Streamflow Monitoring in the Walla Walla Basin

2021-2022 Water Year

FINAL REPORT

Submitted: February 2023

In Cooperation with:

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Abstract

This project has 23 existing surface water monitoring locations in the Oregon portion of the Walla Walla basin in Umatilla County near Milton-Freewater. The project collects streamflow data in the Walla Walla River, its tributaries, and its distributaries. Data are needed to guide current planning efforts to address the Basin's inadequate water supply to meet the needs of aquatic life and agricultural and municipal uses. The data collected are helping guide the Walla Walla Water 2050 planning process, the Walla Walla Basin Bi-State Flow Study, the USGS basin-wide Surface and Groundwater Study, and have been incorporated into both Oregon and Washington state databases. Data collection and sharing allows basin stakeholders to manage projects adaptively, design better projects, and create enhanced outcomes. The Walla Walla Basin Watershed Council uses similar guidelines that the United States Geological Survey and other state agencies use for surface water monitoring. We base our standard operating procedures on their guidelines.

Introduction

Overview

Since 2002, the Walla Walla Basin Watershed Council (WWBWC) has collected flow data throughout the Walla Walla River Valley and currently monitors 23 sites in Oregon on the Walla Walla River, its tributaries, springs, small order streams, and irrigation ditches. Twelve near real-time gauge stations transmit data published hourly on our website at www.wwbwc.org for use by basin partners, state and federal entities, and the public. Eleven 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 projects implemented by the WWBWC

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 westerly from its headwaters in the Blue Mountains into the Walla Walla Valley. The river then heads north with a large portion of the flow being diverted 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, allowing 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 function and provide for agricultural needs.

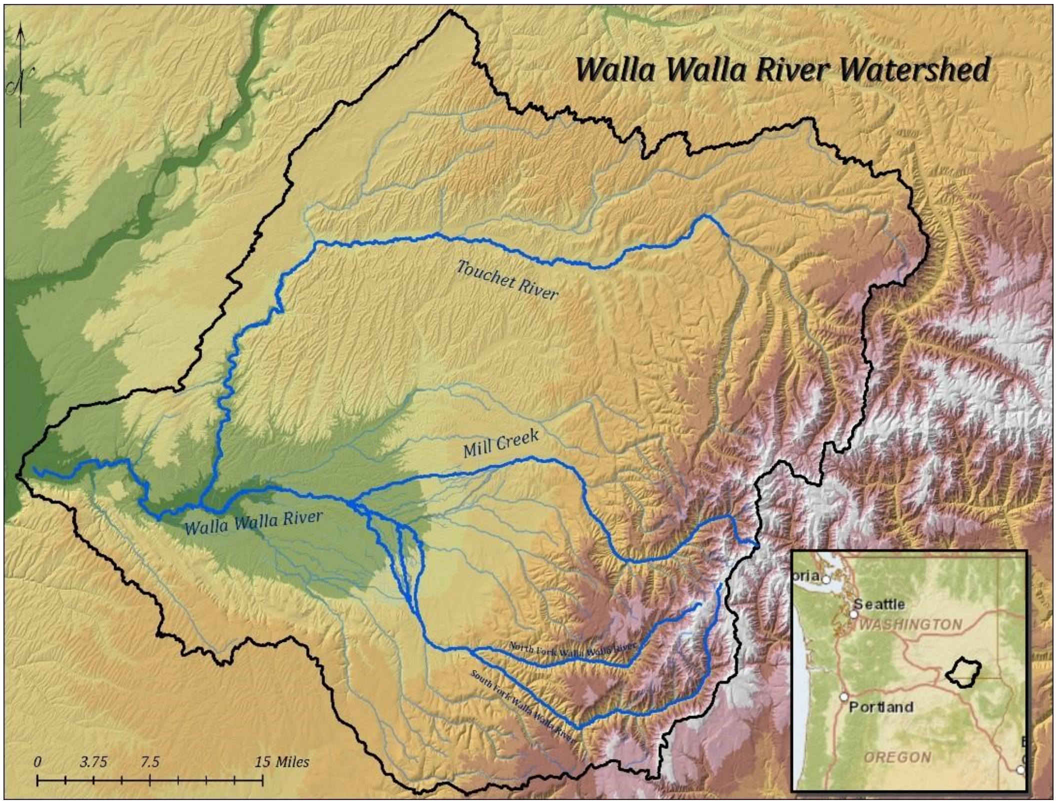

Figure 1. The Walla Walla Basin, a bi-state watershed

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

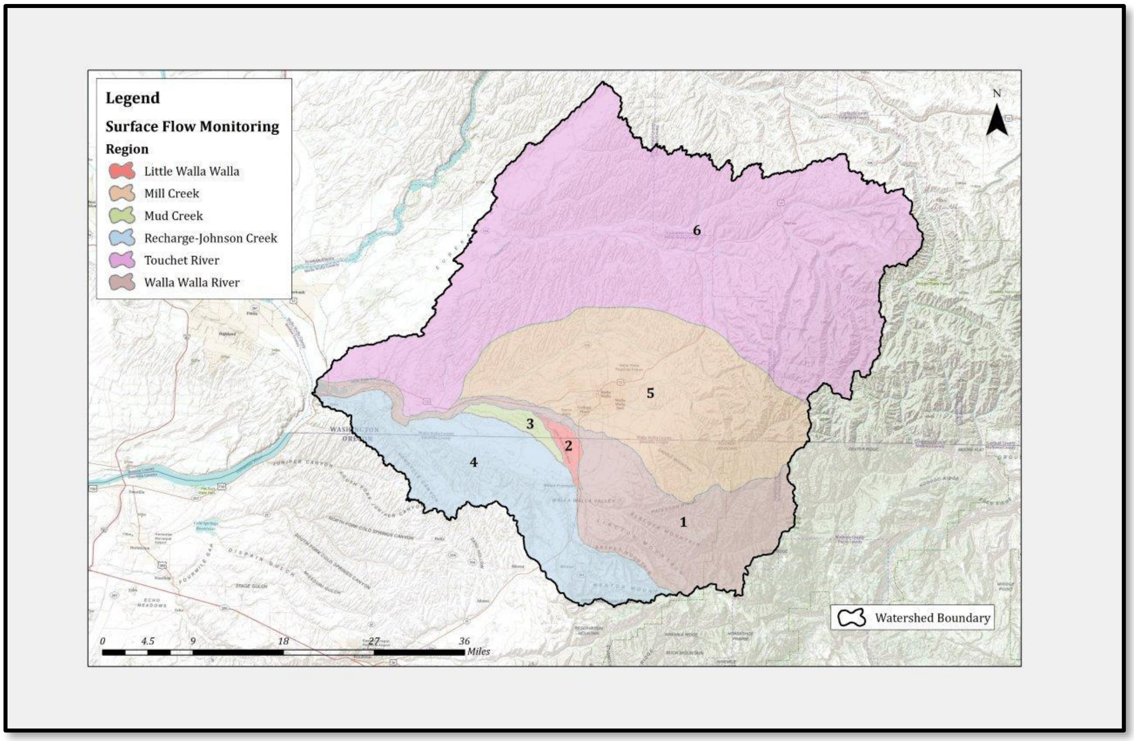

Figure 2. WWBWC Streamflow monitoring sites are organized according to the regions depicted above.

Region	# of Sites
1: Walla Walla River	5
2: Little Walla Walla River/Walla Walla River Irrigation System	10
3: Mud Creek/Fruitvale Irrigation System	2
4: Pine Creek/Hudson Bay Irrigation System	6
Total	23

Table 1. Distribution of WWBWC's current Flow Monitoring Sites

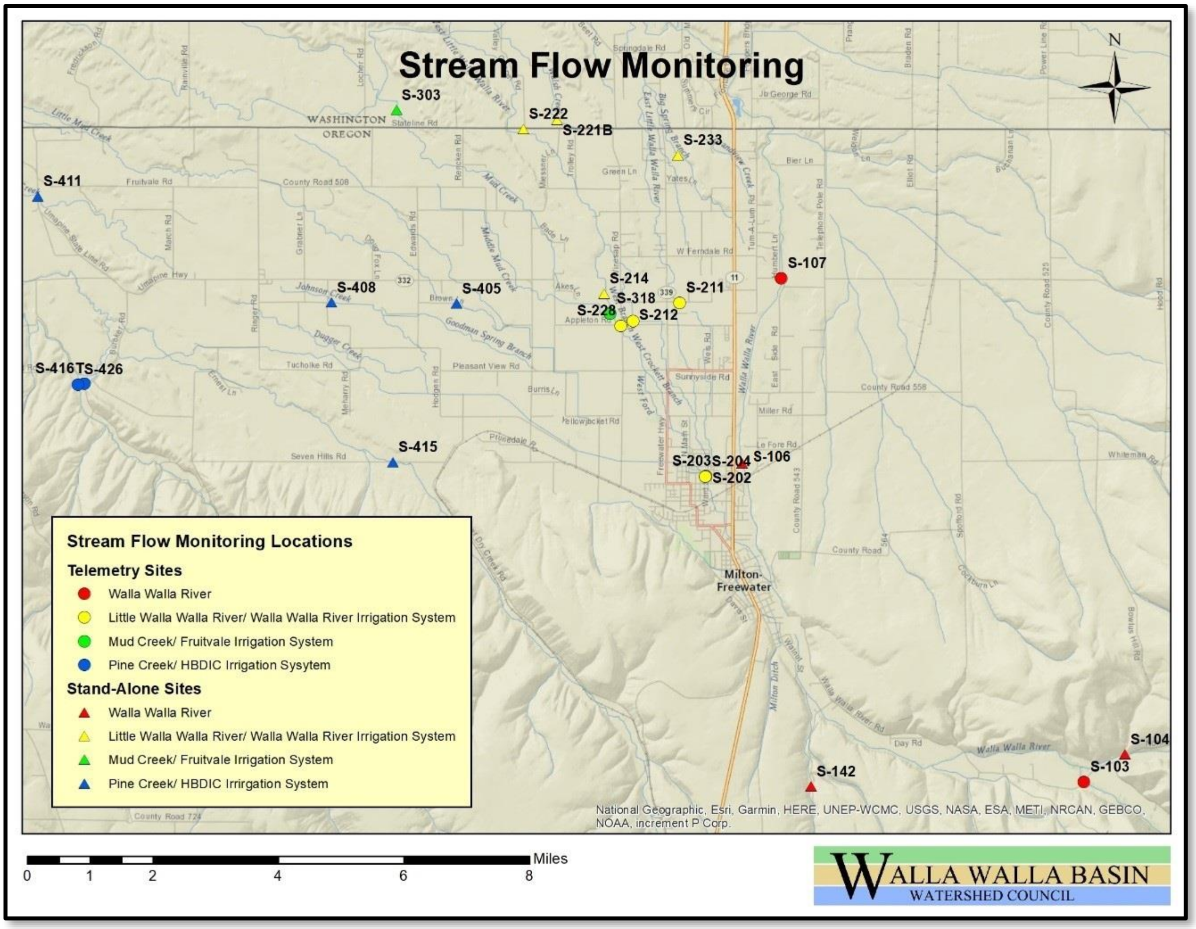

Figure 3. Map showing streamflow monitoring sites as of September 2022.

Methods

Our standard operating procedures are based on USGS, Washington, and Oregon state methods for streamflow monitoring. All flow monitoring activities were conducted according to WWBWC Monitoring Program Standard Operating Procedures[1], which were updated in 2018 to reflect industry standards and the current flow monitoring equipment available.

Near Real-Time Monitoring Sites

Since 2013, WWBWC has strategically installed real-time flow monitoring sites where hourly flow data can benefit the public, tribal, state, and federal agency staff and local resource managers. Figure 4 shows an example of a near real-time monitoring site. Twelve stream sites were monitored during the 2022 water year using near real-time telemetry equipment. WWBWC used electronic sensors and data loggers manufactured by Campbell Scientific to record gauge height at a programmed interval (typically every 15 minutes). These stage data were relayed to the WWBWC

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

office using satellite or radio 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 every two weeks to read the staff gauges and visually inspect equipment. Manual discharge measurements were taken approximately every six weeks using a SonTek FlowTracker Handheld Acoustic Doppler Velocimeter, Marsh-McBirney Flo-Mate 2000 flow meter, or Price AA current meter (Figure 5). Water temperature was measured using a calibrated NIST-traceable YSI 30 handheld meter (www.ysi.com).

Figure 4. At this near real-time monitoring site on the South Fork Walla Walla River (S-103), a cabled sensor, secured to posts, collects water level data. A communication cable transmits the information to a data logger and radio housed in the gauge box. Using radio telemetry, water level and temperature data are sent to the WWBWC office to be processed and published online.

Figure 5. Staff setting up a bridge board flow measurement on South Fork Walla Walla River (S-103) using a Price AA current meter and AquaCalc Pro Plus.

Stand-Alone Flow Monitoring Sites

Many of WWBWC's streamflow monitoring sites are stand-alone stations not equipped with telemetry capability. We visit these sites quarterly to take stage and discharge measurements and to download data. For the 2021-2022 monitoring period, these sites were equipped with Solinst pressure transducers programmed to log water level and temperature measurements at a set interval (typically every 15). Figure 6 shows an example of data logger deployment in a perforated PVC stilling well anchored to a t-post in the off-center of the channel.

A monitoring technician visited each site every three months 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 was conducted (for example, weeds or other debris removed), the water temperature was measured, and photographs were taken.

Most of WWBWC's streamflow monitoring sites have been surveyed with survey-grade Magellan GPS units, providing accurate coordinates and elevations for mapping and analysis.

Figure 6. At this stand-alone monitoring site on the West Little Walla Walla River (S-222), a staff gauge and perforated PVC stilling well enclose a suspended pressure transducer. These are the typical components installed at stand-alone monitoring sites that were visited quarterly for manual data download

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 data corrections were documented within the software and annually reviewed for approval. An explanation of data gaps can be found in Appendix A.

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 (Figures 7-8). 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 9). Rating curves were shifted to reflect channel changes caused by high water events and/or seasonal vegetation growth. Figure 8 displays Walla Walla River below Nursery Bridge flow data calculated by processing stage values through the rating curve equation created for that site (Figures 7-8). 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.

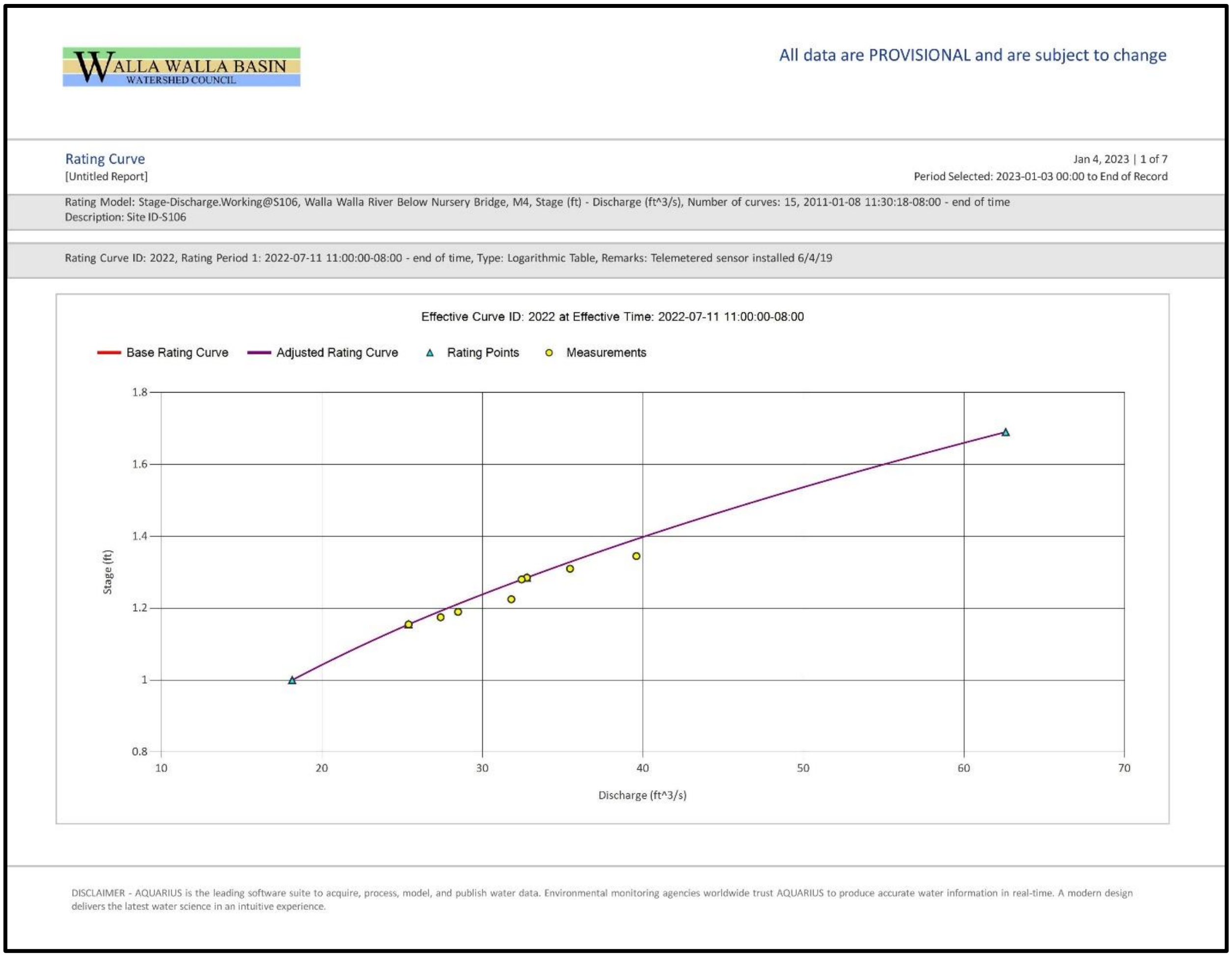

Figure 7. Rating Curve for the Walla Walla River below Nursery Bridge. Yellow dots represent manual discharge measurements. Blue triangles show rating points.

WALLA WALLA BASIN WATERSHED COUNCIL

All data are PROVISIONAL and are subject to change

Rating Curve
[Untitled Report]

Jan 4, 2023 | 2 of 7
Period Selected: 2023-01-03 00:00 to End of Record

Rating Model: Stage-Discharge.Working@S106, Walla Walla River Below Nursery Bridge, M4, Stage (ft) - Discharge (ft^3/s), Number of curves: 15, 2011-01-08 11:30:18-08:00 - end of time
Description: Site ID-S106

Rating Curve ID: 2022, Rating Period 1: 2022-07-11 11:00:00-08:00 - end of time, Type: Logarithmic Table, Remarks: Telemetered sensor installed 6/4/19

Base — Discharge (ft^3/s) — Effective Curve ID: 2022 at Effective Time: 2022-07-11 11:00:00-08:00

Stage (ft)	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
1	18.2	18.6	19.0	19.4	19.9	20.3	20.8	21.3	21.7	22.2
1.1	22.7	23.2	23.6	24.1	24.6	25.1	25.7	26.2	26.7	27.3
1.2	27.8	28.4	28.9	29.5	30.1	30.7	31.3	31.9	32.5	33.1
1.3	33.7	34.3	34.9	35.5	36.2	36.8	37.5	38.1	38.8	39.5
1.4	40.1	40.8	41.5	42.2	42.9	43.6	44.3	45.0	45.8	46.5
1.5	47.2	48.0	48.7	49.5	50.3	51.0	51.8	52.6	53.4	54.2
1.6	55.0	55.8	56.6	57.5	58.3	59.2	60.0	60.9	61.7	62.6

Figure 8. Rating table for the Walla Walla River below Nursey Bridge.

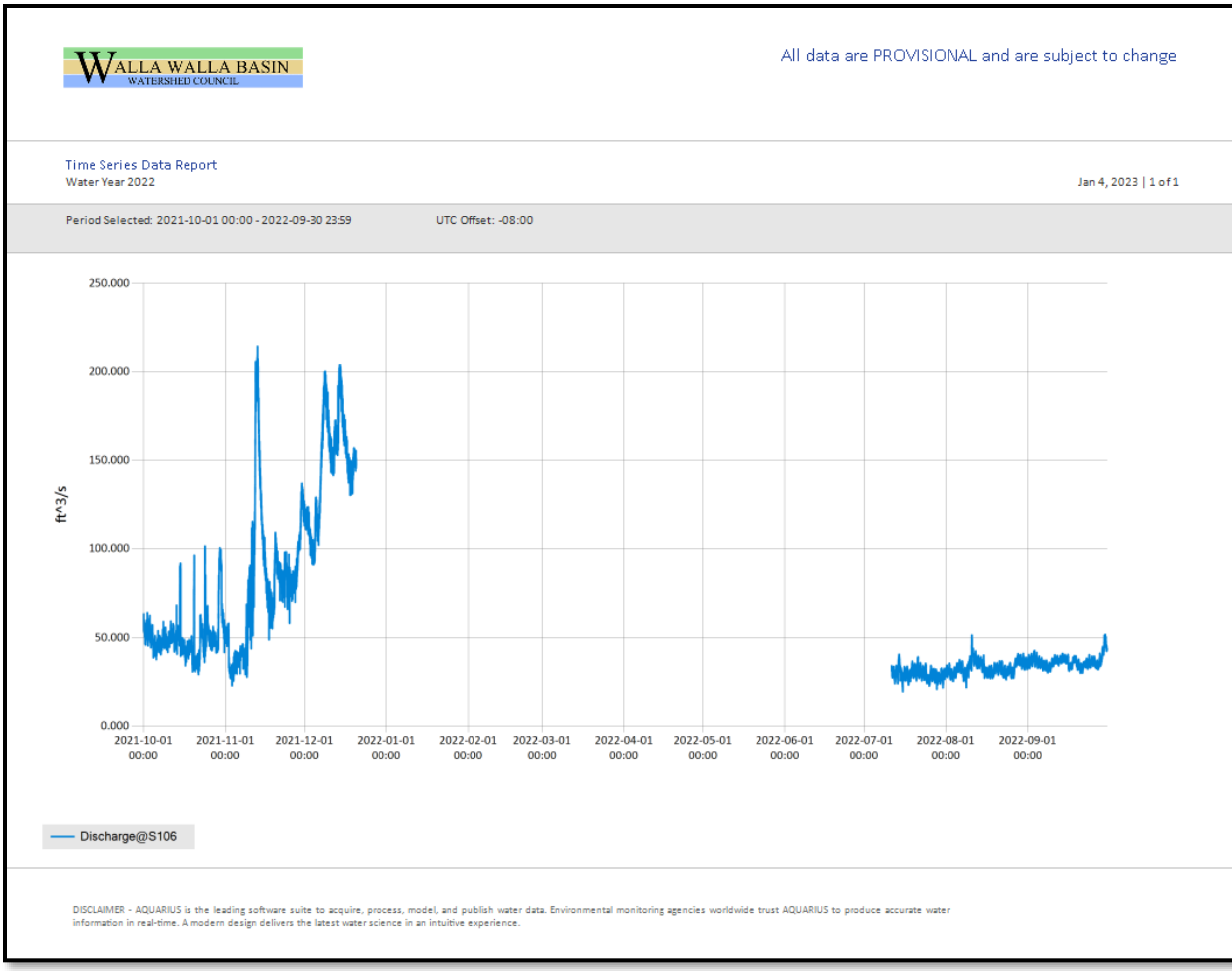

Figure 9. Walla Walla River below Nursey Bridge flow data computed by processing stage data through the rating curve shown in Figure 7.

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 Time-Series, barometric pressure collected by one of the transducers located throughout the valley (Figure 10) was subtracted from stage data to produce a corrected signal showing water levels without the influence of atmospheric pressure.

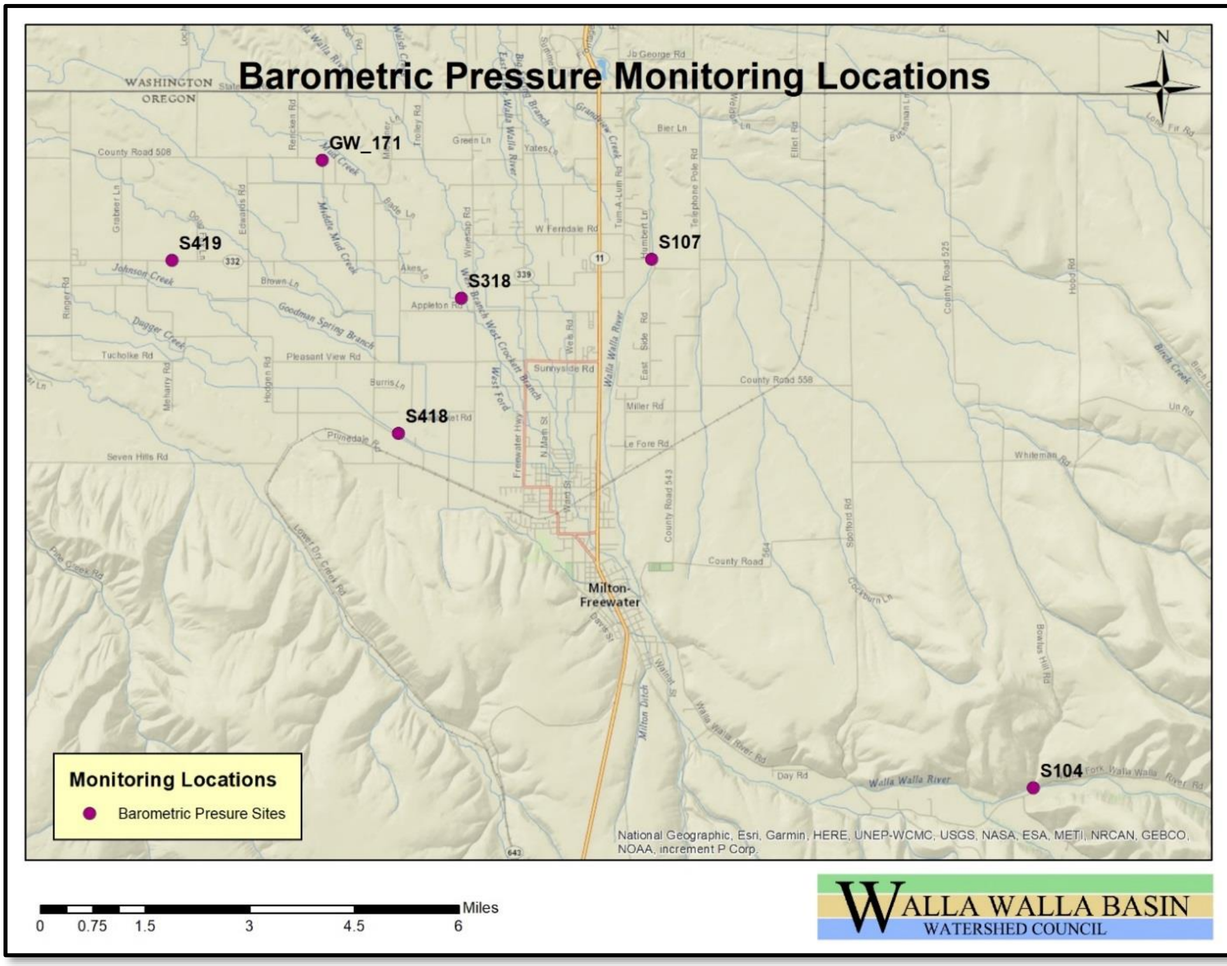

Figure 10. Map showing barometric pressure transducer locations in the Walla Walla Basin.

An essential 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 ADV 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 Flo-Mate 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

Walla Walla River Summer Base Flows

In large part, summertime base flows in the Walla Walla River are supplied by basalt groundwater spring inputs in the upper watershed. The South Fork Walla Walla River (S-103) produces most Walla Walla River base flows, contributing between 95 to 108 cfs during August and September, with the lowest daily mean flow of 97.83 cfs occurring on 9/10/2022 (Figure 11). Summer low flows in 2022 were similar to the lows documented in 2018, 2019, and 2021 but about two cfs lower than the summers of 2016, 2017, and 2020 (Figure 12). Table 2 shows the lowest daily mean flow values with corresponding dates at the South Fork Walla Walla River gauge site during the last six summers.

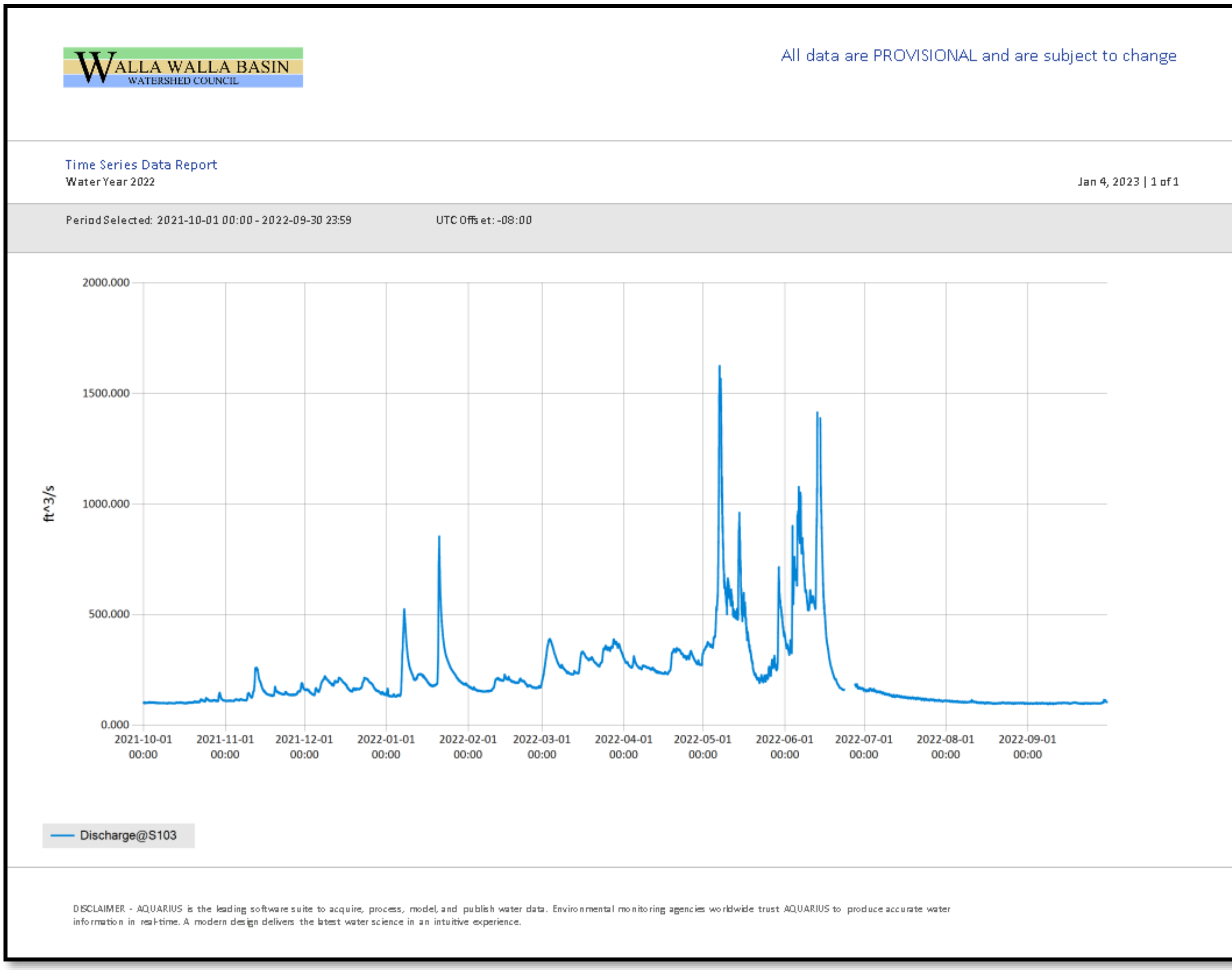

Figure 11. South Fork Walla Walla River near Confluence (S-103) 2022 Water Year Discharge.

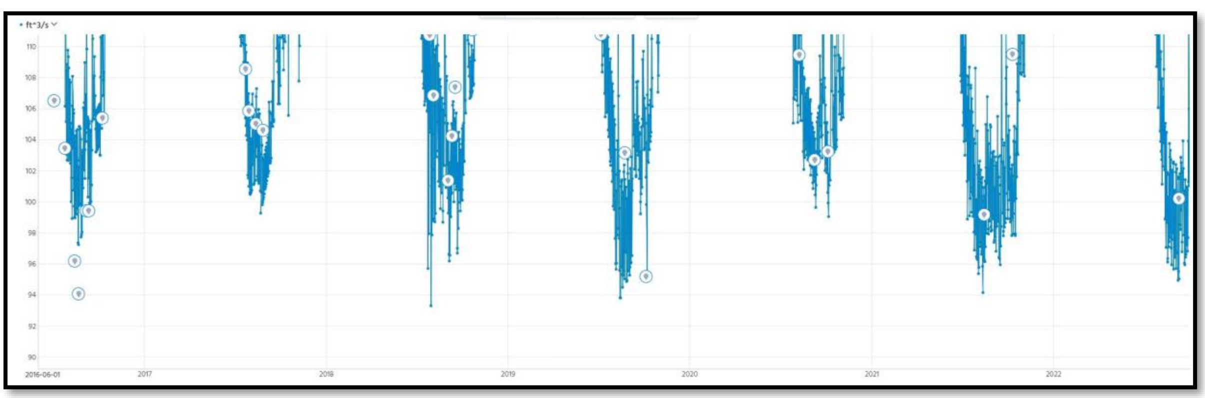

Figure 12. South Fork Walla Walla River near Confluence (S-103) low flow summer months during water years 2016-2022.

S-103 Lowest Daily Mean Flows		
Water Year	**Date**	**Flow**
2016	8/21/2016	100.14 cfs
2017	8/29/2017	101.09 cfs
2018	9/5/2018	98.71 cfs
2019	8/15/2019	96.27 cfs
2020	9/10/2020	101.37 cfs
2021	8/12/2021	96.84 cfs
2022	9/10/2022	97.83

Table 2. Lowest daily mean flows in the South Fork Walla Walla River near Confluence (S-103) during water years 2016-2022.

The North Fork Walla Walla River (S-104) produced 4 to 9 cfs during the low flow season during August and September (Figure 13).

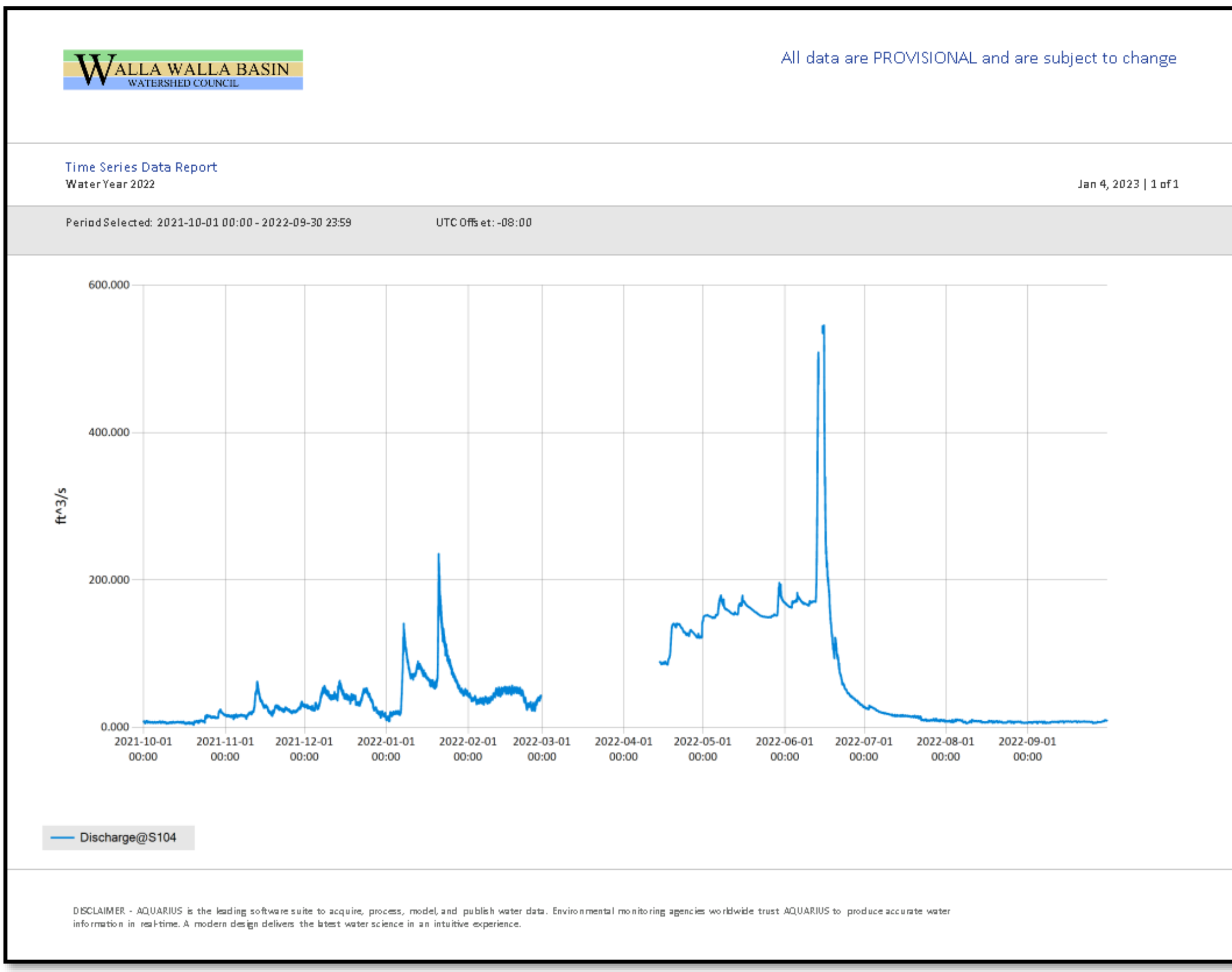

Figure 13. North Fork Walla Walla River near Confluence (S-104) 2022 Water Year Discharge. The gauge was replaced by telemetry equipment to monitor year-round.

Downstream of the North and South Fork confluence, the Walla Walla River at Milton-Freewater (S-105), operated by USGS in WY 2022, had daily mean base flows ranging from 99 to 115 during August and September, with the lowest daily mean flow of 99.25 cfs occurring on 9/28/2022 (Figure 14). Summer low flows in 2022 were in the median compared to previous years (Figure 15). Table 3 shows the lowest daily mean flow values with corresponding dates at the Milton-Freewater gauge site during the last eight summers.

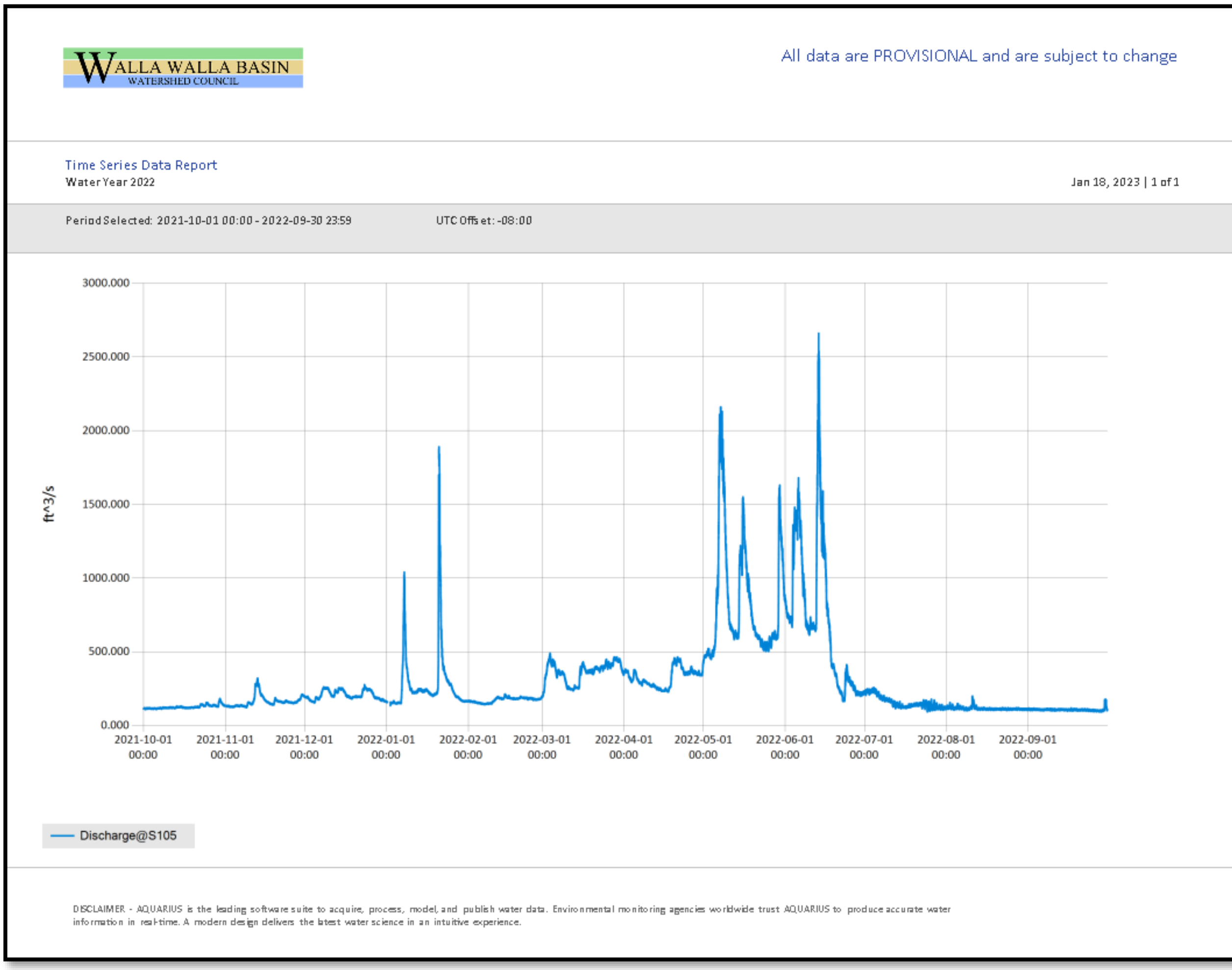

Figure 14. Walla Walla River at Milton-Freewater (S-105) 2022 Water Year Discharge. Data were collected by USGS

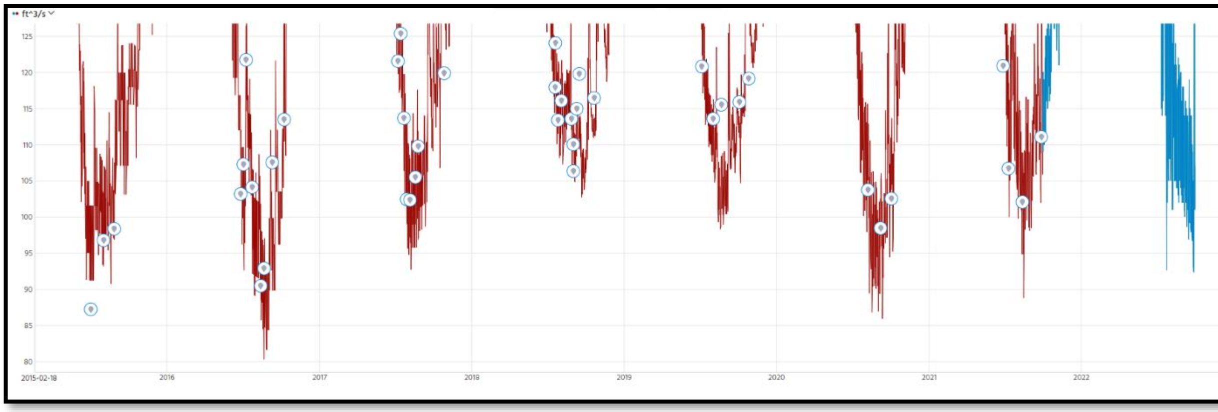

Figure 15. Walla Walla River at Milton-Freewater (S-105) low flow summer months during water years 2015-2022. The red lines are data collected by WWBWC. The blue lines are data collected by USGS.

S-105 Lowest Daily Mean Flows		
Water Year	**Date**	**Flow**
2015	7/8/2015	99.46 cfs
2016	8/28/2016	87.00 cfs
2017	8/9/2017	98.58 cfs
2018	9/29/2018	106.28 cfs
2019	8/22/2019	101.52 cfs
2020	9/12/2020	91.27 cfs
2021	8/16/2021	96.92 cfs
2022	9/28/2022	99.25

Table 16. Lowest daily mean flows in the Walla Walla River at Milton-Freewater (S-105) during water years 2015-2022.

Walla Walla River Bypass Flows in Milton-Freewater

The M4 flow gauge records water levels below Nursery Bridge, tracking conserved Walla Walla River water left instream after the primary Milton-Freewater irrigation diversions. Due to extensive irrigation efficiency projects and the collaboration of local water users, over a quarter of available summertime, Walla Walla River water has been permanently conserved as instream water rights. In 2022, July-September flows fluctuated from 26-47 cfs (Figure 9).

About 2.4 miles downstream of Nursery Bridge, the Walla Walla River below Tum-A-Lum Bridge (S-107) had daily mean base flows ranging from 4-20 cfs during July, August, and September, with the lowest daily mean flow of 4.39 cfs occurring on 7/25/2022 (Figure 16).

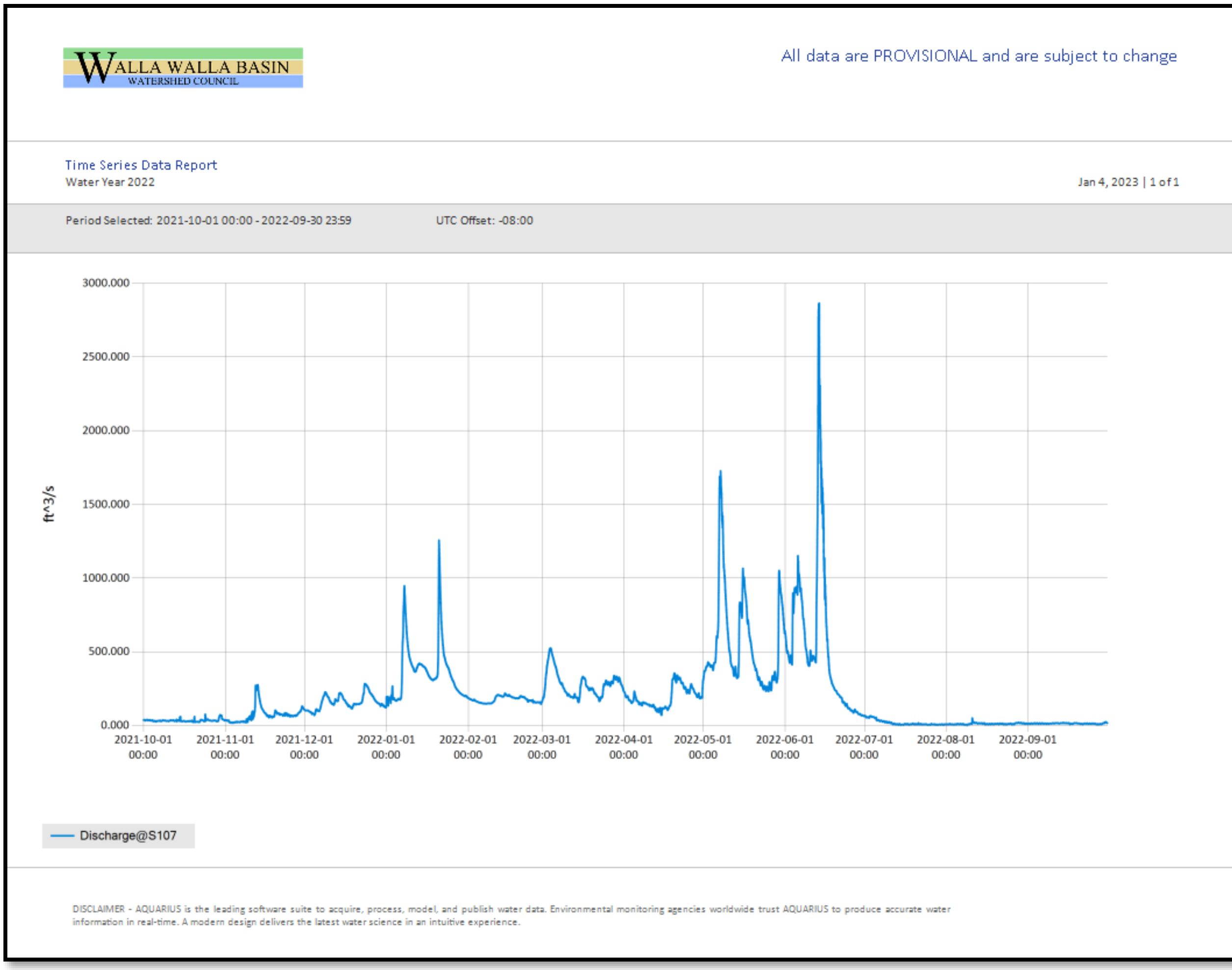

Figure 17. Walla Walla River below Tum-A-Lum Bridge (S-107) 2022 Water Year Discharge.

Walla Walla River Tributaries

The tributaries of the Walla Walla River we monitor are Couse Creek at River Mile 1.1 (S-142), Dry Creek at Seven Hills Road (S-415), and Pine Creek at Schubert Road (S-416T). These seasonal streams are typically dry during the summer, except Couse Creek had water present during the summer months with the lowest daily mean flow of 0.03 cfs on 09/12/2022. Tributaries also experienced high flow events in the 2022 water year. Couse Creek peaked at just over 200 cfs (Figure 17). The peaks at Dry Creek at Seven Hills Road and Pine Creek at Schubert Road were just over 250 cfs and 400 cfs, respectively (Figures 18 and 19), although the high peaks for Dry Creek and pine Creek are a modeled prediction because the highest manual discharge measurements for the 2022 water year are 59 cfs and 53 cfs, respectively.

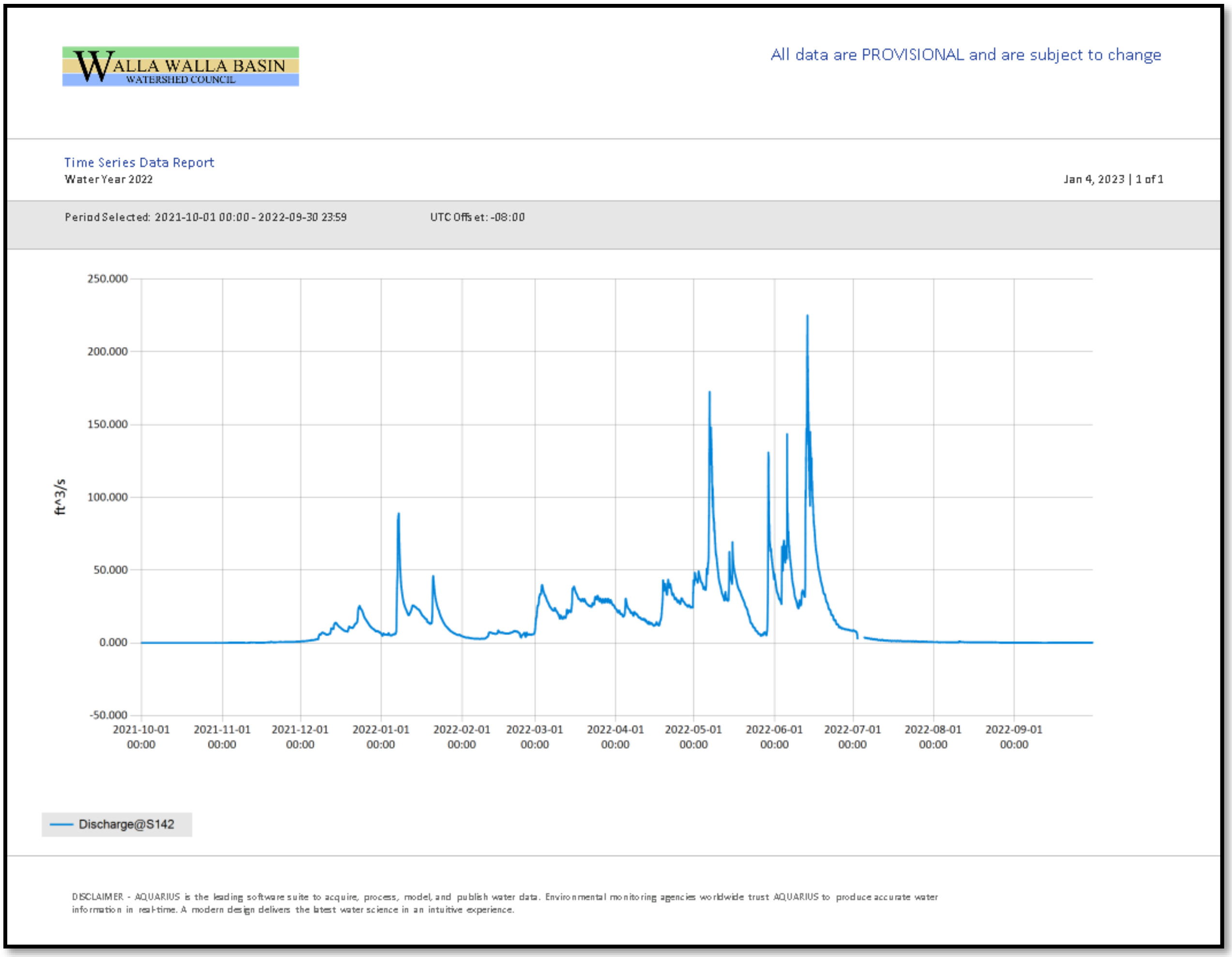

Figure 18. Couse Creek at River Mile 1.1 (S-142) 2022 Water Year Discharge.

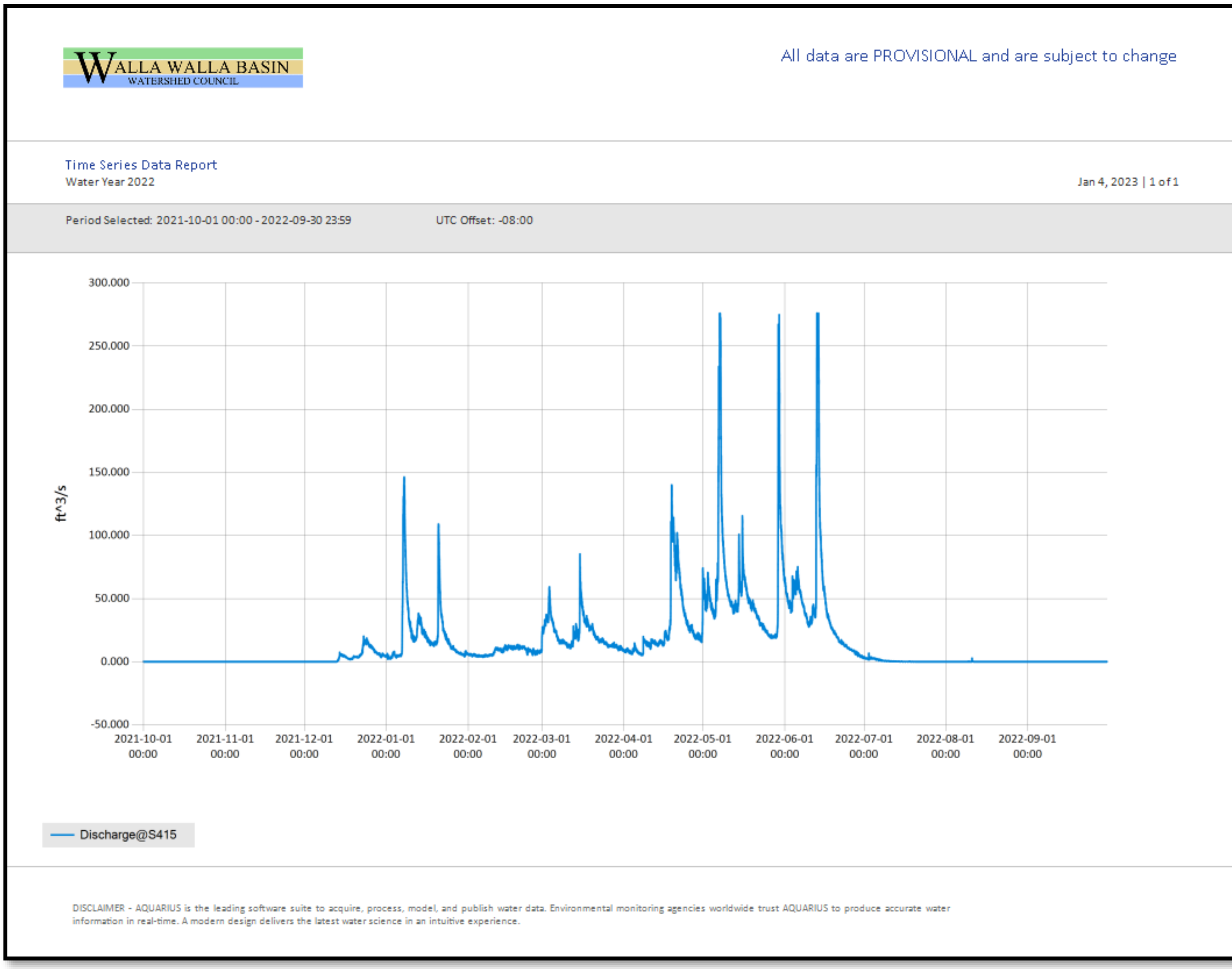

Figure 19. Dry Creek at Seven Hills Road (S-415) 2022 Water Year Discharge.

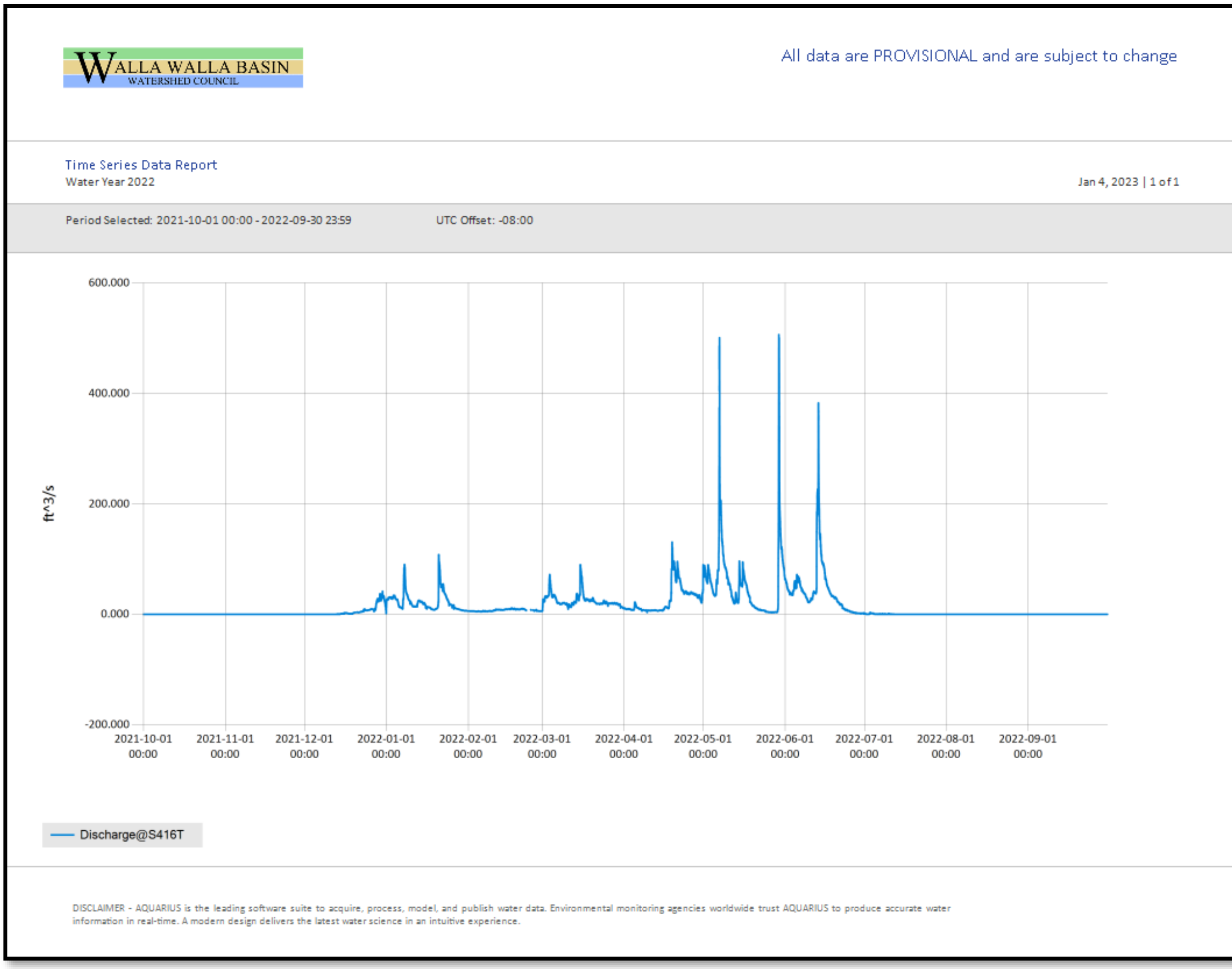

Figure 20. Pine Creek at Schubert Road (S-416T) 2022 Water Year Discharge.

High Flow Event

In the 2022 water year, the Walla Walla River experience seven high flow events that were over 1,000 cfs between January-June 2022. The highest flow event occurred on 6/13/2022, with the peak reaching about 2,800 cfs below Tum-A-Lum Bridge (S-107). Previous years had high flow events of over 4,000 cfs in WY 2018 and 2019, over 9,000 cfs in WY 2020, and over 1,700 cfs in WY 2021.

Aquifer Recharge and Spring Performance Analysis

Fifteen recharge sites operated during the 2022 water year, infiltrating 6,036 acre-feet, including conveyance seepage losses through the irrigation ditches. Factors like freezing from cold weather and ditch maintenance contributed to the season's lower-than-expected recharge volume. Ongoing monitoring of spring performance and groundwater-surface water interactions aids in the adaptive management of these sites.

Discussion/Conclusion

During the 2022 water year, the Walla Walla Basin Watershed Council collected streamflow data from 23 surface water monitoring locations. Data were corrected using manual stage and discharge measurements and published on the WWBWC's website. The data is then used by resource managers, irrigators, federal and state agencies, and private landowners. Monitoring streamflow is essential to the Walla Walla Basin. It documents current conditions and describes trends to inform the development of projects to restore watershed function and increase in-stream flow.

Adaptive Management and Lessons Learned

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 projects implemented by the WWBWC

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 are very much appreciated.

- Bonneville Power Administration
- Confederated Tribes of the Umatilla Indian Reservation
- Walla Walla River Irrigation District
- 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
- U.S. Geological Survey

APPENDIX A

Data Sets

Flow and temperature data for our current and historic monitoring sites are available at the WWBWC website's Surface Water Monitoring page (http://wwbwc.org/monitoring/surfacewater.html). Near real-time sites are updated hourly, and stand-alone sites are updated quarterly.

Explanation of Data Gaps during the 2022 Water Year

Site ID	Site Name	Gap Dates	Explanation
S-103	South Fork Walla Walla River near Confluence	6/23/22 – 6/27/22	Sensor was buried by high flow event, data were not reliable.
S-104	North Fork Walla Walla River near Confluence	2/28/22 – 4/14/22	Removed equipment for high flow event and replaced it with telemetry equipment.
S-106	Walla Walla River below Nursery Bridge	12/20/21 – 7/11/22	Seasonal gauge, only collected data for the summer months.
S-142	Couse Creek at River Mile 1.1	7/2/22 – 7/5/22	Sensor was out of the water, moved the sensor back in the water.
S-202	Crockett Ditch at the Frog	10/1/21 – 9/30/22	Sensor failure.
S-203	Ford Ditch at the Frog	10/1/21 – 3/31/22 4/20/22 – 4/21/22 4/28/22 – 4/29/22 5/31/22 – 6/1/22	Sensor failure.
S-303	Mud Creek at Stateline	2/22/22 2/24/22 2/26/22	Freezing occurred around the sensor, deleted data.
S-318	Fruitvale Ditch	12/28/21 – 1/7/22	Battery failure.
S-408	Johnson Creek	12/31/21 1/2/22 2/23/22 2/25/22 3/6/22	Freezing occurred around the sensor, deleted data.
S-416T	Pine Creek at Schubert Road	1/3/22 – 1/6/22 2/22/22 – 2/26/22	Battery failure. Freezing occurred around the sensor, deleted data.