



Surface Water Monitoring in the Walla Walla Basin
2017 Water Year
FINAL REPORT



Submitted: September 2017

In cooperation with:

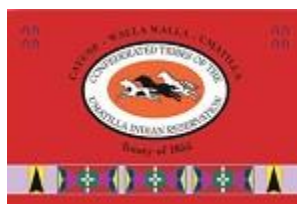
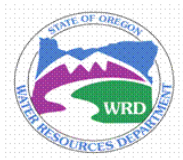


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Introduction

Overview

Since 2002, the Walla Walla Basin Watershed Council (WWBWC) has been building a network of surface flow monitoring stations throughout the Walla Walla River Valley and currently includes 50 sites on the Walla Walla River, its tributaries, springs, small order streams, and irrigation ditches. Seventeen near real-time gauge stations transmit data to in near real-time and are published on our website at www.wwbwc.org while the majority of our monitoring sites are instrumented with data loggers we download quarterly. These data are published on our website for use by basin partners, state and federal entities and the public.

The primary objectives of the WWBWC Surface Water Monitoring network are to:

- Monitor the effectiveness of aquifer recharge projects
- Provide data for surface water/groundwater modeling projects
- Inform water and fisheries management decisions

Surface Water Monitoring Area

The Walla Walla basin covers an area of approximately 1,760 square miles. It lies on the western side of the Blue Mountains, about 70 miles west of where the border between Oregon and Washington meets the Idaho border (Figure 1). The Walla Walla River flows from its headwaters in the Blue Mountains into the Walla Walla Valley and then spreads out into a distributary network that delivers winter and spring flows across the valley floor.

Historically, these distributary channels provided off-channel habitat for fish and other wildlife and also allowed for a significant amount of water to seep into the soil and recharge the valley's unconfined shallow alluvial aquifer system. The decline of the shallow aquifer has been documented for several decades and has led to substantial investment by local, state, and federal entities in artificial aquifer recharge projects designed to restore historic floodplain functions, including restoring spring and creek flows and providing for agricultural needs.

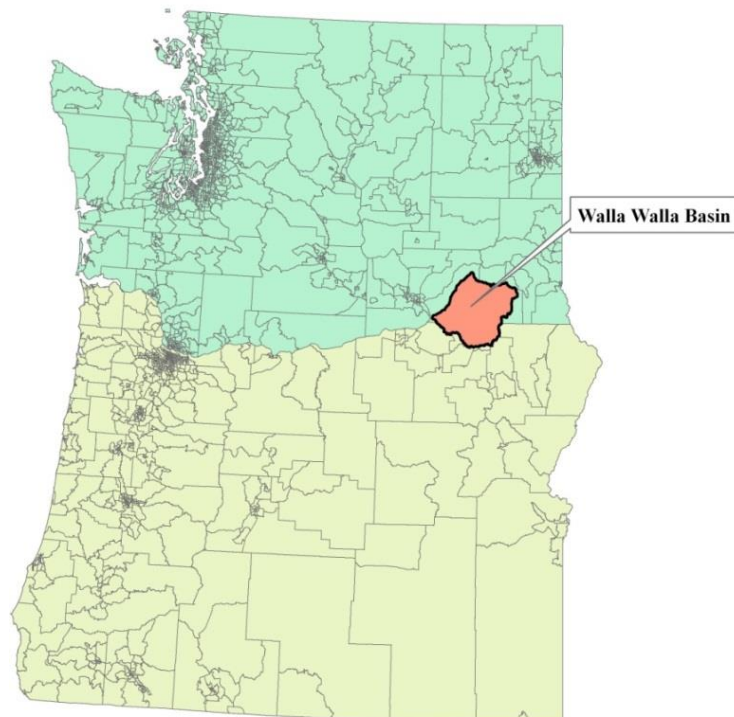


Figure 1. The Walla Walla Basin, a bi-state watershed.

The surface water monitoring network is divided into six different regions of the watershed (Figure 2):

1. Walla Walla River
2. Little Walla Walla River system, including its associated irrigation canals
3. Mud Creek system
4. Pine Creek and the Hudson Bay District Improvement Company irrigation system
5. Mill Creek system
6. Touchet River system

The number of sites in each region is shown in Table 1. Monitoring site locations were developed in coordination with Oregon Water Resources Department, Washington Department of Ecology, local irrigation districts, and other basin partners. Please see Figure 3 for a map of monitoring locations.

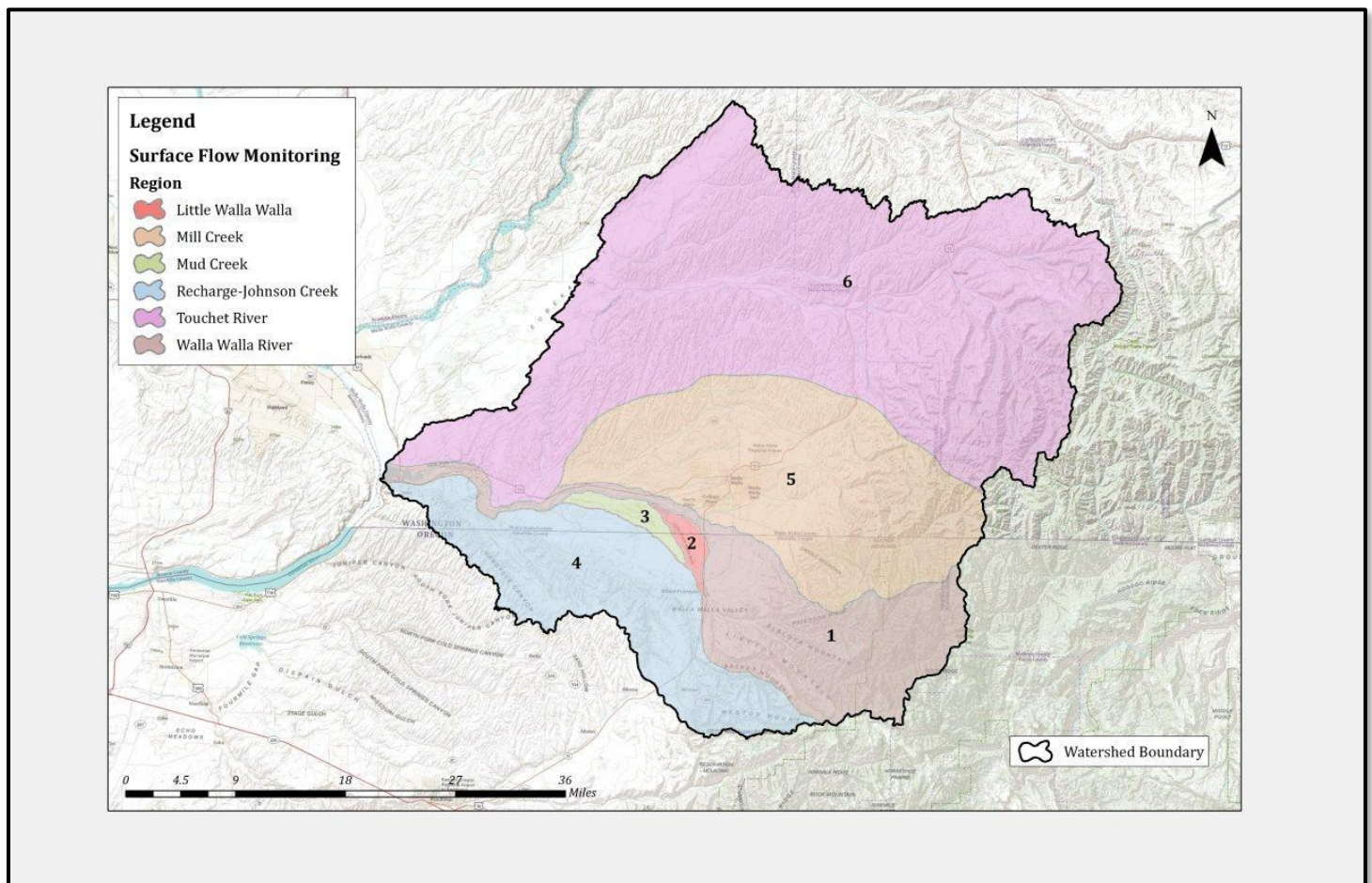


Figure 2. Sites in the WWBWC surface water monitoring network are organized according to the regions depicted above.

Table 1. Overview of the WWBWC's Surface Water Monitoring Network.

Region	# of Sites
1: Walla Walla River	8
2: Little Walla Walla River	20
3: Mud Creek/Fruitvale Irrigation System	4
4: Pine Creek/Hudson Bay Irrigation System	13
5: Mill Creek / Walla Walla Area	5
6: Touchet River	0
Total	50

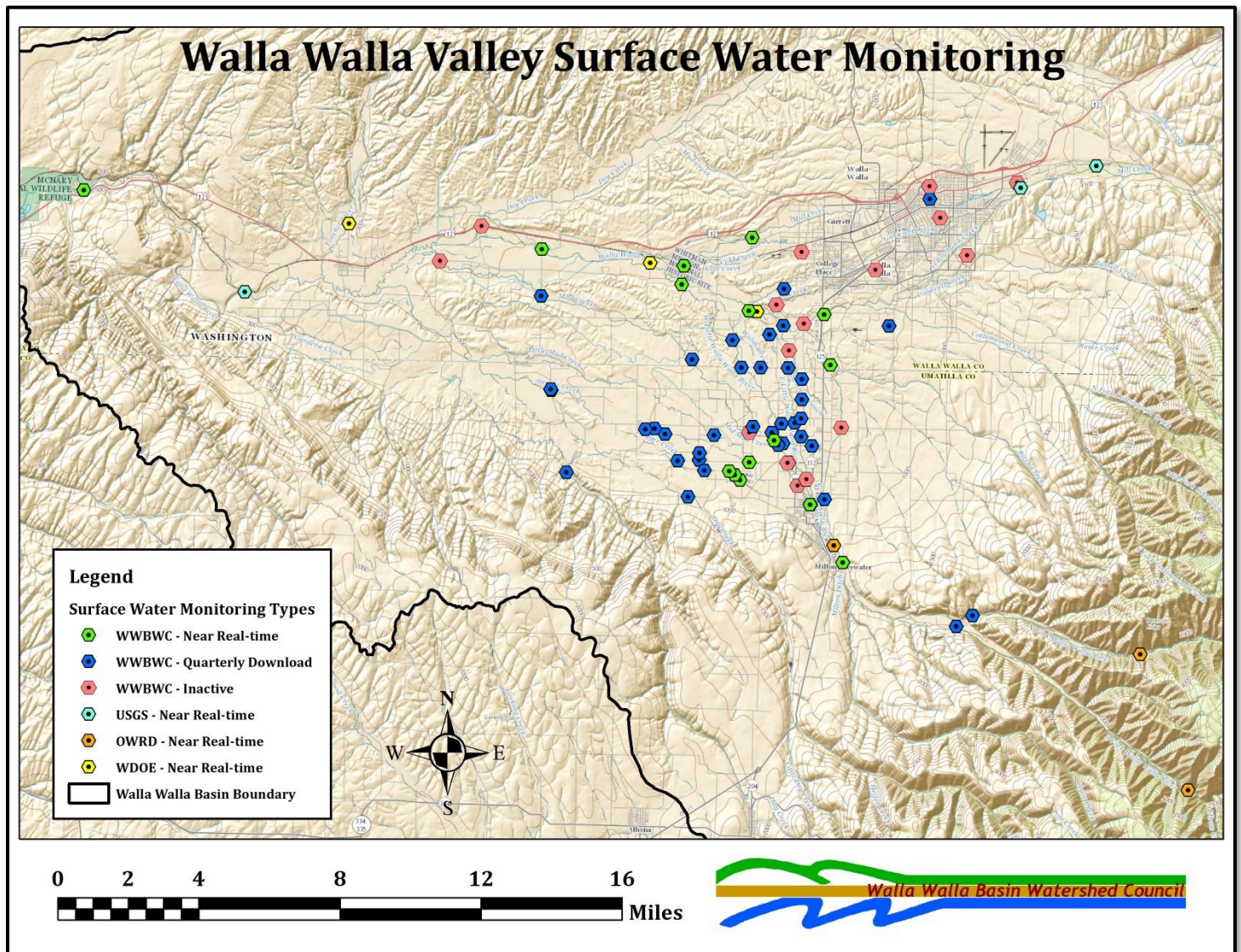


Figure 3. Map showing current surface water monitoring sites as of October 2017. The map includes current and historic WWBWC monitoring sites as well as USGS, OWRD and WDOE gauge stations.

Methods

All monitoring was conducted according to our standard operating procedures¹ based on USGS, Washington and Oregon state methods for surface water monitoring.

Near Real-Time Monitoring Sites

Since 2013, WWBWC has worked to strategically install real-time flow monitoring sites where hourly flow data can benefit the public, state and federal agency staff, and local resource managers. Figure 4 shows an example of a near real-time monitoring site. During the 2017 water year, 17 stream sites were monitored using near real-time telemetry equipment. WWBWC used electronic data loggers manufactured by Campbell Scientific, WaterLog, and In-Situ, Inc to record gauge height at a programmed interval (typically every 15 minutes). These stage data are relayed to the WWBWC office using satellite, radio or cellular telemetry and then processed through customized rating equations (see details below) to produce discharge values that were published hourly online.

Monitoring staff visited the near real-time sites twice a month to read the staff gauges and visually inspect equipment. Manual discharge measurements were taken approximately every 6 weeks using either a SonTek FlowTracker Handheld Acoustic Doppler Velocimeter (Figure 5), Marsh-McBirney Flo-Mate 2000 pressure sensor, or Price AA current meter. Water temperature and specific conductance were measured using a YSI 30 handheld meter (www.ysi.com).

¹ Patten, S.B. 2013. *WWBWC Standard Operating Procedures – Version 1.2*. Walla Walla Basin Watershed Council. www.wwbwc.org.



Figure 4. At this near real-time monitoring site on Mill Creek, flexible conduit secured to a bridge pier protects a sensor and cable that collect and transmit water level data to a communications box equipped with a solar panel, battery and an antenna, which utilizes radio telemetry to transmit data to the WWBWC office to be processed and published online.



Figure 5. Staff taking a wading flow measurement on Mill Creek using a FlowTracker2.

Non-Telemetered Monitoring Sites

Most of the monitoring sites in the WWBWC Surface Water Monitoring network are not telemetered. For the 2017 monitoring period, these sites were equipped with Solinst or In-Situ, Inc pressure transducers programmed to log a water level measurement at a set interval (typically every 15 or 30 minutes). Figure 6 shows an example of data logger deployment in a PVC stilling well anchored to an ecology block in the Walla Walla River.

On a quarterly schedule, a monitoring technician visited each site to read the staff gauge and take a manual discharge measurement. Also during the quarterly visit, stage and water temperature data were downloaded from the logger, site maintenance conducted (for example, weeds or other debris removed), water temperature and specific conductance were measured, and photographs were taken.

Most of the surface water monitoring sites have been surveyed with survey-grade Magellan GPS units, providing accurate coordinates and elevations used for mapping and analysis. Coordinates and elevations for the newest sites in the network were recorded with a handheld GPS unit (Garmin eTrex) and will be properly surveyed as time allows.



Figure 6. Typical equipment installed at monitoring sites that were visited quarterly for manual data download: a staff gauge and PVC stilling well with a suspended pressure transducer.

Data Processing and Analysis

Data were processed using Aquatic Informatics AQUARIUS Time Series software (www.aquaticinformatics.com). Water height recorded by data loggers was graphed with staff gauge readings. Offsets and drift corrections were applied to align logger data with staff gauge readings. All corrections were documented within the software and annually reviewed for approval.

Customized stage-discharge relationship equations were developed using the AQUARIUS rating curve tool. The tool plotted stage data with manual discharge measurements to produce a best-fit curve equation describing the relationship (Figure 7). Based on that equation, a rating table was created to calculate discharge values for each datum in the logger file and produce a continuous discharge signal for the monitoring period (Figure 8). The AQUARIUS rating curve tool allowed us to modify, shift, and re-fit rating curves as site conditions change, resulting in higher quality, more defensible discharge data. Figure 8 displays North Fork Walla Walla River flow data calculated by running stage values through the rating curve equation created for that site (Figure 7). Discharge values higher than manual measurements were produced by the rating equation and were included in the graph but cannot be considered as accurate as those flows that lie within the boundaries of the points used to generate the curve. The manual flow measurements were superimposed onto the flow data in the output graphs so that a viewer can see which calculated flows are above those measurements.

Rating Curve

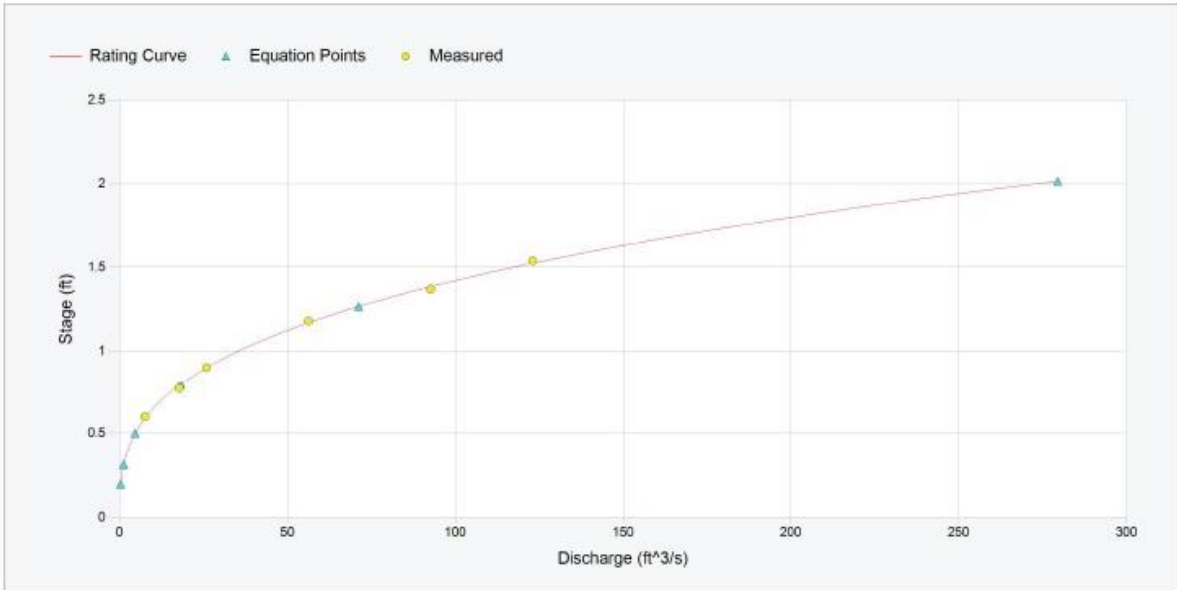
North Fork Walla Walla River

Label: Working
Description: Site ID-S104

Curve on: September 28, 2017

Curve Start Date: May 3, 2017

Location: North Fork Walla Walla River @ NF Bridge



Stage (ft)	0	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.20	0.31	0.36	0.41	0.47	0.53	0.60	0.67	0.75	0.83	0.92
0.30	1.02	1.12	1.23	1.35	1.47	1.60	1.74	1.89	2.05	2.21
0.40	2.38	2.56	2.75	2.95	3.15	3.37	3.60	3.83	4.08	4.33
0.50	4.60	4.88	5.16	5.46	5.77	6.09	6.42	6.77	7.12	7.49
0.60	7.87	8.26	8.67	9.09	9.52	9.96	10.42	10.90	11.38	11.88
0.70	12.40	12.93	13.47	14.03	14.60	15.19	15.80	16.42	17.05	17.70
0.80	18.37	19.06	19.76	20.48	21.21	21.97	22.74	23.53	24.33	25.15
0.90	26.00	26.86	27.74	28.63	29.55	30.49	31.44	32.42	33.41	34.43
1.00	35.46	36.52	37.59	38.69	39.81	40.94	42.10	43.28	44.49	45.71
1.10	46.96	48.23	49.52	50.83	52.17	53.53	54.91	56.32	57.75	59.21
1.20	60.68	62.19	63.71	65.26	66.84	68.44	70.07	71.72	73.40	75.10
1.30	76.83	78.58	80.36	82.17	84.00	85.86	87.75	89.67	91.61	93.58
1.40	95.58	97.60	99.66	101.74	103.85	105.99	108.16	110.36	112.58	114.84
1.50	117.13	119.44	121.79	124.16	126.57	129.01	131.48	133.98	136.51	139.07
1.60	141.66	144.29	146.94	149.63	152.35	155.11	157.89	160.71	163.57	166.45
1.70	169.37	172.32	175.31	178.33	181.39	184.48	187.60	190.76	193.95	197.18
1.80	200.44	203.74	207.08	210.45	213.86	217.30	220.78	224.30	227.85	231.44
1.90	235.07	238.73	242.43	246.17	249.95	253.77	257.62	261.51	265.44	269.41
2.00	273.42	277.47	279.51							

Figure 7. Rating Curve and table for the seasonal gauge on the North Fork Walla Walla River for 2017. Yellow dots represent manual discharge measurements. Blue triangles show rating points created by AQUARIUS Time-Series software based on a best-fit equation relating stage to manual discharge measurements taken during the 2017 monitoring season.

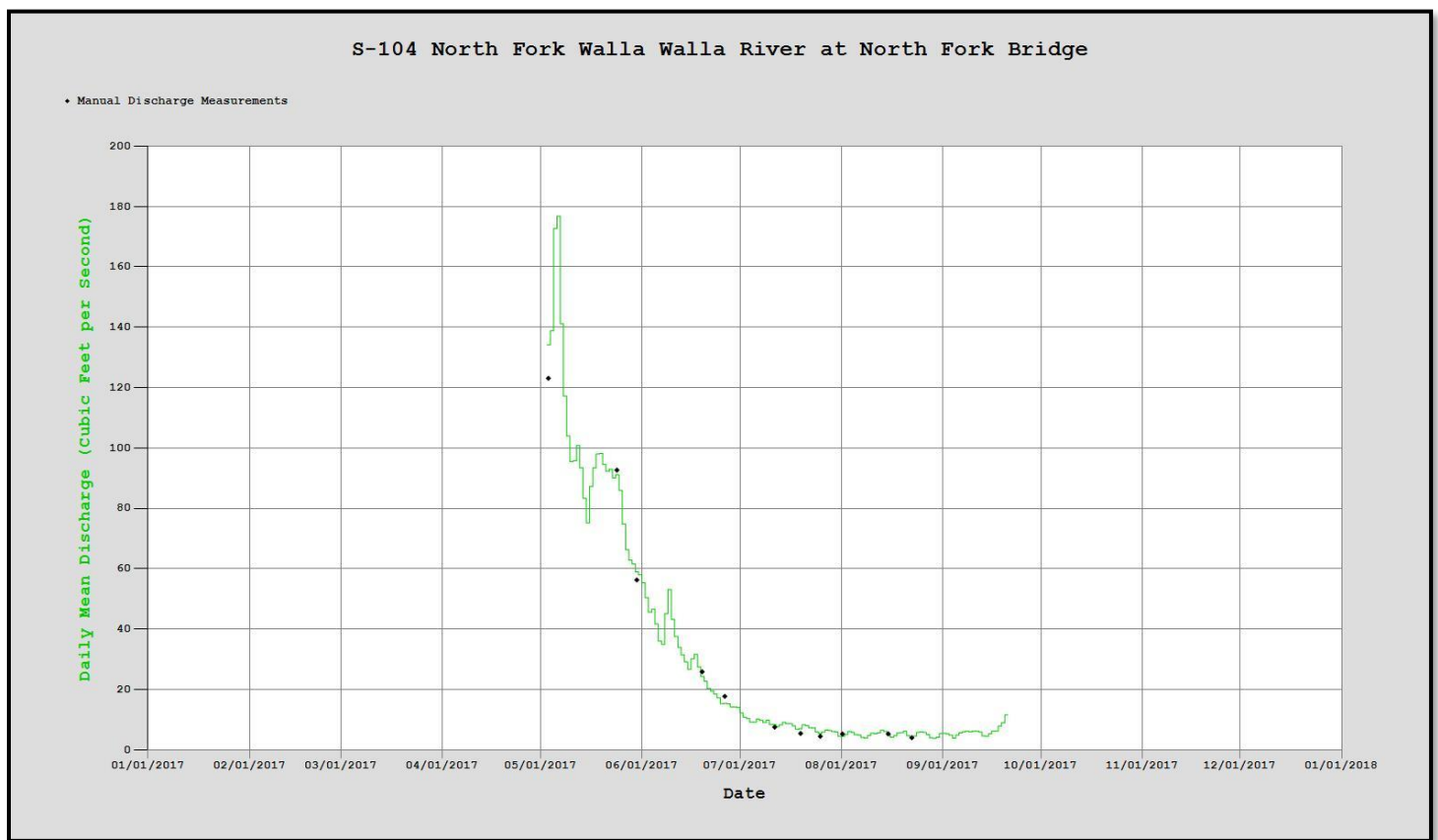


Figure 8. Flow data computed by processing North Fork Walla Walla River stage data through the 2017 rating curve equation shown in Figure 7.

Data from monitoring sites equipped with flumes and weirs were analyzed using equations or tables provided by the engineers who designed the structures. Occasionally, sites with engineered structures were also rated using the rating curve method described above (i.e. for a damaged weir that no longer conforms to its once-engineered characteristics).

At sites instrumented with non-vented pressure transducers, water level data were corrected to account for atmospheric pressure. Using AQUARIUS, barometric pressure collected by one of the transducers located throughout the valley (Figure 9) was subtracted from stage data to produce a corrected signal showing water levels without the influence of atmospheric pressure.

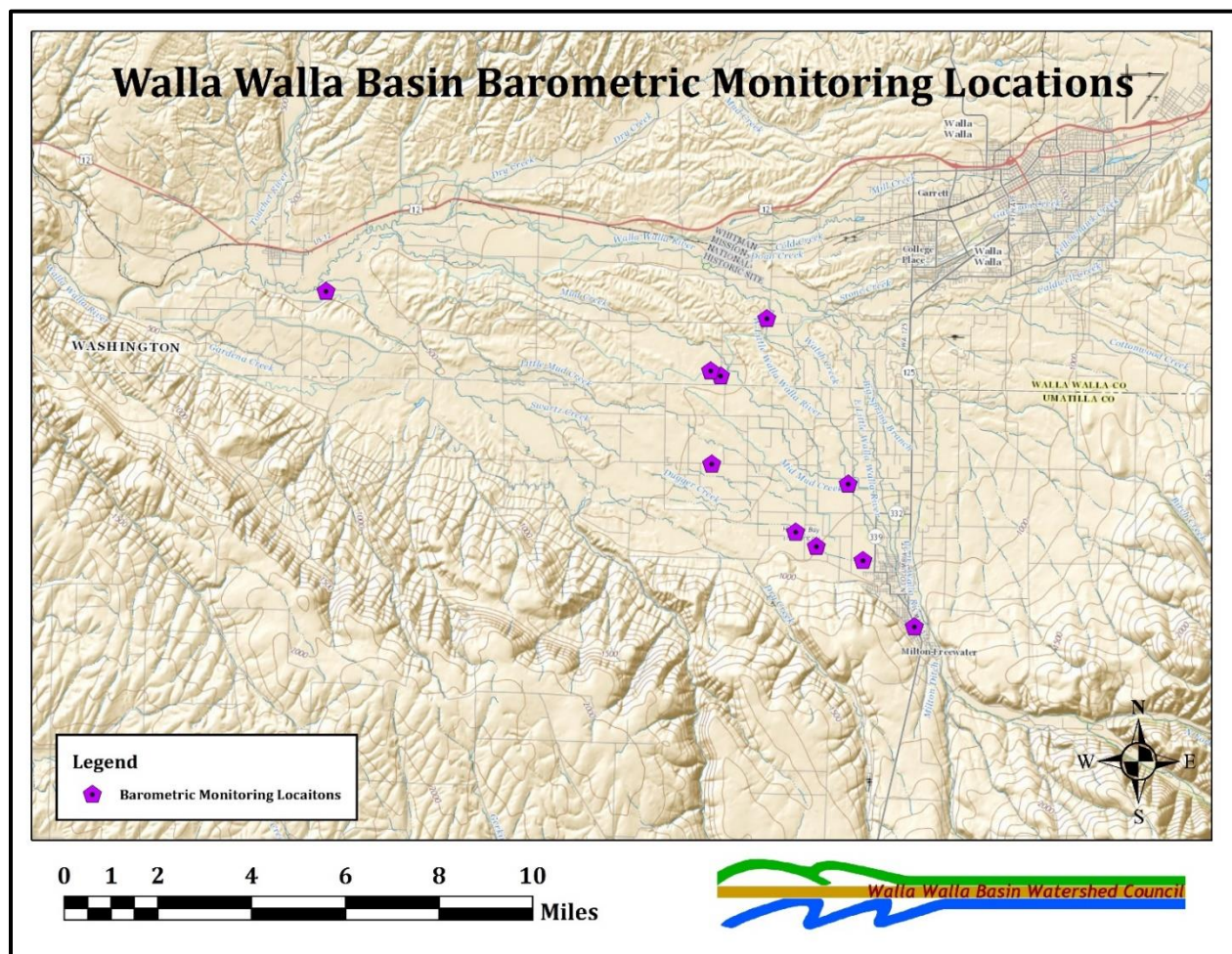


Figure 9. Map showing barometric pressure transducer locations within the surface water monitoring network.

An important part of our quality assurance plan is data grading and approval. We graded data in AQUARIUS based on a scale from “Excellent” to “Unusable” which also includes grades such as “Estimated Good,” “Dry,” “Flooded,” and “Undefined.” Below is an overview of our grading procedure:

- Water level data imported from data loggers received an “estimated” grade (typically “Estimated Very Good” unless degraded conditions such as seasonal vegetation exist) until our yearly review and approval of data.
- Manual staff gauge readings were graded based on site conditions. When the gauge could be easily read, the data point was rated “Excellent” or “Very Good.” If water turbulence or other conditions made accurate reading difficult, the data point was rated “Good,” “Fair,” “Poor,” or “Unusable.”
- Manual discharge measurements taken with the FlowTracker were graded based on the instrument’s built-in quality control report. Based on the “percent overall uncertainty” in the report, we graded the measurement as follows:
 - Overall uncertainty <2%, grade = Excellent
 - Overall uncertainty 2-5%, grade = Very Good
 - Overall uncertainty 5-10%, grade = Good
 - Overall uncertainty 10-20%, grade = Fair
 - Overall uncertainty >20%, grade = Poor
- Manual discharge measurements taken with the Marsh McBirney were graded based on site conditions.
- Flow data processed through the rating curve were graded based on the quality of stage data in addition to the fit of the curve and site conditions.

Results and Discussion

Flow and temperature data for our current and historic monitoring sites are available at the Surface Water Monitoring page of our website (www.wwbwc.org). Near real-time sites are updated hourly, and non-telemetered sites are updated quarterly.

EIM Data

Data from monitoring sites funded by the Washington Department of Ecology's Office of Columbia River have been prepared for inclusion in the state's EIM database but, by request of WDOE staff, should not be uploaded until a data coordinator is hired to assist with the process. Data ready for upload can be accessed by following this link: www.wwbwc.org/images/Monitoring/Reports/EIM_SurfacewaterWY16-17.zip.

Three New Telemetry Sites

During the 2017 water year, we upgraded two existing flow monitoring sites and installed one new flow monitoring site with telemetry equipment. Flow and temperature data are sent hourly by radio telemetry to the WWBWC office for the East Little Walla Walla River near the Mouth (formerly S226, now labeled S236), for Pine Creek near Umapine and for Pine Creek near the Mouth (S425). The telemetered Pine Creek gauge (S416t) is located on the Buroker Road bridge about ¼ mile north (and downstream) of the historic monitoring location (S416). This new gauge location is below an HBDIC diversion and reflects Pine Creek flow values present after irrigation water is diverted. A new monitoring location was established on Pine near its mouth, just south of Touchet, WA. This site, S425, captures Pine Creek flow contributions to the Walla Walla River.

Downing and Ferndale Springs

Downing Spring at Robin Lane (S216) has been seasonally dry since we began monitoring flow there in 2003. The 2016 water year was the driest observed during the period of record, with less than a week of flowing water. Flow data from the 2017 water year looked more typical, with about 3 months of flow between April and July. Because of the low flow conditions in Downing Spring at this location, we transitioned this year to a temperature sensor only. Temperature monitoring will allow us to track the presence or absence of water in Downing Spring, but flow data will not be available.

Ferndale Spring is the name given to a mostly year-round spring that joins the East Little Walla Walla River near the intersection of Ballou Rd and the Old Milton Hwy. We have monitored spring flows at Ferndale Road (S217) since 2003 but have encountered difficulty with extensive vegetation encroachment and other maintenance issues that reduced data quality. In November 2016 we established a new monitoring site behind Ferndale Elementary School (S235) about 0.1 miles north (and downstream) of the historic location and, in May 2017, removed the Ferndale Road site.

Uncertain Future for Monitoring Sites in Washington

We have decommissioned the following non-telemetered flow monitoring sites in Washington due to the uncertainty of funding for the 2018 water year.

- West Little Walla Walla River at Valley Chapel (S224)
- McEvoy Spring (S225)
- Mud Creek at McDonald Rd (S304)
- College Creek at Whitman College (S507)

Walla Walla Basin Integrated Flow Enhancement Study

Flow data collected during the 2017 water year and prior were used to support the Walla Walla Basin Integrated Flow Enhancement Study, an effort to identify strategies to meet instream flow demands while addressing

municipal and agricultural needs. As part of the study, WWBWC staff conducted a flow analysis of the Walla Walla River and its tributaries. A report detailing study methods and results can be found in Appendix B.

Surface and Groundwater Interactions

For over a decade, the WWBWC has worked to provide data supporting a fuller understanding for effective management of the limited water resources in the Walla Walla Valley. In addition to surface and groundwater monitoring, seepage assessments have contributed to our knowledge of how water flows through our valley both above and below ground. A new report analyzing the results of seepage assessments conducted from 2002-2016 is available in Appendix C.

Summary

WWBWC surface water monitoring project continues to produce high quality data utilized to:

- Monitor the effectiveness of aquifer recharge projects
- Provide data for surface water/groundwater modeling projects
- Inform water and fisheries management decisions

During the 2017 water year, the WWBWC completed construction of another new recharge project, bringing our current total to 17 projects. Ongoing monitoring of spring performance and groundwater-surface water interactions aids in the adaptive management of these sites.

Local partners and Washington's Office of Columbia River are continuing to develop strategies that address water shortages in the Walla Walla basin. Irrigators, fish managers, and other basin residents continue to benefit from the availability of reliable stream flow data in the Walla Walla Valley. In addition to project effectiveness monitoring, these data facilitate high-flow event monitoring and analysis, maintenance of minimum instream flows, and improvement of fish passage conditions.

Acknowledgements

Without the support of the Walla Walla Basin Watershed Council's funding agencies, partners and private landowners this project would not be possible. Their involvement and support is very much appreciated.

- Bonneville Power Administration
- Confederated Tribes of the Umatilla Indian Reservation
- Fruitvale Water Users Association
- Hudson Bay District Improvement Company
- Oregon Watershed Enhancement Board
- Oregon Water Resources Department
- U.S. Fish & Wildlife Service
- U.S. Forest Service
- Walla Walla River Irrigation District
- Washington Department of Fish and Wildlife
- Washington Office of Columbia River

APPENDIX A

Explanation of Data Gaps during the 2017 Water Year

Site ID	Gap Dates	Explanation
S104	10/1/16 – 5/3/17	Seasonal gauge only. Pressure transducer was installed 5/3/17.
S106	11/18/16 - 8/6/17	Logger washed away in high flows. New logger installed 8/6/17.
S216	5/31/17 - 9/30/17	Flow data not recorded because we removed pressure transducer and deployed temperature sensor with intention to track only presence/absence of water at this site.
S226	10/27/16 – 3/1/17	Logger failure, no data were logged.
S415	7/21/16 – 1/24/17	Illicit upstream discharge caused sediment inundation at this site on 7/19/17, changing the channel configuration. New logger and new rating established early in 2017.

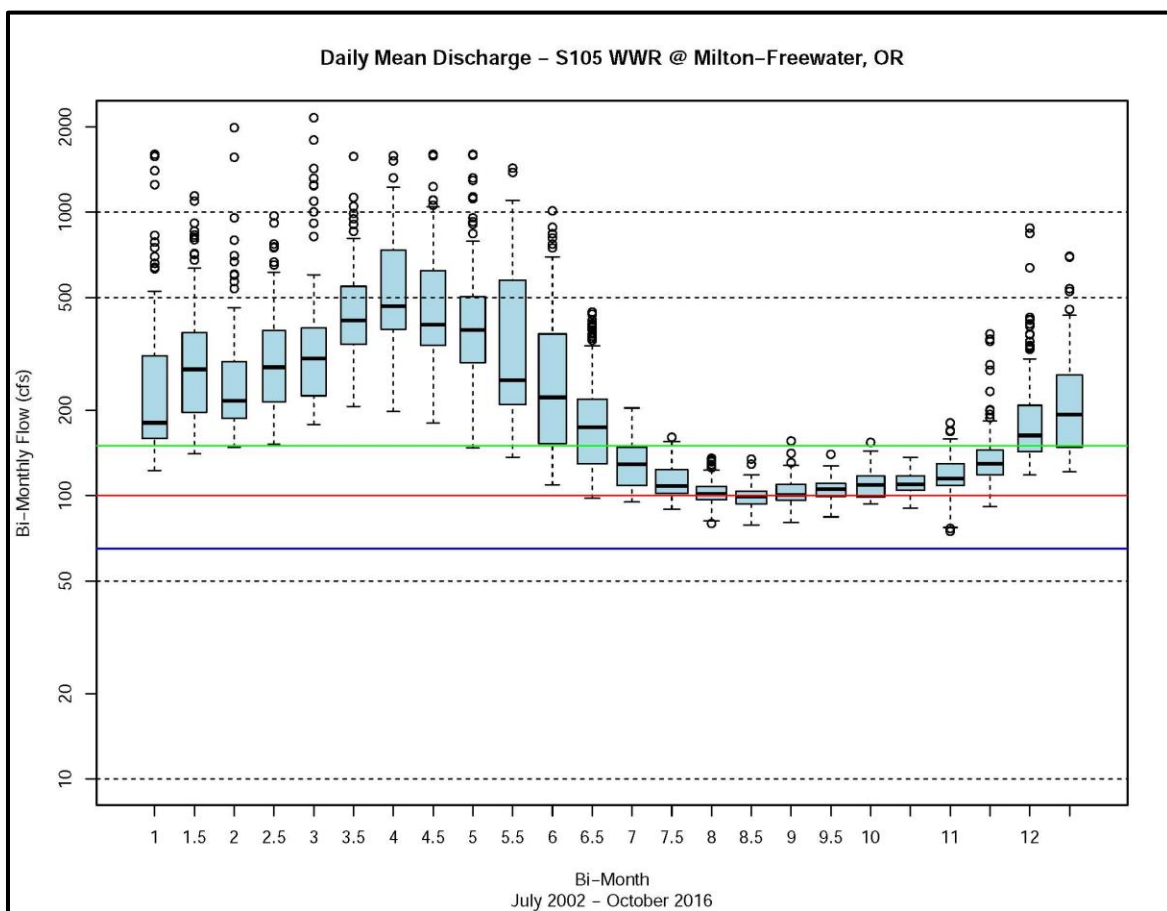
APPENDIX B

Walla Walla Basin Flow Analysis



Walla Walla Basin Flow Analysis

Data Analysis Methods Supporting the Walla Walla Basin Integrated Flow Enhancement Study



FINAL REPORT

August 2017

Walla Walla Basin Flow Analysis

Data Analysis Methods Supporting the Walla Walla Basin Integrated Flow Enhancement Study

Written by:

Steven Patten, Senior Environmental Scientist, WWBWC



Walla Walla Basin Watershed Council

2017

Report available at www.wwbwc.org

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Walla Walla River @ Detour Road (S-110)	
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Upstream of POD	
Historic Downstream of POD	

20% Reservoir Diversion

30% Reservoir Diversion

INTRODUCTION

The Walla Walla River and its tributaries provide for agricultural production, support thriving communities, and sustain resident and anadromous fish populations. As in many western river basins, instream and out-of-stream water demands often exceed available supplies. The Walla Walla Watershed Management Partnership (WWWMP) and the Walla Walla Basin Watershed Council (WWBWC) convened a Steering Committee to develop strategies to meet instream needs. Washington Department of Ecology, Oregon Water Resources Department, Oregon Department of Environmental Quality and Bonneville Power Administration have provided funding for the Walla Walla Basin Stream Flow Enhancement Study (the Study).

The Study intends to identify strategies to meet instream flow demands while addressing out-of-stream municipal and agricultural needs. Objectives include restoring Walla Walla River stream flows to the magnitude necessary to support harvestable populations of native fish species and providing certainty to water right holders that their needs will be met. Study Partners convened a Steering Committee consisting of tribal, state, and local governments, as well as irrigation, municipal, and recreational interests to guide the development of these strategies. The steering committee strives for consensus basis decision-making, which helps inform the Study Partners as they adopt final decisions.

The Steering Committee focused on restoring stream flows in the Walla Walla River from the Little Walla Walla River point of diversion at Cemetery Bridge in Milton-Freewater, OR to the confluence of the Walla Walla and Columbia Rivers, and the committee agreed by consensus to instream flow targets in this reach of the Walla Walla River (Table 1 and Figure 1).

Table 1. Interim Stream Flow Targets for the Walla Walla River in cubic feet per second (cfs)

Time Period	Hybrid Flow Targets
April 1 – June 15	150 cfs
June 16 – June 30	100 cfs
July 1 – November 30	65 cfs

The Steering Committee identified and evaluated a wide range of strategies intended to meet these stream flow targets, including conservation, increasing aquifer recharge, developing large-scale reservoirs, and pumping water from the Columbia River. In order to evaluate these strategies, the Steering Committee assembled the following Technical Workgroups (TWGs), whose function was to evaluate the timing, location, magnitude, costs and benefits of proposed flow improvement strategies:

- ◆ Water Conservation and Infrastructure (Washington)
- ◆ Water Conservation and Infrastructure (Oregon)
- ◆ Managed Aquifer Recharge (MAR)/Aquifer Storage and Recovery (ASR)
- ◆ Surface Water Storage
- ◆ Columbia River Pump Exchange
- ◆ Water Right Transactions and Management
- ◆ Legal
- ◆ Planning

Each of the TWG's were chartered by the Steering Committee to:

1. Develop potential project lists or strategies to meet Flow Study goals;
2. Develop and document a screening process to reduce the list to priority efforts with the greatest likely feasibility in meeting Flow Study goals;
3. Provide a prioritized list of projects for completion of "Project Proposal Templates"; and
4. Participate in a "project pairing" evaluation with the Steering Committee to assemble a preferred alternative of projects designed to meet Flow Study goals.

Based on this planning framework, the Steering Committee is working to develop a consensus recommendation of projects that collectively meet the flow target goals of the Study (Table 1).

As work progressed on project development in the TWG's, a need for additional flow analysis was identified for many, if not all, of the proposed projects. The WWBWC, working with other TWG members and sub-contractors, started a preliminary analysis of flow data as required by various projects.

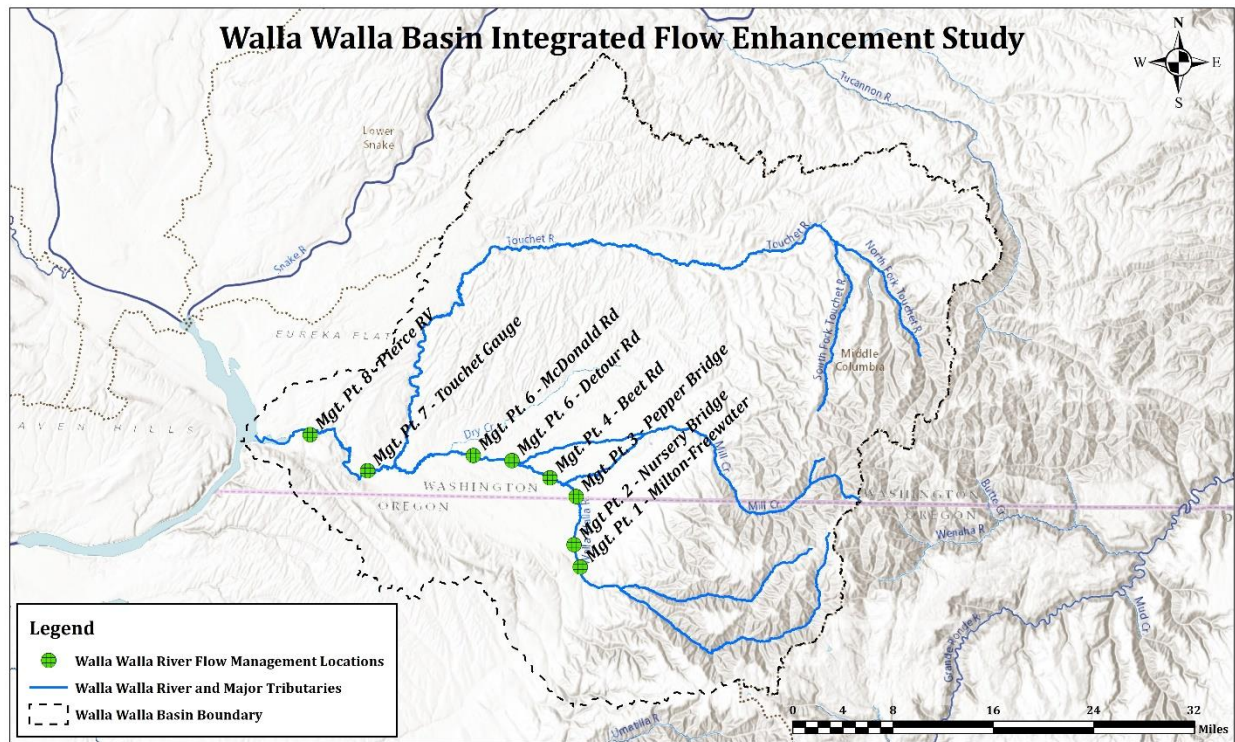


Figure 1 - Map of the Walla Walla Basin indicating flow management locations for the Walla Walla Basin Integrated Flow Enhancement Study.

PURPOSE

The purpose of this report is to document the methods of analysis and the results conducted for various projects within the Walla Walla Basin Integrated Flow Enhancement Study.

FLOW ANALYSIS METHODS & RESULTS

CURRENT INSTREAM FLOW ANALYSIS

The need to quantify current instream flow values, at each of the management points for the Study (Figure 1), was identified by multiple TWG's as projects were being investigated. Period of record for each gauge location is different (see Table 2). Most gauges were installed after the Settlement Agreement in 2000 where three irrigation districts agreed to by-pass 13 cfs in 2000, 18 cfs in 2001, then either either 25/27 cfs at Milton-Freewater or 18/19 cfs at Beet Road to benefit threatened fish species under the Endangered Species Act (ESA).

Table 2. Period of record used for flow analysis at management location gauges on the Walla Walla River (WWR)

Gauge Name/Management Location	Agency	Period of Record
WWR @ Milton-Freewater	WWBWC	2002-2009 (Seasonal) 2009-2016 (Permanent)
WWR @ Below Nursery Bridge (M4)	WWBWC	2002-2016 (Seasonal)
WWR @ Pepper Bridge (Stateline)	WDOE/WWBWC	2004-2012 (Operated by WDOE) 2012-2016 (Operated by WWBWC)
WWR @ Beet Road	WDOE	2002-2016
WWR @ Detour Road	WDOE	2006-2016
WWR @ McDonald Road	WWBWC	2013-2016
WWR @ Below Touchet River	USGS	1951-2016
WWR @ RV Park	WWBWC	2013-2016

Available gauge data was converted into daily average flow, if not already in that format. Data were formatted into a common format (tab delimited text files). [R. the statistical computing and graphics program](#), was utilized to process and compute bi-monthly exceedance flow values from the daily average data (see Appendix A for code info). Basics descriptive statistics of inputted data were conducted as a quick QA/QC of data (e.g. no extremely low/high values or unexpected data gaps). Data were aggregated by bi-month (see Table 3). Minimum, average, maximum, variance, sample size and exceedance values (10%, 25%, 50%, 75%, and 90%) were generated for each bi-month period (Table 4 & Appendix B). Bi-monthly data represents either days 1-15 or days 16-end of the month. The bimonthly data allows for better resolution of flow data as stream flows drop in the late spring/early summer and rise in the late fall.

Table 3. Bimonthly nomenclature used for Current Instream Flow Analysis

Date	Month	Bi-month
January 1-15	1	1
January 16-31	1	1.5
February 1-15	2	2
February 16-28/29	2	2.5
March 1-15	3	3
March 16-31	3	3.5
April 1-15	4	4
April 16-30	4	4.5
May 1-15	5	5
May 16-31	5	5.5
June 1-15	6	6
June 16-30	6	6.5
July 1-15	7	7
July 16-31	7	7.5
August 1-15	8	8
August 16-31	8	8.5
September 1-15	9	9
September 16-30	9	9.5
October 1-15	10	10
October 16-31	10	10.5
November 1-15	11	11
November 16-30	11	11.5
December 1-15	12	12
December 16-31	12	12.5

Table 4. Example of generated bimonthly aggregated data with minimum, maximum, average, variance, sample size and exceedances.

S-105 - Walla Walla River @ Milton-Freewater, OR											
BiMonth	Minimum (cfs)	Median (cfs)	Maximum (cfs)	Mean (cfs)	Quantile.10%	Quantile.25%	Quantile.50%	Quantile.75%	Quantile.90%	Variance	Sample Size.N
1	122.73	180.76	1600.00	294.97	141.86	159.21	180.76	310.18	536.17	74826.60	110
1.5	140.43	278.75	1141.50	342.30	167.22	198.69	278.75	375.71	634.27	43227.59	104
2	147.89	215.66	1987.49	299.23	175.59	187.20	215.66	296.66	450.87	64002.50	103
2.5	151.76	283.85	970.99	330.05	175.38	214.38	283.85	382.25	571.47	29704.41	91
3	178.25	304.38	2154.32	398.55	187.21	224.95	304.38	390.65	732.86	112274.17	105
3.5	206.14	414.82	1572.55	472.20	290.63	341.90	414.82	546.06	708.94	44269.73	112
4	197.93	465.59	1581.63	555.11	262.85	385.93	465.59	734.85	892.68	76100.79	105
4.5	180.12	400.80	1600.00	504.35	199.14	338.88	400.80	614.43	858.54	89582.03	104
5	147.42	384.09	1600.00	467.62	173.11	294.13	384.09	503.03	867.04	102475.21	107
5.5	136.61	255.40	1430.46	382.35	150.54	209.75	255.40	575.55	745.40	75548.62	119
6	108.93	222.05	1011.05	283.79	127.48	152.46	222.05	371.88	497.13	32627.12	131
6.5	97.84	174.02	444.33	191.58	108.16	129.38	174.02	218.47	321.62	6825.28	150
7	94.89	129.09	203.84	130.22	101.32	108.44	129.09	148.24	164.15	638.29	150
7.5	89.62	108.30	160.63	113.16	96.92	101.70	108.30	123.61	141.04	270.73	175
8	79.73	101.39	135.42	103.07	92.85	96.81	101.39	107.48	117.58	122.50	158
8.5	78.77	99.10	134.53	99.03	87.77	93.49	99.10	103.75	110.31	84.66	160
9	80.40	100.56	155.81	102.30	89.17	96.37	100.56	109.40	113.47	122.15	150
9.5	84.11	105.28	139.84	104.72	93.40	99.17	105.28	110.56	114.13	81.18	150
10	93.46	109.22	154.04	109.79	96.59	98.95	109.22	117.22	123.53	133.29	135
10.5	90.26	109.64	136.54	110.98	100.96	104.39	109.64	117.48	121.60	76.74	137
11	74.84	114.73	180.55	118.37	99.74	108.64	114.73	129.71	143.97	372.70	131
11.5	91.34	129.69	372.17	140.13	106.84	118.49	129.69	144.58	179.95	2174.18	120
12	118.33	162.93	879.42	210.66	124.01	143.13	162.93	208.21	353.50	17249.04	99
12.5	121.28	193.14	698.95	227.50	123.98	148.31	193.14	266.31	364.34	12149.11	112

Fifty percent exceedance (50% quantile) values were used to build the “[Walla Walla River Exchange Model](#)” developed by Anton Chiono and others at the Confederated Tribes of the Umatilla Indian Reservation (CTUIR).

Results for each of the management locations (Table 2) are included in Appendix B.

RESERVOIR STORAGE WATER ANALYSIS

A reassessment of the Pine Creek Reservoir is one of the primary projects being investigated in the Study. As part of the reassessment, reservoir engineers requested updated flow data for a variety of rivers and creeks in the Walla Walla Basin to make an initial determination on the volume of water available for filling the reservoir. The effort resulted in the creation of a spreadsheet that includes daily average data for 13 gauge locations, calculated/extrapolated data sets for 3 creek systems and a variety of graphical and statistical analysis.

Stream Gauge Datasets and Period of Records

Figure 2 illustrates stream gauge data and periods of record utilized for the reservoir storage water analysis.

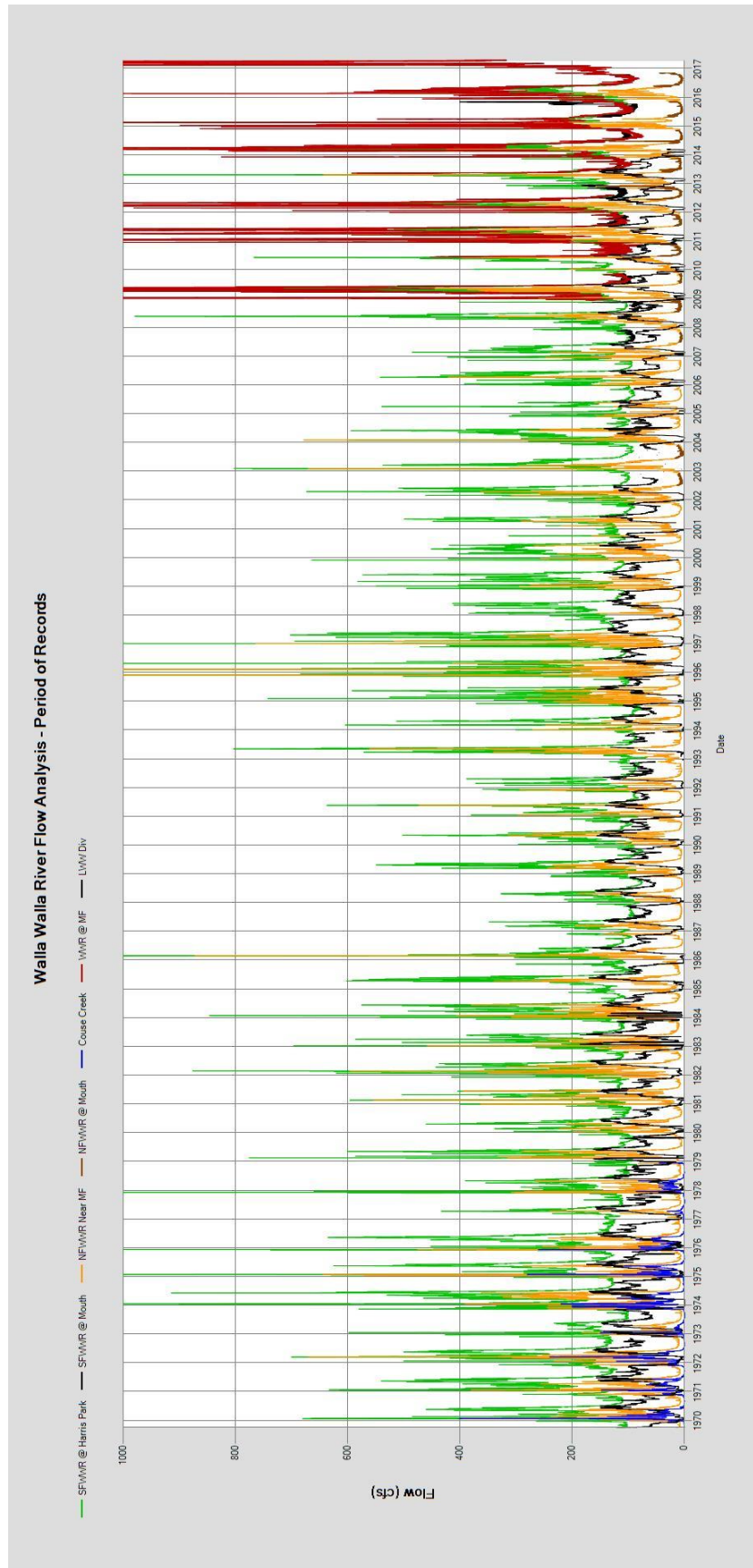


Figure 2 - Hydrograph for stream gauges utilized in the reservoir storage water analysis - 1970-2016.

Walla Walla River Composite Dataset

A composite dataset was created for flows upstream of the point of diversion for the proposed reservoir (Little Walla Walla River POD located at Cemetery Bridge in Milton-Freewater, OR). Flow above the POD includes the South Fork Walla Walla River, North Fork Walla Walla River and Couse Creek. The South and North Forks have gauge data from 1969 to present, however Couse Creek only has gauge data from 1964-1978. The Walla Walla River @ Milton-Freewater gauge has a period of record of 2009-2016, which does not provide enough data for robust analysis. A composite dataset was created by adding the North and South Fork gauges to a derived Couse Creek dataset.

The composite Walla Walla River dataset was calculated by adding daily average flow for the North Fork Walla Walla River, South Fork Walla Walla River and derived Couse Creek.

Couse Creek Derived Dataset

The derived Couse Creek dataset was created by using existing gauge data where available. A correlation between Couse Creek and North Fork Walla Walla River flows was created for the periods where no Couse Creek gauge data was available. Monthly correlations were used to create variable coefficients. North Fork Walla Walla River flow data was multiplied by the monthly variable coefficients to calculate missing Couse Creek flow data.

$$\text{Derived Couse Creek Flow} = \text{North Fork WWR flow} * \text{Monthly Variable Coefficient}$$

Table 5. Monthly variable coefficients for calculating missing Couse Creek flow from North Fork Walla Walla River flow data.

Month	Variable Coefficients
October	0.05
November	0.28
December	0.37
January	0.37
February	0.37
March	0.37
April	0.30
May	0.25
June	0.13
July	0.06
August	0.07
September	0.04

Derived Couse Creek data was graphed with OWRD's Couse Creek gauge data from 1969-1978 and the derived Couse Creek data from the US Army Corps of Engineer's Study (See Walla Walla River Basin No Action Report- Appendix A Hydrology – 2013). The derived Couse Creek dataset is comparable to the dataset created by the US Army Corps of Engineers (USACOE). However, this dataset indicates lower flow values for high flow events compared to the USACOE dataset (Figure 3).

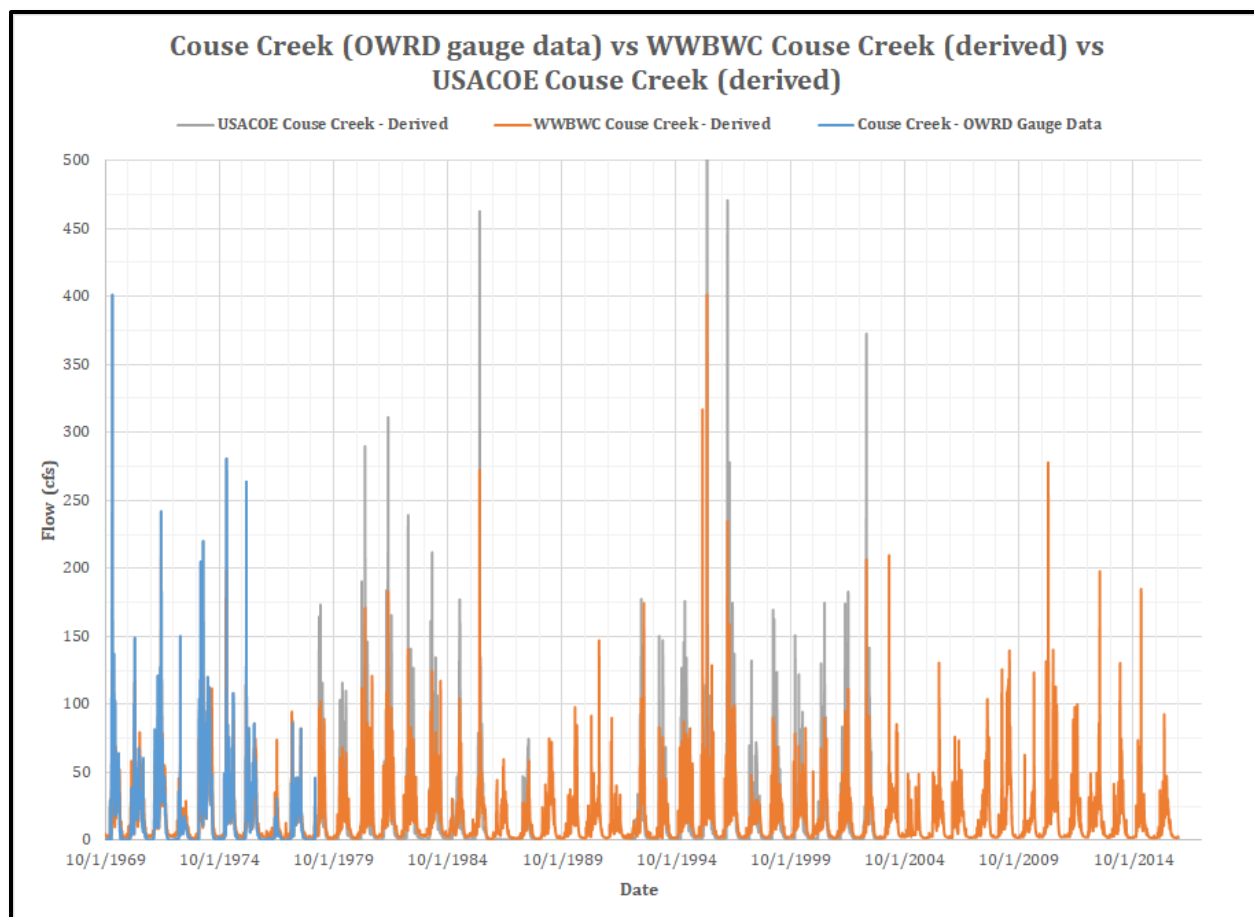


Figure 3 - Hydrograph of Couse Creek datasets. Blue line shows OWRD gauge data for Couse Creek from 1969-1978. Orange line shows WWBWC derived dataset for Couse Creek for 1969-2016. Gray line shows USACOE derived dataset for Couse Creek for 1969-2003.

Pine Creek Derived Dataset

Stream flow data for Pine Creek was collected by OWRD from October 1964 to September 1985. A derived dataset for Pine Creek was created by using existing gauge data where available to expand the Pine Creek dataset. A correlation between Pine Creek and Mill Creek flows was created for the periods where no Pine Creek gauge data was available.

$$\text{Derived Pine Creek Flow} = \text{Mill Creek @ Kooskooskie flow} * 0.2189 + -6.787$$

Derived Pine Creek data was graphed with OWRD's Pine Creek gauge data from 1964-1985 and the derived Pine Creek data from the US Army Corps of Engineer's Study (See Walla Walla River Basin No Action Report- Appendix A Hydrology – 2013). The derived Pine Creek dataset is comparable to the dataset created by the US Army Corps of Engineers (USACOE). However, this dataset indicates lower flow values for high flow events compared to the USACOE dataset (Figure 4).

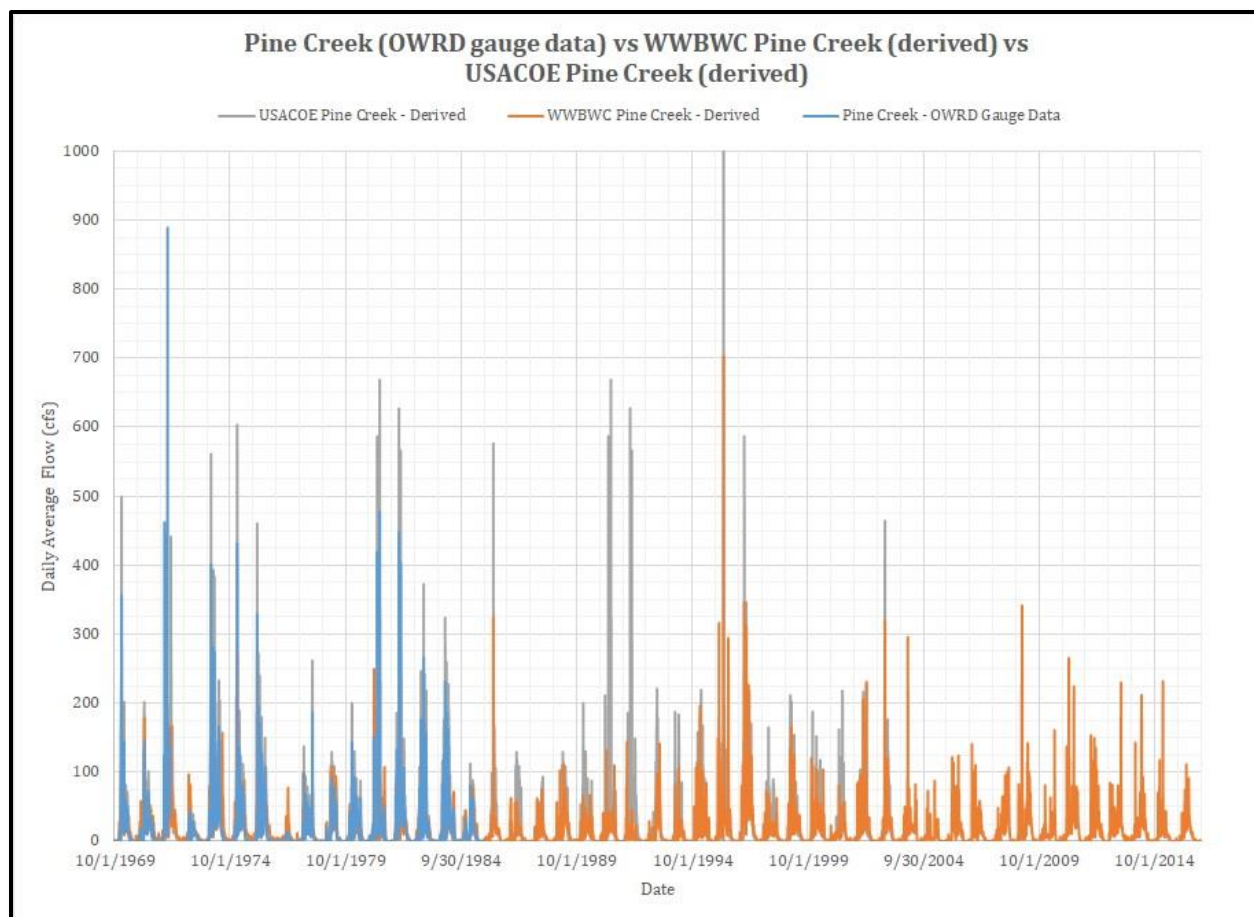


Figure 4 - Hydrograph of Pine Creek datasets. Blue line shows OWRD gauge data for Pine Creek from 1964-1985. Orange line shows WWBWC derived dataset for Couse Creek for 1969-2016. Gray line shows USACOE derived dataset for Couse Creek for 1969-2003.

Mill Creek Composite Dataset

Gauge data for Mill Creek at Kooskooskie exists from 1969 to present, with a data gap from 1976 to 1979. A derived dataset was created for the Mill Creek gauge at Kooskooskie (USGS 14013000) to fill in missing data from October 1, 1976 to October 1, 1979. The derived Mill Creek flow data were created by using a correlation between the North Fork Walla Walla River and Mill Creek flows. The derived data were used where no Mill Creek gauge data was available. The resulting composite dataset was utilized for analysis of water availability in Mill Creek. Derived data for Mill Creek and Mill Creek at Kooskooskie data were graphed for visual comparison (Figure 5).

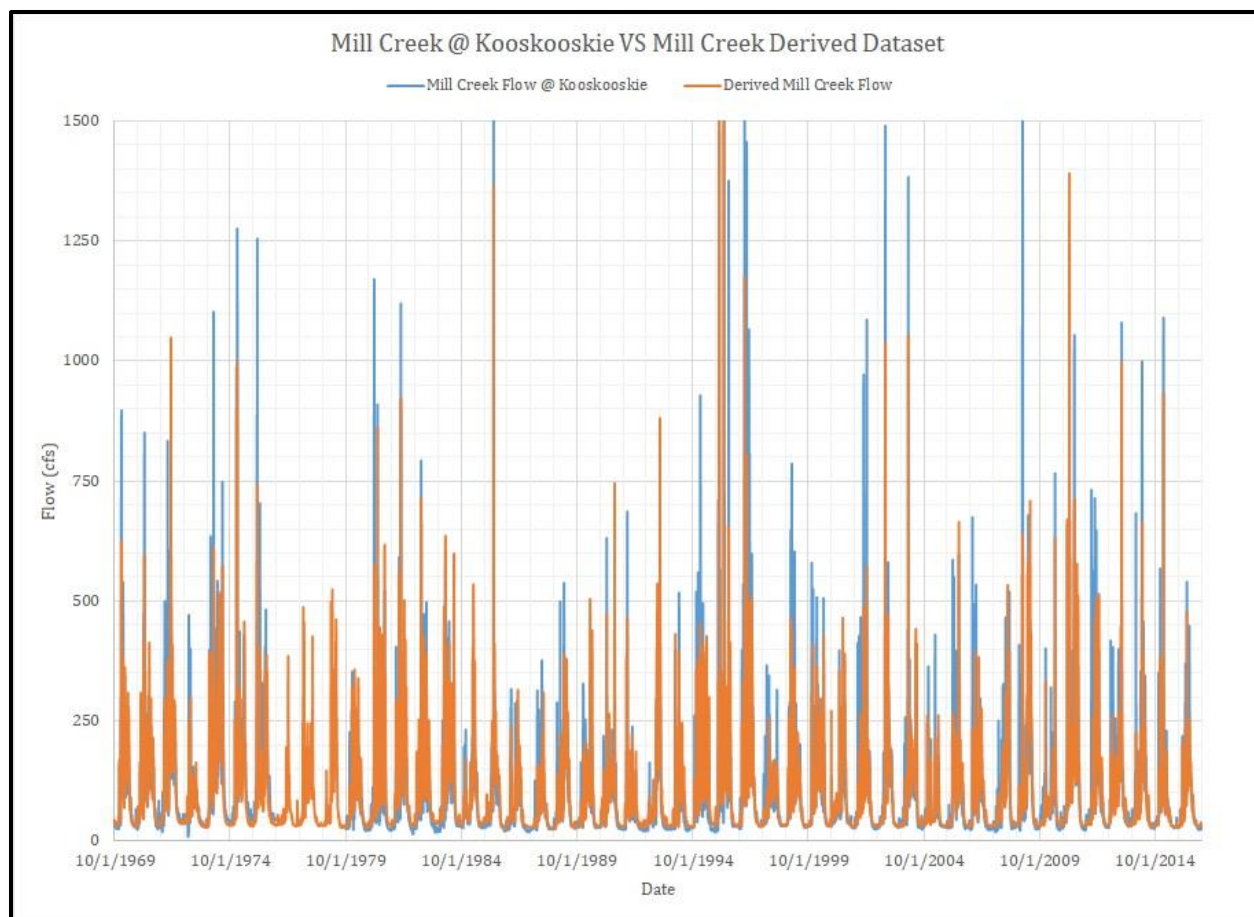


Figure 5 - Hydrograph of flow data from Mill Creek at Kooskooskie gauge (14013000) and derived Mill Creek dataset. Derived dataset was used to fill a data gap in the gauge data from October 1, 1976 to October 1, 1979.

Water Year Ranking Analysis

The Composite Walla Walla River and Pine Creek datasets were analyzed to determine water year ranking. This analysis allows for the determination of “wet” (25% exceedance), “normal” (50% exceedance) and “dry” (75% exceedance) years. Daily average flow was converted into daily volume (acre-feet), which was used to create an annual flow volume for each water year (Oct 1 – Sept 30). Annual flow volumes were then ranked (Tables 6 and 7). Figure 6 illustrates the annual water year ranking in histogram form for the Walla Walla River at Milton-Freewater. Annual flow volumes for the Walla Walla River at Milton-Freewater range from ~55,000 to ~140,000 acre-feet and Figure 7 displays annual ranking over time with a linear trend line. Figures 8 and 9 show the same information for Pine Creek. Annual flow volumes in Pine Creek range from ~3,700 to ~23,000 acre-feet.

Table 6 – Walla Walla River at Milton-Freewater, OR annual flow volume ranking for water years 1970-2016.

Ranking	Water Year	Annual Flow Volume (Acre-feet)
1	1974	140,070
2	1996	125,402
3	1997	122,850
4	2011	120,931
5	1976	115,770
6	1972	114,465
7	2009	112,648
8	1982	108,745
9	1971	108,465
10	1975	106,875
11	1984	105,262
12	2000	96,317
13	1983	95,593
14	1995	93,607
15	1970	93,268
16	2012	92,770
17	2013	92,563
18	1999	92,440
19	2008	91,042
20	2014	90,206
21	2004	89,675
22	1978	87,830
23	1985	87,533
24	1981	86,542
25	1986	86,286
26	1993	85,422
27	1979	84,504
28	2006	83,857
29	2002	83,005
30	2003	82,897
31	2007	82,467
32	1998	81,422
33	2001	79,349
34	1989	79,101
35	2010	76,077
36	2016	75,479
37	1980	75,043
38	1991	74,137
39	2015	72,896
40	1990	70,994
41	1973	67,560
42	1994	67,331
43	1987	64,677
44	1977	62,672
45	1992	62,660
46	2005	60,206
47	1988	55,670

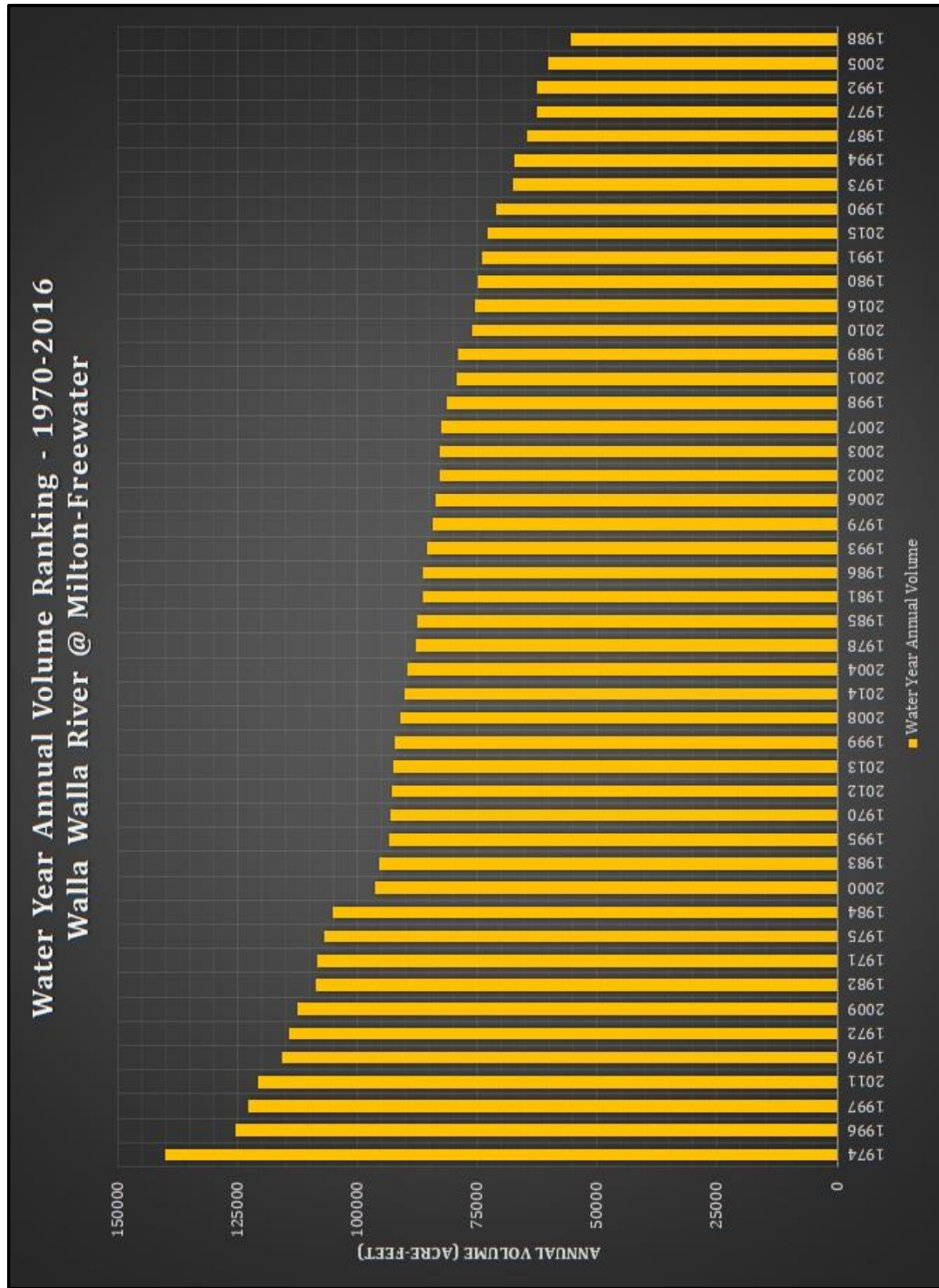


Figure 6 - Histogram of Walla Walla River at Milton-Freewater annual volumes (in acre-feet), ranked from highest volume to lowest volume, water years 1970-2016.

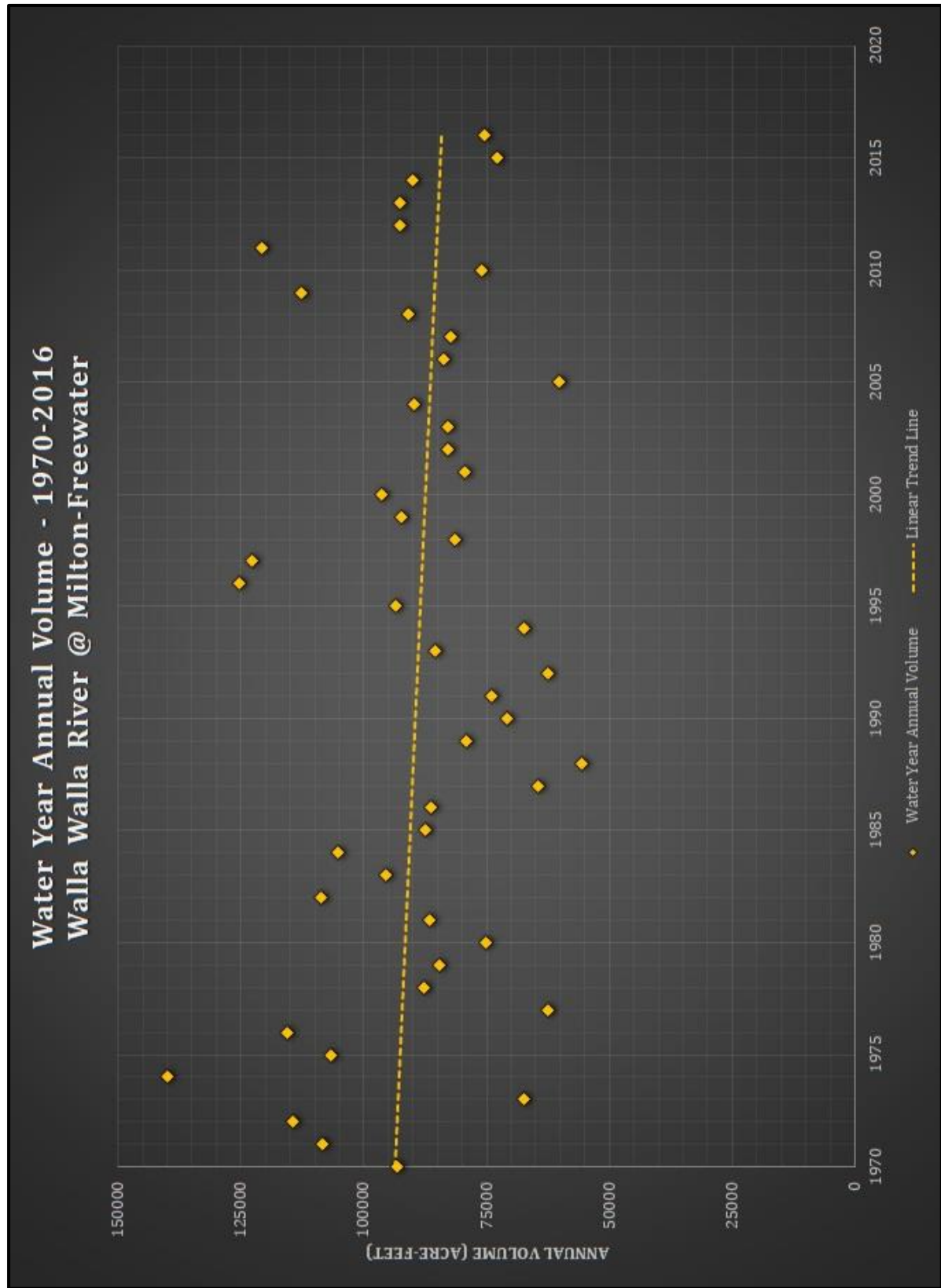


Figure 7 – Scatter plot of Walla Walla River at Milton-Freewater annual volumes (in acre-feet) for water years 1970-2016. Yellow dashed line in a linear trend line of the data.

Table 7 – Pine Creek annual flow volume ranking for water years 1970-2016.

Ranking	Water Year	Annual Flow Volume (Acre-feet)
1	1997	23,600
2	1974	22,346
3	1996	19,633
4	1976	18,445
5	2011	16,119
6	2009	15,403
7	1972	15,138
8	1975	14,450
9	1995	12,417
10	2012	11,916
11	2002	11,827
12	1982	11,816
13	1971	11,665
14	2014	11,614
15	2000	11,609
16	1999	11,351
17	2013	11,278
18	2003	11,104
19	1989	10,539
20	1970	10,404
21	2008	10,350
22	2004	10,278
23	1979	9,949
24	1984	9,917
25	2006	9,775
26	1978	9,636
27	2016	9,581
28	1983	9,048
29	1981	8,932
30	2007	8,635
31	1993	8,609
32	1986	7,947
33	1985	7,840
34	1991	7,625
35	2010	7,089
36	1998	7,045
37	2015	6,939
38	1980	6,624
39	1990	6,480
40	1987	6,091
41	2001	5,560
42	1973	5,552
43	2005	5,026
44	1988	4,986
45	1992	4,691
46	1994	4,581
47	1977	3,755

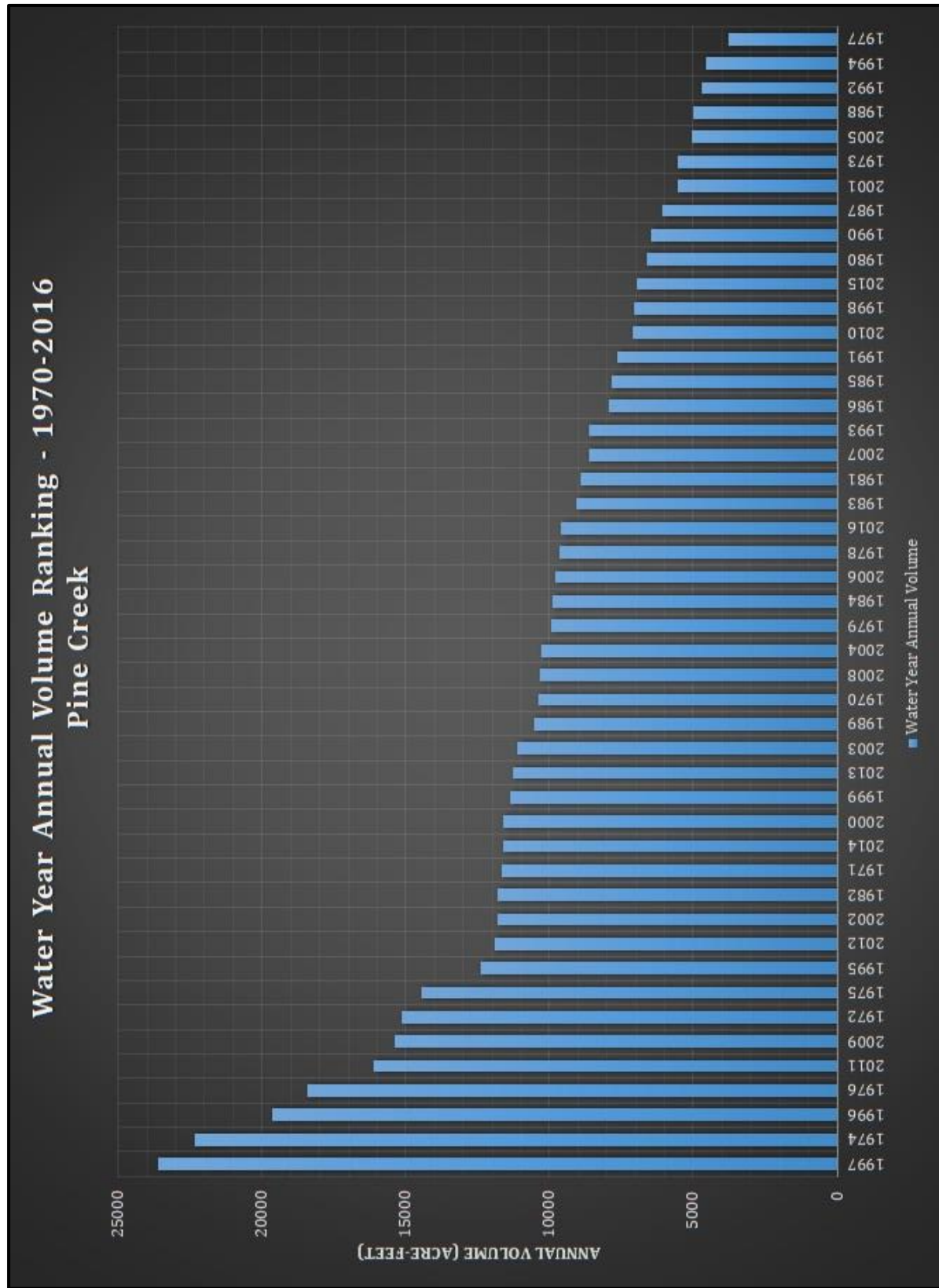


Figure 8 - Histogram of Pine Creek annual volumes (in acre-feet), ranked from highest volume to lowest volume, water years 1970-2016.

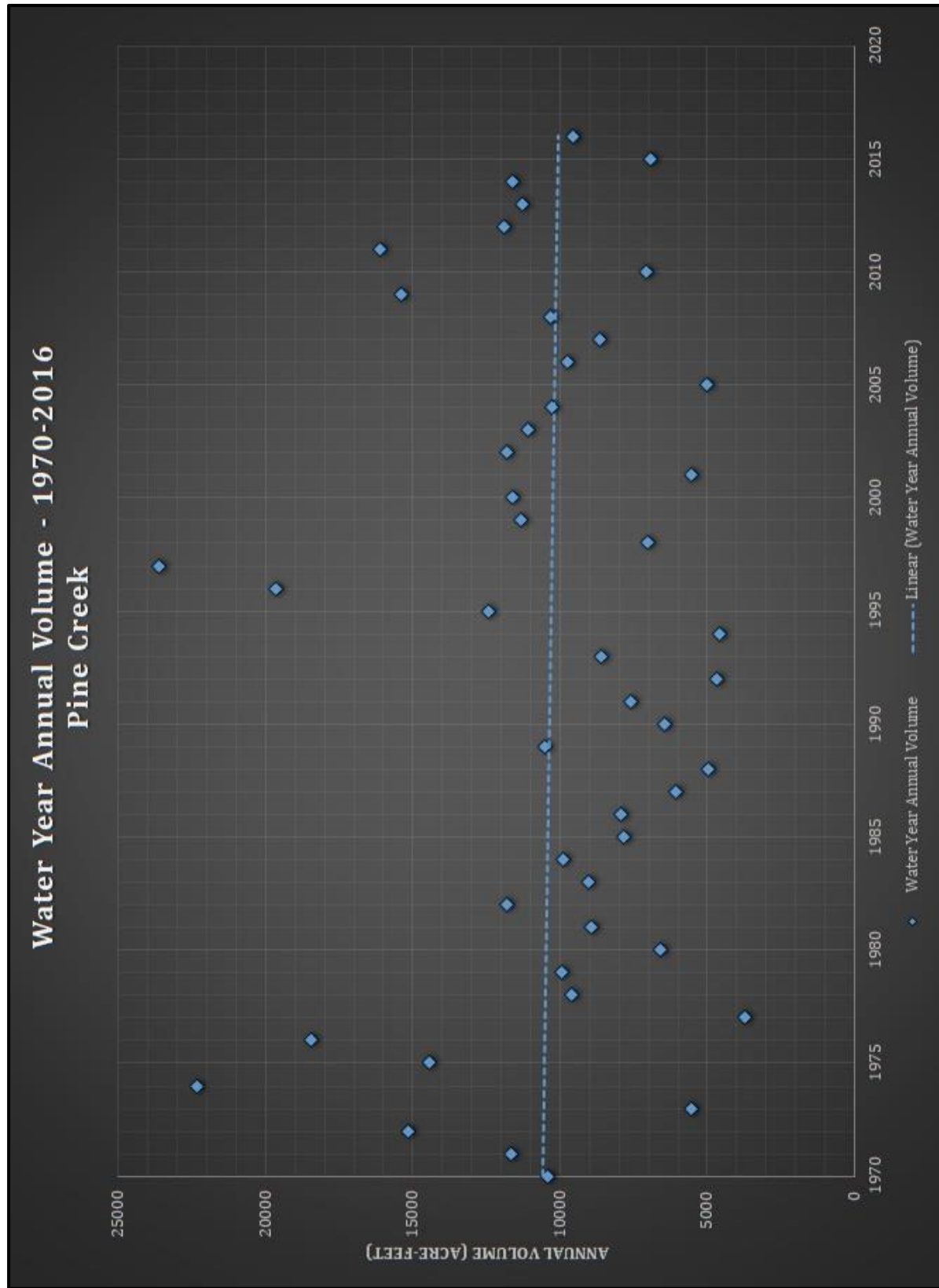


Figure 9 - Scatter plot of Pine Creek annual volumes (in acre-feet) for water years 1970-2016. Blue dashed line in a linear trend line of the data.

Walla Walla River at Milton-Freewater Annual Volume Exceedance

The annual volume values for the Walla Walla River at Milton-Freewater were analyzed to create an annual volume exceedance graph (Figure 10). Water year annual volumes were imported into R and “Flow Duration Curve” (FDC) function within the hydroTSM R package. The FDC function was modified from the default configuration to fit the annual volume exceedance requirements. This analysis is limited by the “short” period of record – 47 years. Therefore, exceedance values should be viewed/used with an understanding of the limited framework of the dataset.

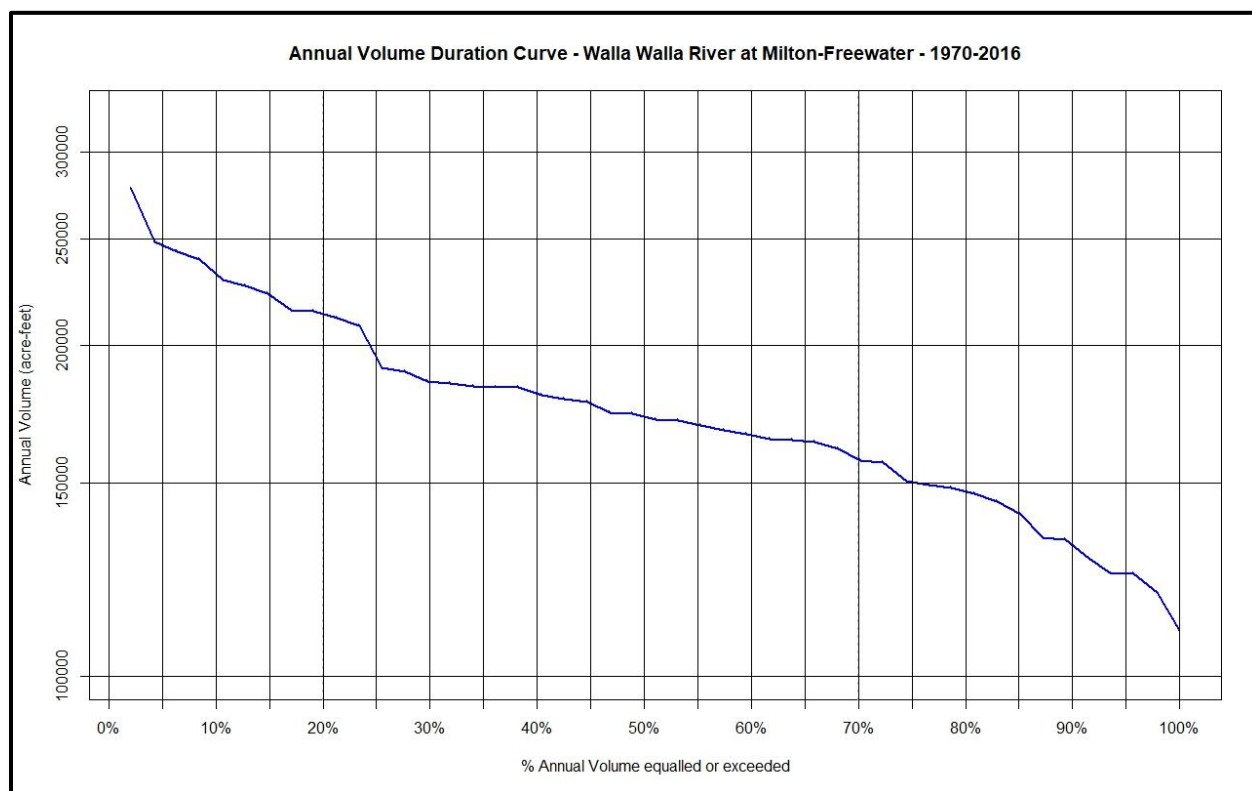


Figure 10 - Annual water volume exceedance graph for the Walla Walla River at Milton-Freewater for water years 1970-2016.

“Dry”, “Normal” and “Wet” Average Hydrographs

Five year average datasets were created to represent “Dry” (75% exceedance), “Normal” (50% exceedance) and “Wet” (25% exceedance) conditions. Utilizing the water year ranking (see above), the five years bracketing each of the exceedances (i.e. 25%, 50% and 75%) were averaged to create a five year average flow for each condition. Each condition (Dry, Normal and Wet) was graphed compared to flow upstream of the Little Walla Walla River point of diversion (POD) at Cemetery Bridge in Milton-Freewater, river mile 45.9, historic flow downstream of the POD, 20% diversion for reservoir storage and 30% diversion for reservoir storage (Figures 11-13).

In addition, five year delta average datasets were created and graphed (Figures 14-16). The delta average datasets for both 20% and 30% diversion indicate when diversions occur (negative values – typically during winter and spring) and when stored reservoir water is utilized to improve instream flows via water rights exchange or direct return to the Walla Walla River (positive values – typically during late spring, summer and fall).

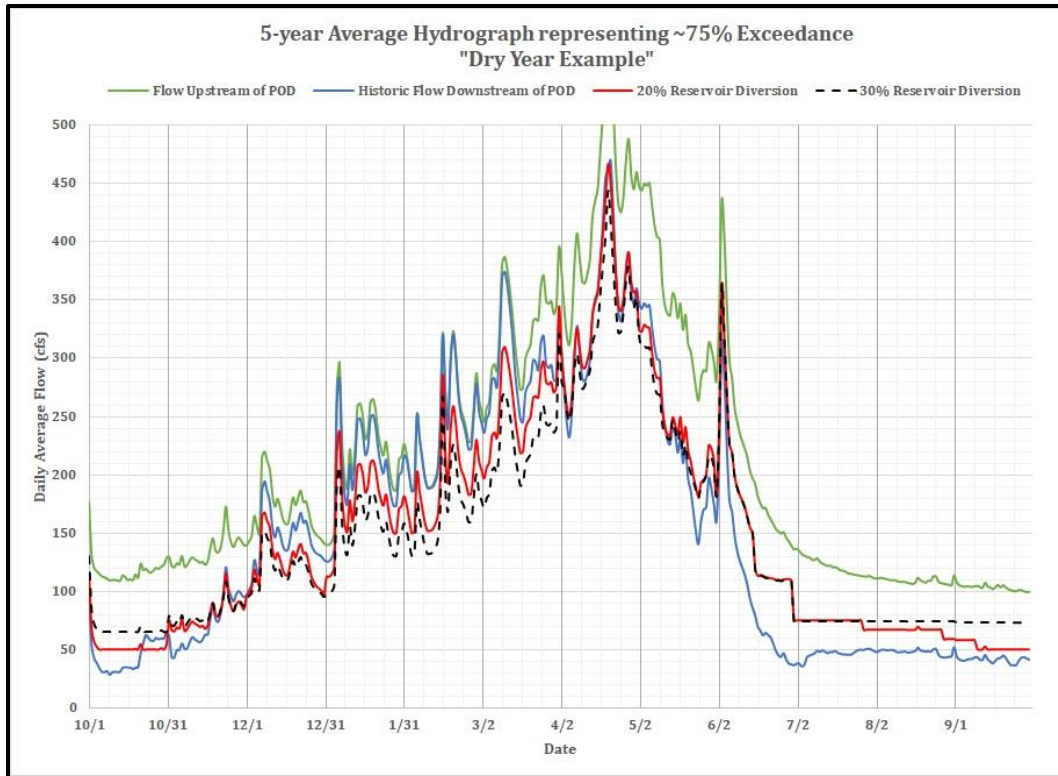


Figure 11 - Hydrograph of the 5-year average representing "Dry" conditions (75% exceedance) under potential reservoir diversion scenarios.

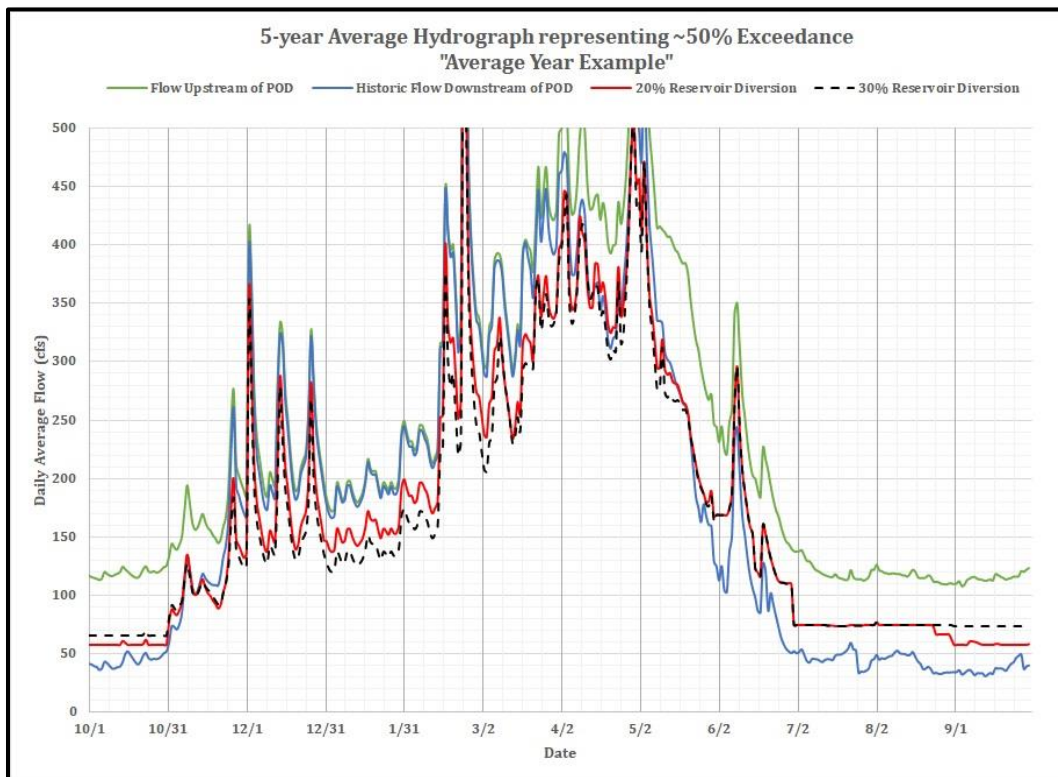


Figure 12 - Hydrograph of the 5-year average representing "Normal" conditions (50% exceedance) under potential reservoir diversion scenarios.

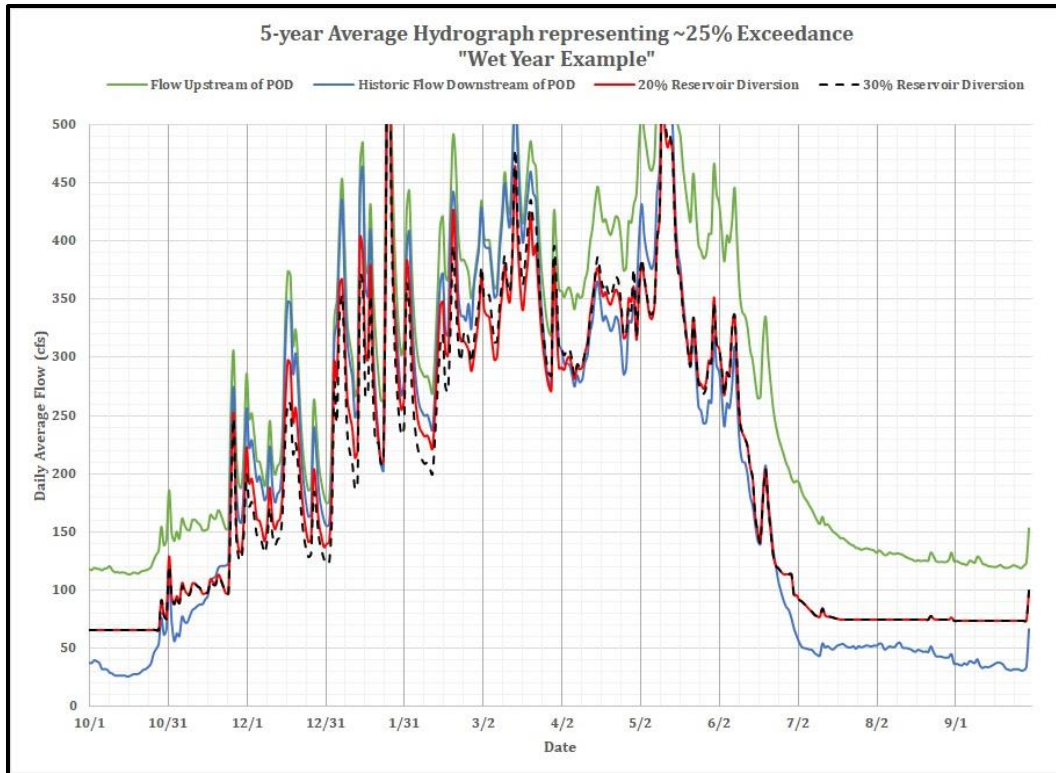


Figure 13 - Hydrograph of the 5-year average representing "Wet" conditions (25% exceedance) under potential reservoir diversion scenarios.

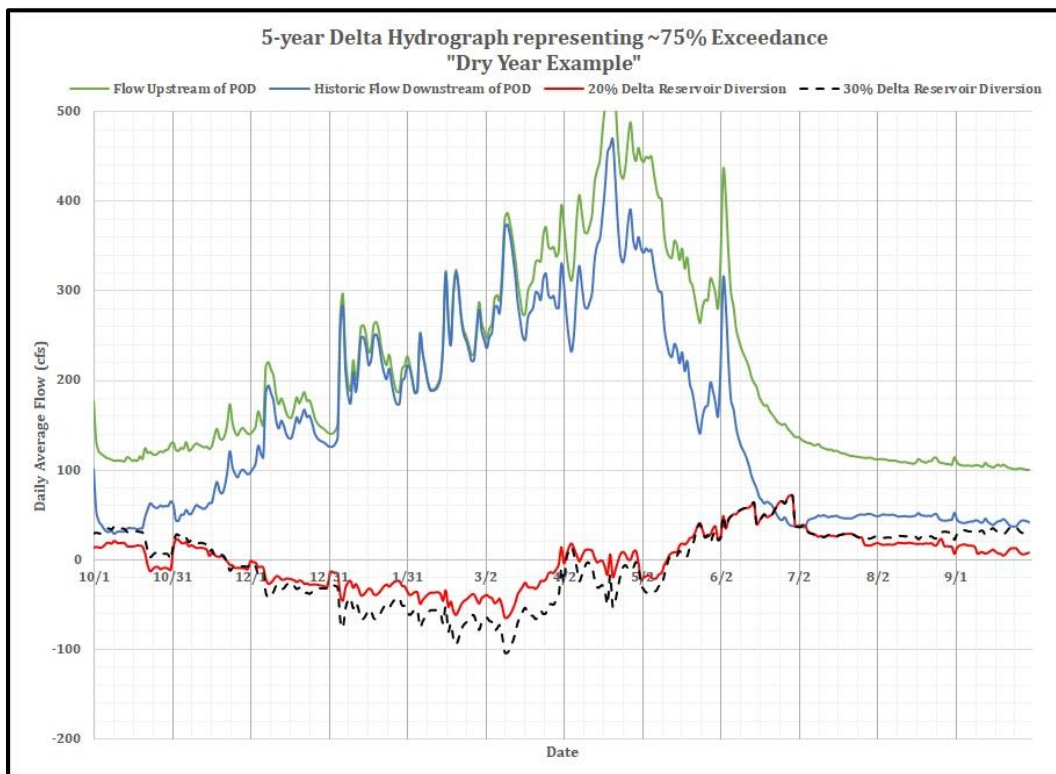


Figure 14 - Hydrograph of the 5-year average representing delta "Dry" conditions (75% exceedance) under potential reservoir diversion scenarios.

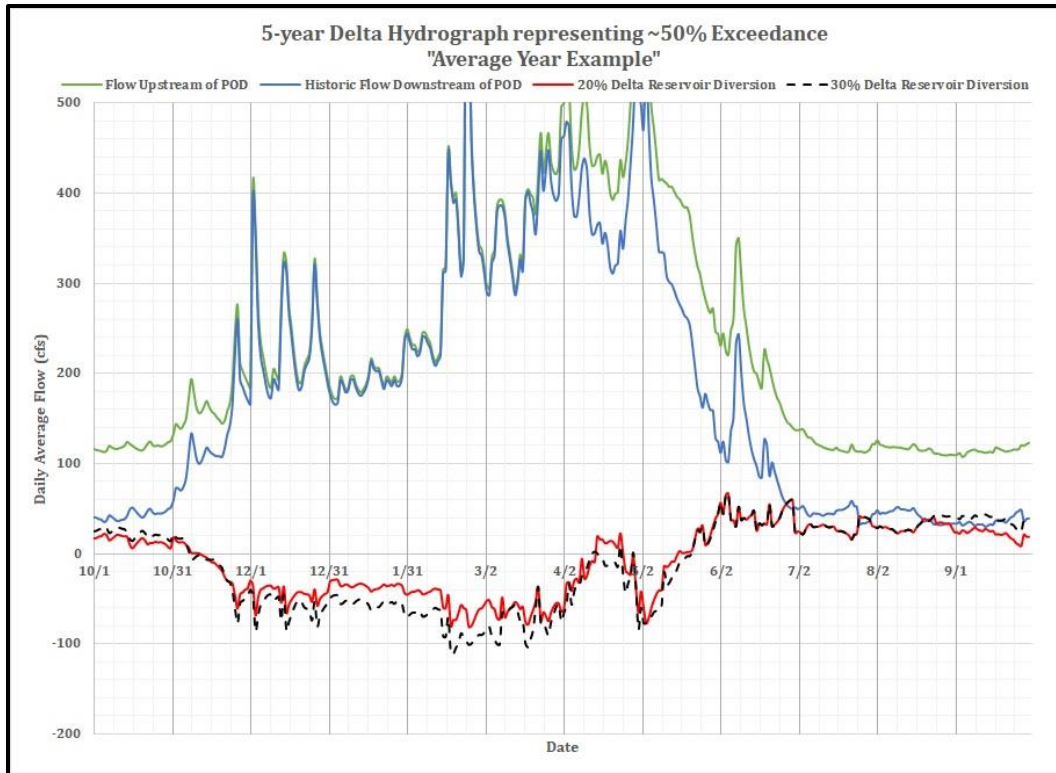


Figure 15 - Hydrograph of the 5-year average representing delta "Normal" conditions (50% exceedance) under potential reservoir diversion scenarios.

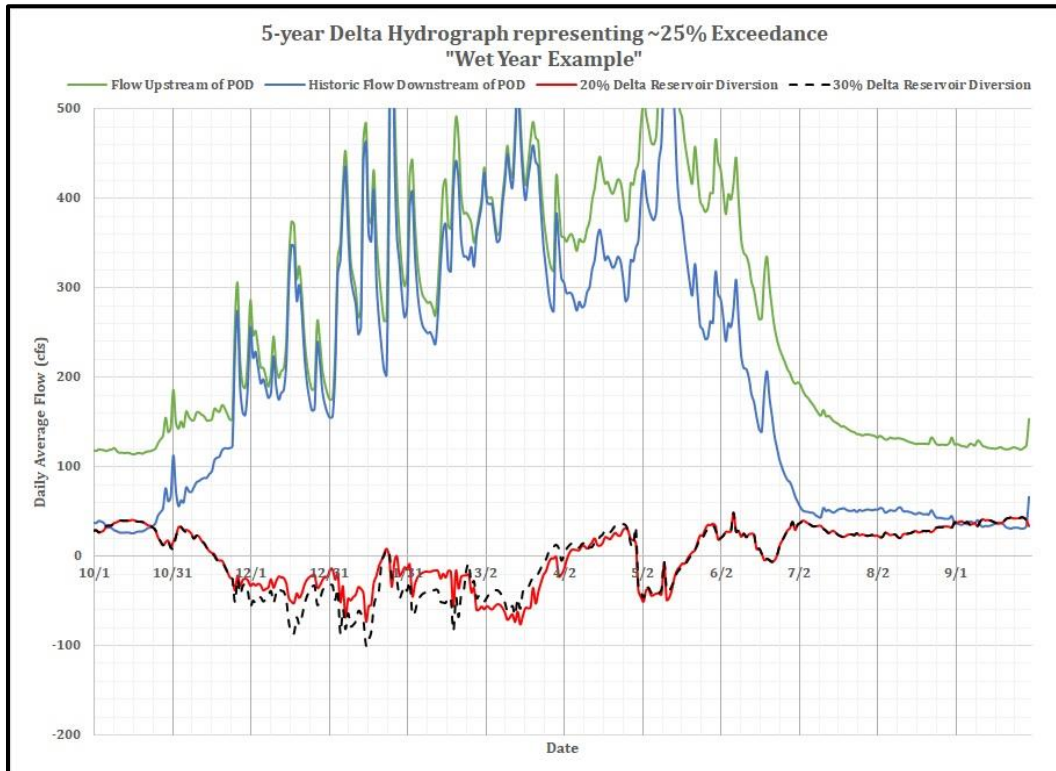


Figure 16 - Hydrograph of the 5-year average representing delta "Wet" conditions (25% exceedance) under potential reservoir diversion scenarios.

Walla Walla River Average Flow

Daily average flow values for the period of record (1970-2016) were averaged to create an average flow dataset for the Walla Walla River at Milton-Freewater (Figure 17). Average values were calculated from the Walla Walla River Composite Dataset (see above).

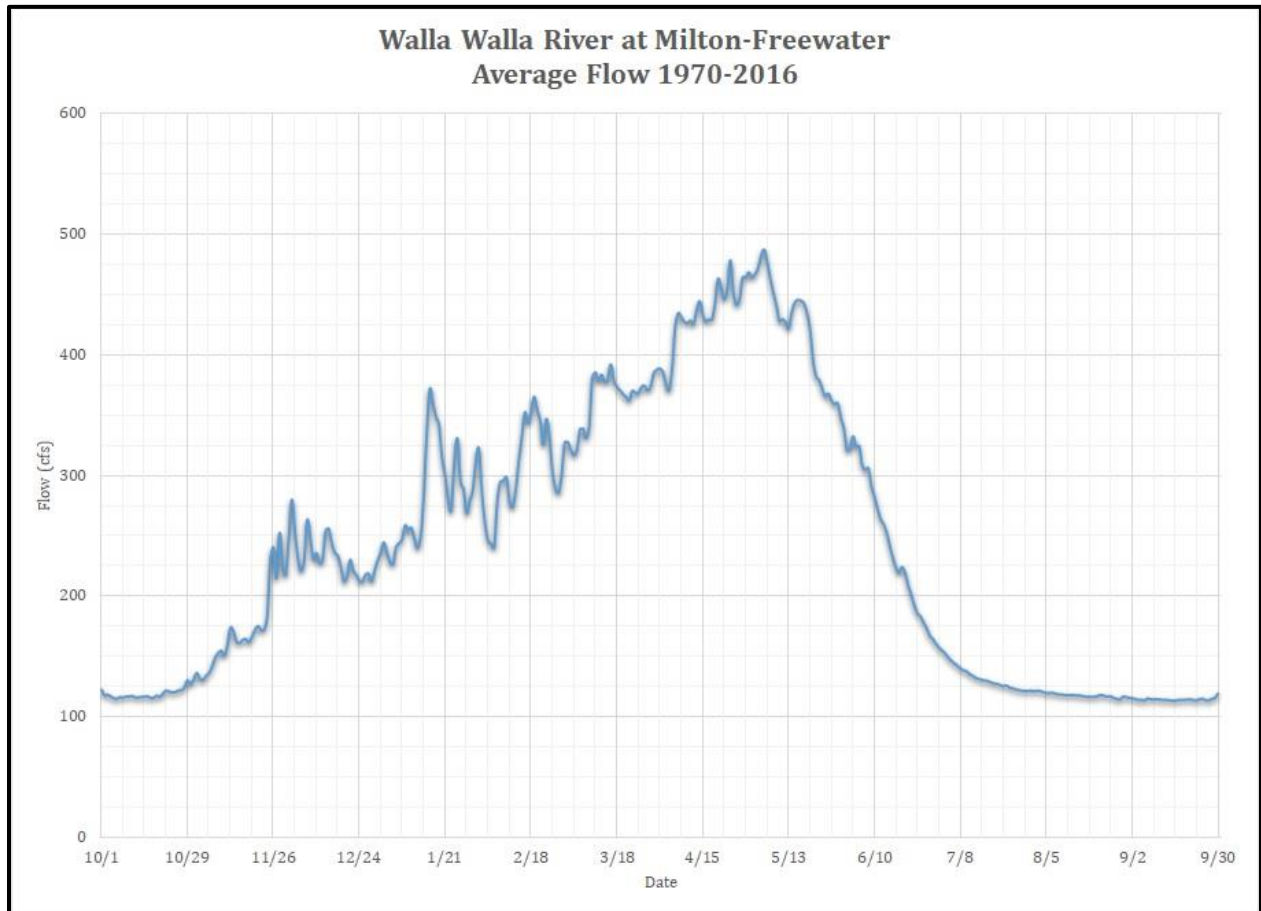


Figure 17 - Hydrograph of average flow for the Walla Walla River at Milton-Freewater for the period of record of water years 1970-2016.

Flood Frequency Analysis

An analysis of flood frequencies was performed on the derived "Walla Walla River Composite" (also known as "Flow Upstream of POD"), "Downstream Historic", "20% Reservoir Diversion" and "30% Reservoir Diversion" datasets. Daily average flow for each dataset was imported into AQUARIUS Time-series (www.aquaticinformatics.com). It should be noted, this analysis differs from most other flood discharge analyzes completed in the past (e.g. Corps 2007, GeoEngineers 2011, and others) including a limited data range (WY 1970-2016), different reach of interest, using daily average flow data ("Walla Walla River Composite"), presenting daily average flow results (instead of instantaneous flow) and other variables. The primary purpose of this analysis was to determine the potential impact of reservoir diversions on frequent (2-10 years) flood flow intensity and,

therefore, should not be used for other purposes. Each dataset was analyzed using AQUARIUS's "Hydrologic Statistics" toolbox (Figure 18). An annual population set was generated from maxima for each year using the California method ($P=\text{rank}/n$) and plotted (Figure 19). A cumulative distribution function chart was created for each population. All common distribution types (e.g. Pearson Type III, Log Pearson, etc) were plotted on the same chart for comparison (Figure 20). Parameters for each distribution type were estimated using AQUARIUS's built in "L-Moments estimator" tool and distribution parameters are included in the data files. Tests for general randomness, independence and trend were conducted (see Figures 21-23). Return periods of 2, 5, 10, 15, 20, 25, 50, 100, 200 and 500 years were analyzed for each dataset. Return values above 25-50 years are likely inaccurate due to a short period of record and the underlying dataset. Flow values are provided for each of the formula types in the cumulative distribution function chart. A summary of each dataset is included in Appendix C.

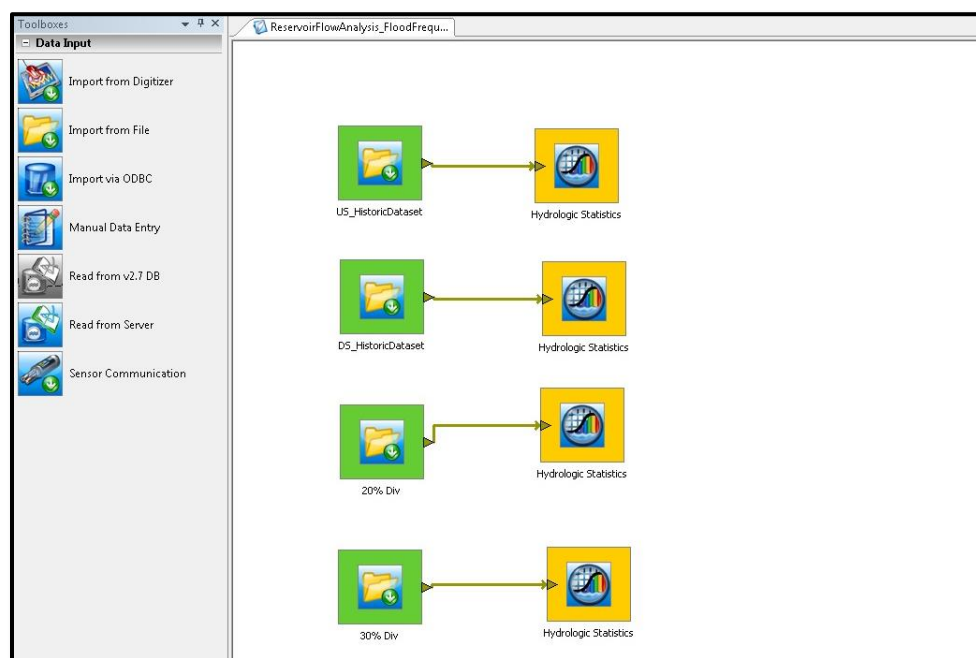


Figure 18 - Screenshot of AQUARIUS Whiteboard with datasets imported and analyzed with the "Hydrologic Statistics" toolbox.

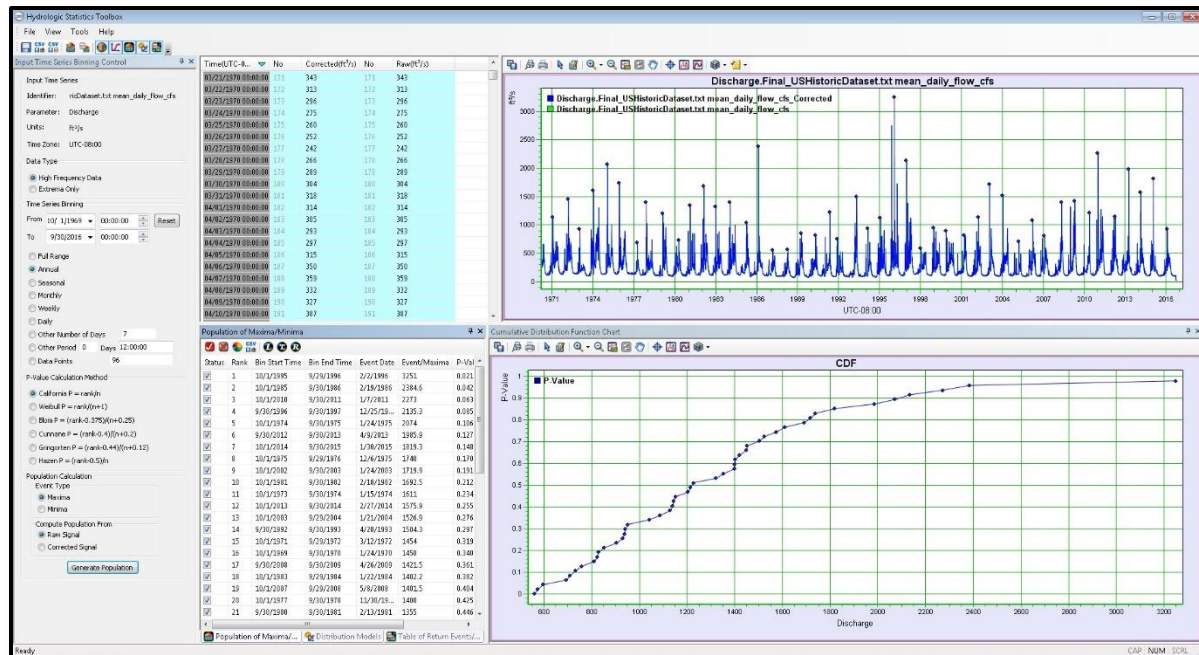


Figure 19 - Screenshot of AQUARIUS Hydrologic Statistics toolbox with annual maxima population generated using the California method ($P=\text{rank}/n$).

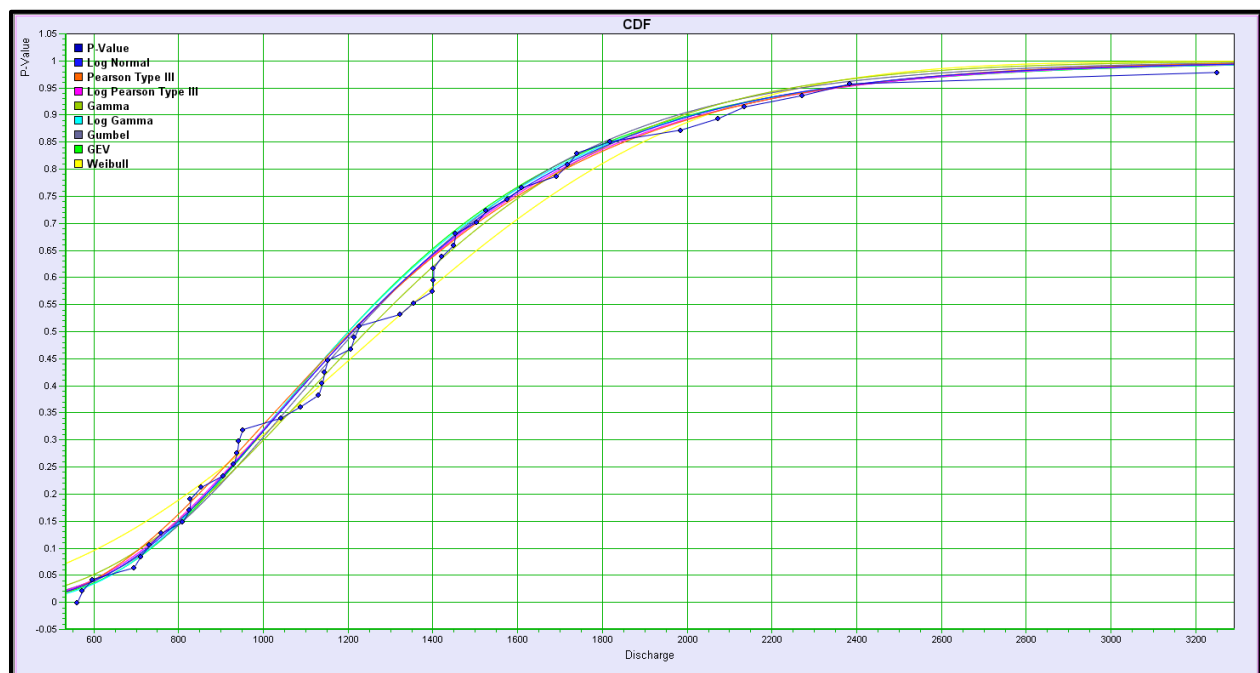


Figure 20 - Cumulative distribution function chart for "Upstream of POD" dataset. Various formula are included for comparison.

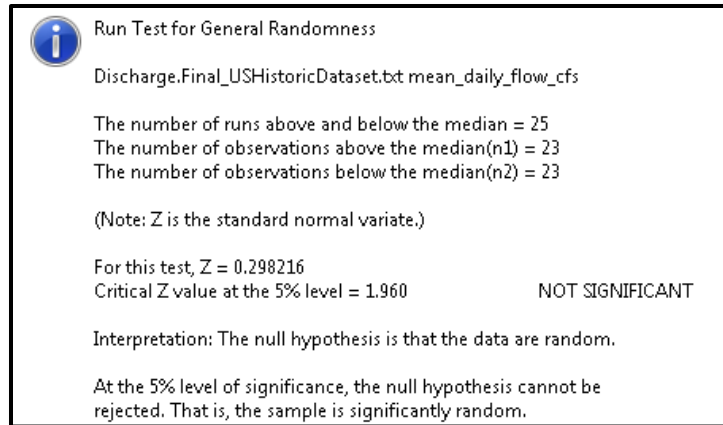


Figure 21 - Screenshot of results of the test for general randomness (built in AQUARIUS).

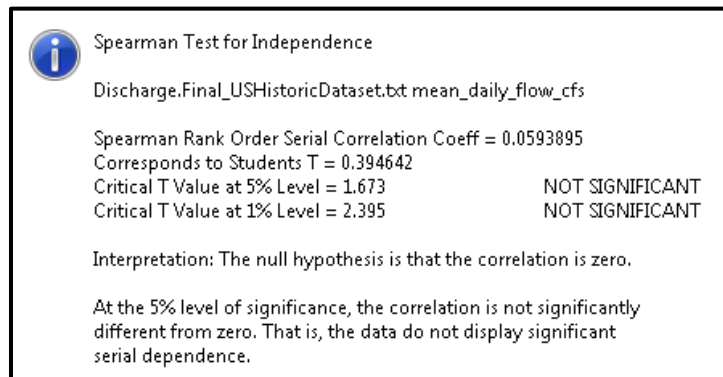


Figure 22 - Screenshot of results of the Spearman test for independence (built in AQUARIUS).

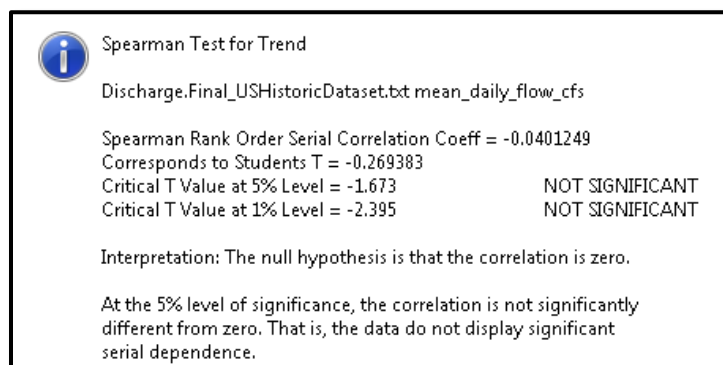


Figure 23 - Screenshot of results of the Spearman test for trend (built in AQUARIUS).

ANNUAL WATER VOLUMES EXAMINATION

An initial examination of total water volumes was conducted at three gauge locations in the Walla Walla Basin: S-105 Walla Walla River @ Milton-Freewater, S-108 Walla Walla River @ Pepper Bridge and S-609 Touchet River at Cummins Road. Daily average flow data was compiled and converted into daily volume (acre-feet). Daily acre-feet values were added on a daily time-step to create total acre-feet hydrographs for each location (Figures 24-29). In addition, available daily acre-feet values were adjusted to account for instream flow requirements. If instream flows were not being met, no water was deemed available. Instream flow requirements were established based on the adopted instream flow targets for the WWR @ Milton-Freewater and Pepper Bridge (100 cfs from July 1 – Nov 30 and 150 cfs from Dec 1 – June 30 – note these values have been adjusted since this analysis was completed – see Table 1) and on Washington Administrative Code (WAC) 173-532 for the Touchet River @ Cummins Road (Instream flows were taken from MP 11 – Touchet River @ Bolles – see Table 8). If a month was closed due to WAC 173-532 (i.e. May-November), there was assumed to be no available water during that month in this analysis.

The Walla Walla River at Milton-Freewater produced between 127,000 and 242,000 acre-feet for the years 2007-2015 (Figure 24). When proposed instream flow targets are applied, potential available water ranges from approximately 36,000 to 150,000 acre-feet per year (Figure 25). This volume of water is not what would/could be permitted, but rather gives an approximation of the potential magnitude of unallocated/unused water at this gauge location. For the Walla Walla River at Pepper Bridge, the annual water volume ranges from 63,000 to 182,000 acre-feet (Figure 26). The difference between the Milton-Freewater and Pepper Bridge gauges is likely a rough estimate of annual diversion for irrigation and other out-of-stream uses. When proposed instream flow targets are applied, potential available water ranges from approximately 13,000 to 108,000 acre-feet per year (Figure 27). This volume of water is not what would/could be permitted, but rather gives an approximation of the potential magnitude of unallocated/unused water at this gauge location. The Touchet River at Cummins Road varies from 60,000 to 239,000 acre-feet a year in annual water volume (Figure 28). When WAC 173-532 instream flows are considered, potential annual water volumes are approximately 8,000 to 132,000 acre-feet per year (Figure 29). This volume of water is not what would/could be permitted, but rather gives an approximation of the potential magnitude of unallocated/unused water at this gauge location.

Table 8. Instream flows for the Touchet River based on WAC 173-532.

Month	Instream Flows – Touchet River at Bolles (MP 11)	Instream Flows – Touchet River at Cummins Road
January	150	150
February	150	150
March	200	200
April	200	200
May	200 (Closure)	200 (Closure)
June	125 (Closure)	125 (Closure)
July	74 (Closure)	74 (Closure)
August	48 (Closure)	48 (Closure)
September	56 (Closure)	56 (Closure)
October	82 (Closure)	82 (Closure)
November	150 (Closure)	150 (Closure)
December	150	150

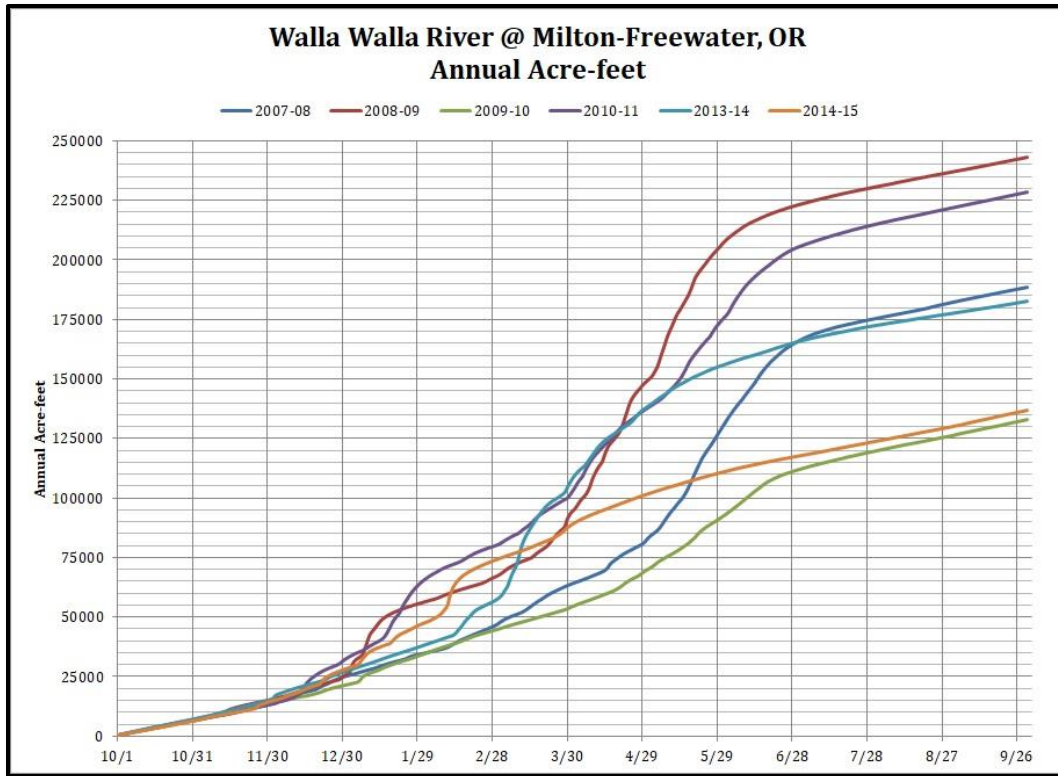


Figure 24 - Annual water volume (acre-feet) for years 2007-2015 for the Walla Walla River at Milton-Freewater.

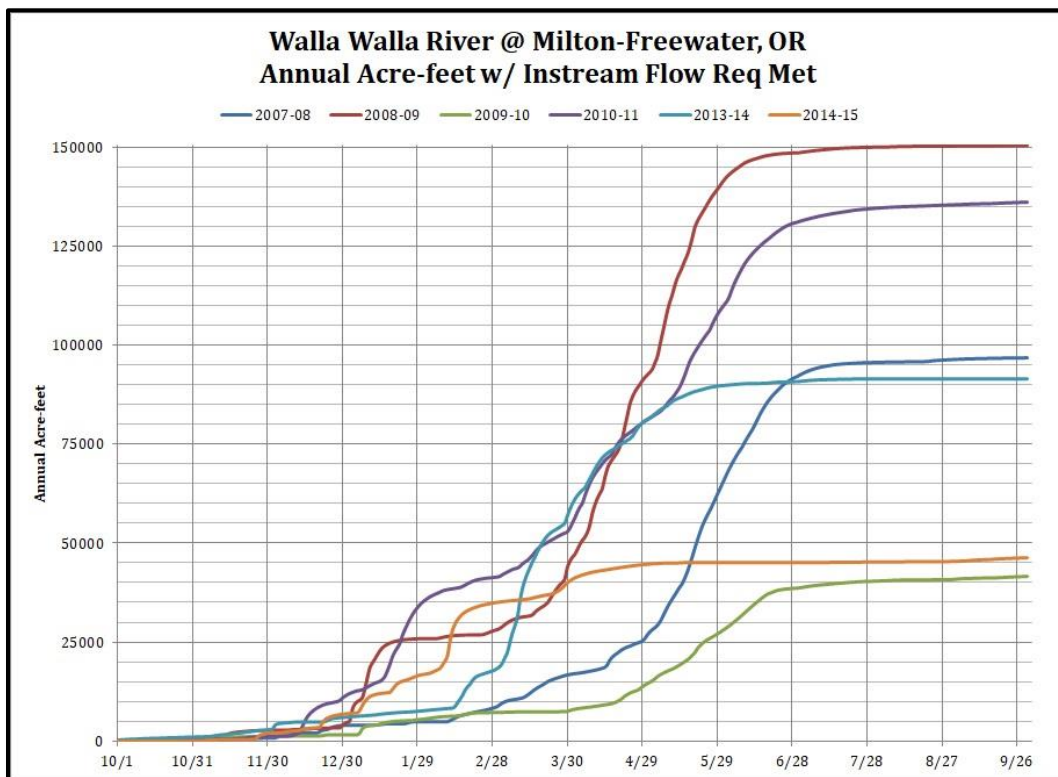


Figure 25 - Annual water volume (acre-feet) after subtracting proposed instream flow targets for years 2007-2015 for the Walla Walla River at Milton-Freewater.

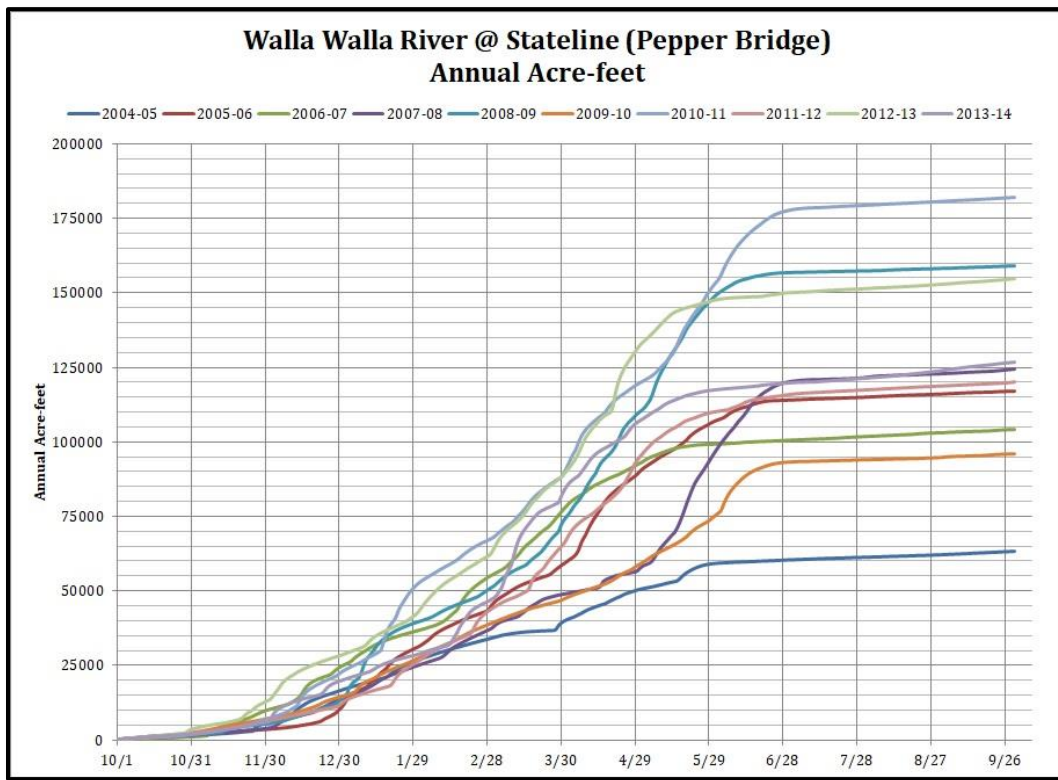


Figure 26 - Annual water volume (acre-feet) for years 2004-2014 for the Walla Walla River at Pepper Bridge.

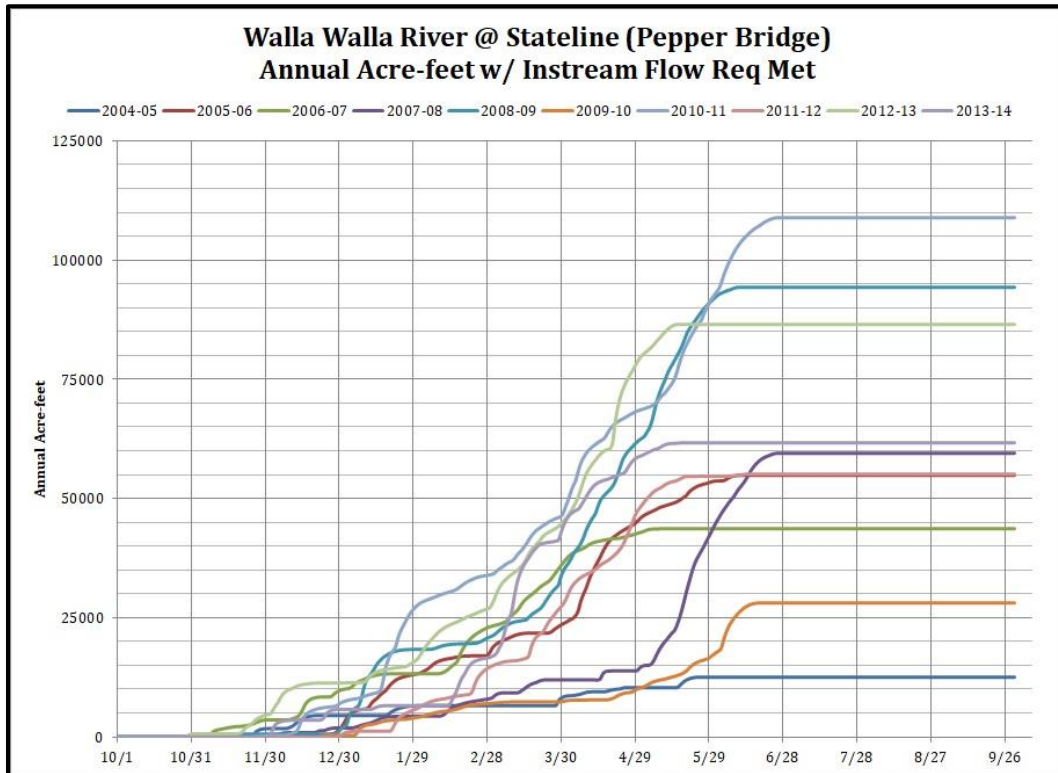


Figure 27 - Annual water volume (acre-feet) after subtracting proposed instream flow targets for years 2004-2014 for the Walla Walla River at Pepper Bridge.

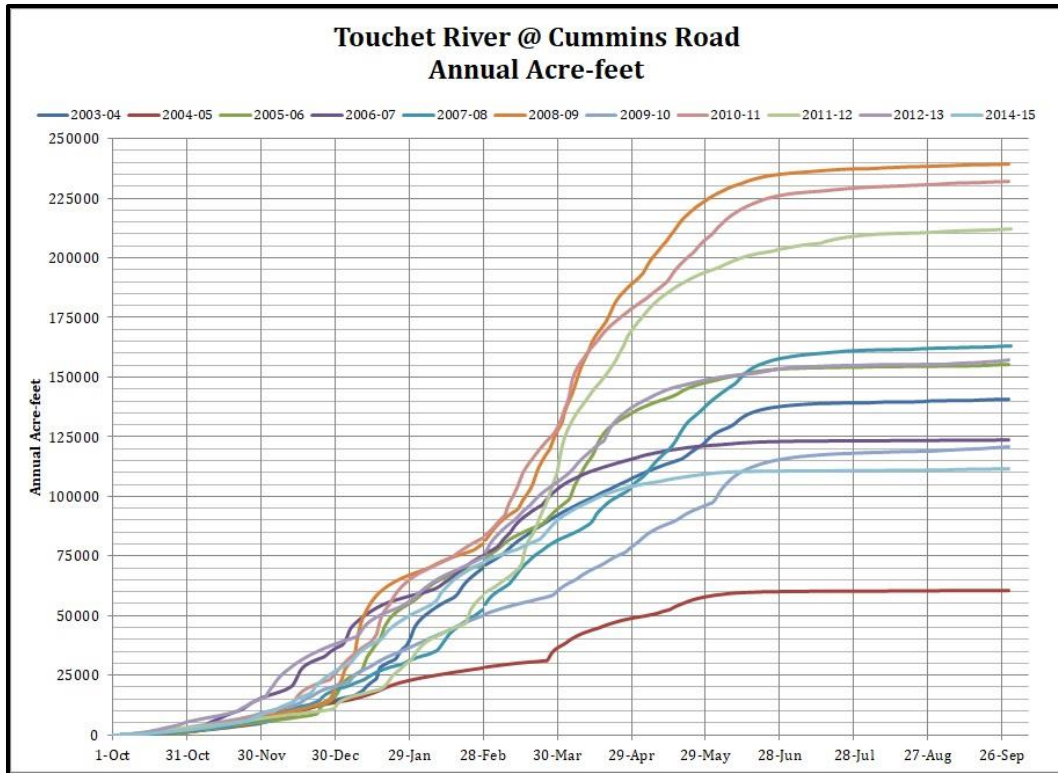


Figure 28 - Annual water volume (acre-feet) for years 2003-2015 for the Touchet River at Cummins Road.

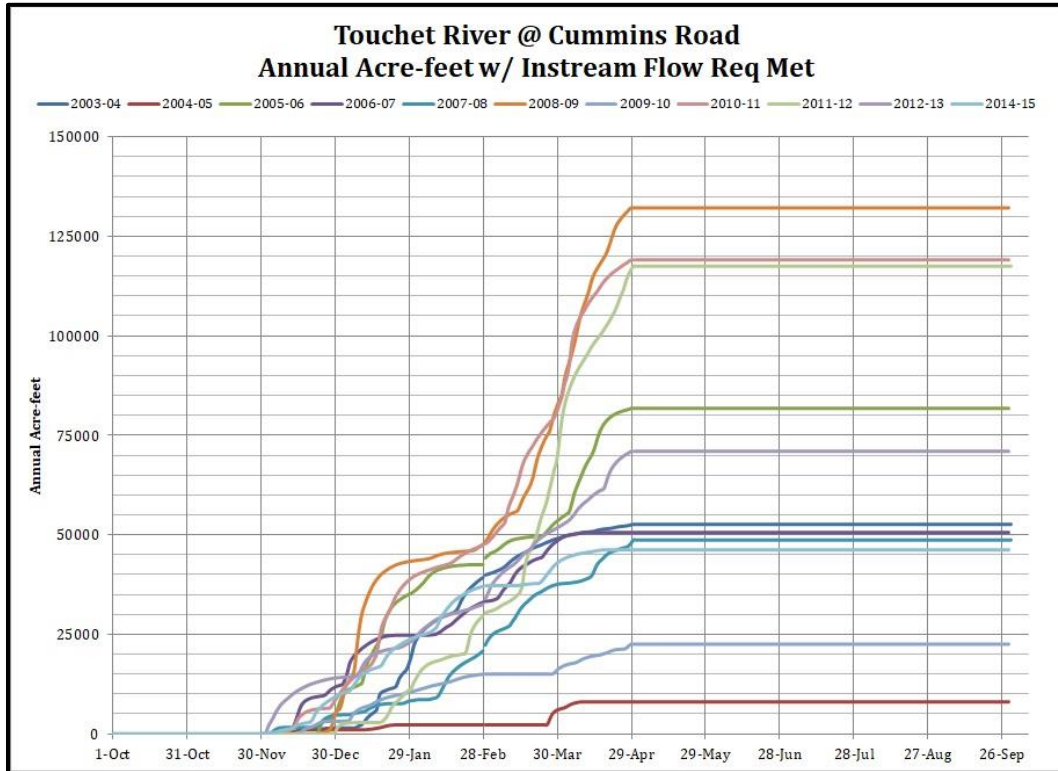


Figure 29 - Annual water volume (acre-feet) after subtracting proposed instream flow targets for years 2003-2015 for the Touchet River at Cummins Road.

MANAGED AQUIFER RECHARGE INSTREAM FLOW CONTRIBUTIONS

Instream flow benefits from active aquifer recharge sites was analyzed using the Walla Walla Basin Integrated Water Flow Model. In support of the Walla Walla Basin Integrated Flow Enhancement Study, GeoSystems Analysis, Inc. applied the calibrated surface water - groundwater numerical finite element model for the Walla Walla Basin to evaluate the potential impacts of proposed water management scenarios on hydrological conditions in the basin. The basin model utilizes the Integrated Water Flow Model (IWFM), developed by the California Department of Water Resources Bay-Delta Office (www.baydeltaoffice.water.ca.gov/modeling/hydrology/IWFM). Results for two scenarios, No Managed Aquifer Recharge (No MAR) and Current Managed Aquifer Recharge (Current MAR), were compared (Figures 30 & 31). The only difference in these scenarios is the operation of managed aquifer recharge sites therefore any instream flow change can be attributed to managed aquifer recharge operations. The entire report is available on the WWBWC website: <http://wwbwc.org/projects/modeling.html>

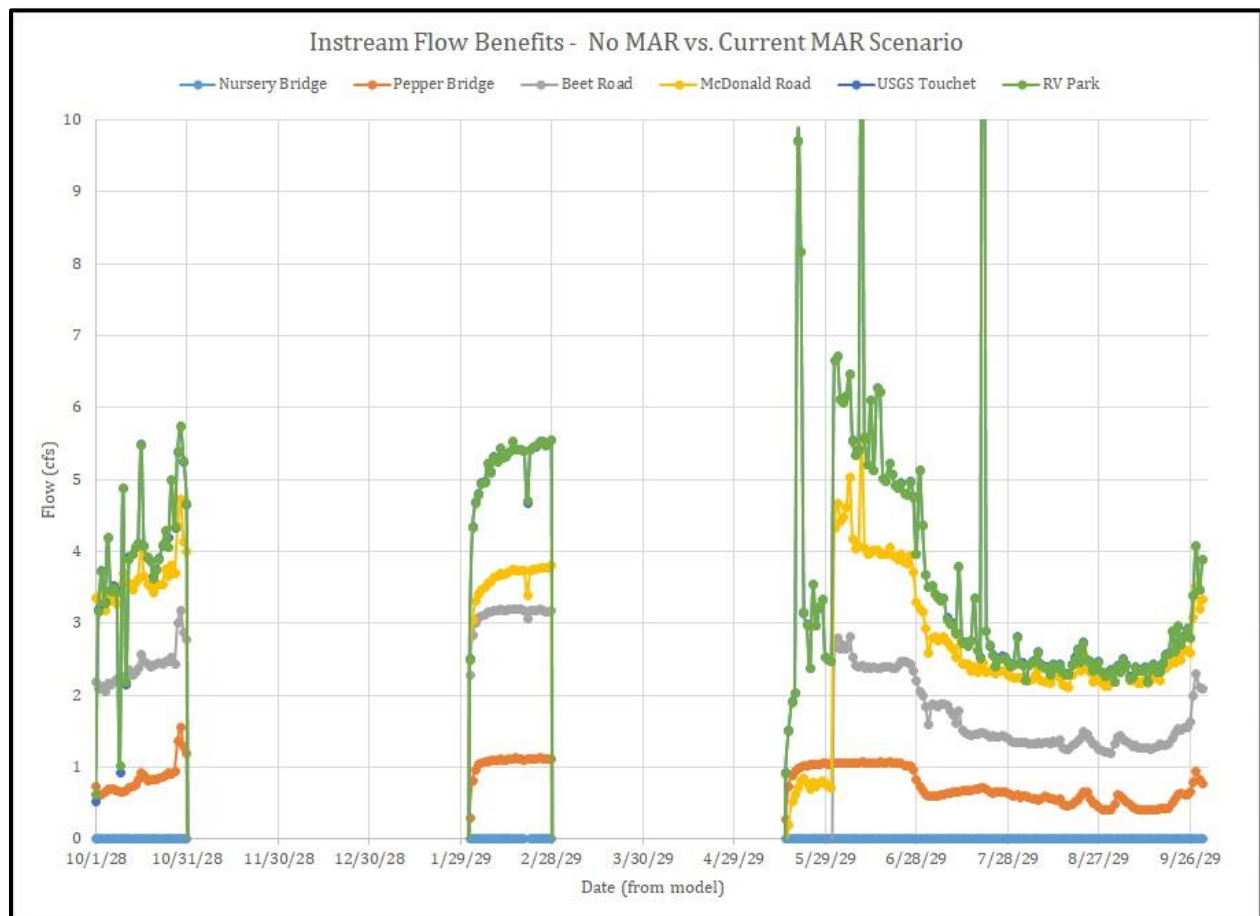


Figure 30 - Instream flow benefits from Current MAR sites at various stream gauge locations on the Walla Walla River. Results are derived from the Walla Walla Basin IWFM model.

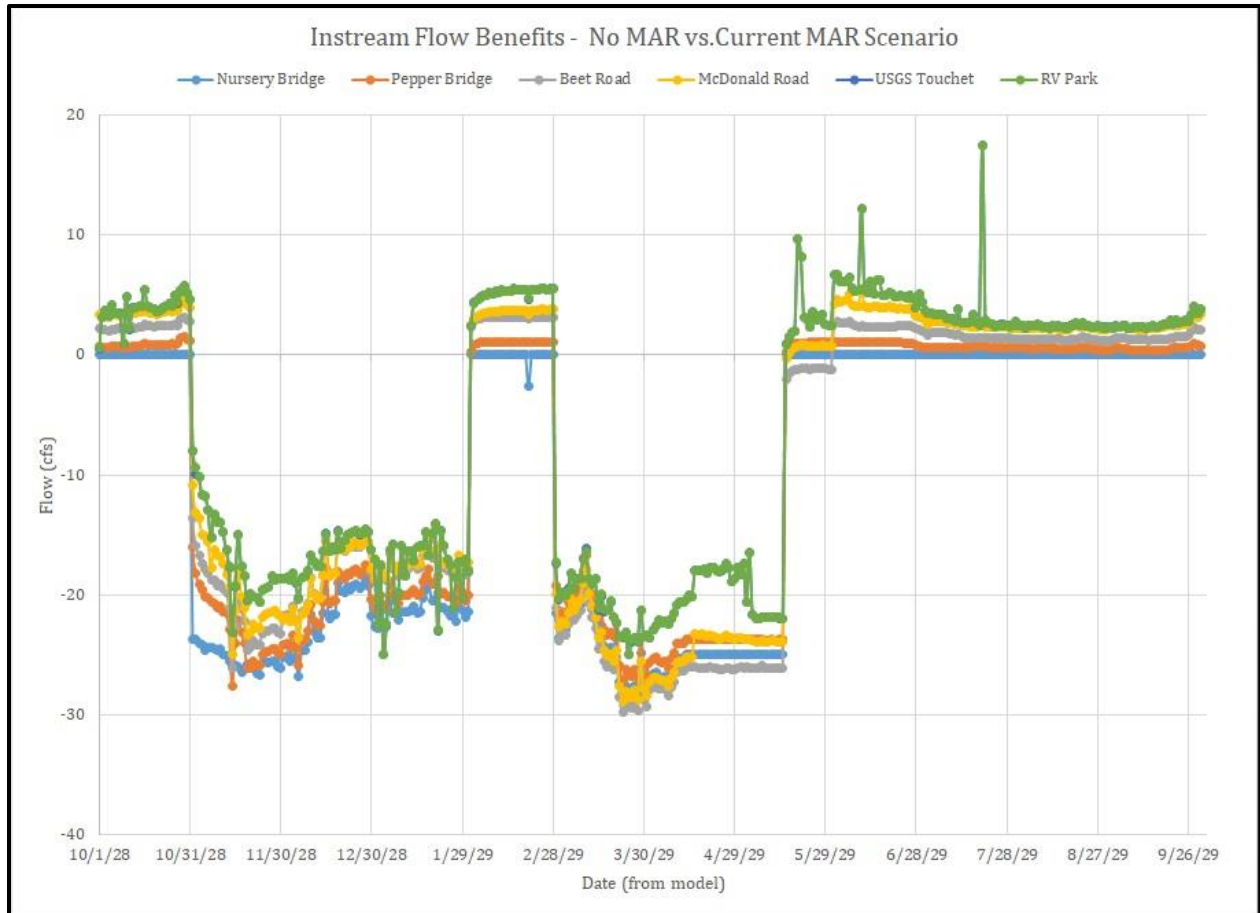


Figure 31 - Instream flow impacts from Current MAR scenarios. Positive values indicate instream flow improvements and negative values indicate MAR diversions during winter/spring periods.

APPENDIX A – R CODE AND FILES

CURRENT INSTREAM FLOW ANALYSIS – EXAMPLE IS S105 (CODE FOR OTHER SITES IS THE SAME EXCEPT FOR SITE NUMBER AND INPUT FILE NAMES)

OCR_FlowAnalysis_S105.R

Steven

Mon Jul 31 16:37:24 2017

+++++

Flow Analysis for OCR WWBIFES

Prepared by Steven Patten, Walla Walla Basin Watershed Council steven.patten@wwbwc.org

January 2017

copyright 2017

+++++

load data for management location

```
inFile <- "S105_MeanMedian_Daily.txt"
```

Data are read using read.delim. na.strings and comment.char arguments are changes from the default. na.strings has Bkw added for some measurememnts that have that value if that is not included the field is loaded as factor requiring casting backflips to get it to numeric values. comment.char has a default value of "". The header of the data file has lines beginning with #'. Setting comment.char to #' tells R to skip those lines

```
s105Data <- read.delim(inFile, na.strings = c("NA", "Bkw"),  
                      comment.char = "#")
```

Rename Columns - The order is the same as in the data file.

```
columnNames <- c("Date", "SiteName", "Agency",  
                "MeanDischarge", "MedianDischarge",  
                "BiMonth")
```

Change the column names to better values

```
names(s105Data) <- columnNames
```

Take a look at the data

```
head(s105Data)
```

```
##           Date SiteName Agency MeanDischarge MedianDischarge BiMonth
## 1 7/17/2002 0:00     S105   WWBWC      111.3163             NA      7.5
## 2 7/18/2002 0:00     S105   WWBWC      110.9842             NA      7.5
## 3 7/19/2002 0:00     S105   WWBWC      107.5567             NA      7.5
## 4 7/20/2002 0:00     S105   WWBWC      106.3937             NA      7.5
## 5 7/21/2002 0:00     S105   WWBWC      105.7015             NA      7.5
## 6 7/22/2002 0:00     S105   WWBWC      107.8320             NA      7.5
```

++++++DESCRIPTIVE STATISTICS++++++

Descriptive statistics and histogram, create with minimum, maximum and range stats

```
min(s105Data$MeanDischarge)
```

```
## [1] NA
```

```
max(s105Data$MeanDischarge)
```

```
## [1] NA
```

```
range(s105Data$MeanDischarge)
```

```
## [1] NA NA
```

If stats return NA values, check for NA

```
any(is.na(s105Data$MeanDischarge))
```

```
## [1] TRUE
```

Determine number of NAs

```
length(which(is.na(s105Data$MeanDischarge)))
```

```
## [1] 2172
```

Summary statistic functions have a na.rm argument to determine whether NA values should be used in calculations. Set na.rm = T to exclude the values

```
min(s105Data$MeanDischarge, na.rm = TRUE)
```

```
## [1] 74.83678
```

```
max(s105Data$MeanDischarge, na.rm = TRUE)
```

```
## [1] 2154.323
```

```
range(s105Data$MeanDischarge, na.rm = TRUE)
```

```
## [1] 74.83678 2154.32281
```


Mean, variance, and sd

```
mean(s105Data$MeanDischarge, na.rm = TRUE)
## [1] 234.2694

var(s105Data$MeanDischarge, na.rm = TRUE)
## [1] 48282.81

sd(s105Data$MeanDischarge, na.rm = TRUE)
## [1] 219.7335
```

Median and quartiles

```
mean(s105Data$MeanDischarge, na.rm = TRUE)
## [1] 234.2694

quantile(s105Data$MeanDischarge, na.rm = TRUE)
##           0%           25%           50%           75%          100%
##  74.83678  108.09271  144.99050  281.84032 2154.32281
```

The quantile has the probs argument to set the percentiles For the 10th and 90th percentiles set probs as

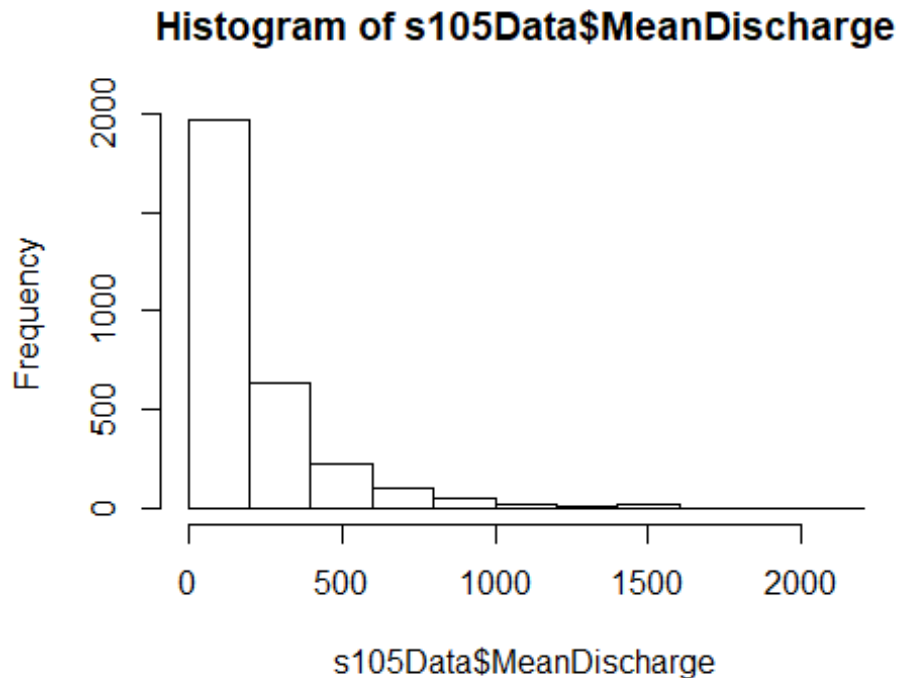
```
quantile(s105Data$MeanDischarge, probs = c(0.1,0.25,0.5,0.75, 0.9), na.rm = T
)
##           10%           25%           50%           75%           90%
##  98.23741 108.09271 144.99050 281.84032 465.63975
```

and summary which brings together mean, median, and quantiles no na.rm here. Summary counts the number of NAs in the data set.

```
summary(s105Data$MeanDischarge)
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##   74.84  108.10  145.00  234.30  281.80 2154.00   2172
```

Visualizing the MeanDischarge distribution hist plots a histogram of data

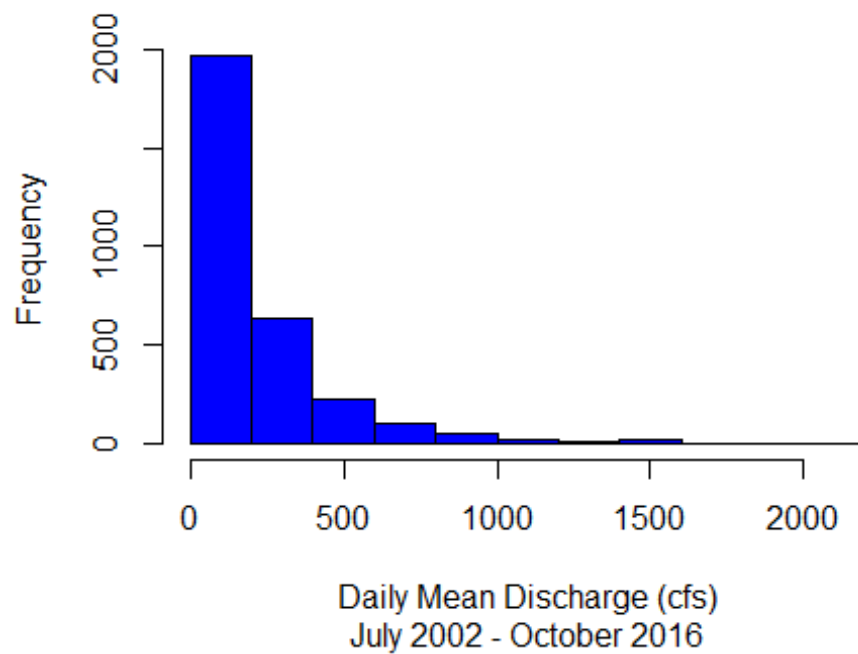
```
hist(s105Data$MeanDischarge)
```



Create title and x-axis labels. The main argument changes the title The xlab argument changes the x-axis label The sub argument adds a subtitle below the x-axis label. The col argument changes the color of the bars

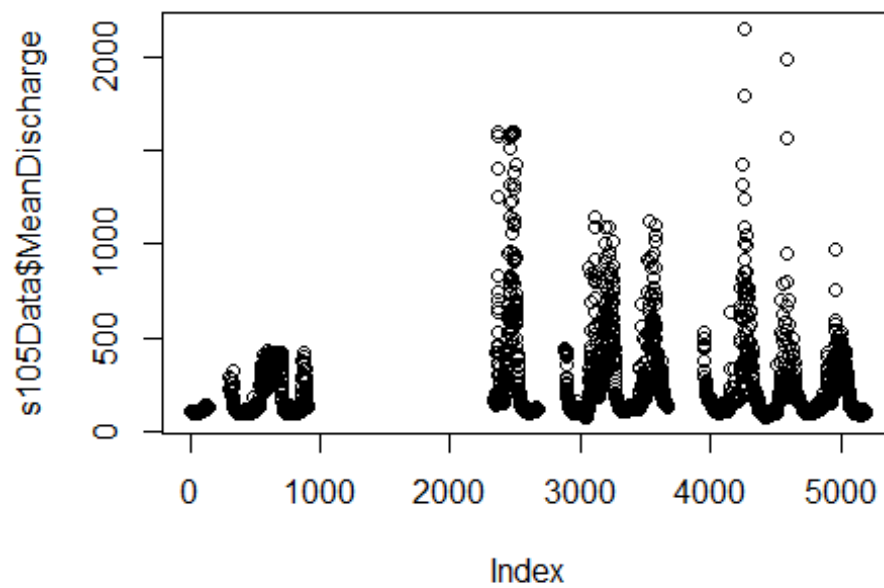
```
hist(s105Data$MeanDischarge,  
     main = "Daily Mean Discharge - S-105 WWR @ Milton-Freewater, OR",  
     xlab = "Daily Mean Discharge (cfs)",  
     sub = "July 2002 - October 2016",  
     col = "blue")
```

Daily Mean Discharge - S-105 WWR @ Milton-Freewater



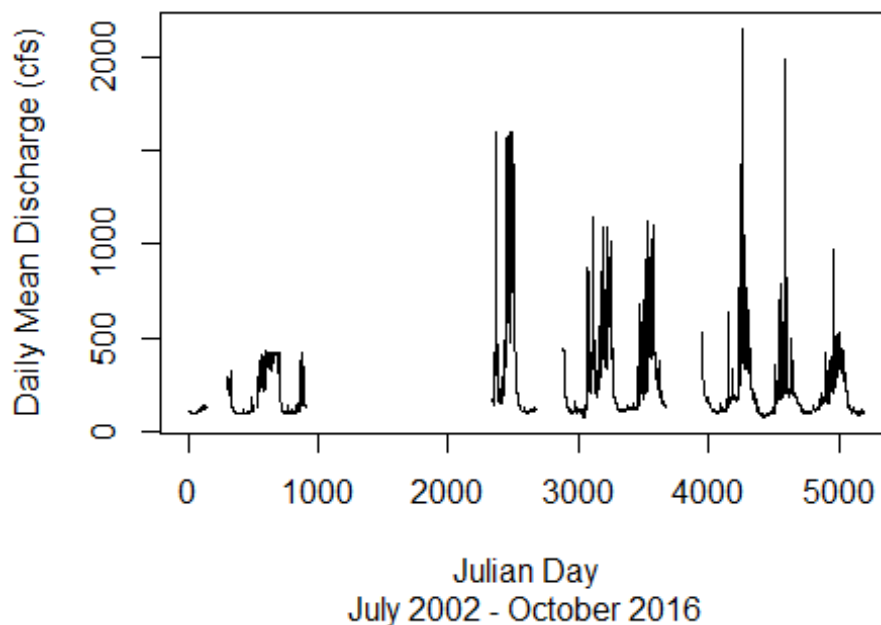
Plot Hydrograph

```
plot(s105Data$MeanDischarge)
```



```
plot(s105Data$MeanDischarge,
     main = "Daily Mean Discharge - S-105 WWR @ Milton-Freewater, OR",
     xlab = "Julian Day",
     ylab = "Daily Mean Discharge (cfs)",
     sub = "July 2002 - October 2016",
     type = "l")
```

Daily Mean Discharge - S-105 WWR @ Milton-Freewater



*****MONTHLY STATISTICS*****
 Descriptive statistics and plots by groups Summary statistics by month Use the aggregate function to do the summary statistics. The first argument is a vector, matrix, or data frame with data to aggregate. The by argument is a list of values to aggregate the data by. It's best to include a name. the last argument is the function to apply during aggregation. This function can only take one value. Since the na.rm argument must be set define an inline function that takes one argument and pass that to the summary statistic function. min

```
aggregate(MeanDischarge ~ BiMonth, data = s105Data,
          function(x) min(x, na.rm = TRUE))
```

```
##      BiMonth MeanDischarge
## 1         1.0      122.72939
## 2         1.5      140.43459
## 3         2.0      147.88823
## 4         2.5      151.76339
## 5         3.0      178.24889
## 6         3.5      206.13590
## 7         4.0      197.92688
## 8         4.5      180.12253
```

```
## 9      5.0      147.41730
## 10     5.5      136.61449
## 11     6.0      108.93333
## 12     6.5       97.84173
## 13     7.0       94.89238
## 14     7.5       89.61708
## 15     8.0       79.72966
## 16     8.5       78.77461
## 17     9.0       80.39524
## 18     9.5       84.10655
## 19    10.0       93.46252
## 20    10.5       90.25554
## 21    11.0       74.83678
## 22    11.5       91.34141
## 23    12.0      118.32603
## 24    12.5      121.27594
```

Define a new function to calculate summary statistics

```
s105Summary <- function(x)
{
  #' calculate some summary statistics
  theMin <- min(x, na.rm = TRUE)
  theMax <- max(x, na.rm = TRUE)
  theMean <- round(mean(x, na.rm = TRUE), digits = 2)
  theVar <- round(var(x, na.rm = TRUE), digits = 2)
  theMedian <- median(x, na.rm = TRUE)
  theQuantile = quantile(x, probs = c(0.1,0.25,0.5,0.75, 0.9), na.rm = T)
  theN <- length(which(!is.na(x)))

  #' build the output vector
  out <- c(Min = theMin, Median = theMedian,
           Max = theMax, Mean = theMean, Quantile = theQuantile,
           Var = theVar, N = theN)
  return(out)
}
```

Use aggregate to create the summary then display it and export it

```
s105Summary <- aggregate(MeanDischarge ~ BiMonth, data = s105Data,
                          s105Summary)

s105Summary
```

##	BiMonth	MeanDischarge.Min	MeanDischarge.Median	MeanDischarge.Max
## 1	1.0	122.72939	180.75754	1600.00000
## 2	1.5	140.43459	278.75007	1141.50034
## 3	2.0	147.88823	215.65565	1987.49222
## 4	2.5	151.76339	283.84897	970.99278
## 5	3.0	178.24889	304.37829	2154.32281
## 6	3.5	206.13590	414.81523	1572.54527
## 7	4.0	197.92688	465.58645	1581.63342

## 8	4.5	180.12253	400.79780	1600.00000
## 9	5.0	147.41730	384.09112	1600.00000
## 10	5.5	136.61449	255.40185	1430.46001
## 11	6.0	108.93333	222.05115	1011.05097
## 12	6.5	97.84173	174.01550	444.33201
## 13	7.0	94.89238	129.09330	203.83792
## 14	7.5	89.61708	108.30179	160.63375
## 15	8.0	79.72966	101.39002	135.41503
## 16	8.5	78.77461	99.09736	134.52777
## 17	9.0	80.39524	100.55505	155.80922
## 18	9.5	84.10655	105.27546	139.84302
## 19	10.0	93.46252	109.21819	154.03974
## 20	10.5	90.25554	109.63659	136.54177
## 21	11.0	74.83678	114.72616	180.55071
## 22	11.5	91.34141	129.69378	372.16544
## 23	12.0	118.32603	162.92647	879.41756
## 24	12.5	121.27594	193.13648	698.94655
##	MeanDischarge.Mean MeanDischarge.Quantile.10%			
## 1		294.97000	141.86134	
## 2		342.30000	167.22394	
## 3		299.23000	175.58672	
## 4		330.05000	175.37592	
## 5		398.55000	187.20647	
## 6		472.20000	290.62697	
## 7		555.11000	262.84643	
## 8		504.35000	199.13560	
## 9		467.62000	173.10711	
## 10		382.35000	150.53920	
## 11		283.79000	127.48246	
## 12		191.58000	108.15637	
## 13		130.22000	101.31755	
## 14		113.16000	96.91656	
## 15		103.07000	92.84980	
## 16		99.03000	87.77316	
## 17		102.30000	89.16546	
## 18		104.72000	93.40176	
## 19		109.79000	96.58554	
## 20		110.98000	100.96323	
## 21		118.37000	99.74450	
## 22		140.13000	106.83741	
## 23		210.66000	124.01479	
## 24		227.50000	123.98129	
##	MeanDischarge.Quantile.25% MeanDischarge.Quantile.50%			
## 1		159.21484	180.75754	
## 2		198.68726	278.75007	
## 3		187.20470	215.65565	
## 4		214.37771	283.84897	
## 5		224.94534	304.37829	
## 6		341.90461	414.81523	
## 7		385.93483	465.58645	

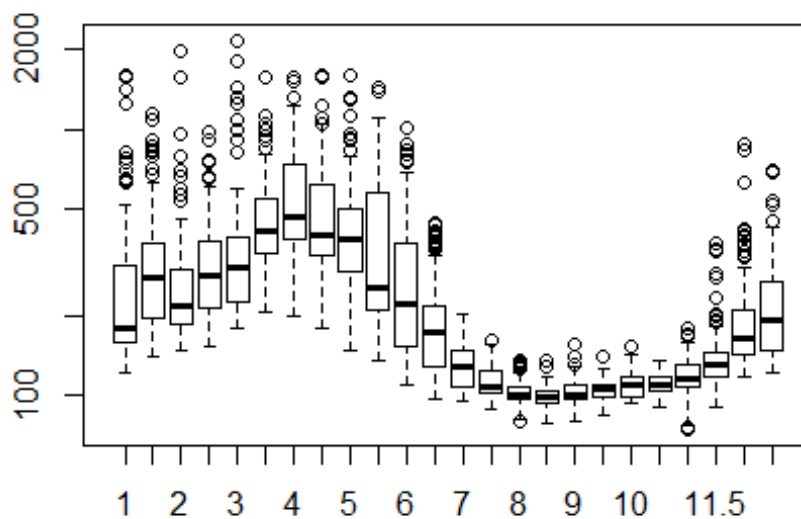
## 8	338.87785	400.79780	
## 9	294.13343	384.09112	
## 10	209.74668	255.40185	
## 11	152.45672	222.05115	
## 12	129.37879	174.01550	
## 13	108.44140	129.09330	
## 14	101.69651	108.30179	
## 15	96.81062	101.39002	
## 16	93.48745	99.09736	
## 17	96.37272	100.55505	
## 18	99.17430	105.27546	
## 19	98.95097	109.21819	
## 20	104.38667	109.63659	
## 21	108.63966	114.72616	
## 22	118.49192	129.69378	
## 23	143.13116	162.92647	
## 24	148.31207	193.13648	
##	MeanDischarge.Quantile.75%	MeanDischarge.Quantile.90%	MeanDischarge.Var
## 1	310.17590	536.17203	74826.60000
## 2	375.70537	634.27055	43227.59000
## 3	296.65996	450.87039	64002.50000
## 4	382.25334	571.47134	29704.41000
## 5	390.64510	732.86171	112274.17000
## 6	546.05920	708.93772	44269.73000
## 7	734.84612	892.67510	76100.79000
## 8	614.42587	858.54267	89582.03000
## 9	503.03304	867.03550	102475.21000
## 10	575.55485	745.39707	75548.62000
## 11	371.87822	497.12697	32627.12000
## 12	218.46773	321.62461	6825.28000
## 13	148.24162	164.15192	638.29000
## 14	123.61348	141.04421	270.73000
## 15	107.48322	117.57907	122.50000
## 16	103.74970	110.31150	84.66000
## 17	109.39619	113.47031	122.15000
## 18	110.56212	114.12661	81.18000
## 19	117.22219	123.52591	133.29000
## 20	117.47831	121.59519	76.74000
## 21	129.70582	143.97406	372.70000
## 22	144.58232	179.94982	2174.18000
## 23	208.21469	353.50080	17249.04000
## 24	266.31321	364.34170	12149.11000
##	MeanDischarge.N		
## 1	110.00000		
## 2	104.00000		
## 3	103.00000		
## 4	91.00000		
## 5	105.00000		
## 6	112.00000		
## 7	105.00000		

```
## 8      104.00000
## 9      107.00000
## 10     119.00000
## 11     131.00000
## 12     150.00000
## 13     150.00000
## 14     175.00000
## 15     158.00000
## 16     160.00000
## 17     150.00000
## 18     150.00000
## 19     135.00000
## 20     137.00000
## 21     131.00000
## 22     120.00000
## 23       99.00000
## 24     112.00000
```

Export the table to a csv file

```
write.csv(s105Summary, file = "S105Summary.csv",
          row.names = FALSE)

boxplot(MeanDischarge ~ BiMonth, data = s105Data, log = "y")
```



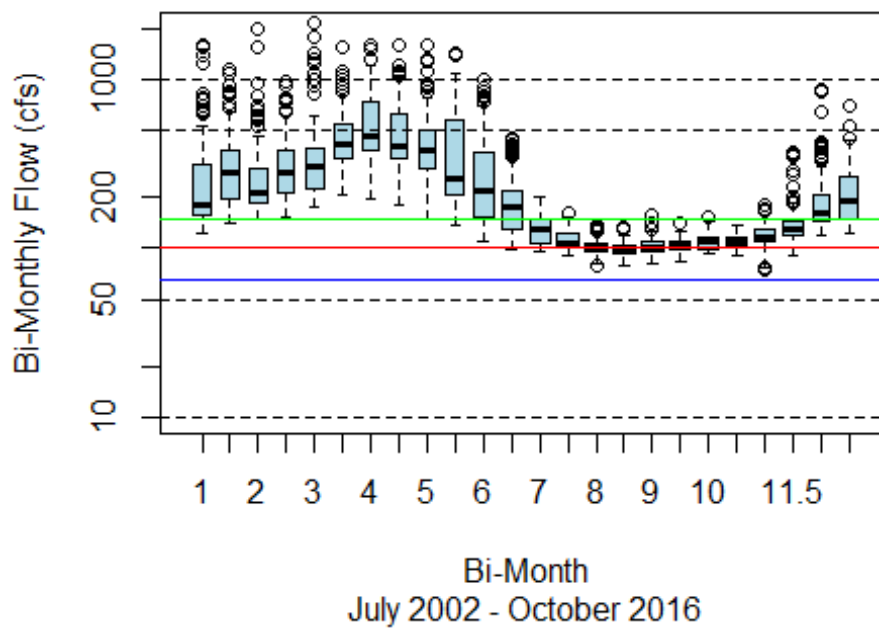
```

boxplot(MeanDischarge ~ BiMonth, data = s105Data,
        main = "Daily Mean Discharge - S105 WWR @ Milton-Freewater, OR",
        sub = "July 2002 - October 2016",
        xlab = "Bi-Month", ylab = "Bi-Monthly Flow (cfs)",
        col = "lightblue", log = "y", ylim=c(10, 2001), cex.lab=1.00, varwidth
h = T)

abline(h=c(65), col = "blue")
abline(h=c(100), col = "red")
abline(h=c(150), col = "green")
abline(h=c(1,5,10,50,500,1000), lty=2, col = "black")

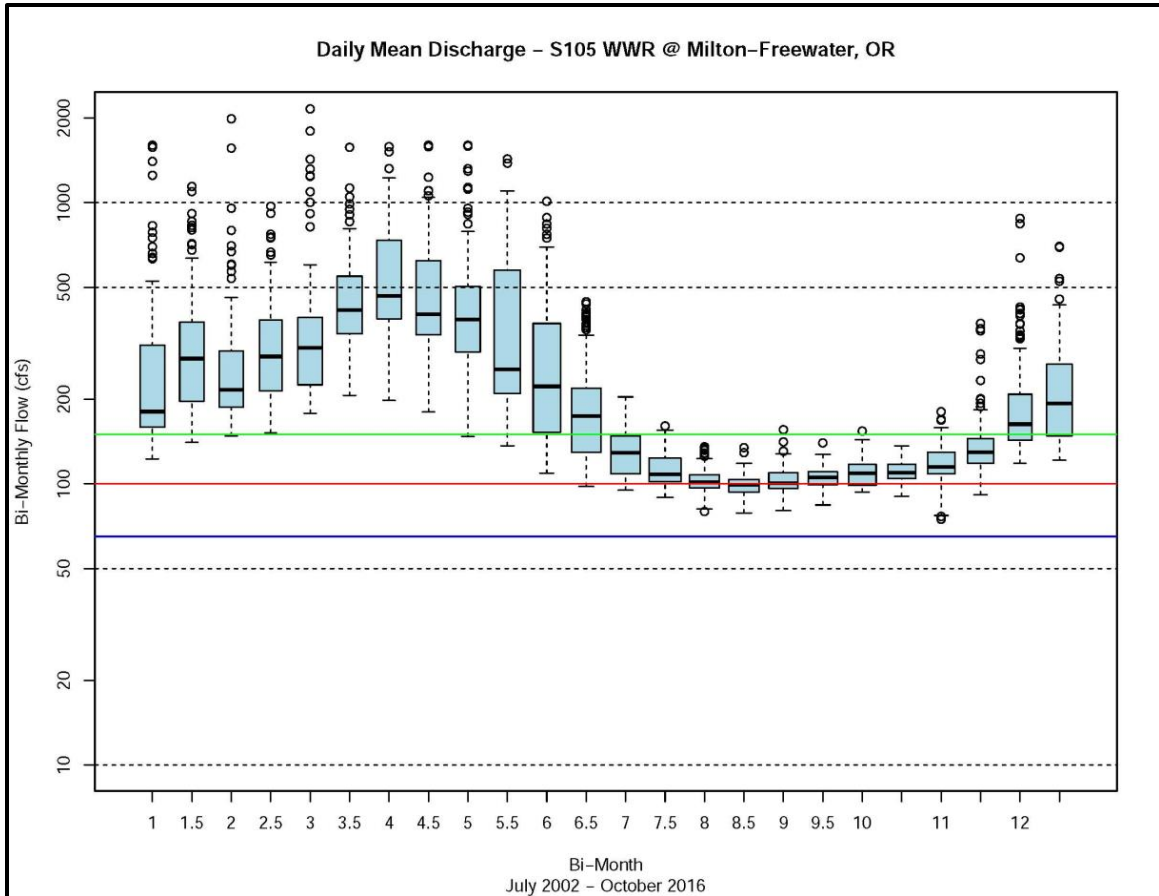
```

Daily Mean Discharge - S105 WWR @ Milton-Freewater



APPENDIX B – CURRENT INSTREAM FLOW ANALYSIS RESULTS

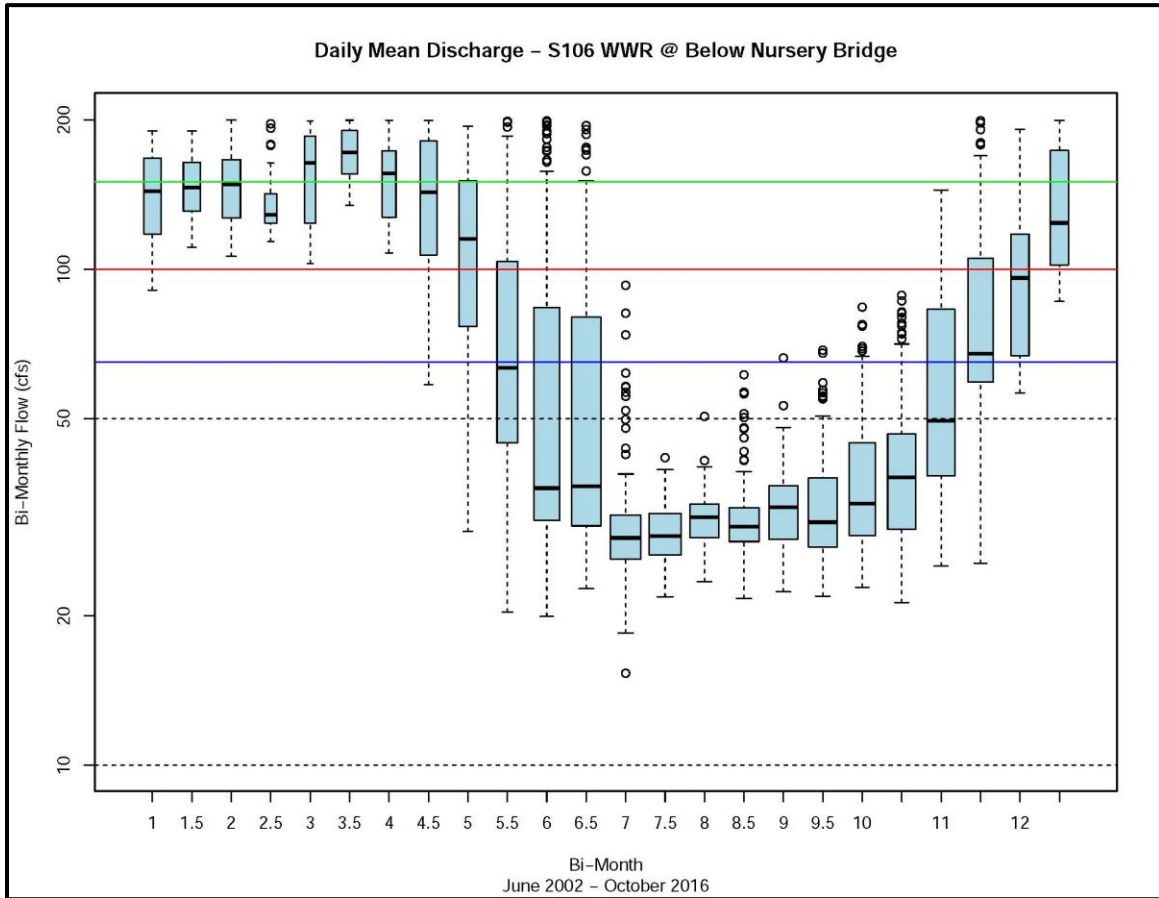
WALLA WALLA RIVER @ MILTON-FREEWATER, OR (S-105)



S-105 - Walla Walla River @ Milton-Freewater, OR

BiMonth	Minimum (cfs)	Median (cfs)	Maximum (cfs)	Mean (cfs)	Quantile.10%	Quantile.25%	Quantile.50%	Quantile.75%	Quantile.90%	Variance	Sample Size
1	122.73	180.76	1600.00	294.97	141.86	159.21	180.76	310.18	536.17	74826.60	110
1.5	140.43	278.75	1141.50	342.30	167.22	198.69	278.75	375.71	634.27	43227.59	104
2	147.89	215.66	1987.49	299.23	175.59	187.20	215.66	296.66	450.87	64002.50	103
2.5	151.76	283.85	970.99	330.05	175.38	214.38	283.85	382.25	571.47	29704.41	91
3	178.25	304.38	2154.32	398.55	187.21	224.95	304.38	390.65	732.86	112274.17	105
3.5	206.14	414.82	1572.55	472.20	290.63	341.90	414.82	546.06	708.94	44269.73	112
4	197.93	465.59	1581.63	555.11	262.85	385.93	465.59	734.85	892.68	76100.79	105
4.5	180.12	400.80	1600.00	504.35	199.14	338.88	400.80	614.43	858.54	89582.03	104
5	147.42	384.09	1600.00	467.62	173.11	294.13	384.09	503.03	867.04	102475.21	107
5.5	136.61	255.40	1430.46	382.35	150.54	209.75	255.40	575.55	745.40	75548.62	119
6	108.93	222.05	1011.05	283.79	127.48	152.46	222.05	371.88	497.13	32627.12	131
6.5	97.84	174.02	444.33	191.58	108.16	129.38	174.02	218.47	321.62	6825.28	150
7	94.89	129.09	203.84	130.22	101.32	108.44	129.09	148.24	164.15	638.29	150
7.5	89.62	108.30	160.63	113.16	96.92	101.70	108.30	123.61	141.04	270.73	175
8	79.73	101.39	135.42	103.07	92.85	96.81	101.39	107.48	117.58	122.50	158
8.5	78.77	99.10	134.53	99.03	87.77	93.49	99.10	103.75	110.31	84.66	160
9	80.40	100.56	155.81	102.30	89.17	96.37	100.56	109.40	113.47	122.15	150
9.5	84.11	105.28	139.84	104.72	93.40	99.17	105.28	110.56	114.13	81.18	150
10	93.46	109.22	154.04	109.79	96.59	98.95	109.22	117.22	123.53	133.29	135
10.5	90.26	109.64	136.54	110.98	100.96	104.39	109.64	117.48	121.60	76.74	137
11	74.84	114.73	180.55	118.37	99.74	108.64	114.73	129.71	143.97	372.70	131
11.5	91.34	129.69	372.17	140.13	106.84	118.49	129.69	144.58	179.95	2174.18	120
12	118.33	162.93	879.42	210.66	124.01	143.13	162.93	208.21	353.50	17249.04	99
12.5	121.28	193.14	698.95	227.50	123.98	148.31	193.14	266.31	364.34	12149.11	112

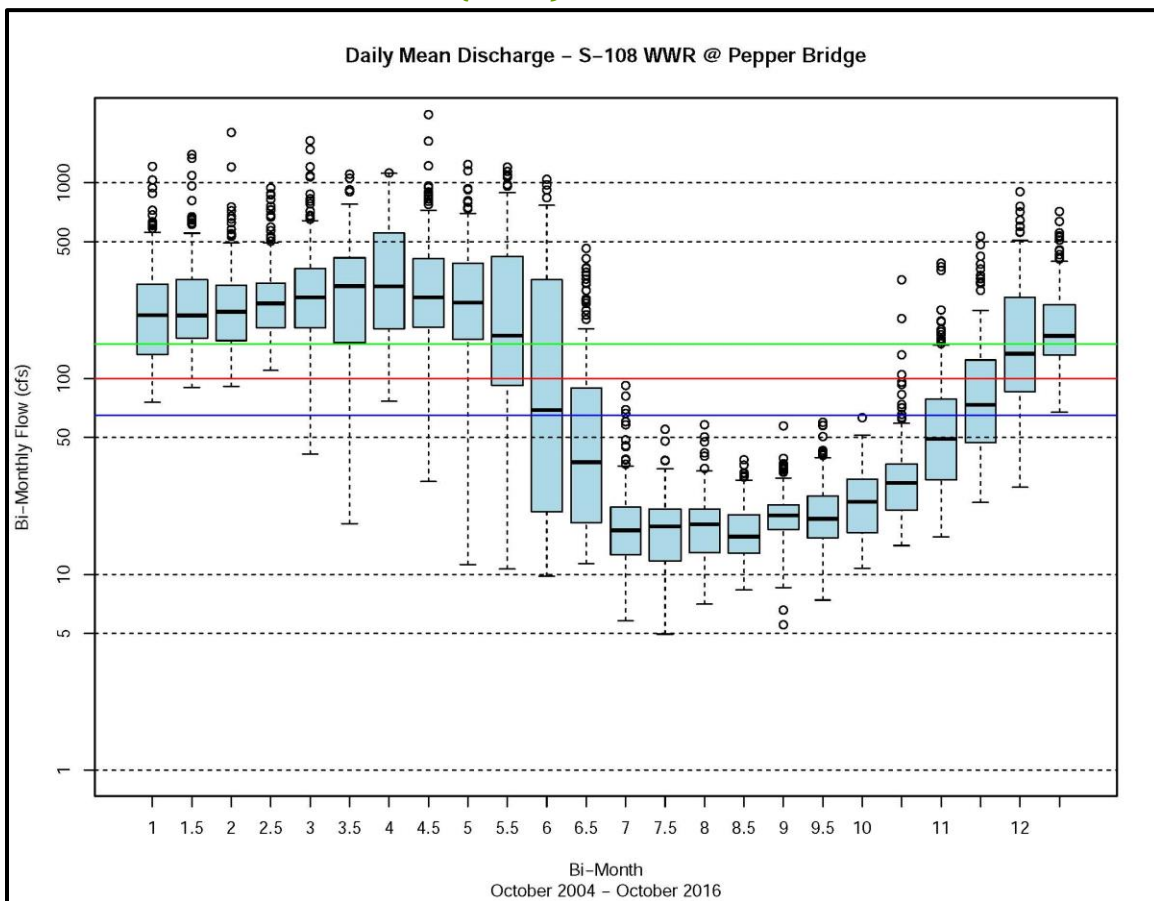
WALLA WALLA RIVER BELOW NURSERY BRIDGE (S-106)



S-106 - Walla Walla River Below Nursery Bridge

BiMonth	Minimum (cfs)	Median (cfs)	Maximum (cfs)	Mean (cfs)	Quantile.10%	Quantile.25%	Quantile.50%	Quantile.75%	Quantile.90%	Variance	Sample Size
1	90.66	143.67	189.79	141.39	101.40	117.66	143.67	167.45	176.73	828.93	53
1.5	110.71	145.96	189.82	149.06	125.74	131.01	145.96	164.25	177.30	427.81	53
2	106.10	148.43	199.79	151.09	122.93	126.98	148.43	166.35	186.48	619.17	61
2.5	113.70	128.78	196.42	138.46	121.78	123.89	128.78	141.76	178.00	533.52	27
3	102.56	163.78	199.02	155.26	112.36	124.99	163.78	184.16	194.93	1078.75	22
3.5	134.56	171.96	199.71	172.32	146.74	155.75	171.96	190.17	195.72	386.14	44
4	107.88	155.88	199.66	153.48	117.75	127.30	155.88	173.20	189.04	707.53	35
4.5	58.48	142.82	199.61	141.99	85.30	106.69	142.82	181.37	191.72	1819.14	51
5	29.58	115.01	194.36	108.11	33.80	77.42	115.01	150.43	164.59	2324.05	60
5.5	20.35	63.27	198.66	80.44	33.32	45.19	63.27	101.92	166.71	2434.94	78
6	19.94	36.19	199.14	64.90	25.14	31.17	36.19	78.26	158.29	2833.24	120
6.5	22.69	36.51	194.76	58.77	25.70	30.39	36.51	79.47	122.58	1837.26	154
7	15.32	28.72	92.75	30.89	23.96	26.05	28.72	31.96	37.69	103.38	169
7.5	0.00	28.99	41.68	28.63	23.85	26.57	28.99	32.19	34.22	35.36	182
8	23.45	31.61	50.48	31.42	26.77	28.76	31.61	33.61	35.73	14.58	150
8.5	21.69	30.27	61.27	31.37	25.01	28.24	30.27	33.01	37.73	39.20	163
9	22.37	33.14	66.25	33.12	25.71	28.57	33.14	36.59	39.38	38.98	150
9.5	21.91	30.90	68.68	33.64	25.58	27.56	30.90	37.89	42.77	78.99	150
10	22.84	33.67	83.87	38.23	27.16	29.12	33.67	44.34	57.63	165.44	126
10.5	21.28	38.07	88.58	42.02	26.26	30.04	38.07	46.50	66.47	238.50	144
11	25.22	49.47	144.32	61.71	29.64	38.33	49.47	82.97	109.44	932.13	138
11.5	25.51	67.55	199.15	84.41	38.81	59.26	67.55	105.13	154.47	1880.18	119
12	56.30	95.99	191.39	98.58	63.70	67.11	95.99	116.17	144.31	1133.19	60
12.5	86.08	123.93	199.40	135.84	90.44	102.78	123.93	172.98	187.98	1405.40	60

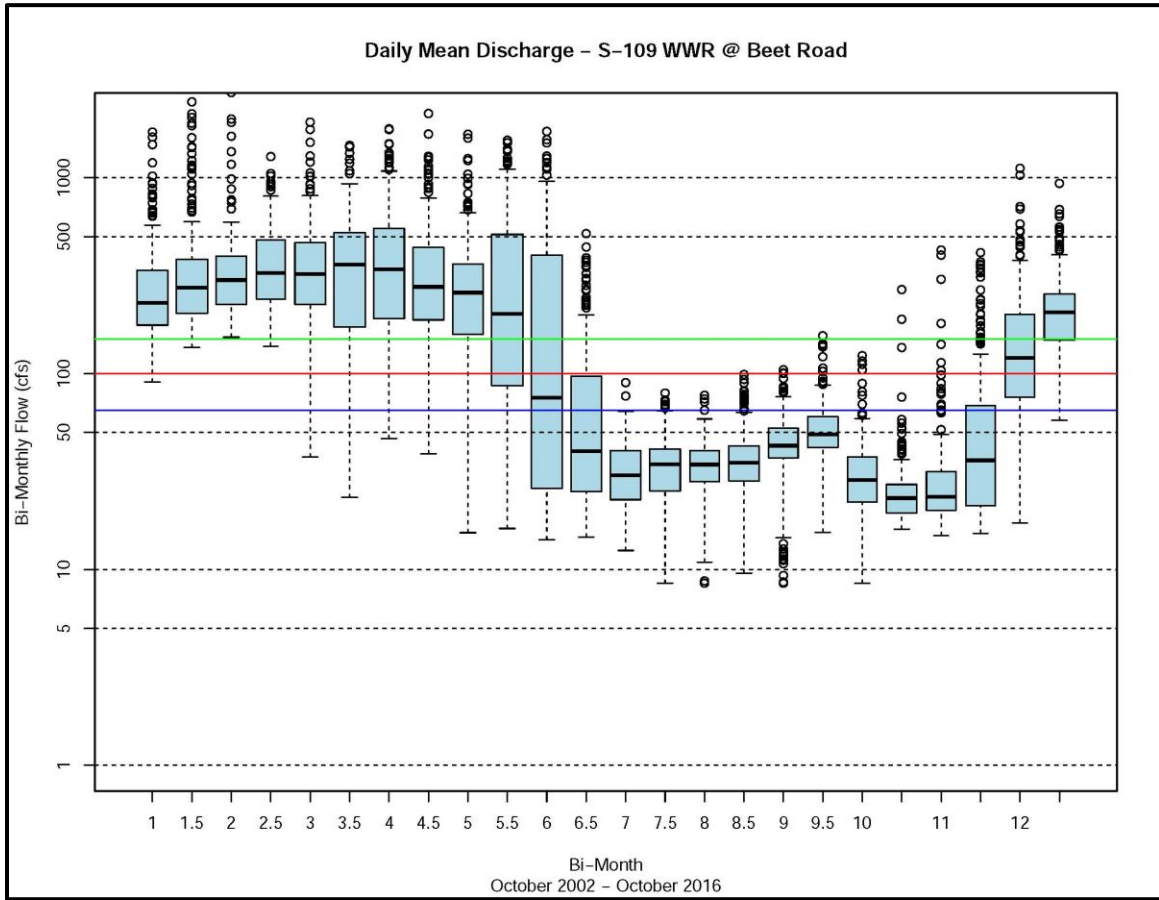
WALLA WALLA RIVER @ PEPPER BRIDGE (S-108)



S-108 - Walla Walla River @ Pepper Bridge

BiMonth	Minimum (cfs)	Median (cfs)	Maximum (cfs)	Mean (cfs)	Quantile.10%	Quantile.25%	Quantile.50%	Quantile.75%	Quantile.90%	Variance	Sample Size
1	75.59	210.96	1212.39	257.09	112.90	133.18	210.96	303.30	486.14	31902.41	180
1.5	89.98	210.11	1393.85	276.46	118.94	161.17	210.11	320.03	493.28	37958.78	188
2	91.19	219.55	1808.01	264.17	128.37	157.39	219.55	298.85	441.37	34393.10	180
2.5	110.16	241.97	941.66	283.56	147.88	182.28	241.97	306.97	509.23	26886.00	158
3	41.14	259.70	1640.80	310.07	112.27	182.16	259.70	365.67	515.96	53342.50	180
3.5	18.16	296.79	1106.39	311.07	104.18	153.23	296.79	412.06	533.19	37046.32	192
4	76.50	295.27	1121.83	380.87	108.79	180.98	295.27	553.92	741.99	62203.67	180
4.5	29.82	259.97	2230.71	335.34	87.32	183.45	259.97	408.85	637.77	74911.89	180
5	11.24	244.12	1240.00	291.80	81.30	158.80	244.12	386.57	543.86	42840.76	180
5.5	10.65	165.41	1201.97	286.75	24.33	92.90	165.41	420.19	666.85	76240.51	192
6	9.80	68.98	1042.20	194.22	15.17	20.95	68.98	319.80	540.09	54196.58	180
6.5	11.35	37.43	462.42	77.28	15.02	18.41	37.43	88.98	213.04	8337.15	180
7	5.80	16.78	92.22	20.26	9.73	12.68	16.78	22.00	33.43	167.16	174
7.5	4.96	17.62	55.11	17.69	9.30	11.71	17.62	21.50	27.90	60.17	192
8	7.05	17.99	58.12	18.58	9.83	12.92	17.99	21.59	28.24	62.28	180
8.5	8.33	15.59	38.51	16.91	10.89	12.86	15.59	20.10	24.35	32.76	192
9	5.53	20.02	57.36	20.22	13.02	17.09	20.02	22.68	26.60	39.40	180
9.5	7.40	19.23	59.81	21.89	12.98	15.44	19.23	25.11	35.37	89.33	180
10	10.75	23.46	63.14	24.85	14.45	16.35	23.46	30.68	38.44	97.33	179
10.5	14.04	29.39	319.48	35.13	18.20	21.35	29.39	36.54	52.75	874.90	192
11	15.54	49.32	388.65	67.76	23.53	30.56	49.32	77.99	155.13	3593.59	180
11.5	23.29	73.49	534.05	105.39	34.30	47.23	73.49	124.43	209.18	8137.40	180
12	27.85	133.93	900.54	185.76	57.08	85.90	133.93	258.70	360.76	21602.11	180
12.5	67.47	165.13	713.61	201.13	96.28	132.06	165.13	236.63	350.73	12470.28	192

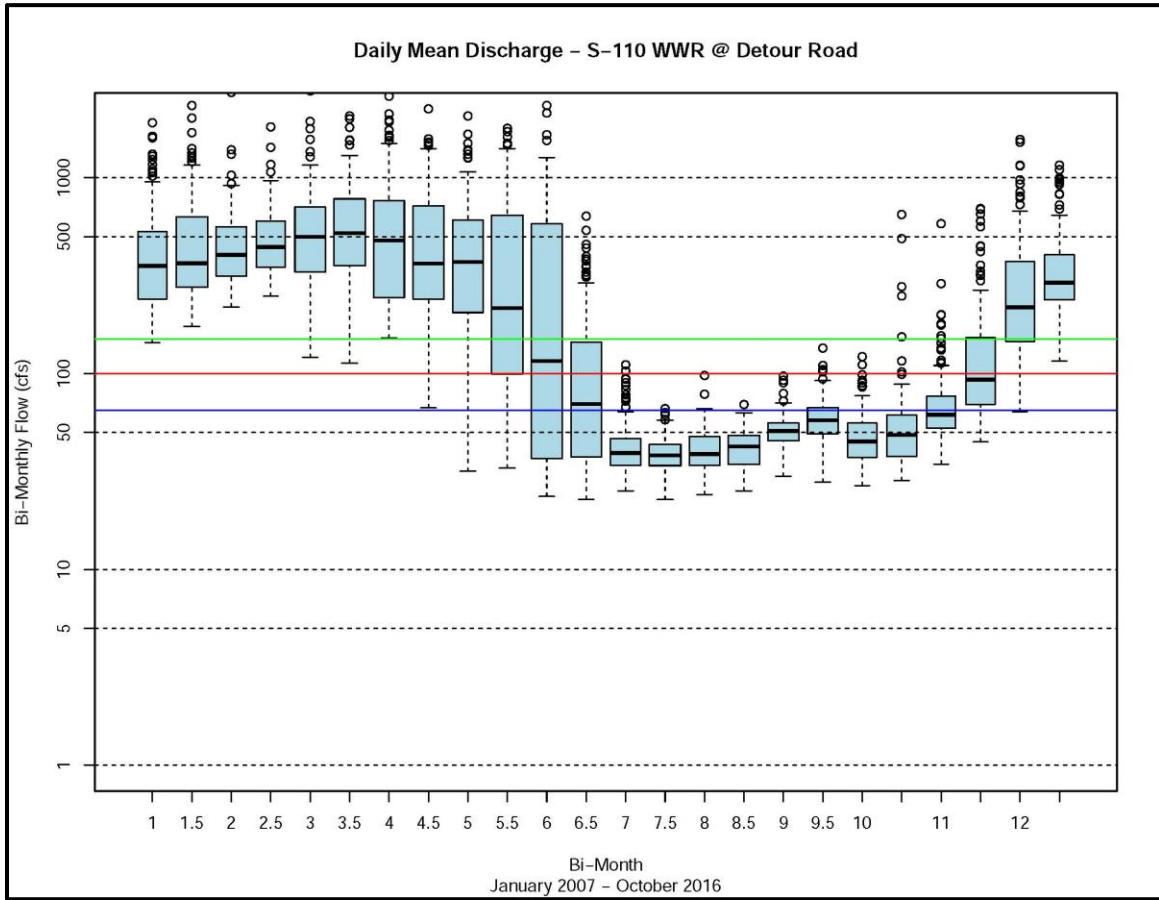
WALLA WALLA RIVER @ BEET ROAD (S-109)



S-109 - Walla Walla River @ Beet Road

BiMonth	Minimum (cfs)	Median (cfs)	Maximum (cfs)	Mean (cfs)	Quantile.10%	Quantile.25%	Quantile.50%	Quantile.75%	Quantile.90%	Variance	Sample Size
1	90.50	230.13	1712.60	307.48	154.60	176.93	230.13	335.72	555.48	59018.55	210
1.5	135.82	275.13	2441.93	385.92	164.54	202.94	275.13	384.29	684.36	129898.69	219
2	153.42	300.49	3788.49	388.76	186.68	225.39	300.49	398.48	544.72	143419.96	210
2.5	137.94	326.49	1283.23	391.61	217.33	240.57	326.49	479.33	675.41	44044.41	186
3	37.47	321.76	1924.53	382.88	137.28	225.08	321.76	466.76	657.31	75069.01	210
3.5	23.29	361.01	1462.55	387.07	73.70	174.36	361.01	521.35	735.32	76096.56	224
4	46.62	340.66	1778.65	435.14	101.59	192.50	340.66	551.58	880.80	113223.10	210
4.5	38.90	277.40	2129.06	362.33	116.84	188.19	277.40	435.25	734.82	86862.95	210
5	15.40	259.21	1670.05	304.75	75.57	159.06	259.21	362.40	550.35	61045.23	210
5.5	16.18	202.00	1553.96	344.73	29.39	86.84	202.00	513.37	906.83	126686.05	224
6	14.16	75.38	1725.57	249.71	21.96	25.94	75.38	402.46	645.78	108994.24	210
6.5	14.63	40.19	518.73	82.35	21.30	25.09	40.19	96.27	226.37	8555.18	210
7	12.49	30.30	89.93	33.08	18.88	22.70	30.30	40.51	52.05	176.79	205
7.5	8.50	34.50	79.51	34.15	12.90	25.15	34.50	41.25	51.57	212.36	208
8	8.50	34.30	77.45	33.81	17.30	28.04	34.30	40.37	46.68	138.65	195
8.5	9.58	35.04	98.89	38.14	24.64	28.33	35.04	42.70	57.30	241.64	208
9	8.50	42.87	104.60	45.70	29.65	37.12	42.87	52.80	67.09	325.16	195
9.5	15.48	48.90	156.00	53.74	33.06	41.98	48.90	60.33	73.64	499.14	206
10	8.50	28.68	123.42	32.59	17.47	22.05	28.68	37.62	50.47	308.72	195
10.5	16.06	23.12	268.58	27.49	17.75	19.41	23.12	27.12	35.71	542.31	208
11	14.90	23.54	427.66	36.26	17.99	20.06	23.54	31.64	63.94	2372.41	195
11.5	15.28	36.07	415.03	69.30	17.86	21.16	36.07	68.81	170.77	6276.85	195
12	17.29	120.38	1118.30	167.73	35.85	75.63	120.38	200.48	335.38	25015.43	195
12.5	57.73	205.32	936.24	228.67	117.11	148.71	205.32	255.17	363.21	15370.22	208

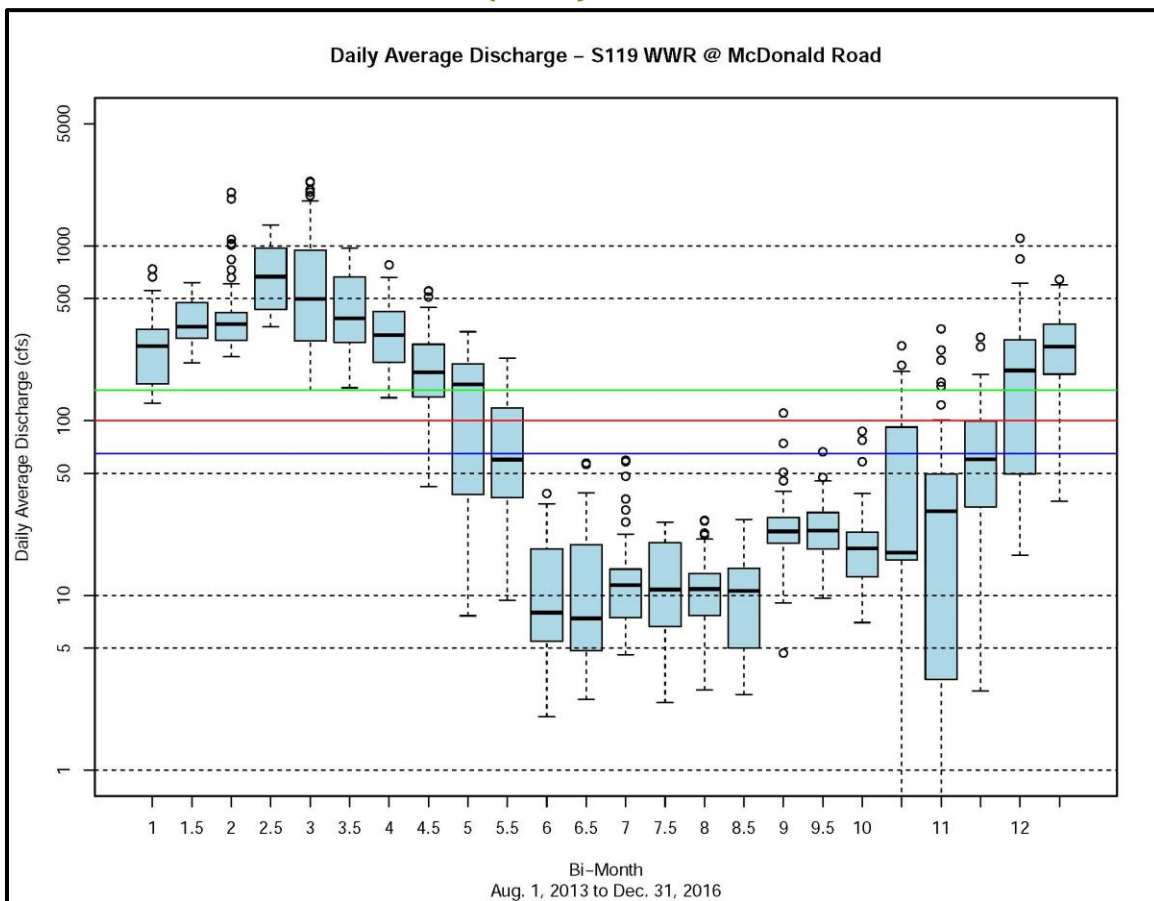
WALLA WALLA RIVER @ DETOUR ROAD (S-110)



S-110 - Walla Walla River @ Detour Road

BiMonth	Minimum (cfs)	Median (cfs)	Maximum (cfs)	Mean (cfs)	Quantile.10%	Quantile.25%	Quantile.50%	Quantile.75%	Quantile.90%	Variance	Sample Size
1	144.00	355.00	3970.00	517.79	189.20	240.50	355.00	531.00	1044.00	302214.01	135
1.5	174.00	366.00	4440.00	532.43	228.70	276.75	366.00	628.75	940.40	257949.53	158
2	219.00	404.00	3280.00	492.92	267.10	315.75	404.00	561.50	693.40	125469.01	150
2.5	249.00	443.00	1820.00	513.92	310.60	349.00	443.00	602.00	789.60	54430.52	133
3	121.00	499.00	3030.00	579.51	218.00	333.25	499.00	707.75	944.20	167887.24	150
3.5	113.00	522.50	2070.00	600.93	170.70	358.25	522.50	779.00	1044.00	138106.40	160
4	152.00	478.50	2610.00	623.45	186.00	244.50	478.50	764.25	1401.00	229139.12	150
4.5	66.80	364.50	4600.00	541.23	178.60	240.50	364.50	716.75	1032.00	257526.36	150
5	31.70	371.50	2070.00	460.41	102.17	205.25	371.50	605.50	929.70	141713.49	150
5.5	32.90	216.00	1790.00	397.87	46.54	100.35	216.00	638.00	988.40	165797.84	160
6	23.60	116.00	2340.00	337.82	30.56	36.85	116.00	573.00	894.30	183451.93	150
6.5	22.80	69.80	637.00	116.31	32.29	37.63	69.80	144.50	311.40	13179.13	150
7	25.20	39.30	111.00	43.61	30.88	34.00	39.30	46.60	61.22	236.73	149
7.5	22.80	38.20	66.20	38.94	29.42	33.90	38.20	43.50	50.82	68.57	159
8	24.10	38.85	97.80	40.81	27.69	34.10	38.85	47.50	52.69	120.16	150
8.5	25.20	42.40	69.50	41.85	29.49	34.40	42.40	48.25	52.90	83.94	160
9	29.90	50.90	97.10	51.48	40.78	45.43	50.90	56.08	61.43	103.18	150
9.5	27.90	57.80	135.00	60.02	44.16	49.33	57.80	66.75	81.02	270.08	150
10	26.80	45.00	122.00	49.28	32.92	37.35	45.00	55.90	69.78	295.95	135
10.5	28.40	48.70	64.90	61.53	35.69	37.80	48.70	60.05	78.18	4687.46	144
11	34.50	61.60	583.00	76.03	42.96	52.70	61.60	76.50	111.80	3276.19	135
11.5	44.80	93.10	697.00	144.03	55.72	69.45	93.10	152.50	317.60	18195.73	135
12	63.80	218.00	1570.00	312.31	116.40	146.00	218.00	373.00	565.20	72643.17	133
12.5	116.00	291.50	1160.00	355.10	170.00	239.00	291.50	403.50	588.50	40713.32	144

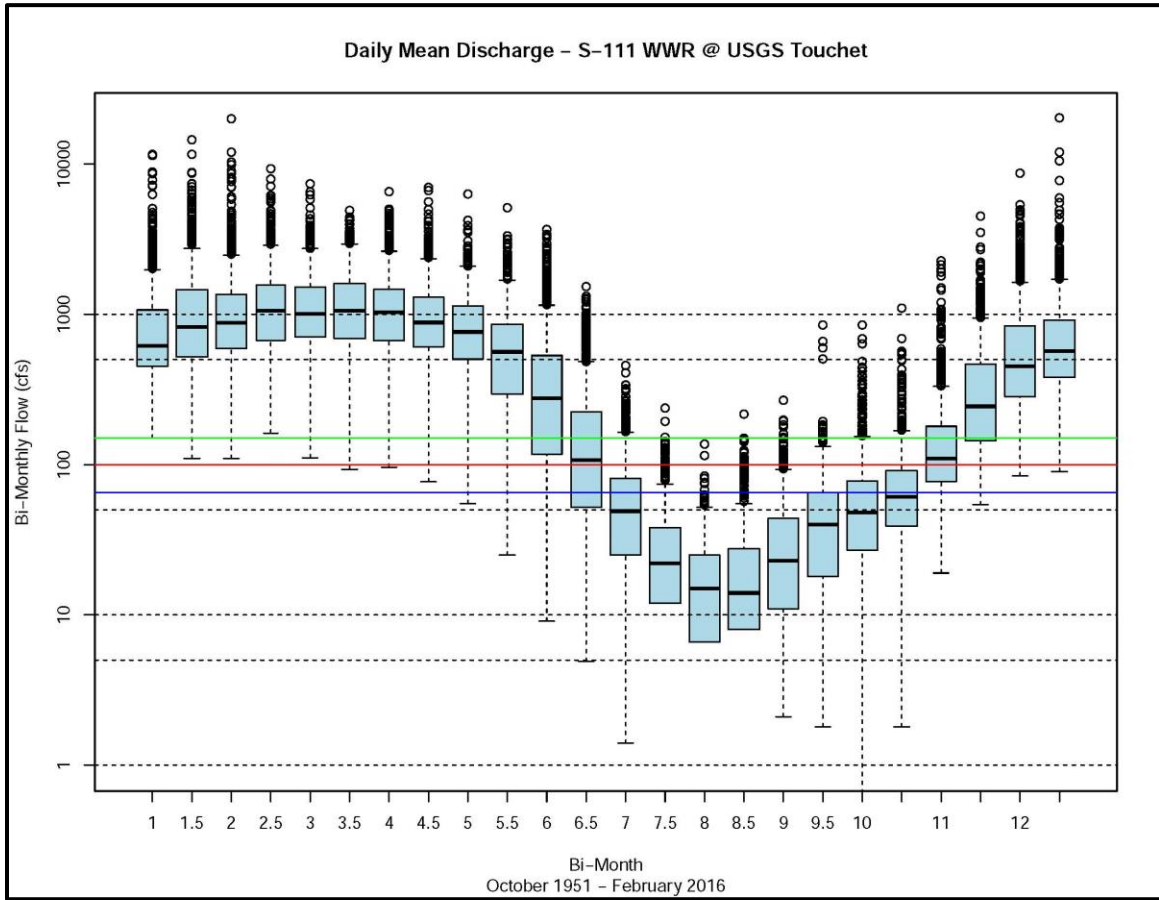
WALLA WALLA RIVER @ McDONALD ROAD (S-119)



S-119 - Walla Walla River @ McDonald Road

BiMonth	Minimum (cfs)	Median (cfs)	Maximum (cfs)	Mean (cfs)	Quantile.10%	Quantile.25%	Quantile.50%	Quantile.75%	Quantile.90%	Variance	Sample Size
1	125.72	267.91	738.59	290.26	149.63	162.13	267.91	334.28	539.92	23041.12	43
1.5	214.31	345.30	618.19	377.63	235.58	296.40	345.30	471.43	548.78	12960.74	48
2	232.26	356.59	2024.10	482.91	245.74	289.04	356.59	416.13	941.99	146913.88	45
2.5	345.39	667.38	1319.42	706.68	366.95	437.18	667.38	970.42	1081.57	86377.79	40
3	149.71	496.90	2339.94	772.94	210.53	286.20	496.90	945.79	1889.34	426687.07	45
3.5	154.36	385.14	972.94	467.66	182.43	283.26	385.14	657.79	873.01	63971.14	48
4	135.32	308.56	779.52	335.44	154.95	215.83	308.56	422.02	574.78	25283.99	45
4.5	41.87	188.87	553.85	213.01	63.39	136.71	188.87	273.81	366.26	16472.00	45
5	7.65	161.09	323.06	139.62	9.63	37.73	161.09	211.60	242.32	8624.27	45
5.5	9.39	59.88	227.91	77.25	23.46	36.43	59.88	115.86	148.08	2889.86	48
6	2.02	7.97	38.28	12.58	4.06	5.46	7.97	18.48	28.59	94.22	45
6.5	2.54	7.39	57.22	14.71	3.44	4.83	7.39	19.48	32.48	195.65	43
7	4.59	11.45	59.38	14.93	5.64	7.45	11.45	14.15	29.02	163.52	45
7.5	2.43	10.81	26.22	12.61	3.22	6.74	10.81	20.03	24.39	60.28	48
8	2.88	10.89	26.89	11.32	4.97	7.69	10.89	13.25	20.41	29.44	60
8.5	2.71	10.60	27.25	10.92	3.55	5.20	10.60	14.33	19.81	40.97	62
9	4.68	23.24	110.63	25.96	14.25	19.88	23.24	27.57	34.65	231.35	60
9.5	9.65	23.47	66.39	25.70	13.86	18.51	23.47	29.69	40.34	120.59	54
10	6.99	18.62	87.06	22.15	8.49	12.82	18.62	23.07	34.30	296.39	39
10.5	0.53	17.60	268.23	64.97	14.54	15.99	17.60	90.37	157.68	4524.95	34
11	0.53	30.27	335.45	48.22	0.71	6.90	30.27	49.15	107.78	4174.08	58
11.5	2.84	60.25	300.62	74.32	3.18	32.40	60.25	98.60	150.04	3810.92	60
12	17.00	193.94	1106.67	222.99	29.09	50.29	193.94	283.80	488.03	46011.33	60
12.5	34.66	265.21	643.46	270.77	111.29	185.69	265.21	356.99	456.90	18914.88	64

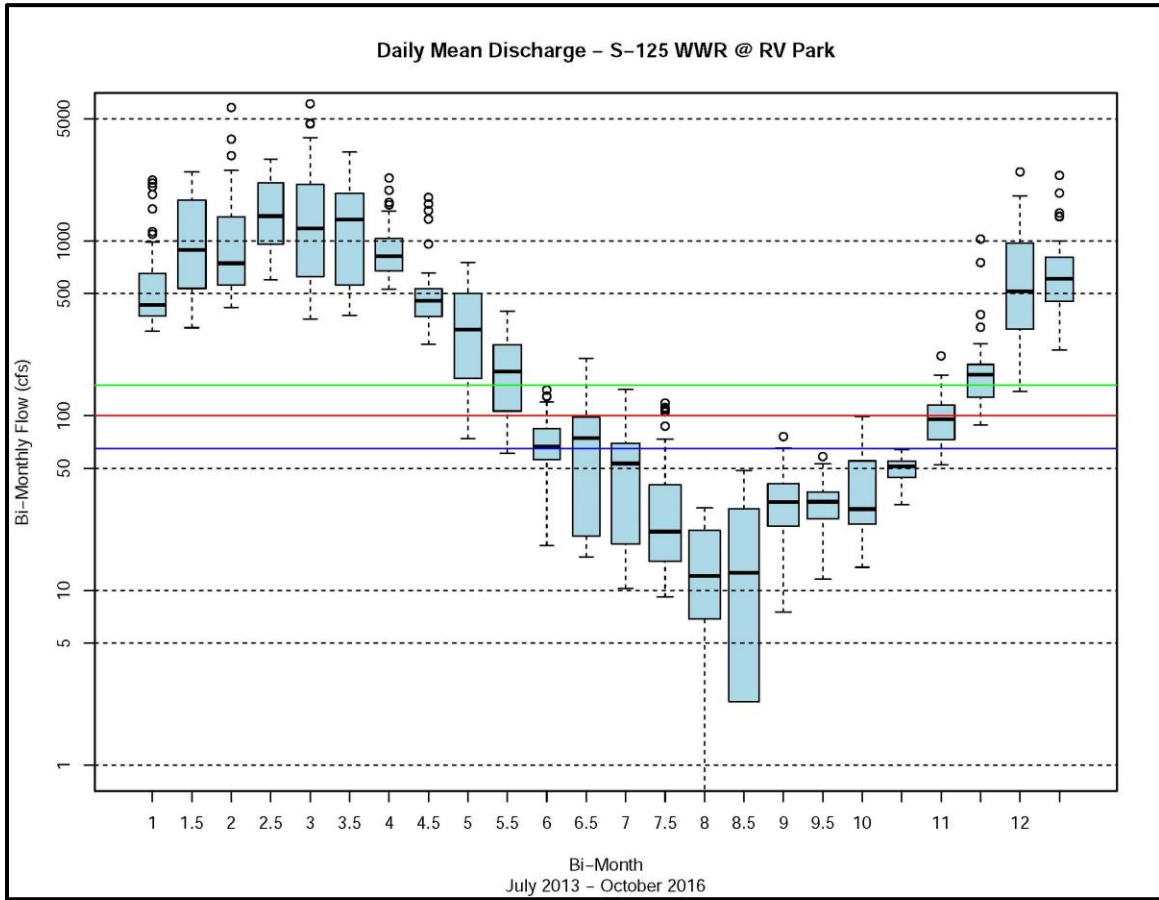
WALLA WALLA RIVER BELOW TOUCHET RIVER (S-111)



S-111 - Walla Walla River Below Touchet River

BiMonth	Minimum (cfs)	Median (cfs)	Maximum (cfs)	Mean (cfs)	Quantile.10%	Quantile.25%	Quantile.50%	Quantile.75%	Quantile.90%	Variance	Sample Size
1	150.00	618.00	11600.00	952.71	332.00	452.00	618.00	1070.00	1820.00	1173098.91	975
1.5	110.00	824.50	14500.00	1225.32	389.80	520.00	824.50	1460.00	1549126.06	1040	
2	110.00	880.00	20000.00	1205.10	440.80	591.00	880.00	1360.00	2110.00	1676810.32	969
2.5	162.00	1060.00	9310.00	1315.73	477.40	670.00	1060.00	1570.00	2389.00	1027225.17	848
3	111.00	1010.00	7390.00	1225.80	500.00	705.00	1010.00	1520.00	2210.00	643629.13	960
3.5	93.00	1060.00	4910.00	1233.05	415.00	691.50	1060.00	1600.00	2210.00	601529.59	1024
4	96.00	1030.00	6550.00	1215.99	473.80	668.00	1030.00	1462.50	2250.00	643675.47	960
4.5	77.00	881.50	6990.00	1058.50	365.80	607.25	881.50	1302.50	1941.00	548723.55	960
5	55.00	764.00	6320.00	875.20	248.50	503.50	764.00	1140.00	1591.00	347818.67	960
5.5	25.00	563.00	5120.00	659.08	111.00	296.75	563.00	860.25	1290.00	274266.67	1024
6	9.10	276.50	3670.00	430.43	51.00	117.75	276.50	532.00	1021.00	249862.22	960
6.5	4.90	107.00	1530.00	179.16	25.00	52.00	107.00	225.00	416.20	41910.68	960
7	1.40	49.00	457.00	63.40	13.00	25.00	49.00	81.00	131.00	3179.18	960
7.5	0.00	22.00	238.00	28.89	6.20	12.00	22.00	38.00	56.00	635.49	1024
8	0.00	15.00	137.00	18.08	3.80	6.60	15.00	25.00	38.00	223.10	960
8.5	0.00	14.00	217.00	21.84	4.50	8.00	14.00	27.25	44.00	552.61	1024
9	2.10	23.00	268.00	31.89	7.00	11.00	23.00	44.00	68.00	870.99	960
9.5	1.80	40.00	850.00	48.81	6.79	18.00	40.00	65.00	98.10	2882.61	960
10	0.02	48.00	850.00	63.56	10.00	27.00	48.00	78.00	111.00	4859.48	960
10.5	1.80	61.00	1100.00	77.94	21.00	39.00	61.00	91.00	141.00	5766.32	1024
11	19.00	110.00	2270.00	165.44	54.00	77.00	110.00	180.00	300.20	41279.37	960
11.5	54.00	244.00	4500.00	382.81	100.90	144.00	244.00	467.25	850.40	163176.29	960
12	84.00	450.00	8690.00	702.16	189.80	284.00	450.00	837.00	1440.00	560524.18	960
12.5	90.00	570.00	20300.00	818.56	260.00	382.00	570.00	914.25	1501.00	1074789.79	1024

WALLA WALLA RIVER @ RV PARK (S-125)



S-125 - Walla Walla River @ RV Park

BiMonth	Minimum (cfs)	Median (cfs)	Maximum (cfs)	Mean (cfs)	Quantile.10%	Quantile.25%	Quantile.50%	Quantile.75%	Quantile.90%	Variance	Sample Size
1	303.87	430.34	2230.47	668.70	331.74	373.37	430.34	650.47	1367.08	261293.02	45
1.5	318.61	890.41	2480.66	1077.68	363.27	541.02	890.41	1650.29	2094.51	447666.85	48
2	416.53	745.41	5809.14	1173.79	476.02	557.94	745.41	1375.13	2238.33	1084685.45	45
2.5	599.77	1386.55	2933.86	1550.53	684.62	956.98	1386.55	2146.39	2453.55	474435.24	39
3	358.25	1176.61	6098.65	1645.65	469.68	624.79	1176.61	2105.42	3534.68	1771282.72	45
3.5	374.28	1323.38	3222.98	1389.25	500.78	562.62	1323.38	1844.79	2620.89	665146.61	48
4	530.85	817.29	2292.18	931.89	575.80	674.84	817.29	1031.94	1431.51	147438.47	45
4.5	256.61	453.72	1774.05	550.90	346.09	369.60	453.72	531.73	839.21	116499.04	45
5	74.15	311.47	753.67	332.61	80.83	163.47	311.47	499.46	609.59	40259.56	45
5.5	60.97	178.59	396.71	200.30	84.03	108.84	178.59	255.17	374.58	10659.25	48
6	18.11	66.64	140.33	70.38	33.76	56.10	66.64	83.86	114.65	849.81	44
6.5	15.56	74.63	212.73	70.43	17.00	20.51	74.63	98.04	116.30	2046.15	45
7	10.28	53.30	141.32	54.26	16.54	18.57	53.30	69.19	108.04	1297.72	50
7.5	9.18	21.73	118.22	34.29	10.92	14.66	21.73	40.17	87.14	895.68	61
8	0.41	12.12	29.63	14.13	2.05	6.97	12.12	21.87	25.60	74.88	60
8.5	0.00	12.61	48.55	16.71	0.22	2.78	12.61	29.10	41.36	231.51	56
9	7.50	32.10	75.99	31.98	12.72	23.45	32.10	40.67	44.92	182.94	60
9.5	11.58	32.17	58.41	32.33	19.99	25.92	32.17	36.44	46.09	100.16	60
10	13.58	29.23	98.54	38.81	14.73	23.94	29.23	55.14	67.19	473.31	45
10.5	30.92	51.33	64.16	49.42	39.97	44.40	51.33	54.79	57.37	59.48	48
11	52.38	95.71	219.97	100.25	64.30	72.93	95.71	115.34	153.86	1247.04	45
11.5	88.52	171.42	1026.45	203.51	115.40	127.45	171.42	196.54	258.14	27630.83	43
12	137.68	514.95	2484.82	703.53	156.32	312.45	514.95	973.26	1483.56	294385.31	45
12.5	237.11	608.70	2370.64	701.61	306.29	458.33	608.70	806.04	1113.77	172014.95	48

DOWNLOAD LINK FOR ANALYSIS FILES (R FILES, PDF GRAPHS AND SPREADSHEETS)

[Download Zipped Folder](#)

APPENDIX C – FLOOD FREQUENCY RESULTS

UPSTREAM OF POD

HydrologicStatsApp
"Upstream of POD"

Log Normal	mu=7.0981 sigma=0.398674
Pearson Type III	mu=1308.01 sigma=544.718 gamma=1.13954
Log Pearson Type III	mu=7.0981 sigma=0.405333 gamma=-0.00831455
Gamma	A=6.55887 B=199.426
Log Gamma	A=323.647 B=0.0219316
Gumbel	mu=1068.62 sigma=403.688
GEV	shape=0.064266 scale=393.149 location=1054.6
Weibull	A=1474.78 B=2.55282

Return Period	Log Normal	Pearson Type III	Log Pearson Type III	Gamma	Log Gamma	Gumbel	GEV	Weibull
2	1210	1207	1210	1242	1201	1217	1200	1278
5	1692	1711	1702	1707	1682	1674	1674	1777
10	2016	2038	2033	1990	2015	1977	2007	2045
15	2201	2219	2221	2142	2207	2148	2202	2179
20	2331	2343	2354	2245	2343	2268	2341	2267
25	2431	2438	2457	2323	2450	2360	2451	2331
50	2743	2725	2776	2556	2784	2644	2798	2516
100	3058	3003	3098	2778	3128	2926	3159	2682
200	3378	3274	3425	2991	3483	3206	3535	2834
500	3811	3624	3868	3263	3972	3577	4057	3017

HISTORIC DOWNSTREAM OF POD

HydrologicStatsApp
"Historic Downstream of POD"

Log Normal	mu=7.05658 sigma=0.431902
Pearson Type III	mu=1270.33 sigma=564.315 gamma=1.0948
Log Pearson Type III	mu=7.05658 sigma=0.440252 gamma=-0.13501
Gamma	A=5.68898 B=223.297
Log Gamma	A=271.441 B=0.0259967
Gumbel	mu=1021.5 sigma=420.922
GEV	shape=0.0559163 scale=411.374 location=1008.76
Weibull	A=1435.6 B=2.41763

Return Period	Log Normal	Pearson Type III	Log Pearson Type III	Gamma	Log Gamma	Gumbel	GEV	Weibull
2	A	1169	1172	1197	1150	1176	1161	1234
5	1669	1691	1685	1684	1660	1653	1652	1748
10	2018	2027	2026	1983	2020	1969	1995	2027
15	2219	2212	2219	2144	2231	2147	2195	2168
20	2361	2339	2353	2254	2382	2272	2338	2260
25	2472	2435	2456	2337	2500	2368	2450	2328
50	2817	2728	2775	2586	2875	2664	2802	2524
100	3170	3010	3093	2824	3265	2958	3167	2700
200	3530	3285	3411	3053	3672	3251	3544	2861
500	4023	3640	3834	3345	4241	3637	4065	3056

20% RESERVOIR DIVERSION

HydrologicStatsApp
"20% Reservoir Diversion"

Log Normal	mu=6.97311 sigma=0.467731
Pearson Type III	mu=1187.85 sigma=576.995 gamma=1.24991
Log Pearson Type III	mu=6.97311 sigma=0.474738 gamma=-0.058158
Gamma	A=4.84262 B=245.291
Log Gamma	A=226.481 B=0.030789
Gumbel	mu=936.247 sigma=418.347
GEV	shape=0.1134 scale=397.47 location=910.874
Weibull	A=1345.83 B=2.21597

Return Period	Log Normal	Pearson Type III	Log Pearson Type III	Gamma	Log Gamma	Gumbel	GEV	Weibull
2	1068	1071	1072	1107	1057	1090	1060	1141
5	1583	1607	1594	1602	1572	1564	1561	1668
10	1944	1961	1956	1911	1945	1878	1930	1961
15	2154	2158	2164	2078	2167	2055	2152	2110
20	2304	2294	2312	2192	2327	2179	2315	2208
25	2421	2398	2428	2279	2453	2274	2443	2281
50	2790	2715	2788	2538	2857	2569	2862	2491
100	3169	3023	3156	2787	3282	2861	3311	2681
200	3561	3324	3533	3028	3731	3152	3796	2856
500	4102	3715	4048	3336	4366	3536	4497	3069

30% RESERVOIR DIVERSION

HydrologicStatsApp
"30% Reservoir Diversion"

Log Normal	mu=6.94738 sigma=0.503735
Pearson Type III	mu=1173.74 sigma=592.695 gamma=1.12065
Log Pearson Type III	mu=6.94738 sigma=0.512636 gamma=-0.289957
Gamma	A=4.30629 B=272.565
Log Gamma	A=192.263 B=0.0361347
Gumbel	mu=912.041 sigma=440.92
GEV	shape=0.0711992 scale=427.716 location=895.063
Weibull	A=1330.18 B=2.13695

Return Period	Log Normal	Pearson Type III	Log Pearson Type III	Gamma	Log Gamma	Gumbel	GEV	Weibull
2	1040	1065	1066	1084	1028	1074	1054	1121
5	1590	1614	1611	1605	1580	1573	1572	1662
10	1984	1968	1971	1932	1992	1904	1939	1965
15	2216	2164	2173	2110	2240	2091	2155	2120
20	2383	2298	2313	2232	2420	2222	2310	2223
25	2513	2401	2420	2324	2563	2322	2431	2299
50	2928	2711	2749	2603	3025	2632	2819	2518
100	3358	3011	3071	2870	3519	2940	3223	2718
200	3808	3303	3389	3129	4047	3247	3646	2903
500	4435	3681	3805	3462	4805	3652	4238	3127

APPENDIX C

Walla Walla Basin Seasonal Seepage Assessments Report: Walla Walla River, Mill Creek, and Touchet River

Walla Walla Basin Seasonal Seepage Assessments Report

Walla Walla River, Mill Creek, and Touchet River



Walla Walla Basin Watershed Council
8/15/2017
www.wwbwc.org



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Background

The Walla Walla River watershed is a bi-state watershed that originates in Oregon and passes through the state of Washington on route to its confluence with the Columbia River (Figure 1). As in many watersheds in the Western United States, the Walla Walla River basin's water quality and endangered species issues are heavily influenced by the timing, availability, quality, and quantity of water originating from both surface and ground sources. The more obvious issue, seasonal variation in supply (winter-spring = higher flows, summer-fall = lower flows), is well documented in readily available annual hydrographs and continuous flow data. Historically, there's been a lack of understanding of how the Walla Walla River and its tributaries stream discharge vary spatially relative to: water use, groundwater inputs, evaporation, irrigation returns, and tributary inputs. From the near-pristine headwaters of the Walla Walla River, Mill Creek, and Touchet River in the Blue Mountains to near the confluence with the Columbia River (Nine Mile Bridge) variations in environmental conditions help shape the various flow profiles within the watershed.

Walla Walla River

The Walla Walla River originates from mountain springs on the western slope of the Blue Mountains in the southeastern part of watershed. The South Fork Walla Walla River, which is the continuation of the mainstem, and the North Fork Walla Walla River originate at an altitude of about 5,000 feet. Both the North Fork and South Fork Walla Walla Rivers flow westward through narrow canyons, and their gradients decrease from the upper reaches to their confluence. At the town of Milton-Freewater the Walla Walla River flows across its alluvial deposits at a gradient of about 50 feet per mile. Near the city of Walla Walla the river is joined by Yellowhawk Creek, East Little Walla Walla River, and by Mill Creek. The river channel grows deeper, and the gradient decreases to about 25 feet per mile in the lower valley, where three major tributaries Pine Creek, Dry Creek, and the Touchet River discharge into the Walla Walla River. Backwater effects on the Columbia River from McNary Dam extend close to 9 miles upstream (below Pierce's RV Park monitoring site) from the mouth of the Walla Walla River.

Mill Creek

Mill Creek originates in the Blue Mountains to the east of the city of Walla Walla at an approximate altitude of 5,000 feet within a closed municipal watershed. The creek flows through narrow canyons to the Walla Walla Valley. The largest Mill Creek tributary is Blue Creek, which originates in the Blue Mountain Front Range at an approximate altitude of 3,000 feet. The largest diversion on Mill Creek is located at the Mill Creek Dam diversion 3 miles east of the city of Walla Walla. The site is a flood control site in which water can be diverted out of Mill Creek and stored in Bennington Lake during flood events. The stored flood water can be released as regulated flow into Russell Creek which flows into Yellowhawk Creek and out to the confluence with the Walla Walla River. Just downstream of the Mill Creek Dam flow is diverted into Yellowhawk and



Upper South Fork Walla Walla River Springs

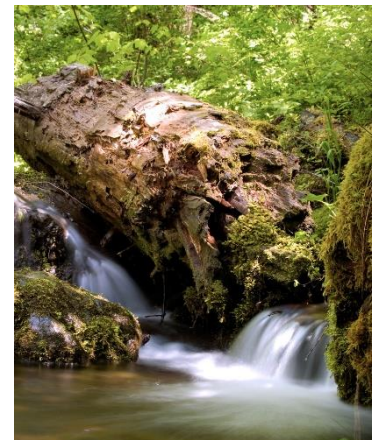


Photo: 2 Upper Mill Creek

Garrison Creeks for use in irrigation, Near Walla Walla, Mill Creek forms several distributary channels which flow across alluvial deposits to the Walla Walla River. The Mill Creek sub-watershed drains approximately 6% of the Walla Walla River Watershed.

Touchet River

The Touchet River is the largest tributary to the Walla Walla River. The Touchet sub-watershed drains approximately 44% of the Walla Walla River Watershed. It originates in the northeastern part of the basin by the combination of several creeks and streams that drain the northern Blue Mountains. The South and North Forks Touchet River originate at altitudes between 4000-5000 feet. The North Fork is considered the upper basin extension of the Touchet River. The North Fork flows to its confluence with South Fork, just above the town of Dayton. The majority of the tributaries that flow into the Touchet River do so above the town of Waitsburg.

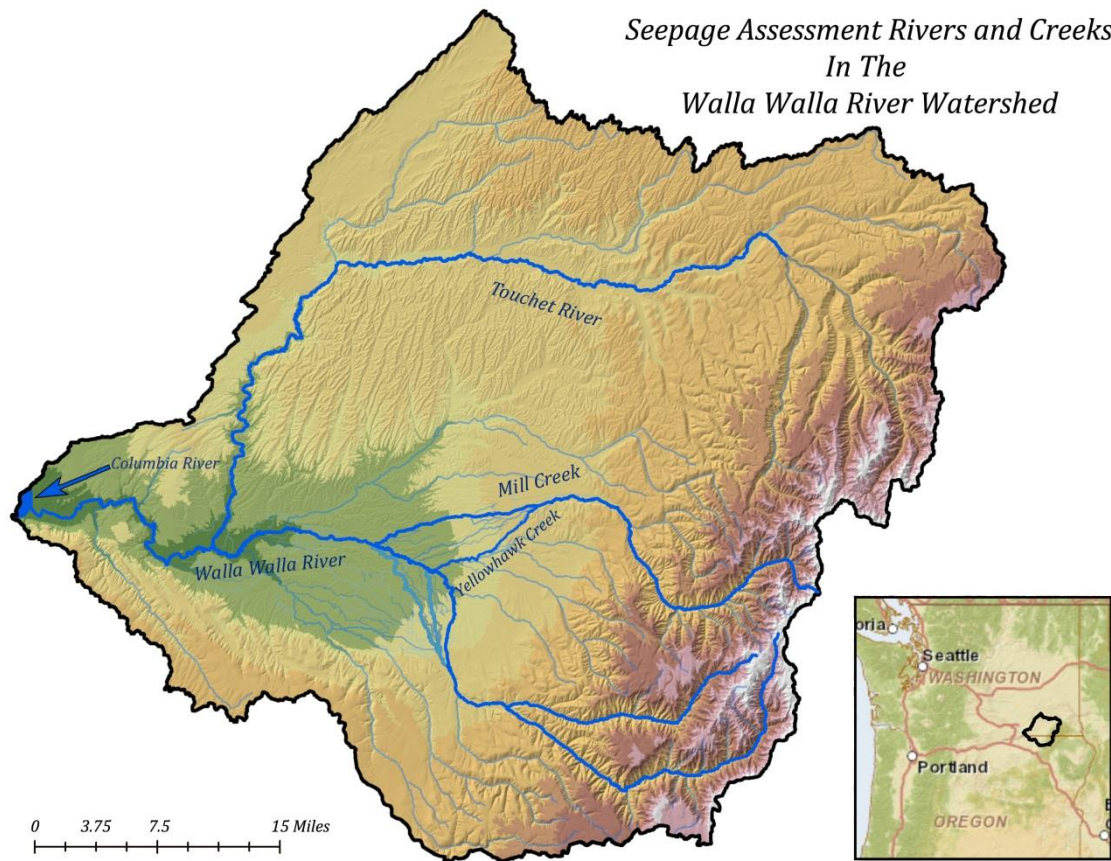


Figure 1: Map of the Walla Walla Watershed showing the Walla Walla River, Touchet River, Mill Creek, and Yellowhawk Creek.

Starting in 2002, WWBWC staff, state and federal agency personnel, and volunteers from Washington and Oregon began conducting seasonal instream flow, diversion inventories, and tributary flow surveys termed “seepage assessments” as a primary first step toward quantifying the spatial variation in water volume for the Walla Walla River. Since 2002 the WWBWC has conducted seasonal seepage assessments on the Walla Walla River. In 2008 seasonal assessments were added on Mill Creek and the Touchet River. Seepage assessments, at first, were conducted in two primary seasons of concern; June, when ESA-listed fish species are moving from the lower to upper watershed to either spawn or rear for the summer months and, August to September, when Clean Water Act water quality issues and low flow volumes are at their most critical levels. This report shares the data collected

from these bi-state cooperative seepage assessments. The focus of the analysis presented in this report is to quantify the channel bed gains and losses for the Walla Walla River, Touchet River, and Mill Creek.

Methodology

Data Collection and Quality

Seepage assessments were typically completed over a 48-hour period with most of the measurements taken during the first 24-hour period. The WWBWC Watershed Monitoring Program Standard Operating Procedures (SOP) outlines the protocols for cross-sectional measurements used by the WWBWC to collect the instream flow data.¹

Data was recorded using a variety of flow methods including hand and spreadsheet calculations. Diversion measurements were made using a variety of methods including: “weir stick” (used in conjunction with a particular weir’s rating table), flow-rate meters on pumps or diversions, estimate of rate of diversion using sprinkler-head-counting method and on the larger diversions continuous flow recorders. Most diversion sites were recorded by direct measurement using weirs, meters and/or flow meters. Tributary inputs were calculated using instream flow

measurements or data from the gauge station closest to the confluence of the tributary and the Walla Walla River. At each gauge the average daily flow was used to represent flow for the site.



While not directly relevant to the analysis shared in this report, each field team also collected additional parameters such as (1) channel and riparian photographs, (2) temperature (F), (3) specific conductivity (uS) (4) cross-sectional channel profile (wetted width and depths in feet). This information is available upon request from the Walla Walla Basin Watershed Council. Data collected by all project partners was individually compiled by each of the collection agencies and then organized and analyzed by the WWBWC.

The data for all of the seepage assessments for the Walla Walla River, Touchet River, Mill Creek, and Yellowhawk Creek can be found in *Attachments A and B*. Data sets include site identification or name, the

digitized river mile², instream flow, and diversion and tributary quantities. The analysis and discussion sections of this report will review the data and identify areas of net gains and losses and discuss general trends. However the main objective of this report is to present this dataset for use by our numerous project and policy-planning partners to better manage and monitor instream flows in the Walla Walla Watershed.

Spatial Flow Model

To assess the longitudinal profile for each system, a spatially-oriented model was needed. The National Agriculture Imagery Program (NAIP) 2006 imagery for Walla Walla County, Columbia County, and the Umatilla County was used as a base layer to digitize the project streams. The thalweg for each system was digitized using ESRI ArcMap. The digitized linear feature provided the ability to break down each system into “GIS river miles”. The diversions, tributaries, and instream flow measuring sites were located by hand held GPS or by identifying the

¹ The WWBWC, April 2013. *WWBWC Watershed Monitoring Program Standard Operating Procedures Version 1.2*, Walla Walla Basin Watershed Council

² ESRI ArcGIS software was used to determine the river mile through digitizing the streams from the 2006 basin satellite imagery.

location using the NAIP imagery in ArcMap. Water managers from both Oregon and Washington worked with WWBWC staff to locate all diversions, tributaries and instream flow sites.

Reach Analysis

Analysis was conducted using a simple mass-balance approach assessing water balance values on a reach-by-reach basis. Reaches were defined by the closest upstream and downstream instream flow measurement. All water budget calculations were performed from a given instream flow site upriver to the next nearest instream flow site. The equations for net tributary inputs and diversion withdraws are mass balance of all values in a defined reach. The basic equations for water budget analysis were³:

$$(1) \quad \text{Net Channel Gains and Losses } (N_{GL}) = (\sum (T_R) - \sum (D_R)) + (Q_{DN} - Q_{UP})$$

Where: $\sum (T_R)$ = Sum of all Tributary Inputs for given reach

$\sum (D_R)$ = Sum of all Diversion withdraws for a given reach

Q_{DN} = Flow value at reach's downstream site

Q_{UP} = Flow value at reach's upstream site

Units: cubic-feet-per-second/reach

$$(2) \quad \text{Net Rate of Channel Bed Gains and Losses } (N_{GL-R}) = (N_{GL}) / (RM_{DN} - RM_{UP})$$

Where: (N_{GL}) = Net Channel Gains and Losses for a given reach

RM_{DN} = River Mile at downstream flow site

RM_{UP} = River Mile at upstream flow site

Units: cubic-feet-per-second/mile/reach

Analysis Assumptions

To correctly identify possible gaining or losing trends, general assumptions must be made to identify and quantify immeasurable components of the model. The assumptions that were made as the data was analyzed are listed below.

- Instream, diversion, and tributary flow data are representative of actual conditions for a particular season: Spring, summer, and fall datasets used in conjunction provide a reasonable and representative flow profile for the river for the corresponding season of measurement.
- Spatial model data node (e.g. diversion, instream flow, and tributary) locations are +/- 25 meters of where they were originally. This assumption is likely to have remained true for many of the sites through the entire field

³ Bower, R.J. 2005. *Walla Walla River Surface Water Budget Assessment: 2002 to 2004*. Walla Walla Basin Watershed Council, www.wwbwc.org

seasons of data collected on the Walla Walla River. In Washington, points of diversion (PODs) can be moved short distances without a formal permitting process while in Oregon moving a POD location is not allowed without POD transfer authorization. In Washington, if a particular POD was known to vary by year, a mid-point was chosen on the respective reach to represent that POD. Because reach analysis based on upstream and downstream instream-measurements, this method seemed applicable.

- Total Instream Net Gains (Total N_{GL}) can only be attributed to accretional⁴ sum of the following sources: groundwater, hyphoreic⁵ inflow, surface irrigation returns or “tail water,” and any unmeasured springs and tributaries. Due to the inability to quantify these various sources via direct measurement N_{GL} is assumed to be a compilation of these various processes.
- Total Instream Net Losses (Total N_R) can only be attributed to the sum of the following losses: a) direct surface evaporation from sun and wind, b) evapotranspiration through riparian plant transpiration, and c) channel bed infiltration or net loss to the underlying alluvial aquifer system. Due to the inability to quantify these various sources via direct measurement they are assumed to be implicit to the sum of Net Losses. Net Losses is used here as relative to surface water, it is understood that in a highly connective aquifer-surface system, water is not truly “lost” and may show up further down gradient as net gains to the river.
- All surface diversions are accounted for in the diversion inventory⁶. The amount of gains and losses relative to the volume of instream flow measurements were assumed to be equal. Although Carter and Anderson assert that a flow measurement made under ideal conditions can have uncertainty as low as 2.2%, conditions at many of the sites measured for these assessments are not ideal⁷. The WWBWC assumes, for the instream flow measurements in this report that accuracy is within (+/-) 10% of the true flow value. This would mean that a 100 cfs measurement would have a confidence range of +/- 10 cfs while a 10 measurement would be +/- 1 cfs. This crude confidence range assumption helps as we analyze and discuss the qualification of river reaches where net gains and losses are apparent as a trend.

⁴ In science, accretion is a process in which the size of something gradually increases by steady addition of smaller parts

⁵ beneath the bed of a stream, where water percolates through interstices between the rocks

⁶ The Assistant Watermaster for the Milton-Freewater area along with the former watermaster for the Walla Walla Valley, Bill Neve of Water Rights Solutions, assisted in the accounting of all diversions on each assessed river, stream, or creek.

⁷ Carter, R. W., and Anderson, I. E., 1963, Accuracy of current-meter measurements: Am. Soc. Civil Engineers Jour., v. 89, no. HY4, p. 105-115.

2016 Results and Discussion

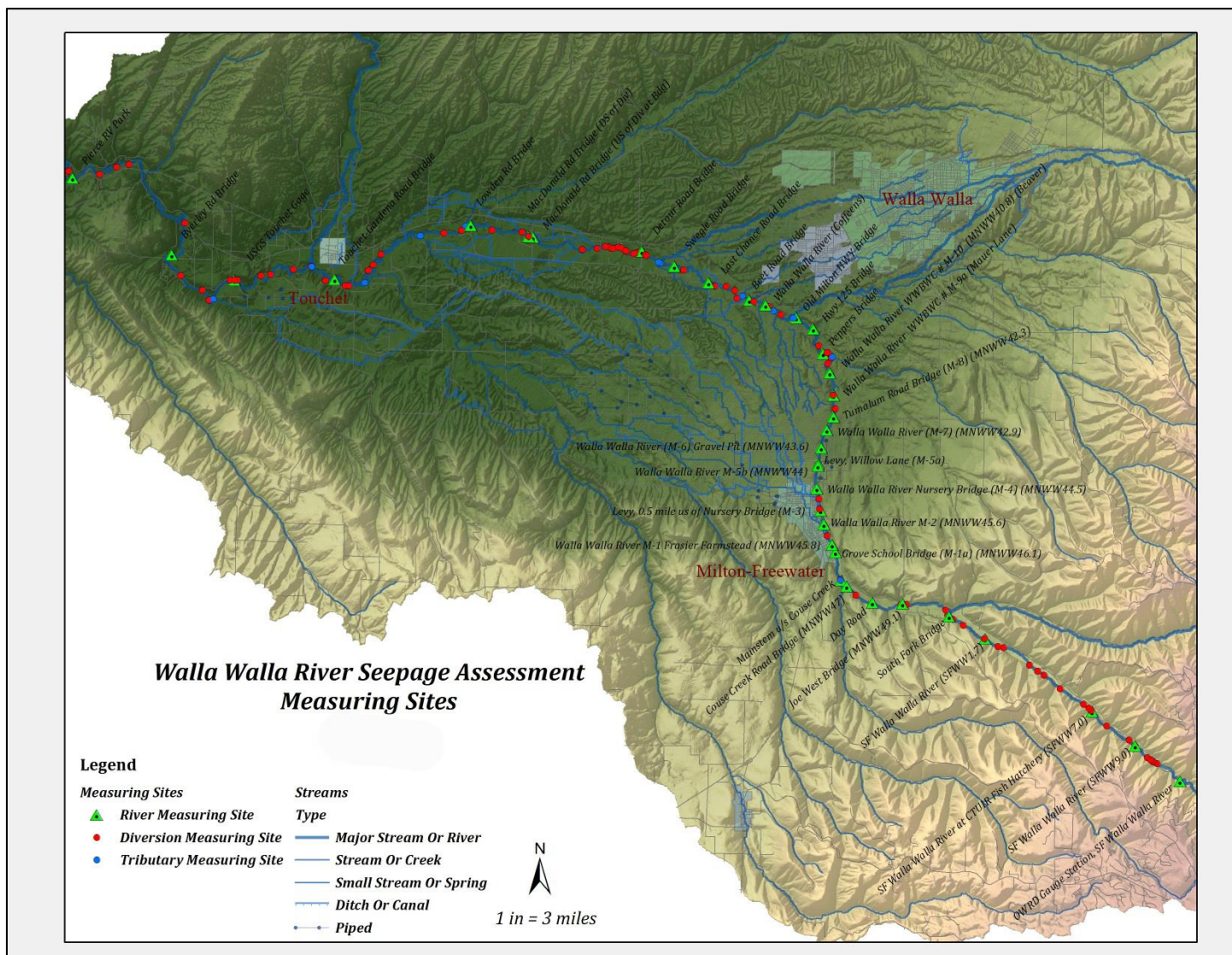
The Walla Walla River seepage assessments have been conducted over the past 14 years through various conditions and seasons. The WWBWC and its agency partners and volunteers began conducting seepage assessments on the Touchet River and Mill Creek systems in the fall of 2008.

2016 Walla Walla River Seepage Assessment

Data was first tabulated into a spreadsheet model and processed for all seepage assessments utilizing the water budget analysis equations (*Attachments A*). Analysis for each reach is applied from the downstream instream flow measurement on that particular line to the next, upriver instream flow site. Each instream location was assigned a Walla Walla River Reach ID and the application of analysis results can be deduced from the designated “Flow Measurement Location (Reach Locations)” column (*Table 1*). Only field-verified data was used for analysis.

Table 1: MS Excel model data table for the July 29, 2016 Walla Walla River seepage run.

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2016 Net Diversion Total (cfs)	2016 Net Tributary Inputs Total (cfs)	2016 Flow (cfs)	Gaining/Losing
RV Park to Byerly Bdg	5.68	1.03	7.40	-0.78	-8.18	0.00	47.70	Gaining
Byerly Bdg to USGS Touchet Gauge	12.88	3.14	10.18	10.18	0.00	0.00	48.48	Gaining
USGS Touchet Gauge to Lowden Rd Bdg	16.12	1.36	16.46	34.98	-5.27	23.78	38.30	Gaining
Lowden Rd Bdg to McDonald Rd Bdg	28.24	-2.33	-5.07	-6.18	-1.11	0.00	3.33	Losing
MacDonald Rd Bdg to Detour Rd Bdg	30.41	-1.90	-6.77	-32.50	-25.73	0.00	9.50	Losing
Detour Rd Bdg to Sweigle Rd Bdg	33.97	-4.01	-4.31	12.93	-0.12	17.36	42.00	Losing
Sweigle Rd Bdg to Last Chance Rd Bdg	35.04	-6.93	-10.24	-9.24	0.00	1.00	29.07	Losing
Last Chance Rd Bdg to Beet Rd Bdg	36.52	0.74	1.34	0.01	-1.80	0.47	38.31	Gaining
Beet Rd Bdg to WWR WDFW #5 Site	38.32	-4.01	-2.07	-6.57	-4.50	0.00	38.30	Losing
WWR WDFW #5 Site to Old Milton Hwy Bdg	38.84	-2.84	-3.91	22.47	0.00	26.38	44.87	Losing
Old Milton Hwy Bdg to Hwy 125 Bdg	40.21	-0.84	-0.61	-0.61	0.00	0.00	22.40	Losing
Hwy 125 Bdg to Pepper Bdg	40.94	4.78	4.61	4.61	0.00	0.00	23.01	Gaining
Pepper Bdg to M-10	41.90	0.88	0.92	0.84	-0.28	0.20	18.40	Gaining
M-10 to Mauer Lane (M9a)	42.94	0.50	0.41	0.41	0.00	0.00	17.56	Gaining
Mauer Lane (M9a) to Tum-A-Lum Bdg (M8)	43.76	1.52	1.01	1.01	0.00	0.00	17.15	Gaining
Tum-A-Lum Bdg (M8) to M7	44.43	-3.14	-1.39	-1.39	0.00	0.00	16.14	Losing
M7 to M5	44.87	-9.66	-10.55	-10.43	0.00	0.12	17.53	Losing
M-5 to Nursery Bdg M-4	45.96	-14.91	-9.85	-9.85	0.00	0.00	27.96	Losing
Nursery Bdg M-4 to M3	46.62	-25.77	-16.57	-20.07	-3.50	0.00	37.81	Losing
M3 to M2	47.26	27.64	12.12	-48.88	-61.00	0.00	57.88	Gaining
M2 to M1a Grove School Bdg	47.70	8.16	7.24	3.74	-3.50	0.00	106.76	Gaining
M1a Grove School Bdg to Couese Creek Rd Bdg	48.59	9.73	10.39	10.39	0.00	0.00	103.02	Gaining
Couese Creek Rd Bdg to Day Road	49.66	-6.71	-6.27	-10.07	-3.80	0.00	92.64	Losing
Day Road to Joe West Bdg	50.59	6.17	6.04	6.04	0.00	0.00	102.71	Gaining
Joe West Bdg to South Fork Bdg	51.57	-0.98	-1.61	-3.10	-8.02	6.53	96.67	Losing
South Fork Bdg to CTUIR Hatchery	53.22	0.89	4.65	-1.10	-5.75	0.00	99.77	Gaining
CTUIR Hatchery to Keating	58.44	2.56	8.72	8.41	-0.31	0.00	100.87	Gaining
Keating to SF Walla Walla BLM Trailhead	60.07							
SF Walla Walla BLM Trailhead	61.85	x	x	x	x	x	92.46	



Water Year Comparison of Datasets

Longitudinal flow profiles (*Figures 3 and 4*) provide a general overview of the seasonal flow rate on the Walla Walla River. The flow profiles are based upon seasonal differences in the Walla Walla River and years of similar conditions were compiled together in each profile (Attachment E). A longitudinal flow profile based on spatial locations of the measurements taken during the June 29, 2016 seepage assessment can be seen in figure 5.

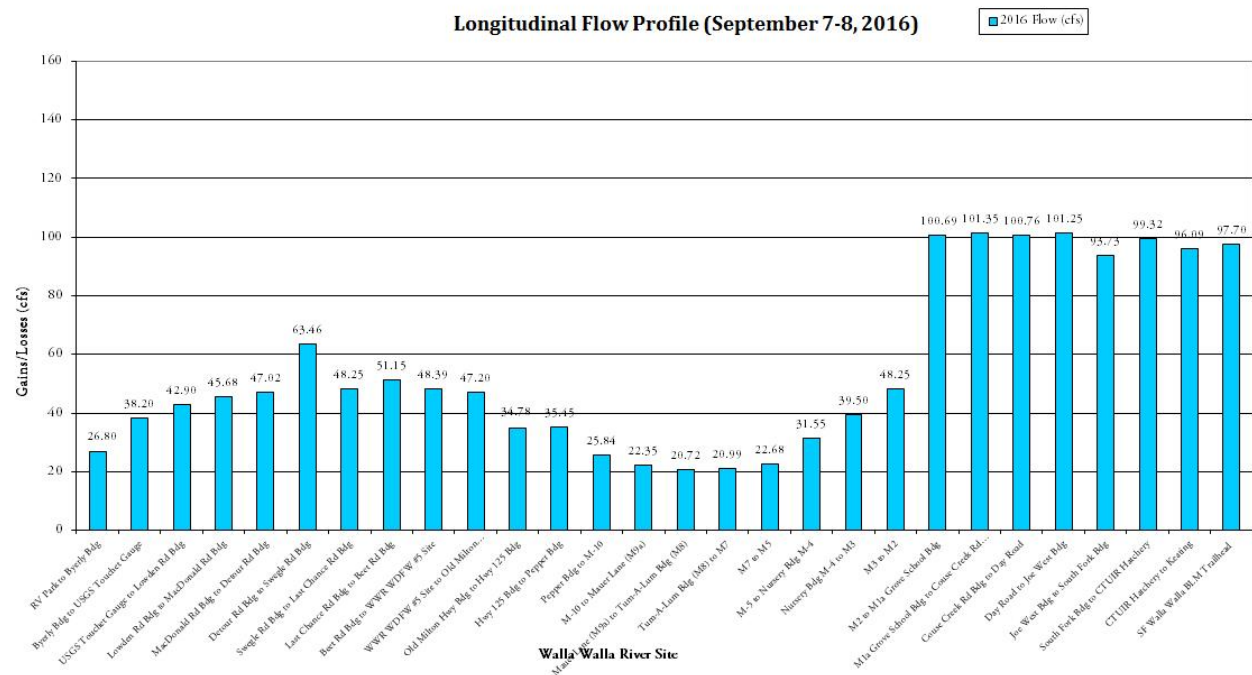
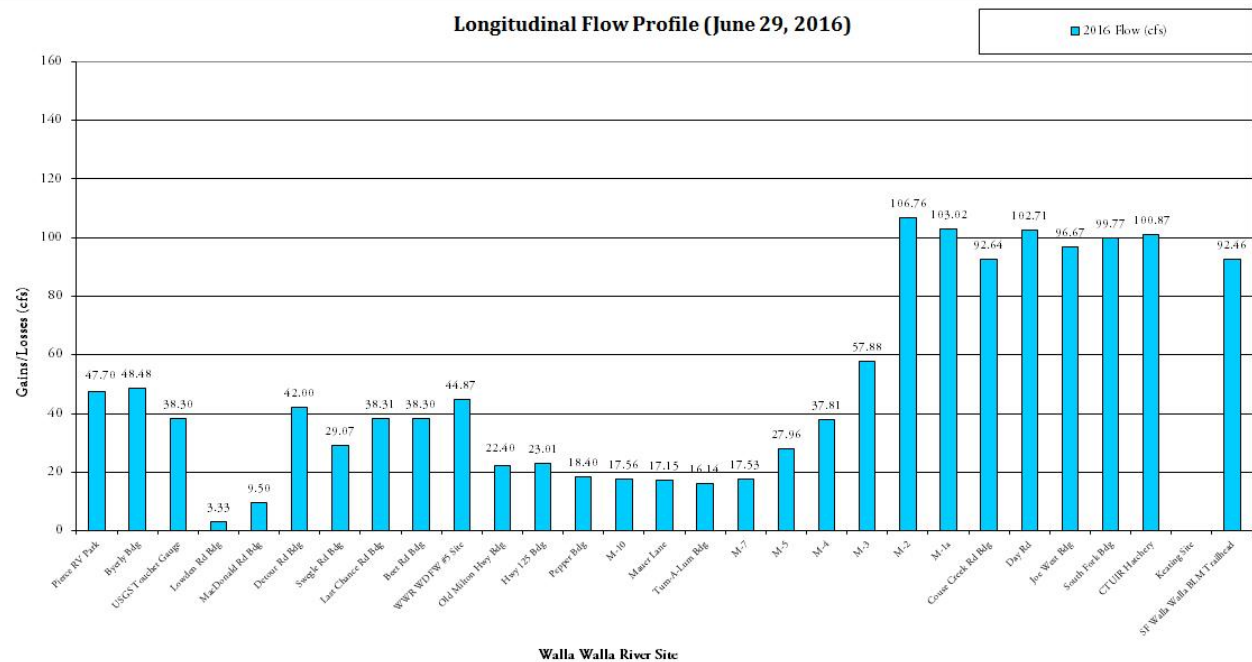


Figure 3 and 4 Walla Walla River Seasonal Flow Profiles 2016

The longitudinal flow profile provides insight of where water is available and/or being used on the Walla Walla River based upon river mile. The most noticeable amount of flow being diverted into the Little Walla Walla River between mile 45 and 50

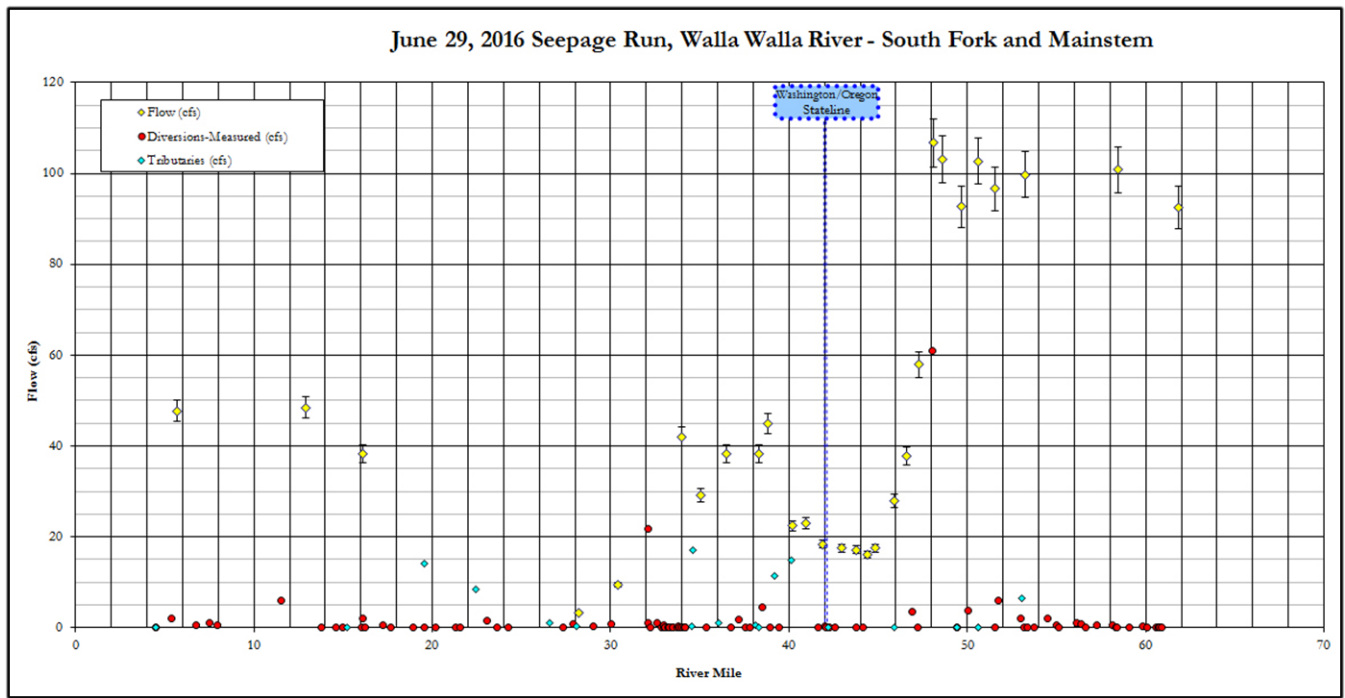


Figure 5: June 29, 2016 Walla Walla River Flow Profile

The results from the 2016 June and September net channel gains and losses (N_{GL}) per reach are documented in figure 6 and figure 7. During the summer of 2016 the Walla Walla River basin experienced normal base flow conditions from the beginning of July through early September. The discharge measurements taken at the McDonald Road Bridge were the lowest recorded discharge values of the June assessment.

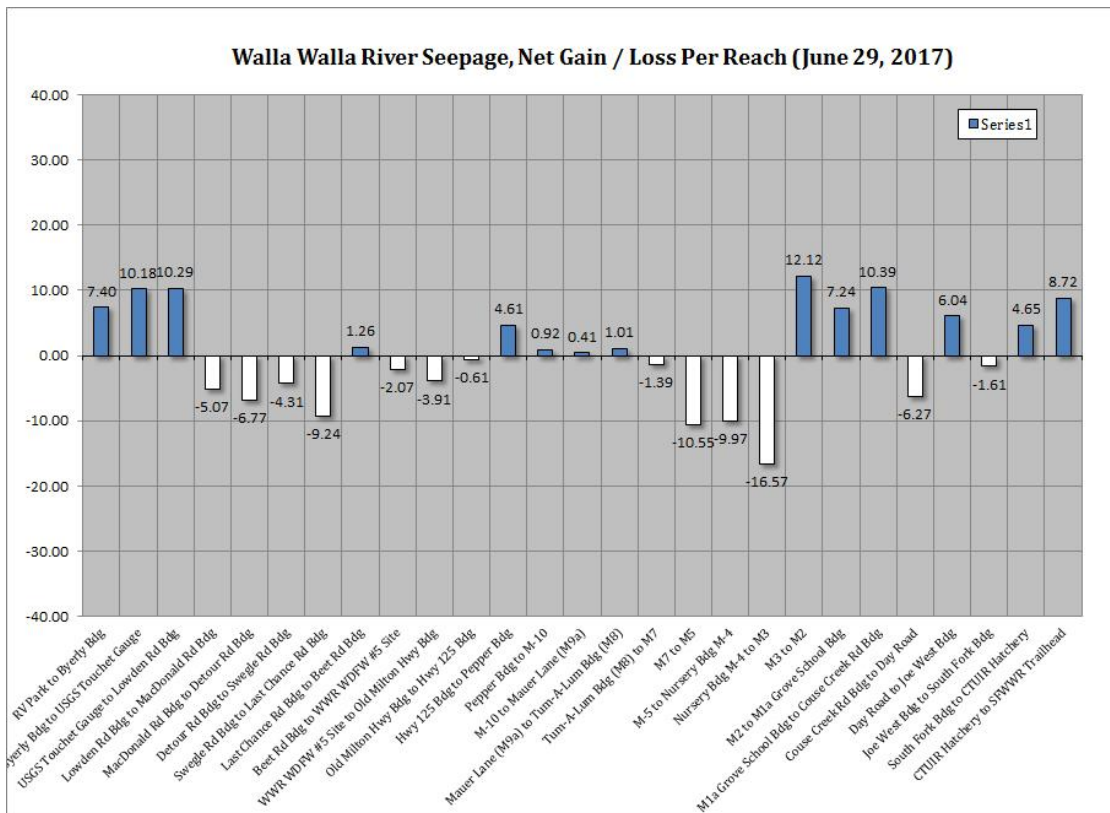


Figure 6: Walla Walla River Net Gain or Loss per Reach, June 29, 2016

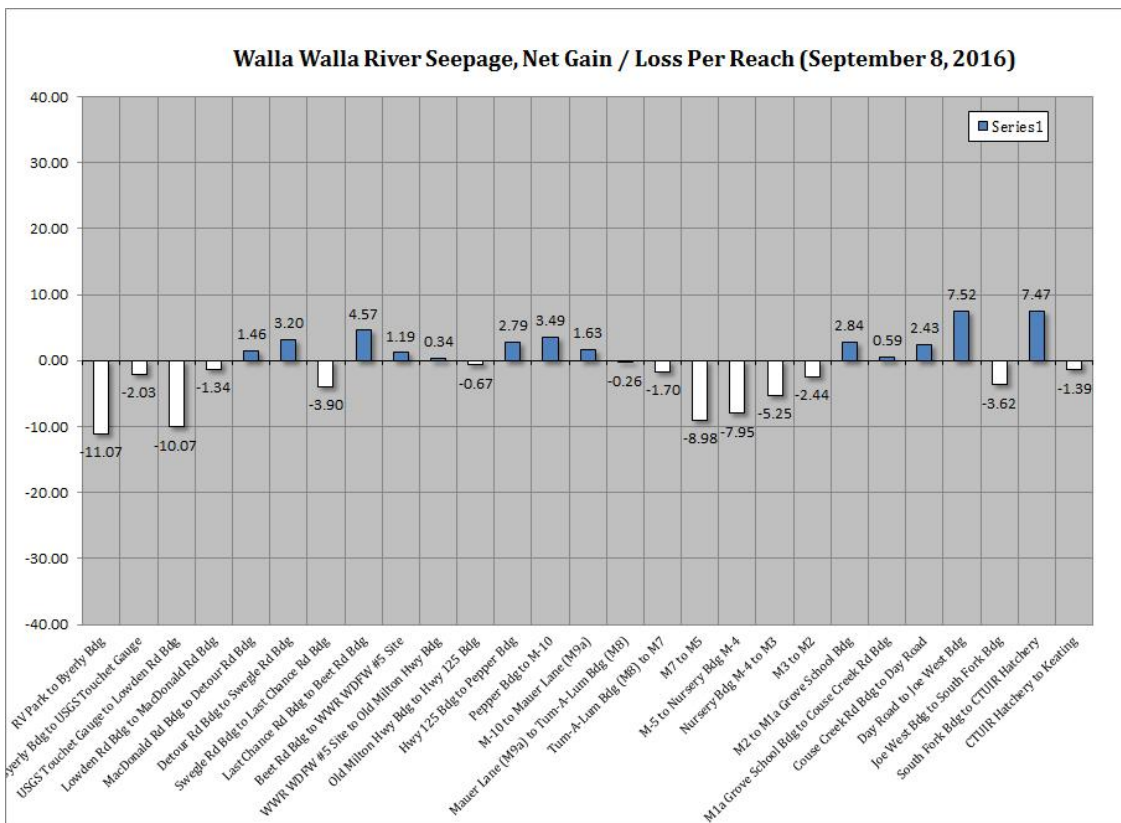


Figure 7: Walla Walla River Net Gain or Loss per Reach, September 8, 2016

Another useful product from this analysis is the net tributary and diversion values associated with each reach of the river. This provides a useful visual tool to assess, relative to instream flow values, the location and magnitude of mainstem flow contributions and identifying the high withdrawal reaches. (Figure 8) Additional Net Reach Analysis graphs for all assessed streams and creeks can be found in Attachment C.

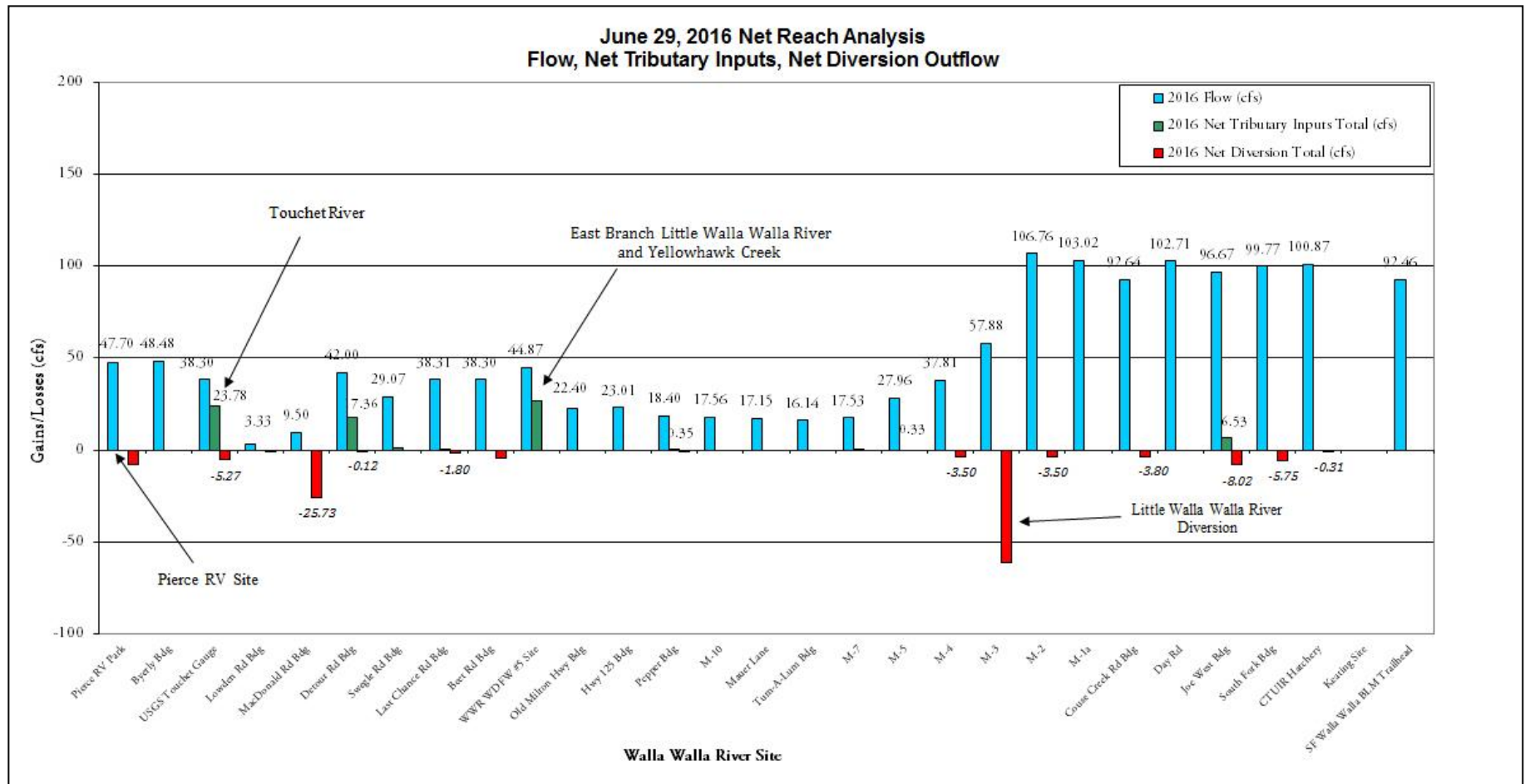


Figure 8: Walla Walla River Net Reach Analysis, June 29, 2016.

Within the Oregon portion of the basin on the Walla Walla River, two upriver sites and the Little Walla Walla River diversion in Milton-Freewater comprise the most visually apparent diversions.

The Little Walla Walla River diversion is in the proximity of where the Walla Walla River historically braided into multiple channels consisting primarily of three main distributaries. (Figure 9) The Tum-A-Lum Branch (now called the mainstem), the East Little Walla Walla River (now named the Crockett Ditch and East Prong of the Little Walla Walla River) and the West Little Walla Walla River (now named the Ford Ditches and West Prong of the Little Walla Walla River).

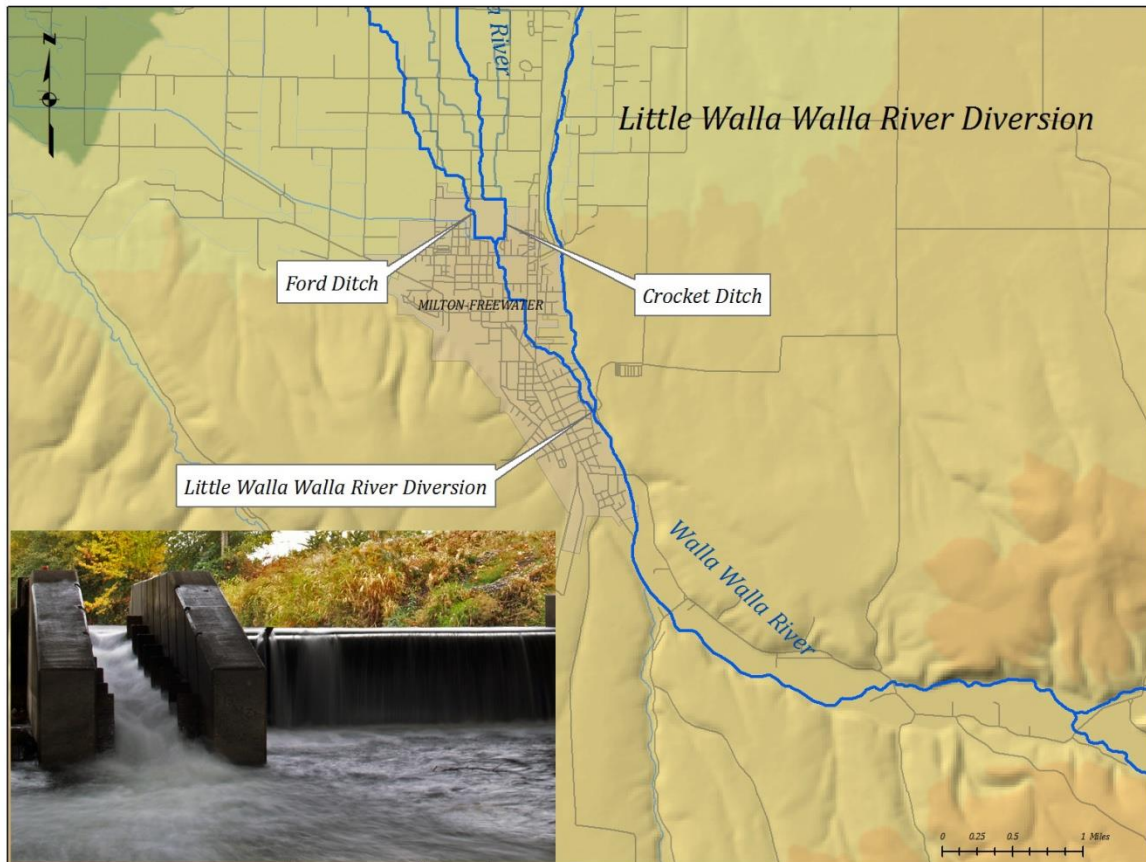


Figure 9: Little Walla Walla Irrigation Diversion at Milton-Freewater

Other distributaries to the west such as Mud, Dry, and Pine Creeks were most likely tied into this distributary system. Many of the historical distributaries west of the mainstem (Tum-A-Lum Branch) were converted into irrigation conveyance systems for hundreds of farms. Because the Little Walla Walla system is currently used mostly for irrigation purposes, it was treated as a diversion for purposes of analysis for the Walla Walla River. It should be noted also that it is generally believed that water lost in this portion of the basin can return to the mainstem Walla Walla River as groundwater and springs (e.g. Big Spring and East Little Walla Walla River flow, and at certain times of year as West Little Walla Walla River flow).

The Walla Walla River after it crosses into Washington State and flows to the Columbia River (Pepper Bridge to the confluence with the Columbia) the major tributary contributions from both the East Branch (Prong)⁸ of the Little Walla Walla River and Yellowhawk Creek help to approximately double or in some years triple the instream flow volumes (Old Milton Highway Bridge, 11.28 cfs, to Walla Walla River (WDFW #5), 22.64 cfs, in July, 2015). The major Washington diversions diverting water out of the Walla Walla River in July appear to be located in the lower section of the river (From the Beet Rd Bridge to MacDonald Road Bridge). Due to the large scale for flow (y-axis) in Figure 8, the smaller point diversions are difficult, if not impossible, to see. A review of the data (*Attachments A-1 through A-22*) does show numerous diversions along most segments of the river.

Water Budget Analysis and Mapping: Channel Bed Gains and Losses

The primary purpose of calculating both the rate and total volumes for net channel gains and losses is to better understand which areas of the river may have groundwater inputs (gains) or channel bed infiltration (losses). This type of information is particularly applicable for the numerous other modeling and research efforts currently underway in the Walla Walla River system⁹. For salmon and bull trout recovery research, the collected data provides spatial reference to potential areas for rearing habitat (groundwater gains provided cool water by volume to gaining reaches while losing reach may indicate thermal or flow barriers). Currently the WWBWC and its partners are studying the relationships between the inflow of groundwater into the Walla Walla River, temperature changes, and fish movements. It also provides valuable information with regard to where ground water from the Little Walla Walla River may reemerge in the Walla Walla River mainstem aside from the more obvious surface tributary sources.

⁸ The source of this tributary water is generally thought to be from springs (primarily from the Big Springs branches and East Prong Little Walla Walla area) located in the Little Walla Walla system that convey ground water returns from the channel bed losses in Oregon's Levee section: Tum-A-Lum Bridge to Grove School Bridge.

Utilizing the simple mass balance equation (*Total Volume of Water Budget = Total Net Gains and Losses + Total Tributary Gains + Total Diversion Losses*) and the total of water exchanged in the designated modeled area from the June 2016 dataset and the 2016 September dataset were further quantified using percent distribution. The percentages of the total volume of water movement in the modeled area relative to distribution are displayed in figures 10 and 11. June 2016 results show that Walla Walla River flows from the OWRD gauge on the upper South Fork to Nine Mile Bridge decline from 92.46 cfs to 47.70 cfs. Diversions (60%, 132.87 cfs) comprise of a significant amount of the water budget while the tributary inputs (34%, 75.8 cfs) and the amount of flow lost to the channel bed (6%, 12.3 cfs).

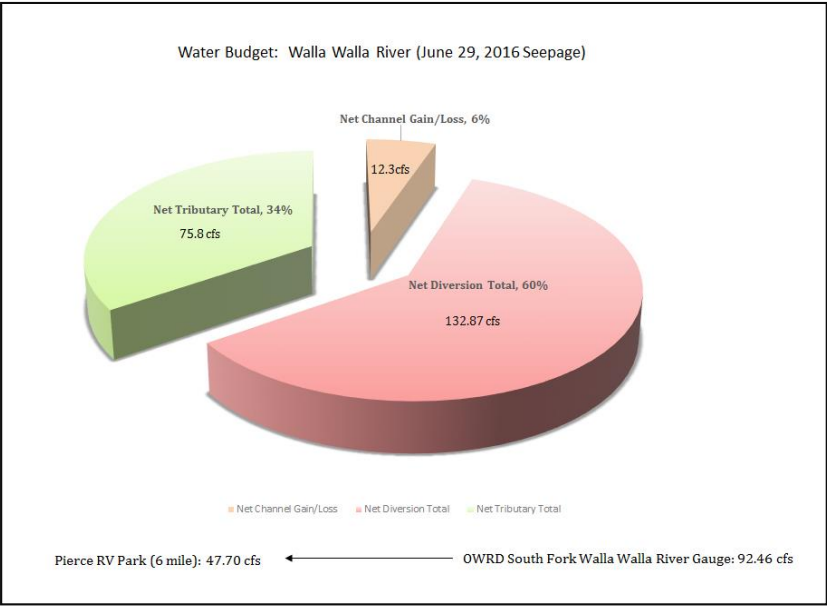


Figure 10: Water Budget June 2016

In September tributary inputs significantly decrease from the June assessment (27%, 46.7 cfs) and instead of a net loss there is a groundwater gains (25%, 32.8 cfs) which combines to make up 59% of the total budget. However, the net diversion total of 54.63 cfs which is 41% percent of the water budget.

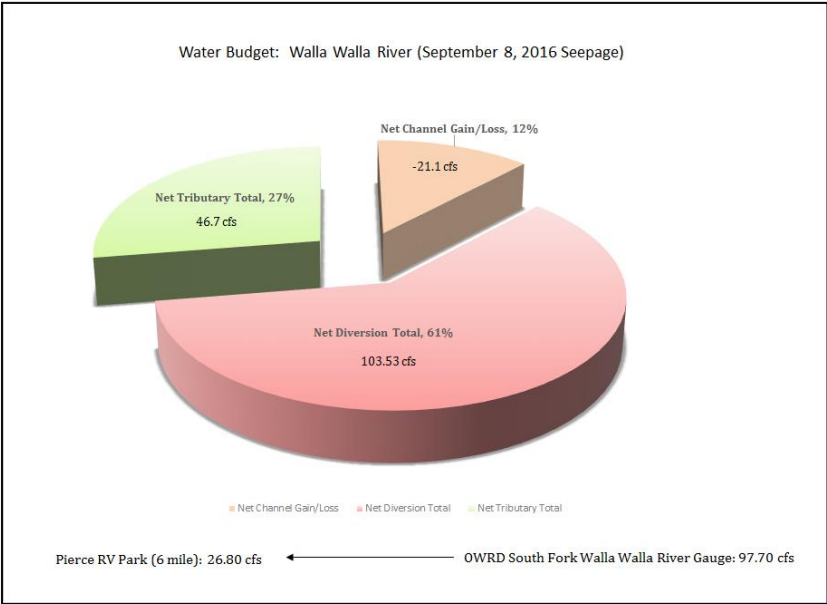


Figure 11: Water Budget Sept. 2016

2016 Mill Creek Seepage Assessment

The seepage assessments on Mill Creek were conducted on June 16 and September 8th of 2016. The WWBWC followed the same procedures discussed in the methodology section. The assessment area begins upstream of the USGS Real-time Gauge Station at the Oregon/Washington Stateline and continues downstream to the confluence with the Walla Walla River (Figure 12). Ten reaches were defined based upon access, proximity to the next reach, and the geomorphology of the system. The thalweg was digitized using ArcMap 10.3 and the digitized layer was transformed into a linear route to break the feature into 25-meter segments. From the 2016 results, Mill Creek has

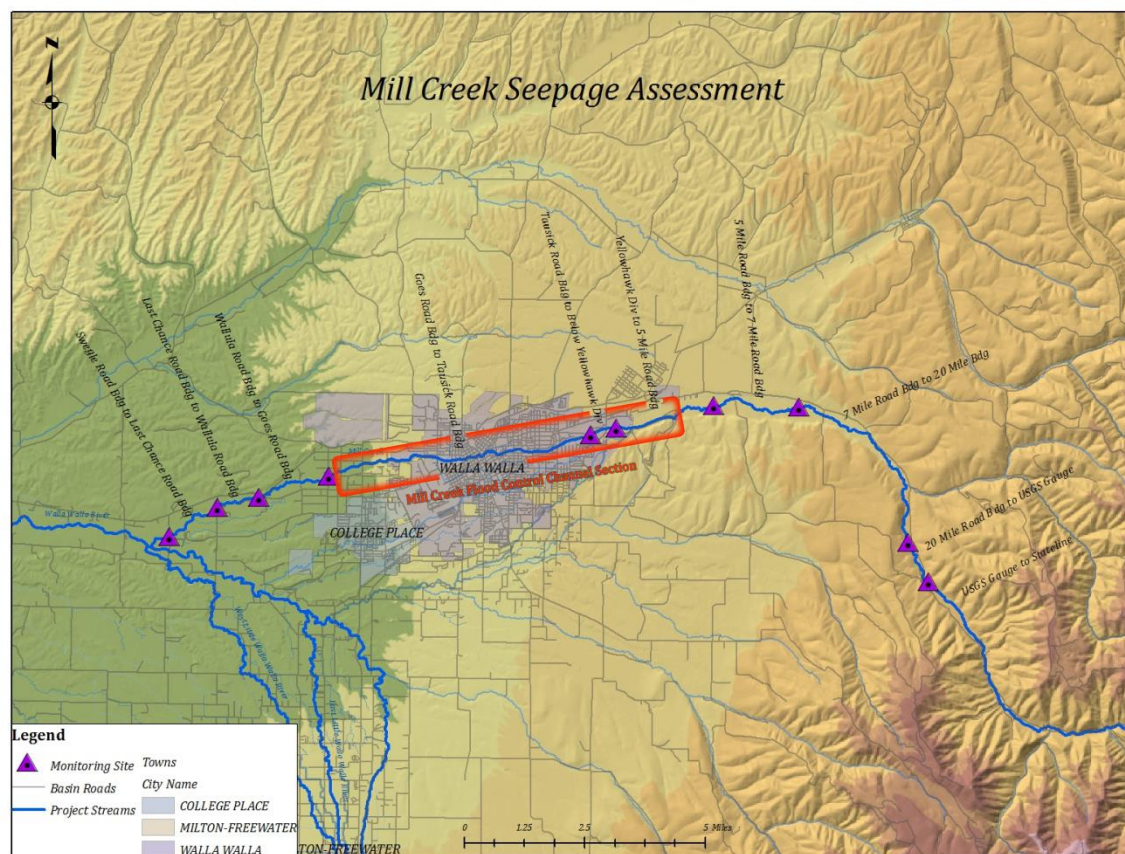


Figure 12: Mill Creek designated project reaches, 2016

a channel bed loss, in early summer, before it enters the concrete section, possibly from the weirs located downstream from the USGS gauge site at the Mill Creek Division which slows the water before it enters into the concrete section. The concrete section continues through the city of Walla Walla then exits back into a natural channel just downstream of Gose Street Bridge. Immediately downstream of the concrete flow control section there is a noticeable channel bed gain from possible return of recharge above the concrete section (Figures 13 and 14).

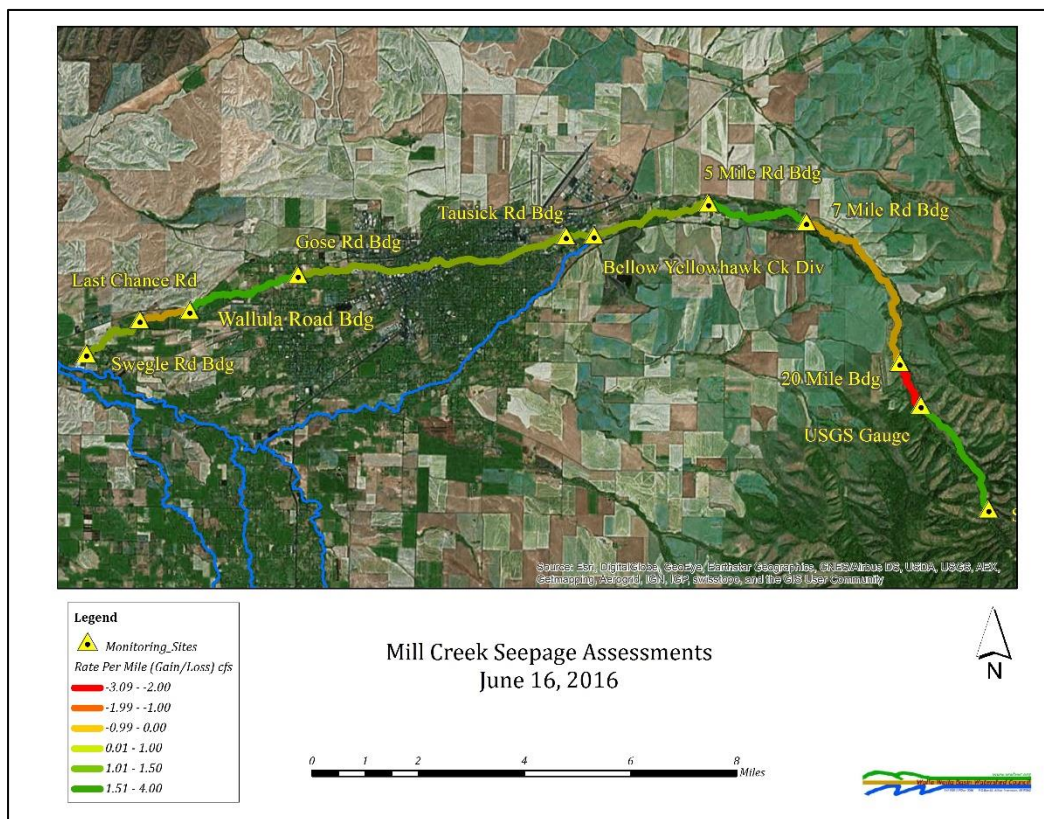


Figure 13: June 16, 2016 Mill Creek Seepage Assessment depicting the gaining and losing reach rates per mile within the assessment area

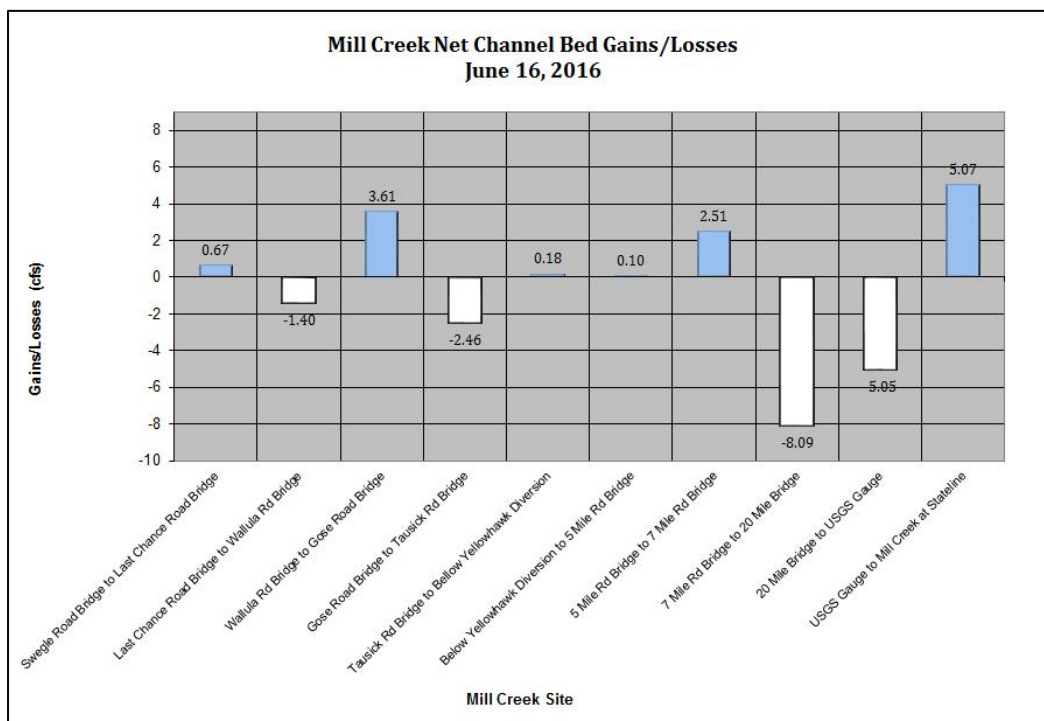


Figure 14: June 16, 2016 Seepage Assessment Net Gains and Losses per Reach

The gaining and losing reaches for both the June and September on lower Mill Creek were consistent showing little variability while the upper reaches were more variable. There were higher losses in the upper reaches in June compared to the September assessment.

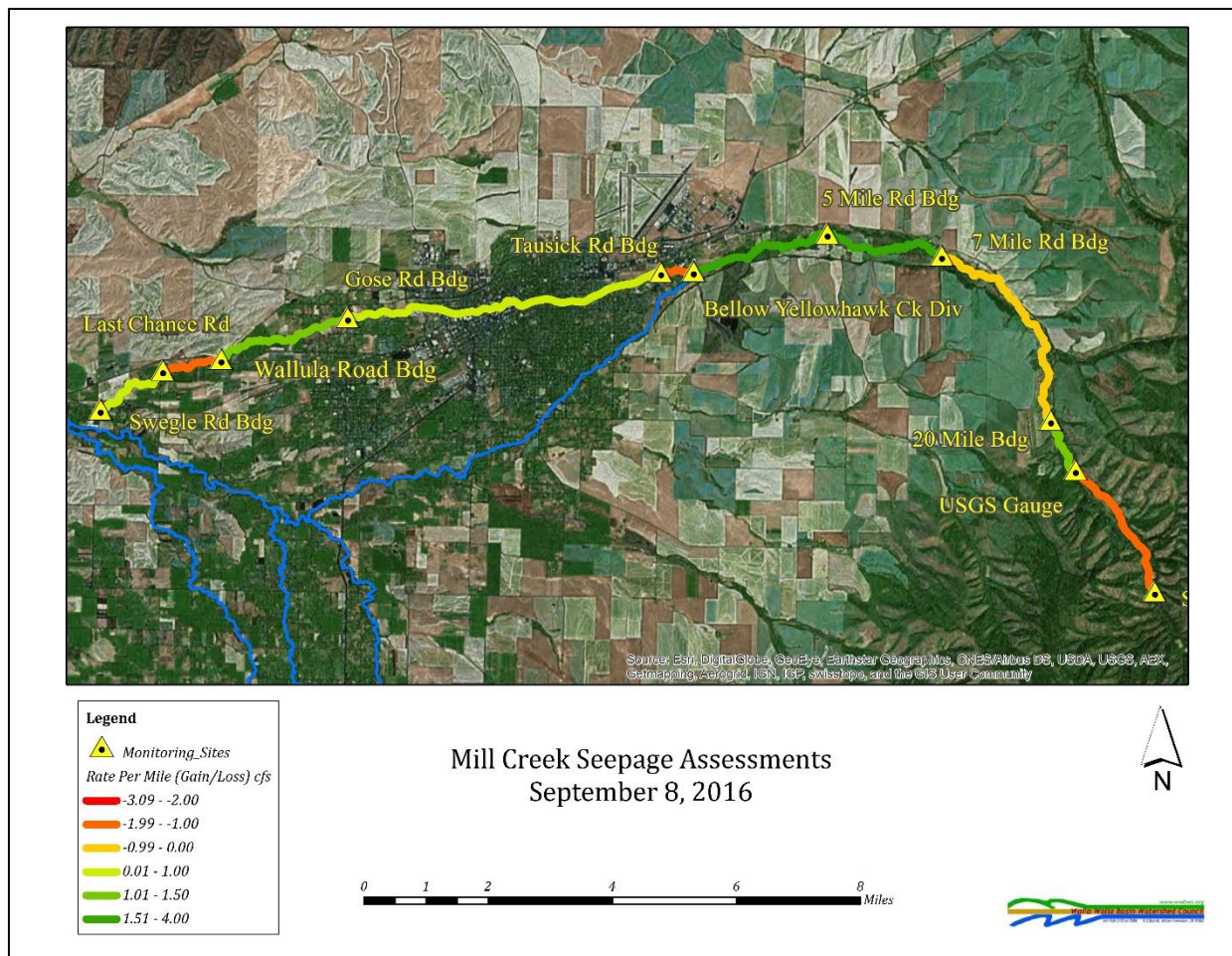


Figure 15: September 8, 2016 Mill Creek Rate Per Mile Gains / Losses per Reach

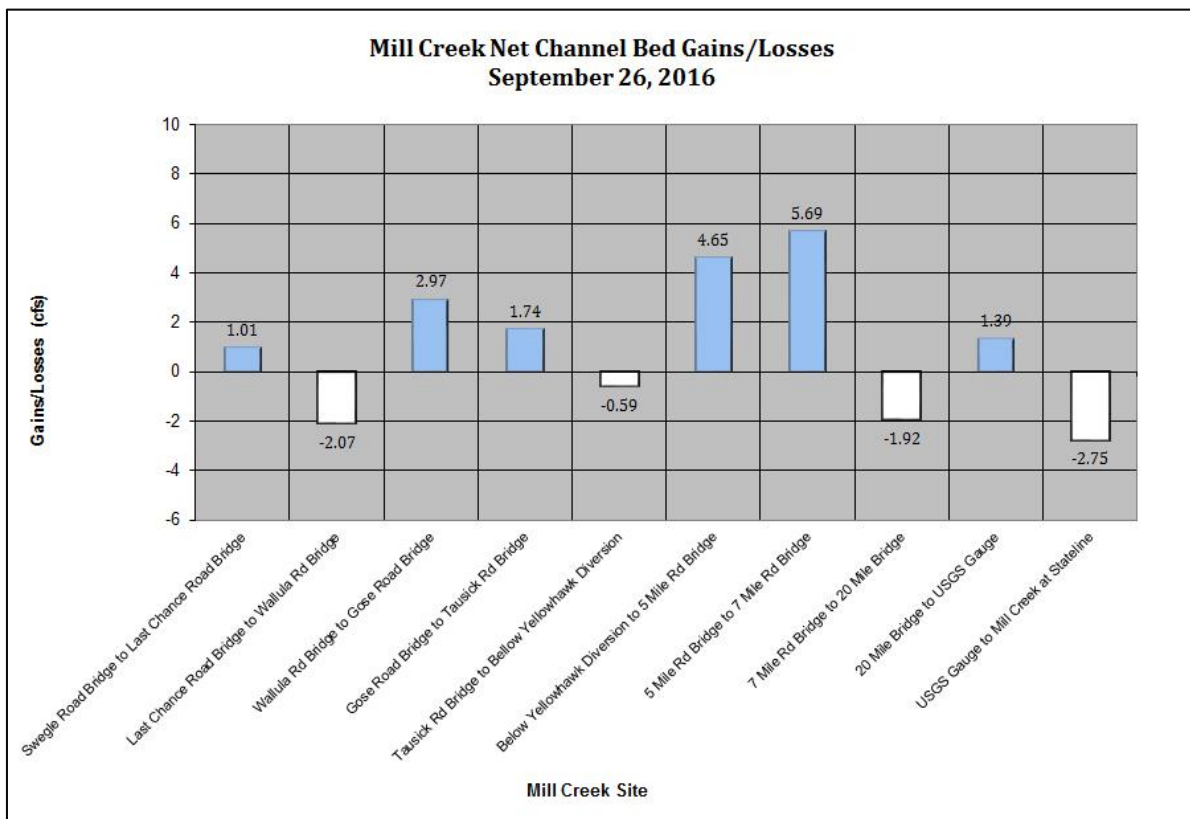


Figure 16: September 8, 2016 Net Gains and Losses per Reach

The datasheets for the two Mill Creek seepage assessments can be found in Attachment B-1.

Utilizing the simple mass balance equation and the total of water exchanged in the designated modeled area from the June 16, 2016 dataset and the September 8, 2016 dataset were further quantified using percent distribution. The percentages of the total volume of water movement in the modeled area relative to distribution are displayed in *figure 17 and figure 18*. June 2016 results show that Mill Creek flows from the Oregon-Washington state line to the confluence with the Walla Walla River decline from 34.33 cfs to 6.33 cfs. Diversions (70%, 35.25 cfs) make up the majority of the water budget while the tributary inputs (20%, 6.2 cfs) and gains from groundwater (10%, 4.4 cfs).

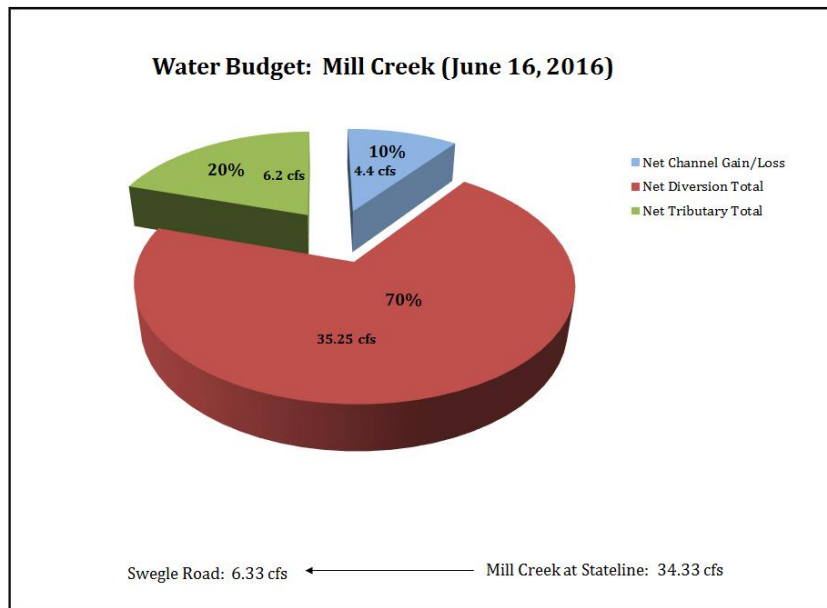


Figure 17: Water Budget June 16, 2016

In September, results show that Mill Creek flows from the Oregon-Washington state line to the confluence with the Walla Walla River decline from 34.29 cfs to 15.98 cfs. Tributary inputs (4%, 6.2 cfs) and gains from groundwater (24%, 4.4 cfs) combine to make up 28% of the total budget while diversions make up the remaining 72% (33.25 cfs).

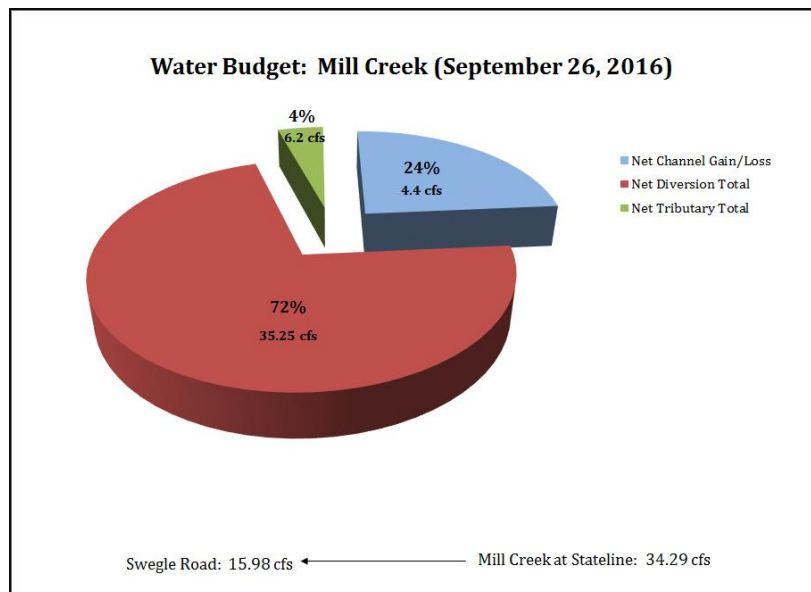


Figure 18: Water Budget September 8, 2016

2016 Touchet River Seepage Assessment

The Touchet River is the largest tributary of the Walla Walla River in southeastern Washington. The river drains an area of approximately 740 square miles and is approximately 66 miles in length from the North and South Fork Touchet River confluence to the Walla Walla River.

The seepage assessments on the Touchet River in 2016 were conducted on June 28th and in September 1st. The WWBWC followed the same procedures discussed in the methodology section. The assessment area begins along the Dayton Levee just downstream of the North and South Forks of the Touchet River downstream to the Walla Walla River close to the town of Touchet. Eleven reaches were defined (Figure 19) based upon access, proximity to the next reach, and the geomorphology of the system. The thalweg was digitized using ArcMap 10.3 then the digitized layer was transformed into a linear route to allow for the ability to break the feature into uniform segments.

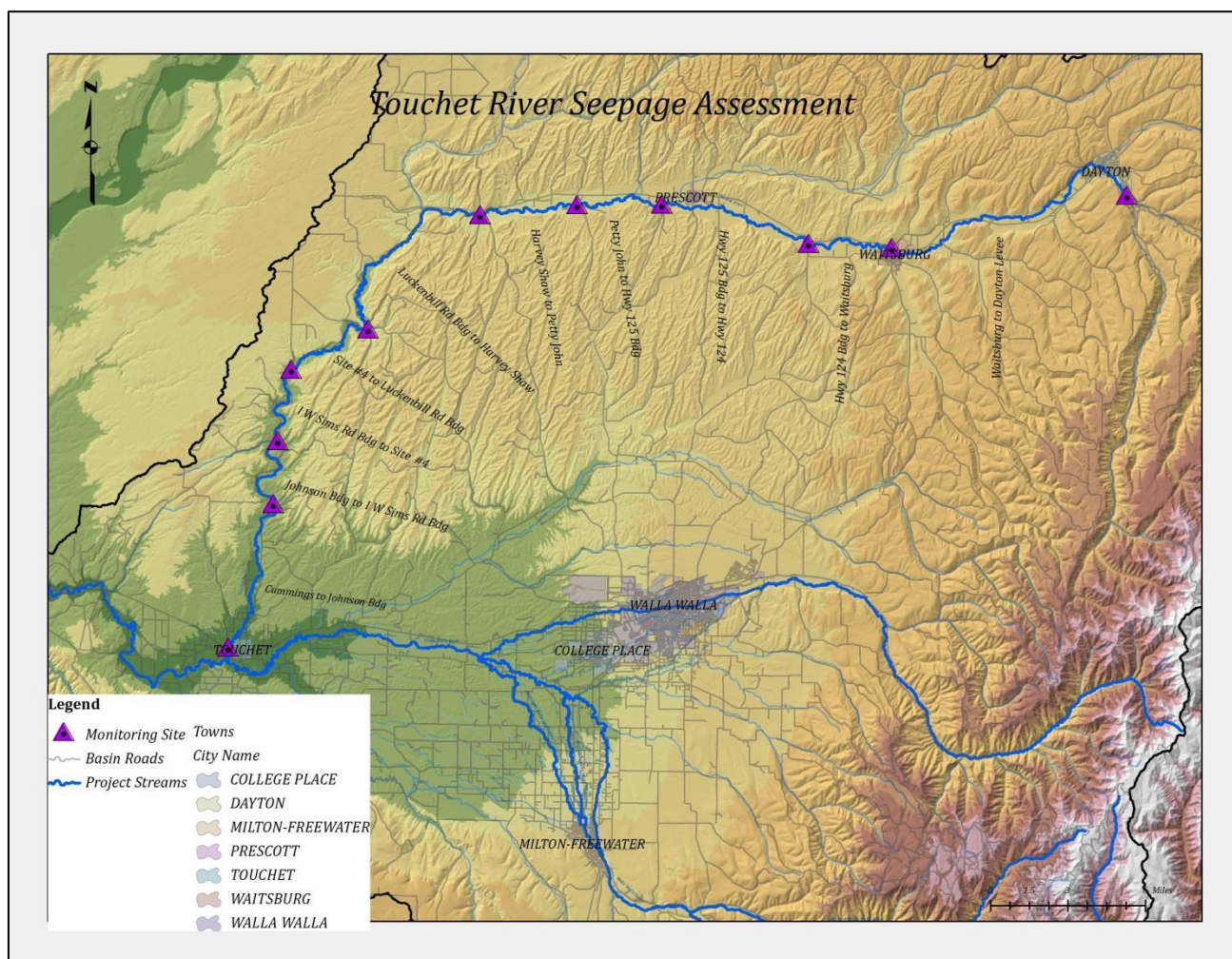


Figure 19: Touchet River Seepage Assessment Sampling Locations and Reaches

The first seepage assessment of 2016 was conducted on June 28th. From the initial 2016 assessment three reaches were defined as gaining while seven reaches were defined as losing. The three gaining reaches were located in the upper, middle, and lower reaches of the Touchet River assessed. (Figures 20 and 21)

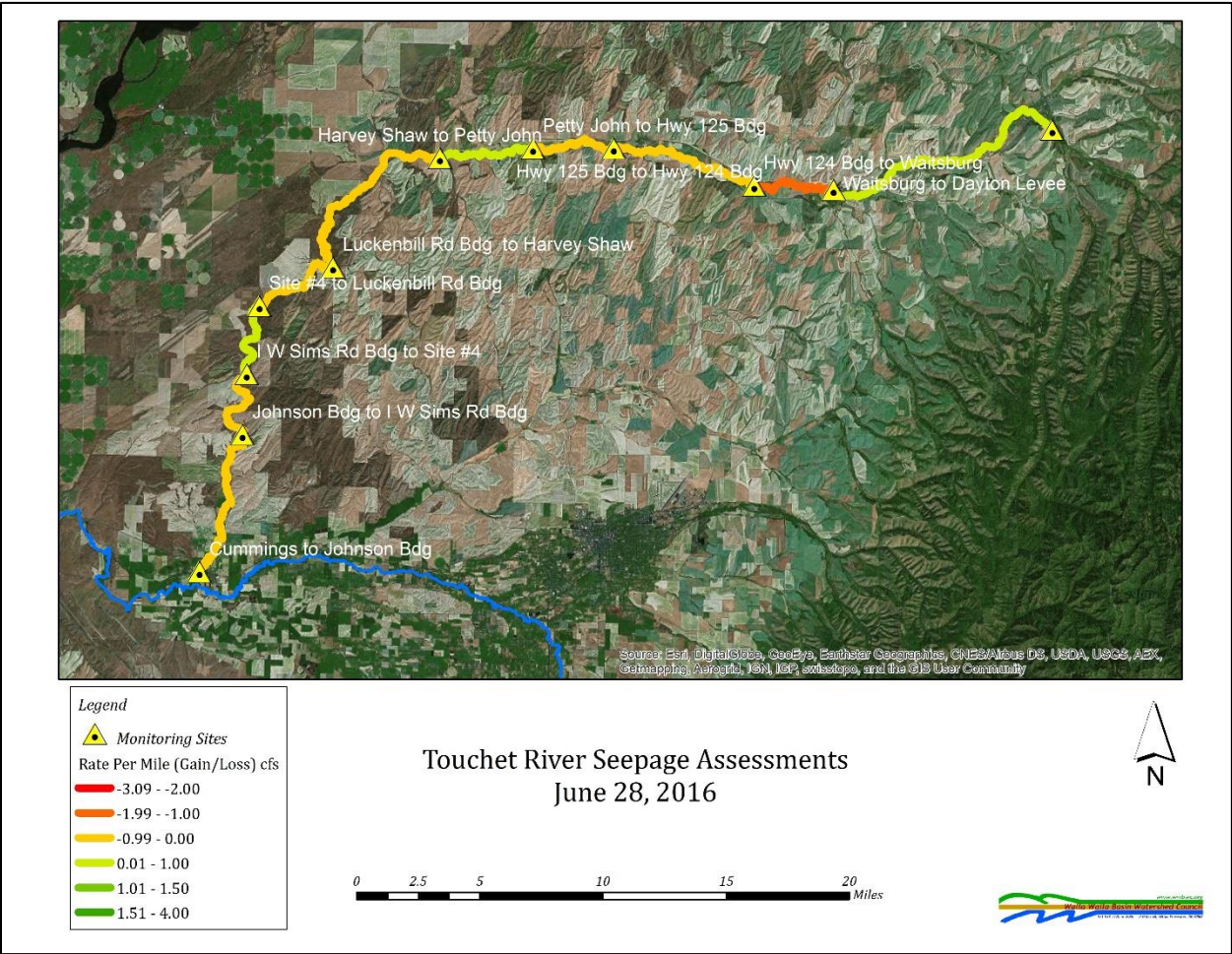


Figure 20: Touchet River Seepage Assessment June 28, 2016 Rate Per Mile (Gains and Losses) per Reach



Touchet River at Hart Road Bridge

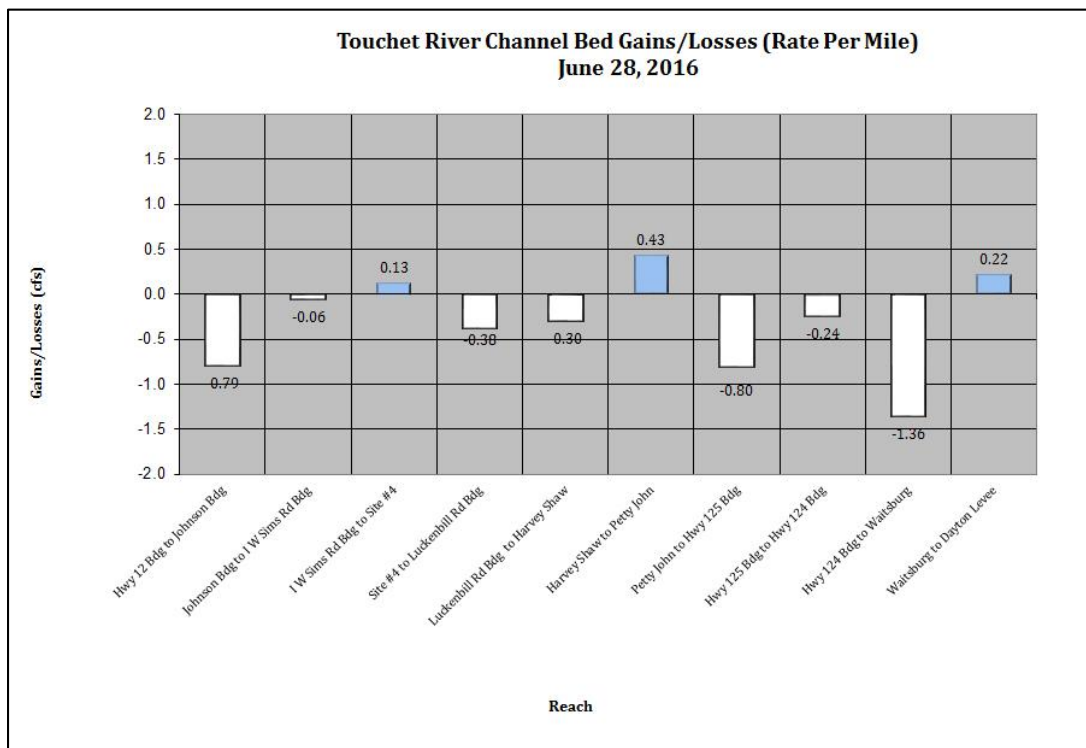


Figure 21 June 28, 2016 Net Gains and Losses per Reach

The second seepage assessment of 2016 on the Touchet River was conducted on September 1st. In the late summer assessment four of the ten reaches were identified as slightly gaining reaches (less than .12 cfs/mile) while six were identified as losing reaches (*Figures 22 and 23*).



Touchet River below the Hwy 125 Bridge

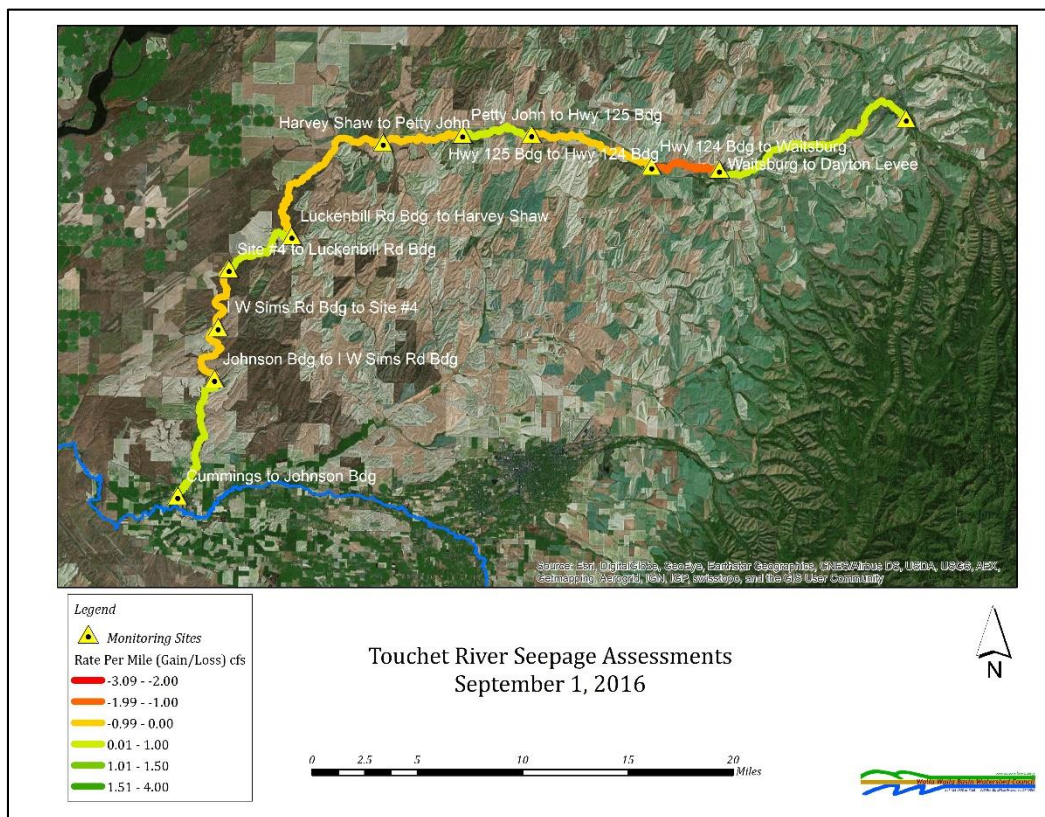


Figure 22: Touchet River Seepage Assessment September 1, 2016 Gains and Losses per Reach

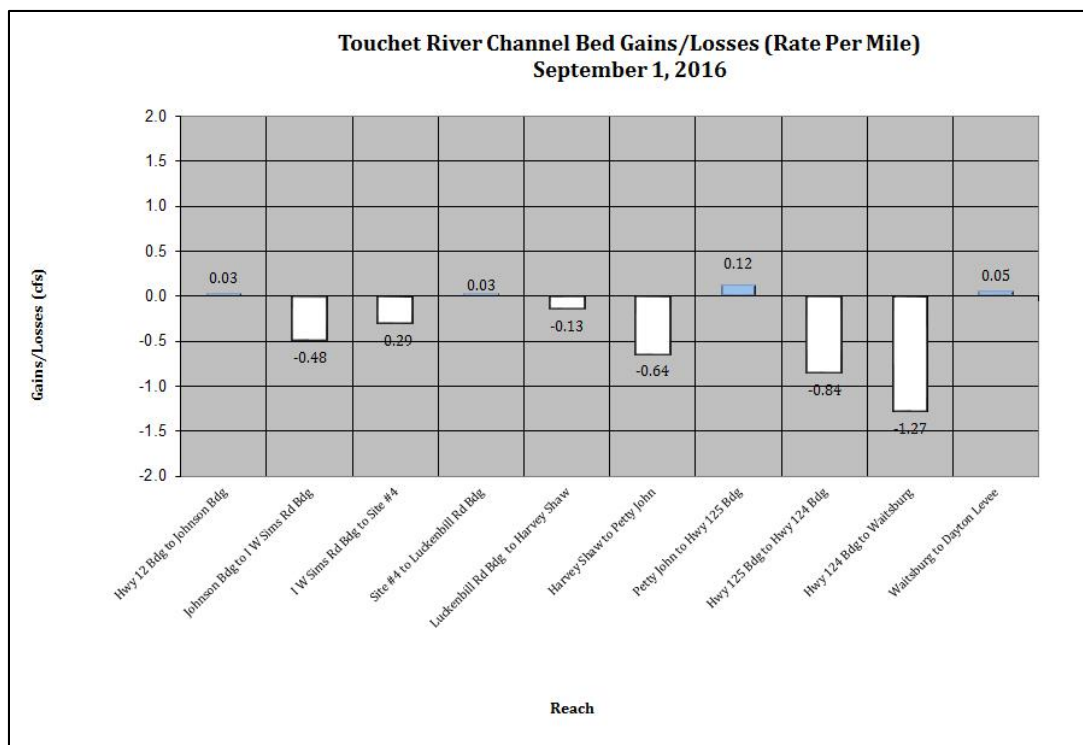


Figure 23: September 1, 2016 Net Gains and Losses per Reach

Utilizing the simple mass balance and the total of water exchanged in the designated modeled area from the June 2016 dataset and the 2016 September dataset were further quantified using percent distribution. The percentages of the total volume of water movement in the modeled area relative to distribution are displayed in figures 24 and 25. June 2016 results show that the Touchet River flows from above Dayton to the confluence with the Walla Walla River decreases from 56.15 cfs to 16.05 cfs. Diversions (56%, 31.32 cfs) take up just over one half

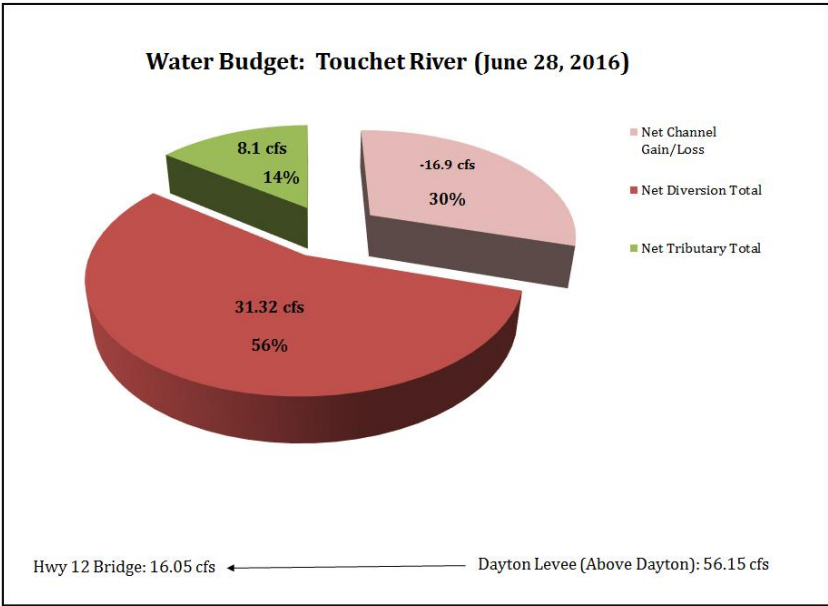


Figure 24: Water Budget June 28, 2016

of the water budget while the tributary inputs (14%, 8.1 cfs) and losses to groundwater (30% 16.9 cfs) total 44% of the total budget.

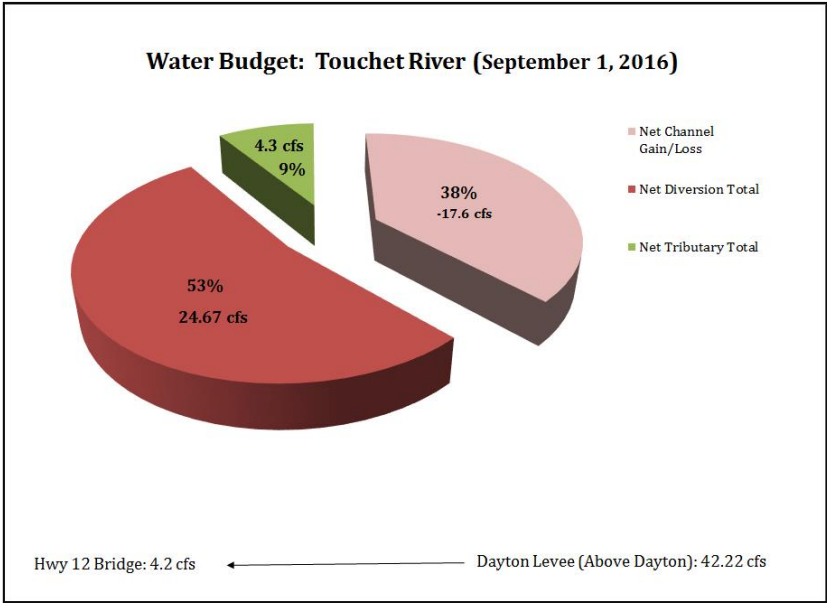


Figure 25: Water Budget Sept. 1, 2016

In September there is a decrease in volume compared to the June assessment. Tributary inputs (9%, 4.3 cfs) and groundwater losses (36%, -15.7 cfs) combine to make up 44% of the total budget while diversions make up the remaining 56% (24.8 cfs). The noticeable difference from the three other systems examined, the Touchet River is consistently a net losing river system in late summer/early fall.

Seepage Assessment Results

The data collected from the assessments conducted on the Walla Walla River, Mill Creek, and the Touchet River from the 2016 and prior years was compiled to produce the final seepage assessment results.

Walla Walla River

Seepage assessments were conducted in the Months of June, July, August, September, October and November. For the purposes of this report the assessments conducted in June were not included.¹⁰ The results below are based on the overall and monthly averages for the assessments.

Flow Measurement Location	Actual River Mile	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Percent Gain/Loss Flow	Average Flow
Pierce's RV Park	8.5	5.68	-0.78	-5.58	-14.7%	42.50
Byerly Road Bridge	12.7	12.88	1.50	6.42	23.9%	47.88
USGS Touchet Gage	15.9	16.12	0.29	4.50	77.6%	43.61
Lowden Rd Bridge	27.6	28.24	0.51	1.11	6.7%	17.43
MacDonald Rd Bridge	29.7	30.41	-0.76	-2.64	-5.3%	20.29
Detour Road	33.3	33.97	-0.08	-0.09	0.3%	44.46
Swegle Road Bridge	34.4	35.04	0.04	0.06	1.5%	35.26
Last Chance Road Bridge	35.8	36.52	0.02	0.03	1.2%	35.14
Beet Road Bridge	37.5	38.32	-2.35	-1.21	-1.5%	36.59
Walla Walla River (WDFW #5 Site)	38.1	38.84	-0.06	-0.09	-3.1%	44.36
Old Milton HWY Bridge	39.5	40.21	0.63	1.12	7.2%	20.51
Peppers Bridge Location	41.1	41.90	1.26	1.31	9.3%	19.19
WWBWC # M-10	42.3	42.94	2.79	2.25	18.0%	16.90
WWBWC # M-9 (Mauer Lane)	43.0	43.76	-1.44	-2.38	-7.6%	15.04
Tumalum Road Bridge (M-8)	43.6	44.43	-1.96	-2.39	-9.2%	15.34
Walla Walla River (M-7)	44.2	44.87	-6.23	-8.89	-34.8%	15.82
Walla Walla River M-5	45.3	45.96	-6.43	-4.77	-14.1%	26.36
Walla Walla River Nursery Bridge (M-4)	45.9	46.62	-14.74	-9.76	-15.7%	30.95
Levy, 0.5 mile us of Nursery Bridge (M-3)	46.7	47.26	-2.67	-2.11	-1.3%	45.93
15th St Bridge (Grove M1)	47.9	48.59	3.73	3.94	4.3%	109.13
Couse Creek Road Bridge	49.0	49.66	-1.54	-1.44	-1.1%	108.34
Day Road	49.9	50.59	3.93	3.84	3.4%	111.80
Joe West Bridge	50.8	51.57	0.57	0.67	1.4%	108.31
South Fork Bridge	52.5	53.22	0.99	5.56	5.4%	106.26
CTUIR Fish Hatchery/Holding Facility	57.6	58.44	0.15	0.50	0.6%	106.57
Private Property (Keating)	59.3	60.07	-1.64	-2.96	-2.4%	106.45
BLM Trailhead	61.1	61.85	x	x	x	111.80

Figure 26: Walla Walla River Seepage Assessment Averages

¹⁰ The June assessments were conducted from June 2002 – 2004 and were mainly focused on the Walla Walla River flowing in Oregon. Also many of the diversions were estimated and not measured.

SF Walla Walla River at Keating to SF Walla Walla River at the BLM Trailhead

This reach is a 1.7 mile¹¹ reach which the upstream end of the reach begins at the BLM Trailhead at the end of the Walla Walla River Road at river mile 61.1¹². This measuring reach is located within a narrow forested canyon environment. On average the measured flow during the assessments on the upstream side of the reach was 111.80 cfs. This reach on average loses 2.4% of its flow to groundwater and has a net loss average of 2.96 cfs.

SF Walla Walla River at the CTUIR Holding/Hatchery Facility to the SF Walla Walla River at Keating

This reach is a 1.63 mile reach which the upstream end of the reach begins at the Keating Site at river mile 59.3. This measuring reach is located within a narrow forested canyon environment. On average the measured flow during the assessments on the upstream side of the reach was 106.45 cfs. This reach on average gains .6% of its flow from groundwater returns and has a net gain average of .5 cfs.

SF Walla Walla River Road Bridge to the SF Walla Walla River at the CTUIR Holding/Hatchery Facility

This reach is a 5.22 mile reach which the upstream end of the reach begins at the CTUIR Holding/Hatchery facility at river mile 57.6. This measuring reach is located within a narrow forested canyon environment to an open canyon environment. On average the measured flow during the assessments on the upstream side of the reach was 106.57 cfs. This reach on average gains 5.4% of its flow from groundwater returns and has a net gain average of 5.56 cfs.



South Fork Walla Walla River at SF Bridge

¹¹ Calculated from the digitized GIS layer used for calculating accurate reach lengths.

¹² River mile distance is in reference to the USGS river mile data.

Walla Walla River at Joe West Bridge to the SF Walla Walla River Road Bridge

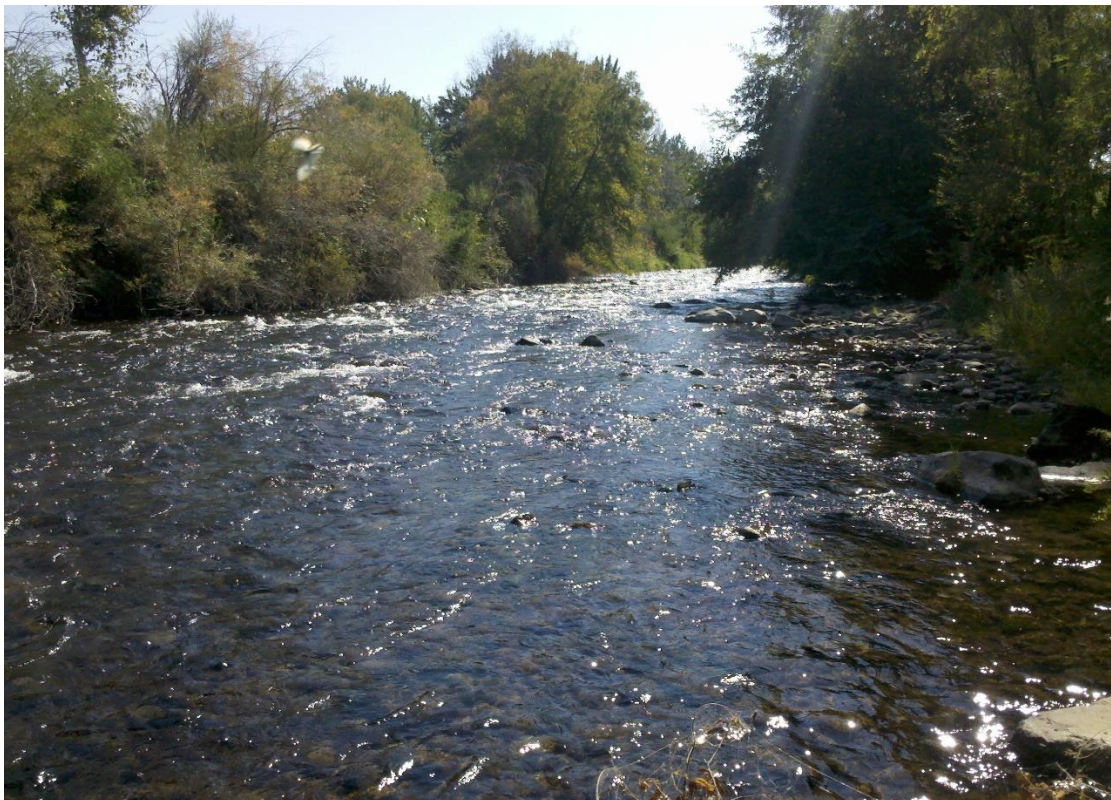
This reach is a 1.65 mile reach which the upstream end of the reach begins at the South Fork Walla Walla River Road Bridge at river mile 52.5. This measuring reach is located within an open canyon environment. On average the measured flow during the assessments on the upstream side of the reach was 106.26 cfs. This reach on average gains 1.4% of its flow from groundwater returns and has a net gain average of .67 cfs.

Walla Walla River at Day Road to the Walla Walla River at the Joe West Bridge

This reach is a .98 mile reach which the upstream end of the reach begins at the Walla Walla River at Joe West Bridge at river mile 50.8. This measuring reach is located within an open canyon environment. On average the measured flow during the assessments on the upstream side of the reach was 108.31 cfs. This reach on average gains 3.4% of its flow from groundwater returns and has a net gain average of 3.84 cfs.

Walla Walla River at the Couse Creek Road Bridge to the Walla Walla River at Day Road

This reach is a .93 mile reach which the upstream end of the reach begins at the Couse Creek Road Bridge at river mile 49.9. This measuring reach is located within an open broad canyon environment. On average the measured flow during the assessments on the upstream side of the reach was 111.80 cfs. This reach on average loses 1.1% of its flow to groundwater and has a net loss average of 1.44 cfs.



Walla Walla River at 15th St. Bridge (Grove M1)

Walla Walla River at the 15th St. Bridge to the Walla Walla River at the Couse Creek Road Bridge

This reach is a 1.07 mile reach which the upstream end of the reach begins at the Walla Walla River at the Couse Creek Road Bridge at river mile 49.0. This measuring reach is located within an open canyon environment in which

the lower end of the reach terminates at the town of Milton-Freewater. This is also the first reach located within the Milton-Freewater flood control levee. On average the measured flow during the assessments on the upstream side of the reach was 108.34 cfs. This reach on average gains 4.3% of its flow from groundwater returns and has a net gain average of 3.94 cfs.

Walla Walla River at M3 to the Walla Walla River at the 15th St. Bridge

This reach is a 1.32 mile reach which the upstream end of the reach begins at the 15th Street Bridge (Grove) at river mile 47.9. This measuring reach is located within the Milton-Freewater flood control levee in the town of Milton-Freewater. On average, the measured flow during the assessments on the upstream side of the reach was 109.13 cfs. A significant amount of flow is diverted in this reach at the Little Walla Walla River Diversion next to the Cemetery Road Bridge. This reach on average loses 1.31% of its flow to groundwater and has a net loss average of 2.11 cfs.

Walla Walla River below Nursery Bridge (M4) to the Walla Walla River at M3

This reach is a .64 mile reach which the upstream end of the reach begins at M3 above Nursery Bridge at river mile 46.7. This measuring reach is located within the Milton-Freewater flood control levee in the town of Milton-Freewater. On average, the measured flow during the assessments on the upstream side of the reach was 45.93 cfs. This reach on average loses 15.7% of its flow to groundwater and has a net loss average of 9.76 cfs.

Walla Walla River at M5 to the Walla Walla River below Nursery Bridge (M4)

This reach is a .66 mile reach which the upstream end of the reach begins at M4 below Nursery Bridge at river mile 45.9. This measuring reach is located within the Milton-Freewater flood control levee northeast of the town of Milton-Freewater. On average, the measured flow during the assessments on the upstream side of the reach was 30.95 cfs. This reach on average loses 14.1% of its flow to groundwater and has a net loss average of 4.77 cfs.

Walla Walla River at M7 to the Walla Walla River at M5

This reach is a 1.09 mile reach which the upstream end of the reach begins at M5 at river mile 45.3. This measuring reach is located within the Milton-Freewater flood control levee northeast of the town of Milton-Freewater. On average, the measured flow during the assessments on the upstream side of the reach was 26.36 cfs. This reach on average loses 38.4% of its flow to groundwater and has a net loss average of 8.89 cfs.

Walla Walla River at the Birch Creek Road Bridge (M8) to the Walla Walla River at M7

This reach is a .44 mile reach which the upstream end of the reach begins at M7 at river mile 44.2. This measuring reach is located within the Milton-Freewater flood control levee northeast of the town of Milton-Freewater. On average, the measured flow during the assessments on the upstream side of the reach was 15.82 cfs. This reach on average loses 9.2 of its flow to groundwater and has a net loss average of 2.39 cfs.



Walla Walla River at the Birch Creek Road Bridge (M8)

Walla Walla River at Mauer Lane (M9) to the Walla Walla River at the Birch Creek Road Bridge (M8)

This reach is a .66 mile reach which the upstream end of the reach begins at the Birch Creek Road Bridge (M8) at river mile 43.6. This measuring reach is located north of the Milton-Freewater flood control. On average, the measured flow during the assessments on the upstream side of the reach was 15.34 cfs. This reach on average loses 7.6 of its flow to groundwater and has a net loss average of 2.38 cfs.

Walla Walla River at M10 to the Walla Walla River at Mauer Lane (M9)

This reach is a .82 mile reach which the upstream end of the reach begins at Mauer Lane (M9) at river mile 43.0. This measuring reach is located within an alluvial flood plain. On average, the measured flow during the assessments on the upstream side of the reach was 15.04 cfs. This reach on average gains 18% of its flow from groundwater returns and has a net gain average of 2.25 cfs.

Walla Walla River at Peppers Bridge to the Walla Walla River at M10

This reach is a 1.04 mile reach which the upstream end of the reach begins at M10 at river mile 42.3. This measuring reach is located within an alluvial flood plain. On average, the measured flow during the assessments on the upstream side of the reach was 16.90 cfs. This reach on average gains 9.3% of its flow from groundwater returns and has a net gain average of 1.31 cfs.

Walla Walla River at Old Milton Highway Bridge to the Walla Walla River at Peppers Bridge

This reach is a 1.69 mile reach which the upstream end of the reach begins at the Walla Walla River at Peppers Bridge at river mile 41.1. This measuring reach is located within an alluvial flood plain and is the last reach located

in Oregon. On average, the measured flow during the assessments on the upstream side of the reach was 19.19 cfs. This reach on average gains 7.2% of its flow from groundwater returns and has a net gain average of 1.12 cfs.

Walla Walla River at WDFW Site #5 to the Walla Walla River at Old Milton Highway Bridge

This reach is a 1.37 mile reach which the upstream end of the reach begins at the Old Milton Highway Road Bridge at river mile 39.5. This measuring reach is located within an alluvial flood plain and is the first reach located in Washington State. On average, the measured flow during the assessments on the upstream side of the reach was 20.51 cfs. This reach on average loses 3.1% of its flow to groundwater and has a net loss average of .09 cfs.

Walla Walla River at the Beet Road Bridge to the Walla Walla River at WDFW Site #5

This reach is a .52 mile reach which the upstream end of the reach begins at the Walla Walla River at WDFW Site #5 at river mile 38.1. This measuring reach is located within an alluvial flood plain. The Gardena Farms Irrigation District Diversion is located within this reach and is one of the largest diversion points on the Walla Walla River. On average, the measured flow during the assessments on the upstream side of the reach was 44.36 cfs. This reach on average loses 1.5% of its flow to groundwater and has a net loss average of 1.21 cfs.

Walla Walla River at the Last Chance Road Bridge to the Walla Walla River at Beet Road Bridge

This reach is a 1.80 mile reach which the upstream end of the reach begins at the Walla Walla River at the Beet Road Bridge at river mile 37.5. This measuring reach is located within an alluvial flood plain. On average, the measured flow during the assessments on the upstream side of the reach was 36.59 cfs. This reach on average gains 1.2% of its flow from groundwater returns and has a net gain average of .03 cfs.



Walla Walla River at Beet Road

Walla Walla River at Swegle Road Bridge to the Walla Walla River at Last Chance Road Bridge

This reach is a 1.48 mile reach which the upstream end of the reach begins at the Walla Walla River at the Last Chance Road Bridge at river mile 35.8. This measuring reach is located within an alluvial flood plain. On average, the measured flow during the assessments on the upstream side of the reach was 35.14 cfs. This reach on average gains 1.5% of its flow from groundwater returns and has a net gain average of .06 cfs.

Walla Walla River at the Detour Road Bridge to the Walla Walla River at the Swegle Road Bridge

This reach is a 1.07 mile reach which the upstream end of the reach begins at the Walla Walla River at the Swegle Road Bridge at river mile 34.4. This measuring reach is located within an alluvial flood plain. On average, the measured flow during the assessments on the upstream side of the reach was 35.26 cfs. This reach on average gains .3% of its flow from groundwater returns, but has a net loss average of .09 cfs.



Walla Walla River at Detour Road Bridge

Walla Walla River at the McDonald Road Bridge to the Walla Walla River at the Detour Road Bridge

This reach is a 3.56 mile reach which the upstream end of the reach begins at the Walla Walla River at the Detour Road Bridge at river mile 33.3. This measuring reach is located within an alluvial flood plain. On average, the measured flow during the assessments on the upstream side of the reach was 44.46 cfs. The last main diversion is located within this reach. In recent years during the months of August and September dry sections of this reach have been documented in previous assessment reports. This reach on average loses 5.3% of its flow to groundwater and has a net loss average of 2.46 cfs.

Walla Walla River at the Lowden Road Bridge to the Walla Walla River at McDonald Road Bridge

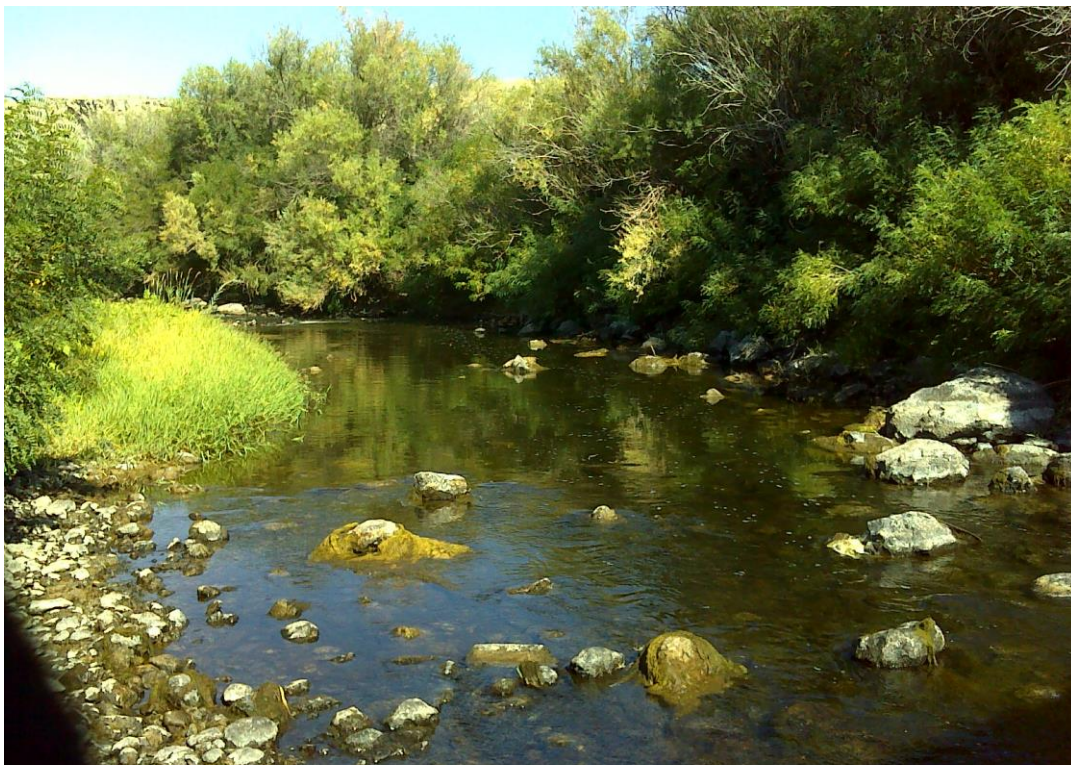
This reach is a 2.17 mile reach which the upstream end of the reach begins at the Walla Walla River at the McDonald Road Bridge at river mile 29.7. This measuring reach is located within an alluvial flood plain. On average, the measured flow during the assessments on the upstream side of the reach was 20.29 cfs. This reach on average gains 6.7% of its flow from groundwater returns and has a net gain average of 1.11 cfs.

Walla Walla River at the USGS Touchet Gauge to the Walla Walla River at the Lowden Road Bridge

This reach is a 12.11 mile reach which the upstream end of the reach begins at the Walla Walla River at the Lowden Road Bridge at river mile 27.6. This measuring reach is located within an alluvial flood plain. The last main tributary the Touchet River enters the Walla Walla River in this reach. On average, the measured flow during the assessments on the upstream side of the reach was 17.43 cfs. This reach on average gains 77.6% of its flow from groundwater returns and has a net gain average of 4.5 cfs.

Walla Walla River at Byerly Road Bridge to the Walla Walla River at the USGS Touchet Gauge

This reach is a 3.24 mile reach which the upstream end of the reach begins at the Walla Walla River at the USGS Touchet Gauge at river mile 15.9. This measuring reach is located within an alluvial flood plain on the upper end of the reach and a broad basalt canyon on the lower end of the reach. On average, the measured flow during the assessments on the upstream side of the reach was 43.61 cfs. This reach on average gains 23.9% of its flow from groundwater returns and has a net gain average of 6.42cfs.



Walla Walla River at Byerly Road Bridge

Mill Creek

Seepage assessments were conducted in the Months of June, July, August, September, and October. The results below are based on the overall and monthly averages for the assessments.

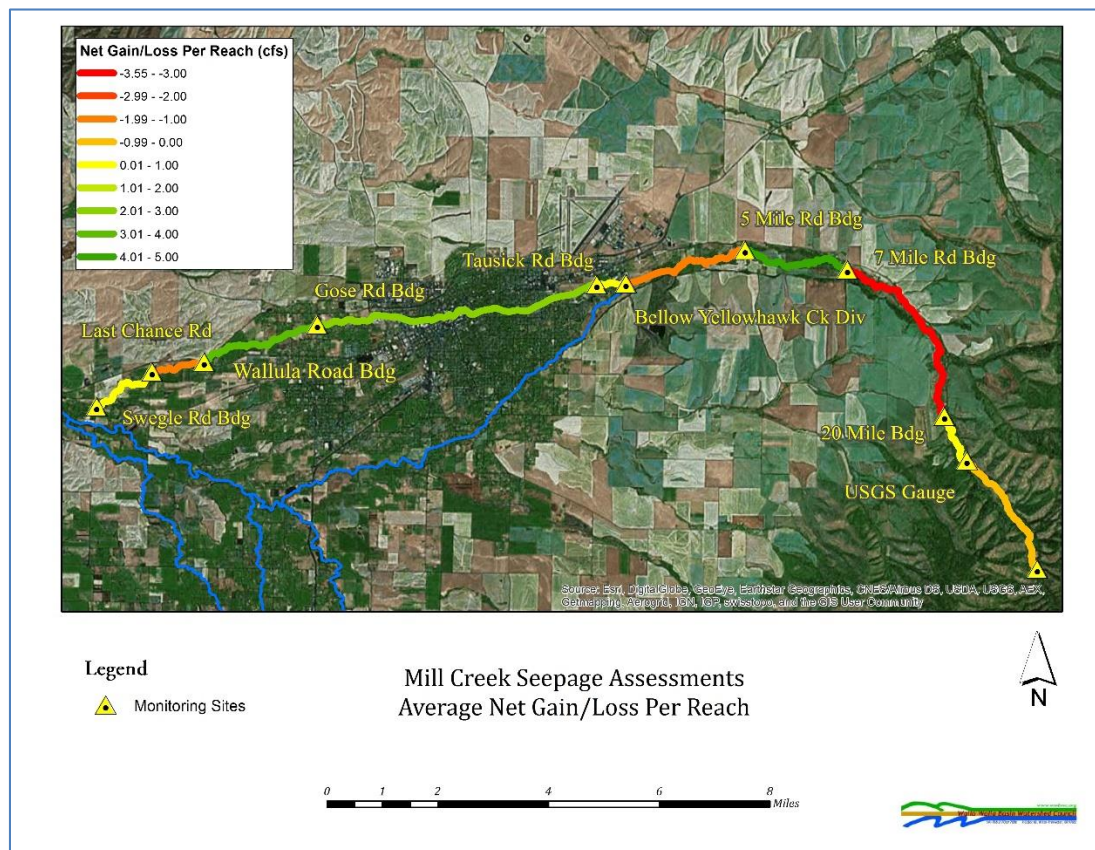


Figure 27: Mill Creek Average Net Gain/Loss

Mill Creek at Stateline to Mill Creek at the USGS Gauge

This reach is a 2.5 mile reach which the upstream end of the reach begins just upstream of the Oregon/Washington State boundary at river mile 23.7. The reach is the uppermost reach assessed during all of the seepage assessments on Mill Creek since 2008. This measuring site on average has the highest flow values recorded and is located in a confined steep canyon environment. Although this reach gains .73% of its flow from groundwater returns on average it actually equates to .01 cfs net loss if you take the average of net gain/loss for the reach.



Mill Creek at Stateline

Average Of All Seepage Assessments	15 Assessments			
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Percent Loss/Gain Flow
Swegle Road Bridge to Last Chance Road Bridge	0.6	0.01	0.01	2.04%
Last Chance Road Bridge to Wallula Rd Bridge	2.0	-1.11	-1.15	-11.90%
Wallula Rd Bridge to Gose Road Bridge	3.1	1.56	3.80	105.94%
Gose Road Bridge to Tausick Rd Bridge	5.5	0.53	2.90	17.74%
Tausick Rd Bridge to Bellow Yellowhawk Diversion	10.9	0.19	0.10	14.40%
Below Yellowhawk Diversion to 5 Mile Rd Bridge	11.5	-0.41	-1.05	-31.52%
5 Mile Rd Bridge to 7 Mile Rd Bridge	14.0	1.85	4.11	1.78%
7 Mile Rd Bridge to 20 Mile Bridge	16.2	-0.90	-3.55	-7.56%
20 Mile Bridge to USGS Gauge	20.2	0.05	0.06	0.70%
USGS Gauge to Mill Creek at Stateline	21.2	0.00	-0.01	0.73%

Figure 28: Mill Creek Seepage Assessment Averages

Mill Creek at the USGS Gauge to Mill Creek at 20 Mile Bridge

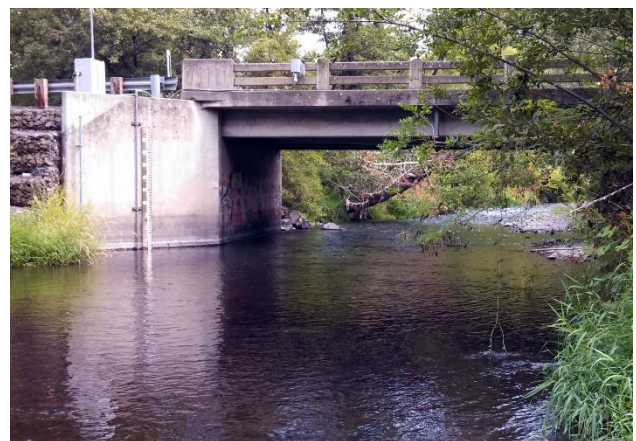
This reach is a 1.0 mile reach which the upstream end of the reach begins at the USGS gauge at river mile 21.2. This measuring site is located within a canyon environment at the upper end of the reach and becomes slightly broader toward the lower end of the reach. On average the measured flow during the assessments on the upstream side of the reach was 36 cfs. This reach on average gains .7% of its flow from groundwater returns, but the net gain/loss for the reach is a net .01 loss. This reach switches from gaining reach to a losing reach for the months of July and October and should be considered an overall neutral reach.

Mill Creek at 20 Mile Bridge to Mill Creek at 7 Mile Road Bridge

This reach is a 3.9 mile reach which the upstream end of the reach begins at the 20 Mile Bridge at river mile 20.2. This measured reach is located in a broad river valley environment. On average the measured flow during the assessments on the upstream side of the reach was 36 cfs. This reach on average loses 7.56% of its flow to groundwater and the average net gain/loss for the reach is 3.55 cfs net loss. This reach was consistently a losing reach throughout the sampling period.

Mill Creek at 7 Mile Road Bridge to Mill Creek at 5 Mile Road Bridge

This reach is a 2.2 mile reach which the upstream end of the reach begins at the 7 Mile Road Bridge at river mile 16.2. This measured reach is located in a broad river valley environment. On average the measured flow during the assessments on the upstream side of the reach was 35.44 cfs. This reach on average gains 1.78 % of its flow from groundwater returns and on average has a net gain of 4.11 cfs. Based on monthly averages this reach was a gaining reach from June-August then switched to a losing reach for the month of September then back to a gaining reach for the one assessment that was conducted in October.



Five Mile Road Bridge

Mill Creek at 5 Mile Road Bridge to Mill Creek just below the Yellowhawk Creek Diversion.

This reach is a 2.5 mile reach which the upstream end of the reach begins at the 5 Mile Road Bridge at river mile 14. This measured reach is located in a broad river valley environment. On average the measured flow during the assessments on the upstream end of the reach was 31.44 cfs. This reach on average loses 31.52% of its flow to groundwater and the average net gain/loss for the reach is 1.05 cfs. There are two main diversions located within the reach, The Mill Creek Dam diversion which diverts water to Bennington Lake and the Yellowhawk Creek Diversion which diverts water for Yellowhawk Creek and Garrison Creek. This reach also is the first reach located in a managed flood control section of Mill Creek. There are concrete weirs located across the channel at regular intervals below the Mill Creek Dam (~40% of the entire reach). Based on monthly averages this reach was a losing reach for the months of June, July, and September while a gaining reach for the months of August and October.



Mill Creek at Five Mile Road Bridge

Mill Creek just below the Yellowhawk Creek Diversion to Mill Creek at Tausick Road Bridge

This reach is a .5 mile reach which the upstream end of the reach begins just below the Yellowhawk Creek Diversion Dam at the USGS gauge site at river mile 11.5. This measured reach is located in a managed flood control river channel with concrete weirs at regular intervals across the entire channel width. On average the measured flow during the assessments on the upstream end of the reach was 9.34 cfs. This reach on average gains 14.4% of its flow from groundwater or a net gain of .10 cfs.

Mill Creek at Tausick Road Bridge to Mill Creek at Gose Road Bridge

This reach is a 5.4 mile reach in which the upstream end of the reach begins at the Tausick Road Bridge at river mile 11. The entire reach is a managed flood control channel in which approximately 45% of the channel is concrete. There are also concrete weirs which extend across the entire channel width. This reach on average gains 17.74% of its flow from groundwater or a net gain of 2.9 cfs some of which can be seen flowing through cracks in

the concrete channel just upstream of the S. Division Street Bridge. Based on the monthly assessment averages this reach was a gaining reach for the months of July, August, and October while a losing reach for the months of June and September.

Mill Creek at Gose Road Bridge to Mill Creek at Wallula Road Bridge

This reach is a 2.4 mile reach in which the upstream end of the reach begins at the Gose Road Bridge just below the managed flood control section of Mill Creek. This reach on average gains 105% of its flow from groundwater or a net gain of 3.8 cfs. Based on the monthly assessment averages this reach was a gaining reach from June – October.

Mill Creek at Wallula Road Bridge to Mill Creek at Last Chance Road Bridge

This reach is a 1.0 mile reach in which the upstream end of the reach begins at the Wallula Road Bridge at river mile 2.0. On average the measured flow during the assessments on the upstream end of the reach was 11.65 cfs. This reach on average loses 11.9% of its flow to groundwater or a net loss of 1.15 cfs. Based on monthly assessment averages this reach was a losing reach from June – October.

Mill Creek at Last Chance Road Bridge to Mill Creek at Swegle Road Bridge

This reach is a 1.5 mile reach in which the upstream end of the reach begins at the Last Chance Road Bridge at mile .6. On average the measured flow during the assessments on the upstream end of the reach was 12.38 cfs. This reach on average gains 2.04% of its flow from groundwater returns or a net gain of .01 cfs. Based on monthly assessment averages this reach was a gaining reach in June, September, and October while a losing reach during the summer months of July and August.

Touchet River

Seepage assessments were conducted in the Months of June, July, August, and September. The results below are based on the overall and monthly averages for the assessments.

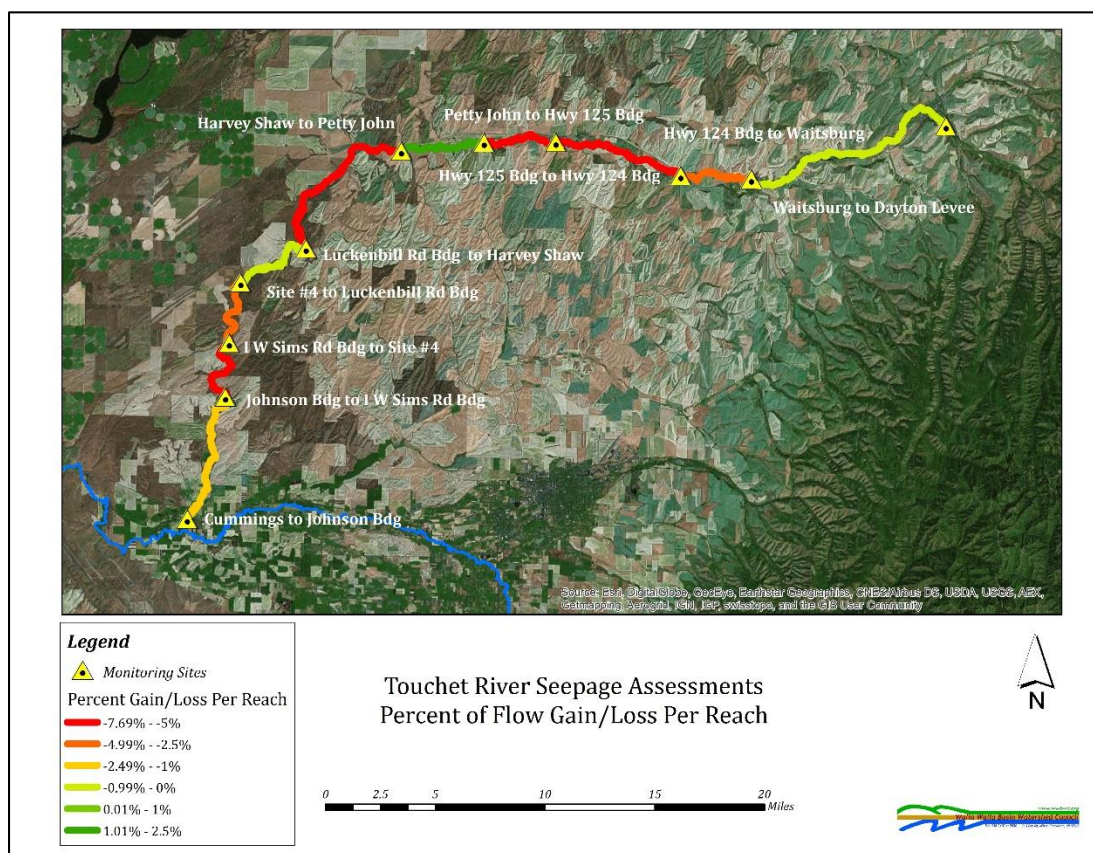


Figure 28: Touchet River Percent Flow Gain/Loss

Average of All Assessments	14 Assessments			
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Average Percent of Flow Gain/Loss
Highway 12 to Johnson Bdg	0.86	-0.42	-0.94	-2.47%
Johnson Bdg to I W Sims Rd Bdg	8.8	-1.54	-1.74	-5.84%
I W Sims Rd Bdg to Site #4	13.18	-0.08	-1.32	-2.51%
Site #4 to Luckenbill Rd Bdg	17.18	0.02	-0.13	-0.25%
Luckenbill Rd Bdg to Harvey Shaw	21.99	-0.89	-2.33	-5.13%
Harvey Shaw to Petty John	32.23	0.59	2.14	2.08%
Petty John to Hwy 125 Bdg	37.2	-1.12	-3.27	-6.96%
Hwy 125 Bdg to Hwy 124 Bdg	41.53	-0.64	-4.15	-7.69%
Hwy 124 Bdg to Waitsburg	48.79	-0.40	-0.99	-4.86%
Waitsburg to Dayton Levee	52.92	0.17	-0.44	-0.13%

Figure 29: Touchet River Seepage Assessment Averages

Touchet River at the Dayton Levee to Touchet River at Waitsburg

This reach is a 12.05 mile reach which the upstream end of the reach begins in the town of Dayton within the Dayton levee section at river mile 64.97. The reach is the uppermost reach assessed during all of the seepage assessments on the Touchet River. This measuring site on average has the highest flow values recorded and is located in a broad canyon environment. On average the measured flow during the assessments on the upstream end of the reach was 64.78 cfs. This reach on average loses .13% of its flow to groundwater or a net loss of .44 cfs. Based on monthly assessment averages this reach was a losing reach from July to August while a gaining reach for June and September.

Touchet River at Waitsburg to Touchet River at the Highway 124 Bridge

This reach is a 4.3 mile reach which the upstream end of the reach begins in the town of Waitsburg within the Bolles Road Bridge at river mile 52.92. On average the measured flow during the assessments on the upstream end of the reach was 61.35 cfs. This reach on average loses 4.86% of its flow to groundwater or a net loss of .99 cfs. Based on monthly assessment averages this reach was a losing reach from August through September while a gaining reach from June through July.

Touchet River at the Highway 124 Bridge to Touchet River at the Highway 125 Bridge

This reach is a 7.26 mile reach which the upstream end of the reach begins at the Highway 124 Bridge at river mile 48.79. On average the measured flow during the assessments on the upstream end of the reach was 61.84 cfs. This reach on average loses 7.69% of its flow to groundwater or a net loss of 4.15 cfs. Based on monthly assessment averages this reach was a losing reach from June – September.

Touchet River at the Highway 125 Bridge to Touchet River at the Petty John Road Bridge

This reach is a 4.33 mile reach which the upstream end of the reach begins at the Highway 125 Bridge at river mile 41.53. On average the measured flow during the assessments on the upstream end of the reach was 56.60 cfs. This reach on average loses 6.96% of its flow to groundwater or a net loss of 3.27 cfs. Based on monthly assessment averages this reach was a losing reach from June – September.

Touchet River at the Petty John Road Bridge to Touchet River at the Harvey Shaw Road Bridge

This reach is a 4.97 mile reach which the upstream end of the reach begins at the Petty John Road Bridge at river mile 37.2. On average the measured flow during the assessments on the upstream end of the reach was 53.34 cfs. This reach on average gains 2.08% of its flow from groundwater or a net gain of 2.14 cfs. Based on monthly assessment averages this reach was a gaining reach from June through July and a losing reach from August through September.

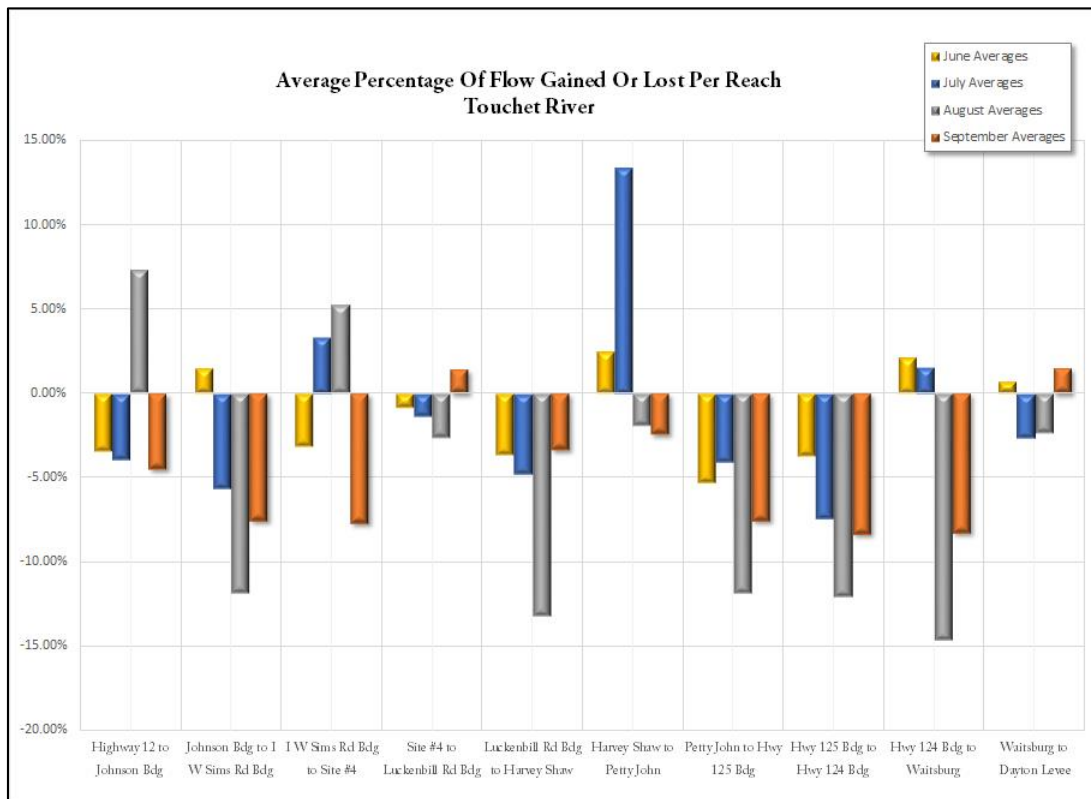


Figure 30: Touchet River Average Percent Flow Gain/Loss Monthly

Touchet River at the Harvey Shaw Road Bridge to Touchet River at the Luckenbill Road Bridge

This reach is a 10.24 mile reach which the upstream end of the reach begins at the Harvey Shaw Road Bridge at river mile 32.23. On average the measured flow during the assessments on the upstream end of the reach was 53.15 cfs. This reach on average loses 5.13% of its flow to groundwater or a net loss of 2.33 cfs. Based on monthly assessment averages this reach was a losing reach from June – September.

Touchet River at the Luckenbill Road Bridge to Touchet River at Site #4

This reach is a 4.81 mile reach which the upstream end of the reach begins at the Luckenbill Road Bridge at river mile 21.99. On average the measured flow during the assessments on the upstream end of the reach was 52.5 cfs. This reach on average loses .25% of its flow to groundwater or a net loss of .13 cfs. Based on monthly assessment averages this reach was a losing reach from June – August while a gaining reach in September.

Touchet River at Site #4 to Touchet River at I W Sims Road Bridge

This reach is a 4 mile reach which the upstream end of the reach begins at Site#4 at river mile 17.18. On average the measured flow during the assessments on the upstream end of the reach was 51.21 cfs. This reach on average loses 2.51% of its flow to groundwater or a net loss of 1.32 cfs. Based on monthly assessment averages this reach was a losing reach in the months of June and September while a gaining reach in the months of July and August.

Touchet River at I W Sims Road Bridge to Touchet River at Johnson Bridge

This reach is a 4.38 mile reach which the upstream end of the reach begins at the I W Sims Road Bridge at river mile 13.18. On average the measured flow during the assessments on the upstream end of the reach was 49.56 cfs. This reach on average loses 5.84% of its flow to groundwater or a net loss of 1.74 cfs. Based on monthly assessment averages this reach was a losing reach from July – September while a gaining reach in the month of June.



Touchet River at IW Sims Road Bridge

Touchet River at Johnson Bridge to Touchet River at Highway 12 Bridge

This reach is a 7.94 mile reach which the upstream end of the reach begins at the Johnson Bridge at river mile 8.8. On average the measured flow during the assessments on the upstream end of the reach was 34.56 cfs. This reach on average loses 2.47% of its flow to groundwater or a net loss of .94 cfs. Based on monthly assessment averages this reach was a losing reach from June – July and the month of September while a gaining reach for the month of August.

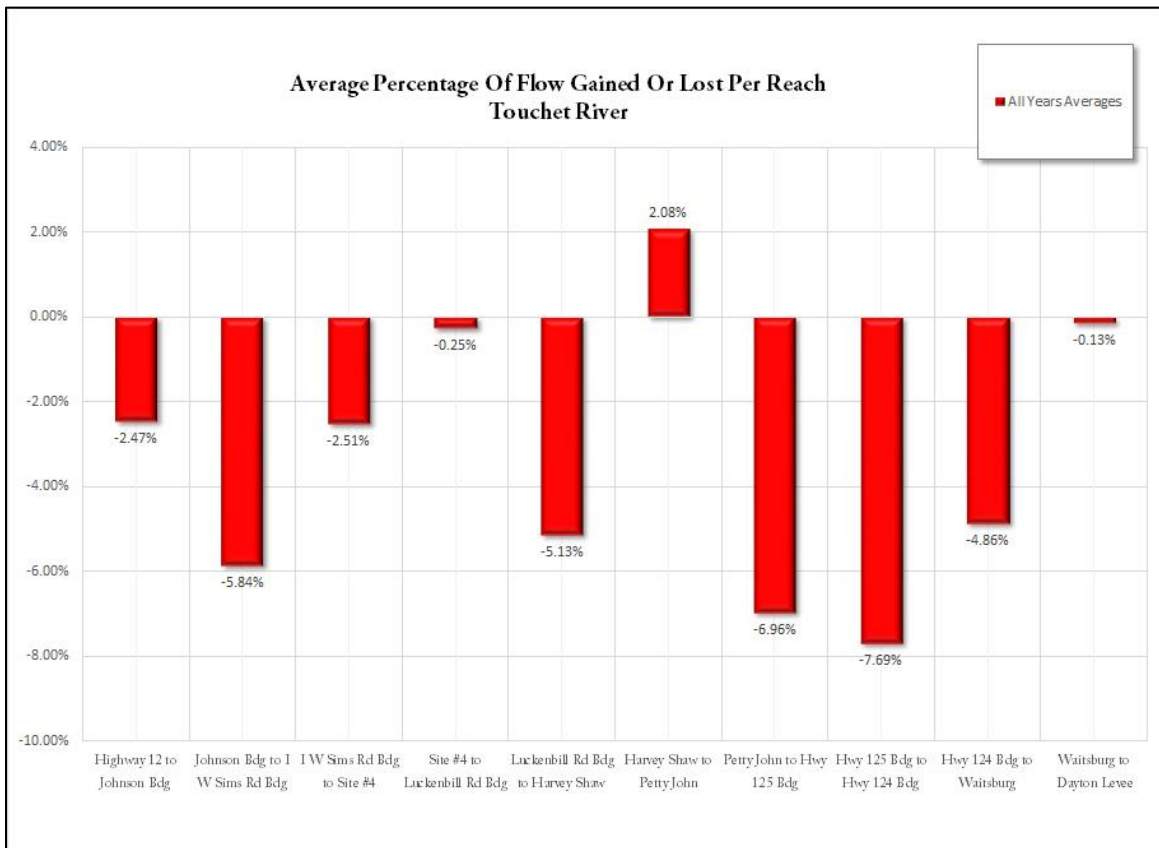


Figure 31: Average Percent Flow Gain/Loss

Summary

The water budget analysis and data sets discussed in this report provide water managers and researchers in the Walla Walla basin a more refined tool by which to look at seasonal and spatial flow distribution in the Walla Walla River, Touchet River, and Mill Creek systems. While these values represent 'snap shots' in time, the information can be coupled with the continuous gauges sites to help piece together the transient nature of each of the flow systems. Rates of net gains and losses provide an estimate of the magnitude of channel bed flux relative to three important irrigation related seasons in the Walla Walla basin.

The analysis tends to support the current theories about where each system shows groundwater gains and losses with several exceptions. Areas such as the Walla Walla River in Oregon at the levee segment that have been shown through other studies to be areas of high loss are confirmed using this data collection and analysis approach.

As the Walla Walla River moves out of the broad to narrow canyon environment above Milton-Freewater into the alluvial gravel rich deposits of the valley floor downstream of Milton-Freewater a significant percentage of flow is lost to channel bed seepage. It is widely believed that the arc of springs located to the west of the Milton-Freewater levee reaches is fed by the high channel bed losses from Nursery Bridge to Birch Creek Road Bridge.

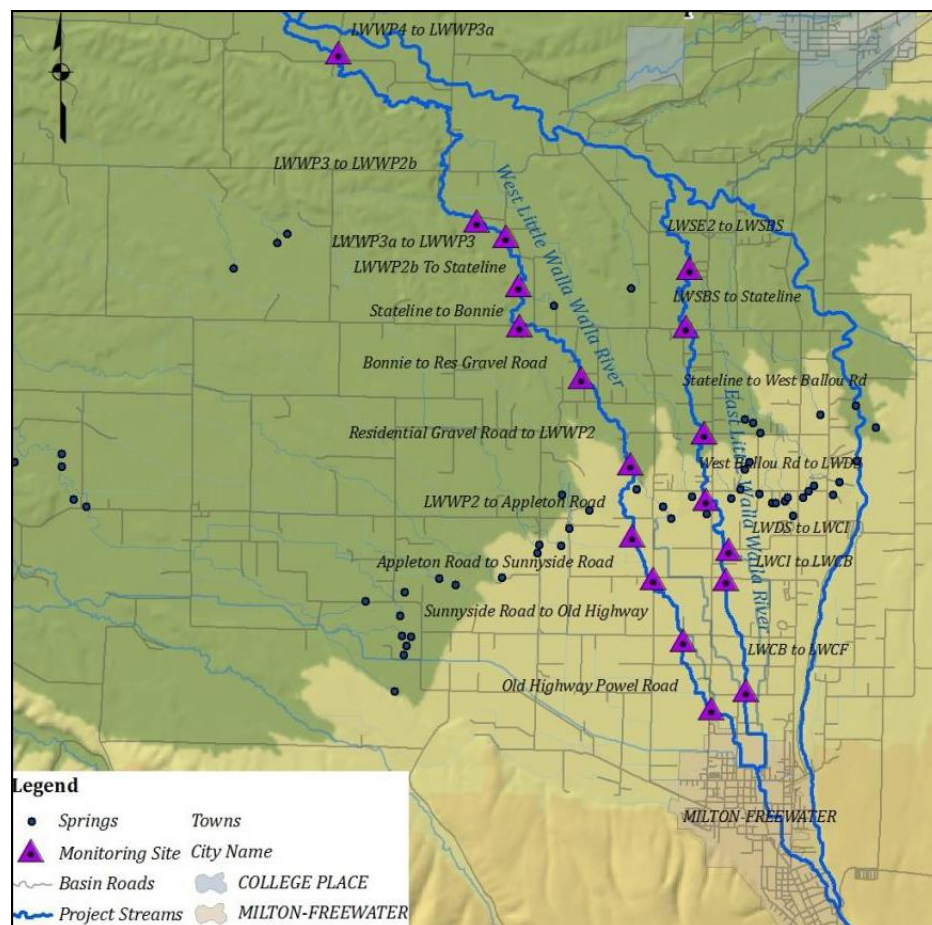


Figure 32: Arc of springs

Water movement through the shallow alluvial aquifer can also be tracked using basin monitoring wells. Water table contours provide an avenue to examine flow direction through the aquifer. By overlaying the seepage results with the water table for the same time period the results show that water leaving the Walla Walla River through the gravel channel moves in a northwesterly direction towards the springs.

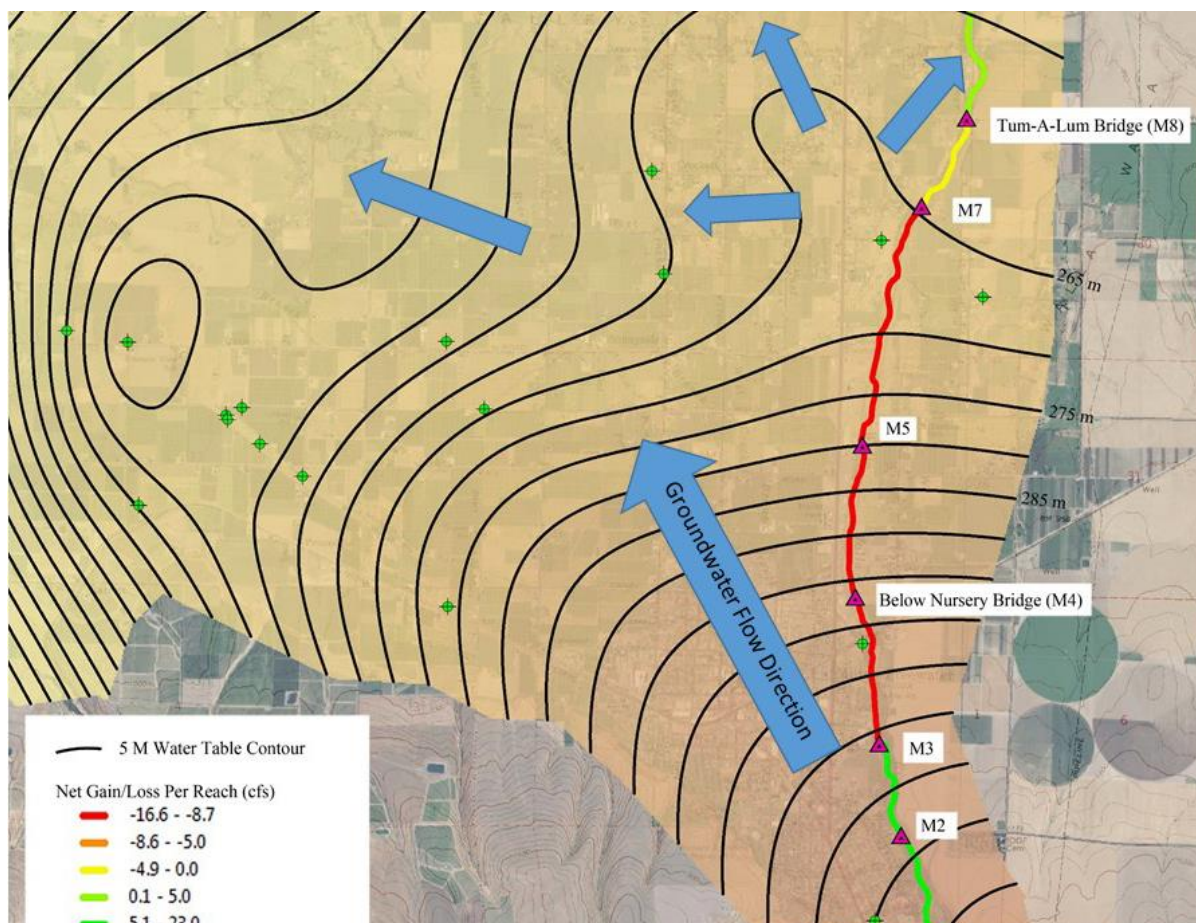


Figure 33: July water table and seepage assessment results

Even though high seepage values are recorded in the levee section of the river, there is a high probability of that same water returning to the system through the springs and back to the Walla Walla River in the East and West Little Walla Walla Rivers. Further studies focused on tracking the high losses in the levee section of the Walla Walla River should occur to fully understand the channel bed losses. By reducing the high losses in the river through the M3 to Birch Creek Road Bridge (M8) reaches a significant amount water would stay on the surface providing additional flow through critical months.

Collaborators

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Attachments

Attachment A

Attachment A-1

June 2002 Seepage Data Set

Flow Measurement Location	Actual River Mile	Rate Per Mile	Net Gain/Loss	Gross Gain/Loss Change (Instream)	Net Diversion Total	Net Trib Total	Flow (cfs)
Peppers Bridge Location (WDFW/WDOE Gauge station)	41.07	15.85	19.50	19.50	0.00	0.00	118.00
Walla Walla River WWBWC # M-10 (MNWW40.8)	42.30	9.20	6.90	6.90	0.00	0.00	98.50
Walla Walla River WWBWC # M-9a (Mauer Lane)	43.05	-1.69	-1.00	-1.00	0.00	0.00	91.60
Tumalum Road Bridge (M-8) (MNWW42.3)	43.64	0.35	0.20	0.20	0.00	0.00	92.60
Walla Walla River (M-7) (MNWW42.9)	44.21	-31.52	-35.30	-35.30	0.00	0.00	92.40
Walla Walla River M-5b (MNWW44)	45.33	14.83	8.60	15.60	0.00	7.00	127.70
Walla Walla River Nursery Bridge (M-4) (MNWW44.5)	45.91	-23.29	-18.40	-18.40	0.00	0.00	112.10
Levy, 0.5 mile us of Nursery Bridge (M-3)	46.70	-25.52	-29.60	-147.20	-117.60	0.00	130.50
Grove School Bridge (M-1a) (MNWW46.1)	47.86	18.26	37.80	32.20	-5.60	0.00	277.70
Day Road	49.93	-33.93	-30.20	-30.20	0.00	0.00	245.50
Joe West Bridge (MNWW49.1)	50.82	19.82	32.50	72.20	-2.10	41.80	275.70
South Fork Bridge	52.46	0.21	1.10	-2.90	-4.00	0.00	203.50
SF Walla Walla River at CTUIR Fish Hatchery (SFWW7.0)	57.63	-12.47	-20.20	-20.20	0.00	0.00	206.40
SF Walla Walla River (SFWW9.0)	59.25	-5.13	-9.40	-9.40	0.00	0.00	226.60
OWRD Gauge Station, SF Walla Walla River	61.08						236.00

Flow data applies to River flow at Location ID

Rate/Net gain-loss/Gross/Net Div and Trib data applies from Location ID to next UPSTREAM site.

<i>Attachment A-2</i>		August 2002 Seepage Data Set					
Flow Measurement Location	Actual River Mile	Rate Per Mile	Net Gain/Loss	Gross Gain/Loss Change (Instream)	Net Diversion Total	Net Trib Total	Flow (cfs)
Peppers Bridge Location (WDFW/WDOE Gauge station)	41.07	-0.82	-0.40	-0.10	0.00	0.30	12.40
Oregon/WA stateline (WDFW Gauge station 2001-2)	41.56	1.49	1.10	1.10	0.00	0.00	12.50
Walla Walla River WWBWC # M-10 (MNWW40.8)	42.30	4.53	3.40	3.40	0.00	0.00	11.40
Walla Walla River WWBWC # M-9a (Mauer Lane)	43.05	-7.46	-4.40	-4.40	0.00	0.00	8.00
Tumalum Road Bridge (M-8) (MNWW42.3)	43.64	-1.23	-0.70	-0.70	0.00	0.00	12.40
Walla Walla River (M-7) (MNWW42.9)	44.21	-13.85	-5.40	-5.40	0.00	0.00	13.10
Walla Walla River (M-6) Gravel Pit (MNWW43.6)	44.60	-21.10	-15.40	-15.40	0.00	0.00	18.50
Walla Walla River M-5b (MNWW44)	45.33	0.00	0.00	7.40	0.00	7.40	33.90
Levy, Willow Lane (M-5a)	45.38	-9.81	-5.20	-5.20	0.00	0.00	26.50
Walla Walla River Nursery Bridge (M-4) (MNWW44.5)	45.91	-10.51	-8.30	-12.90	-4.60	0.00	31.70
Levy, 0.5 mile us of Nursery Bridge (M-3)	46.70	-3.88	-4.50	-54.30	-49.80	0.00	44.60
Grove School Bridge (M-1a) (MNWW46.1)	47.86	6.51	7.10	2.90	-4.20	0.00	98.90
Couse Creek Road Bridge (MNWW47)	48.95	-3.47	-3.40	-6.80	-3.40	0.00	96.00
Day Road	49.93	2.02	1.80	1.80	0.00	0.00	102.80
Joe West Bridge (MNWW49.1)	50.82	3.96	6.50	4.20	-7.80	5.50	101.00
South Fork Bridge	52.46	1.31	1.80	-3.20	-5.00	0.00	96.80
SF Walla Walla River (SFWW1.7)	53.83	1.74	6.60	-0.90	-7.50	0.00	100.00
SF Walla Walla River at CTUIR Fish Hatchery (SFWW7.0)	57.63	5.37	8.70	8.70	0.00	0.00	100.90
SF Walla Walla River (SFWW9.0)	59.25	-4.21	-7.70	-7.80	-0.10	0.00	92.20
OWRD Gauge Station, SF Walla Walla River	61.08	x	x	x	x	x	100.00

Flow data applies to River flow at Location ID

Rate/Net gain-loss/Gross/Net Div and Trib data applies from Location ID to next UPSTREAM site.

Attachment A-3

June 2003 Seepage Data Set

Flow Measurement Location	Actual River Mile	Rate Per Mile	Net Gain/Loss	Gross Gain/Loss Change (Instream)	Net Diversion Total	Net Trib Total	Flow (cfs)
Oregon/WA stateline (WDFW Gauge station 2001-2)	41.56	7.16	5.30	4.90	-0.40	0.00	11.90
Walla Walla River WWBWC # M-10 (MNWW40.8)	42.30	2.13	1.60	1.60	0.00	0.00	7.00
Walla Walla River WWBWC # M-9a (Mauer Lane)	43.05	-11.02	-6.50	-6.50	0.00	0.00	5.40
Tumalum Road Bridge (M-8) (MNWW42.3)	43.64	3.16	1.80	1.80	0.00	0.00	11.90
Walla Walla River (M-7) (MNWW42.9)	44.21	-17.95	-7.00	-7.00	0.00	0.00	10.10
Walla Walla River (M-6) Gravel Pit (MNWW43.6)	44.60	-11.51	-8.40	-8.40	0.00	0.00	17.10
Walla Walla River M-5b (MNWW44)	45.33	-14.72	-8.54	-7.90	0.00	0.64	25.50
Walla Walla River Nursery Bridge (M-4) (MNWW44.5)	45.91	2.28	1.80	-3.40	-5.20	0.00	33.40
Levy, 0.5 mile us of Nursery Bridge (M-3)	46.70	-2.84	-3.30	-80.80	-77.50	0.00	36.80
Grove School Bridge (M-1a) (MNWW46.1)	47.86	8.81	9.60	5.60	-4.00	0.00	117.60
Couse Creek Road Bridge (MNWW47)	48.95	0.20	0.20	-3.10	-3.30	0.00	112.00
Day Road	49.93	3.48	3.10	3.00	-0.10	0.00	115.10
Joe West Bridge (MNWW49.1)	50.82	-8.09	-13.26	-7.00	-4.60	10.86	112.10
South Fork Bridge	52.46	2.96	15.30	6.80	-8.50	0.00	119.10
SF Walla Walla River at CTUIR Fish Hatchery (SFWW7.0)	57.63	-5.00	-8.10	-8.10	0.00	0.00	112.30
SF Walla Walla River (SFWW9.0)	59.25	5.96	10.90	10.70	-0.20	0.00	120.40
OWRD Gauge Station, SF Walla Walla River	61.08						109.70

Flow data applies to River flow at Location ID

Rate/Net gain-loss/Gross/Net Div and Trib data applies from Location ID to next UPSTREAM site.

Attachment A-4

August 2003 Data Set

Flow Measurement Location	Actual River Mile	Rate Per Mile	Net Gain/Loss	Gross Gain/Loss Change (Instream)	Net Diversion Total	Net Trib Total	Flow (cfs)
Highway 12 Bridge (Mouth of Walla Walla River)	0.00						
Nine Mile Bridge	8.54	-1.81	-13.32	-13.32	0.00	0.00	3.64
USGS Touchet Gage	15.91	-2.04	-23.97	-21.24	0.00	2.73	16.96
Lowden Rd Bridge	27.64	13.10	26.59	23.80	-2.79	0.00	38.20
MacDonald Rd Bridge	29.67	-1.71	-6.20	-28.00	-21.80	0.00	14.40
Detour Road	33.29	2.97	3.24	2.24	-1.20	0.20	42.40
Swegle Road Bridge	34.38	-0.46	-0.67	-0.67	0.00	0.00	40.16
Last Chance Road Bridge	35.84	-3.26	-5.47	-7.67	-2.40	0.20	40.83
Beet Road Bridge	37.52	-9.49	-5.60	-5.60	0.00	0.00	42.90
Walla Walla River (WDFW #5 Site)	38.11	0.89	1.20	25.70	-0.80	25.30	48.50
Old Milton HWY Bridge	39.46	2.42	3.90	3.90	0.00	0.00	22.80
Peppers Bridge Location (WDFW/WDOE Gauge station)	41.07	6.37	3.12	3.20	-0.22	0.30	18.90
Oregon/WA stateline (WDFW Gauge station 2001-2)	41.56	0.95	0.70	0.70	0.00	0.00	15.70
Walla Walla River WWBWC # M-10 (MNWW40.8)	42.30	-1.07	-0.80	-0.90	-0.10	0.00	15.00
Walla Walla River WWBWC # M-9a (Mauer Lane)	43.05	-1.69	-1.00	-1.00	0.00	0.00	15.90
Tumalum Road Bridge (M-8) (MNWW42.3)	43.64	-4.56	-2.60	-2.60	0.00	0.00	16.90
Walla Walla River (M-7) (MNWW42.9)	44.21	-12.82	-5.00	-5.00	0.00	0.00	19.50
Walla Walla River (M-6) Gravel Pit (MNWW43.6)	44.60	-21.54	-16.80	-14.20	0.00	2.60	24.50
Levy, Willow Lane (M-5a)	45.38	0.94	0.50	0.50	0.00	0.00	38.70
Walla Walla River Nursery Bridge (M-4) (MNWW44.5)	45.91	-7.09	-5.60	-10.60	-5.00	0.00	38.20
Levy, 0.5 mile us of Nursery Bridge (M-3)	46.70	-3.71	-4.30	-47.80	-43.50	0.00	48.80
Grove School Bridge (M-1a) (MNWW46.1)	47.86	4.22	4.60	-0.70	-5.30	0.00	96.60
Couse Creek Road Bridge (MNWW47)	48.95	6.24	6.12	3.10	-3.02	0.00	97.30
Day Road	49.93	0.56	0.50	0.40	-0.10	0.00	94.20
Joe West Bridge (MNWW49.1)	50.82	3.84	6.30	2.80	-5.40	1.90	93.80
South Fork Bridge	52.46	2.10	2.88	-5.40	-8.28	0.00	91.00
SF Walla Walla River (SFWW1.7)	53.83	2.78	10.56	6.90	-3.66	0.00	103.30
SF Walla Walla River at CTUIR Fish Hatchery (SFWW7.0)	57.63	2.10	3.40	3.40	0.00	0.00	96.40
SF Walla Walla River (SFWW9.0)	59.25	-7.65	-14.00	-14.00	0.00	0.00	93.00
OWRD Gauge Station, SF Walla Walla River	61.08	-4.08	-24.36	0.00	0.00	24.36	107.00
Walla Walla River 47 feet upstream of Burnt Cabin (Find location)	67.05	-1.55	-1.70	1.80	0.00	3.50	89.50
Walla Walla River 71 feet us Table Creek	68.15	8.37	16.23	27.70	0.00	11.47	87.70
SF Walla Walla River (upstream of Skiphorton)	70.09	2.85	10.52	16.60	0.00	6.08	60.00
Upper South Fork Walla Walla River (Reser Creek)	73.78						43.40

Flow data applies to River flow at Location ID

Rate/Net gain-Loss/Gross/Net Div and Trib data applies from Location ID to next UPSTREAM site.

Attachment A-5

June 2004 Data Set

Flow Measurement Location	Actual River Mile (GIS)	Rate Per Mile	Net Gain/Loss	Gross Gain/Loss Change (Instream)	Net Diversion Total	Net Trib Total	Flow (cfs)
Highway 12 Bridge (Mouth of Walla Walla River)	0.00	x	x	x	x	x	x
Nine Mile Bridge	8.54	-0.02	-0.08	-0.08	0.00	0.00	184.54
Cummings Bridge	12.71	-16.53	-52.89	-47.97	0.00	4.92	184.62
USGS Touchet Gage	15.91	16.55	75.62	172.20	-3.86	100.44	232.59
Lowden Rd Bridge	27.64	2.33	4.73	1.94	-2.79	0.00	60.39
MacDonald Rd Bridge	29.67	-2.03	-7.36	-32.91	-25.55	0.00	58.45
Detour Road	33.29	2.25	2.45	35.26	0.00	32.82	91.36
Swegle Road Bridge	34.38	2.53	3.70	3.70	0.00	0.00	56.09
Last Chance Road Bridge	35.84	-1.30	-2.96	-40.23	-40.94	3.67	52.39
Walla Walla River (WDFW #5 Site)	38.11	-9.82	-13.26	49.37	0.00	62.63	92.62
Old Milton HWY Bridge	39.46	1.35	2.17	2.17	0.00	0.00	43.24
Peppers Bridge Location (WDFW/WDOE Gauge station)	41.07	-7.91	-9.73	-7.57	0.00	2.16	41.07
Walla Walla River WWBWC # M-10 (MNWW40.8)	42.30	11.96	16.02	16.02	0.00	0.00	48.64
Tumalum Road Bridge (M-8) (MNWW42.3)	43.64	3.70	2.11	2.11	0.00	0.00	32.62
Walla Walla River (M-7) (MNWW42.9)	44.21	0.18	0.07	0.07	0.00	0.00	30.51
Walla Walla River (M-6) Gravel Pit (MNWW43.6)	44.60	-19.15	-25.09	-23.09	0.00	2.00	30.44
Walla Walla River Nursery Bridge (M-4) (MNWW44.5)	45.91	0.45	0.88	-158.54	-159.42	0.00	53.53
Grove School Bridge (M-1a) (MNWW46.1)	47.86	35.06	30.15	31.84	-1.87	3.56	212.07
Mainstem u/s Couse Creek	48.72	42.62	8.95	8.95	0.00	0.00	180.23
Couse Creek Road Bridge (MNWW47)	48.95	-17.76	-17.41	-19.64	-2.23	0.00	171.28
Day Road	49.93	27.21	24.22	24.17	-0.05	0.00	190.92
Joe West Bridge (MNWW49.1)	50.82	-10.90	-17.90	4.00	-5.40	27.30	166.75
South Fork Bridge	52.46	-1.70	-8.90	-12.90	-4.00	0.00	162.80
SF Walla Walla River (SFWW9.0)	59.25	8.60	29.70	24.30	-5.50	0.00	175.70
OWRD Gauge Station, SF Walla Walla River	61.08	x	x	x	x	x	151.40

Flow data applies to River flow at Location ID

Rate/Net gain-loss/Gross/Net Div and Trib data applies from Location ID to next UPSTREAM site.

Attachment A-6

August 2004 Data Set

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	Net Diversion Total (cfs)	Net Tributary Inputs Total (cfs)	Measured Instream Flow (cfs)
Highway 12 Bridge (Mouth of Walla Walla River)	0.00	x	x	x	x	x	x
Cummings Bridge	12.71	-1.48	-4.74	-6.30	-1.56	0.00	16.70
USGS Touchet Gage	15.91	0.57	2.60	2.52	-1.54	1.46	23.00
Touchet-Gardena Road Bridge	20.48	1.70	12.14	9.01	-3.59	0.46	20.48
Lowden Rd Bridge	27.64	-0.02	-0.05	-8.19	-8.14	0.00	11.47
MacDonald Rd Bridge	29.67	0.96	4.51	-11.08	-17.71	2.12	19.66
Sweeple Road Bridge	34.38	-3.71	-5.42	-5.42	0.00	0.00	30.74
Last Chance Road Bridge	35.84	1.39	2.34	0.79	-2.00	0.45	36.16
Beet Road Bridge	37.52	-2.63	-1.55	-1.55	0.00	0.00	35.37
Walla Walla River (WDFW #5 Site)	38.11	-2.12	-2.86	23.44	-0.29	26.59	36.92
Old Milton HWY Bridge	39.46	1.83	2.96	2.96	0.00	0.00	13.48
Peppers Bridge Location (WDFW/WDOE Gauge station)	41.07	1.14	1.40	1.50	-0.28	0.38	10.52
Walla Walla River WWBWC # M-10 (MNWW40.8) (Beaver)	42.30	1.92	1.44	1.44	0.00	0.00	9.02
Walla Walla River WWBWC # M-9a (Mauer Lane)	43.05	0.41	0.24	0.24	0.00	0.00	7.58
Tumalum Road Bridge (M-8) (MNWW42.3)	43.64	2.00	1.14	1.14	0.00	0.00	7.34
Walla Walla River (M-7) (MNWW42.9)	44.21	-9.97	-3.89	-3.89	0.00	0.00	6.20
Walla Walla River (M-6) Gravel Pit (MNWW43.6)	44.60	-15.79	-12.32	-10.32	0.00	2.00	10.09
Levy, Willow Lane (M-5a)	45.38	-1.75	-0.93	-0.93	0.00	0.00	20.41
Walla Walla River Nursery Bridge (M-4) (MNWW44.5)	45.91	-3.61	-7.07	-77.44	-70.37	0.00	21.34
Grove School Bridge (M-1a) (MNWW46.1)	47.86	8.09	8.82	8.82	0.00	0.00	98.78
Couse Creek Road Bridge (MNWW47)	48.95	-3.29	-3.22	-3.22	0.00	0.00	89.96
Day Road	49.93	-12.24	-10.89	-10.95	-0.06	0.00	93.18
Joe West Bridge (MNWW49.1)	50.82	11.11	18.33	11.57	-6.76	0.00	104.13
South Fork Bridge	52.46	0.49	2.51	-3.90	-6.41	0.00	92.56
SF Walla Walla River at CTUIR Fish Hatchery (SFWW7.0)	57.63	4.09	6.63	6.63	0.00	0.00	96.46
SF Walla Walla River (SFWW9.0)	59.25	-7.65	-14.00	-14.17	-0.17	0.00	89.83
OWRD Gauge Station, SF Walla Walla River	61.08	x	x	x	x	x	104.00

Flow data applies to River flow at Location ID

Rate/Net gain-loss/Gross/Net Div and Trib data applies from Location ID to next UPSTREAM site.

Attachment A-7

2007 August Data Set

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change	2007 Net Diversion Total (cfs)	2004 Net Tributary Inputs Total (cfs)	2004 Flow (cfs)
Nine Mile Bridge	8.50	-0.57	-2.40	-5.58	-3.18	0.00	5.70
Cummings Bridge	12.71	0.32	1.02	-0.70	-1.72	0.00	11.30
USGS Touchet Gage	15.91	0.86	3.94	-0.20	-6.96	2.82	12.00
Lowden Rd Bridge	27.64	1.10	2.24	-6.20	-8.44	0.00	12.20
MacDonald Rd Bridge	29.67	0.70	2.53	-12.20	-14.73	0.00	18.40
Detour Road	33.29	-1.91	-2.08	1.10	0.00	3.18	30.60
Swegle Road Bridge	34.38	0.12	0.18	0.09	-0.09	0.00	29.50
Last Chance Road Bridge	35.84	0.37	0.62	-1.38	-2.00	0.00	29.41
Beet Road Bridge	37.52	3.22	1.90	1.90	0.00	0.00	30.79
Walla Walla River (WDFW #5 Site)	38.11	-2.26	-3.06	14.73	0.00	17.79	28.89
Old Milton HWY Bridge	39.46	0.60	0.97	0.97	0.00	0.00	14.16
Peppers Bridge Location (WDFW/WDOE Gauge station)	41.07	2.88	3.54	3.54	0.00	0.00	13.19
Walla Walla River WWBWC # M-10 (MNWW40.8) (Beaver)	42.30	1.23	0.92	0.92	0.00	0.00	9.65
Walla Walla River WWBWC # M-9a (Mauer Lane)	43.05	-2.90	-1.71	-2.00	-0.29	0.00	8.73
Tumalum Road Bridge (M-8) (MNWW42.3)	43.64	-1.67	-0.96	-0.96	0.00	0.00	10.73
Walla Walla River (M-7) (MNWW42.9)	44.21	-18.44	-7.16	-7.16	0.00	0.00	11.69
Walla Walla River (M-6) Gravel Pit (MNWW43.6)	44.60	-1.26	-0.92	-0.92	0.00	0.00	18.85
Walla Walla River M-5b (MNWW44)	45.33	-1.63	-0.94	-0.94	0.00	0.00	19.77
Levy, Willow Lane (M-5a)	45.38						
Walla Walla River Nursery Bridge (M-4) (MNWW44.5)	45.91	-1.56	-1.69	-4.79	-3.10	0.00	20.71
Walla Walla River M-2 (MNWW45.6)	46.99	-4.56	-4.00	-73.00	-69.00	0.00	25.50
Grove School Bridge (M-1a) (MNWW46.1)	47.86	10.41	11.32	11.32	0.00	0.00	98.50
Couse Creek Road Bridge (MNWW47)	48.95	-2.84	-2.78	-5.52	-2.74	0.00	87.18
Day Road	49.93	0.43	0.38	0.34	-0.04	0.00	92.7
Joe West Bridge (MNWW49.1)	50.82	-0.89	-1.46	-3.26	-6.00	4.20	92.36
South Fork Bridge	52.46	0.38	1.95	-4.78	-6.73	0.00	95.62
SF Walla Walla River at CTUIR Fish Hatchery (SFWW7.0)	57.63	4.59	7.41	7.30	-0.11	0.00	100.4
SF Walla Walla River (SFWW9.0)	59.25	-7.03	-12.89	-12.89	0.00	0.00	93.1
OWRD Gauge Station, SF Walla Walla River	61.08	x	x	x	x	x	105.99

Flow data applies to River flow at Location ID

Rate/Net gain-loss/Gross/Net Div and Trib data applies from Location ID to next UPSTREAM site.

Attachment A-8		2007 October Data Set					
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change	2007 Net Diversion Total (cfs)	2007 Net Tributary Inputs Total (cfs)	2007 Flow (cfs)
Nine Mile Bridge	8.50	-3.04	-12.80	-16.60	-3.80	0.00	54.34
Cummings Bridge	12.71	-2.77	35.14	36.24	-57.40	58.50	70.94
Detour Road	33.29	4.31	4.69	14.09	0.00	9.40	34.70
Swegle Road Bridge	34.38	-0.84	-1.22	-1.31	-0.09	0.00	20.61
Last Chance Road Bridge	35.84	0.80	1.34	0.53	-2.00	1.19	21.92
Beet Road Bridge	37.52	3.35	1.98	-15.31	-17.29	0.00	21.39
Walla Walla River (WDFW #5 Site)	38.11	-1.49	-2.01	20.29	0.00	22.30	36.70
Old Milton HWY Bridge	39.46	-0.64	-1.04	-1.04	0.00	0.00	16.41
Peppers Bridge Location (WDFW/WDOE Gauge station)	41.07	3.22	3.95	3.95	0.00	0.00	17.45
Walla Walla River WWBWC # M-10 (MNWW40.8) (Beaver)	42.30	-1.52	-2.03	-2.03	0.00	0.00	13.50
Tumalum Road Bridge (M-8) (MNWW42.3)	43.64	1.57	0.90	0.90	0.00	0.00	15.53
Walla Walla River (M-7) (MNWW42.9)	44.21	-11.23	-4.36	-4.36	0.00	0.00	14.63
Walla Walla River (M-6) Gravel Pit (MNWW43.6)	44.60	-1.80	-1.40	-1.40	0.00	0.00	18.99
Levy, Willow Lane (M-5a)	45.38	-11.25	-5.94	-5.94	0.00	0.00	20.39
Walla Walla River Nursery Bridge (M-4) (MNWW44.5)	45.91	0.70	0.76	0.76	0.00	0.00	26.33
Walla Walla River M-2 (MNWW45.6)	46.99	-0.91	-0.80	-87.50	-86.70	0.00	25.57
Grove School Bridge (M-1a) (MNWW46.1)	47.86	13.31	14.47	14.47	0.00	0.00	113.07
Couse Creek Road Bridge (MNWW47)	48.95	-1.80	-1.76	-4.50	-2.74	0.00	98.60
Day Road	49.93	6.15	5.44	5.40	-0.05	0.00	103.10
Joe West Bridge (MNWW49.1)	50.82	0.70	1.15	1.15	0.00	0.00	97.70
South Fork Bridge	52.46	2.28	11.77	9.17	-2.60	0.00	96.55
SF Walla Walla River at CTUIR Fish Hatchery (SFWW7.0)	57.63	-3.76	-6.08	-6.08	0.00	0.00	87.38
SF Walla Walla River (SFWW9.0)	59.25	-7.93	-14.54	-14.54	0.00	0.00	93.46
OWRD Gauge Station, SF Walla Walla River	61.08	x	x	x	x	x	108.00
Flow data applies to River flow at Location ID							
Rate/Net gain-loss/Gross/Net Div and Trib data applies from Location ID to next UPSTREAM site.							

Attachment A-9		2008 July Data Set					
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change	2007 Net Diversion Total (cfs)	2007 Net Tributary Inputs Total (cfs)	2007 Flow (cfs)
Nine Mile Bridge	8.5	-0.2	-0.7	-0.7	0.0	0.0	58.3
Cummings Bridge	12.7	0.7	2.4	4.0	1.7	0.0	59.0
USGS Touchet Gage	15.9	-2.5	-11.3	38.3	-1.1	50.7	55.0
Touchet-Gardena Road Bridge	20.5	0.8	6.0	4.3	-3.3	1.6	16.7
Lowden Rd Bridge	27.6	6.7	13.5	-4.5	-18.1	0.0	12.4
MacDonald Rd Bridge	29.7	-7.2	-26.0	-37.4	-11.3	0.0	16.9
Detour Road	33.3	14.2	15.4	21.4	-0.2	6.2	54.3
Swegle Road Bridge	34.4	-1.2	-1.8	-1.8	0.0	0.0	32.9
Last Chance Road Bridge	35.8	-7.4	-12.5	-14.2	-1.8	0.0	34.7
Beet Road Bridge	37.5	25.2	14.9	14.9	0.0	0.0	48.9
Walla Walla River (WDFW #5 Site)	38.1	-1.0	-1.3	15.4	-1.0	17.6	34.0
Old Milton HWY Bridge	39.5	-3.1	-5.0	-5.0	0.0	0.0	18.7
Peppers Bridge Location (WDFW/WDOE Gauge station)	41.1	-0.1	5.9	5.5	-0.4	0.0	23.6
Walla Walla River WWBWC # M-10 (MNWW40.8) (Beaver)	42.3	3.0	2.2	2.2	0.0	0.0	18.1
Walla Walla River WWBWC # M-9a (Mauer Lane)	43.0	-7.4	-4.4	-4.4	0.0	0.0	15.9
Tumalum Road Bridge (M-8) (MNWW42.3)	43.6	-0.8	-0.5	-0.5	0.0	0.0	20.3
Walla Walla River (M-7) (MNWW42.9)	44.2	-5.6	-2.2	-2.2	0.0	0.0	20.8
Walla Walla River (M-6) Gravel Pit (MNWW43.6)	44.6	-8.2	-6.0	-6.0	0.0	0.0	22.9
Walla Walla River M-5b (MNWW44)	45.3	-184.9	-8.7	-8.7	0.0	0.0	28.9
Levy, Willow Lane (M-5a)	45.4	1.9	1.0	1.0	0.0	0.0	37.6
Walla Walla River Nursery Bridge (M-4) (MNWW44.5)	45.9	-10.5	-11.4	-11.4	0.0	0.0	36.6
Walla Walla River M-2 (MNWW45.6)	47.0	9.1	8.0	-78.7	-86.7	0.0	47.9
Grove School Bridge (M-1a) (MNWW46.1)	47.9	-0.2	10.0	10.0	0.0	0.0	126.6
Couse Creek Road Bridge (MNWW47)	49.0	-0.5	-0.5	-3.3	-2.7	0.0	116.6
Day Road	49.9	-5.9	-5.2	-5.3	-0.1	0.0	119.9
Joe West Bridge (MNWW49.1)	50.8	17.9	29.5	35.5	-4.7	10.8	125.1
South Fork Bridge	52.5	0.4	-21.7	-24.3	-2.6	0.0	89.6
SF Walla Walla River at CTUIR Fish Hatchery (SFWW7.0)	57.6	-2.6	-4.2	-4.2	0.0	0.0	113.8
SF Walla Walla River (SFWW9.0)	59.3	5.5	10.0	10.0	0.0	0.0	118.0
OWRD Gauge Station, SF Walla Walla River	61.1	x	x	x	x	x	108.0
Flow data applies to River flow at Location ID							
Rate/Net gain-loss/Gross/Net Div and Trib data applies from Location ID to next UPSTREAM site.							

Attachment A-10 2008 November Data Set (Updated 2017)

Flow Measurement Location	Actual River Mile	Walla Walla River Reach ID	Defined Reach Data *	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2016 Net Diversio n Total (cfs)	2016 Net Tributary Inputs Total (cfs)	2016 Flow (cfs)
Highway 12 Bridge (Mouth of Walla Walla River)	0.0	1	1-2							
Nine Mile Bridge	8.5	2	2-3	5.68	-1.63	-11.73	-15.29	-3.56	0.00	52.04
Cummings Bridge	12.7	3	3-4	12.88	-1.09	-3.54	-10.67	-7.13	0.00	67.33
USGS Touchet Gage	15.9	4	4-5	16.12	-1.29	-5.60	-62.20	-8.90	65.50	78.00
Touchet-Gardena Road Bridge	20.5	5	5-6	20.48	0.28	2.14	4.94	-0.89	3.69	15.80
Lowden Rd Bridge	27.6	6	6-7	28.24	-1.42	-3.08	-11.48	-8.40	0.00	10.86
MacDonald Rd Bridge	29.7	7	7-8	30.41	-1.52	-5.41	-23.86	-18.45	0.00	22.34
Detour Road	33.3	8	8-9	33.97	2.97	3.19	23.69	0.00	20.50	46.20
Swegle Road Bridge	34.4	9	9-10	35.04	2.42	3.58	3.58	0.00	0.00	22.51
Last Chance Road Bridge	35.8	10	10-11	36.52	-0.32	-0.57	-0.57	0.00	0.00	18.93
Beet Road Bridge	37.5	11	11-12	38.32	-5.87	-3.03	-36.63	-33.60	0.00	19.50
Walla Walla River (WDFW #5 Site)	38.1	12	12-13	38.84	0.91	1.25	27.95	0.00	26.70	56.13
Old Milton HWY Bridge	39.5	13	13-14	40.21	1.59	2.68	2.68	0.00	0.00	28.18
Peppers Bridge Location	41.1	14	14-15	41.90	1.27	1.32	1.50	0.00	0.18	25.50
Oregon/WA stateline	41.6	15	15-16							
WWBWC # M-10	42.3	16	16-17	42.94	4.39	3.62	3.62	0.00	0.00	24.00
WWBWC # M-9a	43.0	17	17-18	43.76	-0.72	-0.48	-0.48	0.00	0.00	20.38
Tumalum Road Bridge (M-8)	43.6	18	18-19	44.43	-6.15	-9.43	-9.43	0.00	0.00	20.86
Walla Walla River (M-7)	44.2	19	19-20	44.87						
Walla Walla River (M-6) Gravel Pit	44.6	20	20-21							
Walla Walla River M-5b	45.3	21	21-22	45.96	0.89	0.59	0.59	0.00	0.00	30.29
Levy, Willow Lane (M-5a)	45.4	22	22-23							
Walla Walla River Nursery Bridge (M-4)	45.9	23	23-24	46.62	3.82	7.52	-81.78	-89.30	0.00	29.70
Levy, 0.5 mile us of Nursery Bridge (M-3)	46.7	24	24-25	47.26						
Grove School Bridge (M-1a)	47.9	25	25-26	48.59	13.82	14.74	14.74	0.00	0.00	111.48
Mainstem u/s Couse Creek	48.7	26	26-27							
Couse Creek Road Bridge	49.0	27	27-28	49.66	-5.72	-5.34	-8.56	-3.22	0.00	96.74
Day Road	49.9	28	28-29	50.59	4.99	4.88	2.68	-2.20	0.00	105.30
Joe West Bridge	50.8	29	29-30	51.57	0.18	0.29	0.85	-0.25	0.81	102.62
South Fork Bridge	52.5	30	30-31	53.22	1.67	8.71	4.45	-4.26	0.00	101.77
Private Property (SFWW1.7)	53.8	31	31-32							
CTUIR Fish Hatchery	57.6	32	32-33	58.44	-3.21	-5.25	-5.25	0.00	0.00	97.32
Private Property (SFWW9.0)	59.3	33	33-34	60.07	1.13	2.01	2.01	0.00	0.00	102.57
OWRD Gauge Station,	61.1	34	34-35	61.85	x	x	x	x	x	100.56

<i>Walla Walla River Seepage Assessment, July 2011</i>								
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2011 Net Diversion Total (cfs)	2011 Net Tributary Inputs Total (cfs)	2011 Flow (cfs)	Gaining/Losing
RV Park to Byerly Bdg	5.68	-2.90	-20.91	-21.85	-0.94	0.00	91.86	Losing
Byerly Bdg to USGS Touchet Gauge	12.88	-4.72	-15.29	-15.29	0.00	0.00	113.71	Losing
USGS Touchet Gauge to MacDonald Rd Bdg	16.12	3.77	53.90	119.93	-6.23	72.26	129.00	Gaining
Lowden Rd Bdg	28.24						6.98	Losing
MacDonald Rd Bdg to Detour Rd Bdg	30.41	-0.64	-2.29	-28.23	-25.94	0.00	9.07	Losing
Detour Rd Bdg to Swegle Rd Bdg	33.97	0.10	0.11	8.24	-0.08	8.21	37.30	Gaining
Swegle Rd Bdg to Last Chance Rd Bdg	35.04	2.80	4.13	4.13	0.00	0.00	29.06	Gaining
Last Chance Rd Bdg to Beet Rd Bdg	36.52	-1.12	-2.02	-2.97	-1.56	0.61	24.93	Losing
Beet Rd Bdg to WWR WDFW #5 Site	38.32	-9.51	-4.91	-36.91	-32.00	0.00	27.90	Losing
WWR WDFW #5 Site to Old Milton Hwy Bdg	38.84	4.58	6.29	45.80	0.00	39.50	64.81	Gaining
Old Milton Hwy Bdg to Hwy 125 Bdg	40.21	0.14	0.10	0.10	0.00	0.00	19.01	Gaining
Hwy 125 Bdg to Pepper Bdg	40.94	-0.20	-0.19	-0.19	0.00	0.00	18.91	Losing
Pepper Bdg to M-10	41.90	3.55	3.69	4.40	0.00	0.71	19.10	Gaining
M-10 to Mauer Lane (M9a)	42.94	2.99	2.46	2.46	0.00	0.00	14.70	Gaining
Mauer Lane (M9a) to Tum-A-Lum Bdg (M8)	43.76	1.67	1.11	1.11	0.00	0.00	12.24	Gaining
Tum-A-Lum Bdg (M8) to M7	44.43	-5.73	-2.53	-2.53	0.00	0.00	11.13	Losing
M7 to M5	44.87	-10.77	-11.77	-11.77	0.00	0.00	13.66	Losing
M-5 to Nursery Bdg M-4	45.96	-7.61	-5.03	-4.61	0.00	0.42	25.43	Losing
Nursery Bdg M-4 to M3	46.62	-18.23	-11.72	-8.15	3.57	0.00	30.04	Losing
M3 to M2	47.26	4.47	1.96	1.96	0.00	0.00	38.19	Gaining
M2 to M1a Grove School Bdg	47.70	4.04	3.58	-112.99	-116.57	0.00	36.23	Gaining
M1a Grove School Bdg to Couse Creek Rd Bdg	48.59	-3.98	-4.24	-3.89	-0.08	0.43	149.22	Losing
Couse Creek Rd Bdg to Day Road	49.66	-0.07	-0.07	-2.44	-2.37	0.00	153.11	Losing
Day Road to Joe West Bdg	50.59	20.91	20.46	20.46	0.00	0.00	155.55	Gaining
Joe West Bdg to South Fork Bdg	51.57	-10.24	-16.87	-10.18	-3.37	10.06	135.09	Losing
South Fork Bdg to CTUIR Hatchery	53.22	1.68	8.75	3.35	-5.40	0.00	145.26	Gaining
CTUIR Hatchery to Keating	58.44	8.39	13.70	13.50	-0.20	0.00	141.91	Gaining
Keating to SF Walla Walla BLM Trailhead	60.07	-10.94	-19.44	-19.60	-0.16	0.00	128.41	Losing
SF Walla Walla BLM Trailhead	61.85	x	x	x	x	x	148.01	

Walla Walla River Seepage Assessment, September 2011								
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2011 Net Diversion Total (cfs)	2011 Net Tributary Inputs Total (cfs)	2011 Flow (cfs)	Gaining/Losing
RV Park to Byerly Bdg	5.68	-0.31	-2.27	-3.22	-0.95	0.00	65.13	Losing
Byerly Bdg to USGS Touchet Gauge	12.88	6.04	19.58	15.35	-4.23	0.00	68.35	Gaining
USGS Touchet Gauge to MacDonald Rd Bdg	16.12	0.21	2.99	4.71	-8.75	10.48	53.00	Gaining
Lowden Rd Bdg	28.24						43.60	Losing
MacDonald Rd Bdg to Detour Rd Bdg	30.41	-0.11	-0.40	-21.22	-20.82	0.00	48.29	Losing
Detour Rd Bdg to Swegle Rd Bdg	33.97	2.82	3.03	10.80	0.00	7.77	69.51	Gaining
Swegle Rd Bdg to Last Chance Rd Bdg	35.04	0.72	1.07	0.96	-0.11	0.00	58.71	Gaining
Last Chance Rd Bdg to Beet Rd Bdg	36.52	-3.32	-5.99	-8.44	-2.45	0.00	57.75	Losing
Beet Rd Bdg to WWR WDFW #5 Site	38.32	6.75	3.48	3.48	0.00	0.00	66.19	Gaining
WWR WDFW #5 Site to Old Milton Hwy Bdg	38.84	0.48	0.67	34.52	-0.33	34.19	62.71	Gaining
Old Milton Hwy Bdg to Hwy 125 Bdg	40.21	-6.62	-4.77	-4.77	0.00	0.00	28.19	Losing
Hwy 125 Bdg to Pepper Bdg	40.94	5.44	5.25	5.25	0.00	0.00	32.96	Gaining
Pepper Bdg to M-10	41.90	5.15	5.36	5.72	0.00	0.36	27.71	Gaining
M-10 to Mauer Lane (M9a)	42.94	1.21	1.00	1.00	0.00	0.00	21.99	Gaining
Mauer Lane (M9a) to Tum-A-Lum Bdg (M8)	43.76	-1.18	-0.78	-0.78	0.00	0.00	20.99	Losing
Tum-A-Lum Bdg (M8) to M7	44.43	-2.22	-0.98	-0.98	0.00	0.00	21.77	Losing
M7 to M5	44.87	-9.65	-10.54	-10.54	0.00	0.00	22.75	Losing
M-5 to Nursery Bdg M-4	45.96	-7.01	-4.63	-4.32	0.00	0.31	33.29	Losing
Nursery Bdg M-4 to M3	46.62	-25.00	-16.08	-18.08	-2.01	0.00	37.61	Losing
M3 to M2	47.26	20.92	9.17	-54.83	-64.00	0.00	55.69	Gaining
M2 to M1a Grove School Bdg	47.70	0.98	0.87	0.87	0.00	0.00	110.52	Gaining
M1a Grove School Bdg to Couse Creek Rd Bdg	48.59	-0.64	-0.68	-0.68	0.00	0.00	109.65	Losing
Couse Creek Rd Bdg to Day Road	49.66	-19.26	-17.99	-18.26	-0.69	0.42	110.33	Losing
Day Road to Joe West Bdg	50.59	18.56	18.16	16.96	-1.20	0.00	128.59	Gaining
Joe West Bdg to South Fork Bdg	51.57	-5.57	-9.17	-6.99	-2.68	4.86	111.63	Losing
South Fork Bdg to CTUIR Hatchery	53.22	2.13	11.14	6.64	-4.50	0.00	118.62	Gaining
CTUIR Hatchery to Keating	58.44	-0.56	-0.91	-1.11	-0.20	0.00	111.98	Losing
Keating to SF Walla Walla BLM Trailhead	60.07	1.65	2.93	2.82	-0.11	0.00	113.09	Gaining
SF Walla Walla BLM Trailhead	61.85	X	X	X	X	X	110.27	

Attachment A-13

Walla Walla River Seepage Assessment, July 2012							
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2012 Net Diversion Total (cfs)	2012 Net Tributary Inputs Total (cfs)	2012 Flow (cfs)
Nine Mile Bridge	5.7	-1.6	-11.8	-11.8	0.0	0.0	92.1
Cummings Bridge	12.9	9.8	31.9	31.9	0.0	0.0	103.9
USGS Touchet Gage	16.1	-0.2	-2.2	58.4	-2.6	63.2	72.0
Touchet-Gardena Road Bridge							
Lowden Rd Bridge	28.2	1.4	3.1	-3.3	-6.4	0.0	13.6
MacDonald Rd Bridge	30.4	-0.2	-0.8	-20.6	-19.8	0.0	16.9
Detour Road	34.0	-3.3	-3.5	7.4	-0.1	11.0	37.5
Swegle Road Bridge	35.0	0.8	1.2	1.2	0.0	0.0	30.1
Last Chance Road Bridge	36.5	1.3	2.3	1.8	-1.6	1.1	28.9
Beet Road Bridge	38.3	-16.5	-8.5	-33.1	-24.6	0.0	27.1
Walla Walla River (WDFW #5 Site)	38.8	6.0	8.3	40.6	-0.3	32.7	60.2
Old Milton HWY Bridge	40.2	0.2	0.2	0.2	0.0	0.0	19.6
Peppers Bridge Location (WDFW/WDOE Gauge station)	41.9	-2.3	-2.3	-1.8	0.0	0.5	16.4
Walla Walla River W/BWC # M-10 (MNWW40.8) (Beaver)	42.9	2.6	2.2	2.2	0.0	0.0	18.2
Walla Walla River W/BWC # M-9a (Mauer Lane)	43.8	-0.3	-0.2	-0.2	0.0	0.0	16.0
Tumalum Road Bridge (M-8) (MNWW42.3)	44.4	2.6	1.2	1.2	0.0	0.0	16.2
Walla Walla River (M-7) (MNWW42.9)	44.9	-8.7	-9.5	-9.5	0.0	0.0	15.0
Walla Walla River (M-6) Gravel Pit (MNWW43.6)							
Levy, Willow Lane (M-5a)	46.0	-7.6	-5.0	-4.9	0.0	0.2	24.5
Walla Walla River Nursery Bridge (M-4) (MNWW44.5)	46.6	-8.2	-5.3	-9.4	-4.1	0.0	29.4
Walla Walla River (M-3) Old Smith Ditch Div.	47.3	5.9	2.6	2.6	0.0	0.0	38.7
Walla Walla River M-2 (MNWW45.6)	47.7	-5.7	-5.0	-94.4	-89.4	0.0	36.1
Grove School Bridge (M-1a) (MNWW46.1)	48.6	12.0	12.8	13.2	-0.1	0.5	130.5
Couse Creek Road Bridge (MNWW47)	49.7	-6.3	-5.9	-9.1	-3.2	0.0	117.3
Day Road	50.6	3.6	3.6	3.6	0.0	0.0	126.4
Joe West Bridge (MNWW49.1)	51.6	-1.7	-2.8	2.1	-3.9	8.9	122.8
South Fork Bridge	53.2	-0.2	-1.2	-7.3	-6.1	0.0	120.7
SF Walla Walla River at CTUIR Fish Hatchery (SFWW7.0)	58.4	1.9	3.1	2.9	-0.2	0.0	128.0
SF Walla Walla River (SFWW9.0)	60.1	0.6	1.1	1.1	0.0	0.0	125.1
OWRD Gauge Station, SF Walla Walla River	61.8	x	x	x	x	x	124.0

Attachment A-14

Walla Walla River Seepage Assessments, September 2012							
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2012 Net Diversion Total (cfs)	2012 Net Tributary Inputs Total (cfs)	2012 Flow (cfs)
Nine Mile Bridge	5.7	-1.6	-11.6	-14.9	-3.3	0.0	23.0
Cummings Bridge	12.9	4.2	13.8	7.9	-5.9	0.0	37.9
USGS Touchet Gage	16.1	0.4	5.2	14.7	-3.0	12.5	30.0
Touchet-Gardena Road Bridge							
Lowden Rd Bridge	28.2	-0.3	-0.7	-8.2	-7.5	0.0	15.3
MacDonald Rd Bridge	30.4	1.2	4.2	-24.4	-28.6	0.0	23.5
Detour Road	34.0	-3.8	-4.0	1.1	-0.5	5.6	47.9
Swegle Road Bridge	35.0	-0.8	-1.2	-1.2	0.0	0.0	46.8
Last Chance Road Bridge	36.5	4.7	8.4	6.0	-2.4	0.0	48.0
Beet Road Bridge	38.3	-13.7	-7.1	-7.1	0.0	0.0	42.0
Walla Walla River (WDFW #5 Site)	38.8	0.0	0.0	29.0	0.0	29.0	49.1
Old Milton HWY Bridge	40.2	-1.2	-0.9	-0.9	0.0	0.0	20.1
Peppers Bridge Location (WDFW/WDOE Gau	41.9	-4.5	-4.7	-4.2	0.0	0.5	17.9
Walla Walla River WWBWC # M-10 (MNWW	42.9	9.6	7.9	7.9	0.0	0.0	22.1
Walla Walla River WWBWC # M-9a (Mauer l	43.8	-1.5	-1.0	-1.0	0.0	0.0	14.2
Tumalum Road Bridge (M-8) (MNWW42.3)	44.4	-2.3	-1.0	-1.0	0.0	0.0	15.2
Walla Walla River (M-7) (MNWW42.9)	44.9	-13.4	-14.6	-14.6	0.0	0.0	16.3
Walla Walla River (M-6) Gravel Pit (MNWW43.6)							
Levy, Willow Lane (M-5a)	46.0	-1.6	-1.1	-0.9	0.0	0.2	30.9
Walla Walla River Nursery Bridge (M-4) (MN	46.6	-8.6	-5.6	-7.8	-2.2	0.0	31.8
Walla Walla River (M-3) Old Smith Ditch Div.	47.3	-0.5	-0.2	-0.2	0.0	0.0	39.6
Walla Walla River M-2 (MNWW45.6)	47.7	9.9	8.7	-65.5	-74.2	0.0	39.8
Grove School Bridge (M-1a) (MNWW46.1)	48.6	3.2	3.4	3.4	0.0	0.0	105.3
Couse Creek Road Bridge (MNWW47)	49.7	2.2	2.1	-1.1	-3.2	0.0	101.9
Day Road	50.6	4.4	4.3	4.3	0.0	0.0	103.0
Joe West Bridge (MNWW49.1)	51.6	-1.2	-2.0	-1.6	-3.5	3.9	98.8
South Fork Bridge	53.2	1.2	6.3	1.8	-4.5	0.0	100.4
SF Walla Walla River at CTUIR Fish Hatchery	58.4	-2.9	-4.7	-4.8	-0.1	0.0	98.6
SF Walla Walla River (SFWW9.0)	60.1	-1.0	-1.9	-2.2	-0.3	0.0	103.4
OWRD Gauge Station, SF Walla Walla River	61.8	x	x	x	x	x	105.6

Attachment A-15

Walla Walla River Seepage Assessment July 16th, 2013

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2013 Net Diversion Total (cfs)	2013 Net Tributary Inputs Total (cfs)	2013 Flow (cfs)	Gaining/Losing
RV Park to Byerly Bdg	5.68	-1.89	-13.58	-13.58	0.00	0.00	25.80	Losing
Byerly Bdg to USGS Touchet Gauge	12.88	4.06	13.18	13.18	0.00	0.00	39.38	Gaining
USGS Touchet Gauge to MacDonald Rd Bdg	16.12	0.09	1.08	22.22	-4.21	25.35	26.20	Gaining
Lowden Rd Bdg	28.24	-0.24	-0.52	-0.91	-0.39	0.00	3.98	Losing
MacDonald Rd Bdg to Detour Rd Bdg	30.41	-0.51	-1.80	-27.30	-25.50	0.00	4.89	Losing
Detour Rd Bdg to Swegle Rd Bdg	33.97	-3.58	-3.85	1.14	-0.09	5.08	32.19	Losing
Swegle Rd Bdg to Last Chance Rd Bdg	35.04	2.66	3.92	3.92	0.00	0.00	31.04	Gaining
Last Chance Rd Bdg to Beet Rd Bdg	36.52	2.43	4.39	2.76	-2.16	0.53	27.12	Gaining
Beet Rd Bdg to WWR WDFW #5 Site	38.32	-13.45	-6.94	-19.64	-12.70	0.00	24.36	Losing
WWR WDFW #5 Site to Old Milton Hwy Bdg	38.84	-0.46	-0.64	21.03	-0.38	22.04	44.00	Losing
Old Milton Hwy Bdg to Hwy 125 Bdg	40.21	0.99	0.71	0.71	0.00	0.00	22.98	Gaining
Hwy 125 Bdg to Pepper Bdg	40.94	4.93	4.76	4.11	-0.65	0.00	22.26	Gaining
Pepper Bdg to M-10	41.90	-0.93	-0.97	-0.62	0.00	0.35	18.15	Losing
M-10 to Mauer Lane (M9a)	42.94	3.97	3.27	3.27	0.00	0.00	18.77	Gaining
Mauer Lane (M9a) to Tum-A-Lum Bdg (M8)	43.76	-1.66	-1.10	-1.10	0.00	0.00	15.50	Losing
Tum-A-Lum Bdg (M8) to M7	44.43	-2.56	-1.13	-1.13	0.00	0.00	16.60	Losing
M7 to M5	44.87	-15.09	-16.48	-16.48	0.00	0.00	17.73	Losing
M-5 to Nursery Bdg M-4	45.96	-9.78	-6.46	-6.13	0.00	0.33	34.21	Losing
Nursery Bdg M-4 to M3	46.62	-7.94	-5.10	-8.87	-3.77	0.00	40.34	Losing
M3 to M2	47.26	-13.48	-5.91	-5.91	0.00	0.00	49.21	Losing
M2 to M1a Grove School Bdg	47.70	0.99	0.88	-73.69	-74.57	0.00	55.12	Gaining
M1a Grove School Bdg to Couse Creek Rd Bdg	48.59	2.73	2.91	2.91	0.00	0.00	128.81	Gaining
Couse Creek Rd Bdg to Day Road	49.66	7.16	6.69	3.86	-2.83	0.00	125.90	Gaining
Day Road to Joe West Bdg	50.59	3.73	3.65	3.65	0.00	0.00	122.04	Gaining
Joe West Bdg to South Fork Bdg	51.57	-0.35	-0.58	3.43	-5.72	9.73	118.39	Losing
South Fork Bdg to CTUIR Hatchery	53.22	2.13	11.12	5.10	-6.02	0.00	114.96	Gaining
CTUIR Hatchery to Keating	58.44	1.65	2.69	2.44	-0.25	0.00	109.86	Gaining
Keating to SF Walla Walla BLM Trailhead	60.07	-6.17	-10.96	-11.24	-0.28	0.00	107.42	Losing
SF Walla Walla BLM Trailhead	61.85	x	x	x	x	x	118.66	

Attachment A-16

Walla Walla River Seepage Assessment September 17th, 2013

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2013 Net Diversion Total (cfs)	2013 Net Tributary Inputs Total (cfs)	2013 Flow (cfs)	Gaining/Losing
RV Park to Byerly Bdg	5.68	0.19	1.35	0.79	-0.56	0.00	48.49	Gaining
Byerly Bdg to USGS Touchet Gauge	12.88	0.37	1.20	1.20	0.00	0.00	47.70	Gaining
USGS Touchet Gauge to MacDonald Rd Bdg	16.12	0.99	11.97	26.42	-6.70	21.16	46.50	Gaining
Lowden Rd Bdg	28.24	1.89	4.11	2.78	-1.33	0.00	20.08	Gaining
MacDonald Rd Bdg to Detour Rd Bdg	30.41	-1.65	-5.87	-32.10	-26.23	0.00	17.30	Losing
Detour Rd Bdg to Swegle Rd Bdg	33.97	-4.36	-4.68	5.56	-0.60	10.84	49.40	Losing
Swegle Rd Bdg to Last Chance Rd Bdg	35.04	2.00	2.96	2.80	-0.16	0.00	43.84	Gaining
Last Chance Rd Bdg to Beet Rd Bdg	36.52	1.42	2.56	-0.16	-2.72	0.00	41.04	Gaining
Beet Rd Bdg to WWR WDFW #5 Site	38.32	-14.67	-7.57	-7.57	0.00	0.00	41.20	Losing
WWR WDFW #5 Site to Old Milton Hwy Bdg	38.84	-1.00	-1.38	24.42	0.00	25.80	48.77	Losing
Old Milton Hwy Bdg to Hwy 125 Bdg	40.21	0.50	0.36	0.36	0.00	0.00	24.35	Gaining
Hwy 125 Bdg to Pepper Bdg	40.94	3.72	3.59	3.59	0.00	0.00	23.99	Gaining
Pepper Bdg to M-10	41.90	-2.68	-2.79	-2.39	0.00	0.40	20.40	Losing
M-10 to Mauer Lane (M9a)	42.94	4.78	3.94	3.94	0.00	0.00	22.79	Gaining
Mauer Lane (M9a) to Tum-A-Lum Bdg (M8)	43.76	0.18	0.12	0.12	0.00	0.00	18.85	Gaining
Tum-A-Lum Bdg (M8) to M7	44.43	-0.25	-0.11	-0.11	0.00	0.00	18.73	Losing
M7 to M5	44.87	-10.15	-11.09	-11.09	0.00	0.00	18.84	Losing
M-5 to Nursery Bdg M-4	45.96	-8.19	-5.41	-5.10	0.00	0.31	29.93	Losing
Nursery Bdg M-4 to M3	46.62	-10.30	-6.62	-8.07	-1.45	0.00	35.03	Losing
M3 to M2	47.26	-5.09	-2.23	-2.23	0.00	0.00	43.10	Losing
M2 to M1a Grove School Bdg	47.70	0.36	0.32	-67.53	-67.85	0.00	45.33	Gaining
M1a Grove School Bdg to Couse Creek Rd Bdg	48.59	-4.64	-4.95	-4.95	0.00	0.00	112.86	Losing
Couse Creek Rd Bdg to Day Road	49.66	-3.39	-3.17	-4.59	-1.42	0.00	117.81	Losing
Day Road to Joe West Bdg	50.59	9.83	9.62	9.62	0.00	0.00	122.40	Gaining
Joe West Bdg to South Fork Bdg	51.57	-1.32	-2.17	-2.84	-5.68	5.01	112.78	Losing
South Fork Bdg to CTUIR Hatchery	53.22	2.78	14.49	8.23	-6.26	0.00	115.62	Gaining
CTUIR Hatchery to Keating	58.44	1.77	2.89	2.89	0.00	0.00	107.39	Gaining
Keating to SF Walla Walla BLM Trailhead	60.07	1.54	2.74	2.74	0.00	0.00	104.50	Gaining
SF Walla Walla BLM Trailhead	61.85	x	x	x	x	x	101.76	

Attachment A-17

Walla Walla River Seepage Assessment July 24, 2014

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2014 Net Diversion Total (cfs)	2014 Net Tributary Inputs Total (cfs)	2014 Flow (cfs)	Gaining/Losing
RV Park to Byerly Bdg	5.68	0.21	1.49	0.86	-0.62	0.00	28.30	Gaining
Byerly Bdg to USGS Touchet Gauge	12.88	-6.19	-20.07	-20.07	0.00	0.00	27.43	Losing
USGS Touchet Gauge to MacDonald Rd Bdg	16.12	-0.85	-10.35	8.64	-5.44	24.43	47.50	Losing
Lowden Rd Bdg	28.24	3.06	6.65	6.65	0.00	0.00	38.86	Gaining
MacDonald Rd Bdg to Detour Rd Bdg	30.41	2.13	7.60	-21.21	-28.81	0.00	32.21	Gaining
Detour Rd Bdg to Swegle Rd Bdg	33.97	1.53	1.64	10.62	0.00	8.98	53.42	Gaining
Swegle Rd Bdg to Last Chance Rd Bdg	35.04	-1.46	-2.16	-2.16	0.00	0.00	42.80	Losing
Last Chance Rd Bdg to Beet Rd Bdg	36.52	0.33	0.60	-0.08	-0.87	0.20	44.96	Gaining
Beet Rd Bdg to WWR WDFW #5 Site	38.32	-9.86	-5.09	-5.09	0.00	0.00	45.04	Losing
WWR WDFW #5 Site to Old Milton Hwy Bdg	38.84	3.00	4.13	24.91	-0.22	21.00	50.12	Gaining
Old Milton Hwy Bdg to Hwy 125 Bdg	40.21	-6.44	-4.64	-4.64	0.00	0.00	25.22	Losing
Hwy 125 Bdg to Pepper Bdg	40.94	5.87	5.66	5.66	0.00	0.00	29.86	Gaining
Pepper Bdg to M-10	41.90	5.04	5.24	5.68	0.00	0.44	24.20	Gaining
M-10 to Mauer Lane (M9a)	42.94	1.31	1.08	1.08	0.00	0.00	18.52	Gaining
Mauer Lane (M9a) to Tum-A-Lum Bdg (M8)	43.76	0.24	0.16	0.16	0.00	0.00	17.44	Gaining
Tum-A-Lum Bdg (M8) to M7	44.43	-3.43	-1.52	-1.52	0.00	0.00	17.28	Losing
M7 to M5	44.87	-1.79	-1.95	-1.95	0.00	0.00	18.79	Losing
M-5 to Nursery Bdg M-4	45.96	-27.79	-18.36	-18.06	0.00	0.30	20.74	Losing
Nursery Bdg M-4 to M3	46.62	-16.40	-10.55	-13.03	-2.48	0.00	38.80	Losing
M3 to M2	47.26	16.82	7.37	-58.63	-66.00	0.00	51.83	Gaining
M2 to M1a Grove School Bdg	47.70	11.30	10.02	7.54	-2.48	0.00	110.45	Gaining
M1a Grove School Bdg to Couse Creek Rd Bdg	48.59	-4.98	-5.31	-5.31	0.00	0.00	102.92	Losing
Couse Creek Rd Bdg to Day Road	49.66	-3.69	-3.45	-6.28	-2.83	0.00	108.23	Losing
Day Road to Joe West Bdg	50.59	6.09	5.96	5.96	0.00	0.00	114.51	Gaining
Joe West Bdg to South Fork Bdg	51.57	-4.42	-7.28	-1.11	-4.13	10.30	108.54	Losing
South Fork Bdg to CTUIR Hatchery	53.22	0.74	3.86	-4.26	-8.11	0.00	109.65	Gaining
CTUIR Hatchery to Keating	58.44	-0.94	-1.54	-1.98	-0.45	0.00	113.91	Losing
Keating to SF Walla Walla BLM Trailhead	60.07	-1.15	-2.05	-2.05	0.00	0.00	115.89	Losing
SF Walla Walla BLM Trailhead	61.85	x	x	x	x	x	117.94	

Attachment A-18

Walla Walla River Seepage Assessment September 2, 2014

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2014 Net Diversion Total (cfs)	2014 Net Tributary Inputs Total (cfs)	2014 Flow (cfs)	Gaining/Losing
RV Park	5.68	0.28	2.02	2.02	0.00	0.00	53.41	Gaining
Byerly Rd	12.88	-2.04	-6.61	-6.61	0.00	0.00	51.39	Losing
USGS Gauge	16.12	2.08	25.16	30.41	-7.64	12.89	58.00	Gaining
Lowden Rd Bdg	28.24	-0.04	-0.08	-0.08	0.00	0.00	27.59	Losing
McDonald Rd Bdg	30.41	-0.48	-1.73	-24.43	-22.70	0.00	27.68	Losing
Detour Rd Bdg	33.97	-2.26	-2.43	7.77	0.00	10.20	52.10	Losing
Swegle Rd Bdg	35.04	1.82	2.68	2.55	-0.13	0.00	44.33	Gaining
Last Chance Rd Bdg	36.52	-2.76	-4.99	-6.92	-1.94	0.00	41.78	Losing
Beet Rd Bdg	38.32	3.00	1.55	1.55	0.00	0.00	48.70	Gaining
WWR WDFW #5 Site	38.84	-1.02	-1.40	18.74	0.00	20.14	47.15	Losing
Old Milton Hwy Bdg	40.21	-1.11	-0.80	-0.80	0.00	0.00	28.41	Losing
Hwy 125 Bdg	40.94	2.08	2.01	2.01	0.00	0.00	29.21	Gaining
Pepper Bdg	41.90	1.47	1.53	1.63	0.00	0.10	27.20	Gaining
M-10	42.94	1.23	1.01	1.01	0.00	0.00	25.57	Gaining
Mauer Lane (M9a)	43.76	-7.32	-28.85	-81.63	-52.78	0.00	24.56	Losing
Turn A Turn Bdg (M8) to M7	44.43	0.00	0.00	0.00				Losing
M2 to M1a	44.87	0.00	0.00	0.00				Losing
M-5 to Nursery Bdg M-4	45.08	0.00	0.00	0.00				Losing
Nursery Bdg M-4 to M2	46.82	0.00	0.00	0.00				Losing
M1 to M2	47.18	-2.22	-108.19	-108.19				Losing
M2	47.70	9.92	8.79	7.01	-1.78	0.00	106.19	Gaining
M1 a Grove School Bdg	48.59	-3.11	-3.32	-3.32	0.00	0.00	99.18	Losing
Couse Creek Rd Bdg	49.66	-0.38	-0.35	-3.99	-3.64	0.00	102.50	Losing
Day Road	50.59	3.45	3.37	3.37	0.00	0.00	106.49	Gaining
Joe West Bdg	51.57	1.90	3.13	3.72	-4.98	5.57	103.12	Gaining
South Fork Bdg	53.22	1.51	7.87	1.53	-6.34	0.00	99.40	Gaining
CTUIR Hatchery	58.44	-2.00	-3.26	-3.42	-0.16	0.00	97.88	Losing
Keating	60.07	-0.83	-1.48	-1.48	0.00	0.00	101.30	Losing
SF Walla Walla BLM Trailhead	61.85	X	X	X	X	X	102.78	

Attachment A-19

Walla Walla River Seepage Assessment July 30, 2015

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2015 Net Diversion Total (cfs)	2015 Net Tributary Inputs Total (cfs)	2015 Flow (cfs)	Gaining/Losing
RV Park to Byerly Bdg	5.68	-0.88	-6.32	-6.32	0.00	0.00	0.00	Losing
Byerly Bdg to USGS Touchet Gauge	12.88	-0.17	-0.55	-4.05	-3.50	0.00	6.32	Losing
USGS Touchet Gauge to MacDonald Rd Bdg	16.12	0.38	4.58	8.89	-1.00	5.31	10.37	Gaining
Lowden Rd Bdg	28.24	0.14	0.31	0.31	0.00	0.00	1.49	Gaining
MacDonald Rd Bdg to Detour Rd Bdg	30.41	-1.34	-4.78	-26.28	-21.50	0.00	1.18	Losing
Detour Rd Bdg to Swegle Rd Bdg	33.97	0.84	0.90	3.59	-0.50	3.19	27.46	Gaining
Swegle Rd Bdg to Last Chance Rd Bdg	35.04	0.89	1.32	1.32	0.00	0.00	23.87	Gaining
Last Chance Rd Bdg to Beet Rd Bdg	36.52	-1.49	-2.69	-3.69	-1.00	0.00	22.55	Losing
Beet Rd Bdg to WWR WDFW #5 Site	38.32	-0.77	-0.40	-0.40	0.00	0.00	26.24	Losing
WWR WDFW #5 Site to Old Milton Hwy Bdg	38.84	-2.08	-2.86	15.36	0.00	18.21	26.64	Losing
Old Milton Hwy Bdg to Hwy 125 Bdg	40.21	0.14	0.10	0.10	0.00	0.00	11.28	Gaining
Hwy 125 Bdg to Pepper Bdg	40.94	0.74	0.72	0.72	0.00	0.00	11.18	Gaining
Pepper Bdg to M-10	41.90	-1.47	-1.53	-1.53	0.00	0.00	10.46	Losing
M-10 to Mauer Lane (M9a)	42.94	4.22	3.48	3.48	0.00	0.00	11.99	Gaining
Mauer Lane (M9a) to Tum-A-Lum Bdg (M8)	43.76	-4.18	-2.77	-2.77	0.00	0.00	8.51	Losing
Tum-A-Lum Bdg (M8) to M7	44.43	-0.23	-0.10	-0.10	0.00	0.00	11.28	Losing
M7 to M5	44.87	-13.43	-14.67	-14.55	0.00	0.12	11.38	Losing
M-5 to Nursery Bdg M-4	45.96	-0.54	-0.35	-0.35	0.00	0.00	25.93	Losing
Nursery Bdg M-4 to M3	46.62	-4.08	-2.63	-6.20	-3.57	0.00	26.28	Losing
M3 to M2	47.26	-13.53	-5.93	-60.93	-55.00	0.00	32.48	Losing
M2 to M1a Grove School Bdg	47.70	0.08	0.07	-3.50	-3.57	0.00	93.41	Gaining
M1a Grove School Bdg to Couse Creek Rd Bdg	48.59	1.90	2.03	2.03	0.00	0.00	96.91	Gaining
Couse Creek Rd Bdg to Day Road	49.66	11.27	10.53	7.53	-3.00	0.00	94.88	Gaining
Day Road to Joe West Bdg	50.59	-2.05	-2.01	-2.01	0.00	0.00	87.35	Losing
Joe West Bdg to South Fork Bdg	51.57	2.22	3.66	1.24	-6.72	4.30	89.36	Gaining
South Fork Bdg to CTUIR Hatchery	53.22	2.02	10.54	4.47	-6.07	0.00	88.12	Gaining
CTUIR Hatchery to Keating	58.44	1.21	1.98	1.46	-0.52	0.00	83.65	Gaining
Keating to SF Walla Walla BLM Trailhead	60.07	0.73	1.29	1.29	0.00	0.00	82.19	Gaining
SF Walla Walla BLM Trailhead	61.85	x	x	x	x	x	80.90	

Attachment A-20

Walla Walla River Seepage Assessment September 21-22, 2015

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2015 Net Diversion Total (cfs)	2015 Net Tributary Inputs Total (cfs)	2015 Flow (cfs)	Gaining/Losing
RV Park	5.68	0.47	3.38	3.38	0.00	0.00	20.50	Gaining
Byerly Rd	12.88	4.05	13.13	5.12	-8.01	0.00	17.12	Gaining
USGS Gauge	16.12	-0.03	-0.41	-1.05	-7.16	6.52	12.00	Losing
Lowden Rd Bdg	28.24	-0.34	-0.73	-1.42	-0.69	0.00	13.05	Losing
McDonald Rd Bdg	30.41	-0.88	-3.13	-26.73	-23.60	0.00	14.47	Losing
Detour Rd Bdg	33.97	-0.35	-0.37	8.33	-0.56	9.26	41.20	Losing
Swegle Rd Bdg	35.04	1.09	1.61	1.61	0.00	0.00	32.87	Gaining
Last Chance Rd Bdg	36.52	-1.18	-2.12	-3.65	-1.53	0.00	31.26	Losing
Beet Rd Bdg	38.32	3.84	1.98	1.98	0.00	0.00	34.91	Gaining
WWR WDFW #5 Site	38.84	-4.01	-5.51	18.84	0.00	24.35	32.93	Losing
Old Milton Hwy Bdg	40.21	-0.12	-0.08	-0.08	0.00	0.00	14.09	Losing
Hwy 125 Bdg	40.94	1.82	1.75	1.42	-0.33	0.00	14.17	Gaining
Pepper Bdg	41.90	-0.36	-0.37	-0.37	0.00	0.00	12.75	Losing
M-10	42.94	3.52	2.90	2.90	0.00	0.00	13.12	Gaining
Mauer Lane (M9a)	43.76	-0.60	-2.36	-2.36	0.00	0.00	10.22	Losing
Tum-A-Lum Bdg (M8)	44.43	0.27	0.12	0.12	0.00	0.00	12.58	Gaining
M7	44.87	-10.70	-11.69	-11.50	0.00	0.19	12.46	Losing
M-5	45.96	-6.74	-4.45	-4.45	0.00	0.00	23.96	Losing
Nursery Bdg M-4	46.62	-12.18	-7.83	-10.91	-3.08	0.00	28.41	Losing
M3	47.26	-2.71	-1.19	-71.19	-70.00	0.00	39.32	Losing
M2	47.70	-1.68	-1.49	-1.49	0.00	0.00	110.51	Losing
M1a Grove School Bdg	48.59	15.61	16.65	16.65	0.00	0.00	112.00	Gaining
Couse Creek Rd Bdg	49.66	1.49	1.39	-1.93	-3.32	0.00	95.35	Gaining
Day Road	50.59	5.20	5.09	5.09	0.00	0.00	97.28	Gaining
Joe West Bdg	51.57	-2.81	-4.63	-4.42	-4.32	4.54	92.19	Losing
South Fork Bdg	53.22	-0.61	-3.16	-8.15	-4.99	0.00	96.61	Losing
CTUIR Hatchery	58.44	1.69	2.77	2.65	-0.12	0.00	104.76	Gaining
Keating	60.07	3.67	6.53	6.53	0.00	0.00	102.11	Gaining
SF Walla Walla BLM Trailhead	61.85	x	x	x	x	x	95.58	

Attachment A-21 Walla Walla River Seepage Assessment June 29, 2016

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2016 Net Diversion Total (cfs)	2016 Net Tributary Inputs Total (cfs)	2016 Flow (cfs)	Gaining/Losing
RV Park to Byerly Bdg	5.68	1.03	7.40	-0.78	-8.18	0.00	47.70	Gaining
Byerly Bdg to USGS Touchet Gauge	12.88	3.14	10.18	10.18	0.00	0.00	48.48	Gaining
USGS Touchet Gauge to Lowden Rd Bdg	16.12	1.36	16.46	34.98	-5.27	23.78	38.30	Gaining
Lowden Rd Bdg to McDonald Rd Bdg	28.24	-2.33	-5.07	-6.18	-1.11	0.00	3.33	Losing
MacDonald Rd Bdg to Detour Rd Bdg	30.41	-1.90	-6.77	-32.50	-25.73	0.00	9.50	Losing
Detour Rd Bdg to Swegle Rd Bdg	33.97	-4.01	-4.31	12.93	-0.12	17.36	42.00	Losing
Swegle Rd Bdg to Last Chance Rd Bdg	35.04	-6.93	-10.24	-9.24	0.00	1.00	29.07	Losing
Last Chance Rd Bdg to Beet Rd Bdg	36.52	0.74	1.34	0.01	-1.80	0.47	38.31	Gaining
Beet Rd Bdg to WWR WDFW #5 Site	38.32	-4.01	-2.07	-6.57	-4.50	0.00	38.30	Losing
WWR WDFW #5 Site to Old Milton Hwy Bdg	38.84	-2.84	-3.91	22.47	0.00	26.38	44.87	Losing
Old Milton Hwy Bdg to Hwy 125 Bdg	40.21	-0.84	-0.61	-0.61	0.00	0.00	22.40	Losing
Hwy 125 Bdg to Pepper Bdg	40.94	4.78	4.61	4.61	0.00	0.00	23.01	Gaining
Pepper Bdg to M-10	41.90	0.88	0.92	0.84	-0.28	0.20	18.40	Gaining
M-10 to Mauer Lane (M9a)	42.94	0.50	0.41	0.41	0.00	0.00	17.56	Gaining
Mauer Lane (M9a) to Tum-A-Lum Bdg (M8)	43.76	1.52	1.01	1.01	0.00	0.00	17.15	Gaining
Tum-A-Lum Bdg (M8) to M7	44.43	-3.14	-1.39	-1.39	0.00	0.00	16.14	Losing
M7 to M5	44.87	-9.66	-10.55	-10.43	0.00	0.12	17.53	Losing
M-5 to Nursery Bdg M-4	45.96	-14.91	-9.85	-9.85	0.00	0.00	27.96	Losing
Nursery Bdg M-4 to M3	46.62	-25.77	-16.57	-20.07	-3.50	0.00	37.81	Losing
M3 to M2	47.26	27.64	12.12	-48.88	-61.00	0.00	57.88	Gaining
M2 to M1a Grove School Bdg	47.70	8.16	7.24	3.74	-3.50	0.00	106.76	Gaining
M1a Grove School Bdg to Couse Creek Rd Bdg	48.59	9.73	10.39	10.39	0.00	0.00	103.02	Gaining
Couse Creek Rd Bdg to Day Road	49.66	-6.71	-6.27	-10.07	-3.80	0.00	92.64	Losing
Day Road to Joe West Bdg	50.59	6.17	6.04	6.04	0.00	0.00	102.71	Gaining
Joe West Bdg to South Fork Bdg	51.57	-0.98	-1.61	-3.10	-8.02	6.53	96.67	Losing
South Fork Bdg to CTUIR Hatchery	53.22	0.89	4.65	-1.10	-5.75	0.00	99.77	Gaining
CTUIR Hatchery to Keating	58.44	2.56	8.72	8.41	-0.31	0.00	100.87	Gaining
Keating to SF Walla Walla BLM Trailhead	60.07							
SF Walla Walla BLM Trailhead	61.85	x	x	x	x	x	92.46	

Attachment A-22 Walla Walla River Seepage Assessment September 8, 2016

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2016 Net Diversion Total (cfs)	2016 Net Tributary Inputs Total (cfs)	2016 Flow (cfs)
RV Park to Byerly Bdg	5.68	-1.54	-11.07	-11.40	-0.33	0.00	26.80
Byerly Bdg to USGS Touchet Gauge	12.88	-0.63	-2.03	-4.70	-2.67	0.00	38.20
USGS Touchet Gauge to Lowden Rd Bdg	16.12	-0.83	-10.07	-2.78	-7.93	15.22	42.90
Lowden Rd Bdg to McDonald Rd Bdg	28.24	-0.62	-1.34	-1.34	0.00	0.00	45.68
MacDonald Rd Bdg to Detour Rd Bdg	30.41	0.41	1.46	-16.44	-17.90	0.00	47.02
Detour Rd Bdg to Swegle Rd Bdg	33.97	2.98	3.20	15.22	-1.02	13.04	63.46
Swegle Rd Bdg to Last Chance Rd Bdg	35.04	-2.64	-3.90	-2.90	0.00	1.00	48.25
Last Chance Rd Bdg to Beet Rd Bdg	36.52	2.54	4.57	2.75	-1.82	0.00	51.15
Beet Rd Bdg to WWR WDFW #5 Site	38.32	2.31	1.19	1.19	0.00	0.00	48.39
WWR WDFW #5 Site to Old Milton Hwy Bdg	38.84	0.25	0.34	12.42	0.00	12.09	47.20
Old Milton Hwy Bdg to Hwy 125 Bdg	40.21	-0.93	-0.67	-0.67	0.00	0.00	34.78
Hwy 125 Bdg to Pepper Bdg	40.94	2.89	2.79	2.51	-0.28	0.00	35.45
Pepper Bdg	41.90	x	x	x	x	x	32.94
Flow Measurement Location (Reach Locations)							
Pepper Bdg to M-10	41.90	3.36	3.49	3.49	0.00	0.00	25.84
M-10 to Mauer Lane (M9a)	42.94	1.97	1.63	1.63	0.00	0.00	22.35
Mauer Lane (M9a) to Tum-A-Lum Bdg (M8)	43.76	-0.40	-0.26	-0.26	0.00	0.00	20.72
Tum-A-Lum Bdg (M8) to M7	44.43	-3.84	-1.70	-1.70	0.00	0.00	20.99
M7 to M5	44.87	-8.22	-8.98	-8.87	0.00	0.11	22.68
M-5 to Nursery Bdg M-4	45.96	-12.03	-7.95	-7.95	0.00	0.00	31.55
Nursery Bdg M-4 to M3	46.62	-8.16	-5.25	-8.75	-3.50	0.00	39.50
M3 to M2	47.26	-5.57	-2.44	-52.44	-50.00	0.00	48.25
M2 to M1a Grove School Bdg	47.70	3.20	2.84	-0.66	-3.50	0.00	100.69
M1a Grove School Bdg to Couse Creek Rd Bdg	48.59	0.55	0.59	0.59	0.00	0.00	101.35
Couse Creek Rd Bdg to Day Road	49.66	2.60	2.43	-0.49	-2.92	0.00	100.76
Day Road to Joe West Bdg	50.59	7.69	7.52	7.52	0.00	0.00	101.25
Joe West Bdg to South Fork Bdg	51.57	-2.20	-3.62	-5.58	-7.19	5.22	93.73
South Fork Bdg to CTUIR Hatchery	53.22	1.43	7.47	3.23	-4.24	0.00	99.32
CTUIR Hatchery to SF Walla Walla BLM Trailhead	58.44	-0.41	-1.39	-1.61	-0.22	0.00	96.09
SF Walla Walla BLM Trailhead	61.85	x	x	x	x	x	97.70

Attachment B

Attachment B-1

Mill Creek Seepage Assessments

October, 2008

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2008 Net Diversion Total (cfs)	2008 Net Tributary Inputs Total (cfs)	2008 Flow (cfs)
Swegle Road Bridge	0.5	0.7	1.1	2.3	0.0	1.2	10.5
Last Chance Road Bridge	1.9	-0.4	-0.4	-0.4	0.0	0.0	8.2
Wallula Rd Bridge	2.9	4.7	8.2	7.5	-0.8	0.0	8.6
Goes Bridge	4.7	0.2	1.4	-1.2	-2.6	0.0	1.1
Tausick Rd Bridge	10.6	-5.4	-3.0	-1.5	0.0	1.5	2.3
Below Yellowhawk Diversion	11.1	0.1	0.2	-23.3	-23.4	0.0	3.8
5 Mile Rd Bridge	13.5	1.4	3.0	-1.4	-4.3	0.0	27.1
7 Mile Rd Bridge	15.6	-2.8	-12.6	-11.7	0.0	0.8	28.5
20 Mile Bridge	20.2	7.8	8.2	8.2	0.0	0.0	40.2
USGS Gauge	21.2	-1.7	-2.4	-2.4	0.0	0.0	32.0
Mill Creek At StateLine	22.6	x	x	x	x	x	34.4

July, 2010

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2010 Net Diversion Total (cfs)	2010 Net Tributary Inputs Total (cfs)	2010 Flow (cfs)
Swegle Road Bridge	0.5	-0.2	-0.3	0.7	0.0	1.0	13.9
Last Chance Road Bridge	1.9	-1.2	-1.2	-1.2	0.0	0.0	13.2
Wallula Rd Bridge	2.9	2.7	4.7	4.2	-0.5	0.0	14.4
Goes Bridge	4.7	1.0	5.9	6.0	-0.9	1.0	10.2
Tausick Rd Bridge	10.6	0.8	0.4	0.4	0.0	0.0	4.2
Below Yellowhawk Diversion	11.1	-3.4	-8.0	-32.6	-24.6	0.0	3.8
5 Mile Rd Bridge	13.5	2.5	5.2	-1.7	-6.9	0.0	36.4
7 Mile Rd Bridge	15.6	-0.1	-0.7	0.3	-0.3	1.2	38.1
20 Mile Bridge	20.2	5.0	5.3	5.3	0.0	0.0	37.8
USGS Gauge	21.2	-2.6	-3.7	-4.3	-0.6	0.0	32.5
Mill Creek At StateLine	22.6	x	x	x	x	x	36.8

September, 2011

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2011 Net Diversion Total (cfs)	2011 Net Tributary Inputs Total (cfs)	2011 Flow (cfs)
Swegle Road Bridge	0.5	-0.6	-0.9	0.1	0.0	1.0	5.8
Last Chance Road Bridge	1.9	-1.6	-1.6	-1.6	0.0	0.0	5.7
Wallula Rd Bridge	2.9	2.2	3.8	3.8	-0.1	0.0	7.4
Goes Bridge	4.7	0.8	4.8	0.7	-5.5	0.0	3.6
Tausick Rd Bridge	10.6	-1.3	-0.7	0.9	0.0	1.7	4.3
Below Yellowhawk Diversion	11.1	0.0	0.1	-21.0	-21.1	0.0	3.4
5 Mile Rd Bridge	13.5	-1.9	-4.0	-4.0	0.0	0.0	24.4
7 Mile Rd Bridge	15.6	-0.7	-3.1	-2.3	0.0	0.8	28.3
20 Mile Bridge	20.2	3.4	3.6	3.6	0.0	0.0	30.6
USGS Gauge	21.2	1.2	1.7	1.5	-0.2	0.0	27.0
Mill Creek At StateLine	22.6	x	x	x	x	x	25.5

September, 2012

Flow Measurement Location (Reach Locations)	River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2012 Net Diversion Total (cfs)	2012 Net Tributary Inputs Total (cfs)	2012 Flow (cfs)
Swegle Road Bridge	0.6	-0.8	-1.1	-0.5	0.00	0.65	6.4
Last Chance Road Bridge	2.0	-1.5	-1.6	-1.2	0.41	0.00	6.9
Wallula Rd Bridge	3.1	1.9	4.5	4.3	-0.24	0.00	8.1
Gose Bridge	5.5	1.2	6.6	0.6	-6.11	0.05	3.8
Tausick Rd Bridge	10.9	3.1	1.7	1.6	-0.09	0.02	3.2
Below Yellowhawk Diversion	11.5	0.8	2.1	-20.1	-22.20	0.00	1.6
5 Mile Rd Bridge	14.0	1.0	2.3	-2.7	-5.00	0.00	21.7
7 Mile Rd Bridge	16.2	-1.6	-6.4	-5.8	0.00	0.55	24.4
20 Mile Bridge	20.2	0.2	0.2	0.2	0.00	0.00	30.2
USGS Gauge	21.2	0.0	0.0	0.0	0.00	0.00	30.0
Mill Creek At StateLine	23.7	x	x	x	x	x	30.0

September, 2013

Flow Measurement Location (Reach Locations)	River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2013 Net Diversion Total (cfs)	2013 Net Tributary Inputs Total (cfs)	2013 Flow (cfs)
Swegle Road Bridge	0.6	0.53	0.8	1.2	0.00	0.45	7.69
Last Chance Road Bridge	2.0	-1.02	-1.1	-1.0	0.05	0.00	6.47
Wallula Rd Bridge	3.1	1.50	3.6	3.5	-0.17	0.00	7.49
Gose Bridge	5.5	-0.71	-3.8	-8.4	-5.11	0.50	4.02
Tausick Rd Bridge	10.9	1.08	0.6	2.5	0.00	1.87	12.46
Below Yellowhawk Diversion	11.5	-2.54	-6.5	-23.7	-17.20	0.00	10.00
5 Mile Rd Bridge	14.0	2.57	5.7	-6.8	-12.53	0.00	33.67
7 Mile Rd Bridge	16.2	-0.24	-1.0	3.8	0.00	4.78	40.49
20 Mile Bridge	20.2	-2.24	-2.3	-2.3	0.00	0.00	36.67
USGS Gauge	21.2	1.00	2.5	2.5	0.00	0.00	39.00
Mill Creek At StateLine	23.7	x	x	x	x	x	36.46

June, 2009

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2009 Net Diversion Total (cfs)	2009 Net Tributary Inputs Total (cfs)	2009 Flow (cfs)
Swegle Road Bridge	0.5	0.2	0.3	2.1	0.0	1.8	16.1
Last Chance Road Bridge	1.9	-0.2	-0.2	-0.2	0.0	0.0	14.0
Wallula Rd Bridge	2.9	1.8	3.2	2.1	-1.1	0.0	14.2
Goes Bridge	4.7	0.1	0.7	-1.4	-2.1	0.0	12.1
Tausick Rd Bridge	10.6	-6.8	-3.8	-1.7	0.0	2.1	13.5
Below Yellowhawk Diversion	11.1	-0.6	-1.5	-33.0	-31.5	0.0	15.2
5 Mile Rd Bridge	13.5	2.0	4.2	-0.9	-5.1	0.0	48.2
7 Mile Rd Bridge	15.6	-1.7	-7.6	-6.1	0.0	1.5	49.1
20 Mile Bridge	20.2	4.6	4.8	4.8	0.0	0.0	55.2
USGS Gauge	21.2	-1.5	-2.1	-2.1	0.0	0.0	50.4
Mill Creek At StateLine	22.6	x	x	x	x	x	52.5

July, 2011

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2011 Net Diversion Total (cfs)	2011 Net Tributary Inputs Total (cfs)	2011 Flow (cfs)
Swegle Road Bridge	0.5	-2.0	-2.8	-1.1	0.0	1.7	18.1
Last Chance Road Bridge	1.9	-0.9	-0.9	-1.0	-0.1	0.0	19.2
Wallula Rd Bridge	2.9	2.4	4.2	3.5	-0.7	0.0	20.2
Goes Bridge	4.7	1.3	7.4	2.2	-5.2	0.0	16.7
Tausick Rd Bridge	10.6	-1.7	-1.0	0.5	0.0	1.5	14.5
Below Yellowhawk Diversion	11.1	-0.4	-1.0	-29.5	-28.5	0.0	14.0
5 Mile Rd Bridge	13.5	2.5	5.2	-2.7	-8.0	0.0	43.5
7 Mile Rd Bridge	15.6	0.4	1.7	3.2	-0.3	1.9	46.3
20 Mile Bridge	20.2	-5.7	-6.0	-6.0	0.0	0.0	43.1
USGS Gauge	21.2	1.6	2.2	2.4	0.2	0.0	49.0
Mill Creek At StateLine	22.6	x	x	x	x	x	46.6

July, 2012

Flow Measurement Location (Reach Locations)	River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2012 Net Diversion Total (cfs)	2012 Net Tributary Inputs Total (cfs)	2012 Flow (cfs)
Swegle Road Bridge	0.6	-0.4	-0.5	0.7	0.00	1.2	10.6
Last Chance Road Bridge	2.0	-1.5	-1.6	-1.6	-0.05	0.0	9.9
Wallula Rd Bridge	3.1	2.1	5.1	5.0	-0.16	0.0	11.5
Gose Bridge	5.5	1.0	5.6	0.0	-6.11	0.5	6.6
Tausick Rd Bridge	10.9	1.4	0.8	2.2	0.00	1.4	6.5
Below Yellowhawk Diversion	11.5	-2.9	-7.3	-29.1	-21.80	0.0	4.4
5 Mile Rd Bridge	14.0	0.4	0.8	-4.7	-5.50	0.0	33.4
7 Mile Rd Bridge	16.2	-1.1	-4.5	-3.0	0.00	1.5	38.1
20 Mile Bridge	20.2	0.9	1.0	1.0	0.00	0.0	41.1
USGS Gauge	21.2	-0.7	-1.8	-1.8	0.00	0.0	40.1
Mill Creek At StateLine	23.7	x	x	x	x	x	41.9

June, 2013

Flow Measurement Location (Reach Locations)	River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2013 Net Diversion Total (cfs)	2013 Net Tributary Inputs Total (cfs)	2013 Flow (cfs)
Swegle Road Bridge	0.6	1.23	1.8	2.2	0.00	0.45	47.61
Last Chance Road Bridge	2.0	-0.04	0.0	0.0	0.00	0.00	45.37
Wallula Rd Bridge	3.1	0.18	0.4	0.4	0.00	0.00	45.41
Gose Bridge	5.5	1.29	7.0	4.0	-3.01	0.05	44.96
Tausick Rd Bridge	10.9	3.11	1.7	3.9	0.00	2.23	40.92
Below Yellowhawk Diversion	11.5	0.34	0.9	-24.2	-25.06	0.00	37.00
5 Mile Rd Bridge	14.0	6.56	14.6	-7.1	-21.65	0.00	61.20
7 Mile Rd Bridge	16.2	-0.06	-0.2	7.3	0.00	7.56	68.27
20 Mile Bridge	20.2	-2.96	-3.1	-3.1	0.00	0.00	60.93
USGS Gauge	21.2	-0.18	-0.5	-0.5	0.00	0.00	64.00
Mill Creek At StateLine	23.7	x	x	x	x	x	64.46

Mill Creek Seepage Assessments

August, 2014

Flow Measurement Location (Reach Locations)	River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2014 Net Diversion Total (cfs)	2014 Net Tributary Inputs Total (cfs)	2014 Flow (cfs)
Swegle Road Bridge	0.6	-0.84	-1.2	-1.1	0.00	0.10	4.71
Last Chance Road Bridge	2.0	-0.32	-0.3	-0.3	0.00	0.00	5.83
Wallula Rd Bridge	3.1	0.98	2.4	2.0	-0.33	0.00	6.17
Gose Bridge	5.5	0.72	3.9	-2.7	-7.11	0.50	4.12
Tausick Rd Bridge	10.9	1.52	0.8	1.8	0.00	0.97	6.83
Below Yellowhawk Diversion	11.5	0.49	1.3	-13.7	-14.96	0.00	5.03
5 Mile Rd Bridge	14.0	1.24	2.8	-7.1	-9.85	0.00	18.74
7 Mile Rd Bridge	16.2	-0.43	-1.7	1.2	0.11	2.73	25.84
20 Mile Bridge	20.2	-1.64	-1.7	-1.5	0.16	0.00	24.68
USGS Gauge	21.2	0.82	2.1	2.1	0.00	0.00	26.22
Mill Creek At Stateline	23.7	x	x	x	x	x	24.12

September, 2014

Flow Measurement Location (Reach Locations)	River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2014 Net Diversion Total (cfs)	2014 Net Tributary Inputs Total (cfs)	2014 Flow (cfs)
Swegle Road Bridge	0.6	1.54	2.3	2.4	0.00	0.10	9.78
Last Chance Road Bridge	2.0	-2.53	-2.6	-2.6	0.05	0.00	7.43
Wallula Rd Bridge	3.1	1.03	2.5	2.4	-0.09	0.00	10.01
Gose Bridge	5.5	0.30	1.6	-3.3	-5.41	0.50	7.59
Tausick Rd Bridge	10.9	3.54	1.9	2.6	0.00	0.68	10.87
Below Yellowhawk Diversion	11.5	-0.43	-1.1	-15.7	-14.60	0.00	8.26
5 Mile Rd Bridge	14.0	0.60	1.3	-2.7	-4.00	0.00	23.96
7 Mile Rd Bridge	16.2	-0.42	-1.6	0.8	0.00	2.40	26.63
20 Mile Bridge	20.2	-0.64	-0.7	-0.7	0.00	0.00	25.87
USGS Gauge	21.2	1.69	4.3	4.3	0.00	0.00	26.54
Mill Creek At Stateline	23.7	x	x	x	x	x	22.24

August 5, 2015

Flow Measurement Location (Reach Locations)	River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2014 Net Diversion Total (cfs)	2014 Net Tributary Inputs Total (cfs)	2014 Flow (cfs)
Swegle Road Bridge	0.6	-0.58	-0.8	-0.5	0.00	0.35	4.94
Last Chance Road Bridge	2.0	-1.34	-1.4	-1.4	0.04	0.00	5.43
Wallula Rd Bridge	3.1	2.06	5.0	3.1	-1.95	0.00	6.78
Gose Bridge	5.5	0.26	1.4	-5.1	-6.81	0.30	3.72
Tausick Rd Bridge	10.9	2.08	1.1	3.6	0.00	2.50	8.83
Below Yellowhawk Diversion	11.5	0.05	0.1	-15.6	-15.73	0.00	5.20
5 Mile Rd Bridge	14.0	3.34	7.4	-3.7	-11.13	0.00	20.80
7 Mile Rd Bridge	16.2	-0.90	-3.5	-0.1	0.33	3.07	24.51
20 Mile Bridge	20.2	-3.23	-3.4	-3.4	0.00	0.00	24.65
USGS Gauge	21.2	-0.64	-1.6	-1.6	0.00	0.00	28.00
Mill Creek At Stateline	23.7	x	x	x	x	x	29.62

September 29, 2015

Flow Measurement Location (Reach Locations)	River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2015 Net Diversion Total (cfs)	2015 Net Tributary Inputs Total (cfs)	2015 Flow (cfs)
Swegle Road Bridge	0.6	0.04	0.1	0.4	0.00	0.30	7.40
Last Chance Road Bridge	2.0	-0.80	-0.8	-0.8	0.03	0.00	7.04
Wallula Rd Bridge	3.1	1.08	2.6	2.2	-0.46	0.00	7.84
Gose Bridge	5.5	0.30	1.7	-2.9	-4.93	0.35	5.68
Tausick Rd Bridge	10.9	2.59	1.4	3.4	0.00	2.00	8.61
Below Yellowhawk Diversion	11.5	0.11	0.3	-17.3	-17.58	0.00	5.20
5 Mile Rd Bridge	14.0	2.24	5.0	-5.6	-10.61	0.00	22.51
7 Mile Rd Bridge	16.2	-0.54	-2.1	0.7	0.00	2.77	28.14
20 Mile Bridge	20.2	-1.45	-1.5	-1.5	0.00	0.00	27.49
USGS Gauge	21.2	-1.28	-3.3	-3.3	0.00	0.00	29.00
Mill Creek At Stateline	23.7	x	x	x	x	x	32.26

September 26, 2016

Flow Measurement Location (Reach Locations)	River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2016 Net Diversion Total (cfs)	2016 Net Tributary Inputs Total (cfs)	2016 Flow (cfs)
Swegle Road Bridge	0.6	0.69	1.0	1.1	0.00	0.05	15.98
Last Chance Road Bridge	2.0	-1.99	-2.1	-2.1	0.00	0.00	14.92
Wallula Rd Bridge	3.1	1.22	3.0	2.7	-0.22	0.00	16.99
Gose Bridge	5.5	0.32	1.7	-1.5	-3.21	0.00	14.24
Tausick Rd Bridge	10.9	-1.08	-0.6	0.4	0.00	1.00	15.71
Below Yellowhawk Diversion	11.5	1.83	4.6	-11.0	-15.69	0.00	15.30
5 Mile Rd Bridge	14.0	2.56	5.7	-5.5	-11.15	0.00	26.34
7 Mile Rd Bridge	16.2	-0.49	-1.9	-1.1	0.00	0.79	31.80
20 Mile Bridge	20.2	1.34	1.4	1.4	0.00	0.00	32.93
USGS Gauge	21.2	-1.08	-2.7	-2.7	0.00	0.00	31.54
Mill Creek At Stateline	23.7	x	x	x	x	x	34.29

June 16, 2016

Flow Measurement Location (Reach Locations)	River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2016 Net Diversion Total (cfs)	2016 Net Tributary Inputs Total (cfs)	2016 Flow (cfs)
Swegle Road Bridge	0.6	0.46	0.7	1.1	0.00	0.40	6.33
Last Chance Road Bridge	2.0	-1.34	-1.4	-1.4	-0.04	0.00	5.26
Wallula Rd Bridge	3.1	1.48	3.6	3.3	-0.35	0.00	6.69
Gose Bridge	5.5	-0.45	-2.5	-5.7	-3.81	0.60	3.43
Tausick Rd Bridge	10.9	0.33	0.2	1.2	0.00	1.00	9.10
Below Yellowhawk Diversion	11.5	0.04	0.1	-21.3	-21.37	0.00	7.92
5 Mile Rd Bridge	14.0	1.13	2.5	-4.0	-6.55	0.00	29.19
7 Mile Rd Bridge	16.2	-2.06	-8.1	-1.1	-0.16	7.13	33.23
20 Mile Bridge	20.2	-4.86	-5.0	-5.0	0.00	0.00	34.35
USGS Gauge	21.2	1.99	5.1	5.1	0.00	0.00	39.40
Mill Creek At Stateline	23.7	x	x	x	x	x	34.33

Attachment B-2

Touchet River Seepage Assessments

Composite Seepage Data Set 2009

June 2009 Data Set

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	Net Diversion Total (cfs)	Net Tributary Inputs Total (cfs)	Measured Instream Flow (cfs)
<i>Cummings</i>	0.86	0.14	1.79	-16.21	-18.00	0.00	106.95
<i>Johnson Bridge</i>	8.80	0.42	10.55	10.55	0.00	0.00	123.16
<i>I W Sims Rd Bdg</i>	13.18	-0.31	-12.85	-12.85	0.00	0.00	112.61
<i>Site # 4</i>	17.18	1.38	3.49	1.26	-2.23	0.00	125.46
<i>Luckenbill Rd Bdg</i>	21.99	0.49	6.35	6.35	0.00	0.00	124.20
<i>Hoffman Rd</i>	25.09	-0.60	-11.97	-11.97	0.00	0.00	117.85
<i>Harvey Shaw Rd</i>	32.23	1.06	4.69	4.69	0.00	0.00	129.82
<i>Petty John</i>	37.20	-4.28	-1.01	-1.01	0.00	0.00	125.13
<i>Hwy 125 Bdg</i>	41.53	-0.48	-5.56	-5.69	-0.13	0.00	126.14
<i>Hart Road #5</i>	44.19	-0.62	-7.39	-7.14	-0.91	1.16	131.83
<i>Hwy 124 Bdg</i>	48.79	0.21	19.38	23.08	0.00	3.70	138.97
<i>Waitsburg</i>	52.92	-1.17	-10.27	-8.77	-8.93	10.43	115.89
<i>Dayton Levee</i>	64.97	x	x	x	x	x	124.66

Composite Seepage Data Set 2009

September 2009 Data Set

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	Net Diversion Total (cfs)	Net Tributary Inputs Total (cfs)	Measured Instream Flow (cfs)
<i>Cummings</i>	0.86	-0.23	-1.80	-21.86	-20.06	0.00	11.88
<i>Johnson Bridge</i>	8.80	-0.07	-0.31	-0.31	0.00	0.00	33.74
<i>I W Sims Rd Bdg</i>	13.18	-1.36	-5.43	-5.43	0.00	0.00	34.05
<i>Site # 4</i>	17.18	0.97	4.67	4.67	0.00	0.00	39.48
<i>Luckenbill Rd Bdg</i>	21.99	-0.12	-1.25	-1.25	0.00	0.00	34.81
<i>Harvey Shaw Rd</i>	32.23	0.41	2.03	2.03	0.00	0.00	36.06
<i>Petty John</i>	37.20	-0.61	-2.62	-2.62	0.00	0.00	34.03
<i>Hwy 125 Bdg</i>	41.53	-0.38	-2.75	-2.36	0.00	0.39	36.65
<i>Hwy 124 Bdg</i>	48.79	-2.61	-10.79	-10.59	0.00	0.20	39.01
<i>Waitsburg</i>	52.92	0.13	1.53	0.06	-8.00	6.53	49.60
<i>Dayton Levee</i>	64.97	x	x	x	x	x	49.54

Composite Seepage Data Set 2010

July 2010 Data Set

Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	July 2010 Rate Per Mile (cfs)	July 2010 Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	Net Diversion Total (cfs)	Net Tributary Inputs Total (cfs)	Measured Instream Flow (cfs)
<i>Cummings</i>	0.86	1.58	12.56	19.50	-6.94	0.00	53.51
<i>Johnson Bridge</i>	8.80	0.55	2.39	2.39	0.00	0.00	73.01
<i>I W Sims Rd Bdg</i>	13.18	0.07	0.27	1.05	-0.78	0.00	75.40
<i>Site # 4</i>	17.18	-0.90	-4.35	-2.86	-1.49	0.00	76.45
<i>Luckenbill Rd Bdg</i>	21.99	0.35	3.63	3.63	0.00	0.00	73.59
<i>Harvey Shaw Rd</i>	32.23	-2.57	-12.80	-12.80	0.00	0.00	77.22
<i>Petty John</i>	37.20	2.16	9.33	9.33	0.00	0.00	64.42
<i>Hwy 125 Bdg</i>	41.53	1.67	12.10	11.76	0.00	0.34	73.75
<i>Hwy 124 Bdg</i>	48.79	-0.49	-2.04	-3.04	0.00	1.00	85.51
<i>Waitsburg</i>	52.92	-0.04	-0.50	-0.23	-9.22	8.95	82.47
<i>Dayton Levee</i>	64.97	x	x	x	x	x	82.24

Composite Seepage Data Set 2011		July 2011 Data Set					
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	July 2011 Rate Per Mile (cfs)	July 2011 Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	Net Diversion Total (cfs)	Net Tributary Inputs Total (cfs)	Measured Instream Flow (cfs)
Cummings	0.86	0.73	5.80	17.58	-11.78	0.00	57.04
Johnson Bridge	8.80	1.42	6.22	6.22	0.00	0.00	74.62
I W Sims Rd Bdg	13.18	-1.39	-5.56	-5.56	0.00	0.00	80.84
Site # 4	17.18	1.26	6.07	6.85	-0.78	0.00	75.28
Luckenbill Rd Bdg	21.99	0.23	2.37	2.37	0.00	0.00	82.13
Harvey Shaw Rd	32.23	-0.72	-3.60	-3.60	0.00	0.00	84.50
Petty John	37.20	0.37	1.58	1.58	0.00	0.00	80.90
Hwy 125 Bdg	41.53	-0.07	-0.53	1.07	-1.86	0.26	82.48
Hwy 124 Bdg	48.79	-0.01	-0.04	-2.24	0.00	2.20	83.55
Waitsburg	52.92	0.56	6.71	6.26	-11.27	11.72	81.31
Dayton Levee	64.97	x	x	x	x	x	87.57
Composite Seepage Data Set 2011		September 2011 Data Set					
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	September 2011 Rate Per Mile (cfs)	September 2011 Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	Net Diversion Total (cfs)	Net Tributary Inputs Total (cfs)	Measured Instream Flow (cfs)
Cummings	0.86	-1.20	-9.53	-19.55	-10.02	0.00	7.84
Johnson Bridge	8.80	-0.61	-2.67	-2.67	0.00	0.00	27.39
I W Sims Rd Bridge	13.18	-0.43	-1.72	-2.30	-0.58	0.00	30.06
Site #4	17.18	0.27	1.29	1.29	0.00	0.00	32.36
Luckenbill Rd Bridge	21.99	-0.25	-2.60	-2.60	0.00	0.00	31.07
Harvey Shaw Rd	32.23	0.42	2.07	2.07	0.00	0.00	33.67
Petty John	37.20	-1.76	-7.60	-7.60	0.00	0.00	31.60
Hwy 125 Bdg	41.53	-0.52	-3.79	-4.66	-1.01	0.14	39.20
Hwy 124 Bdg	48.79	0.27	1.11	1.79	-0.07	0.75	43.86
Waitsburg	52.92	0.04	0.54	-7.06	-18.63	11.03	42.07
Dayton Levee	64.97	x	x	x	x	x	49.13
Composite Seepage Data Set 2012		July 2012 Data Set					
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	July 2012 Rate Per Mile (cfs)	July 2012 Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	Net Diversion Total (cfs)	Net Tributary Inputs Total (cfs)	Measured Instream Flow (cfs)
Cummings Rd Bdg	0.86	1.42	11.28	6.28	-5.00	0.00	92.61
Johnson Bdg	8.80	-1.28	-5.60	-5.60	0.00	0.00	86.33
I W Sims Rd Bdg	13.18	0.65	2.60	3.18	0.58	0.00	91.93
Site #4	17.18	-0.49	-2.36	-2.36	0.00	0.00	88.75
Luckenbill Rd Bdg	21.99	-0.66	-6.76	-6.76	0.00	0.00	91.11
Harvey Shaw Rd Bdg	32.23	2.69	13.37	13.37	0.00	0.00	97.87
Petty John Rd Bdg	37.20	0.45	1.95	1.95	0.00	0.00	84.50
Hwy 125 Bdg	41.53	-1.10	-7.98	-7.90	-0.06	0.14	82.55
Hwy 124 Bdg	48.79	0.45	1.85	2.53	-0.07	0.75	90.45
Waitsburg Bdg	52.92	-0.06	-0.73	2.06	-10.23	13.02	87.92
Dayton Levee	64.97	x	x	x	x	x	85.86
Composite Seepage Data Set 2012		September 2012 Data Set					
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Sept 2012 Rate Per Mile (cfs)	Sept. 2012 Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	Net Diversion Total (cfs)	Net Tributary Inputs Total (cfs)	Measured Instream Flow (cfs)
Cummings Rd Bdg	0.86	0.07	0.54	-11.12	-11.66	0.00	17.57
Johnson Bdg	8.80	-0.63	-2.78	-2.78	0.00	0.00	28.69
I W Sims Rd Bdg	13.18	-0.39	-1.54	-0.96	0.58	0.00	31.47
Site #4	17.18	-0.32	-1.53	-1.53	0.00	0.00	32.43
Luckenbill Rd Bdg	21.99	-0.16	-1.61	-1.61	0.00	0.00	33.96
Harvey Shaw Rd Bdg	32.23	0.62	3.08	3.08	0.00	0.00	35.57
Petty John Rd Bdg	37.20	-0.61	-2.64	-2.64	0.00	0.00	32.49
Hwy 125 Bdg	41.53	-0.51	-3.68	-4.73	-1.19	0.14	35.13
Hwy 124 Bdg	48.79	-0.52	-2.15	-1.47	-0.07	0.75	39.86
Waitsburg Bdg	52.92	-0.07	-0.88	-6.56	-10.96	5.28	41.33
Dayton Levee	64.97	x	x	x	x	x	47.89

Composite Seepage Data Set 2013							
June 2013 Data Set							
Flow Measurement Location (Reach Locations)	Actual River Mile (cfs)	June 2013 Rate Per Mile (cfs)	June 2013 Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	Net Diversion Total (cfs)	Net Tributary Inputs Total (cfs)	Measured Instream Flow (cfs)
Cummings Rd Bdg	0.86	0.61	4.85	-10.13	-14.98	0.00	95.40
Johnson Bdg	8.80	-1.08	-4.71	-4.71	0.00	0.00	105.53
I W Sims Rd Bdg	13.18	-0.15	-0.59	-0.59	0.00	0.00	110.24
Site #4	17.18	-0.21	-1.03	-1.03	0.00	0.00	110.83
Luckenbill Rd Bdg	21.99	0.06	0.58	0.58	0.00	0.00	111.86
Harvey Shaw Rd Bdg	32.23	-0.36	-1.80	-1.80	0.00	0.00	111.28
Petty John Rd Bdg	37.20	-2.07	-8.97	-8.97	0.00	0.00	113.08
Hwy 125 Bdg	41.53	0.26	1.87	-0.43	-3.11	0.80	122.05
Hwy 124 Bdg	48.79	0.17	0.70	7.98	-0.28	7.56	122.48
Waitsburg Bdg	52.92	0.52	6.21	2.99	-9.23	6.00	114.50
Dayton Levee	64.97	x	x	x	x	x	111.51
Composite Seepage Data Set 2013							
September 2013 Data Set							
Flow Measurement Location (Reach Locations)	Actual River Mile (cfs)	Sept. 2013 Rate Per Mile (cfs)	Sept. 2013 Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	Net Diversion Total (cfs)	Net Tributary Inputs Total (cfs)	Measured Instream Flow (cfs)
Cummings Rd Bdg	0.86	-0.05	-0.38	-14.82	-14.44	0.00	10.31
Johnson Bdg	8.80	-0.25	-1.11	-1.11	0.00	0.00	25.13
I W Sims Rd Bdg	13.18	-0.92	-3.66	-3.66	0.00	0.00	26.24
Site #4	17.18	0.25	1.20	1.20	0.00	0.00	29.90
Luckenbill Rd Bdg	21.99	-0.57	-5.79	-5.79	0.00	0.00	28.70
Harvey Shaw Rd Bdg	32.23	-0.24	-1.20	-1.20	0.00	0.00	34.49
Petty John Rd Bdg	37.20	-0.82	-3.56	-3.56	0.00	0.00	35.69
Hwy 125 Bdg	41.53	-0.56	-4.07	-3.73	-0.46	0.80	39.25
Hwy 124 Bdg	48.79	-0.75	-3.08	-2.95	-0.28	0.41	42.98
Waitsburg Bdg	52.92	-0.08	-0.92	-3.27	-8.93	6.58	45.93
Dayton Levee	64.97	x	x	x	x	x	49.20
Composite Seepage Data Set 2014							
August 2014 Data Set 2014							
Flow Measurement Location (Reach Locations)	Actual River Mile (cfs)	June 2013 Rate Per Mile (cfs)	June 2013 Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	Net Diversion Total (cfs)	Net Tributary Inputs Total (cfs)	Measured Instream Flow (cfs)
Cummings Rd Bdg	0.86	0.08	0.67	-18.53	-19.20	0.00	4.10
Johnson Bdg	8.80	-0.19	-0.84	-0.84	0.00	0.00	22.63
I W Sims Rd Bdg	13.18	0.12	0.46	0.46	0.00	0.00	23.47
Site #4	17.18	-0.26	-1.23	-2.17	-0.94	0.00	23.00
Luckenbill Rd Bdg	21.99	0.08	0.81	0.81	0.00	0.00	25.18
Harvey Shaw Rd Bdg	32.23	-0.01	-0.05	-0.05	0.00	0.00	24.37
Petty John Rd Bdg	37.20	-1.16	-5.04	-5.04	0.00	0.00	24.42
Hwy 125 Bdg	41.53	-0.18	-1.34	-4.54	-3.20	0.00	29.46
Hwy 124 Bdg	48.79	-1.07	-4.41	-3.80	0.00	0.61	34.00
Waitsburg Bdg	52.92	-0.03	-0.36	-4.77	-10.82	6.41	37.80
Dayton Levee	64.97	x	x	x	x	x	42.58
Composite Seepage Data Set 2014							
September 2014 Data Set 2014							
Flow Measurement Location (Reach Locations)	Actual River Mile (cfs)	Sept. 2013 Rate Per Mile (cfs)	Sept. 2013 Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	Net Diversion Total (cfs)	Net Tributary Inputs Total (cfs)	Measured Instream Flow (cfs)
Cummings Rd Bdg	0.86	-0.06	-0.45	-17.59	-17.14	0.00	4.20
Johnson Bdg	8.80	-1.23	-5.40	-5.40	0.00	0.00	21.79
I W Sims Rd Bdg	13.18	-0.24	-0.95	-0.95	0.00	0.00	27.19
Site #4	17.18	-0.29	-1.41	-2.16	-0.75	0.00	28.14
Luckenbill Rd Bdg	21.99	0.23	2.33	2.33	0.00	0.00	30.30
Harvey Shaw Rd Bdg	32.23	-0.61	-3.05	-3.05	0.00	0.00	27.97
Petty John Rd Bdg	37.20	-1.06	-4.60	-4.60	0.00	0.00	31.02
Hwy 125 Bdg	41.53	-0.04	-0.32	-2.72	-3.20	0.80	35.61
Hwy 124 Bdg	48.79	-0.17	-0.69	-0.77	-0.28	0.20	38.33
Waitsburg Bdg	52.92	0.03	0.31	-6.30	-9.66	3.04	39.10
Dayton Levee	64.97	x	x	x	x	x	45.40

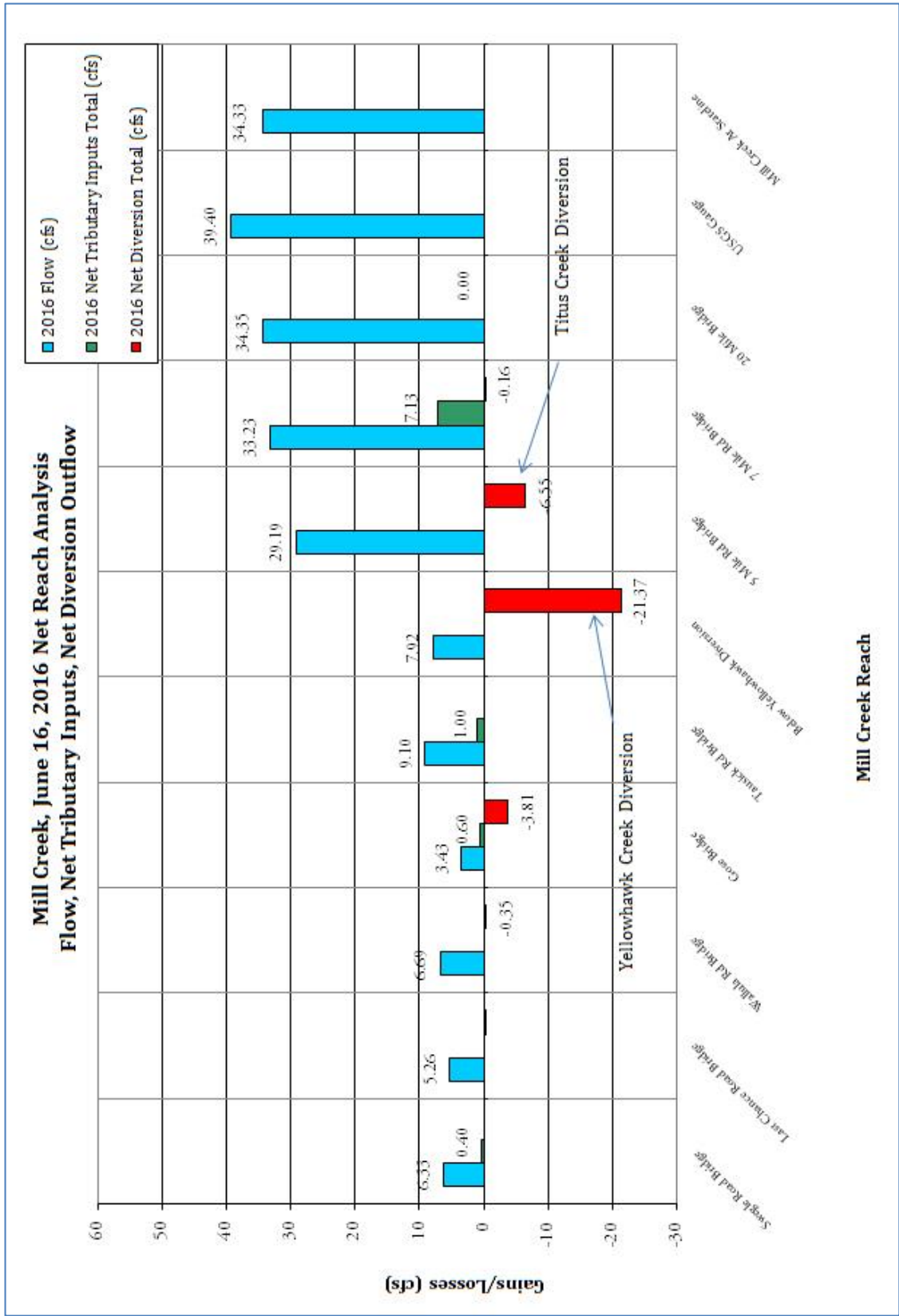
August 4, 2015							
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	August 2015 Rate Per Mile (cfs)	August 2015 Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	Net Diversion Total (cfs)	Net Tributary Inputs Total (cfs)	Measured Instream Flow (cfs)
Hwy 12 Bdg	0.86	0.15	1.23	-7.90	-9.13	0.00	2.65
Johnson Bdg	8.80	-0.61	-2.66	-2.66	0.00	0.00	10.55
I W Sims Rd Bdg	13.18	0.26	1.04	1.04	0.00	0.00	13.21
Site #4	17.18	-0.01	-0.05	-1.05	-1.00	0.00	12.17
Luckenbill Rd Bdg	21.99	-0.54	-5.58	-5.58	0.00	0.00	13.22
Harvey Shaw Rd Bdg	32.23	-0.14	-0.71	-0.71	0.00	0.00	18.80
Petty John Rd Bdg	37.20	-0.32	-1.37	-1.37	0.00	0.00	19.51
Hwy 125 Bdg	41.53	-0.75	-5.43	-6.10	-0.67	0.00	20.88
Hwy 124 Bdg	48.79	-1.37	-5.65	-5.19	0.00	0.46	26.98
Waitsburg Bdg	52.92	-0.12	-1.46	-5.50	-7.30	3.26	32.17
Dayton Levee	64.97	x	x	x	x	x	37.67
September 30, 2015							
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	September 2015 Rate Per Mile (cfs)	September 2015 Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	Net Diversion Total (cfs)	Net Tributary Inputs Total (cfs)	Measured Instream Flow (cfs)
Hwy 12 Bdg	0.85	-0.82	-6.50	-23.29	-16.79	0.00	7.40
Johnson Bdg	8.80	-0.13	-0.59	0.75	1.34	0.00	30.69
I W Sims Rd Bdg	13.18	-0.55	-2.21	-2.21	0.00	0.00	29.94
Site #4	17.18	-0.04	-0.18	-0.18	0.00	0.00	32.15
Luckenbill Rd Bdg	21.99	0.06	0.63	0.63	0.00	0.00	32.33
Harvey Shaw Rd Bdg	32.23	-0.35	-1.72	-1.72	0.00	0.00	31.70
Petty John Rd Bdg	37.20	-0.94	-4.08	-4.08	0.00	0.00	33.42
Hwy 125 Bdg	41.53	-0.30	-2.15	-3.48	-1.33	0.00	37.50
Hwy 124 Bdg	48.79	-0.09	-0.36	-0.36	0.00	0.00	40.98
Waitsburg Bdg	52.92	0.12	1.46	-3.11	-8.07	3.50	41.34
Dayton Levee	64.97	x	x	x	x	x	44.45
June 28, 2016							
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	August 2015 Rate Per Mile (cfs)	August 2015 Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	Net Diversion Total (cfs)	Net Tributary Inputs Total (cfs)	Measured Instream Flow (cfs)
Hwy 12 Bdg	0.86	-0.79	-6.26	-22.43	-16.17	0.00	16.05
Johnson Bdg	8.80	-0.06	-0.25	-0.25	0.00	0.00	38.48
I W Sims Rd Bdg	13.18	0.13	0.50	0.57	0.07	0.00	38.73
Site #4	17.18	-0.38	-1.81	-1.81	0.00	0.00	38.15
Luckenbill Rd Bdg	21.99	-0.30	-3.07	-3.07	0.00	0.00	39.97
Harvey Shaw Rd Bdg	32.23	0.43	2.14	2.14	0.00	0.00	43.04
Petty John Rd Bdg	37.20	-0.80	-3.46	-3.46	0.00	0.00	40.90
Hwy 125 Bdg	41.53	-0.24	-1.74	-4.33	-2.79	0.20	44.37
Hwy 124 Bdg	48.79	-1.36	-5.62	-2.97	0.00	2.65	48.70
Waitsburg Bdg	52.92	0.22	2.66	-4.49	-12.43	5.29	51.66
Dayton Levee	64.97	x	x	x	x	x	56.15
September 1, 2016							
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	August 2015 Rate Per Mile (cfs)	August 2015 Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	Net Diversion Total (cfs)	Net Tributary Inputs Total (cfs)	Measured Instream Flow (cfs)
Hwy 12 Bdg	0.86	0.03	0.23	-15.33	-15.56	0.00	4.20
Johnson Bdg	8.80	-0.48	-2.10	-2.10	0.00	0.00	19.53
I W Sims Rd Bdg	13.18	-0.29	-1.17	-1.17	0.00	0.00	21.63
Site #4	17.18	0.03	0.13	0.13	0.00	0.00	22.80
Luckenbill Rd Bdg	21.99	-0.13	-1.35	-1.35	0.00	0.00	22.68
Harvey Shaw Rd Bdg	32.23	-0.64	-3.17	-3.17	0.00	0.00	24.03
Petty John Rd Bdg	37.20	0.12	0.52	0.52	0.00	0.00	27.20
Hwy 125 Bdg	41.53	-0.84	-6.10	-7.21	-1.11	0.00	26.68
Hwy 124 Bdg	48.79	-1.27	-5.24	-4.04	0.00	1.20	33.89
Waitsburg Bdg	52.92	0.05	0.63	-4.29	-8.00	3.08	37.93
Dayton Levee	64.97	x	x	x	x	x	42.22

Attachment B-3

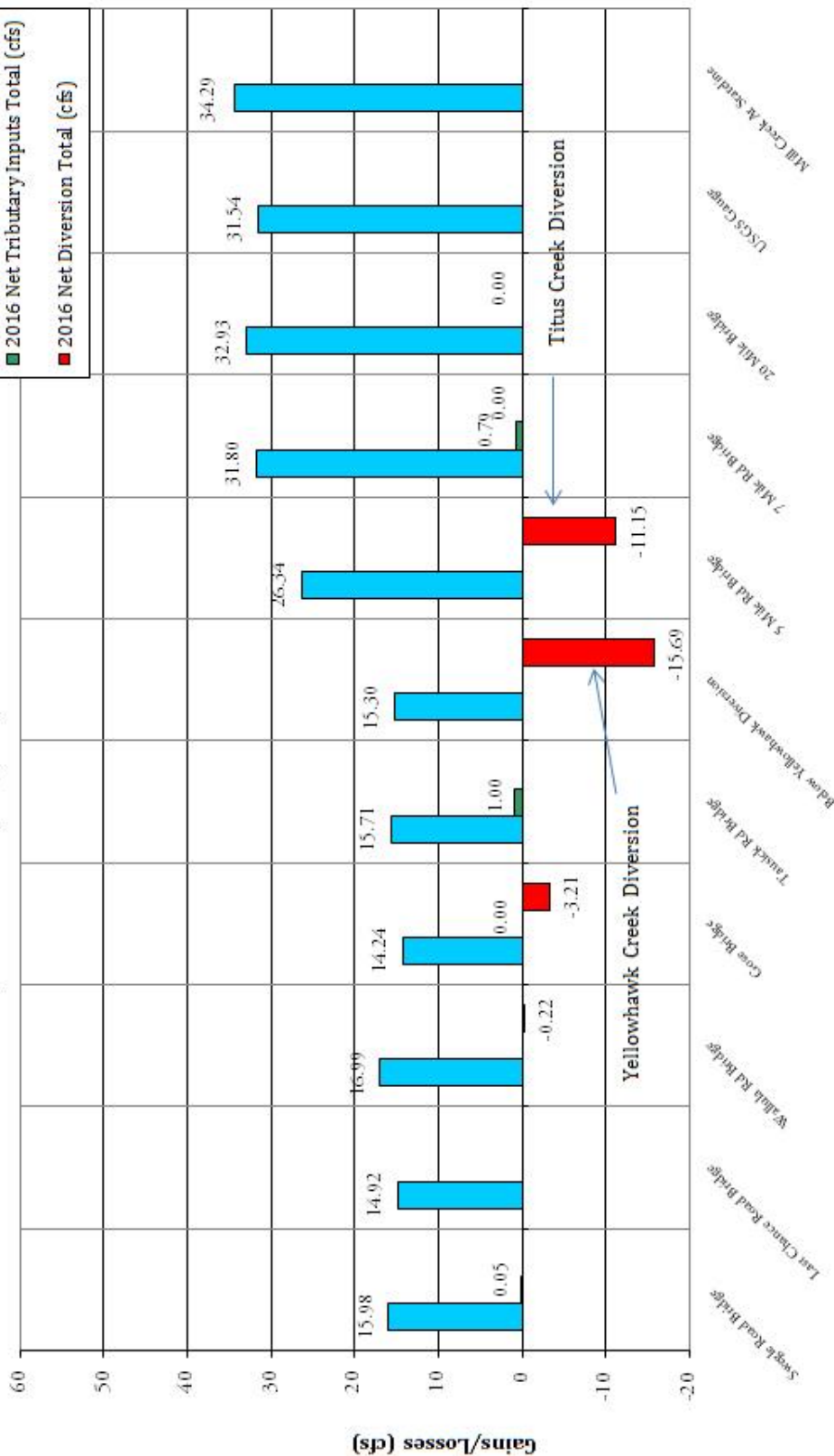
Yellowhawk Seepage Assessment

June 2011 Seepage Assessment								
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2011 Net Diversion Total (cfs)	2011 Net Tributary Inputs Total (cfs)	2011 Flow (cfs)	Gaining/Losing
Yellowhawk #1 to Yellowhawk #2	0.02	1.91	1.38	-2.24	-3.62	0.00	27.26	Gaining
Yellowhawk #2 to Yellowhawk #3	0.74	-4.04	-3.85	-12.41	-8.56	0.00	25.02	Losing
Yellowhawk #3 to Yellowhawk #4	1.70	1.37	1.03	5.38	0.00	4.35	12.61	Gaining
Yellowhawk #4 to Yellowhawk #5	2.45	-3.27	-2.01	-2.41	-0.40	0.00	17.99	Losing
Yellowhawk #5 to Yellowhawk #6	3.06	7.67	6.60	6.60	0.00	0.00	15.58	Gaining
Yellowhawk #6 to Yellowhawk #7	3.92	-2.53	-1.94	-1.94	0.00	0.00	22.18	Losing
Yellowhawk #7 to Yellowhawk #8	4.69	3.66	15.31	59.30	-0.50	44.49	20.24	Gaining
Yellowhawk #8 -	8.87	x	x	x	x	x	79.54	Gaining
September 2011 Seepage Assessment								
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2011 Net Diversion Total (cfs)	2011 Net Tributary Inputs Total (cfs)	2011 Flow (cfs)	Gaining/Losing
Yellowhawk #1 to Yellowhawk #2	0.02	1.56	1.13	-0.68	-1.81	0.00	19.04	Gaining
Yellowhawk #2 to Yellowhawk #3	0.74	-4.22	-4.02	-6.69	-2.67	0.00	18.36	Losing
Yellowhawk #3 to Yellowhawk #4	1.70	-0.43	-0.32	3.26	0.00	3.58	11.67	Losing
Yellowhawk #4 to Yellowhawk #5	2.45	1.85	1.14	1.14	0.00	0.00	14.93	Gaining
Yellowhawk #5 to Yellowhawk #6	3.06	-0.17	-0.15	-0.15	0.00	0.00	16.07	Losing
Yellowhawk #6 to Yellowhawk #7	3.92	-1.62	-1.24	-1.24	0.00	0.00	15.92	Losing
Yellowhawk #7 to Yellowhawk #8	4.69	0.72	3.02	0.91	-2.63	0.52	14.68	Gaining
Yellowhawk #8 -	8.87	x	x	x	x	x	15.59	Gaining
June 27, 2012 Yellowhawk Creek Seepage Assessment								
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2012 Net Diversion Total (cfs)	2012 Net Tributary Inputs Total (cfs)	2012 Flow (cfs)	Gaining/Losing
Yellowhawk #1 to Yellowhawk #2	0.02	-1.12	-0.81	-2.02	-1.21	0.00	23.04	Losing
Yellowhawk #2 to Yellowhawk #3	0.74	0.34	0.32	-5.79	-6.11	0.00	21.02	Gaining
Yellowhawk #3 to Yellowhawk #4	1.70	-2.43	-1.83	4.72	0.00	6.55	15.23	Losing
Yellowhawk #4 to Yellowhawk #5	2.45	-1.97	-1.21	-1.81	-0.60	0.00	19.95	Losing
Yellowhawk #5 to Yellowhawk #6	3.06	3.44	2.96	2.96	0.00	0.00	18.14	Gaining
Yellowhawk #6 to Yellowhawk #7	3.92	-0.77	-0.59	-0.59	0.00	0.00	21.10	Losing
Yellowhawk #7 to Yellowhawk #8	4.69	1.39	5.79	18.25	-1.00	13.46	20.51	Gaining
Yellowhawk #8 -	8.87	x	x	x	x	x	38.76	Gaining
September 4, 2012 Yellowhawk Creek Seepage Assessment								
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2012 Net Diversion Total (cfs)	2012 Net Tributary Inputs Total (cfs)	2012 Flow (cfs)	Gaining/Losing
Yellowhawk #1 to Yellowhawk #2	0.02	0.19	0.14	-2.23	-2.37	0.00	17.87	Gaining
Yellowhawk #2 to Yellowhawk #3	0.74	0.56	0.53	-2.57	-3.10	0.00	15.64	Gaining
Yellowhawk #3 to Yellowhawk #4	1.70	-0.64	-0.48	2.16	0.00	2.64	13.07	Losing
Yellowhawk #4 to Yellowhawk #5	2.45	-1.22	-0.75	-1.35	-0.60	0.00	15.23	Losing
Yellowhawk #5 to Yellowhawk #6	3.06	2.95	2.54	2.54	0.00	0.00	13.88	Gaining
Yellowhawk #6 to Yellowhawk #7	3.92	-1.76	-1.35	-1.35	0.00	0.00	16.42	Losing
Yellowhawk #7 to Yellowhawk #8	4.69	-0.26	-1.10	-0.78	-0.75	1.07	15.07	Losing
Yellowhawk #8 -	8.87	x	x	x	x	x	14.29	

June 27, 2013 Yellowhawk Creek Seepage Assessment								
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2013 Net Diversion Total (cfs)	2013 Net Tributary Inputs Total (cfs)	2013 Flow (cfs)	Gaining/Losing
Yellowhawk #1 to Yellowhawk #2	0.02	4.18	3.02	0.40	-2.62	0.00	23.15	Gaining
Yellowhawk #2 to Yellowhawk #3	0.74	-1.44	-1.37	-5.07	-3.70	0.00	23.55	Losing
Yellowhawk #3 to Yellowhawk #4	1.70	-1.49	-1.12	0.92	0.00	2.04	18.48	Losing
Yellowhawk #4 to Yellowhawk #5	2.45	-1.59	-0.98	-2.09	-1.11	0.00	19.40	Losing
Yellowhawk #5 to Yellowhawk #6	3.06	1.52	1.31	1.31	0.00	0.00	17.31	Gaining
Yellowhawk #6 to Yellowhawk #7	3.92	-0.03	-0.02	-0.02	0.00	0.00	18.62	Losing
Yellowhawk #7 to Yellowhawk #8	4.69	0.51	2.12	5.02	-0.22	3.12	18.60	Gaining
Yellowhawk #8 -	8.87	x	x	x	x	x	23.62	Gaining
September 4, 2013 Yellowhawk Seepage Assessment								
Flow Measurement Location (Reach Locations)	Actual River Mile (GIS)	Rate Per Mile (cfs)	Net Gain/Loss (cfs)	Gross Instream Gain/Loss Change (cfs)	2013 Net Diversion Total (cfs)	2013 Net Tributary Inputs Total (cfs)	2013 Flow (cfs)	Gaining/Losing
Yellowhawk #1 to Yellowhawk #2	0.02	2.28	1.65	-0.56	-2.21	0.00	15.71	Gaining
Yellowhawk #2 to Yellowhawk #3	0.74	0.67	0.64	-2.57	-3.21	0.00	15.15	Gaining
Yellowhawk #3 to Yellowhawk #4	1.70	-1.87	-1.41	0.77	0.00	2.18	12.58	Losing
Yellowhawk #4 to Yellowhawk #5	2.45	-1.04	-0.64	-1.24	-0.60	0.00	13.35	Losing
Yellowhawk #5 to Yellowhawk #6	3.06	6.37	5.48	5.48	0.00	0.00	12.11	Gaining
Yellowhawk #6 to Yellowhawk #7	3.92	-4.92	-3.77	-3.77	0.00	0.00	17.59	Losing
Yellowhawk #7 to Yellowhawk #8	4.69	-0.34	-1.40	-1.64	-0.75	0.51	13.82	Losing
Yellowhawk #8 -	8.87	x	x	x	x	x	12.18	Gaining

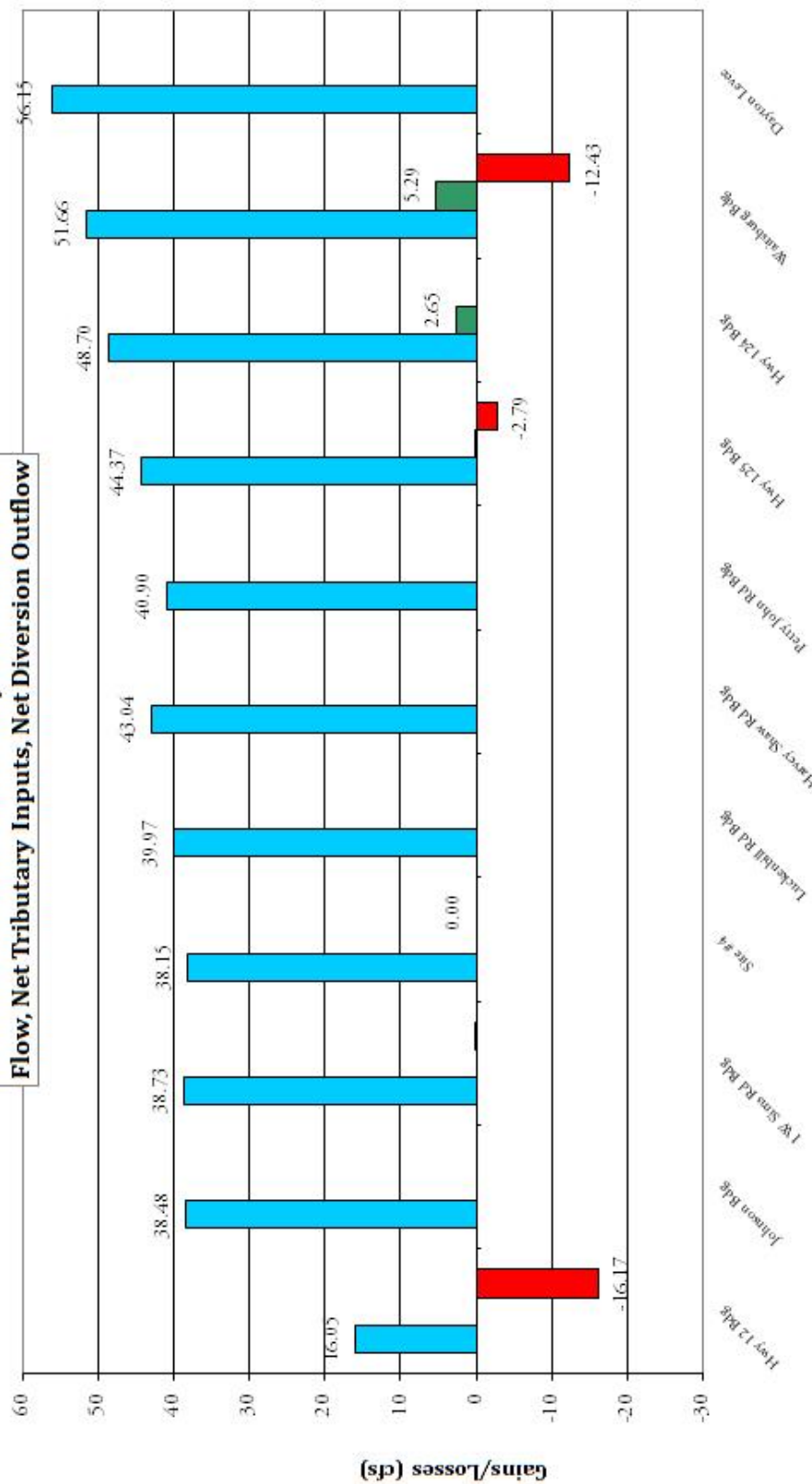


Mill Creek, September 26, 2016 Net Reach Analysis Flow, Net Tributary Inputs, Net Diversion Outflow



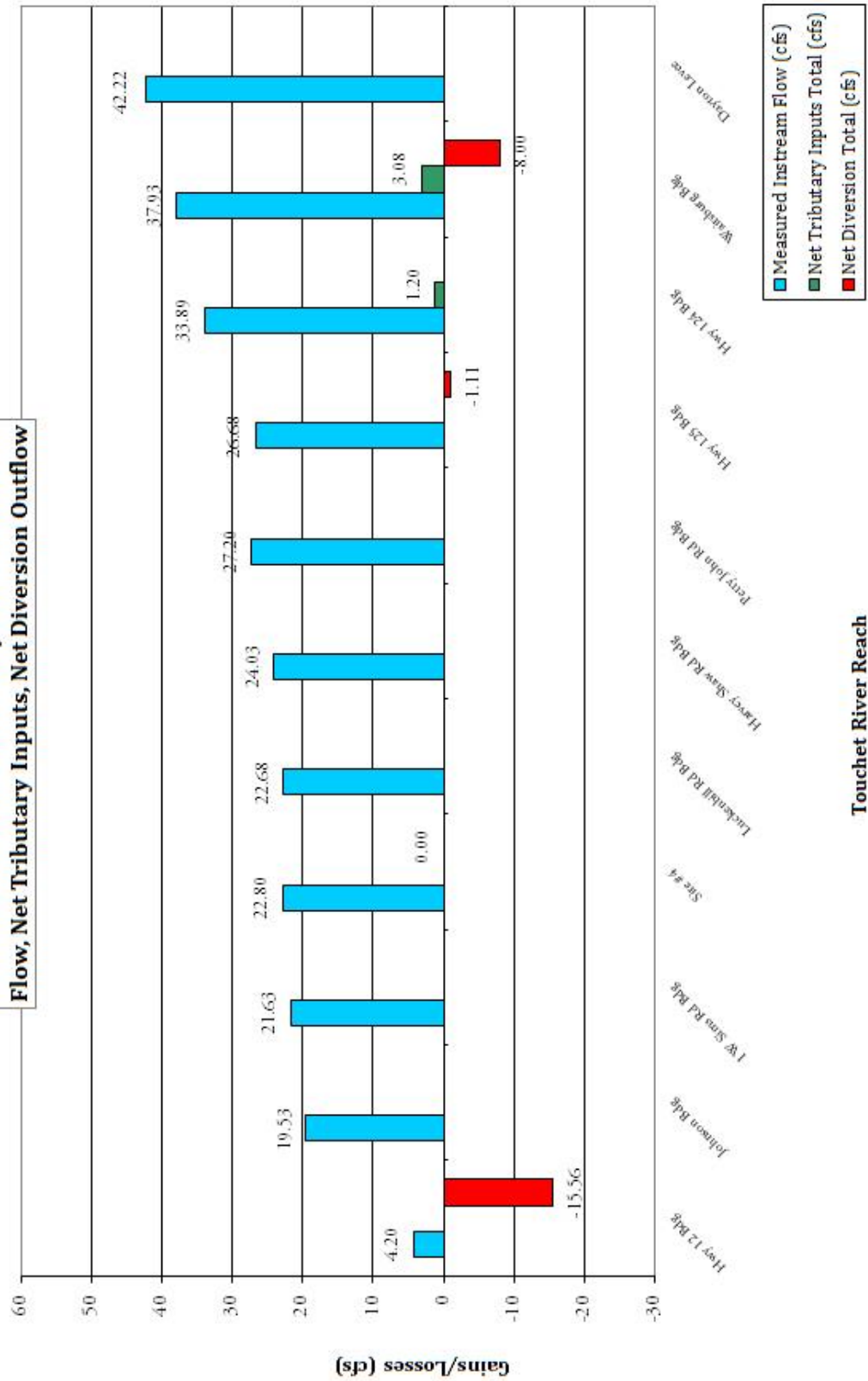
Mill Creek Reach

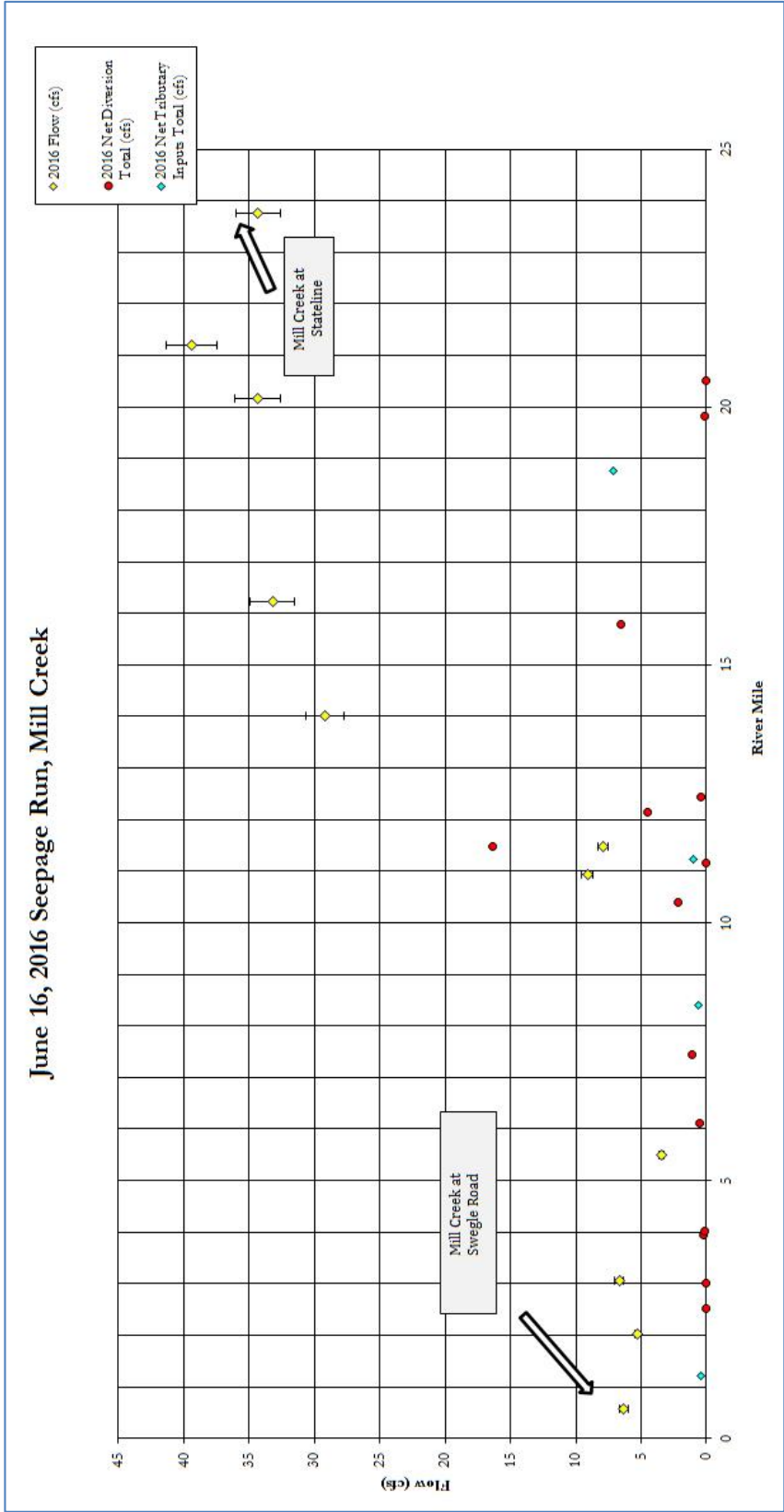
**Touchet River, June 28, 2016
Net Reach Analysis
Flow, Net Tributary Inputs, Net Diversion Outflow**



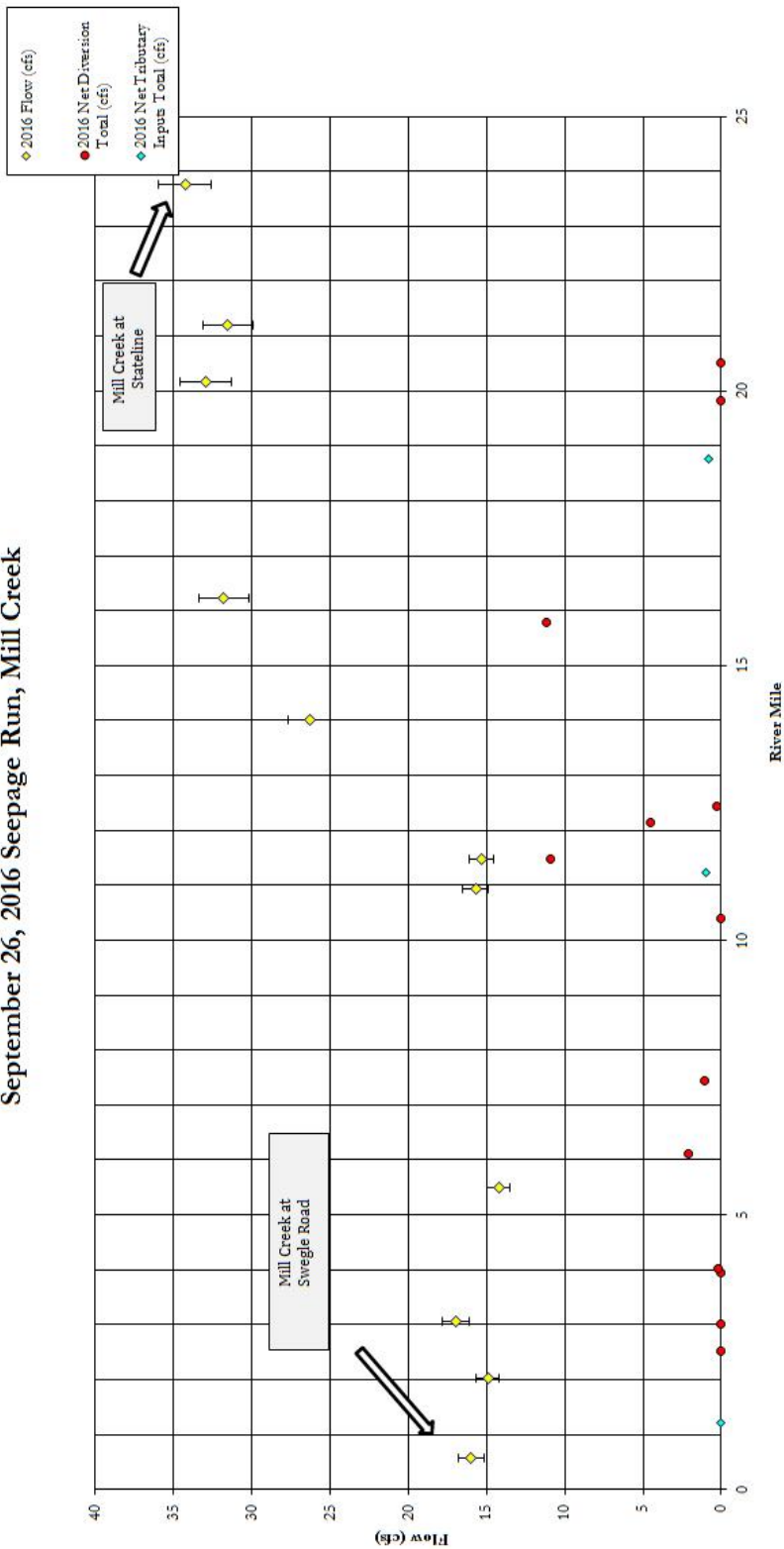
Touchet River Reach

Touchet River, September 1, 2016
Net Reach Analysis
Flow, Net Tributary Inputs, Net Diversion Outflow

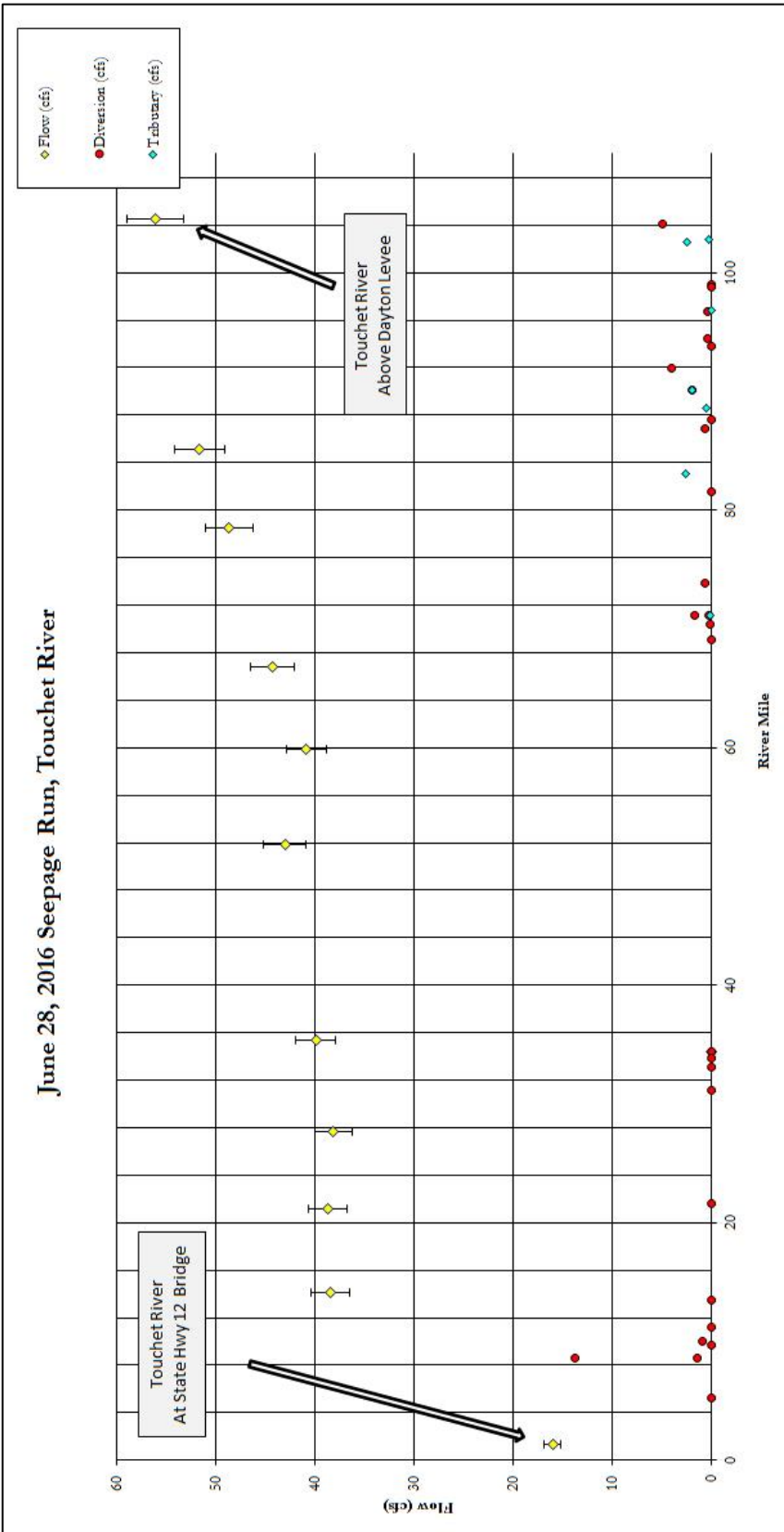




September 26, 2016 Seepage Run, Mill Creek



June 28, 2016 Seepage Run, Touchet River



September 1, 2016 Seepage Run, Touchet River

