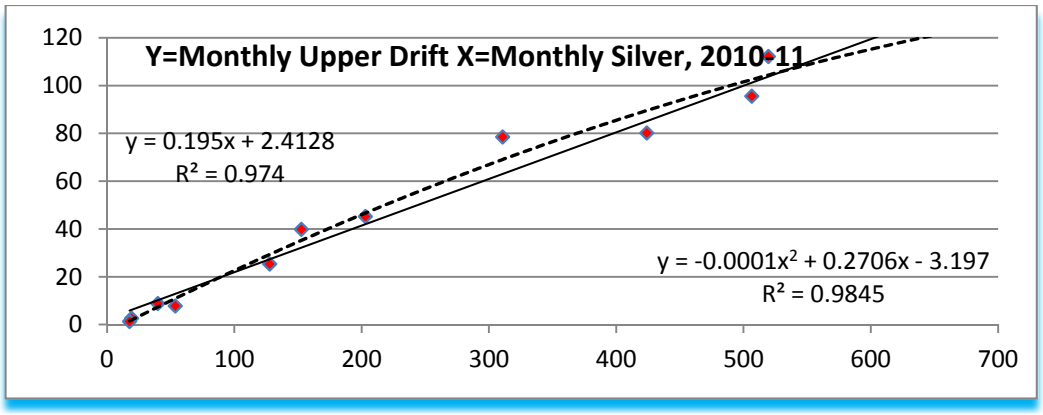

Monthly Flow Correlation, 2013-14
Y=Upper Drift X=Pudding @ Woodburn
Upper Drift Monthly Flows, cfs
y = 0.0495x + 1.6357
R² = 0.9937
y = -2E-06x² + 0.0544x + 0.2531
R² = 0.9946
0
20
40
60
80
100
120
140
0
500
1000
1500
2000
2500
3000
Pudding @ Woodburn Monthly Flows, cfs

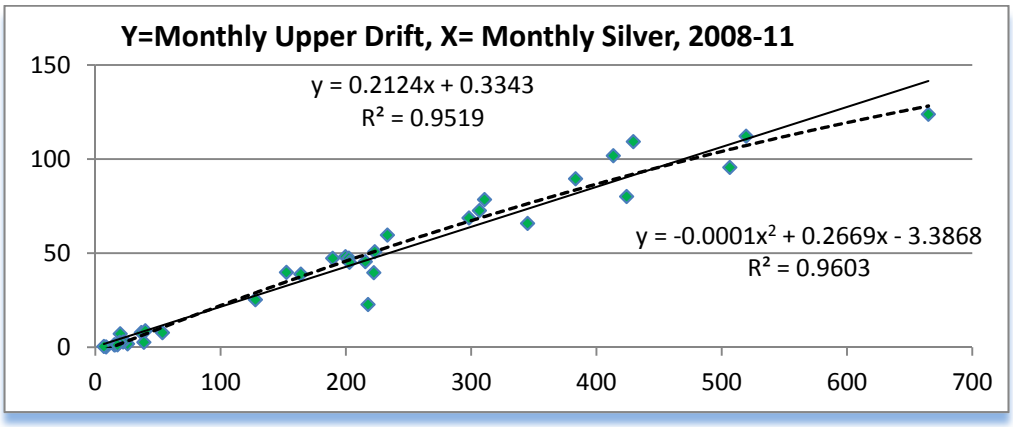


Figures 5.23 **Monthly** Flow Scatter Plots
(X=Silver @ Silverton Y=Upper Drift))

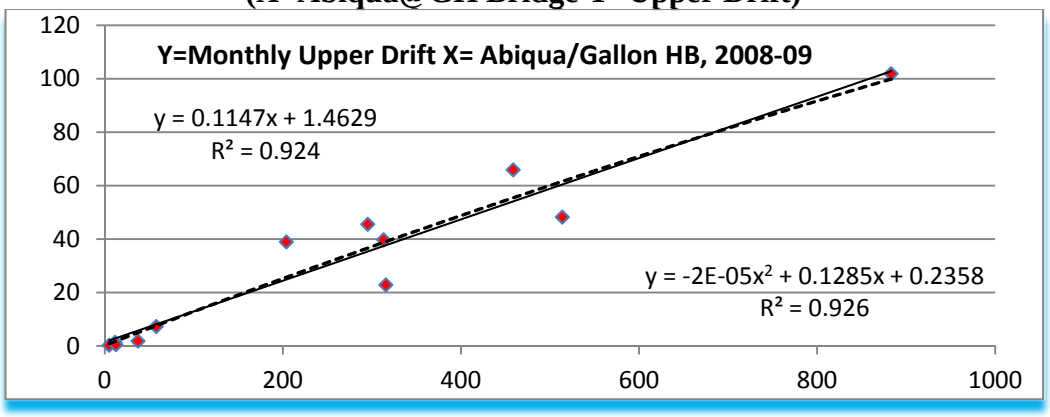


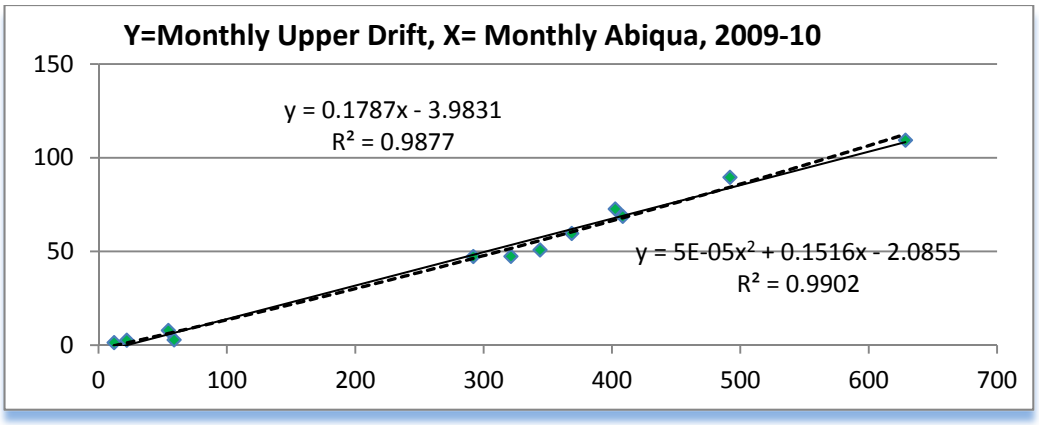


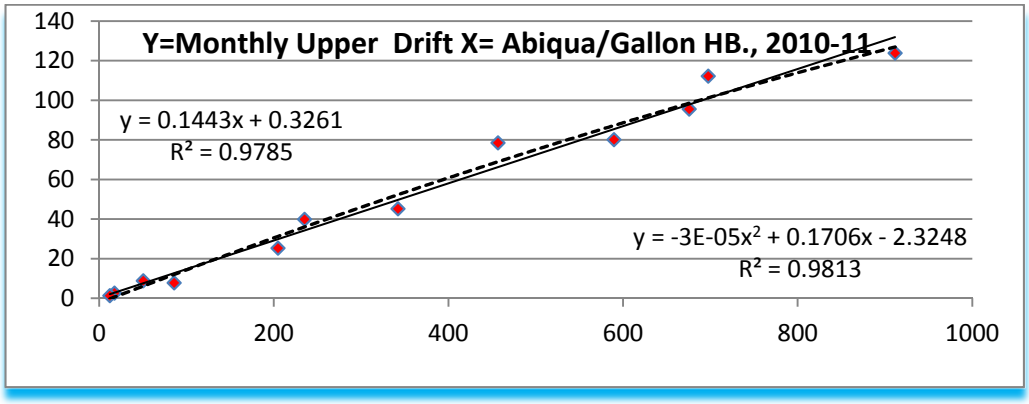


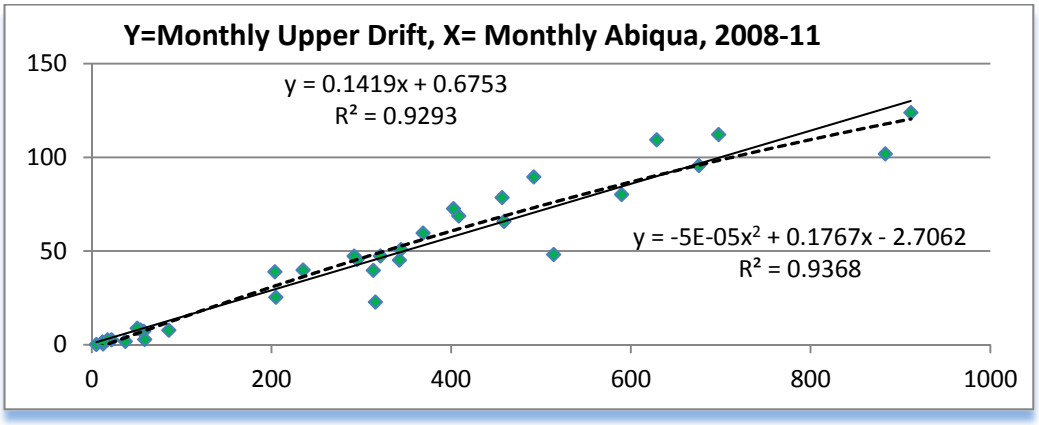


Figures 5.24 **Monthly** Flow Scatter Plots
(X=Abiqua@GH Bridge Y=Upper Drift)



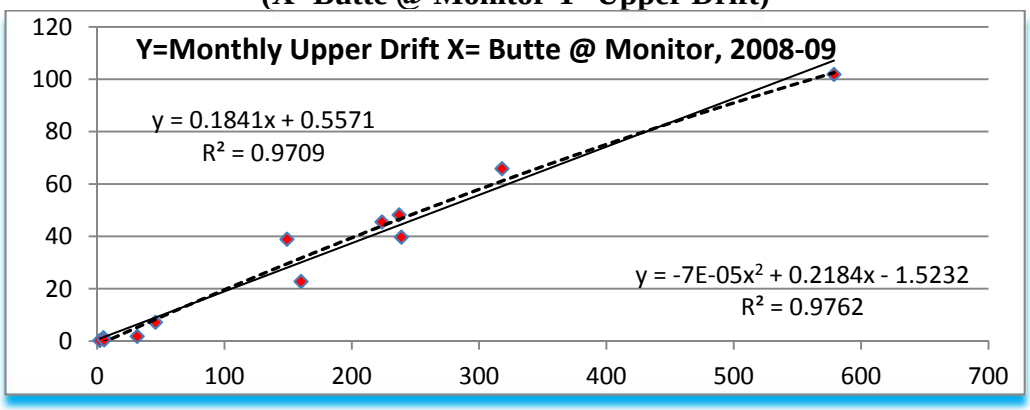

Y=Monthly Upper Drift, X= Monthly Abiqua, 2009-10
y = 0.1787x - 3.9831
R² = 0.9877
y = 5E-05x² + 0.1516x - 2.0855
R² = 0.9902
150
100
50
0
0
100
200
300
400
500
600
700

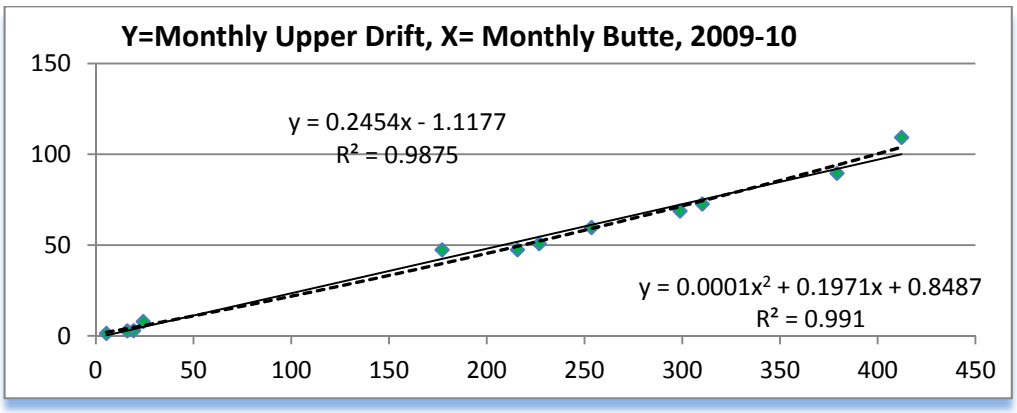

Y=Monthly Upper Drift X= Abiqua/Gallon HB., 2010-11
y = 0.1443x + 0.3261
R² = 0.9785
y = -3E-05x² + 0.1706x - 2.3248
R² = 0.9813
140
120
100
80
60
40
20
0
0
200
400
600
800
1000

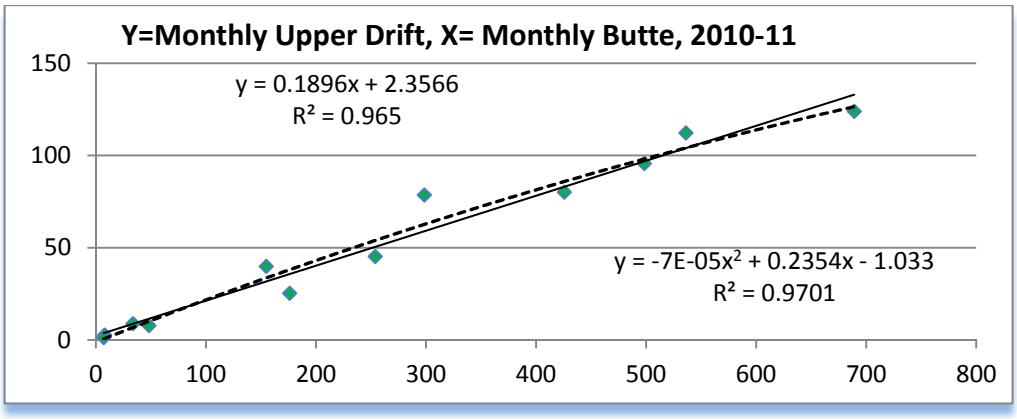

Y=Monthly Upper Drift, X= Monthly Abiqua, 2008-11
y = 0.1419x + 0.6753
R² = 0.9293
y = -5E-05x² + 0.1767x - 2.7062
R² = 0.9368
150
100
50
0
0
200
400
600
800
1000

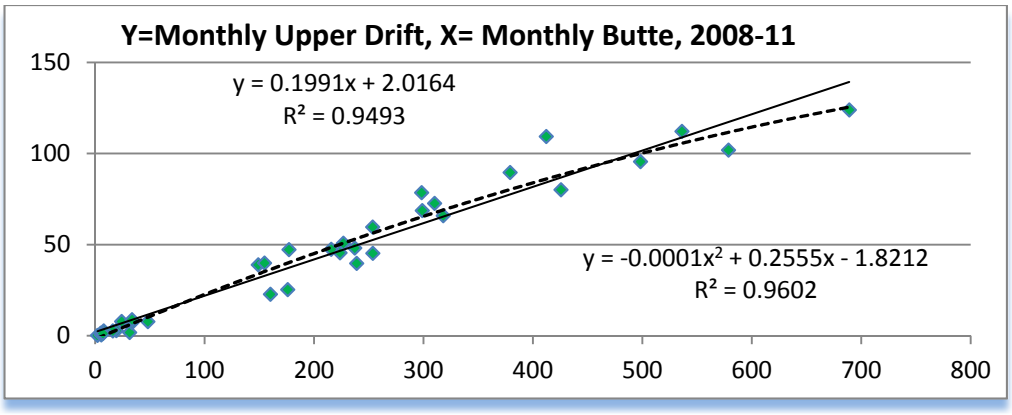
Figures 5.25 Monthly Flow Scatter Plots

(X=Butte @ Monitor Y=Upper Drift)

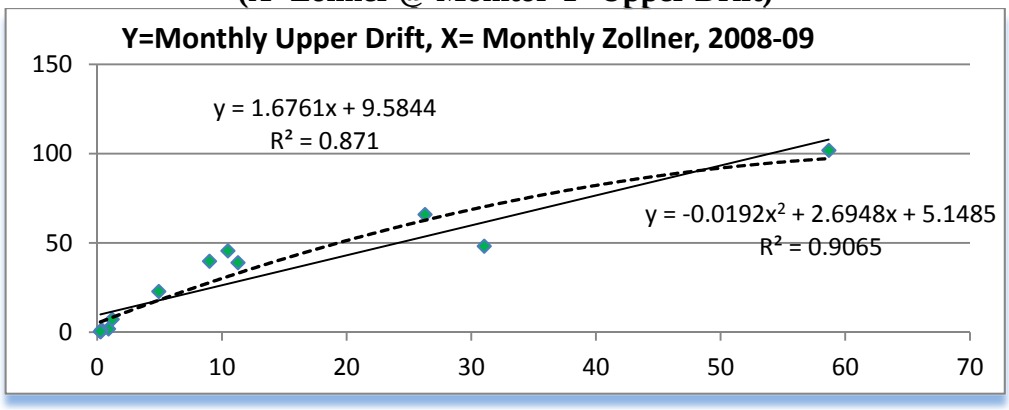


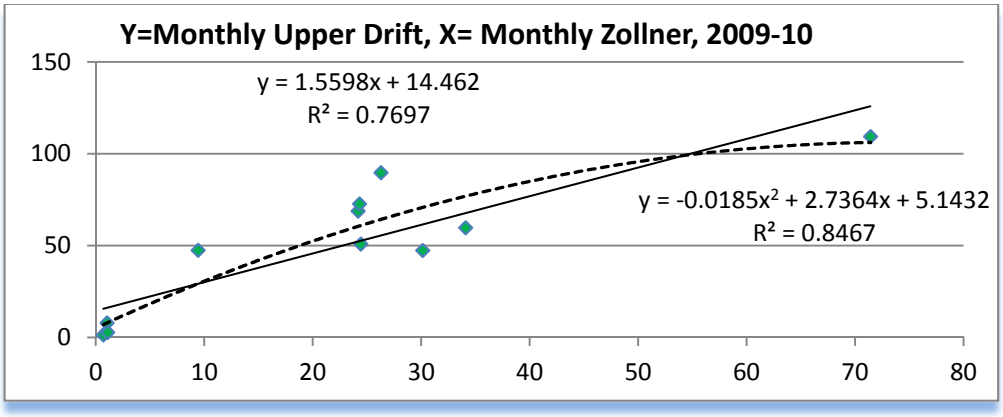


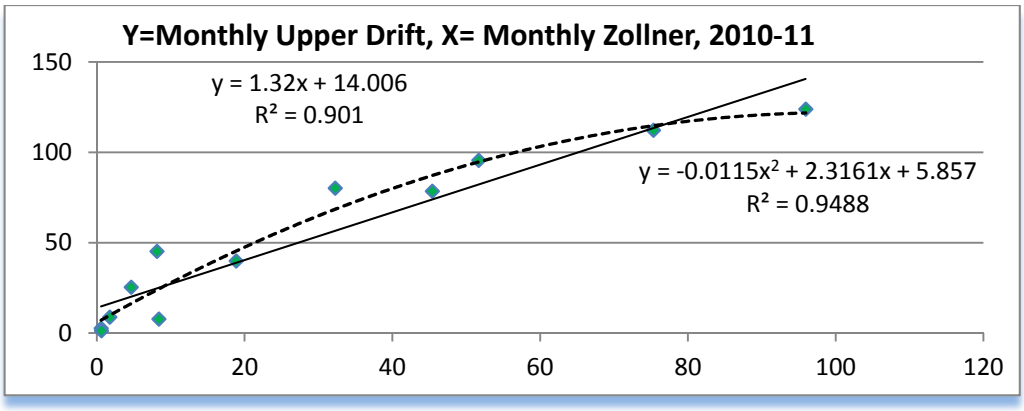


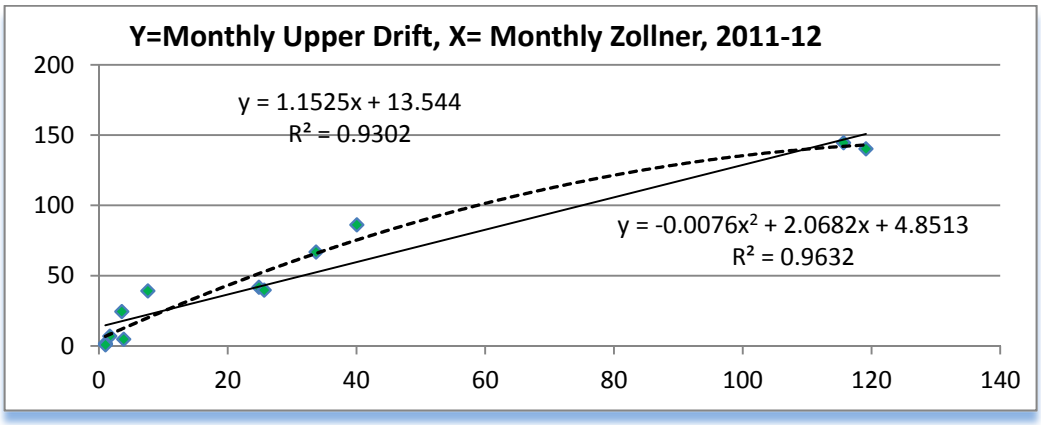


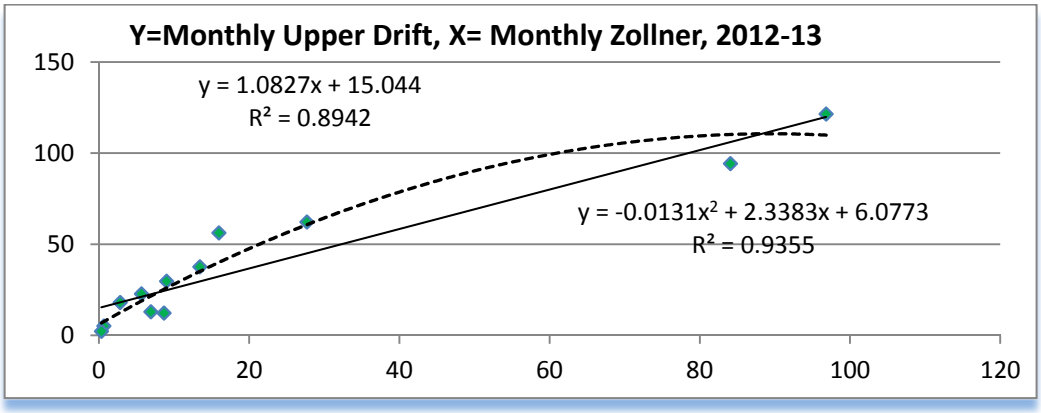
Figures 5.26 **Monthly** Flow Scatter Plots
(X=Zollner @ Monitor Y=Upper Drift)

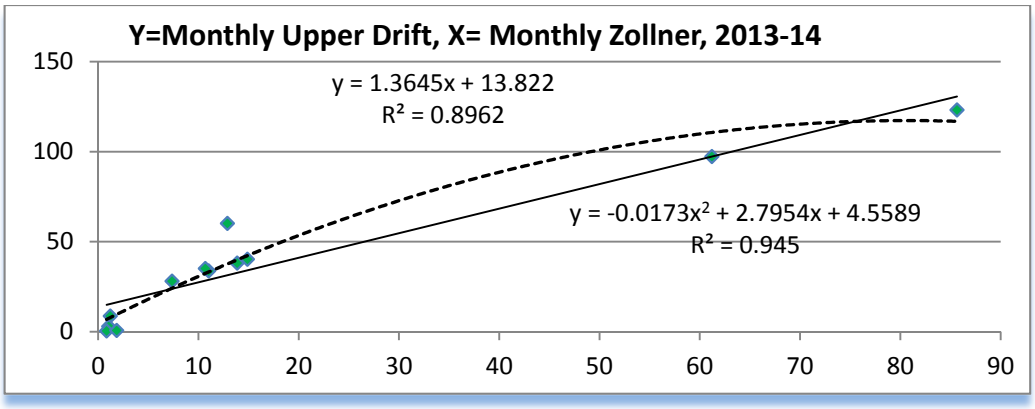





Y=Monthly Upper Drift, X= Monthly Zollner, 2010-11
y = 1.32x + 14.006
R² = 0.901
y = -0.0115x² + 2.3161x + 5.857
R² = 0.9488
150
100
50
0
0
20
40
60
80
100
120


Y=Monthly Upper Drift, X= Monthly Zollner, 2011-12
y = 1.1525x + 13.544
R² = 0.9302
y = -0.0076x² + 2.0682x + 4.8513
R² = 0.9632
200
150
100
50
0
0
20
40
60
80
100
120
140


Y=Monthly Upper Drift, X= Monthly Zollner, 2012-13
y = 1.0827x + 15.044
R² = 0.8942
y = -0.0131x² + 2.3383x + 6.0773
R² = 0.9355
150
100
50
0
0
20
40
60
80
100
120



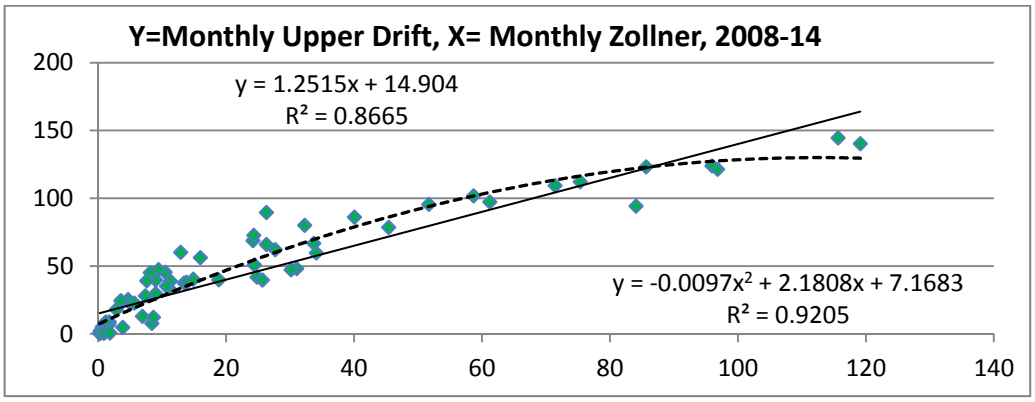


Table 5.2 summarizes the values of the correlation indicator R^2 obtained through the polynomial order 2 scatter plots, linking Upper Drift Creek data to equivalent data at other nearby streams. For each water year, the highest values are shown in bold and the lowest, in italics. As expected, the flows recorded at the lower Hibbard Road gauge yield the highest R^2 values. The lowest values of R^2 apply to the flows of Zollner Creek @ Monitor.

Table 5.2 Monthly Correlation Factor R^2 (order 2 polynomial trend line)
(Upper Drift vs. Other Nearby Streams)

HY	Abiqua @Silverton	Butte @Monitor	Lower Drift	Pudding @Aurora	Pudding @Woodburn	Silver @Silverton	Zollner @Mt. Angel
DAILY FLOWS							
2008-09	0.8714	**0.9563**	0.9560	*0.8064*	0.8112	0.8902	0.8765
2009-10	0.9295	0.9499	**0.9871**	0.8794	0.8991	0.9657	*0.7614*
2010-11	0.9161	0.9029	**0.9816**	0.8659	0.8803	0.9495	*0.8038*
2011-12				*0.7198*	0.7342		**0.778**
2012-13				0.8398	**0.8562**		*0.7699*
2013-14				0.8958	**0.9107**		*0.868*
2008-11	0.8729	0.9143	**0.9558**	0.8402	0.8579	0.9176	*0.7649*
2008-14				0.8111	**0.8249**		*0.7585*

MONTHLY FLOWS							
2008-09	0.926	0.9762	**0.9973**	0.9849	0.9848	0.9346	*0.9065*
2009-10	0.9902	0.991	**0.9936**	0.9905	0.9912	**0.9936**	*0.8467*
2010-11	0.9813	0.9701	**0.9919**	0.9857	0.9881	0.9845	*0.9488*
2011-12				**0.9776**	0.9753		*0.9632*
2012-13				0.9842	**0.9895**		*0.9355*
2013-14				**0.9949**	0.9946		*0.945*
2008-11	0.9368	0.9602	**0.9861**	0.9775	0.9828	0.9603	*0.909*
2008-14				**0.9793**	0.9768		*0.9205*

The best correlation indicators R^2 based on the three years of records (Oct. 2008 – Sep. 2011) are listed in Table 5.3. The ranking of these indicators help define the best gauging sites that could be used to generate more flow data for Upper Drift Creek, if the gauging stations involved continue to be operated without any problems.

Table 5.3 Station Ranking Based on Best Correlation Indicators
(Oct. 2008 – Sep. 2011 Stream Flows)

Ranking for **Daily** Flows	Daily Flows Correlation Indicator R^2	Ranking for **Monthly** Flows	Monthly Flows Correlation Indicator R^2
1. Drift Creek @ Hibbard Rd.	0.9558	1. Drift Creek @ Hibbard Rd	0.9862
2. Silver @ Silverton	0.9176	2. Pudding @ Woodburn	0.9823
3. Butte @ Monitor.	0.9143	3. Pudding @ Aurora	0.9793
4. Abiqua@ G.H. Bridge	0.8729	4. Butte @ Monitor	0.9604
5. Pudding @ Woodburn	0.8579	5. Silver@ Silverton	0.9566
6. Pudding @ Aurora	0.8402	6. Abiqua @ G.H. Bridge	0.9376
7. Zollner @ Mt. Angel	0.7649	7. Zollner @ Mt. Angel	0.8804

The above station ranking is based only on Oct. 2008 – Sep. 2011 stream flow data. Since the main practical purposes of the hydrologic runoff yield study is to develop more historical runoff data for Drift Creek, the selection of the ultimate station to be used as data generation index should also account for the length of the records collected (preferably in the most recent past) at that station. As of mid-November 2014, data availability is listed in Table 5.4 (which is an update of Table 3.1).

Table 5.4 Stream Gages, Drainage Areas, Period of Records and Number of Years (as of mid-November 2014)

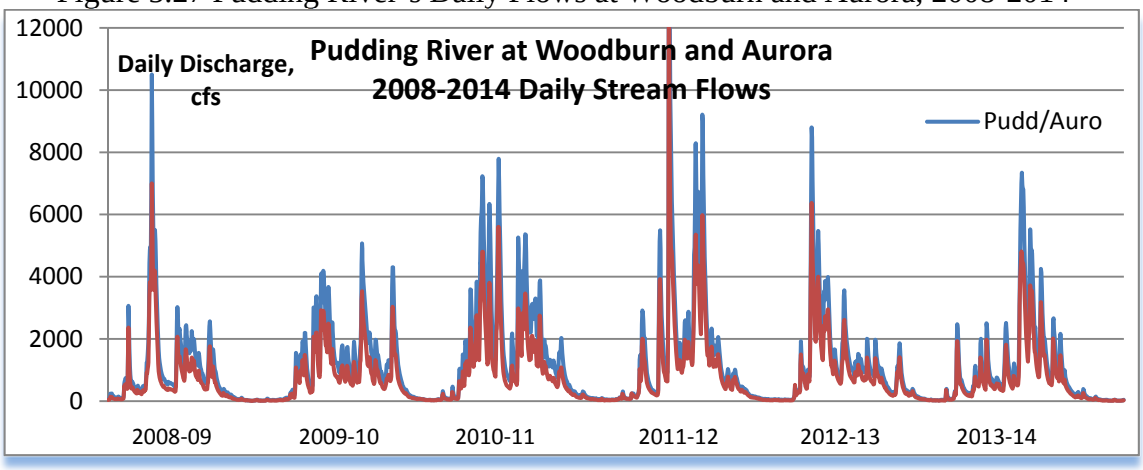
USGS Site Number	Site Name and Location	Drainage Area, sq. mi. (Multiple of Drift Cr. Site A)	Record Period	Number of years
14200300	Silver Creek At Silverton	47.9 (3.03)	1963-1969 and 1970-1979, 2008-2011, 2014 (Jun-Oct)	20
14200400	Little Abiqua Creek Near Scotts Mills	9.81 (0.62)	1993-2004, 2014 (Jun-Oct)	13
(*)	Lower Abiqua at Gallon House Bridge	75.7 (4.92)	2008-2011	3
14201000	Pudding River Near Mt. Angel	203 (12.85)	1939-1966	28
14201300	Zollner Creek Near Mt. Angel	15.0 (0.95)	1993-2008- to date	21
14201340	Pudding River Near Woodburn	314 (19.87)	1997-2008, 2009- to date	17
14202000	Pudding River Near Aurora	479 (30.32)	1928-1963, 1994-1997, and 2002 to date	54
14201500	Butte Creek at Monitor	58.70 (3.72)	1936-1985, 2008-11, 2014(Jan-Oct)	55
(**)	Drift Cr. @ Victor Point Rd	15.8 (1.00)	2008- to date	6
(*)	Drift Cr. @ Hibbard Rd. Bridge	24.8 (1.57)	2008-2011, May 2014 to date	4

(*) Stations operated by Marion Co. Soil & Conservation District (**) Station operated by EVWD's Contractor

Current focus is on number of years of records, relative drainage sizes, and status of the recording gauge (active vs. discontinued). In that context, the Pudding River is the stream with the longest records. Of the two Pudding River recording sites that are still active (Aurora and Woodburn), the Aurora gauge has by far the longer period of record of the two sites: 54 years of actual flows (as of mid-October 2014 and potentially 28 years of additional reconstituted flows between 1963 and 1993). Considering that their R^2 values are not that much different, the data from the Aurora site are more advantageous to use because they cover a longer period of records and, hence, a wider range of run-off conditions.

Daily stream flow hydrographs for the Pudding River at Woodburn and Aurora for the 2008 through 2014 hydrologic years are plotted in Figure 5.27, followed by a scatter plot showing the correlation between daily stream flows at those two sites. The high correlation R^2 values (0.9846 for linear regression and 0.9886 for the polynomial order 2 regression) strongly support the use of stream flow data recorded at Woodburn to fill in any previous data gaps of Pudding River at Aurora, if and when needed.

Figure 5.27 Pudding River's Daily Flows at Woodburn and Aurora, 2008-2014



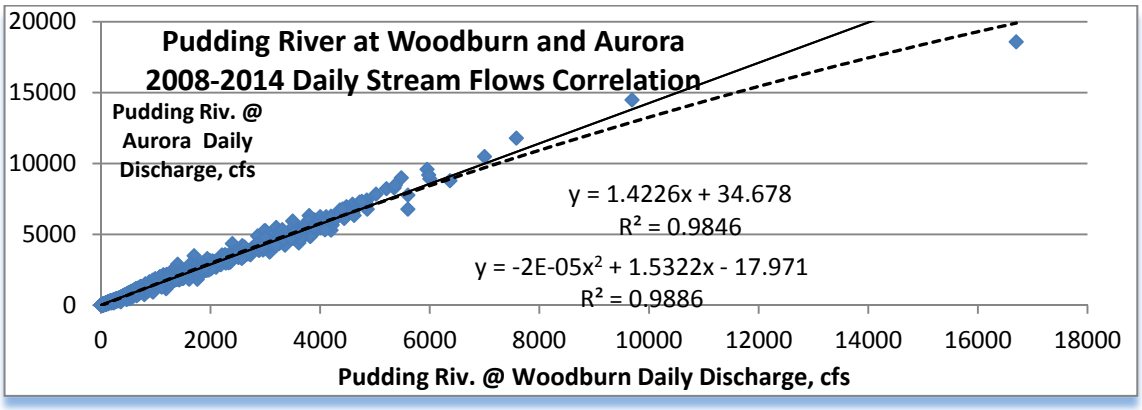


Table 5.5 contains the 2008-14 mean monthly discharges of the Pudding River near Aurora. The median annual runoff volume at that site, based on 52 years of stream flow measurements between 1928 and 2014, (excluding 1965-65 and 1997-98, which contain data gaps), is about 894,000 AF.

Table 5.5 Pudding River at Aurora Mean Monthly Discharges (cfs)

Hydro Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	*Annual Ave.*
2008-09	132.6	767.8	1110.1	3281.8	830.1	1810.3	1174.8	1117.8	247.3	57.8	21.6	36.9	882.41
2009-10	99.8	1179.6	1508.2	2843.5	1287.6	1452.1	2252.3	1069.2	1644.8	183.7	49.3	90.1	1138.36
2010-11	275.9	1857.3	4141.0	3344.2	1109.6	3538.7	2467.0	1184.6	798.2	207.9	83.9	50.6	1588.25
2011-12	107.3	950.1	829.6	4723.2	1944.5	4085.5	3065.7	1056.1	596.0	203.7	66.7	49.9	1473.18
2012-13	307.2	2577.6	3382.9	1502.1	1442.6	1219.0	1025.7	615.7	455.9	106.3	32.7	203.0	1072.57
2013-14	664.2	844.3	898.9	1040.7	3492.2	2885.2	1640.5	997.3	253.9	116.5	32.7	34.1	1075.06

A relevant question is, how does the runoff of the last six hydrologic years (2008-2014) compare with other runoff years, based on the historical records of Pudding River @ Aurora going as far back as 1928? The answer to this question is provided in Table 5.6, based on the

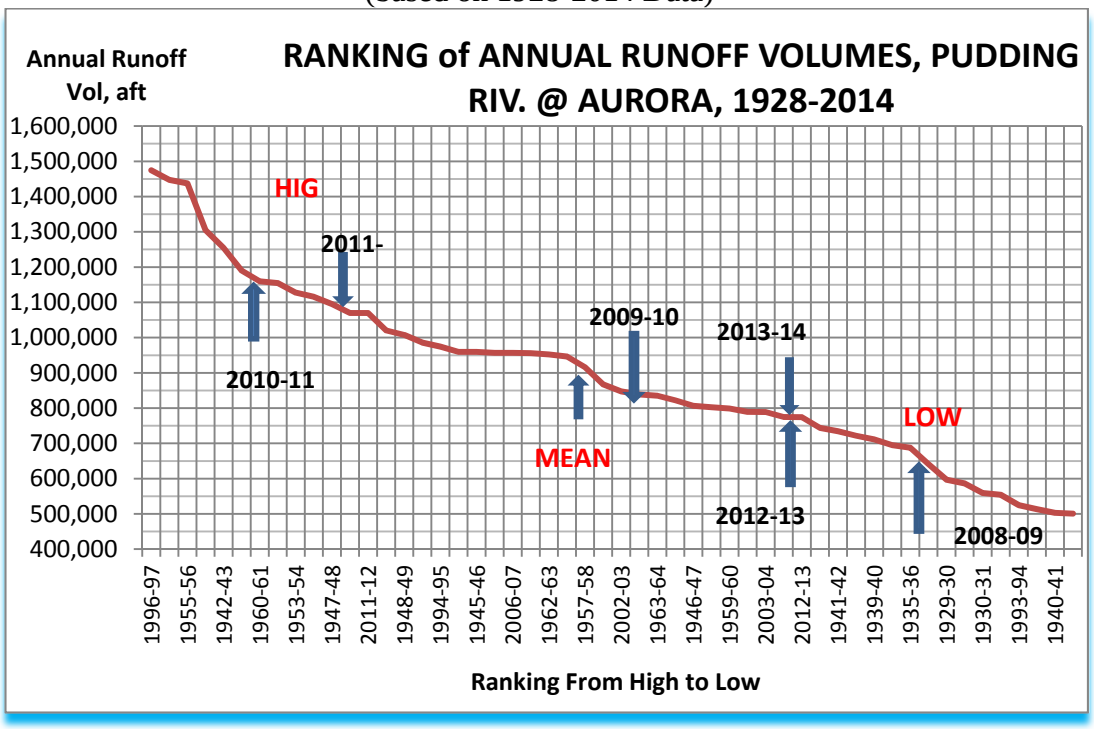
ranking of the annual runoff years. With an annual runoff volume of 641,582 AF at that site, the October 2008-September 2009 hydrologic year would rank 44rd in the existing 52 year record period. By the same token, the 821,837 AF volume for 2009-10 would rank 30th, and the 1,154,752 AF volume for 2010-11 would rank 8th. For the last three water years, the 2011-12 annual runoff volume of 1,069,775 AF would rank 13th, the 2012-13 annual runoff volume of 774,173 AF would rank 37th, and the 2013-14 annual runoff volume of 766,771 AF would rank 36th. See Table 5.6 and Figure 5.28.

Table 5.6 Pudding River at Aurora: Annual Runoff Volume Ranking
(as of mid-October 2014)

Ranking	Annual Runoff Volume (AF)	Hydrologic Year (Oct-Sep)	Runoff Size		Ranking	Annual Runoff Volume (AF)	Hydrolo-gic Year (Oct-Sep)	Runoff Size
1	1,474,450	1996-97			27	847,532	2002-03	
2	1,447,386	1995-96			28	839,022	1934-35	
3	1,437,398	1955-56			29	835,282	1963-64	
4	1,304,908	1950-51			30	821,837	2009-10	
5	1,254,722	1942-43			31	806,562	1946-47	
6	1,190,121	1937-38			32	802,527	1954-55	
7	1,159,557	1960-61			33	799,099	1959-60	
8	1,154,752	2010-11			34	789,243	1961-62	
9	1,127,442	1953-54	High		35	788,919	2003-04	
10	1,115,792	1949-50			36	774,173	2012-13	
11	1,095,130	1947-48			37	766,771	2013-14	
12	1,069,919	2005-06			38	743,883	1936-37	
13	1,069,775	2011-12			39	734,391	1941-42	
14	1,020,183	1932-33			40	721,816	1956-57	
15	1,007,579	1948-49			41	711,335	1939-40	
16	985,724	1931-32			42	695,169	1944-45	Low
17	974,484	1994-95			43	687,904	1935-36	
18	959,376	1952-53			44	641,582	2008-09	
19	959,325	1945-46			45	596,992	1929-30	
20	956,901	1951-52			46	586,594	1938-39	
21	956,679	2006-07			47	559,244	1930-31	
22	955,863	2007-08			48	554,344	1928-29	
23	952,064	1962-63			49	525,012	1993-94	
24	946,422	1958-59			50	513,563	1943-44	
25	916,004	1957-58			51	502,791	1940-41	
26	867,553	1933-34	Ave		52	500,823	2004-05	

Ave.=1 to 52 894,056 AF

Figure 5.28 Ranking of Annual Stream Flow Volumes of the Pudding River @ Aurora (based on 1928-2014 Data)



Because of the close relationship between the runoff of the Pudding River near Aurora and Upper Drift Creek, the above information shed some light on the long-term runoff conditions at the proposed project site. Of the last six water years, two of them (2010-11 and 2011-12) witness fairly high runoff amounts, three (2009-10, 2012-13, and 2013-14) experienced slightly below average runoff, and one (2008-09) was considerably below the average.

Another important consideration is the October-April runoff volume. Table 5.7 contains a list of data related to Pudding River near Aurora and Drift Creek at the project site. This information provides some indications on the range of runoff volume expected at the project on a long-term perspective.

Table 5.7 October-April Runoff Volume, Pudding River and Upper Drift

Water Year	Oct-Apr Runoff Vol., Upper Drift Creek (1)	Oct-Apr Runoff Vol., Pudding @Aurora (2)	Upper Drift Vol./ Pudding@Aurora Vol.
2008-09	19,159	551,075	0.0347
2009-10	25,601	638,574	0.0401
2010-11	32,049	1,013,493	0.0316
2011-12	31,419	949,805	0.0331
2012-13	24,102	688,577	0.0350
2013-14	23,235	679,148	0.0342
2008-14	25,928	753,445	0.0348
1928-14	*(28,000)**	805,999	

Using the average volume ratio of 0.0348 and the 52-year (within the 1928-2014 period) average October-April for Pudding River @ Aurora of 805,999 AF, the expected long-term October-April runoff volume average at Upper Drift site would be about 28,000 AF. This average ratio of 0.0348 is close to the drainage area ratio for the two basins involved: [15.4 sq. mi. /479 sq. mi.]= 0.03215. The relatively minor difference between 0.0348 and 0.03215 is to be expected given the fact that, according to the normal annual precipitation map for the Pudding watershed, more rainfall is expected to fall each year over Drift Creek's watershed than over Pudding River's watershed. On the other hand, because of its much larger drainage area, Pudding River probably has a larger baseflow than Drift Creek.

As stated earlier**,** review of the 2008-2014 stream flow data at Upper Drift Creek and other nearby streams clearly suggested that, in order to extend the runoff records of Upper Drift Creek, the most promising gauging station to concentrate on is the Pudding River near Aurora station, followed by the Pudding River near Woodburn. Therefore, future study efforts will be focused on examining how closely predicted data for Upper Drift Creek based on data collected at those two Pudding River stations match actually observed stream flows.

6. Development of Regression Equations Based on 2008-2014 Data

Regression equations have been developed using the statistical correlation between the flows measured at Pudding River flows at Aurora and Upper Drift Creek flows at Victor Point. This section examines how the generated data for Upper Drift Creek, using order 2 polynomial regression trend based on 2008-2014 data, compare with observed data for the corresponding water year. The regression equations developed so far as plotted in the previous section and using the order 2 polynomial regression trend are listed in Table 6.1, with daily and monthly flow data reconstitution results presented separately.

Table 6.1 Regression Equations Used for Upper Drift Cr.
(based on Pudding Riv. @ Aurora)

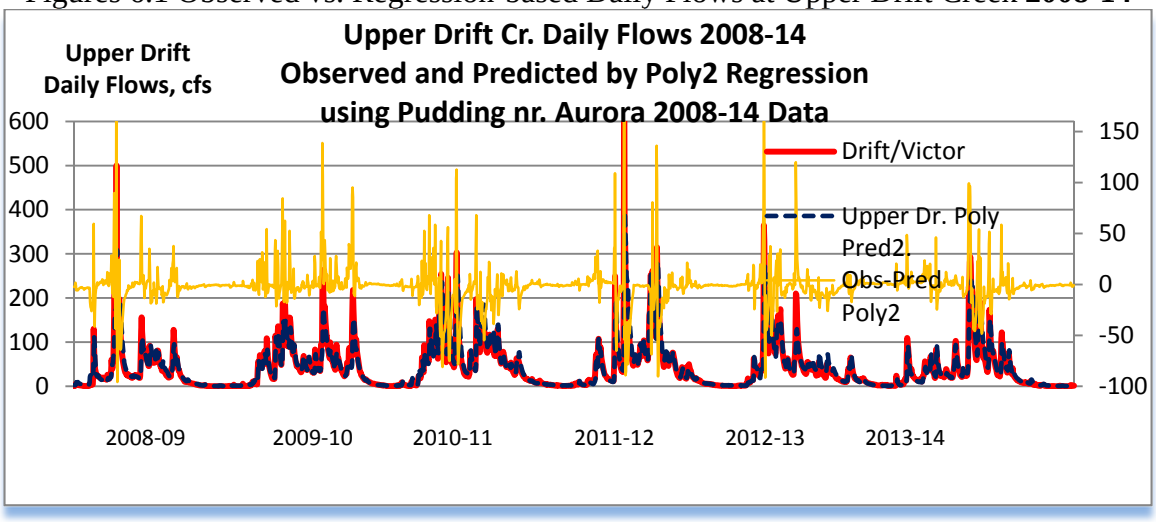
Time Step	Data Base	Regression Equations	R^2
Daily	2008-09	Y=-1E-06X^2+0.0418X-2.1791	0.8064
Daily	2009-10	Y=-6E-07X^2+0.0428X-0.3903	0.8794
Daily	2010-11	Y=-2E-06X^2+0.0379X+0.2981	0.8659
Daily	*2008-11*	*Y=-2E-06X^2+0.0416X-0.8081*	0.8402
Daily	2011-12	Y=-1E-06X^2+0.0389X+1.1204	0.7198
Daily	2012-13	Y=-2E-06X^2+0.0438X-1.8271	0.8398
Daily	2013-14	Y=-6E-07X^2+0.037X+1.0148	0.8958
Daily	*2008-14*	*Y=-1E-06X*2+0.0399X+0.0937*	*0.8111*
Monthly	2008-09	Y=-4E-06X^2+0.0453X-2.1196	0.9849
Monthly	2009-10	Y=-3E-06X^2+0.0475X-1.3567	0.9905
Monthly	2010-11	Y=-3E-06X^2+0.0423X-1.467	0.9857
Monthly	*2008-11*	*Y=-4E-06X^2+0.048X-2.3533*	*0.9793*
Monthly	2011-12	Y=-1E-06X^2+0.0368X+1.9126	0.9776
Monthly	2012-13	Y=4E-07X^2+0.0348X+1.7107	0.9842

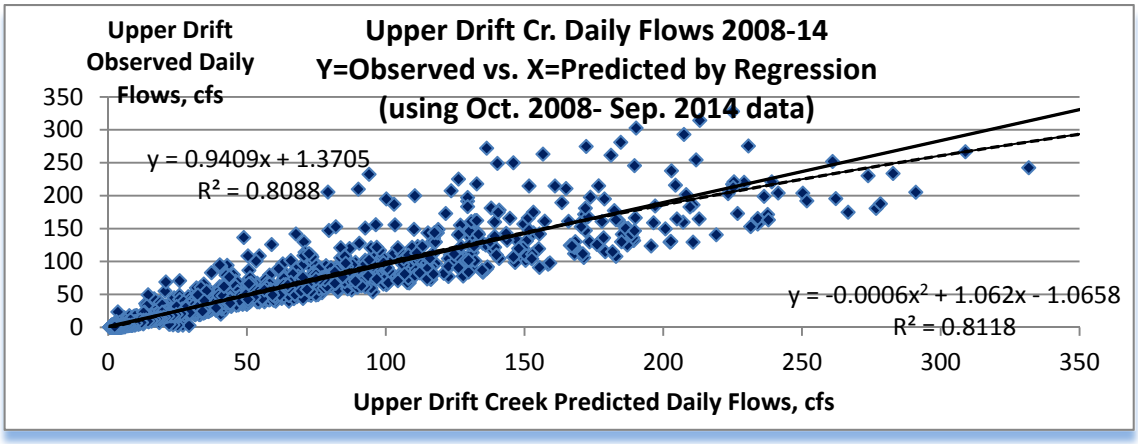
Monthly	2013-14	Y=-1E06X^2+0.0397X -0.1409	0.9949
Monthly	*2008-14*	*Y=-3E-06X^2+0.0431X-0.8109*	*0.9775*

6.1 Daily Flows

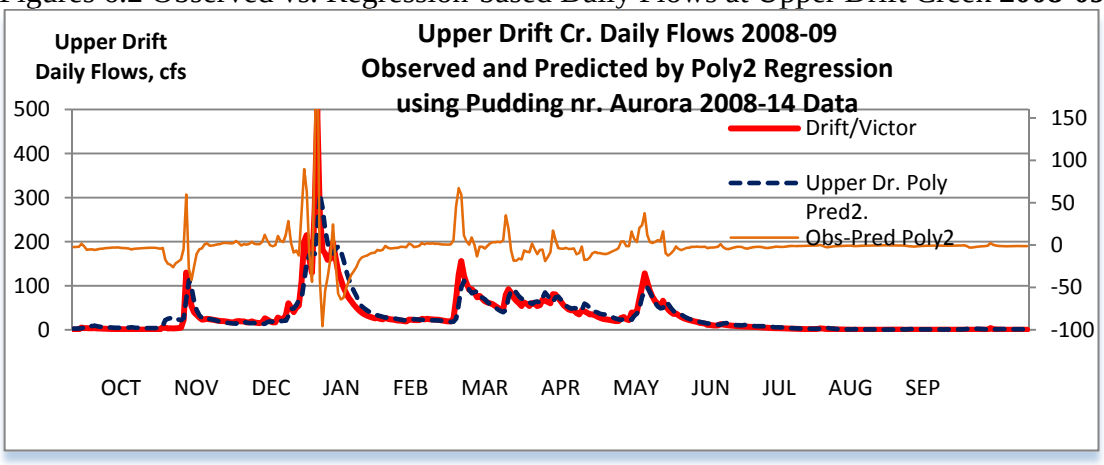
The hydrographs of the Daily Observed vs. Synthesized flows at Upper Drift Creek are plotted on Figure 6.1 for all 2008-14 water years, and on Figure 6.2 through 6.6 for each year of that period. The synthesized daily flows were developed using polynomial order 2 regression equation based on 2008-2014 daily flows of Upper Creek and Pudding River near Aurora (Y= -1E-06X^2 + 0.0399X + 0.0937; see Figure 5.15). The Observed minus Predicted error differences are graphed for each day. In addition, scatter plots of predicted vs. observed stream flows are also shown for each water year, along with the values of the correlation indices R^2.

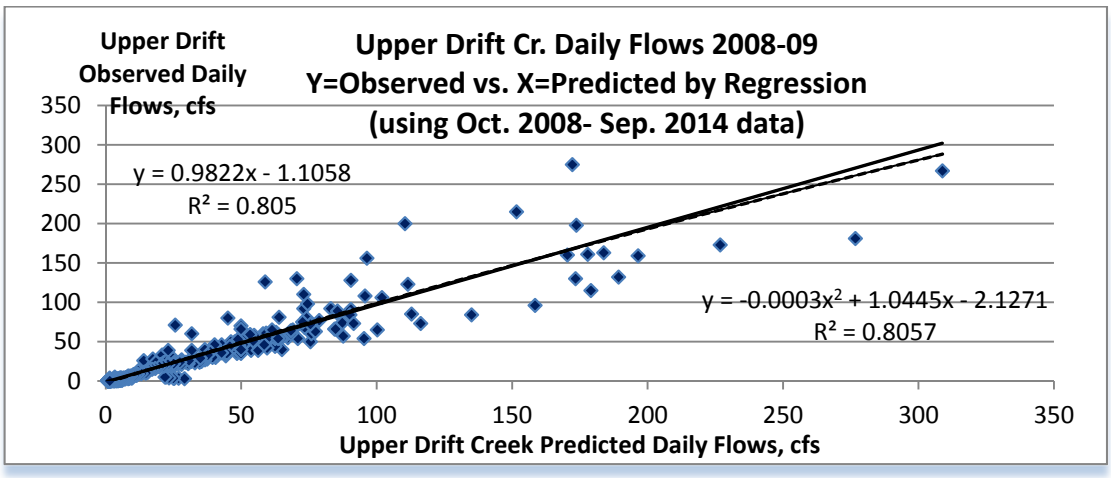
Figures 6.1 Observed vs. Regression-based Daily Flows at Upper Drift Creek **2008-14**



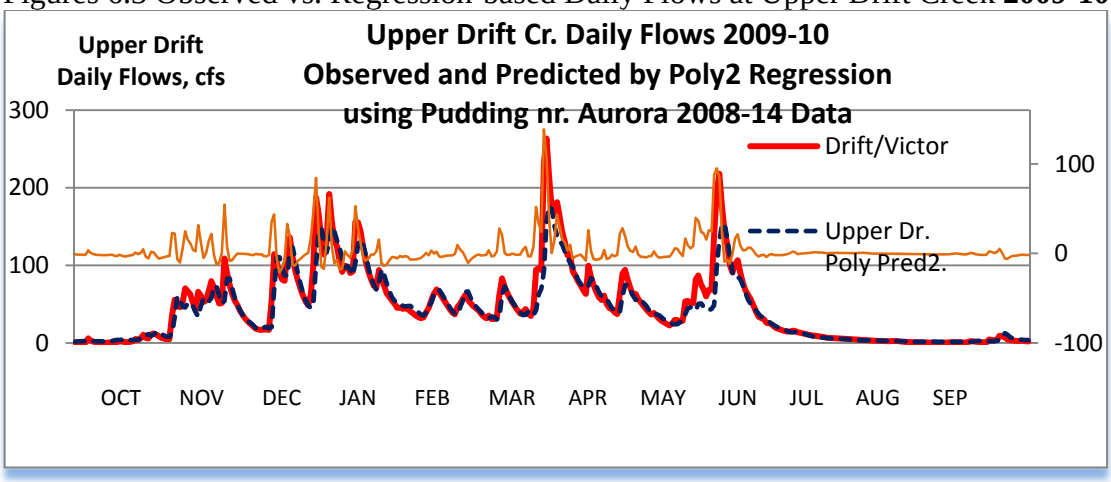


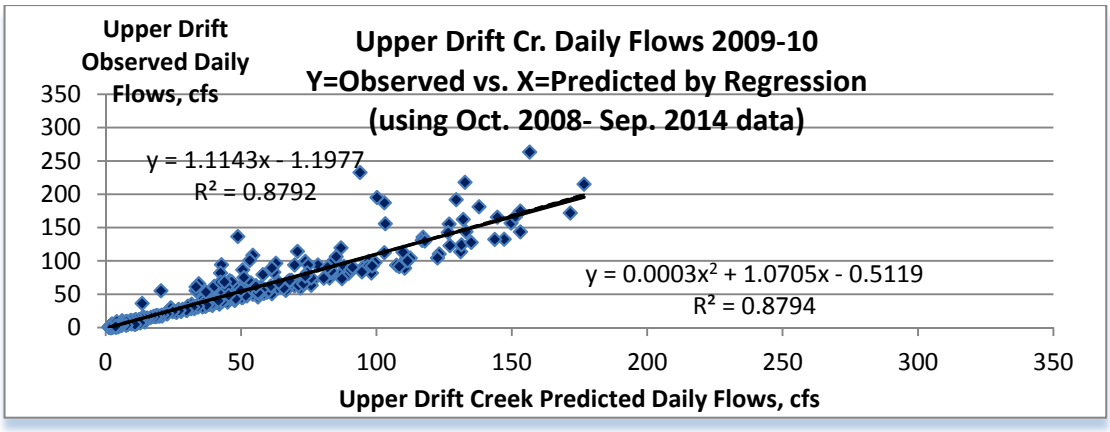
Figures 6.2 Observed vs. Regression-based Daily Flows at Upper Drift Creek **2008-09**



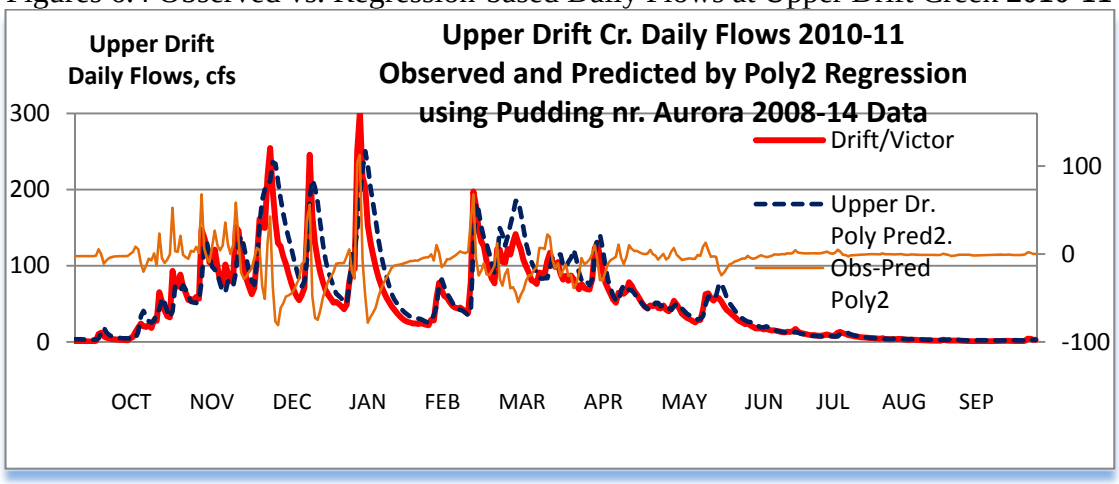


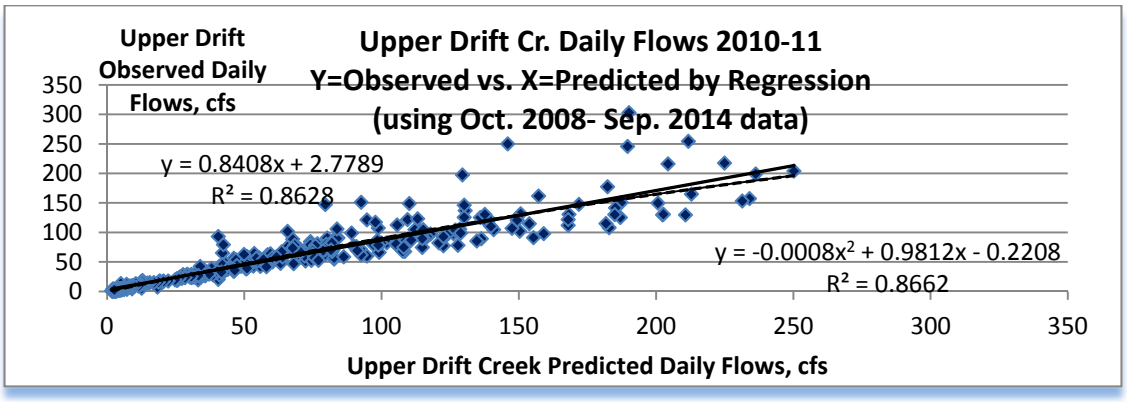
Figures 6.3 Observed vs. Regression-based Daily Flows at Upper Drift Creek **2009-10**



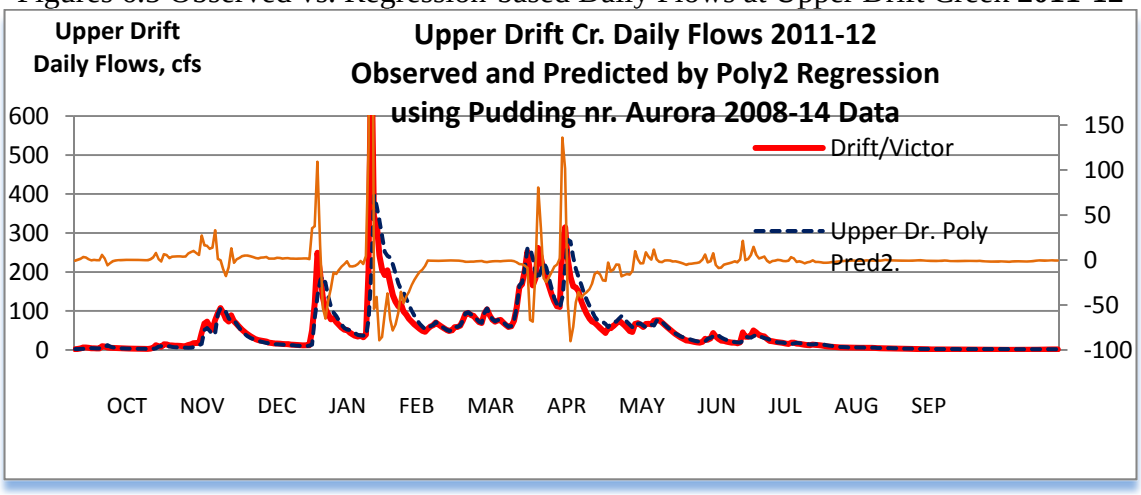


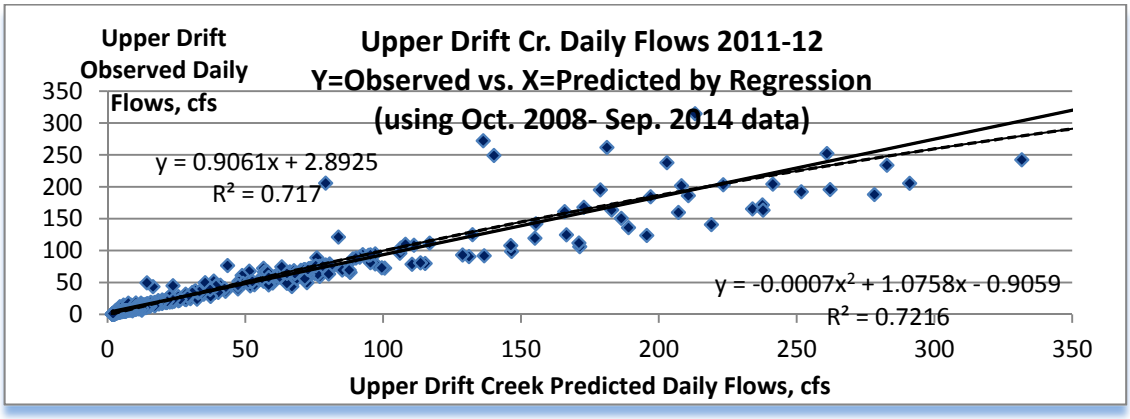
Figures 6.4 Observed vs. Regression-based Daily Flows at Upper Drift Creek **2010-11**



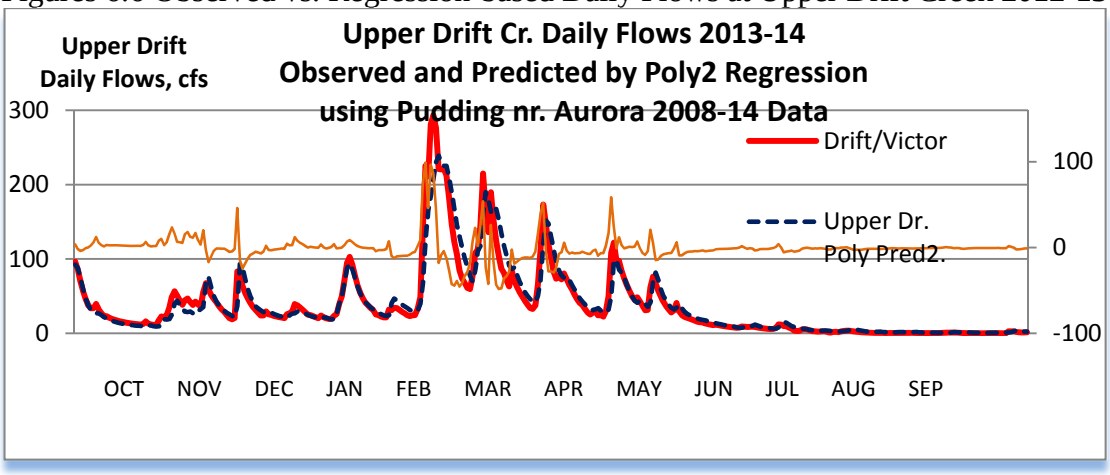


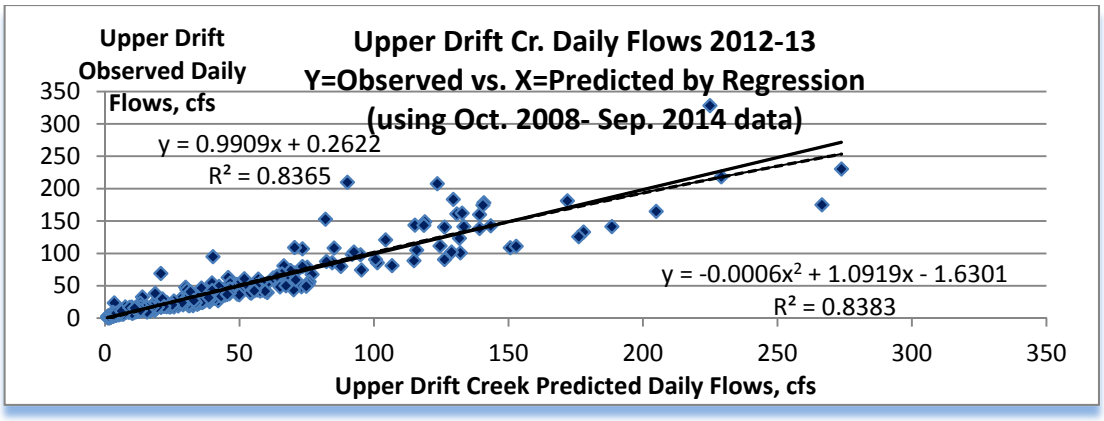
Figures 6.5 Observed vs. Regression-based Daily Flows at Upper Drift Creek **2011-12**



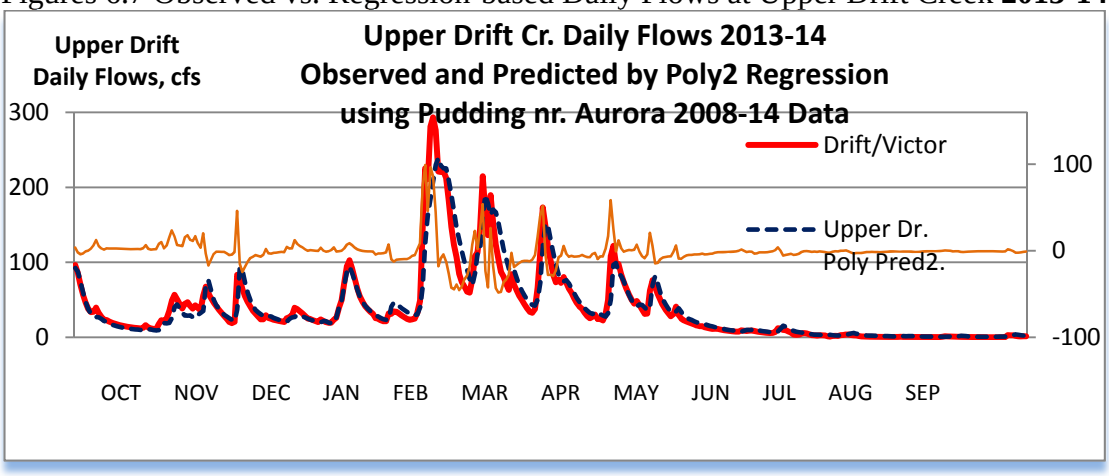


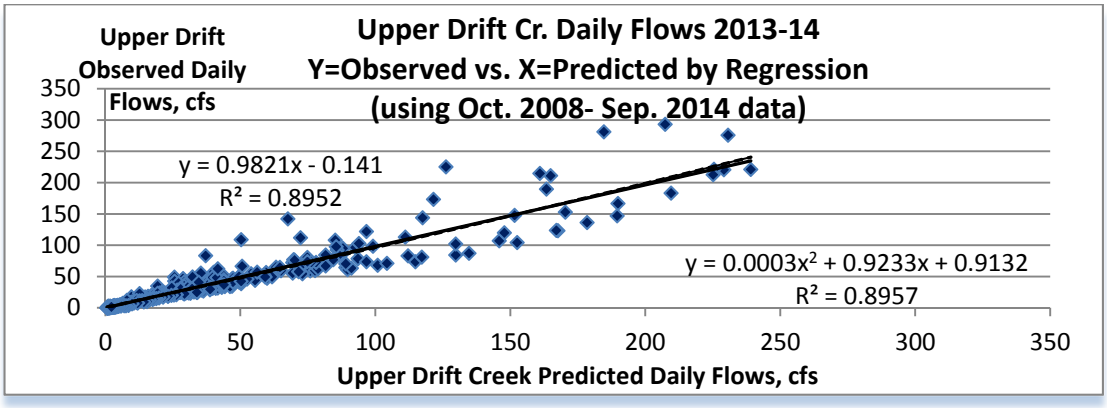
Figures 6.6 Observed vs. Regression-based Daily Flows at Upper Drift Creek **2012-13**





Figures 6.7 Observed vs. Regression-based Daily Flows at Upper Drift Creek **2013-14**





The results of the flows at Upper Drift Creek generated by regression equations involving daily Oct. 2008-2014 data of the Pudding River at Aurora are summarized in Table 6.2 in the condensed form of monthly values, and plotted in Figures 6.8, 6.9, 6.10, 6.11, 6.12 and 6.13. Differences between monthly observed and calculated values are also shown.

Table 6.2. Results of Daily Synthesized Flows (Expressed in Monthly Values)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2008-09Ob	1.83	22.82	48.19	101.87	38.93	65.90	39.73	45.55	7.24	1.35	0.24	0.49
2008-09Pr	5.36	29.70	41.43	113.24	32.03	68.89	45.42	43.07	9.89	2.40	0.96	1.57
Obs-Pr	*-3.54*	*-6.88*	*6.77*	*-11.37*	*6.90*	*-2.99*	*-5.69*	*2.48*	*-2.65*	*-1.04*	*-0.72*	*-1.07*
2009-10Ob	2.84	50.84	59.66	109.37	47.32	68.76	89.62	47.43	72.70	7.90	1.38	2.71
2009-10Pr	4.06	45.43	57.12	104.85	49.74	55.02	83.94	41.81	62.74	7.38	2.06	3.67
Obs-Pr	*-1.22*	*5.41*	*2.55*	*4.52*	*-2.42*	*13.74*	*5.68*	*5.62*	*9.96*	*0.52*	*-0.68*	*-0.96*
2010-11Ob	7.79	78.55	123.90	95.62	39.89	112.20	80.17	45.24	25.35	8.86	2.69	1.33
2010-11Pr	10.95	70.27	145.41	118.95	42.98	127.80	91.98	45.90	31.04	8.34	3.44	2.11
Obs-Pr	*-3.16*	*8.27*	*-21.50*	*-23.33*	*-3.09*	*-15.60*	*-11.81*	*-0.66*	*-5.68*	*0.51*	*-0.75*	*-0.78*
2011-12Ob	4.83	41.86	39.81	140.27	66.83	144.60	86.17	39.21	24.52	6.98	1.87	0.80
2011-12Pr	4.36	36.21	31.37	148.63	73.58	142.20	108.32	40.89	23.48	8.17	2.75	2.08
Obs-Pr	*0.47*	*5.65*	*8.44*	*-8.36*	*-6.75*	*2.40*	*-22.15*	*-1.68*	*1.04*	*-1.19*	*-0.88*	*-1.28*
2012-13Ob	12.25	94.24	121.47	62.22	56.23	37.61	29.75	22.76	18.07	5.17	2.22	12.94
2012-13Pr	12.06	89.60	121.08	55.00	55.19	47.27	39.98	24.07	17.99	4.32	1.40	8.05
Obs-Pr	*0.18*	*4.63*	*0.39*	*7.22*	*1.04*	*-9.66*	*-10.23*	*-1.31*	*0.07*	*0.85*	*0.82*	*4.90*
2013-14Ob	28.09	38.15	33.78	40.31	123.21	97.41	60.21	35.19	8.76	3.01	0.53	0.75
2013-14Pr	25.79	32.90	34.90	40.19	121.59	105.10	62.27	38.71	10.16	4.73	1.40	1.45
Obs-Pr	*2.30*	*5.25*	*-1.12*	*0.12*	*1.62*	*-7.69*	*-2.07*	*-3.51*	*-1.40*	*-1.72*	*-0.87*	*-0.70*

Figure 6.8 Plots of Observed vs. Regression-synthesized Daily Flows, **2008-09** (shown on monthly basis)

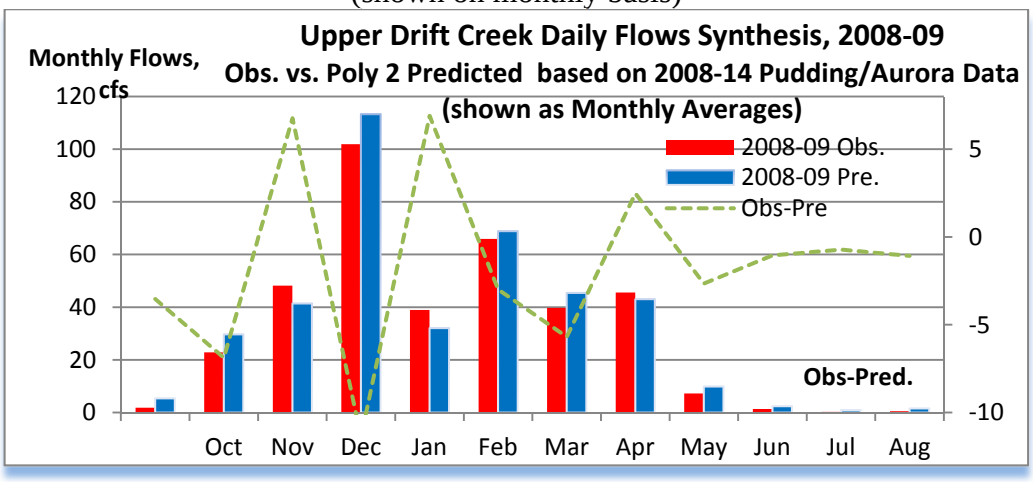


Figure 6.9 Plots of Observed vs. Regression-synthesized Daily Flows, **2009-10** (shown on monthly basis)

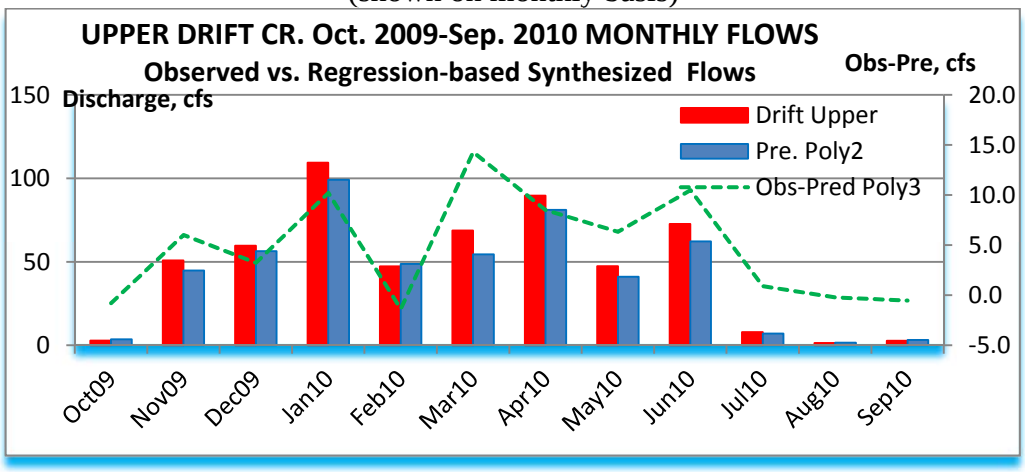


Figure 6.10 Plots of Observed vs. Regression-synthesized Daily Flows, **2010-11** (shown on monthly basis)

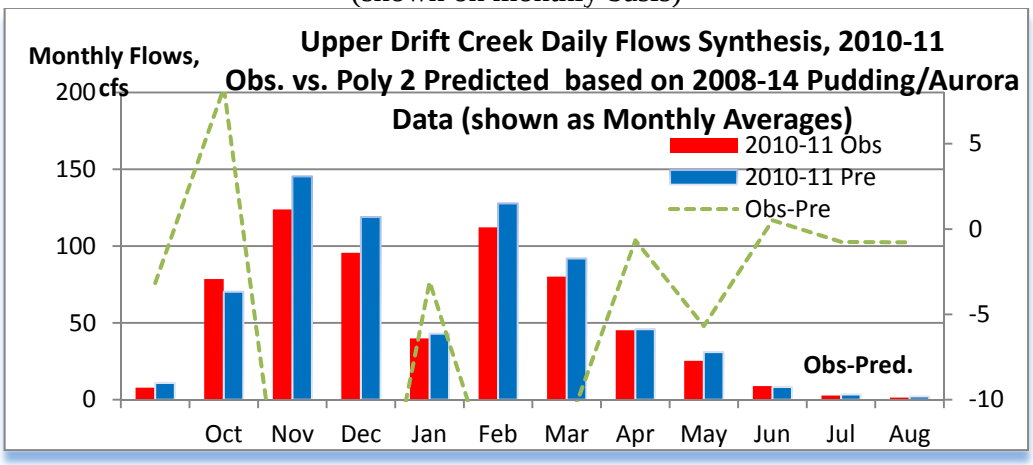


Figure 6.11 Plots of Observed vs. Regression-synthesized Daily Flows, **2011-12** (shown on monthly basis)

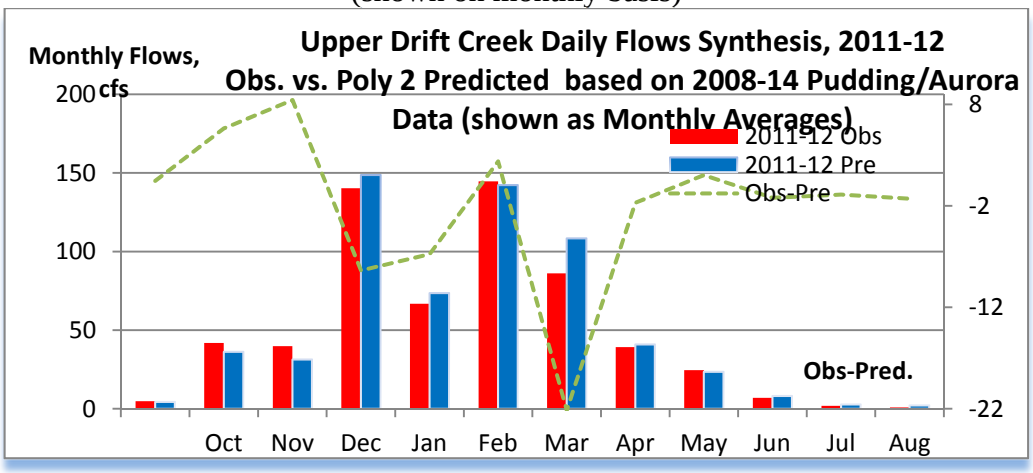


Figure 6.12 Plots of Observed vs. Regression-synthesized Daily Flows, 2012-13 (shown on monthly basis)

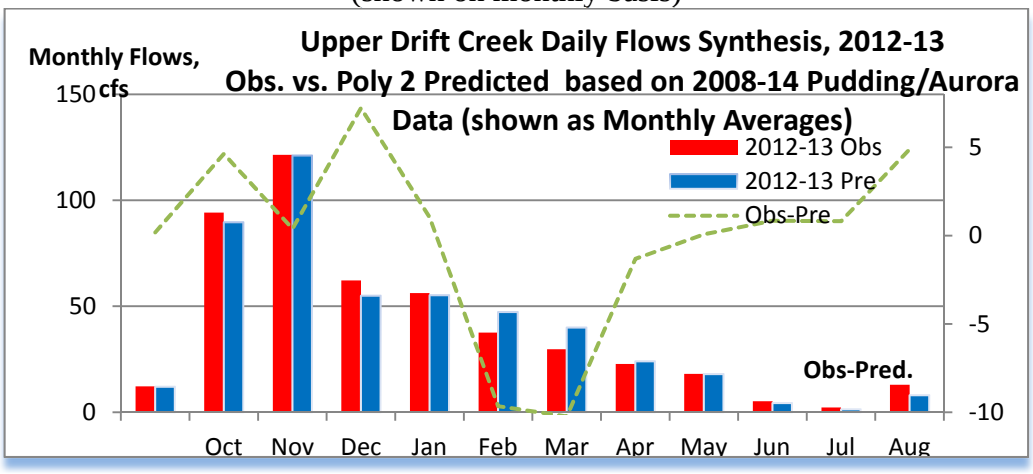
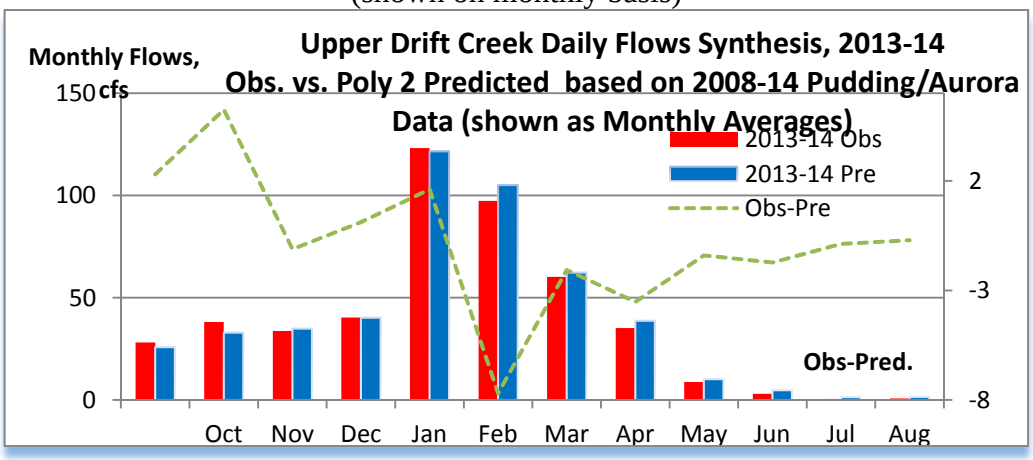
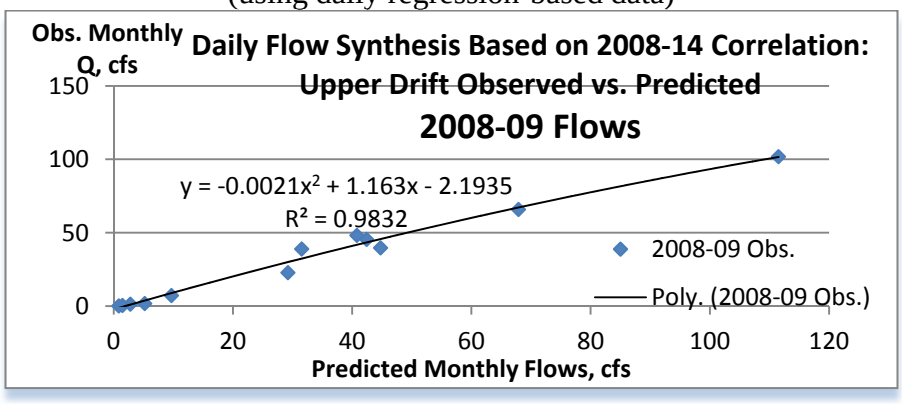


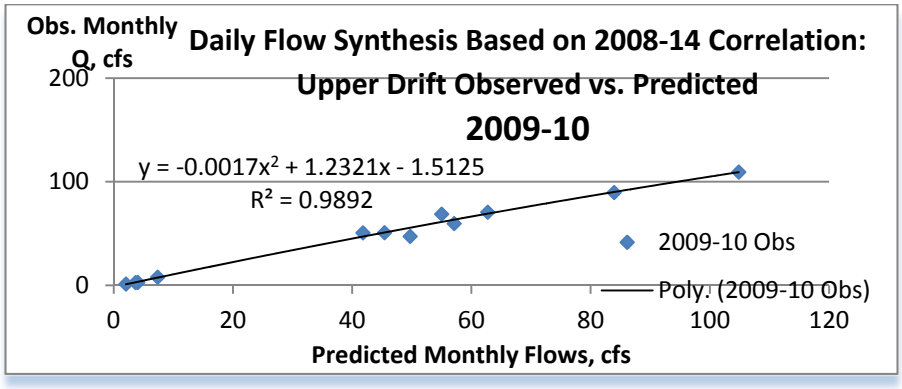
Figure 6.13 Plots of Observed vs. Regression-synthesized Daily Flows, 2013-14 (shown on monthly basis)

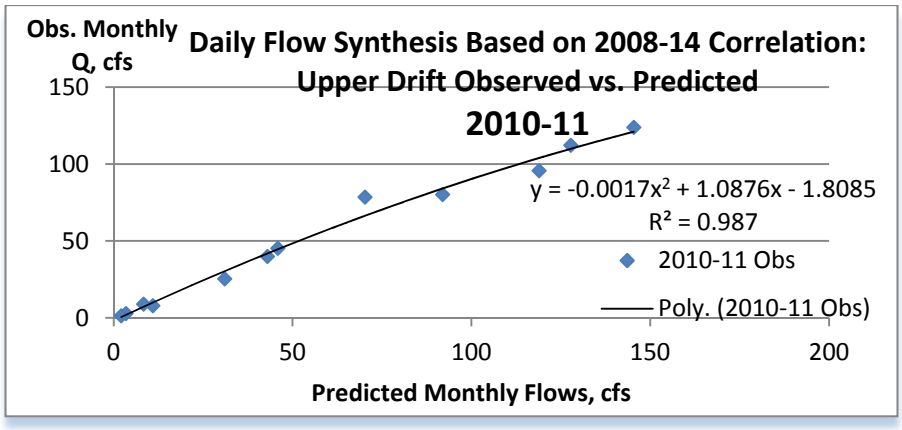


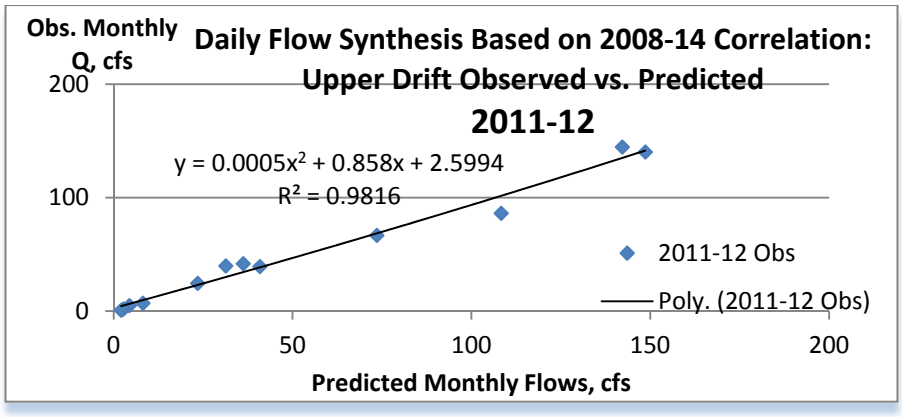
The group of scatter plots for the monthly average flows that were calculated based on daily values reconstituted through regression formulas are shown below in Figure 6.14 for each of the water years of the 2008- 2014 period, and for the entire 6 water years. This information illustrates the (greater) level of prediction accuracy achieved when monthly (instead of daily) values are used.

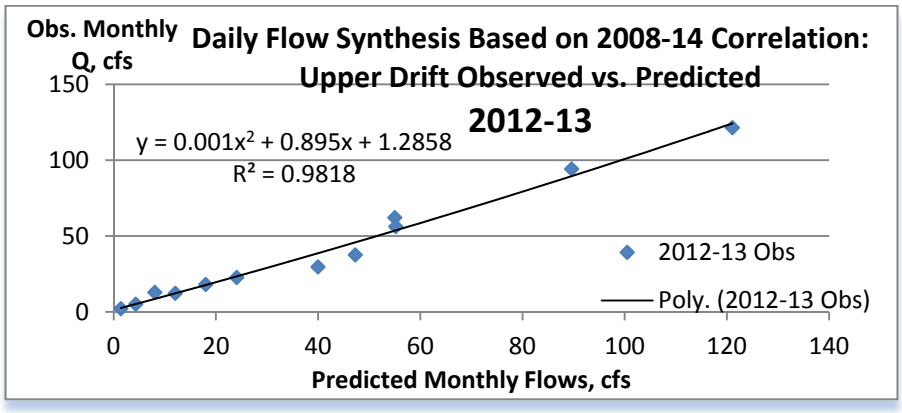
Figures 6.14 Scatter Plots of Observed vs. Calculated Monthly Flows
(using daily regression-based data)

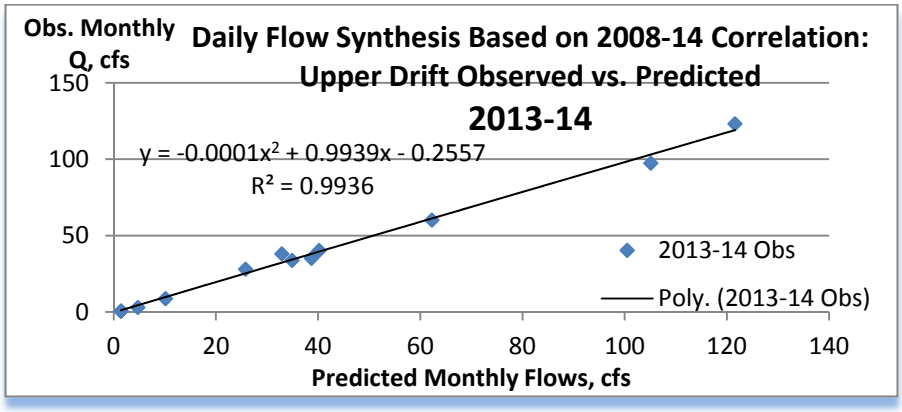


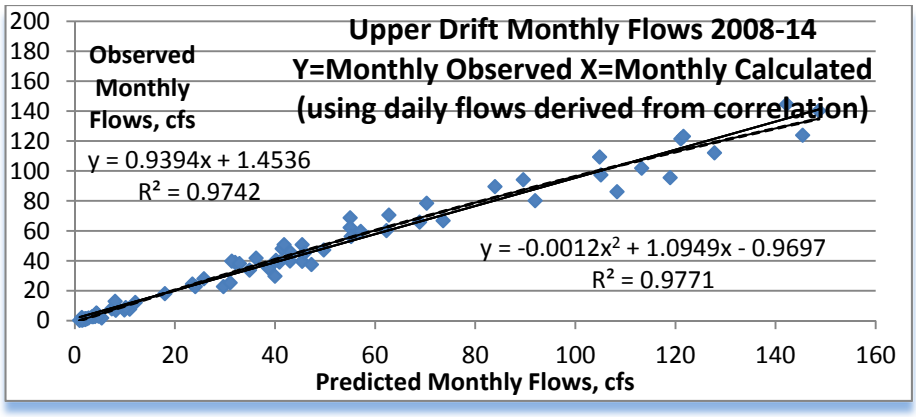





Daily Flow Synthesis Based on 2008-14 Correlation:
Upper Drift Observed vs. Predicted
2011-12
Obs. Monthly Q, cfs
y = 0.0005x² + 0.858x + 2.5994
R² = 0.9816
2011-12 Obs
Poly. (2011-12 Obs)
Predicted Monthly Flows, cfs
0
100
200
0
50
100
150
200


Daily Flow Synthesis Based on 2008-14 Correlation:
Upper Drift Observed vs. Predicted
2012-13
Obs. Monthly Q, cfs
y = 0.001x² + 0.895x + 1.2858
R² = 0.9818
2012-13 Obs
Poly. (2012-13 Obs)
Predicted Monthly Flows, cfs
0
50
100
150
0
20
40
60
80
100
120
140


Daily Flow Synthesis Based on 2008-14 Correlation:
Upper Drift Observed vs. Predicted
2013-14
Obs. Monthly Q, cfs
y = -0.0001x² + 0.9939x - 0.2557
R² = 0.9936
2013-14 Obs
Poly. (2013-14 Obs)
Predicted Monthly Flows, cfs
0
50
100
150
0
20
40
60
80
100
120
140



6.2 Regression-based Monthly Flows

The hydrographs of the **Monthly** Observed vs. Synthesized flows at Upper Drift Creek are plotted on Figures 6.15 through 6.20 for each of the water year during the 2008-14 period. The synthesized monthly flows were developed using polynomial order 2 regression equation based on 2008-2014 monthly flows of Upper Creek and Pudding River near Aurora (Y=-3E06X^2+0.0431X-0.8109; see Figure 5.21). The Observed minus Predicted error differences are also shown for each month.

Figure 6.15 Observed vs. Regression-based Monthly Flows at Upper Drift Creek **2008-09**

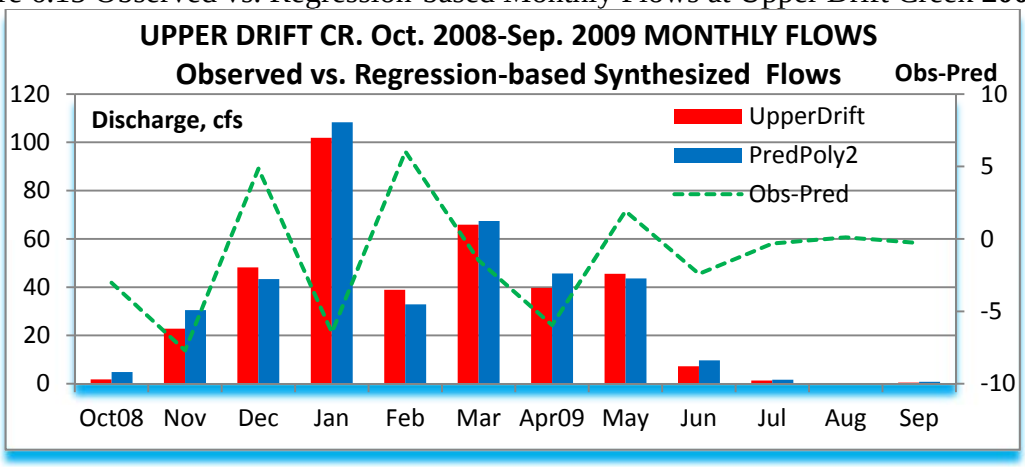


Figure 6.16 Observed vs. Regression-based Monthly Flows at Upper Drift Creek **2009-10**

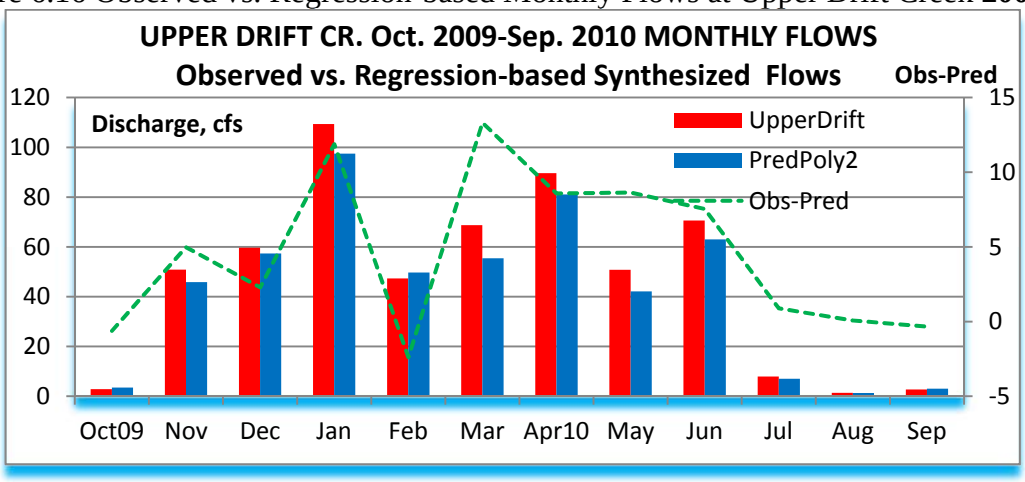


Figure 6.17 Observed vs. Regression-based Monthly Flows at Upper Drift Creek **2010-11**

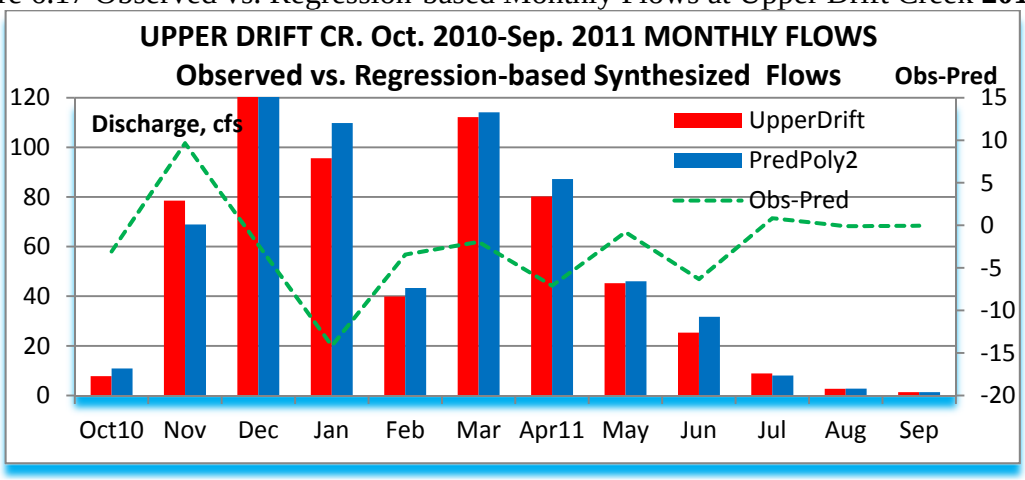


Figure 6.18 Observed vs. Regression-based Monthly Flows at Upper Drift Creek **2011-12**

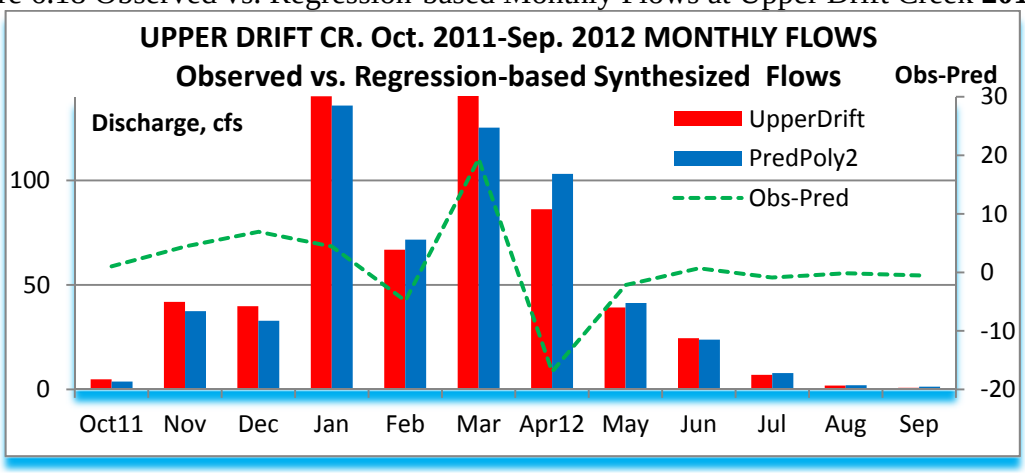


Figure 6.19 Observed vs. Regression-based Monthly Flows at Upper Drift Creek **2012-13**

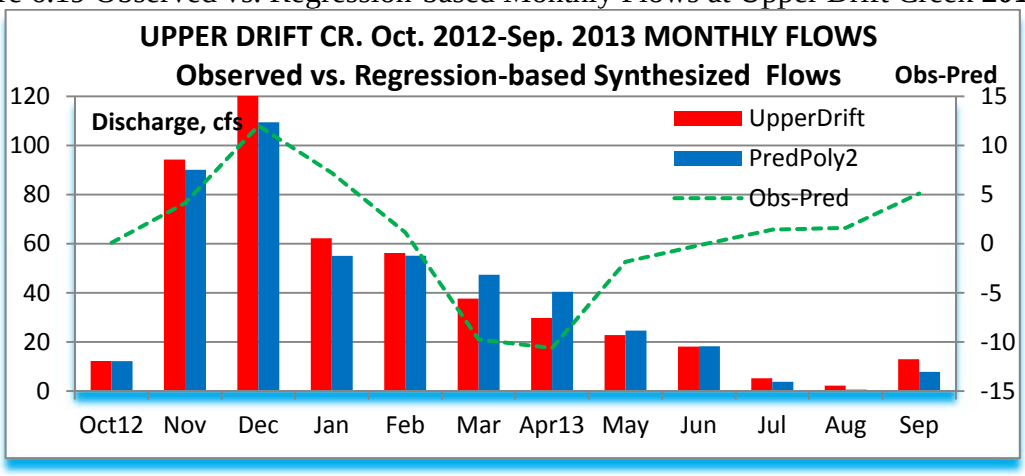
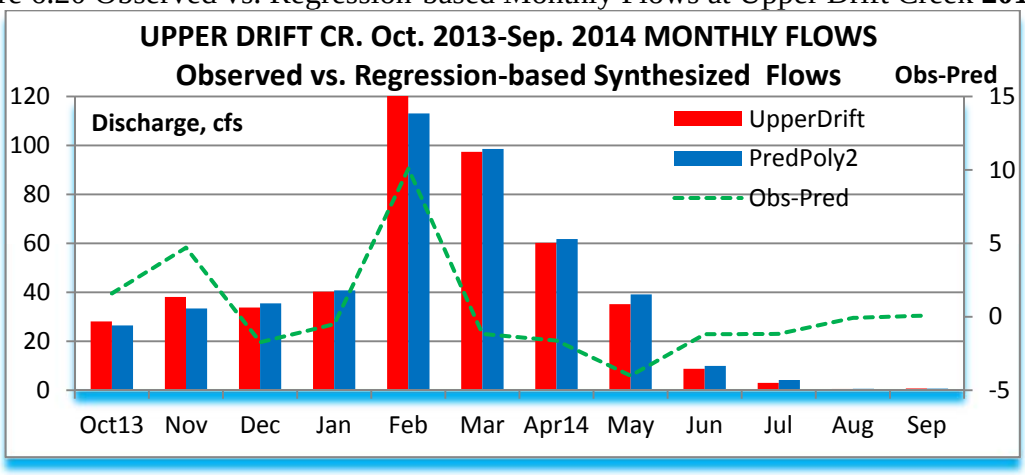


Figure 6.20 Observed vs. Regression-based Monthly Flows at Upper Drift Creek **2013-14**



Figures 6.21 and 6.22 show the same monthly information as above on a multi-year basis and provide an overall view of the prediction errors that result from applying a polynomial order 2 regression equation based on 2008-2014 monthly data.

Figure 6.21 Observed vs. Regression-based Monthly Flows at Upper Drift Creek (2008-14; Observed – Predicted in cfs)

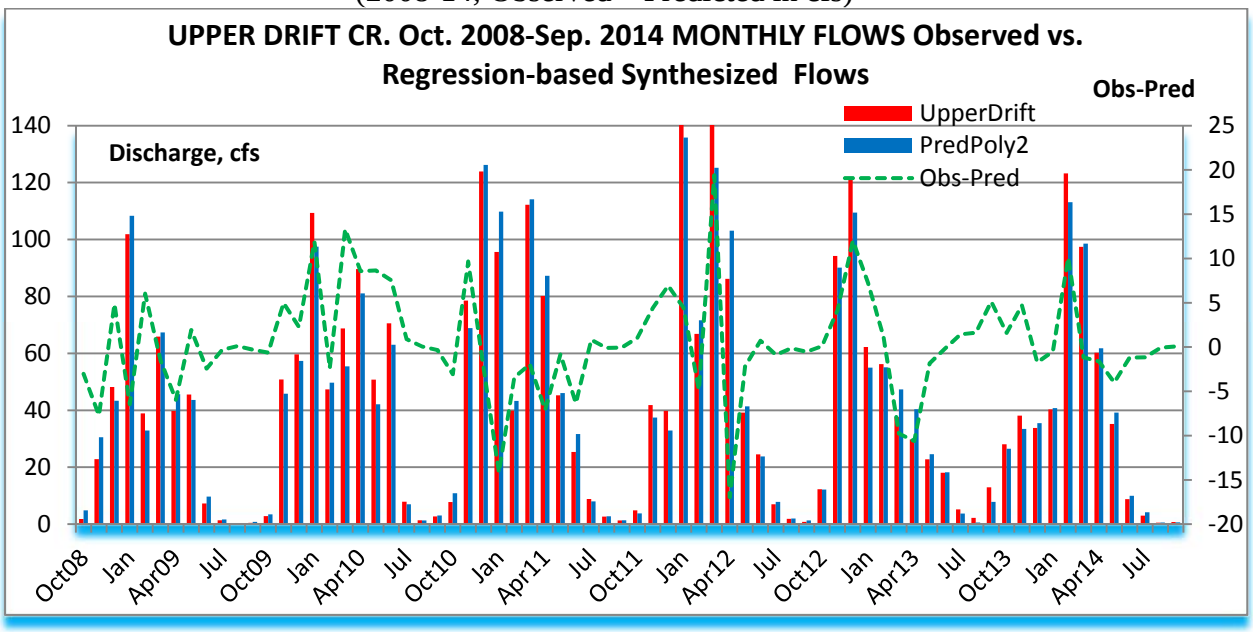
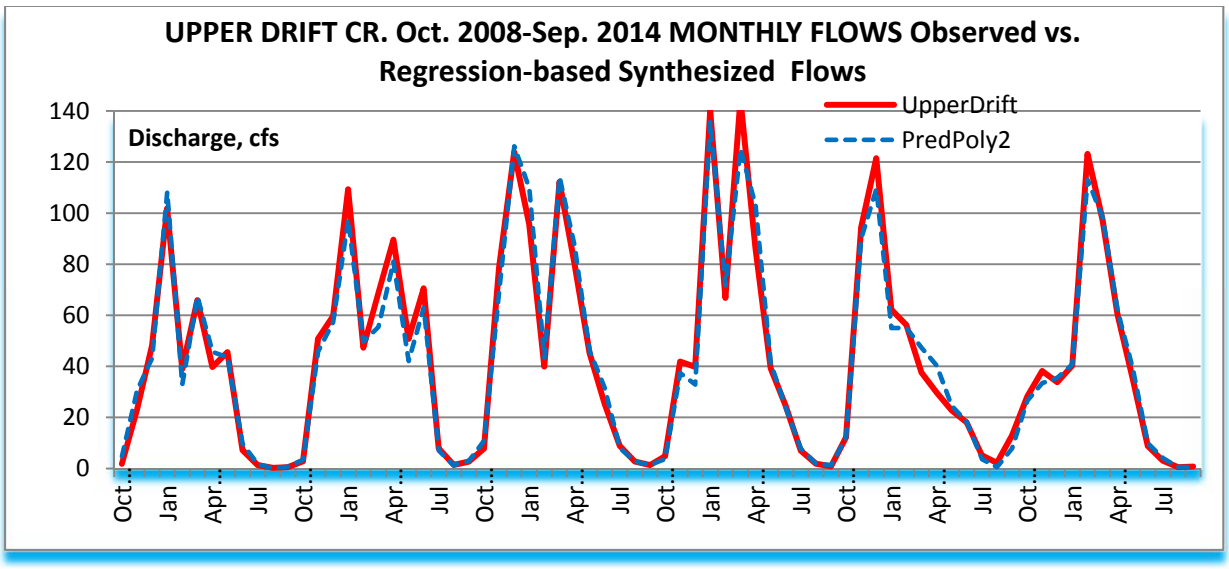
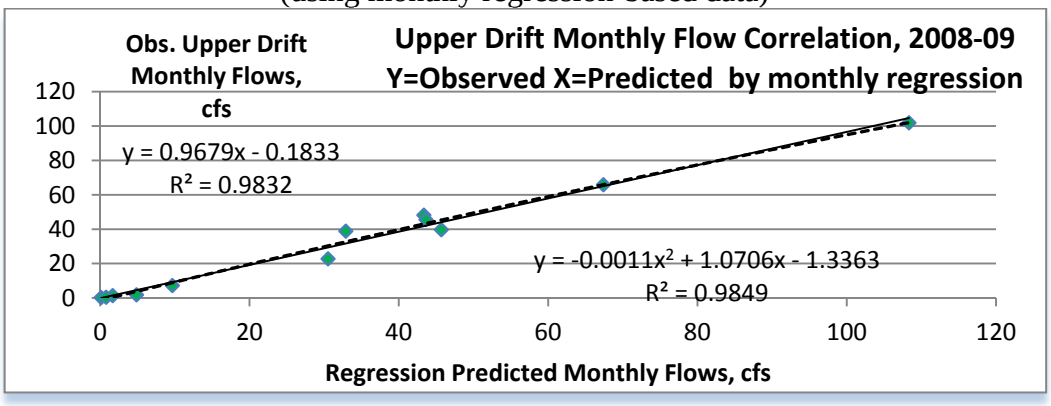


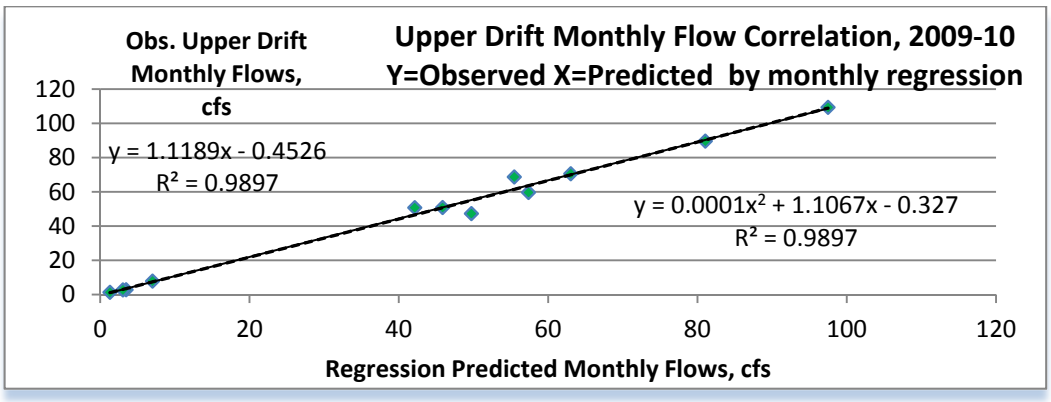
Figure 6.22 Observed vs. Regression-based Monthly Flows at Upper Drift Creek 2008-14

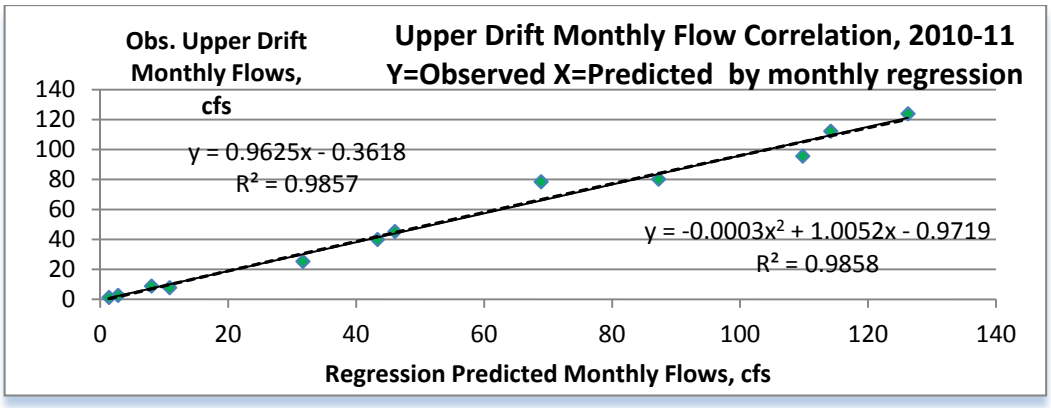


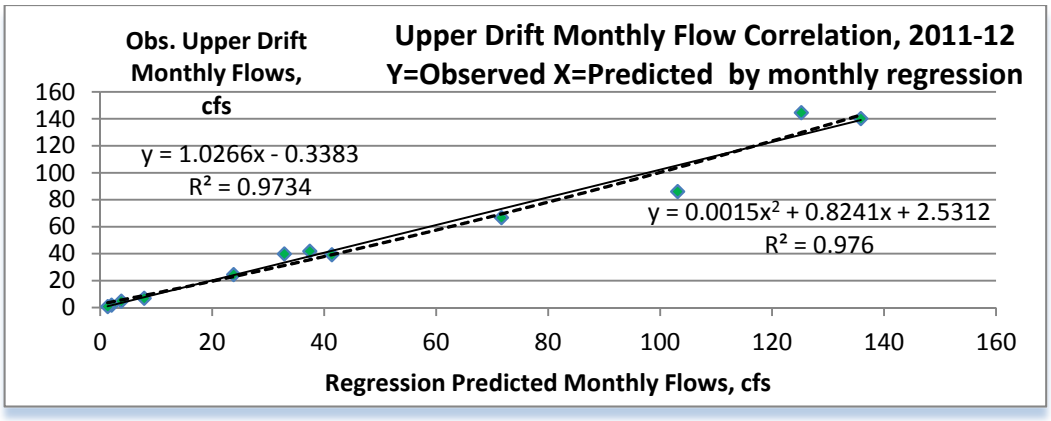
The group of scatter plots for the monthly average flows that were calculated based on monthly values reconstituted through regression formulas are shown below in Figures 6.23 for each of the water years of the 2008 - 2014 period, and for the entire 6 water years. As mentioned earlier, this information shows the greater level of prediction accuracy achieved when monthly results are used instead of daily results.

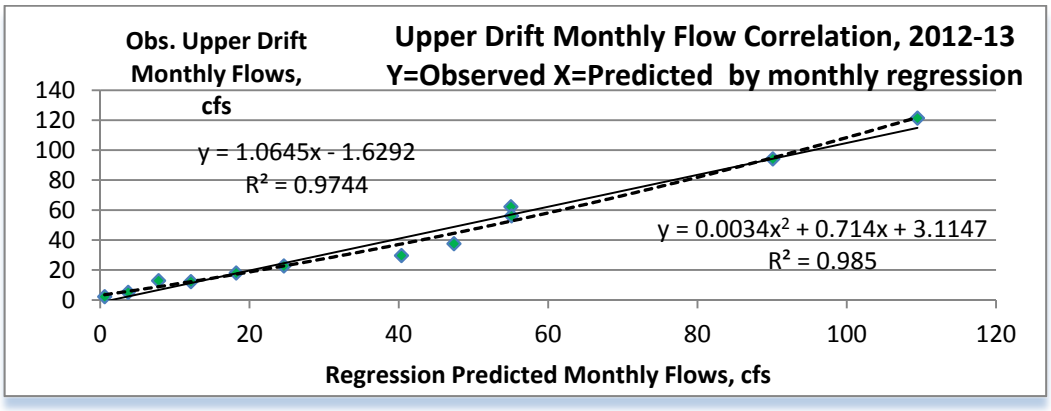
Figures 23. Scatter Plots of Observed vs. Calculated Monthly Flows
(using monthly regression-based data)

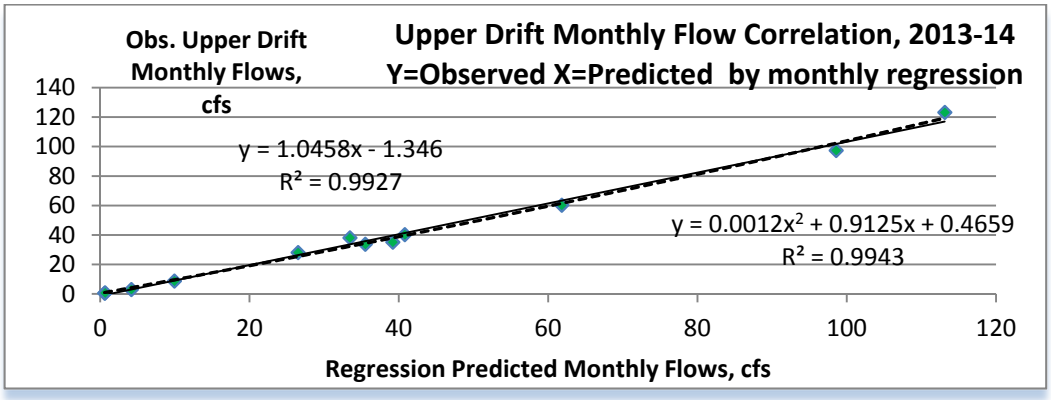


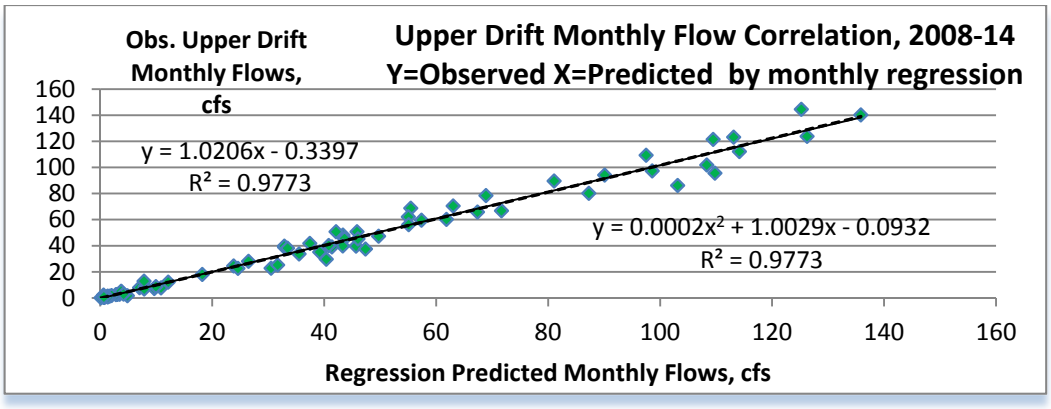





Upper Drift Monthly Flow Correlation, 2011-12
Y=Observed X=Predicted by monthly regression
Obs. Upper Drift Monthly Flows, cfs
y = 1.0266x - 0.3383
R² = 0.9734
y = 0.0015x² + 0.8241x + 2.5312
R² = 0.976
Regression Predicted Monthly Flows, cfs


Upper Drift Monthly Flow Correlation, 2012-13
Y=Observed X=Predicted by monthly regression
Obs. Upper Drift Monthly Flows, cfs
y = 1.0645x - 1.6292
R² = 0.9744
y = 0.0034x² + 0.714x + 3.1147
R² = 0.985
Regression Predicted Monthly Flows, cfs


Upper Drift Monthly Flow Correlation, 2013-14
Y=Observed X=Predicted by monthly regression
Obs. Upper Drift Monthly Flows, cfs
y = 1.0458x - 1.346
R² = 0.9927
y = 0.0012x² + 0.9125x + 0.4659
R² = 0.9943
Regression Predicted Monthly Flows, cfs



6.3 Comparison of Statistically Synthesized Daily and Monthly Flows

The results of the monthly flow synthesis are listed in Table 6.3. Predicted monthly numbers for Upper Drift Creek were derived from application of a polynomial 2 regression equation based on correlation between 2008-14 monthly flow data at Upper Drift and Pudding at Aurora. The table contains an additional line in italics showing the monthly equivalent "Observed minus Synthesized" numbers previously listed in Table 6.2.

Table 6.3. Results of Monthly Synthesized Flows

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2008-09Ob	1.83	22.82	48.19	101.87	38.93	65.90	39.73	45.55	7.24	1.35	0.24	0.49
2008-09Pr	4.85	30.51	43.34	108.32	32.90	67.38	45.68	43.62	9.66	1.67	0.12	0.78
Obs-Pre	-3.02	-7.69	4.86	-6.45	6.03	-1.48	-5.95	1.93	-2.42	-0.32	-0.12	-0.29
2009-10Ob	2.84	50.84	59.66	109.37	47.32	68.76	89.62	50.77	70.57	7.90	1.38	2.71
2009-10Pr	3.46	45.86	57.37	97.49	49.71	55.45	81.05	42.12	63.03	7.01	1.31	3.05
Obs-Pre	-0.62	4.98	2.30	11.88	-2.39	13.31	8.58	8.65	7.55	0.89	0.07	-0.34
2010-11Ob	7.79	78.55	123.90	95.62	39.89	112.20	80.17	45.24	25.35	8.86	2.69	1.33
2010-11Pr	10.85	68.89	126.22	109.77	43.32	114.14	87.26	46.04	31.68	8.02	2.79	1.36
Obs-Pre	-3.06	9.66	-2.32	-14.15	-3.43	-1.94	-7.09	0.80	-6.33	0.83	-0.10	-0.03
2011-12Ob	4.83	41.86	39.81	140.27	66.83	144.60	86.17	39.21	24.52	6.98	1.87	0.80
2011-12Pr	3.78	37.43	32.88	135.83	71.65	125.20	103.12	41.36	23.81	7.84	2.01	1.33
Obs-Pre	1.05	4.43	6.93	4.44	-4.82	19.40	-16.95	-2.15	0.71	-0.86	-0.14	-0.52
2012-13Ob	12.25	94.24	121.47	62.22	56.23	37.61	29.75	22.76	18.07	5.17	2.22	12.94
2012-13Pr	12.15	90.09	109.47	55.02	55.09	47.37	40.36	24.59	18.22	3.74	0.60	7.82
Obs-Pre	0.10	4.14	12.01	7.20	1.14	-9.76	-10.61	-1.84	-0.15	1.43	1.62	5.13
2013-14Ob	28.09	38.15	33.78	40.31	123.21	97.41	60.21	35.19	8.76	3.01	0.53	0.75
2013-14Pr	26.49	33.44	35.51	40.80	113.12	98.57	61.82	39.19	9.94	4.17	0.60	0.66
Obs-Pre	1.60	4.71	-1.72	-0.49	10.09	-1.16	-1.61	-4.00	-1.18	-1.16	-0.07	0.09

The results for both the daily and monthly flow syntheses indicate that the stream flow data generated for Drift Creek at the project site using regression equations linked to the Pudding River flows at Aurora are within acceptable ranges.

In most cases, stream flow data are developed on a daily basis. However, depending on the intended application and if a monthly stream flow synthesis is easier to perform and/or yields better results, stream flow data could be developed on a monthly basis –especially when daily flow fluctuations are not critical to the project operation. In this particular case, exploration of the two possible approaches was performed mainly to see which one would work better than the other. Drift Creek, flowing in a smaller watershed, could be more reflective to daily local storm effects than the Pudding River and, thus, could lead to more fluctuating hydrographs. Such an impact would normally be less critical when working on a longer time frame.

It is also possible that using data recorded at a site geographically closer to Victor Point and controlling a smaller catchment area (such as Woodburn for the Pudding River and Silverton for Silver Creek) might yield comparable or even better results. As noted earlier, however, the other important consideration to keep in mind is the record length at those sites compared to Aurora's 52+ year records.

In addition to graphical plots of observed and predicted hydrographs, Table 6.4 provides some numerical indices of the accuracy of the stream flow synthesis using daily and monthly data. Accuracy indices include the correlation R^2 and the annual October-September runoff volume for each of the six water years. The best predictions are highlighted in bold.

Table 6.4 Correlation R^2 and Annual Runoff Volume
of Daily and Monthly Stream Flow Synthesis

Water Year	R^2 (Daily)	R^2 (Monthly)	Obs. Annual Runoff V, AF	Pred.Ann. Volume, AF (Daily)	Pred.Annual Volume AF (Monthly)	(OBS-PRE)/OBS (Daily) In %	(OBS-PRE)/OBS (Monthly) In %
2008-09	0.9832	**0.9849**	22,629	23,855	**23,536**	-5.42	**-4.01**
2009-10	0.9892	**0.9898**	33,749	**31,148**	30,482	**7.92**	9.89
2010-11	**0.9870**	0.9857	37,606	**37,610**	39,346	**-0.01**	-4.63
2011-12	**0.9816**	0.9776	36,178	**37,016**	35,284	**-2.32**	2.47
2012-13	0.9818	**0.9842**	28,553	**28,625**	28,026	**-0.25**	1.85
2013-14	**0.9936**	0.9848	27,908	28,522	**27,659**	-2.20	**0.89**

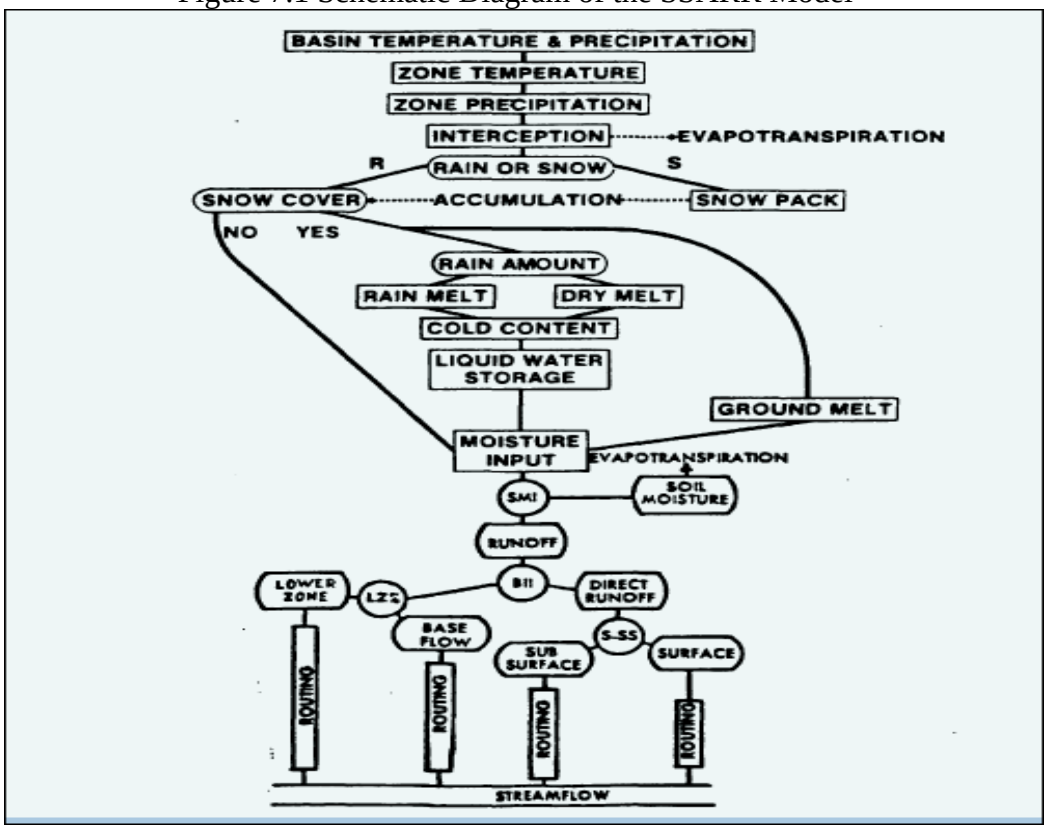
Based on the information shown in Table 6.4, the monthly stream flow predictions for Upper Drift Creek are within 1 and 10 percent, and fairly close to one another regardless of the daily or monthly procedure used. Neither approach seems to be consistently better than the other. Both need slight adjustments to exactly match the actually observed annual runoff volume.

7. Stream Flow Reconstitution Using Rainfall-Runoff Model

In addition to the statistical correlation approach that allows for development of regression equations needed to predict daily (and monthly) stream flow, another possible approach frequently used for the same purpose is to develop a deterministic rainfall-runoff model. This section documents the steps taken under this approach and provides some ideas about the accuracy of the model predictions.

Daily flows for Drift Creek at the project site were generated by a deterministic rainfall-runoff model based on the same procedures as the ones used in the U.S. Army Corps of Engineers' "Streamflow Synthesis and Reservoir Regulation" (SSARR) model. See Figure 7.1. For easy reference purposes, the rainfall-runoff model developed for Drift Creek is coded-named FLO4DRIFT. Its main inputs are the watershed runoff characteristics such as drainage area, soil-moisture indices that control excess runoff and infiltration, basin routing coefficients of each runoff components, and rainfall and/or snow data.

Figure 7.1 Schematic Diagram of the SSARR Model



As stated in the 1987 SSARR User Manual, "*the successful application of the SSARR Model is dependent upon derivations of the various parameters and relationships specific to a particular watershed or river system. Some of the relationships are general and, therefore, are applicable to many sub-basins within a major drainage. Others can be specifically derived for a particular watershed. Some are relationships which can be observed or derived, while others must be considered to be 'model parameters' which only have qualitative physical significance. Watershed runoff characteristics are primarily determined by trial-and-error solutions with the*

computer program to obtain the best fit of historical stream flow data. This procedure is repeated until adequate verification of observed flows is obtained".

Simulation of Upper Drift Creek's daily flows is performed on an annual basis, starting on October 1 and ending on September 30. Initial soil moisture conditions, which determine the runoff coefficient at the start of the water year, can be either specified by the user, or automatically calculated by the model using the previous year results. This allows FLO4DRIFT to perform a smooth and continuous multi-year simulation throughout the 2008-2014 hydrologic years.

The rainfall coefficient RC is one of the most critical modeling elements since it determines how much rainfall amounts recorded at the index station actually falls over the drainage area. While the modeling starts with a given RC value, slight changes may be required from year to year to actually match the actual rainfall distribution and the resulting runoff volume. For example, in order to match the 2008-09 observed annual runoff volume, rainfall at Salem Airport had to be multiplier by a factor of 1.9 to account for infiltration, evaporation losses, and lack of snow information. For a slightly below average year like 2009-10, the rainfall multiplier is 1.5. For an above average year like 2010-11, the rainfall multiplier is 1.7. Table 7.1 provides a sample output for the FLO4DRIFT model.

Table 7.1 Sample FLO4DRIFT Model Output

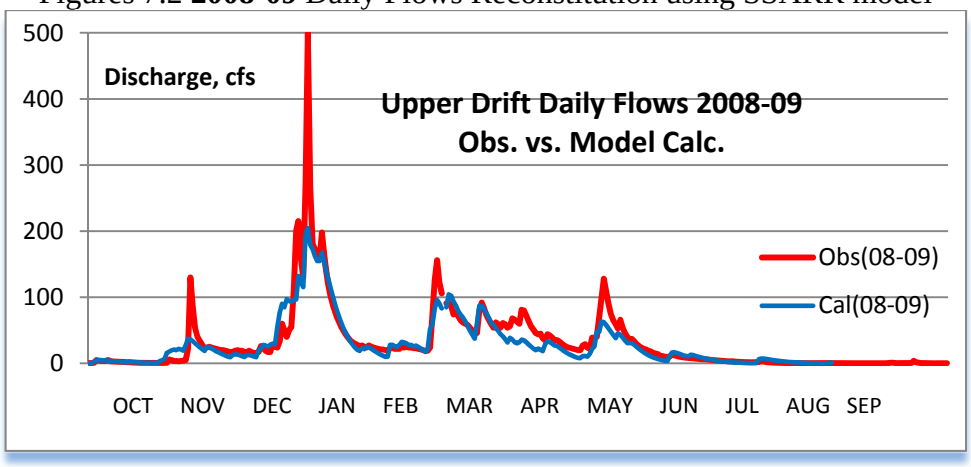
TS= 2.0 TSS= 8.0 TSBF= 24.0 TSBII= 32.0 W(1)= 1.70
RUNOFF VOL (AF) = 37,673 CAL(Before Routing)= 38,795 OBS/CAL Ratio= 1.030
Title:DRIFT CREEK 2010-11
RUN DATE:05-20-2012 21:04:02

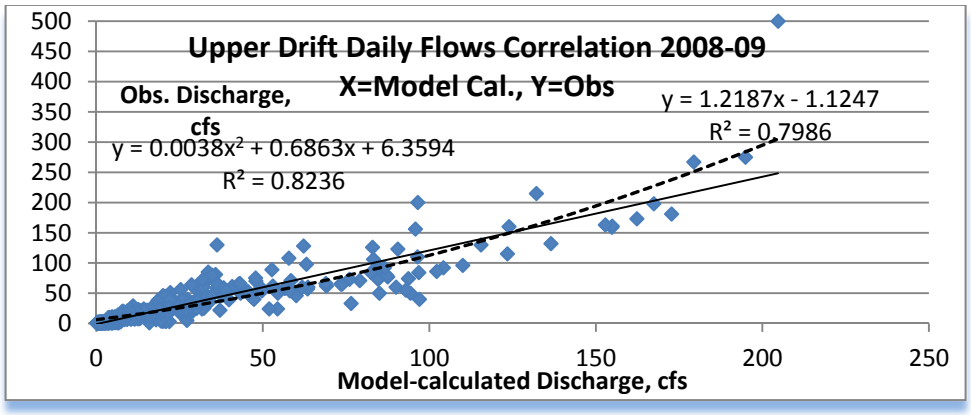
							<.....	D I S C H A R G E S				.....>
DD/MM/YR	RAIN	ETI	SMI	ROP	BII	BFP	SUR	SUB	BFL	BASE	QCAL	QOBS
	in.	in.	in.				cfs	cfs	cfs	cfs	cfs	cfs
---	---	---	---	---	---	---	---	---	---	---	---	---
1/10/10	0.00	0.07	0.10	.15	1.00	.20	0.0	0.0	0.0	0.1	0.1	0.9
2/10/10	0.00	0.07	0.03	.15	0.45	.30	0.0	0.0	0.0	0.1	0.1	0.9
3/10/10	0.00	0.07	0.00	.15	0.21	.44	0.0	0.0	0.0	0.1	0.1	0.9
4/10/10	0.00	0.07	0.00	.15	0.09	.58	0.0	0.0	0.0	0.1	0.1	0.9
5/10/10	0.00	0.07	0.00	.15	0.04	.70	0.0	0.0	0.0	0.1	0.1	0.7
6/10/10	0.00	0.07	0.00	.15	0.02	.76	0.0	0.0	0.0	0.1	0.1	0.6
7/10/10	0.00	0.07	0.00	.15	0.01	.78	0.0	0.0	0.0	0.1	0.1	0.5
8/10/10	0.00	0.07	0.00	.15	0.00	.79	0.0	0.0	0.0	0.1	0.1	0.5
9/10/10	1.41	0.07	0.00	.15	0.00	.80	2.0	2.7	2.9	0.1	7.7	1.3
10/10/10	0.00	0.07	1.19	.19	0.00	.80	1.0	3.1	4.6	0.1	8.8	10.0
11/10/10	0.00	0.07	1.12	.19	0.00	.80	0.4	2.7	5.5	0.1	8.6	12.0
12/10/10	0.00	0.07	1.05	.18	0.00	.80	0.1	2.0	5.9	0.1	8.1	7.4
13/10/10	0.00	0.07	0.98	.18	0.00	.80	0.0	1.4	5.9	0.1	7.4	5.4
14/10/10	0.00	0.07	0.91	.18	0.00	.80	0.0	1.0	5.6	0.1	6.7	4.3
15/10/10	0.00	0.07	0.84	.18	0.00	.80	0.0	0.7	5.3	0.1	6.0	3.7
16/10/10	0.00	0.07	0.77	.17	0.00	.80	0.0	0.4	4.8	0.1	5.3	3.0
17/10/10	0.00	0.07	0.70	.17	0.00	.80	0.0	0.3	4.3	0.1	4.7	2.9
18/10/10	0.00	0.07	0.63	.17	0.00	.80	0.0	0.2	3.8	0.1	4.1	2.7
19/10/10	0.12	0.07	0.56	.17	0.00	.80	0.1	0.4	3.7	0.1	4.2	2.4
20/10/10	0.00	0.07	0.60	.17	0.00	.80	0.1	0.4	3.4	0.1	3.9	2.0
21/10/10	0.00	0.07	0.53	.17	0.00	.80	0.0	0.3	3.1	0.1	3.5	2.0
22/10/10	0.00	0.07	0.46	.16	0.00	.80	0.0	0.2	2.8	0.1	3.1	4.7
23/10/10	0.00	0.07	0.39	.16	0.00	.80	0.0	0.2	2.4	0.1	2.7	6.5
24/10/10	1.46	0.07	0.32	.16	0.00	.80	2.3	3.0	5.3	0.1	10.7	13.0
25/10/10	1.17	0.07	1.54	.20	0.00	.80	3.4	6.3	10.1	0.1	20.0	19.0

RAIN= rainfall amount; ET=evapo-transpiration index; SMI=soil moisture index
ROP = rainfall runoff percent; BII= base flow infiltration index; BFP=base flow percent
SUR =surface runoff; SUB= sub-surface runoff; BASE= base flow; QCAL=calculated discharge
QOBS= observed s=discharge

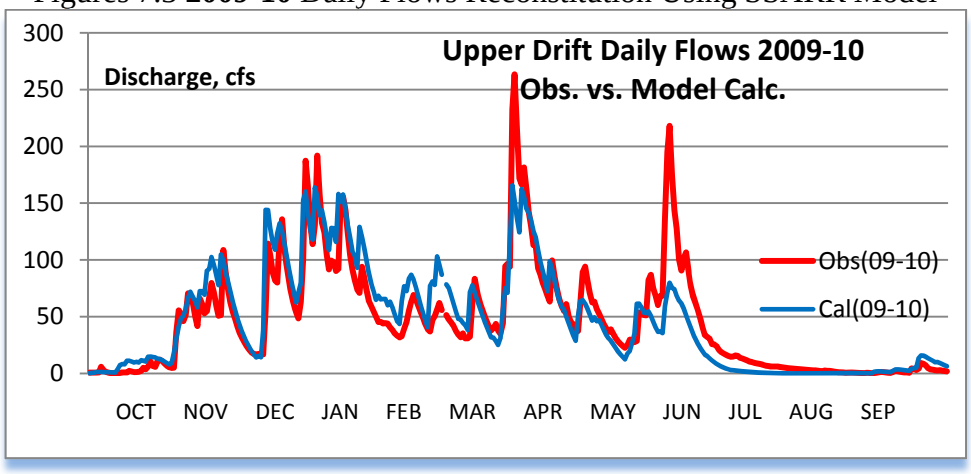
The results of the deterministic modeling work using rainfall data at the Salem airport are documented below in the form of daily hydrograph plots and numerical and graphic tabulations of observed and calculated data. Figures 7.2 through 7.7 show the hydrographs of observed versus model-predicted daily flows for the six water years involved (2008-14). Scatter plots are also provided to show the accuracy of the modeling results for each water year and the values of the correlation indicator R^2 for both a "linear" regression line and an "order 2 polynomial" curve.

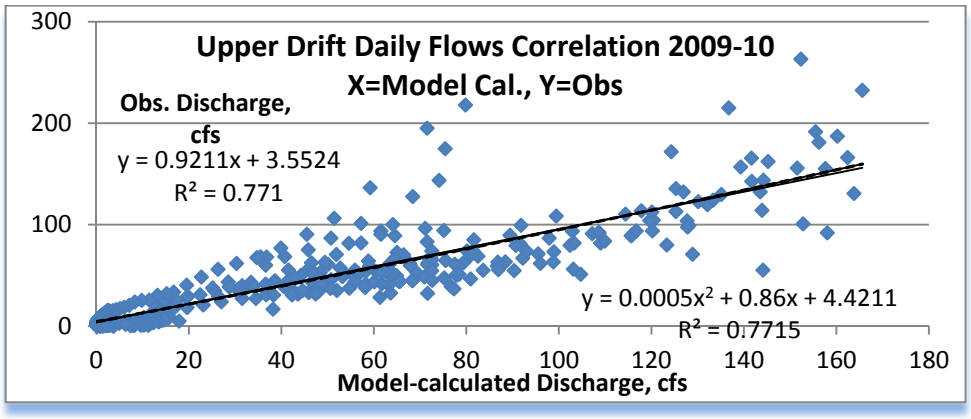
Figures 7.2 **2008-09** Daily Flows Reconstitution using SSARR model



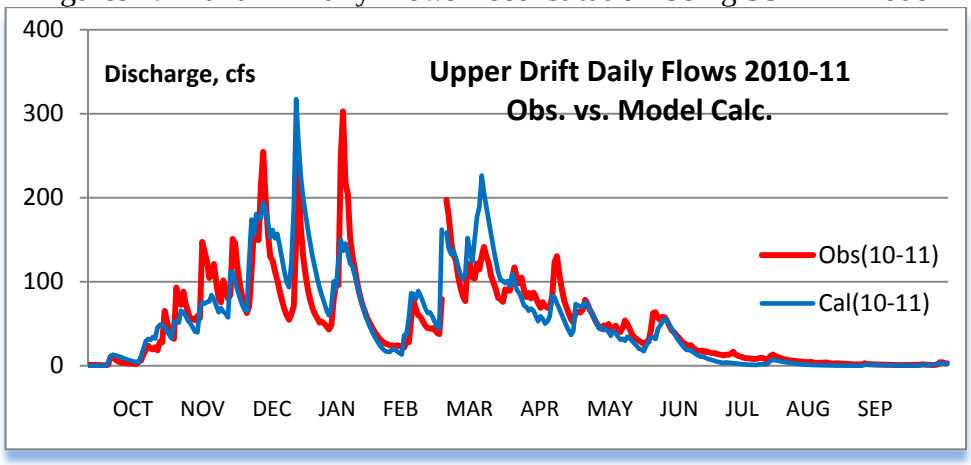


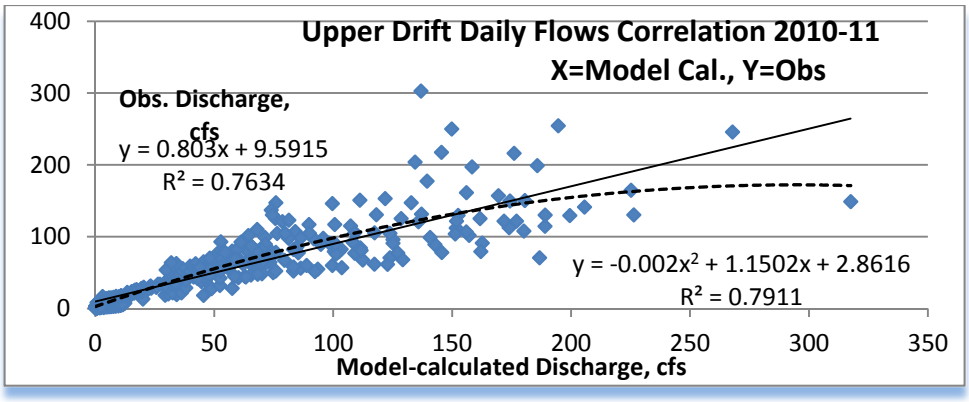
Figures 7.3 **2009-10** Daily Flows Reconstitution Using SSARR Model



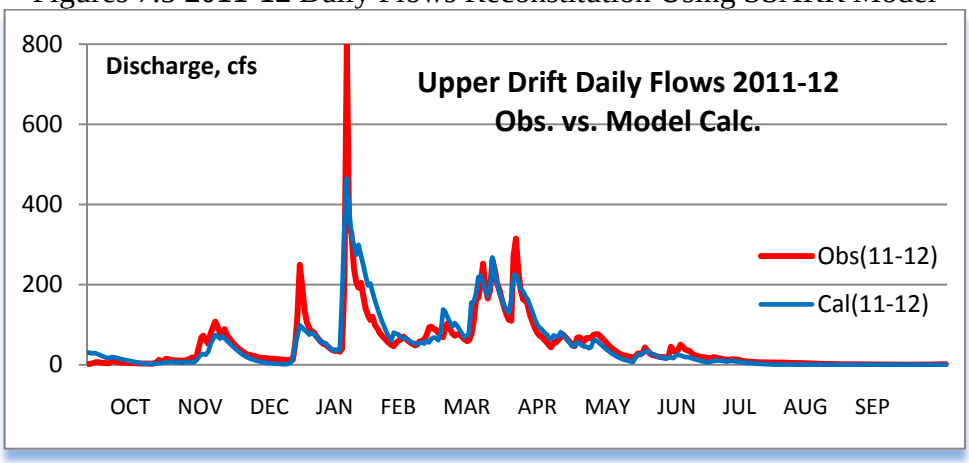


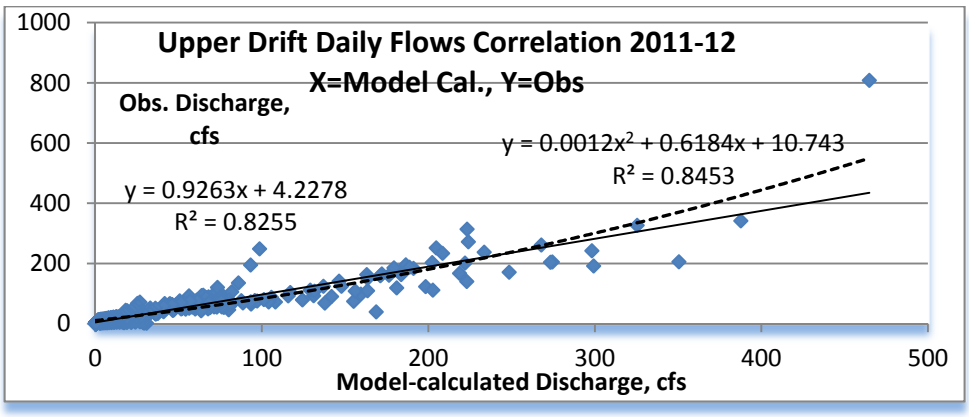
Figures 7.4 **2010-11** Daily Flows Reconstitution Using SSARR Model



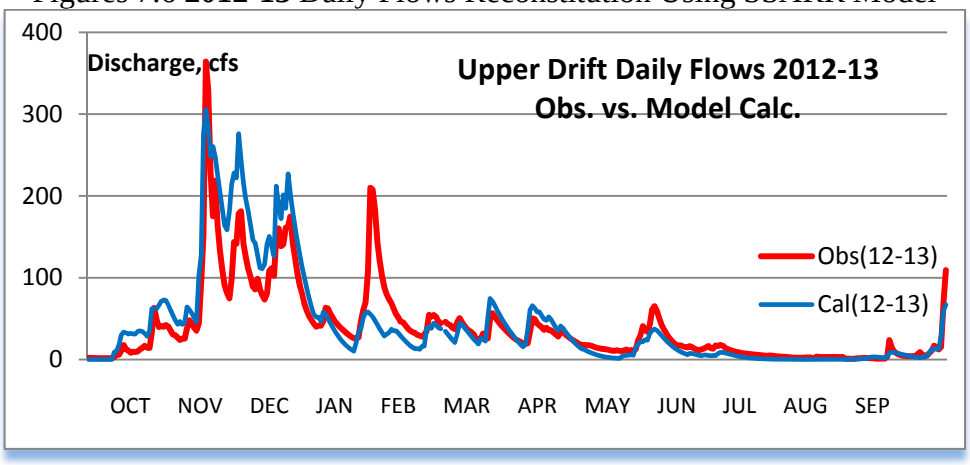


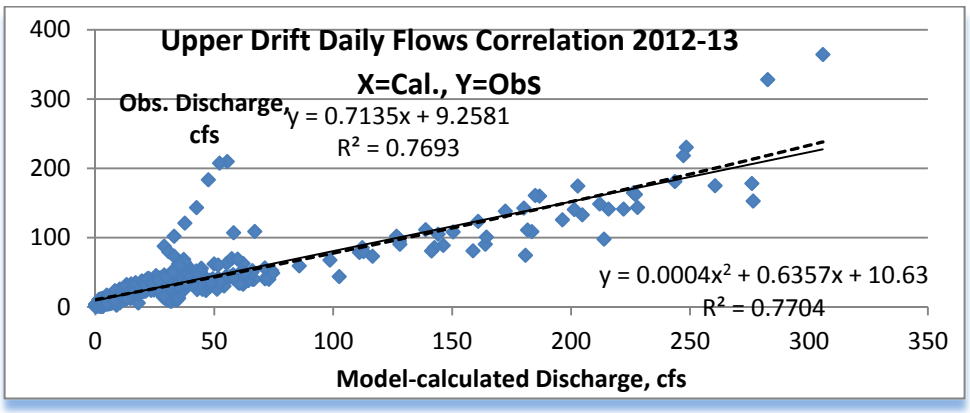
Figures 7.5 **2011-12** Daily Flows Reconstitution Using SSARR Model



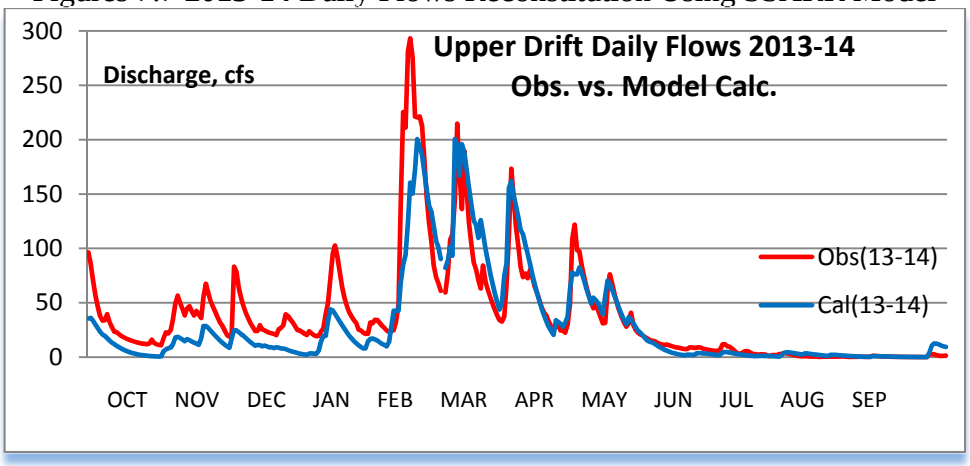


Figures 7.6 **2012-13** Daily Flows Reconstitution Using SSARR Model





Figures 7.7 **2013-14** Daily Flows Reconstitution Using SSARR Model



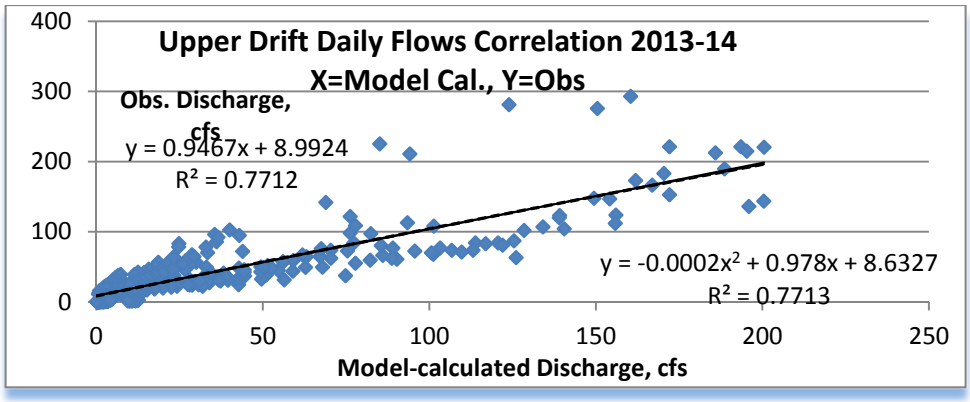


Table 7.2 summarizes the numerical values of the correlation indicator R^2 for the polynomial regression curves in each of the water year, for both model-calculated and regression-based daily stream flow predictions for Upper Drift Creek. The highest R^2 value for each year is shown in bold.

Table 7.2 R^2 Values of Daily Flow Reconstitution by Model and Regression

	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2008-14
Linear Trend							
Model-Calculated	0.7986	0.7710	0.7634	0.8255	0.7693	0.7712	0.7761
Regression-based	0.8050	0.8792	0.8628	0.7170	0.8366	0.8952	0.8088
Polynomial 2 Trend							
Model-Calculated	**0.8236**	0.7715	0.7911	**0.8453**	0.7704	0.7713	0.7767
Regression-based	0.8057	**0.8794**	**0.8662**	0.7216	**0.8383**	**0.8957**	**0.8118**

The results generated appear to be reasonably acceptable. The shape of the hydrograph and the total runoff volume in particular look very good. The R^2 values would be higher if the timing of the observed and calculated stream flows were more tightly fit. Obviously, more years of data are needed to cover a wider range of other runoff conditions. A higher runoff year for Drift Creek can be expected to have heavier rainfall, more sluggish soil conditions and some snowfall in the upper part of the basin, conditions that were practically non-existent in 2008-14. Also, the use of additional rainfall stations other than Salem Airport will be necessary to improve the results by more accurately representing the areal rainfall distribution over the Drift Creek's catchment area.

The main challenge with the rainfall-runoff modeling approach is to find a consistently representative rainfall multiplier (RFM) to generate the discharges for each water year. While the Salem Airport daily precipitation amounts closely reflect the daily fluctuations of Upper Drift Creek daily discharges, different RFM values had to be used to closely match the creek's observed and model-calculated annual runoff volume. For the six water years spanning from October 2008 to September 2014, the following slightly variable RFM values were used: 1.7, 1.5, 1.5, 1.5, 1.5, and 1.7 (1.60 average). Selected modeling details are shown in Table 7.3.

Table 7.3 Selected Rainfall-Runoff Model Simulation Details

HY	Salem Ann. Rainfall (")	Rainfall Multiplier	Adjusted Rain-fall (")	Rainfall Vol (AF)	Calculated Runoff (AF)	Observed Runoff (AF)	Difference OBS-CAL (AF)	Error Diff /OBS	Model Runoff Coeff.
2008-09	27.9	1.7	47.43	39,968	19,382	22,704	3,322	0.146	0.485
2009-10	44.6	1.5	66.90	56,374	33,849	33,748	-101	-0.003	0.600
2010-11	46.1	1.5	69.15	58,220	38,188	37,678	-510	-0.014	0.656
2011-12	43.5	1.5	65.25	54,933	35,748	36,250	502	0.014	0.651
2012-13	39.5	1.7	67.15	56,628	30,626	28,625	-2,001	-0.070	0.541
Average	38.4	1.6	60.72	51,166	30,066	31,164	1,098	0.044	0.588

From the above results, daily discharges calculated by the polynomial 2 regression equation based on the 2008-14 daily Pudding River flows at Aurora (X) and daily Drift Creek flows at the project site (Y) led to a higher R^2 value than for the model-calculated, Salem rainfall-based flows, in 2 out of 6 cases. To date, regression-based discharge predictions, using Pudding River discharges, are more accurate than those obtained via rainfall-runoff modeling. However, both procedures are promising and still deserve further evaluation because of their complementary application potential in reconstituting historical records and generating future runoff forecasts. For one, the modeling approach is irreplaceable when stream flows in response to fixed precipitation amounts have to be generated, as is the case when dealing with Probable Maximum Precipitation (PMP) and Probable Maximum Flood (PMF), and real-time inflow or flood forecasting.

8. Comparison of Predicted vs. Observed 2011-14 Stream Flows

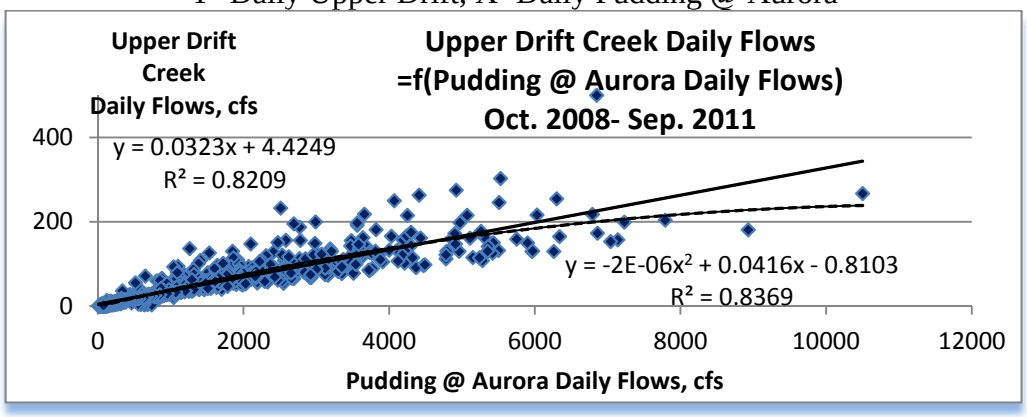
This section provides some ideas on the accuracy the daily flows predicted for Upper Drift Creek using (1) regression-based equations and (2) rainfall-runoff modeling. Only the polynomial order 2 trend is used in this section, since it yields better correlation than the linear trend in most cases. The corresponding regression equation is based on October 2008 – September 2011 Upper Drift Creek (Y) and Pudding at Aurora (X) daily flows. The rainfall-runoff model is calibrated based on 2008-11 Upper Drift Creek daily flows and daily precipitations at the Salem Airport for the specific year of interest.

The test data are the more recent data collected during October 2011 – September 2014 period. They were not part of the data used to develop the prediction tools. The observed and predicted hydrographs are shown on the primary axis, along with the Observed – Predicted differences on the secondary axis. They are followed by a scatter plot with the R^2 correlation value that reflects the level of prediction accuracy in each case.

8.1 Comparison Using Regression-based Stream Flows

The R^2 values and the Observed – Predicted differences are greatly influenced by time shifts in daily flows. For that reason, in addition to the daily flow predictions, results related to the equivalent monthly flows are also presented in each case. The scatter plot showing how the regression equation used in this section is derived is illustrated in Figure 8.1.

Figure 8.1 Scatter Plot Based on 2008-11 Daily Flows
Y=Daily Upper Drift, X=Daily Pudding @ Aurora

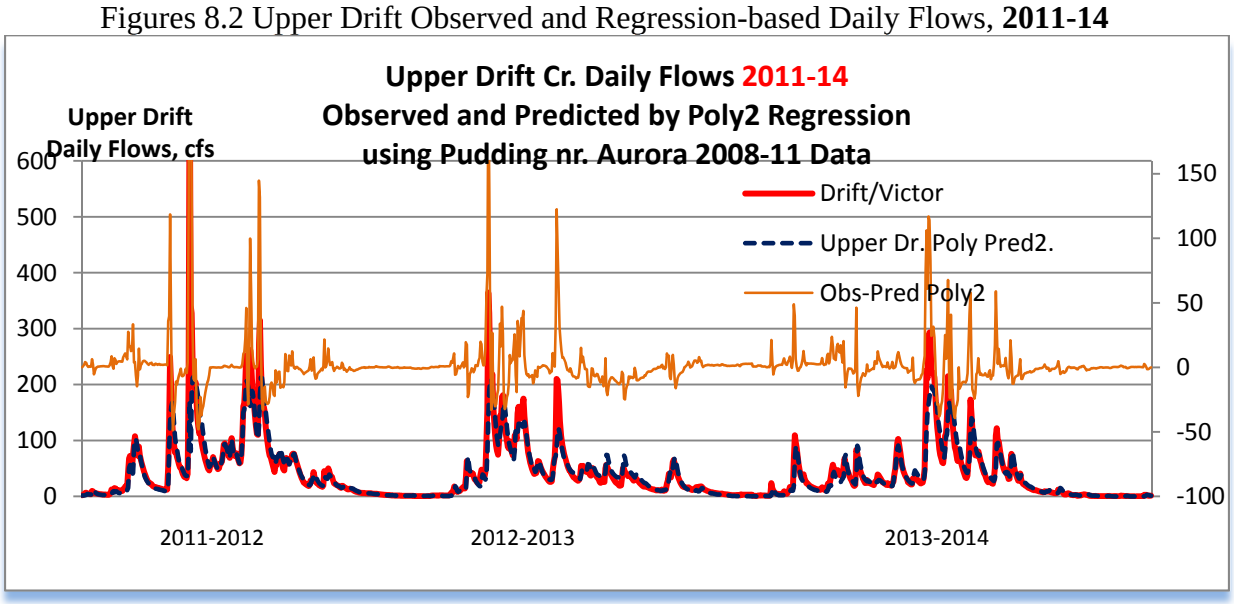


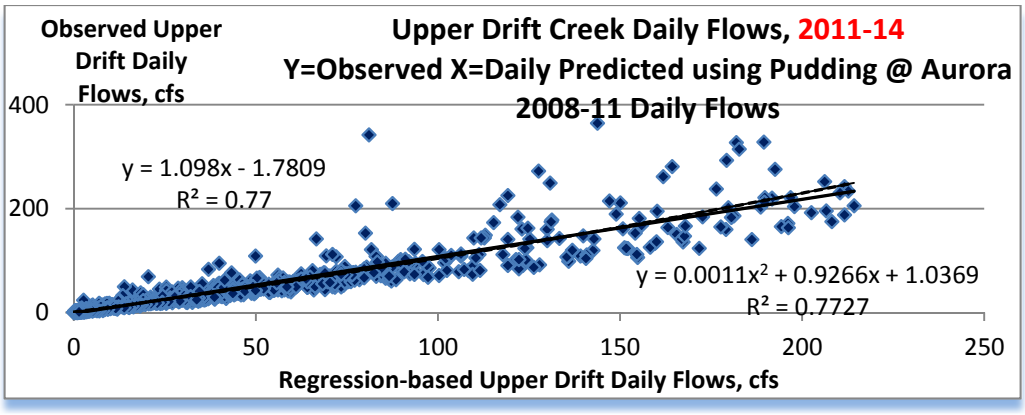
The regression equation used is listed below, with Y=Calculated Upper Drift daily flow, and X=Observed Pudding River at Aurora daily flows:

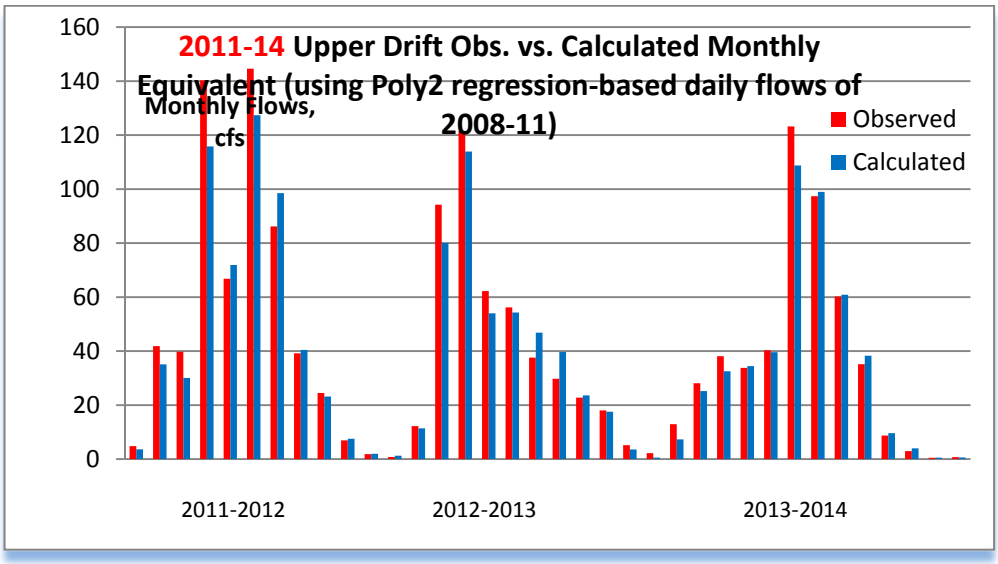
Y= -2E-06X^2 + 0.0416 X – 0.8103 (R^2= 0.8369)

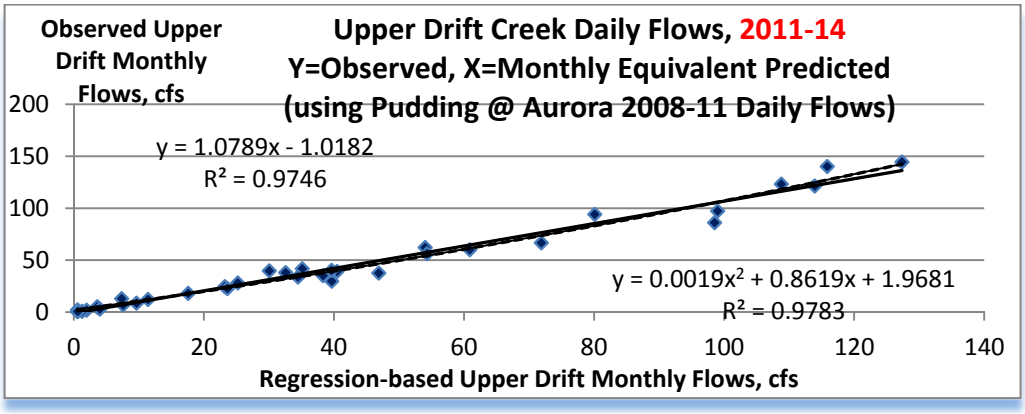
Using that regression equation, the hydrographs of the calculated Upper Drift daily flows are shown in Figures 8.2, 8.3, 8.4 and 8.5 for 2011-12, 2012-13, 2013-14 and 2011-14 water years respectively. Scatter plots are also provided for each water year, directly below the hydrographs.

Figures 8.2 Upper Drift Observed and Regression-based Daily Flows, **2011-14**

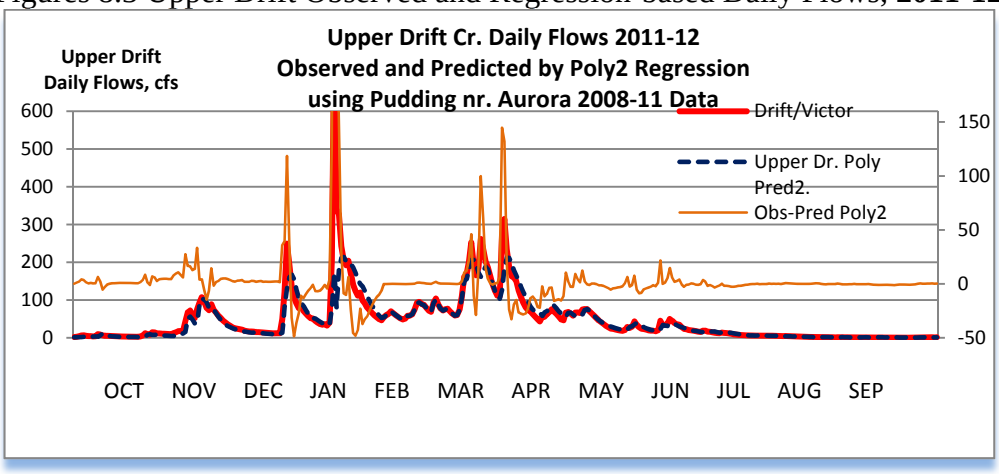


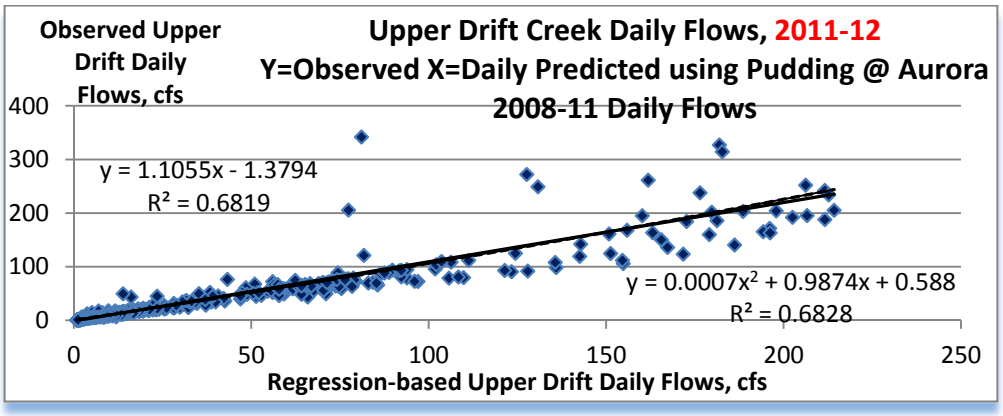

Upper Drift Creek Daily Flows, 2011-14
Y=Observed X=Daily Predicted using Pudding @ Aurora 2008-11 Daily Flows
Observed Upper Drift Daily Flows, cfs
y = 1.098x - 1.7809
R² = 0.77
y = 0.0011x² + 0.9266x + 1.0369
R² = 0.7727
400
200
0
0
50
100
150
200
250
Regression-based Upper Drift Daily Flows, cfs

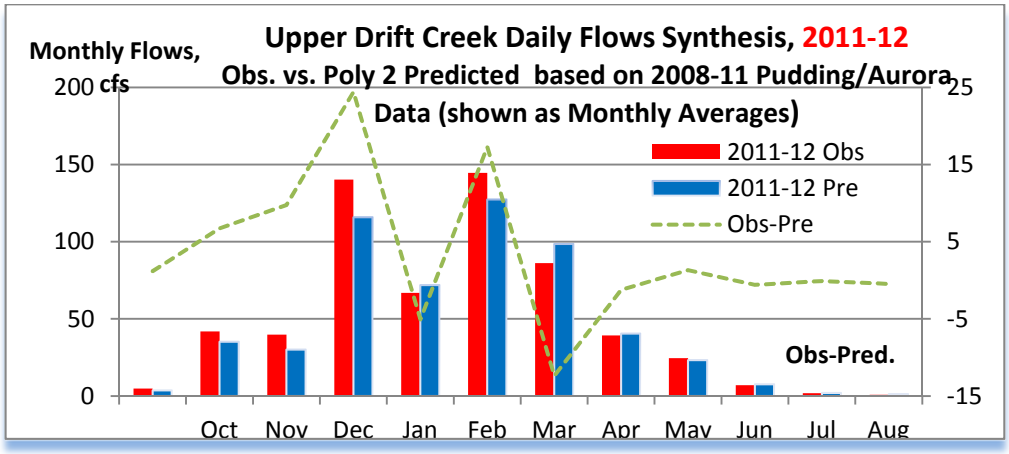

2011-14 Upper Drift Obs. vs. Calculated Monthly Equivalent (using Poly2 regression-based daily flows of 2008-11)
Monthly Flows, cfs
Observed
Calculated
160
140
120
100
80
60
40
20
0
2011-2012
2012-2013
2013-2014

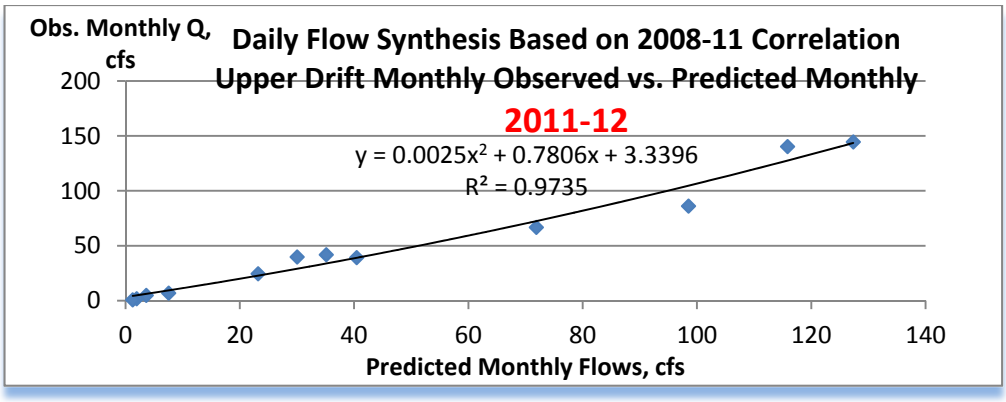

Upper Drift Creek Daily Flows, 2011-14
Y=Observed, X=Monthly Equivalent Predicted (using Pudding @ Aurora 2008-11 Daily Flows)
Observed Upper Drift Monthly Flows, cfs
y = 1.0789x - 1.0182
R² = 0.9746
y = 0.0019x² + 0.8619x + 1.9681
R² = 0.9783
200
150
100
50
0
0
20
40
60
80
100
120
140
Regression-based Upper Drift Monthly Flows, cfs

Figures 8.3 Upper Drift Observed and Regression-based Daily Flows, **2011-12**

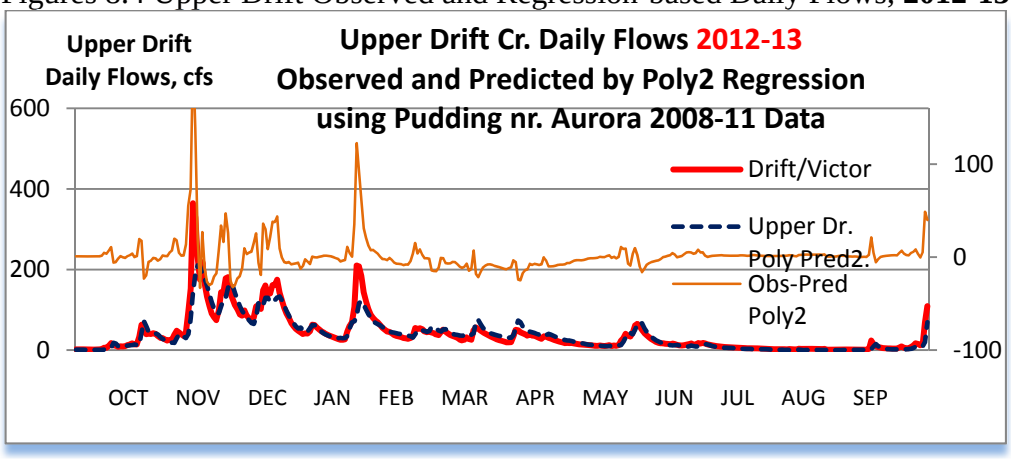


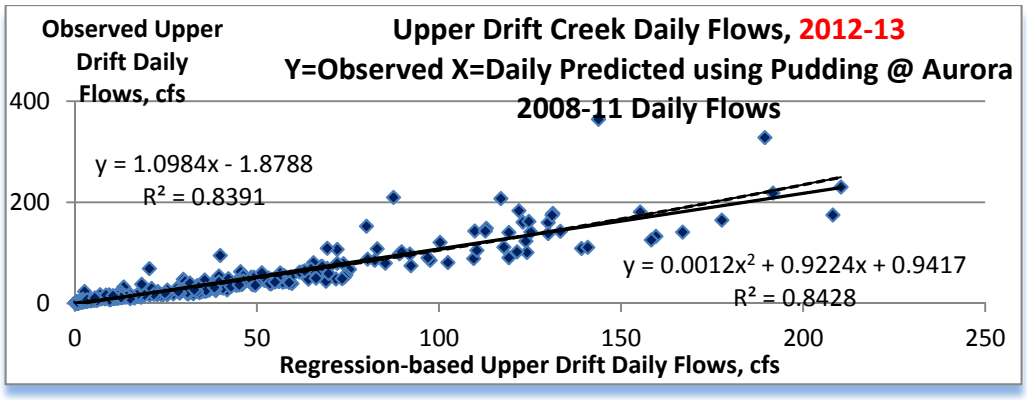


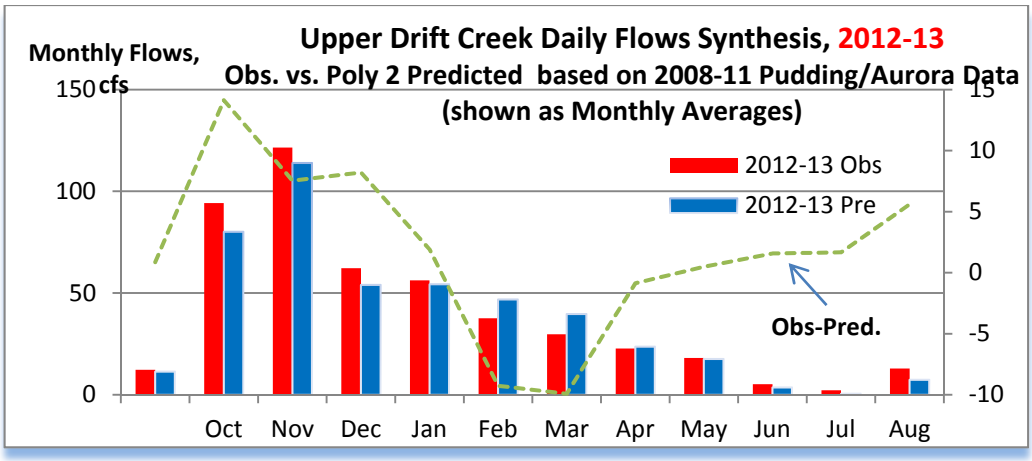


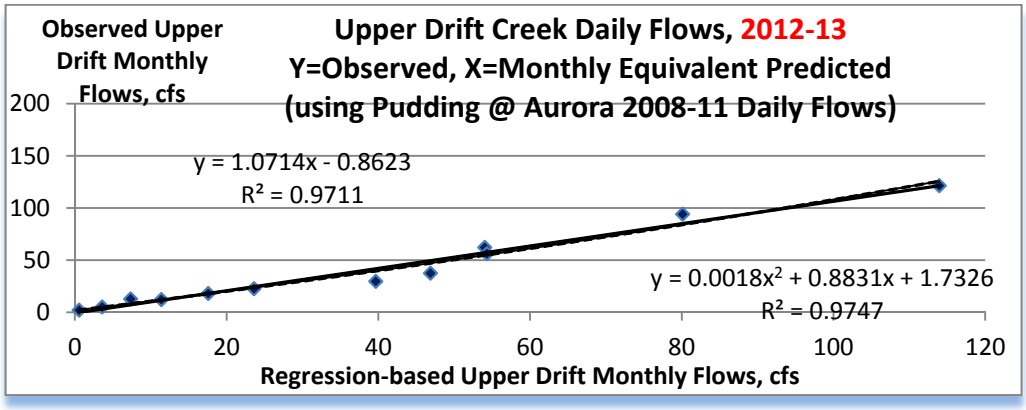


Figures 8.4 Upper Drift Observed and Regression-based Daily Flows, **2012-13**

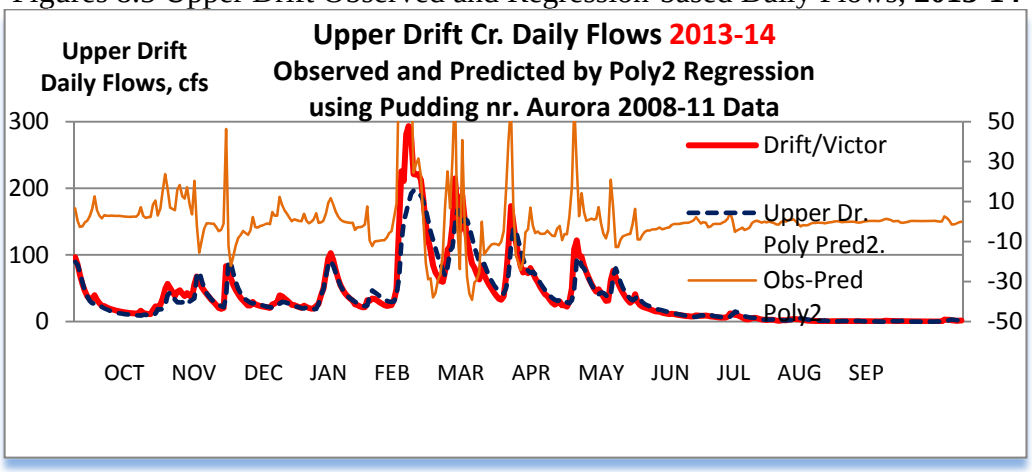


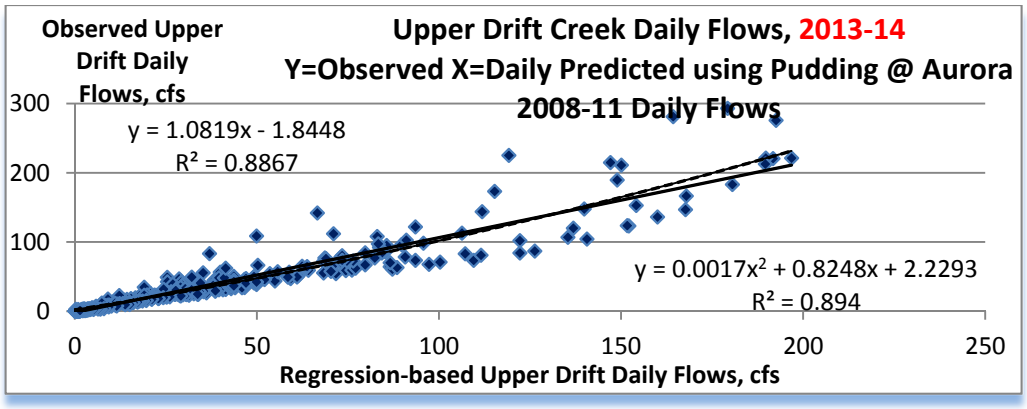


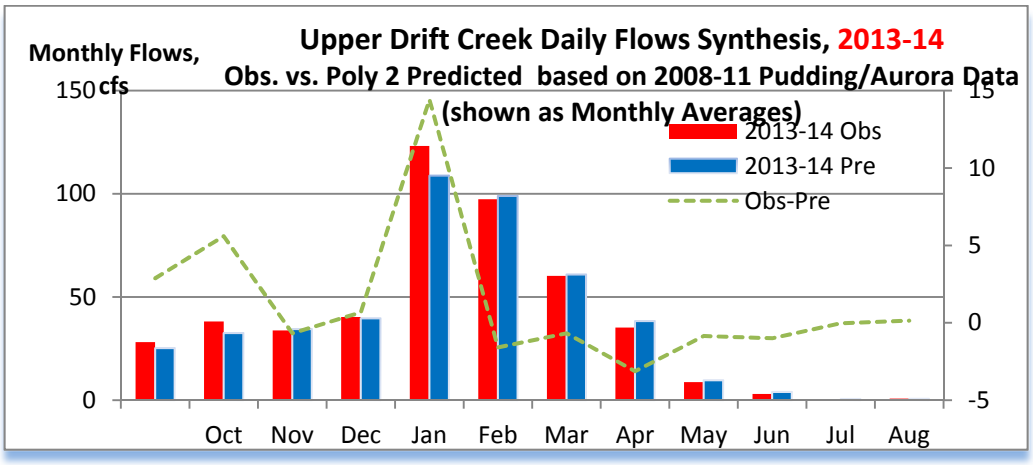


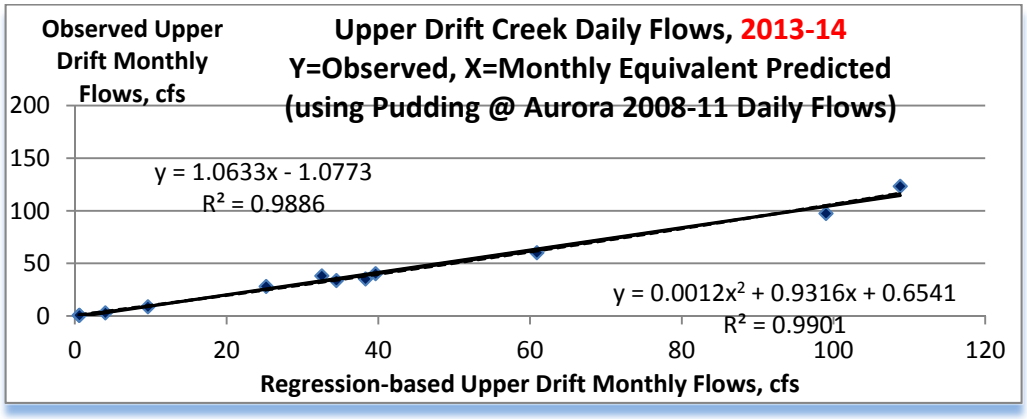


Figures 8.5 Upper Drift Observed and Regression-based Daily Flows, **2013-14**









Observed and predicted monthly runoff volumes for each of water year tested are summarized in Table 8.1, including prediction differences.

Table 8.1 Summary of Observed and Regression-Predicted Runoff Volumes

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2011-12 Obs	4.83	41.86	39.81	140.27	66.83	144.60	86.17	39.21	24.52	6.98	1.87	0.80
2011-12 Pre	3.62	35.13	30.05	115.84	71.89	127.34	98.53	40.45	23.20	7.57	1.96	1.26
Obs-Pre	*1.21*	*6.74*	*9.76*	*24.43*	*-5.06*	*17.26*	*-12.36*	*-1.23*	*1.32*	*-0.59*	*-0.08*	*-0.46*
2012-13 Obs	12.25	94.24	121.47	62.22	56.23	37.61	29.75	22.76	18.07	5.17	2.22	12.94
2012-13 Pre	11.39	80.10	113.92	54.01	54.32	46.87	39.65	23.61	17.57	3.58	0.55	7.34
Obs-Pre	*0.86*	*14.14*	*7.55*	*8.21*	*1.91*	*-9.26*	*-9.91*	*-0.85*	*0.50*	*1.59*	*1.67*	*5.61*
2013-14 Obs	28.09	38.15	33.78	40.31	123.21	97.41	60.21	35.19	8.76	3.01	0.53	0.75
2013-14 Pre	25.21	32.55	34.46	39.62	108.78	98.99	60.88	38.31	9.62	4.00	0.55	0.61
Obs-Pre	*2.88*	*5.60*	*-0.68*	*0.68*	*14.43*	*-1.58*	*-0.68*	*-3.12*	*-0.85*	*-0.99*	*-0.02*	*0.14*

Figure 8.6 shows the plot of cumulative "observed" versus "regression-based" monthly runoff volumes for each of the three water years tested. The observed and calculated annual runoff volumes are summarized in Table 8.2.

Figure 8.6 Plot of Cumulative Observed and Regression-based Runoff Volumes

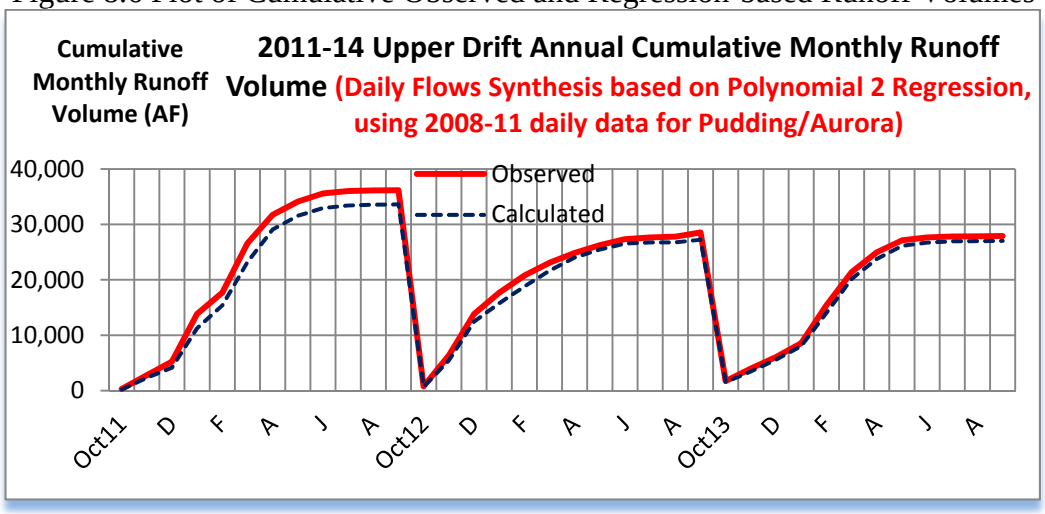


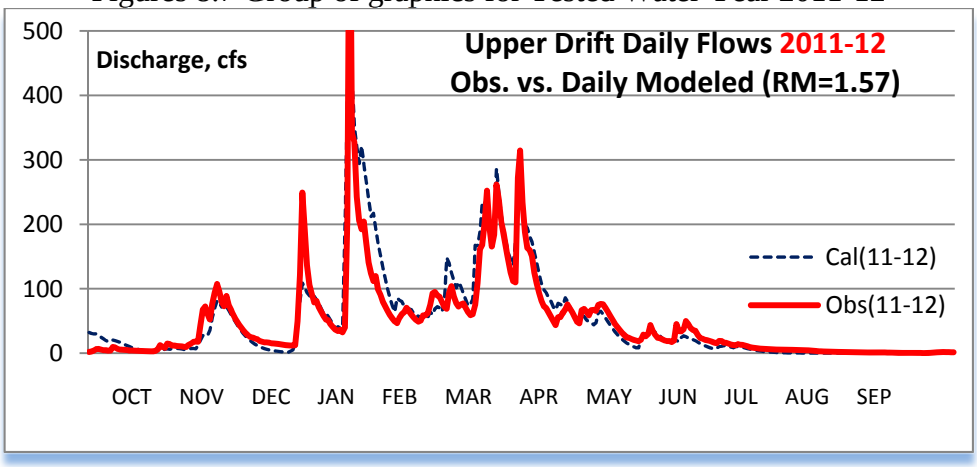
Table 8.2 Summary of Observed and Regression-Predicted Annual Runoff Volumes, and R^2

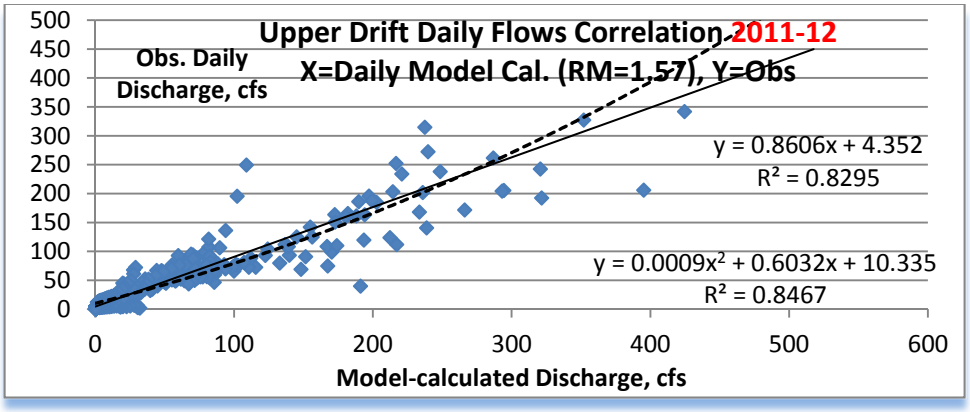
Water Years	Observed, Obs	Predicted, Pre	(Obs-Pred)/Obs %	R^2 (daily)	R^2 (monthly)
2011-12	36,178	33,631	-7.04%	0.6828	0.9735
2012-13	28,553	27,232	-4.63%	0.8428	0.9747
2013-14	27,908	27,031	-3.14%	0.8940	0.9901

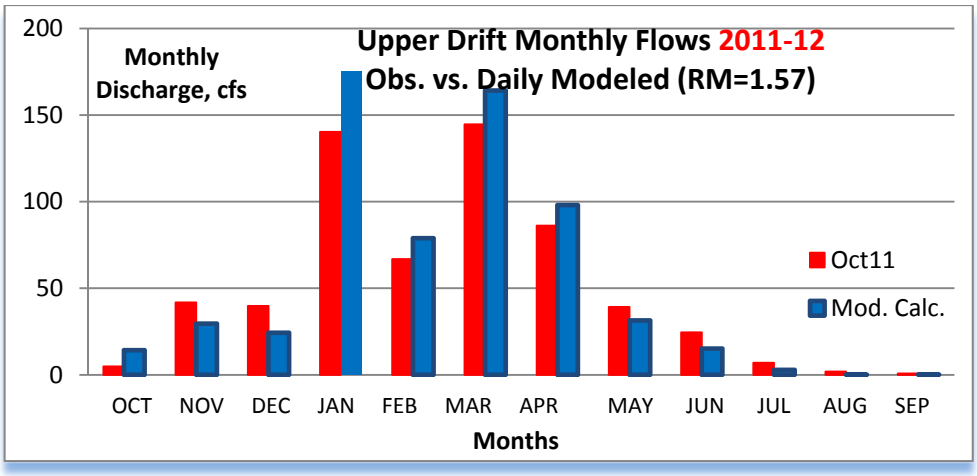
8.2 Comparison Based on Model-Reconstructed Stream Flows

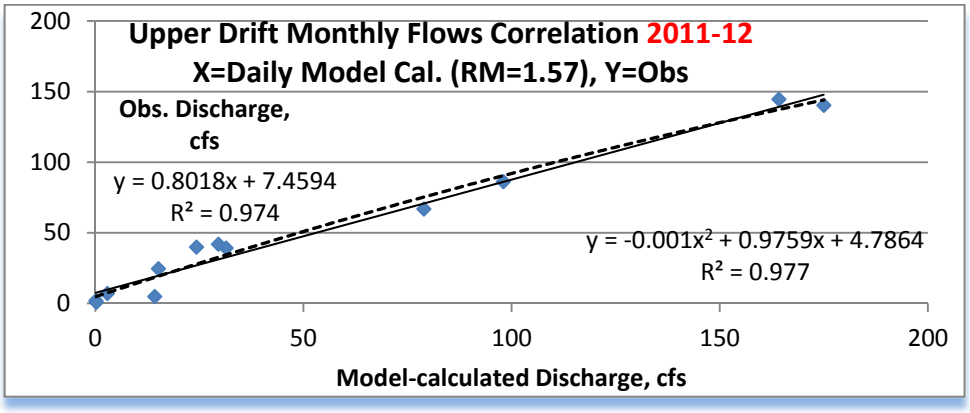
The average rainfall multiplier used for each of the 2008-11 model calibration years is equal to (1.7 +1.5 +1.5)/3= 1.57. Model predictions for 2011-14 are based on that 1.57 rainfall multiplier (RM) and the daily precipitations at Salem Airport for each of year tested. Observed and calculated hydrographs are shown for each tested water year in the group of figures starting from Figure 8.7 and ending at Figure 8.9. Each group consists of plots of (1) Daily hydrographs, (2) Scatter plot for daily flows, (3) Monthly bar charts, and (4) Scatter plots for monthly flows.

Figures 8.7 Group of graphics for Tested Water Year 2011-12

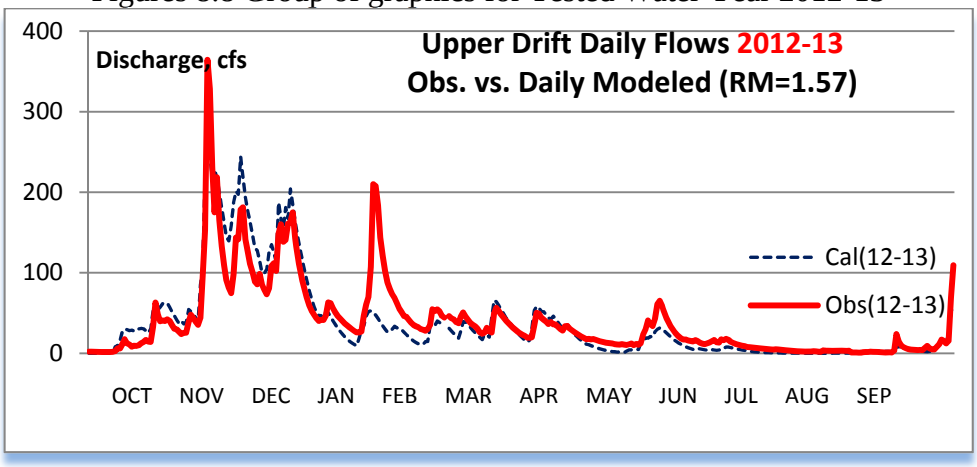


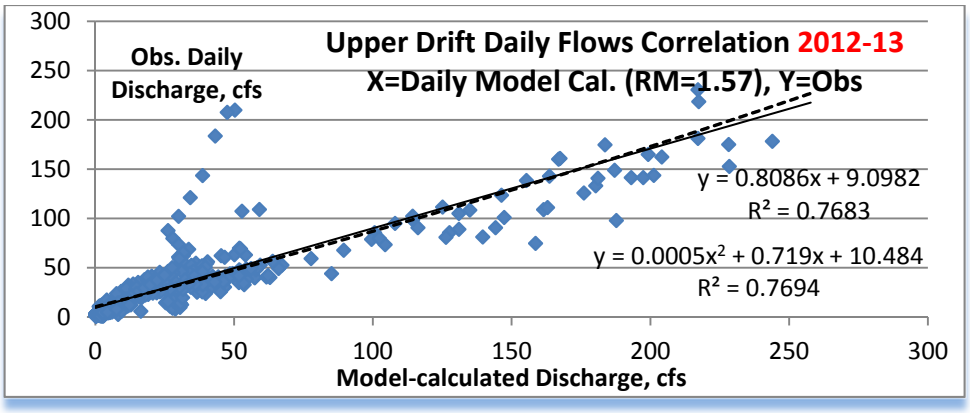


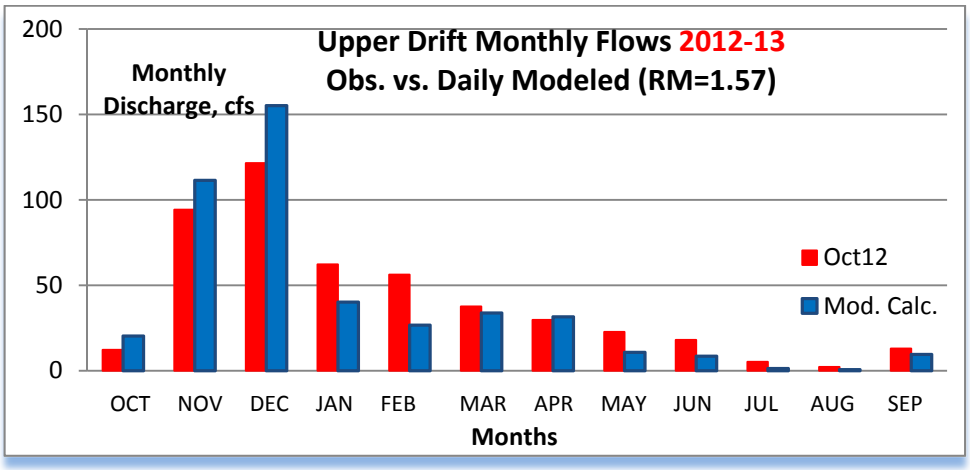


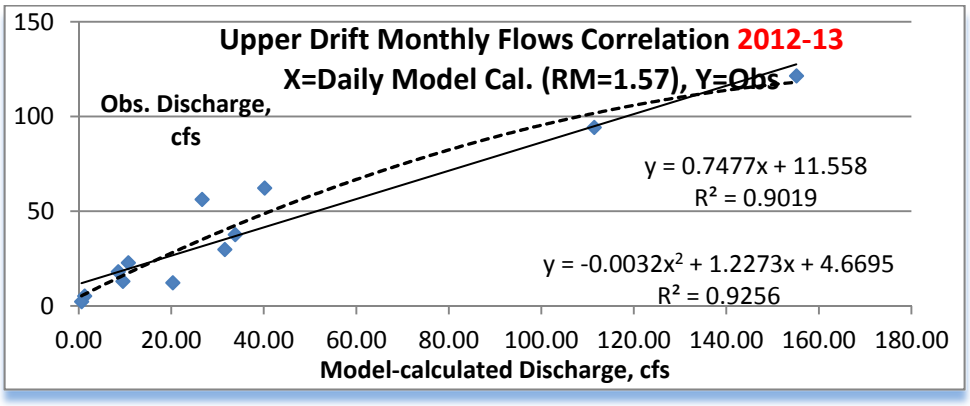


Figures 8.8 Group of graphics for Tested Water Year 2012-13

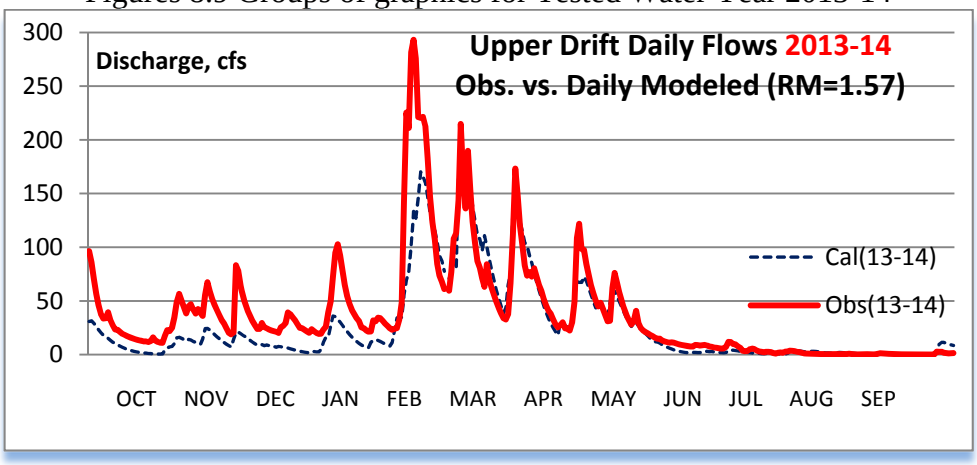


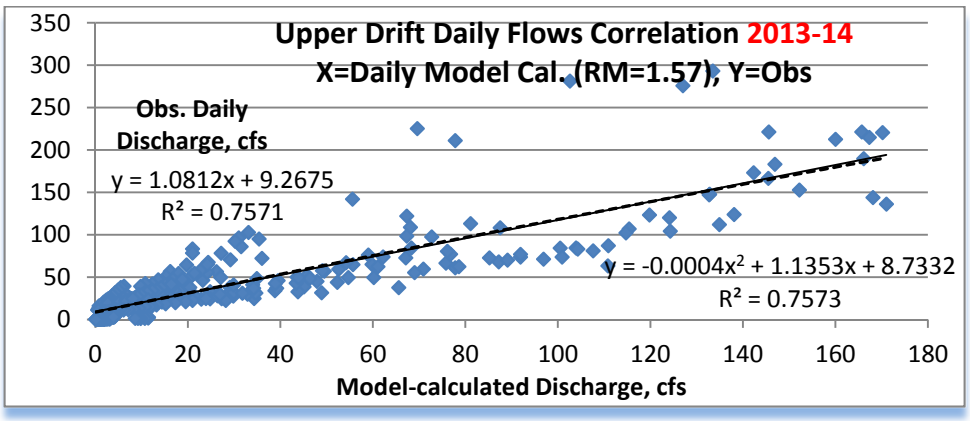

Upper Drift Daily Flows Correlation 2012-13
X=Daily Model Cal. (RM=1.57), Y=Obs
Obs. Daily Discharge, cfs
y = 0.8086x + 9.0982
R² = 0.7683
y = 0.0005x² + 0.719x + 10.484
R² = 0.7694
Model-calculated Discharge, cfs
0
50
100
150
200
250
300

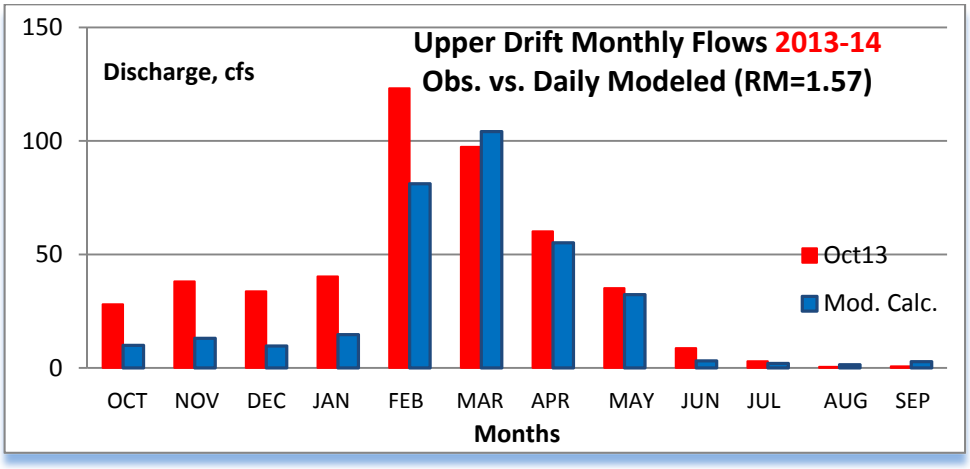

Upper Drift Monthly Flows 2012-13
Obs. vs. Daily Modeled (RM=1.57)
Monthly Discharge, cfs
Oct12
Mod. Calc.
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Months
0
50
100
150
200

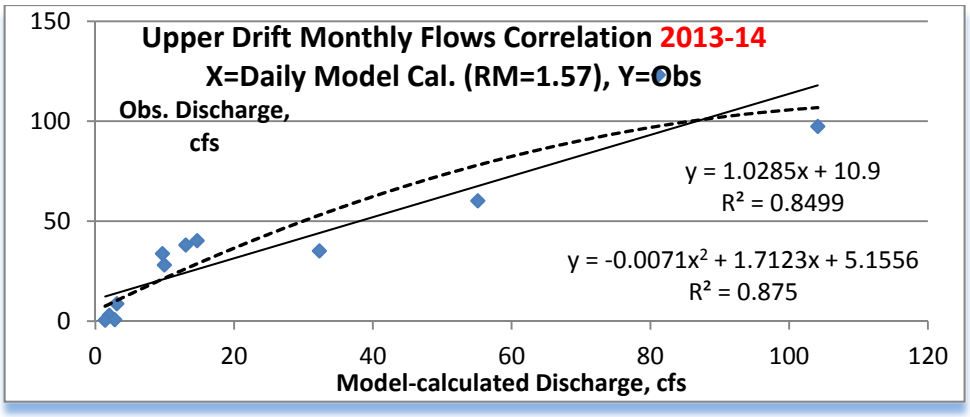

Upper Drift Monthly Flows Correlation 2012-13
X=Daily Model Cal. (RM=1.57), Y=Obs
Obs. Discharge, cfs
y = 0.7477x + 11.558
R² = 0.9019
y = -0.0032x² + 1.2273x + 4.6695
R² = 0.9256
Model-calculated Discharge, cfs
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
0
50
100
150

Figures 8.9 Groups of graphics for Tested Water Year 2013-14









Like for regression-based predictions, observed and model-predicted monthly runoff volumes for each of water year tested are summarized in Table 8.3, including prediction differences.

Table 8.3 Summary of Observed and Model-Predicted Runoff Volumes

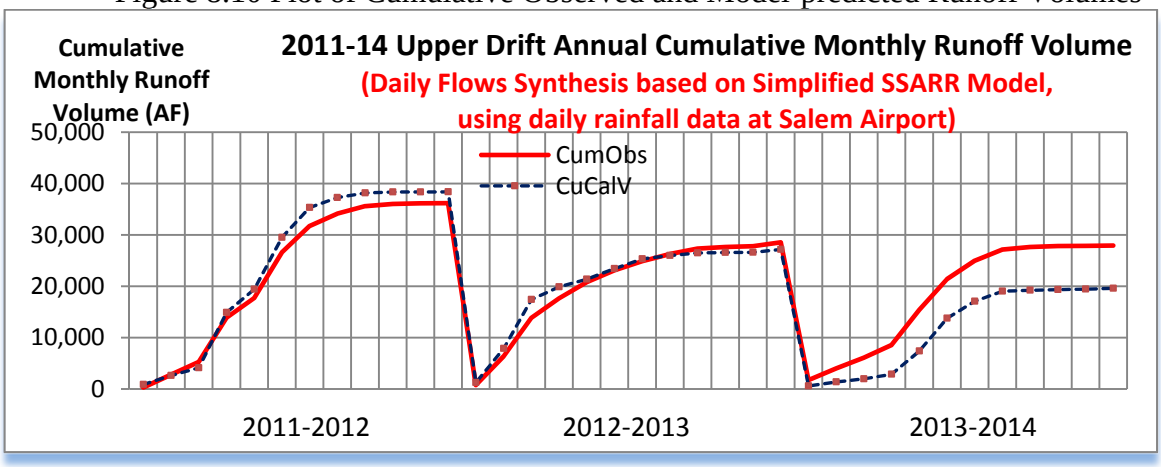
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2011-12 Obs	4.83	41.86	39.81	140.27	66.83	144.60	86.17	39.21	24.52	6.98	1.87	0.80
2011-12 Pre	14.26	29.55	24.27	174.98	78.90	164.18	98.00	31.40	15.16	2.89	0.11	0.21
Obs-Pre	*-9.43*	*12.32*	*15.54*	*-34.71*	*-12.08*	*-19.58*	*-11.83*	*7.81*	*9.72*	*4.09*	*1.77*	*0.59*
2012-13 Obs	12.25	94.24	121.47	62.22	56.23	37.61	29.75	22.76	18.07	5.17	2.22	12.94
2012-13 Pre	20.32	111.43	155.15	40.17	26.66	33.80	31.56	10.71	8.52	1.25	0.59	9.53
Obs-Pre	*-8.07*	*-17.19*	*-33.67*	*22.05*	*29.57*	*3.81*	*-1.82*	*12.05*	*9.55*	*3.92*	*1.63*	*3.42*
2013-14 Obs	28.09	38.15	33.78	40.31	123.21	97.41	60.21	35.19	8.76	3.01	0.53	0.75
2013-14 Pre	9.94	13.03	9.65	14.65	81.13	104.13	55.11	32.29	3.09	2.00	1.42	2.78
Obs-Pre	*18.16*	*25.12*	*24.13*	*25.65*	*42.08*	*-6.72*	*5.09*	*2.90*	*5.67*	*1.01*	*-0.89*	*-2.03*

The observed and calculated annual runoff volumes are summarized in Table 8.4 and Figure 8.10 shows the plot of cumulative "observed" versus "model-predicted" monthly runoff volumes for each of the three water years tested.

Table 8.4 Summary of Observed and Model-Predicted Annual Runoff Volumes, and R^2

Water Years	Observed, Obs	Predicted, Pre	(Obs-Pred)/Obs %	R^2 (daily)	R^2 (monthly)
2011-12	36,178	38,372	-6.07%	0.8467	0.9770
2012-13	28,553	27,166	4.86%	0.7694	0.9256
2013-14	27,908	19,607	29.74%	0.7573	0.8750

Figure 8.10 Plot of Cumulative Observed and Model-predicted Runoff Volumes



8.3 Conclusions on Prediction Accuracy

The results of the test based on 2011-14 daily stream flows and using statistical and modeling tools calibrated with 2008-11 data are generally within acceptable ranges, based on the values of the correlation R^2, the general shape of the hydrographs, and the runoff volume. The strong correlation between the Pudding River and Drift Creek stream flows is a steady foundation to build on in any attempt to extend the hydrologic data base, especially when using a longer time step that minimizes the impact of time shift between discharges at stations that are 30+ miles apart. Hence, correlation between monthly average flows is always higher than correlation between daily flows.

The other possible option involving the use of a rainfall-runoff model also produces reasonably acceptable results, in terms of hydrograph shapes and timing of high discharges -- although not as good as the equivalent, regression-based predictions. This is due mostly to the use of a unique rainfall station (Salem Airport) as precipitation index to the entire Drift Creek basin and the challenging need to specify the right rainfall multiplier every year to match the runoff volume of that year.

Based on the foregoing, regression-based predictions for Upper Drift Creek appear to be more accurate than model-based predictions. However, both regression and modeling deserve to be further investigated to complement each other and to respond to other study needs, such as real-time inflow forecasting and probable maximum flood events determination.

9. Updated Ranking of Low, Average and High Runoff Water Years

Representative low, average and high flow years are needed to define the range of runoff conditions that can be expected at the project site based on historical flow data. Data for the Pudding River near Aurora site were used because they cover the longest stream flow gauging

records of all streams in the same general physical area as Drift Creek, and produce a high statistical correlation indicator R^2 with the Drift Creek Upper site data.

Figure 5.28 and Table 5.6, which are shown earlier in this report, contain the observed annual (October-September) runoff volumes of the Pudding River at Aurora ranked from highest to lowest for the 52 fully monitored years between 1928 and 2014. The ranking is used to help identify the typical average, low and high runoff water years as described further below.

The mean annual (October-September) runoff volume for those 52 years is about 894,000 AF. This 50% exceedance level volume is between the 916,004 AF recorded in 1957-58 (ranked 25th out of 52) and the 867,553 aft recorded in 1933-34 (ranked 26th out of 52). Therefore, using this criteria, the 26th ranked 1933-34 water year qualifies as the representative average water year (RAY).

The annual (October-September) runoff volume that is exceeded 80% of the 52 years (52 x0.80=41.6 years) corresponds to the 42+1=43th ranked. The 43th ranked 1935-36 water year, with an annual runoff volume of 687,904 AF, thus qualifies as a representative low flow year (RLY). Note that in the previous (2012) analysis, the 1944-45 water year with an annual runoff volume of 695,169 AF was the selected RLY).

By the same token, the annual runoff volume that is exceeded 20% of the 52 years corresponds to the 10+1=11th ranked runoff. Based on that criteria, the 11th ranked 1947-48 water year, with an annual runoff volume of 1,095,130 AF, is selected as representative high flow water year (RHY). Note that in 2012, the 1949-50 water year with an annual runoff volume of 1,127,442 AF was the selected RHY, which superseded the 1947- 48 water year with an annual runoff volume of 1,095,130 aft selected as RHY in Report Update #2. This was the result of the 2010-11 water year (with an annual runoff volume of 1,154,752 AF) being ranked 8th, ahead to 1949-50 and 1947-48. See Table 9.1.

Because of the strong correlation between the stream flows of the Pudding River at Aurora and those at the project site, as confirmed by the data collected during 2008-14, those same representative years for Pudding River at Aurora will be treated as typical average, low, and high water years respectively for Drift Creek at the project site as well.

It should be noted that the changes in average, low, and high water years due to the addition of the latest flow data are procedural in nature and may be driven only by a relatively small (less than 0.2%) change in runoff volume and/or water year ranking, and not by the runoff hydrograph shape. Because the selection of representative years was only based on annual runoff volume ranking, candidate water years may have comparable volume amounts but the shape of their runoff hydrograph may be different.

Table 9.1 Summary of Representative Years Selection

Flow Years	Representative Hydrologic Years	Observed Oct-Apr. Runoff Vol. (AF) Pudding @ Aurora	Multiplier (if applied)
High	1947-48	961,931	
	(1949-50)	(1,008,572)	(0.037)
	(1947-48)	(961,931)	(0.038)
	(1949-50)	(1,008,572)	(0.0362)
Average	1933-34	798,321	
	(1933-34)	(798,321)	(0.037)
	(1933-34)	(798,321)	(0.038)
	(1957-58)	(851,445)	(0.0362)
Low	1935-36	585,279	
	(1944-45)	(550,657)	(0.037)
	(1944-45)	(550,657)	(0.038)
	(1935-36)	(585,279)	(0.0362)

Once the high, average and low water years are selected, the estimated Upper Drift Creek stream flows for those years are generated using the order 2 polynomial regression equation linking 2008-14 stream flow data at Pudding River at Aurora with those at Upper Drift Creek to define the shape of the hydrographs. Furthermore, those regression-based stream flows need to be adjusted to ensure that the annual runoff volume matches the equivalent volume for the Pudding River at Aurora, i.e. using an adjustment factor equal to the average volume ratio for the 2008-14 period.

Calculation details for the 6-year average volume ratio are shown in Table 9.2.

Table 9.2 Calculation of Runoff Volume Adjustment Factor

Water Year	Upper Drift Annual Runoff Volume V1	Pudding@Aurora Annual Runoff Volume V2	Ratio V1/V2
2008-09	22,629	641,582	0.03527
2009-10	33,827	821,837	0.04116
2010-11	37,606	1,154,752	0.03257
2011-12	36,178	1,069,775	0.03382
2012-13	28,553	774,173	0.03688
2013-14	27,908	766,771	0.03640
Average 2008-14			0.036016

To complete the hydrographs of the representative flow years, the following steps were performed as listed below and summarized in Table 9.3:

- Step I: determine the expected annual runoff volume for Pudding River at Aurora during the selected three years --1935-36, 1933-34 and 1947-48.
- Step II: estimate Upper Drift Creek's annual runoff volume for those same three years using the 0.036016 multiplier.

- Step III: calculate the Upper Drift Creek regression-based flows (using the polynomial 2 formula: Y=-0.000002*X^2+0.0566*X+0.7543), and
- Step IV: calculate Upper Drift Creek's corresponding annual runoff volumes and the adjustment factor needed to maintain the proper ratio with Pudding River runoff volume. Apply that correction faction to the regression-based daily stream flows.

Table 9.3 Estimation of Upper Drift Creek's Runoff Volumes

Step I) Pudding River at Aurora Monthly Flows, cfs

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Lo 35-36	135.9	318.7	668.3	4351.6	1773.4	1428.1	1001.7	858.9	489.3	191.2	68.5	79.9
Av 33-34	295.4	699.7	5170.3	3633.2	864.4	1324.8	1141.8	695.5	207.2	101.8	68.2	62.2
Hi 47-48	1774.2	*12.3*	1518.2	3663.5	2311.4	2454.2	1730.0	1416.3	395.6	146.1	109.2	116.4

Step II) Annual Runoff volume

	Pudding/AuroraAnnual Runoff Volume, AF (1)	Multiplier (2)	Estimated Upper Drift Ann. Runoff Vol: (1)*(2)
Lo 35-36	684,370	0.036016	24,648
Av 33-4	869,277	0.036016	31,308
Hi 47-48	1,095,201	0.036016	39,444

Step III) Upper Drift's Regression-based, Unadjusted Monthly Flows, cfs

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Lo 35-36	8.40	18.52	37.36	199.04	91.43	76.66	55.22	47.77	27.94	11.49	4.62	5.26
Av 33-4	16.97	38.84	218.91	177.59	48.02	70.84	61.39	38.92	12.39	6.50	4.60	4.27
Hi 47-48	88.65	127.50	81.24	160.81	115.00	126.03	92.62	76.09	22.79	8.98	6.91	7.31

Step IV) Adjustment of Annual Runoff Volume

	Upper Drift Unadjusted Regression-based Annual Runoff Volume, AF (1)	Target Upper Drift Creek Annual Runoff Volume, AF (from Step II) (2)	Multiplier to use to Adjust Estimated Regression-based Stream Flows of Upper Drift Creek (3)=(2)/(1)
Lo 35-36	35,308	24,648	0.6981
Av 33-4	42,467	31,308	0.7372
Hi 47-48	55,230	39,444	0.7142

Figure 9.1 shows the hydrographs of the estimated daily flows at Upper Drift Creek for the representative low, average and high flow years. Figure 9.2 shows the plots of the equivalent monthly flows. The most visible factor that appears to best characterize those years is the runoff volume during the October-December period. Figure 9.3 shows the cumulative runoff volume for each year.

Figure 9.1 Estimated Drift Creek's daily flows during representative low, average and high flow years.

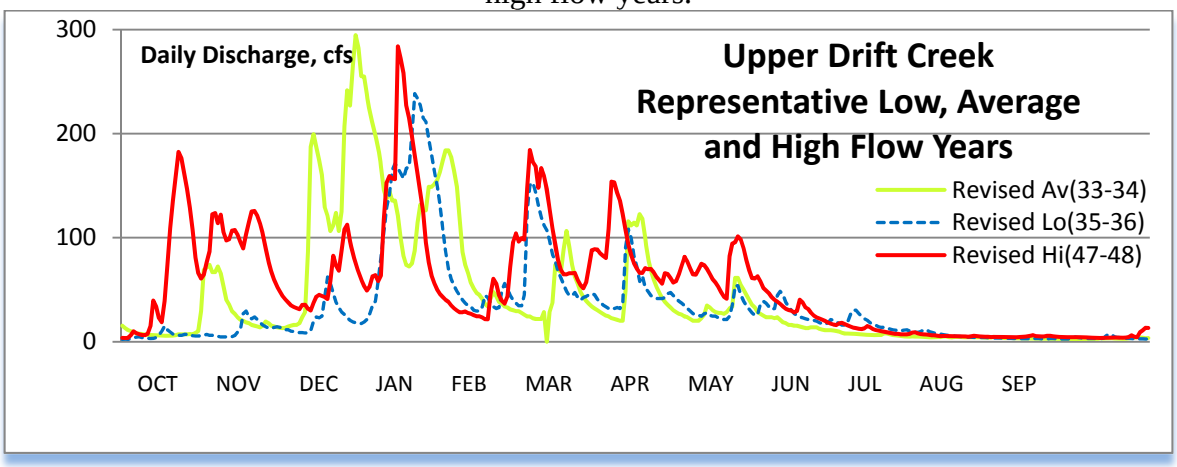


Figure 9.2 Plots of Estimated Drift Creek's Monthly flows during representative low, average and high flow years.

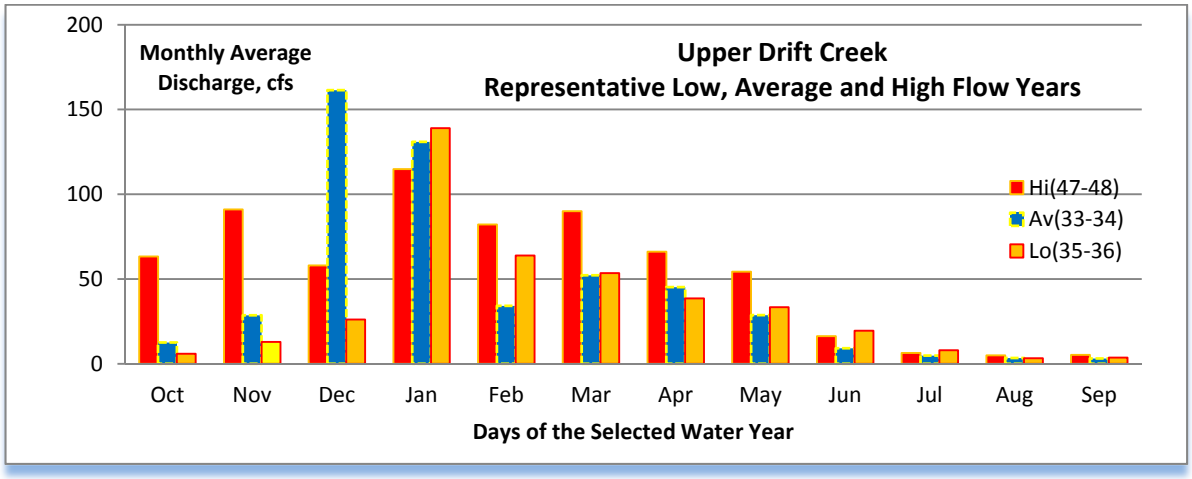
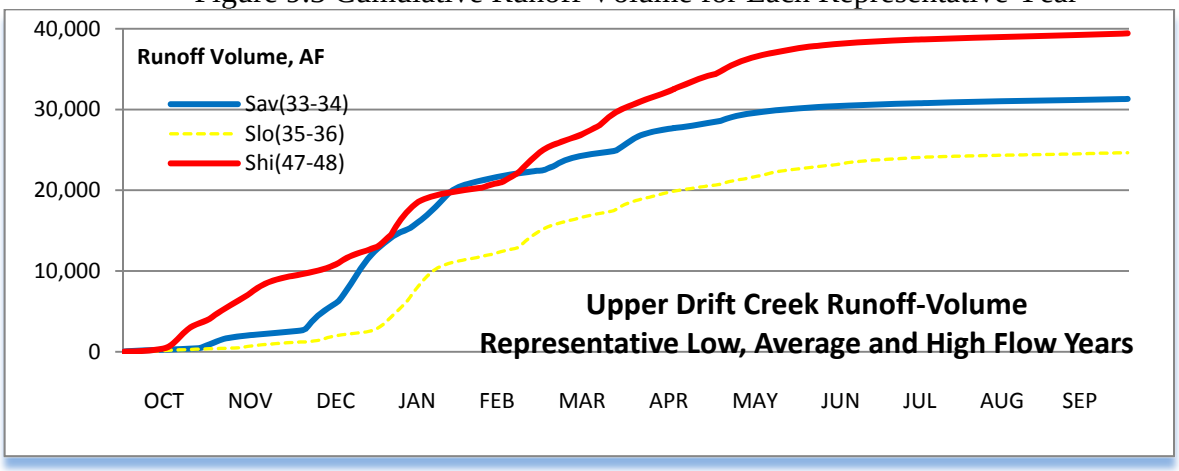


Figure 9.3 Cumulative Runoff Volume for Each Representative Year



It should be noted that another potential procedure to generate daily flows for representative flow years is through rainfall and/or snow-based modeling tools. Daily discharge reconstitution for the three representative years using the rainfall-runoff FLO4DRIFT model is feasible pending selection of appropriate sets of annual rainfall data that would qualify as "high", "average" and "low" precipitation years. This alternative has not been fully explored, due to the lack of rainfall data and lower study priority.

Another impediment in the modeling option is the lack of data on snow-fed runoff on Drift Creek, as a sizeable portion of the runoff during high flow years in this basin is most probably derived from snow-melt. Snow daily data that are available now through the Portland National Weather Service page: http://www.weather.gov/climate/index.php?wfo=pqr only go back roughly 5 years. If in the future such a reconstitution is deemed necessary, data going back to 1892 from Salem, including daily max/min/average temperature, heating and cooling degree days, precipitation, snowfall and snow depth could be ordered from the Western Regional Climate Center, 2215 Raggio Parkway, Reno, NV 89512 Phone: 775-674-7010 Fax: 775-674-7001 http://www.wrcc.dri.edu

The estimated (and adjusted) daily stream flows data for the three representative flow years are listed in the Appendix for potential use in other study applications.

10. Updating of Previous October-April Runoff Volume Frequency Curve

The runoff volume estimates for Drift Creek described in the February 2007 report were only based on drainage area and basin mean annual precipitation-- not on actual runoff data which were then not available. The first update of the original estimates was made based on the relationships established between actual monthly discharges of the Pudding River near Aurora and those of Drift Creek at the project site using the 2008-2009 stream flow measurements. Those estimates have been gradually updated to reflect the significance of the more recent stream flow measurements.

The procedure includes the steps listed below and is further illustrated by numbers shown in Table 10.1:

- Compiling existing historical October-April runoff volumes for Pudding River near Aurora over the entire 1928-2014 period of record,
- Multiplying the Pudding River data by a factor of 0.0348 (see Table 5.7) (except for 2008-14 for which actual Upper Drift October-April runoff volumes are used) to produce the corresponding October-April runoff volumes for Drift Creek at the project site. The previous multiplier used in Report Update #1 was 0.0362. It was changed to 0.038 in the Report Update #2.
- Performing the statistical frequency analysis to produce an updated frequency curve for the October-April runoff volume. Calculations were made according to the procedure outlined in the U.S. Army Corps of Engineers manual, "Statistical Methods in Hydrology" by L. Beard (1962).

The accuracy of the frequency curve relies heavily on the single multiplier used to convert the October-April runoff volumes from the Pudding River near Aurora to Drift Creek at the project site. That multiplier is only based on six years of observed data, and will need to be updated as more data are collected. Multipliers that vary with the runoff and precipitation conditions and thus change from year to year would be more appropriate. In that sense, data permitting, the use of a precipitation-runoff model would an improvement.

Table 10.1 Details of Statistical Volume Frequency Calculation

N	Hydro Yr Oct-Apr	Pudding Oct-Apr Vol (AF)	Drift Oct-Apr Vol (AF)	Log(Vol) X	X^2	Dev X-M x	x^2
		Multiplier=	0.0348				
1	1928-29	470,330	16,367	4.213982	17.757644	-0.203660	0.041477
2	1029-30	506,791	17,636	4.246408	18.031982	-0.171234	0.029321
3	1930-31	498,485	17,347	4.239231	17.971082	-0.178411	0.031830
4	1931-32	904,509	31,477	4.497992	20.231933	0.080350	0.006456
5	1932-33	840,124	29,236	4.465923	19.944465	0.048281	0.002331
6	1933-34	798,321	27,782	4.443757	19.746974	0.026115	0.000682
7	1934-35	778,303	27,085	4.432728	19.649077	0.015086	0.000228
8	1935-36	585,279	20,368	4.308942	18.566983	-0.108700	0.011816
9	1936-37	616,209	21,444	4.331307	18.760223	-0.086335	0.007454
10	1937-38	1,122,245	39,054	4.591667	21.083405	0.174025	0.030285
11	1938-39	539,529	18,776	4.273594	18.263606	-0.144048	0.020750
12	1939-40	648,682	22,574	4.353611	18.953930	-0.064031	0.004100
13	1940-41	419,148	14,586	4.163947	17.338452	-0.253695	0.064361
14	1941-42	613,602	21,353	4.329466	18.744276	-0.088176	0.007775
15	1942-43	1,147,435	39,931	4.601307	21.172029	0.183665	0.033733
16	1943-44	454,753	15,825	4.199355	17.634581	-0.218287	0.047649
17	1944-45	550,657	19,163	4.282460	18.339467	-0.135182	0.018274
18	1945-46	894,637	31,133	4.493226	20.189081	0.075584	0.005713
19	1946-47	734,364	25,556	4.407491	19.425974	-0.010151	0.000103
20	1947-48	961,931	33,475	4.524723	20.473120	0.107081	0.011466
21	1948-49	909,843	31,663	4.500546	20.254912	0.082904	0.006873
22	1949-50	1,008,572	35,098	4.545286	20.659626	0.127644	0.016293
23	1950-51	1,237,781	43,075	4.634223	21.476023	0.216581	0.046907
24	1951-52	868,953	30,240	4.480576	20.075557	0.062934	0.003961
25	1952-53	811,270	28,232	4.450745	19.809128	0.033103	0.001096
26	1953-54	1,025,958	35,703	4.552709	20.727158	0.135067	0.018243
27	1954-55	674,511	23,473	4.370568	19.101867	-0.047074	0.002216
28	1955-56	1,357,641	47,246	4.674364	21.849681	0.256722	0.065906
29	1956-57	648,236	22,559	4.353312	18.951329	-0.064330	0.004138

30	1957-58	851,445	29,630	4.471736	19.996421	0.054094	0.002926
31	1958-59	834,219	29,031	4.462859	19.917113	0.045217	0.002045
32	1959-60	642,653	22,364	4.349556	18.918636	-0.068086	0.004636
33	1960-61	1,056,599	36,770	4.565489	20.843694	0.147847	0.021859
34	1961-62	660,499	22,985	4.361451	19.022258	-0.056191	0.003157
35	1962-63	780,119	27,148	4.433740	19.658051	0.016098	0.000259
36	1963-64	746,995	25,995	4.414897	19.491315	-0.002745	0.000008
37	1993-94	473,466	16,477	4.216868	17.781976	-0.200774	0.040310
38	1994-95	890,685	30,996	4.491303	20.171806	0.073661	0.005426
39	1995-96	1,302,397	45,323	4.656323	21.681340	0.238681	0.056968
40	1996-97	1,373,397	47,794	4.679375	21.896554	0.261733	0.068504
41	2002-03	759,339	26,425	4.422015	19.554216	0.004373	0.000019
42	2003-04	691,029	24,048	4.381076	19.193823	-0.036567	0.001337
43	2004-05	381,407	13,273	4.122968	16.998864	-0.294674	0.086833
44	2005-06	1,000,928	34,832	4.541982	20.629601	0.124340	0.015460
45	2006-07	908,008	31,599	4.499669	20.247020	0.082027	0.006728
46	2007-08	831,396	28,933	4.461387	19.903976	0.043745	0.001914
47	2008-09	551,076	19,159	4.282374	18.338727	-0.135268	0.018297
48	2009-10	638,574	25,601	4.408259	19.432746	-0.009383	0.000088
49	2010-11	1,013,493	32,049	4.505816	20.302380	0.088174	0.007775
50	2011-12	949,805	31,419	4.497193	20.224743	0.079551	0.006328
51	2012-13	688,577	24,102	4.382054	19.202400	-0.035588	0.001266
52	2013-14	679,148	23,235	4.366143	19.063204	-0.051499	0.002652
				X	X^2	x	x^2
			N=	52			
			S(X)=	229.93798		0	0.896235
			M=	4.42188423			
			S(X^2)=		1017.65443	S^2=	0.01757323
			[S(X)^2]/N		1016.75913	S=	0.13256407
			S(x^2)=		0.896235		

Pn	0.25	1	10	50	90	99	99.75
k (N=52)	2.979	2.432	1.316	0.000	-1.316	-2.432	-2.979
Log(V)=	4.816726	4.744280	4.596272	4.421884	4.247496	4.099488	4.027042
Vol, AF	65,573	55,498	39,470	26,417	17,681	12,574	10,642

	LogQ=M+kS						
N-1=40	3.01	2.45	1.32	0	-1.32	-2.45	-3.01
N-1=60	2.94	2.41	1.31	0	-1.31	-2.41	-2.94
N-1=51	2.979	2.432	1.316	0.000	-1.316	-2.432	-2.979

All previously made statistical October-April runoff volume estimates are listed in Table 11.2 for the same frequencies of occurrence. Those estimates include:

1) Estimates made in 2007, based on **78** years of observed and **synthesized** Pudding River runoff between 1928 and **2005**),
2) Estimates made in 2010 (based on **47** years of observed Pudding River runoff between 1928 and **2009,** and using a 0.0362 flow conversion multiplier),
3) Estimates made in **2011** (based on **48** years of Pudding River data between 1928 and 2010, and using a 0.038 flow conversion multiplier),
4) Estimates made in 2012 (based on **49** years of Pudding River data between 1928 and 2011, and using a 0.037 flow conversion multiplier), and
5) Estimates made in 2014 (based on **52** years of Pudding River data between 1928 and 2014, and using a 0.0348 flow conversion multiplier.

There are some slight volume changes between the various October-April runoff volume estimates made over the past six years. They all look reasonably favorable with respect to the 12,000 acre-foot storage volume target used for the project. They also match OWRD water surface availability data covered in Section 12.

Table 10.2. Statistical October-April Runoff Volume Estimates for Drift Cr. @ Victor Point, using 52 years of Pudding River Observed Flows

Pn	0.25	1	10	50	90	99	99.75
Recurrence Interval (Years)	400	100	10	2	1.11	1.01	1.0025
Vol (date:2014)	65,573	55,498	39,470	26,417	17,681	12,574	10,642
Vol (date:2012)	70,532	59,571	42,164	27,858	18,407	13,028	11,003
Vol (date:2011)	73,617	61,887	43,377	28,628	18,894	13,243	11,133
Vol (date:2010)	70,468	59,521	41,661	27,360	17,968	12,576	10,622
Vol (date:2007)	98,736	82,429	58,384	38,522	25,417	18,002	15,029

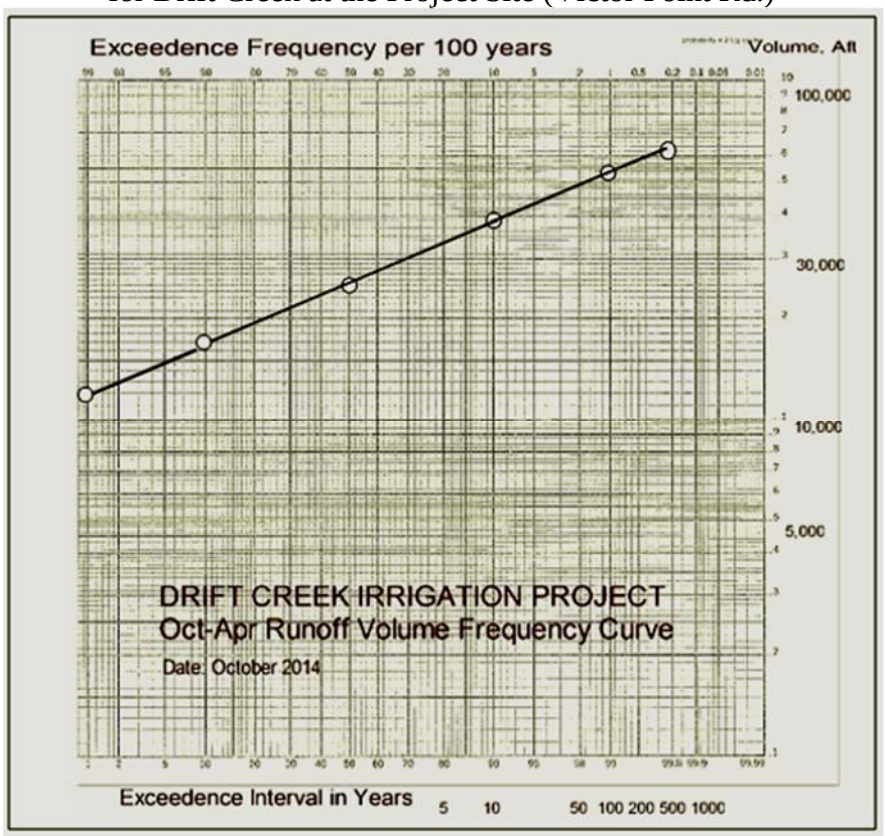
The updated October-April runoff volume frequency curves for Drift Creek at the project site based on the 2008-14 stream flow gauging records are shown in Figure 10.1.

For the record and to be fully consistent with the 2007 results, a statistical frequency analysis was also performed using flows for Pudding River near Aurora flows covering the entire 86 years between 1928 and 2014, including 52 years of observed flows and 34 more years of synthesized flows using rainfall and snow data at Salem. A 0.037 multiplier (instead of 0.0362 used in 2010 and 0.038 used in 2011) was used to convert Pudding River flows into Drift Creek flows. The results are summarized in Table 10.3, along with (1) previously estimated runoff volumes using 82 years of combined observed and synthesized data, and (2) estimated runoff volume using 49 years of actually observed data. Details of the calculation under this procedure are provided in the Appendix.

Table 10.3 Statistical October-April Runoff Volume Estimates for Drift Cr. @ Victor Point, using 86Years of Pudding River Observed and Synthesized Data (1928-2014)

Pn	0.25	1	10	50	90	99	99.75
k (N=86)	2.899	2.387	1.298	0.000	-1.298	-2.387	-2.899
Log(V)=	4.805492	4.734185	4.582760	4.402116	4.221472	4.070046	3.998739
Vol, AF	63,899	54,223	38,261	25,242	16,652	11,750	9,971

Figure 10.1 October-April Runoff Volume Frequency Curve for Drift Creek at the Project Site (Victor Point Rd.)



11. Water Availability and Draft Water Use Permit

Two OWRD issues that directly affect this hydrologic update --water availability and water use permit provisions-- are discussed in this section. The procedure used to estimate the 90% and 95% exceedance frequencies, which are not covered by OWRD, and its results are also documented.

11.1 Water Availability

OWRD defines water availability as *"the amount of water that can be appropriated from a given point on a given stream for new out-of-stream consumptive uses. It is obtained from the natural stream flow by subtracting existing in-stream water rights and out-of-stream*

consumptive uses". . Current standards for new appropriation of water are: *(1) consumptive use from allocations for out-of-stream uses can total no more than the 80-percent exceedance natural stream flow, and (2) allocations for in-stream flows can be no more than the 50-percent exceedance natural stream flow".*

OWRD provides up-to-date water availability data for Drift Creek at its confluence with the Pudding River for the 50% and 80% exceedance levels at the following address: http://apps.wrd.state.or.us/apps/wars/wars_display_wa_tables/display_wa_details.aspx?ws_id=70781&exlevel=80&scenario_id=1

Originally, the drainage area used for that site was shown as being 17.91 sq. mi., which is different from the 25.1 sq. mi. area calculated by Harvest Geographics, Inc. for the same location and lower than the 24.8 sq. mi. area used by Marion Water and Conservation Service District for a Drift Creek stream gauging site near Silverton and upstream from the mouth of Drift Creek. Following contacts by members of the project team, OWRD recognized that Drift Creek watershed was incorrectly delineated and subsequently changed the drainage area to 25.25 sq. mi. in early April 2010. The revised OWRD also reports a mean annual precipitation over Drift Creek watershed of 61.61 inches.

The water availability data as of 5/5/2015 shown on OWRD's website are listed in Table 11.1 for the 50% and 80% exceedance levels. Compared to the previous data postings, in-stream flow requirements remain the same but updates were made by OWRD for Consumptive Uses and Storages, as confirmed during a conference call on June 9, 2015. As a result, data shown for the Expected Stream Flows (third column from the right hand side) and Net Water Available (last column to the right) have been changed. The new numbers include the older flows and the additional flows requested by EVWD in its water use permit application, which was submitted in February 2013 and recommended for approval with conditions by OWRD in July 2014.

Table 11.1 Revised Water Availability Data for Drift Creek at Its Mouth, in cfs
(as of 5/5/2015)

a) 50% Exceedance DRIFT CR > PUDDING R - AT MOUTH

Water Availability as of 5/5/2105

Col. 1	Col. 2	Col.3	Col. 4	Col. 5	Col. 6	Col. 7
Month	Natural Stream Flow	Consumptive Uses and Storages	Expected Stream Flow	Reserved Stream Flow	Instream Flow Requirement	Net Water Available
JAN	149.00	54.40	94.60	0.00	40.00	54.60
FEB	133.00	46.40	86.60	0.00	40.00	46.60
MAR	108.00	33.20	74.80	0.00	40.00	34.80
APR	68.10	13.70	54.40	0.00	40.00	14.40
MAY	32.70	0.22	32.50	0.00	30.10	2.38
JUN	41.90	0.44	41.50	0.00	13.60	27.90
JUL	18.30	0.77	17.50	0.00	3.00	14.50
AUG	8.40	0.61	7.79	0.00	2.00	5.79
SEP	4.65	0.30	4.35	0.00	2.00	2.35

OCT	7.56	0.02	7.54	0.00	5.26	2.28
NOV	61.10	10.80	50.30	0.00	40.00	10.30
DEC	138.00	48.80	89.20	0.00	40.00	49.20
ANN	46,300.00	12,600.00	33,700.00	0.00	17,800.00	15,900.00

Average annual stream flow discharge at 50% Exceedance level = 63.88 cfs

b) 80% Exceedance DRIFT CR > PUDDING R - AT MOUTH

Water Availability as of 5/22/2012

Month	Natural Stream Flow	Consumptive Uses and Storages	Expected Stream Flow	Reserved Stream Flow	Instream Flow Requirement	Net Water Available
JAN	67.30	54.40	12.90	0.00	40.00	-27.10
FEB	74.90	46.40	28.50	0.00	40.00	-11.50
MAR	66.80	33.20	33.60	0.00	40.00	-6.36
APR	48.80	13.70	35.10	0.00	40.00	-4.93
MAY	24.20	0.22	24.00	0.00	30.10	-6.12
JUN	11.50	0.44	11.10	0.00	13.60	-2.54
JUL	5.51	0.77	4.74	0.00	3.00	1.74
AUG	3.34	0.61	2.73	0.00	2.00	0.73
SEP	3.09	0.30	2.79	0.00	2.00	0.79
OCT	4.27	0.02	4.25	0.00	5.26	-1.01
NOV	23.70	10.80	12.90	0.00	40.00	-27.10
DEC	65.80	48.80	17.00	0.00	40.00	-23.00
ANN	46,300.00	12,600.00	33,700.00	0.00	17,800.00	15,900.00

Average annual stream flow discharge at 80% Exceedance level = 33.05 cfs

OWRD exceedance stream flows *"are determined directly from gage records, or for ungaged streams, by estimation through modeling"*. Since the natural stream flow numbers listed above were listed long before October 2008, when actual stream flow monitoring started at the Upper Drift Creek station, those numbers must have been based on modeling results. The following paragraphs document the extent to which the listed 50% and 80% annual runoff volume compare with actually monitored stream flow volumes.

For the 50% exceedance, the OWRD-calculated natural stream flow volume is 39,817 AF for the October-April runoff volume of Drift Creek at its mouth -- a 25.25 sq. mi. drainage area. The actually observed runoff volume for Drift Creek at the lower gauging station (24.8 sq. mi. drainage area) for October 2009-April 2011 (a slightly below average water year) was 35,699 AF. After drainage area adjustment, the observed runoff volume for Drift Creek at its mouth would be 35,699*(25.25/24.8) = 36,347 AF. As calculated, the two numbers are off by less than 9%, part of which could be attributed to higher rainfall distribution over the lower part of the watershed.

For the 80% exceedance flows, the OWRD-calculated natural stream flow volume for Drift Creek at its mouth is only 18,100 AF. This is considerably lower than the 27,847 AF runoff volume observed at Hibbard Road during the October 2008- April 2009 period, a water year that can classified as a low flow year at the 80% or even a lower exceedance level. This could either indicate that the OWRD data for the 80% exceedance level is underestimated or that the 2008-09 flow year should have been ranked higher compared to other historical years. Obviously, this cannot be reliably determined yet with just six years of actual stream flow data.

As briefly discussed with OWRD staff at the June 9, 2015 conference call, updating of the natural stream flows currently shown in Column 2 of the OWRD water availability 50% and 80% exceedance tables is not being contemplated by the Department any time in the near future. Therefore, absent changes in numbers shown in columns 3, 5 and 6, numbers in columns 4 and 7 will not change.

11.2 Draft Water Use Provisions

As listed in the Proposed Final Order to Water Rights Application Number R-87871 issued by OWRD-Water Rights Service Division on July 22, 2014, recommendations include the following:

- Source of water: unnamed streams, tributaries of Drift Creek, and Drift Creek, tributary of Pudding River
- Storage facility: Drift Creek Reservoir
- Purpose or use of the stored water: storage for irrigation and flow augmentation
- Maximum volume: 12,000 acre-feet each year
- Water may be appropriated for storage during the period: November 1 through April 30
- The permittee shall pass all live flow during May 1 through October
- Date of priority: February 21, 2013

All of the above provisions have been complied with in hydrologic model studies completed to date. The only partial exceptions are (1) the new October - April refill season, and (2) the provision to pass all live flows during May 1 through October. As modeled so far, both refilling the reservoir and passing live flows are not date specific, but inflow and minimum in-stream flow requirement specific. A result, the impacts of those two new provisions turned out to be relatively minimal. Future model runs will more strictly apply the two provisions.

Also, as stated in the draft permit, "*the use of water allowed herein may be made only at times when sufficient water is available to satisfy all prior rights, including prior rights for maintaining in-stream flows*". Therefore, identifying those prior rights and including them in the model study as part of the reservoir release requirements will be necessary in future study updates.

The project team should continue to work closely with OWRD staff to stay informed, watch for any changes in the draft water use permit, address those changes in the model study, and document their impacts on previous study results.

11.3 Estimating 90% and 95% Exceedance Monthly Flows

Two additional exceedance frequencies, 90% and 95%, are needed for Drift Creek natural monthly flows to support further discussions on reservoir release operations. To perform this task, a procedure was developed based on observed stream flow data collected during the 2008-2014 hydrologic years to reflect actual runoff conditions, and using the OWRD 80% exceedance frequencies to ensure maximum consistency with OWRD data.

The steps involved are as follows:

1. Develop flow duration curves for each month, using the October 2008-September 2014 observed daily flows recorded at the Upper Drift Station; read out the monthly flow values for 50%, 80%, 90% and 95% exceedance frequencies;
2. Adjust the above values to calculate equivalent numbers applicable to Drift Creek at the mouth. The multiplier used is equal to the drainage area at the mouth divided by the drainage area at Upper Drift Creek, 25.25/14.50=1.6961;
3. Calculate the multipliers needed to match the results of Step 2 estimates with OWRD's 50% and 80% values; and
4. Use linear interpolation from the 50% and 80% multipliers to calculate the multipliers needed for the 90% and 95% exceedance values.

The above procedure is summarized in Table 11.2, and the results are illustrated in Figure 12.1 covering the 50%, 80%, 90% and 95% exceedance values.

Figure 11.1 50%, 80%, 90% and 95 % Exceedance Natural Stream Flows for Drift Creek

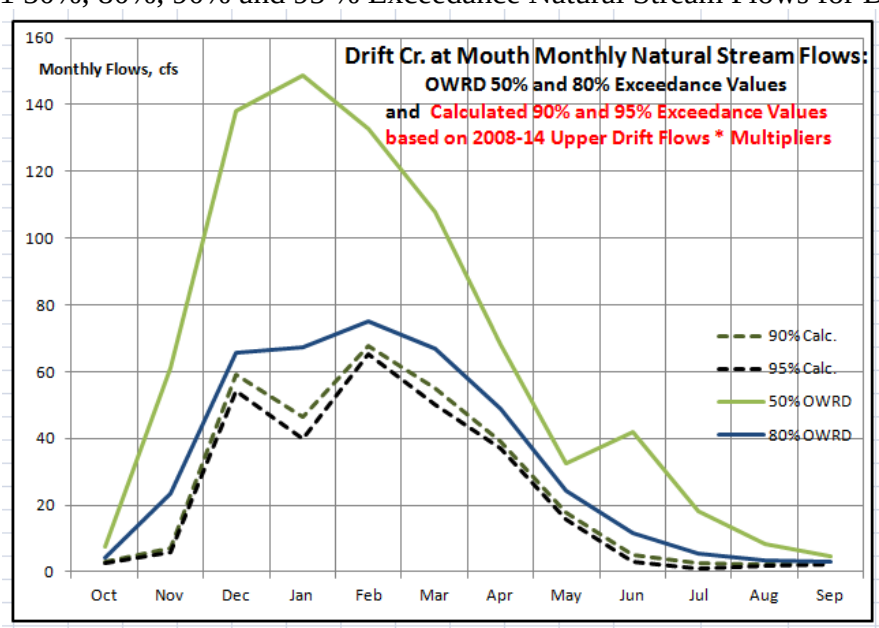


Table 11.1 Procedure to Estimate the 90% and 95% Exceedance Stream Flows for Drift Creek

Row	DATE	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
R2	% Exceed.	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs	cfs
R3													
R4	Values based on Duration Curves of 2008-2014 Upper Drift Flows												
R5	50%	3.98	43.93	53.74	63.60	47.81	71.15	60.96	36.20	15.51	5.03	1.25	1.01
R6	80%	1.06	18.02	20.05	34.40	25.00	42.01	30.28	19.78	8.79	2.20	0.35	0.27
R7	90%	0.61	5.39	16.80	25.41	22.12	34.06	21.90	13.31	5.88	1.15	0.23	0.19
R8	95%	0.51	4.78	14.90	22.70	21.00	30.70	20.00	11.32	5.10	0.57	0.15	0.16
R9													
R10	Drainage area, sq.mi.		mouth=	25.25		Upper D	15.40		Mult.=	1.64			
R11													
R12	Values based on Duration Curves of 2008-2014 Upper Drift Flows * Drainage Area adjustment 1.63961												
R13	50%	6.53	72.03	88.11	104.28	78.39	116.66	99.95	59.35	25.43	8.25	2.05	1.66
R14	80%	1.74	29.55	32.87	56.40	40.99	68.88	49.65	32.43	14.41	3.61	0.57	0.44
R15	90%	1.00	8.84	27.55	41.66	36.27	55.85	35.91	21.82	9.64	1.89	0.38	0.31
R16	95%	0.84	7.84	24.43	37.22	34.43	50.34	32.79	18.56	8.36	0.93	0.25	0.26
R17													
R18	OWRD Water Availability (from website)												
R19	50% OWRD	7.56	61.10	138.00	149.00	133.00	108.00	68.10	32.70	41.90	18.30	8.40	4.65
R20	80% OWRD	4.27	23.70	65.80	67.30	74.90	66.80	48.80	24.20	11.50	5.51	3.34	3.09
R21													
R22	Multiplier R19/R13, R20/R14 and Proportional Linear Adjustments from 50% and 80% Data												
R23	50% (Obs-based)	1.16	0.85	1.57	1.43	1.70	0.93	0.68	0.55	1.65	2.22	4.10	2.81
R24	80%(Obs-based)	2.46	0.80	2.00	1.19	1.83	0.97	0.98	0.75	0.80	1.53	5.82	6.98
R25	90%(Obs-based)	2.89	0.79	2.15	1.11	1.87	0.98	1.08	0.81	0.51	1.30	6.39	8.37
R26	95%(Obs-based)	3.11	0.78	2.22	1.08	1.89	0.99	1.13	0.84	0.37	1.18	6.68	9.07
R27													
R28	Calculated Water Availability R15*R25 and R16*R26												
R29	90% Calc.	2.89	6.95	59.13	46.44	67.85	54.98	38.90	17.70	4.96	2.45	2.41	2.61
R30	95% Calc.	2.60	6.11	54.22	40.02	65.16	49.92	37.18	15.66	3.12	1.10	1.64	2.38

12. Ecological and Channel Maintenance Flows

A report was completed in March 2010 by Ellis Ecological Services, Inc. to "address the need for the proposed dam to provide trigger flows for upstream fish migration and flushing flows to move coarse bed streams and enhance habitat conditions below the dam".

Ecological Flows

The Ellis report concluded that "Oregon Department of Fish and Wildlife's in-stream flow water right, which increases incrementally from about 3 cfs in September to 40 cfs by mid-November, should be adequate to trigger upstream migration and provide sufficient water depths for migration through the reach. No other trigger flow requirements were identified in the analyses." Even if some habitat enhancement downstream of the dam site is undertaken, and assuming that spawning and rearing habitat was improved in this reach, more than sufficient

flow should be available through ODFW's in-stream flow water to allow access to such habitat improvements.

Flushing Flow Analysis

The Ellis report also indicated that "flushing flows needed to move coarse bed streams are usually provided by a 2-3 year flood event", and estimated that the 2-year flood event would be approximately 630 cfs. Therefore, the project will be required to "bypass all flows greater than 630 cfs".

Based on the above, the dam would have to pass all flows up to ODFW's in-stream flow water right and all flows above the 2-year flood peak of 630 cfs.

13. Reservoir Modeling

There is a need to test how the proposed reservoir would best operate under various inflow conditions to meet all the flow requirements mentioned above and still be able to store enough water for irrigation purposes. Because the project would basically operate alone, for a single purpose, and in a relatively small size watershed, a simple reservoir regulation model, coded name RES4DRIFT, was developed using the Quick-Basic programming language.

RES4DRIFT uses the reservoir storage information prepared by Stuntzner Engineering, including storage elevation, volume, and surface area. See Table 13.1 and Figures 13.1 through 13.4. Release capability numbers were provided by Murray-Smith & Associates for the outlets and by PSU for the 50-foot long broad-crest spillway weir (with crest located at Elevation 667 feet msl). Model parameters related to the upper portion of the reservoir are extracted based on the trend line equations.

The reservoir upper bound is set that same elevation 667' used in the Murray-Smith & Associates report, and the reservoir lower bound is at elevation 620' --compared to an upper bound elevation of 680' used in previous model runs. The Probable Maximum Flood will raise the reservoir over the spillway by 7-Feet to 684'. The top of dam is a safe 3-feet (freeboard) over this elevation at 687'. Therefore, any additional inflow that would drive the elevation higher than 677' would be passed through by the outlet tower or over the spillway.

Table 13.1 Drift Creek Reservoir Characteristics

Elevation (ft msl)	Dam Height, (ft)	Reservoir Area (acre)	Reservoir Storage (AF)	Conduits Cap. (cfs)	Spillway Capacity (cfs)	Total Release (cfs)
616	0	0.40	0	0.0	0	0
620	4	3.66	8	15.0	0	0
621	5		49	92.1	0	92
622	6		89	106.4	0	106
623	7		129	118.9	0	119
624	8		170	130.3	0	130

625	9	4.45	210	140.7	0	141
626	10		251	150.4	0	150
627	11		291	159.6	0	160
628	12		332	168.2	0	168
629	13		372	176.4	0	176
630	14	77.24	413	184.2	0	184
631	15		512	191.8	0	192
632	16		611	199.0	0	199
633	17		710	206.0	0	206
634	18		810	212.7	0	213
635	19	121.27	962	219.3	0	219
636	20		1,115	225.7	0	226
637	21		1,268	231.8	0	232
638	22		1,420	237.9	0	238
639	23		1,573	243.7	0	244
640	24	184.04	1,726	386.0	0	386
641	25		1,946	394.6	0	395
642	26		2,167	403.1	0	403
643	27		2,388	411.4	0	411
644	28		2,608	419.6	0	420
645	29	220.71	2,829	427.6	0	428
646	30		3,050	435.4	0	435
647	31		3,271	443.1	0	443
648	32		3,491	450.7	0	451
649	33		3,712	458.1	0	458
650	34	257.39	3,933	465.5	0	465
651	35		4,212	472.7	0	473
652	36		4,490	479.8	0	480
653	37		4,769	486.8	0	487
654	38		5,048	493.7	0	494
655	39	288.88	5,327	500.5	0	501
656	40		5,606	507.2	0	507
657	41		5,885	513.9	0	514
658	42		6,164	520.4	0	520
659	43		6,443	526.9	0	527
660	44	300.37	6,722	533.3	0	533
661	45		7,035	539.6	0	540
662	46		7,349	545.8	0	546
663	47		7,662	552.0	0	552
664	48		7,976	558.1	0	558
665	49	313.54	8,289	564.1	0	564
666	50		8,603	570.1	0	570

667	51	318.84	8,917	576.0	0	576
668	52		9,230	581.9	901	1,482
669	53		9,544	587.6	2,547	3,135
670	54	326.81	9,857	593.4	4,679	5,273
671	55		10,198	599.1	7,204	7,803
672	56		10,538	604.7	10,068	10,673
673	57		10,878	610.2	13,235	13,845
674	58		11,218	615.8	16,678	17,294
675	59	340.15	11,558	621.2	20,377	20,998
676	60		11,898	626.7	24,314	24,941
677	**61**		**12,238**	**632.1**	**28,477**	**29,109**
678	62		12,579	637.4	32,854	33,491
679	63		12,919	642.7	37,434	38,077
680	64	353.49	13,259	647.9	42,210	42,857
685	69	366.83	14,960	674.6	64,000	64,675
686	70	367.91	15,364	676.2	68,065	68,741
687	71	368.87	15,772	677.6	71,916	72,593
688	72	369.68	16,186	678.8	75,512	76,191
689	73	370.37	16,605	679.7	78,815	79,494

NOTES: 1. Sources: (*)= MSA (**)= PSU Q=25.5 x H^1.5 (metric)
2. Some cells not critical to the analysis are left unfilled.
3. New values related to the top 9 feet of the reservoir are shown in yellow.
4. The 15 cfs outlet capacity added for El. 620 is to meet minimum in-stream flow.

Figure 13.1. Satellite Contour Map of the Proposed Project Site

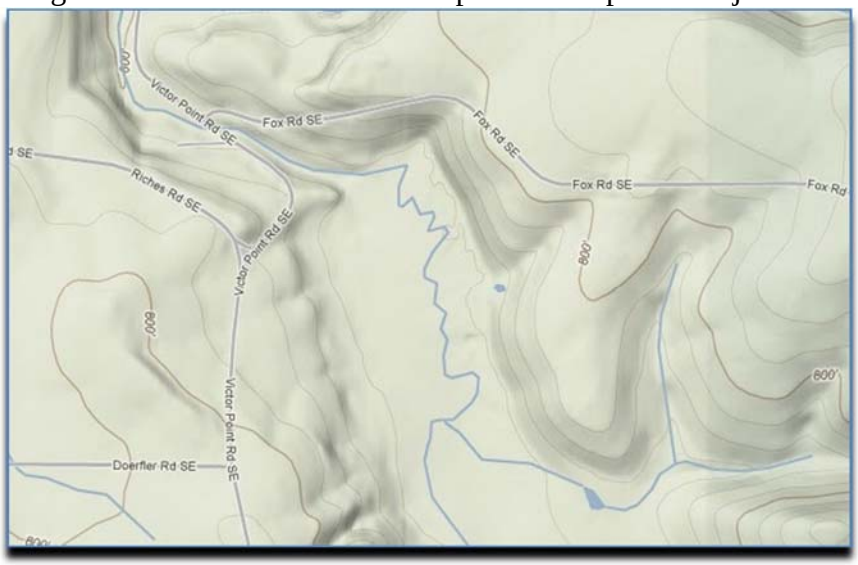


Figure 13.2 Project Dam Height vs. Storage

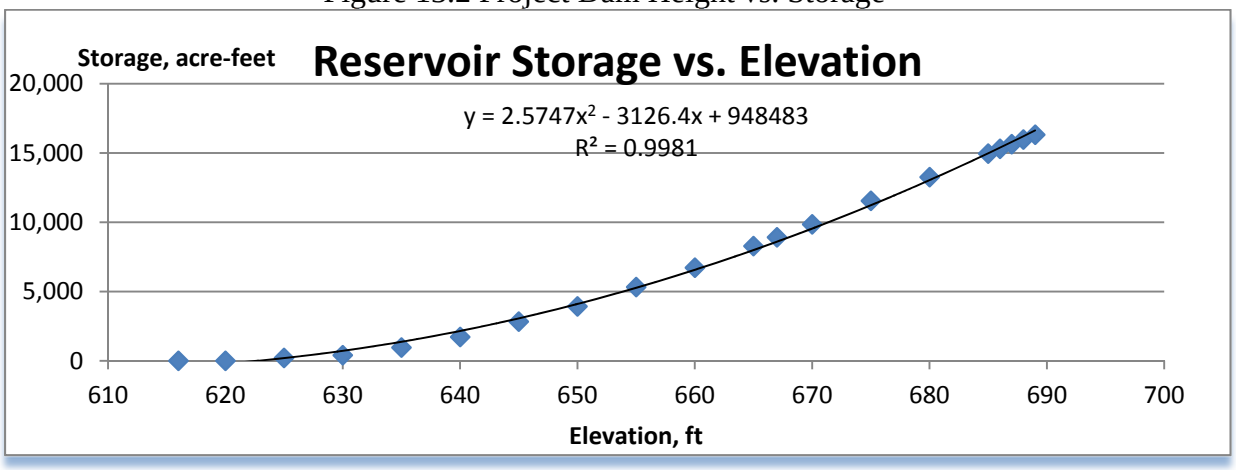


Figure 13.3 Project Area vs. Elevation

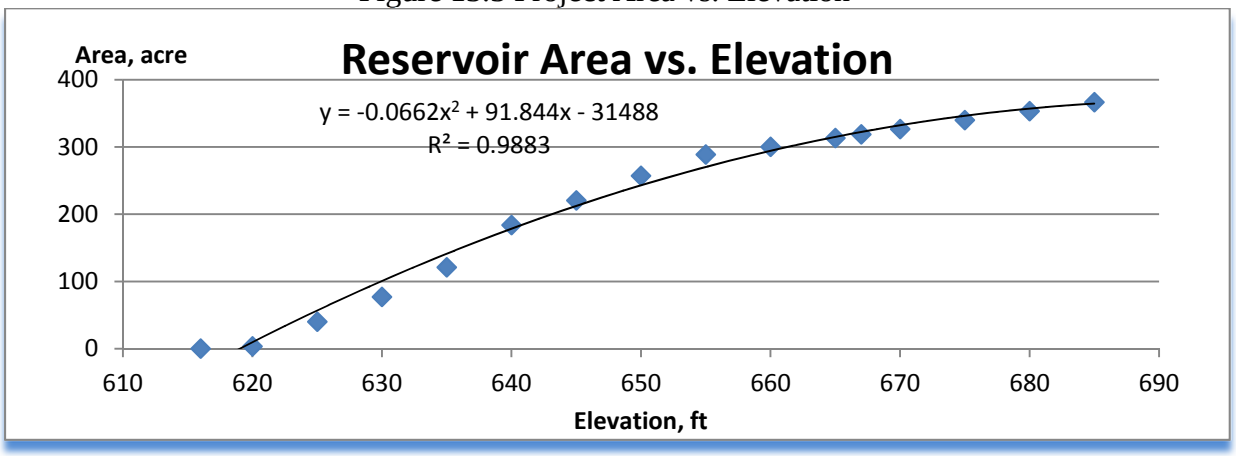


Figure 13.4
Project Outlets Release Capacity (Original source: MSA)

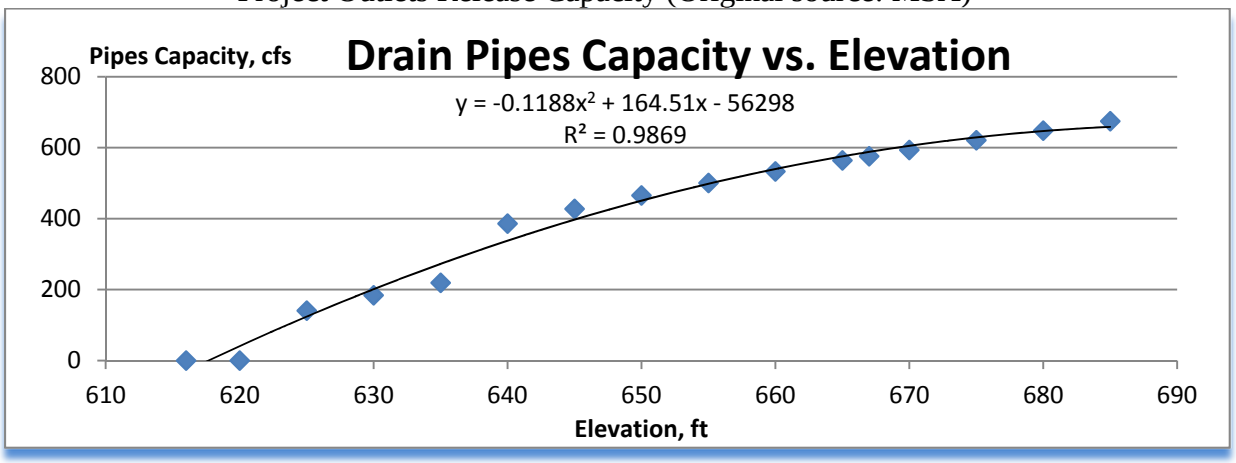
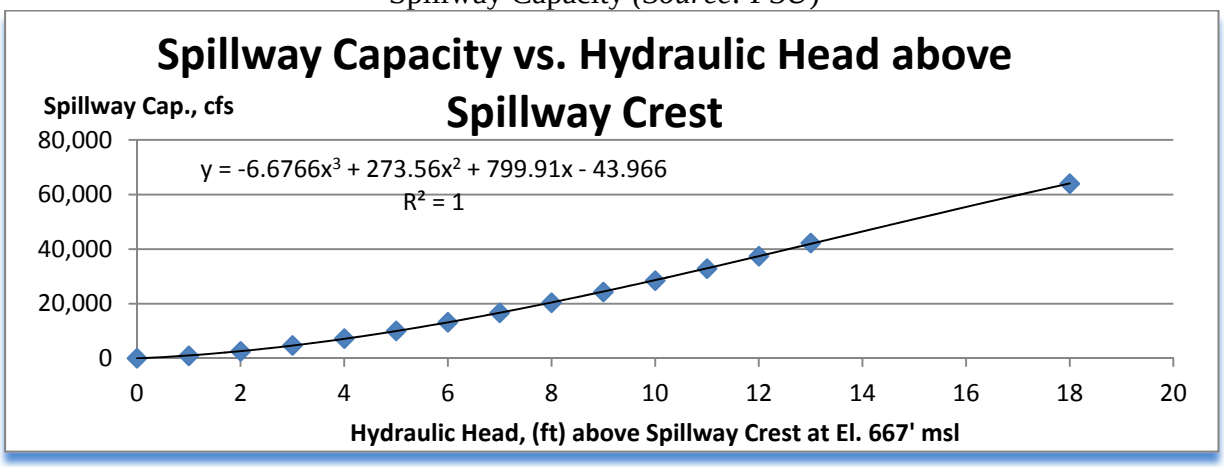
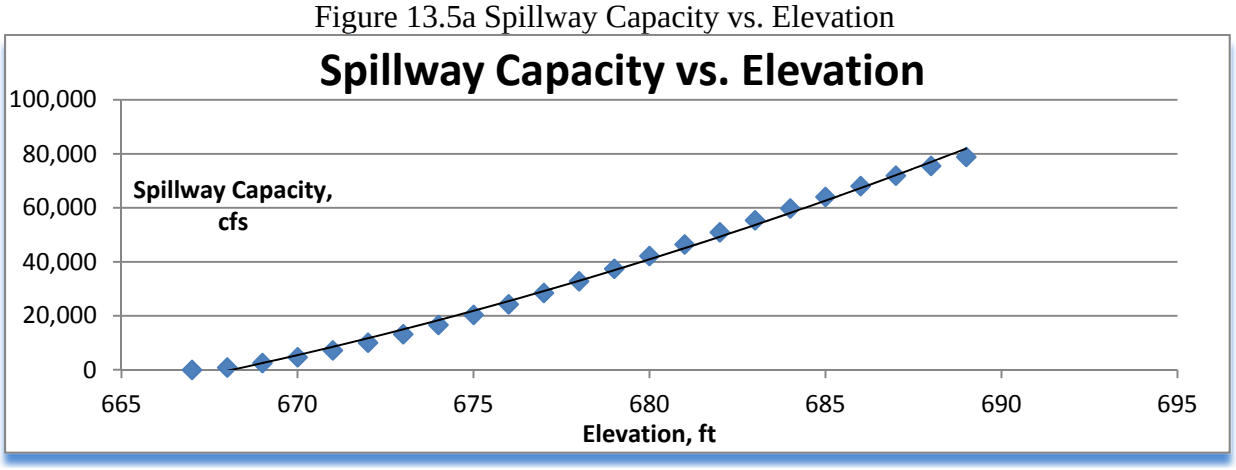


Figure 13.5
Spillway Capacity *(Source: PSU)*



As quoted in the report, "Drift Creek Reservoir model", prepared by PSU Water Quality Research Group in June 2011, “the spillway was … a broad-crested weir. Using the equation for a weir with a well-rounded upstream edge (Streeter and Wylie, 1985): Q=1.67 LH^1.5 where Q was the flow rate (cms), L was the weir width (m) and H was the head”. The equation was further reduced to Q(cms)= 22.5 H^1.5, to reflect the 50 foot long spillway width. Note that the polynomial equation and the R^2 value shown in Figure 13.5 above were automatically provided by Excel based on the Outlet Capacity vs. Pool Elevation data. The polynomial equation should yield comparable outlet capacity values as the Q=1.67 LH^1.5 equation. Figure 13.5a is a replicate of Figure 13.5, showing elevation on the X axis.

Figure 13.5a Spillway Capacity vs. Elevation



RES4DRIFT also uses any set of daily inflow data provided by the user. For model testing purpose, flows patterned after the 1957-58 average runoff year were used to simulate the operation. Project releases are subject to flows needed to meet (1) the “Consumptive Uses and Storages”, and “In-stream Flow Requirement” numbers listed in OWRD Water Availability Calculation table for Drift Creek at the mouth (see Table 13.2), and (2) the ecological and

flushing flow requirements mentioned in the previous section. Project release requirements are summarized in Table 13.2.

Table 13.2 Project Release Requirements, in cfs

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Consumptive Use and Storage	2.28	2.03	0.03	0.04	0.22	0.44	0.77	0.61	0.3	0.02	0.93	2.11
Water Req.	40	40	40	40	30.1	13.6	3	2	2	5.26	40	40
Total	42.28	42.03	40.03	40.04	30.33	14.04	3.77	2.61	2.30	5.28	40.93	42.11
Flushing*	630	630	630	630	630	630	630	630	630	630	630	630

(*) The project is required to "bypass all flows greater than 630 cfs" (no water storing)

Originally, it was conservatively assumed that the flow requirements at the project site are the same as those specified for Drift Creek at its mouth. Hydrologically, applicable water rights and irrigation flows, among others, would be less at the project site than at the mouth of the creek. This is especially true for this case when the drainage area controlled by the project (at Victor Point) is only about 60 percent of the total drainage area of the creek. A detailed inventory of the sites involved, a detailed estimate of the local inflow and, above all, a final call by OWRD will determine the appropriate releases to be made in real-time.

Table 13.3 shows one way to calculate the monthly local inflow between the project site and the mouth of the creek for hydrologic years 2008-09 and 2009-10 respectively. Basically, the local inflow is calculated as the difference between the flow at the mouth (Qmouth) and the flow at the project (Qproj). Qmouth is derived from the flow at the lower (Hibbard Road) station in direct proportion of the drainage area at the mouth (25.25 sq. mi.) and the drainage area at Hibbard Road station (24.8 sq. mi.). Qproj is the flow recorded at the project site, at the Victor Road Junction (15.4 sq. mi.).

Through e-mail exchange back in May 2010 with OWRD Water Rights Section, it was understood that, under some conditions, the project could rely on local inflow to meet part of the relevant in-stream water rights (ISWR) downstream from it. The project may also not be required to release more than the natural inflow at the project site to meet those water rights. As a result, the water right portions that the project has to meet could be lower than the full water rights listed for the creek at its mouth. Therefore, for planning purposes, both options are still kept open in the modeling work.

The other OWRD general guidance was that "*water stored legally needs not be released later unless a call is made by a senior downstream storage right that has not been able to fill despite attempting to make full use of its right to store. This was rare, and may never have happened west of the Cascades. In other words, there is a profound distinction in this regard between stored water and live flow, and any in-stream water right (ISWR) refers to live flow*".

Furthermore, OWRD staff cautioned about the distinction between allocation and regulation. "*Allocation can occur only if water is available; ODFW may also request minimum bypass flows as a permit condition if no ISWR exists. With regard to meeting an ISWR, the flows simply need to be met upon measurement (regardless of whether the right is for a point or reach).*

If they are not met, regulation in favor of them occurs. All live flow must be passed outside the storage season".

The above directions are followed in the reservoir modeling whenever possible, especially when downstream senior water rights can be predicted. Because the modeling work conducted to date is investigative in nature, many reservoir release options that are hydrologically feasible have been considered and evaluated for study purposes.

Table 13.3 Monthly Water Right Requirements at Project Site, cfs

a) October 2008-2009 Water Year

		Mean Monthly Discharges, 2008-09												AFT
Station	DA	OCT 08	NOV 08	DEC 08	JAN 09	FEB 09	MAR 09	APR 09	MAY 09	JUN 09	JUL 09	AUG 09	SEP 09	annual
Drift/Victor	15.4	1.83	22.82	48.19	101.87	38.93	65.90	39.73	45.55	7.25	1.35	0.24	0.49	22629.8
Drift/Lower	24.8	4.20	28.50	117.20	151.50	51.10	100.50	50.30	55.10	9.00	1.80	0.60	0.90	34602.8
Victor/Lower	0.621	0.435	0.801	0.411	0.672	0.762	0.656	0.790	0.827	0.806	0.753	0.393	0.546	0.654
Drift/mouth	25.25	4.3	29.0	119.3	154.2	52.0	102.3	51.2	56.1	9.2	1.8	0.6	0.9	35230.6
ISWR mouth		5.28	40.92	42.09	42.25	42.01	40.02	40.04	30.23	14.04	3.76	2.61	2.30	18,340
Local Flow	9.9	2.5	6.2	71.1	52.4	13.1	36.4	11.5	10.6	1.9	0.5	0.4	0.4	12,601
ISWR Required		2.8	34.7	-29.0	-10.1	28.9	3.6	28.6	19.7	12.1	3.3	2.2	1.9	8,147
Actual ISWR Release		1.83	22.82	0.00	0.00	28.91	3.60	28.56	19.68	7.25	1.35	0.24	0.49	6,764
Check		4.28	29.02	71.13	52.38	42.01	40.02	40.04	30.23	9.16	1.83	0.61	0.92	19,365
Storageable flows		0.00	0.00	48.19	101.87	10.02	62.30	11.17	25.87	0.00	0.00	0.00	0.5	15,895
Salem Rainfall		0.96	3.59	6.02	3.56	2.90	3.03	1.35	3.03	1.39	0.68	0.18	1.20	27.89
Qmouth/Qproj.	1.640	2.34	1.27	2.48	1.51	1.34	1.55	1.29	1.23	1.26	1.35	2.59	1.87	1.67
Qlocal/Qproj	0.640	1.34	0.27	1.48	0.51	0.34	0.55	0.29	0.23	0.26	0.35	1.59	0.87	0.67

b) October 2009-2010 Water Year

		Mean Monthly Discharges, 2009-10												AFT
Station	DA	OCT09	NOV09	DEC09	JAN10	FEB10	MAR10	APR10	MAY10	JUN10	JUL10	AUG10	SEP10	annual
Drift/Victor	15.4	3.2	50.8	59.7	109.4	47.3	68.8	89.6	47.4	72.7	7.9	1.4	2.7	33,777
Drift/Lower	24.8	5.32	73.87	83.32	149.00	69.93	95.16	116.90	57.00	92.53	7.87	1.59	2.87	45,462
Victor/Lower	0.621	0.594	0.688	0.716	0.734	0.677	0.723	0.767	0.832	0.786	1.003	0.868	0.946	0.743
Drift/mouth	25.25	5.4	75.2	84.8	151.7	71.2	96.9	119.0	58.0	94.2	8.0	1.6	2.9	46,287
ISWR mouth		5.28	40.92	42.09	42.25	42.01	40.02	40.04	30.23	14.04	3.76	2.61	2.30	18,345
Local Flow	9.9	2.3	24.4	25.2	42.3	23.9	28.1	29.4	10.6	21.5	0.1	0.2	0.2	12,508
ISWR Required		3.0	16.6	16.9	-0.1	18.1	11.9	10.6	19.6	-7.5	3.6	2.4	2.1	4,798
Actual ISWR Release		3.02	16.55	16.92	0.00	18.13	11.89	10.64	19.63	0.00	3.64	1.38	2.09	6,221
Check		5.28	40.92	42.09	42.34	42.01	40.02	40.04	30.23	21.51	3.76	1.62	2.30	18,729
Storageable flows		0.14	34.29	42.74	109.37	29.19	56.87	78.98	27.80	72.70	4.26	0.00	2.7	27,671
Salem Rainfall		0.96	3.59	6.02	3.56	2.90	3.03	1.35	3.03	1.39	0.68	0.18	1.20	27.89
Qmouth/Qproj.	1.640	1.71	1.48	1.42	1.39	1.50	1.41	1.33	1.22	1.30	1.01	1.17	1.08	1.34
Qlocal/Qproj	0.640	0.71	0.48	0.42	0.39	0.50	0.41	0.33	0.22	0.30	0.01	0.17	0.08	0.34

Starting from a specified pool elevation, the model currently accepts three modes of operation including (1) releasing daily outflows at pre-defined discharge rates for each month of

the year, (2) following a rule curve to reach designated end-of-the month elevations, and (3) releasing water above specified inflow rates. The model automatically controls the project release to prevent the reservoir from going below the project's lower bound or above its upper bound. It also keeps track of the release violations when the project cannot release the required outflow either for lack of available storage or reservoir overflow. See Table 13.4.

Table 13.4 Sample RES4DRIFT Model Output

Initial Begin-period: ELE= 653.0 S(aft)=4776.8
Reservoir Upper Bound ELE= 677.00 S(aft)= 12,238
Reservoir Lower Bound ELE= 620.00 S(aft)= 8
SUMMARY RESULTS OF RESERVOIR SIMULATION
Run Date:03-13-2015 00:32:12

I	DA	MO	YR	QIN	ELE1	ISWR	CONSU	QLOC	REQ	QREQ	IRR	QIRR	QREL	V	ELE2	STORAGE
1	1	10	2009	0.70	653.03	5.26	0.02	0.50	4.78	0.70	0.00	0.00	0.70	1	653.03	4,777
2	2	10	2009	0.70	653.03	5.26	0.02	0.50	4.78	0.70	0.00	0.00	0.70	1	653.03	4,777
3	3	10	2009	0.70	653.03	5.26	0.02	0.50	4.78	0.70	0.00	0.00	0.70	1	653.03	4,777
4	4	10	2009	0.70	653.03	5.26	0.02	0.50	4.78	0.70	0.00	0.00	0.70	1	653.03	4,777
5	5	10	2009	0.80	653.03	5.26	0.02	0.57	4.71	0.80	0.00	0.00	0.80	1	653.03	4,777
6	6	10	2009	5.80	653.03	5.26	0.02	4.12	1.16	1.16	0.00	0.00	1.16	0	653.06	4,786
7	7	10	2009	2.90	653.06	5.26	0.02	2.06	3.22	2.90	0.00	0.00	2.90	1	653.06	4,786
8	8	10	2009	1.40	653.06	5.26	0.02	0.99	4.29	1.40	0.00	0.00	1.40	1	653.06	4,786
9	9	10	2009	0.70	653.06	5.26	0.02	0.50	4.78	0.70	0.00	0.00	0.70	1	653.06	4,786
10	10	10	2009	0.30	653.06	5.26	0.02	0.21	5.07	0.30	0.00	0.00	0.30	1	653.06	4,786
11	11	10	2009	0.10	653.06	5.26	0.02	0.07	5.21	0.10	0.00	0.00	0.10	1	653.06	4,786
12	12	10	2009	0.10	653.06	5.26	0.02	0.07	5.21	0.10	0.00	0.00	0.10	1	653.06	4,786

QIN=natural inflow; ELE(1) =beginning-of-day storage elevation; ISWR= sum of in-stream water rights, and storage and irrigation withdrawals; ISWR (in-stream flow at the creek mouth); CONSU (consumptive use and storage); QLOC= local inflow between project site and the mouth of the creek; REQ=required minimum project release to meet in-stream flow requirements); QREQ (actual release to meet in-stream flow requirements); IRR= required irrigation needs); QIRR (actual release for irrigation); QREL= actual project release; VIOL= violation (0=normal, 1=too small inflow, 2=exceed upper bound, 3=exceed lower bound, 4=pass flow greater than 630 cfs for flushing purposes), 5=exceed outlet capacity; ELE(2(=end-of-day storage elevation, in AF).

As for irrigation releases, there are two possibilities to test the ground. The first option is to use a given percentage of the actual volume of the water stored in the reservoir on April 30, VSW, to define the required daily irrigation releases. Assuming a VSW of 8,000 AF, the proposed agricultural release schedule (through the proposed conduit) could be as follows:

10% in May (25.8 AF per day or approximately 13 CFS)
10% in June (26.7 AF per day or approximately 13.5 CFS)
20% in July (51.6 AF per day or approximately 26.0 CFS)
30% in August (77.41 AF per day or approximately 39.0 CFS)
30% in September (80 AF per day or approximately 40.33 CFS)

In a dry year, when the V volume of the water stored in the reservoir on April 30 is less than 8,000 AF, the project release could conceivably be proportionately reduced by keeping the same percentage and lowering the base volume amount from 8,000 AF to V aft. By the same token, under very wet conditions, the reservoir could have a storage volume greater than 8,000 AF on April 30, which would lead to proportionally increased irrigation withdrawals --same volume percentages but greater VSW.

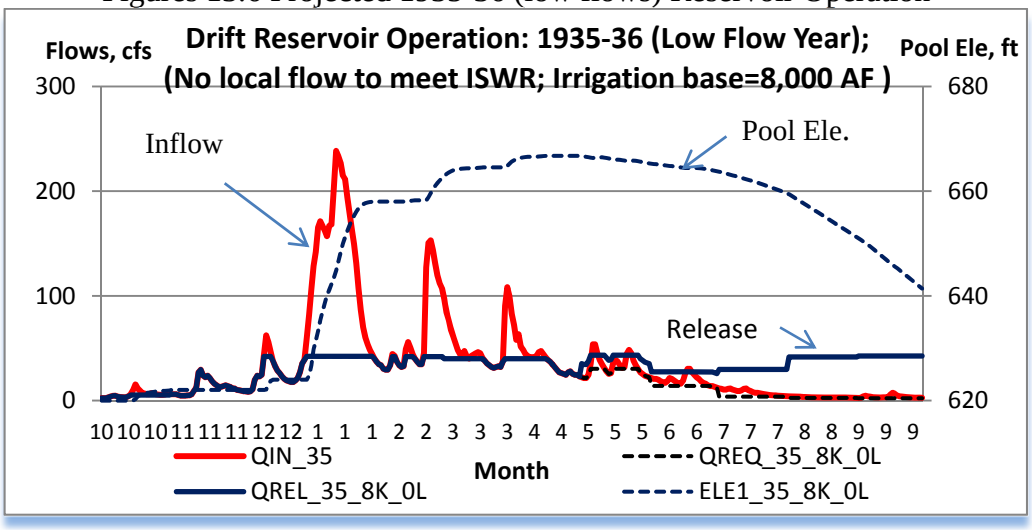
In this case, since VSW is expected to vary from year-to-year depending on the runoff, irrigation release discharges for the year would not be known until after April 30. Whatever irrigation releases are determined then, there will always be enough stored water to feed those the releases throughout the irrigation season.

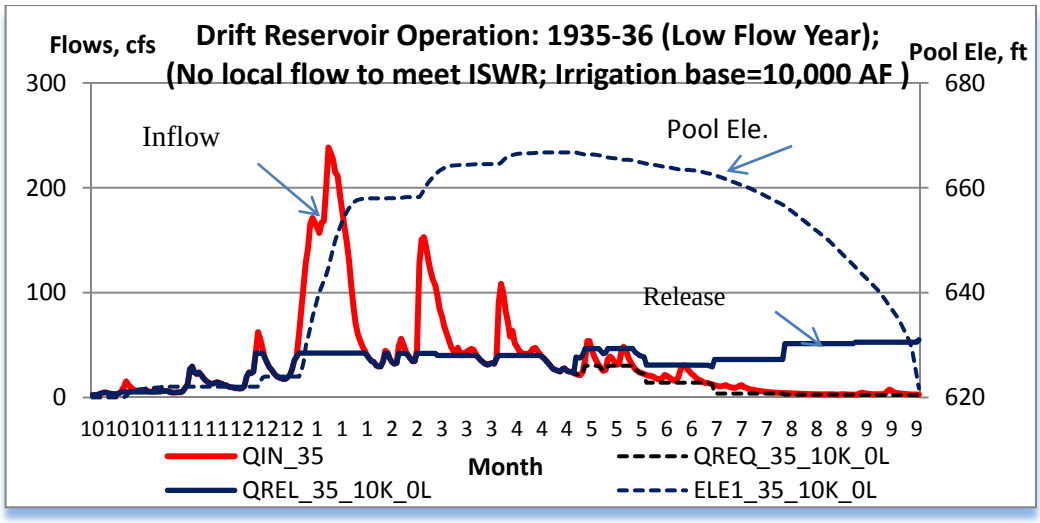
The second option is to set a firm VSW, regardless of the runoff forecasts for the year, and plan the irrigation releases based on that VSW volume alone, irrespective of the actual VSW as of April 30. While this option provides a bigger picture of the operating scenario, the irrigation releases could fall short if the actual VSW cannot sustain the required releases. As mentioned earlier, irrigation requirements under this option based on stored volumes of 10,000 and 12,000 AF were also modeled. These are extensions to the original 8,000 AF base volume scenario explored earlier, assuming the same irrigation releases every year regardless of stored water at the start of the irrigation season for that year.

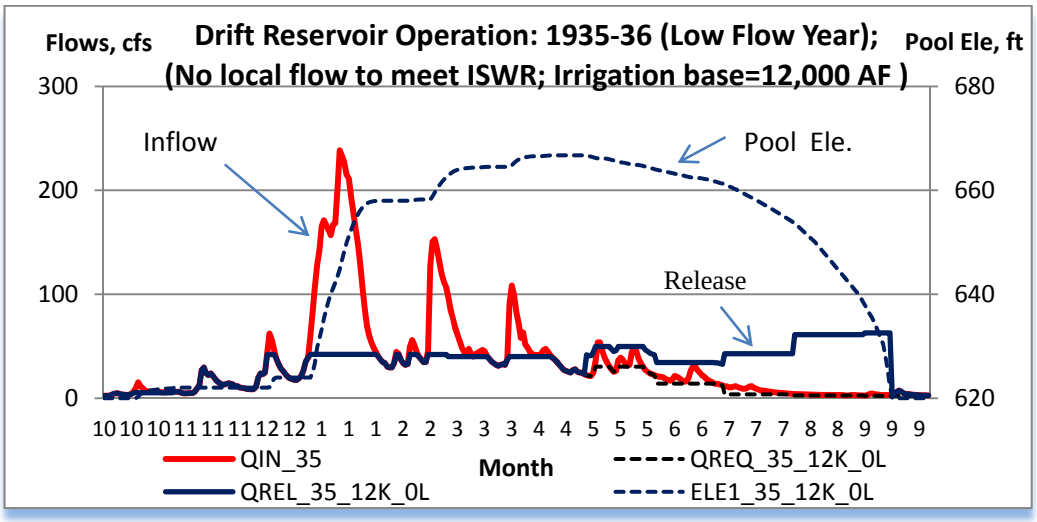
This chapter focuses on the modeling results for the representative (low, average and high) flow years. Modeling results for the more recent 2002-2014 stream flows will be covered later in the report.

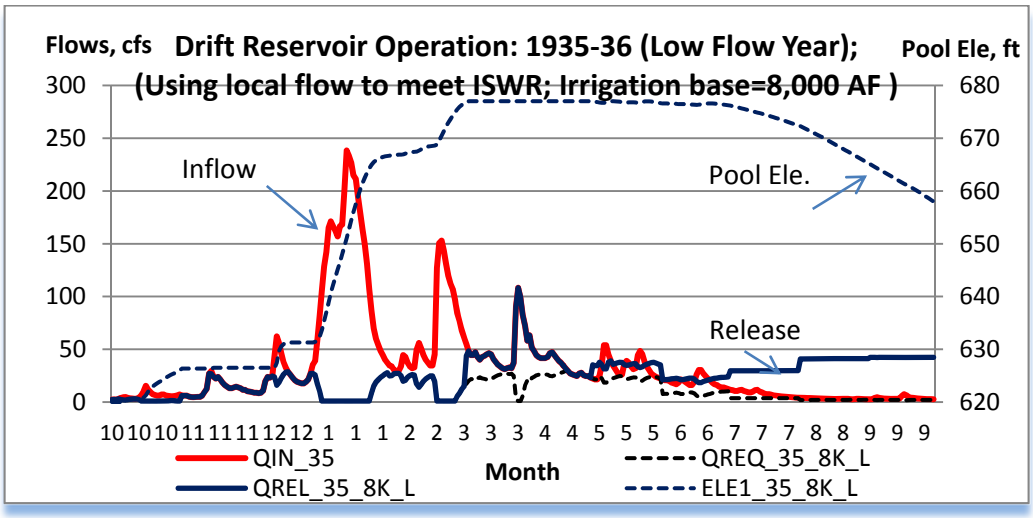
Figures 13.6, 13.7 and 13.8 (with and without ISWR adjustments) based on the 1935-36 (low), 1934-35 (average) and 1947-58 (high) water years respectively illustrate how the project would operate if it starts from empty (Elevation 620') on October 1. Irrigation requirements are those based in each case on assumed available storage volume of 8000, 10000 and 12000 AF.

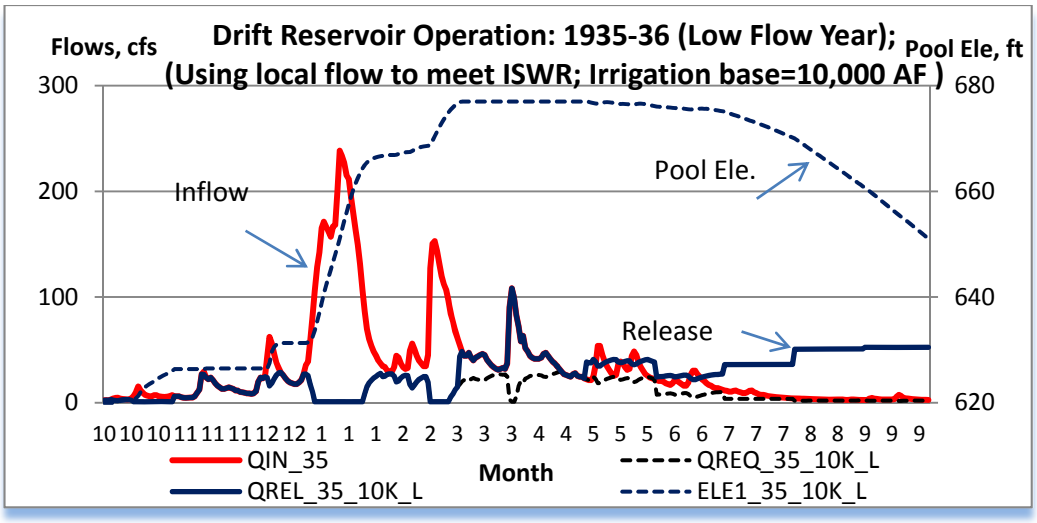
Figures 13.6 Projected 1935-36 (low flows) Reservoir Operation

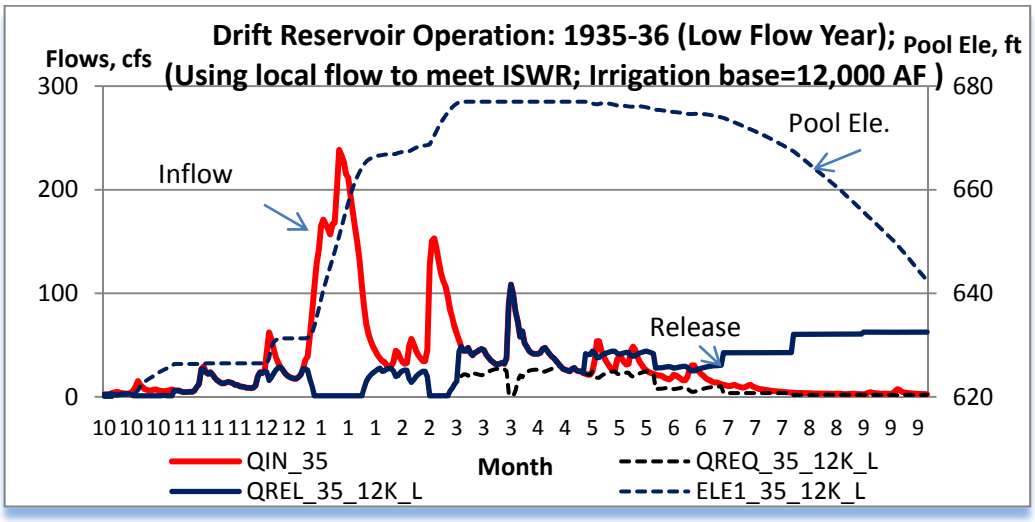



Drift Reservoir Operation: 1935-36 (Low Flow Year);
(No local flow to meet ISWR; Irrigation base=10,000 AF)
Flows, cfs
Pool Ele, ft
Inflow
Pool Ele.
Release
Month
QIN_35
QREL_35_10K_0L
QREQ_35_10K_0L
ELE1_35_10K_0L

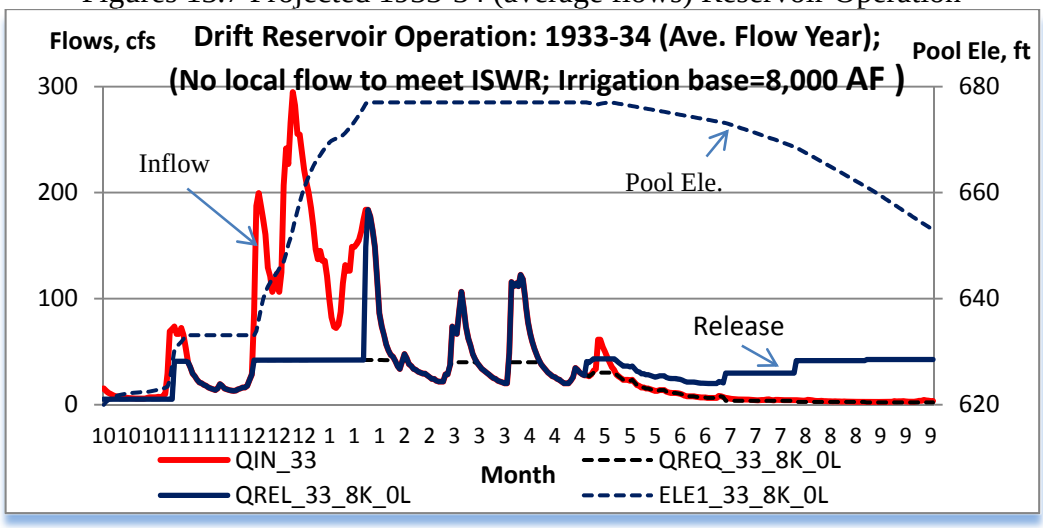

Drift Reservoir Operation: 1935-36 (Low Flow Year);
(No local flow to meet ISWR; Irrigation base=12,000 AF)
Flows, cfs
Pool Ele, ft
Inflow
Pool Ele.
Release
Month
QIN_35
QREL_35_12K_0L
QREQ_35_12K_0L
ELE1_35_12K_0L

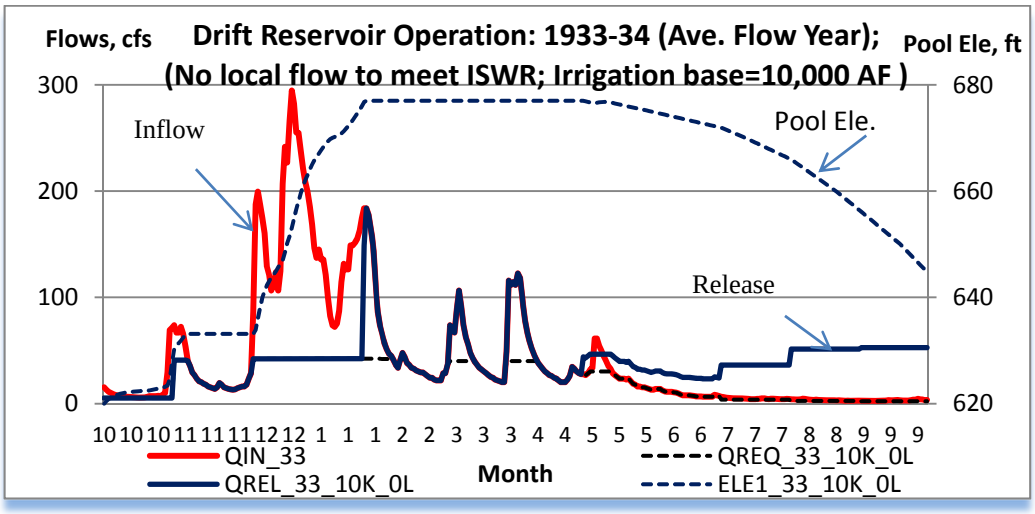

Drift Reservoir Operation: 1935-36 (Low Flow Year);
(Using local flow to meet ISWR; Irrigation base=8,000 AF)
Flows, cfs
Pool Ele, ft
Inflow
Pool Ele.
Release
Month
QIN_35
QREL_35_8K_L
QREQ_35_8K_L
ELE1_35_8K_L

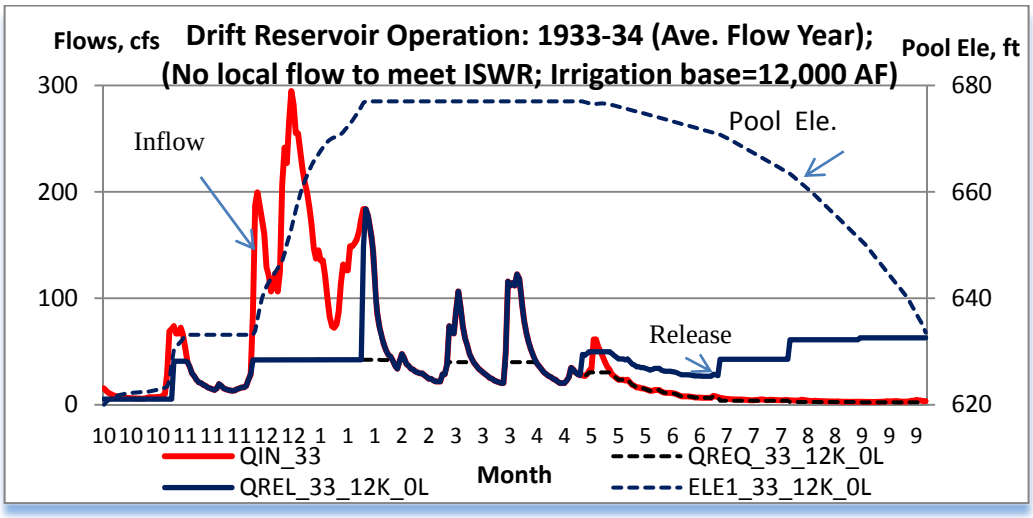


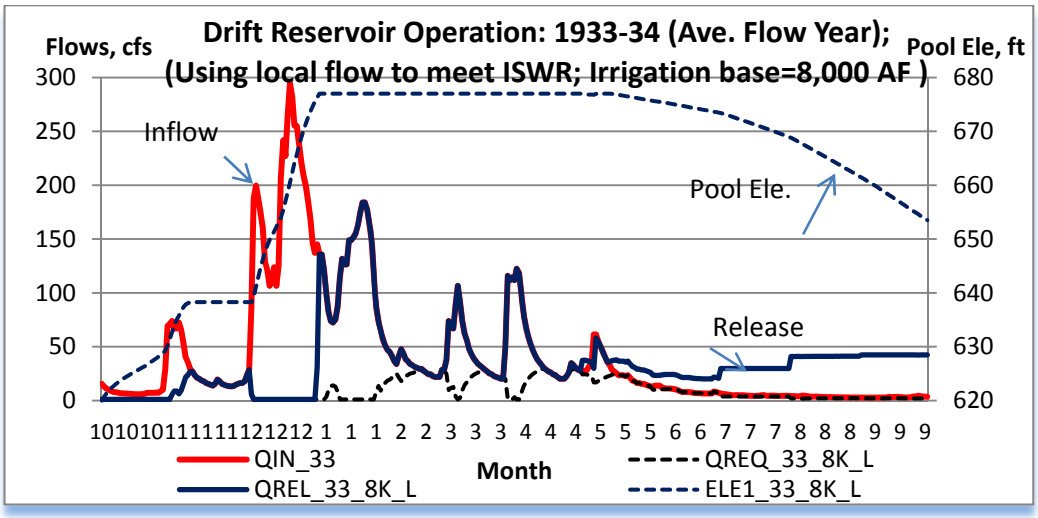


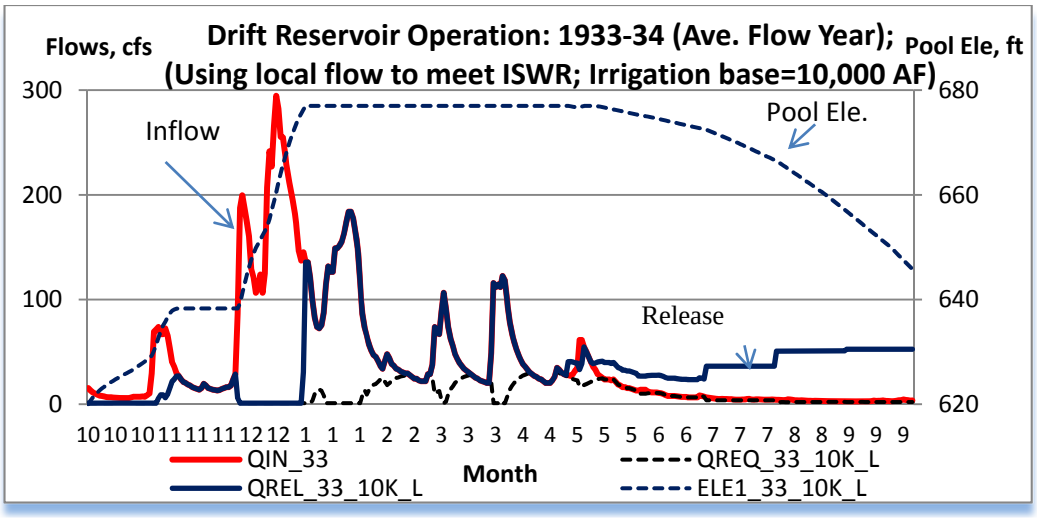
Figures 13.7 Projected 1933-34 (average flows) Reservoir Operation

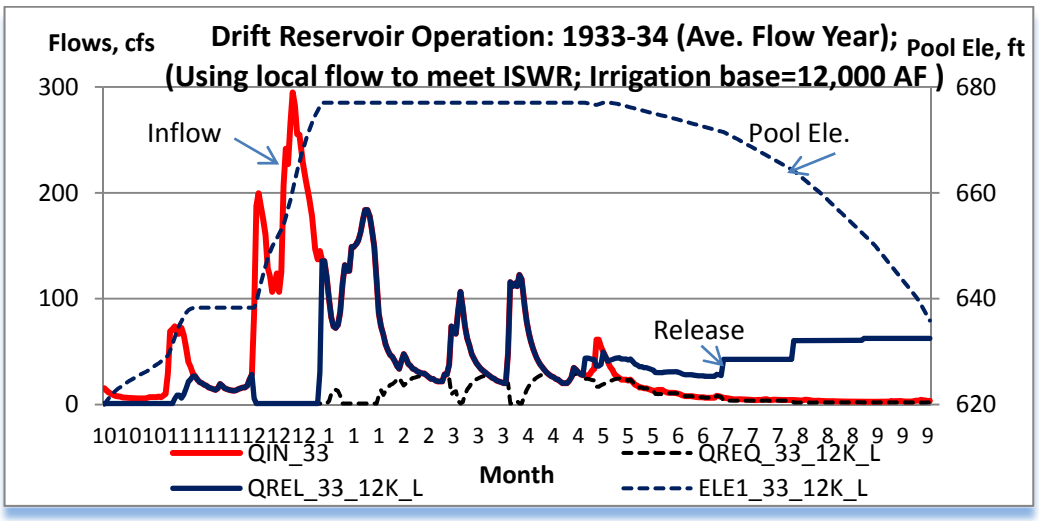



Drift Reservoir Operation: 1933-34 (Ave. Flow Year);
(No local flow to meet ISWR; Irrigation base=10,000 AF)
Flows, cfs
Pool Ele, ft
Inflow
Pool Ele.
Release
Month
QIN_33
QREL_33_10K_0L
QREQ_33_10K_0L
ELE1_33_10K_0L

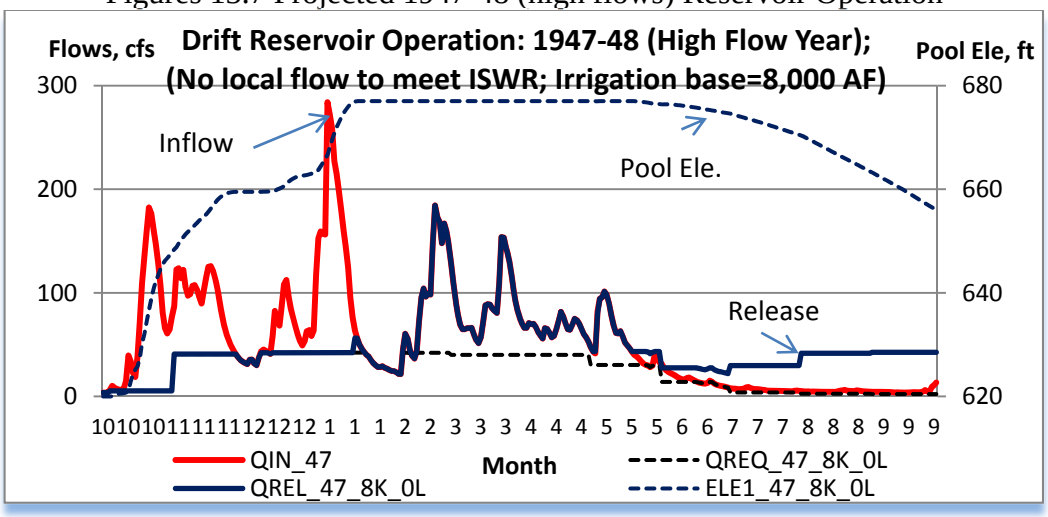

Drift Reservoir Operation: 1933-34 (Ave. Flow Year);
(No local flow to meet ISWR; Irrigation base=12,000 AF)
Flows, cfs
Pool Ele, ft
Inflow
Pool Ele.
Release
Month
QIN_33
QREL_33_12K_0L
QREQ_33_12K_0L
ELE1_33_12K_0L

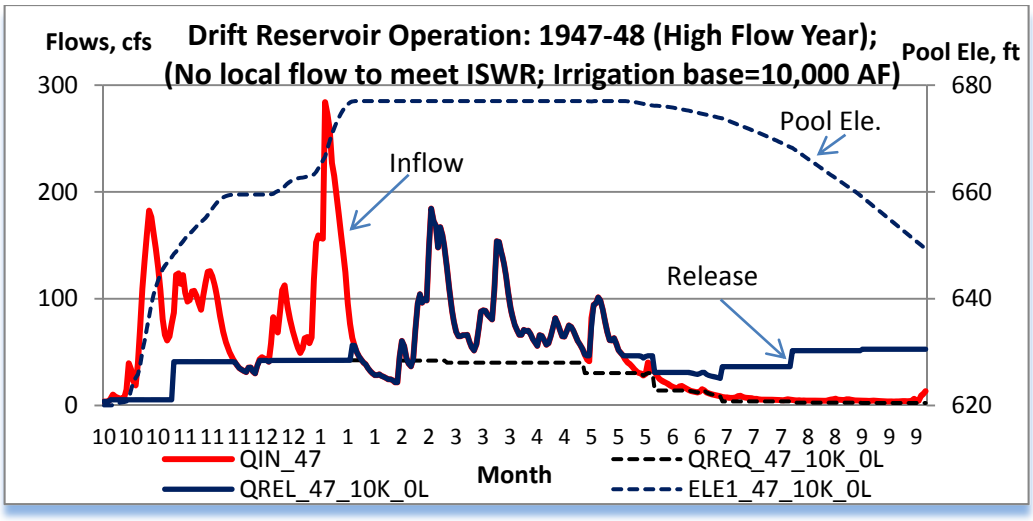

Drift Reservoir Operation: 1933-34 (Ave. Flow Year);
(Using local flow to meet ISWR; Irrigation base=8,000 AF)
Flows, cfs
Pool Ele, ft
Inflow
Pool Ele.
Release
Month
QIN_33
QREL_33_8K_L
QREQ_33_8K_L
ELE1_33_8K_L

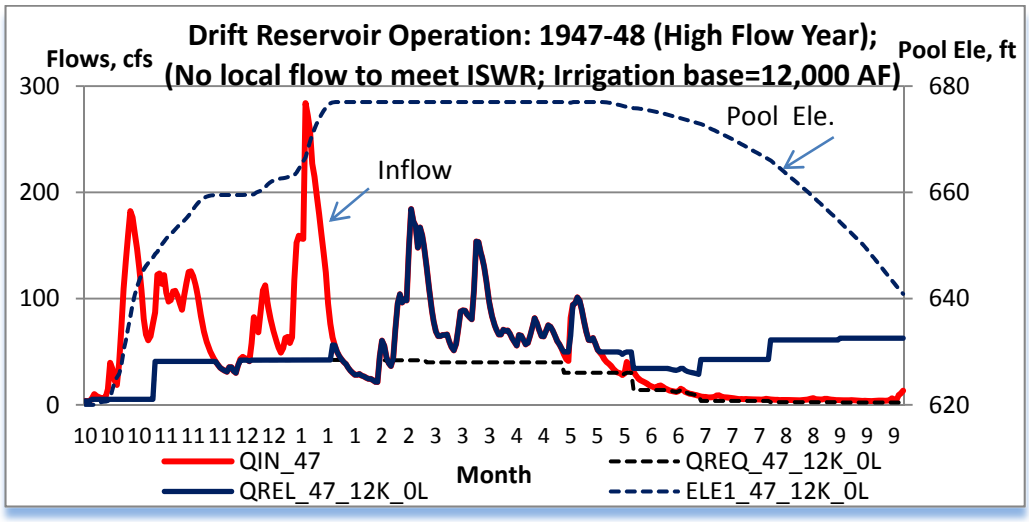


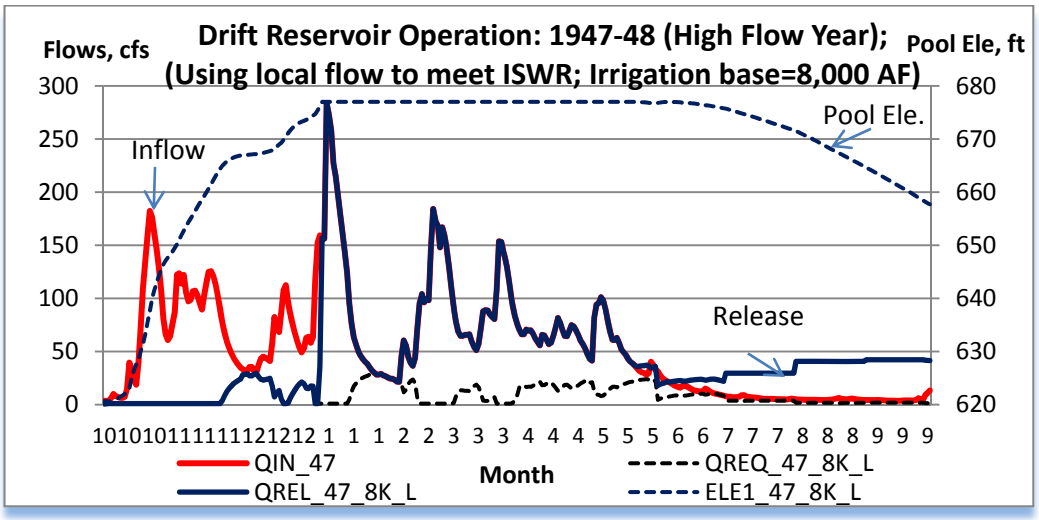


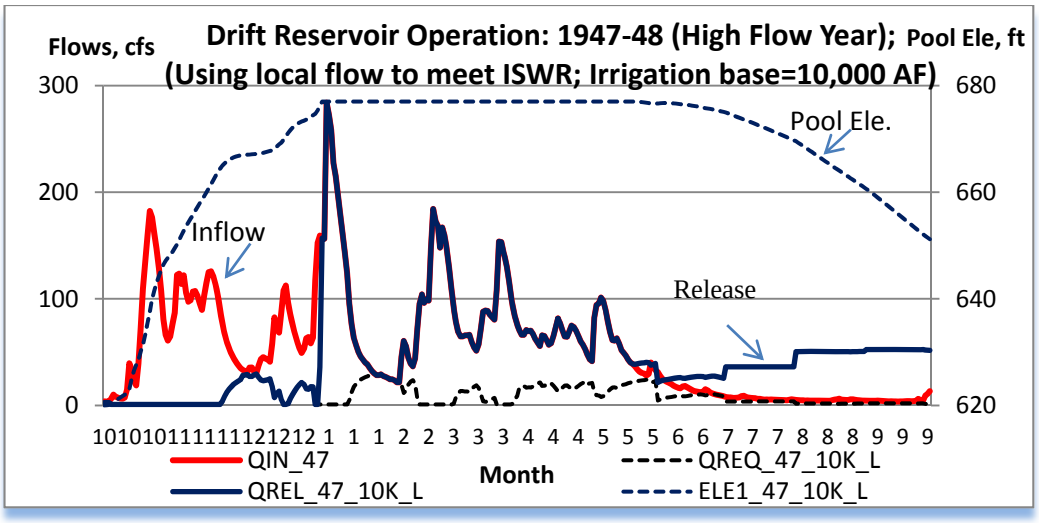
Figures 13.7 Projected 1947-48 (high flows) Reservoir Operation

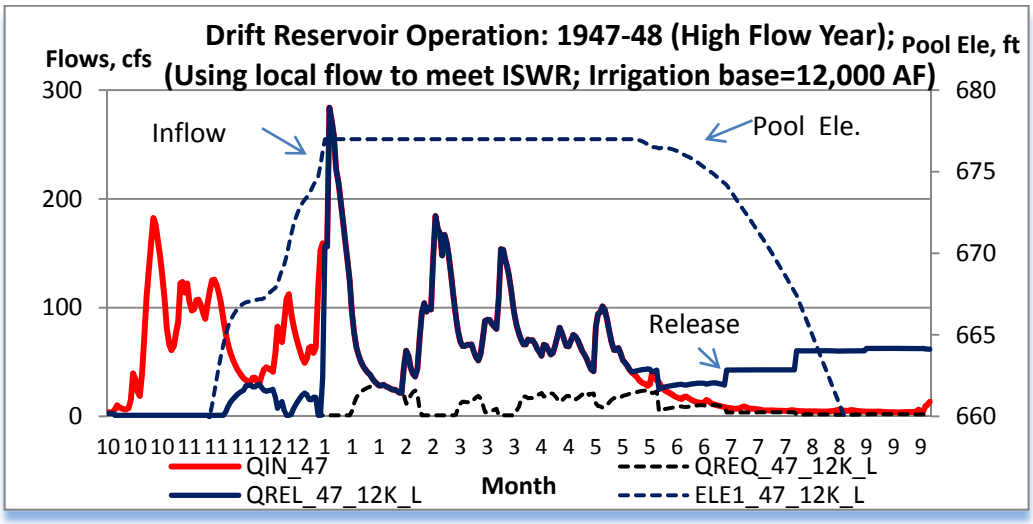



Drift Reservoir Operation: 1947-48 (High Flow Year);
(No local flow to meet ISWR; Irrigation base=10,000 AF)
Flows, cfs
Pool Ele, ft
300
200
100
0
680
660
640
620
Inflow
Pool Ele.
Release
10 10 10 11 11 11 12 12 1 1 1 2 2 3 3 3 4 4 5 5 5 6 6 7 7 7 8 8 9 9 9
QIN_47
QREL_47_10K_0L
Month
QREQ_47_10K_0L
ELE1_47_10K_0L


Drift Reservoir Operation: 1947-48 (High Flow Year);
(No local flow to meet ISWR; Irrigation base=12,000 AF)
Flows, cfs
Pool Ele, ft
300
200
100
0
680
660
640
620
Inflow
Pool Ele.
10 10 10 11 11 11 12 12 1 1 1 2 2 3 3 3 4 4 5 5 5 6 6 7 7 7 8 8 9 9 9
QIN_47
QREL_47_12K_0L
Month
QREQ_47_12K_0L
ELE1_47_12K_0L


Drift Reservoir Operation: 1947-48 (High Flow Year);
(Using local flow to meet ISWR; Irrigation base=8,000 AF)
Flows, cfs
Pool Ele, ft
300
250
200
150
100
50
0
680
670
660
650
640
630
620
Inflow
Pool Ele.
Release
10 10 10 11 11 11 12 12 12 1 1 1 2 2 3 3 3 4 4 4 5 5 5 6 6 7 7 7 8 8 8 9 9 9
QIN_47
QREL_47_8K_L
Month
QREQ_47_8K_L
ELE1_47_8K_L





Results of reservoir operations for other hydrologic years and using less drastic pool elevations at the start of the annual refill season are provided in the next section. RES4DRIFT model is ready to accept more reliable flow data when it becomes available, along with up-to-date information on proposed irrigation withdrawals after the storage season. It is flexible enough to accommodate any changes in reservoir characteristics and test the feasibility of meeting additional use of the stored water on a daily basis. A sample printout for part of the model output is provided in Appendix.

14. Modeling of Daily Reservoir Operation Using 2002-2014 Data

In May 2012**,** RES4DRIFT was modified to allow for multi-year continuous daily simulation of reservoir operation using the same release criteria as stated above. These criteria include the following:

1. Release the lesser of the inflow and the in-stream requirements to meet in-stream flow requirement; store the flow difference in the reservoir whenever feasible. [This particular criteria was applied to all model runs performed prior to 2014. Date-related criteria had to be added once it was found out that the OWRD draft permit issued in July 2014 specified that storage is only allowed between November 1 and April 30, and that "*permittee shall pass all live flows during May 1 and October 30*". Furthermore, earlier model runs only used the in-stream flow requirements shown in OWRD water availability table as the minimum downstream release requirements. In later model runs, after issuance of the draft water use permit, prior water rights were added to those minimum requirements to account for the EVWD's junior water rights status].
2. Provide the option of (1) relying or (2) not relying on the local inflow to help meet part of the in-stream flow requirement (ISR) at the mouth. Option (1) means that the project has to meet 100% of the ISR, while Option (2) means that the reservoir has to meet only the difference between ISR and the local inflow,
3. Pass inflows greater than 630 cfs for "peak flow" flushing purposes,
4. Limit all reservoir releases to the outlet pipe capacity as allowed by the hydraulic head (difference between the pool elevation reached at the time of the release and the hydro-turbine generator),
5. Meet the specified monthly irrigation release whenever possible,
6. Keep the reservoir at or below its assumed upper bound elevation of 677 feet msl, and
7. Keep the reservoir at or above its assumed lower bound elevation of 620 feet msl.

As an example, the modeling procedure applied to an incoming daily flow QIN that reaches the impoundment on Day D, when the reservoir pool is at Elevation EL1, can be described as follows. The total release requirements QTR on Day D include minimum downstream in-stream flows and consumptive uses QMIN, existing water rights QWR, and irrigation needs QIR. QTR may or may not be reduced depending on whether the local inflow between the project site and the mouth of the river is allowed to be accounted for in this operation or not. Furthermore, QMIN and QWR are mandatory requirements; any inflow up to QMIN + QWR has to be released; only inflow greater than QMIN+QWR can be stored. On the other hand, meeting QIR is optional and primarily relies on stored water and release than exceeds QMIN + QWR.

Once QTR is set, QIN is discharged in totality if it is equal to or greater than the flushing flow of 630 cfs. If it is less than 630 cfs, then QIN will be released in full if it is less than or equal to QTR, and only partially released up to the QTR amount if it is greater than QTR. In the later case, the difference QIN - QTR is stored in the reservoir to increase the water level in the reservoir from Elevation EL1 to Elevation EL2. EL2 may not exceed the reservoir upper bound. If it does, the remaining QIN-QTR amount is released to keep the reservoir within the set upper bound limit.

More detailed programming instructions for the above procedure are listed in the Appendix. As noted later in the report, more date-specific reservoir refill and release criteria as listed in the draft water use permit issued by OWRD on July 22, 2014 will have to included in future study updates.

Daily flow data are also shown in the Appendix. They were entered manually for each day of the 12-year period, from October 1, 2002 through the end of September 2014. The model simulation relies on regression-based daily flows derived from observed daily flow data of Pudding River at Aurora for the October 2002 – September 2008 period, and on actually observed data for Upper Drift Creek for the October 2008 – September 2014 period. October 1, 2002 was the day when stream gauging resumed for the Pudding River at Aurora, after a 5-year inactivity period. On this October 1, 2002 start date, the model assumes the reservoir was empty.

14. 1 Modeling Using Irrigation Releases for 8,000 AF of Stored Water

This simulation was mainly designed to test how the project would operate on a continuous basis for a sufficient period of records, using the listed criteria (or within slight variations thereof). The developed model can be used to test the sensitivity of the various criteria on pool variations, reservoir releases, reservoir refill period, etc.

In principle, operational flexibility is a plus. Therefore, not having to meet the full protected rights at the mouth would be advantageous. In practicality, however, that edge really depends on actual runoff situations and can vary from year to year, because (1) regardless of the water rights, we only have to release no more water than what is coming in, and (2) when we reach the top of the reservoir, we have no choice but to release the incoming inflow. To some extent, this is somewhat similar to adopting 1 October as the "official" date for the reservoir refill, while in fact the actual refill is flow and water rights-based --not a calendar date-based.

In the model simulation, the reservoir was assumed to start empty on October 1, 2002 and to operate on a continuous basis throughout the 12 year period. Pool elevation on October 1 of Hydrologic Year Y2 is controlled by the elevation reached on September 30 of the previous Hydrologic Year Y1.

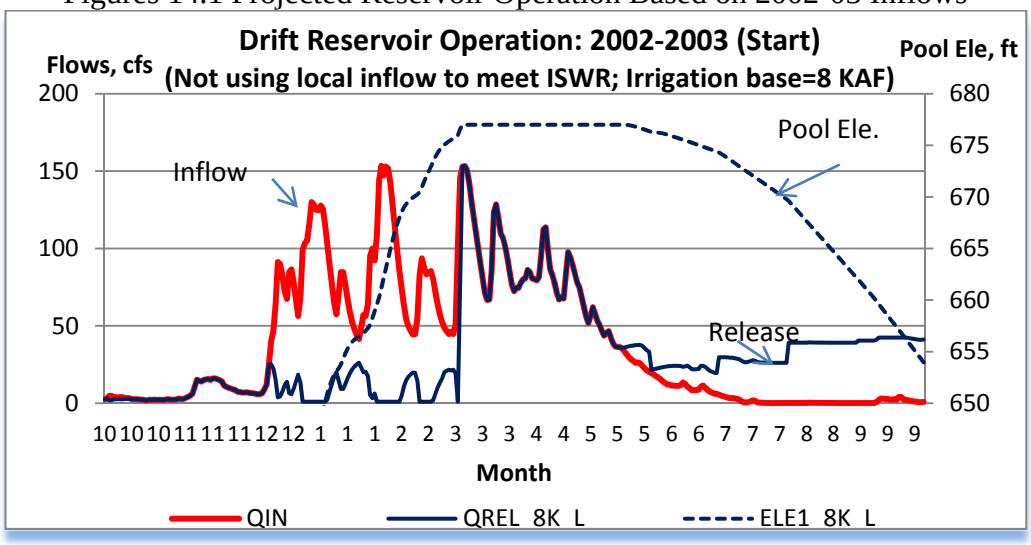
Figures 14.1 through 14.12 illustrate the variations of the reservoir pool elevation during the October 1, 2002 – September 30, 2008 and October 1, 2008 – September 2014 continuous simulation periods respectively. They provide a general idea on the potential storage volume impacts when meeting protected water rights at the mouth with and without accounting for local inflow's contribution. In general, the impacts of relying on local inflows to meet the in-stream flow requirements at the mouth of the creek appear to be relatively minor in terms of storage volume reached on 30 April, as the reservoir would fill in all 2002 through 2014 water years except one.

The plots attempt to show the daily variation of the various parameters that dictate the pool variation over those 12 years. Parameters include the inflow QIN, starting pool elevation ELE1, ins-stream water rights at the creek's mouth ISWR, consumptive use CONSU, theoretical release requirement REQ, actual release requirement QREQ, theoretical irrigation requirement IRR, permissible irrigation requirement QIRR, actual reservoir release QREL, violation code VIOL, end-of-day pool elevation ELE2, and end-of-day reservoir storage STORAGE.

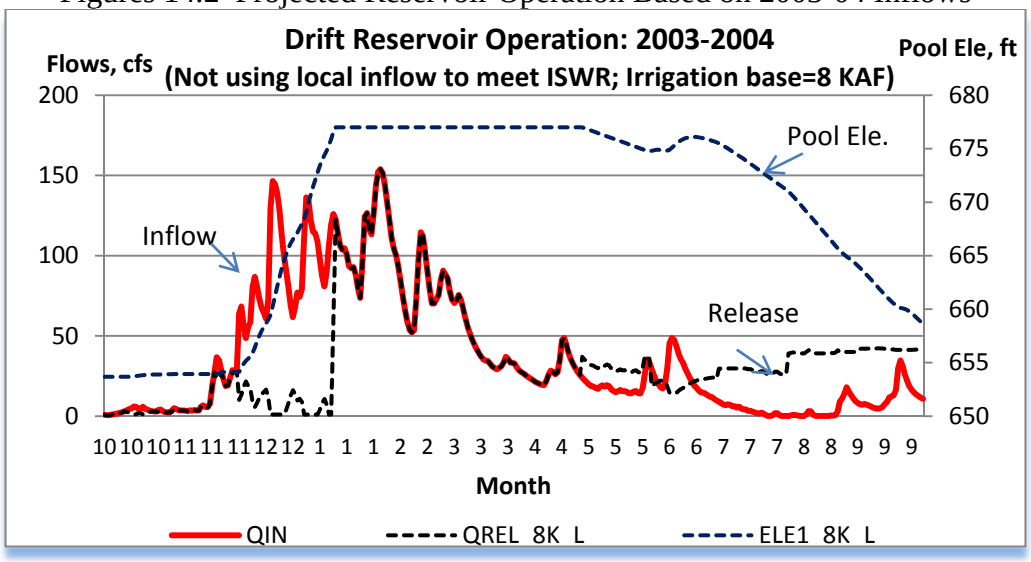
For easier visual interpretation, only the main parameters are actually graphically shown --inflow, outflow, and pool elevation. The volume of the irrigation base are noted under the title,

along with the assumed role assigned to the local inflow in meeting the in-stream flow requirements at the mouth. Pool elevation is graphed as a dashed curve to show how it changes during the water year, between the full pool elevation of 677' and the minimum pool elevation of 620'. More details covering the results for the entire 12 years are provided in the next section.

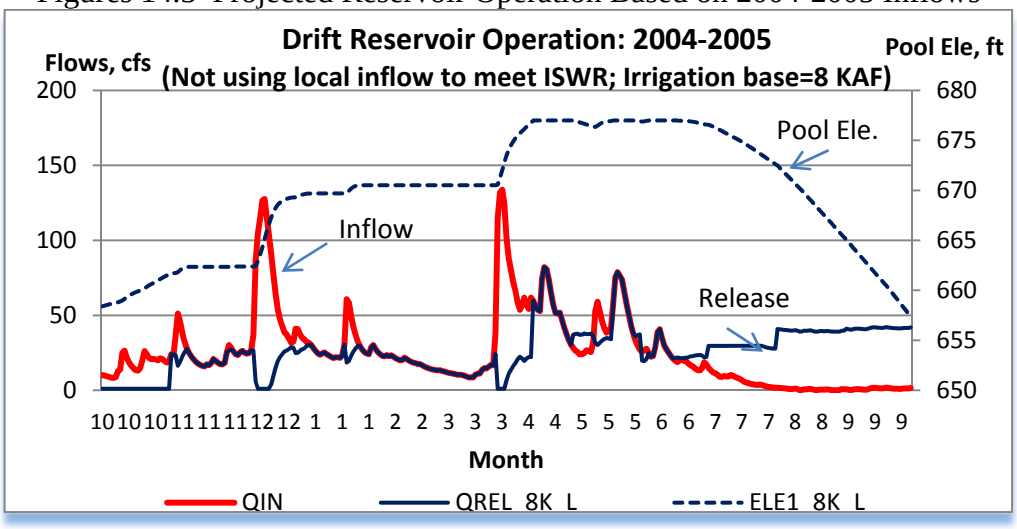
Figures 14.1 Projected Reservoir Operation Based on 2002-03 Inflows



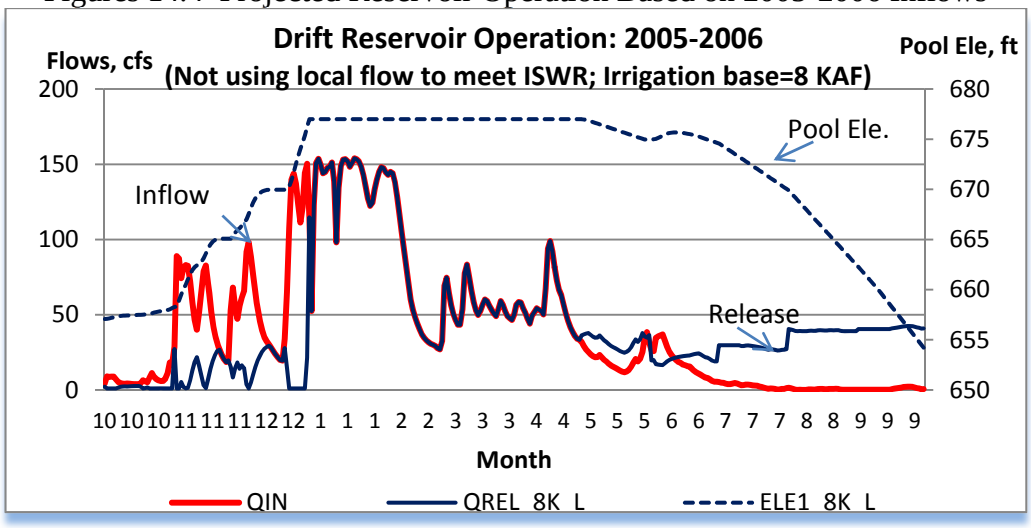
Figures 14.2 Projected Reservoir Operation Based on 2003-04 Inflows



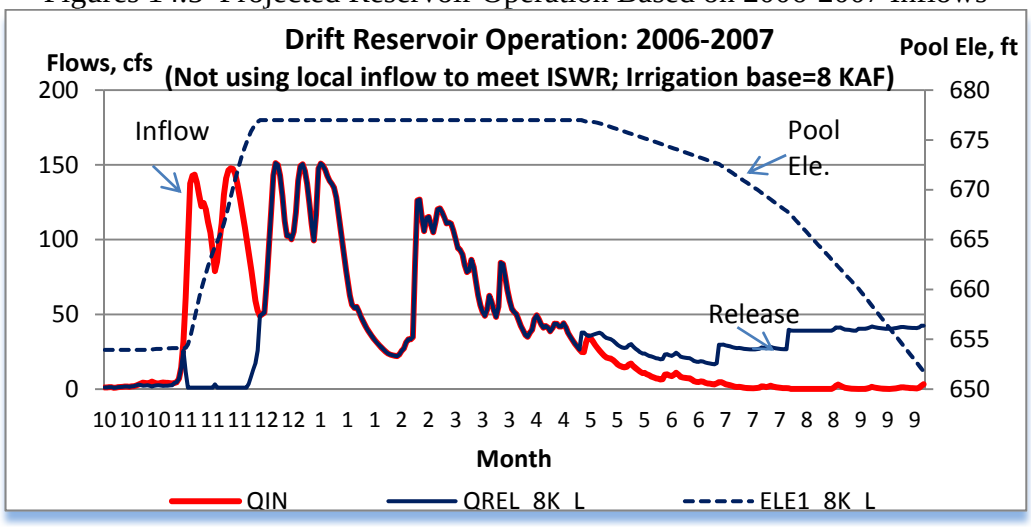
Figures 14.3 Projected Reservoir Operation Based on 2004-2005 Inflows



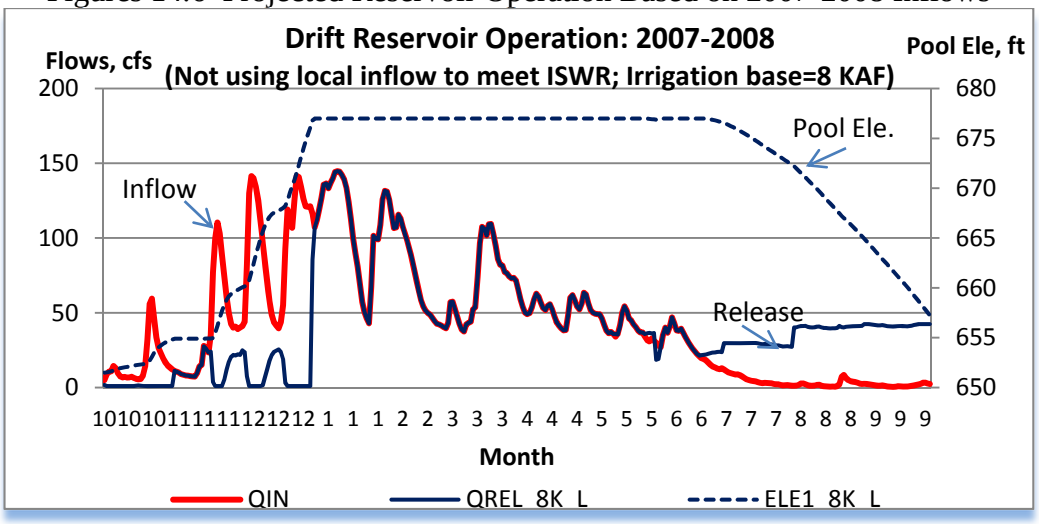
Figures 14.4 Projected Reservoir Operation Based on 2005-2006 Inflows



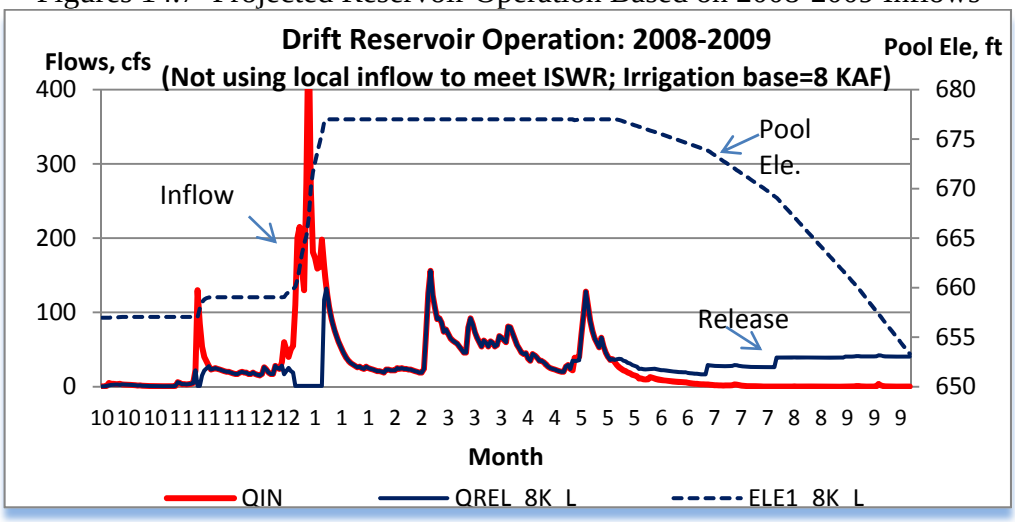
Figures 14.5 Projected Reservoir Operation Based on 2006-2007 Inflows



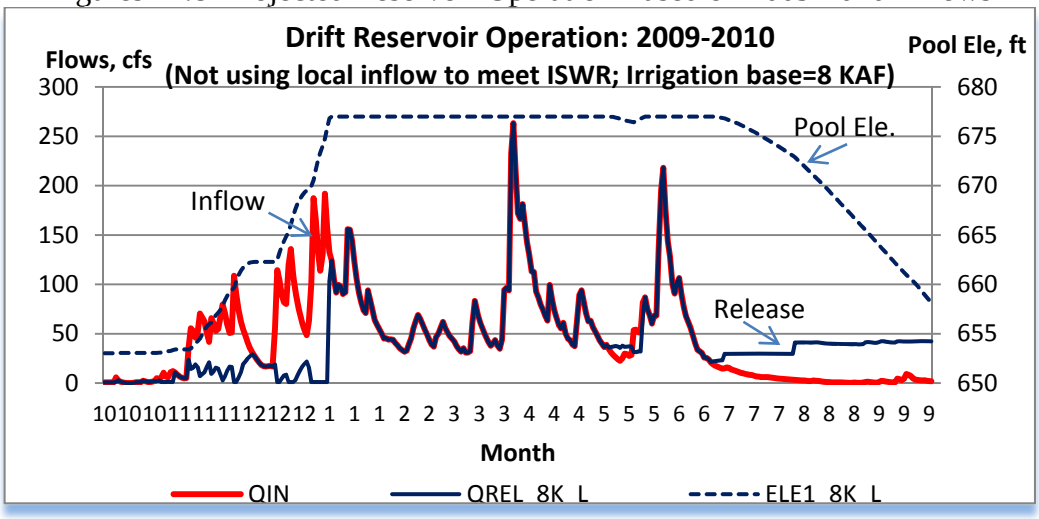
Figures 14.6 Projected Reservoir Operation Based on 2007-2008 Inflows



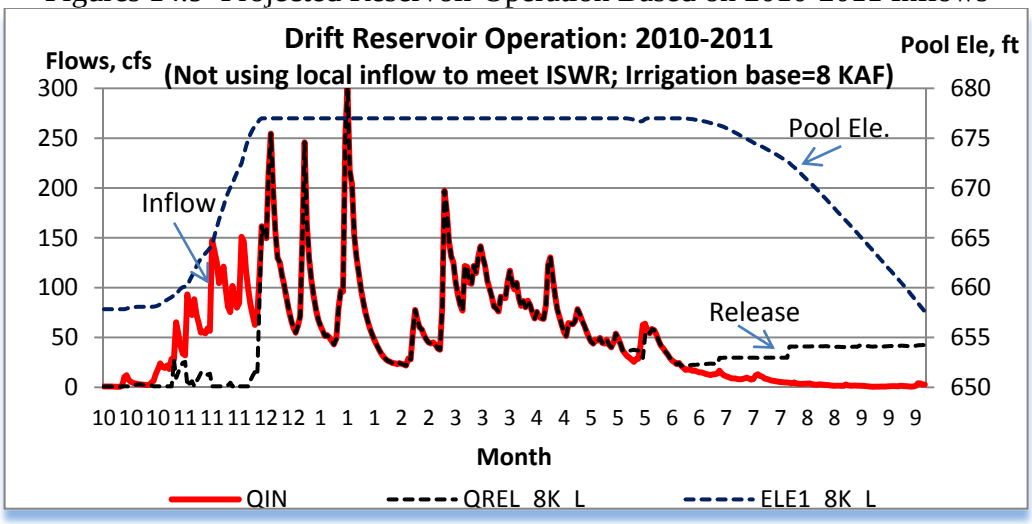
Figures 14.7 Projected Reservoir Operation Based on 2008-2009 Inflows



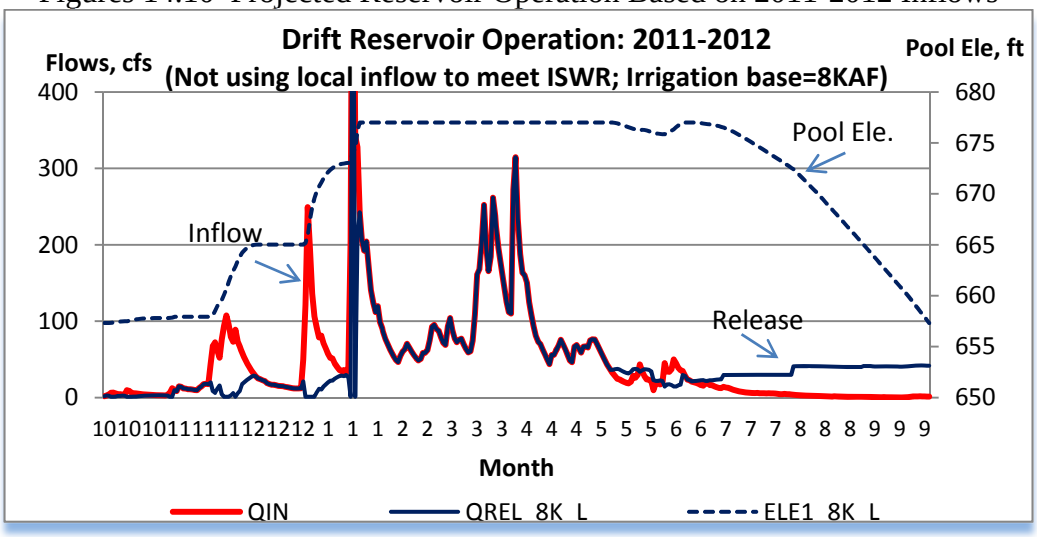
Figures 14.8 Projected Reservoir Operation Based on 2009-2010 Inflows



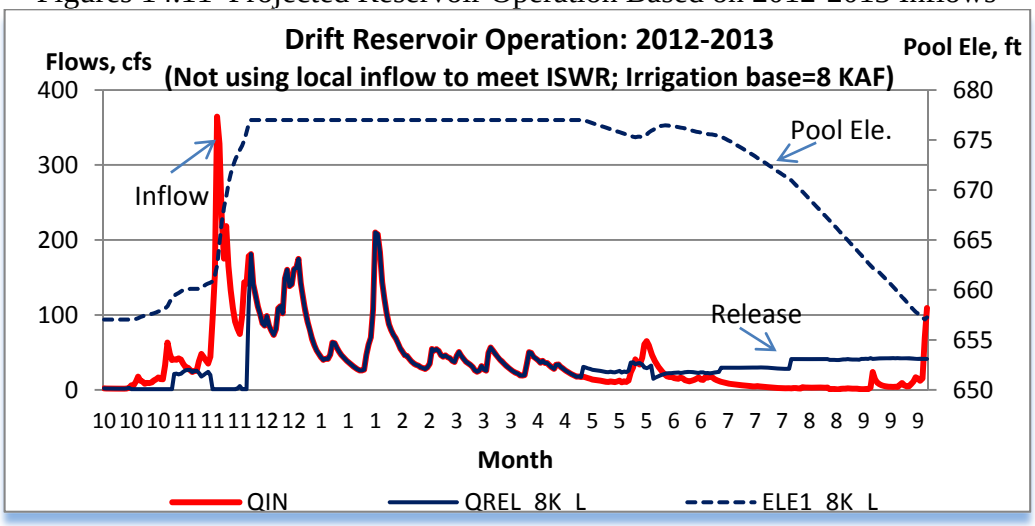
Figures 14.9 Projected Reservoir Operation Based on 2010-2011 Inflows



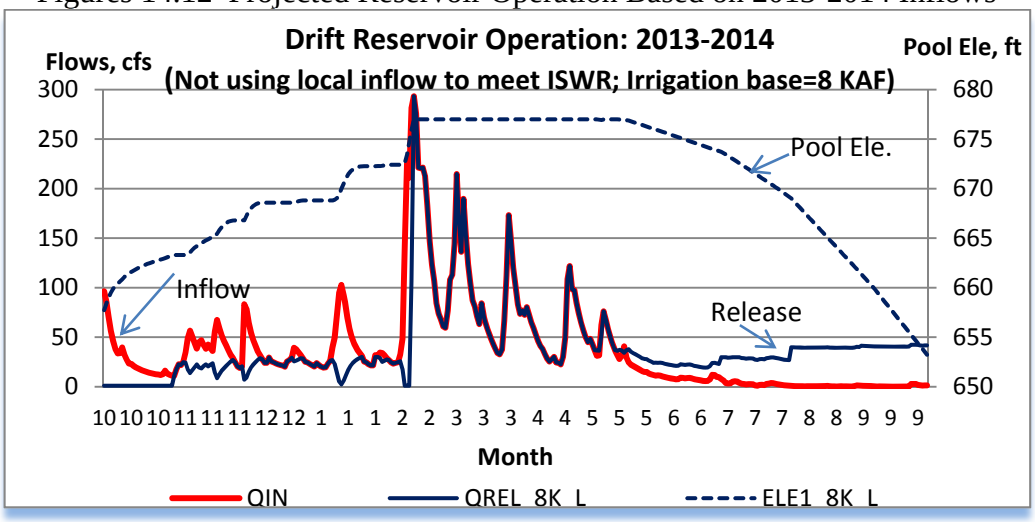
Figures 14.10 Projected Reservoir Operation Based on 2011-2012 Inflows



Figures 14.11 Projected Reservoir Operation Based on 2012-2013 Inflows



Figures 14.12 Projected Reservoir Operation Based on 2013-2014 Inflows



More detailed numerical model outputs for the two operating modes –with and without reliance on local inflows to meet in-stream water rights at the mouth—are provided in the Appendix. To save space, only outputs related to 2008-2014 are provided.

Reservoir release violation codes include the following:
0=normal (release unrestricted)
1=too small inflow (release limited by the inflow)
2=exceed upper bound (release made when the reservoir cannot store water)
3=exceed lower bound (release made when the reservoir is empty)
4=pass flow greater than 630 cfs for flushing purposes
5=release limited by outlet capacity

14. 2 Projected Operation Using Higher Irrigation Release Discharges

Two additional multi-year reservoir modeling runs were made in February 2015, using irrigation releases applicable to a reservoir refill volume of 10,000 AF and 12,000 AF (in addition to the 8,000 AF scenario used in previous model simulations. As done before, separated model runs performed in each case assuming (1) zero credit and (2) full credit for local inflow in meeting existing water rights at the mouth of Drift Creek. Results are illustrated in Figures 14.13 through 14.15 for reservoir pool elevations.

Figure 14.13 Reservoir Pool Variations, 2002-2014, 8 KAF Irrigation Volume

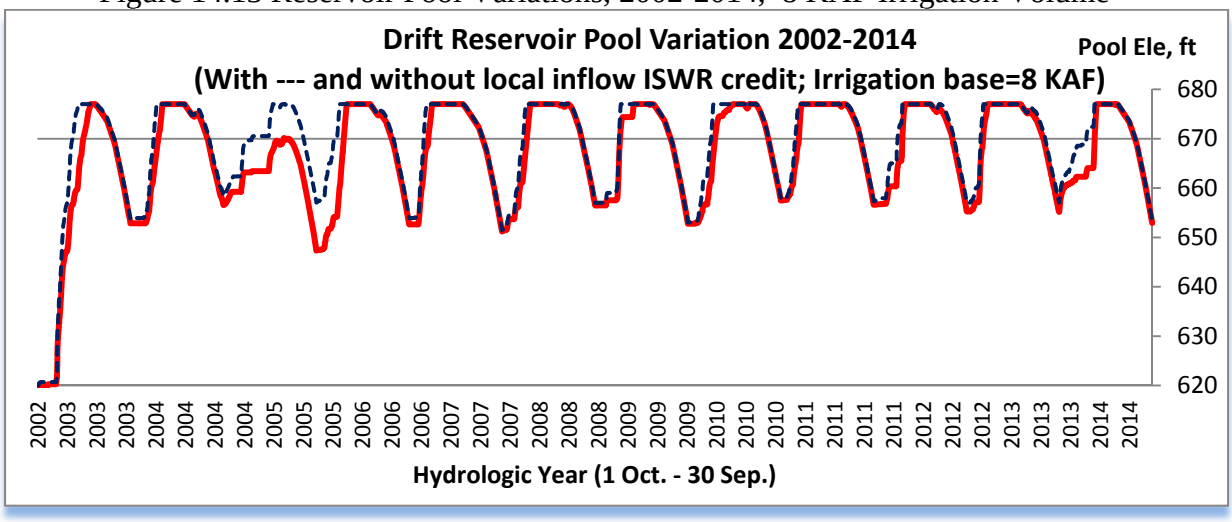


Figure 14.14 Reservoir Pool Variations, 2002-2014, 10 KAF Irrigation Volume

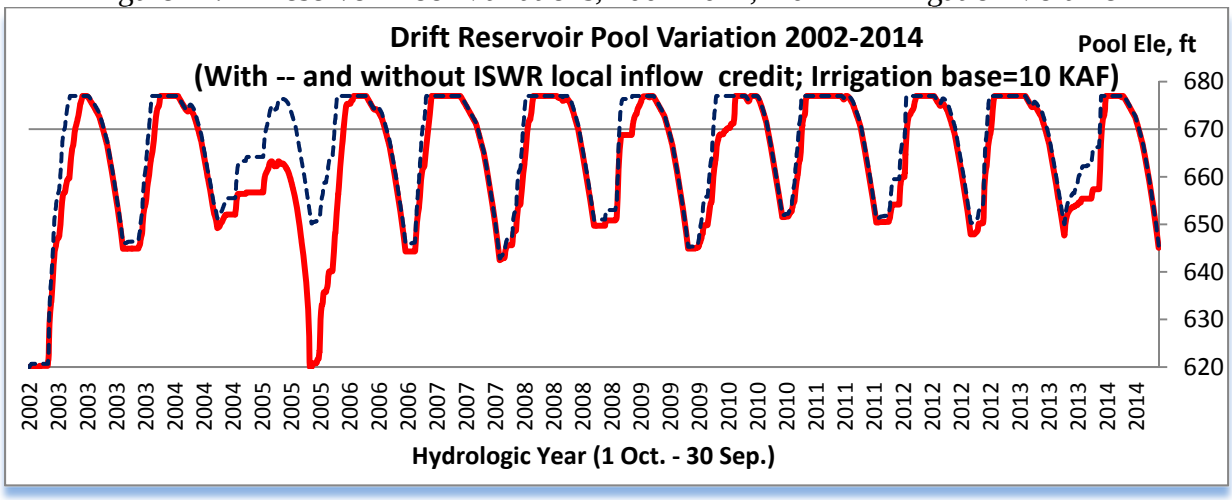
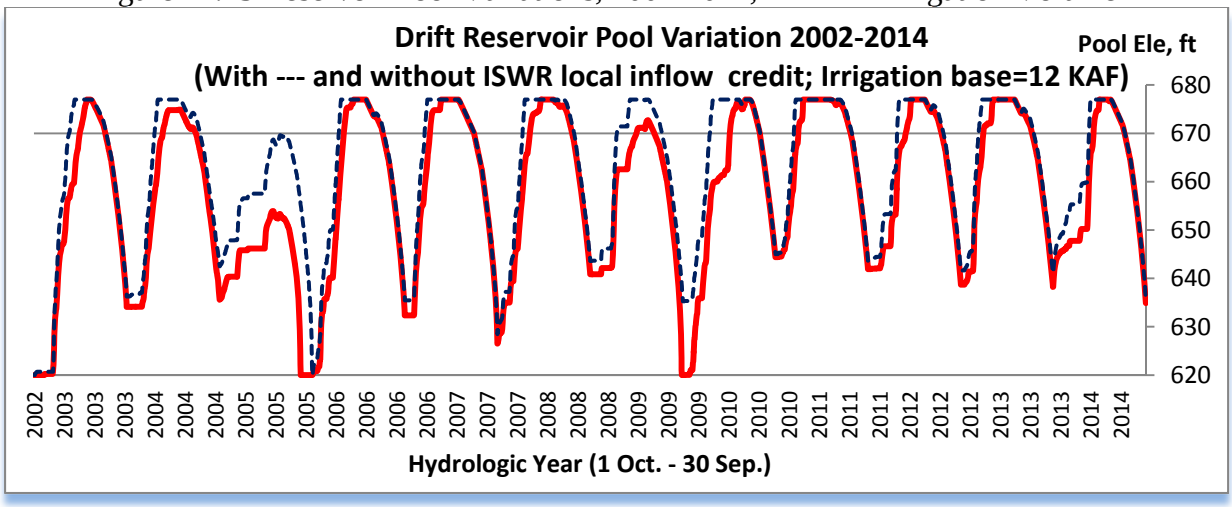


Figure 14.15 Reservoir Pool Variations, 2002-2014, 12 KAF Irrigation Volume



Based on the above plots, the role of the local inflow in meeting water rights and the size of the irrigation releases are the two major factors in the reservoir refill during the 12 year period tested. With an irrigation base volume of 8 KAF, the reservoir would fill every year if local inflow credit is allowed; if not, the reservoir would not fill for one year. The same situation would occur with an irrigation volume of 10 KAF, except that in this case, the reservoir would be empty in one year. Finally, with an irrigation volume of 12 KAF, the refill would be even worse --with no refill in one year and going empty in two years.

Results for the reservoir releases are illustrated below, in Figures 14.16 through 14.18. A monthly time step is selected for better visual clarity.

Figure 14.16 Average Monthly Release, 2002-2014, 8 KAF Irrigation Volume

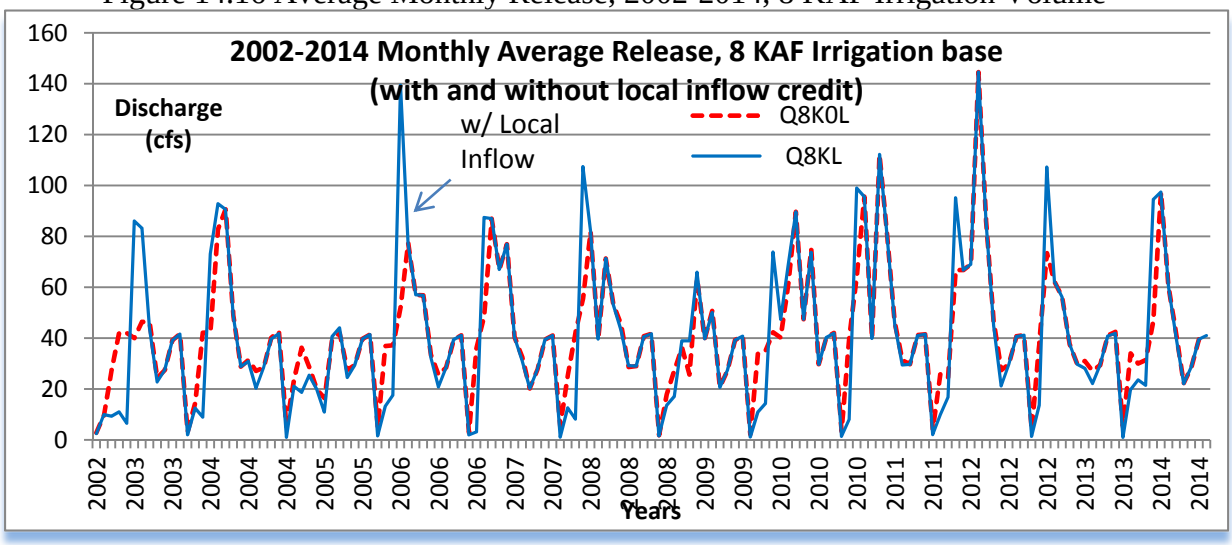


Figure 14.17 Daily Release, 2002-2014, 10 KAF Irrigation Volume

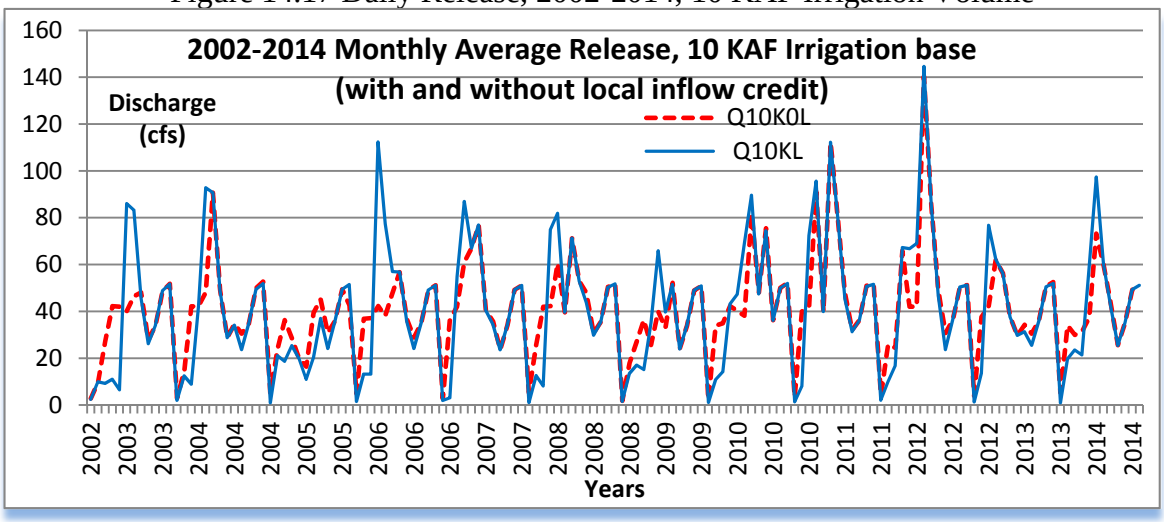
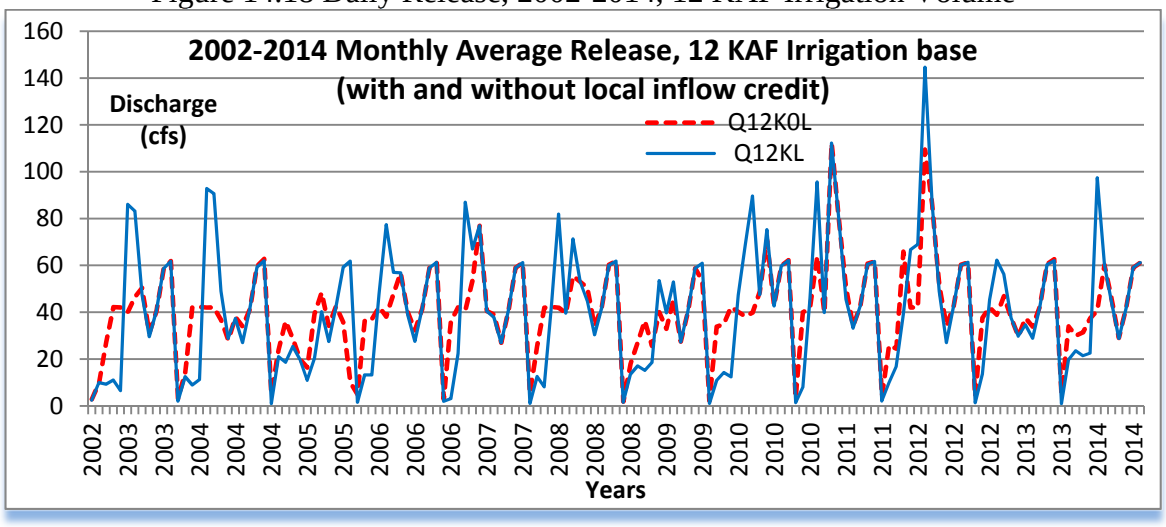


Figure 14.18 Daily Release, 2002-2014, 12 KAF Irrigation Volume



Release differences are hardly visible when they are plotted as above on a 12-year time span. They will be a little more obvious when shorter time spans are used and focused on the release season. See next section.

15 Pre- and Post-Project Flow Duration Curves

Stream flows released from the reservoir represent the erosive energy of the river and, as such, directly affect bank erosion and mud flats conditions in the river reach downstream from the dam. Higher flows generally mean stronger currents, higher flow velocities, and greater wetted perimeter areas under water and, therefore, more severe bank erosion. Low flows, on the other hand, mean slower currents, less downstream bank areas under water and, as a result, less severe bank erosion.

Based on the above, the operation of Drift Creek Reservoir, which is bound to change the natural flow regime of Drift Creek below the dam site, is expected to cause either less downstream bank erosion or more of the same, depending on the time of the year. Less downstream bank erosion is expected to occur during the October-April reservoir refill season, when all flows not needed to meet in-stream flow requirements --except for those greater than 630 cfs-- will be stored in the reservoir. More downstream bank erosion downstream, on the other hand, is to occur during the May- September period, when storage water will be released for irrigation purposes, at discharge rates that will be several folds higher than natural stream flows observed during that same period of the year.

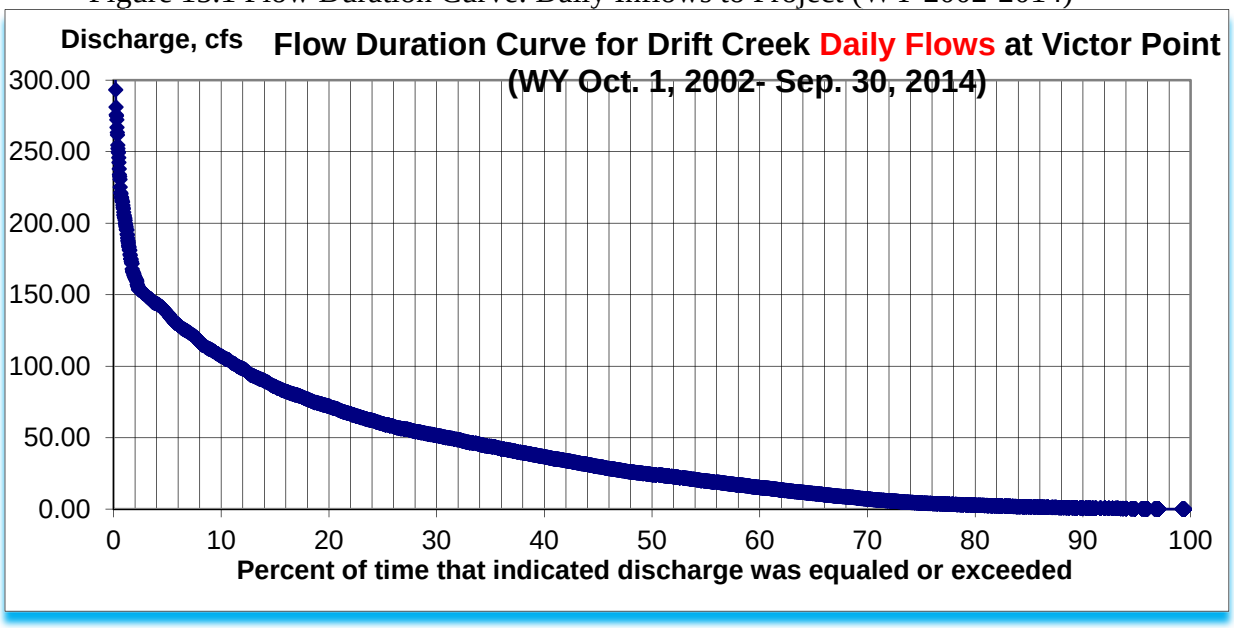
Flow duration curves were prepared to show the percent of time during which specified flow rates immediately below the reservoir are exceeded during the pre- and post-project flow regimes. The analysis is explained in detail at OSU website

http://streamflow.engr.oregonstate.edu/analysis/flow/tutorial.htm and involves several steps listed below:

1) List the daily stream flows in chronological order from October 1, 2002 to September 30, 2014;
2) Count the total number of time step intervals in the period of records;
3) Rank those daily stream flows by magnitude, from largest to smallest (using Excel "rank" command";
4) Calculate the percent of time that each discharge is equaled or exceeded. The exceedance probability is calculated as follows:
   P = 100 * [M / (n + 1)]
   P = the probability that a given flow will be equaled or exceeded (% of time)
   M = the ranked position on the listing (dimensionless)
   n = the number of events for period of record (dimensionless)
5) Create a formula to calculate this value for each record using the information from Step 2: (=(E2/('Step 2'!D4020+1))*100).
6) Graph the "exceedance probability" versus the discharge. The graph can have either linear or logarithmic axes. Linear axes are selected for the flow duration curve shown below.

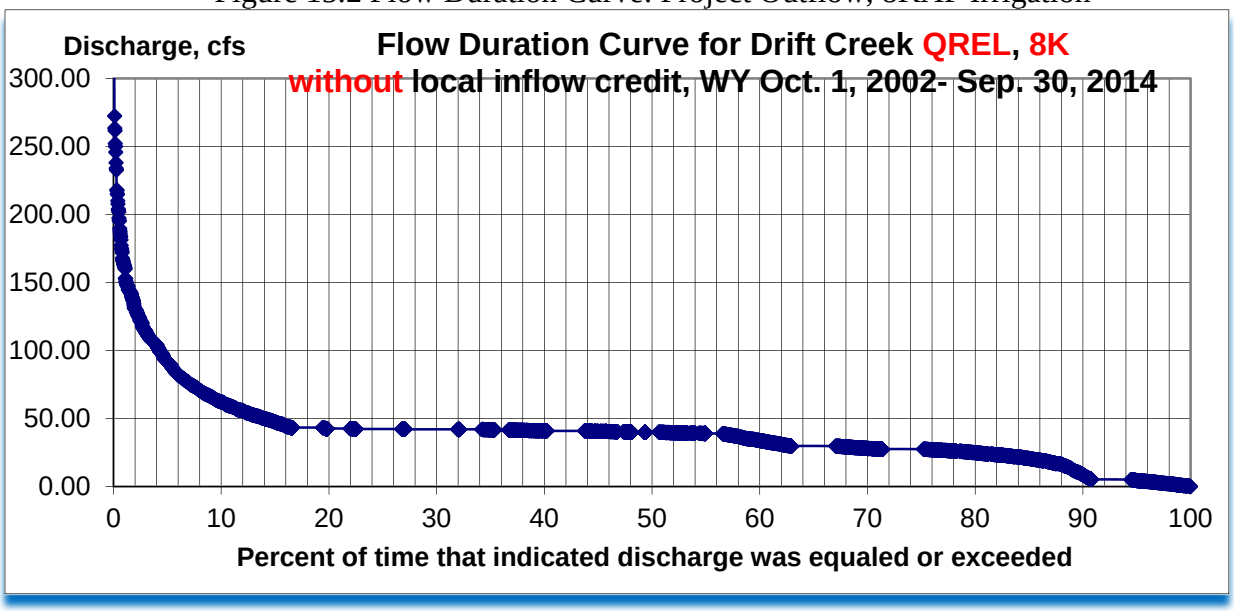
Figure 15.1 represents the flow duration curve of the inflows to the project for the 2002-2014 period -- a picture of the pre-project flow regime.

Figure 15.1 Flow Duration Curve: Daily Inflows to Project (WY 2002-2014)



Figures 15.2 through 15.4 represent the flow duration curves for the **outflows** for the three irrigation base volumes of 8000, 10000 and 12000 AF, with and without local inflow credit in meeting the in-stream water rights at the mouth of the creek.

Figure 15.2 Flow Duration Curve: Project Outflow, 8KAF Irrigation



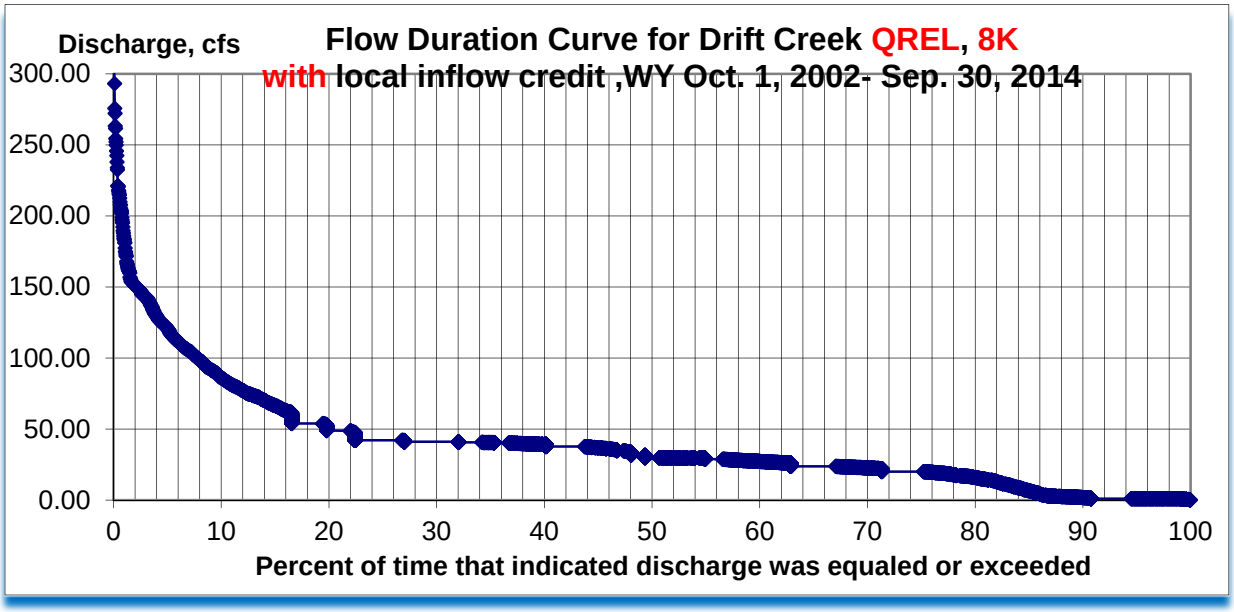
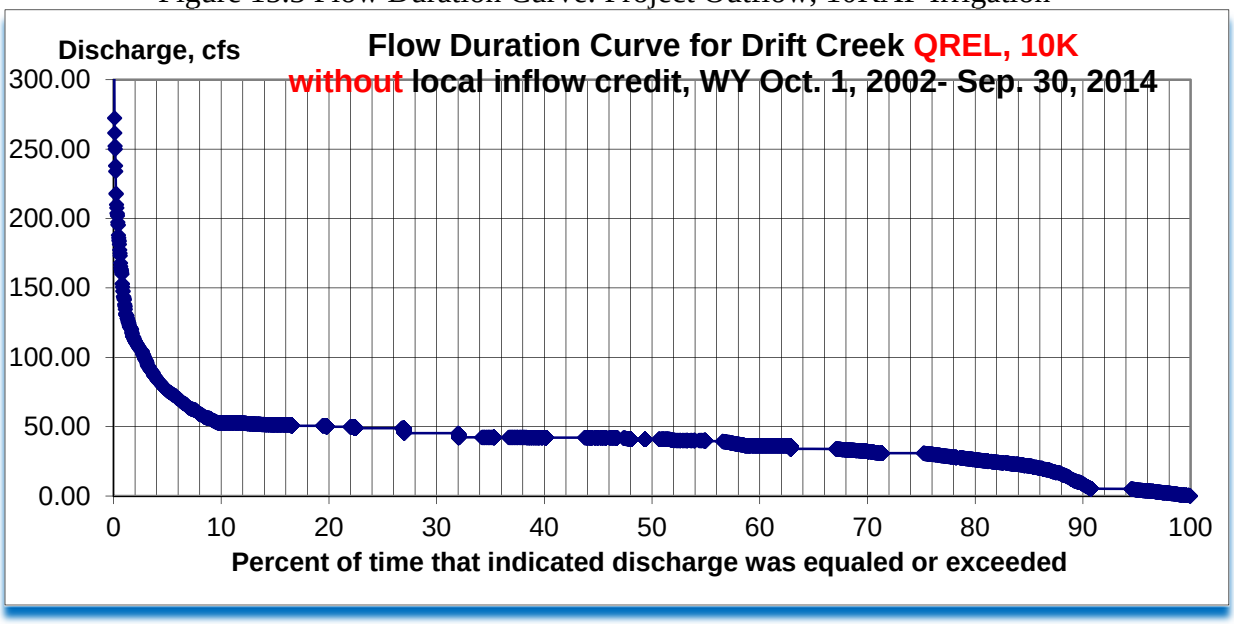


Figure 15.3 Flow Duration Curve: Project Outflow, 10KAF Irrigation



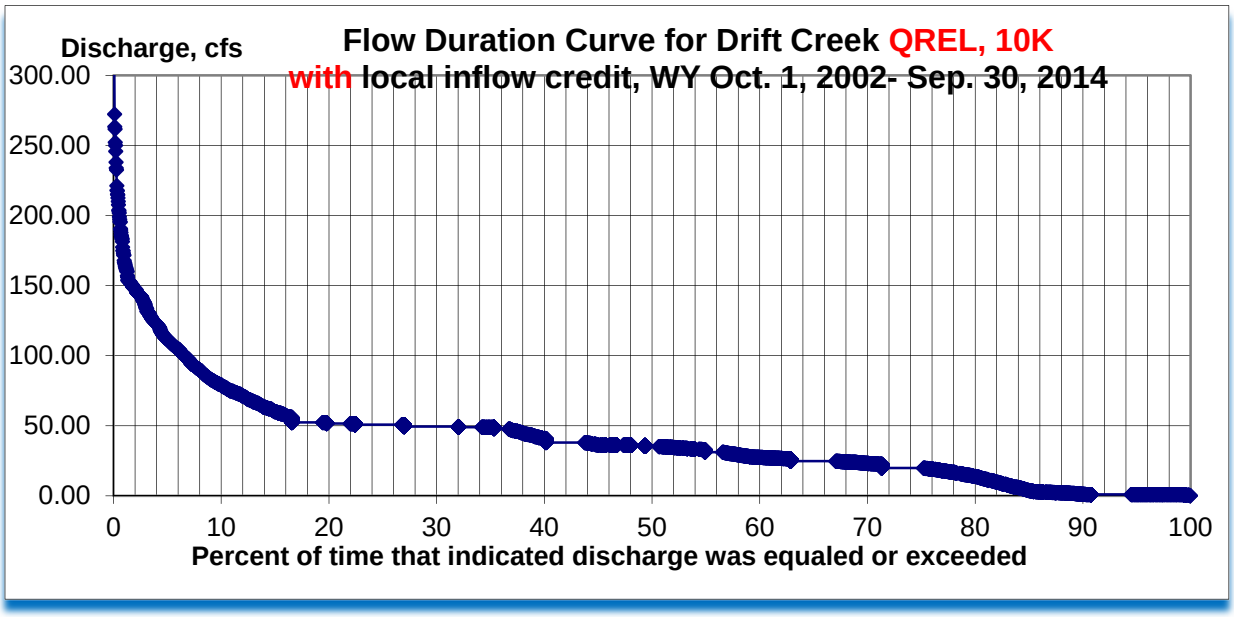
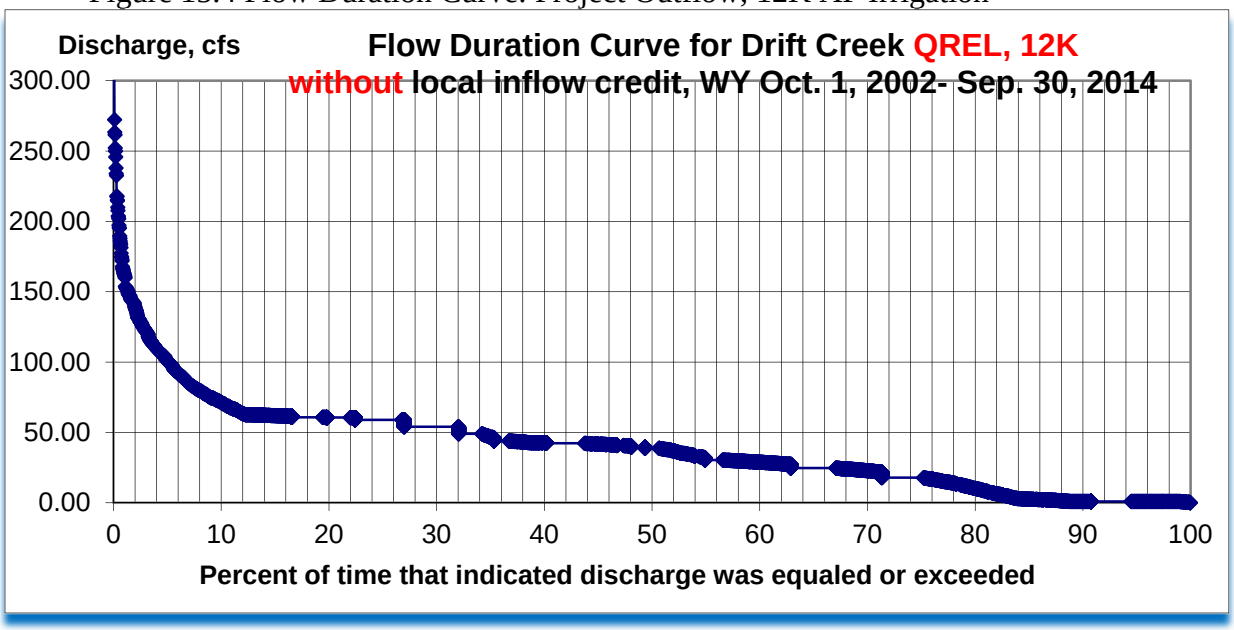
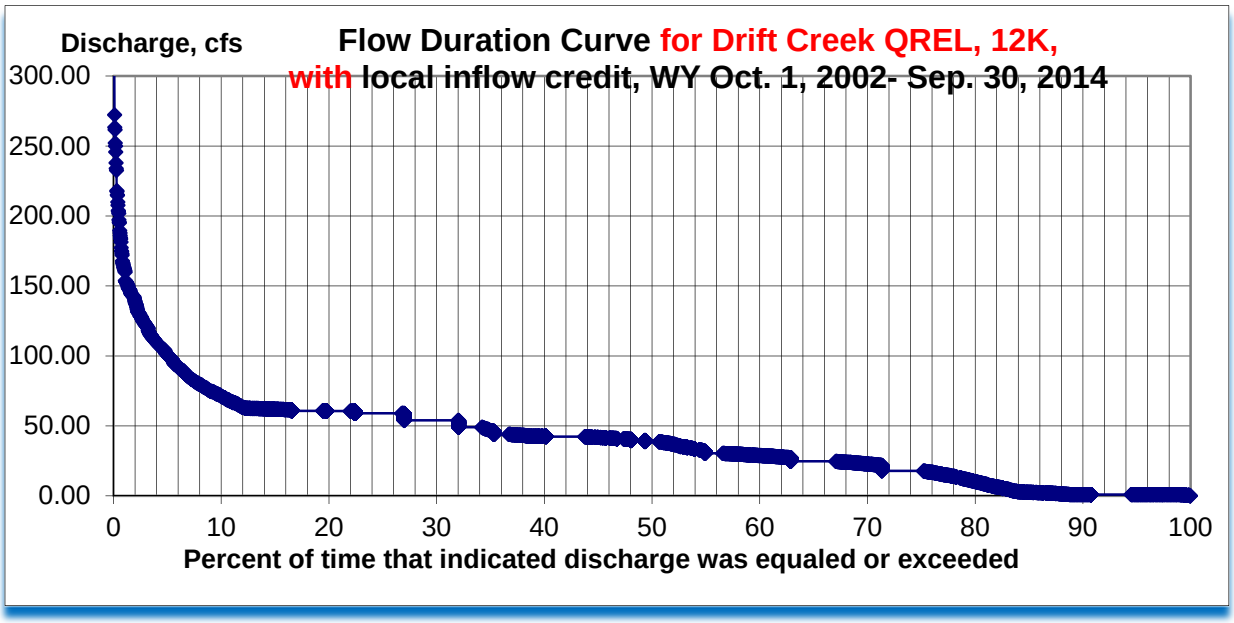


Figure 15.4 Flow Duration Curve: Project Outflow, 12K AF Irrigation





The differences in the discharges may be hard to detect from the graphics shown above. Table 15.1, which contains the discharges close to the 50 percent exceedance for each operating scenario, provides some ideas on the level of the changes in stream flow compared to the natural conditions at that 50% exceedance level.

Table 15.1 Discharges Near the 50% Exceedance Level (**Full Year Time Span)**

Operating Scenarios	% Exceedance PE1	Flows at PE1, cfs	% Exceedance PE2	Flow at PE2, cfs
QREL_8K0L (*)	49.34	40.03	50.66	40.00
QREL_10K0L	49.34	40.93	50.66	40.93
QREL_12K0L	49.34	38.81	50.66	38.80
QREL_8KL	49.34	40.03	50.66	40.00
QREL_10KL	49.34	40.93	50.66	40.93
QREL_12KL	49.34	38.81	50.66	38.80
Natural Inflows	49.98	24.24	50.00	24.21

(*) 8K0L= 8KAF Irrigation, no local inflow credit; 8KL= 8 KAF irrigation, with local inflow credit

Figures 15.5 through 15.8 represent flow duration curves covering the months that are going to experience greater increases in stream flows because of the reservoir releases and, therefore, the most impacts on bank erosion. These months spread from May through September.

Figure 15.5 Flow Duration Curve: May-September **Inflows**, WY 2002-2014

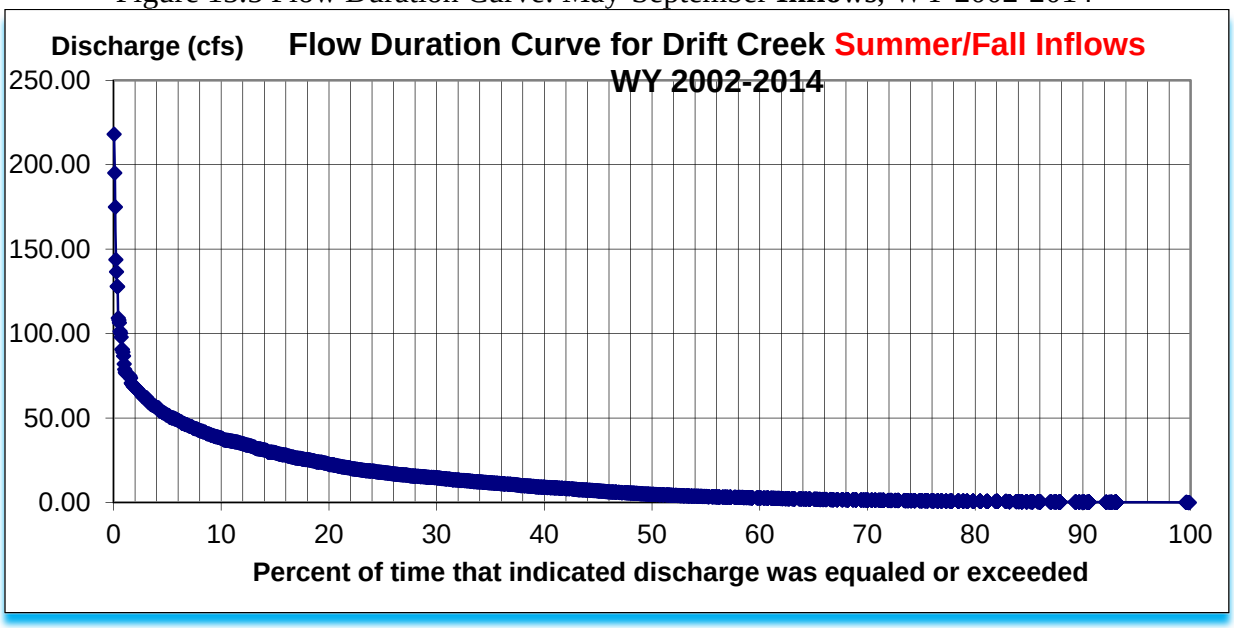
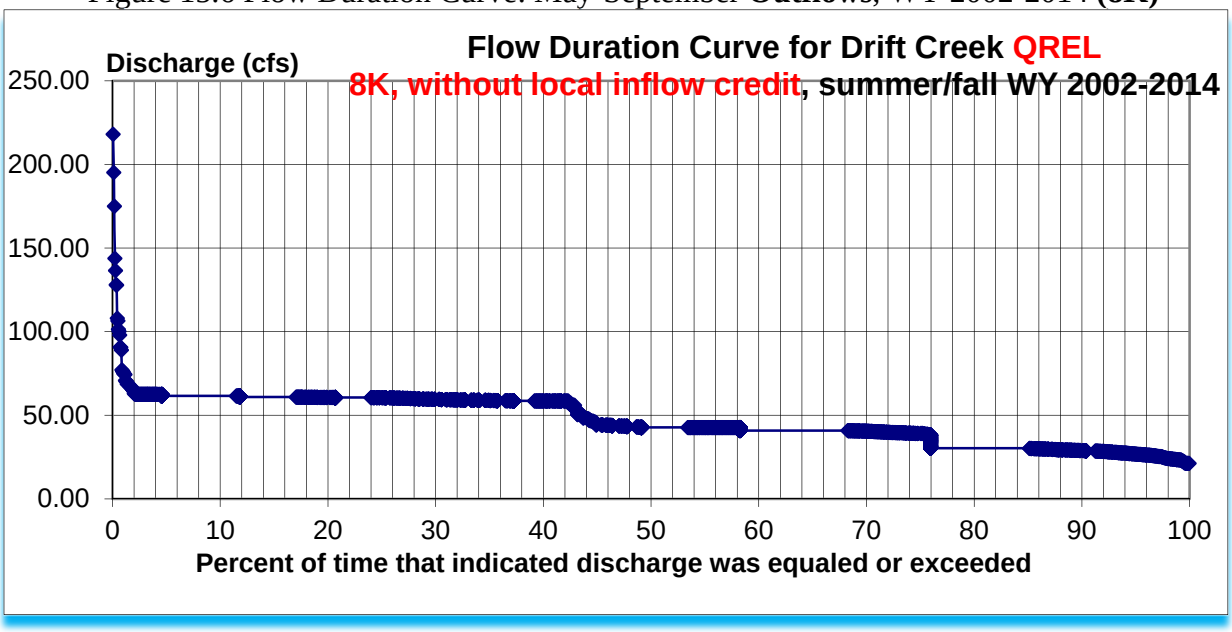


Figure 15.6 Flow Duration Curve: May-September **Outflows**, WY 2002-2014 **(8K)**



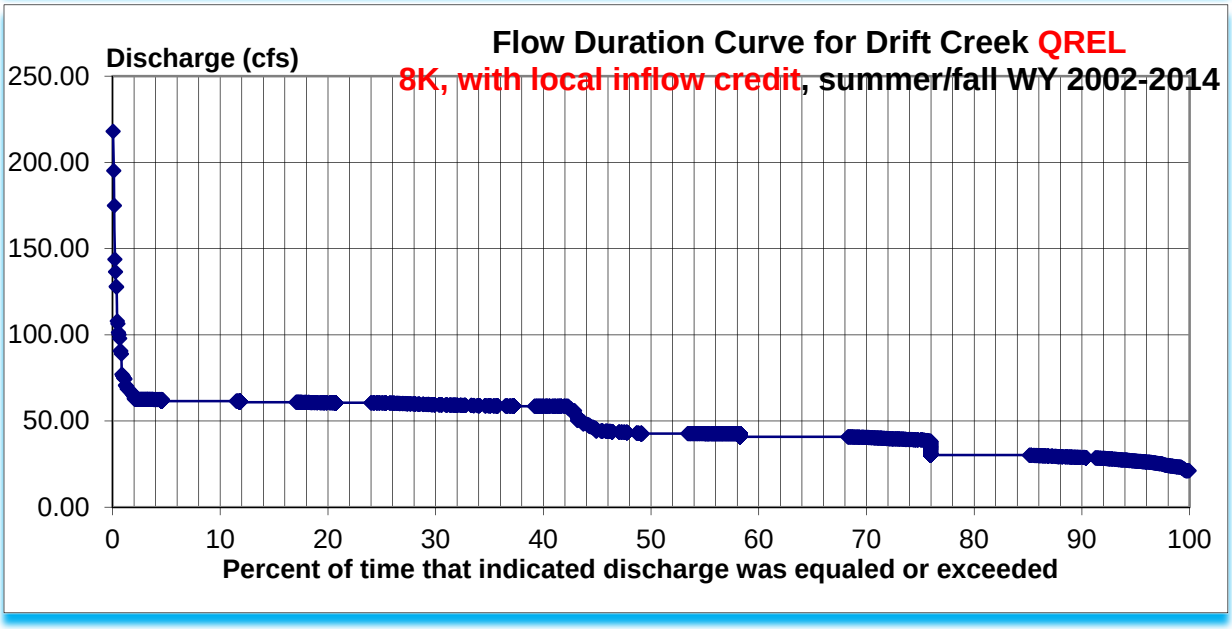
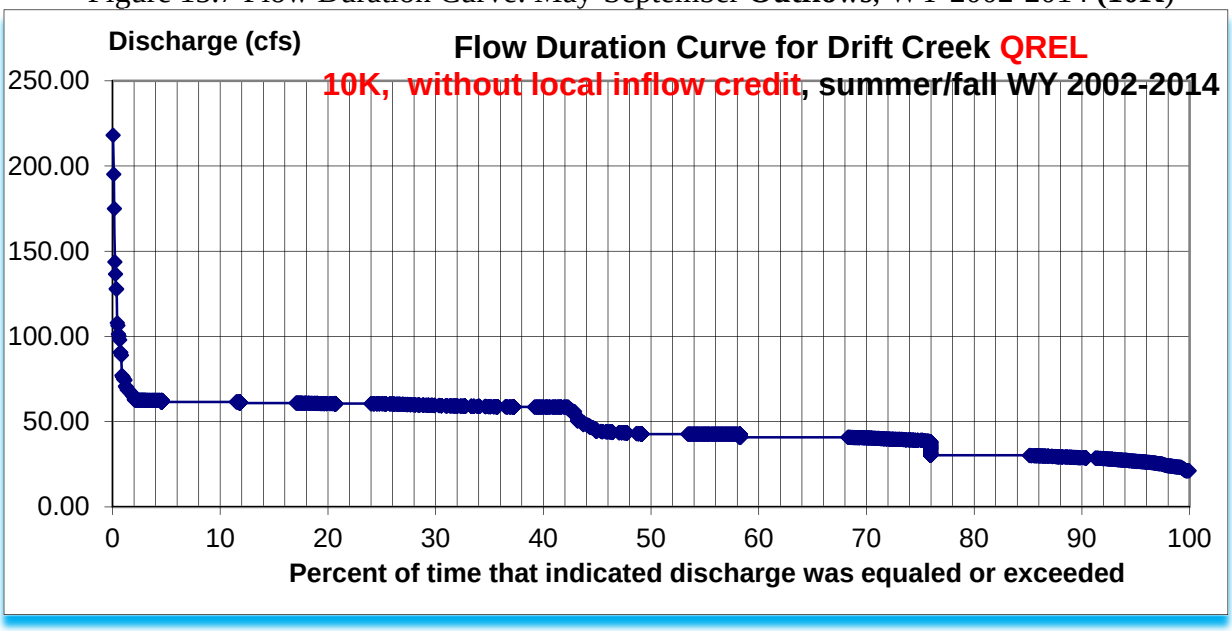


Figure 15.7 Flow Duration Curve: May-September **Outflows**, WY 2002-2014 **(10K)**



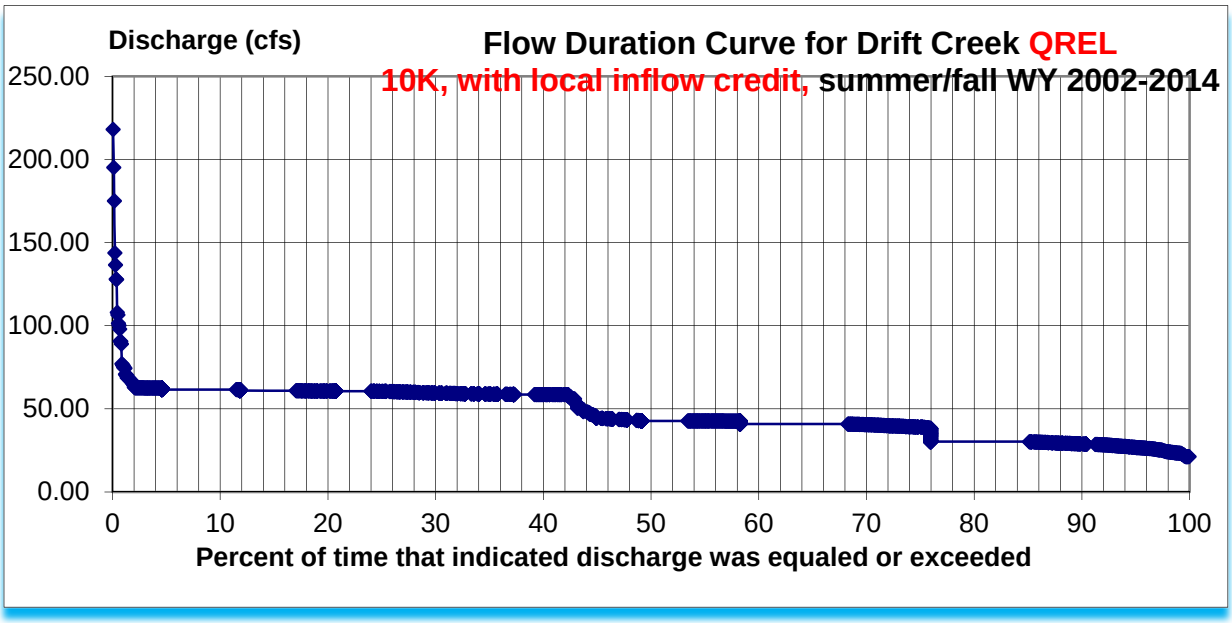
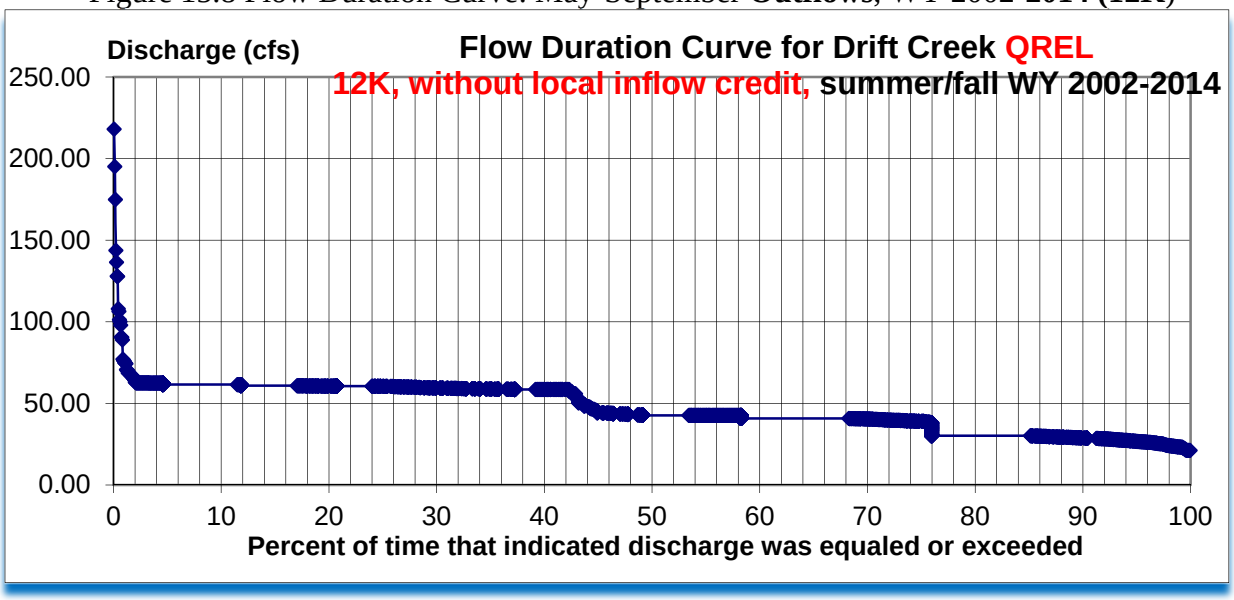


Figure 15.8 Flow Duration Curve: May-September **Outflows**, WY 2002-**2014 (12K**)



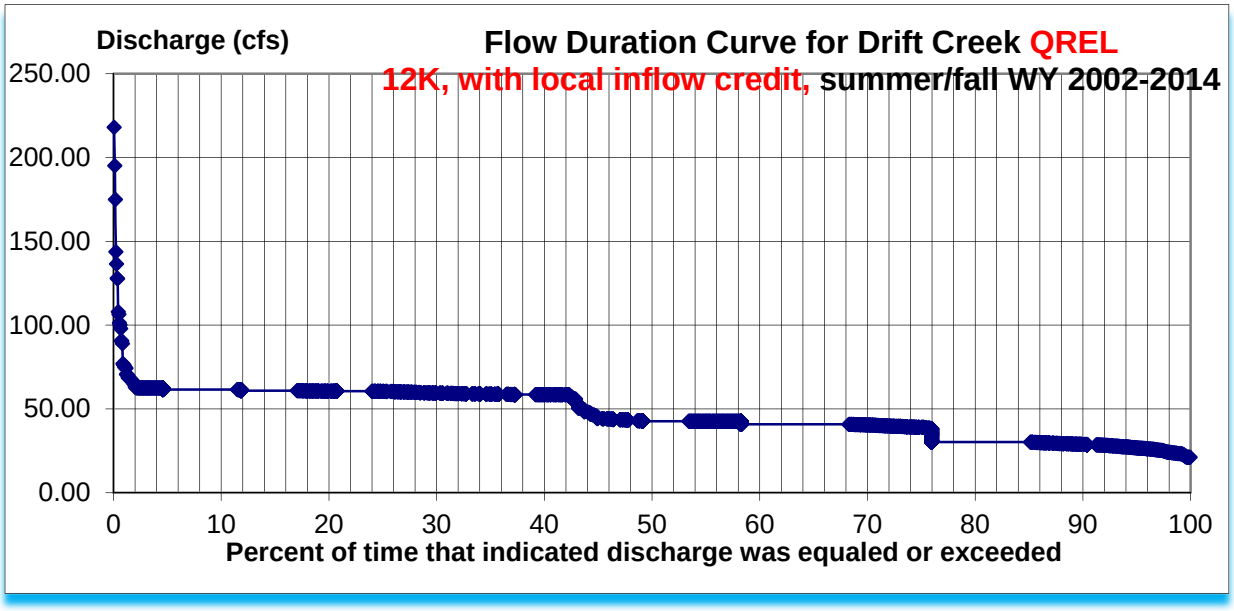


Table 15.2 provides numbers that reflect the minute changes in discharges expected to occur under various operating scenarios.

Based on the results graphically and numerically shown above, the differences in inflow and post-project outflows at the 50% exceedance level are more visible than differences in irrigation releases. Overall, 50 percent of the stream flows during spring through fall are expected to increase from the current 24 cfs average to around 39 cfs or more.

Table 15.2 Discharges Near the 50% Exceedance Level (**May-September** Time Span)

Operating Scenarios	% Exceedance PE1	Flows at PE1, cfs	% Exceedance PE2	Flow at PE2, cfs
QREL_8K0L (*)	49.34	40.03	50.66	40.00
QREL_10K0L	49.34	40.93	50.66	40.93
QREL_12K0L	49.34	38.81	50.66	38.80
QREL_8KL	49.34	40.03	50.66	40.00
QREL_10KL	49.34	40.93	50.66	40.93
QREL_12KL	49.34	38.81	50.66	38.80
Natural Inflows	49.978	24.24	50.00	24.21

(*) 8K0L= 8KAF Irrigation, no local inflow credit; 8KL= 8 KAF irrigation, with local inflow credit

To complement the flow duration curves, Figures 15.9 and 15.10 show the projected daily flows for the May-September season under the three irrigation volume bases and with and without local inflow credit. While the local inflow credit can impact reservoir releases during the October-through-March refill season, its effect on the summer-through-fall stream flows period is very limited.

Figure 15.9 Projected Daily Flows for the May-September Season, without local inflow credit

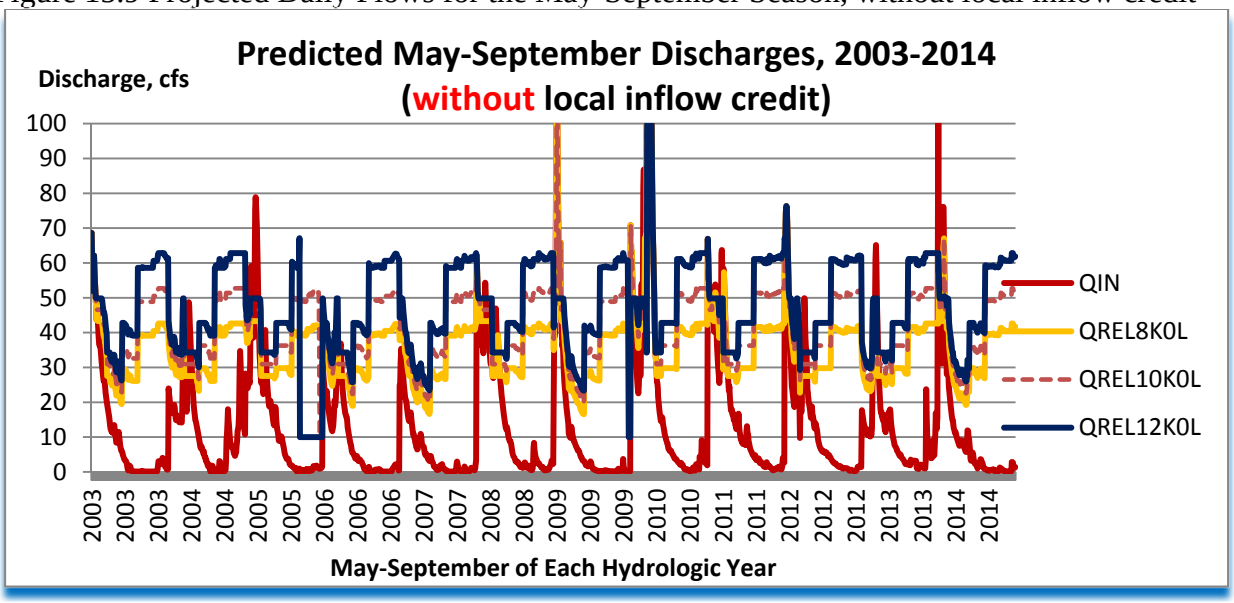
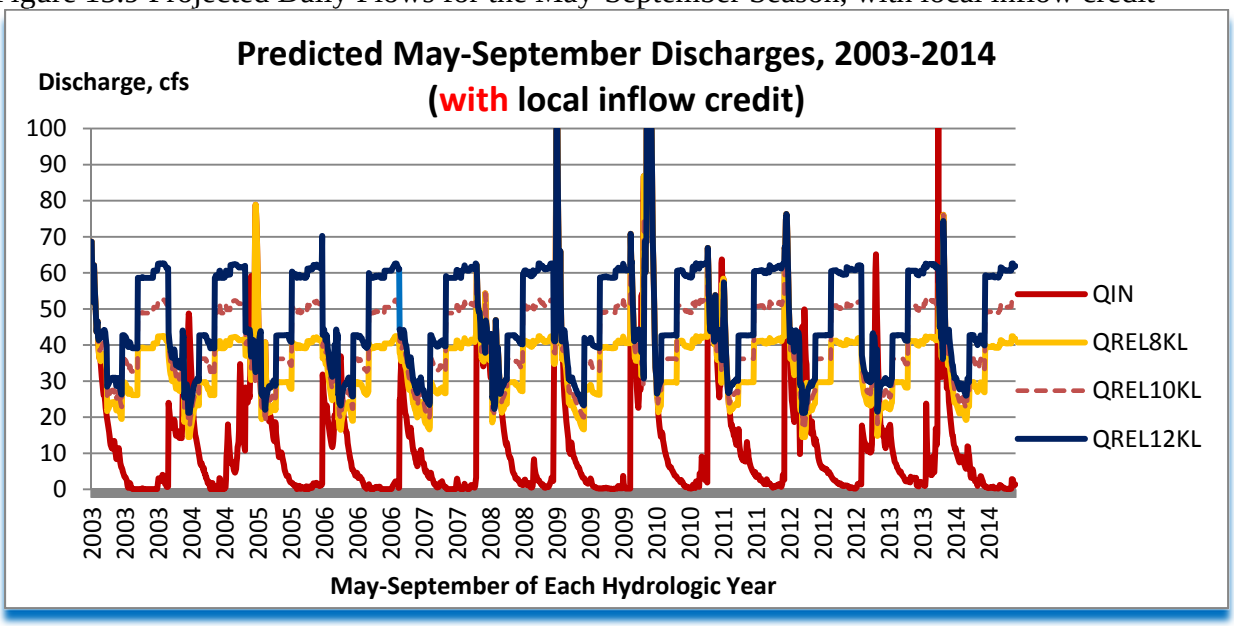


Figure 15.9 Projected Daily Flows for the May-September Season, with local inflow credit



Significant increases in summer/fall stream flows are likely to have an impact on stream bank erosion and sediment deposition. Other bank erosion-related parameters that need to be examined in the future would include flow velocity and wetted perimeters in the river reaches below the proposed dam site.

16. Evaporation Losses

A subject that had not been addressed in previous reports was evaporation, because its impact on the total runoff inflow to the project was assumed to be relatively low. Now that more relevant data are available, it is deemed appropriate to take a closer look and come up with a more detailed estimate of evaporation losses that could affect water availability at the project. The subject is approached from two different angles, long-term and short-term perspectives, using rainfall, pan evaporation, duration, and storage surface area data. The calculation procedure is as outlined in the US Army Corps of Engineers' Hydrologic Engineering Center Training Course on Hydropower, 28 February -11 March 1977 in Davis, California.

In the rainfall-runoff watershed model that was based only on the Salem Airport rainfall data (see Section 7), the rainfall multiplier needed to match Salem rainfall with Lower Drift Creek runoff ranged from 1.5 to 1.9, depending on the overall runoff conditions. This is mostly due to the fact that rainfall distribution is normally more intense over the Drift Creek Basin than over the Salem area. See the isohyet map shown earlier in Figure 3.2. For this assessment, an average rainfall multiplier of 1.6 is used.

Based on the results of the same rainfall-runoff modeling effort, the average runoff which contributes to the stream flow is 58.8 percent of the rainfall over the watershed. This means that, while runoff on the exposed surface of the reservoir is 100 percent, it is only 58.8 percent over

this same area prior to the construction of the reservoir. Consequently, runoff to the project is increased by 100-58.8=41.2 percent of the precipitation over the reservoir surface.

Also, the rate of evaporation is taken as 70 percent of pan evaporation and based on the area of the reservoir at the average pool. Monthly average pan evaporation data posted on the Western Regional Climate Center's website at: http://www.wrcc.dri.edu/htmlfiles/westevap.final.html for several Oregon stations relatively close to Drift Creek are shown in Table 16.1. The average annual pan evaporation at those stations is 37.3 inches.

Table 16.1 Monthly Pan Evaporation Rates for Selected Oregon Sites

	PERIOD OF RECORD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
ASTOR EXPERIMENT STN	1948-1973	0.56	0.96	1.47	2.21	3.75	3.95	4.65	4.10	2.95	1.65	0.87	0.70	27.82
BEND 7 NE	1991-2005	0.00	0.00	0.00	4.25	6.14	6.69	8.66	7.91	5.42	0.00	0.00	0.00	39.07
CORVALLIS STATE UNIV	1889-2005	0.00	0.00	1.79	2.96	4.59	5.86	7.70	7.07	5.06	2.33	0.96	0.00	38.32
COTTAGE GROVE DAM	1943-2005	0.00	1.27	2.16	3.07	4.56	5.60	7.75	6.70	4.47	2.06	0.82	0.00	38.46
DETROIT DAM	1954-2005	0.19	1.16	1.69	2.51	4.38	5.90	7.68	6.64	4.24	2.05	0.88	0.46	37.78
DORENA DAM	1948-2005	0.00	1.01	1.94	2.95	4.98	6.11	8.19	7.15	4.66	2.01	0.00	0.00	39.00
FERN RIDGE DAM	1943-2005	0.39	0.79	1.92	3.17	5.03	6.21	8.12	7.09	4.76	2.21	0.67	0.34	40.70

Rainfall data recorded at Salem Airport between October through September 2014 were listed in Table 3.12. Salem Airport rainfall data were multiplied by an average multiplier of 1.6 to derive the estimated rainfall over Drift Creek Basin during the period of interest. The last parameter, average reservoir surface elevation, ware extracted from selected reservoir model outputs.

Table 16.2 shows the details of the estimation of average net evaporation loss for the 6 year period starting from October 2008 through September 2014 (72 months). With a total of 230.0 inches of precipitation recorded at Salem Airport, the adjusted 6-year total rainfall estimate over Drift Creek watershed is 230.1x1.6=368 inches. The average annual pan evaporation extracted from Table 5.1 is 37.3 inches, which leads to a 6-year evaporation amount of 37.3 x 6=223.8 inches.

For the long-term period, given the fact that (1) rainfall over the basin is considerably higher than evaporation and (2) the relatively small size of the catchment area, the evaporation loss would only be equivalent to 0.03 cfs, which is negligible.

Table 16.2 Estimation of Long-term Net Evaporation Loss for Drift Creek (2008-2014)

Items	Comments	Calculation	Results
Total Rainfall (")	Salem Rain: 230" Mult.= 1.6	230*1.6	368.00
Pre-project runoff (")	Ave. Runoff C=0 .588	0.588*368	216.38
Additional runoff over reservoir (")	(1-.588)	(1.000-0.588)*368	151.62
Pan evaporation (")	37.3"	37.3x6	223.80
Reservoir evaporation (")	70% of pan evap.	223.8*.70	156.66
Net evaporation (")	Res. Eva. - Add. RO	156.66-151.62	5.04
Number of months	Oct 2008 to Sep 2014	72	72
Ave. monthly evap. Loss (")	Net Evap./Nb. Months	5.04/72	0.07
Ave. pool elevation (' msl)	From Continuous Modeling	670.5	670.5
Area of ave. pool el. (acre)	From Ele. vs. Area Curve	332	332
Net evaporation Loss (cfs)	Using Conversion Formula (*)	(0.07/12)*(332/60.33)	0.03

(*) Formula to convert 1 cfs during any month to month-second-feet

=(1 cfs x 3600 sec x 24 hours x 30 days)/53,4560 cubic feet)=60.33 AF

The long-term calculation works with average numbers and provides a constant evaporation loss rate over each month of the years of interest. A more accurate approach is to compute, each month, the net evaporation based on the net evaporation rate applied to the average reservoir area during that month. To respond to that need, calculation of evaporation loss for a shorter, monthly time period was performed, focusing on 2008-2009, which was driest of the last six hydrologic years and also recorded the lowest monthly average stream flow in August 2009. The results of the 2008-2009 evaporation loss calculation are summarized in Table 16.3.

Table 16.3 Estimation of Monthly Evaporation Losses for Drift Creek (2008-2009)

Items	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
Salem Rainfall (")	0.95	3.62	6.02	3.56	2.90	3.03	1.40	3.04	1.39	0.68	0.17	1.20
Total Rainfall (")	1.62	6.15	10.23	6.05	4.93	5.15	2.38	5.17	2.36	1.16	0.29	2.04
Pre-project runoff (")	0.78	2.98	4.96	2.94	2.39	2.50	1.15	2.51	1.15	0.56	0.14	0.99
Additional runoff over reservoir (")	0.83	3.17	5.27	3.12	2.54	2.65	1.23	2.66	1.22	0.60	0.15	1.05
Pan evaporation (")	1.76	0.60	0.21	0.16	0.74	1.57	3.02	4.78	5.76	7.54	6.67	4.51
Reservoir evaporation (")	1.23	0.42	0.15	0.11	0.52	1.10	2.11	3.34	4.03	5.28	4.67	3.16
Net evaporation (")	0.40	-2.75	-5.12	-3.00	-2.02	-1.56	0.89	0.68	2.82	4.68	4.52	2.11
Number of months	1	1	1	1	1	1	1	1	1	1	1	1
Ave. monthly evap. Loss (")	0.40	-2.75	-5.12	-3.00	-2.02	-1.56	0.89	0.68	2.82	4.68	4.52	2.11
Ave. pool elevation (' msl) (*)	649.8	650.7	652.0	669.3	671.9	674.8	676.0	676.0	673.7	669.2	661.2	649.6
Area of ave. pool el. (acre)	240	245	252	328	336	344	347	347	341	328	297	239

Net evaporation Loss (cfs)	0.13	-0.93	-1.78	-1.36	-0.94	-0.74	0.42	0.33	1.33	2.12	1.86	0.69
Natural Av. Inflows, cfs	1.83	22.82	48.19	101.87	38.93	65.90	39.73	45.55	7.24	1.35	0.24	0.49
Post-project Av. Inflows, cfs	1.69	23.75	49.98	103.23	39.87	66.64	39.31	45.22	5.92	-0.76	-1.62	-0.20

(*) Average pool elevations based on the all 6 operating scenarios (with and without local inflow credit and using 8 Kaf, 10Kaf and 12 Kaf irrigation volumes).

Based on the foregoing, net evaporation losses over the proposed Drift Creek Reservoir are expected to be negligible. This is mainly due to the relatively small (less than 350 acres) size of the reservoir surface.

17. Climate Change Impacts on Drift Creek Flow Regime

Climate changes, which seem to be slowly taking place under various shapes and forms around the world, are likely to be more visible in the Pacific Northwest in the not-too-distant future. If parts of this region are to become warmer and/or experience new seasonal precipitation distributions, changes in hydrologic conditions would be unavoidable. Therefore, when dealing with a long-term project like Drift Creek that depends on stream flows and is designed to operate for several decades into the future, a succinct assessment of this global issue is needed to answer the basic question, "How would climate change affect the flow regime of Drift Creek in the next 40 years?"

The assessment is based on currently available information provided by researchers and analysis of historic observations trend lines. It focuses on the three main drivers of the flow regime of Drift Creek: precipitation (P), temperature (T) and runoff (Q). No snow impacts are considered since Drift Creek flows in a relatively low elevation, rain dominant watershed of the west Cascades region with little snow-melt and peak flows in the winter months. Other factors that normally control hydrologic responses to climate changes are not directly addressed in this report. Those factors include geographical location (e.g., east or west side of the Cascade Range), shorter-term climate patterns (e.g., Pacific Decadal Oscillation, El Niño, etc.), elevation, geology, soil infiltration, vegetation, and land use. The assessment also includes projections on the shapes of future stream flow hydrographs, based on the results of recent regional modeling efforts.

17.1 Assessments/Projections by Regional Researchers

Climate change assessments and projections by selected research projects are quoted below to provide a general idea on the type and magnitude of the actual and projected changes for the Pacific Northwest regions.

U.S. Natural Climate Data Center (2001): "*Global temperature changed by over 1 degree Fahrenheit between 1880 and 2000"*.

University of Washington Climate Impacts Group (UW-CIG): *Both Pacific Northwest temperature and precipitation have increased over the 20th century. On average, the region*

warmed about 1.5°F; warming was largest west of the Cascades during winter and spring.[...]. Winter precipitation in the Willamette Valley will likely increase and spring/summer precipitation will decrease. Within the Cascades, average annual temperature is expected to increase along with changes in precipitation patterns (more rain in winter). Warming is expected continue, with a likely warming rate of about 0.5°F decade. [....] While future changes in precipitation are less certain, overall, precipitation is projected to increase. Most likely scenario: wetter, more intense runoff in the winter/spring and less base stream flow during the summer months.

Cayan et al. (2001): "*All areas of the Pacific Northwest region became warmer and some areas received more winter precipitation over the course of the 20th century. [....] Western United States spring temperatures increased from 1.8 to 5.4 degrees Fahrenheit [ºF]) between 1970 and 1998.*

Regonda et al. (2005): "*Increased winter precipitation trends during 1950–1999 at many western United States sites, including several in the Pacific Northwest, although a consistent region-wide trend is not apparent over this period. [....] Based on 1950–1999 data from 89 stream gauges in the western United State system, significant trends toward earlier runoff were found in the Pacific Northwest.*

Luce and Holden (2009): "*Stream flow reductions are observed during 1948–2006 and significant trends in annual stream flow reductions during dry years*".

Mote and Salathé 2010): "*Projected increases in average annual Pacific Northwest temperature of 2.0°F by the 2020s, 3.2°F by the 2040s, and 5.3°F by the 2080s (compared to 1970–1999). [...] Projected changes in average annual precipitation, averaged over all models, are small (+1 to +2 percent), but some models project an enhanced seasonal precipitation cycle with changes toward wetter autumns and winters and drier summers*".

US Bureau of Reclamation, US Army Corps of Engineers and Bonneville Power Administration Joint Operating Committee (2011): "[Based on model projections*], Columbia River Basin annual air temperatures are expected to rise from 1 to 3 degrees Fahrenheit above the historical reference period by the 2020 period, and 2 to 5 degrees Fahrenheit by the 2040 period. This change would affect Columbia River Basin precipitation and snowpack patterns (more rain, less snow) [...] and seasonal river flows. [....] Overall, yearly precipitation changes in the study were minimal -- an average annual precipitation over all models increase 1 to 2 percent. [....] All of the climate change scenarios exhibited a seasonal shift of higher flows in the winter and lower flows in the summer... due in part to more winter precipitation in the form of rain instead of snow, and increased snowmelt earlier in the year due to warmer temperatures*".

Dalton, M.M., P.W. Mote, and A.K. Snover (2013): "*During 1895–2011, the Northwest warmed by about 0.7 °C, while precipitation fluctuated with no consistent trend. [....] The Northwest is expected to experience an increase in temperature year-round with more warming in summer and little change in annual precipitation. [....] Annual average precipitation is projected to change by about +3%, with individual models ranging from –4.7% to +13.5%. [...] For every season, some models project decreases and others increases, although for summer more models project decreases than increases, with the largest projected change of about –30%*

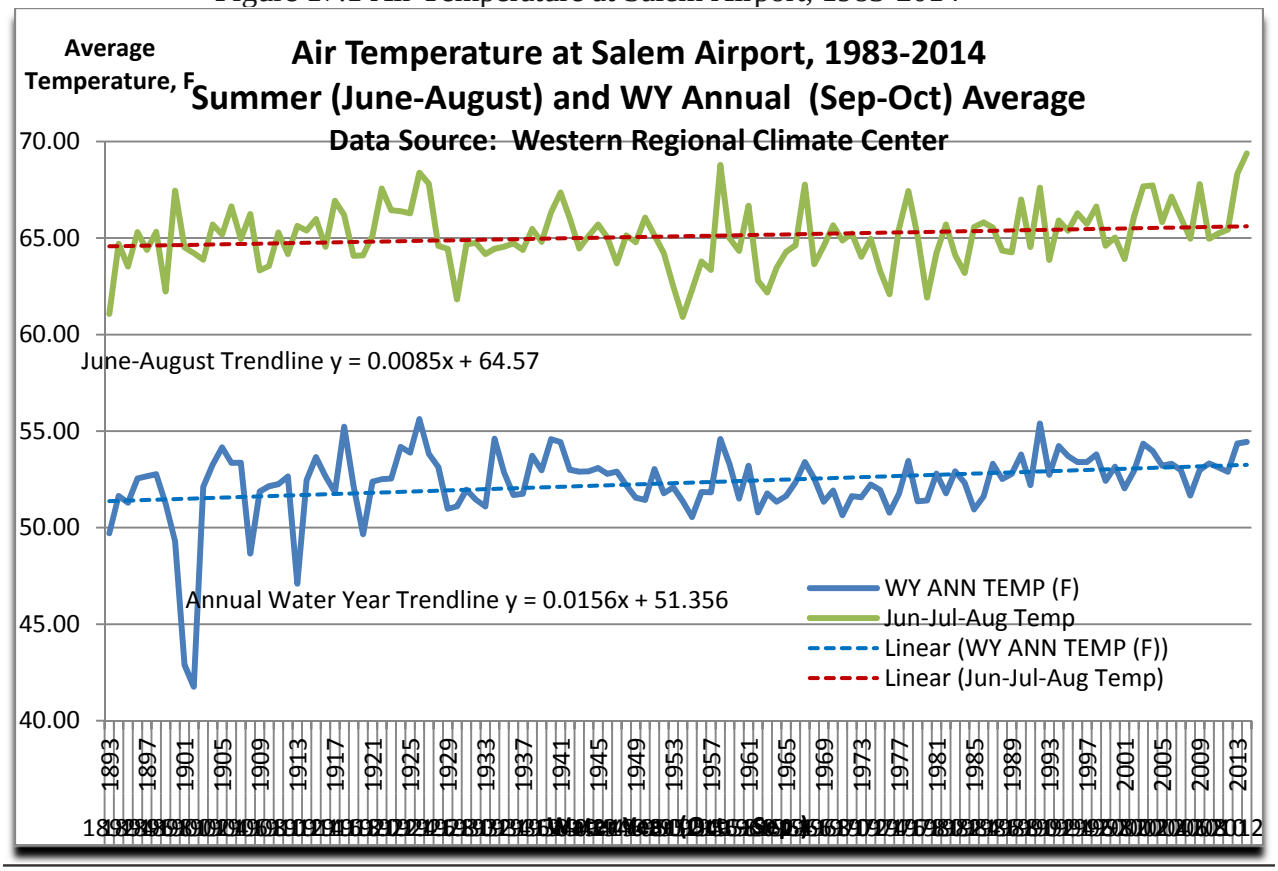
by 2041–2070. [....] Models that project the largest warming in summer also tend to project the largest precipitation decreases".

17.2 Trend Line Assessments Using Historical Records

To support and/or verify the accuracy of the T, P and Q numbers listed above, a trend line assessment is performed using historic data recorded at locations closest to the Drift Creek Basin. The trend will be classified as not significant if the slope of the trend line is not significantly different from zero.

(1) **Air temperature** at Salem Airport, going back as far as 1893 (121 years up to 2014). This information can be used as heat index for the region that includes Drift Creek drainage basin. Temperature data recorded during 5 years between 1893 and 1920 contains some monthly gaps that have to be filled assuming the same mean averages of similar months in the years immediately before and after the gap. The trend lines of the average air temperature over (1) the October - September water year, and (2) June-August summer period are shown in Figure 17.1. [Note that long-term water temperature data would be another interesting parameter to examine in the future, if the needed data are available].

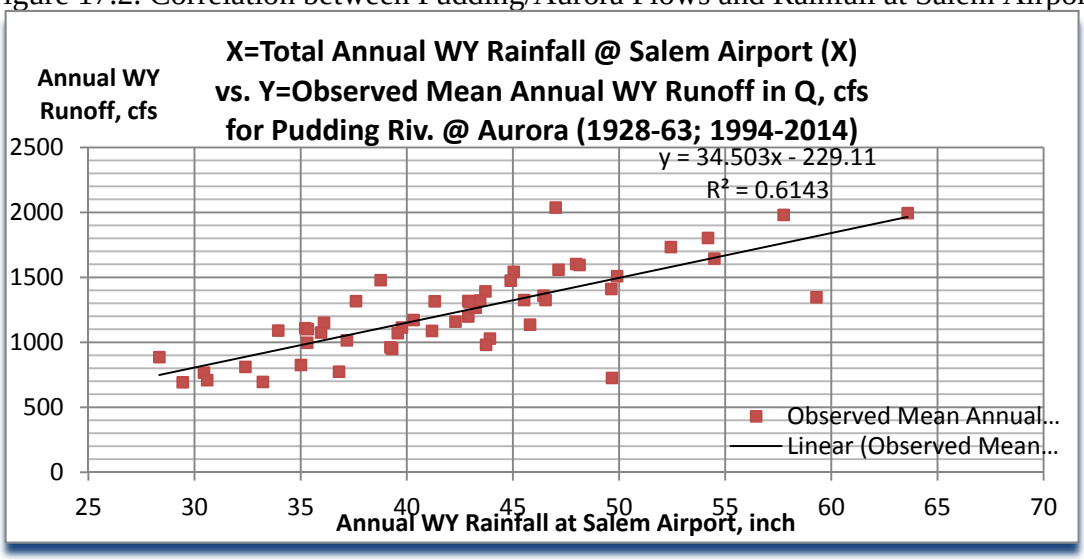
Figure 17.1 Air Temperature at Salem Airport, 1983-2014



(2) **Precipitation** (rainfall) at Salem Airport, going as far back as 1893 (121 years up to 2014). Rainfall can be used to represent runoff conditions since Drift Creek is in a rain-dominant

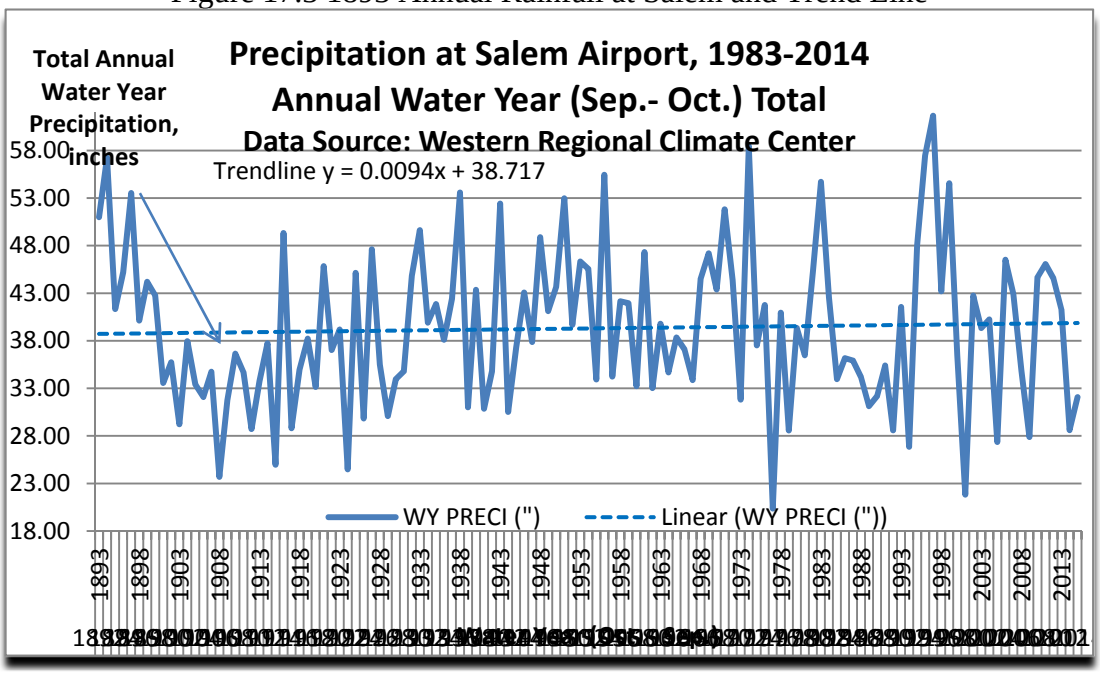
watershed. The annual correlation between Pudding River near Aurora flows and Salem Airport rainfall has an R^2 correlation value of 0.6143, which is within acceptable reach. See Figure 17.2.

Figure 17.2. Correlation between Pudding/Aurora Flows and Rainfall at Salem Airport



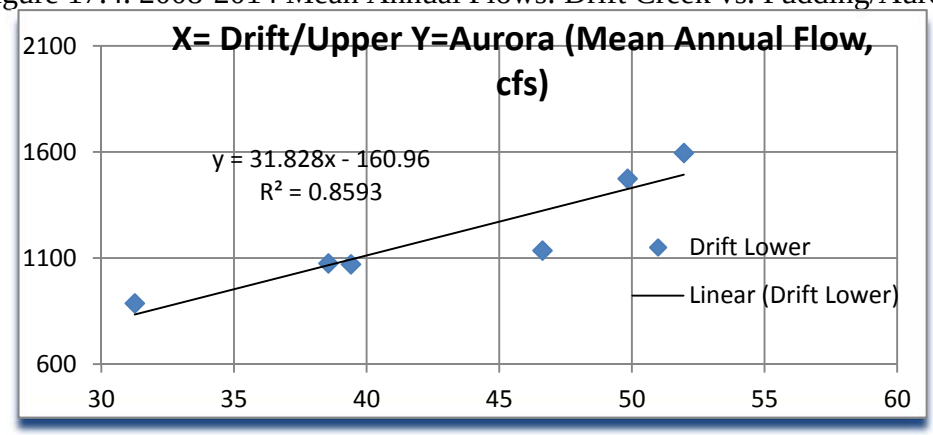
Rainfall data recorded at Salem Airport during 6 years between 1893 and 1901 contains some monthly gaps that have to be filled assuming the same mean average rainfall amounts for similar months in the years immediately before and after the gap. The 1893-2014 rainfall annual amounts and the trend line for that period is shown in Figure 17.3.

Figure 17.3 1893 Annual Rainfall at Salem and Trend Line



(3) **Stream flows** of the Pudding River near Aurora, stretching from 1928 through 2014 with two gaps (1964-1993 and 1998-2001). This is a 86 year long period with 52 years of continuous observed records. The 34-year gaps can be either left unfilled, or filled with statistically synthesized data. The Pudding River near Aurora station is selected because of (a) its long-period of record and (b) its reasonably good regression correlation with Drift Creek data, with an R^2 of 0.8593, based on Sep. 2008- Oct. 2014 observed stream flow data. See Figure 17.4.

Figure 17.4. 2008-2014 Mean Annual Flows: Drift Creek vs. Pudding/Aurora



Annual stream flows variations of Pudding River near Aurora between 1928 and 2014 and their trend lines are shown in Figures 17.5 (data gap unfilled) and 17.6 (data gap filled).

Figure 17.5 1928-2014 Pudding Riv./Aurora Mean Annual Flows (with gap)

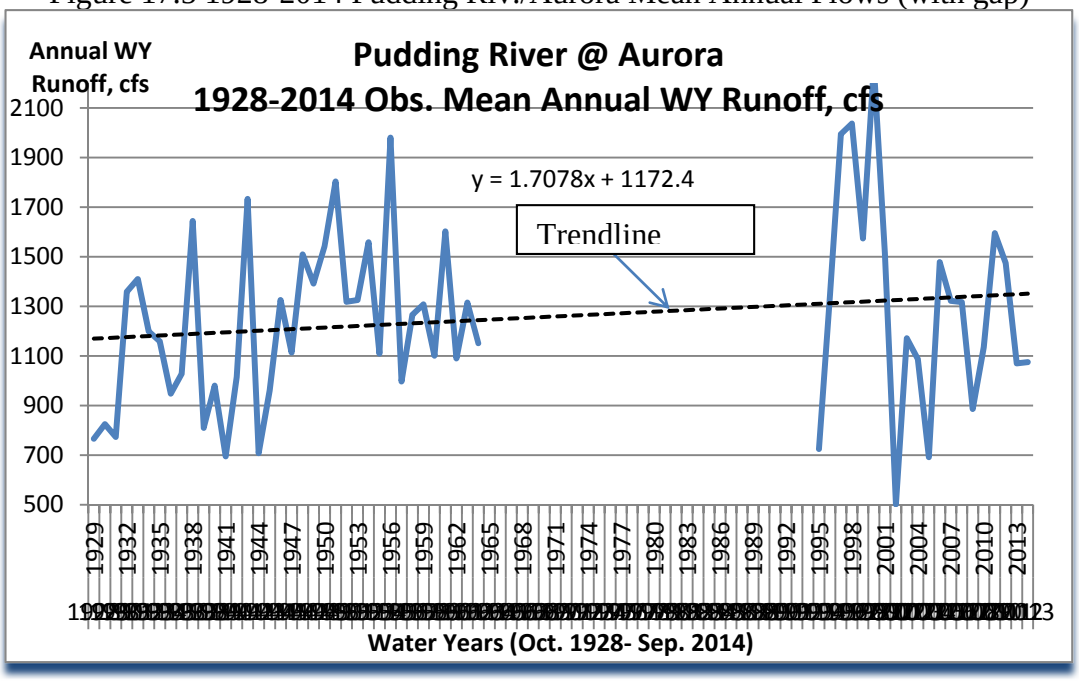
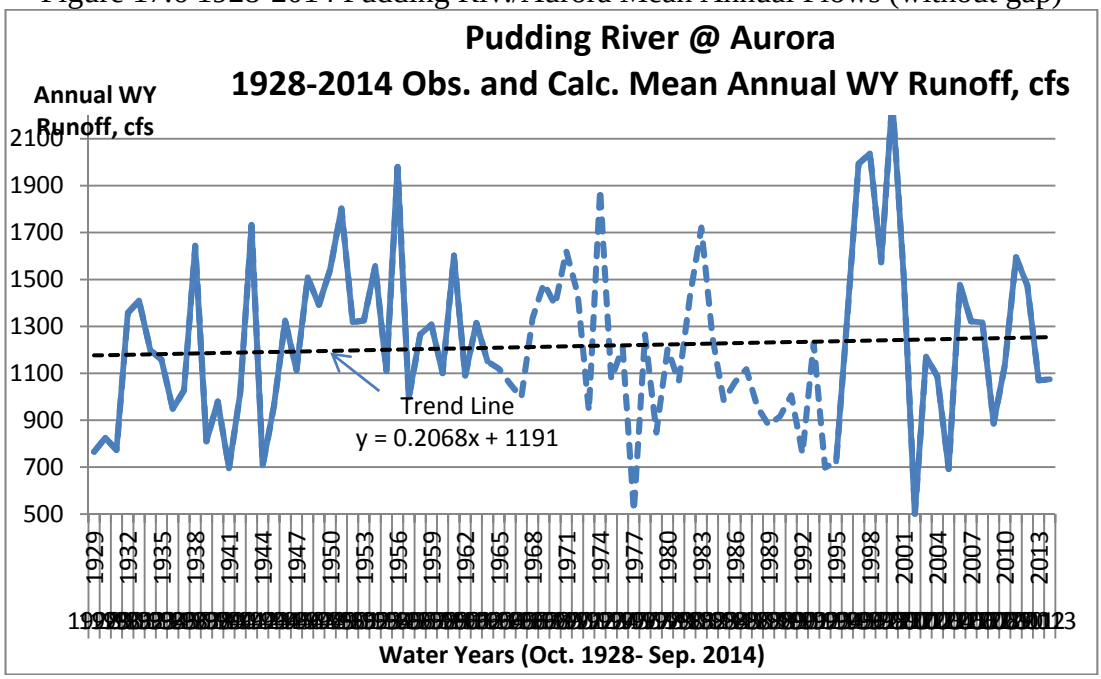


Figure 17.6 1928-2014 Pudding Riv./Aurora Mean Annual Flows (without gap)

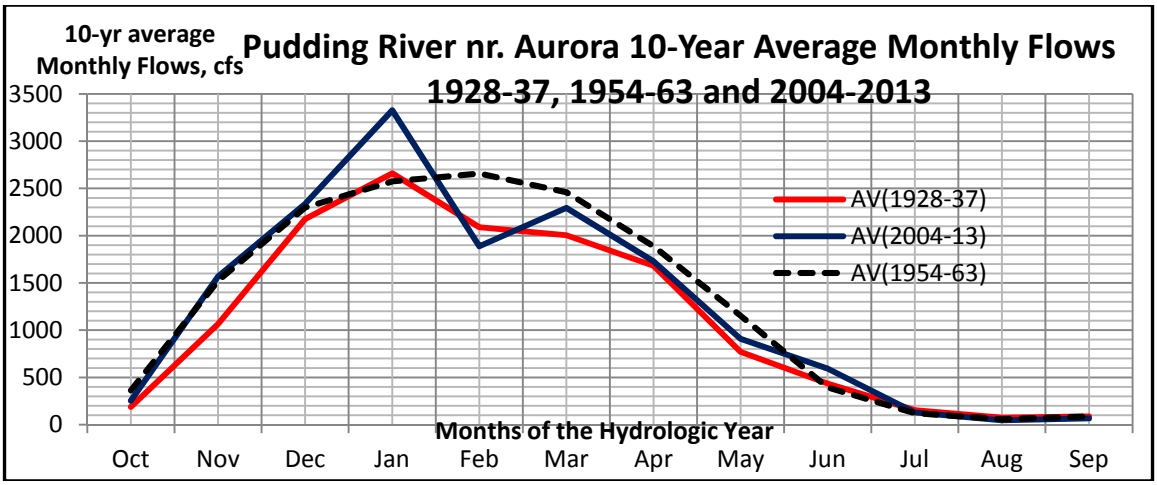


In addition to average annual stream flows, average monthly flows for the Pudding River near Aurora are also plotted for three different 10-year periods (1928-37, 1954-63 and 2004-2013) to detect temporal and quantitative flow changes between those periods. See Table 17.1 and 17.7.

Table 17.1 10-year average monthly flows, Pudding River near Aurora

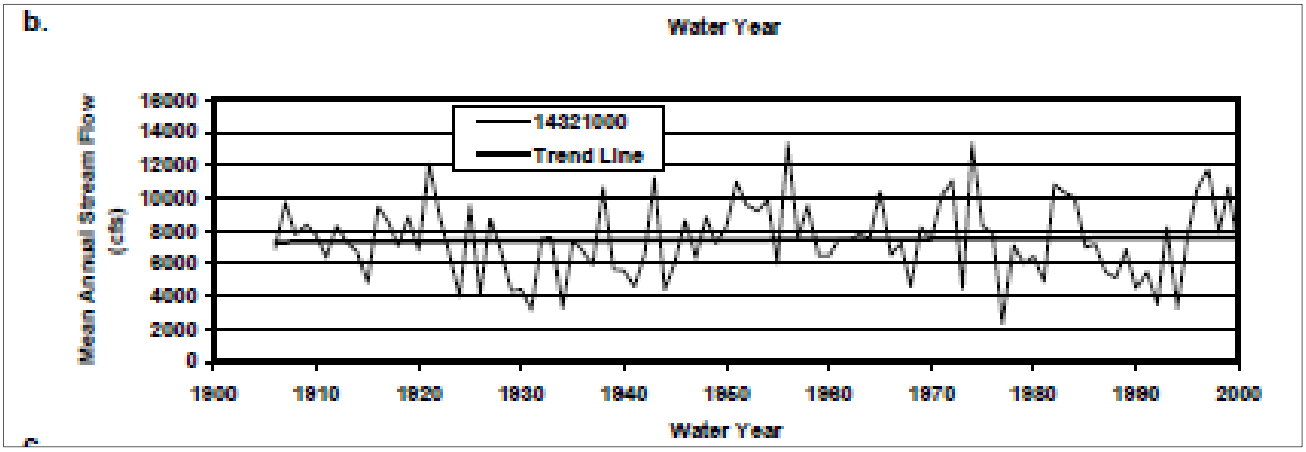
Av. Q	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1928-1937	187.8	1065.2	2176.1	2659.3	2088.9	2004.1	1680.5	770.7	435.8	154.6	73.7	85.7
1954-1963	364.1	1524.4	2300.0	2575.8	2658.4	2460.1	1888.1	1153.0	395.0	121.7	58.5	87.3
2004-2013	253.6	1568.0	2337.2	3327.4	1887.3	2295.0	1729.3	906.8	592.8	127.9	46.4	65.1

Figure 17.7 10-year average monthly flows, Pudding River near Aurora



The last piece of information examined is the plot of the mean annual stream flows of the Willamette River at Albany between 1900 and 2000, excerpted from the OWRD Report, "Determining Surface Water Availability in Oregon, Open File Report SW 02-002, June 2002". See Figure 17.8. Some slight increases were depicted for that 100 year time span based on the slowly climbing trend line.

Figure 17.8 Mean annual stream flows, Willamette River at Albany (1900 and 2000)



The results of the analysis described above for the Pudding River near Aurora are summarized below. For lack of better data, the conclusions reached for the Pudding River are assumed to be generally applicable as well to Drift Creek (one of its own tributaries).

- Average annual stream flows, based on Pudding River near Aurora data, shows a trend line increase from 1180 cfs in 1928 to 1350 cfs in 2014 (about 14%) over the past 86 years.
- Average annual precipitation, based on Salem rainfall data, shows a trend line increase of 2.8% (from about 38.9" to 41.1") over the past 121 years.
- Average annual air temperature, based on Salem temperature data, shows a trend line increase of 4.1% (from about 51.2 inches to about 53.3 inches) over the past 121 years.
- Average June through August air temperature, based on Salem temperature data, shows a trend line increase of 1.9% (from about 64.4 degree F to about 65.6 degree F) over the past 121 years.

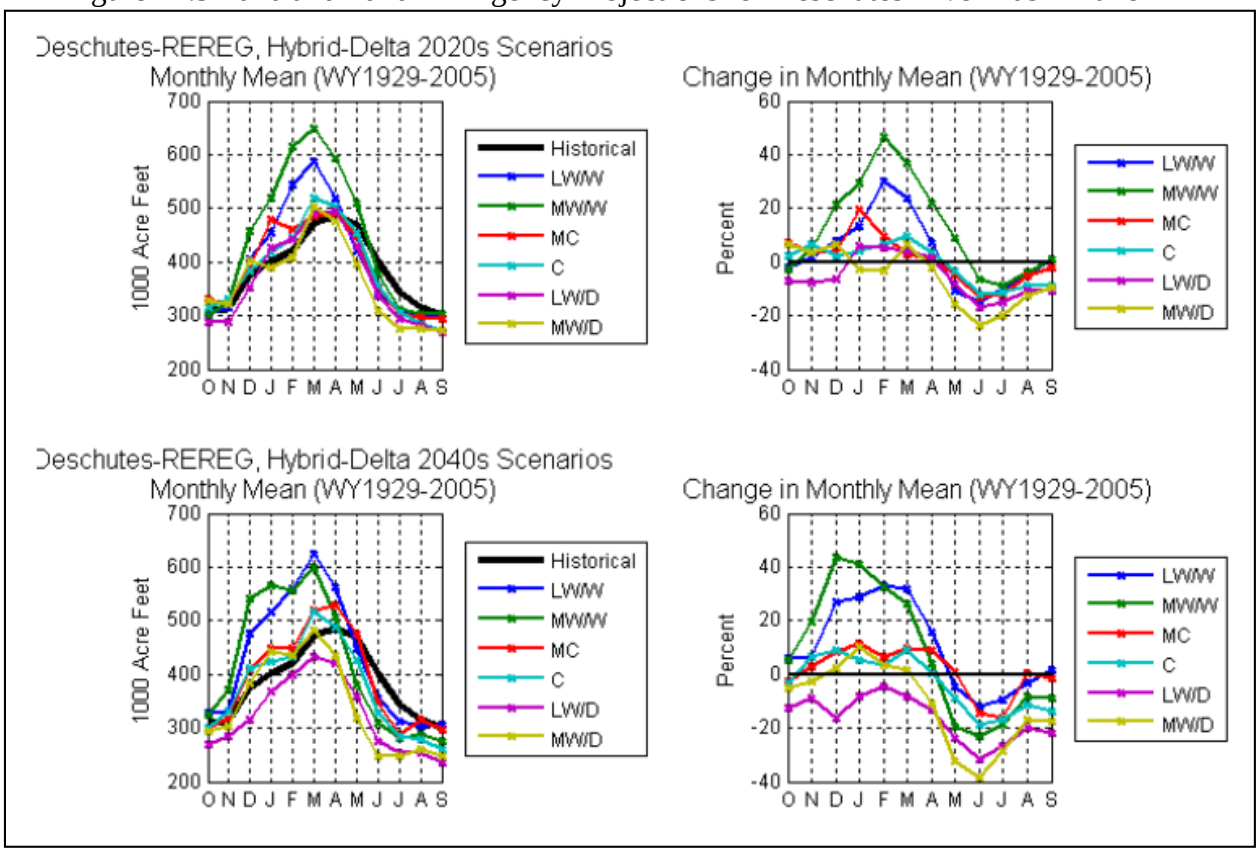
- Based on 10-year monthly average flows plots, there does not seem to be a clear, easily explainable pattern of changes in the steam flow hydrographs between 1928 and 2014. In general, the more recent average monthly flows appear to be slightly higher than those occurring in the 1930's. More recent January average flows also seem to be now higher than before.

17.3 Climate Change Projections for Drift Creek Flows

Climate change projections for Drift Creek were based on the modeling results of the Tri-Agency (Reclamation, Corps of Engineers and BPA) 2011 Study. The Study included a water supply forecast that reflects future hydrologic and climate conditions in the Columbia River Basin and associated sub-basins -- Yakima, Deschutes, and Snake River sub-basins. Of those three basins, the Deschutes River Basin was selected for the Drift Creek projection, because of its nearest vicinity to the Drift Creek watershed (despite its west side of the Cascades location, a limitation far less critical than the one associated with farther drainage basins).

Two time frame targets (2020 and 2040) were selected from the Tri-Agency's Climate Change Study, which also assumed six qualitative scenarios: central (C), more warming and wetter (MW/W), less warming and wetter (LW/W), more warming and drier (MW/D), less warming and drier (LW/D), minimal change (MC), roughly targeting less warming and central precipitation change. The results of the changes projected by the Tri-Agency Study for the Deschutes River Basin are illustrated in Figure 17.9. Those results were applied to Drift Creek with some adjustments.

Figure 17.9 2020 and 2040 Tri-Agency Projections for Deschutes River Basin Runoff



The procedure used to adjust the above results and make them applicable to Drift Creek Basin includes the following steps:

1. Calculate Pudding/Aurora monthly averages (in cfs) for the period 1929-2014 (Only observed data; no g
See Table 17.2 below.

Table 17.2 Pudding River near Aurora 1929-2014 Average Monthly Flows

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	A
Q, cfs	335.3	1403.8	2470.2	2843.1	2736.3	2095.0	1543.4	874.3	427.1	148.2	68

2. Calculate regression equations and R^2 Correlation values for 2008-2014 monthly flows for Drift Creek vs. for Pudding/Aurora. See Figure 17.10 and Table 17.3.

Figures 17.10 Monthly Average Flows Regression Drift Cr. vs. Pudding/Aurora

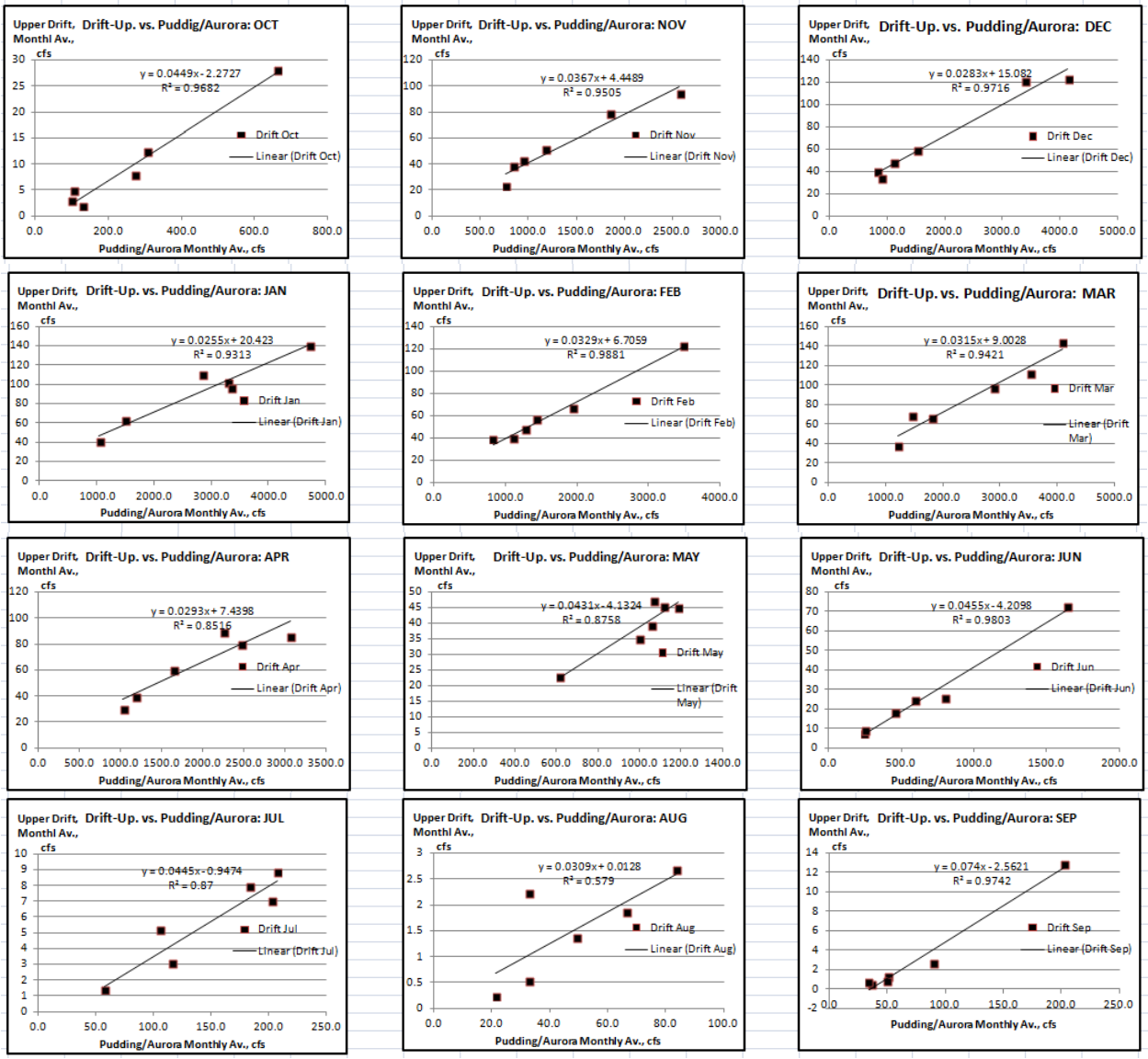


Table 17.3 Linear Regression Equations Y (Drift)= a * X (Pudding) + b

Month	a	b	R^2
Oct	0.0449	-2.2727	0.9682
Nov	0.0367	4.4489	0.9505
Dec	0.0283	15.082	0.9716
Jan	0.0255	20.423	0.9313
Feb	0.0329	6.7059	0.9481
Mar	0.0315	9.0028	0.9421
Apr	0.0293	7.4398	0.8516
May	0.0431	-4.1324	0.8753
Jun	0.0455	-4.2098	0.9803
Jul	0.0445	-0.9474	0.8700
Aug	0.0309	0.0128	0.5790
Sep	0.0740	-2.5621	0.9742

18. Conclusions

1. This hydrologic analysis report Update #4 complements the earlier reports prepared in February 2007 (Update #1), June 2010 (Update #2), and October 2012 (Update #3) in the light of more recent stream flow data collected for Drift Creek (during October 2011-September 2014). 2008-11 discharge measurements at the proposed project site on Victor Road and a station further downstream, closer to Drift Creek confluence with the Pudding River, seem to produce fairly consistent results.

2. As expected, the challenge continues to be the still relatively limited number of real-time discharge data. So far, only six years of actually observed data stretching from April 2008 to September 2014 are available. The 2008-09 period was dry; 2009-10 and 2012-14 slightly below average, and 2010-12 high years in the top ten. Those six years did cover the lower side and the high side of the expected runoff at the project, but they still leave open questions on the higher side of the runoff with more significant snow-melt contribution.

3. How to extend the stream flow records was one of the key issues. To address that need, attempts were made to identify reliable statistical correlations between Drift Creek discharges and discharges at other nearby streams. Of the six streams under consideration, Pudding River near Aurora has by far the longest period of records – 52+ years of observed flows and an additional 34 year period of synthesized flows using rainfall and snow data at Salem. One could either use the Drift Creek versus Pudding River regression equations to generate up over 80+ years of flow data for Drift Creek, or develop a rainfall-runoff model to link Drift Creek flows with rainfall and snow data at Salem. So far, the regression-based predictions appear to be more reliable than model predictions because of data limitation.

4. Other data discussed in this report include water availability, in-stream water rights, and ecological and channel maintenance flows. Based on the June 9, 2015 conference call with

OWRD staff, there are no immediate plans for OWRD to update natural stream flows listed for the 50% and 80% exceedance frequencies. Those flows were based on modeling results related to ungaged watersheds, and do not reflect any of the observed stream flow monitoring data recorded for Drift Creek.

5. Additional data for the 90% and 95% exceedance frequencies were developed using a simplified procedure based on 2008-2014 observed stream flows at Upper Drift Creek to reflect actual runoff conditions, with adjustment to both represent data at the mouth of the creek and ensure maximum consistency with OWRD data.

6. The latest information received from OWRD staff in early June 2015 covers OWRD Proposed Final Order on the draft permit that was issued to EVWD on July 22, 2014. Some of the provisions listed in the draft permit, including the definition of the authorized refill period (November 1 through April 30), the requirement to pass all live flows during May 1 through October 31, and the specification that the "*use of allowed water may only be made at times when sufficient water is available to satisfy all prior rights*" are slightly more restrictive than originally assumed and used as reservoir refill criteria in the model runs performed up to now. Based on previous exploratory model runs, those generally more date-specific criteria did not have any significant impacts on the timing and quantity of water that can be stored in the reservoir. They will, however, be more closely modeled in future study updates.

7. Based on the updated water availability information provided on the Internet by OWRD, the likelihood to see an October-April runoff volume of 12,000 AF available for storage at the project site looks reasonably good. That volume is estimated at 17,700 AF for the 90% exceedance frequency (EF); 26,400 cfs for the 50% EF (a 2 year exceedance interval); and 39,500 cfs for the 10% EF (10 year exceedance interval).

8. The October-April runoff volumes listed above can be stored in the reservoir when the project has to meet 100% of the required in-stream flows listed for Drift Creek at its confluence with the Pudding River. Since the drainage area below the project contributes about 40% of the creek's runoff at the mouth, the actual runoff volume that can be stored would be greater than indicated if that local inflow may be used to meet part of the in-stream requirements. A sequential mass curve was prepared using the 2008-2014 observed stream flow data at Upper Drift Creek as an additional tool to help determine the storage required to provide a given set of in-stream and irrigation release requirements.

9. Under both the 2008-09 and 2009-10 runoff conditions and assuming that the project starts empty, the project would not have filled under full release requirements. However, the project would have filled when relying on the local inflow to meet part of those release requirements. By the same token, under the wetter 2010-11 runoff conditions, the project would have filled even if it starts empty on October 1 and has to release 100 percent of the in-stream flow requirements (when allowed by the actual inflow).

10. In preparation for more detailed analyses covering a wider range of runoff conditions, both statistical regression and deterministic computer modeling tools had to be set up. The statistical procedure was based on 2008-14 data and led to the definition of representative low, average and high flow years.

11. Two computer models were developed for Drift Creek. The rainfall-runoff deterministic model is code-named FLO4DRIFT. Once fully calibrated, this runoff model can generate daily flows for any site along Drift Creek based on rainfall (and snow) input. The RES4DRIFT reservoir model, on the other hand, can simulate reservoir operation under various inflow and outflow scenarios on a daily time step. Daily reservoir release criteria closely follow the release requirements currently in effect with regard to meeting consumptive and in-stream water rights, and pre-planned irrigation releases.

12. A 12-year continuous time series reservoir simulation was performed for the October 1, 2002 – September 30, 2014 with the reservoir starting empty on October 1, 2002. The October 1, 2002 start date was the day the Pudding River gauge at Aurora resumed its operation after a long period of inactivity. The inflows to the project for October 1, 2002 through September 30, 2008 were derived through the use of regression equations based on daily flows of the Pudding River at Aurora, while daily inflows for the October 1, 2008 – September 30, 2014 were actually recorded flows at the project site.

13. This simulation indicates that meeting in-stream water rights with or without relying on local inflows may not be that critical to being able to fill the reservoir by April 30 in most years. Three irrigation release levels were also modeled using base storage volumes of 8000, 10000 and 12000 AF to predict the outflows that could affect the water surface level and annual bank exposure. Model results, including predicted reservoir pool and release discharge, are available for further evaluation for each day of the October 1, 2002 - September 30, 2014 simulation.

14. Over the last six years, the annual runoff volume ranged from 22,629 AF to 37,606 AF, with largest volume occurring during the October 1, 2010 – September 30, 2011 water year. It appears that 2009-10, 2010-11, and 2011-12 were high flow years; 2012-13 and 2013-14 were close to average runoff years; and 2008-09, a low flow year. The six year average annual runoff was 31,117 AF. Hydrologic data that would be most useful in the near future are data that relate to high runoff conditions that possibly also include some snow-melt effects.

15. Flow duration curves were developed for the reservoir release season, from April through September, when the post-project stream flows are expected to be greater than the pre-project conditions. During that period, 50 percent of the stream flows are predicted to increase from the current 25 cfs to about 50 cfs and, thus, could have an impact on bank erosion in the reach below the dam.

16. Evaporation losses for both the entire October 2008-September 2014 period and each of the 12 months of the October 2008-September hydrologic years were predicted to be negligible, mainly because of the small size (about 310 acres) of the reservoir storage surface.

17. Evaluation of climate changes impacts on the Drift Creek flow regime of Drift Creek was also evaluated based on trend line analysis of long-term precipitation and air temperature data recorded at Salem, and on Pudding River stream flows at Aurora. Slightly warmer air temperature and slightly greater runoff trends were identified, but there are not enough data to more accurately explain current and/or predict future hydrographs shifts for Drift Creek. However, a wetter and warmer summer is predicted in most studies for the next 20 to 40 years. An attempt to define the range of possible future changes in Drift Creek's hydrograph in 2020 and 2040 was made based on assumptions used by a tri-agency climate change work group.

18. There will be a continuing need to work closely with OWRD to keep tract of its water availability data and ensure that the latest requirements for reservoir refill and release are modeled as accurately as possible in future Drift Creek hydrologic updates. There will soon be a need to spend significant efforts in other hydrology-related adjacent areas as well, including dam-break analysis and daily operational simulation to support the project’s physical and economic feasibility studies. The scope of future studies needs to be expanded beyond the reservoir area into the downstream reaches, addressing fish passage, in-stream water quality conditions, etc. The project's readiness and capability to release flushing flows of 630 cfs also deserves closer attention.

19. Bank erosion and mud flats movement have also raised some concerns, due to significant increases predicted for stream flows during summer and fall. Therefore, higher study priority should be soon assigned to this subject, including taking a look at stream velocities, wetted perimeters, and soil composition of the river bank downstream from the proposed dam site.

20. The validity of the conclusions reached so far in large part dependent on the length of the available stream flow data. As more of those data are available, more information will be gained to adequately cover all the most likely possible runoff conditions, and inspire more confidence on the study results.

19. Acknowledgments

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- Black Rock Consulting, Bend, OR
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- GSI Water Solutions, Corvallis, OR
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- Marion Soil and Water Conservation District, Salem, OR
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- Oregon Water Resources Department (Hydrographics/Measurement & Reporting)
- Oregon Water Resources Department (Water Rights Program)
- Oregon Water Resources Department (Water Availability)
- Portland State University Water Quality Research Group
- Water & Energy Resource Services, Clackamas, OR

A P P E N D I X

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3. 2008-11 Daily Flows at Nearby Streams (Pudding River at Aurora and at Woodburn, Zollner Creek, Abiqua, Silver Creek)
4. Monthly Flows of Pudding River at Aurora, 1928-2011
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11. Monthly Temperature at Salem McNary Field, OR
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13. Estimated Upper Drift Creek Daily Stream Flows for Representative Years (1935-36, 1933-34 and 1947-48)

Appendix 1. Summary of Drainage Areas

(Source: Marion SWCD)

Lower Abiqua Creek abv. Gallon House Bridge…..	75.7 sq. mi.
Butte Creek @ Monitor (14201500) ……	58.9 sq. mi.
Lower Drift Creek @ Hibbard Rd. ……	24.8 sq. mi.
Upper Drift Creek @ Victor Point Bridge……	15.4 sq. mi.
Upper Pudding River @ Selah Springs Rd. ……	34.5 sq. mi.
Silver Creek @ Silverton, OR (14200300) ……	48.3 sq. mi.

Appendix 2. Lower Drift Cr. Daily Flow Data

Appendix 2.1 2008-09 Daily Flow Data (Finalized 5/4/10)

MARION SOIL AND WATER CONSERVATION DISTRICT

Lower Drift Creek @ Hibbard Rd. Bridge, Silverton, OR

LAT:44 58 36 LONG: 122 49 47 DA 24.8 SQ.MI. CO MARION

DAILY DISCHARGE IN CFS WATER YEAR **OCT 2008 TO SEP 2009**

Day	Oct08	Nov08	Dec08	Jan09	Feb09	Mar09	Apr09	May09	Jun09	Jul09	Aug09	Sep09
1	0.96	.68	16	400	33	117	80	25	14	3.7	.67	.23
2	.95	.85	21	800	32	122	101	45	13	3.1	.61	.25
3	1.5	2	21	400	31	123	98	50	12	2.7	.46	.21
4	8	7.8	19	340	30	107	89	48	13	2.4	.43	.18

5	7.2	6	18	300	29	112	79	87	18	2.4	.43	.73
6	7.2	4.6	18	270	33	108	71	113	15	2.3	.49	1.6
7	6.5	4.7	17	400	35	97	65	151	14	1.9	.73	1.7
8	6.5	3.8	18	490	33	97	60	131	13	1.7	.79	1.3
9	7.2	4.7	17	325	31	95	56	109	12	1.9	.87	.86
10	6.3	5	15	185	32	92	58	92	11	2	.88	.79
11	5.8	6.2	15	157	37	86	49	80	11	2	.64	.79
12	5.5	31	17	133	35	78	46	71	11	2.6	.82	.71
13	5	150	26	116	34	72	55	65	10	3.9	.86	.47
14	4.2	98	24	101	35	71	54	77	10	3.4	.82	.52
15	3.8	70	20	90	35	115	49	62	9	2.8	.86	.51
16	3.5	54	18	81	34	140	46	52	7.9	2.3	.87	2.2
17	2.4	43	17	72	33	131	44	46	7.8	1.9	.77	2.6
18	2	33	30	65	31	116	42	41	7.6	1.5	.76	1.7
19	1.5	28	27	58	30	104	38	43	7.6	1.4	.54	1.2
20	1.2	28	25	50	28	95	35	40	7.3	1.3	.47	1
21	1.1	29	40	48	28	87	34	35	6.6	1.3	.4	.79
22	1.2	31	70	47	25	94	31	31	6	1.2	.44	.72
23	.86	29	60	42	29	91	30	28	5.4	1.3	.25	.52
24	.68	26	55	40	73	83	27	25	5	1.1	.41	.44
25	.62	24	70	41	137	88	25	23	4.4	.98	.56	.39
26	.58	23	60	38	183	91	24	23	4.4	1	.56	.4
27	.61	21	160	36	153	85	23	23	3.9	.76	.43	.41
28	.62	21	250	39	132	84	30	21	4.1	.52	.27	.54
29	.61	18	300	37		104	34	19	3.6	.17	.44	1.4
30	.64	18	230	35		90	29	17	3.8	.61	.34	1.2
31	.63		190	34		84		15		.65	.49	
Mean	3.1	27.4	60.8	170.0	50.4	98.7	50.1	54.5	9.0	1.8	0.6	0.9
Vol (AF)	191	1,630	3,738	10,450	2,798	6,067	2,980	3,350	535	111	37	54

2008-09 Annual Volume (AF)= 31,942

Appendix 2.2 2009-10 Lower Drift Cr. Daily Flow Data

Day	Oct09	Nov09	Dec09	Jan10	Feb10	Mar10	Apr10	May10	Jun10	Jul10	Aug10	Sep10
1	1.20	20.0	75.	271.0	71.0	74.0	225.0	84.0	224.0	18.0	2.8	1.3
2	1.20	16.0	64.	225.0	71.0	67.0	217.0	75.0	273.0	19.0	2.7	1.5
3	1.20	13.0	54.	167.0	68.0	65.0	231.0	75.0	221.0	18.0	2.7	1.4
4	1.20	11.0	47.	136.0	67.0	61.0	215.0	67.0	183.0	17.0	2.8	1.3
5	1.30	14.0	42.	150.0	67.0	56.0	192.0	61.0	165.0	16.0	2.6	0.9
6	4.10	24.0	37.	265.0	62.0	51.0	175.0	56.0	134.0	14.0	2.5	0.9
7	3.30	48.0	34.	199.0	59.0	48.0	156.0	50.0	121.0	12.0	2.1	1.1
8	2.40	75.0	31.	164.0	54.0	53.0	156.0	46.0	133.0	11.0	2.3	1.7
9	1.70	71.0	25.	157.0	52.0	46.0	136.0	43.0	137.0	9.9	2.3	2.1
10	1.50	61.0	23.	135.0	49.0	45.0	123.0	47.0	116.0	8.9	2.6	1.7
11	1.30	69.0	23.	120.0	52.0	49.0	113.0	42.0	99.0	8.3	2.2	1.7
12	1.30	103.0	22.	134.0	60.0	85.0	106.0	38.0	86.0	8.3	2.1	1.5
13	1.40	95.0	21.	134.0	68.0	124.0	92.0	35.0	79.0	7.9	1.9	1.3
14	2.80	87.0	20.	125.0	80.0	109.0	84.0	33.0	73.0	7.5	1.5	1.6
15	2.70	68.0	73.	125.0	92.0	95.0	126.0	30.0	65.0	6.6	1.4	2.3
16	2.90	55.0	175.	217.0	99.0	85.0	110.0	29.0	59.0	5.1	1.3	3.4
17	5.40	72.0	167.	218.0	91.0	78.0	97.0	30.0	48.0	4.9	1.3	3.0
18	7.30	90.0	128.	203.0	85.0	68.0	85.0	35.0	45.0	4.8	1.2	3.5
19	6.60	76.0	112.	170.0	78.0	61.0	75.0	35.0	43.0	5.0	1.1	9.9
20	5.10	75.0	111.	147.0	70.0	57.0	70.0	36.0	37.0	4.8	0.9	8.6
21	3.70	103.0	192.	128.0	64.0	55.0	78.0	37.0	34.0	4.6	0.9	7.3
22	2.50	121.0	212.	114.0	59.0	62.0	63.0	65.0	32.0	4.3	1.2	4.7
23	3.60	109.0	156.	102.0	56.0	53.0	55.0	67.0	28.0	3.7	1.0	3.6
24	6.00	89.0	129.	100.0	68.0	49.0	52.0	64.0	25.0	3.7	0.4	3.2

25	6.30	73.0	107.	137.0	69.0	59.0	47.0	62.0	23.0	3.7	0.3	3.1
26	10.00	71.0	90.	125.0	78.0	117.0	45.0	94.0	20.0	3.2	0.4	3.0
27	19.00	168.0	77.	109.0	89.0	130.0	76.0	103.0	20.0	2.9	0.9	2.9
28	13.00	140.0	65.	97.0	80.0	124.0	103.0	90.0	19.0	2.8	1.0	2.6
29	10.00	109.0	58.	87.0		303.0	108.0	83.0	224.0	2.7	1.0	2.5
30	16.00	90.0	75.	82.0		333.0	96.0	74.0	273.0	2.8	1.0	2.4
31	19.00		138.	76.0		288.0		81.0		2.7	1.0	
Mean	5.3	73.87	83.32	149.00	69.93	95.16	116.90	57.00	101.30	7.87	1.59	2.87
Vol (AF)	327	4,395	5,122	9,159	3,883	5,850	6,954	3,504	6,026	484	98	171

2009-10 Annual Volume (AF)= 45,973

Appendix 2.3 2010-11 Lower Drift Cr. Daily Flow Data

Day	Oct10	Nov10	Dec10	Jan11	Feb11	Mar11	Apr11	May11	Jun11	Jul11	Aug11	Sep11
1	2.1	30.0	287.0	213.0	59.0	142.0	139.0	89.0	77.0	19.0	2.5	1.5
2	1.9	88.0	284.0	176.0	54.0	356.0	151.0	82.0	77.0	15.0	2.1	1.6
3	2.2	75.0	219.0	150.0	51.0	307.0	124.0	74.0	73.0	13.0	2.2	1.5
4	2.4	57.0	178.0	129.0	47.0	247.0	112.0	66.0	65.0	12.0	2.3	1.5
5	2.1	45.0	146.0	112.0	44.0	217.0	121.0	60.0	59.0	10.0	1.9	1.2
6	2.1	47.0	122.0	101.0	42.0	205.0	114.0	57.0	55.0	8.7	1.8	1.1
7	2.1	155.0	105.0	89.0	41.0	170.0	136.0	61.0	50.0	8.5	2.0	1.2
8	2.3	125.0	134.0	88.0	39.0	146.0	123.0	59.0	46.0	8.3	1.9	0.9
9	5.6	121.0	245.0	82.0	36.0	126.0	109.0	61.0	41.0	7.9	2.0	1.2
10	21.0	154.0	346.0	74.0	34.0	117.0	99.0	55.0	37.0	7.9	2.0	1.2
11	18.0	122.0	319.0	67.0	33.0	212.0	108.0	54.0	36.0	7.0	2.1	1.1
12	5.3	105.0	309.0	77.0	33.0	198.0	98.0	60.0	33.0	9.4	1.8	1.2
13	1.4	89.0	410.0	139.0	42.0	168.0	94.0	53.0	34.0	9.3	1.7	1.1
14	1.1	91.0	459.0	179.0	42.0	169.0	101.0	50.0	30.0	7.5	1.6	0.9
15	1.2	87.0	391.0	177.0	85.0	200.0	123.0	54.0	27.0	6.9	1.8	1.0
16	1.2	95.0	314.0	477.0	116.0	186.0	194.0	64.0	25.0	8.1	1.7	1.0
17	1.2	97.0	253.0	525.0	99.0	233.0	201.0	59.0	22.0	13.0	1.4	1.2
18	1.2	309.0	241.0	401.0	89.0	256.0	167.0	55.0	22.0	16.0	1.6	1.2
19	1.1	254.0	212.0	380.0	86.0	223.0	137.0	49.0	24.0	13.0	1.6	1.4
20	1.1	229.0	198.0	291.0	76.0	203.0	114.0	45.0	21.0	12.0	1.5	1.3
21	1.1	184.0	177.0	253.0	69.0	175.0	101.0	41.0	19.0	9.2	1.5	1.0
22	1.3	189.0	151.0	218.0	65.0	157.0	89.0	39.0	18.0	8.1	1.4	1.3
23	2.3	217.0	122.0	182.0	63.0	141.0	79.0	36.0	17.0	7.1	1.4	1.2
24	14.0	166.0	107.0	155.0	65.0	123.0	73.0	34.0	16.0	6.1	1.4	0.8
25	23.0	138.0	97.0	132.0	61.0	120.0	93.0	37.0	15.0	5.4	1.4	0.8
26	32.0	132.0	113.0	115.0	57.0	113.0	91.0	38.0	15.0	5.1	1.6	1.3
27	24.0	183.0	139.0	102.0	56.0	132.0	87.0	61.0	14.0	4.3	1.6	1.7
28	20.0	159.0	324.0	91.0	59.0	132.0	89.0	84.0	15.0	3.6	1.5	2.2
29	24.0	135.0	484.0	81.0		131.0	105.0	86.0	15.0	3.4	1.4	1.8
30	18.0	151.0	338.0	73.0		159.0	98.0	77.0	15.0	2.7	1.4	1.6
31	37.0		255.0	65.0		179.0		73.0		3.0	1.4	
Mean	8.82	134.30	241.26	174.00	58.68	182.03	115.67	58.48	33.77	8.73	1.73	1.27
Vol (AF)	542	7,990	14,831	10,696	3,258	11,190	6,881	3,595	2,009	537	106	76

2010-11 Annual Volume (AF)= 61,711

Appendix 3 Daily Flows at Nearby Streams

Table A3.1 Pudding River at Aurora Daily Discharge (2008-09)

Days	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	70	93	366	4920	644	2410	1790	590	349	105	21	19
2	66	109	354	6850	613	2200	1670	583	323	93	19	20
3	73	128	441	10500	584	2270	1950	808	309	87	17	21
4	81	235	492	8930	559	2320	1990	936	298	79	15	20
5	130	563	447	6860	545	2080	1790	1290	300	73	14	21
6	236	641	414	5750	538	1920	1570	1960	368	67	13	29
7	217	682	391	5110	570	1810	1410	2410	389	68	13	48
8	211	740	381	4970	620	1640	1310	2560	371	61	13	79
9	243	632	390	5310	602	1510	1250	2270	329	59	13	78
10	205	591	377	5500	581	1420	1270	1910	294	59	15	65
11	181	553	351	5150	572	1310	1260	1600	271	55	21	55
12	170	681	334	4470	585	1190	1140	1380	259	59	25	45
13	155	1850	351	3730	580	1100	1180	1260	254	70	21	39
14	141	3060	451	3160	567	1030	1550	1290	277	92	19	34
15	128	2550	480	2690	552	1160	1460	1660	285	110	26	33
16	120	1700	466	2330	546	1920	1290	1520	259	100	42	33
17	113	1140	429	1990	540	2400	1150	1290	231	77	44	31
18	112	842	438	1630	531	2440	1060	1100	215	63	46	29
19	114	681	505	1390	512	2240	1010	989	206	49	39	33
20	112	585	520	1250	487	2000	937	965	203	42	28	38
21	116	583	526	1140	468	1860	903	892	208	40	22	40
22	128	629	809	1040	459	1790	884	782	211	39	21	38
23	147	593	1230	959	466	1750	839	695	203	29	19	35
24	129	555	1260	892	651	1630	775	635	182	26	19	34
25	114	509	1470	838	1530	1540	710	580	163	26	18	32
26	112	476	1760	805	2580	1660	648	536	142	36	20	31
27	105	445	1920	752	3020	1690	602	499	136	35	21	31
28	100	415	2990	711	2740	1610	578	460	132	28	17	31
29	96	395	4250	719		1930	627	431	131	23	15	31
30	94	378	4860	714		2250	642	401	120	20	17	35
31	91		4960	676		2040		369		23	18	
Ave	132.6	767.8	1110.1	3281.8	830.1	1810.3	1174.8	1117.8	247.3	57.8	21.6	36.9
Vol (AF)	8150	45676	68241	201742	46089	111286	69891	68713	14710	3556	1331	2197

Table A3.2 Pudding River at Aurora Daily Discharge (2009-10)

Pudding @ Aurora

2009-2010

Days	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	41	343	1500	2770	1310	1520	4900	1780	1130	359	76	33
2	49	364	1250	4030	1250	1350	4240	1590	1260	344	79	32
3	48	291	1070	4110	1240	1220	3820	1440	2690	354	79	31
4	54	239	921	3610	1220	1110	3640	1500	3660	366	72	34
5	55	203	808	3180	1230	1020	3470	1460	4300	336	66	37
6	56	200	722	3560	1230	928	3210	1340	4300	308	66	38
7	61	338	653	4190	1160	850	2970	1240	3730	280	64	39
8	56	852	578	4000	1080	810	2770	1110	3020	255	62	37
9	51	1550	475	3620	1010	873	2640	1010	2430	227	67	45
10	48	1460	460	3350	943	853	2410	936	2240	201	67	59
11	49	1200	445	2930	908	774	2170	953	2260	188	60	64
12	47	1180	503	2600	998	852	2000	916	2170	186	55	62
13	48	1330	527	2670	1220	1620	1910	835	1940	177	52	58
14	53	1330	475	2540	1350	1910	1870	765	1670	170	48	53
15	57	1210	516	2340	1650	1730	1940	709	1440	160	44	50
16	87	1010	1860	2780	1760	1530	2210	664	1290	150	39	52
17	95	878	3010	3480	1790	1360	2130	629	1170	142	38	58
18	91	1240	2990	3670	1660	1230	1920	609	1070	138	36	69
19	111	1500	2630	3490	1490	1110	1720	613	956	140	34	100
20	111	1410	2310	3050	1330	1000	1570	684	868	137	34	190
21	96	1390	2310	2590	1180	919	1490	804	820	127	35	319
22	90	1510	3190	2210	1060	930	1470	949	760	122	36	270
23	94	1920	3370	1980	959	1050	1300	1160	689	116	40	187
24	97	1890	2900	1800	956	979	1150	1180	627	109	42	147
25	108	1600	2390	2070	1180	926	1090	1110	572	102	39	131
26	141	1330	2010	2530	1420	1100	1000	1090	524	97	33	120
27	150	1410	1680	2320	1730	1640	1030	1310	489	91	32	106
28	260	2190	1420	2000	1740	1830	1600	1320	462	80	34	98
29	283	2190	1240	1740		2510	1970	1200	421	75	32	94
30	232	1830	1160	1530		4410	1960	1150	386	80	32	89
31	276		1380	1410		5070		1090		79	36	
Ave	99.8	1179.6	1508.2	2843.5	1287.6	1452.1	2252.3	1069.2	1644.8	183.7	49.3	90.1
Vol (AF)	6137	70174	92711	174801	71495	89263	133991	65729	97849	11295	3032	5358

Table A3.3 Pudding River at Aurora Daily Discharge (2010-11)

Pudding @ Aurora

2010-2011

Days	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	84	1050	2470	5280	1190	3560	3120	1660	1610	313	118	59
2	82	1080	3580	4370	1080	5260	3130	1520	1990	303	112	53
3	80	1500	3840	3510	988	4910	3120	1410	2030	267	103	50
4	78	1330	3460	2910	914	4220	2680	1290	1780	252	99	46
5	77	1030	2920	2470	854	3760	2640	1190	1510	234	94	44
6	75	828	2460	2190	820	3530	2840	1120	1320	216	93	53
7	72	1040	2100	1900	800	3170	3000	1110	1200	201	98	55
8	71	1930	1980	1660	783	2740	3300	1210	1070	196	100	50
9	77	1840	2850	1570	767	2390	2920	1330	952	191	98	53
10	119	1770	4430	1480	715	2960	2430	1320	850	183	97	51
11	319	1950	5430	1380	671	4180	2120	1210	779	180	93	48
12	463	1790	5900	1320	647	3910	2180	1230	722	172	89	47
13	315	1570	6030	1950	741	3480	2080	1260	674	173	86	49
14	226	1360	6300	3210	906	3860	1970	1140	664	190	84	49
15	180	1340	7230	3390	1190	4320	2170	1080	629	186	85	44
16	153	1320	7140	4070	2000	4790	3070	1210	564	173	87	42
17	140	1440	6260	5530	2170	5360	3810	1300	519	177	80	44
18	129	2100	5420	6790	1890	5350	3880	1220	484	261	75	47
19	120	3590	4780	7790	1670	4780	3350	1130	484	307	72	51
20	116	3580	4210	7040	1510	4120	2650	1030	518	296	67	52
21	112	3090	3770	5970	1340	3540	2160	942	472	288	67	53
22	111	2650	3350	5240	1210	3130	1830	886	428	248	65	52
23	106	2530	2930	4490	1120	2830	1580	844	392	220	65	50
24	123	2370	2530	3720	1080	2600	1420	793	371	199	63	47
25	325	2020	2190	3120	1050	2420	1390	749	350	181	61	47
26	871	1720	1920	2660	975	2230	1790	783	327	166	59	45
27	1040	1720	2100	2290	899	2200	1970	867	316	157	59	50
28	846	2120	2980	1960	1090	2220	1850	1290	307	145	67	59
29	691	2110	5510	1650		2220	1790	1550	315	130	99	65
30	648	1950	6340	1450		2620	1770	1570	318	123	92	63
31	704		5960	1310		3040		1480		118	75	
Ave	275.9	1857.3	4141.0	3344.2	1109.6	3538.7	2467.0	1184.6	798.2	207.9	83.9	50.6
Vol (AF)	16961	110489	254558	205578	61612	217535	146762	72824	47483	12782	5160	3010

Table A3.4 Pudding River at Aurora Daily Discharge (2011-12)

Pudding @ Aurora

2011-2012

Days	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	60	223	1460	5490	3610	2550	9210	1660	545	360	106	50
2	58	249	1230	4890	3130	2870	9000	1700	510	348	101	53
3	65	208	1050	3780	2700	2400	7290	1650	499	313	97	60
4	73	217	914	2990	2340	2090	6130	1990	480	285	91	60
5	91	244	806	2550	2030	1940	5400	2060	601	261	87	57
6	119	203	721	2300	1760	2030	4730	1910	878	247	85	54
7	119	176	651	1980	1560	2070	4080	1700	839	224	82	53
8	107	170	593	1690	1380	1870	3540	1520	813	206	75	52
9	102	158	544	1470	1430	1690	3080	1360	906	192	68	51
10	104	152	501	1360	1590	1560	2670	1220	1010	176	63	54
11	102	144	464	1340	1680	1600	2260	1090	953	167	65	58
12	182	136	435	1220	1880	2000	2010	982	851	164	69	60
13	311	144	407	1100	1730	3010	1900	892	784	166	71	51
14	225	188	383	998	1590	4710	1900	822	739	168	70	41
15	167	256	363	956	1460	4940	1750	766	669	161	64	41
16	138	303	354	949	1350	6170	1530	715	601	158	60	41
17	121	415	348	915	1270	8240	1800	662	547	156	57	43
18	108	1330	332	2090	1320	8290	1910	613	498	150	55	45
19	98	1470	319	5670	1540	7140	1920	571	485	152	54	46
20	92	1260	313	18600	1550	5770	2140	535	476	151	58	44
21	86	988	300	14500	1650	5220	2330	518	445	146	65	42
22	82	1120	289	11800	2010	5980	2120	570	409	133	60	42
23	79	2470	276	9600	2530	6730	1880	733	394	130	55	46
24	78	2910	263	7850	2600	6260	1700	791	429	121	52	52
25	77	2860	255	7430	2440	5280	1520	922	470	117	49	55
26	76	2600	257	7280	2370	4370	1480	1030	440	116	48	53
27	76	2150	280	6570	2130	3650	1770	957	433	115	52	50
28	71	2000	359	5720	1920	3180	1780	828	431	112	52	48
29	71	2030	2220	4880	1840	2920	1630	725	386	360	52	47
30	77	1730	3890	4360		3770	1510	652	360	348	53	47
31	110		5140	4090		6350		594		313	53	
Ave	107.3	950.1	829.6	4723.2	1944.5	4085.5	3065.7	1056.1	596.0	200.5	66.7	49.9
Vol (AF)	6593	56523	50997	290347	111821	251147	182377	64919	35458	12326	4103	2967

Table A3.5 Pudding River at Aurora Daily Discharge (2012-13)

Pudding @ Aurora

2012-2013

Days	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	45	1190	2540	2030	3230	1240	891	579	1440	242	35	44
2	47	1140	3130	1770	2810	1520	877	526	1170	220	31	42
3	45	1110	3680	1560	2470	1500	835	486	988	198	32	40
4	43	1080	3910	1410	2180	1410	798	463	842	181	41	38
5	41	998	4910	1470	1930	1270	791	446	728	168	44	37
6	41	839	5470	1290	1810	1200	976	424	634	161	50	83
7	39	715	5050	1140	1720	1350	1460	393	555	152	40	258
8	38	650	4290	1200	1630	1360	1970	364	491	151	31	393
9	39	583	3640	1420	1510	1260	1840	345	440	145	27	252
10	40	520	3120	1660	1390	1150	1550	329	398	132	27	167
11	42	476	2720	1650	1290	1050	1400	311	359	122	26	125
12	45	471	2450	1480	1200	1000	1290	295	330	111	31	100
13	55	763	2240	1320	1150	979	1190	287	312	102	33	86
14	78	1010	1980	1180	1130	935	1150	281	323	99	29	73
15	114	968	1800	1070	1090	924	1110	274	343	98	27	70
16	187	861	1740	988	1050	932	1050	262	302	91	26	70
17	467	775	2260	921	1030	1000	996	270	269	83	25	70
18	421	1030	3410	865	998	1080	924	288	243	77	29	71
19	261	2170	3540	821	956	997	872	292	223	76	32	71
20	222	4410	3240	787	926	1090	966	308	253	78	31	69
21	247	6790	3860	758	888	2000	1050	321	299	74	28	76
22	282	8800	3860	783	801	1990	994	327	268	76	22	90
23	303	8480	3460	759	1020	1700	926	540	241	75	21	101
24	316	6950	3600	776	1260	1450	858	810	248	65	24	152
25	332	6050	3660	917	1200	1300	792	1110	299	60	28	227
26	373	5110	3900	1480	1280	1190	738	1110	331	51	36	307
27	342	4220	3990	1850	1240	1100	692	1020	393	43	44	330
28	348	3460	3630	1930	1180	1040	650	1340	369	39	42	275
29	1180	2880	3150	2400		996	621	1670	315	42	44	524
30	1920	2550	2700	3380		949	608	1860	272	43	41	1850
31	1570		2330	3560		913		1760		40	38	
Ave	307.2	2568.3	3331.0	1439.5	1441.8	1221.8	1028.8	615.8	455.9	106.3	32.7	203.0
Vol (AF)	18884	152788	204765	88491	80052	75106	61205	37857	27123	6534	2013	12078

Table A3.6 Pudding River at Aurora Daily Discharge (2013-14)

Pudding @ Aurora

2013-2014

Days	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	2470	230	556	546	1140	2050	3570	1460	384	300	55	24
2	2330	240	951	519	1070	1830	3040	1280	365	246	51	37
3	1960	317	2500	509	993	2260	2590	1130	342	213	50	34
4	1550	482	2370	546	929	3010	2240	1060	319	189	50	30
5	1210	470	1920	539	870	3200	2060	1130	303	173	54	46
6	963	489	1560	498	804	4550	1970	1110	285	159	45	44
7	796	650	1280	475	762	5520	2010	1020	266	152	38	37
8	708	1030	1090	489	758	5130	1890	919	246	134	35	28
9	691	1130	935	686	777	4630	1700	1070	237	114	29	20
10	681	984	854	1030	1020	4860	1530	1840	224	102	27	17
11	625	841	787	1280	1770	4750	1360	2160	204	87	31	17
12	560	740	729	1820	3460	4280	1220	1880	189	83	37	15
13	508	733	696	2340	4680	3720	1100	1540	188	82	38	15
14	468	748	725	2510	5340	3190	999	1300	219	91	36	14
15	428	686	707	2280	6140	2810	909	1130	249	94	34	14
16	397	651	657	1960	7010	2430	838	989	240	87	37	16
17	370	768	624	1650	7340	2300	796	879	251	79	39	16
18	349	831	593	1400	6950	2370	829	822	294	69	40	16
19	328	905	569	1220	6810	2080	866	885	264	61	42	16
20	312	1850	553	1080	6800	1820	783	995	226	59	34	19
21	299	2000	533	980	6220	1610	740	866	211	68	26	21
22	287	1620	618	891	5510	1440	709	746	200	74	22	22
23	276	1300	675	819	4770	1300	823	668	189	81	21	25
24	264	1100	689	757	4070	1190	1300	621	170	105	19	41
25	257	967	756	701	3570	1110	2590	587	159	126	20	72
26	248	855	744	651	3120	1090	2660	541	160	143	21	97
27	243	771	712	613	2710	1310	2270	503	199	119	18	87
28	239	705	676	590	2390	1900	2160	476	289	105	15	70
29	269	645	636	624		3320	1970	457	388	89	15	60
30	265	591	599	1050		4250	1690	442	358	71	17	54
31	240		571	1210		4130		412		57	19	
Ave	664.2	844.3	898.9	1,040.7	3.492.2	2,885.2	1,640.4	997.3	253.9	116.50	32.7	34.1
Vol (AF)	40832	50227	55258	63975	193904	177362	97587	61307	15105	7163	2012.7	2030

Appendix 4. Monthly Flows, Pudding River @ Aurora (1928-2014)

USGS 14202000 PUDDING RIVER AT AURORA, OR **00060** Discharge, cfs												
YEAR	Monthly mean in cfs (Calculation Period: 1928-10-01 -> 2014-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1928										162.0	605.2	1,273
1929	1,875	1,066	1,097	1,752	757.1	374.1	125.0	67.1	57.3	68.5	81.5	1,907
1930	962.2	3,868	1,073	682.9	828.4	374.9	128.1	71.0	79.6	123.4	460.5	573.4
1931	1,464	956.7	1,652	3,086	327.2	349.1	181.2	74.4	70.0	204.6	1,780	2,593
1932	3,304	2,010	3,312	1,754	743.7	332.4	123.1	74.6	60.0	161.3	1,613	2,168
1933	3,574	2,263	2,937	1,262	1,361	1,101	206.9	97.0	205.3	295.5	699.7	5,170
1934	3,633	864.4	1,325	1,142	695.5	207.2	101.8	68.2	62.2	355.4	1,975	2,842
1935	2,992	1,535	1,996	1,217	551.1	183.6	124.3	64.6	72.4	135.9	318.7	668.3
1936	4,352	1,773	1,428	1,002	858.9	489.3	191.2	68.5	79.9	66.1	78.9	662.4
1937	766.5	3,563	2,100	3,239	901.5	730.1	265.7	97.1	109.6	305.1	3,039	3,904
1938	3,670	2,990	3,121	1,668	682.1	216.5	99.0	54.8	60.7	120.3	888.6	1,204
1939	1,853	2,679	1,702	638.3	241.9	294.2	124.3	51.9	64.9	149.7	151.0	1,679
1940	1,353	3,532	2,491	1,477	671.6	158.0	66.7	49.6	81.0	205.1	1,110	1,863
1941	1,885	831.5	598.5	456.3	638.3	337.2	116.8	73.2	212.9	298.2	1,138	3,408
1942	1,719	2,277	916.2	498.4	929.1	661.7	242.7	94.1	60.6	78.1	3,098	4,624
1943	3,768	3,916	1,035	2,713	720.4	616.8	217.2	119.8	94.0	543.8	783.8	1,130
1944	1,463	1,466	1,047	1,120	474.4	283.3	97.3	54.2	58.5	70.9	373.2	435.9
1945	1,517	2,466	2,527	1,879	1,623	414.6	116.4	72.3	142.5	108.2	1,801	2,955
1946	3,488	2,507	3,000	1,028	466.5	263.8	179.1	71.0	83.1	353.0	2,006	3,452
1947	1,572	1,999	1,421	1,448	322.5	475.2	196.6	102.3	96.3	1,774	2,482	1,518
1948	3,664	2,311	2,454	1,730	1,416	395.6	146.1	109.2	116.4	295.3	1,508	3,661
1949	1,209	5,600	2,067	1,086	1,081	250.3	112.5	66.7	90.4	245.0	699.7	2,004
1950	4,735	4,263	3,310	1,638	990.8	471.5	143.4	78.7	77.5	1,170	4,643	3,239
1951	4,853	3,208	2,624	887.2	703.1	203.3	79.5	50.6	64.1	914.4	1,497	3,283
1952	2,241	3,474	1,905	1,130	618.3	327.5	364.0	69.4	64.1	63.8	104.3	792.7
1953	5,576	3,743	2,142	1,179	1,171	897.6	183.2	97.5	91.9	326.7	1,770	4,772
1954	3,721	3,375	1,506	1,656	418.0	707.9	282.5	112.5	157.9	390.6	1,028	1,808
1955	1,895	1,255	1,795	3,054	1,193	500.5	224.4	76.7	107.5	1,036	3,039	5,704
1956	5,722	2,127	3,115	1,630	682.1	365.3	116.4	71.0	76.9	331.8	755.7	1,421
1957	1,108	1,872	3,945	1,361	658.7	360.2	91.2	58.5	41.3	153.1	404.8	2,959
1958	2,982	4,384	1,459	2,011	567.4	305.5	95.2	33.9	60.0	103.3	1,846	1,874
1959	4,017	3,067	1,716	1,347	1,061	441.8	123.1	39.4	180.0	578.6	515.3	879.6
1960	1,374	2,789	2,543	2,037	1,820	532.5	84.2	54.3	73.5	142.4	2,775	1,883
1961	2,006	5,550	4,235	1,264	1,214	271.8	78.9	35.4	86.3	258.6	776.9	2,880
1962	1,322	1,242	2,589	1,882	1,454	417.9	85.7	75.1	77.6	461.1	2,163	2,302

1963	819.2	2,458	1,548	3,355	2,192	287.1	187.3	57.5	85.2	185.3	1,940	1,289
1964	4,513	1,840	1,656	939.9	687.7	467.2	131.0	83.5	84.6			
1993							290.4	116.5	73.6	79.5	99.1	1,114
1994	2,050	1,590	1,741	1,225	375.3	373.1	59.1	11.3	32.8	346.5	2,557	2,957
1995	3,017	3,335	1,595	1,123	812.2	329.4	111.8	54.8	67.8	520.0	2,233	4,323
1996	3,888	6,948	1,988	1,867	1,552	523.5	158.5	38.7	106.2	606.6	3,387	6,090
1997	4,643	2,875	3,728	1,446	727.9	498.3	178.6	63.9	197.6			
2002										86.6	255.4	1,383
2003	2,565	2,973	3,116	2,345	1,034	291.8	53.2	13.1	53.7	93.3	393.6	2,705
2004	3,364	2,884	1,296	727.5	469.7	618.8	98.9	106.2	329.4	428.9	617.0	1,579
2005	758.5	496.7	824.6	1,620	1,132	570.2	180.7	35.0	44.5	185.4	1,476	2,559
2006	6,873	2,506	1,507	1,515	527.8	469.2	81.5	27.0	33.0	85.3	3,454	3,554
2007	2,814	2,001	2,166	1,035	500.0	178.2	58.7	27.0	34.7	424.7	1,005	3,051
2008	3,524	2,371	1,992	1,387	1,092	691.7	134.7	76.5	53.9	132.6	767.8	1,110
2009	3282.0	830.1	1810.0	1175.0	1118.0	247.3	57.8	21.6	36.9	99.8	1180.0	1508.0
2010	2844.0	1288.0	1452.0	2252.0	1069.0	1645.0	183.7	49.3	90.1	275.9	1857.0	4141
2011	3344.0	1110.0	3539.0	2467.0	1185.0	798.2	207.9	83.9	50.6	107.3	950.1	829.6
2012	4723.0	1944.0	4085.0	3066.0	1056.0	596.0	203.7	66.7	49.9	307.2	2578.0	3383.0
2013	1502.0	1443.0	1219.0	1026.0	615.7	455.9	106.3	32.7	203.0	664.2	844.3	898.9
2014	1040.7	3492.2	2885.2	1640.4	997.3	253.9	116.5	32.7	34.1			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

** No Incomplete data have been used for statistical calculation. Bold numbers=more recent data

Appendix 5. Observed Monthly Oct. –Apr. Flows (cfs), Pudding River nr. Aurora

(1928-2014)

Hydro Year=	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Oct-Apr Vol (AF)
1928-29	162.0	605.2	1273.0	1875.0	1066.0	1097.0	1752.0	470,330
1929-30	68.5	81.5	1907.0	962.2	3868.0	1073.0	682.9	506,791
1930-31	123.4	460.5	573.4	1464.0	956.7	1652.0	3086.0	498,485
1931-32	204.6	1780.0	2593.0	3304.0	2010.0	3312.0	1754.0	904,509
1932-33	161.3	1613.0	2168.0	3574.0	2263.0	2937.0	1262.0	840,124
1933-34	295.5	699.7	5170.0	3633.0	864.4	1325.0	1142.0	798,321
1934-35	355.4	1975.0	2842.0	2992.0	1535.0	1996.0	1217.0	778,303
1935-36	135.9	318.7	668.3	4352.0	1773.0	1428.0	1002.0	585,279
1936-37	66.1	78.9	662.4	766.5	3563.0	2100.0	3239.0	616,209
1937-38	305.1	3039.0	3904.0	3670.0	2990.0	3121.0	1668.0	1,122,245
1938-39	120.3	888.6	1204.0	1853.0	2679.0	1702.0	638.3	539,529
1939-40	149.7	151.0	1679.0	1353.0	3532.0	2491.0	1477.0	648,682

1940-41	205.1	1110.0	1863.0	1885.0	831.5	598.5	456.3	419,148
1941-42	298.2	1138.0	3408.0	1719.0	2277.0	916.2	498.4	613,602
1942-43	78.1	3098.0	4624.0	3768.0	3916.0	1035.0	2713.0	1,147,435
1943-44	543.8	783.8	1130.0	1463.0	1466.0	1047.0	1120.0	454,753
1944-45	70.9	373.2	435.9	1517.0	2466.0	2527.0	1879.0	550,657
1945-46	108.2	1801.0	2955.0	3488.0	2507.0	3000.0	1028.0	894,637
1946-47	353.0	2006.0	3452.0	1572.0	1999.0	1421.0	1448.0	734,364
1947-48	1774.0	2482.0	1518.0	3664.0	2311.0	2454.0	1730.0	961,931
1948-49	295.3	1508.0	3661.0	1209.0	5600.0	2067.0	1086.0	909,843
1949-50	245.0	699.7	2004.0	4735.0	4263.0	3310.0	1638.0	1,008,572
1950-51	1170.0	4643.0	3239.0	4853.0	3208.0	2624.0	887.2	1,237,781
1951-52	914.4	1497.0	3283.0	2241.0	3474.0	1905.0	1130.0	869,953
1952-53	63.8	104.3	792.7	5576.0	3743.0	2142.0	1179.0	811,270
1953-54	326.7	1770.0	4772.0	3721.0	3375.0	1506.0	1656.0	1,025,958
1954-55	390.6	1028.0	1808.0	1895.0	1255.0	1795.0	3054.0	674,511
1955-56	1036.0	3039.0	5704.0	5722.0	2127.0	3115.0	1630.0	1,357,641
1956-57	331.8	755.7	1421.0	1108.0	1872.0	3945.0	1361.0	648,236
1957-58	153.1	404.8	2959.0	2982.0	4384.0	1459.0	2011.0	851,445
1958-59	103.3	1846.0	1874.0	4017.0	3067.0	1716.0	1347.0	834,219
1959-60	578.6	515.3	879.6	1374.0	2789.0	2543.0	2037.0	642,653
1960-61	142.4	2775.0	1883.0	2006.0	5550.0	4235.0	1264.0	1,056,599
1961-62	258.6	776.9	2880.0	1322.0	1242.0	2589.0	1882.0	660,499
1962-63	461.1	2163.0	2302.0	819.2	2458.0	1548.0	3355.0	780,119
1963-64	185.3	1940.0	1289.0	4513.0	1840.0	1656.0	939.9	746,995
1993-94	79.5	99.1	1114.0	2050.0	1590.0	1741.0	1225.0	473,466
1994-95	346.5	2557.0	2957.0	3017.0	3335.0	1595.0	1123.0	890,685
1995-96	520.0	2233.0	4323.0	3888.0	6948.0	1988.0	1867.0	1,302,397
1996-97	606.6	3387.0	6090.0	4643.0	2875.0	3728.0	1446.0	1,373,397
2002-03	86.6	255.4	1383.0	2565.0	2973.0	3116.0	2345.0	759,339
2003-04	93.3	393.6	2705.0	3364.0	2884.0	1296.0	727.5	691,029
2004-05	428.9	617.0	1579.0	758.5	496.7	824.6	1620.0	381,407
2005-06	185.4	1476.0	2559.0	6873.0	2506.0	1507.0	1515.0	1,000,928
2006-07	85.3	3454.0	3554.0	2814.0	2001.0	2166.0	1035.0	908,008
2007-08	424.7	1005.0	3051.0	3524.0	2371.0	1992.0	1387.0	831,396
2008-09	132.58	767.80	1110.10	3281.81	830.07	1810.32	1174.83	551,076
2009-10	99.84	1179.60	1508.16	2843.55	1287.64	1452.06	2252.33	638,574
2010-11	275.90	1857.27	4140.97	3344.19	1109.64	3538.71	2467.00	1,013,493
2011-12	107.26	950.13	829.58	4723.16	1944.48	4085.48	3065.67	949,805
2012-13	307.19	2577.63	3382.90	1502.10	1442.64	1219.00	1025.67	688,577
2013-14	664.23	844.30	898.87	1040.74	3492.25	2885.16	1640.47	679,148

Note: monthly flows are in cfs; last column numbers represent runoff volume in AF

Appendix 6. Monthly Flows of Other Nearby Streams

A6.1 Zollner Creek

USGS 14201300 ZOLLNER CREEK NEAR MT ANGEL, OR 00060, Discharge, cfs												
YEAR	Monthly mean in cfs (Calculation Period: 1993-10-01 -> 2008-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1993										1.67	1.89	35.6
1994	51.4	55.5	16.0	11.2	2.05	4.75	0.237	0.275	0.294	16.8	70.7	61.6
1995	62.8	48.2	30.7	9.05	4.86	2.60	1.12	0.795	1.00	9.65	86.6	82.0
1996	103.4	113.8	24.5	25.9	21.8	3.65	1.12	0.598	1.70	23.1	121.3	186.9
1997	78.2	45.0	91.5	20.0	6.35	6.60	1.66	0.932	2.54	12.4	24.4	26.1
1998	40.6	33.1	38.6	8.14	10.0	4.91	1.59	0.522	1.22	3.67	55.2	91.8
1999	77.2	102.6	43.4	10.0	4.40	1.53	0.631	0.404	0.239	0.934	27.8	42.1
2000	49.6	57.9	29.2	5.80	5.26	2.05	0.771	0.264	0.698	1.78	3.09	10.9
2001	7.47	9.27	10.4	9.32	3.58	1.67	0.381	0.142	0.185	0.976	33.6	97.6
2002	66.5	37.2	35.9	6.15	2.88	0.950	0.712	0.278	0.434	0.798	1.51	35.0
2003	58.7	37.1	49.9	38.5	7.87	1.63	0.548	0.590	0.686	1.39	5.48	46.6
2004	51.4	40.1	13.7	2.75	2.11	2.41	0.376	0.156	0.278	3.05	5.13	20.8
2005	8.83	6.99	17.5	21.0	14.5	2.67	0.342	0.307	0.450	4.94	42.3	81.8
2006	128.1	32.7	25.2	23.0	5.02	2.98	0.314	0.474	0.281	0.700	78.1	68.6
2007	44.3	39.8	29.1	12.6	4.20	0.932	0.606	0.301	0.481	8.76	19.4	63.0
2008	70.3	32.2	27.1	14.7	2.53	1.17	0.269	0.434	0.331	**0.9**	**16.7**	**123**
2009	**264.1**	**19.0**	**28.0**	**8.6**	**9.8**	**1.1**	**0.3**	**0.3**	**0.3**			
Mean of monthly Discharge	**72.7**	**44.4**	**31.9**	**14**	**6.7**	**2.6**	**0.69**	**0.40**	**0.69**	**5.72**	**37.1**	**67.1**

A6.2 Pudding Riv. @ Woodburn

USGS 14201340 PUDDING RIVER NEAR WOODBURN, OR 00060, Discharge, cfs												
YEAR	Monthly mean in cfs (Calculation Period: 1997-10-01 -> 2008-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1997										599.7	936.3	1,024
1998	2,318	1,564	1,613	718.8	846.2	459.5	112.0	39.6	43.5	174.4	1,394	2,845
1999	2,842	2,835	2,082	924.8	812.4	293.5	98.0	52.9	33.4	61.3	1,025	2,023
2000	1,881	1,920	1,346	504.5	677.5	350.5	72.9	25.0	36.9	101.7	202.0	716.9

2001	477.8	460.2	581.5	774.1	429.5	171.2	54.1	25.5	19.9	64.3	787.2	2,507
2002	2,062	1,850	1,639	947.5	353.5	188.7	94.1	22.1	24.3	28.5	173.4	1,059
2003	1,792	2,050	2,117	1,670	694.7	145.1	34.5	13.5	23.4	58.2	314.5	1,964
2004	2,445	2,062	966.3	503.8	278.1	424.4	65.4	56.8	182.7	288.5	505.1	1,195
2005	603.2	386.6	561.0	1,123	819.3	450.2	115.5	28.1	23.3	132.6	1,095	1,720
2006	4,612	1,698	1,113	1,094	347.4	332.2	54.2	21.6	16.3	42.8	2,405	2,359
2007	1,897	1,373	1,469	694.7	299.6	102.9	41.8	18.5	25.6	283.1	713.5	2,069
2008	2,371	1,646	1,437	1,004	723.9	417.8	62.5	47.9	33.7	74.2	556.7	821.8
2009	2,237	562.9	1,147	727.0	710.0	148.2	39.0	15.6	20.2	61.2	777.7	1007.0
2010	1954.7	834.5	992.1	1432.8	685.5	1076.7	126.6	42.4	64.7	181.81	1211.5	2720.6
2011	2150.1	624.4	2233.9	1535.7	712.5	465.9	133.2	51.2	31.7	92.2	668.9	594.6
2012	3331.7	1419.7	2843.2	2175.7	777.0	451.4	150.3	39.5	27.8	258.5	1894.4	2443.2
2013	1090.5	1030.8	856.6	711.5	451.5	338.7	75.1	22.7	168.8	489.7	600.4	657.9
2014	732.1	2423.4	2040.2	1175.3	685.3	162.7	74.5	19.8	17.1			

Appendix 7. Oct-Apr Runoff Volume Statistical Frequency

FOR DRIFT CREEK AT PROJECT SITE –BASED ON 86 YEARS OF FLOWS OF PUDDING RIVER NEAR AURORA (52 YEARS OF OBSERVED FLOWS BETWEEN 1928-2014 + 34 YEARS OF SYNTHESIZED FLOWS)

N	Hydro Yr Oct-Apr	Pudding Oct-Apr Vol (AF)	Drift Oct-Apr Vol (AF)	Log(Vol) X	X^2	Dev X-M x	x^2
		Multiplier=	0.0348				
1	1928-29	470,330	16,367	4.213982	17.757644	-0.188134	0.035394
2	1929-30	506,791	17,636	4.246408	18.031982	-0.155708	0.024245
3	1930-31	498,485	17,347	4.239231	17.971082	-0.162884	0.026531
4	1931-32	904,509	31,477	4.497992	20.231933	0.095876	0.009192
5	1932-33	840,124	29,236	4.465923	19.944465	0.063807	0.004071
6	1933-34	798,321	27,782	4.443757	19.746974	0.041641	0.001734
7	1934-35	778,303	27,085	4.432728	19.649077	0.030612	0.000937
8	1935-36	585,279	20,368	4.308942	18.566983	-0.093174	0.008681
9	1936-37	616,209	21,444	4.331307	18.760223	-0.070809	0.005014
10	1937-38	1,122,245	39,054	4.591667	21.083405	0.189551	0.035930
11	1938-39	539,529	18,776	4.273594	18.263606	-0.128522	0.016518
12	1939-40	648,682	22,574	4.353611	18.953930	-0.048505	0.002353
13	1940-41	419,148	14,586	4.163947	17.338452	-0.238169	0.056725
14	1941-42	613,602	21,353	4.329466	18.744276	-0.072650	0.005278
15	1942-43	1,147,435	39,931	4.601307	21.172029	0.199192	0.039677

16	1943-44	451,846	15,724	4.196570	17.611197	-0.205546	0.042249
17	1944-45	550,657	19,163	4.282460	18.339467	-0.119655	0.014317
18	1945-46	894,637	31,133	4.493226	20.189081	0.091110	0.008301
19	1946-47	734,364	25,556	4.407491	19.425974	0.005375	0.000029
20	1947-48	957,349	33,316	4.522650	20.454359	0.120534	0.014528
21	1948-49	909,843	31,663	4.500546	20.254912	0.098430	0.009688
22	1949-50	1,008,572	35,098	4.545286	20.659626	0.143170	0.020498
23	1950-51	1,237,781	43,075	4.634223	21.476023	0.232107	0.053874
24	1951-52	862,064	30,000	4.477119	20.044592	0.075003	0.005625
25	1952-53	811,270	28,232	4.450745	19.809128	0.048629	0.002365
26	1953-54	1,025,958	35,703	4.552709	20.727158	0.150593	0.022678
27	1954-55	674,511	23,473	4.370568	19.101867	-0.031548	0.000995
28	1955-56	1,353,423	47,099	4.673013	21.837049	0.270897	0.073385
29	1956-57	648,236	22,559	4.353312	18.951329	-0.048803	0.002382
30	1957-58	851,445	29,630	4.471736	19.996421	0.069620	0.004847
31	1958-59	834,219	29,031	4.462859	19.917113	0.060743	0.003690
32	1959-60	637,122	22,172	4.345802	18.885994	-0.056314	0.003171
33	1960-61	1,056,599	36,770	4.565489	20.843694	0.163374	0.026691
34	1961-62	660,499	22,985	4.361451	19.022258	-0.040664	0.001654
35	1962-63	780,119	27,148	4.433740	19.658051	0.031624	0.001000
36	1963-64	743,346	25,868	4.412770	19.472541	0.010654	0.000114
37	1964-65	766,851	26,686	4.426290	19.592045	0.024174	0.000584
38	1965-66	721,428	25,106	4.399772	19.357996	-0.002344	0.000005
39	1966-67	657,317	22,875	4.359354	19.003968	-0.042762	0.001829
40	1967-68	708,640	24,661	4.392005	19.289707	-0.010111	0.000102
41	1968-69	1,012,349	35,230	4.546910	20.674386	0.144794	0.020965
42	1969-70	874,116	30,419	4.483148	20.098619	0.081032	0.006566
43	1970-71	1,047,283	36,445	4.561643	20.808590	0.159527	0.025449
44	1971-72	873,458	30,396	4.482821	20.095687	0.080705	0.006513
45	1972-73	470,469	16,372	4.214110	17.758725	-0.188006	0.035346
46	1973-74	1,259,453	43,829	4.641761	21.545947	0.239645	0.057430
47	1974-75	707,696	24,628	4.391426	19.284622	-0.010690	0.000114
48	1975-76	786,755	27,379	4.437419	19.690685	0.035303	0.001246
49	1976-77	197,929	6,888	3.838089	14.730925	-0.564027	0.318127
50	1977-78	668,444	23,262	4.366644	19.067582	-0.035472	0.001258
51	1978-79	418,772	14,573	4.163557	17.335206	-0.238559	0.056910
52	1979-80	757,077	26,346	4.420719	19.542759	0.018603	0.000346
53	1980-81	597,766	20,802	4.318110	18.646078	-0.084005	0.007057
54	1981-82	926,194	32,232	4.508281	20.324599	0.106165	0.011271
55	1982-83	1,012,188	35,224	4.546840	20.673758	0.144725	0.020945
56	1983-84	740,659	25,775	4.411198	19.458664	0.009082	0.000082
57	1984-85	612,787	21,325	4.328889	18.739278	-0.073227	0.005362
58	1985-86	597,101	20,779	4.317627	18.641903	-0.084489	0.007138

59	1986-87	678,463	23,611	4.373105	19.124051	-0.029010	0.000842
60	1987-88	599,374	20,858	4.319277	18.656155	-0.082839	0.006862
61	1988-89	529,715	18,434	4.265622	18.195527	-0.136494	0.018631
62	1989-90	550,087	19,143	4.282011	18.335615	-0.120105	0.014425
63	1990-91	606,560	21,108	4.324453	18.700894	-0.077663	0.006032
64	1991-92	544,536	18,950	4.277606	18.297912	-0.124510	0.015503
65	1992-93	727,869	25,330	4.403632	19.391979	0.001517	0.000002
66	1993-94	473,466	16,477	4.216868	17.781976	-0.185248	0.034317
67	1994-95	890,685	30,996	4.491303	20.171806	0.089188	0.007954
68	1995-96	1,288,619	44,844	4.651704	21.638348	0.249588	0.062294
69	1996-97	1,373,397	47,794	4.679375	21.896554	0.277260	0.076873
70	1997-98	787,841	27,417	4.438018	19.696002	0.035902	0.001289
71	1998-99	758,191	26,385	4.421358	19.548405	0.019242	0.000370
72	1999-00	726,590	25,285	4.402869	19.385252	0.000753	0.000001
73	2000-01	381,814	13,287	4.123431	17.002684	-0.278685	0.077665
74	2001-02	867,323	30,183	4.479760	20.068251	0.077644	0.006029
75	2002-03	759,339	26,425	4.422015	19.554216	0.019899	0.000396
76	2003-04	685,310	23,849	4.377466	19.162211	-0.024650	0.000608
77	2004-05	381,407	13,273	4.122968	16.998864	-0.279148	0.077924
78	2005-06	1,000,928	34,832	4.541982	20.629601	0.139866	0.019563
79	2006-07	908,008	31,599	4.499669	20.247020	0.097553	0.009517
80	2007-08	831,396	28,933	4.461387	19.903976	0.059271	0.003513
81	2008-09	551,076	19,159	4.282374	18.338727	-0.119742	0.014338
82	2009-10	638,574	25,601	4.408259	19.432746	0.006143	0.000038
83	2010-11	1,013,493	32,049	4.505816	20.302380	0.103700	0.010754
84	2011-12	949,805	31,419	4.497193	20.224743	0.095077	0.009040
85	2012-13	688,577	24,102	4.382054	19.202400	-0.020062	0.000402
86	2013-14	679,148	23,235	4.366143	19.063204	-0.035973	0.001294
				X	X^2	x	x^2
			N=	86			
			S(X)=	378.581961		0	1.645484
			M=	4.40211582			
			S(X^2)=		1668.20712	S^2=	0.01935864
			[S(X)^2]/N		1666.56164	S=	0.13913531
			S(x^2)=		1.645484		

Pn	0.25	1	10	50	90	99	99.75
k (N=86)	2.899	2.387	1.298	0.000	-1.298	-2.387	-2.899
Log(V)=	4.805492	4.734185	4.582760	4.402116	4.221472	4.070046	3.998739
Vol, AF	63,899	54,223	38,261	25,242	16,652	11,750	9,971

Appendix 8. Time Step Computer Modeling

A8.1 Sample FLO4DRIFT Runoff Model Input

```
DRIFT CREEK 2008-14  (11Oct14)
NQIN, 1,CKE,0.001, smi(ndf),0.1, bii(ndf), 1,qbase,0.1
CETI, 0.05,.07,.10,.15,.20,.22,.22,.20,.13,.07,.03,.03
area, 15.8, NSTA, 1,ts,2.0, tss,8, tsbf,24, tsbii,32
w(i),1.5
nsmi, 5
smi/rop, 0,0.15,  2.5,0.23,  5,0.36,  12,1.00,  100,1.00
nbii, 10
bii/bfp, 0,.8, 0.1,.57, .2,.45, .3,.37, .4,.32, .5,.29, .6,.27, 1.,.2, 2.,.1, 100,.1
nke, 4
RN/KE, 0,1, .5,.3, 2,0., 99, 0.
kss,0.09
nks, 9
RG/RS, 0,0, .016,.0026, .033,.008, .05,.015, .067,.024, .083,.036, .1,.05, .5,.41, 1.0,0.99
0,2008,2009,Discharge
oct, 0.5,0.5,1.0,5.0,4.0,3.8,3.5,3.5,5.0,3.0,2.8,2.6,2.5,2.3,2.1, 2,1.6,1.8,1.3,  1,  1,1.2, .8,0.7, .6, .6, .6, .6, .6, .6, .6
nov, 0.7,  .7, 1,  6,  5,3.3,3.5,  3,3.5,  4,  5, 22,130, 85, 54, 40, 34, 28, 23, 24, 25, 24, 23, 22, 21, 20, 20, 19, 18, 17
dec,  17, 19, 20, 19, 19, 17, 17, 19, 17, 16, 15, 17, 26, 23, 19,17, 17, 28, 25, 24, 33, 60, 50, 40, 50, 5,110,200,215,160, 130
jan, 275,500,267,181,173,159,161,198,163,132,115, 96, 84, 73, 65,57, 50, 44, 39, 35, 32, 30, 28, 26, 27, 25, 24, 27, 25, 24, 23
feb,  22, 21, 21, 20, 19, 23, 23, 22, 22, 22, 25, 24, 25, 24, 24, 23, 23, 22, 21, 20, 19, 19, 24, 71,126,156,123,106
mar,  91, 92, 86, 74, 77, 71, 65, 62, 60, 58, 54, 50, 46, 46, 80, 92, 84, 73, 66, 60, 54, 62, 59, 54, 61, 59, 54, 56, 68, 66, 63
apr,  60, 81, 80, 72, 64, 56, 51, 46, 44, 45, 38, 35, 44, 42, 39,35, 35, 33, 30, 27, 25, 24, 23, 22, 21, 20, 20, 27, 29, 24
may,  22, 39, 39, 40, 70, 98,128,108, 89, 75, 65, 59, 53, 66, 54, 46, 40, 36, 37, 33, 29, 26, 24, 22, 21, 19, 18, 16, 15, 14, 11
jun,  11, 10,9.8, 10, 13, 12, 11, 10,9.3,8.8,8.7,8.4,7.9,7.5,7.2, 6.8,6.5,6.2,6.2,  6,5.8,5.1,4.7,4.4,  4,  4,3.5,3.2,3.2,3.1
jul,  3,2.7,2.3,  2,  2,1.8,1.7,1.6,1.7,1.8,1.8,  2,  3,2.8,2.1,1.6,1.2,.92,.78,.73,.66,.63,.57,.51,.40,.35,.31,.29,.26,.25,.24
aug, .23,.23,.23,.22,.23,.25,.28,.35,.42,.34,.30,.39,.50,.35,.30,29,.26,.20,.18,.17,.15,.15,.15,.14,.13,.13,.13,.13,.15,.16,.17
sep, .16,.17,.19,.19,.49,.90,.85,.40,.29,.30,.29,.27,.25,.25,.73,3.7,1.7,.83,.43,.32,.27,.23,.21,.20,.19,.18,.17,.17,.18,.22
1.7, 2008-09 PRECIPITATION
oct,0,0,.31,.10,.03,.01,.02,0,.03,0,0,0,0,0,0,.01,0,.07,0,0,0,0,0,0,0,0,0,0,0,0,0.37
nov,.05,.20,.84,.10,.18,.14,.02,.26,.01,.02,.64,.59,0,0,0,0,0,0,0,.45,.04,0,0,0,.04,0,.01,0,0,.03
dec,.23,.08,0,0,0,0,.22,0,0,0,0,.52,.12,.25,0,0,.22,.12,.03,.88,.68,.47,0,.47,.09,.16,.27,.18,.84,.09,.10
jan,1.32,.64,0,.26,.09,.14,.27,.46,0,0,.05,.01,0,0,0,0,0,0,0,0,0,0,0,.04,.14,0,.13,.01,0,0,0
feb,0,0,0,0,.04,.40,0,0,.03,.13,.13,.02,.02,0,.08,0,.10,0,0,0,0,.17,.65,.21,.56,.36,0,0
mar,.21,.50,.12,0,.07,0,.08,.07,.04,0,0,0,0,.58,.62,.14,.07,0,0,0,.08,.02,.06,0,.05,0,0,.27,0,0,.05
apr,.13,.16,.03,0,0,0,0,.02,.14,0,0,.37,.17,.01,0,0,.07,0,0,0,0,0,.01,0,0,0,.04,.19,0,0
may,.24,.35,.15,.80,.06,.59,.06,0,0,.01,0,.02,.45,.02,0,0,0,.17,.12,0,0,0,0,0,0,0,0,0,0,0,0
jun,0,0,.02,.56,.35,0,0,0,0,0,.05,.05,.27,.01,0,0,0,.03,0,.01,.04,0,0,0,0,0,0,0,0,0,0
jul,0,0,0,0,0,0,0,0,0,0,0,.68,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
aug,0,0,0,0,0,0,0,0,0,0,0,.09,0,0,0,0,0,0,0,0,0,0,0,0,0,.03,0,0,.05,0,0,0
sep,0,0,0,0,.53,.22,.09,0,0,0,0,0,0,0,0,.13,0,0,.06,0,0,0,0,0,0,0,0,0,0,.15,.02
-1,2009,2010,DISCHARGE
oct09,.70,.70,.70,.70,.79,5.78,2.87,1.42,.67,.30,.14,.05,.01,.41,.95,.85,.91,2.26,1.72,1.07,1.06,1.35,2.09,4.89
   3.68,6.11,10.53,6.52,5.80,10.91,12.15
nov,10.79,8.59,6.66,5.42,4.78,5.08,36.28,55.48,52.93,46.11,51.62,70.48,66.70,62.52,50.95,41.70,65.84,60.65,52.80
   54.80,67.07,79.67,71.38,59.61,50.82,51.31,108.69,89.71,74.28,62.44
dec,54.39,48.26,41.19,35.61,31.07,27.47,24.13,21.00,18.39,17.07,16.81,17.13,17.46,16.84,55.29,114.32,103.93
   89.10,82.03,80.05,119.79,135.69,110.51,93.72,81.40,70.00,60.92,53.72,48.54,62.75,100.94
jan,187.27,165.74,132.53,113.88,130.90,191.81,157.00,132.48,124.22,104.58,91.60,99.40,97.79,90.21,91.97,155.85
   155.43,143.91,122.95,104.39,91.33,81.97,73.89,70.91,93.90,83.75,73.38,63.59,59.02,54.70,50.00
feb,45.19,45.43,44.04,44.32,43.94,40.61,38.22,35.25,33.35,31.71,32.79,39.27,45.29,55.18,63.16,68.98,64.85,59.67
   54.35,49.01,43.59,38.99,36.92,46.62,50.28,56.25,61.95,55.78
mar,51.35,47.56,44.84,42.01,37.53,34.17,31.81,35.16,30.86,30.79,32.37,61.17,83.26,72.85,64.35,57.41,52.17,46.22
   41.64,37.87,40.14,43.58,37.75,34.79,43.75,94.43,96.52,93.94,232.61,263.37,215.25
apr,171.98,166.41,181.37,162.35,142.77,129.91,113.09,112.58,92.67,86.88,79.64,74.54,68.17,63.26,99.46,85.35,74.17
   65.93,59.30,55.28,60.96,50.16,45.01,43.31,39.20,37.25,62.12,89.32,94.04,82.19
```

may,70.85,62.56,63.13,56.63,52.36,47.98,43.37,39.85,36.46,38.71,34.80,31.07,28.35,26.15,24.13,22.61,25.01,29.70
29.28,27.45,28.51,53.49,54.12,51.45,51.19,81.95,86.80,75.31,68.72,60.16,68.22
jun,68.46,136.61,195.20,218.07,174.99,143.78,127.85,100.15,90.73,101.39,106.54,90.62,77.12,67.57,61.91,56.13,48.52,40.54
,33.76
32.08,30.63,25.78,25.48,23.87,20.65,18.78,17.54,16.39,15.39,14.59
jul,14.77,15.78,15.30,13.73,13.06,12.24,11.35,10.54,9.99,9.27,8.93,8.43,8.15,7.40,6.73,6.46,6.12,6.04,6.00,6.06
5.70,5.42,5.12,4.83,4.56,4.26,3.89,3.81,3.83,3.64,3.51
aug,3.19,3.03,2.80,2.71,2.65,2.40,2.11,2.05,2.60,2.31,2.23,1.96,1.60,1.25,1.05,0.99,0.81,0.61,0.72,0.78,0.69,0.65
0.56,0.44,0.33,0.31,0.51,0.40,0.24,0.30,0.54
sep,1.00,1.32,1.12,0.77,0.51,0.43,1.13,2.24,1.98,1.51,1.20,0.93,0.76,0.65,4.38,3.89,2.88,4.27,9.06,8.42,7.00,4.66
3.51,3.15,2.76,2.60,2.80,2.42,2.10,1.86
1.5, 2009-10 PRECIPITATION
Oct-09,0,0.06,0,0.08,0,0,0,0,0,0,0,0,0.4,0.38,0.03,0,0.41,0,0,0,0.17,0,0.3,0,0.01,0.52,0.03,0.05,0.08,0,0.09
Nov-09,0,0,0,0,0.21,0.78,0.85,0.64,0.41,0.21,0.42,0.54,0.35,0,0.08,0.01,0.71,0.18,0.1,0.79,0.26,0.49,0,0,0,0.86,0.12,0,0,0.01
Dec-09,0,0,0,0,0,0,0,0,0,0,0,0.11,0,0.65,1.78,0.55,0.09,0,0.07,0.49,0.38,0.07,0,0,0,0,0.02,0,0.37,0.33,1.23
Jan-10,0.54,0,0,0.07,0.93,0.2,0,0.37,0.04,0,0.03,0.58,0.25,0,0.88,0.23,0.42,0,0,0.07,0,0.18,0,0.78,0.12,0.07,0,0,0,0.08,0.01
Feb-10,0.24,0.07,0.15,0.13,0,0.21,0,0,0,0.08,0.49,0.36,0.02,0.36,0.19,0.04,0,0,0,0,0,0,0.78,0.25,0.1,0.6,0,0
Mar-10,0,0.12,0,0.02,0,0,0.14,0.05,0.06,0.01,0.76,0.28,0,0,0,0,0.01,0,0,0,0.11,0,0,0.25,0.62,0.51,0,1,1.06,0.14,0
Apr-10,0,0.91,0.22,0.1,0.23,0.13,0.06,0.18,0,0.04,0.11,0.02,0.02,0.76,0.07,0,0,0,0.07,0.1,0,0,0,0,0,0.69,0.44,0.14,0.04,0.02
May-10,0,0,0.26,0.01,0.18,0,0,0,0.04,0.06,0,0,0,0,0,0,0.33,0.14,0.34,0.37,0.96,0.1,0.04,0,0.18,0.22,0,0,0,0.03,0.21
Jun-10,0.09,1.03,0.55,0.42,0,0.18,0,0.09,0.14,0.06,0,0,0,0,0.01,0.01,0,0,0,0.06,0,0,0,0,0,0,0,0,0
Jul-10,0.02,0.02,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Aug-10,0,0,0,0,0,0,0,0,0.02,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.18,0
Sep-10,0,0,0,0,0,0,0,0.18,0.12,0,0,0,0,0,0,0.27,0.07,0.04,1.05,0.15,0.01,0,0,0.03,0,0,0.15,0,0,0,0
-1,2010,2011,DISCHARGE
oct10,0.93,0.89,0.87,0.85,0.70,0.58,0.48,0.49,1.34,10.27,12.07,7.36,5.38,4.34,3.66,3.31,2.95,2.68,2.45,2.29,2.19
4.66,6.54,13.30,18.51,23.92,20.36,19.53,21.88,18.34,28.39
nov,27.76,65.17,52.99,41.19,33.72,32.08,93.07,76.55,72.60,88.34,73.01,64.54,54.87,56.06,54.18,59.11,56.68,147.34
137.00,125.47,104.50,107.28,121.10,99.00,80.73,75.48,101.56,90.63,79.97,84.46
dec,150.98,146.27,117.08,97.92,82.74,72.05,62.73,70.85,112.46,161.50,150.43,149.68,216.24,254.46,199.07,157.15
129.72,125.35,112.07,102.02,89.26,77.25,67.60,59.93,54.81,61.51,70.77,148.98,245.75,164.79,129.61
jan,107.95,91.19,78.10,68.02,61.75,56.90,51.46,52.29,49.88,46.57,42.96,48.52,79.27,97.22,95.98,250.04,302.76
217.56,203.90,153.15,130.74,114.96,97.94,85.55,74.58,66.05,58.64,52.69,47.35,42.39,37.93
feb,33.98,30.72,28.21,26.29,25.39,24.27,24.09,23.23,24.34,23.58,22.57,21.81,28.92,28.09,56.26,77.59,67.17,60.02
58.04,52.18,47.81,44.88,44.00,44.94,42.47,39.01,37.81,79.31
mar,197.32,177.45,147.41,131.63,125.27,105.42,92.36,82.51,76.97,121.70,120.77,104.77,103.92,121.83,114.71,130.45
141.44,130.18,121.67,106.88,98.89,90.87,80.86,79.09,76.00,90.95,89.78,89.38,105.84,117.06,104.72
apr,98.27,104.75,89.55,81.81,86.61,80.34,86.91,82.17,74.60,69.10,75.56,70.82,69.17,68.74,82.27,123.00,130.35
110.06,92.64,78.28,70.35,62.51,55.49,51.56,64.36,63.94,63.28,66.73,78.25,73.58
may,66.94,62.00,56.02,50.39,46.05,43.75,47.76,46.90,49.48,44.48,43.92,47.69,42.48,40.20,44.97,53.75,49.46,43.82
37.15,34.01,31.41,29.68,27.57,25.55,28.32,28.72,42.19,62.67,63.70,57.14,54.31
jun,58.42,57.30,52.73,46.85,41.84,39.17,35.83,32.91,29.38,26.93,25.32,23.32,24.53,21.52,19.45,17.62,17.76,17.88
16.48,16.94,15.67,14.86,15.04,14.21,13.39,12.86,12.31,13.15,13.04,13.88
jul,16.74,13.55,11.88,10.96,10.09,9.23,8.84,8.78,8.23,8.03,8.17,8.93,9.65,8.70,7.71,8.31,11.94,13.12,11.37,10.55
8.91,8.36,7.47,6.84,6.37,6.13,5.70,5.40,5.01,4.78,4.75
aug,4.51,4.09,4.76,3.76,3.51,3.43,3.55,3.64,3.69,3.89,3.14,2.69,2.55,2.90,2.88,2.60,2.34,2.19,2.04,1.72,1.55,1.67
1.65,1.50,1.45,2.79,2.02,1.67,1.69,1.78,1.62
sep,1.56,1.45,1.34,1.13,1.01,0.66,0.55,0.56,0.69,0.70,0.66,0.72,0.80,0.99,1.10,1.18,1.14,0.98,1.39,1.52,1.20,1.07
0.89,0.73,0.90,1.41,4.04,3.95,2.78,2.75
1.5, 2010-11 PRECIPITATION
Oct-10,0,0,0,0,0,0,0,0.02,0.4,0.83,0,0,0,0,0,0,0,0,0, 0,0.01,0.86,0.69,0.67,0.17,0,0.39,0,0.91,0.27
Nov-10,0.16,0,0,0,0,1.05,0.15,0.11,0.66,0.07,0.02,0,0.08,0.01,0,0.16,0.92,0.41,0.1,0.23,0.18,0.37,0,0,0,0.34,0.04,0.12,0.04,1.22
Dec-10,0.33,0,0,0,0,0.05,0.15,1.18,1.12,0.14,0.77,0.22,0.34,0.59,0.15,0,0,0.49,0.12,0.41,0,0,0,0.02,0.14,0.69,1.1,1.7,0.24,0,0
Jan-11,0,0,0,0,0.08,0,0.04,0.06,0.04,0,0.08,0.34,0.63,0,0.72,0.62,0.02,0.41,0,0,0.18,0,0,0,0,0,0.01,0.02,0,0
Feb-11,0,0,0,0.02,0.04,0.05,0.11,0,0,0,0,0.51,0.07,0.46,0.6,0.09,0.01,0.34,0,0, 0,0.05,0.17,0.02,0,0,0.1,1.67
Mar,0.55,0.14,0.18,0.3,0.01,0,0.06,0.14,0.34,0.89,0,0.1,0.72,0.7,0.54,0.87,0.05,0.11,0.01,0.03,0.03,0,0.04,0.1,0.24,0.17,0.27,0.
07,0.48,0.02,0
Apr-11,0.15,0.05,0,0.17,0.06,0.22,0.09,0,0,0.3,0.04,0,0.22,0.26,0.63,0.09,0,0.02,0,0,0,0,0,0.27,0.84,0.11,0.13,0.17,0.28,0.05
May-11,0,0.07,0,0,0.02,0.23,0.02,0.19,0,0,0.34,0,0,0,0.19,0.01,0.31,0,0,0,0,0,0.08,0,0.41,0.33,0.23,0.06,0.01,0.64,0.26
Jun-11,0.29,0.23,0,0,0,0,0,0,0,0,0,0.15,0.07,0,0,0,0,0.11,0,0,0,0,0,0,0,0,0.02,0.11,0,0
Jul-11,0,0,0,0,0,0,0,0,0,0,0,0.13,0,0,0,0.21,0.4,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Aug-11,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.11,0,0,0,0,0

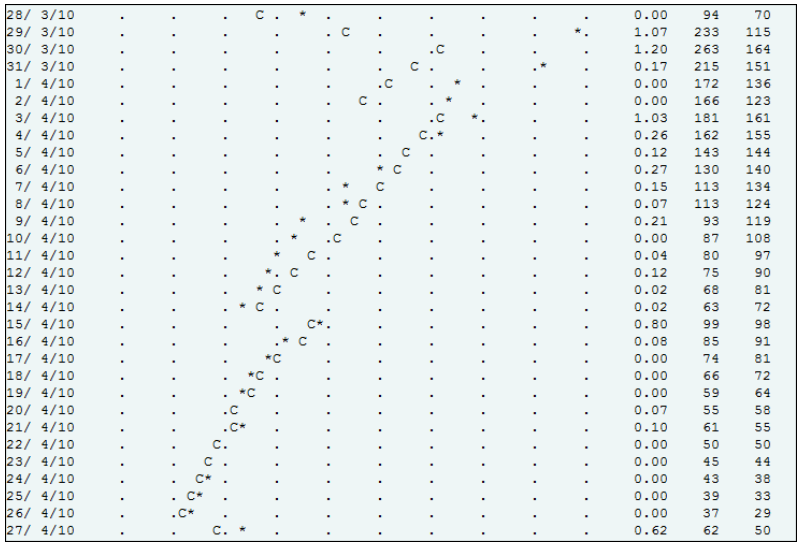
Sep-11,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.02,0.06,0,0,0,0,0,0.16,0.05,0.06,0,0,0
-1,2011,2012,DISCHARGE
oct11,1.80,2.72,4.03,6.33,6.55,5.58,4.50,4.46,3.86,4.07,9.72,8.88,6.57,5.60,5.45,
5.05,4.83,4.22,3.96,3.83,3.65,3.49,3.41,3.27,3.13,3.07,2.91,2.76,3.71,6.14,12.25
nov, 9.75,8.39,14.76,14.10,11.94,11.80,11.04,10.94,10.46,9.87,9.63,12.68,14.69,17.64
18.07,17.74,43.59,67.75,72.31,61.11,52.26,76.57,93.71,107.40,95.88,79.18,73.03,88.82,73.83,66.94
dec, 58.40,51.91,45.76,40.58,35.89,31.68,27.96,25.17,24.17,22.68,21.67,18.89,17.73,16.72
16.83,16.27,15.32,15.13,14.87,14.01,13.56,12.98,12.50,12.02,11.89,12.00,12.27,49.60,121.21,249.25,195.25
jan,136.07,106.17,91.88,78.75,81.18,71.08,64.24,57.43,52.03,51.10,44.71,40.12,36.28,34.51
36.15,32.55,39.79,205.75,808.62,342.00,327.25,242.50,205.46,192.30,204.22,171.59,140.72
123.71,111.88,119.60,98.69
feb, 90.72,79.80,72.60,65.93,59.62,54.12,49.25,46.63,54.49,60.20,63.39,70.41,65.15,60.20
55.56,51.61,48.73,50.53,58.42,58.77,62.32,74.94,92.70,95.05,89.67,87.29,79.09,71.81,69.01
mar, 93.37,104.02,88.31,77.71,72.51,75.63,77.02,70.06,63.74,59.13,60.55,74.59,108.62,161.28,167.97,201.90
252.18,195.68,165.53,184.46,261.65,237.99,203.23,186.13,163.62,141.99,124.99,111.85,110.03, 272.33,314.63
apr,233.97,187.98,163.40,159.95,150.60,124.75,108.06,93.09,80.95,73.02,69.68,62.97,56.29,49.73
43.72,55.83,55.95,62.38,68.03,75.65,69.53,63.38,56.07,48.75,46.37,66.68,68.69,64.17,58.80,66.61
may, 67.05,65.56,74.76,76.32,76.01,70.28,64.37,58.10,51.84,45.70,40.89,36.20,31.74,28.03,24.60
23.71,22.00,20.63,19.38,18.65,20.79,28.56,26.09,29.60,43.48,34.50,28.35,23.96,23.27,21.35,19.78
jun, 18.78,18.76,17.21,19.65,45.07,34.13,33.80,37.08,49.87,45.11,38.90,35.86,34.61,28.30,23.40
22.61,20.80,19.90,19.01,17.79,16.38,15.51,18.87,18.74,16.43,16.07,14.74,13.40,12.59,12.38
jul, 14.01,13.15,12.78,11.81,10.70,9.37,8.58,8.14,7.58,7.08,6.74,6.43,6.18,5.93,5.87,6.12,5.76
5.65,5.61,5.47,5.73,5.47,5.52,5.22,4.78,4.49,4.52,4.83,4.53,4.35,4.01
aug, 3.69,3.47,3.27,2.99,2.82,2.67,2.54,2.43,2.45,2.41,2.26,2.05,1.89,1.69,1.63,1.58,1.43,1.36
1.69,1.58,1.40,1.25,1.09,0.98,0.94,1.12,1.12,1.12,1.09,1.06,1.06
sep, 1.06,0.98,0.95,0.87,0.65,0.40,0.36,0.34,0.57,0.63,0.54,0.49,0.40,0.31,0.26,0.25,0.23,0.23
0.29,0.42,0.62,1.09,1.48,1.56,1.56,1.63,1.61,1.57,1.35,1.38
1.5, 2011-12 PRECIPITATION
Oct-11,0.32,0.13,0.24,0.31,0.01,0,0.03,0,0.07,0.25,0.36,0.04,0.03,0.06,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.08,0.05,0.12,0.05
Nov-11,0,0.26,0,0,0.21,0.02,0.04,0.02,0,0,0.14,0.1,0,0.09,0,0.52,0.66,0.44,0.11,0,0.63,1.01,0.69,0.53,0,0,0.45,0,0.01,0.03
Dec-11,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.01,0,0,0,0,0,0,0.08,0.07,0.38,1.19,0.71,0.77,0
Jan-12,0,0.1,0,0.35,0.04,0.05,0,0,0.21,0.03,0,0,0,0.2,0.04,0.13,2.18,2.47,2.13,0.65,0.15,0.19,0,0.77,0.04,0.08,0,0,0.5,0,0.01
Feb-12,0.05,0,0,0,0,0,0.03,0.54,0.11,0.14,0,0.12,0.1,0.11,0,0.06,0.13,0.06,0.15,0.17,0.01,0.28,0,0.31,0.17,0.08,0,0.47,1.05
Mar-12,0.21,0,0,0,0.38,0.03,0,0,0,0.26,0.31,1.26,0.45,0.69,0.93,0.48,0.07,0,0.07,0.63,1.27,0.07,0,0,0.07,0.01,0.16,0.15,0.81,1.13,0.54
Apr-12,0.24,0,0.27,0.08,0.19,0,0,0,0,0.13,0.15,0.06,0.1,0,0.11,0.38,0.11,0.13,0.4,0,0,0,0,0,0.17,0.35,0.03,0,0.07,0.11
May-12,0.02,0.21,0.5,0.13,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.07,0.57,0.27,0.01,0.27,0.26,0,0,0,0,0
Jun-12,0.09,0,0.08,0.3,0,0,0.47,0.17,0,0,0,0.14,0,0,0,0,0,0,0.01,0,0,0.22,0.22,0.06,0.14,0.02,0,0,0,0.28
Jul-12,0.04,0.02,0.01,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Aug-12,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
Sep-12,0,0,0,0,0,0,0,0,0,0,0.02,0,0,0,0,0,0,0,0,0,0,0,0.01,0,0.01,0,0,0,0,0,0
-1,2012,2013,DISCHARGE
oct12,2.03,1.95,1.92,1.85,1.78,1.61,1.58,1.59,1.70,1.72,1.80,2.67,6.13,5.98,10.89,17.61,12.42,11.02,8.21,9.43,9.19
9.94,12.60,14.21,16.63,14.46,14.24,32.91,63.04,48.69,39.84
nov,40.72,40.21,42.08,40.44,35.02,30.52,29.64,26.63,23.90,25.33,25.61,38.17,47.86,43.91,39.18,35.25,44.06,95.11
152.95,364.40,328.25,230.55,175.09,218.49,164.96,133.15,108.97,90.71,81.26,74.71
dec,97.97,143.66,141.51,178.28,181.20,141.43,125.95,111.14,101.09,89.00,85.72,98.58,85.66,78.82,73.43,80.94,108.52
111.59,102.25,148.92,160.18,138.54,140.80,161.01,162.39,174.77,142.90,123.61,105.14,90.73,79.96
jan,67.67,59.44,52.59,47.87,43.58,40.17,41.62,41.41,46.90,63.22,62.21,56.13,50.93,46.37,43.06,39.86,37.05,34.55
32.05,29.75,27.65,25.95,25.88,27.13,46.67,60.62,69.87,107.25,210.04,207.69,183.62
feb,143.61,121.15,102.24,87.76,79.73,73.63,68.67,62.23,55.45,50.94,46.32,45.40,41.50,37.89,35.16,33.54,32.40,30.19
29.20,27.98,30.04,35.05,54.63,52.45,54.46,51.95,46.46,44.39
mar,46.07,43.50,42.11,38.73,37.26,45.40,50.61,45.69,41.54,37.72,35.50,33.49,30.70,26.13,24.24,25.73,31.71,27.18
25.77,49.17,56.51,52.63,48.36,44.18,40.81,37.97,34.82,31.88,29.22,26.66,24.64
apr,23.02,21.61,19.43,19.24,19.78,34.42,50.35,49.34,44.09,41.76,39.41,36.26,38.72,35.92,35.70,32.89,30.28,28.18
33.53,33.81,30.69,28.55,26.19,24.21,22.40,20.71,19.05,17.60,17.92,17.33
may,17.69,16.76,15.73,14.82,13.91,13.33,12.90,12.55,12.20,11.43,10.89,10.67,11.32,10.74,10.44,11.20,12.24,10.18
11.54,10.53,12.47,23.38,29.80,40.66,35.88,33.83,42.88,61.00,65.12,59.32,50.08
jun,42.50,36.81,31.86,27.49,23.87,20.76,18.19,17.15,17.17,16.00,15.29,14.78,16.30,15.24,13.06,12.04,11.43,12.38
13.41,14.94,16.52,13.76,13.42,17.32,16.44,17.92,16.83,14.45,12.92,11.71
jul,10.78,9.98,9.28,8.66,7.84,7.47,7.25,6.98,6.56,6.21,5.89,5.63,5.40,5.03,4.67,4.58,4.97,4.67,4.18,3.96,3.79
3.63,3.37,3.12,2.81,2.48,2.24,2.19,2.22,2.22,2.20
aug,2.15,2.61,2.53,2.07,1.93,3.51,3.22,3.08,3.03,2.98,3.08,3.22,3.22,3.17,3.03,2.93,3.17,1.09,1.13,1.14,0.90

```
   0.83,1.35,1.69,1.74,2.09,1.77,1.60,1.58,1.58,1.30
sep,1.08,1.05,1.17,1.03,3.14,23.75,14.50,9.74,7.58,6.22,5.22,4.61,4.28,4.18,4.02,4.14,3.99,6.57,9.08,5.88,4.67
   4.83,7.88,11.15,16.86,15.29,12.33,15.62,69.21,109.21
1.7, 2012-13 PRECIPITATION
Oct-12,0,0,0,0,0,0,0,0,0,0,0,0.96,0.02,0.67,0.8,0.22,0,0.06,0.2,0.08,0.15,0.31,0.15,0.09,0.01,0,0.48,1.16,0.12,0.18,0.28
Nov-12,0.3,0.19,0.14,0,0,0.02,0.01,0.02,0.27,0,0.21,0.59,0,0.05,0,0,1.22,0.75,1.92,1.12,0.51,0,0.57,0.15,0,0,0,0.02,0.26,0.6
Dec-12,0.74,0.58,0.32,0.93,0,0.03,0.07,0.1,0.02,0,0.24,0,0,0.23,0.29,0.53,0.36,0.04,0.03,1.09,0.12,0.2,0.63,0.05,0.77,0.01
0.01,0,0.01,0,0
Jan-13,0,0,0,0,0.01,0.09,0.11,0,0.29,0.03,0,0,0,0,0,0,0,0,0,0,0,0,0.23,0.23,0.11,0.27,0.14,0.07,0.02,0.03,0
Feb-13,0,0,0,0,0.12,0.1,0.13,0,0.07,0,0,0,0,0,0,0.01,0,0.05,0,0.12,0.02,0.45,0.07,0.01,0.2,0,0,0.06
Mar-13,0,0,0,0,0,0.3,0.32,0,0,0,0,0,0,0,0,0.24,0,0,0.68,0.56,0.03,0.01,0,0,0,0.04,0.02,0.01,0,0,0
Apr-13,0,0,0,0.16,0.49,0.62,0.2,0.02,0,0.14,0,0.03,0.11,0.24,0,0,0,0.05,0.28,0,0,0,0,0,0,0,0,0,0.05,0
May-13,0,0,0,0,0,0,0,0,0,0,0,0,0.02,0,0,0.14,0.1,0,0.05,0.04,0,0.73,0.19,0.25,0.01,0.24,0.04,0.59,0.24,0.19,0.02,0
Jun-13,0,0,0,0,0,0,0,0,0,0,0,0,0,0.22,0,0,0,0,0.02,0.16,0.01,0,0,0.11,0.02,0.33,0.15,0,0,0,0
Jul-13,0,0,0,0,0,0,0,0,0,0,0,0,0,0
```

A8.2 Sample FLO4DRIFT Runoff Model Output

DD/MM/YR	RAIN in.	ETI in.	SMI in.	ROP	BII	BFP	SUR cfs	SUB cfs	BFL cfs	BASE cfs	QCAL cfs	QOBS cfs
							<..... D I S C H A R G E S					.....>
1/ 4/10	0.00	0.15	9.65	.78	0.00	.80	9.4	18.6	107.5	0.1	135.6	172.0
2/ 4/10	0.00	0.15	9.50	.77	0.00	.80	3.1	13.8	106.3	0.1	123.3	166.4
3/ 4/10	1.37	0.15	9.35	.76	0.00	.80	28.6	16.7	115.4	0.1	160.7	181.4
4/ 4/10	0.33	0.15	9.66	.79	0.00	.80	16.8	17.7	120.1	0.1	154.7	162.4
5/ 4/10	0.15	0.15	9.65	.78	0.00	.80	7.5	16.4	119.9	0.1	143.8	142.8
6/ 4/10	0.34	0.15	9.56	.78	0.00	.80	5.5	16.2	118.6	0.1	140.4	129.9
7/ 4/10	0.19	0.15	9.56	.78	0.00	.80	3.5	15.1	115.1	0.1	133.8	113.1
8/ 4/10	0.09	0.15	9.50	.77	0.00	.80	1.8	12.9	109.2	0.1	124.1	112.6
9/ 4/10	0.27	0.15	9.38	.76	0.00	.80	2.6	12.4	103.9	0.1	119.0	92.7
10/ 4/10	0.00	0.15	9.36	.76	0.00	.80	1.2	10.0	96.3	0.1	107.6	86.9
11/ 4/10	0.06	0.15	9.21	.74	0.00	.80	0.7	8.0	88.2	0.1	96.9	79.6
12/ 4/10	0.16	0.15	9.08	.73	0.00	.80	1.2	7.4	81.1	0.1	89.8	74.5
13/ 4/10	0.03	0.15	9.01	.73	0.00	.80	0.7	6.2	73.7	0.1	80.6	68.2
14/ 4/10	0.03	0.15	8.88	.71	0.00	.80	0.4	5.0	66.2	0.1	71.7	63.3
15/ 4/10	1.14	0.15	8.74	.70	0.00	.80	17.6	10.4	69.7	0.1	97.8	99.5
16/ 4/10	0.11	0.15	9.06	.73	0.00	.80	9.3	11.4	70.2	0.1	90.9	85.3
17/ 4/10	0.00	0.15	8.96	.72	0.00	.80	3.5	9.6	67.7	0.1	80.9	74.2
18/ 4/10	0.00	0.15	8.81	.71	0.00	.80	1.2	7.2	63.4	0.1	71.9	65.9
19/ 4/10	0.00	0.15	8.66	.69	0.00	.80	0.4	5.1	58.1	0.1	63.7	59.3
20/ 4/10	0.11	0.15	8.51	.68	0.00	.80	0.6	4.5	53.3	0.1	58.5	55.3
21/ 4/10	0.15	0.15	8.41	.67	0.00	.80	1.0	4.8	49.5	0.1	55.4	61.0
22/ 4/10	0.00	0.15	8.34	.67	0.00	.80	0.4	4.0	45.1	0.1	49.7	50.2
23/ 4/10	0.00	0.15	8.19	.65	0.00	.80	0.2	3.0	40.5	0.1	43.8	45.0
24/ 4/10	0.00	0.15	8.04	.64	0.00	.80	0.1	2.1	35.9	0.1	38.2	43.3
25/ 4/10	0.00	0.15	7.89	.62	0.00	.80	0.0	1.5	31.6	0.1	33.1	39.2
26/ 4/10	0.00	0.15	7.74	.61	0.00	.80	0.0	1.0	27.5	0.1	28.6	37.3
27/ 4/10	1.03	0.15	7.59	.60	0.00	.80	11.1	6.7	32.2	0.1	50.0	62.1
28/ 4/10	0.66	0.15	7.98	.63	0.00	.80	11.2	12.0	39.6	0.1	62.9	89.3
29/ 4/10	0.21	0.15	8.18	.65	0.00	.80	6.0	13.3	44.6	0.1	64.0	94.0
30/ 4/10	0.06	0.15	8.15	.65	0.00	.80	2.5	11.8	46.6	0.1	61.0	82.2

A8.3 Sample FLO4DRIFT Runoff Model Hydrograph Plot



A8.4 Release Criteria Used for the Reservoir Model RES4DRIFT

1. Start the pool at a given elevation ELE --normally at Elevation reached at the end of the last calculation time step
2. Input the Inflow to the reservoir for that day, QIN
3. Calculate the storage XSTOR at Elevation ELE --based on Elevation vs. Storage Curve
4. Calculate the capacity of the outlet at Elevation ELE --using the Elevation vs. Capacity Curve
5. Initialize for Time Step IN

```
viol(in) = 0   'violation code)
qloc(in) = qin(in) * aqloc(i): IF qloc(in) < 0 THEN qloc(in) = 0  'local inflow between Reservoir and
River mouth
quse(in) = mquse(i)    ' required consumptive use
qinstr(in) = mqinstr(i)  ' required instream flows
qirrig(in) = mirrig(i)   ' required irrigation flows
qreq(in) = qinstr(in) + quse(in) - qloc(in)  ' required release flows from the reservoir
IF qreq(in) < qminmin THEN qreq(in) = qminmin  'release from Reservoir should be at least = a pre-
specified Minimum Q
req = qreq(in)   'final reservoir release target for time step IN
```

6. Sort out release restrictions

6.1 If inflow is >630 cfs, release the full inflow amount. Assign Violation code=4. Go to Step 7

```
If qin(in) > 630 THEN qrel(in) = qin(in): viol(in) = 4
```

6.2 If inflow is < the required release, then:
Assign Violation Code=1
- if there is no irrigation requirement, then just release the inflow and go to Step 7
- if there is an irrigation requirement, then release the inflow + the irrigation requirement

```
IF qin(in) <= qreq(in) THEN
viol(in) = 1
IF mirrig(i) = 0 THEN qrel(in) = qin(in): qreq(in) = qin(in):  GOTO 3006
IF mirrig(i) > 0 THEN qrel(in) = qin(in) + qirrig(in): qreq(in) = qin(in): GOTO 3006
END IF
```

6.3 If inflow is > required release, then:
- if there is no irrigation requirement, then release the required amount (instream flow at the mouth minus the local inflow), and go to Step 7
- if there is an irrigation requirement, then release the required amount (instream flow at the mouth minus the local inflow and plus the irrigation amount), and go to Step 7

```
IF qin(in) > qreq(in) THEN
IF mirrig(i) = 0 THEN qrel(in) = qreq(in): GOTO 3006
IF mirrig(i) > 0 THEN qrel(in) = qreq(in) + qirrig(in): GOTO 3006
END IF
```

7. Check for release restrictions
If the proposed release is > release capacity at the given elevation, then:

Assign a violation code 4 and limit the release to the outlet capacity

```
IF qrel(in) > qqcap(in) THEN qrel(in) = qqcap(in): viol(in) = 4
```

8. Calculate the new storage at the end of the time step IN and check for upper/lower bound violation

```
stor(in + 1) = stor(in) + (qin(in) - qrel(in)) * 1.983
```

8.1 If the pool is within the lower and upper bounds, continue to Step 9

```
IF stor(in + 1) < vlupper AND stor(in + 1) > vlower THEN GOTO 3113
```

8.2 If the pool is higher than Upper Bound, set the pool to Upper bound and increase the release as needed

```
IF stor(in + 1) > vupper THEN
delv = stor(in + 1) - vupper: qadj = delv / 1.983
qrel(in) = qrel(in) + qadj: viol(in) = 2: stor(in + 1) = vupper: GOTO 3113
END IF
```

8.3 If the pool is lower than Lower bound, set the pool to Lower Bound and decrease the release as needed

```
IF stor(in + 1) < vlower THEN
delv = stor(in + 1) - vlower: qadj = delv / 1.983
qrel(in) = qrel(in) - qadj: viol(in) = 3: stor(in + 1) = vlower
END IF
```

9. Double-check for release capacity: Assign violation code to 5 if the release has to be again limited to outlet capacity

```
IF qrel(in) > qcapmax THEN viol(in) = 5: qrel(in) = qcapmax
```

10. If needed, recalculate end-of-time step storage and pool elevation.

```
FOR j = 1 TO npoint: xx(j) = STO(j): yy(j) = E(j): NEXT j:
np = npoint: try = stor(in + 1): ele(in + 1) = out1
```

11. Print results

```
PRINT "  I DA MO   YR     QIN    ELE1  ISWR CONSU   QLOC   REQ  QREQ   IRR  QIRR   QREL V
ELE2   STORAGE"
```

12. Go the next time step IN=1

VIOL= violation code
0=normal
1=too small inflow
2=exceed upper bound

3=exceed lower bound
4=pass flow greater than 630 cfs for flushing purposes
5=release limited by outlet capacity

As noted in the main report, more date-specific criteria will be added in future updates as called for in the draft water permit issued by OWRD on July 22, 2014.

A8.5 Input Data Used in Multi-Year Reservoir Simulation

```
MULTI-YEAR CONTINOUS RESERVOIR SMILATION Starting Oct 2002 Ending Sep 2014
2002-03, Pudding River at Aurora
Regression equation used to convert Pudding 2 Drift flows,-2E-06,0.0416,-0.8081
OCT, 79.0, 90.0,132.0,132.0,115.0,109.0,108.0,112.0,110.0, 99.0, 99.0, 95.0, 82.0, 81.0, 80.0
     78.0, 75.0, 73.0, 65.0, 65.0, 73.0, 70.0, 73.0, 71.0, 71.0, 72.0, 70.0, 75.0, 80.0, 75.0, 75.0
NOV, 75.0, 78.0, 90.0, 84.0, 83.0, 99.0,114.0,134.0,162.0,269.0,381.0,365.0,352.0,378.0,387.0
    393.0,379.0,400.0,405.0,391.0,377.0,357.0,296.0,271.0,255.0,245.0,231.0,222.0,197.0,191.0
DEC,183.0,181.0,187.0,178.0,173.0,171.0,164.0,157.0,157.0,171.0,231.0,306.0,629.0, 1020, 1200
     1710, 2610, 2560, 2290, 1960, 1810, 2380, 2440, 2150, 1800, 1480, 1830, 2900, 3080, 3150, 3630
JAN, 4360, 4270, 4080, 4060, 4230, 4110, 3570, 3020, 2530, 2110, 1740, 1510, 1910, 2380, 2380
     2100, 1810, 1560, 1370, 1230, 1130, 1060, 1270, 1500, 1480, 1710, 2760, 2940, 2650, 3290, 5390
FEB, 7620, 8680, 7780, 6330, 5170, 4230, 3440, 2880, 2430, 2030, 1660, 1420, 1290, 1210, 1140
     1150, 1430, 2320, 2700, 2500, 2330, 2370, 2400, 2220, 1950, 1700, 1510, 1360
MAR, 1260, 1200, 1150, 1190, 1150, 1320, 3010, 5510, 6590, 6710, 6140, 5230, 4450, 3850, 3320
     2960, 2610, 2240, 1930, 1790, 1800, 2410, 4000, 4270, 3790, 3340, 3220, 2990, 2700, 2380, 2100
APR, 1970, 2040, 2040, 2150, 2220, 2240, 2430, 2380, 2240, 2220, 2200, 2270, 2790, 3460, 3520
     2920, 2450, 2310, 2140, 1930, 1800, 1850, 1820, 2320, 2850, 2710, 2540, 2340, 2150, 2050
MAY, 1850, 1650, 1470, 1350, 1480, 1650, 1520, 1390, 1310, 1210, 1120, 1170, 1200, 1080,981.0
    930.0,919.0,923.0,898.0,846.0,797.0,750.0,713.0,685.0,656.0,659.0,647.0,602.0,563.0,531.0,506.0
JUN,489.0,468.0,441.0,417.0,390.0,359.0,331.0,311.0,303.0,291.0,291.0,286.0,285.0,297.0,339.0
    315.0,273.0,249.0,219.0,217.0,220.0,225.0,271.0,291.0,254.0,224.0,194.0,179.0,164.0,161.0
JUL,150.0,134.0,125.0,115.0,104.0, 99.0, 99.0, 93.0, 84.0, 77.0, 53.0, 36.0, 30.0, 36.0, 48.0
     61.0, 56.0, 36.0, 27.0, 26.0, 26.0, 21.0, 20.0, 18.0, 14.0, 10.0, 10.0,  9.0, 10.0, 12.0, 11.0
AUG, 10.0,  9.0,  9.0,  9.0, 12.0, 14.0, 15.0, 15.0, 19.0, 27.0, 25.0, 20.0, 13.0, 11.0, 11.0
     14.0, 16.0, 16.0, 13.0, 13.0, 10.0, 12.0,  9.0,  8.0, 11.0, 13.0, 13.0, 13.0, 10.0,  8.0,  8.0
SEP,  9.0, 14.0, 14.0, 13.0, 17.0, 16.0, 13.0, 20.0, 35.0, 67.0, 91.0, 91.0, 83.0, 85.0, 74.0
     74.0, 80.0, 73.0,114.0,112.0, 76.0, 72.0, 65.0, 56.0, 52.0, 48.0, 39.0, 35.0, 35.0, 39.0
2003-04, Pudding River at Aurora
Regression equation used to convert Pudding 2 Drift flows,-2E-06,0.0416,-0.8081
OCT, 38.0, 34.0, 35.0, 41.0, 47.0, 54.0, 60.0, 66.0, 78.0, 92.0,108.0,122.0,136.0,161.0,155.0
    126.0,129.0,156.0,127.0,113.0,103.0, 93.0, 88.0, 86.0,112.0,116.0, 89.0, 78.0, 74.0, 74.0,102.0
NOV,136.0,121.0,106.0,101.0,102.0, 99.0, 92.0,104.0, 99.0,109.0,102.0,101.0,158.0,177.0,153.0
    151.0,203.0,474.0,687.0,931.0,884.0,721.0,576.0,471.0,480.0,601.0,719.0,691.0,749.0, 1710
DEC, 1840, 1480, 1260, 1450, 1540, 2230, 2450, 2230, 2000, 1820, 1720, 1610, 1970, 4320, 5610
     5430, 4970, 4270, 3500, 2950, 2590, 2240, 1870, 1640, 1820, 2120, 2030, 2180, 3390, 4760, 4580
JAN, 3920, 3580, 3530, 3300, 2870, 2480, 2250, 2560, 3190, 3790, 4130, 3960, 3540, 3200, 3090
     3130, 2970, 2690, 2650, 2670, 2490, 2210, 2010, 2820, 4040, 4160, 3640, 3500, 4150, 5330, 6440
FEB, 7000, 6280, 5350, 4560, 3940, 3400, 3120, 2950, 2680, 2360, 2040, 1770, 1560, 1410, 1360
     1400, 1980, 2850, 3560, 3450, 3010, 2570, 2180, 1900, 1900, 1990, 2070, 2400, 2590
MAR, 2510, 2420, 2140, 1970, 1910, 1960, 2070, 1970, 1790, 1610, 1460, 1330, 1230, 1140, 1070
    998.0,939.0,894.0,876.0,869.0,824.0,779.0,754.0,737.0,756.0,784.0,845.0,938.0,905.0,844.0,840.0
APR,824.0,761.0,714.0,686.0,663.0,634.0,610.0,585.0,562.0,538.0,520.0,502.0,490.0,485.0,551.0
    650.0,712.0,691.0,656.0,687.0,890.0, 1220, 1260, 1140, 1000,892.0,813.0,748.0,694.0,646.0
```

```
MAY,601.0,562.0,530.0,496.0,471.0,464.0,441.0,426.0,460.0,480.0,463.0,483.0,468.0,418.0,392.0
    374.0,390.0,408.0,392.0,393.0,379.0,361.0,359.0,386.0,393.0,363.0,357.0,437.0,664.0,898.0,851.0
JUN,741.0,641.0,559.0,500.0,452.0,434.0,497.0,751.0, 1170, 1260, 1230, 1130,998.0,904.0,842.0
    752.0,673.0,601.0,538.0,481.0,447.0,404.0,374.0,367.0,353.0,330.0,310.0,299.0,274.0,251.0
JUL,233.0,214.0,190.0,180.0,193.0,184.0,166.0,163.0,145.0,158.0,131.0,118.0,118.0, 96.0, 97.0
     83.0, 74.0, 61.0, 58.0, 69.0, 55.0, 34.0, 12.0, 11.0, 31.0, 61.0, 61.0, 35.0, 16.0, 10.0, 10.0
AUG, 20.0, 30.0, 39.0, 33.0, 31.0, 14.0, 13.0, 18.0, 45.0, 92.0, 90.0, 42.0, 24.0, 17.0,  9.0
      8.0,  7.0,  7.0, 19.0, 29.0, 28.0, 33.0, 88.0,237.0,281.0,355.0,451.0,384.0,331.0,279.0,238.0
SEP,213.0,193.0,187.0,198.0,187.0,176.0,158.0,141.0,135.0,128.0,137.0,151.0,197.0,227.0,295.0
    311.0,331.0,408.0,750.0,879.0,788.0,655.0,549.0,468.0,413.0,374.0,343.0,319.0,295.0,275.0
2004-05, Pudding River at Aurora
Regression equation used to convert Pudding 2 Drift flows,-2E-06,0.0416,-0.8081
OCT,260.0,251.0,240.0,230.0,219.0,215.0,228.0,326.0,347.0,626.0,664.0,542.0,466.0,413.0,370.0
    340.0,331.0,369.0,500.0,655.0,598.0,542.0,520.0,524.0,515.0,503.0,534.0,523.0,488.0,465.0,492.0
NOV,604.0,600.0,928.0, 1330, 1180,973.0,812.0,704.0,628.0,568.0,521.0,482.0,450.0,425.0,409.0
    402.0,437.0,424.0,455.0,524.0,495.0,461.0,439.0,433.0,458.0,636.0,761.0,716.0,652.0,604.0
DEC,591.0,637.0,661.0,629.0,612.0,622.0,668.0,940.0, 2430, 3130, 3560, 4160, 4220, 3620, 3090
     2610, 2130, 1710, 1400, 1220, 1090,985.0,944.0,877.0,802.0,822.0, 1050, 1040,948.0,889.0,854.0
JAN,813.0,795.0,762.0,707.0,659.0,617.0,597.0,614.0,634.0,604.0,582.0,559.0,540.0,553.0,551.0
    543.0,577.0,771.0, 1610, 1540, 1280, 1080,936.0,823.0,743.0,683.0,640.0,616.0,603.0,721.0,761.0
FEB,693.0,642.0,606.0,577.0,568.0,587.0,571.0,584.0,564.0,537.0,517.0,502.0,507.0,545.0,524.0
    496.0,477.0,461.0,454.0,441.0,438.0,421.0,400.0,382.0,368.0,356.0,348.0,342.0
MAR,337.0,340.0,327.0,319.0,306.0,296.0,289.0,283.0,274.0,264.0,267.0,261.0,250.0,236.0,223.0
    222.0,224.0,269.0,282.0,287.0,346.0,372.0,368.0,396.0,425.0,420.0,981.0, 3580, 4470, 4590, 4060
APR, 3000, 2490, 2220, 1960, 1770, 1540, 1400, 1490, 1640, 1500, 1420, 1640, 1580, 1470, 1400
     1380, 2040, 2290, 2240, 2020, 1740, 1500, 1340, 1330, 1350, 1210, 1070,953.0,850.0,765.0
MAY,710.0,664.0,639.0,602.0,603.0,626.0,669.0,662.0,639.0,804.0, 1390, 1560, 1380, 1190, 1060
    980.0, 1010, 1070, 1530, 2070, 2180, 2100, 2010, 1760, 1510, 1310, 1130,970.0,837.0,752.0,683.0
JUN,641.0,676.0,696.0,620.0,560.0,571.0,728.0,988.0, 1040,886.0,751.0,683.0,631.0,573.0,529.0
    493.0,472.0,502.0,512.0,492.0,482.0,445.0,418.0,397.0,364.0,342.0,337.0,372.0,467.0,437.0
JUL,376.0,336.0,303.0,290.0,263.0,233.0,230.0,246.0,235.0,242.0,262.0,252.0,229.0,214.0,198.0
    179.0,154.0,139.0,131.0,119.0,114.0,106.0,105.0,108.0,104.0, 92.0, 79.0, 72.0, 66.0, 63.0, 62.0
AUG, 62.0, 60.0, 54.0, 50.0, 47.0, 42.0, 39.0, 41.0, 46.0, 38.0, 19.0, 25.0, 37.0, 34.0, 41.0
     42.0, 31.0, 23.0, 24.0, 30.0, 32.0, 28.0, 33.0, 31.0, 25.0, 19.0, 15.0, 18.0, 24.0, 39.0, 37.0
SEP, 36.0, 29.0, 22.0, 29.0, 36.0, 39.0, 37.0, 35.0, 29.0, 30.0, 39.0, 51.0, 59.0, 58.0, 55.0
     52.0, 48.0, 55.0, 62.0, 57.0, 52.0, 47.0, 45.0, 43.0, 41.0, 44.0, 50.0, 50.0, 48.0, 57.0
2005-06, Pudding River at Aurora
Regression equation used to convert Pudding 2 Drift flows,-2E-06,0.0416,-0.8081
OCT,121.0,232.0,224.0,230.0,230.0,185.0,144.0,125.0,118.0,115.0,119.0,117.0,112.0,109.0,110.0
    108.0,123.0,170.0,154.0,140.0,219.0,284.0,225.0,189.0,168.0,158.0,160.0,197.0,280.0,458.0,424.0
NOV,719.0, 2530, 2470, 2030, 2260, 2320, 2300, 1960, 1530, 1200, 1020, 1350, 1750, 2180, 2310
     1910, 1470, 1170,945.0,790.0,672.0,583.0,515.0,464.0,491.0, 1380, 1830, 1450, 1220, 1470
DEC, 1630, 1760, 2620, 2870, 2510, 2090, 1710, 1400, 1190, 1010,888.0,818.0,762.0,706.0,646.0
    589.0,541.0,499.0,489.0,859.0, 1740, 3260, 5000, 5340, 4810, 3990, 3410, 3900, 5400, 6090, %10800
JAN, %13000, %10400, 8220, 6870, 5980, 5370, 5450, 5720, 5830, 6220, 9450, %11500, 9740, 8510, 7720
     6740, 6390, 8550, 8200, 7170, 6730, 6340, 5830, 5250, 4680, 4200, 3940, 4040, 4560, 5000, 5460
FEB, 5790, 5700, 5420, 5270, 5460, 5370, 4880, 4260, 3660, 3140, 2700, 2300, 1930, 1590, 1390
```

```
     1250, 1130, 1030,938.0,878.0,830.0,797.0,771.0,754.0,735.0,697.0,676.0,820.0
MAR, 1870, 2040, 1730, 1480, 1310, 1200, 1110, 1110, 1400, 2140, 2330, 2050, 1770, 1540, 1380
     1290, 1370, 1490, 1590, 1560, 1470, 1390, 1320, 1270, 1410, 1560, 1480, 1360, 1270, 1230, 1200
APR, 1300, 1490, 1540, 1530, 1420, 1330, 1220, 1130, 1280, 1350, 1420, 1390, 1370, 1300, 1810
     2710, 2900, 2640, 2270, 1980, 1780, 1670, 1490, 1320, 1180, 1060,978.0,907.0,858.0,842.0
MAY,803.0,731.0,673.0,632.0,592.0,563.0,544.0,546.0,582.0,541.0,501.0,472.0,438.0,410.0,387.0
    369.0,350.0,327.0,309.0,297.0,312.0,338.0,386.0,455.0,515.0,475.0,518.0,633.0,888.0,979.0,797.0
JUN,661.0,646.0,877.0,902.0,919.0,936.0,828.0,719.0,636.0,579.0,536.0,499.0,466.0,450.0,422.0
    412.0,396.0,392.0,356.0,322.0,296.0,274.0,256.0,233.0,214.0,205.0,186.0,161.0,149.0,149.0
JUL,143.0,133.0,130.0,118.0,109.0,109.0,117.0,127.0,119.0,106.0, 93.0, 94.0,102.0,103.0, 98.0
     91.0, 88.0, 85.0, 73.0, 66.0, 56.0, 44.0, 37.0, 43.0, 41.0, 34.0, 24.0, 27.0, 35.0, 36.0, 47.0
AUG, 53.0, 45.0, 36.0, 23.0, 21.0, 23.0, 20.0, 20.0, 20.0, 27.0, 29.0, 26.0, 26.0, 33.0, 36.0
     34.0, 30.0, 30.0, 36.0, 35.0, 34.0, 37.0, 36.0, 26.0, 17.0, 16.0, 13.0, 13.0, 12.0, 14.0, 15.0
SEP, 14.0, 13.0, 13.0, 13.0, 19.0, 16.0, 13.0, 14.0, 13.0, 10.0, 10.0, 12.0, 16.0, 20.0, 23.0
     32.0, 40.0, 44.0, 49.0, 56.0, 64.0, 68.0, 71.0, 70.0, 68.0, 58.0, 48.0, 42.0, 29.0, 32.0
2006-07, Pudding River at Aurora
Regression equation used to convert Pudding 2 Drift flows,-2E-06,0.0416,-0.8081
OCT, 44.0, 46.0, 51.0, 50.0, 39.0, 42.0, 50.0, 53.0, 55.0, 61.0, 60.0, 55.0, 62.0, 66.0, 75.0
     89.0,104.0,120.0,116.0,110.0,120.0,136.0,121.0,111.0,108.0,117.0,122.0,119.0,119.0,113.0,109.0
NOV,116.0,129.0,183.0,363.0,801.0, 1620, 2890, 4850, 5250, 5310, 4890, 4350, 3940, 4050, 3830
     3430, 3130, 2650, 2180, 2400, 2900, 3390, 4360, 5110, 5590, 5750, 5690, 5380, 4830, 4260
DEC, 3810, 3440, 3020, 2630, 2250, 1870, 1560, 1370, 1270, 1300, 1330, 1920, 2750, 3740, 5280
     6210, 6040, 5260, 4300, 3460, 3040, 3050, 2950, 3150, 3730, 4980, 5930, 6100, 5560, 4830, 4050
JAN, 3380, 2920, 3660, 5730, 6160, 5970, 5640, 5230, 4970, 4820, 4640, 4250, 3690, 3150, 2700
     2330, 1990, 1670, 1480, 1420, 1440, 1350, 1240, 1160, 1070,999.0,943.0,888.0,828.0,779.0,741.0
FEB,705.0,664.0,627.0,595.0,578.0,567.0,559.0,554.0,583.0,642.0,683.0,788.0,841.0,841.0,880.0
     2390, 4140, 4170, 3570, 3170, 3550, 3590, 3350, 3140, 3430, 3830, 3860, 3730
MAR, 3570, 3390, 3420, 3380, 3190, 2960, 2730, 2680, 2570, 2320, 2160, 2200, 2440, 2280, 1960
     1670, 1470, 1340, 1270, 1390, 1660, 1540, 1370, 1250, 1440, 2370, 2340, 2060, 1770, 1560, 1400
APR, 1340, 1300, 1190, 1080, 1000,920.0,888.0,957.0, 1010, 1210, 1280, 1200, 1110, 1050, 1080
     1050,983.0, 1040, 1120, 1120, 1070, 1070, 1130, 1060,956.0,884.0,822.0,764.0,715.0,663.0
MAY,623.0,621.0,789.0,896.0,862.0,805.0,744.0,692.0,646.0,601.0,561.0,529.0,519.0,510.0,485.0
    451.0,415.0,392.0,375.0,367.0,375.0,412.0,428.0,386.0,353.0,326.0,296.0,274.0,276.0,254.0,237.0
JUN,218.0,205.0,188.0,183.0,171.0,175.0,247.0,254.0,235.0,224.0,245.0,278.0,247.0,212.0,201.0
    196.0,192.0,189.0,168.0,143.0,134.0,131.0,141.0,136.0,119.0,109.0,105.0, 98.0, 93.0,109.0
JUL,127.0,127.0,112.0, 95.0, 87.0, 81.0, 69.0, 58.0, 53.0, 56.0, 50.0, 43.0, 37.0, 35.0, 32.0
     33.0, 34.0, 38.0, 42.0, 62.0, 59.0, 50.0, 59.0, 72.0, 61.0, 53.0, 46.0, 41.0, 38.0, 35.0, 35.0
AUG, 33.0, 23.0, 18.0, 14.0, 14.0, 17.0, 18.0, 19.0, 15.0, 15.0, 16.0, 15.0, 17.0, 19.0, 19.0
     14.0, 12.0, 11.0, 13.0, 21.0, 39.0, 72.0, 89.0, 72.0, 54.0, 40.0, 36.0, 33.0, 26.0, 19.0, 14.0
SEP, 12.0, 10.0, 12.0, 19.0, 29.0, 41.0, 56.0, 46.0, 37.0, 36.0, 28.0, 24.0, 19.0, 19.0, 18.0
     21.0, 27.0, 34.0, 40.0, 47.0, 47.0, 42.0, 39.0, 35.0, 34.0, 33.0, 31.0, 40.0, 69.0, 96.0
2007-08, Pudding River at Aurora
Regression equation used to convert Pudding 2 Drift flows,-2E-06,0.0416,-0.8081
OCT,136.0,229.0,271.0,275.0,362.0,325.0,243.0,195.0,178.0,186.0,177.0,179.0,190.0,171.0,156.0
    149.0,154.0,206.0,355.0,803.0, 1470, 1570, 1190,847.0,657.0,569.0,487.0,420.0,370.0,338.0,308.0
NOV,284.0,269.0,252.0,230.0,219.0,210.0,206.0,198.0,194.0,192.0,249.0,354.0,380.0,699.0,651.0
    587.0,891.0, 2130, 2940, 3370, 3060, 2520, 2020, 1600, 1290, 1090, 1020, 1040,996.0, 1020
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DEC, 1050, 1130, 2300, 4360, 5140, 5020, 4630, 4080, 3420, 2810, 2340, 1920, 1520, 1260, 1120
     1060, 1010, 1120, 1440, 2670, 3770, 3500, 3220, 4090, 5150, 5080, 4610, 4150, 3880, 3860, 3880
JAN, 3640, 3240, 3450, 3790, 4180, 4720, 4770, 4560, 4800, 5020, 5380, 5430, 5400, 5210, 4960
     4580, 4030, 3470, 2930, 2560, 2250, 1850, 1500, 1310, 1190, 1100, 1800, 3000, 2920, 2910, 3300
FEB, 4130, 4450, 4420, 4110, 3630, 3210, 3230, 3610, 3490, 3240, 3030, 2850, 2630, 2430, 2190
     1940, 1710, 1540, 1420, 1340, 1290, 1260, 1200, 1140, 1090, 1080, 1060, 1030, 1010
MAR, 1110, 1500, 1510, 1370, 1230, 1090,988.0,952.0, 1080, 1110, 1130, 1360, 1400, 2020, 2810
     3250, 3200, 3010, 3320, 3330, 3060, 2740, 2420, 2290, 2270, 2130, 2100, 2030, 1990, 2000, 1940
APR, 1750, 1560, 1410, 1300, 1270, 1290, 1400, 1560, 1670, 1610, 1490, 1390, 1350, 1430, 1460
     1360, 1230, 1120, 1060, 1010,971.0,979.0, 1240, 1590, 1640, 1540, 1420, 1360, 1470, 1690
MAY, 1650, 1480, 1350, 1300, 1280, 1270, 1270, 1190, 1070,967.0,921.0,944.0,907.0,862.0,913.0
     1070, 1300, 1420, 1340, 1190, 1150, 1080, 1030,970.0,935.0,935.0,866.0,799.0,778.0,827.0,790.0
JUN,753.0,706.0,677.0,887.0, 1020,929.0, 1040, 1210, 1100,972.0,964.0, 1000,925.0,845.0,779.0
    716.0,657.0,610.0,563.0,522.0,492.0,477.0,456.0,420.0,384.0,354.0,339.0,319.0,310.0,326.0
JUL,305.0,282.0,259.0,244.0,234.0,226.0,228.0,214.0,193.0,170.0,149.0,135.0,126.0,120.0,115.0
    103.0, 92.0, 88.0, 92.0, 89.0, 87.0, 86.0, 74.0, 71.0, 70.0, 60.0, 52.0, 55.0, 58.0, 53.0, 47.0
AUG, 47.0, 49.0, 61.0, 82.0, 83.0, 71.0, 56.0, 48.0, 47.0, 49.0, 59.0, 62.0, 48.0, 40.0, 38.0
     34.0, 32.0, 34.0, 33.0, 40.0, 71.0,186.0,216.0,167.0,135.0,119.0,110.0,104.0, 94.0, 81.0, 75.0
SEP, 78.0, 75.0, 69.0, 64.0, 58.0, 53.0, 47.0, 47.0, 52.0, 45.0, 38.0, 33.0, 31.0, 30.0, 33.0
     39.0, 38.0, 35.0, 35.0, 34.0, 37.0, 44.0, 52.0, 60.0, 68.0, 77.0, 95.0, 95.0, 82.0, 74.0
2008-09, Upper Drift Creek
Regression equation used to convert Pudding 2 Drift flows,0,1,0
OCT,  0.5,  0.5,  1.0,  5.0,  4.0,  3.8,  3.5,  3.5,  4.0,  3.0,  2.8,  2.6,  2.5,  2.3,  2.1
      2.0,  1.6,  1.8,  1.3,  1.0,  1.0,  1.2,  0.8,  0.7,  0.6,  0.6,  0.6,  0.6,  0.6,  0.6,  0.6
NOV,  0.6,  0.7,  1.0,  6.0,  5.0,  3.3,  3.5,  3.0,  3.5,  4.0,  5.0, 22.0,130.0, 85.0, 54.0
     40.0, 34.0, 28.0, 23.0, 24.0, 25.0, 24.0, 23.0, 22.0, 21.0, 20.0, 20.0, 19.0, 18.0, 17.0
DEC, 17.0, 19.0, 20.0, 19.0, 19.0, 17.0, 17.0, 19.0, 17.0, 16.0, 15.0, 17.0, 26.0, 23.0, 19.0
     17.0, 17.0, 28.0, 25.0, 24.0, 33.0, 60.0, 50.0, 40.0, 50.0, 55.0,110.0,200.0,215.0,160.0,130.0
JAN,275.0,500.0,267.0,181.0,173.0,159.0,161.0,198.0,163.0,132.0,115.0, 96.0, 84.0, 73.0, 65.0
     57.0, 50.0, 44.0, 39.0, 35.0, 32.0, 30.0, 28.0, 26.0, 27.0, 25.0, 24.0, 27.0, 25.0, 24.0, 23.0
FEB, 22.0, 21.0, 21.0, 20.0, 19.0, 23.0, 23.0, 22.0, 22.0, 22.0, 25.0, 24.0, 25.0, 24.0, 24.0
     23.0, 23.0, 22.0, 21.0, 20.0, 19.0, 19.0, 24.0, 71.0,126.0,156.0,123.0,106.0
MAR, 91.0, 92.0, 86.0, 74.0, 77.0, 71.0, 65.0, 62.0, 60.0, 58.0, 54.0, 50.0, 46.0, 46.0, 80.0
     92.0, 84.0, 73.0, 66.0, 60.0, 54.0, 62.0, 59.0, 54.0, 61.0, 59.0, 54.0, 56.0, 68.0, 66.0, 63.0
APR, 60.0, 81.0, 80.0, 72.0, 64.0, 56.0, 51.0, 46.0, 44.0, 45.0, 38.0, 35.0, 44.0, 42.0, 39.0
     35.0, 35.0, 33.0, 30.0, 27.0, 25.0, 24.0, 23.0, 22.0, 21.0, 20.0, 20.0, 27.0, 29.0, 24.0
MAY, 22.0, 39.0, 39.0, 40.0, 70.0, 98.0,128.0,108.0, 89.0, 75.0, 65.0, 59.0, 53.0, 66.0, 54.0
     46.0, 40.0, 36.0, 37.0, 33.0, 29.0, 26.0, 24.0, 22.0, 21.0, 19.0, 18.0, 16.0, 15.0, 14.0, 11.0
JUN, 11.0, 10.0,  9.8, 10.0, 13.0, 12.0, 11.0, 10.0,  9.3,  8.8,  8.7,  8.4,  7.9,  7.5,  7.2
      6.8,  6.5,  6.2,  6.2,  6.0,  5.8,  5.1,  4.7,  4.4,  4.0,  4.0,  3.5,  3.2,  3.2,  3.1
JUL,  3.0,  2.7,  2.3,  2.0,  2.0,  1.8,  1.7,  1.6,  1.7,  1.8,  1.8,  2.0,  3.0,  2.8,  2.1
      1.6,  1.2,  0.9,  0.8,  0.7,  0.7,  0.6,  0.6,  0.5,  0.4,  0.3,  0.3,  0.3,  0.3,  0.3,  0.2
AUG,  0.2,  0.2,  0.2,  0.2,  0.2,  0.3,  0.3,  0.3,  0.4,  0.3,  0.3,  0.4,  0.5,  0.3,  0.3
      0.3,  0.3,  0.2,  0.2,  0.2,  0.2,  0.2,  0.2,  0.1,  0.1,  0.1,  0.1,  0.1,  0.2,  0.2,  0.2
SEP,  0.2,  0.2,  0.2,  0.2,  0.5,  0.9,  0.9,  0.4,  0.3,  0.3,  0.3,  0.3,  0.3,  0.3,  0.7
      3.7,  1.7,  0.8,  0.4,  0.3,  0.3,  0.2,  0.2,  0.2,  0.2,  0.2,  0.2,  0.2,  0.2,  0.2
2009-10, UPPER DRIFT CR
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Regression equation used to convert Pudding 2 Drift flows,0,1,0
OCT,  0.7,  0.7,  0.7,  0.7,  0.8,  5.8,  2.9,  1.4,  0.7,  0.3,  0.1,  0.1,  0.0,  0.4,  0.9
      0.9,  0.9,  2.3,  1.7,  1.1,  1.1,  1.3,  2.1,  4.9,  3.7,  6.1, 10.5,  6.5,  5.8, 10.9, 12.1
NOV, 10.8,  8.6,  6.7,  5.4,  4.8,  5.1, 36.3, 55.5, 52.9, 46.1, 51.6, 70.5, 66.7, 62.5, 51.0
     41.7, 65.8, 60.7, 52.8, 54.8, 67.1, 79.7, 71.4, 59.6, 50.8, 51.3,108.7, 89.7, 74.3, 62.4
DEC, 54.4, 48.3, 41.2, 35.6, 31.1, 27.5, 24.1, 21.0, 18.4, 17.1, 16.8, 17.1, 17.5, 16.8, 55.3
    114.3,103.9, 89.1, 82.0, 80.1,119.8,135.7,110.5, 93.7, 81.4, 70.0, 60.9, 53.7, 48.5, 62.8,100.9
JAN,187.3,165.7,132.5,113.9,130.9,191.8,157.0,132.5,124.2,104.6, 91.6, 99.4, 97.8, 90.2, 92.0
    155.8,155.4,143.9,123.0,104.4, 91.3, 82.0, 73.9, 70.9, 93.9, 83.8, 73.4, 63.6, 59.0, 54.7, 50.0
FEB, 45.2, 45.4, 44.0, 44.3, 43.9, 40.6, 38.2, 35.2, 33.4, 31.7, 32.8, 39.3, 45.3, 55.2, 63.2
     69.0, 64.9, 59.7, 54.4, 49.0, 43.6, 39.0, 36.9, 46.6, 50.3, 56.3, 62.0, 55.8
MAR, 51.4, 47.6, 44.8, 42.0, 37.5, 34.2, 31.8, 35.2, 30.9, 30.8, 32.4, 61.2, 83.3, 72.9, 64.3
     57.4, 52.2, 46.2, 41.6, 37.9, 40.1, 43.6, 37.8, 34.8, 43.8, 94.4, 96.5, 93.9,232.6,263.4,215.2
APR,172.0,166.4,181.4,162.4,142.8,129.9,113.1,112.6, 92.7, 86.9, 79.6, 74.5, 68.2, 63.3, 99.5
     85.4, 74.2, 65.9, 59.3, 55.3, 61.0, 50.2, 45.0, 43.3, 39.2, 37.3, 62.1, 89.3, 94.0, 82.2
MAY, 70.8, 62.6, 63.1, 56.6, 52.4, 48.0, 43.4, 39.8, 36.5, 38.7, 34.8, 31.1, 28.3, 26.2, 24.1
     22.6, 25.0, 29.7, 29.3, 27.5, 28.5, 53.5, 54.1, 51.5, 51.2, 82.0, 86.8, 75.3, 68.7, 60.2, 68.2
JUN, 68.5,136.6,195.2,218.1,175.0,143.8,127.8,100.2, 90.7,101.4,106.5, 90.6, 77.1, 67.6, 61.9
     56.1, 48.5, 40.5, 33.8, 32.1, 30.6, 25.8, 25.5, 23.9, 20.6, 18.8, 17.5, 16.4, 15.4, 14.6
JUL, 14.8, 15.8, 15.3, 13.7, 13.1, 12.2, 11.4, 10.5, 10.0,  9.3,  8.9,  8.4,  8.2,  7.4,  6.7
      6.5,  6.1,  6.0,  6.0,  6.1,  5.7,  5.4,  5.1,  4.8,  4.6,  4.3,  3.9,  3.8,  3.8,  3.6,  3.5
AUG,  3.2,  3.0,  2.8,  2.7,  2.6,  2.4,  2.1,  2.0,  2.6,  2.3,  2.2,  2.0,  1.6,  1.2,  1.0
      1.0,  0.8,  0.6,  0.7,  0.8,  0.7,  0.6,  0.6,  0.4,  0.3,  0.3,  0.5,  0.4,  0.2,  0.3,  0.5
SEP,  1.0,  1.3,  1.1,  0.8,  0.5,  0.4,  1.1,  2.2,  2.0,  1.5,  1.2,  0.9,  0.8,  0.7,  4.4
      3.9,  2.9,  4.3,  9.1,  8.4,  7.0,  4.7,  3.5,  3.1,  2.8,  2.6,  2.8,  2.4,  2.1,  1.9
2010-11, UPPER DRIFT CR.
Regression equation used to convert Pudding 2 Drift flows,0,1,0
OCT,  0.9,  0.9,  0.9,  0.9,  0.7,  0.6,  0.5,  0.5,  1.3, 10.3, 12.1,  7.4,  5.4,  4.3,  3.7
      3.3,  3.0,  2.7,  2.5,  2.3,  2.2,  4.7,  6.5, 13.3, 18.5, 23.9, 20.4, 19.5, 21.9, 18.3, 28.4
NOV, 27.8, 65.2, 53.0, 41.2, 33.7, 32.1, 93.1, 76.6, 72.6, 88.3, 73.0, 64.5, 54.9, 56.1, 54.2
     59.1, 56.7,147.3,137.0,125.5,104.5,107.3,121.1, 99.0, 80.7, 75.5,101.6, 90.6, 80.0, 84.5
DEC,151.0,146.3,117.1, 97.9, 82.7, 72.1, 62.7, 70.8,112.5,161.5,150.4,149.7,216.2,254.5,199.1
    157.1,129.7,125.3,112.1,102.0, 89.3, 77.3, 67.6, 59.9, 54.8, 61.5, 70.8,149.0,245.8,164.8,129.6
JAN,107.9, 91.2, 78.1, 68.0, 61.8, 56.9, 51.5, 52.3, 49.9, 46.6, 43.0, 48.5, 79.3, 97.2, 96.0
    250.0,302.8,217.6,203.9,153.1,130.7,115.0, 97.9, 85.6, 74.6, 66.1, 58.6, 52.7, 47.3, 42.4, 37.9
FEB, 34.0, 30.7, 28.2, 26.3, 25.4, 24.3, 24.1, 23.2, 24.3, 23.6, 22.6, 21.8, 28.9, 28.1, 56.3
     77.6, 67.2, 60.0, 58.0, 52.2, 47.8, 44.9, 44.0, 44.9, 42.5, 39.0, 37.8, 79.3
MAR,197.3,177.4,147.4,131.6,125.3,105.4, 92.4, 82.5, 77.0,121.7,120.8,104.8,103.9,121.8,114.7
    130.4,141.4,130.2,121.7,106.9, 98.9, 90.9, 80.9, 79.1, 76.0, 90.9, 89.8, 89.4,105.8,117.1,104.7
APR, 98.3,104.8, 89.6, 81.8, 86.6, 80.3, 86.9, 82.2, 74.6, 69.1, 75.6, 70.8, 69.2, 68.7, 82.3
    123.0,130.4,110.1, 92.6, 78.3, 70.3, 62.5, 55.5, 51.6, 64.4, 63.9, 63.3, 66.7, 78.3, 73.6
MAY, 66.9, 62.0, 56.0, 50.4, 46.0, 43.8, 47.8, 46.9, 49.5, 44.5, 43.9, 47.7, 42.5, 40.2, 45.0
     53.8, 49.5, 43.8, 37.2, 34.0, 31.4, 29.7, 27.6, 25.5, 28.3, 28.7, 42.2, 62.7, 63.7, 57.1, 54.3
JUN, 58.4, 57.3, 52.7, 46.8, 41.8, 39.2, 35.8, 32.9, 29.4, 26.9, 25.3, 23.3, 24.5, 21.5, 19.5
     17.6, 17.8, 17.9, 16.5, 16.9, 15.7, 14.9, 15.0, 14.2, 13.4, 12.9, 12.3, 13.1, 13.0, 13.9
JUL, 16.7, 13.6, 11.9, 11.0, 10.1,  9.2,  8.8,  8.8,  8.2,  8.0,  8.2,  8.9,  9.6,  8.7,  7.7
      8.3, 11.9, 13.1, 11.4, 10.6,  8.9,  8.4,  7.5,  6.8,  6.4,  6.1,  5.7,  5.4,  5.0,  4.8,  4.8
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AUG,  4.5,  4.1,  4.8,  3.8,  3.5,  3.4,  3.5,  3.6,  3.7,  3.9,  3.1,  2.7,  2.5,  2.9,  2.9
      2.6,  2.3,  2.2,  2.0,  1.7,  1.5,  1.7,  1.6,  1.5,  1.4,  2.8,  2.0,  1.7,  1.7,  1.8,  1.6
SEP,  1.6,  1.4,  1.3,  1.1,  1.0,  0.7,  0.5,  0.6,  0.7,  0.7,  0.8,  0.7,  0.8,  1.0,  1.1
      1.2,  1.1,  1.0,  1.4,  1.5,  1.2,  1.1,  0.9,  0.7,  0.9,  1.4,  4.0,  3.9,  2.8,  2.7
2011-12, UPPER DRIFT CR.
Regression equation used to convert Pudding 2 Drift flows,0,1,0
OCT, 1.80,2.72,4.03,6.33,6.55,5.58,4.50,4.46,3.86,4.07,9.72,8.88,6.57,5.60,5.45
     5.05,4.83,4.22,3.96,3.83,3.65,3.49,3.41,3.27,3.13,3.07,2.91,2.76,3.71,6.14,12.25
NOV, 9.75,8.39,14.76,14.10,11.94,11.80,11.04,10.94,10.46,9.87,9.63,12.68,14.69,17.64,18.07
    17.74,43.59,67.75,72.31,61.11,52.26,76.57,93.71,107.40,95.88,79.18,73.03,88.82,73.83,66.94
DEC,58.40,51.91,45.76,40.58,35.89,31.68,27.96,25.17,24.17,22.68,21.67,18.89,17.73,16.72,16.83
    16.27,15.32,15.13,14.87,14.01,13.56,12.98,12.50,12.02,11.89,12.00,12.27,49.60,121.21,249.25,195.25
JAN,136.07,106.17,91.88,78.75,81.18,71.08,64.24,57.43,52.03,51.10,44.71,40.12,36.28,34.51,36.15
     32.55,39.79,205.75,808.62,342.00,327.25,242.50,205.46,192.30,204.22,171.59,140.72,123.71,111.88,119.60,98.69
FEB,90.72,79.80,72.60,65.93,59.62,54.12,49.25,46.63,54.49,60.20,63.39,70.41,65.15,60.20,55.56
    51.61,48.73,50.53,58.42,58.77,62.32,74.94,92.70,95.05,89.67,87.29,79.09,71.81,69.01
MAR,93.37,104.02,88.31,77.71,72.51,75.63,77.02,70.06,63.74,59.13,60.55,74.59,108.62,161.28,167.97
   201.90,252.18,195.68,165.53,184.46,261.65,237.99,203.23,186.13,163.62,141.99,124.99,111.85,110.03,272.33,314.63
APR,233.97,187.98,163.40,159.95,150.60,124.75,108.06,93.09,80.95,73.02,69.68,62.97,56.29,49.73,43.72
    55.83,55.95,62.38,68.03,75.65,69.53,63.38,56.07,48.75,46.37,66.68,68.69,64.17,58.80,66.61
MAY,67.05,65.56,74.76,76.32,76.01,70.28,64.37,58.10,51.84,45.70,40.89,36.20,31.74,28.03,24.60
    23.71,22.00,20.63,19.38,18.65,20.79,28.56,26.09,29.60,43.48,34.50,28.35,23.96,23.27,21.35,9.78
JUN,18.78,18.76,17.21,19.65,45.07,34.13,33.80,37.08,49.87,45.11,38.90,35.86,34.61,28.30,23.40
    22.61,20.80,19.90,19.01,17.79,16.38,15.51,18.87,18.74,16.43,16.07,14.74,13.40,12.59,12.38
JUL,14.01,13.15,12.78,11.81,10.70,9.37,8.58,8.14,7.58,7.08,6.74,6.43,6.18,5.93,5.87
     6.12,5.76,5.65,5.61,5.47,5.73,5.47,5.52,5.22,4.78,4.49,4.52,4.83,4.53,4.35,4.01
AUG,3.69,3.47,3.27,2.99,2.82,2.67,2.54,2.43,2.45,2.41,2.26,2.05,1.89,1.69,1.63
    1.58,1.43,1.36,1.69,1.58,1.40,1.25,1.09,0.98,0.94,1.12,1.12,1.12,1.09,1.06,1.06
SEP,1.06,0.98,0.95,0.87,0.65,0.40,0.36,0.34,0.57,0.63,0.54,0.49,0.40,0.31,0.26
    0.25,0.23,0.23,0.29,0.42,0.62,1.09,1.48,1.56,1.56,1.63,1.61,1.57,1.35,1.38
2012-13, UPPER DRIFT CR.
Regression equation used to convert Pudding 2 Drift flows,0,1,0
OCT,2.03,1.95,1.92,1.85,1.78,1.61,1.58,1.59,1.70,1.72,1.80,2.67,6.13,5.98,10.89
   17.61,12.42,11.02,8.21,9.43,9.19,9.94,12.60,14.21,16.63,14.46,14.24,32.91,63.04,48.69,39.84
NOV,40.72,40.21,42.08,40.44,35.02,30.52,29.64,26.63,23.90,25.33,25.61,38.17,47.86,43.91,39.18
    35.25,44.06,95.11,152.95,364.40,328.25,230.55,175.09,218.49,164.96,133.15,108.97,90.71,81.26,74.71
DEC,97.97,143.66,141.51,178.28,181.20,141.43,125.95,111.14,101.09,89.00,85.72,98.58,85.66,78.82,73.43
    80.94,108.52,111.59,102.25,148.92,160.18,138.54,140.80,161.01,162.39,174.77,142.90,123.61,105.14,90.73,79.96
JAN,67.67,59.44,52.59,47.87,43.58,40.17,41.62,41.41,46.90,63.22,62.21,56.13,50.93,46.37,43.06
    39.86,37.05,34.55,32.05,29.75,27.65,25.95,25.88,27.13,46.67,60.62,69.87,107.25,210.04,207.69,183.62
FEB,143.61,121.15,102.24,87.76,79.73,73.63,68.67,62.23,55.45,50.94,46.32,45.40,41.50,37.89,35.16
    33.54,32.40,30.19,29.20,27.98,30.04,35.05,54.63,52.45,54.46,51.95,46.46,44.39
MAR,46.07,43.50,42.11,38.73,37.26,45.40,50.61,45.69,41.54,37.72,35.50,33.49,30.70,26.13,24.24
    25.73,31.71,27.18,25.77,49.17,56.51,52.63,48.36,44.18,40.81,37.97,34.82,31.88,29.22,26.66,24.64
APR,23.02,21.61,19.43,19.24,19.78,34.42,50.35,49.34,44.09,41.76,39.41,36.26,38.72,35.92,35.70
    32.89,30.28,28.18,33.53,33.81,30.69,28.55,26.19,24.21,22.40,20.71,19.05,17.60,17.92,17.33
MAY,17.69,16.76,15.73,14.82,13.91,13.33,12.90,12.55,12.20,11.43,10.89,10.67,11.32,10.74,10.44
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    11.20,12.24,10.18,11.54,10.53,12.47,23.38,29.80,40.66,35.88,33.83,42.88,61.00,65.12,59.32,50.08
JUN,42.50,36.81,31.86,27.49,23.87,20.76,18.19,17.15,17.17,16.00,15.29,14.78,16.30,15.24,13.06
    12.04,11.43,12.38,13.41,14.94,16.52,13.76,13.42,17.32,16.44,17.92,16.83,14.45,12.92,11.71
JUL,10.78,9.98,9.28,8.66,7.84,7.47,7.25,6.98,6.56,6.21,5.89,5.63,5.40,5.03,4.67,4.58,4.97,4.67
    4.18,3.96,3.79,3.63,3.37,3.12,2.81,2.48,2.24,2.19,2.22,2.22,2.20
AUG,2.15,2.61,2.53,2.07,1.93,3.51,3.22,3.08,3.03,2.98,3.08,3.22,3.22,3.17,3.03
    2.93,3.17,1.09,1.13,1.14,0.90,0.83,1.35,1.69,1.74,2.09,1.77,1.60,1.58,1.58,1.30
SEP,1.08,1.05,1.17,1.03,3.14,23.75,14.50,9.74,7.58,6.22,5.22,4.61,4.28,4.18,4.02
    4.14,3.99,6.57,9.08,5.88,4.67,4.83,7.88,11.15,16.86,15.29,12.33,15.62,69.21,109.21
2013-14, UPPER DRIFT CR.
Regression equation used to convert Pudding 2 Drift flows,0,1,0
OCT,96.34,85.87,70.45,56.48,46.18,37.79,33.64,33.95,39.54,32.29,27.39,23.46,22.99,21.09,19.53
    18.35,17.23,16.27,15.48,14.72,14.02,13.42,12.87,12.41,12.26,11.81,12.69,16.12,13.09,11.91,11.22
NOV,11.01,17.57,22.71,21.82,24.75,34.67,49.06,56.60,50.60,44.53,38.42,44.75,46.86,41.96,38.30
    42.53,38.95,36.02,55.54,67.42,58.88,51.71,46.38,41.63,36.70,32.24,28.93,24.72,20.42,18.92
DEC,20.55,83.23,78.44,64.42,54.43,47.22,41.01,35.47,31.61,27.59,24.04,24.05,29.41,25.62,24.59
    23.42,22.49,21.80,21.29,20.29,25.51,27.03,29.34,39.27,37.66,34.72,31.82,28.40,25.01,24.49,23.00
JAN,21.60,20.42,23.71,21.79,20.19,19.25,19.53,23.27,26.12,39.55,49.60,72.18,95.01,102.72,92.32
    78.22,64.94,54.52,47.17,41.54,37.57,34.07,31.26,25.40,24.52,22.61,21.44,21.51,31.92,31.14,34.39
FEB,34.02,31.64,28.94,26.76,24.53,23.23,24.01,24.73,32.58,48.43,141.99,225.28,211.02,281.20,293.23
    275.75,221.22,220.53,221.26,212.60,183.14,146.96,123.21,106.95,84.26,73.63,67.86,60.97
MAR,59.52,76.97,108.07,112.98,143.84,214.80,166.53,136.19,189.68,152.83,123.79,104.29,87.10,81.03,71.15
    63.24,84.22,70.13,62.33,55.32,49.49,43.82,38.62,34.04,32.73,37.46,66.47,112.03,173.18,147.83,119.96
APR,102.06,83.02,73.56,76.95,72.56,80.38,72.73,64.90,59.21,52.06,45.91,40.99,37.97,32.77,28.21
    25.37,27.47,30.07,24.54,24.27,22.48,29.88,49.38,108.76,121.93,98.39,97.50,84.35,73.82,64.70
MAY,57.08,50.13,44.99,48.28,42.89,36.86,31.14,31.61,62.31,76.09,67.03,57.63,49.41,42.52,36.78
    32.01,28.04,30.96,40.80,29.69,24.75,22.39,20.98,19.80,18.46,17.18,15.68,14.90,14.83,13.32,12.38
JUN,11.77,11.18,11.49,11.09,10.40,9.66,9.15,8.71,8.30,7.85,7.49,7.64,9.14,8.85,8.45
    8.79,8.97,8.42,7.58,7.17,6.74,6.26,5.89,5.72,5.85,7.22,11.93,11.76,9.89,9.51
JUL,7.73,6.31,3.72,3.23,3.39,5.05,5.58,5.17,3.92,2.86,2.70,2.22,2.58,2.60,2.41
    1.38,0.98,1.80,1.95,1.69,2.79,3.05,3.66,3.60,3.17,2.67,2.34,1.67,1.15,1.00,0.90
AUG,0.75,0.81,0.66,0.62,0.55,0.47,0.35,0.45,0.45,0.47,0.46,0.44,0.62,0.55,0.55
    0.63,0.76,0.50,0.38,0.26,0.25,0.31,0.42,0.36,0.37,0.34,0.22,0.26,0.68,1.25,1.12
SEP,1.04,0.84,0.84,0.75,0.62,0.42,0.30,0.20,0.26,0.26,0.18,0.12,0.07,0.06,0.05
    0.16,0.16,0.21,0.25,0.18,0.11,0.22,2.81,2.71,2.70,1.78,1.40,1.12,1.31,1.37
END
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A8.6 Model Output for 2008-2009 Multi-Year Simulation
(Relying on local Inflow in Meeting Water Rights)

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 I=10 MONTH= 7 (JUL)  QMIN=   3.00
 I=11 MONTH= 8 (AUG)  QMIN=   2.00
 I=12 MONTH= 9 (SEP)  QMIN=   2.00


Absolute Minimum Release= 1.00


MONTHLY CONSUMPTIVE USES AND STORAGES
 I= 1 MONTH=10 (OCT)  QMIN=   0.02
 I= 2 MONTH=11 (NOV)  QMIN=   0.93
 I= 3 MONTH=12 (DEC)  QMIN=   2.11
 I= 4 MONTH= 1 (JAN)  QMIN=   2.28
 I= 5 MONTH= 2 (FEB)  QMIN=   2.03
 I= 6 MONTH= 3 (MAR)  QMIN=   0.03
 I= 7 MONTH= 4 (APR)  QMIN=   0.04
 I= 8 MONTH= 5 (MAY)  QMIN=   0.22
 I= 9 MONTH= 6 (JUN)  QMIN=   0.44
 I=10 MONTH= 7 (JUL)  QMIN=   0.77
 I=11 MONTH= 8 (AUG)  QMIN=   0.61
 I=12 MONTH= 9 (SEP)  QMIN=   0.30

Multiplier for MONTHLY LOCAL INFLOW BETWEEN SITE A AND CREEK MOUTH (AQLOC)
 I= 1 MONTH=10 (OCT)  AQLOC=   0.71
 I= 2 MONTH=11 (NOV)  AQLOC=   0.48
 I= 3 MONTH=12 (DEC)  AQLOC=   0.42
 I= 4 MONTH= 1 (JAN)  AQLOC=   0.39
 I= 5 MONTH= 2 (FEB)  AQLOC=   0.50
 I= 6 MONTH= 3 (MAR)  AQLOC=   0.41
 I= 7 MONTH= 4 (APR)  AQLOC=   0.33
 I= 8 MONTH= 5 (MAY)  AQLOC=   0.22
 I= 9 MONTH= 6 (JUN)  AQLOC=   0.30
 I=10 MONTH= 7 (JUL)  AQLOC=   0.01
 I=11 MONTH= 8 (AUG)  AQLOC=   0.17
 I=12 MONTH= 9 (SEP)  AQLOC=   0.08


YESLOC=1 (0=Local Inflow Not Accounted for in Meeting ISTR at the mouth)


Operating Mode: Project Must meet MinQ-Qloc
Title:Time Series Multi-year Continuous Reservoir Simulation Date:03-13-2015 Time:00:32:12

Irrigation Monthly Requirement starting in Oct (cfs) based on IRRVOL=  8,000 AF:
 OCT/  0.0
 NOV/  0.0
 DEC/  0.0
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 JAN/  0.0
 FEB/  0.0
 MAR/  0.0
 APR/  0.0
 MAY/ 13.0
 JUN/ 13.5
 JUL/ 26.0
 AUG/ 39.0
 SEP/ 40.3

TOTAL INFLOW VOLUME (AF)= 22,630
Initial Begin-period: ELE= 657.0  S(aft)=5877.5
Reservoir Upper Bound ELE= 677.00 S(aft)= 12,238
Reservoir Lower Bound ELE= 620.00 S(aft)=      8
SUMMARY RESULTS OF RESERVOIR SIMULATION
 Run Date:03-13-2015 00:32:12
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I	DA	MO	YR	QIN	ELE1	ISWR	CONSU	QLOC	REQ	QREQ	IRR	QIRR	QREL	V	ELE2	STORAGE
1	1	10	2008	0.50	656.97	5.26	0.02	0.35	4.93	0.50	0.00	0.00	0.50	1	656.97	5,877
2	2	10	2008	0.50	656.97	5.26	0.02	0.35	4.93	0.50	0.00	0.00	0.50	1	656.97	5,877
3	3	10	2008	1.00	656.97	5.26	0.02	0.71	4.57	1.00	0.00	0.00	1.00	1	656.97	5,877
4	4	10	2008	5.00	656.97	5.26	0.02	3.55	1.73	1.73	0.00	0.00	1.73	0	657.00	5,884
5	5	10	2008	4.00	657.00	5.26	0.02	2.84	2.44	2.44	0.00	0.00	2.44	0	657.01	5,887
6	6	10	2008	3.80	657.01	5.26	0.02	2.70	2.58	2.58	0.00	0.00	2.58	0	657.02	5,889
7	7	10	2008	3.50	657.02	5.26	0.02	2.48	2.80	2.80	0.00	0.00	2.80	0	657.02	5,891
8	8	10	2008	3.50	657.02	5.26	0.02	2.48	2.80	2.80	0.00	0.00	2.80	0	657.03	5,892
9	9	10	2008	4.00	657.03	5.26	0.02	2.84	2.44	2.44	0.00	0.00	2.44	0	657.04	5,895
10	10	10	2008	3.00	657.04	5.26	0.02	2.13	3.15	3.00	0.00	0.00	3.00	1	657.04	5,895
11	11	10	2008	2.80	657.04	5.26	0.02	1.99	3.29	2.80	0.00	0.00	2.80	1	657.04	5,895
12	12	10	2008	2.60	657.04	5.26	0.02	1.85	3.43	2.60	0.00	0.00	2.60	1	657.04	5,895
13	13	10	2008	2.50	657.04	5.26	0.02	1.77	3.51	2.50	0.00	0.00	2.50	1	657.04	5,895
14	14	10	2008	2.30	657.04	5.26	0.02	1.63	3.65	2.30	0.00	0.00	2.30	1	657.04	5,895
15	15	10	2008	2.10	657.04	5.26	0.02	1.49	3.79	2.10	0.00	0.00	2.10	1	657.04	5,895
16	16	10	2008	2.00	657.04	5.26	0.02	1.42	3.86	2.00	0.00	0.00	2.00	1	657.04	5,895
17	17	10	2008	1.60	657.04	5.26	0.02	1.14	4.14	1.60	0.00	0.00	1.60	1	657.04	5,895
18	18	10	2008	1.80	657.04	5.26	0.02	1.28	4.00	1.80	0.00	0.00	1.80	1	657.04	5,895
19	19	10	2008	1.30	657.04	5.26	0.02	0.92	4.36	1.30	0.00	0.00	1.30	1	657.04	5,895
20	20	10	2008	1.00	657.04	5.26	0.02	0.71	4.57	1.00	0.00	0.00	1.00	1	657.04	5,895
21	21	10	2008	1.00	657.04	5.26	0.02	0.71	4.57	1.00	0.00	0.00	1.00	1	657.04	5,895
22	22	10	2008	1.20	657.04	5.26	0.02	0.85	4.43	1.20	0.00	0.00	1.20	1	657.04	5,895
23	23	10	2008	0.80	657.04	5.26	0.02	0.57	4.71	0.80	0.00	0.00	0.80	1	657.04	5,895
24	24	10	2008	0.70	657.04	5.26	0.02	0.50	4.78	0.70	0.00	0.00	0.70	1	657.04	5,895
25	25	10	2008	0.60	657.04	5.26	0.02	0.43	4.85	0.60	0.00	0.00	0.60	1	657.04	5,895
26	26	10	2008	0.60	657.04	5.26	0.02	0.43	4.85	0.60	0.00	0.00	0.60	1	657.04	5,895
27	27	10	2008	0.60	657.04	5.26	0.02	0.43	4.85	0.60	0.00	0.00	0.60	1	657.04	5,895
28	28	10	2008	0.60	657.04	5.26	0.02	0.43	4.85	0.60	0.00	0.00	0.60	1	657.04	5,895
29	29	10	2008	0.60	657.04	5.26	0.02	0.43	4.85	0.60	0.00	0.00	0.60	1	657.04	5,895
30	30	10	2008	0.60	657.04	5.26	0.02	0.43	4.85	0.60	0.00	0.00	0.60	1	657.04	5,895

31	31	10	2008	0.60	657.04	5.26	0.02	0.43	4.85	0.60	0.00	0.00	0.60	1	657.04	5,895
32	1	11	2008	0.60	657.04	40.00	0.93	0.29	40.64	0.60	0.00	0.00	0.60	1	657.04	5,895
33	2	11	2008	0.70	657.04	40.00	0.93	0.34	40.59	0.70	0.00	0.00	0.70	1	657.04	5,895
34	3	11	2008	1.00	657.04	40.00	0.93	0.48	40.45	1.00	0.00	0.00	1.00	1	657.04	5,895
35	4	11	2008	6.00	657.04	40.00	0.93	2.88	38.05	6.00	0.00	0.00	6.00	1	657.04	5,895
36	5	11	2008	5.00	657.04	40.00	0.93	2.40	38.53	5.00	0.00	0.00	5.00	1	657.04	5,895
37	6	11	2008	3.30	657.04	40.00	0.93	1.58	39.35	3.30	0.00	0.00	3.30	1	657.04	5,895
38	7	11	2008	3.50	657.04	40.00	0.93	1.68	39.25	3.50	0.00	0.00	3.50	1	657.04	5,895
39	8	11	2008	3.00	657.04	40.00	0.93	1.44	39.49	3.00	0.00	0.00	3.00	1	657.04	5,895
40	9	11	2008	3.50	657.04	40.00	0.93	1.68	39.25	3.50	0.00	0.00	3.50	1	657.04	5,895
41	10	11	2008	4.00	657.04	40.00	0.93	1.92	39.01	4.00	0.00	0.00	4.00	1	657.04	5,895
42	11	11	2008	5.00	657.04	40.00	0.93	2.40	38.53	5.00	0.00	0.00	5.00	1	657.04	5,895
43	12	11	2008	22.00	657.04	40.00	0.93	10.56	30.37	22.00	0.00	0.00	22.00	1	657.04	5,895
44	13	11	2008	130.00	657.04	40.00	0.93	62.40	1.00	1.00	0.00	0.00	1.00	0	657.95	6,151
45	14	11	2008	85.00	657.95	40.00	0.93	40.80	1.00	1.00	0.00	0.00	1.00	0	658.55	6,318
46	15	11	2008	54.00	658.55	40.00	0.93	25.92	15.01	15.01	0.00	0.00	15.01	0	658.83	6,395
47	16	11	2008	40.00	658.83	40.00	0.93	19.20	21.73	21.73	0.00	0.00	21.73	0	658.96	6,431
48	17	11	2008	34.00	658.96	40.00	0.93	16.32	24.61	24.61	0.00	0.00	24.61	0	659.02	6,450
49	18	11	2008	28.00	659.02	40.00	0.93	13.44	27.49	27.49	0.00	0.00	27.49	0	659.03	6,451
50	19	11	2008	23.00	659.03	40.00	0.93	11.04	29.89	23.00	0.00	0.00	23.00	1	659.03	6,451
51	20	11	2008	24.00	659.03	40.00	0.93	11.52	29.41	24.00	0.00	0.00	24.00	1	659.03	6,451
52	21	11	2008	25.00	659.03	40.00	0.93	12.00	28.93	25.00	0.00	0.00	25.00	1	659.03	6,451
53	22	11	2008	24.00	659.03	40.00	0.93	11.52	29.41	24.00	0.00	0.00	24.00	1	659.03	6,451
54	23	11	2008	23.00	659.03	40.00	0.93	11.04	29.89	23.00	0.00	0.00	23.00	1	659.03	6,451
55	24	11	2008	22.00	659.03	40.00	0.93	10.56	30.37	22.00	0.00	0.00	22.00	1	659.03	6,451
56	25	11	2008	21.00	659.03	40.00	0.93	10.08	30.85	21.00	0.00	0.00	21.00	1	659.03	6,451
57	26	11	2008	20.00	659.03	40.00	0.93	9.60	31.33	20.00	0.00	0.00	20.00	1	659.03	6,451
58	27	11	2008	20.00	659.03	40.00	0.93	9.60	31.33	20.00	0.00	0.00	20.00	1	659.03	6,451
59	28	11	2008	19.00	659.03	40.00	0.93	9.12	31.81	19.00	0.00	0.00	19.00	1	659.03	6,451
60	29	11	2008	18.00	659.03	40.00	0.93	8.64	32.29	18.00	0.00	0.00	18.00	1	659.03	6,451
61	30	11	2008	17.00	659.03	40.00	0.93	8.16	32.77	17.00	0.00	0.00	17.00	1	659.03	6,451
62	1	12	2008	17.00	659.03	40.00	2.11	7.14	34.97	17.00	0.00	0.00	17.00	1	659.03	6,451
63	2	12	2008	19.00	659.03	40.00	2.11	7.98	34.13	19.00	0.00	0.00	19.00	1	659.03	6,451
64	3	12	2008	20.00	659.03	40.00	2.11	8.40	33.71	20.00	0.00	0.00	20.00	1	659.03	6,451
65	4	12	2008	19.00	659.03	40.00	2.11	7.98	34.13	19.00	0.00	0.00	19.00	1	659.03	6,451
66	5	12	2008	19.00	659.03	40.00	2.11	7.98	34.13	19.00	0.00	0.00	19.00	1	659.03	6,451
67	6	12	2008	17.00	659.03	40.00	2.11	7.14	34.97	17.00	0.00	0.00	17.00	1	659.03	6,451
68	7	12	2008	17.00	659.03	40.00	2.11	7.14	34.97	17.00	0.00	0.00	17.00	1	659.03	6,451
69	8	12	2008	19.00	659.03	40.00	2.11	7.98	34.13	19.00	0.00	0.00	19.00	1	659.03	6,451
70	9	12	2008	17.00	659.03	40.00	2.11	7.14	34.97	17.00	0.00	0.00	17.00	1	659.03	6,451
71	10	12	2008	16.00	659.03	40.00	2.11	6.72	35.39	16.00	0.00	0.00	16.00	1	659.03	6,451
72	11	12	2008	15.00	659.03	40.00	2.11	6.30	35.81	15.00	0.00	0.00	15.00	1	659.03	6,451
73	12	12	2008	17.00	659.03	40.00	2.11	7.14	34.97	17.00	0.00	0.00	17.00	1	659.03	6,451
74	13	12	2008	26.00	659.03	40.00	2.11	10.92	31.19	26.00	0.00	0.00	26.00	1	659.03	6,451
75	14	12	2008	23.00	659.03	40.00	2.11	9.66	32.45	23.00	0.00	0.00	23.00	1	659.03	6,451
76	15	12	2008	19.00	659.03	40.00	2.11	7.98	34.13	19.00	0.00	0.00	19.00	1	659.03	6,451
77	16	12	2008	17.00	659.03	40.00	2.11	7.14	34.97	17.00	0.00	0.00	17.00	1	659.03	6,451

78	17	12	2008	17.00	659.03	40.00	2.11	7.14	34.97	17.00	0.00	0.00	17.00	1	659.03	6,451
79	18	12	2008	28.00	659.03	40.00	2.11	11.76	30.35	28.00	0.00	0.00	28.00	1	659.03	6,451
80	19	12	2008	25.00	659.03	40.00	2.11	10.50	31.61	25.00	0.00	0.00	25.00	1	659.03	6,451
81	20	12	2008	24.00	659.03	40.00	2.11	10.08	32.03	24.00	0.00	0.00	24.00	1	659.03	6,451
82	21	12	2008	33.00	659.03	40.00	2.11	13.86	28.25	28.25	0.00	0.00	28.25	0	659.06	6,460
83	22	12	2008	60.00	659.06	40.00	2.11	25.20	16.91	16.91	0.00	0.00	16.91	0	659.37	6,546
84	23	12	2008	50.00	659.37	40.00	2.11	21.00	21.11	21.11	0.00	0.00	21.11	0	659.57	6,603
85	24	12	2008	40.00	659.57	40.00	2.11	16.80	25.31	25.31	0.00	0.00	25.31	0	659.68	6,632
86	25	12	2008	50.00	659.68	40.00	2.11	21.00	21.11	21.11	0.00	0.00	21.11	0	659.88	6,690
87	26	12	2008	55.00	659.88	40.00	2.11	23.10	19.01	19.01	0.00	0.00	19.01	0	660.12	6,761
88	27	12	2008	110.00	660.12	40.00	2.11	46.20	1.00	1.00	0.00	0.00	1.00	0	660.81	6,977
89	28	12	2008	200.00	660.81	40.00	2.11	84.00	1.00	1.00	0.00	0.00	1.00	0	662.07	7,372
90	29	12	2008	215.00	662.07	40.00	2.11	90.30	1.00	1.00	0.00	0.00	1.00	0	663.43	7,796
91	30	12	2008	160.00	663.43	40.00	2.11	67.20	1.00	1.00	0.00	0.00	1.00	0	664.43	8,111
92	31	12	2008	130.00	664.43	40.00	2.11	54.60	1.00	1.00	0.00	0.00	1.00	0	665.25	8,367
93	1	1	2009	275.00	665.25	40.00	2.28	107.25	1.00	1.00	0.00	0.00	1.00	0	666.98	8,910
94	2	1	2009	500.00	666.98	40.00	2.28	195.00	1.00	1.00	0.00	0.00	1.00	0	670.13	9,900
95	3	1	2009	267.00	670.13	40.00	2.28	104.13	1.00	1.00	0.00	0.00	1.00	0	671.68	10,427
96	4	1	2009	181.00	671.68	40.00	2.28	70.59	1.00	1.00	0.00	0.00	1.00	0	672.73	10,784
97	5	1	2009	173.00	672.73	40.00	2.28	67.47	1.00	1.00	0.00	0.00	1.00	0	673.73	11,125
98	6	1	2009	159.00	673.73	40.00	2.28	62.01	1.00	1.00	0.00	0.00	1.00	0	674.65	11,439
99	7	1	2009	161.00	674.65	40.00	2.28	62.79	1.00	1.00	0.00	0.00	1.00	0	675.58	11,756
100	8	1	2009	198.00	675.58	40.00	2.28	77.22	1.00	1.00	0.00	0.00	1.00	0	676.73	12,147
101	9	1	2009	163.00	676.73	40.00	2.28	63.57	1.00	1.00	0.00	0.00	116.75	2	677.00	12,238
102	10	1	2009	132.00	677.00	40.00	2.28	51.48	1.00	1.00	0.00	0.00	132.00	2	677.00	12,238
103	11	1	2009	115.00	677.00	40.00	2.28	44.85	1.00	1.00	0.00	0.00	115.00	2	677.00	12,238
104	12	1	2009	96.00	677.00	40.00	2.28	37.44	4.84	4.84	0.00	0.00	96.00	2	677.00	12,238
105	13	1	2009	84.00	677.00	40.00	2.28	32.76	9.52	9.52	0.00	0.00	84.00	2	677.00	12,238
106	14	1	2009	73.00	677.00	40.00	2.28	28.47	13.81	13.81	0.00	0.00	73.00	2	677.00	12,238
107	15	1	2009	65.00	677.00	40.00	2.28	25.35	16.93	16.93	0.00	0.00	65.00	2	677.00	12,238
108	16	1	2009	57.00	677.00	40.00	2.28	22.23	20.05	20.05	0.00	0.00	57.00	2	677.00	12,238
109	17	1	2009	50.00	677.00	40.00	2.28	19.50	22.78	22.78	0.00	0.00	50.00	2	677.00	12,238
110	18	1	2009	44.00	677.00	40.00	2.28	17.16	25.12	25.12	0.00	0.00	44.00	2	677.00	12,238
111	19	1	2009	39.00	677.00	40.00	2.28	15.21	27.07	27.07	0.00	0.00	39.00	2	677.00	12,238
112	20	1	2009	35.00	677.00	40.00	2.28	13.65	28.63	28.63	0.00	0.00	35.00	2	677.00	12,238
113	21	1	2009	32.00	677.00	40.00	2.28	12.48	29.80	29.80	0.00	0.00	32.00	2	677.00	12,238
114	22	1	2009	30.00	677.00	40.00	2.28	11.70	30.58	30.00	0.00	0.00	30.00	1	677.00	12,238
115	23	1	2009	28.00	677.00	40.00	2.28	10.92	31.36	28.00	0.00	0.00	28.00	1	677.00	12,238
116	24	1	2009	26.00	677.00	40.00	2.28	10.14	32.14	26.00	0.00	0.00	26.00	1	677.00	12,238
117	25	1	2009	27.00	677.00	40.00	2.28	10.53	31.75	27.00	0.00	0.00	27.00	1	677.00	12,238
118	26	1	2009	25.00	677.00	40.00	2.28	9.75	32.53	25.00	0.00	0.00	25.00	1	677.00	12,238
119	27	1	2009	24.00	677.00	40.00	2.28	9.36	32.92	24.00	0.00	0.00	24.00	1	677.00	12,238
120	28	1	2009	27.00	677.00	40.00	2.28	10.53	31.75	27.00	0.00	0.00	27.00	1	677.00	12,238
121	29	1	2009	25.00	677.00	40.00	2.28	9.75	32.53	25.00	0.00	0.00	25.00	1	677.00	12,238
122	30	1	2009	24.00	677.00	40.00	2.28	9.36	32.92	24.00	0.00	0.00	24.00	1	677.00	12,238
123	31	1	2009	23.00	677.00	40.00	2.28	8.97	33.31	23.00	0.00	0.00	23.00	1	677.00	12,238
124	1	2	2009	22.00	677.00	40.00	2.03	11.00	31.03	22.00	0.00	0.00	22.00	1	677.00	12,238

125	2	2	2009	21.00	677.00	40.00	2.03	10.50	31.53	21.00	0.00	0.00	21.00	1	677.00	12,238
126	3	2	2009	21.00	677.00	40.00	2.03	10.50	31.53	21.00	0.00	0.00	21.00	1	677.00	12,238
127	4	2	2009	20.00	677.00	40.00	2.03	10.00	32.03	20.00	0.00	0.00	20.00	1	677.00	12,238
128	5	2	2009	19.00	677.00	40.00	2.03	9.50	32.53	19.00	0.00	0.00	19.00	1	677.00	12,238
129	6	2	2009	23.00	677.00	40.00	2.03	11.50	30.53	23.00	0.00	0.00	23.00	1	677.00	12,238
130	7	2	2009	23.00	677.00	40.00	2.03	11.50	30.53	23.00	0.00	0.00	23.00	1	677.00	12,238
131	8	2	2009	22.00	677.00	40.00	2.03	11.00	31.03	22.00	0.00	0.00	22.00	1	677.00	12,238
132	9	2	2009	22.00	677.00	40.00	2.03	11.00	31.03	22.00	0.00	0.00	22.00	1	677.00	12,238
133	10	2	2009	22.00	677.00	40.00	2.03	11.00	31.03	22.00	0.00	0.00	22.00	1	677.00	12,238
134	11	2	2009	25.00	677.00	40.00	2.03	12.50	29.53	25.00	0.00	0.00	25.00	1	677.00	12,238
135	12	2	2009	24.00	677.00	40.00	2.03	12.00	30.03	24.00	0.00	0.00	24.00	1	677.00	12,238
136	13	2	2009	25.00	677.00	40.00	2.03	12.50	29.53	25.00	0.00	0.00	25.00	1	677.00	12,238
137	14	2	2009	24.00	677.00	40.00	2.03	12.00	30.03	24.00	0.00	0.00	24.00	1	677.00	12,238
138	15	2	2009	24.00	677.00	40.00	2.03	12.00	30.03	24.00	0.00	0.00	24.00	1	677.00	12,238
139	16	2	2009	23.00	677.00	40.00	2.03	11.50	30.53	23.00	0.00	0.00	23.00	1	677.00	12,238
140	17	2	2009	23.00	677.00	40.00	2.03	11.50	30.53	23.00	0.00	0.00	23.00	1	677.00	12,238
141	18	2	2009	22.00	677.00	40.00	2.03	11.00	31.03	22.00	0.00	0.00	22.00	1	677.00	12,238
142	19	2	2009	21.00	677.00	40.00	2.03	10.50	31.53	21.00	0.00	0.00	21.00	1	677.00	12,238
143	20	2	2009	20.00	677.00	40.00	2.03	10.00	32.03	20.00	0.00	0.00	20.00	1	677.00	12,238
144	21	2	2009	19.00	677.00	40.00	2.03	9.50	32.53	19.00	0.00	0.00	19.00	1	677.00	12,238
145	22	2	2009	19.00	677.00	40.00	2.03	9.50	32.53	19.00	0.00	0.00	19.00	1	677.00	12,238
146	23	2	2009	24.00	677.00	40.00	2.03	12.00	30.03	24.00	0.00	0.00	24.00	1	677.00	12,238
147	24	2	2009	71.00	677.00	40.00	2.03	35.50	6.53	6.53	0.00	0.00	71.00	2	677.00	12,238
148	25	2	2009	126.00	677.00	40.00	2.03	63.00	1.00	1.00	0.00	0.00	126.00	2	677.00	12,238
149	26	2	2009	156.00	677.00	40.00	2.03	78.00	1.00	1.00	0.00	0.00	156.00	2	677.00	12,238
150	27	2	2009	123.00	677.00	40.00	2.03	61.50	1.00	1.00	0.00	0.00	123.00	2	677.00	12,238
151	28	2	2009	106.00	677.00	40.00	2.03	53.00	1.00	1.00	0.00	0.00	106.00	2	677.00	12,238
152	1	3	2009	91.00	677.00	40.00	0.03	37.31	2.72	2.72	0.00	0.00	91.00	2	677.00	12,238
153	2	3	2009	92.00	677.00	40.00	0.03	37.72	2.31	2.31	0.00	0.00	92.00	2	677.00	12,238
154	3	3	2009	86.00	677.00	40.00	0.03	35.26	4.77	4.77	0.00	0.00	86.00	2	677.00	12,238
155	4	3	2009	74.00	677.00	40.00	0.03	30.34	9.69	9.69	0.00	0.00	74.00	2	677.00	12,238
156	5	3	2009	77.00	677.00	40.00	0.03	31.57	8.46	8.46	0.00	0.00	77.00	2	677.00	12,238
157	6	3	2009	71.00	677.00	40.00	0.03	29.11	10.92	10.92	0.00	0.00	71.00	2	677.00	12,238
158	7	3	2009	65.00	677.00	40.00	0.03	26.65	13.38	13.38	0.00	0.00	65.00	2	677.00	12,238
159	8	3	2009	62.00	677.00	40.00	0.03	25.42	14.61	14.61	0.00	0.00	62.00	2	677.00	12,238
160	9	3	2009	60.00	677.00	40.00	0.03	24.60	15.43	15.43	0.00	0.00	60.00	2	677.00	12,238
161	10	3	2009	58.00	677.00	40.00	0.03	23.78	16.25	16.25	0.00	0.00	58.00	2	677.00	12,238
162	11	3	2009	54.00	677.00	40.00	0.03	22.14	17.89	17.89	0.00	0.00	54.00	2	677.00	12,238
163	12	3	2009	50.00	677.00	40.00	0.03	20.50	19.53	19.53	0.00	0.00	50.00	2	677.00	12,238
164	13	3	2009	46.00	677.00	40.00	0.03	18.86	21.17	21.17	0.00	0.00	46.00	2	677.00	12,238
165	14	3	2009	46.00	677.00	40.00	0.03	18.86	21.17	21.17	0.00	0.00	46.00	2	677.00	12,238
166	15	3	2009	80.00	677.00	40.00	0.03	32.80	7.23	7.23	0.00	0.00	80.00	2	677.00	12,238
167	16	3	2009	92.00	677.00	40.00	0.03	37.72	2.31	2.31	0.00	0.00	92.00	2	677.00	12,238
168	17	3	2009	84.00	677.00	40.00	0.03	34.44	5.59	5.59	0.00	0.00	84.00	2	677.00	12,238
169	18	3	2009	73.00	677.00	40.00	0.03	29.93	10.10	10.10	0.00	0.00	73.00	2	677.00	12,238
170	19	3	2009	66.00	677.00	40.00	0.03	27.06	12.97	12.97	0.00	0.00	66.00	2	677.00	12,238
171	20	3	2009	60.00	677.00	40.00	0.03	24.60	15.43	15.43	0.00	0.00	60.00	2	677.00	12,238

172	21	3	2009	54.00	677.00	40.00	0.03	22.14	17.89	17.89	0.00	0.00	54.00	2	677.00	12,238
173	22	3	2009	62.00	677.00	40.00	0.03	25.42	14.61	14.61	0.00	0.00	62.00	2	677.00	12,238
174	23	3	2009	59.00	677.00	40.00	0.03	24.19	15.84	15.84	0.00	0.00	59.00	2	677.00	12,238
175	24	3	2009	54.00	677.00	40.00	0.03	22.14	17.89	17.89	0.00	0.00	54.00	2	677.00	12,238
176	25	3	2009	61.00	677.00	40.00	0.03	25.01	15.02	15.02	0.00	0.00	61.00	2	677.00	12,238
177	26	3	2009	59.00	677.00	40.00	0.03	24.19	15.84	15.84	0.00	0.00	59.00	2	677.00	12,238
178	27	3	2009	54.00	677.00	40.00	0.03	22.14	17.89	17.89	0.00	0.00	54.00	2	677.00	12,238
179	28	3	2009	56.00	677.00	40.00	0.03	22.96	17.07	17.07	0.00	0.00	56.00	2	677.00	12,238
180	29	3	2009	68.00	677.00	40.00	0.03	27.88	12.15	12.15	0.00	0.00	68.00	2	677.00	12,238
181	30	3	2009	66.00	677.00	40.00	0.03	27.06	12.97	12.97	0.00	0.00	66.00	2	677.00	12,238
182	31	3	2009	63.00	677.00	40.00	0.03	25.83	14.20	14.20	0.00	0.00	63.00	2	677.00	12,238
183	1	4	2009	60.00	677.00	40.00	0.04	19.80	20.24	20.24	0.00	0.00	60.00	2	677.00	12,238
184	2	4	2009	81.00	677.00	40.00	0.04	26.73	13.31	13.31	0.00	0.00	81.00	2	677.00	12,238
185	3	4	2009	80.00	677.00	40.00	0.04	26.40	13.64	13.64	0.00	0.00	80.00	2	677.00	12,238
186	4	4	2009	72.00	677.00	40.00	0.04	23.76	16.28	16.28	0.00	0.00	72.00	2	677.00	12,238
187	5	4	2009	64.00	677.00	40.00	0.04	21.12	18.92	18.92	0.00	0.00	64.00	2	677.00	12,238
188	6	4	2009	56.00	677.00	40.00	0.04	18.48	21.56	21.56	0.00	0.00	56.00	2	677.00	12,238
189	7	4	2009	51.00	677.00	40.00	0.04	16.83	23.21	23.21	0.00	0.00	51.00	2	677.00	12,238
190	8	4	2009	46.00	677.00	40.00	0.04	15.18	24.86	24.86	0.00	0.00	46.00	2	677.00	12,238
191	9	4	2009	44.00	677.00	40.00	0.04	14.52	25.52	25.52	0.00	0.00	44.00	2	677.00	12,238
192	10	4	2009	45.00	677.00	40.00	0.04	14.85	25.19	25.19	0.00	0.00	45.00	2	677.00	12,238
193	11	4	2009	38.00	677.00	40.00	0.04	12.54	27.50	27.50	0.00	0.00	38.00	2	677.00	12,238
194	12	4	2009	35.00	677.00	40.00	0.04	11.55	28.49	28.49	0.00	0.00	35.00	2	677.00	12,238
195	13	4	2009	44.00	677.00	40.00	0.04	14.52	25.52	25.52	0.00	0.00	44.00	2	677.00	12,238
196	14	4	2009	42.00	677.00	40.00	0.04	13.86	26.18	26.18	0.00	0.00	42.00	2	677.00	12,238
197	15	4	2009	39.00	677.00	40.00	0.04	12.87	27.17	27.17	0.00	0.00	39.00	2	677.00	12,238
198	16	4	2009	35.00	677.00	40.00	0.04	11.55	28.49	28.49	0.00	0.00	35.00	2	677.00	12,238
199	17	4	2009	35.00	677.00	40.00	0.04	11.55	28.49	28.49	0.00	0.00	35.00	2	677.00	12,238
200	18	4	2009	33.00	677.00	40.00	0.04	10.89	29.15	29.15	0.00	0.00	33.00	2	677.00	12,238
201	19	4	2009	30.00	677.00	40.00	0.04	9.90	30.14	30.00	0.00	0.00	30.00	1	677.00	12,238
202	20	4	2009	27.00	677.00	40.00	0.04	8.91	31.13	27.00	0.00	0.00	27.00	1	677.00	12,238
203	21	4	2009	25.00	677.00	40.00	0.04	8.25	31.79	25.00	0.00	0.00	25.00	1	677.00	12,238
204	22	4	2009	24.00	677.00	40.00	0.04	7.92	32.12	24.00	0.00	0.00	24.00	1	677.00	12,238
205	23	4	2009	23.00	677.00	40.00	0.04	7.59	32.45	23.00	0.00	0.00	23.00	1	677.00	12,238
206	24	4	2009	22.00	677.00	40.00	0.04	7.26	32.78	22.00	0.00	0.00	22.00	1	677.00	12,238
207	25	4	2009	21.00	677.00	40.00	0.04	6.93	33.11	21.00	0.00	0.00	21.00	1	677.00	12,238
208	26	4	2009	20.00	677.00	40.00	0.04	6.60	33.44	20.00	0.00	0.00	20.00	1	677.00	12,238
209	27	4	2009	20.00	677.00	40.00	0.04	6.60	33.44	20.00	0.00	0.00	20.00	1	677.00	12,238
210	28	4	2009	27.00	677.00	40.00	0.04	8.91	31.13	27.00	0.00	0.00	27.00	1	677.00	12,238
211	29	4	2009	29.00	677.00	40.00	0.04	9.57	30.47	29.00	0.00	0.00	29.00	1	677.00	12,238
212	30	4	2009	24.00	677.00	40.00	0.04	7.92	32.12	24.00	0.00	0.00	24.00	1	677.00	12,238
213	1	5	2009	22.00	677.00	30.10	0.22	4.84	25.48	22.00	13.00	13.00	35.00	1	676.92	12,213
214	2	5	2009	39.00	676.92	30.10	0.22	8.58	21.74	21.74	13.00	13.00	34.74	0	676.95	12,221
215	3	5	2009	39.00	676.95	30.10	0.22	8.58	21.74	21.74	13.00	13.00	34.74	0	676.97	12,230
216	4	5	2009	40.00	676.97	30.10	0.22	8.80	21.52	21.52	13.00	13.00	35.52	2	677.00	12,238
217	5	5	2009	70.00	677.00	30.10	0.22	15.40	14.92	14.92	13.00	13.00	70.00	2	677.00	12,238
218	6	5	2009	98.00	677.00	30.10	0.22	21.56	8.76	8.76	13.00	13.00	98.00	2	677.00	12,238

219	7	5	2009	128.00	677.00	30.10	0.22	28.16	2.16	2.16	13.00	13.00	128.00	2	677.00	12,238
220	8	5	2009	108.00	677.00	30.10	0.22	23.76	6.56	6.56	13.00	13.00	108.00	2	677.00	12,238
221	9	5	2009	89.00	677.00	30.10	0.22	19.58	10.74	10.74	13.00	13.00	89.00	2	677.00	12,238
222	10	5	2009	75.00	677.00	30.10	0.22	16.50	13.82	13.82	13.00	13.00	75.00	2	677.00	12,238
223	11	5	2009	65.00	677.00	30.10	0.22	14.30	16.02	16.02	13.00	13.00	65.00	2	677.00	12,238
224	12	5	2009	59.00	677.00	30.10	0.22	12.98	17.34	17.34	13.00	13.00	59.00	2	677.00	12,238
225	13	5	2009	53.00	677.00	30.10	0.22	11.66	18.66	18.66	13.00	13.00	53.00	2	677.00	12,238
226	14	5	2009	66.00	677.00	30.10	0.22	14.52	15.80	15.80	13.00	13.00	66.00	2	677.00	12,238
227	15	5	2009	54.00	677.00	30.10	0.22	11.88	18.44	18.44	13.00	13.00	54.00	2	677.00	12,238
228	16	5	2009	46.00	677.00	30.10	0.22	10.12	20.20	20.20	13.00	13.00	46.00	2	677.00	12,238
229	17	5	2009	40.00	677.00	30.10	0.22	8.80	21.52	21.52	13.00	13.00	40.00	2	677.00	12,238
230	18	5	2009	36.00	677.00	30.10	0.22	7.92	22.40	22.40	13.00	13.00	36.00	2	677.00	12,238
231	19	5	2009	37.00	677.00	30.10	0.22	8.14	22.18	22.18	13.00	13.00	37.00	2	677.00	12,238
232	20	5	2009	33.00	677.00	30.10	0.22	7.26	23.06	23.06	13.00	13.00	36.06	0	676.98	12,232
233	21	5	2009	29.00	676.98	30.10	0.22	6.38	23.94	23.94	13.00	13.00	36.94	0	676.94	12,217
234	22	5	2009	26.00	676.94	30.10	0.22	5.72	24.60	24.60	13.00	13.00	37.60	0	676.87	12,194
235	23	5	2009	24.00	676.87	30.10	0.22	5.28	25.04	24.00	13.00	13.00	37.00	1	676.79	12,168
236	24	5	2009	22.00	676.79	30.10	0.22	4.84	25.48	22.00	13.00	13.00	35.00	1	676.72	12,142
237	25	5	2009	21.00	676.72	30.10	0.22	4.62	25.70	21.00	13.00	13.00	34.00	1	676.64	12,116
238	26	5	2009	19.00	676.64	30.10	0.22	4.18	26.14	19.00	13.00	13.00	32.00	1	676.57	12,090
239	27	5	2009	18.00	676.57	30.10	0.22	3.96	26.36	18.00	13.00	13.00	31.00	1	676.49	12,065
240	28	5	2009	16.00	676.49	30.10	0.22	3.52	26.80	16.00	13.00	13.00	29.00	1	676.41	12,039
241	29	5	2009	15.00	676.41	30.10	0.22	3.30	27.02	15.00	13.00	13.00	28.00	1	676.34	12,013
242	30	5	2009	14.00	676.34	30.10	0.22	3.08	27.24	14.00	13.00	13.00	27.00	1	676.26	11,987
243	31	5	2009	11.00	676.26	30.10	0.22	2.42	27.90	11.00	13.00	13.00	24.00	1	676.19	11,961
244	1	6	2009	11.00	676.19	13.60	0.44	3.30	10.74	10.74	13.50	13.50	24.24	0	676.11	11,935
245	2	6	2009	10.00	676.11	13.60	0.44	3.00	11.04	10.00	13.50	13.50	23.50	1	676.03	11,908
246	3	6	2009	9.80	676.03	13.60	0.44	2.94	11.10	9.80	13.50	13.50	23.30	1	675.95	11,882
247	4	6	2009	10.00	675.95	13.60	0.44	3.00	11.04	10.00	13.50	13.50	23.50	1	675.87	11,855
248	5	6	2009	13.00	675.87	13.60	0.44	3.90	10.14	10.14	13.50	13.50	23.64	0	675.81	11,834
249	6	6	2009	12.00	675.81	13.60	0.44	3.60	10.44	10.44	13.50	13.50	23.94	0	675.74	11,810
250	7	6	2009	11.00	675.74	13.60	0.44	3.30	10.74	10.74	13.50	13.50	24.24	0	675.66	11,784
251	8	6	2009	10.00	675.66	13.60	0.44	3.00	11.04	10.00	13.50	13.50	23.50	1	675.59	11,757
252	9	6	2009	9.30	675.59	13.60	0.44	2.79	11.25	9.30	13.50	13.50	22.80	1	675.51	11,730
253	10	6	2009	8.80	675.51	13.60	0.44	2.64	11.40	8.80	13.50	13.50	22.30	1	675.43	11,704
254	11	6	2009	8.70	675.43	13.60	0.44	2.61	11.43	8.70	13.50	13.50	22.20	1	675.35	11,677
255	12	6	2009	8.40	675.35	13.60	0.44	2.52	11.52	8.40	13.50	13.50	21.90	1	675.27	11,650
256	13	6	2009	7.90	675.27	13.60	0.44	2.37	11.67	7.90	13.50	13.50	21.40	1	675.19	11,623
257	14	6	2009	7.50	675.19	13.60	0.44	2.25	11.79	7.50	13.50	13.50	21.00	1	675.11	11,597
258	15	6	2009	7.20	675.11	13.60	0.44	2.16	11.88	7.20	13.50	13.50	20.70	1	675.03	11,570
259	16	6	2009	6.80	675.03	13.60	0.44	2.04	12.00	6.80	13.50	13.50	20.30	1	674.96	11,543
260	17	6	2009	6.50	674.96	13.60	0.44	1.95	12.09	6.50	13.50	13.50	20.00	1	674.88	11,516
261	18	6	2009	6.20	674.88	13.60	0.44	1.86	12.18	6.20	13.50	13.50	19.70	1	674.80	11,490
262	19	6	2009	6.20	674.80	13.60	0.44	1.86	12.18	6.20	13.50	13.50	19.70	1	674.72	11,463
263	20	6	2009	6.00	674.72	13.60	0.44	1.80	12.24	6.00	13.50	13.50	19.50	1	674.64	11,436
264	21	6	2009	5.80	674.64	13.60	0.44	1.74	12.30	5.80	13.50	13.50	19.30	1	674.56	11,409
265	22	6	2009	5.10	674.56	13.60	0.44	1.53	12.51	5.10	13.50	13.50	18.60	1	674.48	11,382

266	23	6	2009	4.70	674.48	13.60	0.44	1.41	12.63	4.70	13.50	13.50	18.20	1	674.41	11,356
267	24	6	2009	4.40	674.41	13.60	0.44	1.32	12.72	4.40	13.50	13.50	17.90	1	674.33	11,329
268	25	6	2009	4.00	674.33	13.60	0.44	1.20	12.84	4.00	13.50	13.50	17.50	1	674.25	11,302
269	26	6	2009	4.00	674.25	13.60	0.44	1.20	12.84	4.00	13.50	13.50	17.50	1	674.17	11,275
270	27	6	2009	3.50	674.17	13.60	0.44	1.05	12.99	3.50	13.50	13.50	17.00	1	674.09	11,249
271	28	6	2009	3.20	674.09	13.60	0.44	0.96	13.08	3.20	13.50	13.50	16.70	1	674.01	11,222
272	29	6	2009	3.20	674.01	13.60	0.44	0.96	13.08	3.20	13.50	13.50	16.70	1	673.93	11,195
273	30	6	2009	3.10	673.93	13.60	0.44	0.93	13.11	3.10	13.50	13.50	16.60	1	673.85	11,168
274	1	7	2009	3.00	673.85	3.00	0.77	0.03	3.74	3.00	26.00	26.00	29.00	1	673.70	11,117
275	2	7	2009	2.70	673.70	3.00	0.77	0.03	3.74	2.70	26.00	26.00	28.70	1	673.55	11,065
276	3	7	2009	2.30	673.55	3.00	0.77	0.02	3.75	2.30	26.00	26.00	28.30	1	673.40	11,014
277	4	7	2009	2.00	673.40	3.00	0.77	0.02	3.75	2.00	26.00	26.00	28.00	1	673.25	10,962
278	5	7	2009	2.00	673.25	3.00	0.77	0.02	3.75	2.00	26.00	26.00	28.00	1	673.10	10,911
279	6	7	2009	1.80	673.10	3.00	0.77	0.02	3.75	1.80	26.00	26.00	27.80	1	672.95	10,859
280	7	7	2009	1.70	672.95	3.00	0.77	0.02	3.75	1.70	26.00	26.00	27.70	1	672.79	10,807
281	8	7	2009	1.60	672.79	3.00	0.77	0.02	3.75	1.60	26.00	26.00	27.60	1	672.64	10,756
282	9	7	2009	1.70	672.64	3.00	0.77	0.02	3.75	1.70	26.00	26.00	27.70	1	672.49	10,704
283	10	7	2009	1.80	672.49	3.00	0.77	0.02	3.75	1.80	26.00	26.00	27.80	1	672.34	10,653
284	11	7	2009	1.80	672.34	3.00	0.77	0.02	3.75	1.80	26.00	26.00	27.80	1	672.19	10,601
285	12	7	2009	2.00	672.19	3.00	0.77	0.02	3.75	2.00	26.00	26.00	28.00	1	672.04	10,550
286	13	7	2009	3.00	672.04	3.00	0.77	0.03	3.74	3.00	26.00	26.00	29.00	1	671.88	10,498
287	14	7	2009	2.80	671.88	3.00	0.77	0.03	3.74	2.80	26.00	26.00	28.80	1	671.73	10,447
288	15	7	2009	2.10	671.73	3.00	0.77	0.02	3.75	2.10	26.00	26.00	28.10	1	671.58	10,395
289	16	7	2009	1.60	671.58	3.00	0.77	0.02	3.75	1.60	26.00	26.00	27.60	1	671.43	10,343
290	17	7	2009	1.20	671.43	3.00	0.77	0.01	3.76	1.20	26.00	26.00	27.20	1	671.28	10,292
291	18	7	2009	0.90	671.28	3.00	0.77	0.01	3.76	0.90	26.00	26.00	26.90	1	671.13	10,240
292	19	7	2009	0.80	671.13	3.00	0.77	0.01	3.76	0.80	26.00	26.00	26.80	1	670.98	10,189
293	20	7	2009	0.70	670.98	3.00	0.77	0.01	3.76	0.70	26.00	26.00	26.70	1	670.82	10,137
294	21	7	2009	0.70	670.82	3.00	0.77	0.01	3.76	0.70	26.00	26.00	26.70	1	670.67	10,086
295	22	7	2009	0.60	670.67	3.00	0.77	0.01	3.76	0.60	26.00	26.00	26.60	1	670.52	10,034
296	23	7	2009	0.60	670.52	3.00	0.77	0.01	3.76	0.60	26.00	26.00	26.60	1	670.37	9,983
297	24	7	2009	0.50	670.37	3.00	0.77	0.00	3.76	0.50	26.00	26.00	26.50	1	670.22	9,931
298	25	7	2009	0.40	670.22	3.00	0.77	0.00	3.77	0.40	26.00	26.00	26.40	1	670.07	9,879
299	26	7	2009	0.30	670.07	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.91	9,828
300	27	7	2009	0.30	669.91	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.74	9,776
301	28	7	2009	0.30	669.74	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.58	9,725
302	29	7	2009	0.30	669.58	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.41	9,673
303	30	7	2009	0.30	669.41	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.25	9,622
304	31	7	2009	0.20	669.25	3.00	0.77	0.00	3.77	0.20	26.00	26.00	26.20	1	669.09	9,570
305	1	8	2009	0.20	669.09	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	668.84	9,493
306	2	8	2009	0.20	668.84	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	668.59	9,415
307	3	8	2009	0.20	668.59	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	668.35	9,338
308	4	8	2009	0.20	668.35	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	668.10	9,261
309	5	8	2009	0.20	668.10	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	667.85	9,183
310	6	8	2009	0.30	667.85	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	667.61	9,106
311	7	8	2009	0.30	667.61	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	667.36	9,029
312	8	8	2009	0.30	667.36	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	667.11	8,951

313	9	8	2009	0.40	667.11	2.00	0.61	0.07	2.54	0.40	39.00	39.00	39.40	1	666.87	8,874
314	10	8	2009	0.30	666.87	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	666.62	8,797
315	11	8	2009	0.30	666.62	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	666.37	8,719
316	12	8	2009	0.40	666.37	2.00	0.61	0.07	2.54	0.40	39.00	39.00	39.40	1	666.13	8,642
317	13	8	2009	0.50	666.13	2.00	0.61	0.09	2.53	0.50	39.00	39.00	39.50	1	665.88	8,565
318	14	8	2009	0.30	665.88	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	665.63	8,487
319	15	8	2009	0.30	665.63	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	665.39	8,410
320	16	8	2009	0.30	665.39	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	665.14	8,333
321	17	8	2009	0.30	665.14	2.00	0.61	0.05	2.56	0.30	39.00	39.00	39.30	1	664.89	8,255
322	18	8	2009	0.20	664.89	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	664.65	8,178
323	19	8	2009	0.20	664.65	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	664.40	8,101
324	20	8	2009	0.20	664.40	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	664.15	8,023
325	21	8	2009	0.20	664.15	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	663.91	7,946
326	22	8	2009	0.20	663.91	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	663.66	7,869
327	23	8	2009	0.20	663.66	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	663.41	7,791
328	24	8	2009	0.10	663.41	2.00	0.61	0.02	2.59	0.10	39.00	39.00	39.10	1	663.16	7,714
329	25	8	2009	0.10	663.16	2.00	0.61	0.02	2.59	0.10	39.00	39.00	39.10	1	662.92	7,637
330	26	8	2009	0.10	662.92	2.00	0.61	0.02	2.59	0.10	39.00	39.00	39.10	1	662.67	7,559
331	27	8	2009	0.10	662.67	2.00	0.61	0.02	2.59	0.10	39.00	39.00	39.10	1	662.42	7,482
332	28	8	2009	0.10	662.42	2.00	0.61	0.02	2.59	0.10	39.00	39.00	39.10	1	662.18	7,405
333	29	8	2009	0.20	662.18	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	661.93	7,327
334	30	8	2009	0.20	661.93	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	661.68	7,250
335	31	8	2009	0.20	661.68	2.00	0.61	0.03	2.58	0.20	39.00	39.00	39.20	1	661.44	7,173
336	1	9	2009	0.20	661.44	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	661.18	7,093
337	2	9	2009	0.20	661.18	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	660.93	7,013
338	3	9	2009	0.20	660.93	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	660.67	6,933
339	4	9	2009	0.20	660.67	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	660.42	6,853
340	5	9	2009	0.50	660.42	2.00	0.30	0.04	2.26	0.50	40.33	40.33	40.83	1	660.16	6,773
341	6	9	2009	0.90	660.16	2.00	0.30	0.07	2.23	0.90	40.33	40.33	41.23	1	659.89	6,693
342	7	9	2009	0.90	659.89	2.00	0.30	0.07	2.23	0.90	40.33	40.33	41.23	1	659.61	6,613
343	8	9	2009	0.40	659.61	2.00	0.30	0.03	2.27	0.40	40.33	40.33	40.73	1	659.32	6,533
344	9	9	2009	0.30	659.32	2.00	0.30	0.02	2.28	0.30	40.33	40.33	40.63	1	659.04	6,453
345	10	9	2009	0.30	659.04	2.00	0.30	0.02	2.28	0.30	40.33	40.33	40.63	1	658.75	6,373
346	11	9	2009	0.30	658.75	2.00	0.30	0.02	2.28	0.30	40.33	40.33	40.63	1	658.46	6,293
347	12	9	2009	0.30	658.46	2.00	0.30	0.02	2.28	0.30	40.33	40.33	40.63	1	658.18	6,213
348	13	9	2009	0.30	658.18	2.00	0.30	0.02	2.28	0.30	40.33	40.33	40.63	1	657.89	6,133
349	14	9	2009	0.30	657.89	2.00	0.30	0.02	2.28	0.30	40.33	40.33	40.63	1	657.60	6,053
350	15	9	2009	0.70	657.60	2.00	0.30	0.06	2.24	0.70	40.33	40.33	41.03	1	657.32	5,973
351	16	9	2009	3.70	657.32	2.00	0.30	0.30	2.00	2.00	40.33	40.33	42.33	0	657.04	5,896
352	17	9	2009	1.70	657.04	2.00	0.30	0.14	2.16	1.70	40.33	40.33	42.03	1	656.75	5,816
353	18	9	2009	0.80	656.75	2.00	0.30	0.06	2.24	0.80	40.33	40.33	41.13	1	656.47	5,736
354	19	9	2009	0.40	656.47	2.00	0.30	0.03	2.27	0.40	40.33	40.33	40.73	1	656.18	5,656
355	20	9	2009	0.30	656.18	2.00	0.30	0.02	2.28	0.30	40.33	40.33	40.63	1	655.89	5,576
356	21	9	2009	0.30	655.89	2.00	0.30	0.02	2.28	0.30	40.33	40.33	40.63	1	655.61	5,497
357	22	9	2009	0.20	655.61	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	655.32	5,417
358	23	9	2009	0.20	655.32	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	655.03	5,337
359	24	9	2009	0.20	655.03	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	654.75	5,257

360	25	9	2009	0.20	654.75	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	654.46	5,177
361	26	9	2009	0.20	654.46	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	654.17	5,097
362	27	9	2009	0.20	654.17	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	653.89	5,017
363	28	9	2009	0.20	653.89	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	653.60	4,937
364	29	9	2009	0.20	653.60	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	653.31	4,857
365	30	9	2009	0.20	653.31	2.00	0.30	0.02	2.28	0.20	40.33	40.33	40.53	1	653.03	4,777

A8.7 Output Data for 2008-2009 Multi-Year Simulation

(Without Relying on local Inflow in Meeting Water Rights)

Irrigation base volume: 8,000 AF

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20	20	10	2008	1.00	656.49	5.26	0.02	0.00	5.28	1.00	0.00	0.00	1.00	1	656.49	5,742
21	21	10	2008	1.00	656.49	5.26	0.02	0.00	5.28	1.00	0.00	0.00	1.00	1	656.49	5,742
22	22	10	2008	1.20	656.49	5.26	0.02	0.00	5.28	1.20	0.00	0.00	1.20	1	656.49	5,742
23	23	10	2008	0.80	656.49	5.26	0.02	0.00	5.28	0.80	0.00	0.00	0.80	1	656.49	5,742
24	24	10	2008	0.70	656.49	5.26	0.02	0.00	5.28	0.70	0.00	0.00	0.70	1	656.49	5,742
25	25	10	2008	0.60	656.49	5.26	0.02	0.00	5.28	0.60	0.00	0.00	0.60	1	656.49	5,742
26	26	10	2008	0.60	656.49	5.26	0.02	0.00	5.28	0.60	0.00	0.00	0.60	1	656.49	5,742
27	27	10	2008	0.60	656.49	5.26	0.02	0.00	5.28	0.60	0.00	0.00	0.60	1	656.49	5,742
28	28	10	2008	0.60	656.49	5.26	0.02	0.00	5.28	0.60	0.00	0.00	0.60	1	656.49	5,742
29	29	10	2008	0.60	656.49	5.26	0.02	0.00	5.28	0.60	0.00	0.00	0.60	1	656.49	5,742
30	30	10	2008	0.60	656.49	5.26	0.02	0.00	5.28	0.60	0.00	0.00	0.60	1	656.49	5,742
31	31	10	2008	0.60	656.49	5.26	0.02	0.00	5.28	0.60	0.00	0.00	0.60	1	656.49	5,742
32	1	11	2008	0.60	656.49	40.00	0.93	0.00	40.93	0.60	0.00	0.00	0.60	1	656.49	5,742
33	2	11	2008	0.70	656.49	40.00	0.93	0.00	40.93	0.70	0.00	0.00	0.70	1	656.49	5,742
34	3	11	2008	1.00	656.49	40.00	0.93	0.00	40.93	1.00	0.00	0.00	1.00	1	656.49	5,742
35	4	11	2008	6.00	656.49	40.00	0.93	0.00	40.93	6.00	0.00	0.00	6.00	1	656.49	5,742
36	5	11	2008	5.00	656.49	40.00	0.93	0.00	40.93	5.00	0.00	0.00	5.00	1	656.49	5,742
37	6	11	2008	3.30	656.49	40.00	0.93	0.00	40.93	3.30	0.00	0.00	3.30	1	656.49	5,742
38	7	11	2008	3.50	656.49	40.00	0.93	0.00	40.93	3.50	0.00	0.00	3.50	1	656.49	5,742
39	8	11	2008	3.00	656.49	40.00	0.93	0.00	40.93	3.00	0.00	0.00	3.00	1	656.49	5,742
40	9	11	2008	3.50	656.49	40.00	0.93	0.00	40.93	3.50	0.00	0.00	3.50	1	656.49	5,742
41	10	11	2008	4.00	656.49	40.00	0.93	0.00	40.93	4.00	0.00	0.00	4.00	1	656.49	5,742
42	11	11	2008	5.00	656.49	40.00	0.93	0.00	40.93	5.00	0.00	0.00	5.00	1	656.49	5,742
43	12	11	2008	22.00	656.49	40.00	0.93	0.00	40.93	22.00	0.00	0.00	22.00	1	656.49	5,742
44	13	11	2008	130.00	656.49	40.00	0.93	0.00	40.93	40.93	0.00	0.00	40.93	0	657.12	5,919
45	14	11	2008	85.00	657.12	40.00	0.93	0.00	40.93	40.93	0.00	0.00	40.93	0	657.43	6,006
46	15	11	2008	54.00	657.43	40.00	0.93	0.00	40.93	40.93	0.00	0.00	40.93	0	657.53	6,032
47	16	11	2008	40.00	657.53	40.00	0.93	0.00	40.93	40.00	0.00	0.00	40.00	1	657.53	6,032
48	17	11	2008	34.00	657.53	40.00	0.93	0.00	40.93	34.00	0.00	0.00	34.00	1	657.53	6,032
49	18	11	2008	28.00	657.53	40.00	0.93	0.00	40.93	28.00	0.00	0.00	28.00	1	657.53	6,032
50	19	11	2008	23.00	657.53	40.00	0.93	0.00	40.93	23.00	0.00	0.00	23.00	1	657.53	6,032
51	20	11	2008	24.00	657.53	40.00	0.93	0.00	40.93	24.00	0.00	0.00	24.00	1	657.53	6,032
52	21	11	2008	25.00	657.53	40.00	0.93	0.00	40.93	25.00	0.00	0.00	25.00	1	657.53	6,032
53	22	11	2008	24.00	657.53	40.00	0.93	0.00	40.93	24.00	0.00	0.00	24.00	1	657.53	6,032
54	23	11	2008	23.00	657.53	40.00	0.93	0.00	40.93	23.00	0.00	0.00	23.00	1	657.53	6,032
55	24	11	2008	22.00	657.53	40.00	0.93	0.00	40.93	22.00	0.00	0.00	22.00	1	657.53	6,032
56	25	11	2008	21.00	657.53	40.00	0.93	0.00	40.93	21.00	0.00	0.00	21.00	1	657.53	6,032
57	26	11	2008	20.00	657.53	40.00	0.93	0.00	40.93	20.00	0.00	0.00	20.00	1	657.53	6,032
58	27	11	2008	20.00	657.53	40.00	0.93	0.00	40.93	20.00	0.00	0.00	20.00	1	657.53	6,032
59	28	11	2008	19.00	657.53	40.00	0.93	0.00	40.93	19.00	0.00	0.00	19.00	1	657.53	6,032
60	29	11	2008	18.00	657.53	40.00	0.93	0.00	40.93	18.00	0.00	0.00	18.00	1	657.53	6,032
61	30	11	2008	17.00	657.53	40.00	0.93	0.00	40.93	17.00	0.00	0.00	17.00	1	657.53	6,032
62	1	12	2008	17.00	657.53	40.00	2.11	0.00	42.11	17.00	0.00	0.00	17.00	1	657.53	6,032
63	2	12	2008	19.00	657.53	40.00	2.11	0.00	42.11	19.00	0.00	0.00	19.00	1	657.53	6,032
64	3	12	2008	20.00	657.53	40.00	2.11	0.00	42.11	20.00	0.00	0.00	20.00	1	657.53	6,032
65	4	12	2008	19.00	657.53	40.00	2.11	0.00	42.11	19.00	0.00	0.00	19.00	1	657.53	6,032
66	5	12	2008	19.00	657.53	40.00	2.11	0.00	42.11	19.00	0.00	0.00	19.00	1	657.53	6,032

67	6	12	2008	17.00	657.53	40.00	2.11	0.00	42.11	17.00	0.00	0.00	17.00	1	657.53	6,032
68	7	12	2008	17.00	657.53	40.00	2.11	0.00	42.11	17.00	0.00	0.00	17.00	1	657.53	6,032
69	8	12	2008	19.00	657.53	40.00	2.11	0.00	42.11	19.00	0.00	0.00	19.00	1	657.53	6,032
70	9	12	2008	17.00	657.53	40.00	2.11	0.00	42.11	17.00	0.00	0.00	17.00	1	657.53	6,032
71	10	12	2008	16.00	657.53	40.00	2.11	0.00	42.11	16.00	0.00	0.00	16.00	1	657.53	6,032
72	11	12	2008	15.00	657.53	40.00	2.11	0.00	42.11	15.00	0.00	0.00	15.00	1	657.53	6,032
73	12	12	2008	17.00	657.53	40.00	2.11	0.00	42.11	17.00	0.00	0.00	17.00	1	657.53	6,032
74	13	12	2008	26.00	657.53	40.00	2.11	0.00	42.11	26.00	0.00	0.00	26.00	1	657.53	6,032
75	14	12	2008	23.00	657.53	40.00	2.11	0.00	42.11	23.00	0.00	0.00	23.00	1	657.53	6,032
76	15	12	2008	19.00	657.53	40.00	2.11	0.00	42.11	19.00	0.00	0.00	19.00	1	657.53	6,032
77	16	12	2008	17.00	657.53	40.00	2.11	0.00	42.11	17.00	0.00	0.00	17.00	1	657.53	6,032
78	17	12	2008	17.00	657.53	40.00	2.11	0.00	42.11	17.00	0.00	0.00	17.00	1	657.53	6,032
79	18	12	2008	28.00	657.53	40.00	2.11	0.00	42.11	28.00	0.00	0.00	28.00	1	657.53	6,032
80	19	12	2008	25.00	657.53	40.00	2.11	0.00	42.11	25.00	0.00	0.00	25.00	1	657.53	6,032
81	20	12	2008	24.00	657.53	40.00	2.11	0.00	42.11	24.00	0.00	0.00	24.00	1	657.53	6,032
82	21	12	2008	33.00	657.53	40.00	2.11	0.00	42.11	33.00	0.00	0.00	33.00	1	657.53	6,032
83	22	12	2008	60.00	657.53	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	657.65	6,068
84	23	12	2008	50.00	657.65	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	657.71	6,083
85	24	12	2008	40.00	657.71	40.00	2.11	0.00	42.11	40.00	0.00	0.00	40.00	1	657.71	6,083
86	25	12	2008	50.00	657.71	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	657.77	6,099
87	26	12	2008	55.00	657.77	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	657.86	6,124
88	27	12	2008	110.00	657.86	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	658.34	6,259
89	28	12	2008	200.00	658.34	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	659.46	6,572
90	29	12	2008	215.00	659.46	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	660.62	6,915
91	30	12	2008	160.00	660.62	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	661.36	7,149
92	31	12	2008	130.00	661.36	40.00	2.11	0.00	42.11	42.11	0.00	0.00	42.11	0	661.92	7,323
93	1	1	2009	275.00	661.92	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	663.39	7,784
94	2	1	2009	500.00	663.39	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	666.29	8,692
95	3	1	2009	267.00	666.29	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	667.71	9,138
96	4	1	2009	181.00	667.71	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	668.58	9,413
97	5	1	2009	173.00	668.58	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	669.41	9,672
98	6	1	2009	159.00	669.41	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	670.14	9,904
99	7	1	2009	161.00	670.14	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	670.83	10,139
100	8	1	2009	198.00	670.83	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	671.74	10,448
101	9	1	2009	163.00	671.74	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	672.44	10,687
102	10	1	2009	132.00	672.44	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	672.96	10,865
103	11	1	2009	115.00	672.96	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	673.39	11,009
104	12	1	2009	96.00	673.39	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	673.70	11,116
105	13	1	2009	84.00	673.70	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	673.94	11,198
106	14	1	2009	73.00	673.94	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	674.12	11,259
107	15	1	2009	65.00	674.12	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	674.25	11,304
108	16	1	2009	57.00	674.25	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	674.34	11,334
109	17	1	2009	50.00	674.34	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	674.39	11,349
110	18	1	2009	44.00	674.39	40.00	2.28	0.00	42.28	42.28	0.00	0.00	42.28	0	674.40	11,352
111	19	1	2009	39.00	674.40	40.00	2.28	0.00	42.28	39.00	0.00	0.00	39.00	1	674.40	11,352
112	20	1	2009	35.00	674.40	40.00	2.28	0.00	42.28	35.00	0.00	0.00	35.00	1	674.40	11,352
113	21	1	2009	32.00	674.40	40.00	2.28	0.00	42.28	32.00	0.00	0.00	32.00	1	674.40	11,352

114	22	1	2009	30.00	674.40	40.00	2.28	0.00	42.28	30.00	0.00	0.00	30.00	1	674.40	11,352
115	23	1	2009	28.00	674.40	40.00	2.28	0.00	42.28	28.00	0.00	0.00	28.00	1	674.40	11,352
116	24	1	2009	26.00	674.40	40.00	2.28	0.00	42.28	26.00	0.00	0.00	26.00	1	674.40	11,352
117	25	1	2009	27.00	674.40	40.00	2.28	0.00	42.28	27.00	0.00	0.00	27.00	1	674.40	11,352
118	26	1	2009	25.00	674.40	40.00	2.28	0.00	42.28	25.00	0.00	0.00	25.00	1	674.40	11,352
119	27	1	2009	24.00	674.40	40.00	2.28	0.00	42.28	24.00	0.00	0.00	24.00	1	674.40	11,352
120	28	1	2009	27.00	674.40	40.00	2.28	0.00	42.28	27.00	0.00	0.00	27.00	1	674.40	11,352
121	29	1	2009	25.00	674.40	40.00	2.28	0.00	42.28	25.00	0.00	0.00	25.00	1	674.40	11,352
122	30	1	2009	24.00	674.40	40.00	2.28	0.00	42.28	24.00	0.00	0.00	24.00	1	674.40	11,352
123	31	1	2009	23.00	674.40	40.00	2.28	0.00	42.28	23.00	0.00	0.00	23.00	1	674.40	11,352
124	1	2	2009	22.00	674.40	40.00	2.03	0.00	42.03	22.00	0.00	0.00	22.00	1	674.40	11,352
125	2	2	2009	21.00	674.40	40.00	2.03	0.00	42.03	21.00	0.00	0.00	21.00	1	674.40	11,352
126	3	2	2009	21.00	674.40	40.00	2.03	0.00	42.03	21.00	0.00	0.00	21.00	1	674.40	11,352
127	4	2	2009	20.00	674.40	40.00	2.03	0.00	42.03	20.00	0.00	0.00	20.00	1	674.40	11,352
128	5	2	2009	19.00	674.40	40.00	2.03	0.00	42.03	19.00	0.00	0.00	19.00	1	674.40	11,352
129	6	2	2009	23.00	674.40	40.00	2.03	0.00	42.03	23.00	0.00	0.00	23.00	1	674.40	11,352
130	7	2	2009	23.00	674.40	40.00	2.03	0.00	42.03	23.00	0.00	0.00	23.00	1	674.40	11,352
131	8	2	2009	22.00	674.40	40.00	2.03	0.00	42.03	22.00	0.00	0.00	22.00	1	674.40	11,352
132	9	2	2009	22.00	674.40	40.00	2.03	0.00	42.03	22.00	0.00	0.00	22.00	1	674.40	11,352
133	10	2	2009	22.00	674.40	40.00	2.03	0.00	42.03	22.00	0.00	0.00	22.00	1	674.40	11,352
134	11	2	2009	25.00	674.40	40.00	2.03	0.00	42.03	25.00	0.00	0.00	25.00	1	674.40	11,352
135	12	2	2009	24.00	674.40	40.00	2.03	0.00	42.03	24.00	0.00	0.00	24.00	1	674.40	11,352
136	13	2	2009	25.00	674.40	40.00	2.03	0.00	42.03	25.00	0.00	0.00	25.00	1	674.40	11,352
137	14	2	2009	24.00	674.40	40.00	2.03	0.00	42.03	24.00	0.00	0.00	24.00	1	674.40	11,352
138	15	2	2009	24.00	674.40	40.00	2.03	0.00	42.03	24.00	0.00	0.00	24.00	1	674.40	11,352
139	16	2	2009	23.00	674.40	40.00	2.03	0.00	42.03	23.00	0.00	0.00	23.00	1	674.40	11,352
140	17	2	2009	23.00	674.40	40.00	2.03	0.00	42.03	23.00	0.00	0.00	23.00	1	674.40	11,352
141	18	2	2009	22.00	674.40	40.00	2.03	0.00	42.03	22.00	0.00	0.00	22.00	1	674.40	11,352
142	19	2	2009	21.00	674.40	40.00	2.03	0.00	42.03	21.00	0.00	0.00	21.00	1	674.40	11,352
143	20	2	2009	20.00	674.40	40.00	2.03	0.00	42.03	20.00	0.00	0.00	20.00	1	674.40	11,352
144	21	2	2009	19.00	674.40	40.00	2.03	0.00	42.03	19.00	0.00	0.00	19.00	1	674.40	11,352
145	22	2	2009	19.00	674.40	40.00	2.03	0.00	42.03	19.00	0.00	0.00	19.00	1	674.40	11,352
146	23	2	2009	24.00	674.40	40.00	2.03	0.00	42.03	24.00	0.00	0.00	24.00	1	674.40	11,352
147	24	2	2009	71.00	674.40	40.00	2.03	0.00	42.03	42.03	0.00	0.00	42.03	0	674.56	11,410
148	25	2	2009	126.00	674.56	40.00	2.03	0.00	42.03	42.03	0.00	0.00	42.03	0	675.05	11,576
149	26	2	2009	156.00	675.05	40.00	2.03	0.00	42.03	42.03	0.00	0.00	42.03	0	675.72	11,802
150	27	2	2009	123.00	675.72	40.00	2.03	0.00	42.03	42.03	0.00	0.00	42.03	0	676.19	11,963
151	28	2	2009	106.00	676.19	40.00	2.03	0.00	42.03	42.03	0.00	0.00	42.03	0	676.56	12,090
152	1	3	2009	91.00	676.56	40.00	0.03	0.00	40.03	40.03	0.00	0.00	40.03	0	676.86	12,191
153	2	3	2009	92.00	676.86	40.00	0.03	0.00	40.03	40.03	0.00	0.00	68.00	2	677.00	12,238
154	3	3	2009	86.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	86.00	2	677.00	12,238
155	4	3	2009	74.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	74.00	2	677.00	12,238
156	5	3	2009	77.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	77.00	2	677.00	12,238
157	6	3	2009	71.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	71.00	2	677.00	12,238
158	7	3	2009	65.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	65.00	2	677.00	12,238
159	8	3	2009	62.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	62.00	2	677.00	12,238
160	9	3	2009	60.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	60.00	2	677.00	12,238

161	10	3	2009	58.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	58.00	2	677.00	12,238
162	11	3	2009	54.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	54.00	2	677.00	12,238
163	12	3	2009	50.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	50.00	2	677.00	12,238
164	13	3	2009	46.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	46.00	2	677.00	12,238
165	14	3	2009	46.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	46.00	2	677.00	12,238
166	15	3	2009	80.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	80.00	2	677.00	12,238
167	16	3	2009	92.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	92.00	2	677.00	12,238
168	17	3	2009	84.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	84.00	2	677.00	12,238
169	18	3	2009	73.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	73.00	2	677.00	12,238
170	19	3	2009	66.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	66.00	2	677.00	12,238
171	20	3	2009	60.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	60.00	2	677.00	12,238
172	21	3	2009	54.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	54.00	2	677.00	12,238
173	22	3	2009	62.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	62.00	2	677.00	12,238
174	23	3	2009	59.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	59.00	2	677.00	12,238
175	24	3	2009	54.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	54.00	2	677.00	12,238
176	25	3	2009	61.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	61.00	2	677.00	12,238
177	26	3	2009	59.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	59.00	2	677.00	12,238
178	27	3	2009	54.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	54.00	2	677.00	12,238
179	28	3	2009	56.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	56.00	2	677.00	12,238
180	29	3	2009	68.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	68.00	2	677.00	12,238
181	30	3	2009	66.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	66.00	2	677.00	12,238
182	31	3	2009	63.00	677.00	40.00	0.03	0.00	40.03	40.03	0.00	0.00	63.00	2	677.00	12,238
183	1	4	2009	60.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	60.00	2	677.00	12,238
184	2	4	2009	81.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	81.00	2	677.00	12,238
185	3	4	2009	80.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	80.00	2	677.00	12,238
186	4	4	2009	72.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	72.00	2	677.00	12,238
187	5	4	2009	64.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	64.00	2	677.00	12,238
188	6	4	2009	56.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	56.00	2	677.00	12,238
189	7	4	2009	51.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	51.00	2	677.00	12,238
190	8	4	2009	46.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	46.00	2	677.00	12,238
191	9	4	2009	44.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	44.00	2	677.00	12,238
192	10	4	2009	45.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	45.00	2	677.00	12,238
193	11	4	2009	38.00	677.00	40.00	0.04	0.00	40.04	38.00	0.00	0.00	38.00	1	677.00	12,238
194	12	4	2009	35.00	677.00	40.00	0.04	0.00	40.04	35.00	0.00	0.00	35.00	1	677.00	12,238
195	13	4	2009	44.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	44.00	2	677.00	12,238
196	14	4	2009	42.00	677.00	40.00	0.04	0.00	40.04	40.04	0.00	0.00	42.00	2	677.00	12,238
197	15	4	2009	39.00	677.00	40.00	0.04	0.00	40.04	39.00	0.00	0.00	39.00	1	677.00	12,238
198	16	4	2009	35.00	677.00	40.00	0.04	0.00	40.04	35.00	0.00	0.00	35.00	1	677.00	12,238
199	17	4	2009	35.00	677.00	40.00	0.04	0.00	40.04	35.00	0.00	0.00	35.00	1	677.00	12,238
200	18	4	2009	33.00	677.00	40.00	0.04	0.00	40.04	33.00	0.00	0.00	33.00	1	677.00	12,238
201	19	4	2009	30.00	677.00	40.00	0.04	0.00	40.04	30.00	0.00	0.00	30.00	1	677.00	12,238
202	20	4	2009	27.00	677.00	40.00	0.04	0.00	40.04	27.00	0.00	0.00	27.00	1	677.00	12,238
203	21	4	2009	25.00	677.00	40.00	0.04	0.00	40.04	25.00	0.00	0.00	25.00	1	677.00	12,238
204	22	4	2009	24.00	677.00	40.00	0.04	0.00	40.04	24.00	0.00	0.00	24.00	1	677.00	12,238
205	23	4	2009	23.00	677.00	40.00	0.04	0.00	40.04	23.00	0.00	0.00	23.00	1	677.00	12,238
206	24	4	2009	22.00	677.00	40.00	0.04	0.00	40.04	22.00	0.00	0.00	22.00	1	677.00	12,238
207	25	4	2009	21.00	677.00	40.00	0.04	0.00	40.04	21.00	0.00	0.00	21.00	1	677.00	12,238

208	26	4	2009	20.00	677.00	40.00	0.04	0.00	40.04	20.00	0.00	0.00	20.00	1	677.00	12,238
209	27	4	2009	20.00	677.00	40.00	0.04	0.00	40.04	20.00	0.00	0.00	20.00	1	677.00	12,238
210	28	4	2009	27.00	677.00	40.00	0.04	0.00	40.04	27.00	0.00	0.00	27.00	1	677.00	12,238
211	29	4	2009	29.00	677.00	40.00	0.04	0.00	40.04	29.00	0.00	0.00	29.00	1	677.00	12,238
212	30	4	2009	24.00	677.00	40.00	0.04	0.00	40.04	24.00	0.00	0.00	24.00	1	677.00	12,238
213	1	5	2009	22.00	677.00	30.10	0.22	0.00	30.32	22.00	13.00	13.00	35.00	1	676.92	12,213
214	2	5	2009	39.00	676.92	30.10	0.22	0.00	30.32	30.32	13.00	13.00	43.32	0	676.90	12,204
215	3	5	2009	39.00	676.90	30.10	0.22	0.00	30.32	30.32	13.00	13.00	43.32	0	676.87	12,195
216	4	5	2009	40.00	676.87	30.10	0.22	0.00	30.32	30.32	13.00	13.00	43.32	0	676.85	12,189
217	5	5	2009	70.00	676.85	30.10	0.22	0.00	30.32	30.32	13.00	13.00	45.03	2	677.00	12,238
218	6	5	2009	98.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	98.00	2	677.00	12,238
219	7	5	2009	128.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	128.00	2	677.00	12,238
220	8	5	2009	108.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	108.00	2	677.00	12,238
221	9	5	2009	89.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	89.00	2	677.00	12,238
222	10	5	2009	75.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	75.00	2	677.00	12,238
223	11	5	2009	65.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	65.00	2	677.00	12,238
224	12	5	2009	59.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	59.00	2	677.00	12,238
225	13	5	2009	53.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	53.00	2	677.00	12,238
226	14	5	2009	66.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	66.00	2	677.00	12,238
227	15	5	2009	54.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	54.00	2	677.00	12,238
228	16	5	2009	46.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	46.00	2	677.00	12,238
229	17	5	2009	40.00	677.00	30.10	0.22	0.00	30.32	30.32	13.00	13.00	43.32	0	676.98	12,232
230	18	5	2009	36.00	676.98	30.10	0.22	0.00	30.32	30.32	13.00	13.00	43.32	0	676.94	12,217
231	19	5	2009	37.00	676.94	30.10	0.22	0.00	30.32	30.32	13.00	13.00	43.32	0	676.90	12,205
232	20	5	2009	33.00	676.90	30.10	0.22	0.00	30.32	30.32	13.00	13.00	43.32	0	676.84	12,184
233	21	5	2009	29.00	676.84	30.10	0.22	0.00	30.32	29.00	13.00	13.00	42.00	1	676.77	12,159
234	22	5	2009	26.00	676.77	30.10	0.22	0.00	30.32	26.00	13.00	13.00	39.00	1	676.69	12,133
235	23	5	2009	24.00	676.69	30.10	0.22	0.00	30.32	24.00	13.00	13.00	37.00	1	676.61	12,107
236	24	5	2009	22.00	676.61	30.10	0.22	0.00	30.32	22.00	13.00	13.00	35.00	1	676.54	12,081
237	25	5	2009	21.00	676.54	30.10	0.22	0.00	30.32	21.00	13.00	13.00	34.00	1	676.46	12,055
238	26	5	2009	19.00	676.46	30.10	0.22	0.00	30.32	19.00	13.00	13.00	32.00	1	676.39	12,030
239	27	5	2009	18.00	676.39	30.10	0.22	0.00	30.32	18.00	13.00	13.00	31.00	1	676.31	12,004
240	28	5	2009	16.00	676.31	30.10	0.22	0.00	30.32	16.00	13.00	13.00	29.00	1	676.23	11,978
241	29	5	2009	15.00	676.23	30.10	0.22	0.00	30.32	15.00	13.00	13.00	28.00	1	676.16	11,952
242	30	5	2009	14.00	676.16	30.10	0.22	0.00	30.32	14.00	13.00	13.00	27.00	1	676.08	11,926
243	31	5	2009	11.00	676.08	30.10	0.22	0.00	30.32	11.00	13.00	13.00	24.00	1	676.01	11,901
244	1	6	2009	11.00	676.01	13.60	0.44	0.00	14.04	11.00	13.50	13.50	24.50	1	675.93	11,874
245	2	6	2009	10.00	675.93	13.60	0.44	0.00	14.04	10.00	13.50	13.50	23.50	1	675.85	11,847
246	3	6	2009	9.80	675.85	13.60	0.44	0.00	14.04	9.80	13.50	13.50	23.30	1	675.77	11,820
247	4	6	2009	10.00	675.77	13.60	0.44	0.00	14.04	10.00	13.50	13.50	23.50	1	675.69	11,794
248	5	6	2009	13.00	675.69	13.60	0.44	0.00	14.04	13.00	13.50	13.50	26.50	1	675.61	11,767
249	6	6	2009	12.00	675.61	13.60	0.44	0.00	14.04	12.00	13.50	13.50	25.50	1	675.54	11,740
250	7	6	2009	11.00	675.54	13.60	0.44	0.00	14.04	11.00	13.50	13.50	24.50	1	675.46	11,713
251	8	6	2009	10.00	675.46	13.60	0.44	0.00	14.04	10.00	13.50	13.50	23.50	1	675.38	11,686
252	9	6	2009	9.30	675.38	13.60	0.44	0.00	14.04	9.30	13.50	13.50	22.80	1	675.30	11,660
253	10	6	2009	8.80	675.30	13.60	0.44	0.00	14.04	8.80	13.50	13.50	22.30	1	675.22	11,633
254	11	6	2009	8.70	675.22	13.60	0.44	0.00	14.04	8.70	13.50	13.50	22.20	1	675.14	11,606

255	12	6	2009	8.40	675.14	13.60	0.44	0.00	14.04	8.40	13.50	13.50	21.90	1	675.06	11,579
256	13	6	2009	7.90	675.06	13.60	0.44	0.00	14.04	7.90	13.50	13.50	21.40	1	674.98	11,553
257	14	6	2009	7.50	674.98	13.60	0.44	0.00	14.04	7.50	13.50	13.50	21.00	1	674.91	11,526
258	15	6	2009	7.20	674.91	13.60	0.44	0.00	14.04	7.20	13.50	13.50	20.70	1	674.83	11,499
259	16	6	2009	6.80	674.83	13.60	0.44	0.00	14.04	6.80	13.50	13.50	20.30	1	674.75	11,472
260	17	6	2009	6.50	674.75	13.60	0.44	0.00	14.04	6.50	13.50	13.50	20.00	1	674.67	11,446
261	18	6	2009	6.20	674.67	13.60	0.44	0.00	14.04	6.20	13.50	13.50	19.70	1	674.59	11,419
262	19	6	2009	6.20	674.59	13.60	0.44	0.00	14.04	6.20	13.50	13.50	19.70	1	674.51	11,392
263	20	6	2009	6.00	674.51	13.60	0.44	0.00	14.04	6.00	13.50	13.50	19.50	1	674.43	11,365
264	21	6	2009	5.80	674.43	13.60	0.44	0.00	14.04	5.80	13.50	13.50	19.30	1	674.35	11,339
265	22	6	2009	5.10	674.35	13.60	0.44	0.00	14.04	5.10	13.50	13.50	18.60	1	674.28	11,312
266	23	6	2009	4.70	674.28	13.60	0.44	0.00	14.04	4.70	13.50	13.50	18.20	1	674.20	11,285
267	24	6	2009	4.40	674.20	13.60	0.44	0.00	14.04	4.40	13.50	13.50	17.90	1	674.12	11,258
268	25	6	2009	4.00	674.12	13.60	0.44	0.00	14.04	4.00	13.50	13.50	17.50	1	674.04	11,231
269	26	6	2009	4.00	674.04	13.60	0.44	0.00	14.04	4.00	13.50	13.50	17.50	1	673.96	11,205
270	27	6	2009	3.50	673.96	13.60	0.44	0.00	14.04	3.50	13.50	13.50	17.00	1	673.88	11,178
271	28	6	2009	3.20	673.88	13.60	0.44	0.00	14.04	3.20	13.50	13.50	16.70	1	673.80	11,151
272	29	6	2009	3.20	673.80	13.60	0.44	0.00	14.04	3.20	13.50	13.50	16.70	1	673.73	11,124
273	30	6	2009	3.10	673.73	13.60	0.44	0.00	14.04	3.10	13.50	13.50	16.60	1	673.65	11,098
274	1	7	2009	3.00	673.65	3.00	0.77	0.00	3.77	3.00	26.00	26.00	29.00	1	673.50	11,046
275	2	7	2009	2.70	673.50	3.00	0.77	0.00	3.77	2.70	26.00	26.00	28.70	1	673.34	10,995
276	3	7	2009	2.30	673.34	3.00	0.77	0.00	3.77	2.30	26.00	26.00	28.30	1	673.19	10,943
277	4	7	2009	2.00	673.19	3.00	0.77	0.00	3.77	2.00	26.00	26.00	28.00	1	673.04	10,891
278	5	7	2009	2.00	673.04	3.00	0.77	0.00	3.77	2.00	26.00	26.00	28.00	1	672.89	10,840
279	6	7	2009	1.80	672.89	3.00	0.77	0.00	3.77	1.80	26.00	26.00	27.80	1	672.74	10,788
280	7	7	2009	1.70	672.74	3.00	0.77	0.00	3.77	1.70	26.00	26.00	27.70	1	672.59	10,737
281	8	7	2009	1.60	672.59	3.00	0.77	0.00	3.77	1.60	26.00	26.00	27.60	1	672.43	10,685
282	9	7	2009	1.70	672.43	3.00	0.77	0.00	3.77	1.70	26.00	26.00	27.70	1	672.28	10,634
283	10	7	2009	1.80	672.28	3.00	0.77	0.00	3.77	1.80	26.00	26.00	27.80	1	672.13	10,582
284	11	7	2009	1.80	672.13	3.00	0.77	0.00	3.77	1.80	26.00	26.00	27.80	1	671.98	10,531
285	12	7	2009	2.00	671.98	3.00	0.77	0.00	3.77	2.00	26.00	26.00	28.00	1	671.83	10,479
286	13	7	2009	3.00	671.83	3.00	0.77	0.00	3.77	3.00	26.00	26.00	29.00	1	671.68	10,427
287	14	7	2009	2.80	671.68	3.00	0.77	0.00	3.77	2.80	26.00	26.00	28.80	1	671.53	10,376
288	15	7	2009	2.10	671.53	3.00	0.77	0.00	3.77	2.10	26.00	26.00	28.10	1	671.37	10,324
289	16	7	2009	1.60	671.37	3.00	0.77	0.00	3.77	1.60	26.00	26.00	27.60	1	671.22	10,273
290	17	7	2009	1.20	671.22	3.00	0.77	0.00	3.77	1.20	26.00	26.00	27.20	1	671.07	10,221
291	18	7	2009	0.90	671.07	3.00	0.77	0.00	3.77	0.90	26.00	26.00	26.90	1	670.92	10,170
292	19	7	2009	0.80	670.92	3.00	0.77	0.00	3.77	0.80	26.00	26.00	26.80	1	670.77	10,118
293	20	7	2009	0.70	670.77	3.00	0.77	0.00	3.77	0.70	26.00	26.00	26.70	1	670.62	10,067
294	21	7	2009	0.70	670.62	3.00	0.77	0.00	3.77	0.70	26.00	26.00	26.70	1	670.46	10,015
295	22	7	2009	0.60	670.46	3.00	0.77	0.00	3.77	0.60	26.00	26.00	26.60	1	670.31	9,963
296	23	7	2009	0.60	670.31	3.00	0.77	0.00	3.77	0.60	26.00	26.00	26.60	1	670.16	9,912
297	24	7	2009	0.50	670.16	3.00	0.77	0.00	3.77	0.50	26.00	26.00	26.50	1	670.01	9,860
298	25	7	2009	0.40	670.01	3.00	0.77	0.00	3.77	0.40	26.00	26.00	26.40	1	669.85	9,809
299	26	7	2009	0.30	669.85	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.68	9,757
300	27	7	2009	0.30	669.68	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.52	9,706
301	28	7	2009	0.30	669.52	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.35	9,654

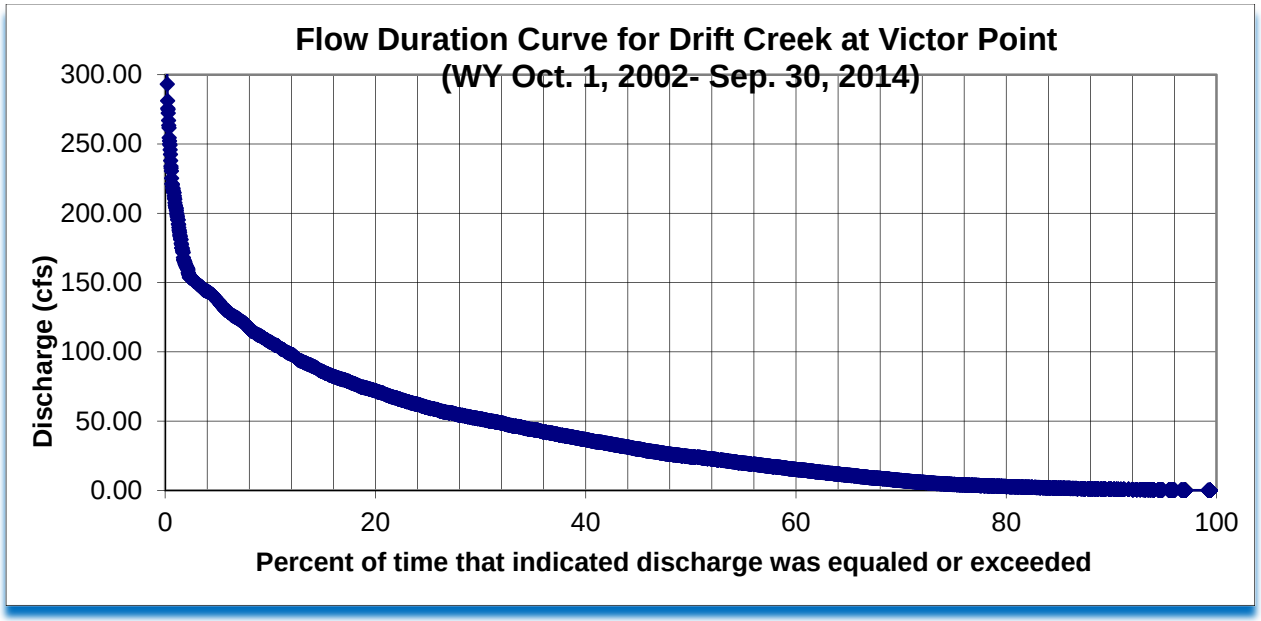
302	29	7	2009	0.30	669.35	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.19	9,602
303	30	7	2009	0.30	669.19	3.00	0.77	0.00	3.77	0.30	26.00	26.00	26.30	1	669.02	9,551
304	31	7	2009	0.20	669.02	3.00	0.77	0.00	3.77	0.20	26.00	26.00	26.20	1	668.86	9,499
305	1	8	2009	0.20	668.86	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	668.61	9,422
306	2	8	2009	0.20	668.61	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	668.37	9,345
307	3	8	2009	0.20	668.37	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	668.12	9,267
308	4	8	2009	0.20	668.12	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	667.87	9,190
309	5	8	2009	0.20	667.87	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	667.63	9,113
310	6	8	2009	0.30	667.63	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	667.38	9,035
311	7	8	2009	0.30	667.38	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	667.13	8,958
312	8	8	2009	0.30	667.13	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	666.89	8,881
313	9	8	2009	0.40	666.89	2.00	0.61	0.00	2.61	0.40	39.00	39.00	39.40	1	666.64	8,803
314	10	8	2009	0.30	666.64	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	666.39	8,726
315	11	8	2009	0.30	666.39	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	666.15	8,649
316	12	8	2009	0.40	666.15	2.00	0.61	0.00	2.61	0.40	39.00	39.00	39.40	1	665.90	8,571
317	13	8	2009	0.50	665.90	2.00	0.61	0.00	2.61	0.50	39.00	39.00	39.50	1	665.65	8,494
318	14	8	2009	0.30	665.65	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	665.41	8,417
319	15	8	2009	0.30	665.41	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	665.16	8,339
320	16	8	2009	0.30	665.16	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	664.91	8,262
321	17	8	2009	0.30	664.91	2.00	0.61	0.00	2.61	0.30	39.00	39.00	39.30	1	664.67	8,185
322	18	8	2009	0.20	664.67	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	664.42	8,107
323	19	8	2009	0.20	664.42	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	664.17	8,030
324	20	8	2009	0.20	664.17	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	663.93	7,953
325	21	8	2009	0.20	663.93	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	663.68	7,875
326	22	8	2009	0.20	663.68	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	663.43	7,798
327	23	8	2009	0.20	663.43	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	663.19	7,721
328	24	8	2009	0.10	663.19	2.00	0.61	0.00	2.61	0.10	39.00	39.00	39.10	1	662.94	7,643
329	25	8	2009	0.10	662.94	2.00	0.61	0.00	2.61	0.10	39.00	39.00	39.10	1	662.69	7,566
330	26	8	2009	0.10	662.69	2.00	0.61	0.00	2.61	0.10	39.00	39.00	39.10	1	662.45	7,489
331	27	8	2009	0.10	662.45	2.00	0.61	0.00	2.61	0.10	39.00	39.00	39.10	1	662.20	7,411
332	28	8	2009	0.10	662.20	2.00	0.61	0.00	2.61	0.10	39.00	39.00	39.10	1	661.95	7,334
333	29	8	2009	0.20	661.95	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	661.71	7,257
334	30	8	2009	0.20	661.71	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	661.46	7,179
335	31	8	2009	0.20	661.46	2.00	0.61	0.00	2.61	0.20	39.00	39.00	39.20	1	661.21	7,102
336	1	9	2009	0.20	661.21	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	660.96	7,022
337	2	9	2009	0.20	660.96	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	660.70	6,942
338	3	9	2009	0.20	660.70	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	660.45	6,862
339	4	9	2009	0.20	660.45	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	660.19	6,782
340	5	9	2009	0.50	660.19	2.00	0.30	0.00	2.30	0.50	40.33	40.33	40.83	1	659.93	6,702
341	6	9	2009	0.90	659.93	2.00	0.30	0.00	2.30	0.90	40.33	40.33	41.23	1	659.64	6,622
342	7	9	2009	0.90	659.64	2.00	0.30	0.00	2.30	0.90	40.33	40.33	41.23	1	659.35	6,542
343	8	9	2009	0.40	659.35	2.00	0.30	0.00	2.30	0.40	40.33	40.33	40.73	1	659.07	6,462
344	9	9	2009	0.30	659.07	2.00	0.30	0.00	2.30	0.30	40.33	40.33	40.63	1	658.78	6,382
345	10	9	2009	0.30	658.78	2.00	0.30	0.00	2.30	0.30	40.33	40.33	40.63	1	658.50	6,302
346	11	9	2009	0.30	658.50	2.00	0.30	0.00	2.30	0.30	40.33	40.33	40.63	1	658.21	6,222
347	12	9	2009	0.30	658.21	2.00	0.30	0.00	2.30	0.30	40.33	40.33	40.63	1	657.92	6,142
348	13	9	2009	0.30	657.92	2.00	0.30	0.00	2.30	0.30	40.33	40.33	40.63	1	657.64	6,062

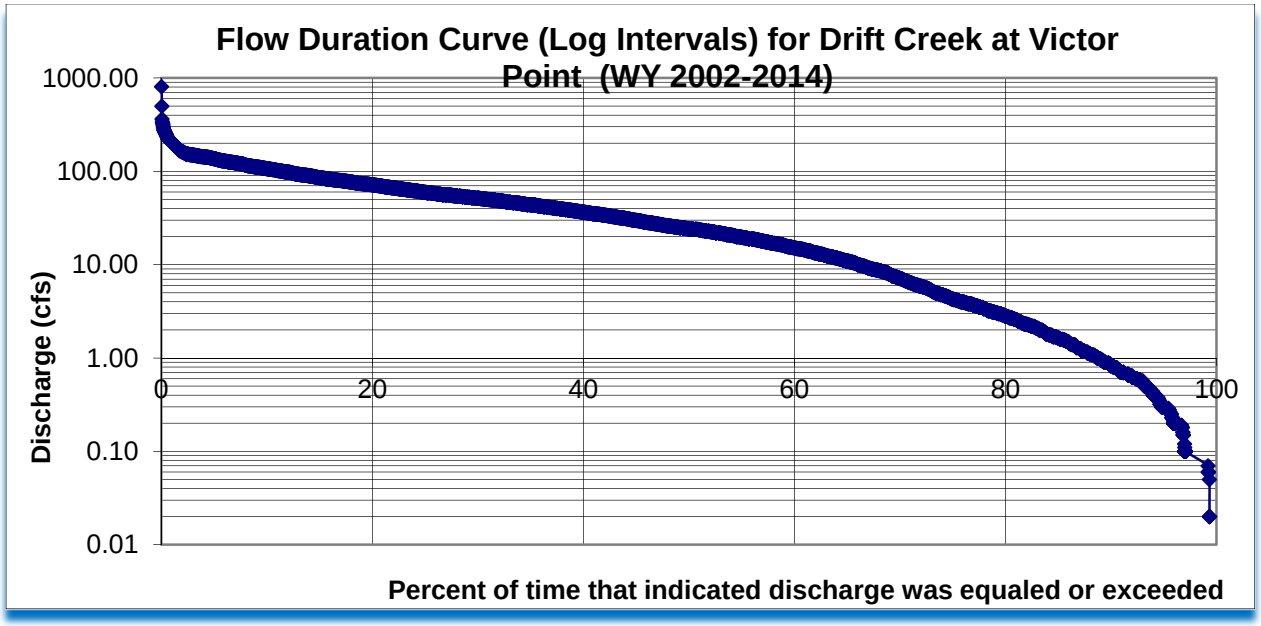
349	14	9	2009	0.30	657.64	2.00	0.30	0.00	2.30	0.30	40.33	40.33	40.63	1	657.35	5,982
350	15	9	2009	0.70	657.35	2.00	0.30	0.00	2.30	0.70	40.33	40.33	41.03	1	657.06	5,902
351	16	9	2009	3.70	657.06	2.00	0.30	0.00	2.30	2.30	40.33	40.33	42.63	0	656.79	5,825
352	17	9	2009	1.70	656.79	2.00	0.30	0.00	2.30	1.70	40.33	40.33	42.03	1	656.50	5,745
353	18	9	2009	0.80	656.50	2.00	0.30	0.00	2.30	0.80	40.33	40.33	41.13	1	656.21	5,665
354	19	9	2009	0.40	656.21	2.00	0.30	0.00	2.30	0.40	40.33	40.33	40.73	1	655.93	5,585
355	20	9	2009	0.30	655.93	2.00	0.30	0.00	2.30	0.30	40.33	40.33	40.63	1	655.64	5,505
356	21	9	2009	0.30	655.64	2.00	0.30	0.00	2.30	0.30	40.33	40.33	40.63	1	655.35	5,425
357	22	9	2009	0.20	655.35	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	655.07	5,345
358	23	9	2009	0.20	655.07	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	654.78	5,265
359	24	9	2009	0.20	654.78	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	654.49	5,185
360	25	9	2009	0.20	654.49	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	654.21	5,105
361	26	9	2009	0.20	654.21	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	653.92	5,025
362	27	9	2009	0.20	653.92	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	653.63	4,945
363	28	9	2009	0.20	653.63	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	653.34	4,865
364	29	9	2009	0.20	653.34	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	653.06	4,785
365	30	9	2009	0.20	653.06	2.00	0.30	0.00	2.30	0.20	40.33	40.33	40.53	1	652.77	4,705

Appendix 9. Flow Duration Curve: Sample Output

DATE (Month, Day, Year)	STREAMFLOW (CFS)	Rank	Percent Exceeded
1/19/2012	808.62	1	0.023
1/2/2009	500.00	2	0.046
11/20/2012	364.40	3	0.068
1/20/2012	342.00	4	0.091
11/21/2012	328.25	5	0.114
1/21/2012	327.25	6	0.137
3/31/2012	314.63	7	0.160
1/17/2011	302.80	8	0.182
2/15/2014	293.23	9	0.205
2/14/2014	281.20	10	0.228
2/16/2014	275.75	11	0.251
1/1/2009	275.00	12	0.274
3/30/2012	272.33	13	0.297
1/3/2009	267.00	14	0.319
3/30/2010	263.40	15	0.342

3/21/2012	261.65	16	0.365
12/14/2010	254.50	17	0.388
3/17/2012	252.18	18	0.411
1/16/2011	250.00	19	0.433
12/30/2011	249.25	20	0.456
12/29/2010	245.80	21	0.479
1/22/2012	242.50	22	0.502
3/22/2012	237.99	23	0.525
4/1/2012	233.97	24	0.547
3/29/2010	232.60	25	0.570
11/22/2012	230.55	26	0.593
2/12/2014	225.28	27	0.616
2/19/2014	221.26	28	0.639
2/17/2014	221.22	29	0.661
2/18/2014	220.53	30	0.684
11/24/2012	218.49	31	0.707
6/4/2010	218.10	32	0.730
1/18/2011	217.60	33	0.753
12/13/2010	216.20	34	0.776
3/31/2010	215.20	35	0.798
12/29/2008	215.00	36	0.821
3/6/2014	214.80	37	0.844
2/20/2014	212.60	38	0.867
2/13/2014	211.02	39	0.890
1/29/2013	210.04	40	0.912
1/30/2013	207.69	41	0.935
1/18/2012	205.75	42	0.958
1/23/2012	205.46	43	0.981
1/25/2012	204.22	44	1.004
1/19/2011	203.90	45	1.026
3/23/2012	203.23	46	1.049
3/16/2012	201.90	47	1.072


Flow Duration Curve for Drift Creek at Victor Point
(WY Oct. 1, 2002- Sep. 30, 2014)
Discharge (cfs)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0
20
40
60
80
100
Percent of time that indicated discharge was equaled or exceeded



Appendix 10. Monthly Sum of Snowfalls at Salem McNary Field, OR

Monthly Sum of Snowfall (Inches)
(357500)
File last updated on Jul 29, 2014
a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not
sum (or average) to the long-term annual value.
MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5
Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR(S)	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	ANN
1892-93	-----z	-----z	-----z	-----z	-----z	-----z	9.70	6.00	-----z	-----z	-----z	-----z	15.70j
1893-94	-----z	-----z	-----z	-----z	-----z	-----z	0.00	0.00	-----z	-----z	-----z	-----z	0.00j

1894-95	-----z	-----z	-----z	-----z	0.00	-----z	-----z	-----z	0.00	-----z	-----z	-----z	0.00j
1895-96	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00	-----z	0.00	-----z	-----z	0.00j
1896-97	-----z	-----z	-----z	-----z	-----z	-----z	1.00	-----z	0.00	0.00	-----z	-----z	1.00i
1897-98	-----z	-----z	-----z	-----z	3.00	-----z	3.00	-----z	-----z	-----z	-----z	-----z	6.00j
1898-99	0.00	-----z	-----z	-----z	-----z	-----z	-----z	11.00	-----z	-----z	-----z	-----z	11.00j
1899-00	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00l
1900-01	-----z	-----z	-----z	-----z	-----z	-----z	3.00	-----z	-----z	-----z	-----z	-----z	3.00k
1901-02	-----z	-----z	-----z	-----z	-----z	-----z	1.00	0.00	0.00	-----z	-----z	-----z	1.00i
1902-03	-----z	-----z	-----z	0.00	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00k
1903-04	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.90	-----z	-----z	-----z	-----z	0.90k
1904-05	-----z	-----z	-----z	-----z	-----z	-----z	3.00	-----z	-----z	-----z	-----z	-----z	3.00k
1905-06	-----z	-----z	-----z	-----z	-----z	0.00	-----z	-----z	-----z	0.00	0.00	-----z	0.00i
1906-07	0.00	0.00	0.00	0.00	-----z	-----z	-----z	-----z	-----z	-----z	0.00	-----z	0.00g
1907-08	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00l
1908-09	-----z	-----z	-----z	0.00	-----z	0.00	16.00y	-----z	-----z	-----z	-----z	-----z	0.00j
1909-10	0.00	-----z	-----z	-----z	0.00	-----z	2.00	3.00	0.00	-----z	-----z	-----z	5.00g
1910-11	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00l
1911-12	-----z	-----z	-----z	-----z	1.00	-----z	-----z	-----z	-----z	-----z	-----z	-----z	1.00k
1912-13	-----z	-----z	-----z	-----z	-----z	-----z	6.00	-----z	-----z	-----z	-----z	-----z	6.00k
1913-14	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00	-----z	-----z	0.00k
1914-15	-----z	0.00	0.00	0.00	0.00	-----z	0.00	0.00	-----z	0.00	0.00	0.00	0.00c
1915-16	0.00	0.00	0.00	-----z	-----z	-----z	15.00	3.00	0.00	-----z	0.00	0.00	18.00d
1916-17	0.00	0.00	0.00	0.00	-----z	1.00	-----z	0.00	-----z	0.00	-----z	-----z	1.00e
1917-18	-----z	0.00	0.00	0.00	0.00	0.00	0.00	2.50	-----z	0.00	0.00	0.00	2.50b
1918-19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-----z	0.00	0.00	0.00	0.00a
1919-20	0.00	0.00	-----z	0.00	-----z	23.00	0.00	0.00	1.50	-----z	-----z	-----z	24.50e
1920-21	-----z	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.60a
1921-22	0.00	0.00	0.00	-----z	0.00	6.70y	0.20	0.90	0.00	0.00	0.00	0.00	1.10b
1922-23	0.00	0.00	0.00	0.00	0.00	5.00	0.80	7.50	0.00	0.00	0.00	0.00	13.30
1923-24	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00
1924-25	0.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00
1925-26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1926-27	0.00	0.00	0.00	0.00	0.00	-----z	4.30	0.00	0.00	0.00	0.00	0.00	4.30a
1927-28	0.00	0.00	0.00	0.00	0.00	2.50	2.00	0.00	0.00	0.00	0.00	0.00	4.50
1928-29	0.00	0.00	0.00	0.00	0.00	7.50	11.70	0.00	0.00	0.00	0.00	0.00	19.20
1929-30	0.00	0.00	0.00	0.00	0.00	0.00	18.70	0.00	0.00	0.00	0.00	0.00	18.70
1930-31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1931-32	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.50
1932-33	0.00	0.00	0.00	0.00	0.00	0.30	2.10	1.00	0.00	0.00	0.00	0.00	3.40
1933-34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1934-35	0.00	0.00	0.00	0.00	0.00	0.00	9.80	0.00	0.00	0.00	0.00	0.00	9.80
1935-36	0.00	0.00	0.00	5.00	0.00	0.00	0.00	1.20	2.00	0.00	0.00	0.00	8.20

1936-37	0.00	0.00	0.00	0.00	0.00	0.00	8.80	25.20	0.00	0.00	0.00	0.00	34.00
1937-38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00	0.00	1.20
1938-39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00
1939-40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1940-41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1941-42	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
1942-43	0.00	0.00	0.00	0.00	0.00	1.50	22.10	0.00	0.00	0.00	0.00	0.00	23.60
1943-44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1944-45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1945-46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00
1946-47	0.00	0.00	0.00	0.00	0.00	0.00	2.90	0.00	0.00	0.00	0.00	0.00	2.90
1947-48	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.50	0.00	0.00	0.00	1.00
1948-49	0.00	0.00	0.00	0.00	0.00	0.30	3.50	2.40	0.00	0.00	0.00	0.00	6.20
1949-50	0.00	0.00	0.00	0.00	0.00	0.00	32.80	0.30	0.40	0.00	0.00	0.00	33.50
1950-51	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	10.90	0.00	0.00	0.00	11.00
1951-52	0.00	0.00	0.00	0.00	0.00	0.20	2.50	5.80	0.00	0.00	0.00	0.00	8.50
1952-53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1953-54	0.00	0.00	0.00	0.00	0.00	0.00	7.60	0.00	0.70	0.00	0.00	0.00	8.30
1954-55	0.00	0.00	0.00	0.00	0.00	0.50	0.80	0.00	0.70	0.00	0.00	0.00	2.00
1955-56	0.00	0.00	0.00	0.00	5.80	0.00	5.50	2.10	1.80	0.00	0.00	0.00	15.20
1956-57	0.00	0.00	0.00	0.00	0.00	8.20	2.40	0.00	0.00	0.00	0.00	0.00	10.60
1957-58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1958-59	0.00	0.00	0.00	0.00	0.00	0.00	3.40	2.10	0.00	0.00	0.00	0.00	5.50
1959-60	0.00	0.00	0.00	0.00	0.00	0.00	6.90	0.00	8.50	0.00	0.00	0.00	15.40
1960-61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1961-62	0.00	0.00	0.00	0.00	0.00	0.00	2.50	8.40	2.60	0.00	0.00	0.00	13.50
1962-63	0.00	0.00	0.00	0.00	0.00	0.00	6.60	0.00	0.00	0.00	0.00	0.00	6.60
1963-64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1964-65	0.00	0.00	0.00	0.00	0.00	5.70	0.00	0.00	0.00	0.00	0.00	0.00	5.70
1965-66	0.00	0.00	0.00	0.00	0.00	7.40	1.70	0.20	0.60	0.00	0.00	0.00	9.90
1966-67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1967-68	0.00	0.00	0.00	0.00	0.00	1.00	9.30	0.00	0.00	0.00	0.00	0.00	10.30
1968-69	0.00	0.00	0.00	0.00	0.00	12.60	21.90	0.40	0.00	0.00	0.00	0.00	34.90
1969-70	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.20
1970-71	0.00	0.00	0.00	0.00	0.00	0.90	11.10	8.10	1.40	0.00	0.00	0.00	21.50
1971-72	0.00	0.00	0.00	0.00	0.00	2.20	0.40	0.00	0.30	0.10	0.00	0.00	3.00
1972-73	0.00	0.00	0.00	0.00	0.00	14.60	0.70	0.00	0.00	0.00	0.00	0.00	15.30
1973-74	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50
1974-75	0.00	0.00	0.00	0.00	0.00	0.00	1.60	0.00	0.00	0.00	0.00	0.00	1.60
1975-76	0.00	0.00	0.00	0.00	0.00	1.50	0.00	0.00	0.30	0.00	0.00	0.00	1.80
1976-77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1977-78	0.00	0.00	0.00	0.00	6.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.10

1978-79	0.00	0.00	0.00	0.00	1.50	2.90	2.20	0.60	0.00	0.00	0.00	0.00	7.20
1979-80	0.00	0.00	0.00	0.00	0.00	0.00	1.80	0.00	0.00	0.00	0.00	0.00	1.80
1980-81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1981-82	0.00	0.00	0.00	0.00	0.00	0.00	4.40	0.60	0.00	0.00	0.00	0.00	5.00
1982-83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1983-84	0.00	0.00	0.00	0.00	0.00	4.30	0.00	0.00	0.00	0.00	0.00	0.00	4.30
1984-85	0.00	0.00	0.00	0.00	0.00	0.30	0.00	4.60	0.00	0.00	0.00	0.00	4.90
1985-86	0.00	0.00	0.00	0.00	2.00	6.50	0.00	3.60	0.00	0.00	0.00	0.00	12.10
1986-87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987-88	0.00	0.00	0.00	0.00	0.00	5.80	1.00	0.00	0.00	0.00	0.00	0.00	6.80
1988-89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.90	0.70	0.00	0.00	0.00	9.60
1989-90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.60	0.00	0.00	0.00	0.00	9.60
1990-91	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.00	1.20
1991-92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1992-93	0.00	0.00	0.00	0.00	0.00	7.90	10.00	14.10	0.00	0.00	0.00	0.00	32.00
1993-94	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40
1994-95	0.00	0.00	0.00	0.00	0.00	1.90	0.10	3.10	0.00	0.00	0.00	0.00	5.10
1995-96	0.00	0.00	0.00	0.00	0.00	0.00a	0.00	-----z	-----z	-----z	-----z	-----z	0.00e
1996-97	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00l
1997-98	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00l
1998-99	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00l
1999-00	-----z	-----z	-----z	-----z	-----z	-----z	0.00r	0.00n	0.00o	0.00	0.00	0.00c	0.00i
2000-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00d	0.00	0.00	0.00	0.00
2001-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00x	-----z	-----z	-----z	-----z	0.00e
2002-03	0.00q	-----z	0.00s	0.00y	0.00v	-----z	-----z	0.00t	-----z	0.00o	0.00t	0.00s	0.00l
2003-04	0.00s	0.00s	0.00q	0.00t	0.00u	0.00y	-----z	0.00v	0.00m	0.00k	0.00o	0.00a	0.00k
2004-05	0.00	0.00	0.00e	0.00q	0.00r	0.00u	0.00m	0.00j	0.00r	0.00w	0.00l	0.00o	0.00i
2005-06	0.00	0.00	0.00e	0.00o	0.00t	0.00r	-----z	0.00n	-----z	0.00t	0.00l	0.00	0.00h
2006-07	0.00	0.00a	0.00e	0.00h	0.00w	0.00r	0.00r	0.00y	0.00s	0.00q	0.00m	0.00c	0.00h
2007-08	0.00	0.00	0.00e	0.00s	0.00n	0.00x	0.00v	0.00v	-----z	0.00u	0.00h	0.00h	0.00i
2008-09	0.00	0.00b	0.00d	0.00k	0.00n	0.00v	0.00p	0.00s	0.00v	0.00p	0.00m	0.00	0.00h
2009-10	0.00	0.00a	0.00c	0.00l	0.00x	0.00r	0.00y	0.00r	0.00v	0.00x	0.00m	0.00e	0.00h
2010-11	0.00	0.00	0.00a	0.00l	0.00u	0.00w	0.00s	0.00r	-----z	0.00v	0.00v	0.00i	0.00i
2011-12	0.00a	0.00a	0.00d	0.00k	0.00y	0.00p	0.00s	0.00t	0.00w	0.00y	0.00i	0.00h	0.00i
2012-13	0.00b	0.00a	0.00	0.00j	0.00q	-----z	0.00s	0.00p	0.00o	0.00l	0.00o	0.00e	0.00h
2013-14	0.00	0.00	0.00h	0.00m	0.00w	0.00k	0.00o	0.00v	0.00s	0.00s	0.00g	0.00a	0.00i
2014-15	0.00e	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00k
						Period of Record Statistics							
MEAN	0.00	0.00	0.00	0.06	0.24	1.69	2.92	1.56	0.43	0.00	0.00	0.00	6.87
S.D.	0.00	0.00	0.00	0.54	0.99	3.77	5.65	3.79	1.57	0.01	0.00	0.00	8.70
SKEW	0.00	0.00	0.00	9.06	4.92	3.28	2.93	3.74	5.44	9.06	0.00	0.00	1.74
MAX	0.00	0.00	0.00	5.00	6.10	23.00	32.80	25.20	10.90	0.10	0.00	0.00	34.90

MIN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YRS	95.00	95.00	93.00	85.00	85.00	82.00	92.00	89.00	82.00	85.00	83.00	88.00	73.00

Appendix 11. Monthly Temperature at Salem McNary Field, OR

Monthly Average of Average Daily Temperature (Degree Fahrenheit)

(357500)

File last updated on Jul 29, 2014

a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,

z = 26 or more days missing, A = Accumulations present

Long-term means based on columns; thus, the monthly row may not sum (or average) to the long-term annual value.

MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5

Individual Months not used for annual or monthly statistics if more than 5 days are missing.

Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1892	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z
1893	33.82	40.48b	45.38a	47.45	53.76	57.83a	61.95	63.44	56.62	48.32	43.48	43.97	49.71
1894	41.32	38.86	44.92	50.17	54.90	59.28a	64.97	69.85	59.58	52.21	46.17	39.16	51.78
1895	38.90	42.50	44.27	51.67	53.06w	61.20	64.29	65.08	56.97	53.68	43.87	42.16	51.33a
1896	43.26	45.90	45.26	47.53	52.69	60.67	69.65	65.61	60.20	54.05	39.60	44.74	52.43
1897	39.87	-----z	43.28o	53.40	59.53	60.88	63.39	68.90	58.70	52.15	45.82	42.95	54.56b
1898	38.77t	45.25	43.13	51.62	56.13	62.55	65.37	68.05	61.42	51.52	44.32b	37.79	53.38a
1899	44.39	43.02c	44.08a	48.22	52.97	58.68b	65.97	62.05	61.87	50.10	50.62	43.29	52.10
1900	42.98b	42.80	50.26	50.65	58.47	65.85	69.23	67.27	-----z	55.45b	-----z	-----z	55.88c
1901	-----z	-----z	-----z	-----z	57.35e	58.98e	-----z	67.18l	59.62a	59.35a	-----z	40.60a	55.18g
1902	37.86c	46.14	44.98	49.47	56.00	60.93	-----z	-----z	59.62	53.58	44.05	41.72b	49.44b
1903	43.18	40.23	45.31	48.36b	55.65	62.72	63.65	65.27	61.52	53.82	45.78	41.44	52.24
1904	41.94	41.43	43.63	53.73	57.68	62.33	66.81	67.97	62.47	55.15	50.18	42.79	53.84
1905	40.52	42.50	50.98	54.38	55.65	60.75	68.82	65.98	62.23	50.58	43.10	40.45	53.00
1906	43.53	44.52	45.06	54.68	56.56	59.52	71.95	68.45	61.90	55.10	47.13	43.89	54.36
1907	35.85	46.98c	45.69	52.12	58.16	61.83	67.65	65.38w	60.56u	-----z	47.30y	43.04r	52.61e
1908	41.88n	44.08q	46.02b	51.31c	51.13h	60.27	70.41d	68.04q	60.42	53.98	47.97	38.98	53.67d
1909	34.60	43.88	47.32	49.77	53.47a	61.72	62.90	65.35	62.53	53.29	46.67	35.17b	51.39
1910	38.34b	39.55	51.26	52.55	59.18	59.92	67.21	63.52	59.07	54.85	45.50	43.24	52.85
1911	38.71	40.12	48.50	49.48b	53.56	59.64a	69.45	66.79	57.22	52.42	46.46b	41.13	51.96
1912	42.21	44.77a	45.44g	49.35	57.37	61.68	67.02e	63.82i	60.12a	50.35	46.32	40.48	51.97b
1913	38.58e	40.45	44.66	50.85	56.63	61.83	66.08	68.98	-----z	51.34	42.63	38.10f	52.20b
1914	43.04f	41.27	47.62b	51.00b	59.21	60.35	68.31	67.50	59.03	55.29	46.23b	36.56	53.85a
1915	39.48	44.50	51.89	54.83	55.85	61.13	66.52	70.31	61.23	56.53	46.15	42.44	54.24

1916	33.00	46.21	46.47	52.25	52.94	60.98	64.16	68.50a	62.25	52.63	41.93	38.47	51.65
1917	41.17a	41.05	41.66	47.88	54.15	61.27	69.05	70.47	62.27	54.97	50.52	47.90	53.53
1918	43.82a	41.71	47.61	55.67	55.65	66.17	65.96c	66.45	66.30	54.60a	44.45	40.68	54.09
1919	40.40b	41.39	45.39	50.45a	55.32a	58.95a	66.74	66.55	60.72	45.95a	-----z	32.02k	53.18b
1920	37.59c	39.46a	43.83a	47.22	53.06	60.40	64.68	67.23	59.93g	51.50a	44.62	42.48	50.19a
1921	39.50b	45.02	46.58	49.65	55.32	63.70	65.15	66.58	58.50	55.70a	47.76a	38.61d	52.67
1922	35.62b	39.07	42.69	47.59a	57.13	66.23	69.47	67.00	63.28	53.67b	40.85d	38.91i	52.96a
1923	42.56e	37.20c	45.48a	51.98a	56.90	61.82	67.58	69.92	63.67	54.42	48.00	41.41d	53.41
1924	39.31b	47.53	45.58	52.02	60.32	65.02	67.27	66.89	62.40	54.68	45.05a	35.90	53.50
1925	44.55b	45.98a	46.61	53.20	59.66	63.20	69.34	66.31	62.12	54.17a	44.88b	44.91b	54.58
1926	40.82	47.86	52.27	59.28	58.16	67.02	70.82	67.31	60.00a	56.00	48.58	41.79	55.83
1927	39.15h	44.32	46.15	51.05	54.21	64.68	69.63	69.12a	61.28	54.03a	49.28a	37.18a	54.63a
1928	39.53	42.53	50.10	50.28	61.02	60.40a	67.97	65.42	60.07h	53.65d	44.69a	38.00	52.14a
1929	34.06	36.00	46.89	47.42	55.92	61.19a	65.21	66.93c	61.78	56.10a	42.90	45.11	51.63
1930	27.44	45.86	47.29g	51.39c	51.16f	57.48b	62.23a	65.77g	60.50g	48.94m	42.45j	38.61h	48.88g
1931	42.79l	41.14f	45.76j	50.76i	58.62f	59.91h	67.26h	66.85g	60.47a	53.60f	41.75b	38.61	46.94i
1932	38.18a	39.59	45.92	49.22g	54.70c	63.80	63.69	66.77	61.58	55.69	46.89c	36.03a	52.08a
1933	38.76	38.15b	45.65	49.47	52.10	60.62	64.98	66.90	57.82	54.18a	43.75	46.21	51.55
1934	45.65	45.93	52.03	55.95	58.27	62.27	64.48	66.58	59.98	55.47	49.48b	42.26	54.86
1935	40.66c	43.09a	42.69e	49.28e	54.19b	61.95	65.85	65.85	63.55	51.57a	40.95	39.08	51.56
1936	42.69	35.41	44.05	53.50	58.27	62.60	65.55	66.02	60.58	55.32	41.71a	42.68	52.37
1937	30.06	41.55	48.56	50.00	57.16	62.67	65.69	64.81	60.90	56.00	48.82	42.37	52.38
1938	39.29	42.59	45.26	51.75	56.95	63.07	69.24	64.11	65.22	53.97	42.53	41.94	52.99
1939	41.87	39.77	47.53	52.93	57.53	59.65	67.79	66.95	63.23	54.32	47.12	44.76	53.62
1940	39.66	45.33	49.35	52.37	59.20a	64.02	66.50	68.48	63.85	56.56	43.45	42.71	54.29
1941	41.95	45.34	51.15	53.03	56.63	62.15	71.97	67.97	60.28	53.92	46.62	42.13	54.43
1942	35.63	43.04	45.69	51.85	55.87	60.18	68.56	69.32	63.17	55.31	45.77	43.94	53.19
1943	33.84	43.98	45.32	53.32	54.48	60.25	67.02	66.10	65.47	54.55	45.67	39.16	52.43
1944	39.24	42.79	45.79	50.80	56.37	61.37	67.73	66.24	65.30	57.37	45.23	38.42	53.05
1945	42.10	44.57	44.50	49.65	57.95	61.70	68.06	67.34	60.15	53.34	45.75	41.05	53.01
1946	40.26	42.61	46.13	50.27	58.45	60.38	67.32	67.37	60.45	50.18	43.52	41.63	52.38
1947	37.00	45.48	49.02	53.35	60.61	60.65	65.73	64.68	62.95	54.37	46.68	42.08	53.55
1948	39.50	40.62	43.98	47.55	55.21	64.97	65.48	64.97	60.97	51.71	43.15	37.48	51.30
1949	29.47	40.73	46.73	52.75	58.94	62.13	66.00	66.23	63.30	48.66	49.15	40.16	52.02
1950	29.61	41.29	44.79	48.40	55.19	62.17	67.29	68.71	61.72	51.89	46.77	47.40	52.10
1951	39.81	43.12	40.92	52.52	55.84	64.02	66.68	64.73	62.68	53.10	45.23	37.55	52.18
1952	38.45	40.57	44.15	50.40	55.42	59.32	67.32	66.00	63.82	57.40	38.60	41.02	51.87
1953	46.94	43.00	44.85	49.15	54.08	57.50	64.61	65.35	62.52	54.16	47.63	42.50	52.69
1954	40.16	42.86	42.90	48.83	55.58	57.00	62.68	63.06	59.03	51.31	49.00	40.08	51.04
1955	39.15	40.02	41.39	45.22	53.05	59.88	62.53	64.52	60.42	53.21	43.00	41.11	50.29
1956	41.08	36.95	43.89	51.28	58.55	58.45	67.77	65.16	61.73	51.63	42.37	40.03	51.57
1957	32.94	42.68	46.89	51.80	58.35	61.67	64.63	63.74	65.27	53.21	42.85	43.03	52.25

1958	42.85	48.27	44.97	50.22	60.95	64.95	71.16	70.24	62.38	55.37	46.88	45.52	55.31
1959	42.76	42.88	45.98	50.78	54.00	61.57	67.94	65.44	60.15	54.32	44.22	39.60	52.47
1960	36.60	41.57	44.34	49.55	52.45	60.68	67.56	64.76	62.42	54.79	46.85	40.08	51.80
1961	42.95	46.09	46.34	49.05	53.95	63.27	67.50	69.26	58.32	52.53	41.23	40.97	52.62
1962	37.06	40.73	43.89	50.83	51.37	59.28	64.31	64.79	62.52	52.61	46.72	41.74	51.32
1963	33.69	47.73	44.37	47.03	55.16	59.12	61.85	65.58	65.68	53.74	46.07	39.85	51.66
1964	41.63	40.28	43.61	48.03	53.63	60.27	66.39	63.77	58.80	53.19	41.93	39.53	50.92
1965	40.48	43.04	46.61	50.32	52.15	58.93	67.21	66.73	59.55	55.31	47.92	37.82	52.17
1966	39.58	40.54	44.55	50.53	54.85	61.80	65.18	66.89	63.23	52.60	47.12	44.18	52.59
1967	44.10	42.59	43.08	44.58	54.34	64.13	67.58	71.60	64.90	54.29	46.43	41.95	53.30
1968	39.63	48.10	47.29	46.85	54.50	59.60	66.13	65.21	60.45	51.42	45.33	37.00	51.79
1969	32.95	40.32	46.24	49.08	58.87	65.35	64.90	63.50	61.10	49.85	44.07	41.92	51.51
1970	41.63	44.93	45.45	45.77	54.16	64.37	67.18	65.44	58.30	50.63	43.58	39.00	51.70
1971	39.06	39.41	41.92	47.12	53.29	58.18	67.34	69.10	59.13	50.58	44.50	39.47	50.76
1972	38.26	43.19	47.85	45.93	56.50	59.97	67.55	68.19	57.55	50.10	46.35	36.15a	51.47
1973	38.84	43.84	44.61	49.10	55.73	61.08	67.44	63.56	62.10	51.90	43.95	43.37	52.13
1974	37.53	41.21	46.08	49.32	52.84	61.80	65.76	67.35	65.73	53.00	46.40	43.00	52.50
1975	42.58	41.88	43.55	45.32	54.23	59.83	67.05	63.05	63.53	51.58	43.90	41.92	51.53
1976	40.66	40.21	42.47	47.13	53.24	56.85	65.26	64.16	61.97	52.08	45.90	38.73	50.72
1977	37.63	44.45	44.45	50.58	51.77	61.78	64.55	70.08	58.93	52.05	44.57	43.16	52.00
1978	41.37	45.25	48.15	48.88	54.76	65.18	68.79	68.34	60.98	54.13	39.35	34.74	52.49
1979	31.21	42.64	49.00	50.43	56.76	61.73	67.89	65.65	62.88	54.63	41.72	44.76	52.44
1980	35.53	43.14	44.55	50.67	53.69	57.52	65.48	62.74	62.48	53.56	47.28	42.84	51.62
1981	40.60	43.11	46.52	50.55	54.53	59.00	65.05	68.66	61.90	50.37	44.53	42.90	52.31
1982	38.53	41.55	44.48	45.83	54.69	65.05	65.65	66.42	61.37	53.32	42.33	41.10	51.69
1983	43.23	46.04	48.92	50.10	57.29	60.27	64.32	67.74	60.30	52.66	49.30	38.39	53.21
1984	43.19	44.17	48.63	47.75	52.89	57.38	65.44	66.76	61.28	51.39	44.40	37.42	51.72
1985	34.27	39.59	42.74	51.37	55.13	61.20	70.13	65.39	58.33	51.18	37.28	33.23	49.99
1986	43.19	44.34	50.15	48.35	55.23	64.17	63.45	69.82	58.92	53.65	46.63	39.58	53.12
1987	39.48	43.82	47.26	51.90	58.03	63.97	64.84	67.81	62.70	56.08	46.90	38.85	53.47
1988	39.34	43.33	45.58	51.10	53.69	60.48	66.77	65.81	62.25	56.63	46.82	40.52	52.69
1989	41.61	34.73	46.37	54.57	56.23	63.28	64.58	64.92	63.10	52.95	47.35	39.56	52.44
1990	42.76	41.27	47.79	52.73	55.21	62.27	69.60	69.11	64.87	51.19	46.87	34.44	53.17
1991	39.50	48.62	44.61	49.18	53.08	57.88	67.95	67.77	65.38	54.21	47.28	41.60	53.09
1992	44.10	47.57	50.52	53.80	60.82	65.75	68.89	68.18	62.00	55.05	46.12	39.19	55.16
1993	36.32	39.38	49.11	52.27	60.48	61.23	63.16	67.19	63.30	56.50	40.48	41.05	52.54
1994	44.27	42.95	50.18	53.20	59.19	61.65	69.06	67.03	65.15	52.63	41.68	42.24	54.10
1995	44.44	46.48	47.42	49.93	58.98	62.58	68.50	65.06	64.63	52.34	51.07	42.23	54.47
1996	41.92	42.17	47.23	51.85	53.13	60.87	70.21	67.77	59.95	52.42	45.18	42.45	52.93
1997	40.92	42.30	46.39	49.43	60.37	60.53	66.92	69.77	64.10	51.98	48.00	39.50	53.35
1998	43.95	45.46	47.26	50.43	54.56	61.28	69.61	69.00	64.47	52.35	47.70	39.90	53.83
1999	41.74	43.07	44.65	49.33	53.34	59.87	66.06	67.87	63.22	53.90	49.35	42.53	52.91

2000	40.13	43.43b	44.23	51.28	55.74	63.57	65.95	65.56	62.17	53.21	41.27	40.52	52.25
2001	40.56	41.79	46.68	47.85	57.29	58.57	66.03	67.15	63.57	52.55	47.58	41.16	52.56
2002	41.06	43.21	43.74	50.40	54.00	61.98	68.81	67.52a	63.17	52.10	46.37	43.13	52.96
2003	44.92	43.59	49.00	49.50	55.77	64.05	70.23	68.76	64.80	56.92	43.70	41.69	54.41
2004	39.52	43.59	49.15	52.53	56.74	63.10	69.97	70.10	60.58	54.24	43.80	42.47	53.82
2005	41.82	41.36	48.63	50.20	57.89	59.70	68.85	68.94	60.58	54.19	42.47	39.81	52.87
2006	44.39	41.41	44.55	50.90	57.11	64.30	69.76	67.39	63.40	51.98	46.92	39.58	53.47
2007	38.06	44.30	48.98	49.82	56.66	61.07	69.85	67.27	61.30	51.50	43.63	40.11	52.71
2008	37.08	43.09	43.27	46.42	56.84b	59.27	68.03	67.61	63.08	51.76	47.80	37.06	51.78
2009	39.65	41.09	44.15	49.43	57.23	63.87	71.19	68.32	64.38	53.34	46.87	37.23	53.06
2010	46.24	46.29	47.23	49.70	54.37	60.00	67.50	67.40	63.65	54.53	45.40	43.87	53.85
2011	42.26	40.95	47.03	47.47	53.55	60.73	65.92	69.08	66.57	54.50	45.03	38.74	52.65
2012	42.13	42.67	43.92	51.57	55.73	59.83	66.85	69.63	64.13	55.08	47.62	42.23	53.45
2013	37.13	43.55	47.63	51.55	58.15	63.93	70.45	70.61	64.33	51.56	45.70	36.16	53.40
2014	41.29	42.32	49.08	52.93	59.81	63.17	72.12c	-----z	-----z	-----z	-----z	-----z	54.39e
					Period of Record Statistics								
MEAN	39.66	42.73	46.15	50.40	55.99	61.46	66.94	66.89	61.82	53.36	45.30	40.77	52.65
S.D.	3.71	2.71	2.44	2.45	2.32	2.21	2.30	1.99	2.20	2.06	2.65	2.72	1.14
SKEW	-0.90	-0.24	0.43	0.25	0.28	0.23	0.03	-0.08	-0.11	-0.29	-0.38	-0.19	0.19
MAX	46.94	48.62	52.27	59.28	61.02	67.02	72.12	71.60	66.57	59.35	51.07	47.90	55.83
MIN	27.44	34.73	40.92	44.58	51.37	56.85	61.85	62.05	56.62	45.95	37.28	33.23	49.71
YRS	116.00	118.00	117.00	119.00	118.00	121.00	119.00	114.00	115.00	118.00	116.00	115.00	102.00

Appendix 12. 1892-2014 Monthly Precipitation at Salem McNary Field, OR

(Inches)

(357500)

File last updated on Jul 29, 2014

a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,

z = 26 or more days missing, A = Accumulations present

Long-term means based on columns; thus, the monthly row may not sum (or average) to the long-term annual value.

MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5

Individual Months not used for annual or monthly statistics if more than 5 days are missing.

Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1892	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	6.08	6.08k
1893	1.90	5.43	4.16	7.50	4.20	1.24	0.00	0.10	3.55	7.49	9.33	4.18	49.08

1894	9.92	4.32	10.13	3.68	2.24	3.50	0.19	0.00	2.27	4.39	2.19	4.62	47.45
1895	13.72	1.89	4.56	2.34	4.10k	0.50	0.61	0.23	2.18	0.00	3.71	11.16	40.90a
1896	6.35	3.31	2.69	6.12	5.54	0.99	0.00	1.00	0.66	2.97	16.99	8.31	54.93
1897	-----z	5.73	6.11	2.29b	1.78	1.77	0.64	0.28	1.77b	2.08	11.67	7.76	41.88a
1898	3.43a	5.64	2.15	2.44	1.75	1.61	0.40	0.06	1.13	4.65	6.82	4.31	34.39
1899	5.76a	6.35	4.13	3.72	3.90	0.25	0.00	2.91	1.40	3.95	9.22	6.58	48.17
1900	4.15	2.98	4.25	2.60	3.90	2.20	0.62	0.00	-----z	4.70	2.76	6.86	35.02a
1901	7.08a	5.13	-----z	0.72w	1.79	0.50e	-----z	0.30	3.25	1.25	4.39a	5.32	29.01c
1902	1.48	7.90b	6.00	3.71	3.59	0.90	-----z	-----z	0.42	1.07	7.98	7.49	40.54b
1903	4.56	0.88	2.73	1.20a	1.09	1.30	0.40	0.29	0.23	1.65	8.28	1.95	24.56
1904	3.78	9.47	9.04	1.68	0.43	0.32	0.80	0.14	0.42	2.82	6.53	6.65	42.08
1905	4.71	2.08	4.64	0.86	1.57	0.59	0.05	0.03	2.86	4.26	2.26	4.58	28.49
1906	5.42	5.78	1.94	1.58	1.85	2.50	0.00	0.00	1.92	2.38	5.99	4.65	34.01
1907	8.01	4.34	2.88	1.69	0.92	1.55a	0.67	1.07	0.60e	0.58a	1.37g	7.68f	22.31b
1908	3.54e	1.63d	2.63	1.99	2.38	1.06	0.02	0.52a	0.30	4.88	3.61	2.90	25.46
1909	8.28	5.98b	1.51	0.51	1.02	0.18	1.96	0.02	0.90	3.24	10.56	4.80	38.96
1910	5.63	4.92	1.24	2.20	1.58	1.19	0.00	0.02	1.26	1.80	8.03	4.02	31.89
1911	8.43	1.72	0.59	1.83	2.78	0.85	0.06	0.00	4.56	0.81	1.97	3.95	27.55
1912	5.52	3.94	1.79	2.03	2.40	2.70	0.32	1.81	1.49	3.22	5.78	4.72	35.72
1913	4.36	1.20	3.36	2.24	2.24	3.48	0.29	0.30	2.57	2.17b	5.54	3.39	31.14
1914	8.71	4.12	2.56	2.59	1.96	1.85	0.00	0.00	4.84	3.34	3.38	2.52	35.87
1915	4.08	3.64	1.88	1.40	2.38	0.94	0.99	0.00	0.42	1.54	8.06	7.22	32.55
1916	5.39	6.43	9.96	2.59	2.58	1.31	2.72	0.35	1.17	1.43	7.12	4.71	45.76
1917	1.30	2.83	3.73	3.62	1.60	1.13	0.02	0.00	1.32	0.00	3.24	14.03	32.82
1918	4.39	5.68	3.81	1.22	1.08	0.00	0.67	0.67	0.17	2.83	3.94	3.76	28.22
1919	8.43	8.10	4.54	3.18	0.81	0.16	0.05	0.00	2.42	1.42	5.85	6.05	41.01
1920	2.98	0.34	4.24	3.37	0.25	2.69	0.55	0.95	4.45	4.97c	6.76	8.29	39.84
1921	7.27	6.90	5.07	1.93	1.62	1.05g	0.00	0.13	1.86	3.69	10.37	2.81a	41.65a
1922	3.11	4.33	6.14	2.16	0.93	0.03	0.00	1.49	1.97	4.91	2.57	10.41	38.05
1923	10.17	2.62	1.99	1.70	1.89	0.97	1.21x	0.05	0.70	2.21	3.80	6.22	32.32a
1924	3.54	2.59b	1.29	1.10	0.61	0.22	0.00	0.53	2.37	8.31	7.98	4.61	33.15
1925	6.73	8.07	1.41	2.71a	1.86	0.96	0.00	0.77	1.73	0.03	5.65	3.40	33.32
1926	3.21	8.91	0.64	0.49	2.95	0.24	0.00	2.42	1.89	4.28	9.30	4.84	39.17
1927	8.90	9.05	2.65	1.46	1.75	1.54	0.01	0.12	3.71	3.91	7.02	3.11	43.23
1928	4.83	1.29	8.00	5.21	0.45	0.85	0.05	0.00	0.78	1.78	7.15	7.64	38.03
1929	2.50	1.28	2.51	4.09	1.10	1.71	0.00	0.05	0.27	1.17	0.63	11.09	26.40
1930	3.98	6.43	1.93	3.95	1.75	0.99	0.01	0.01	2.03	1.92	3.75	3.30	30.05
1931	6.77	3.46	6.49	3.38	0.78	3.35	0.00	0.00	1.59	4.48	7.38	10.98	48.66
1932	6.08	2.00	6.06	3.38	3.06	0.22	0.65	0.54	0.01	4.33	7.96	7.77	42.06
1933	9.26	4.38	5.89	0.48	4.61	1.58	0.00	0.37	2.99	3.83	1.63	17.54	52.56
1934	6.40	1.59	3.89	2.33	1.35	0.34	0.30	0.27	0.43	3.64	9.49	9.38	39.41
1935	4.39	4.00	6.20	1.87	0.41	0.36	0.39	0.53	1.20	3.30	2.26	5.99	30.90

1936	10.22	5.57	3.13	1.13	3.41	1.11	0.49	0.00	1.49	0.21	0.48	6.37	33.61
1937	6.17	10.36	3.19	7.68	1.60	4.61	0.13	0.71	0.91	3.41	11.13	13.60	63.50
1938	4.48	7.60	8.42	2.27	0.78	0.08	0.36	0.06	1.38	3.68	4.26	5.18	38.55
1939	6.00	5.08	2.65	0.39	0.90	0.98	0.47	1.04	0.38	2.63	0.84	10.32	31.68
1940	4.75	11.66	5.94	1.99	2.17	0.07	0.62	0.00	2.36	3.79	4.55	5.03	42.93
1941	4.25	1.43	1.95	1.80	3.83	0.49	0.03	1.33	2.37	2.87	5.36	8.43	34.14
1942	4.79	3.10	1.27	1.74	4.58	1.69	0.92	0.04	0.01	2.04	13.38	11.70	45.26
1943	4.35	4.50	6.71	2.75	1.09	3.38	0.32	2.14	0.06	6.31	2.36	5.17	39.14
1944	5.27	3.53	1.64	2.75	0.93	0.50	0.05	0.05	1.97	1.54	4.30	2.67	25.20
1945	5.34	5.92	6.67	2.89	4.44	0.32	0.51	0.20	2.46	1.75	10.73	6.25	47.48
1946	6.57	5.77	5.72	1.14	1.15	1.28	0.72	0.09	1.89	4.55	8.04	4.45	41.37
1947	3.23	3.43	5.29	2.24	0.18	3.60	1.41	0.44	1.01	11.17	3.42	4.11	39.53
1948	6.73	6.35	5.01	3.85	4.15	0.38	0.60	0.52	2.60	2.26	7.56	9.14	49.15
1949	0.57	12.31	3.06	1.00	2.23	0.97	0.26	0.38	1.37	2.31	5.86	5.45	35.77
1950	11.70	6.22	4.86	1.88	1.21	2.80	0.18	0.35	0.84	10.74	9.67	6.10	56.55
1951	9.49	5.43	4.02	0.98	2.49	0.01	0.17	0.65	3.22	7.29	6.99	6.73	47.47
1952	6.60	4.86	2.59	1.57	0.20	2.64	0.00	0.00	0.20	0.83	1.73	8.63	29.85
1953	15.40	4.87	4.95	1.58	3.76	1.34	0.00	1.65	1.59	3.06	6.99	7.80	52.99
1954	9.99	5.87	3.02	2.70	1.34	2.47	0.31	0.72	1.28	3.45	5.07	6.26	42.48
1955	2.63	2.25	3.66	5.18	1.18	1.09	0.86	0.00	2.30	7.78	6.75	12.22	45.90
1956	12.68	5.42	5.91	0.64	1.61	1.20	0.00	0.37	0.87	6.50	1.03	2.94	39.17
1957	2.38	4.93	8.16	2.02	2.77	2.10	0.18	0.27	0.96	2.98	3.31	8.87	38.93
1958	8.80	7.04	2.50	3.71	1.38	2.53	0.00	0.03	1.00	2.23	7.18	4.71	41.11
1959	11.15	4.98	4.45	1.12	2.09	1.41	0.50	0.02	2.10	1.53	2.06	3.97	35.38
1960	4.41	5.41	6.99	3.50	3.59	0.47	0.00	0.65	0.65	2.75	9.45	3.24	41.11
1961	4.79	10.82	8.19	3.19	2.44	0.30	0.96	0.28	0.91	3.18	4.42	6.64	46.12
1962	1.11	3.97	5.65	3.03	2.11	0.69	0.00	0.70	1.53	4.55	8.54	3.01	34.89
1963	2.80	3.34	6.51	4.07	3.70	0.85	0.91	0.09	1.41	3.59	6.52	3.85	37.64
1964	11.19	0.78	3.55	1.28	0.59	1.73	0.45	0.41	0.74	0.93	8.44	12.40	42.49
1965	8.15	1.57	0.87	2.41	1.16	1.11	0.19	0.99	0.13	2.20	7.00	7.95	33.73
1966	6.60	2.24	6.08	1.07	0.78	0.58	0.53	0.40	1.66	2.06	5.88	7.32	35.20
1967	7.29	2.06	3.84	2.02	1.87	0.69	0.00	0.00	0.84	5.08	3.30	5.45	32.44
1968	6.37	7.73	3.32	1.47	3.46	1.29	0.39	4.17	2.48	6.14	6.49	11.05	54.36
1969	8.61	3.24	1.63	2.51	0.89	2.94	0.05	0.05	3.58	4.44	3.21	9.23	40.38
1970	13.47	4.46	1.92	2.63	1.36	0.85	0.01	0.00	1.81	3.25	7.18	9.74	46.68
1971	6.49	4.34	6.93	4.05	1.89	2.47	0.01	1.49	3.98	3.09	6.27	8.18	49.19
1972	7.98	4.68	4.96	3.79	2.40	0.69	0.12	0.14	2.07	0.70	3.77	8.70	40.00
1973	5.64	1.62	3.50	1.69	1.11	1.48	0.00	0.80	2.80	2.79	15.23	11.08	47.74
1974	10.89	5.56	7.95	1.48	0.90	0.41	1.80	0.11	0.28	2.15	7.42	6.94	45.89
1975	4.96	4.68	4.22	2.20	1.66	0.81	0.51	1.96	0.00	5.51	6.06	6.07	38.64
1976	5.47	6.92	3.66	2.00	1.33	1.04	0.67	1.89	1.13	1.51	1.13	1.26	28.01
1977	0.88	2.83	3.33	0.62	3.76	0.73	0.26	1.70	2.36	2.37	6.19	8.73	33.76

1978	5.67	3.54	1.23	3.50	2.97	0.48	1.07	2.56	2.64	0.37	4.50	2.64	31.17
1979	2.84	7.19	2.17	2.82	2.20	0.65	0.30	0.70	2.19	6.06	3.83	6.95	37.90
1980	6.58	4.04	3.48	3.58	1.53	1.99	0.22	0.04	1.05	1.45	5.24	10.44	39.64
1981	2.09	3.29	3.45	2.06	2.19	3.33	0.15	0.00	2.78	4.63	7.54	9.73	41.24
1982	6.11	6.02	2.81	3.80	0.73	1.36	0.33	0.41	1.83	3.04	4.92	9.26	40.62
1983	6.00	10.57	8.56	2.72	2.12	2.48	2.63	2.09	0.32	1.31	10.06	6.49	55.35
1984	2.34	5.50	4.40	3.74	3.32	4.19	0.03	0.00	1.19	4.31	12.70	3.71	45.43
1985	0.24	3.44	3.80	0.93	0.65	2.42	0.32	0.20	1.25	3.17	4.81	2.51	23.74
1986	6.25	8.26	2.89	1.30	2.22	0.42	1.23	0.00	3.12	2.71	7.24	3.86	39.50
1987	7.67	3.52	3.98	2.36	1.52	0.26	2.51	0.15	0.14	0.47	3.00	10.92	36.50
1988	6.78	0.75	3.34	3.56	2.39	1.97	0.03	0.00	0.98	0.12	9.50	3.23	32.65
1989	3.57	2.79	6.47	1.06	1.08	1.03	0.77	0.48	1.03	2.50	3.09	3.95	27.82
1990	8.51	5.31	2.39	1.67	1.94	1.09	0.47	0.85	0.42	5.63	4.91	2.82	36.01
1991	2.42	3.72	5.18	3.84	4.51	1.55	0.11	0.67	0.04	1.70	5.94	3.73	33.41
1992	4.76	4.46	0.89	4.35	0.05	1.12	0.50	0.38	0.70	3.52	4.84	7.83	33.40
1993	4.77	1.61	5.12	5.64	3.59	3.17	1.05	0.40	0.01	1.11	1.26	6.84	34.57
1994	4.28	4.21	2.56	2.16	1.61	1.14	0.00	0.05	1.64	7.96	7.09	4.91	37.61
1995	8.63	4.35	4.44	4.41	1.29	1.48	0.36	1.29	1.81	4.07	9.07	7.28	48.48
1996	8.26	13.01	3.08	5.72	3.21	0.74	0.90	0.20	1.94	4.78	10.11	15.01	66.96
1997	9.07	2.08	7.32	3.41	2.71	1.86	0.36	1.13	3.81	6.45	4.40	3.16	45.76
1998	9.06	6.18	4.96	1.63	5.56	0.98	0.10	0.04	0.68	2.52	11.70	8.66	52.07
1999	9.61	11.40	5.06	1.35	1.90	1.43	0.15	0.68	0.09	2.44	7.26	5.38	46.75
2000	7.05	6.92	2.98	1.29	1.56	0.71	0.09	0.03	0.75	2.40	2.53	3.62	29.93
2001	1.81	1.22	2.82	2.49	1.45	1.89	0.24	0.78	0.57	3.35	9.02	8.03	33.67
2002	8.93	3.54	4.47	1.77	1.35	1.22	0.07	0.02	0.98	0.47	3.84	11.20	37.86
2003	7.38	2.78	4.79	5.54	1.74	0.62	0.00	0.03	0.94	2.47	4.99	10.42	41.70
2004	6.65	5.10	1.43	2.13	2.06	1.78	0.09	1.04	2.08	3.30	2.14	3.89	31.69
2005	1.43	0.49	4.15	2.82	4.65	1.90	0.21	0.05	2.33	2.70	6.04	11.52	38.29
2006	13.37	2.12	4.17	2.46 a	2.88	0.65	0.07	0.00	0.54	0.65	15.15	7.35	49.41
2007	3.92	5.33	2.35	2.29	1.27	0.78	0.34	0.72	2.76	4.24	3.75	8.25	36.00
2008	8.34	1.89	3.54	1.97	0.43	0.74	0.00	1.28	0.41	0.96	3.59	6.02	29.17
2009	3.56	2.90	3.03	1.35	3.03	1.39	0.68	0.18	1.20	2.61	8.02	6.14	34.09
2010	5.85	4.07	5.20	4.35	3.47	2.64	0.04	0.20	2.07	5.22	6.44	9.95	49.50
2011	3.25	4.31	7.16	4.15	3.40	0.98	0.74	0.11	0.35	2.15	5.96	3.32	35.88
2012	11.29	4.14	9.98	3.08	2.31	2.20	0.07	0.00	0.04	5.94	8.92	7.40	55.37
2013	1.63	1.42	2.21	2.39	2.94	1.02	0.00	0.35	7.05	0.63	2.68	1.27	23.59
2014	2.26	7.01	7.32	2.71	2.07	0.64	0.46	0.35	1.19				
					Period of Record Statistics								
MEAN	6.04	4.69	4.20	2.57	2.08	1.33	0.39	0.52	1.56	3.19	6.12	6.65	39.32
S.D.	3.08	2.63	2.16	1.38	1.20	0.97	0.52	0.71	1.20	2.09	3.22	3.13	8.47
SKEW	0.54	0.86	0.67	1.14	0.72	1.05	2.45	2.24	1.29	1.14	0.69	0.72	0.57
MAX	15.40	13.01	10.13	7.68	5.56	4.61	2.72	4.17	7.05	11.17	16.99	17.54	66.96

MIN	0.24	0.34	0.59	0.39	0.05	0.00	0.00	0.00	0.00	0.00	0.48	1.26	23.59
YRS	121.00	122.00	121.00	121.00	121.00	121.00	119.00	120.00	120.00	121.00	120.00	121.00	113.00

Appendix 13. Upper Drift Creek Daily Stream Flows for Representative Years

(1935-36, 1933-34 and 1947-48)

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Estimated daily stream flows for representative flow years (33-34 av; 35-36 low; 47-48 high)
Oct33,15.39,13.06,11.22,10.16,9.09,8.10,7.77,7.44,6.78,6.66,6.53,6.37,6.20,6.04,5.96
      5.91,5.79,5.79,5.91,6.41,7.11,7.11,7.11,7.11,7.44,7.11,8.43,10.16,29.44,69.06,71.25
Nov33,73.79,66.86,66.86,72.34,65.76,53.44,40.23,35.62,29.44,26.86,23.50,21.05,20.25,18.63,17.82
      16.20,15.39,14.61,13.84,15.39,19.44,17.82,15.39,14.61,13.84,13.43,13.06,13.43,14.61,15.39
Dec33,16.20,16.20,17.82,23.50,28.57,86.27,187.23,199.51,187.23,174.48,160.45,129.16,121.24,106.50,111.81
      123.79,106.50,125.06,206.98,241.62,226.99,265.78,294.71,282.06,255.29,254.82,237.99,221.45,208.81,199.51,185.45
Jan34,168.52,146.26,137.22,145.07,135.68,135.68,121.24,99.76,82.39,73.79,72.34,75.24,87.33,114.43,131.66
      126.33,126.33,148.92,148.92,151.55,155.32,162.98,174.48,183.91,183.91,177.67,164.38,148.92,118.34,86.27,73.79
Feb34,65.76,56.83,51.17,46.97,45.06,41.20,36.52,33.82,41.20,47.74,43.90,38.32,36.52,33.82,32.91
      31.18,30.31,29.44,29.44,27.69,26.02,24.34,24.34,22.66,21.86,21.86,21.86,28.57
Mar34,28.57,37.42,73.79,69.06,66.86,88.73,106.50,91.51,73.79,62.43,55.71,47.74,43.13,39.25,36.52
      33.82,32.05,30.31,28.57,26.86,25.18,24.34,22.66,21.86,21.05,20.25,20.25,48.89,115.74,111.81,114.43
Apr34,111.81,122.52,118.34,99.76,81.32,69.06,60.20,53.44,46.97,42.36,38.32,35.62,32.91,30.31,28.57
      26.86,26.02,24.34,23.50,21.86,20.25,20.25,20.25,22.66,26.02,34.72,32.91,30.31,28.57,27.69
May34,27.69,26.86,28.57,32.05,33.82,61.32,61.32,54.58,50.03,45.06,40.23,35.62,32.91,28.57,26.86
      25.18,23.50,23.50,23.50,22.66,23.50,21.05,18.63,17.82,16.20,16.20,15.39,15.39,14.61,13.84,13.06
Jun34,13.06,13.84,13.84,13.84,12.29,11.51,11.14,11.14,11.14,10.77,10.40,9.66,8.60,7.90,7.90
      7.90,7.90,7.52,7.19,6.86,6.86,6.86,6.49,6.49,6.49,6.49,6.49,8.27,7.90,7.19
Jul34,6.49,6.16,5.83,5.58,5.17,4.96,4.96,5.05,4.92,4.92,4.84,4.71,4.47,4.30,4.26
      4.30,4.47,4.51,4.92,5.05,4.47,4.26,4.63,4.63,4.47,4.38,4.30,4.30,4.30,4.47,4.38
Aug34,4.13,4.13,3.97,3.88,4.01,4.63,4.47,4.13,3.76,3.64,3.55,3.72,3.47,3.39,3.26
      3.26,3.14,3.22,3.18,3.14,3.05,3.14,2.97,2.89,2.76,2.81,2.76,2.64,2.64,2.72,2.76
Sep34,2.89,2.89,2.81,2.81,2.76,2.64,2.51,2.51,2.64,2.72,2.81,2.89,3.39,3.14,3.22
      3.26,3.47,3.14,3.05,2.89,2.81,2.97,3.26,3.72,3.80,4.51,4.05,3.88,3.39,3.55

Oct35,2.38,2.46,2.38,3.13,3.99,4.58,4.78,3.99,3.52,3.36,3.13,3.32,4.23,6.50,10.20
      15.34,11.64,9.50,7.48,6.81,6.15,6.15,7.13,7.13,6.15,5.84,5.52,5.52,5.84,6.50,7.13
Nov35,6.15,6.15,6.15,5.29,4.70,4.66,4.78,4.97,4.97,6.15,9.50,12.37,27.05,29.52,23.84,22.25,23.84
      21.46,18.41,16.11,14.57,13.10,13.10,13.84,14.57,13.84,13.10,11.64,11.64,10.20
Dec35,9.85,9.50,8.80,8.80,8.45,8.80,10.90,19.93,23.84,23.05,24.64,43.76,62.27,55.95,46.29
      38.09,32.88,28.70,26.22,23.05,20.70,19.17,18.41,17.64,17.64,19.17,21.46,27.05,35.44,39.01,59.12
Jan36,81.70,105.87,128.48,142.13,165.22,171.21,166.73,162.16,156.97,166.73,168.24,201.12,238.45,233.59,227.09
      214.94,211.46,194.26,178.96,163.69,149.52,131.09,107.12,86.66,69.87,60.17,53.82,48.45,44.48,40.11,37.17
Feb36,34.59,33.73,30.35,29.52,29.52,33.73,44.48,42.66,37.17,33.73,32.02,32.88,49.53,55.95,50.61
      44.48,40.11,37.17,34.59,34.59,45.21,127.31,150.60,153.00,143.51,131.09,119.63,112.06,107.12
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Mar36,97.03,84.02,77.01,67.47,61.22,54.88,48.45,44.48,44.48,47.37,42.66,40.11,42.66,43.76,45.21,46.29,45.21
      40.84,38.09,35.44,33.73,32.02,31.17,32.02,32.88,32.02,37.17,90.58,108.36,99.58,82.69
Apr36,72.27,58.06,63.31,51.68,48.45,44.48,42.66,41.57,41.57,41.57,42.66,46.29,47.37,44.48,41.57
      39.01,37.17,34.59,32.02,29.52,27.05,26.22,25.43,24.64,27.05,27.88,25.43,24.64,24.64,23.05
May36,22.25,21.46,21.46,24.64,35.44,53.82,53.82,45.21,39.01,34.59,31.17,27.88,25.43,26.22,36.29
      39.01,37.17,33.73,31.17,32.02,44.48,48.45,45.21,38.09,33.73,30.35,27.05,25.43,23.84,23.05,22.25
Jun36,21.46,20.70,20.70,19.93,18.41,17.64,16.88,18.41,21.46,20.70,19.17,17.64,16.11,16.11,19.17
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      3.84,4.00,4.13,4.08,3.96,4.08,4.45,6.13,4.89,4.41,9.12,10.91,13.37,13.21
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East Valley Water District: Water Supply Development Project

Marion County, Oregon

East Valley Water District (District) was founded to supply irrigation water to its members' lands in Marion and Clackamas Counties. The District covers over 36,000 acres of high value agricultural land extending from north of Silverton to south of Woodburn and Mollala; between the Pudding River on the west and Cascade Mountain foothills on the east.

PROJECT DESCRIPTION

The District's members are currently served by a combination of individual farm wells and direct withdrawals from local surface waters; both sources are limited and extremely constrained. Over 26,000 acres of the District's service area lie within two Groundwater Limited Areas (GLAs), Mt Angel and Gladtidings. GLAs are protected from water withdrawals by the Oregon Water Resources Department. Nearly three square miles of high-value irrigated agriculture are at risk without the development of a safe, sustainable water supply development project.

East Valley Water District must develop a supplemental water supply source to provide irrigation water to its members to satisfy current and future demands. The District has studied water needs and alternative sources for over twenty years. Extensive studies determined a surface water storage facility on Drift Creek six miles southeast of Silverton, Oregon is the most viable option to provide a safe, sustainable and economical supply of water to East Valley Water District.

The District studied over 75 potential sites for the project. Stringent screening criteria including evaluation of stream flows, environmental conditions, geological considerations and fault lines deemed Drift Creek as the most viable location for the reservoir.

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LANDOWNER CONCERNS

The issues raised by landowners surrounding the reservoir site are typical of the development of any surface reservoir; and the District has every intention of working with the landowners to resolve their issues in a fair and respectful manner. The District has been forthcoming of all requests by landowners, and has every intention of continuing to do so as more information becomes available. The issues raised include the acquisition of the property, operational characteristics, and the impacts and benefits of the reservoir to surrounding landowners.

The reservoir location on Drift Creek is about five miles from the District boundary. The District will need to acquire the land within the footprint of the reservoir. The District has every intention to pay fair market value of the land that needs to be purchased. While the District holds authority for eminent domain, using that process is considered a last resort. Even under eminent domain, the landowners will be paid fair market value for their property.

Landowners have also raised concern of the aesthetics and operation of the reservoir. According to detailed modeling studies, the reservoir will have a normal operating range of about 22ft between the normal low water level (654 ft. elevation in fall) and normal high-water level (676 ft. elevation in late spring.) Most of this range lies between steep terrain and should not create mud flats. The southwest corner of the reservoir is the area most affected by the operating range - the District is willing to identify ways to remedy any issues with landowners through landscaping or other strategies.

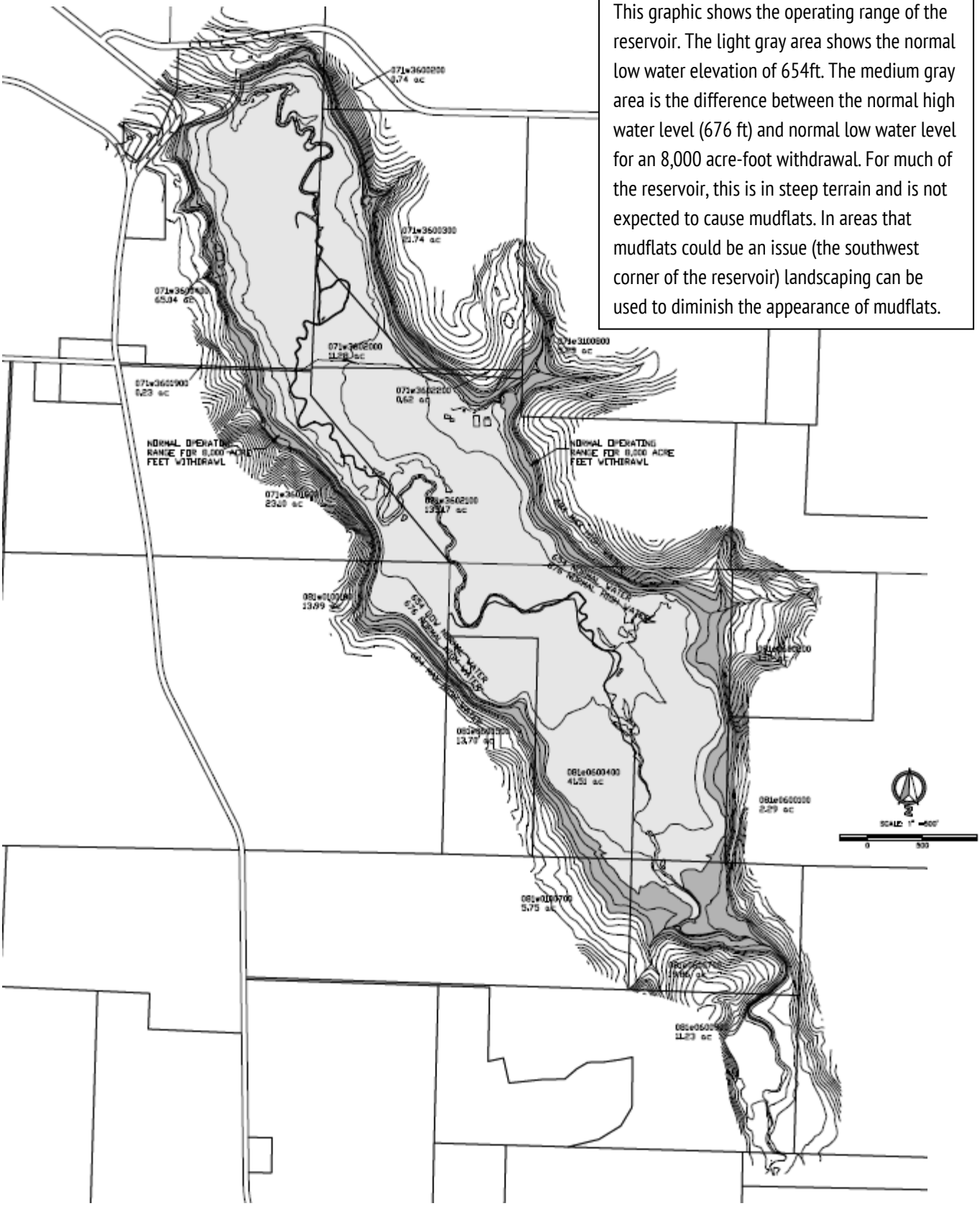
Due to the location of the reservoir outside of the boundaries of the District, surrounding landowners have expressed that they feel their families are bearing the burden and impacts of the reservoir without any benefits. There are opportunities for landowners to benefit from the reservoir. The District has offered access to water from the reservoir to the landowners for their irrigation needs. Additionally, the District is willing to collaborate with landowners to explore other benefits that could be realized through the implementation of the reservoir.

East Valley Water District prefers to work with landowners in a fair manner that leads to sharing of benefits from the reservoir. The District understands the sensitive issues at hand, and looks forward to resolving them amicably.

CURRENT STATUS

The District is currently seeking access to properties surrounding the reservoir to perform studies needed for environmental permitting efforts. Access was denied by landowners. On January 5, 2015, Marion County Circuit Court Judge Claudia Burton confirmed that irrigation districts, like EVWD, can enter property to conduct field studies necessary to determine whether that property would be suitable for a water storage reservoir. The judge's ruling allowed EVWD to move forward with field studies on the properties for which access had previously been denied. Since then, the District has performed cultural resources and fisheries investigations. All field and other studies are anticipated to last 12-18 months. The District is regularly updating their website with updates and findings from the studies.

East Valley Water District: Water Supply Development Project

Marion County, Oregon

This graphic shows the operating range of the reservoir. The light gray area shows the normal low water elevation of 654ft. The medium gray area is the difference between the normal high water level (676 ft) and normal low water level for an 8,000 acre-foot withdrawal. For much of the reservoir, this is in steep terrain and is not expected to cause mudflats. In areas that mudflats could be an issue (the southwest corner of the reservoir) landscaping can be used to diminish the appearance of mudflats.