Walla Walla Basin Watershed Council

# Streamflow Monitoring in the Walla Walla Basin

## *2019-2020 Water Year*

## FINAL REPORT


**Submitted: January 2021**

***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 19 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 that are published hourly on our website at [www.wwbwc.org](http://www.wwbwc.org) for use by basin partners, state and federal entities and the public. Seven 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 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.

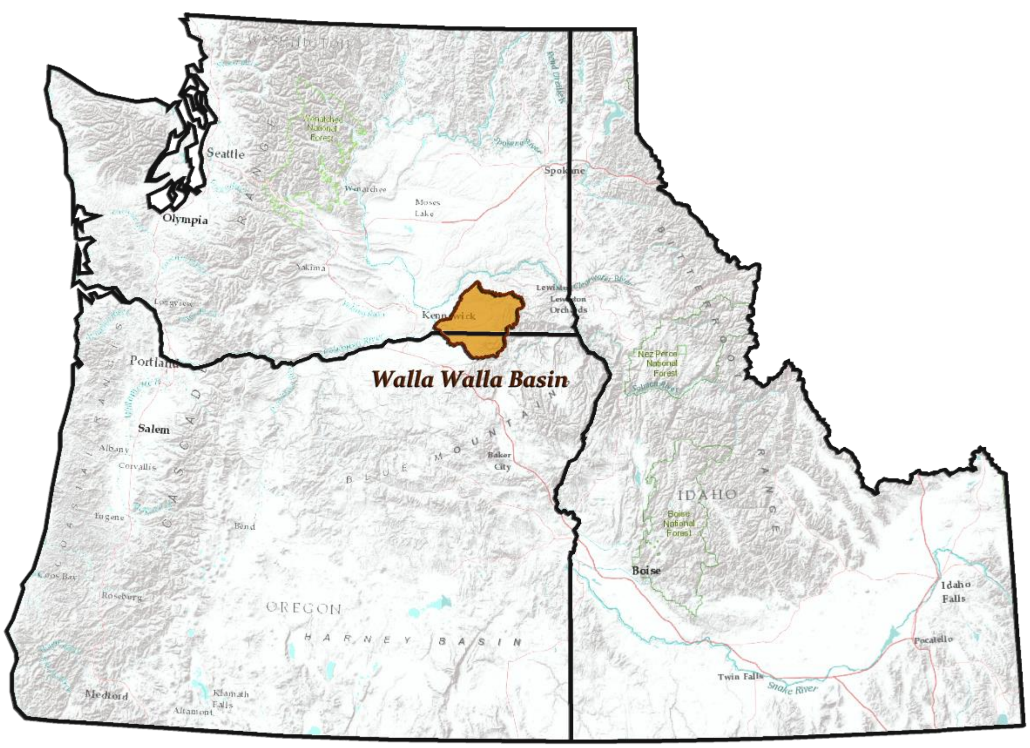


**Figure 1. The Walla Walla Basin, a bi-state watershed**

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 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.

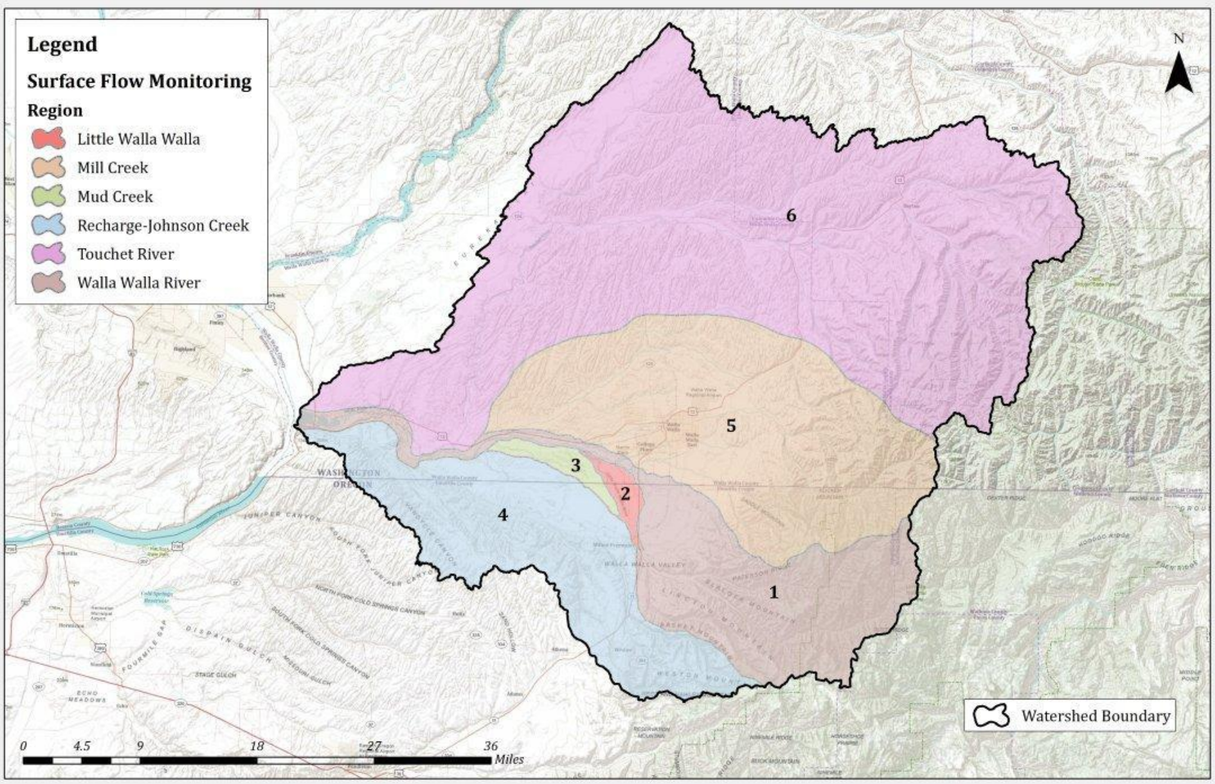


**Figure 2. WWBWC Streamflow monitoring sites are organized according to the regions depicted above.**

| Region | # of Sites |
|---|---|
| 1: Walla Walla River | 6 |
| 2: Little Walla Walla River | 9 |
| 3: Mud Creek/Fruitvale Irrigation System | 1 |
| 4: Pine Creek/Hudson Bay Irrigation System | 3 |
| Total | 19 |

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

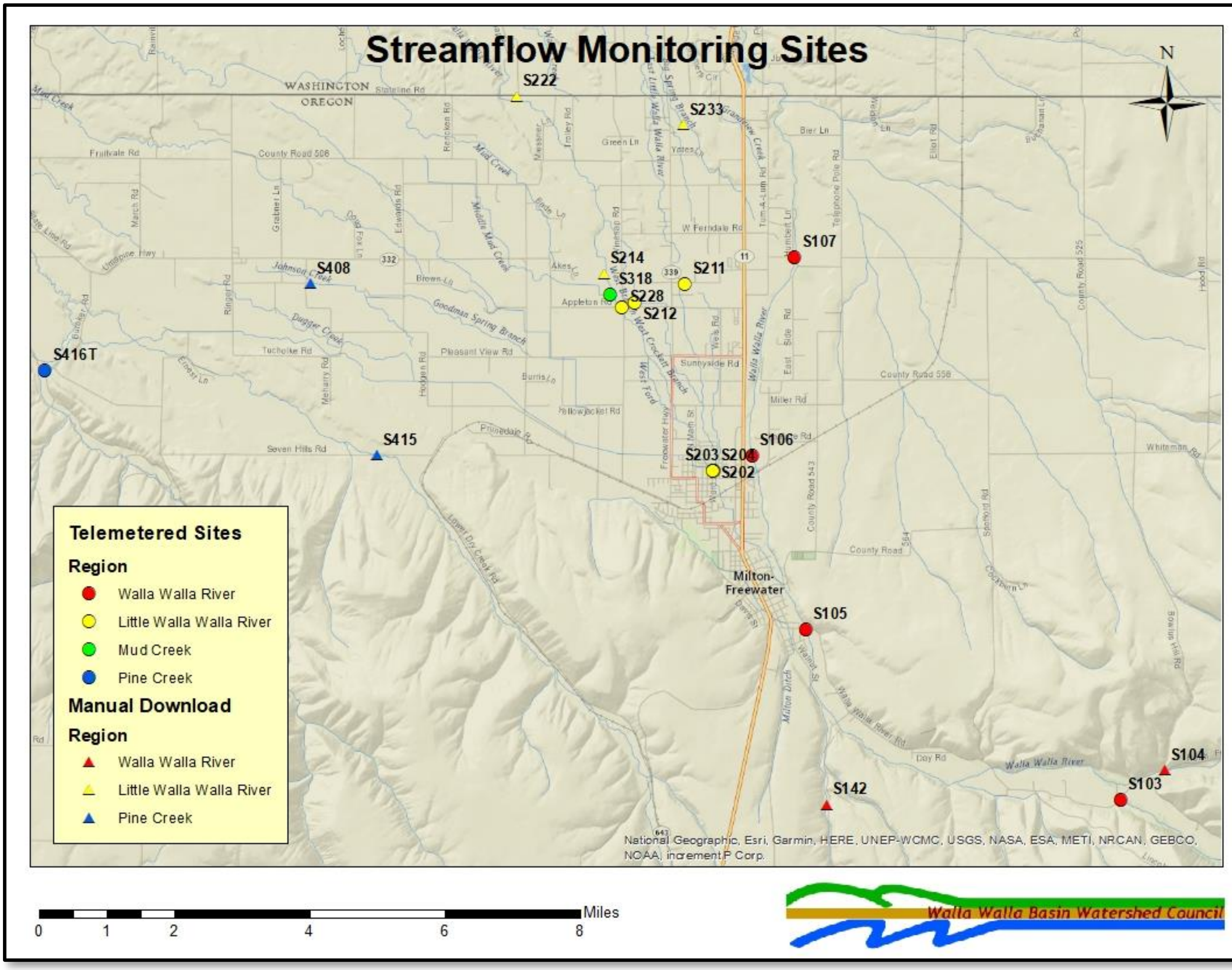


Figure 3. Map showing OWEB-funded streamflow monitoring sites as of October 2020.

# 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 worked to strategically install 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. During the 2020 water year, 12 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 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 twice a month to read the staff gauges and visually inspect equipment. Manual discharge measurements were taken approximately every 6 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).

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

**Figure 4. At this near real-time monitoring site on the Walla Walla River (S-107), a cabled sensor, secured to a boulder in the channel, 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 2020 monitoring period, these sites were equipped with Solinst or In-Situ, Inc 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 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 WWBWC's 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. 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](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. 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.**

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## Rating Curve

2019-2020 Water Year

Label: Working
Description: Site ID-S106
Curve on: January 27, 2021 Curve Start Date: February 6, 2020 Location: Walla Walla River Below Nursery Bridge, M4

| Stage (ft) | 0 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.24 | 0.67 | 1.24 | 1.92 | 2.69 | 3.54 |
| 1.20 | 4.48 | 5.48 | 6.55 | 7.68 | 8.88 | 10.13 | 11.44 | 12.79 | 14.20 | 15.66 |
| 1.30 | 17.17 | 18.72 | 20.32 | 21.96 | 23.65 | 25.38 | 27.14 | 28.95 | 30.80 | 32.68 |
| 1.40 | 34.60 | 36.56 | 38.55 | 40.58 | 42.64 | 44.74 | 46.88 | 49.04 | 51.24 | 53.47 |
| 1.50 | 55.74 | 58.03 | 60.36 | 62.72 | 65.11 | 67.52 | 69.97 | 72.45 | 74.95 | 77.49 |
| 1.60 | 80.05 | 82.64 | 85.26 | 87.91 | 90.59 | 93.29 | 96.02 | 98.77 | 101.55 | 104.36 |
| 1.70 | 107.19 | 110.05 | 112.94 | 115.84 | 118.78 | 121.74 | 124.72 | 127.73 | 130.76 | 133.82 |
| 1.80 | 136.90 | 140.00 | 143.13 | 146.28 | 149.46 | 152.65 | 155.87 | 159.12 | 162.38 | 165.67 |
| 1.90 | 168.98 | 172.31 | 175.67 | 179.04 | 182.44 | 185.86 | 189.30 | 192.76 | 196.24 | 199.75 |
| 2.00 | 203.28 | 206.82 | 210.39 | 213.98 | 217.58 | 221.21 | 224.86 | 228.53 | 232.22 | 235.93 |
| 2.10 | 239.66 | 243.41 | 247.18 | 250.97 | 254.77 | 258.60 | 262.45 | 266.31 | 270.20 | 274.10 |
| 2.20 | 278.03 | 281.97 | 285.93 | 289.91 | 293.90 | 297.92 | 301.96 | 306.01 | 310.08 | 314.17 |
| 2.30 | 318.28 | 322.40 | 326.55 | 330.71 | 334.89 | 339.09 | 343.30 | 347.53 | 351.78 | 356.05 |
| 2.40 | 360.34 | 364.64 | 368.96 | 373.30 | 377.65 | 382.02 | 386.41 | 388.70 | | |

Date Processed: January 27, 2021 14:17

AQUARIUS TIME-SERIES™ SOFTWARE

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

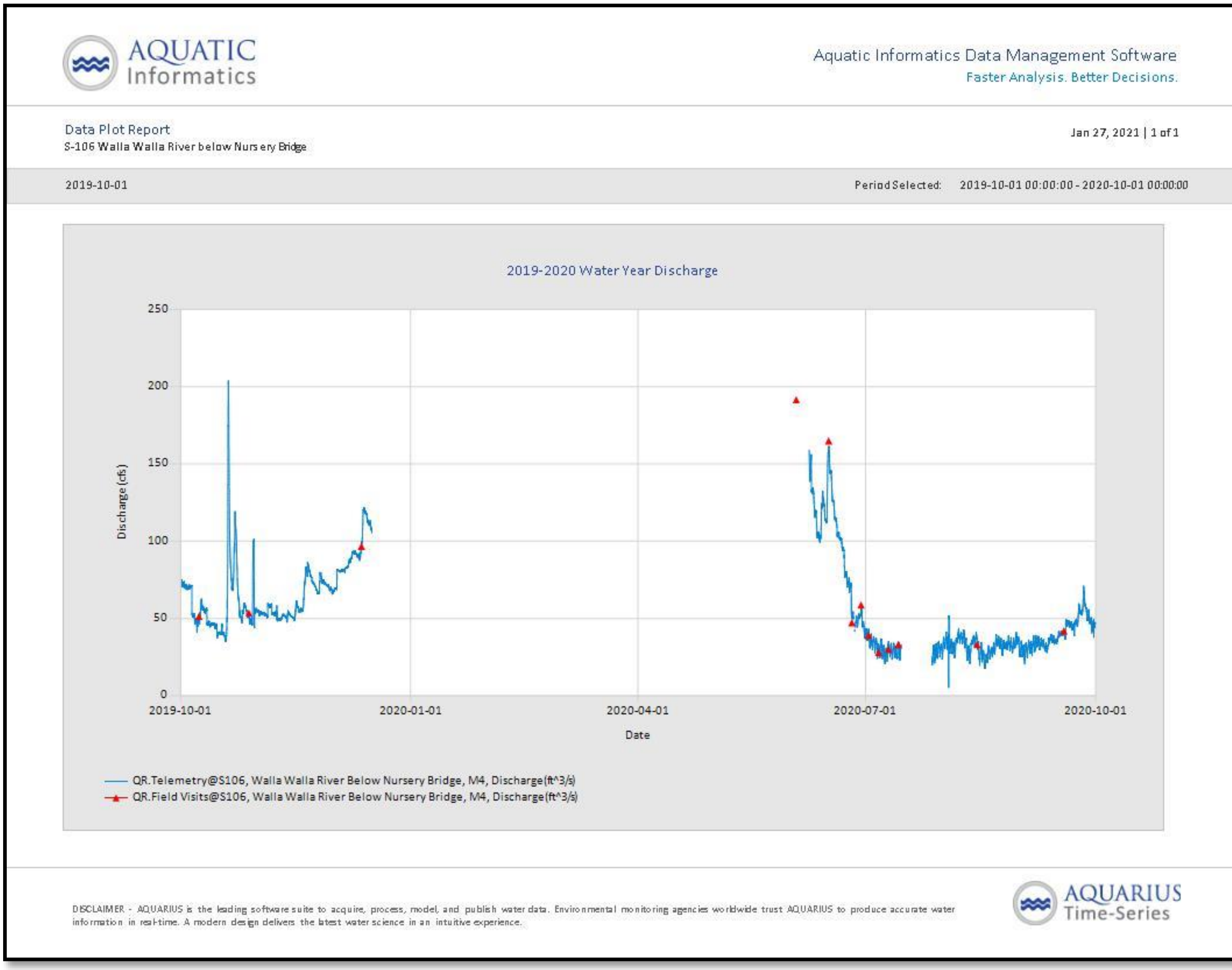


**Figure 9. Walla Walla River below Nursey Bridge flow data computed by processing stage data through the rating table shown in Figure 7. This site was installed in June 2019**

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.

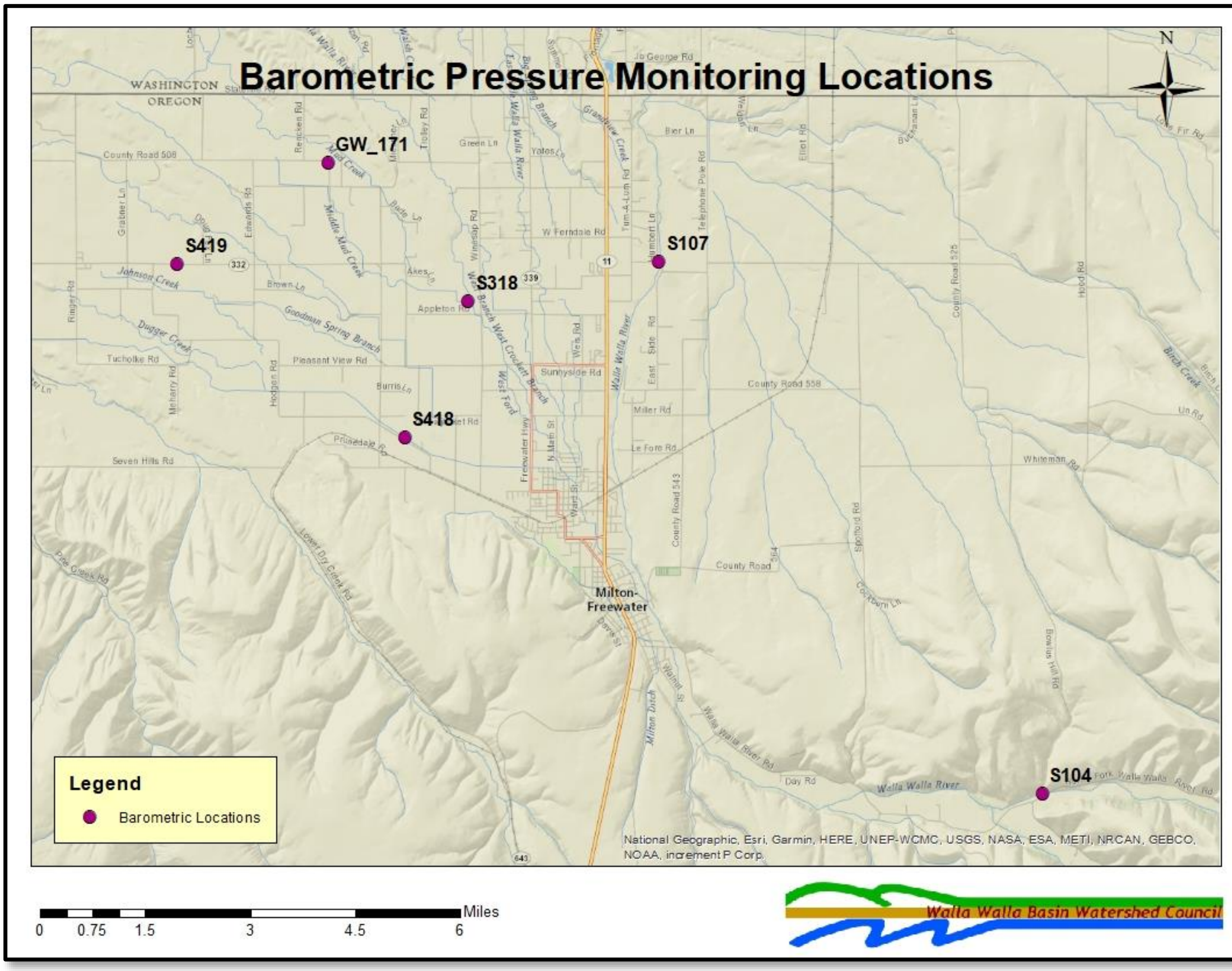


Figure 10. Map showing barometric pressure transducer locations in the Walla Walla Basin.

An 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 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 MarshMcBirney 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 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 stand-alone sites are updated quarterly.

### February 2020 Flood

The flood that started on February 6th, 2020 was one of the biggest Walla Walla River high flow events on record. A flood warning was issued by the National Weather Service within 6 hours before the Walla Walla River started to rise dramatically. Like most peak flows in mixed rain and snow watersheds, the event was caused by unseasonably warm weather and rain on snow in the upper portions of the basin. Extensive infrastructure and private property damage resulted, ranging from levee erosion, road washouts, diversions filled and blocked with debris and sediment, and flooding of homes and pastures (Figure 11). Local excavation crews were on stand-by at all the bridges in Milton-Freewater to remove any big trees that got caught on the bridges. Since the Walla Walla River had large debris suspended in the water, no high flow measurements were taken due to safety concerns, but stage measurements were taken at most of the stream gauging sites. Following the event, USGS conducted a channel survey at the Walla Walla River at Milton-Freewater (S-105) and produced a modeled peak flow of just under 10,000 cfs. Using the modeled peak, WWBWC flow data suggest the river sustained a discharge mean of almost 9,000 cfs for a full 24 hour period and exceeded 1,000 cfs for four days (Figure 12).

Most of the stream gauging sites experienced channel changes from the flood. The South Fork Walla Walla River near the confluence (S-103), Walla River at Tum-A-Lum Bridge (S-107), 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) experienced scouring while the North Fork Walla Walla River near the confluence (S-104) and Walla Walla River at Milton-Freewater (S-105) experienced deposition based on photos and measurements taken before and after the February flood event. The measurements taken after the event were used to create a shift in the rating curve. The damage to our equipment varied during the 2020 flood. The metal conduit housing the orifice line broke at a joint and the end of the orifice line was buried at South Fork Walla Walla River near the confluence (S-103). New metal conduit and orifice line were deployed under the bridge for better protection. The t-post, staff gauge, PVC, and pressure transducer at the North Fork Walla Walla River near the confluence (S-104) were washed away and new equipment were installed. The pressure transducer at Couse Creek at river mile 1.1 (S-142) moved during the flood event and was anchored back to its original position. The t-post, staff gauge, PVC, and pressure transducer at Dry Creek at Seven Hills Road (S-415) were washed away but were recovered after the event except for the pressure transducer and equipment were re-installed along the wing wall of the bridge for better protection.


**Figure 11. South Fork Walla Walla River near Confluence (S-103) during the 2020 flood.**

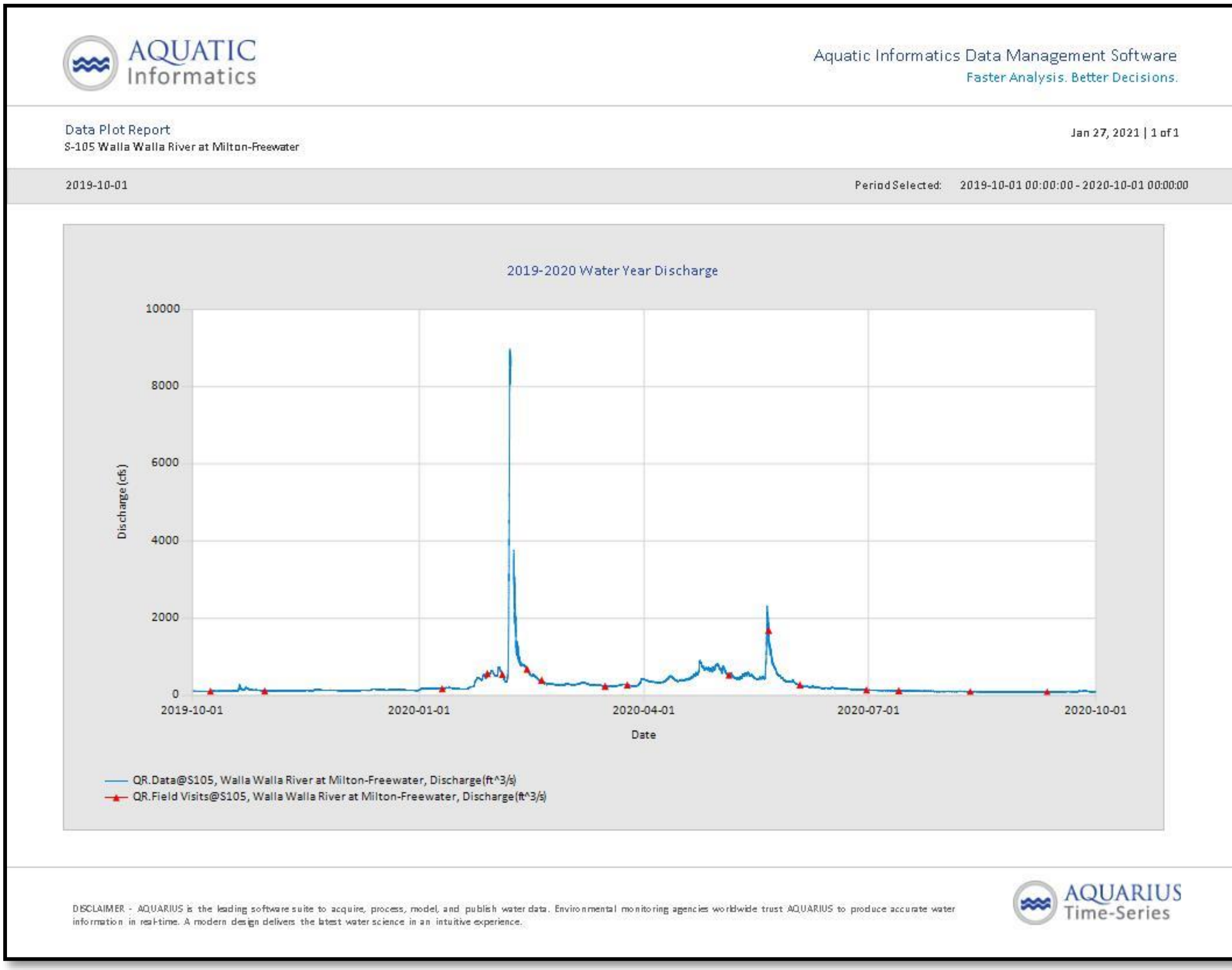


**Figure 12. Walla Walla River at Milton-Freewater (S-105) 2019-2020 Water Year Discharge**

## May 2020 High Flow Event

The Walla Walla River experienced a second high flow event on May 20th, 2020. Though this event wasn't as high as the flood in February, it was still powerful enough to change the shape of the channel at several of our stream gauging sites. Certain sites experienced changes to the rating and were adjusted based on new discharge measurements. The South Fork Walla Walla River near the confluence (S-103), the North Fork Walla Walla River near the confluence (S-104), and Dry Creek at Seven Hills Road (S-415) experienced scouring while the Walla Walla River at Tum-A-Lum Bridge (S-107), Couse Creek at river mile 1.1 (S-142), and Pine Creek at Schubert Road (S-416T) experienced deposition based on photos and measurements taken before and after the May event. The measurements taken after the event were used to create a shift in the rating curve.

## Walla Walla River Summer Base Flows

Summertime base flows in the Walla Walla River are supplied, in large part, by basalt groundwater spring inputs in the upper watershed. The South Fork Walla Walla River (S-103) produces the majority of Walla Walla River base flows, contributing between 110 and 100 cfs during August and September, the lowest flow months of the 2020 water year (Figure 13). The North Fork Walla Walla River (S-104) produced 3 to 9 cfs during the low flow season during August and September (Figure 14).

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Data Plot Report
S-103 South Fork Walla Walla River near Confluence

Jan 27, 2021 | 1 of 1

2019-10-01

Period Selected: 2019-10-01 00:00:00 - 2020-10-01 00:00:00

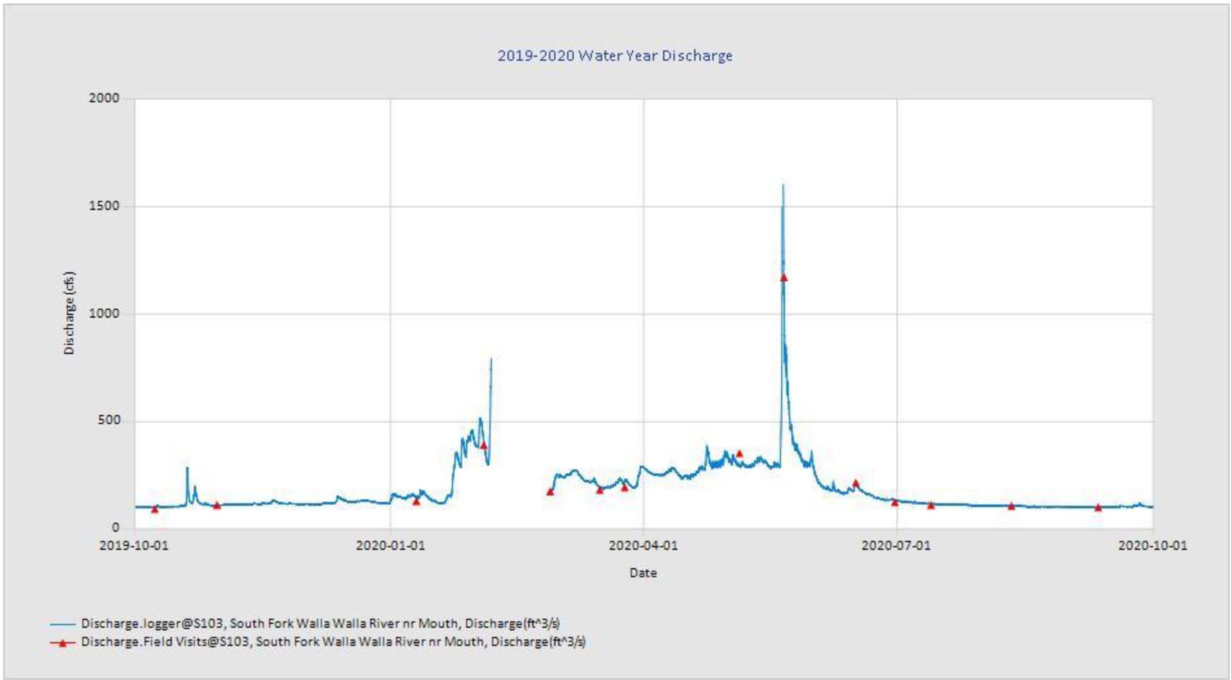




**Figure 11. South Fork Walla Walla River near Confluence (S-103) 2019-2020 Water Year Discharge**

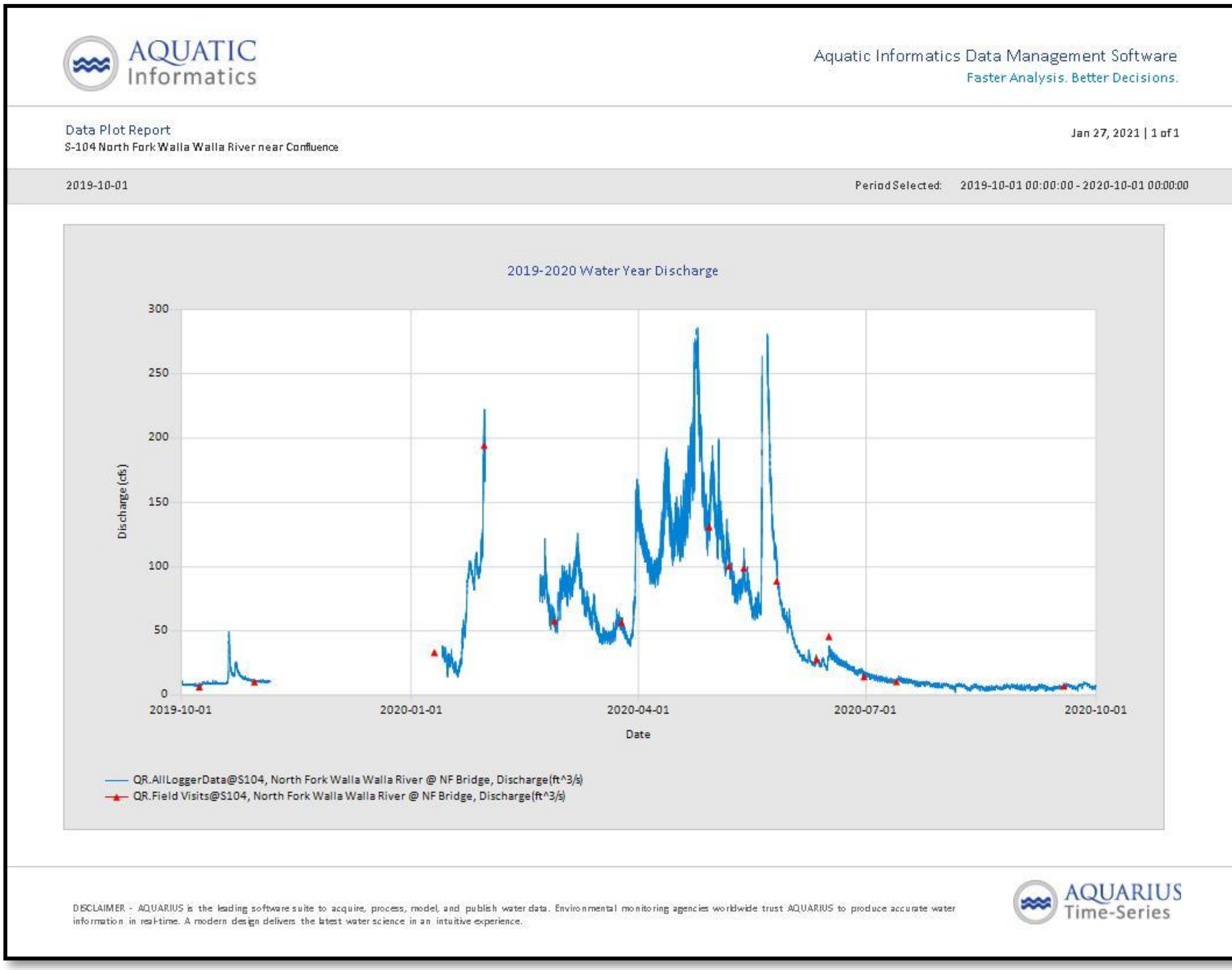


**Figure 14. North Fork Walla Walla River near Confluence (S-104) 2019-2020 Water Year Discharge**

Downstream of the North and South Fork confluence, the Walla Walla River at Milton-Freewater (S-105) had daily mean base flows ranging from 91 to 110 during August and September, with the lowest daily mean flow of 91.27 cfs occurring on 09/12/2020 (Figure 15). Summer low flows in 2020 were similar to the lows documented in 2016 but about 10-15 cfs lower than the summers of 2017-2019. Table 2 shows the lowest daily mean flow values with corresponding dates at the Milton-Freewater gauge site during the last 6 summers.

| 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 |

**Table 2. Lowest daily mean flows in the Walla Walla River at Milton-Freewater (S-105) during water years 2015-2020.**

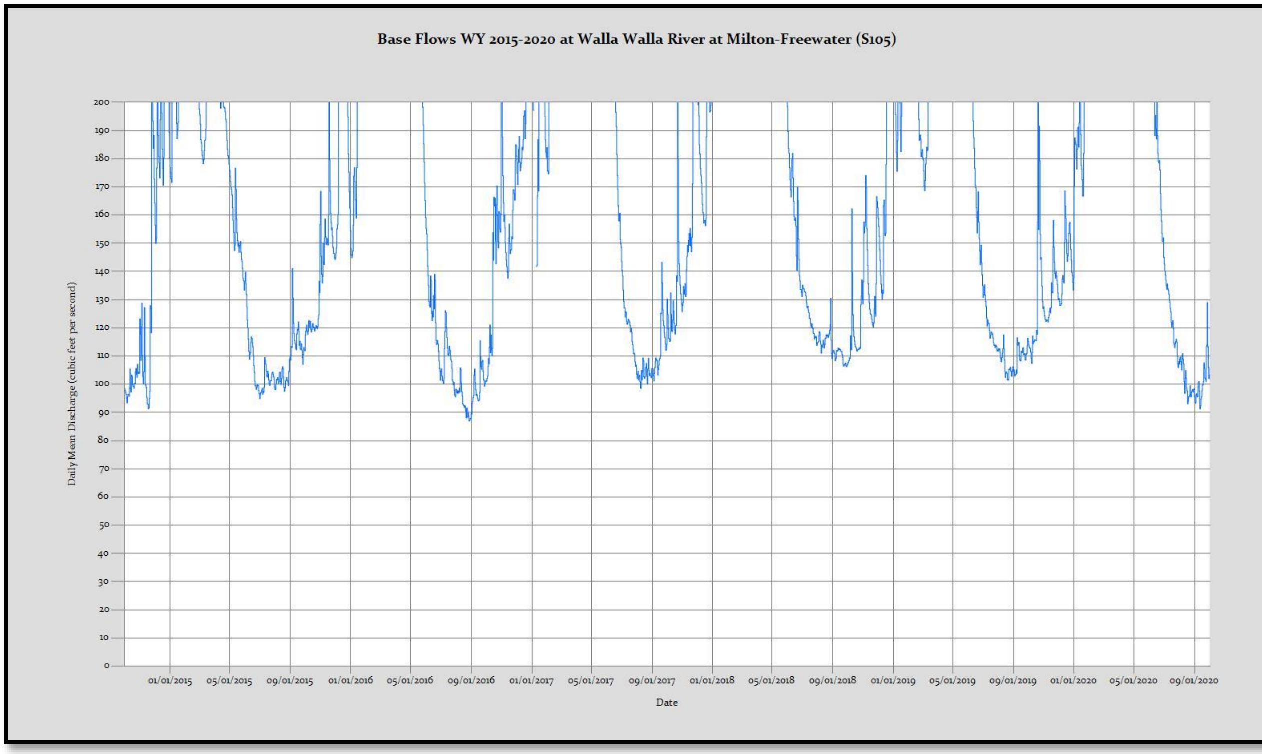


Figure 15. Seasonal low flows in the Walla Walla River at Milton-Freewater (S-105) during water years 2015-2020.

## 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 2020, June flows dropped from 160 cfs to 40 cfs while July and August flows fluctuated from 20-40 cfs (Figure 9).

## 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 months. In 2020 however, landowners reported that Couse Creek had a trickle of water flowing throughout the summer. Tributaries also experienced high flows during the February 2020 event. Couse Creek peaked just over 800 cfs. The peak at Pine Creek at Schubert Road was above our rating curve based on our high measurement of 250 cfs but we predict the peak was well over 400 cfs. Equipment at Dry Creek was washed away during the flood so high flow stage data are unavailable, but Dry Creek and Pine Creek are similar systems so it is likely that Dry Creek crested above 400 cfs as well.

## Aquifer Recharge and Spring Performance Analysis

During the 2020 water year, fourteen recharge sites operated, infiltrating total of 5173 acre-feet including conveyance seepage losses through the irrigation ditches. The irrigation ditches were shut off for an extra month due to flood damage to the Little Walla Walla Diversion, therefore less recharge water was put into the ground compared to last year. Ongoing monitoring of spring performance and groundwater-surface water interactions aids in the adaptive management of these sites.

## 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 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 is 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

## Explanation of Data Gaps during the 2020 Water Year

| Site ID | Site Name | Gap Dates | Explanation |
|---|---|---|---|
| S-103 | South Fork Walla Walla River near Confluence | 2/6/20 – 2/27/20<br>5/5/20 – 5/11/20 | Damage to equipment during flood event<br>Unusable Data |
| S-104 | North Fork Walla Walla River near Confluence | 12/16/19 – 1/13/20<br>1/30/20 – 2/21/20 | Logger Failure<br>Damage to equipment during flood event |
| S-106 | Walla Walla River below Nursery Bridge | 12/16/19 – 6/8/20<br>6/16/20 – 6/17/20<br>7/15/20 – 7/22/20 | Seasonal Gauge<br>Battery Failure<br>Battery Failure |
| S-142 | Couse Creek at R.M. 1.1 | 6/19/20 – 9/30/20 | Equipment was out of the water |
| S-318 | Fruitvale Ditch | 12/29/19 – 1/2/20 | Battery Failure |
| S-415 | Dry Creek at Seven Hills Road | 1/15/20 – 2/27/20 | Damage to equipment during flood event |
| S416T | Pine Creek at Schubert Road | 2/6/20 – 2/10/20<br>4/13/20 – 4/14/20<br>4/26/20 – 4/27/20<br>4/29/20 – 4/30/20 | Damage to equipment during flood event<br>Unusable Data<br>Unusable Data<br>Unusable Data |