BPA Project No. 2000-039-00 - CCR-232426
BPA Project Title: Walla Walla Basin Salmonid Monitoring and Evaluation Project
Contractor: Confederated Tribes of the Umatilla Indian Reservation

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Project: Walla Walla River Stream Gauge Monitoring and Data Distribution

Annual Report

2013

Submitted: February 27th, 2014 (Rev. 3/1/14)

Prepared by,
The Walla Walla Basin Watershed Council

In cooperation with

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Introduction

Overview

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 out across the valley floor. Historically, these distributary channels provided off-channel habitat for fish and other wildlife, but also allowed for a significant amount of water to seep into the soil and recharge the valley's alluvial aquifer system. The decline of the shallow aquifer has been document 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.

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. The network includes flow monitoring sites in the Walla Walla River, its tributaries, springs, small order streams, and irrigation ditches. Six near real time gauge stations transmit data to 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.

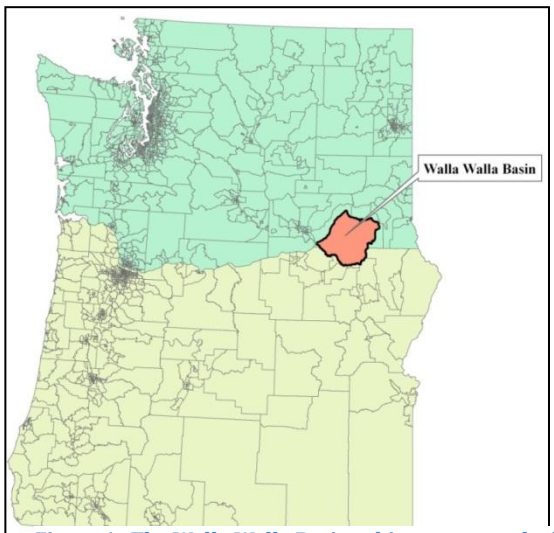


Figure 1. The Walla Walla Basin, a bi-state watershed.

The Walla Walla Basin Watershed Council, Walla Walla Watershed Management Partnership, Washington Department of Fish and Wildlife (WDFW), and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) in 2011 began a local discussion in regards to the Washington Department of Ecology (WDOE) pulling back from its' commitment to monitor the stream discharge on the Walla Walla River at Pepper Bridge and Beet Road (through the summer low flow period). As fish enhancement projects focused on listed species continue to occur within the Walla Walla Watershed the Walla Walla River discharge information continues to be a vital tool in the understanding of how much water is available and when it's available within the watershed.

Surface Water Monitoring Sites

Two new monitoring sites were established in 2013, the Pierce RV Park (S125) site and at the McDonald Road bridge (S119) site. Both new locations also have pit tag arrays extending across the Walla Walla River channel. The McDonald Road Bridge site has been listed as an area of concern by the WDFW during low instream flow periods. The location downstream of the last major diversion (Garden City) and upstream of the Walla Walla River and Touchet River confluence, typically during

low flow periods has flow levels below 20 cubic feet per second (cfs). In 2012 the Bergevin-Williams Diversion which was directly downstream of the McDonald Road Bridge was moved upstream as part of a diversion consolidation project. Of the 20 cfs in river at McDonald Road Bridge a portion of that flow was taken at the Bergevin-Williams diversion leaving very low surface flow remaining instream below the diversion. With the last major diversion upstream of McDonald Road Bridge starting in 2013 additional low surface flow pressure was placed on the McDonald Road reach.

The flow data collected in the 2013 season from the two new sites, S119 and S125 will be used to analyze with the pit tag data to look for correlations between salmonid movement stream flows. With the added two monitoring sites the total monitoring sites rose to 7 sites (Figure 2). Five sites on the mainstem Walla Walla River and one site on the North Fork Walla Walla River near its mouth and one site on the South Fork Walla Walla River near its mouth.

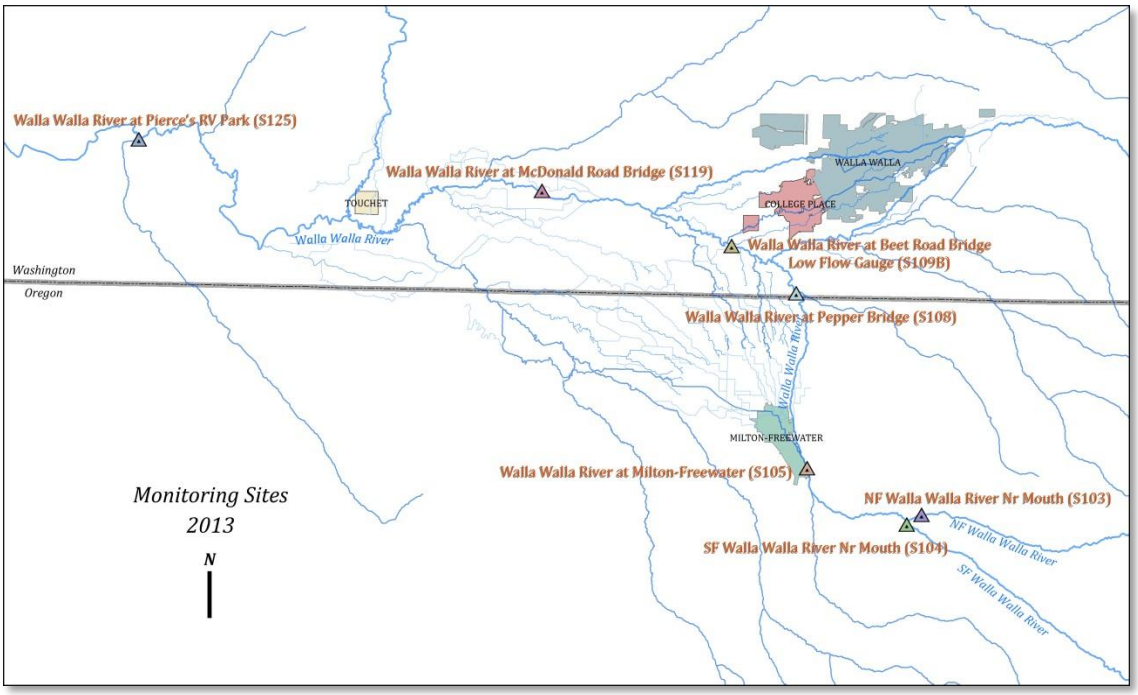


Figure 2 Monitoring site locations

Data Access

Discharge data for six near real time gauging stations are updated hourly and available on our website at www.wwbwc.org. At our other surface monitoring stations, stage data is logged every half hour and is downloaded quarterly. The data are rated to produce discharge values, which are also made available on our website. Figure 4 shows a screenshot of our monitoring locations map online and links to download hydrographs and .csv files of our surface water data.

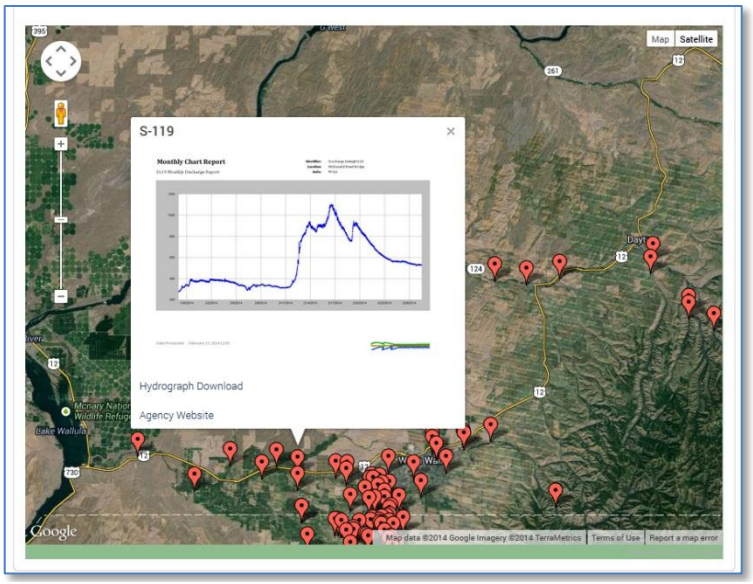


Figure 3 A screenshot of the Surface Water Monitoring Map on the www.wwbwc.org website.

Methods

In 2013, the *WWBWC Standard Operating Procedures – Version 1.2* was written based on USGS and Washington and Oregon state methods for surface water monitoring. Please see Appendix A for the Surface Water Monitoring portion of the standard operating procedures document.

The WWBWC uses electronic data loggers manufactured by Campbell Scientific, TruTrack, Solinst, WaterLog, and In-Situ, Inc to record gauge height. Some of these loggers record the water level directly, and some are pressure transducers. Most sites record stage every 30 minutes. On a quarterly schedule, a monitoring technician visited each site to read the staff gauge and take a manual discharge measurement using either a FlowTracker Handheld Acoustic Doppler Velocimeter or Marsh-McBirney Flo-Mate 2000 pressure sensor (See Figure 4). Also during the quarterly visit data were downloaded, site maintenance conducted (for example, weeds or other debris removed), and a photograph was taken. We also collected conductivity and temperature

Figure 4 WWBWC staff taking a flow cross section on the Walla Walla River.

data using a handheld conductivity meter (YSI 30). Further details regarding site visit protocols can be found in Appendix A.
Most of the surface water monitoring sites have been surveyed with survey-grade GPS units, providing accurate longitude, latitude and elevation. GPS coordinates and elevation for the newest sites in the network was recorded with a handheld unit (Garmin eTrex) and will be properly surveyed as time allows.

Data Processing and Analysis

Data were processed using the 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. This approach to data processing replaces our previous method of manually correcting logger data in MS Excel and, we believe, results in more accurate stage data.

Stage vs. discharge relationships were developed using the AQUARIUS rating curve tool. The tool plots stage data with manual discharge measurements to produce a best-fit curve equation describing the relationship (Figure 5). Based on that equation, a rating table is created to calculate

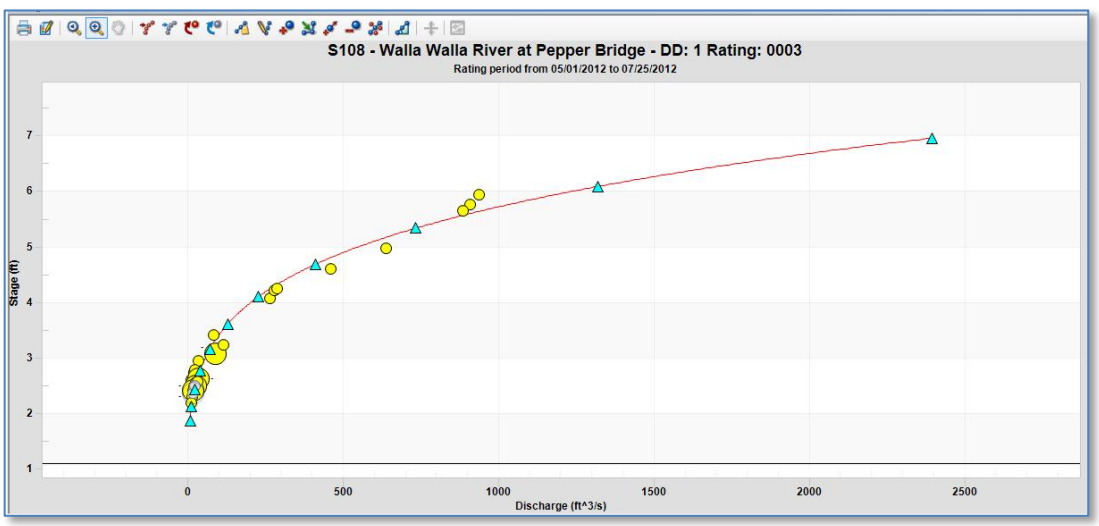


Figure 5 Rating Curve for Pepper Bridge (S-108) during the 2012-2013 monitoring period. Yellow dots represent manual discharge measurements. Blue triangles show rating points created by AQUARIUS based on a best-fit equation relating stage to manual discharge measurement.

discharge values for each datum in the logger file and produce a continuous discharge signal for the monitoring period (Figure 6). The AQUARIUS rating curve tool allowed us to modify, shift, and re-fit rating curves as site conditions changed, resulting in higher quality, more defensible discharge data. Figure 6 displays the flow data from Pepper Bridge (S-108) whose rating curve is shown in Figure 5. Discharge values higher than manual measurements are produced by the rating equation and are 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 are

superimposed onto the flow data in the output graphs so that a viewer can see which calculated flows are above those measurements.

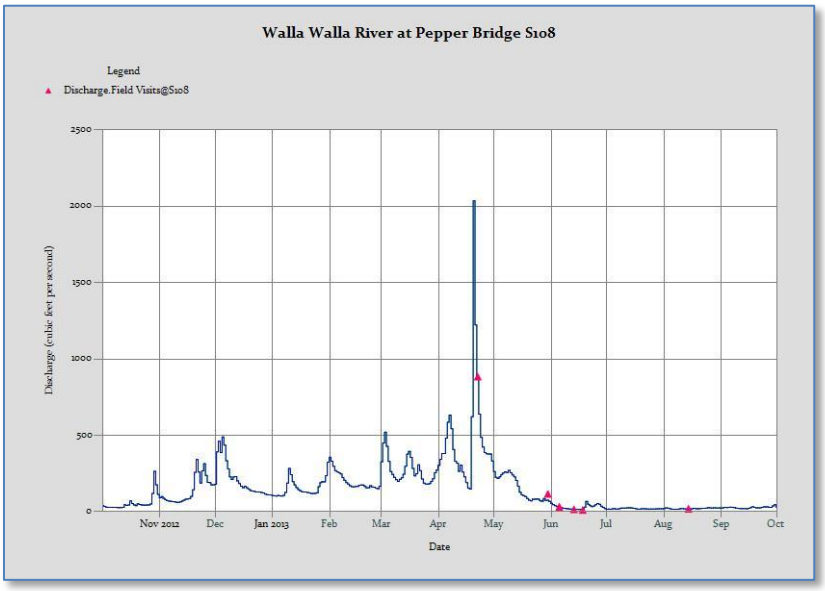


Figure 6 Data from the Walla Walla River at Pepper Bridge. Red triangles represent manual discharge measurements taken there.

At sites instrumented with non-vented pressure transducers, water level data must be compensated for atmospheric pressure. Using AQUARIUS, water level data were corrected by subtracting barometric pressure collected by one of four transducers located throughout the valley.

An important part of our quality assurance plan is data grading and approval. We grade 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 receive 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 are graded based on site conditions. When the gauge can be easily read, the data point is rated "Excellent" or "Very Good." If water turbulence or other conditions make accurate reading difficult, the data point will be rated "Good," "Fair," "Poor," or "Unusable."
- Manual discharge measurements taken with the FlowTracker are graded based on the instrument's built-in quality control report. Based on the " percent overall uncertainty" in the report, we grade the measurement as follows:

- 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 are graded based on site conditions.
- Flow data processed through the rating curve are graded based on the quality of stage data in addition to the fit of the curve and site conditions.

Results and Discussion

Hydrographs for the seven surface water monitoring sites are available in Appendix B. Installation of the S125 gauge occurred on the 9th of July and the installation of the S119 gauge occurred on the 30th of July. Both gauges were not in place collecting data as the mainstem Walla Walla River dropped to its base flow. The analysis of data collected upstream at the low flow Beet Road gauge during the first week of July confirmed the decrease in available Walla Walla River water. During the low flow months there was an average of 15 to 20 cfs loss between the low flow Beet Road gauge and the McDonald Road gauge.

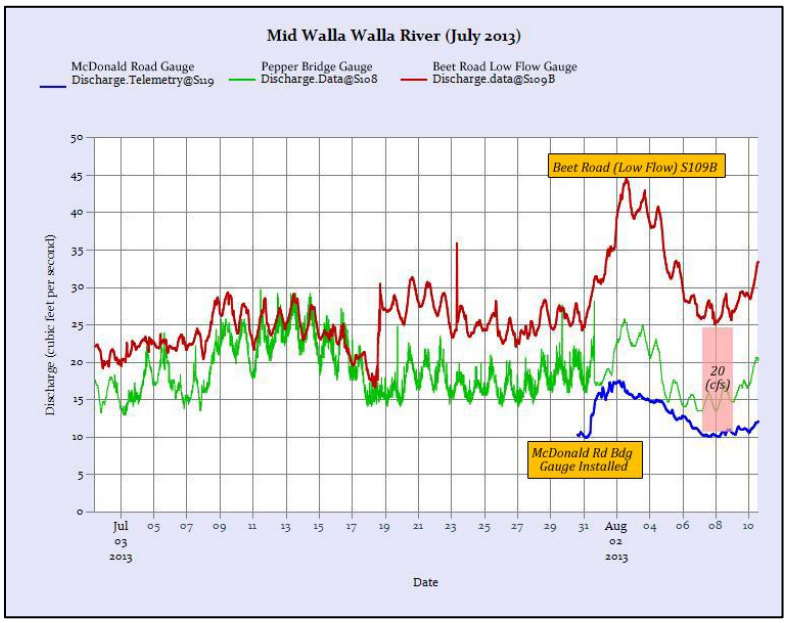


Figure 7 Mid Walla Walla River Gauges

The loss is due to irrigation withdrawals and streambed losses through seepage. If the rate of difference between the two gauge sites holds through the late June/ early July period the discharge at McDonald Road would be on average 5 cfs. The upcoming year's data collection should provide additional understanding of the discharge relationship between the "mid" Walla Walla River gauge sites.

Summary

WWBWC surface water monitoring efforts continue to provide high quality data to track the success of restoration projects, support surface and groundwater modeling projects, and guide future water management decisions.

Using surface water monitoring data collected during this project period, WWBWC worked with Jacob Sherberg, Oregon State University and GeoSystems Analysis Inc. to run model scenarios using the Integrated Water Flow Model (IWFM). An analysis of model outputs entitled *Design of Shallow Aquifer Recharge for Agricultural and Ecological Water Supply* is currently in review for publication.

As local collaborators and Washington's Office of Columbia River develop strategies to address water shortage in the Walla Walla basin, they are considering expansion of the IWFM to include regions northeast of the current model boundary. Monitoring data collected by WWBWC would be an integral component of model expansion.

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.

Appendix A

Excerpt from *WWBWC Standard Operating Procedures – Version 1.2*, *pages 20-28*

Surface Water Monitoring

Note: These procedures are based on and modified from:

Myers, J. 2009. Standard Operation Procedure for Conducting Stream Hydrology Site Visits. Version 1.0. Washington Department of Ecology – Environmental Assessment Program. EAP057.

ODEQ, 2009. Water Monitoring and Assessment Mode of Operations Manual. Watersheds Quality Monitoring Field Sampling Standard Operating Procedure – Laboratory and Environmental Assessment Division. Version 3.2

Rantz, S. E., and others. 1982 Measurement and Computation of Streamflow: Volume I. Measurment of Stage and Dischage. U.S. Geological Survey Water-Supply Paper 2175.

Rantz, S. E., and others. 1982 Measurement and Computation of Streamflow: Volume II. Computation of Discharge. U.S. Geological Survey Water-Supply Paper 2175.

Shedd, J. R. 2011. Standard Operating Procedure for Measuring and Calculating Stream Discharge. Version 1.1. Washington Department of Ecology – Environmental Assessment Program. EAP056.

Shedd, J.R. 2008. Standard Operating Procedure for Measuring Gage Height of Streams. Version 1.0. Washington Department of Ecology – Environmental Assessment Program. EAP042.

Equipment

- Four foot top set wading rod
- Mechanical Current Meter (Price AA or pygmy), Swoffer, Marsh-McBirney Velocity Meter, or SonTek Acoustic Doppler
- AquaCalc or FlowTracker computer
- Bridge Board
- Sounding Reel
- Columbus sounding weight
- Tape Down Measuring Tape (with weight attached)
- Laser Level
- Stadia Rod
- NIST Thermometer
- YSI-30 Temperature and Conductivity Meter
- Measuring tape (100’ or 200’)
- Chest or Hip Waders
- Laptop Computer
- Cables for connecting to Data logger
    - LT-300 Cable
    - LT-500 Cable
    - WaterLog Cable or Memory Card
    - Campbell Scientific Cable or Card
- Pen or Pencil
- Data sheets

Vertical Stage Measurement

Vertical stage measurements are obtained from mounted staff gauges. Most staff gauges used by the WWBWC are graduated in 0.01 feet increments. Measurements should be recorded to 0.01 feet resolution. Below is a photo of a typical WWBWC staff gauge.

1. Read the water level on the staff gauge to the nearest 0.01. If the water level is fluctuating during the reading take the average water level and note the range of fluctuation (1.25 ±0.04 where 1.25 is the average water level and 0.04 is the range above or below the average).
2. If water level fluctuations are excessive you can create a temporary stilling well around the staff gauge to get a more accurate reading. You can use a 5-gallon bucket with the bottom cut out for the temporary stilling well.
3. Take the necessary time to obtain an accurate staff gauge reading – both the water level and uncertainty.
4. Record the date, time and measurement data on the data sheet.

Tape-Down Stage Measurement

Measuring tape-down stage involves lowering a measuring tape with a weight attached to the end to the water surface from a reference point. Often the reference point is a metal washer attached to a bridge railing.

1. Locate the reference point
2. Lower the weighted tape down to the water surface. The weight should only just touch the water surface creating a small "V" shape on the water surface.
3. Read the tape at the edge of the reference point and record to the nearest 0.01. Include uncertainty caused by wave action or wind.
4. Because the weight is attached to the end of the measuring tape, record the correction factor that needs to be applied to the reference point reading.

Laser Level Stage Measurement

Laser levels are used to measure stage height from a known elevation and allow a check on the vertical staff gauge elevation.

1. Place the laser level on the platform of known elevation.
2. Confirm that the platform's elevation has not changed by measuring the elevation of reference marks/points with the stadia rod. Record data on the Stream Gage Logger Notes datasheet. Reference marks or points are placed near the laser level platform and are typically bolts in large boulders or other stable objects. Compare reference point elevations to ensure platform has not moved.
3. Place the stadia rod as close as possible to the primary staff gauge (typically the vertical staff gauge).
4. Read the laser level using the laser sensor on the stadia rod. Record level.
5. Observe and record the water level (including level of uncertainty) on the stadia rod.
6. Complete the calculations on the Stream Gage Logger Notes datasheet to compute the laser level stage. For the calculations you take the laser rod reading minus the depth of water and that equals the differential laser to water surface. Take the elevation of the laser beam minus the differential to get the laser level stage.

Discharge Measurement (Wading)

1. Select an appropriate location to perform a discharge measurement (refer to Rantz, 1982 for full details). A good cross section will typically have the following characteristics: relatively straight channel with parallel edges, defined edges, uniform shape, free of vegetative growth and large cobbles or boulders, free of eddies, slack water and turbulence, depths greater than 0.5 feet, velocities greater than 0.5 feet per second that are evenly distributed, close to the gauging station. Often some or many of the above criteria cannot be met. The best available cross section location should be chosen.
2. Stretch a measuring tape across the channel where the measurement will be taken. The tape should be perpendicular to as much of the flow as possible to reduce oblique flow angles.
3. Determine the width of the wetted channel and divide the width into 25-30 segments. Cells should be divided such that each cell has approximately 5% of the total flow and no more than 10%. Segments should be shorter where flow is more concentrated or the bottom is irregular. The width of any segment should not be less than three tenths of a foot (0.3 feet).
4. Start at either the right or left edge of water (REW or LEW). Record tape distance for edge of water.
5. Set wading rod at location for the first measurement. Determine the depth of water.
6. If depth is less than 1.5 feet use the one point method of measuring velocity at 0.6 of the depth.
7. If depth is equal to or greater than 1.5 feet use the two point method of measuring at both 0.2 and 0.8 of the depth and average the velocities.
8. In cases where there is no logarithmic relationship to the velocities in the water column (this is when the 0.2 velocity is less than the 0.8 velocity or the 0.2 velocity is more than twice the 0.8 velocity) the three point method should be used. The three point method measures at 0.2, 0.6 and 0.8. The 0.2 and 0.8 velocities should be averaged and then that result should be averaged with the 0.6 velocity. This weights the 0.6 velocity at 50% and the 0.2 and 0.8 each at 25%.
9. Each velocity measurement should average velocity data for 40 seconds to address variations in water velocity over time at a single measurement point.
10. If water flow direction is not perpendicular to the measuring tape the meter should be pointed directly into the direction of flow. Use the data sheet to measure the angle coefficient (and apply a correction to the velocity) for velocity measurements not perpendicular to the

measuring tape (see figure below). Align the point of origin on the measuring tape. Rotate the data sheet until the opposite long edge is parallel to the direction of flow (the same direction the meter is pointed). The angle coefficient is read where the measuring tape intersects the data sheet. Multiply the velocity measurement by the angle coefficient to calculate the perpendicular velocity.

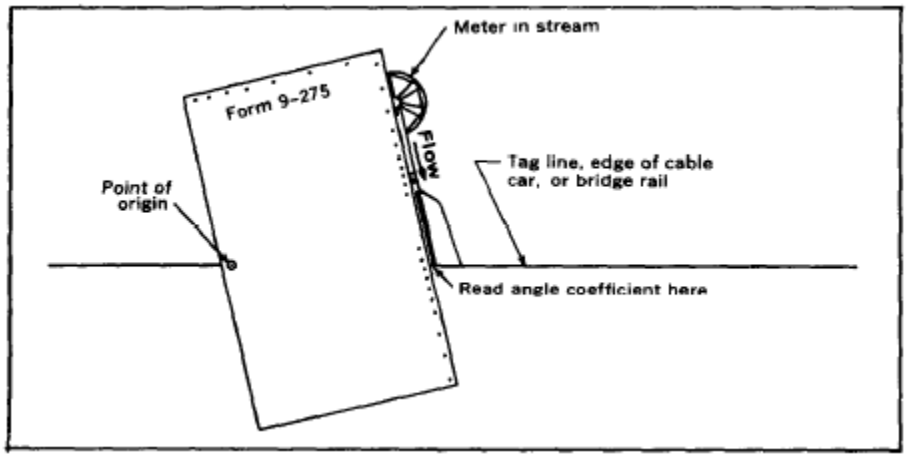


Figure taken from Rantz, 1982.

11. Repeat steps 5-10 for each of the subsequent measurement locations across the cross section until you reach the opposite edge of water.
12. Rate the measurement on a scale from excellent to poor. Rating can be based upon observed conditions as well as information from the AquaCalc file. Observations that can influence the rating of a measurement include (but are not limited to): channel characteristics, proximity to bridges or other structures, number and degree of oblique current angles, condition of equipment, weather, water level bounce and velocity pile up on wading rod and others. Use observations and professional judgment in rating a measurement. Measurements are rated excellent if the discharge value is with 2% of the actual flow value, good if within 5%, fair if within 8% and poor if within 13%.

Discharge Measurement (Bridge)

This section will describe differences between wading and bridge discharge measurements. Follow the procedure for wading discharge measurements above with the following changes:

1. The choice of cross section locations is obviously limited when measuring from a bridge.
2. Use a bridge board, sounding reel, and Columbus weight instead of a wading rod
3. Increase velocities measurements near bridge piers
4. Use the one point method on depths less than 2.5 feet and the two point method on depths equal to or greater than 2.5 feet.
5. Sometimes, water flow direction is all oblique to the bridge. In these cases multiply the raw average velocity of the measurement by the cosine of the angle between current direction and the cross section.

Discharge Calculation

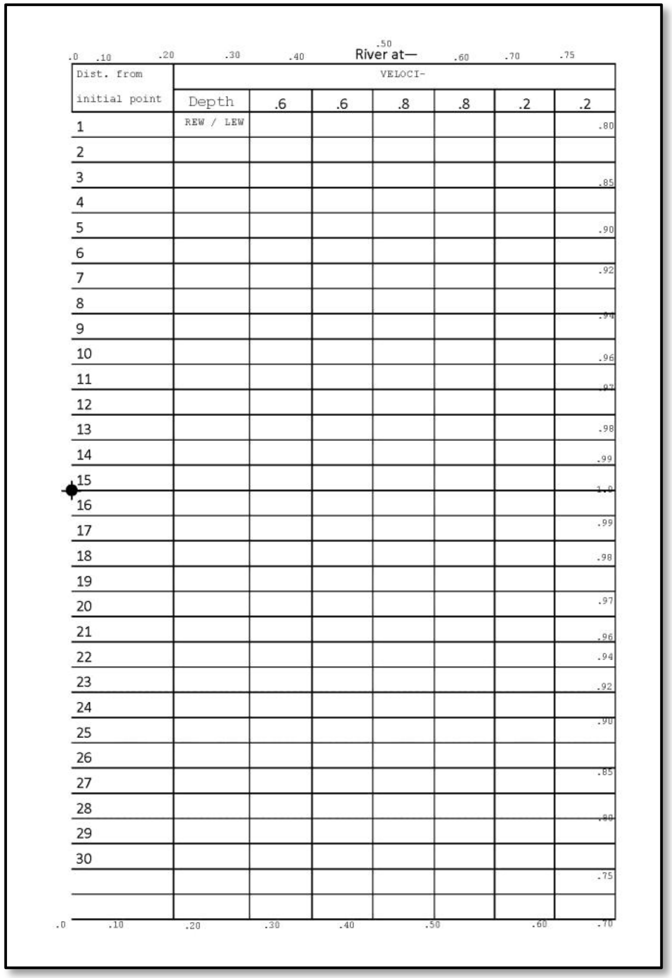
Discharge is calculated using the mid-section method in which each section extends halfway between measurement locations. The flow through each section is calculated by multiplying the average velocity with the cross-sectional area of the section. See references for a complete description of discharge calculations.

Station Visit (without Discharge Measurement)

River gauging stations and real-time stations are visited twice a month to collect staff gauge readings, perform any site maintenance and download data. These visits do not include a discharge measurement.

1. Open gauge station and retrieve data sheet.
2. Record primary gauge reading in the PGI row (see above for procedure). This is often a vertical staff gauge.
3. Record secondary gauge reading in the SGI row (see above for procedure). Often this is a tape-down measurement.
4. Record auxiliary gauge reading if present in the AUX row. Used for alternate staff gauge readings.
5. Record water temperature from the gauge station.
6. Record water temperature with the NIST thermometer or the YSI-30.
7. Record air temperature from the gauge station.
8. Record air temperature from the NIST thermometer or the YSI-30.
9. Record battery volts.
10. Download data from the data logger and record on the data sheet.
11. Purge the pressure sensor (if equipped).
12. Record battery minimum and maximum.
13. Reset Stats screen.
14. Note any problems, maintenance issues or other information at the bottom of the data sheet.
15. Close and secure the gauge station.

Discharge Notes Data Sheet

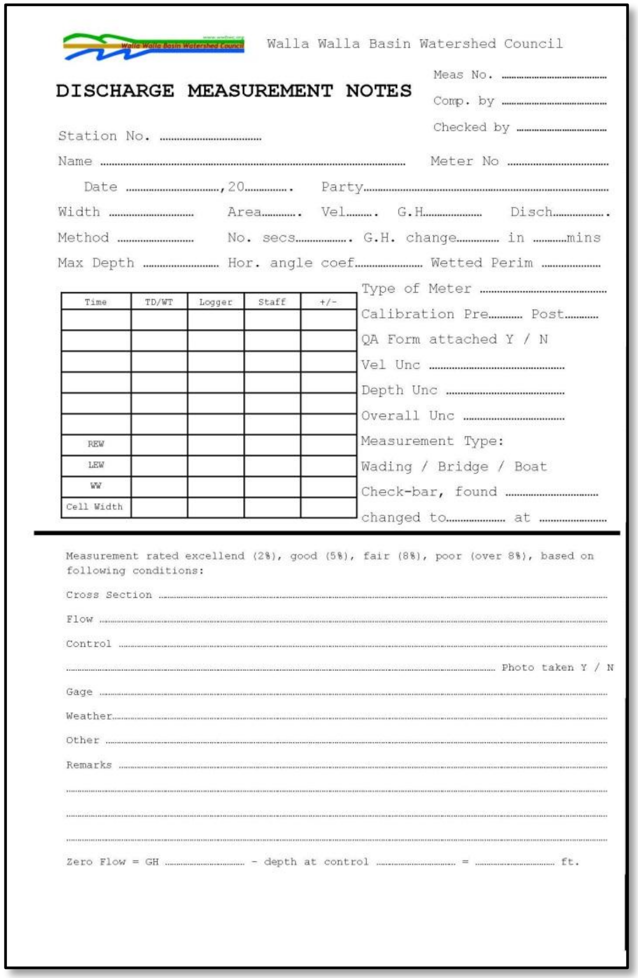


.0 .10 .20 .30 .40 .50 River at— .60 .70 .75

Dist. from		VELOCI-					
initial point	Depth	.6	.6	.8	.8	.2	.2
1	REW / LEW						
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

.80 .85 .90 .92 .94 .96 .97 .98 .99 1.0 .99 .98 .97 .96 .94 .92 .90 .85 .80 .75 .70

.0 .10 .20 .30 .40 .50 .60 .70



Walla Walla Basin Watershed Council

DISCHARGE MEASUREMENT NOTES

Meas No. ……………………

Comp. by ……………………

Checked by ……………………

Station No. ……………………

Name …………………………………………… Meter No ……………………

Date ……………………, 20………. Party……………………………………

Width …………… Area………. Vel……. G.H…………… Disch…………….

Method …………… No. secs…………. G.H. change………. in ………mins

Max Depth …………… Hor. angle coef…………… Wetted Perim ……………

Time	TD/WT	Logger	Staff	+/-
REW				
LEW				
WW				
Cell Width				

Type of Meter ……………………

Calibration Pre………. Post……….

QA Form attached Y / N

Vel Unc ……………………

Depth Unc ……………………

Overall Unc ……………………

Measurement Type:

Wading / Bridge / Boat

Check-bar, found ……………………

changed to…………… at ……………

Measurement rated excellend (2%), good (5%), fair (8%), poor (over 8%), based on following conditions:

Cross Section ……………………………………………………

Flow ……………………………………………………

Control ……………………………………………………

…………………………………………………… Photo taken Y / N

Gage ……………………………………………………

Weather……………………………………………………

Other ……………………………………………………

Remarks ……………………………………………………

……………………………………………………

……………………………………………………

……………………………………………………

Zero Flow = GH …………… - depth at control …………… = …………… ft.

Gaging Station Log Data Sheet

Walla Walla Basin Watershed Council

Gaging Station Log

Station Name: _____ Station Number _____ Water Year _____

Party												
Date												
Time												
PGI												
SGI												
AUX												
LOGGER												
H20 TEMP.												
THERMISTOR												
AIR TEMP.												
THERMISTOR												
BATT. V												
REPLACED (Y / N)												
DOWNLOADED (Y / N)												
PURGE (Y / N)												
SYNCED (Y / N)												
SYSTEM RESETS												
BATT. V (MIN/MAX)												
RESET STAT SCREENS (Y / N)												
MEASUREMENT (Y / N)												
MGH												
MEASURED Q												
PROFESSIONAL RATING												
METHOD												
LOCATION												
MAX DEPTH												
MAX VELOCITY												
PZF												
CONTROL (LOCATION, CONDITION, ETC.)												

Stream Gage Notes Data Sheet

Walla Walla Basin Watershed Council

WWBWC Stream Gage Logger Notes

Station name .....

Station # ..... Party .....

DATE					
TIME (PST)					
LOGGER					
STAFF GAGE					
WIRE WEIGHT					
CHECK BAR					
TAPE DOWN					
CORR. FACTOR					
CORRECTED TD					
TD RP ELEVATION					
CORRECTED TD					
= WS ELEV @ TD					
LASER: LASER ROD READING					
- WATER SURFACE, ROD READING					
= DIFFERENTIAL, LASER TO WATER SURFACE					
LASER BEAM ELEVATION					
DIFFERENTIAL					
= STAGE					
WATER TEMP				ELEVATION	READING
THERMISTER			LL RP1		
AIR TEMP			LL RP2		
THERMISTER			LL RP3		

Batt V ..... Min ..... Max .....

Reset Stats Y / N Batt Replaced Y / N

GOES Time OK Y / N

Data Downloaded Y / N .NEW File Erased Y / N

Desiccant Condition ..... Changed Y / N

CSG checked Y / N

HWM ..... ft on stick + Ref Elev ..... ft

= HWM Elev ..... ft. Cleaned Y / N

Added Cork Y / N

Remarks:.....

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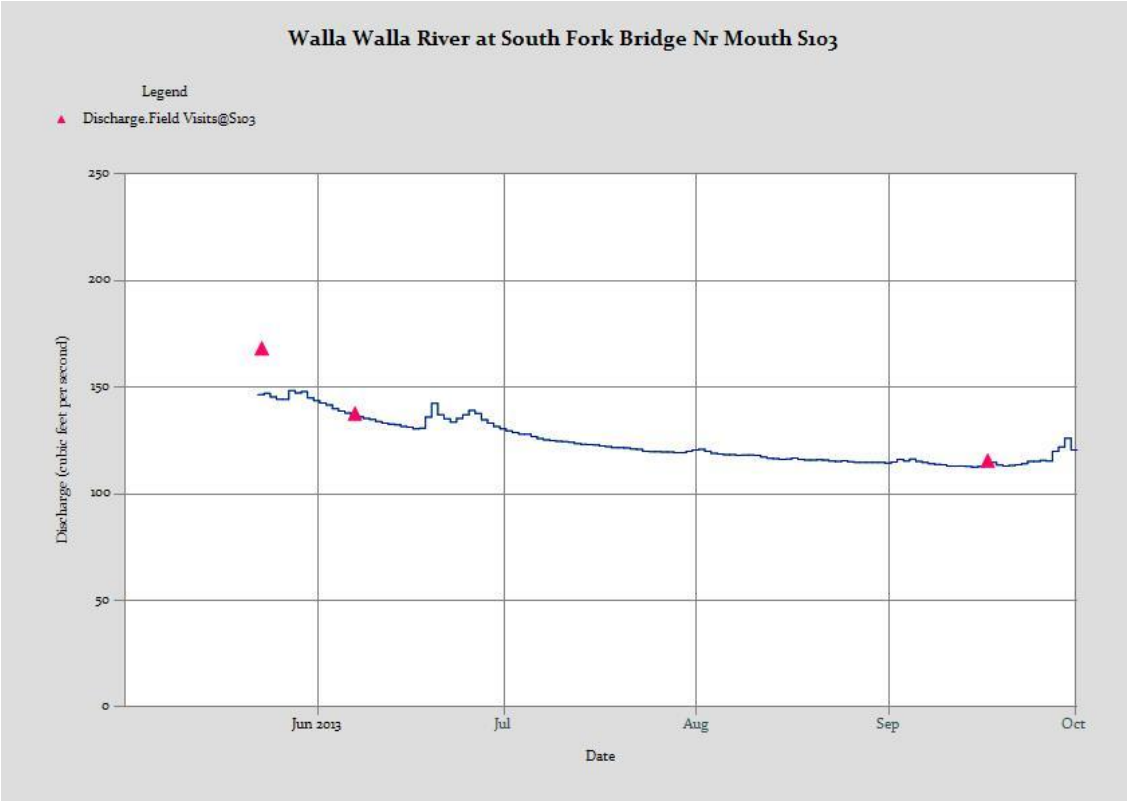
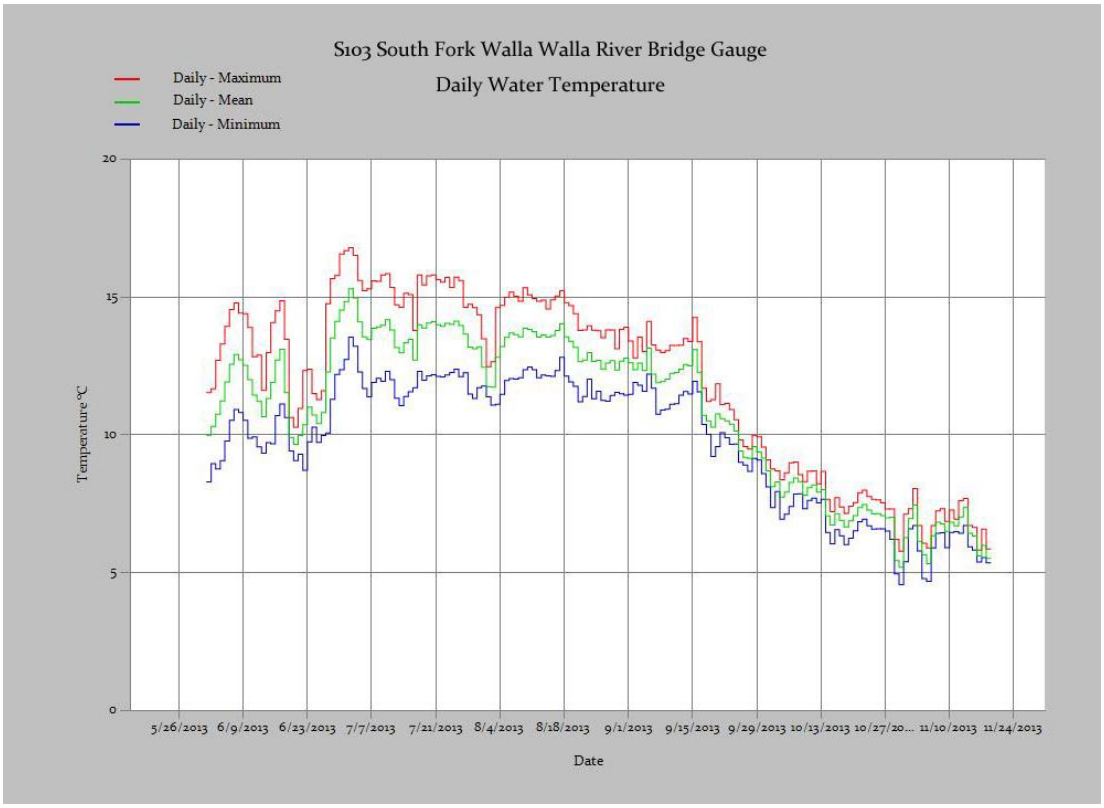
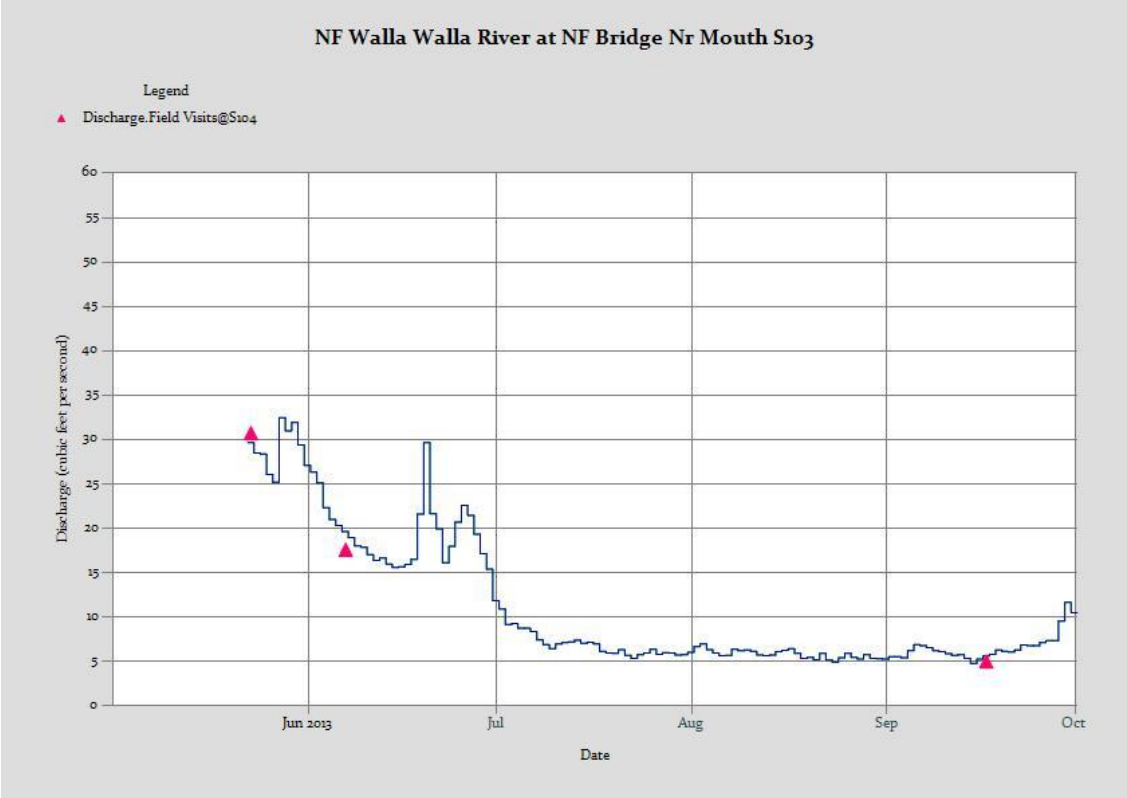
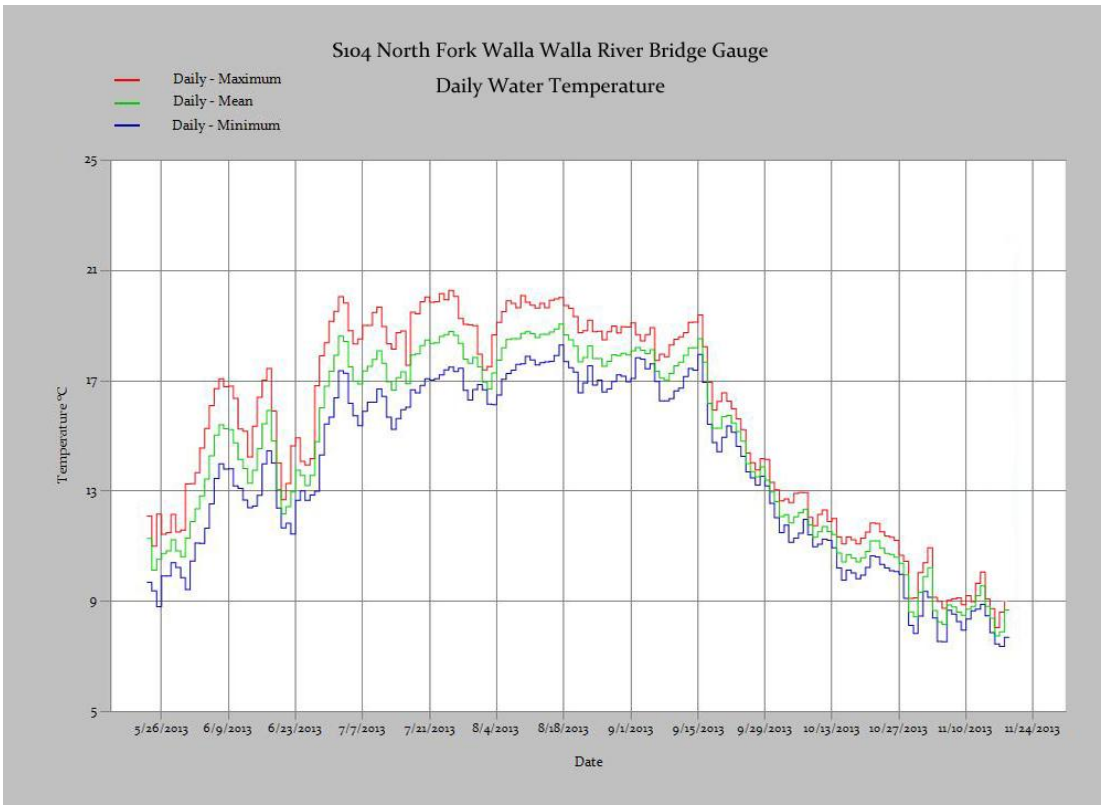
Appendix B

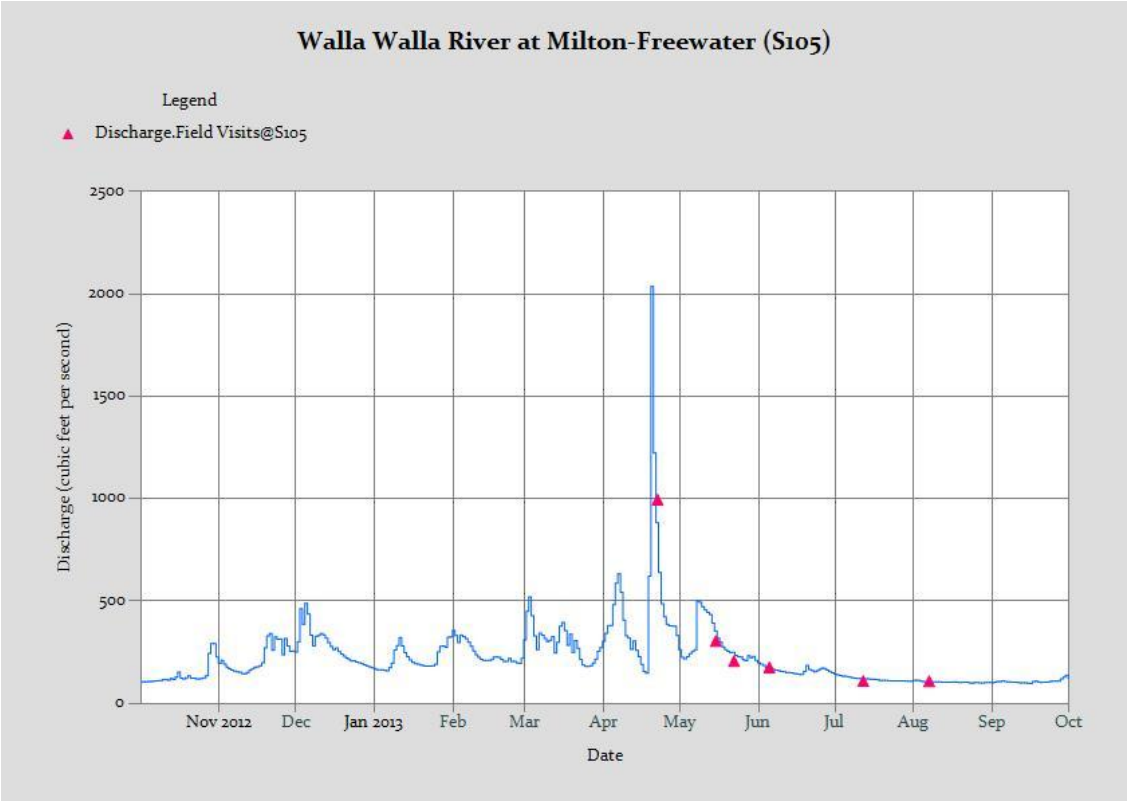
Surface Flow Monitoring Hydrographs (2012-2013 Water Year)

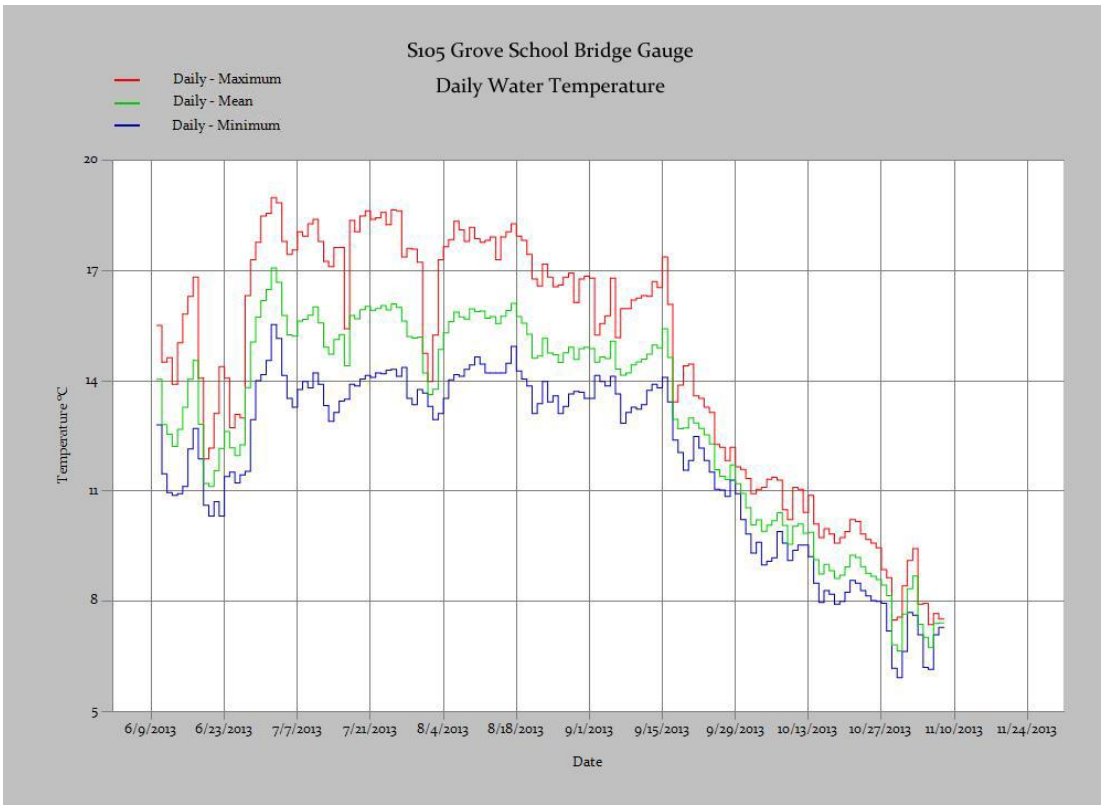


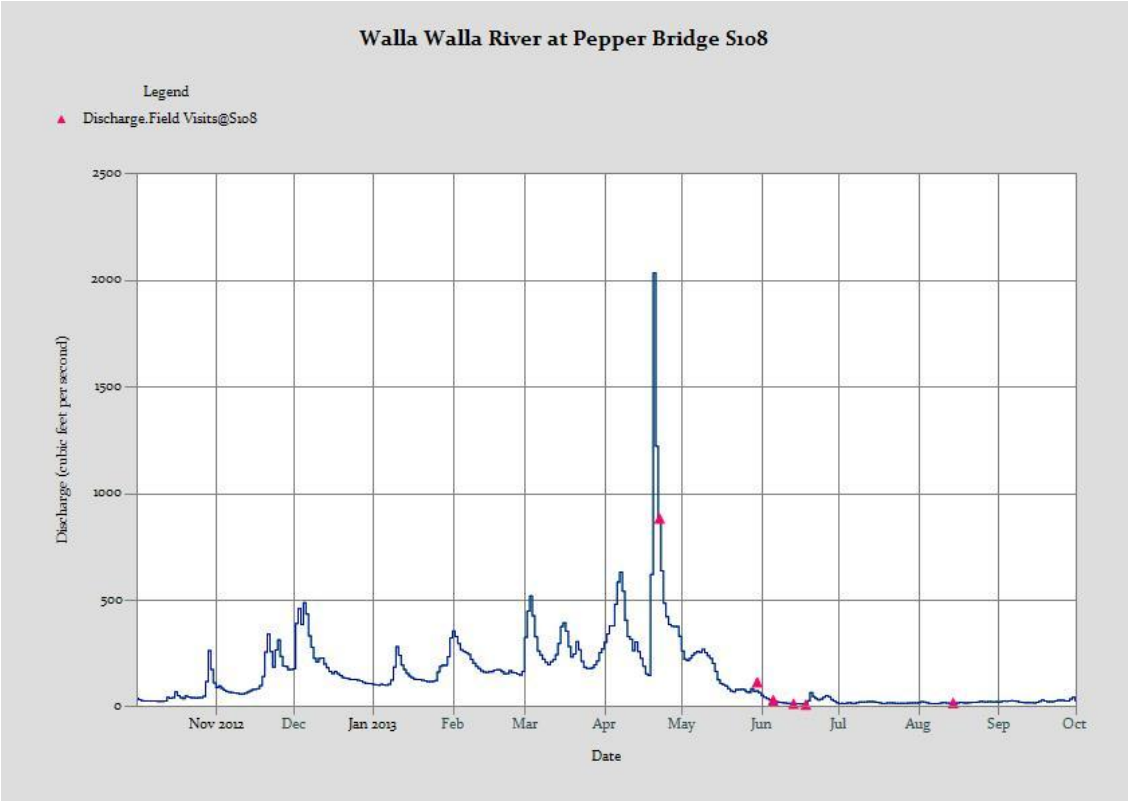


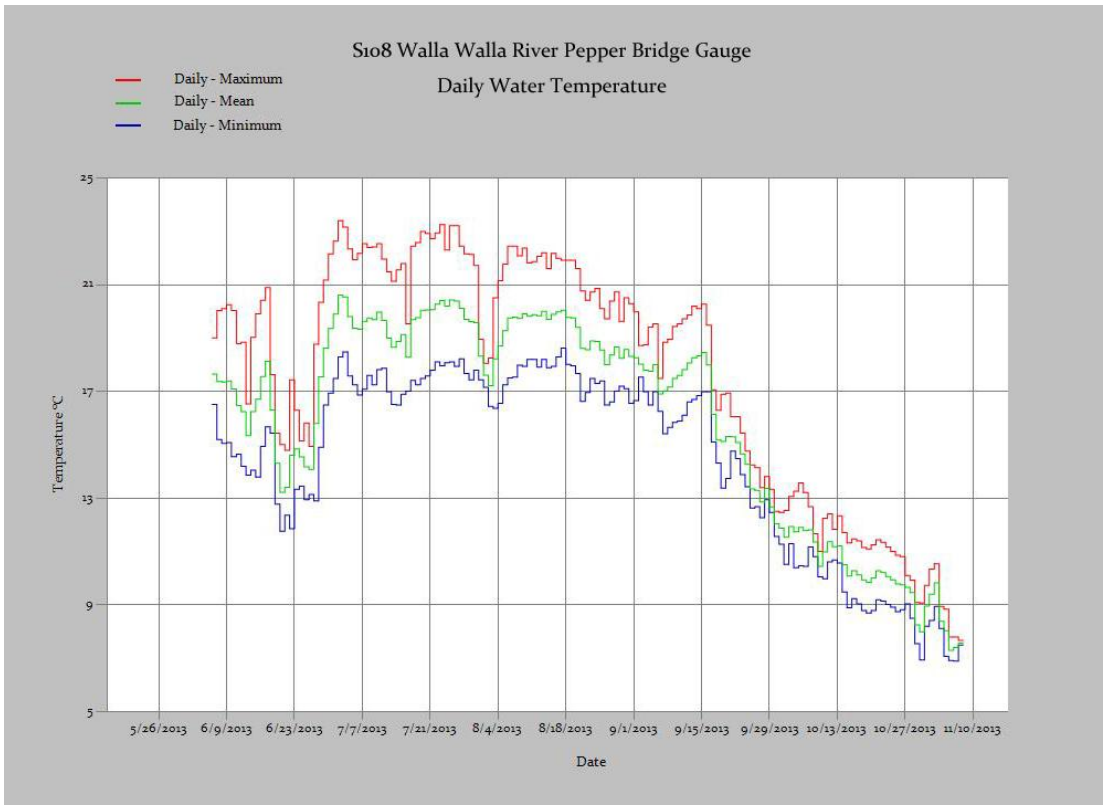

NF Walla Walla River at NF Bridge Nr Mouth S103
Legend
Discharge.Field Visits@S104
Discharge (cubic feet per second)
60
55
50
45
40
35
30
25
20
15
10
5
0
Jun 2013
Jul
Aug
Sep
Oct
Date

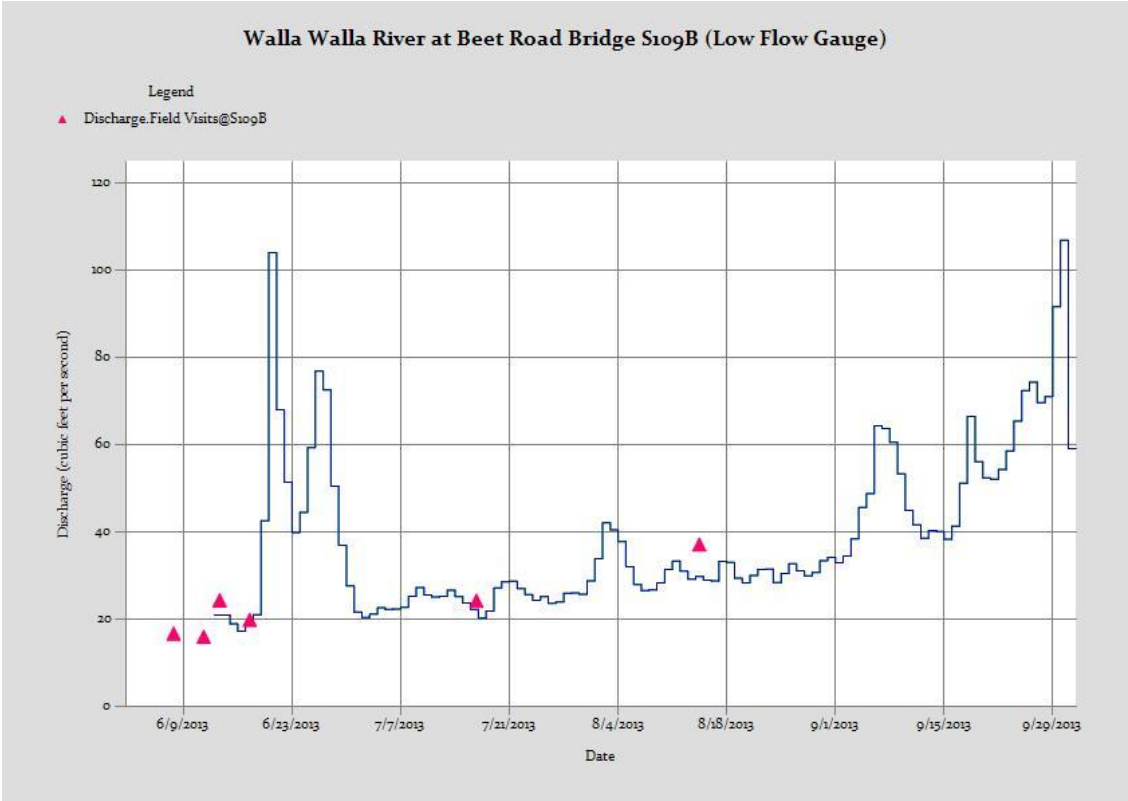

S104 North Fork Walla Walla River Bridge Gauge
Daily Water Temperature
Daily - Maximum
Daily - Mean
Daily - Minimum
Temperature °C
25
21
17
13
9
5
5/26/2013
6/9/2013
6/23/2013
7/7/2013
7/21/2013
8/4/2013
8/18/2013
9/1/2013
9/15/2013
9/29/2013
10/13/2013
10/27/2013
11/10/2013
11/24/2013
Date

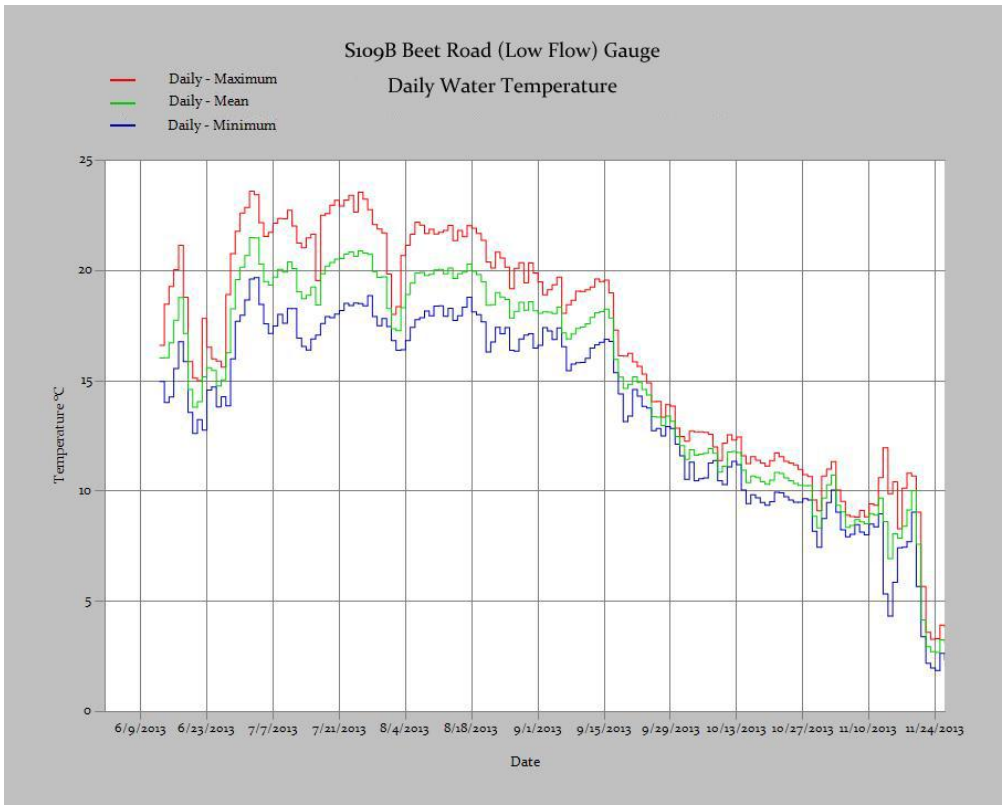

Walla Walla River at Milton-Freewater (S105)
Legend
Discharge.Field Visits@S105
Discharge (cubic feet per second)
2500
2000
1500
1000
500
0
Nov 2012
Dec
Jan 2013
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Date

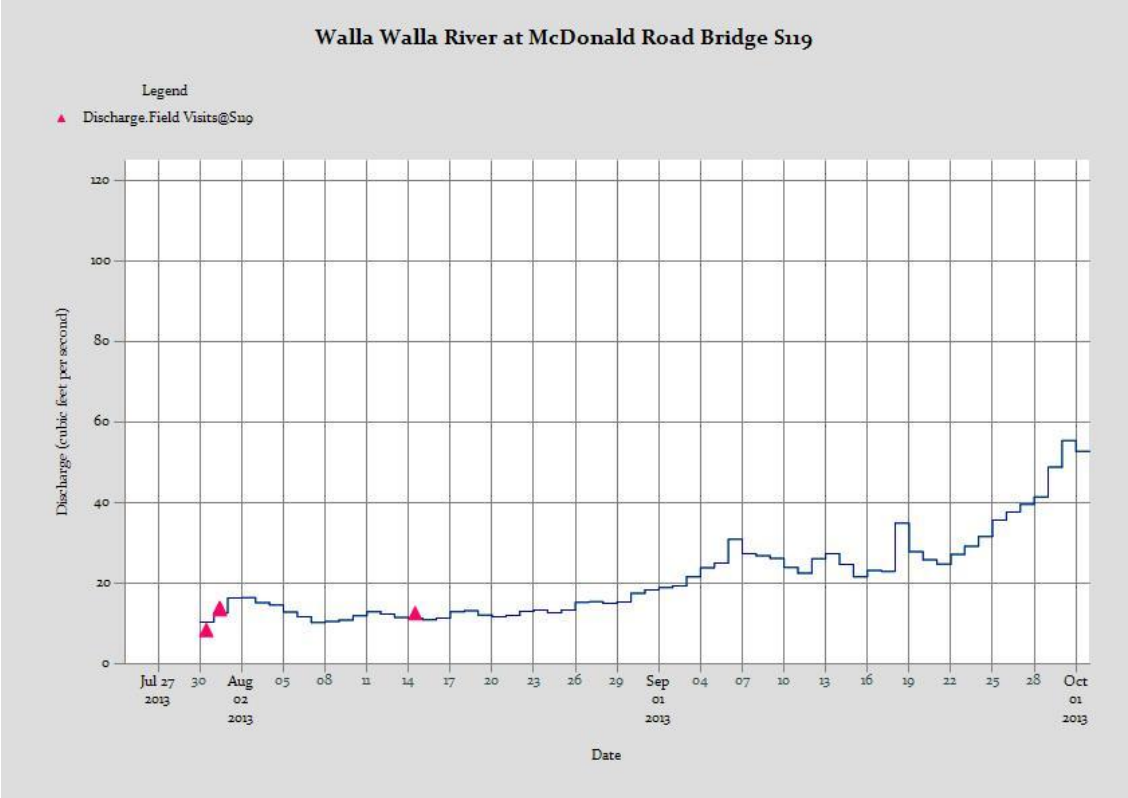

S105 Grove School Bridge Gauge
Daily Water Temperature
Daily - Maximum
Daily - Mean
Daily - Minimum
Temperature °C
20
17
14
11
8
5
6/9/2013
6/23/2013
7/7/2013
7/21/2013
8/4/2013
8/18/2013
9/1/2013
9/15/2013
9/29/2013
10/13/2013
10/27/2013
11/10/2013
11/24/2013
Date

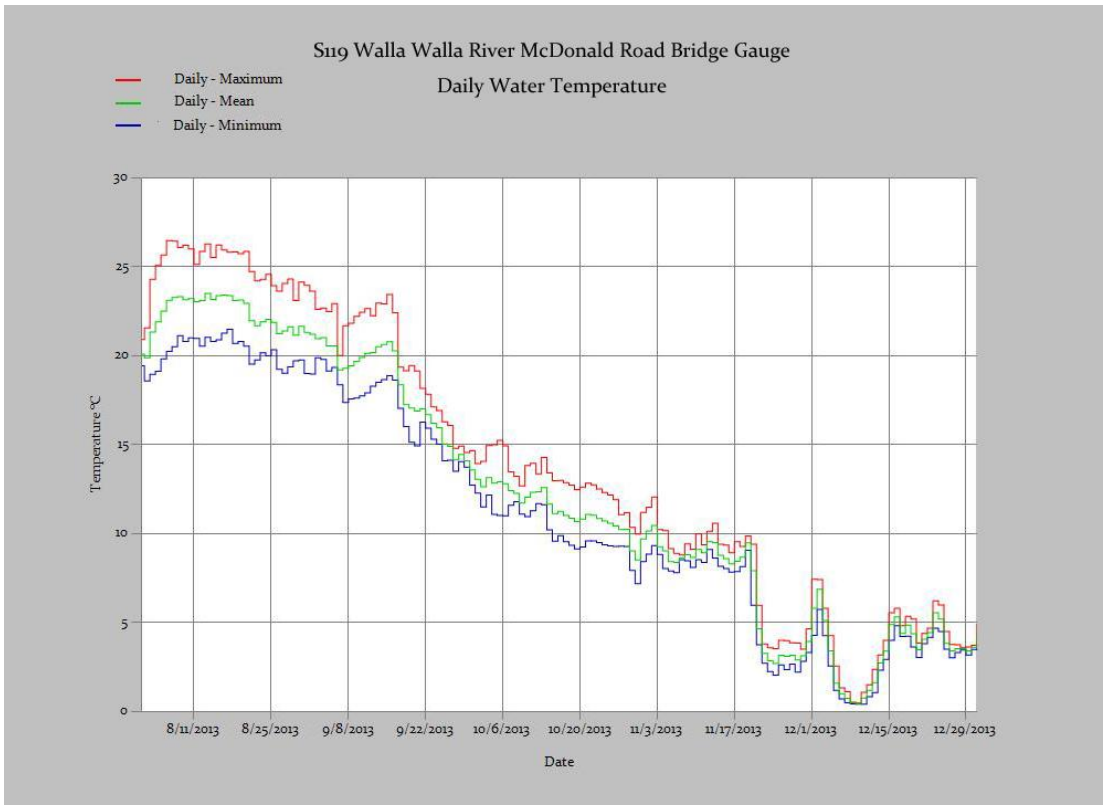

Walla Walla River at Pepper Bridge S108
Legend
Discharge.Field Visits@S108
Discharge (cubic feet per second)
2500
2000
1500
1000
500
0
Nov 2012
Dec
Jan 2013
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Date

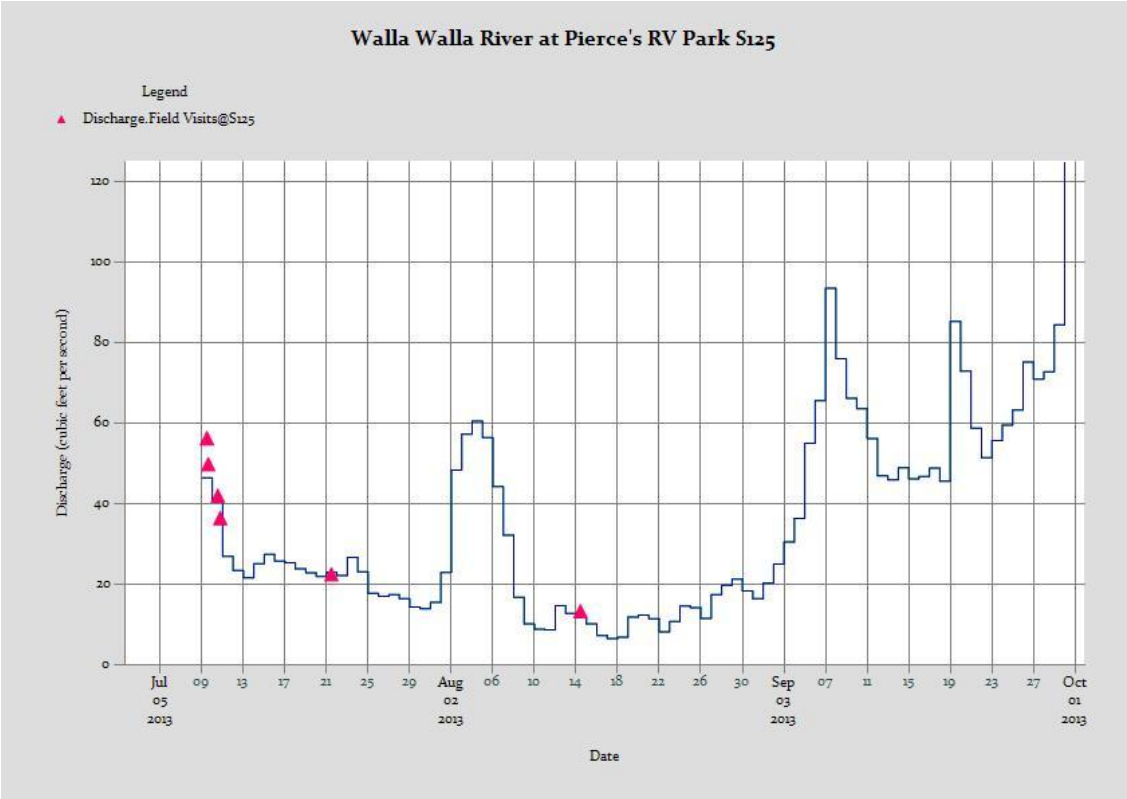

S108 Walla Walla River Pepper Bridge Gauge
Daily Water Temperature
Daily - Maximum
Daily - Mean
Daily - Minimum
Temperature °C
25
21
17
13
9
5
5/26/2013
6/9/2013
6/23/2013
7/7/2013
7/21/2013
8/4/2013
8/18/2013
9/1/2013
9/15/2013
9/29/2013
10/13/2013
10/27/2013
11/10/2013
Date

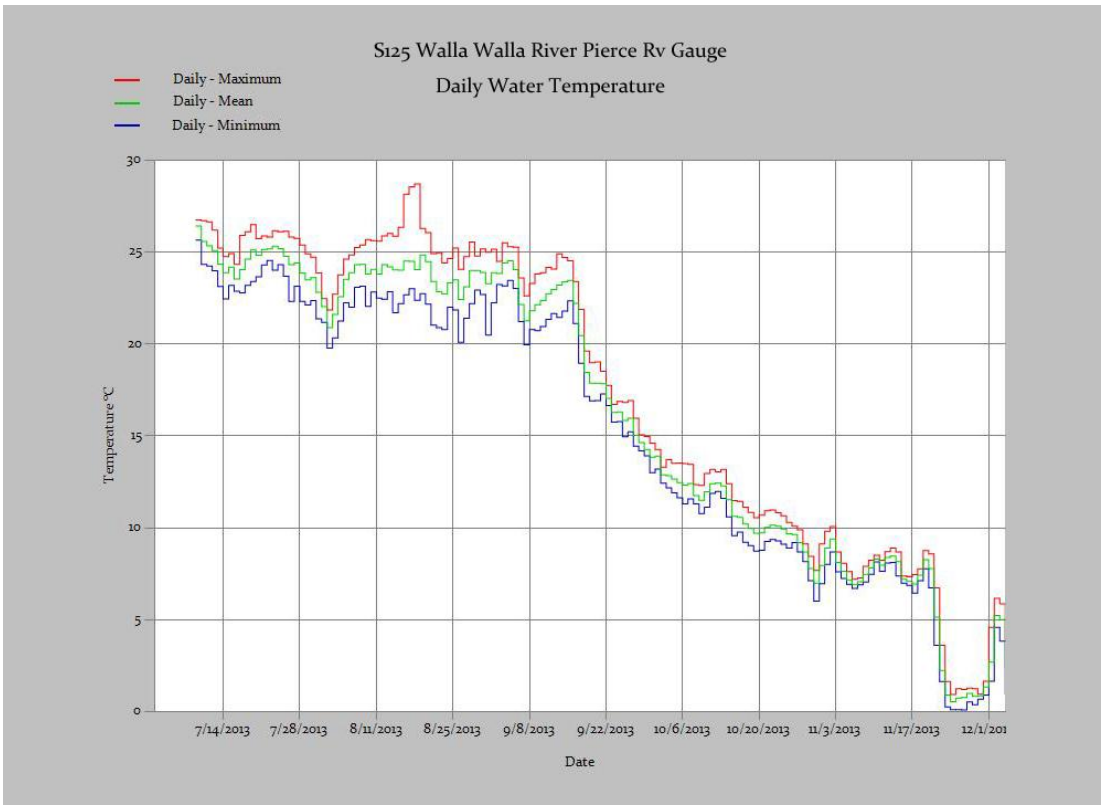

Walla Walla River at Beet Road Bridge S109B (Low Flow Gauge)
Legend
Discharge.Field Visits@S109B
Discharge (cubic feet per second)
0
20
40
60
80
100
120
6/9/2013
6/23/2013
7/7/2013
7/21/2013
8/4/2013
8/18/2013
9/1/2013
9/15/2013
9/29/2013
Date


S109B Beet Road (Low Flow) Gauge
Daily Water Temperature
Daily - Maximum
Daily - Mean
Daily - Minimum
Temperature °C
0
5
10
15
20
25
6/9/2013
6/23/2013
7/7/2013
7/21/2013
8/4/2013
8/18/2013
9/1/2013
9/15/2013
9/29/2013
10/13/2013
10/27/2013
11/10/2013
11/24/2013
Date


Walla Walla River at McDonald Road Bridge S119
Legend
Discharge.Field Visits@S119
Discharge (cubic feet per second)
0
20
40
60
80
100
120
Jul 27 2013
30
Aug 02 2013
05
08
11
14
17
20
23
26
29
Sep 01 2013
04
07
10
13
16
19
22
25
28
Oct 01 2013
Date


S119 Walla Walla River McDonald Road Bridge Gauge
Daily Water Temperature
Daily - Maximum
Daily - Mean
Daily - Minimum
Temperature °C
0
5
10
15
20
25
30
8/11/2013
8/25/2013
9/8/2013
9/22/2013
10/6/2013
10/20/2013
11/3/2013
11/17/2013
12/1/2013
12/15/2013
12/29/2013
Date


Walla Walla River at Pierce's RV Park S125
Legend
Discharge.Field Visits@S125
Discharge (cubic feet per second)
120
100
80
60
40
20
0
Jul 05 2013
09
13
17
21
25
29
Aug 02 2013
06
10
14
18
22
26
30
Sep 03 2013
07
11
15
19
23
27
Oct 01 2013
Date


S125 Walla Walla River Pierce Rv Gauge
Daily Water Temperature
Daily - Maximum
Daily - Mean
Daily - Minimum
Temperature °C
30
25
20
15
10
5
0
7/14/2013
7/28/2013
8/11/2013
8/25/2013
9/8/2013
9/22/2013
10/6/2013
10/20/2013
11/3/2013
11/17/2013
12/1/201
Date

Appendix C

Surface Site Locations

Site Name	Stream/Spring Name	East	North	Elevation (m)
103	South Fork Walla Walla	398611.42	5083319.45	417.2712
104	North Fork Walla Walla	399370.9	5083810.12	429.4632
105	Walla Walla at Milton Freewater	393438.004	5086234.287	334.202
108	Walla Walla at Pepper Bridge	392885.00	5095255.00	234
109B	Walla Walla at Beet Rd, seasonal	389167.64	5097715.94	205
119	Walla Walla at McDonald Rd	379702.08	5100532.28	157
125	Walla Walla at Pierce RV Park	358797.88	5103224.88	106