Walla Walla Basin Watershed Council

Streamflow Monitoring in the Walla Walla Basin

2018 Water Year

FINAL REPORT

Submitted: February 2019

In cooperation with:

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Introduction

Overview

Since 2002, the Walla Walla Basin Watershed Council (WWBWC) has collected flow data throughout the Walla Walla River Valley and currently monitors 50 sites on the Walla Walla River, its tributaries, springs, small order streams, and irrigation ditches. Twenty-five near real-time gauge stations transmit data that are published hourly on our website at www.wwbwc.org for use by basin partners, state and federal entities and the public. Twenty-five stand-alone monitoring sites are instrumented with data loggers we download quarterly for data processing and online publishing.

The primary objectives of WWBWC's streamflow monitoring are to:

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

Streamflow 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.

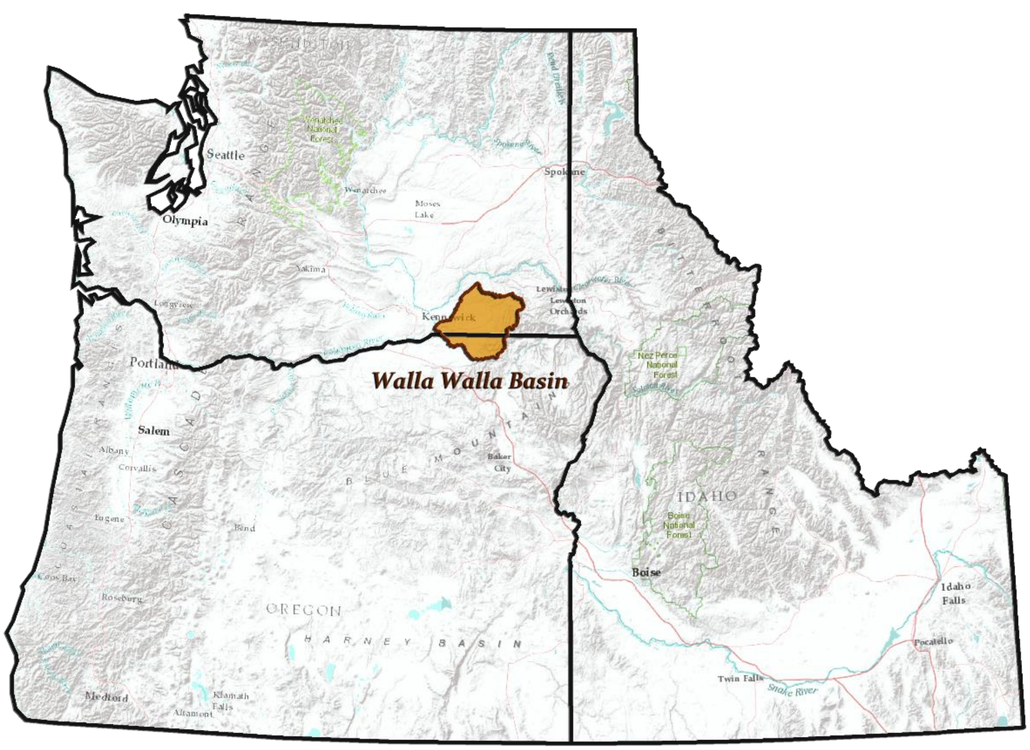


Figure 1. The Walla Walla Basin, a bi-state watershed.

Flow monitoring sites are 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.

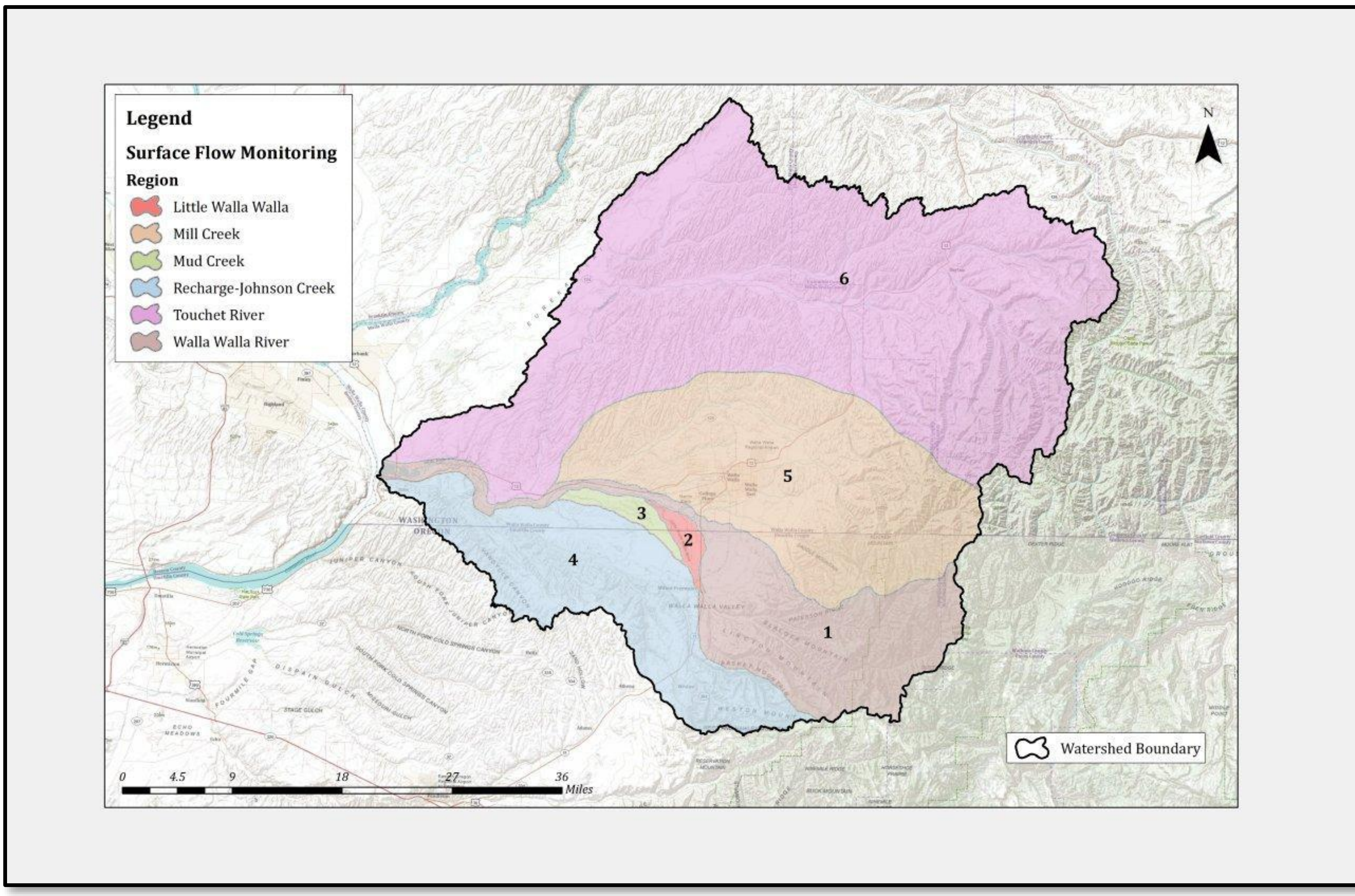


Figure 2. WWBWC Streamflow monitoring sites are organized according to the regions depicted above.

Table 1. Distribution of WWBWC Flow Monitoring Sites

Region	# of Sites
1: Walla Walla River	12
2: Little Walla Walla River	17
3: Mud Creek/Fruitvale Irrigation System	4
4: Pine Creek/Hudson Bay Irrigation System	15
5: Mill Creek / Walla Walla Area	2
6: Touchet River	0
Total	50

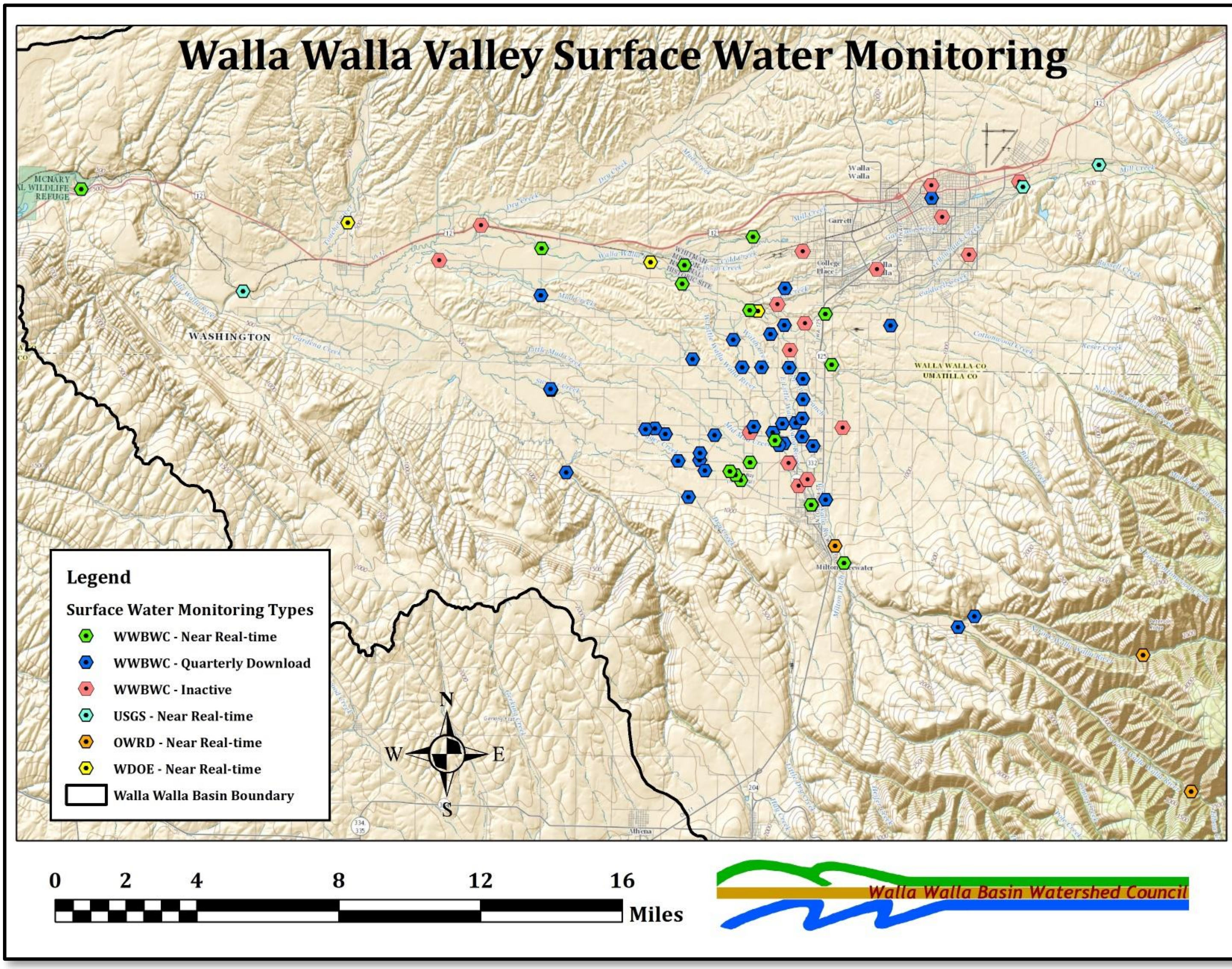


Figure 3. Map showing current streamflow monitoring sites as of October 2018. The map includes current and historic WWBWC monitoring sites as well as USGS, OWRD and WDOE gauge stations.

Methods

Our standard operating procedures are based on USGS, Washington and Oregon state methods for streamflow monitoring. In 2018 we reviewed new agency methods and updated the WWBWC Monitoring Program Standard Operating Procedures[1] to reflect industry standards and the current monitoring equipment available. Early in the 2018 water year flow monitoring was conducted according to WWWC's 2013 SOP[2], and we adopted the updated methods in the fall.

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 2018 water year, 25 stream sites were monitored using near real-time telemetry equipment. WWBWC used electronic sensors and 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 were 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 was measured using a calibrated NIST traceable YSI 30 handheld meter (www.ysi.com).

[1] Walla Walla Basin Watershed Council (2018). *WWBWC Standard Operating Procedures – Version 1.3.* http://wwbwc.org/images/Monitoring/SOP/WWBWC_SOP.pdf
[2] Walla Walla Basin Watershed Council (2013). *WWBWC Standard Operating Procedures – Version 1.2.* http://wwbwc.org/images/Monitoring/SOP/WWBWC_SOP_2013.pdf

Figure 4. At this near real-time monitoring site on the East Little Walla Walla River, a cabled sensor secured to a T-post and staff gauge in the channel collects water level data. A communication cable transmits the information to a data logger and radio housed on the streambank. Using radio telemetry, water level and temperature data are sent to the WWBWC office to be processed and published online.

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

Stand-Alone Flow Monitoring Sites

Many of WWBWC's streamflow monitoring sites are stand-alone stations we visit quarterly to take stage and discharge measurements and to download data. For the 2018 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 perforated PVC stilling well anchored to an ecology block in the Walla Walla River.

Every three months, 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 was measured and photographs were taken.

Most of the streamflow 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 stand-alone monitoring sites that were visited quarterly for manual data download: a staff gauge and perforated 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 plotted with staff gauge readings. Offsets and drift corrections were applied as warranted. 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 utilized a logarithmic plot of stage and discharge measurements to produce a rating 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). Rating curves were shifted to reflect channel changes caused by high water events and/or seasonal vegetation growth. Figure 8 displays Walla Walla River at Pepper Bridge 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 plotted with the flow data in the output graphs so that a viewer can see which calculated flows are above those measurements.

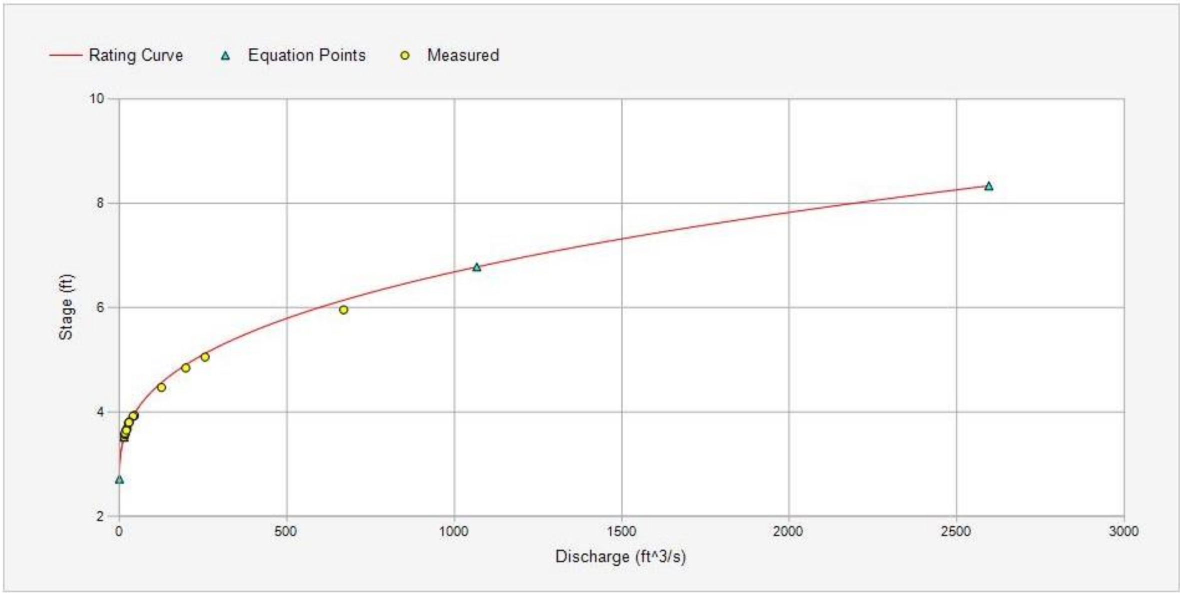
For additional detail about data processing and analysis, see our 2018 SOP V1.3.

Rating Curve

Walla Walla River at Pepper Bridge

Label: Working
Description: Site ID-S108

Curve on: September 24, 2018   Curve Start Date: February 7, 2018   Location: Walla Walla River at Pepper Bridge



Stage (ft)	0	.01	.02	.03	.04	.05	.06	.07	.08	.09
2.70	0.00	0.00	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.08
2.80	0.09	0.11	0.13	0.15	0.18	0.20	0.24	0.27	0.30	0.34
2.90	0.38	0.43	0.48	0.53	0.59	0.65	0.71	0.78	0.85	0.93
3.00	1.01	1.09	1.18	1.28	1.38	1.48	1.59	1.71	1.83	1.96
3.10	2.09	2.23	2.37	2.52	2.68	2.84	3.01	3.18	3.36	3.55
3.20	3.75	3.95	4.16	4.38	4.60	4.83	5.07	5.32	5.57	5.84
3.30	6.11	6.39	6.67	6.97	7.27	7.59	7.91	8.24	8.58	8.93
3.40	9.29	9.66	10.04	10.43	10.82	11.23	11.65	12.08	12.51	12.96
3.50	13.42	13.89	14.34	14.80	15.27	15.74	16.23	16.73	17.23	17.75
3.60	18.27	18.80	19.35	19.90	20.47	21.04	21.63	22.22	22.83	23.44
3.70	24.07	24.70	25.35	26.01	26.68	27.36	28.05	28.75	29.47	30.19
3.80	30.93	31.67	32.43	33.20	33.99	34.78	35.59	36.40	37.23	38.07
3.90	38.93	39.79	40.67	41.56	42.46	43.38	44.31	45.25	46.20	47.17
4.00	48.14	49.14	50.14	51.16	52.19	53.23	54.29	55.36	56.45	57.54
4.10	58.65	59.78	60.92	62.07	63.24	64.42	65.61	66.82	68.04	69.28
4.20	70.53	71.80	73.08	74.37	75.68	77.00	78.34	79.70	81.06	82.45
4.30	83.85	85.26	86.69	88.13	89.59	91.07	92.56	94.06	95.58	97.12
4.40	98.67	100.24	101.83	103.43	105.04	106.67	108.32	109.99	111.67	113.37
4.50	115.08	116.81	118.56	120.32	122.10	123.90	125.72	127.55	129.40	131.26
4.60	133.14	135.04	136.96	138.89	140.85	142.82	144.80	146.81	148.83	150.87
4.70	152.93	155.00	157.10	159.21	161.34	163.49	165.65	167.84	170.04	172.26

Figure 7. Rating Curve and a portion of the rating table for the Walla Walla River at Pepper Bridge. Yellow dots represent manual discharge measurements. Blue triangles show rating points.

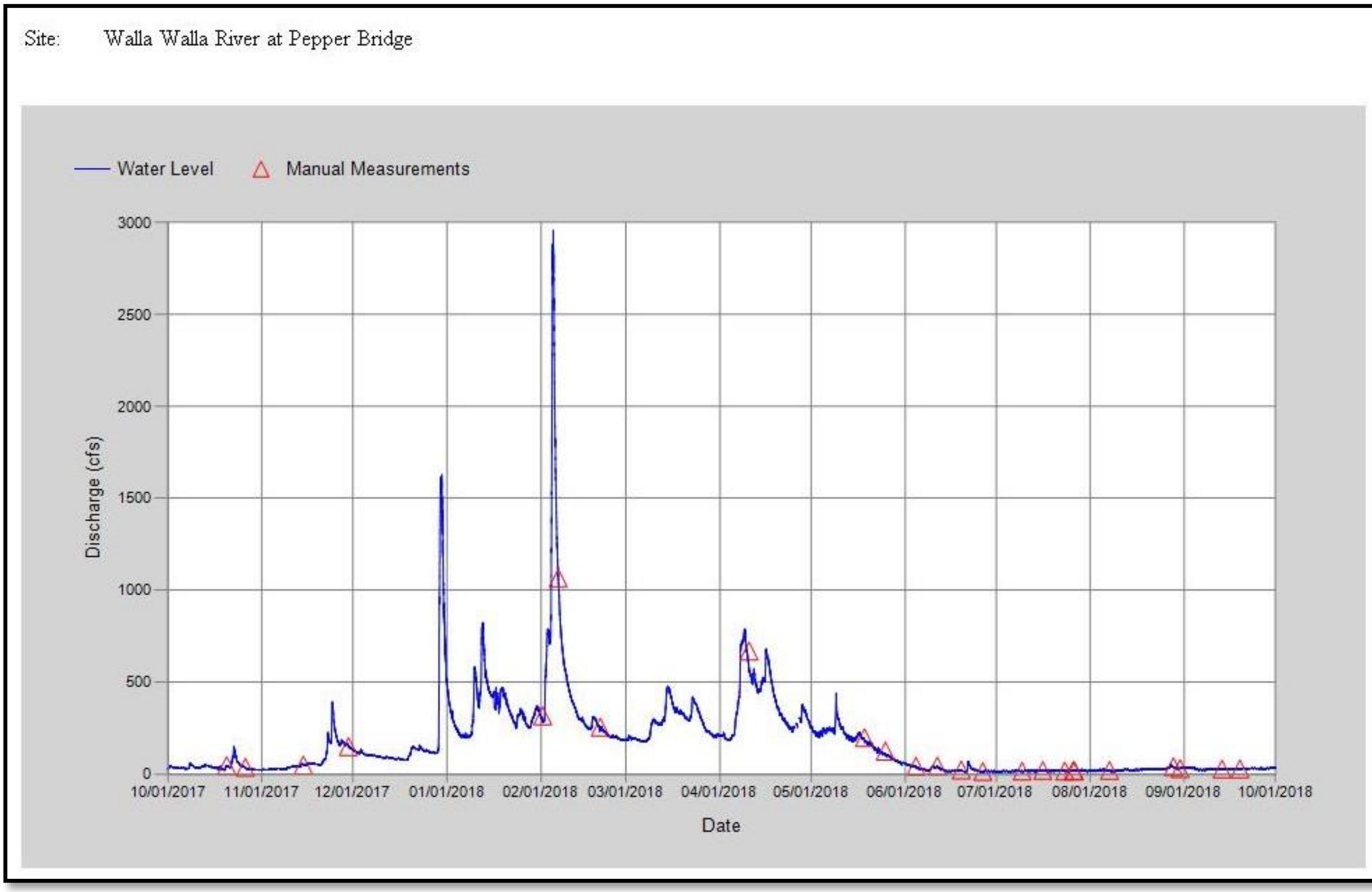


Figure 8. Walla Walla River at Pepper Bridge flow data computed by processing stage data through the rating table shown in Figure 7.

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.

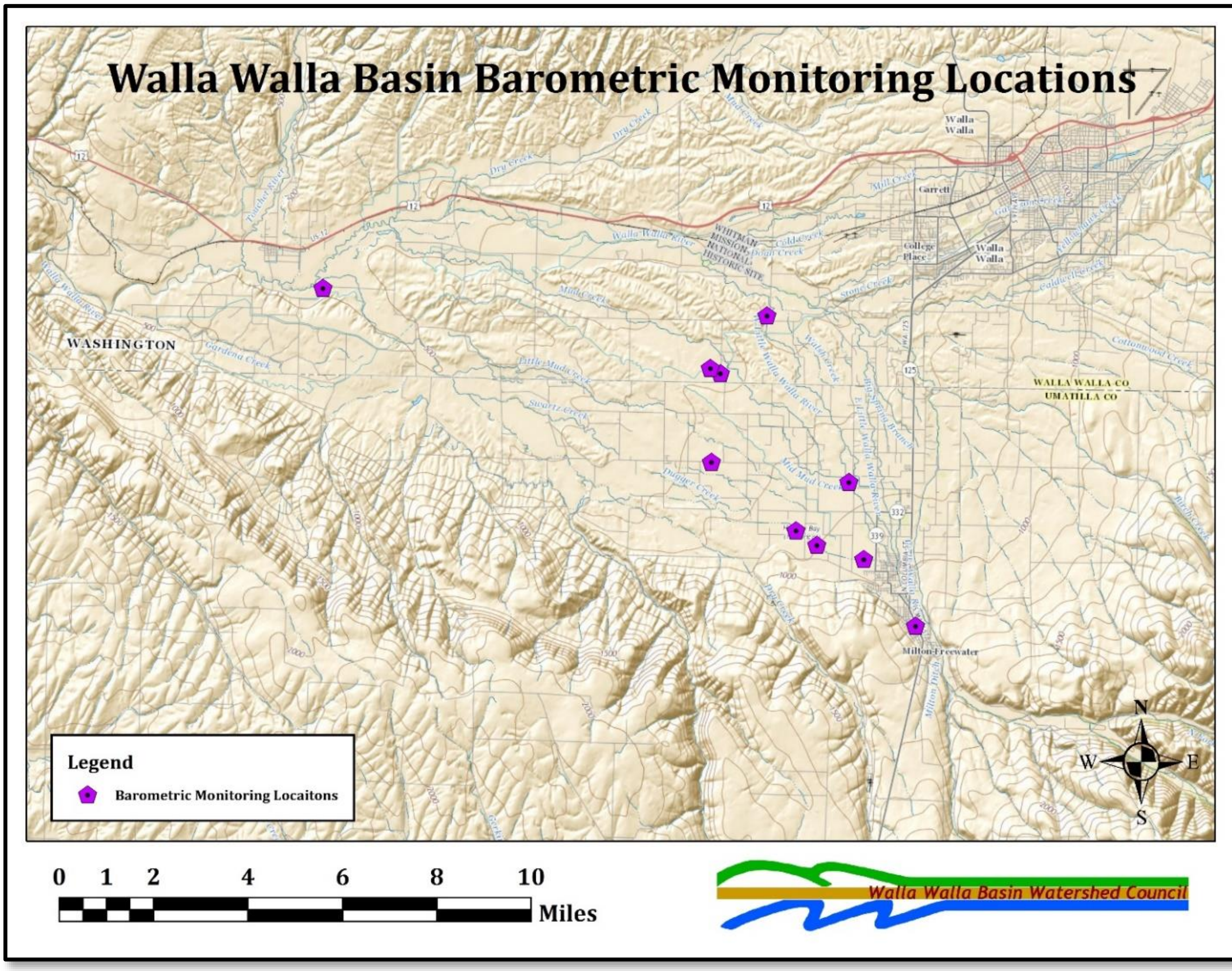


Figure 9. Map showing barometric pressure transducer locations in the Walla Walla Basin.

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 as well as professional judgment. 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 measurement 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.

February Channel Changing Event

A spring freshet during the first week in February 2018 brought about channel changes evident at several gauging stations on the Walla Walla River. We were able to capture high flow measurements on the tail end of the event, increasing the accuracy of higher flow predictions of our rating curves.

Six New Telemetry Sites

During the 2018 water year, we upgraded three existing flow monitoring sites at the end of the Walla Walla River Irrigation District, enabling them to send data via the radio network. We also installed flow monitoring sites with telemetry equipment on Mud Creek at Barney Rd, the Lowden 2/Garden City diversion from the Walla Walla River and also the HBDIC ditch at Schubert Rd.

Walla Walla Basin Instream Flow Enhancement Study

The WWBWC, Walla Walla Watershed Management Partnership, Confederated Tribes of the Umatilla Indian Reservation, Washington's Office of Columbia River, the Bureau of Land Management and local stakeholders are conducting a Walla Walla Basin Instream Flow Enhancement Study, an effort to identify strategies to meet instream flow demands while addressing municipal and agricultural needs[3]. WWBWC flow data collected during the 2018 water year and prior were used to support the study.

Aquifer Recharge and Spring Performance Analysis

During the 2018 water year, the WWBWC completed construction of three new managed recharge projects in the alluvial aquifer. Funding for managed aquifer recharge operations was not available in Washington. Twelve sites on the Oregon side of the basin did operate in 2018, recharging 8,287 acre-feet. Ongoing monitoring of spring performance and groundwater-surface water interactions aids in the adaptive management of these sites.

One of the purposes of the recharge program is to enhance spring performance. Spring performance and the potential factors influencing spring performance were evaluated for 2004-2017. In 9 of the 12 springs considered, the annual yield (acre-feet of water per year) showed an increasing trend over time. Of the factors influencing spring performance for which data were found, the operation of the managed aquifer recharge program was the only factor which could have resulted in the observed pattern of increased yields[4]. Changes over time in the other factors would have decreased spring performance.

Summary and Acknowledgements

The WWBWC's streamflow monitoring efforts continue to produce high quality data utilized to:

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

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[3] http://wwbwc.org/assessment/57-wwflow.html

[4] Cobb and Keller (2019), *Water Year 2018 Oregon Walla Walla Basin Aquifer Recharge Report: Draft Report.*

Resource managers, irrigators and other basin residents continue to rely on the availability of reliable streamflow data in the Walla Walla Valley. Without the support of the WWBWC'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 2018 Water Year

Site ID	Site Name	Gap Dates	Explanation
S125	Walla Walla R at Pierce RV Park	8/2/18-8/6/18	Logger dry
S142	Lowden 2/Garden City ditch diversion	2/9/18-2/12/18 2/22/18-3/5/18	Data logger failure Data logger failure
S202	WWRID Crockett ditch at Frog	10/1/7-9/30/18	Stage data only, rating not possible due to site conditions
S214	Ford Branch End	7/11/18-7/13/18	Logger dry
S204	HBDIC ditch at Frog	4/13/18-4/24/18	Battery failure
S220	East Little Walla Walla at Stateline	10/4/17-10/13/17	Unusable data, poor site conditions
S227	West Little Walla Walla near Mouth	12/5/17-12/6/17 1/18/18-2/1/18	Battery failure
S401	White Ditch at Johnson Recharge	2/19/18-3/2/18	Data unusable, logger failure
S403	Johnson Recharge outflow	7/18/18-10/12/18	Logger failure. Site was dry during this time, no recharge occurring.
S407	Dugger Cr at White Ditch Split	7/18/18-10/12/18	Data logger failure
S416	Pine Creek at Shubert	1/15/18-1/23/18 2/7/18-2/12/18 3/14/18-4/3/18	Unusable data, logger movement during high flows
S426	HBDIC ditch at Schubert		Established this new monitoring site on 2/20/18