www.wwbwc.org
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Surface Water Monitoring in the Walla Walla Basin

2012 – 2013

FINAL Report

Submitted: March 2014

In cooperation with

Table of Contents

Introduction 2

Overview 2

Surface Water Monitoring Area 3

New Monitoring Sites 4

Data Access 4

Methods 5

Data Processing and Analysis 7

Results and Discussion 9

Summary 12

Acknowledgements 12

Appendix A 13

Excerpt from *WWBWC Standard Operating Procedures – Version 1.2, pages 20-28* 13

Surface Water Monitoring 13

Equipment 13

Vertical Stage Measurement 14

Tape-Down Stage Measurement 14

Laser Level Stage Measurement 14

Discharge Measurement (Wading) 15

Discharge Measurement (Bridge) 16

Discharge Calculation 17

Station Visit (without Discharge Measurement) 17

Discharge Notes Data Sheet 18

Gaging Station Log Data Sheet 19

Stream Gage Notes Data Sheet 20

Appendix B 21

Surface Flow Monitoring Hydrographs 21

Appendix C 58

Explanation of Data Gaps 2012-2013 58

Appendix D 61

Surface Site Locations 61

Introduction

Overview

Since 2002, the Walla Walla Basin Watershed Council (WWBWC) has been building a network of surface flow monitoring stations throughout the Walla Walla River Valley. The network has grown to include 60 sites monitoring flow 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.

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.

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

- Monitor the effectiveness of aquifer recharge projects
- Provide data for groundwater modeling projects
- Inform future local water management decisions

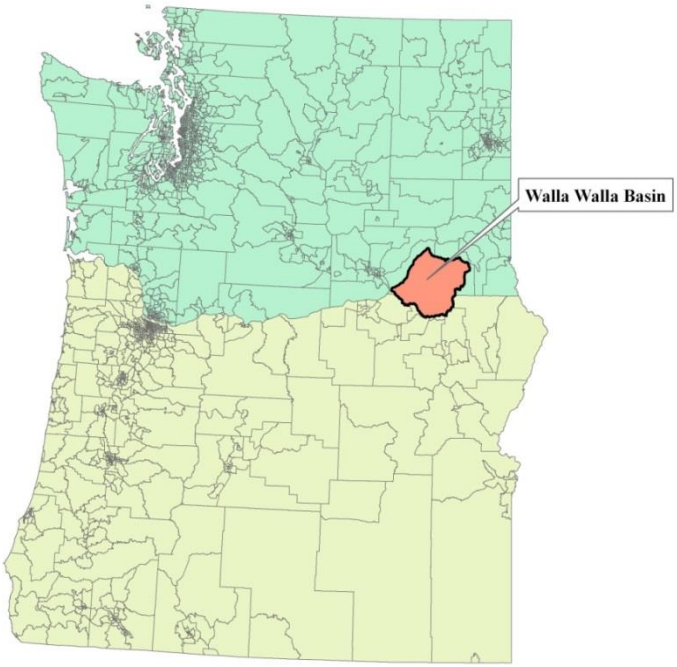


Figure 1. The Walla Walla Basin, a bi-state watershed.

Surface Water Monitoring Area

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

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

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

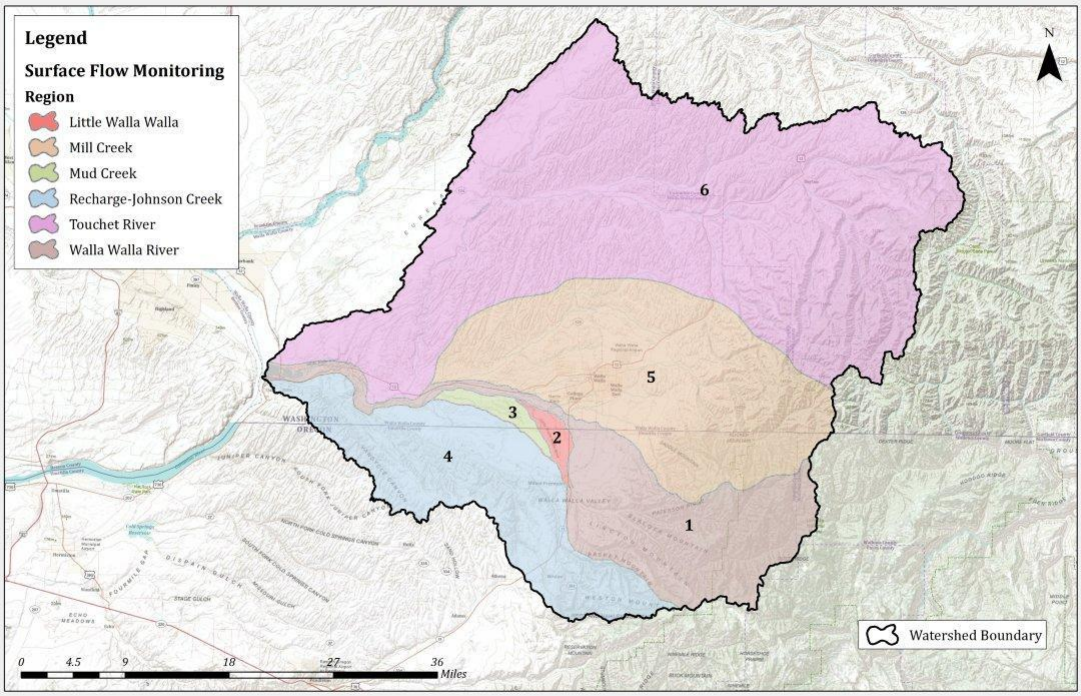


Figure 2. Sites in the WWBWC surface water monitoring network are organized according to the regions depicted above.

Table 1. Overview of the Surface Water Monitoring Network.

Region	# of Sites
1: Walla Walla River	9
2: Little Walla Walla River	22
3: Mud Creek System	5
4: Pine Creek/Hudson Bay Irrigation System	14
5: Mill Creek / Walla Walla Area	10
6: Touchet River	0
Total	62

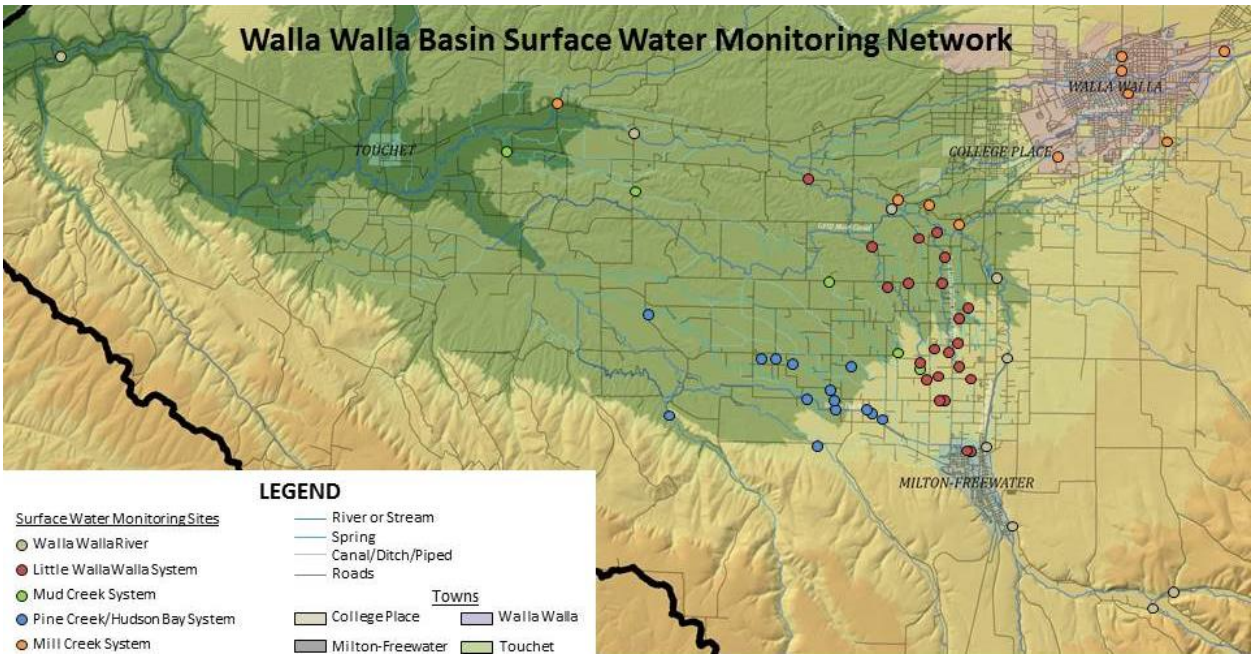


Figure 3. Map showing current WWBWC surface water monitoring sites as of January 2014.

New Monitoring Sites

Since the end of 2011, the WWBWC's surface water monitoring network has grown to include five new gauge stations on the mainstem Walla Walla River, three new sites in the Mud Creek system, five in the Pine Creek/Hudson Bay system, and three in the Mill Creek/City of Walla Walla area. We've decommissioned several monitoring sites because either they provided unreliable data or the data were no longer needed for management decisions.

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.

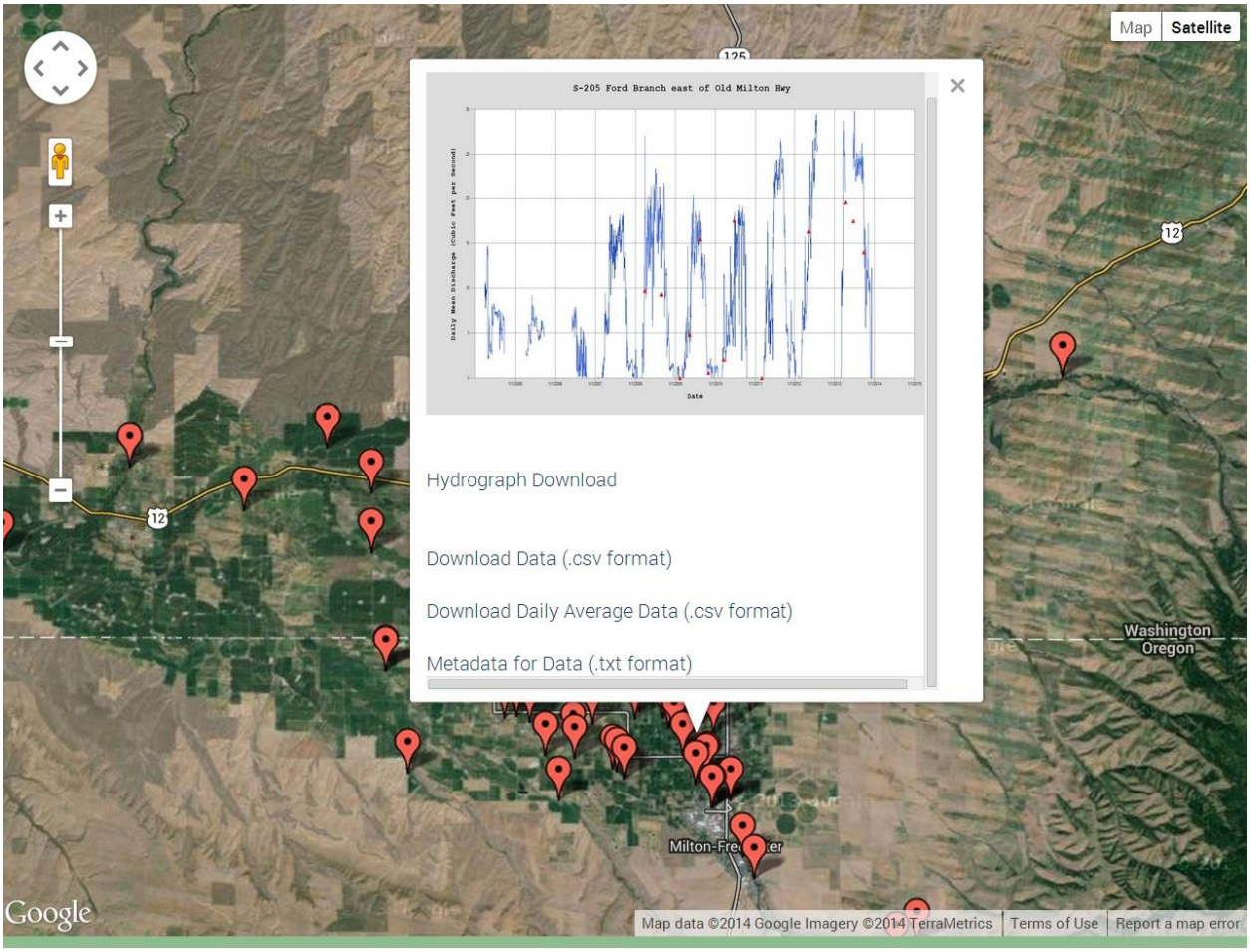


Figure 4. A screenshot of the Surface Water Monitoring Map on the www.wwbwc.org website.

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. Figure 5 shows an example of data logger deployment in a pvc stilling well anchored to a T-post.

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, Price AA current meter, or Marsh-McBirney Flo-Mate 2000 pressure sensor (See Figure 6). 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 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.

Figure 5. Like most WWBWC monitoring locations, this site uses a PVC stilling well and a staff gauge lashed to a fence post that was pounded into the streambed.

Figure 6. Staff taking a quarterly flow measurement of the Walla Walla River using a Marsh McBirney velocity meter.

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 7). Based on that equation, a rating table is created to calculate discharge values for each datum in the logger file and produce a continuous discharge signal for the monitoring period (Figure 8). The AQUARIUS rating curve tool allowed us to modify, shift, and re-fit rating curves as site conditions changed, resulting in higher quality, more defensible discharge data. Figure 8 displays the flow data from Lassiter Spring Branch (S-509) whose rating curve is shown in Figure 7. 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.

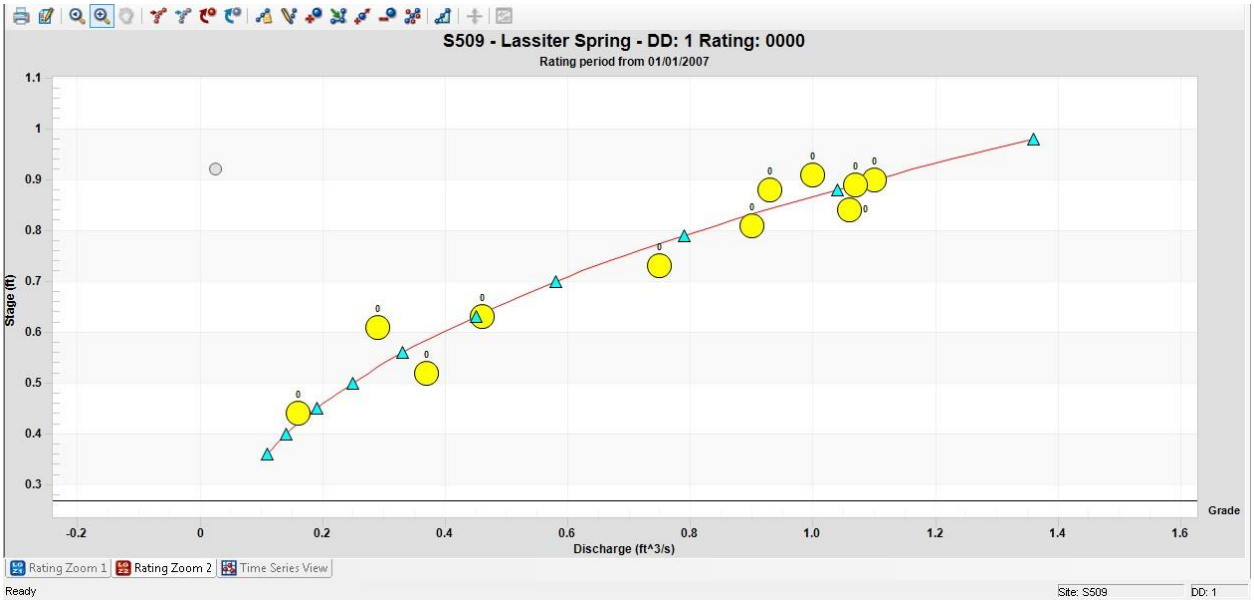


Figure 7. Rating Curve for Lassiter Spring Branch (S-509) during the 2007-2012 monitoring period. Yellow dots represent manual discharge measurements. Blue triangles show rating points created by AQUARIUS based on a best-fit equation relating stage to manual discharge measurements.

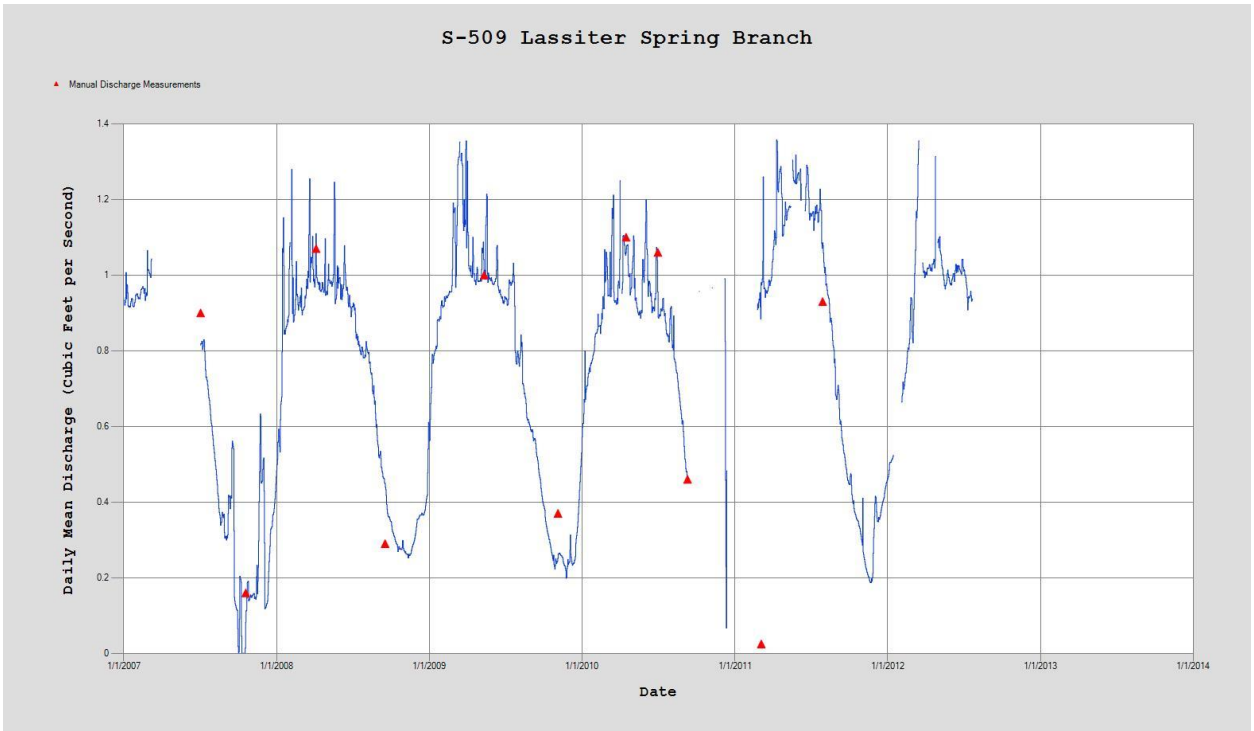


Figure 8. Data from Lassiter Spring Branch near its source. Red triangles represent manual discharge measurements taken there.

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 (such as in the case of a damaged weir that no longer conforms to its once-engineered characteristics).

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%, 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 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 all surface water monitoring sites are available in Appendix B. An explanation of data gaps during the 2012-2013 project period is available in Appendix C.

Springs feeding Johnson Creek (S-408) performed noticeably better after the 2010 expansion of the Johnson Aquifer Recharge site (Figure 9). Flows in Big Spring (S-219), Ferndale Spring (S-217), and Downing Spring (S-216) seemed to trend higher in 2012 and 2013 than the previous years. This could be due to increased downcutting and seepage from the Walla Walla River flowing through the Tum-A-Lum reach (Figures 10-12).

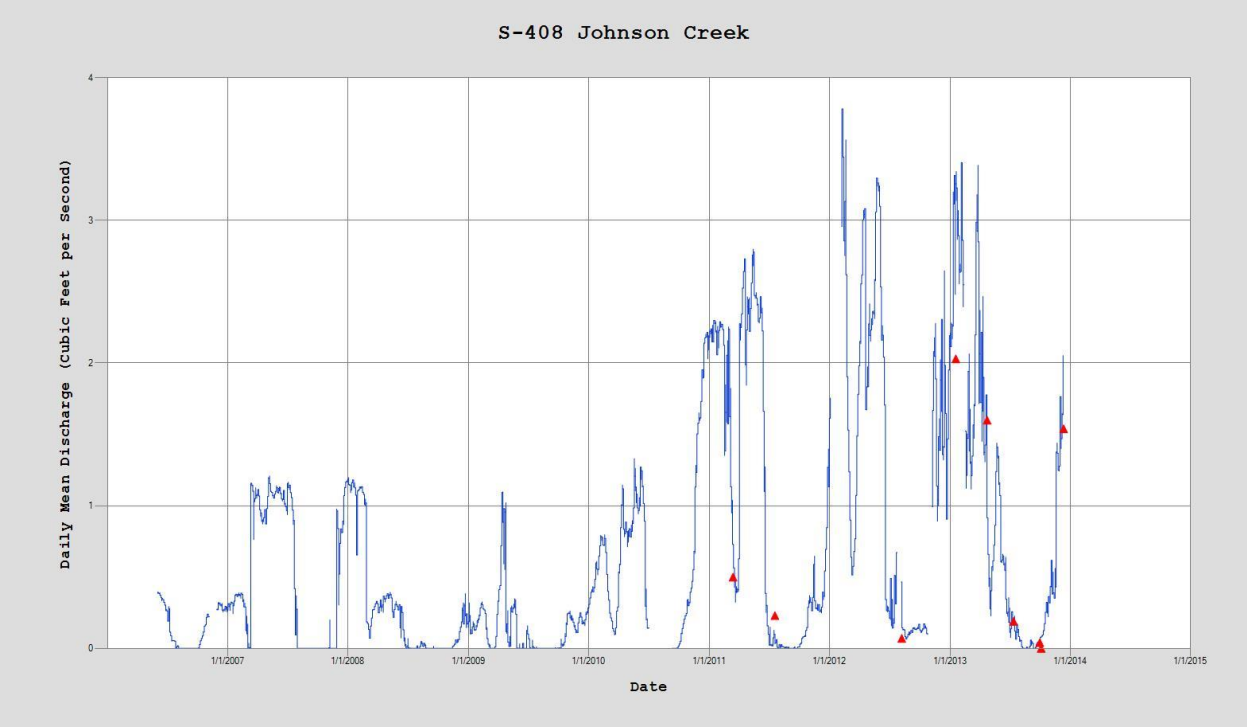


Figure 9. Hydrograph showing Johnson Creek, whose springs are fed by the Johnson Aquifer Recharge water, showing noticeably higher flows after the 2010 expansion of the site.

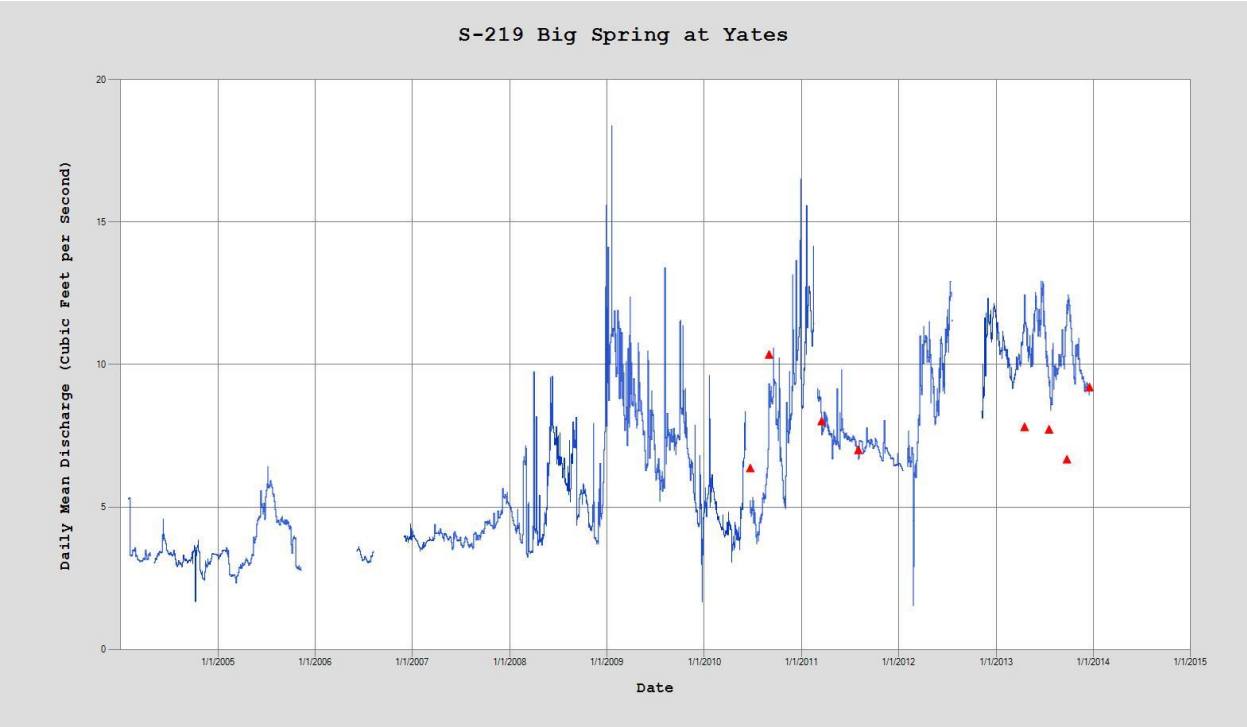


Figure 10. Hydrograph showing Big Spring flows at Yates Lane.

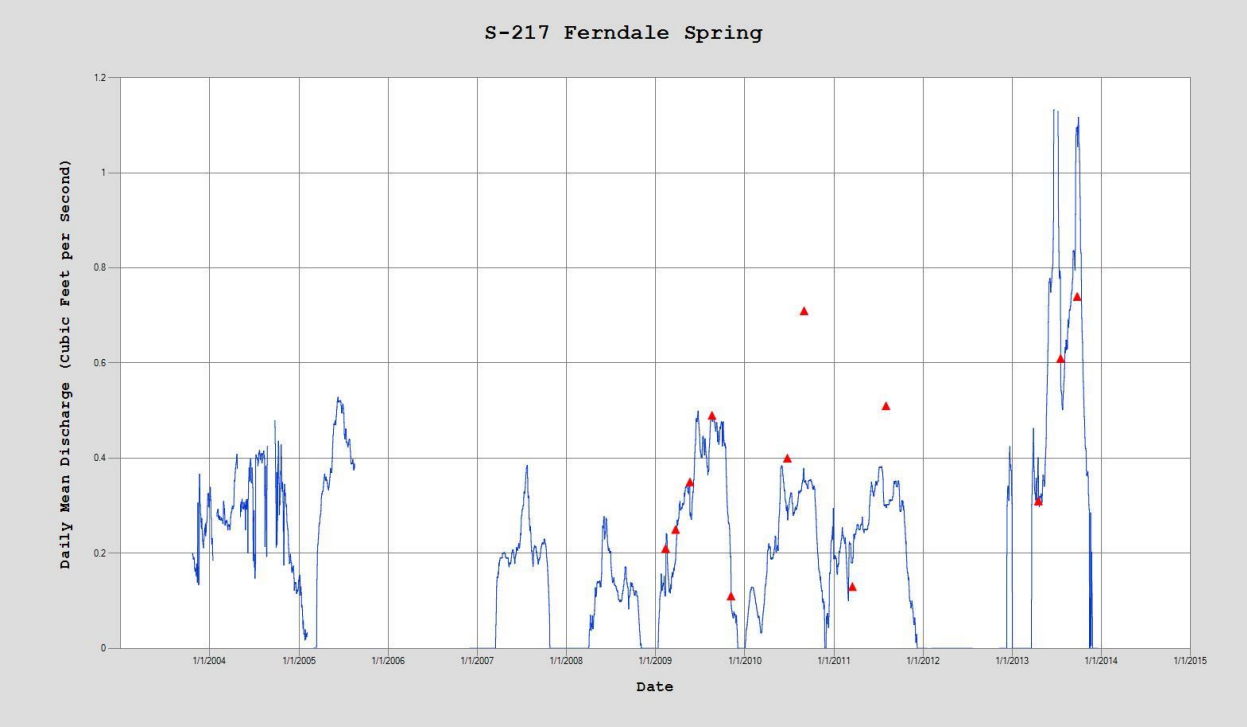


Figure 11. Hydrograph showing Ferndale Spring flows at Ferndale Road.

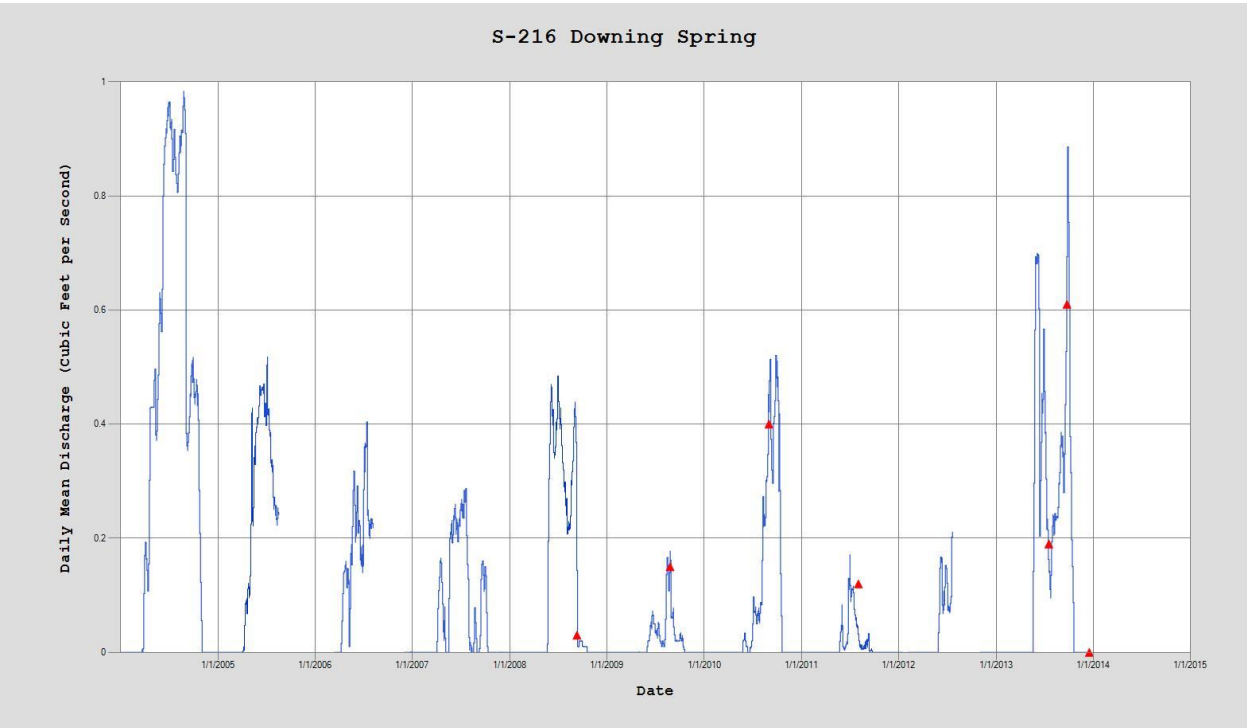


Figure 12. Hydrograph showing Downing Spring flows at Robin Lane.

There are many factors which may make data collected at a site unreliable or even unusable for a period of time. One of the main problems affecting the WWBWC's surface water monitoring network is seasonal vegetation growth. This is a problem because the vegetation grows in or near the water and impedes the free flow of the water at a site. The water level rises to go over or around the vegetation in the stream. This makes the rating model used to transform stage into flow report higher flow values than it should.

Summary

WWBWC surface water monitoring efforts continue to provide high quality data to track the success of shallow aquifer recharge projects, support modeling projects, and guide future water management decisions. During the 2012-2013 project period the WWBWC completed an aquifer recharge strategic plan, and six new recharge projects were installed. Ongoing monitoring of spring performance and groundwater-surface water interactions aids in the adaptive management of these new sites.

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.

Acknowledgements

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

- Hudson Bay District Improvement Company
- Oregon Water Resources Department
- Oregon Watershed Enhancement Board
- U.S. Fish & Wildlife Service
- U.S. Forest Service
- Walla Walla River Irrigation District
- Washington Department of Ecology

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, or Marsh-McBirney Velocity Meter
- AquaCalc 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.

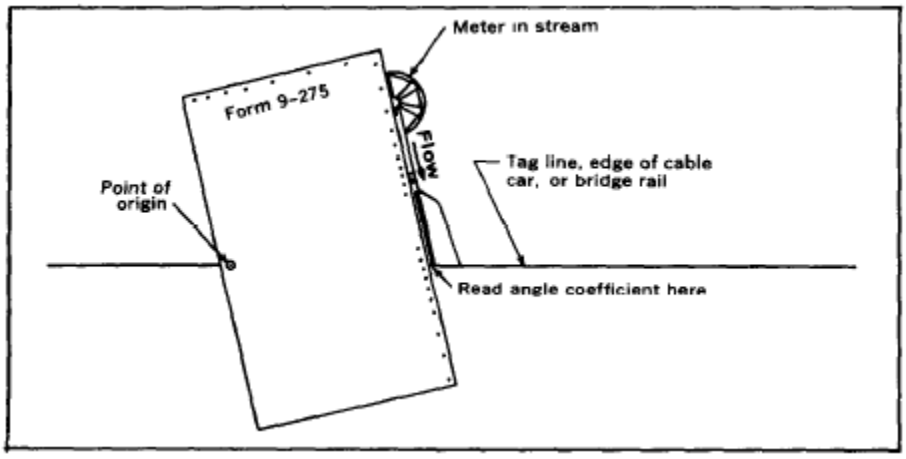


Figure taken from Rantz, 1982.

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

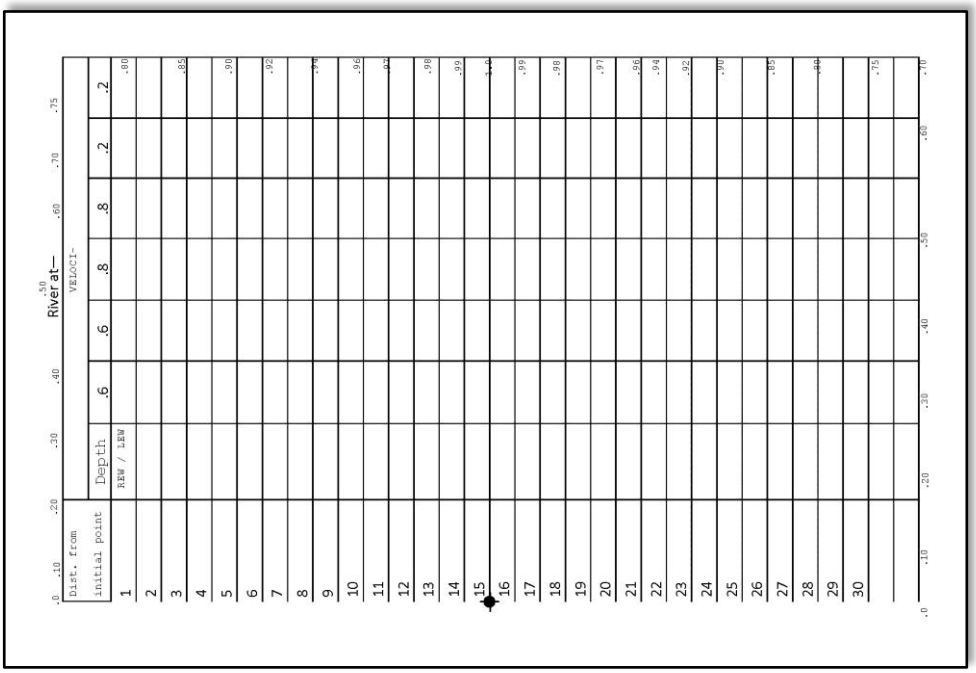
Discharge is calculated using the mid-section method in which each section extends halfway between measurement locations. The flow through each section is calculated by multiplying the average velocity with the cross-sectional area of the section. See references for a complete description of discharge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



Walla Walla Basin Watershed Council

DISCHARGE MEASUREMENT NOTES

Meas No. .....

Station No. ..... Checked by .....

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 .....

Type of Meter .....

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

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 .....

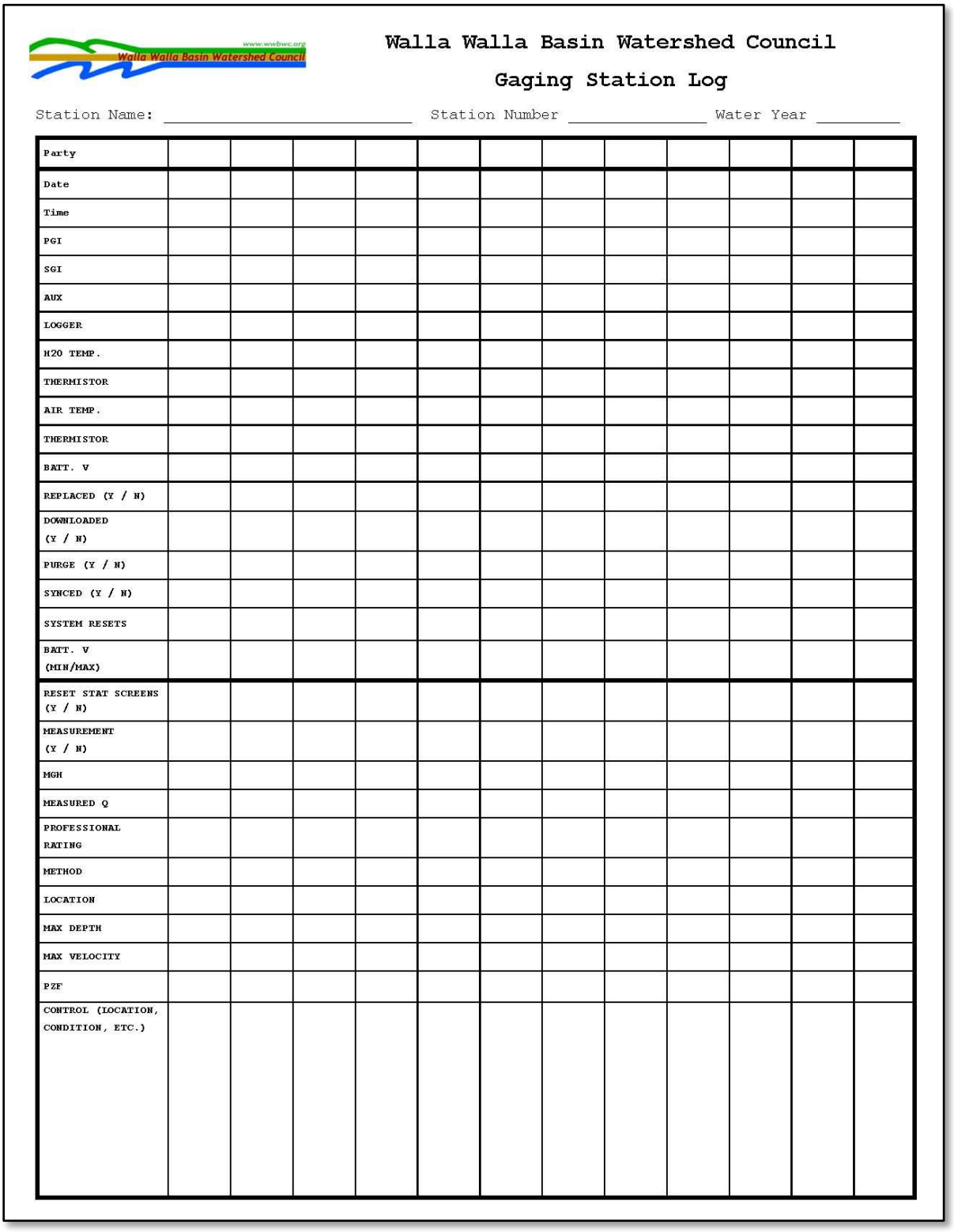
Other .....

Remarks .....

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

Dist. from initial point	Depth REW / LEW	.6	.6	.8	.8	.2	.2
1							.80
2							
3							.85
4							
5							.90
6							
7							.92
8							.94
9							
10							.96
11							.97
12							
13							.98
14							.99
15							1.0
16							.99
17							
18							.98
19							
20							.97
21							.96
22							.94
23							.92
24							
25							.90
26							
27							.85
28							.80
29							
30							.75

Gaging Station Log Data Sheet



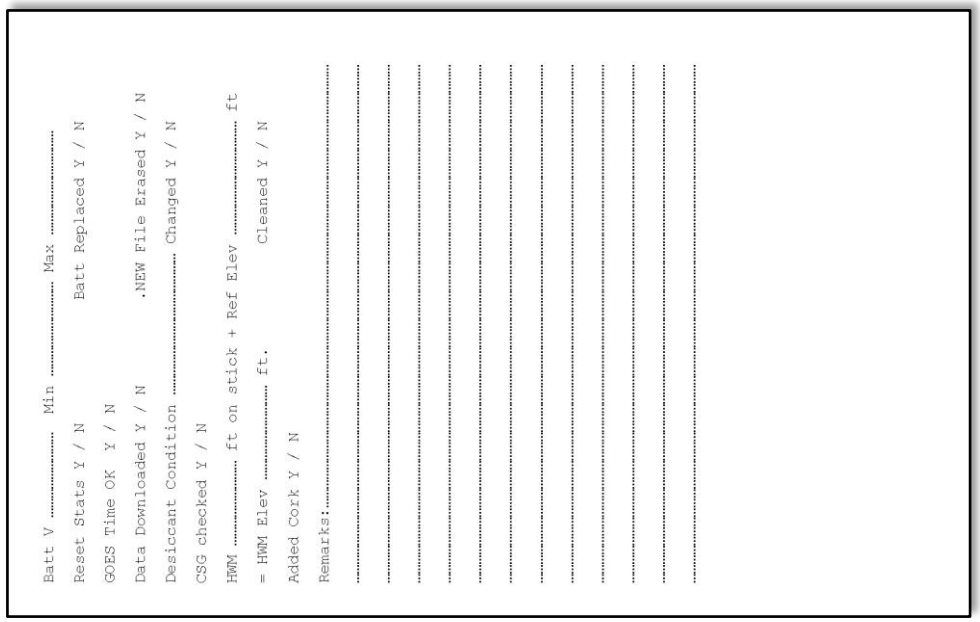
Walla Walla Basin Watershed Council

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 ..... Party .....

Station # .....

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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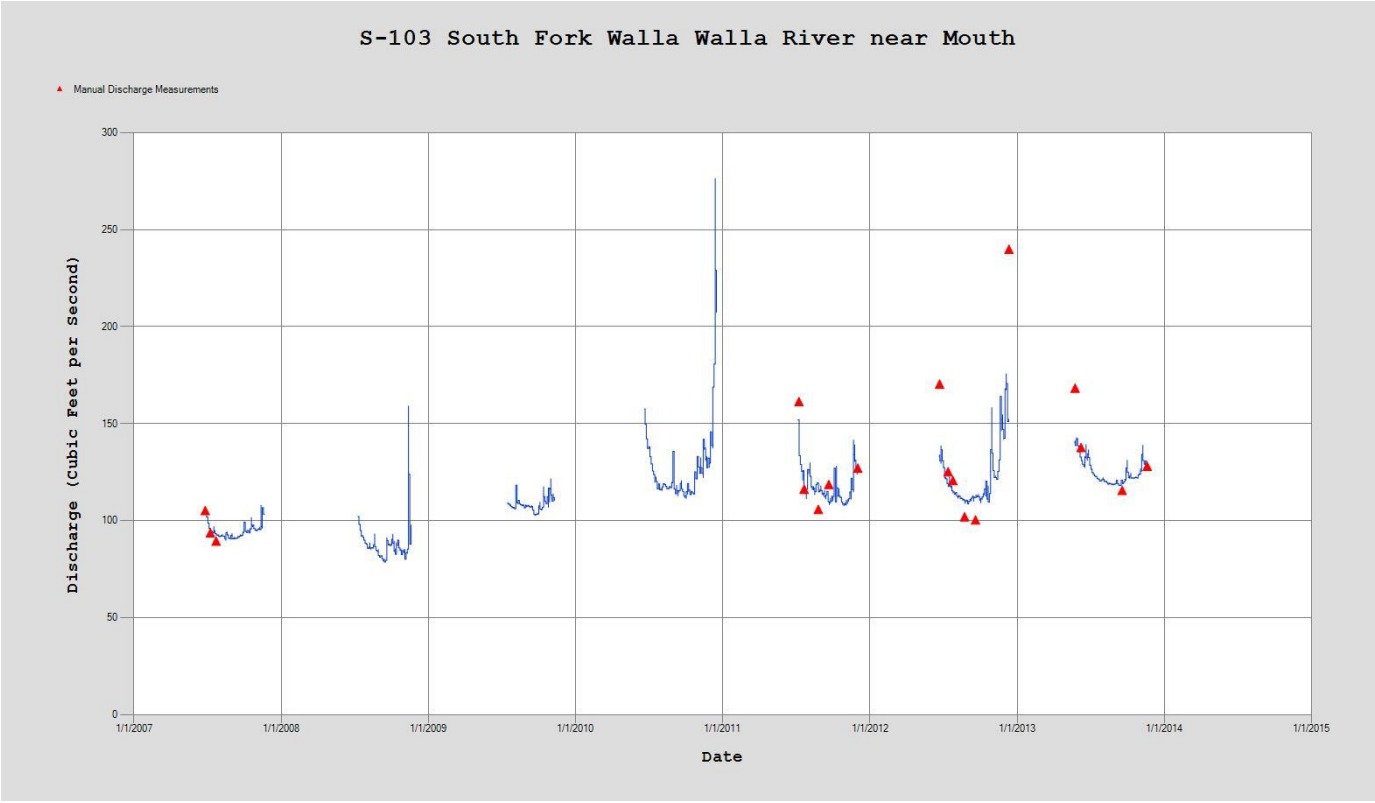
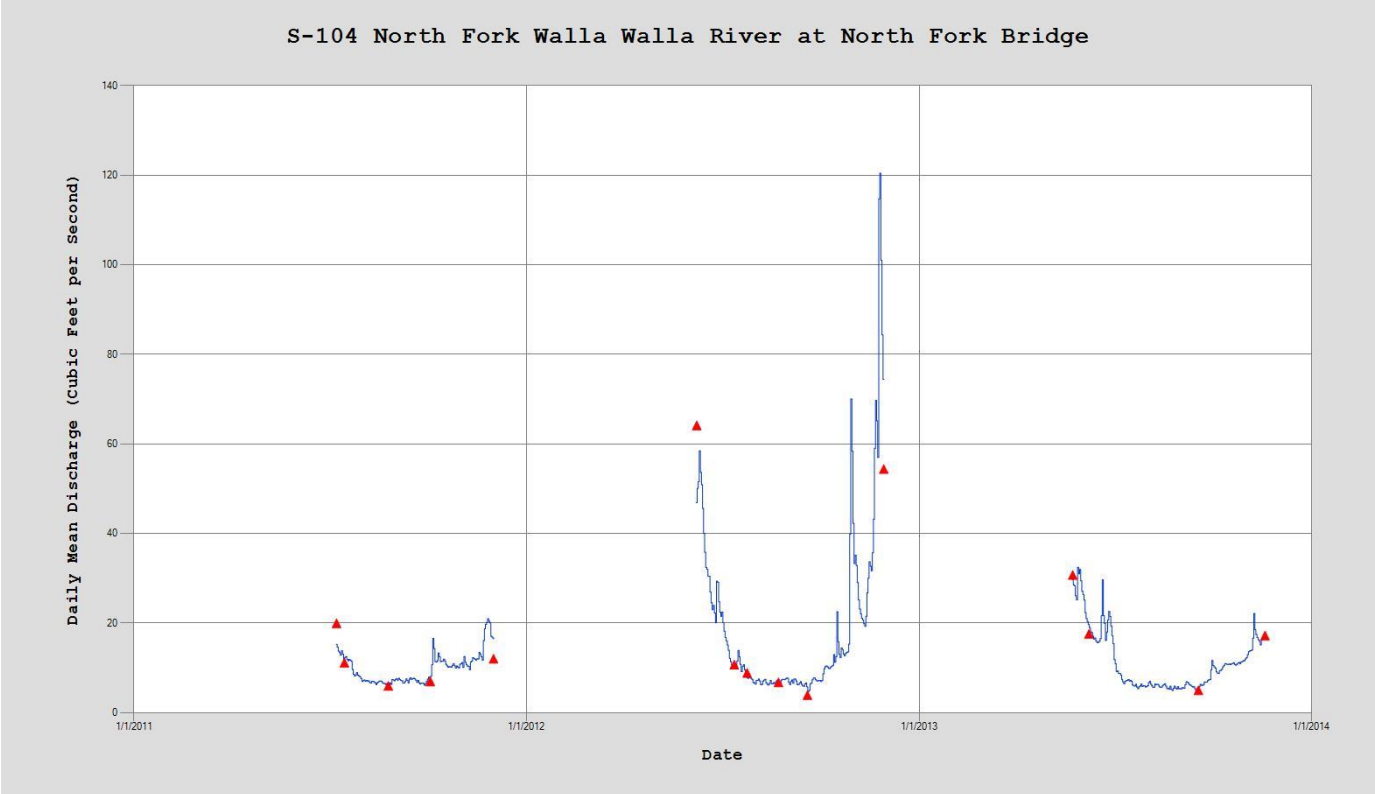
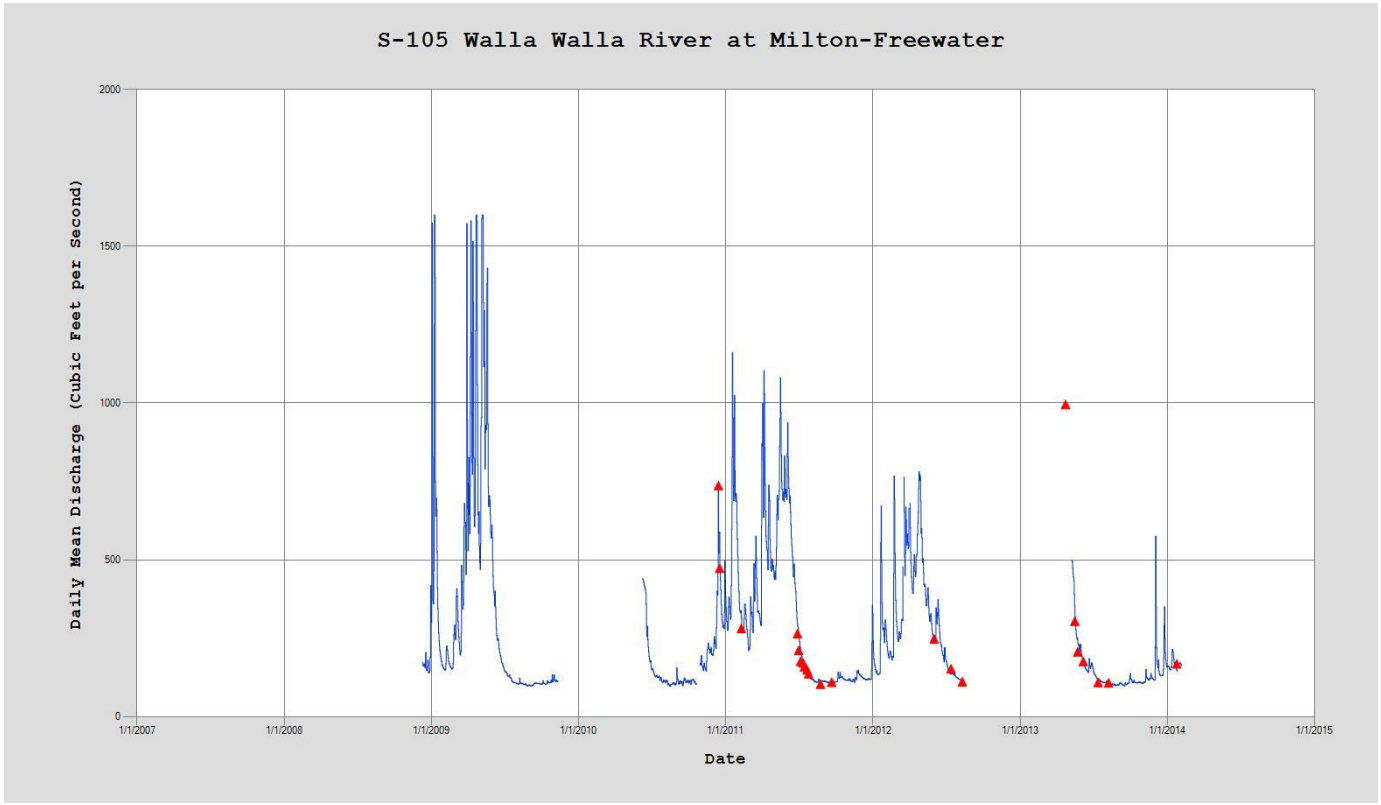
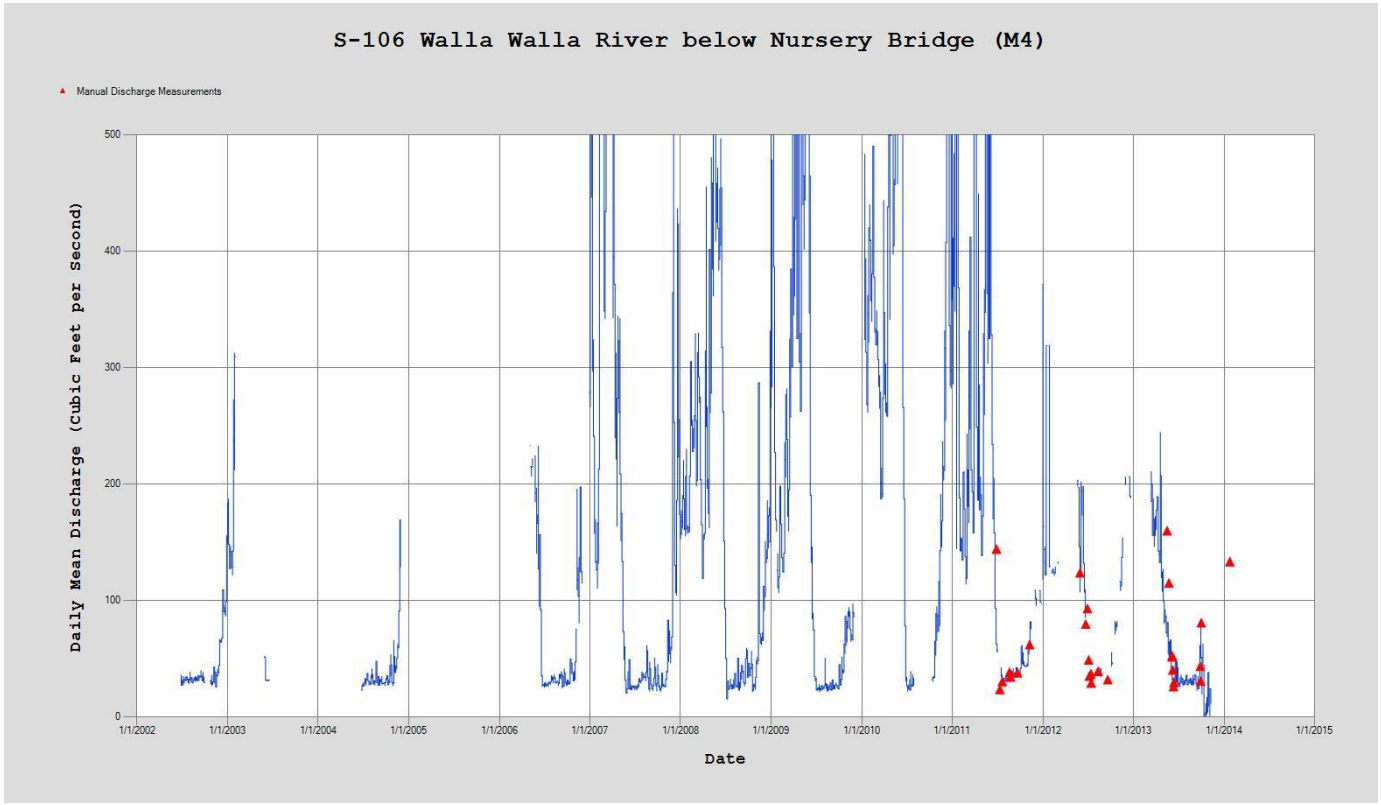
Appendix B

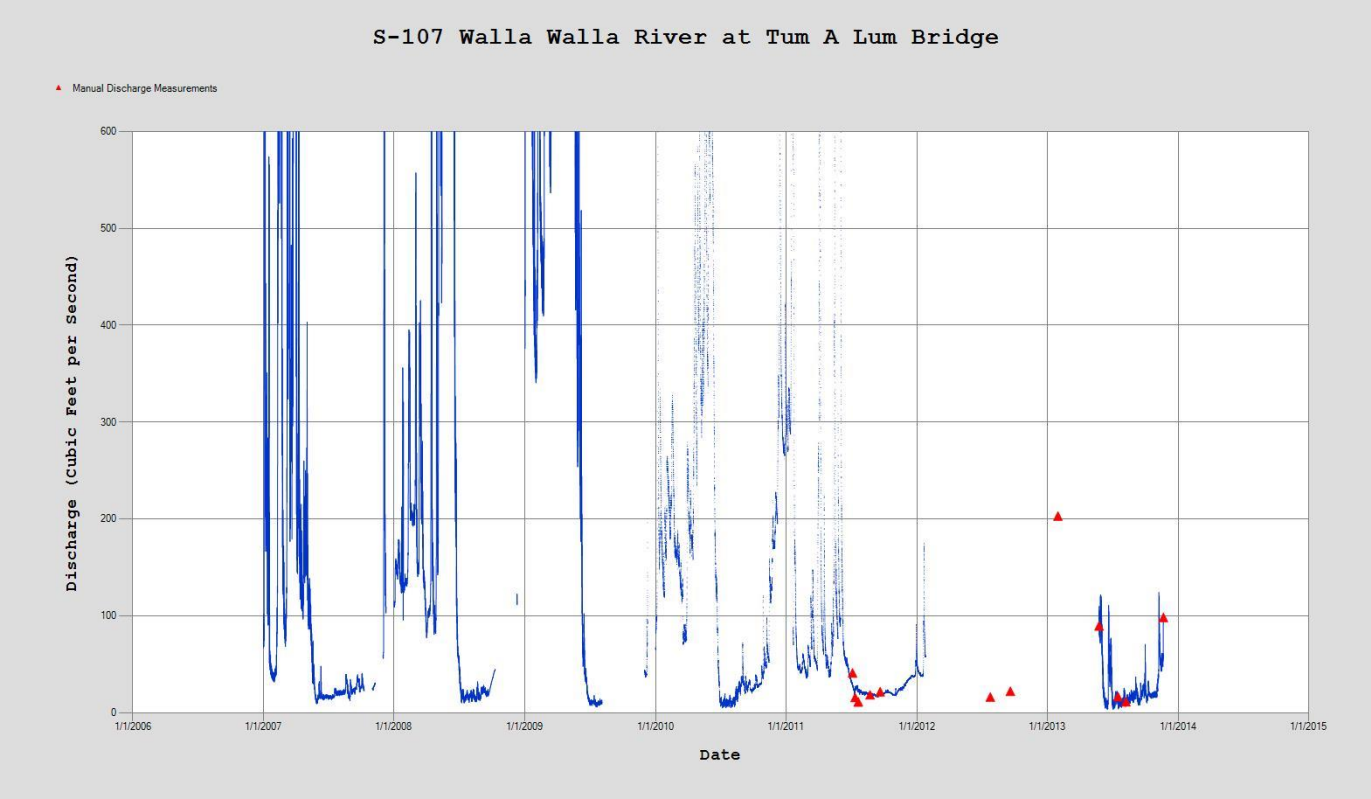
Surface Flow Monitoring Hydrographs

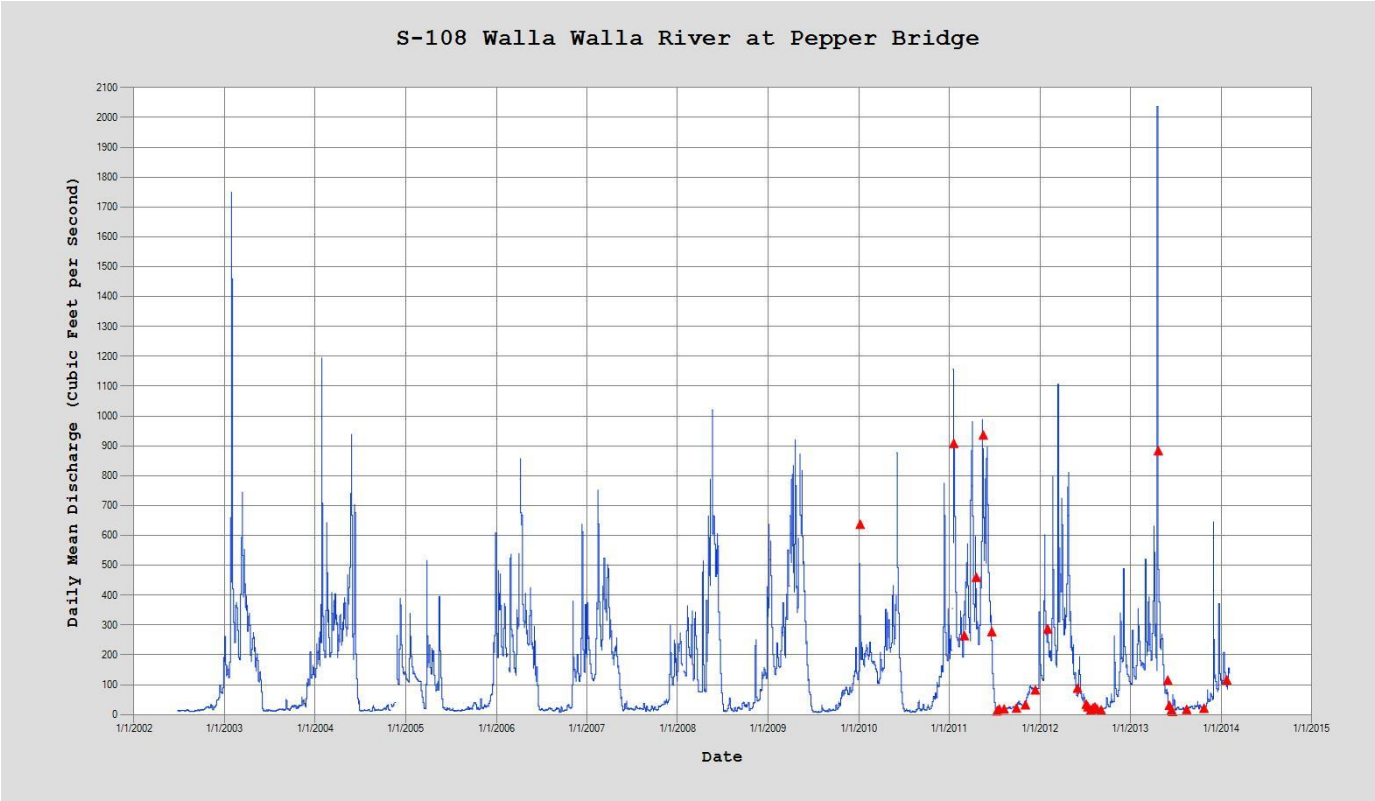


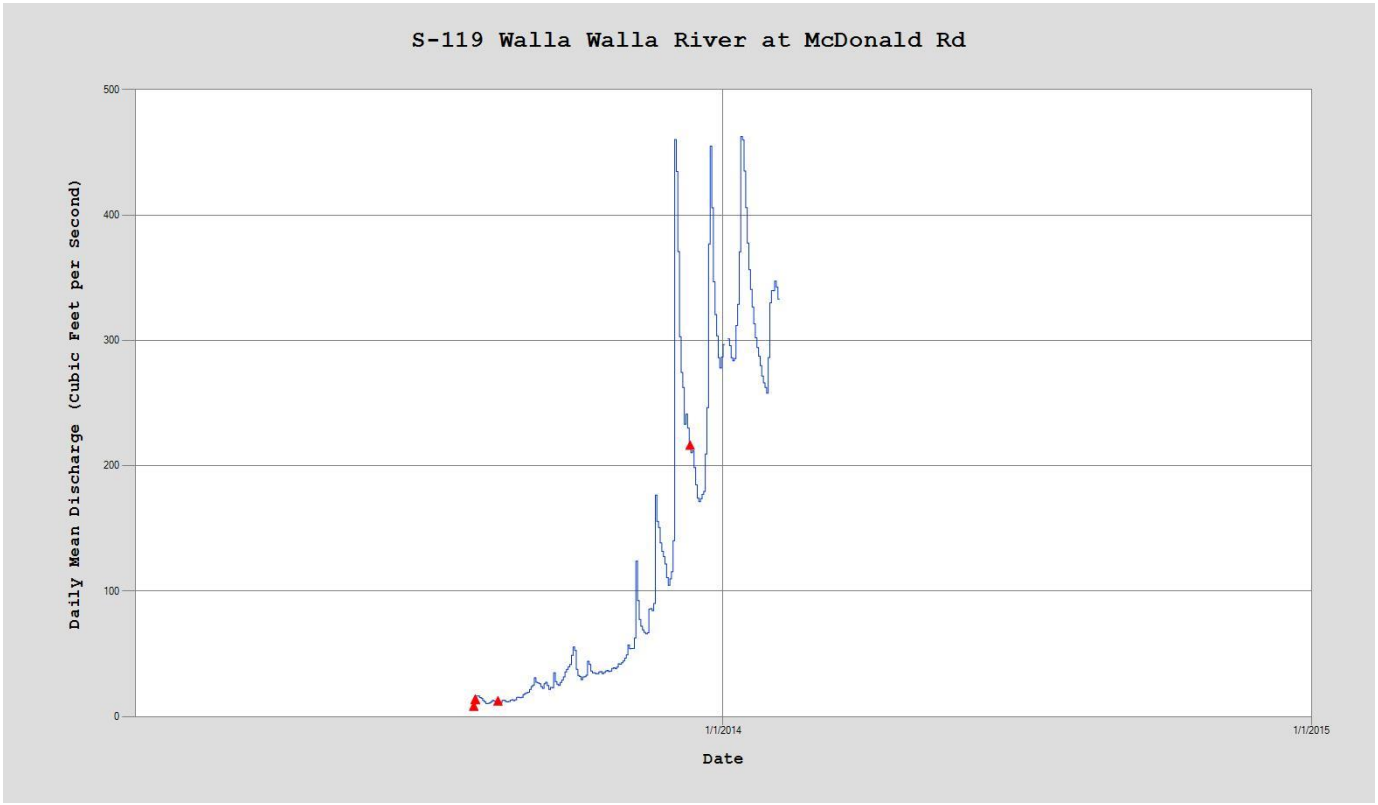


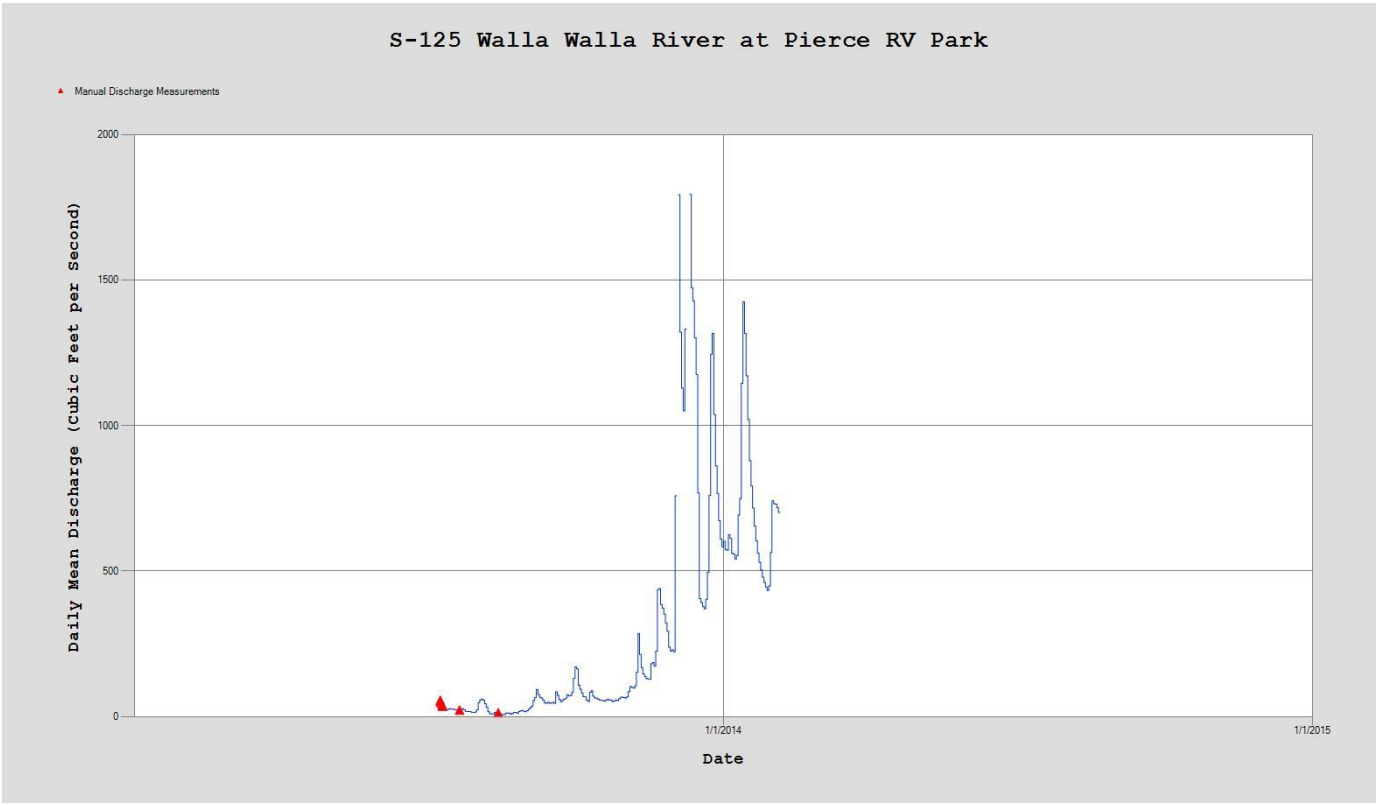

S-105 Walla Walla River at Milton-Freewater
Daily Mean Discharge (Cubic Feet per Second)
2000
1500
1000
500
0
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

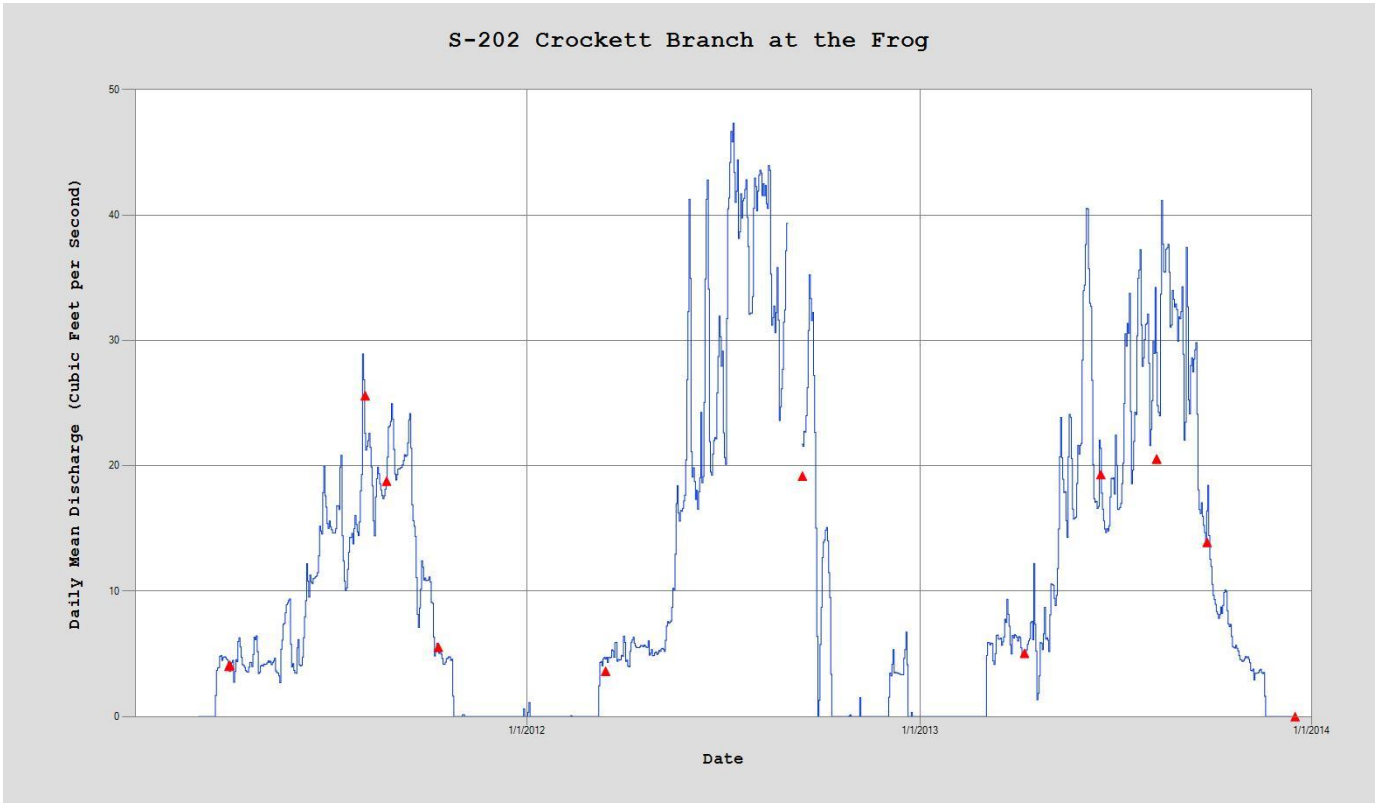

S-106 Walla Walla River below Nursery Bridge (M4)
Manual Discharge Measurements
Daily Mean Discharge (Cubic Feet per Second)
500
400
300
200
100
0
1/1/2002
1/1/2003
1/1/2004
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

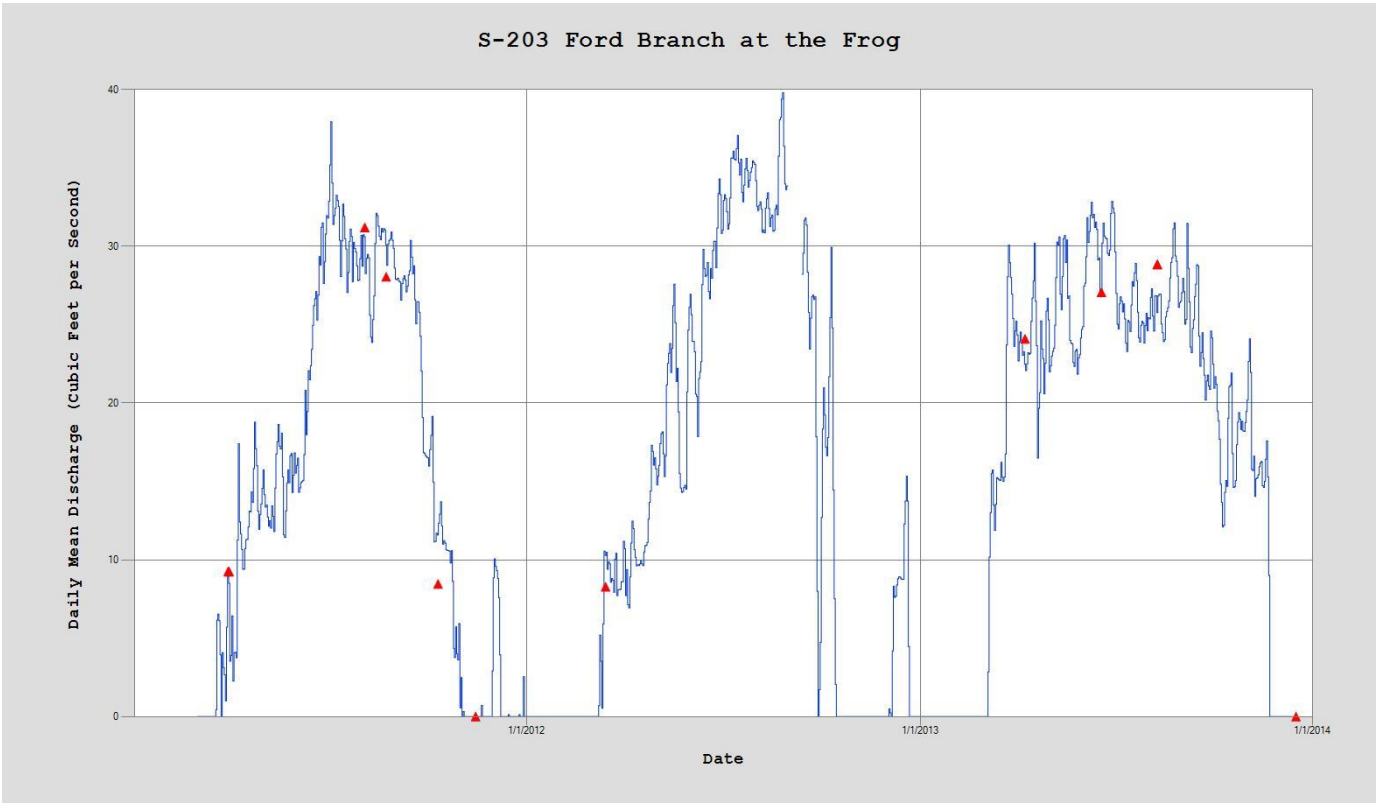

S-107 Walla Walla River at Tum A Lum Bridge
Manual Discharge Measurements
Discharge (Cubic Feet per Second)
600
500
400
300
200
100
0
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

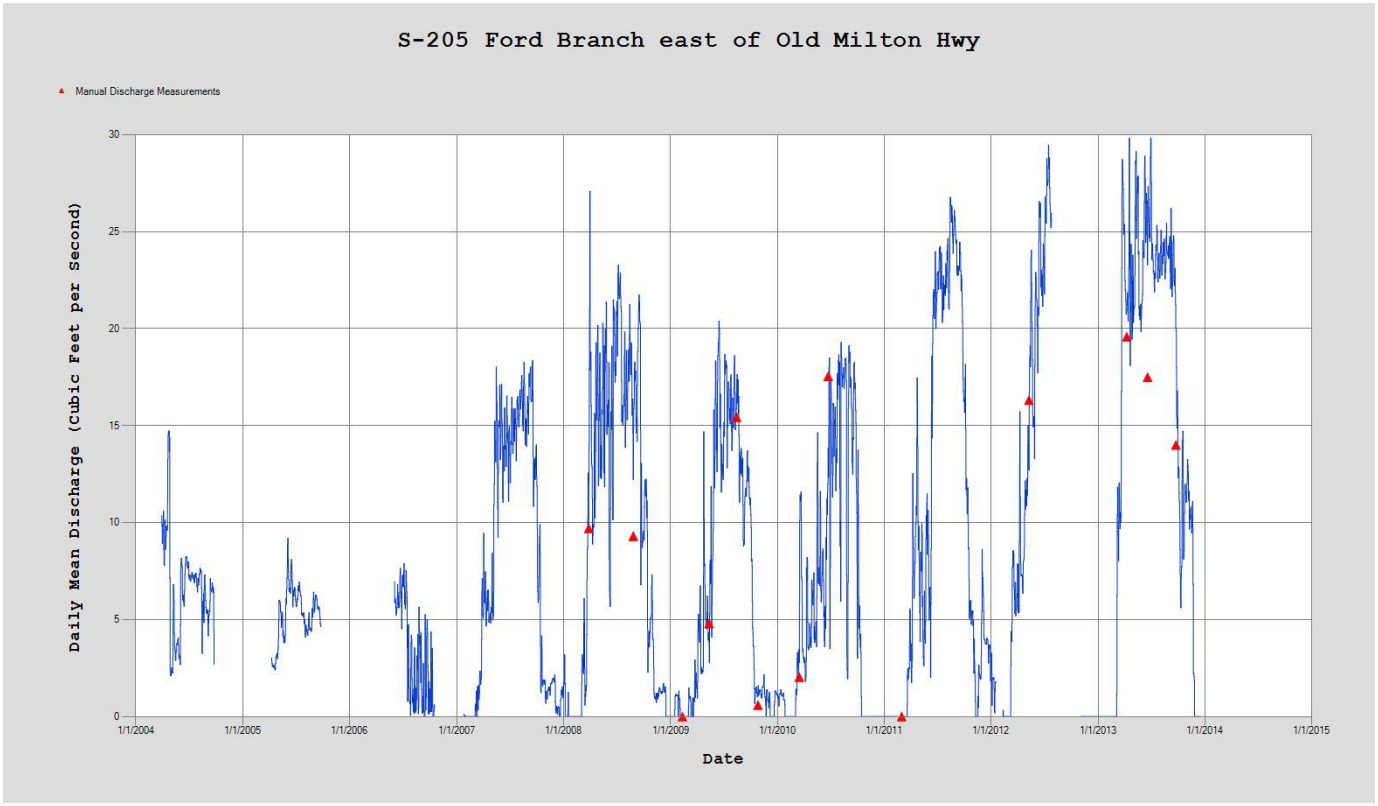

S-108 Walla Walla River at Pepper Bridge
Daily Mean Discharge (Cubic Feet per Second)
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1/1/2002
1/1/2003
1/1/2004
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

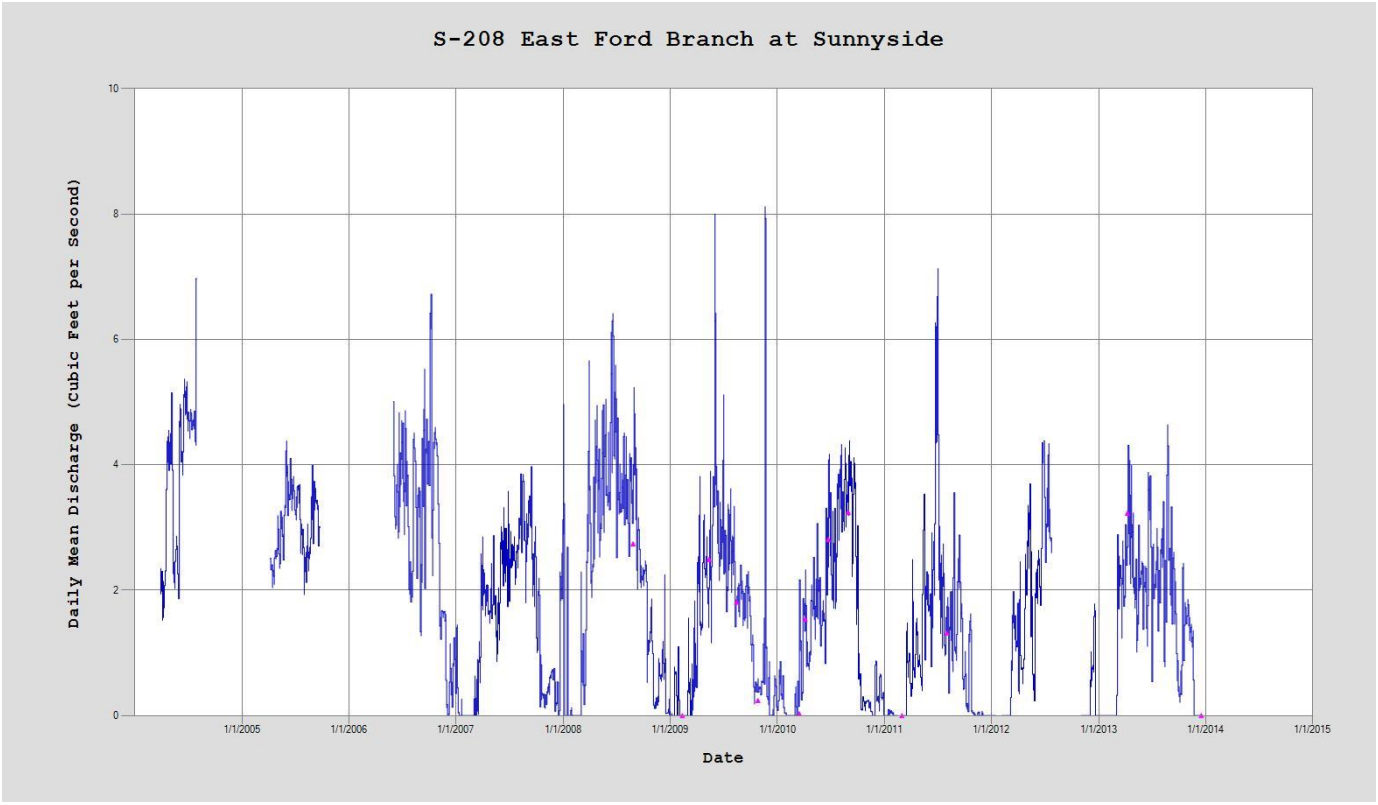

S-119 Walla Walla River at McDonald Rd
Daily Mean Discharge (Cubic Feet per Second)
500
400
300
200
100
0
1/1/2014
1/1/2015
Date

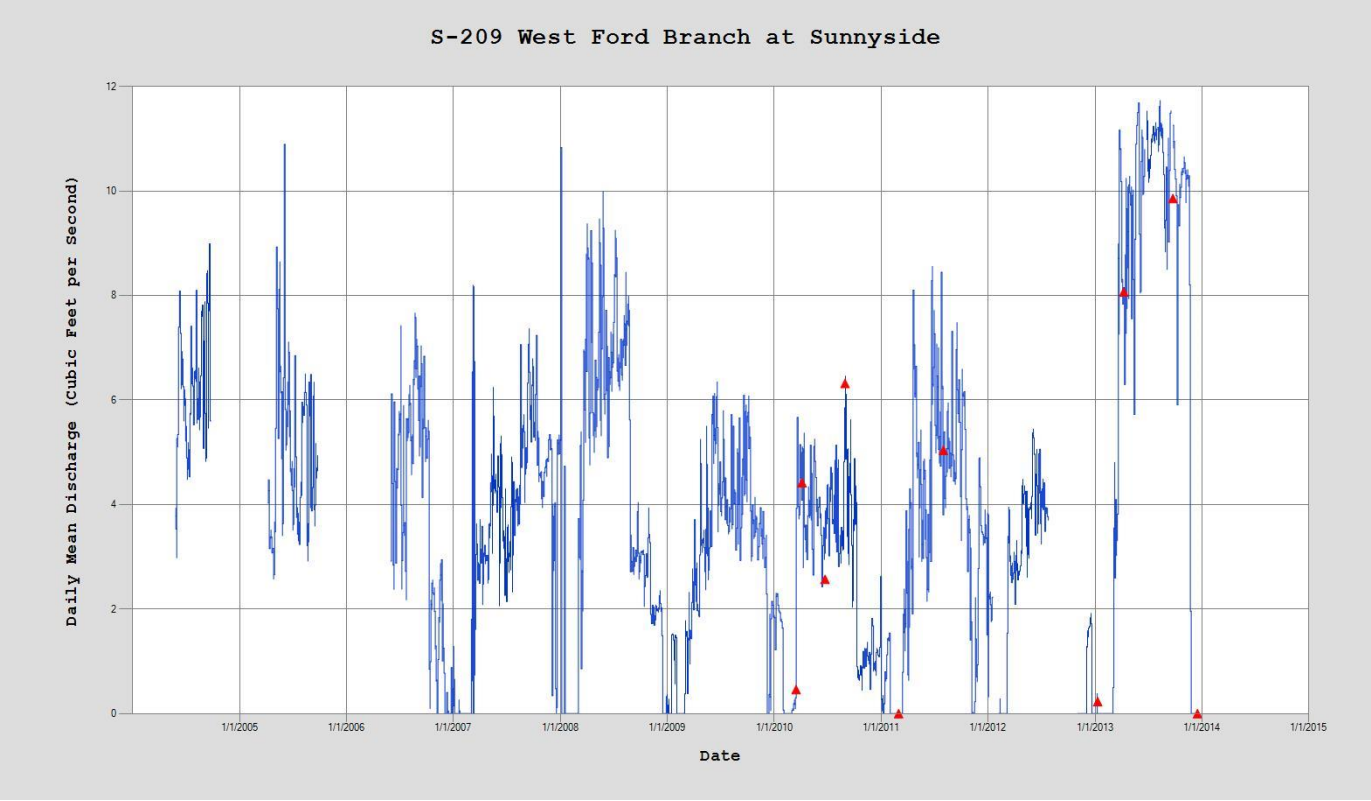

S-125 Walla Walla River at Pierce RV Park
Manual Discharge Measurements
Daily Mean Discharge (Cubic Feet per Second)
2000
1500
1000
500
0
1/1/2014
1/1/2015
Date

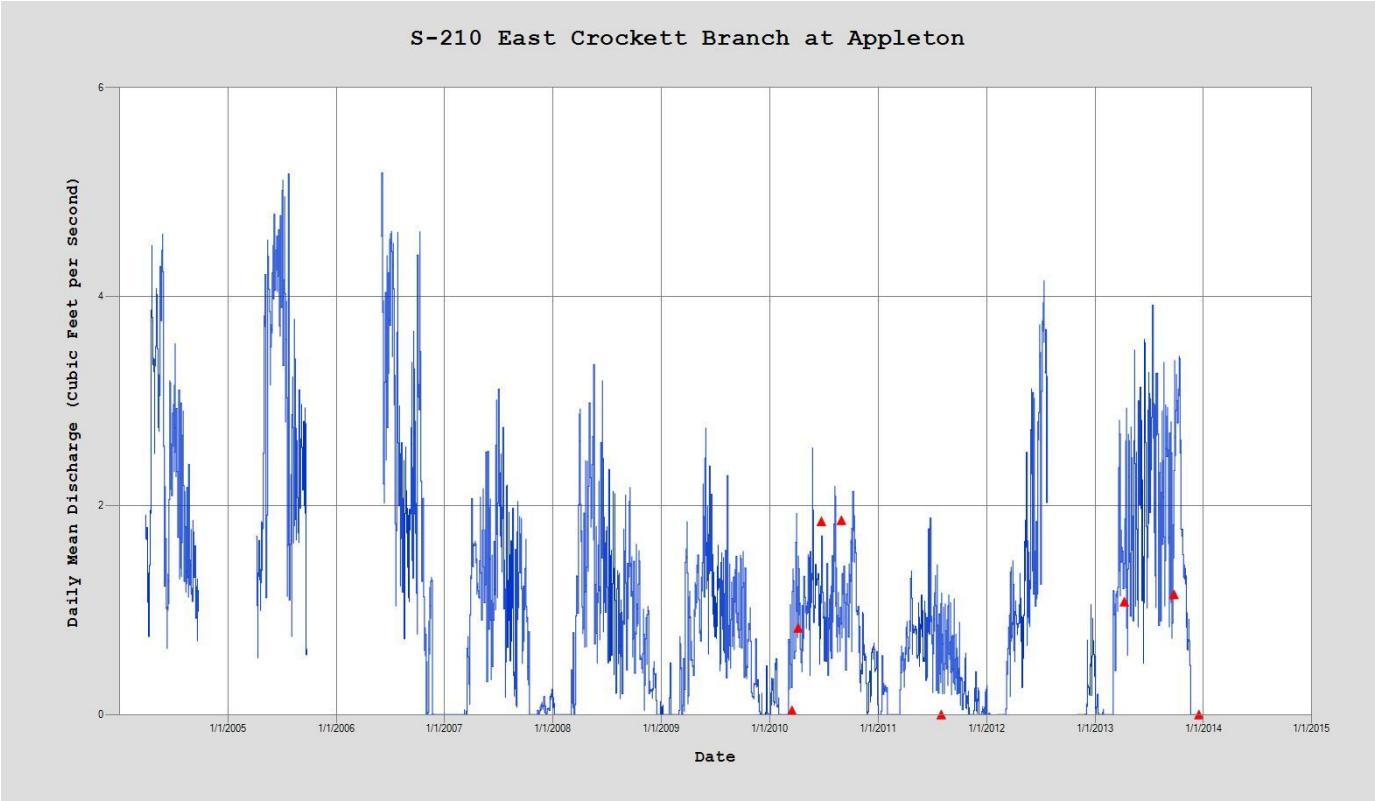

S-202 Crockett Branch at the Frog
Daily Mean Discharge (Cubic Feet per Second)
50
40
30
20
10
0
1/1/2012
1/1/2013
1/1/2014
Date

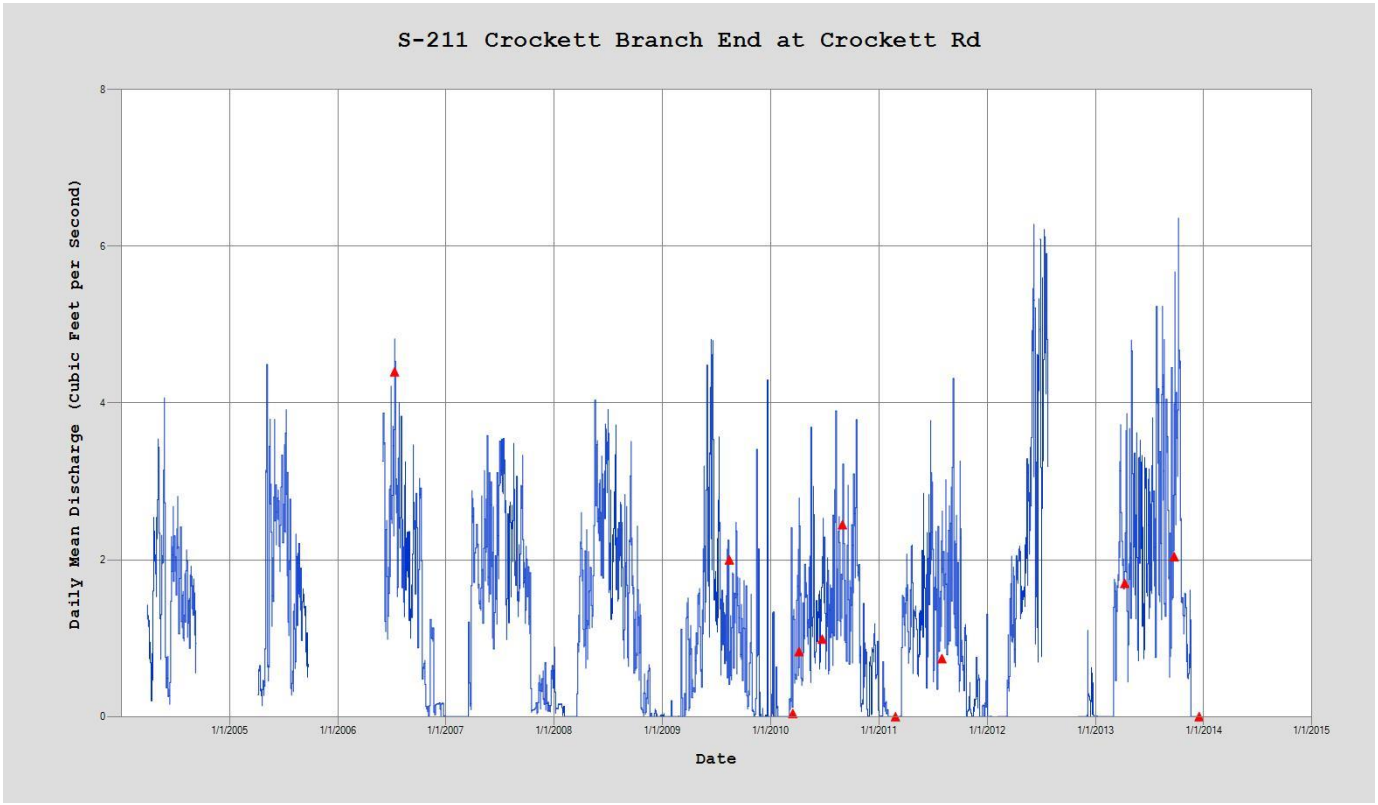

S-203 Ford Branch at the Frog
Daily Mean Discharge (Cubic Feet per Second)
40
30
20
10
0
1/1/2012
1/1/2013
1/1/2014
Date

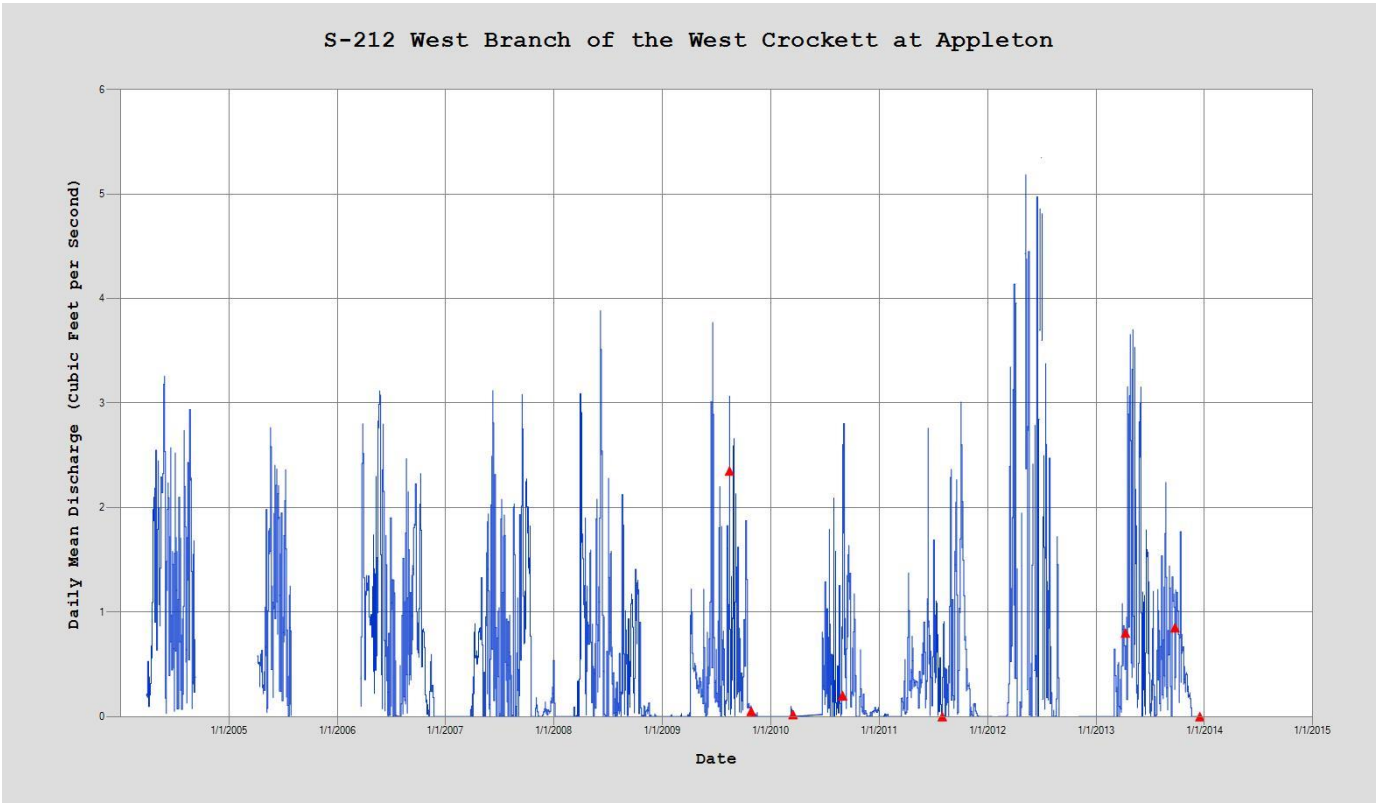

S-205 Ford Branch east of Old Milton Hwy
Manual Discharge Measurements
Daily Mean Discharge (Cubic Feet per Second)
30
25
20
15
10
5
0
1/1/2004
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

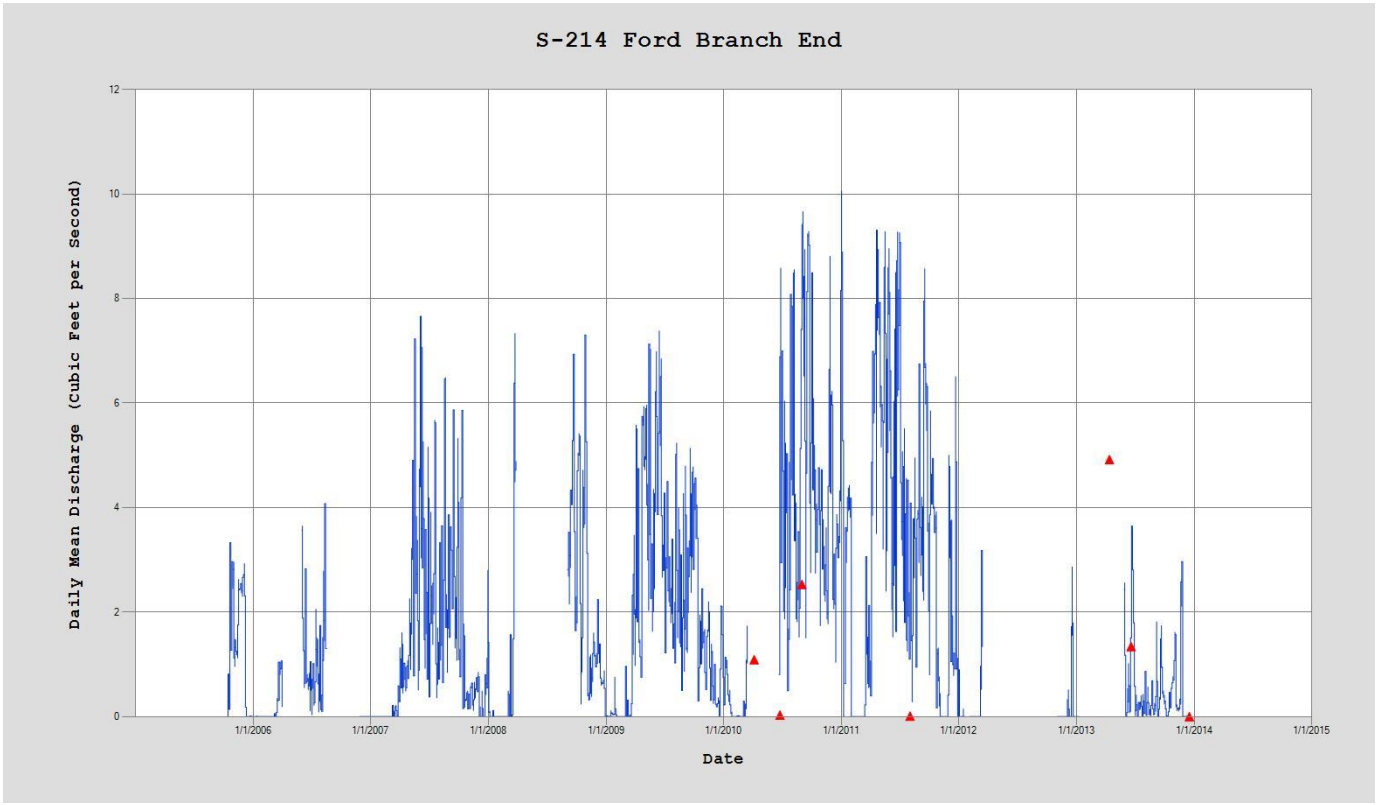

S-208 East Ford Branch at Sunnyside
Daily Mean Discharge (Cubic Feet per Second)
10
8
6
4
2
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

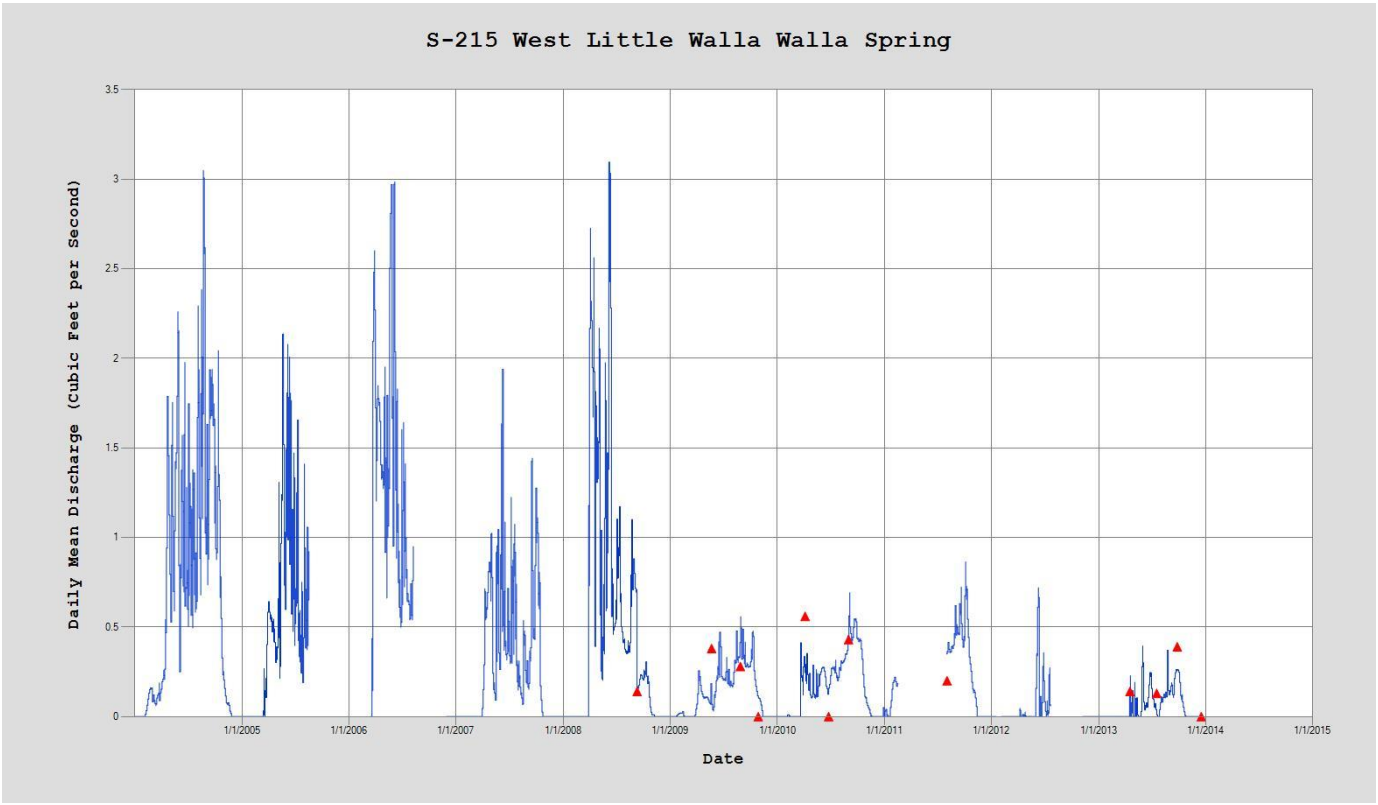

S-209 West Ford Branch at Sunnyside
Daily Mean Discharge (Cubic Feet per Second)
12
10
8
6
4
2
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

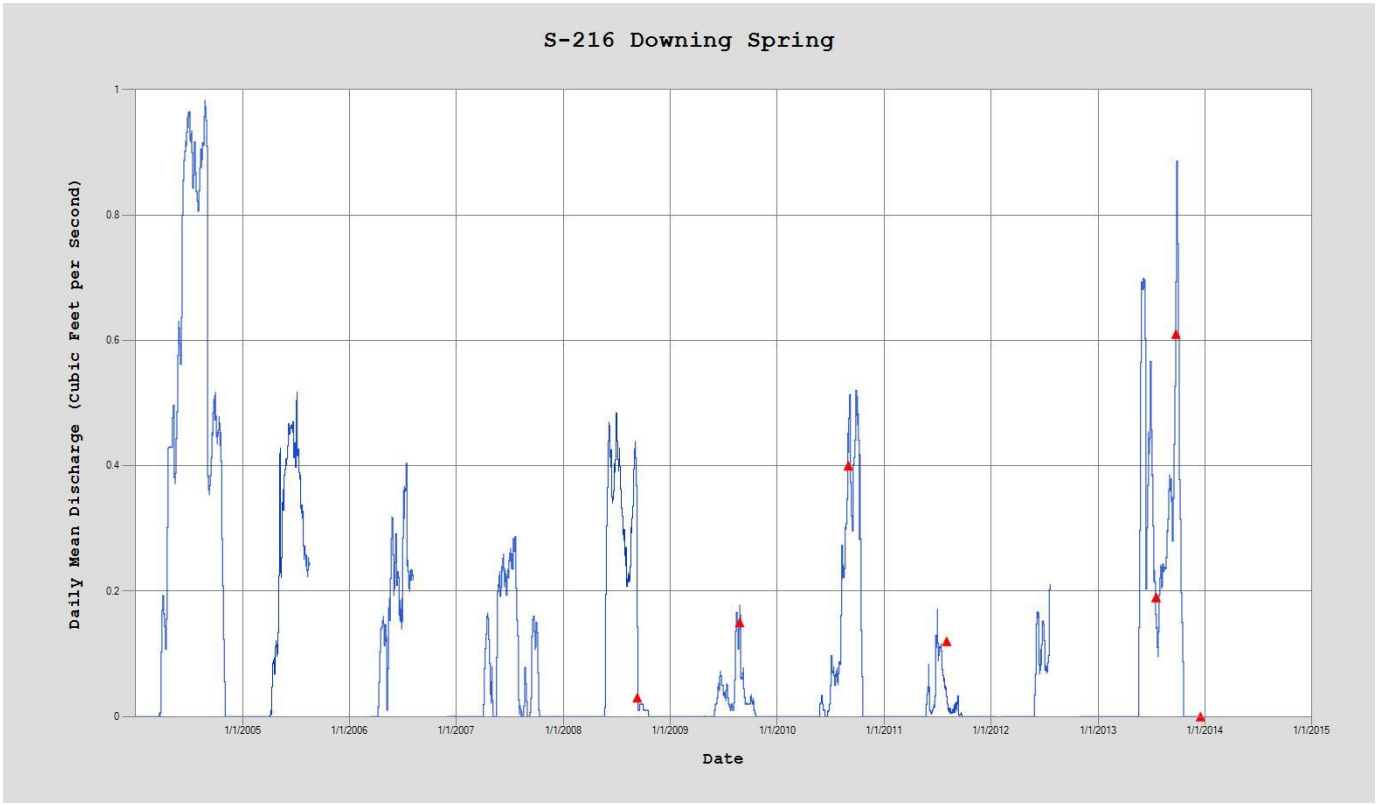

S-210 East Crockett Branch at Appleton
Daily Mean Discharge (Cubic Feet per Second)
6
4
2
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

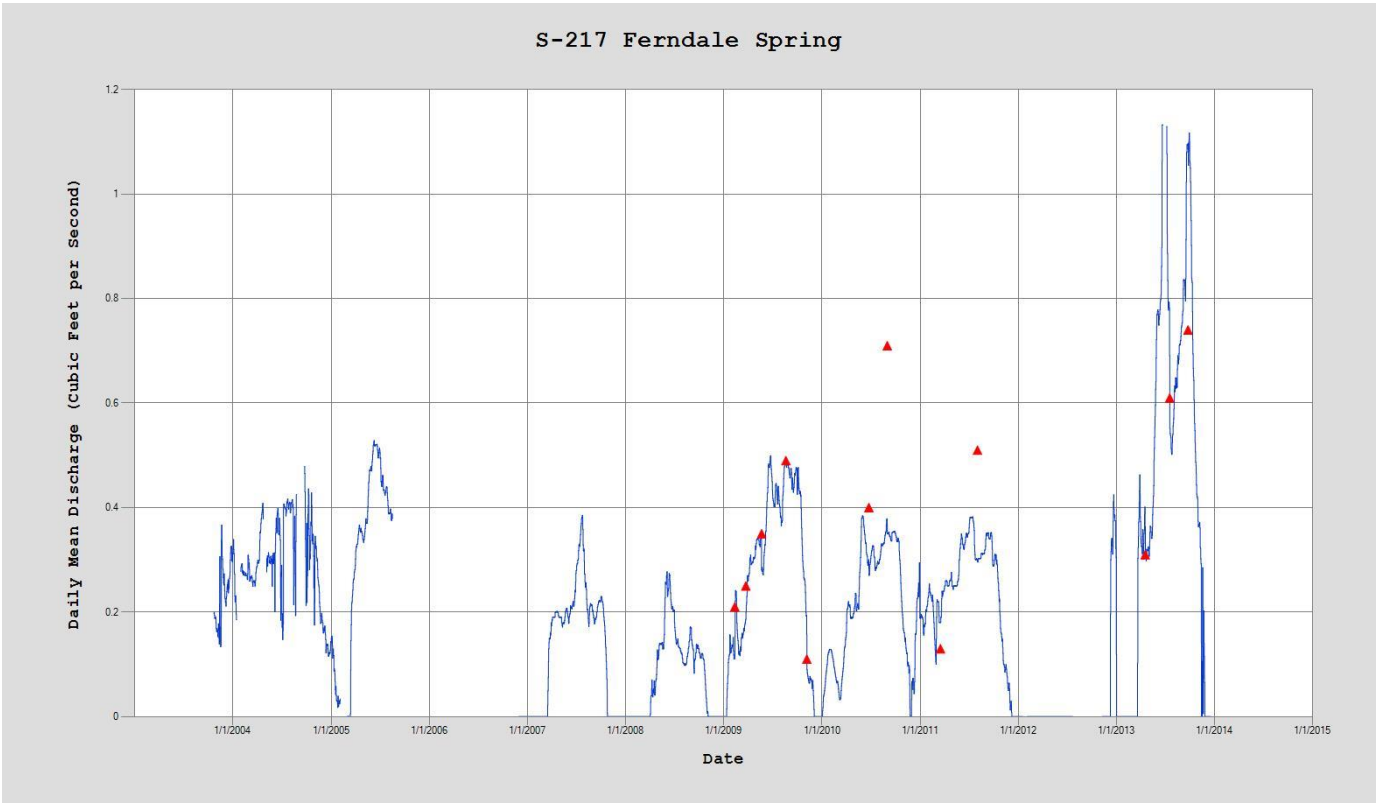

S-211 Crockett Branch End at Crockett Rd
Daily Mean Discharge (Cubic Feet per Second)
0
2
4
6
8
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

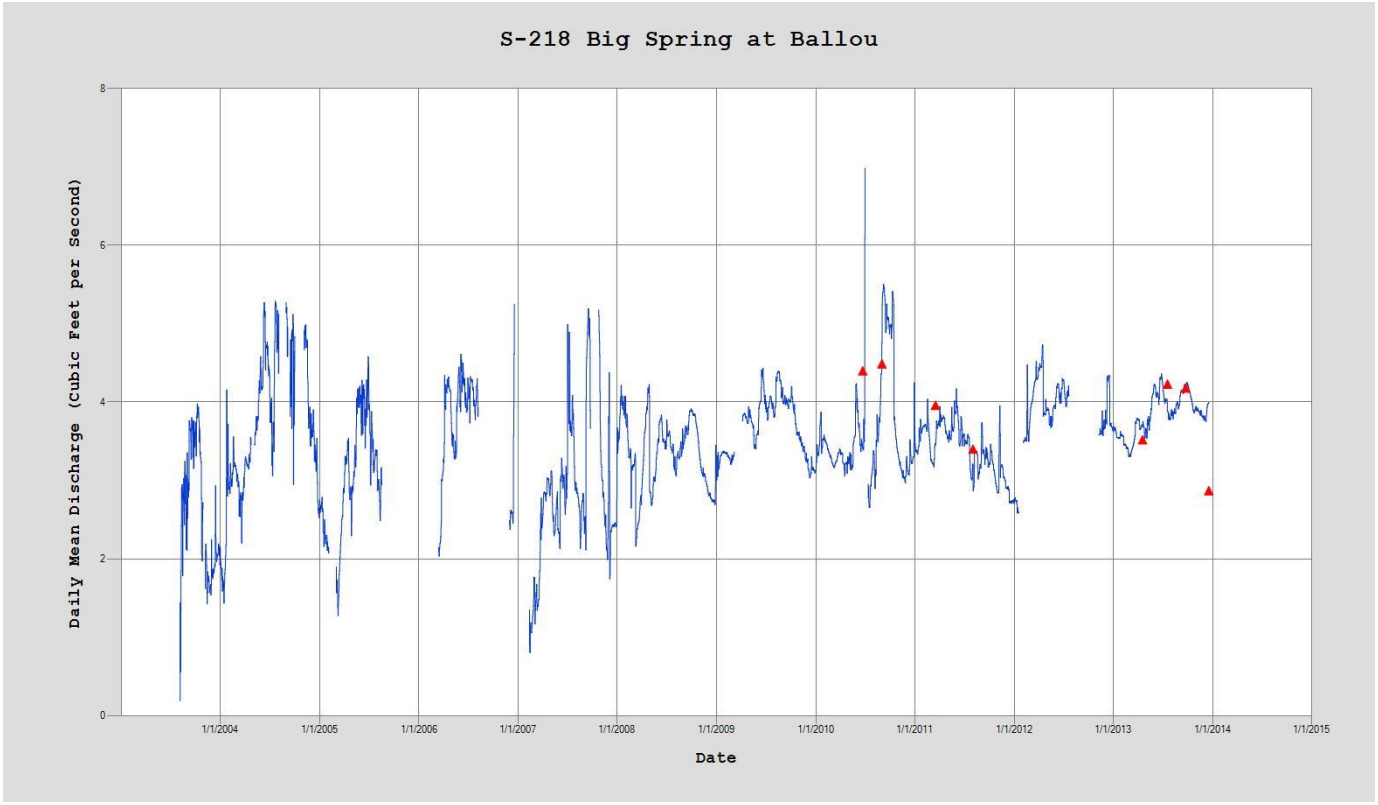

S-212 West Branch of the West Crockett at Appleton
Daily Mean Discharge (Cubic Feet per Second)
0
1
2
3
4
5
6
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

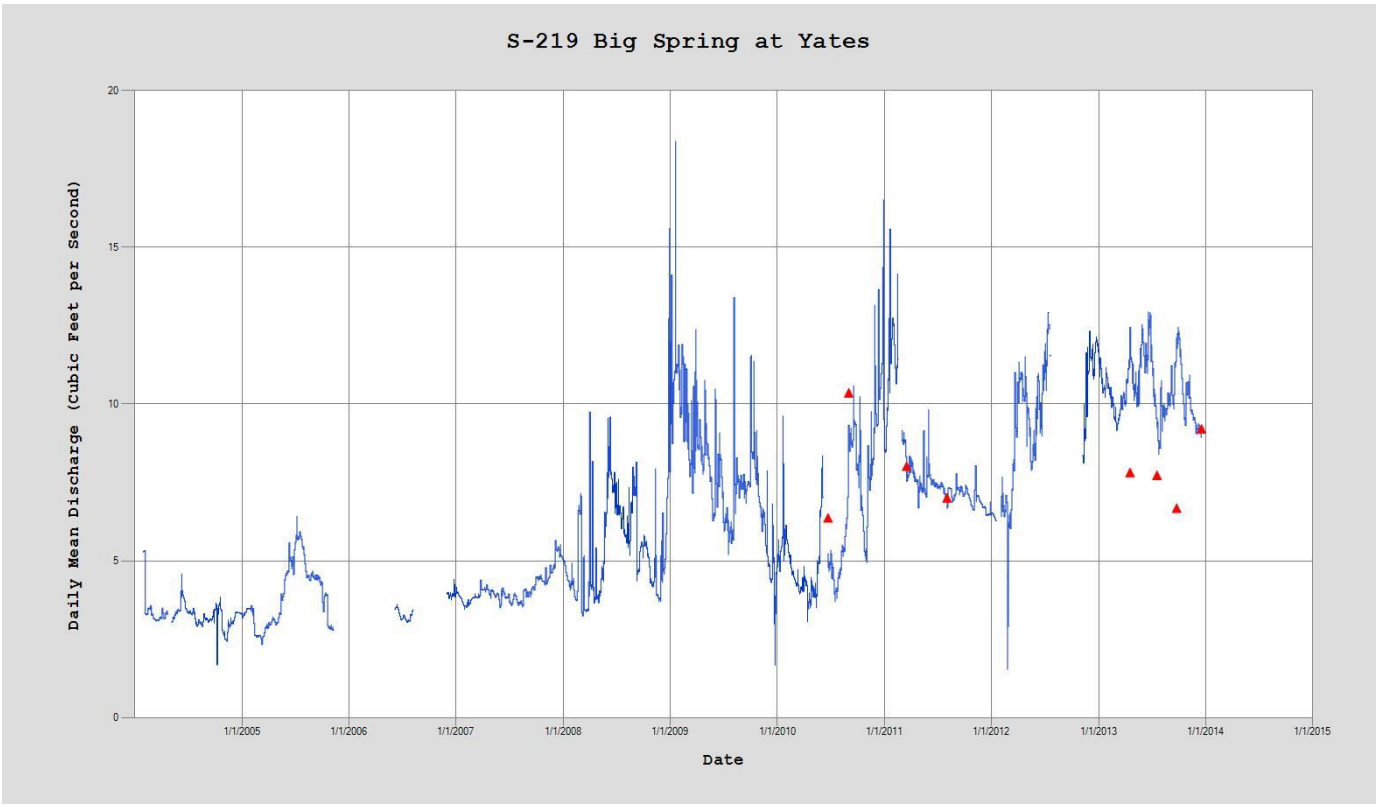

S-214 Ford Branch End
Daily Mean Discharge (Cubic Feet per Second)
12
10
8
6
4
2
0
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

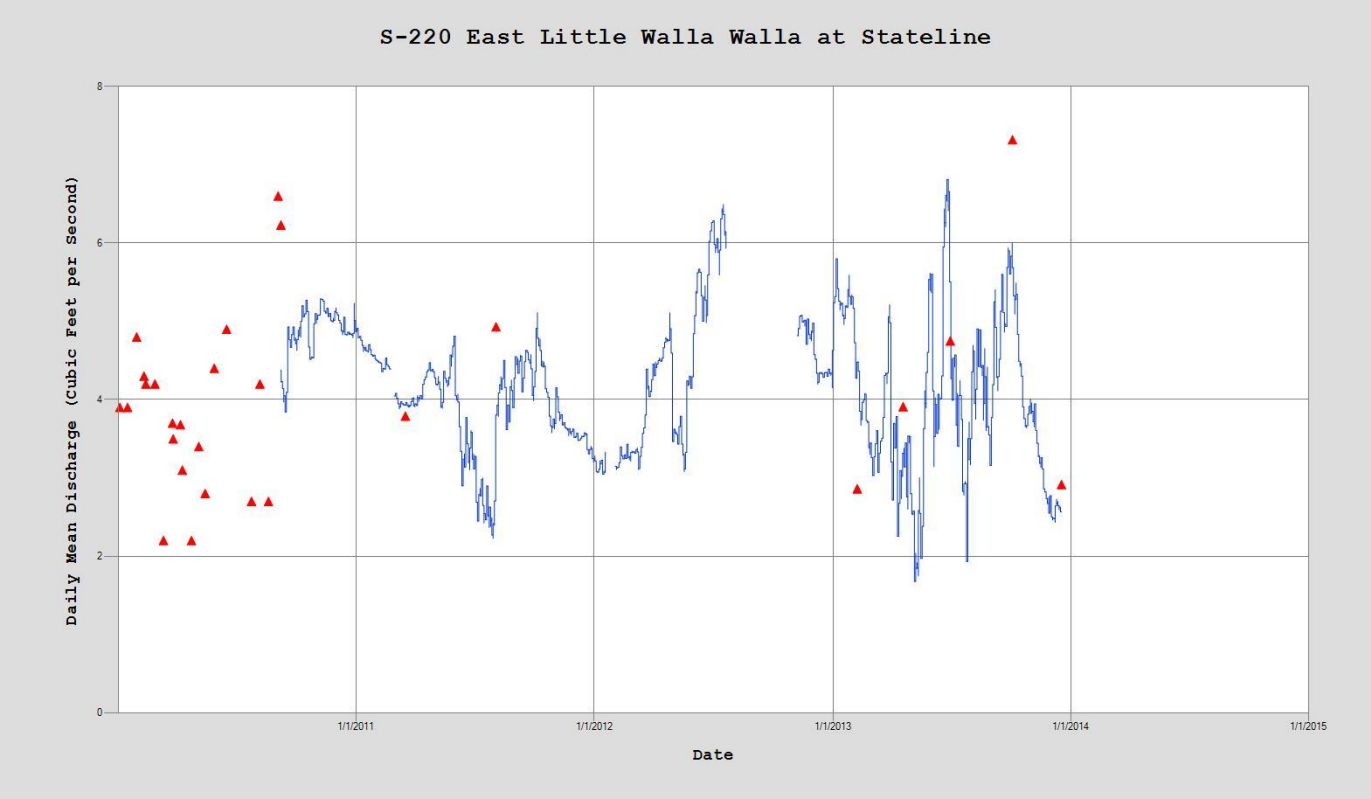

S-215 West Little Walla Walla Spring
Daily Mean Discharge (Cubic Feet per Second)
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

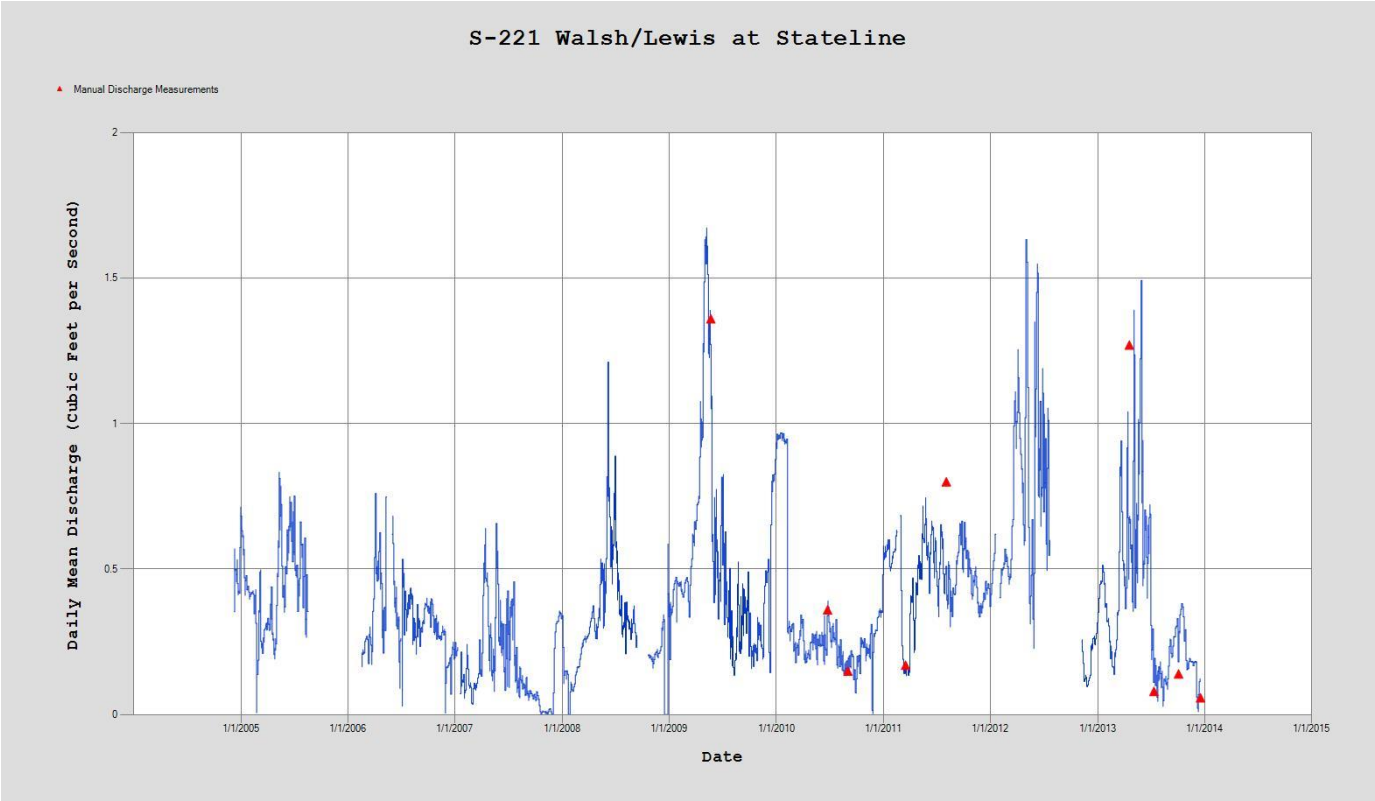

S-216 Downing Spring
Daily Mean Discharge (Cubic Feet per Second)
1
0.8
0.6
0.4
0.2
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

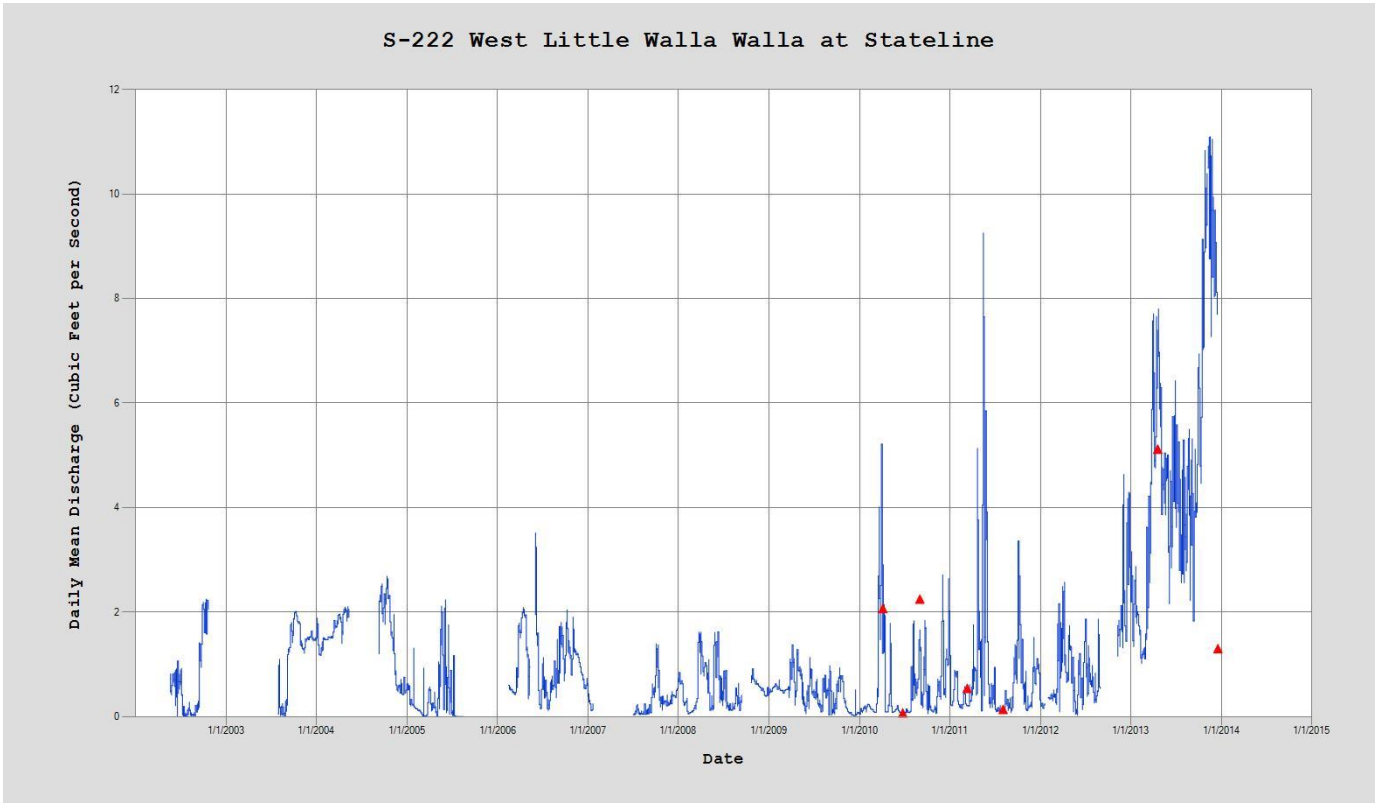

S-217 Ferndale Spring
Daily Mean Discharge (Cubic Feet per Second)
1.2
1
0.8
0.6
0.4
0.2
0
1/1/2004
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

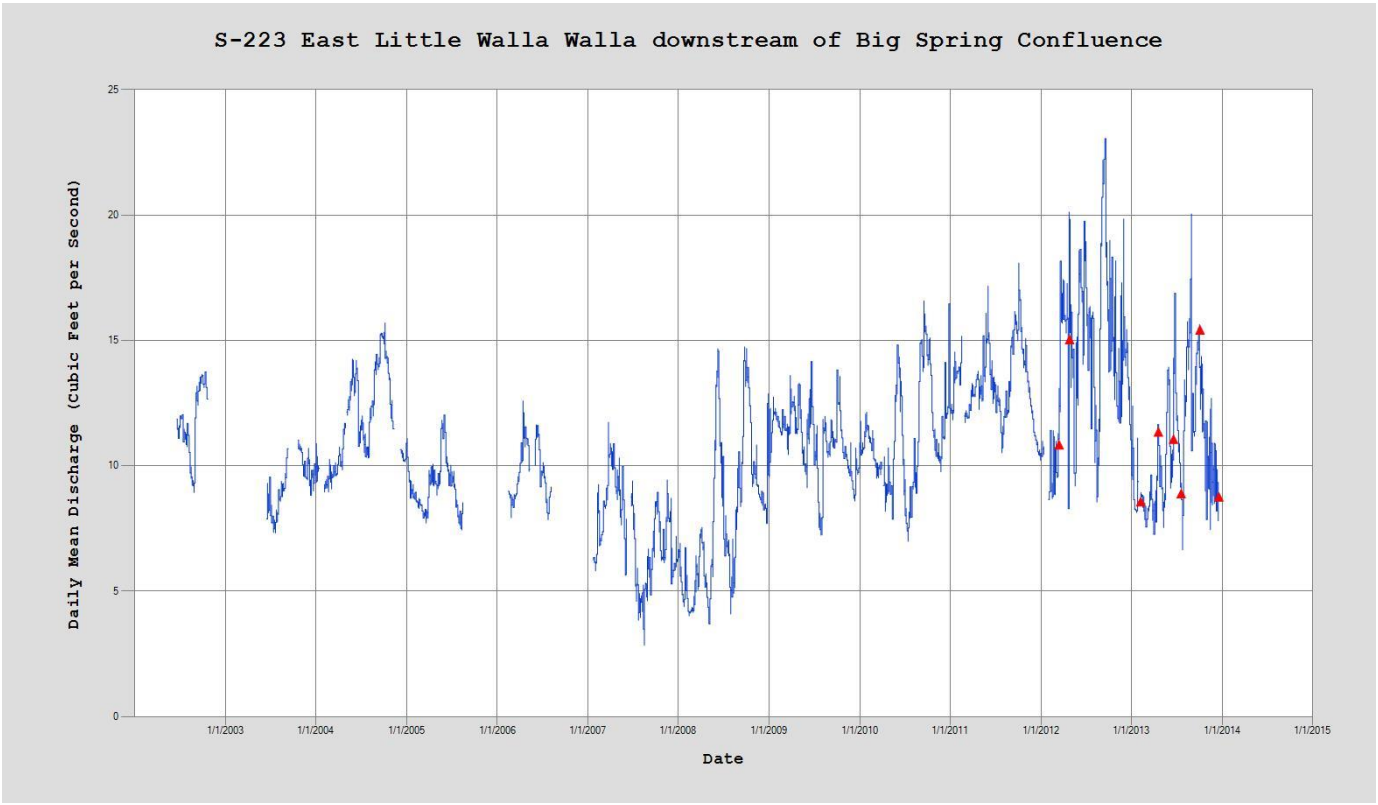

S-218 Big Spring at Ballou
Daily Mean Discharge (Cubic Feet per Second)
0
2
4
6
8
1/1/2004
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

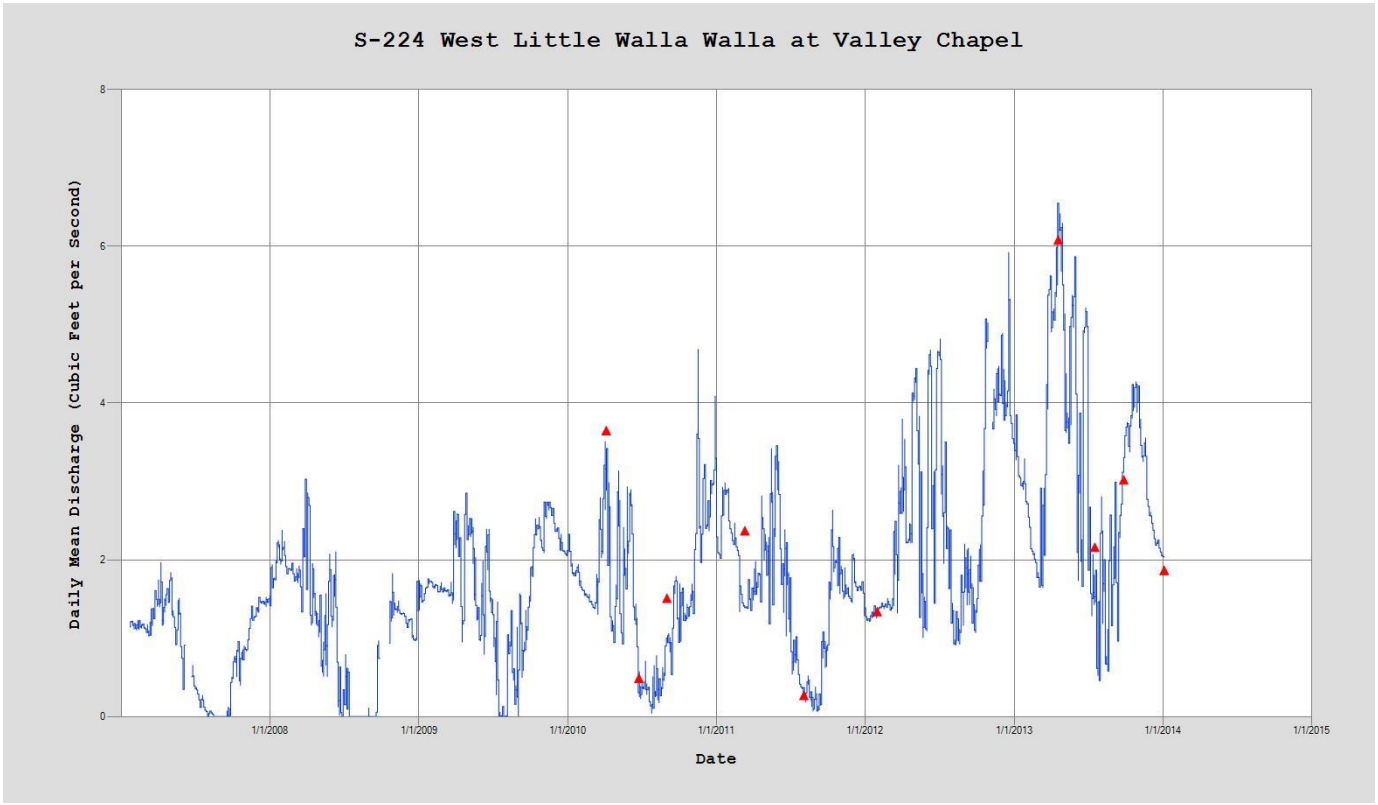

S-219 Big Spring at Yates
Daily Mean Discharge (Cubic Feet per Second)
0
5
10
15
20
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

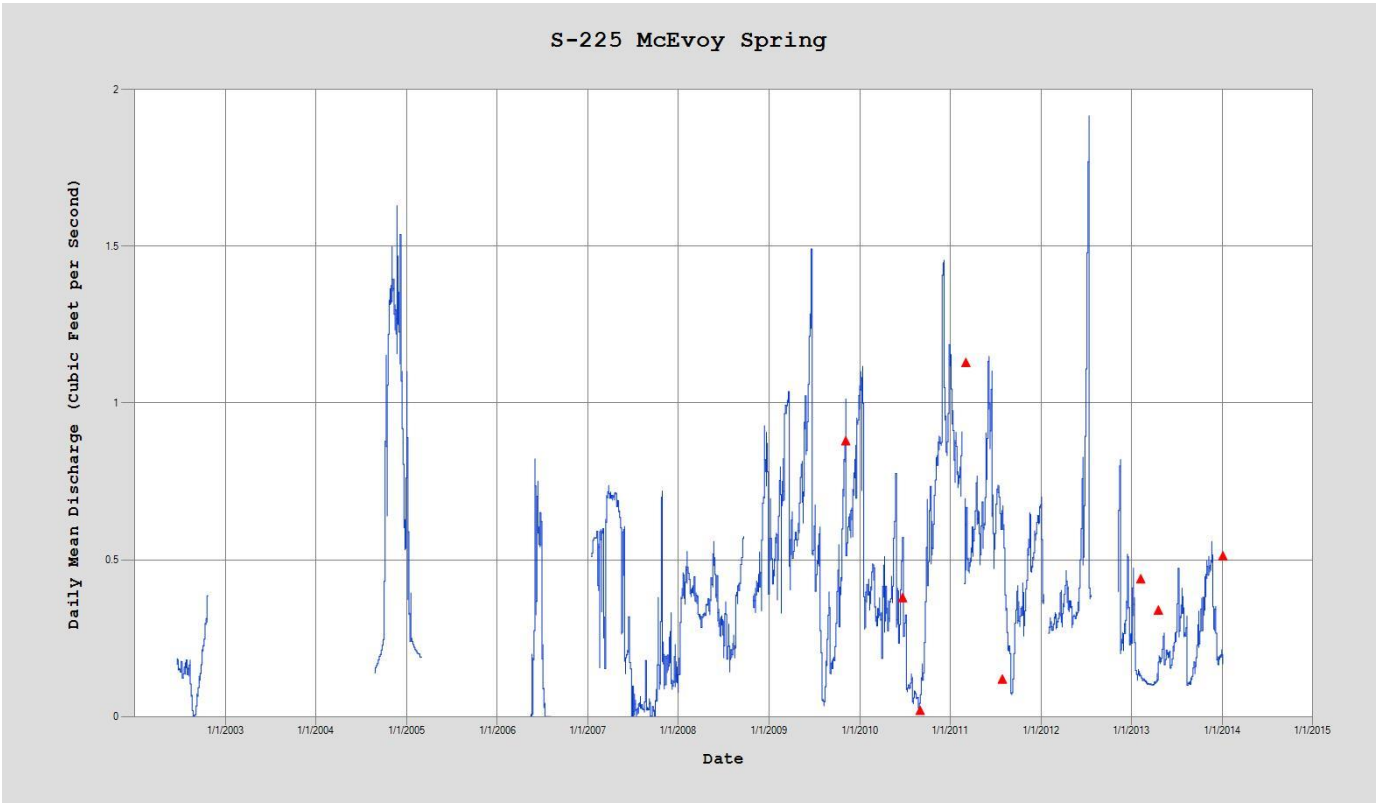

S-220 East Little Walla Walla at Stateline
Daily Mean Discharge (Cubic Feet per Second)
8
6
4
2
0
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

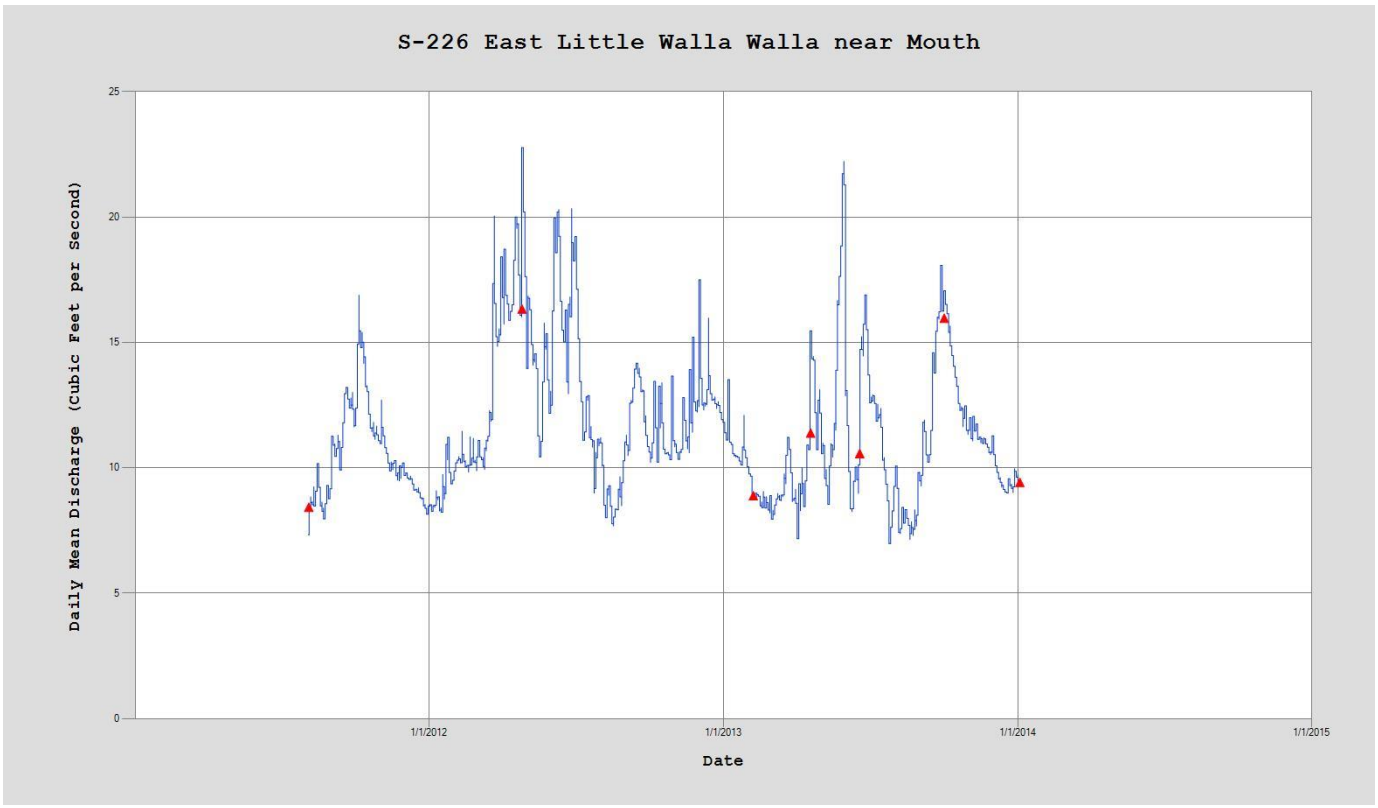

S-221 Walsh/Lewis at Stateline
Manual Discharge Measurements
Daily Mean Discharge (Cubic Feet per Second)
2
1.5
1
0.5
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

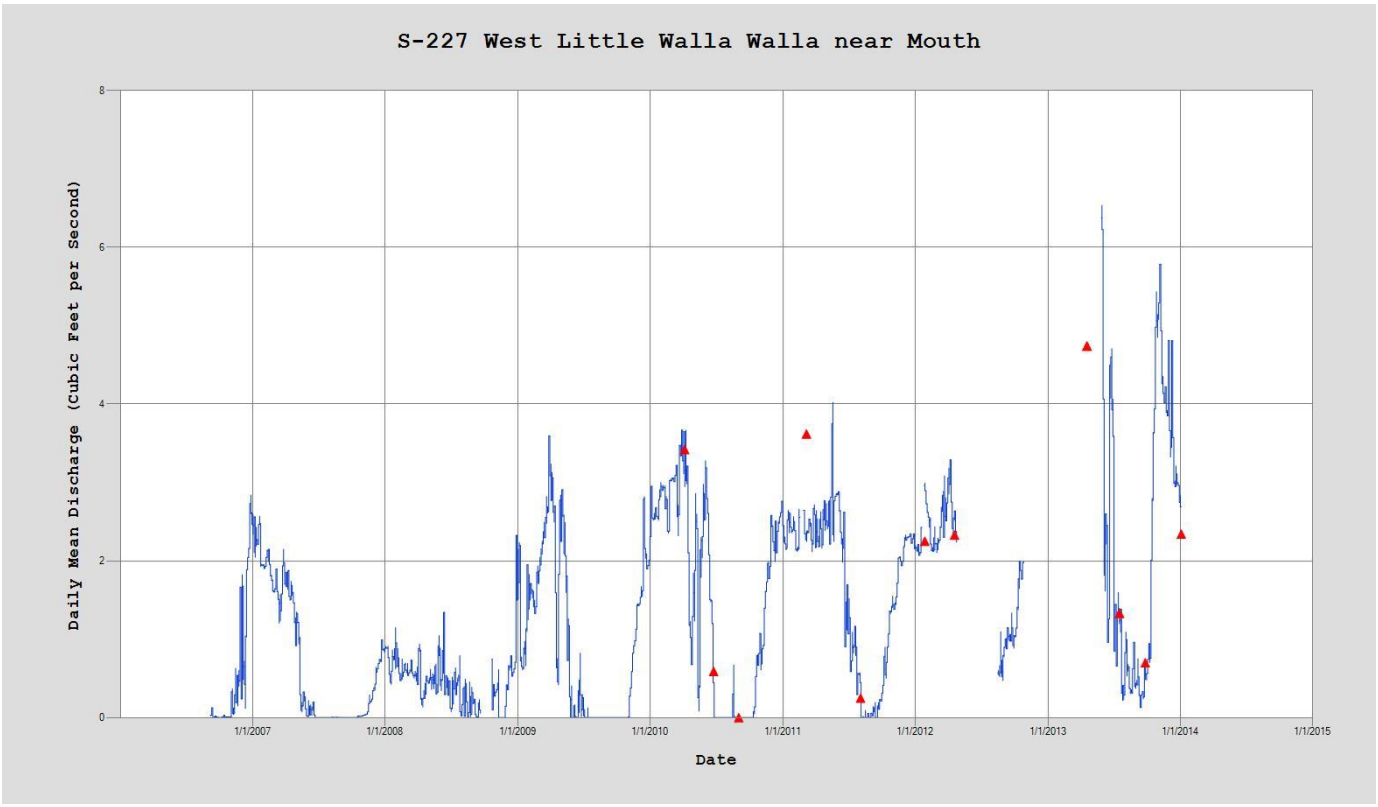

S-222 West Little Walla Walla at Stateline
Daily Mean Discharge (Cubic Feet per Second)
0
2
4
6
8
10
12
1/1/2003
1/1/2004
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

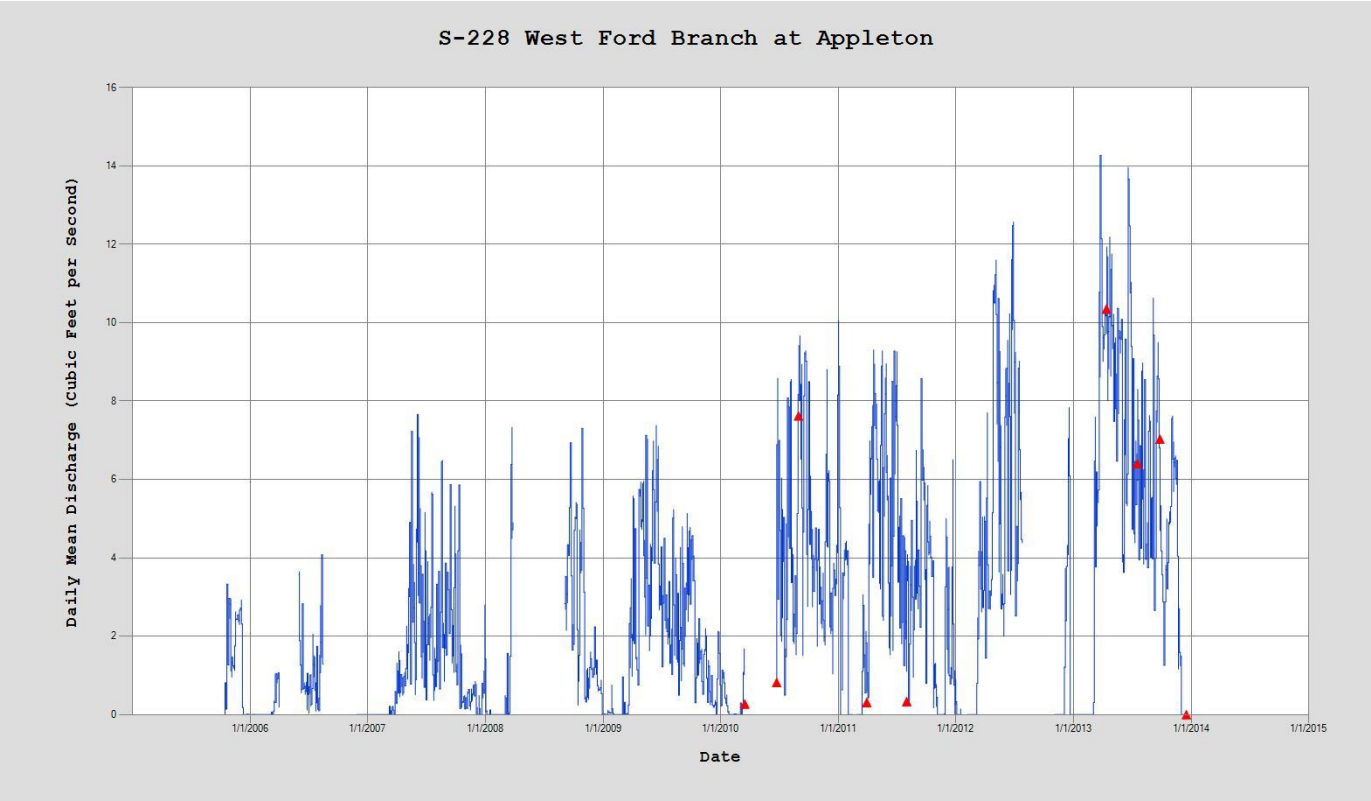

S-223 East Little Walla Walla downstream of Big Spring Confluence
Daily Mean Discharge (Cubic Feet per Second)
0
5
10
15
20
25
1/1/2003
1/1/2004
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

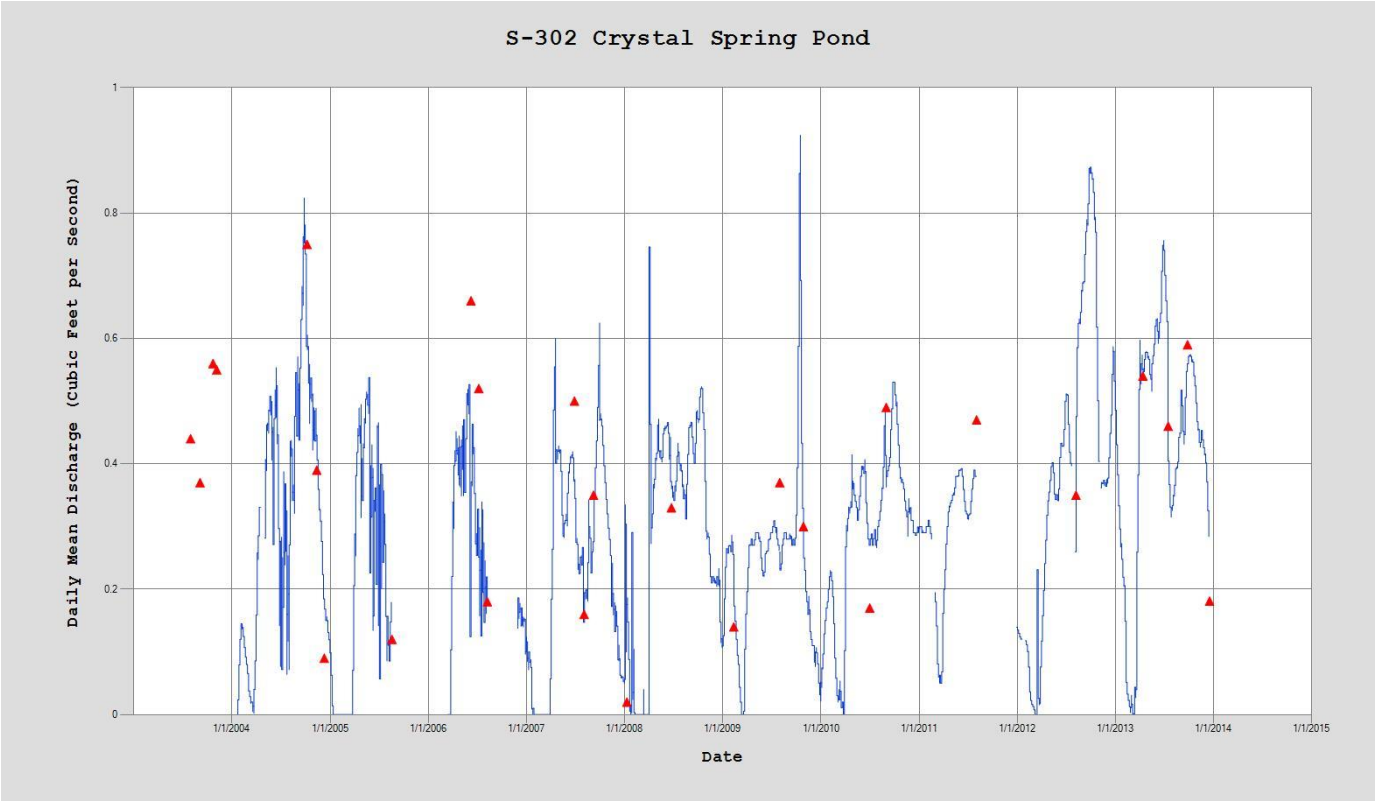

S-224 West Little Walla Walla at Valley Chapel
Daily Mean Discharge (Cubic Feet per Second)
0
2
4
6
8
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

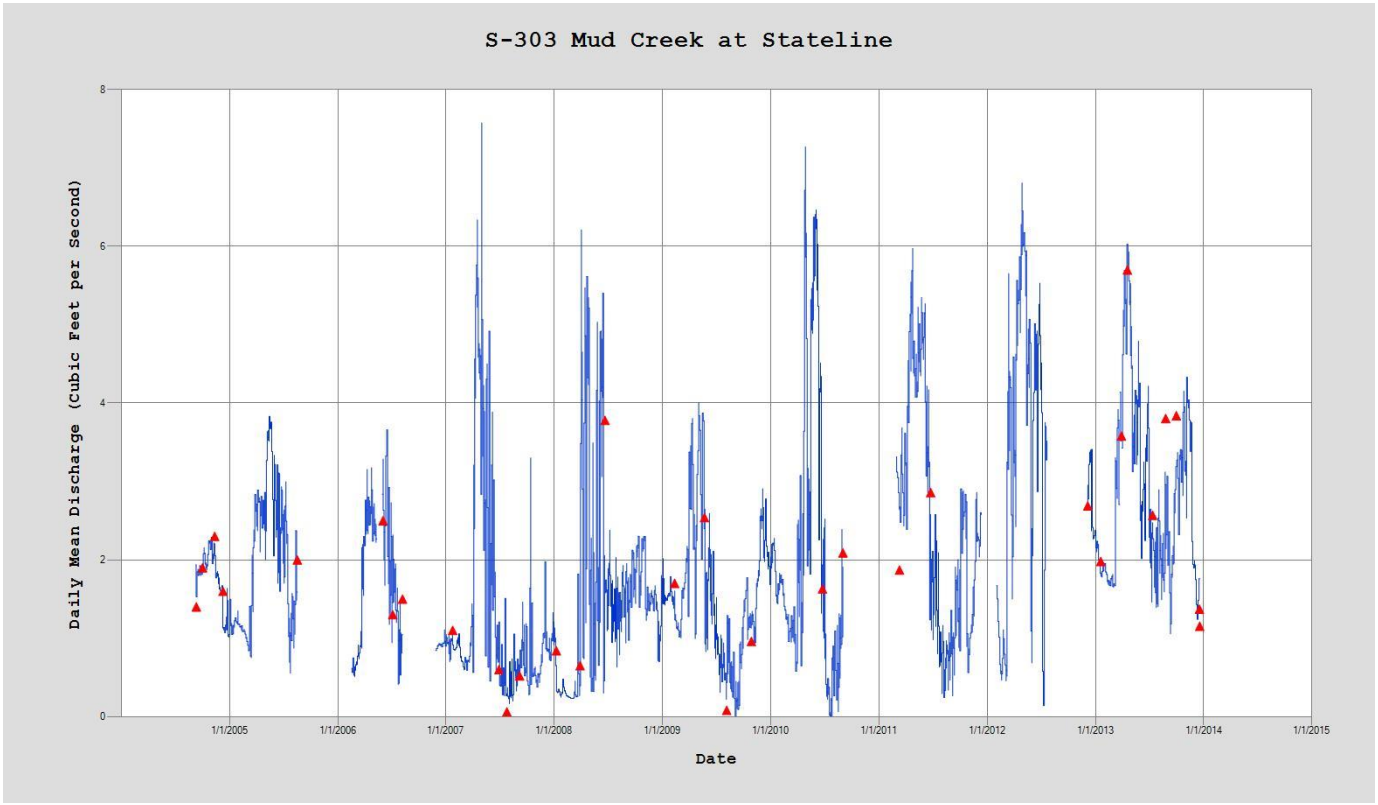

S-225 McEvoy Spring
Daily Mean Discharge (Cubic Feet per Second)
0
0.5
1
1.5
2
1/1/2003
1/1/2004
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

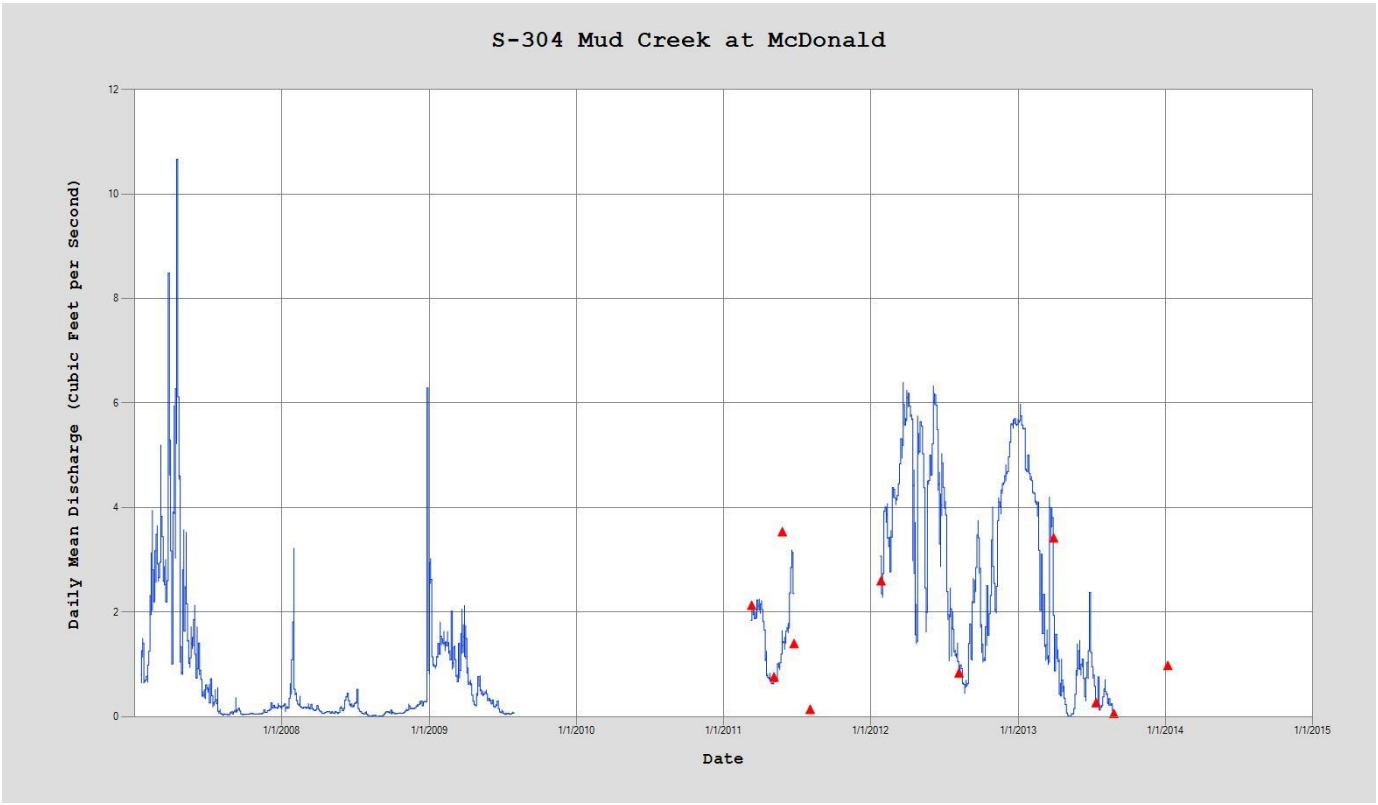

S-226 East Little Walla Walla near Mouth
Daily Mean Discharge (Cubic Feet per Second)
25
20
15
10
5
0
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

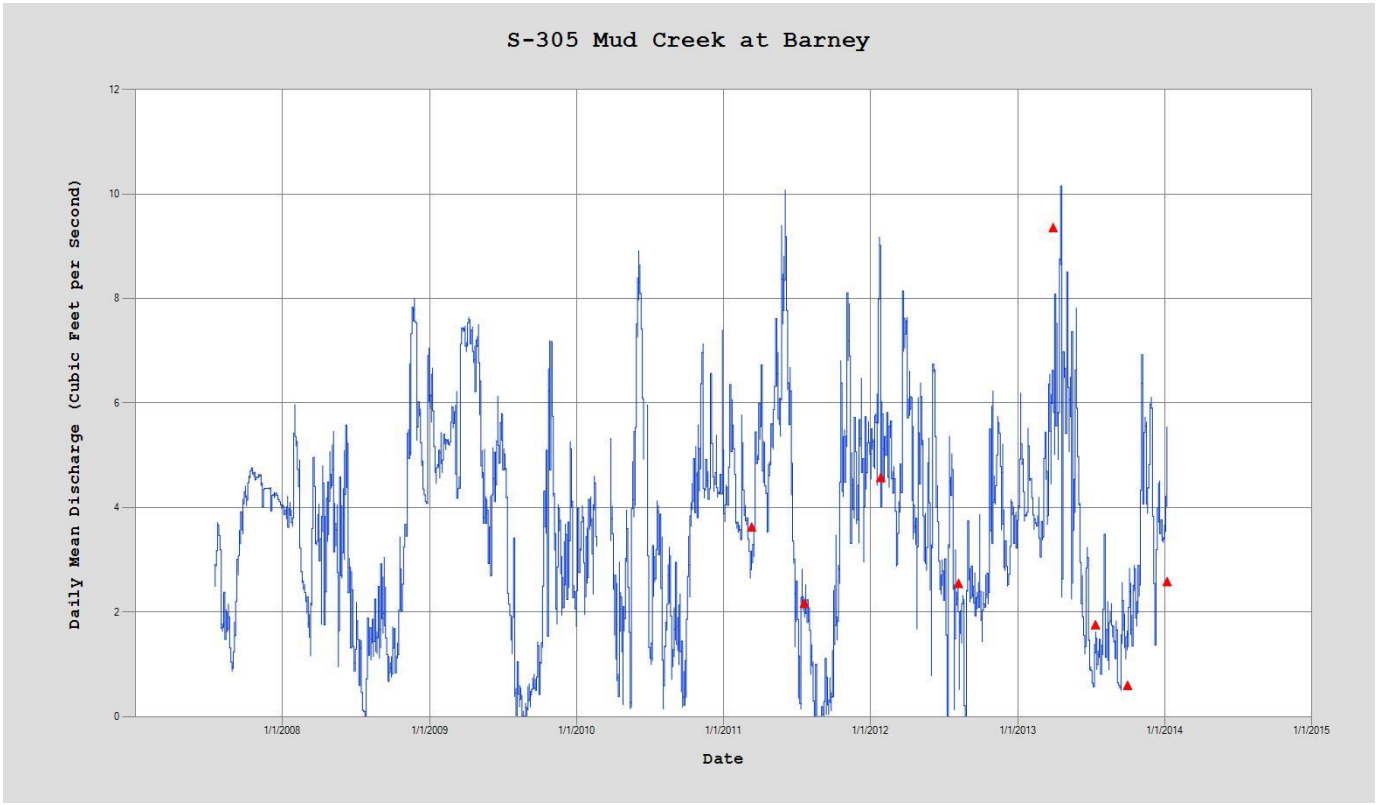

S-227 West Little Walla Walla near Mouth
Daily Mean Discharge (Cubic Feet per Second)
8
6
4
2
0
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

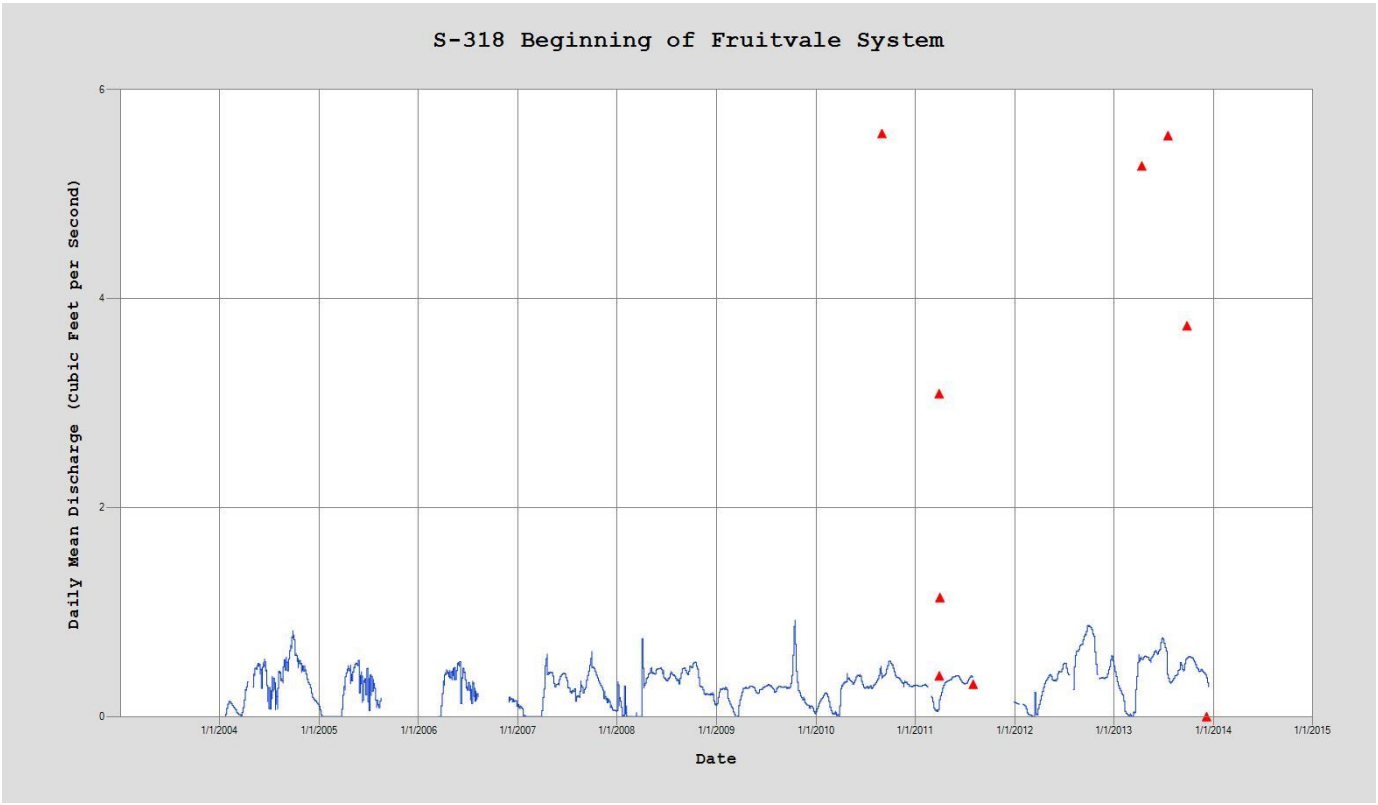

S-228 West Ford Branch at Appleton
Daily Mean Discharge (Cubic Feet per Second)
16
14
12
10
8
6
4
2
0
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

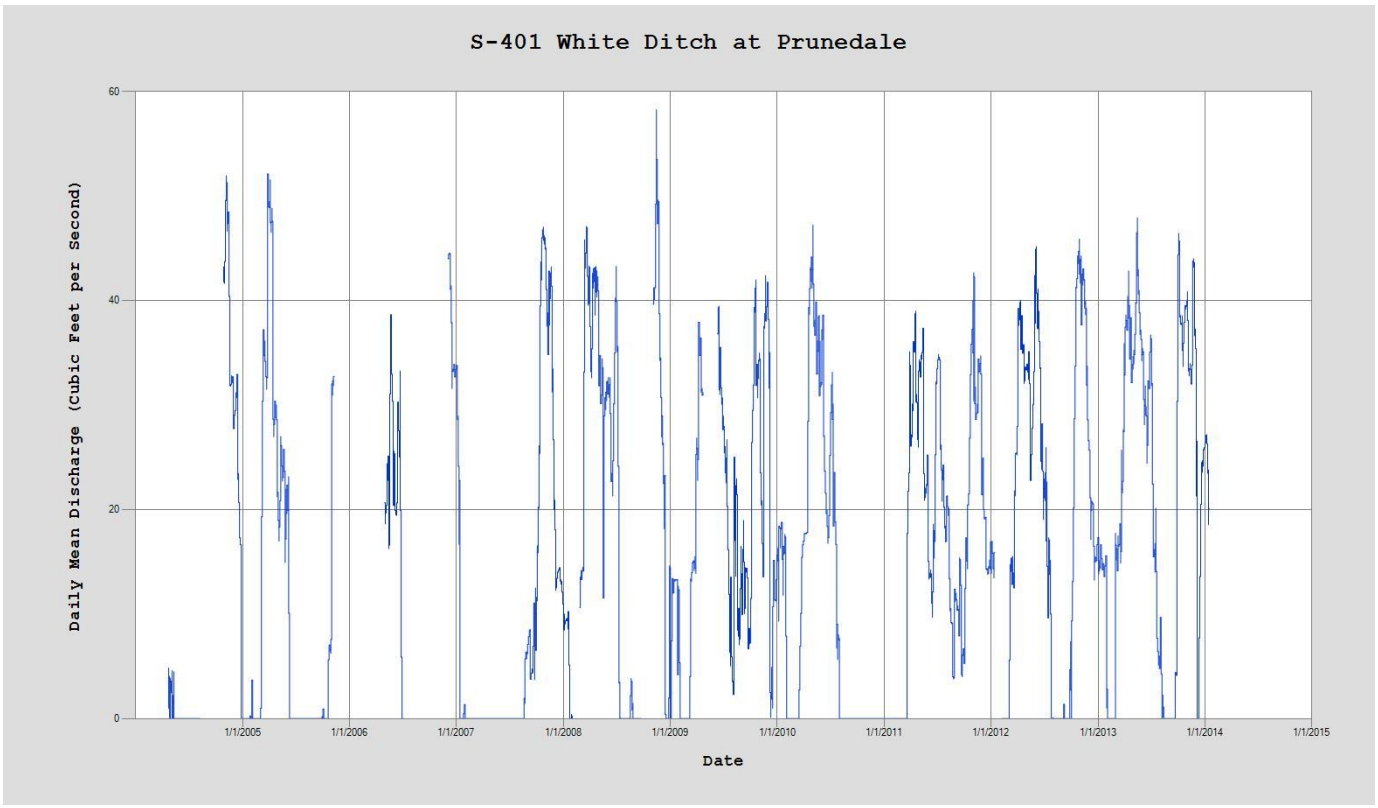

S-302 Crystal Spring Pond
Daily Mean Discharge (Cubic Feet per Second)
1
0.8
0.6
0.4
0.2
0
1/1/2004
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

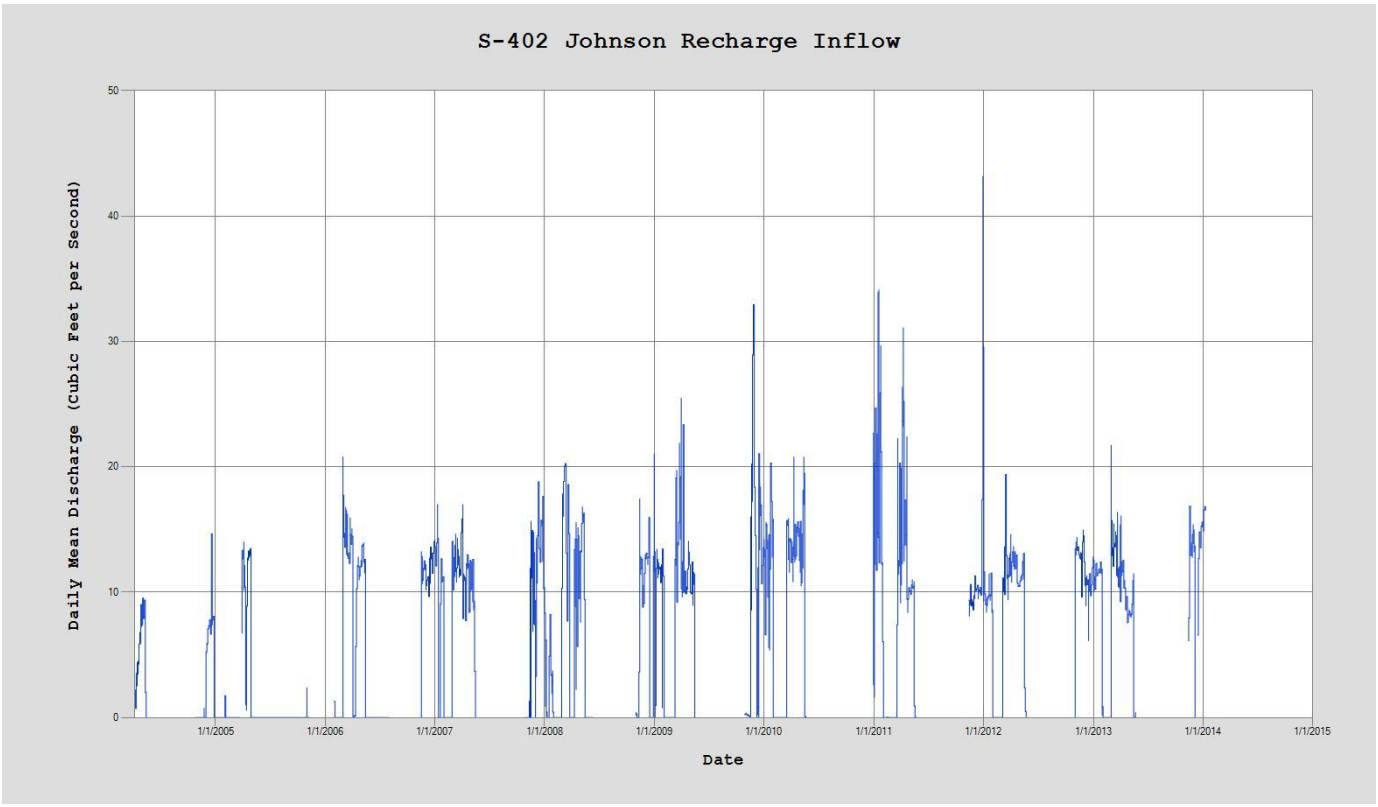

S-303 Mud Creek at Stateline
Daily Mean Discharge (Cubic Feet per Second)
0
2
4
6
8
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

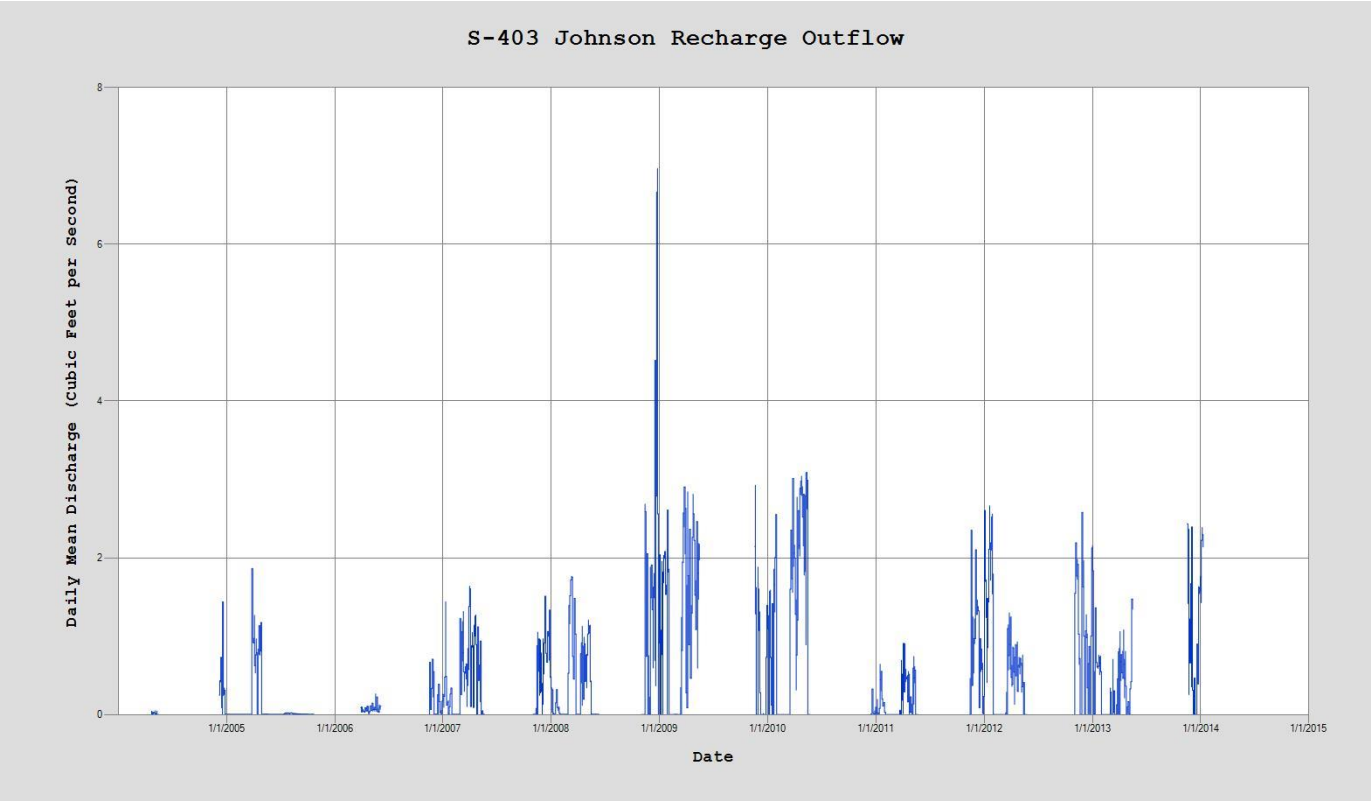

S-304 Mud Creek at McDonald
Daily Mean Discharge (Cubic Feet per Second)
0
2
4
6
8
10
12
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

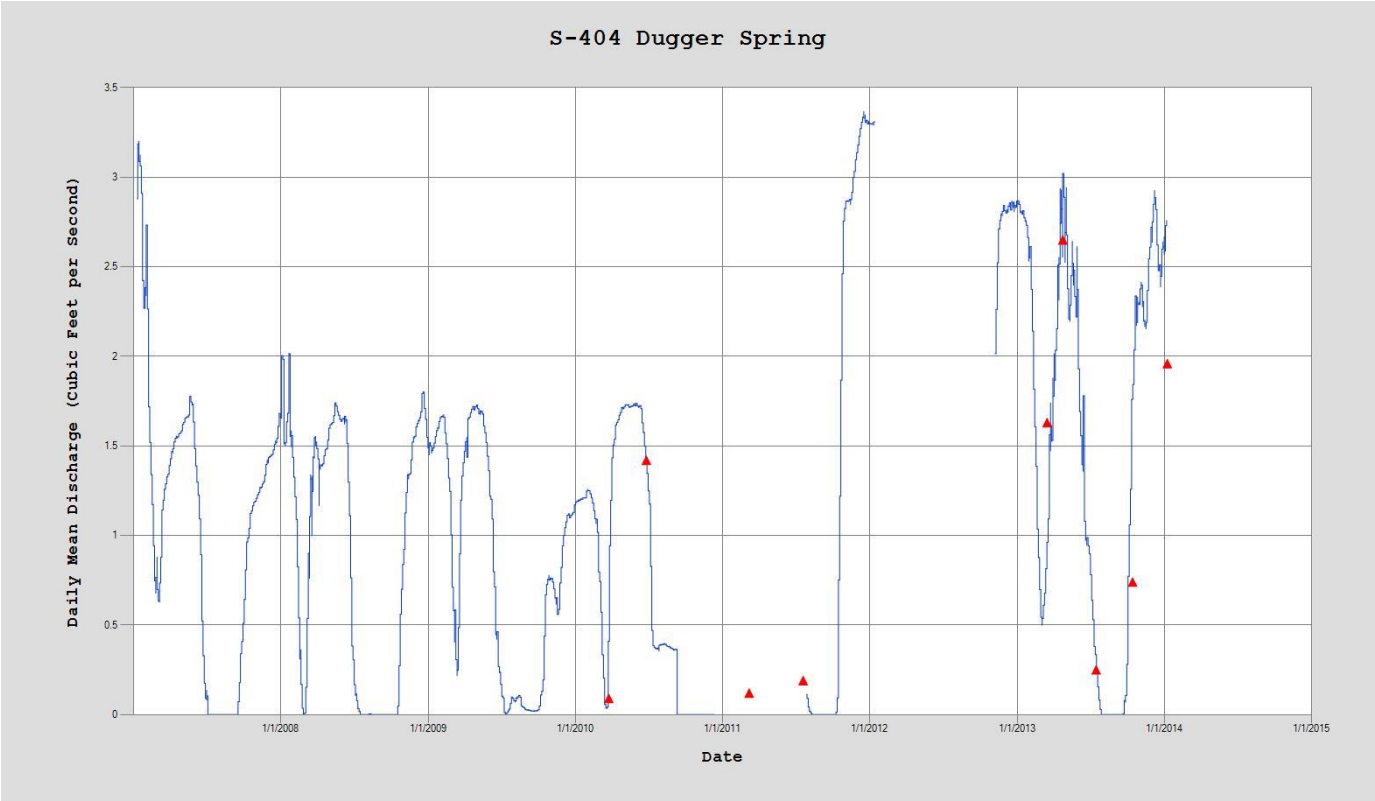

S-305 Mud Creek at Barney
Daily Mean Discharge (Cubic Feet per Second)
0
2
4
6
8
10
12
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

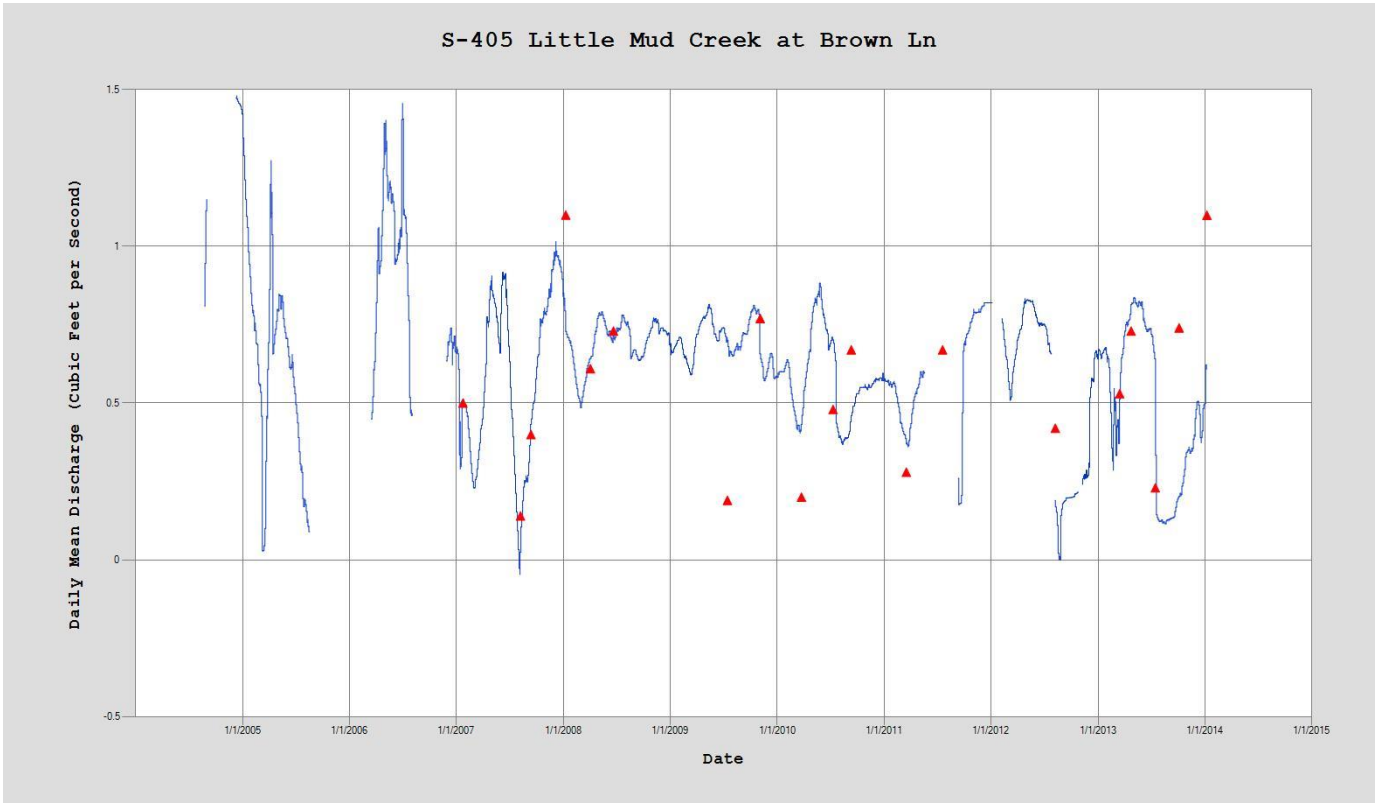

S-318 Beginning of Fruitvale System
Daily Mean Discharge (Cubic Feet per Second)
0
2
4
6
1/1/2004
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

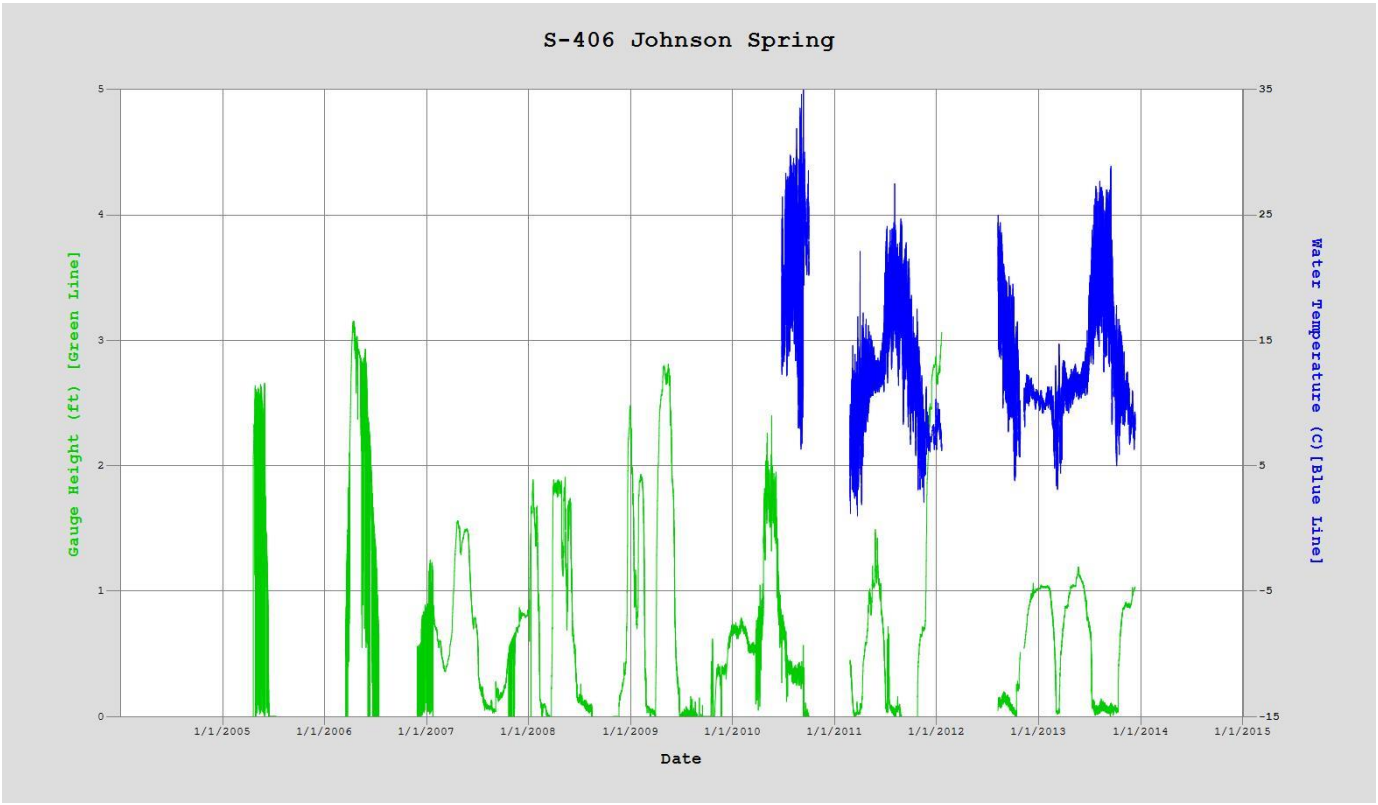

S-401 White Ditch at Prunedale
Daily Mean Discharge (Cubic Feet per Second)
60
40
20
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

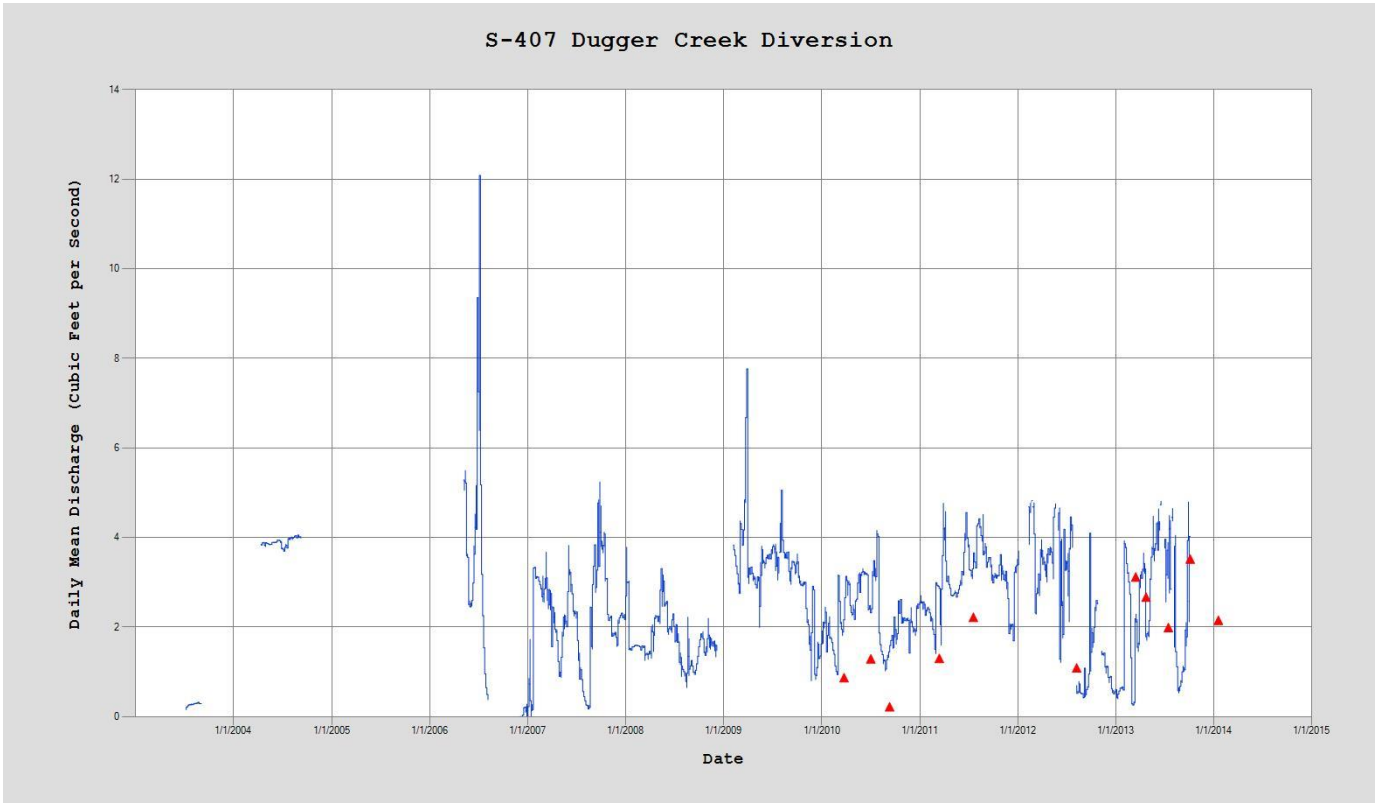

S-402 Johnson Recharge Inflow
Daily Mean Discharge (Cubic Feet per Second)
50
40
30
20
10
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

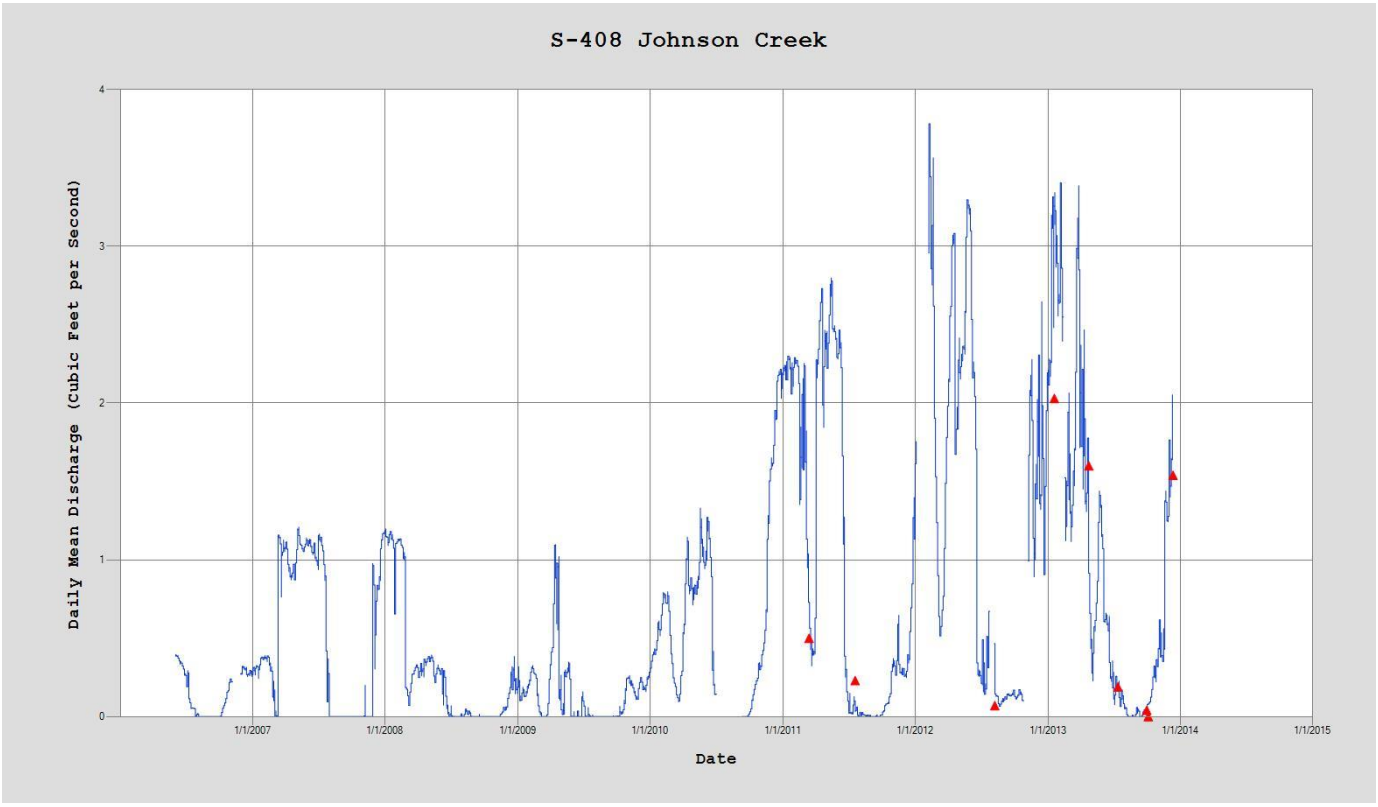

S-403 Johnson Recharge Outflow
Daily Mean Discharge (Cubic Feet per Second)
8
6
4
2
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

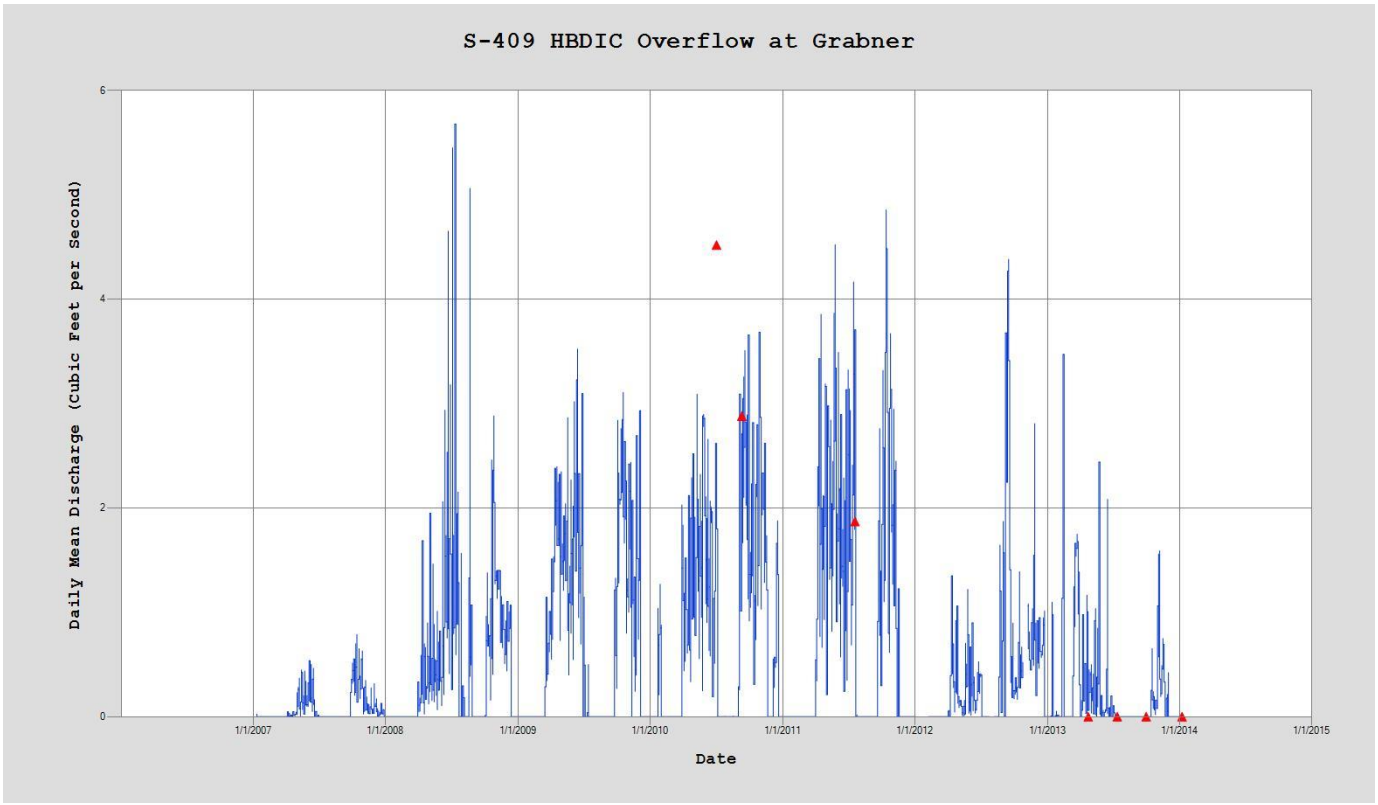

S-404 Dugger Spring
Daily Mean Discharge (Cubic Feet per Second)
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

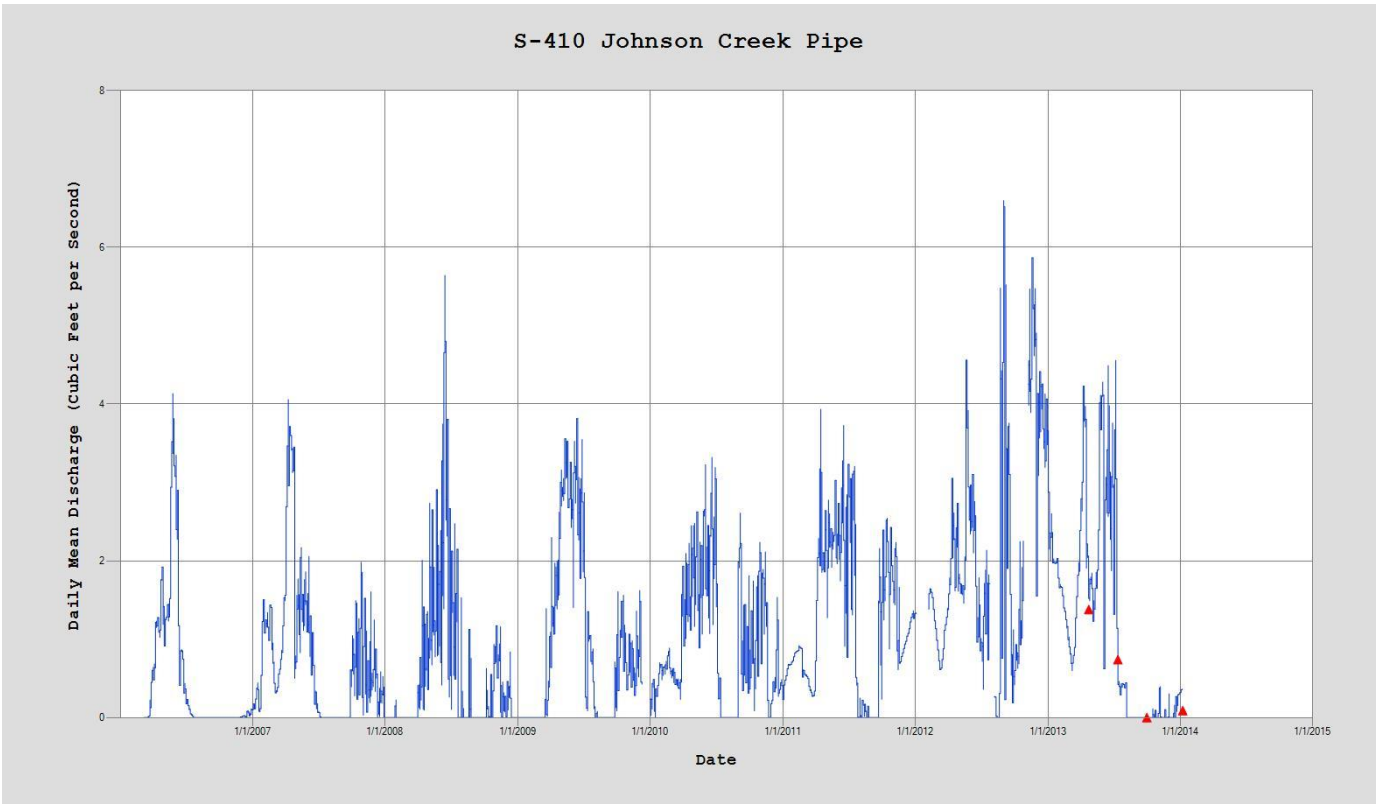

S-405 Little Mud Creek at Brown Ln
Daily Mean Discharge (Cubic Feet per Second)
1.5
1
0.5
0
-0.5
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

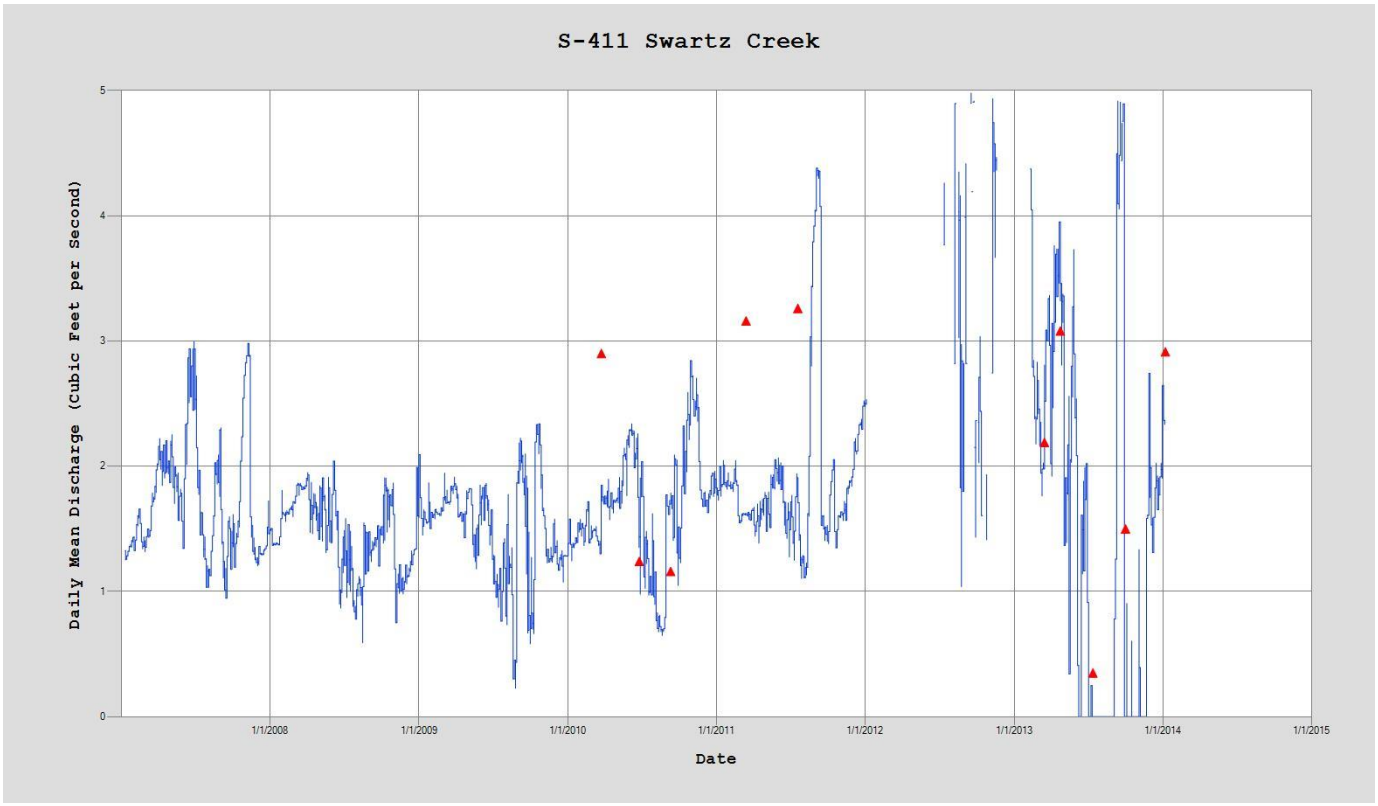

S-406 Johnson Spring
Gauge Height (ft) [Green Line]
Water Temperature (C) [Blue Line]
5
4
3
2
1
0
35
25
15
5
-5
-15
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

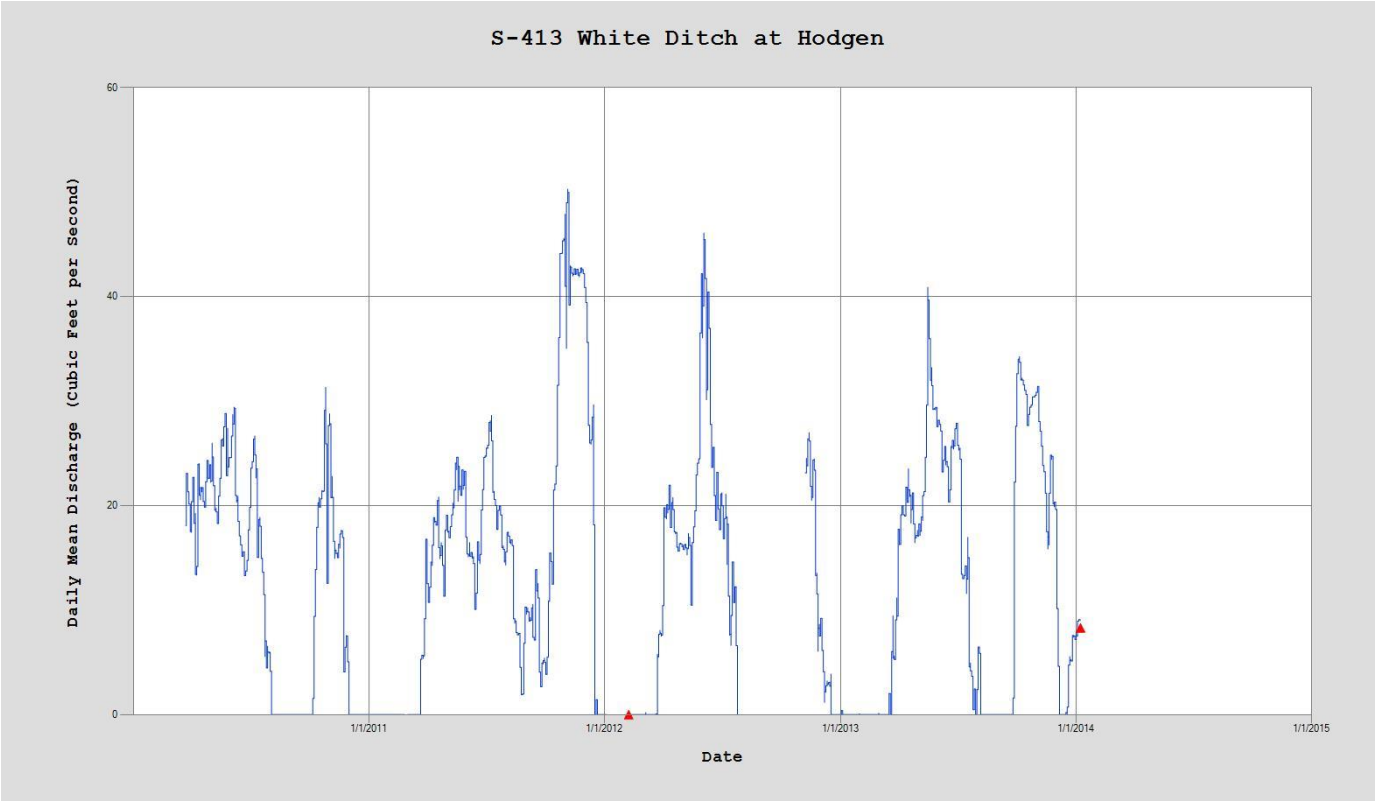

S-407 Dugger Creek Diversion
Daily Mean Discharge (Cubic Feet per Second)
0
2
4
6
8
10
12
14
1/1/2004
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

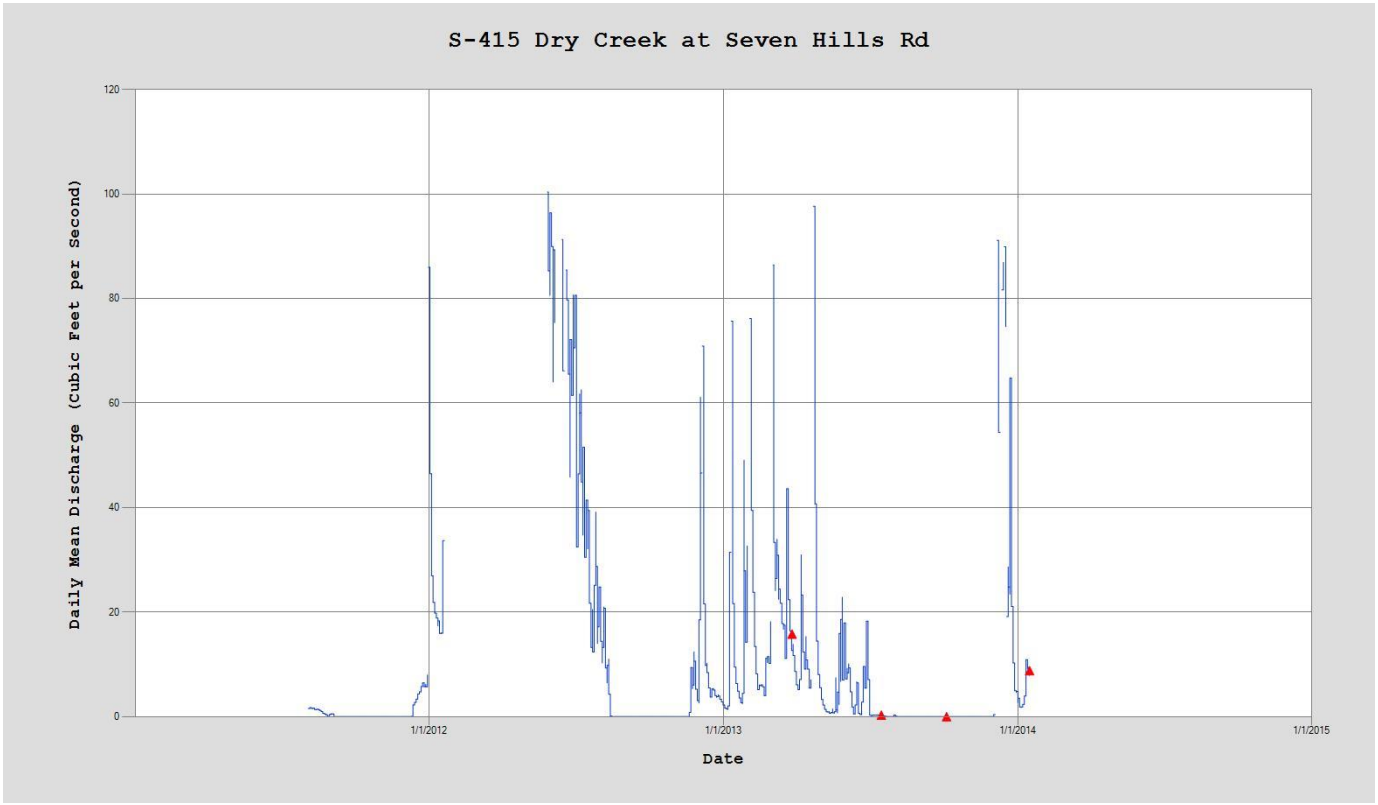

S-408 Johnson Creek
Daily Mean Discharge (Cubic Feet per Second)
0
1
2
3
4
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

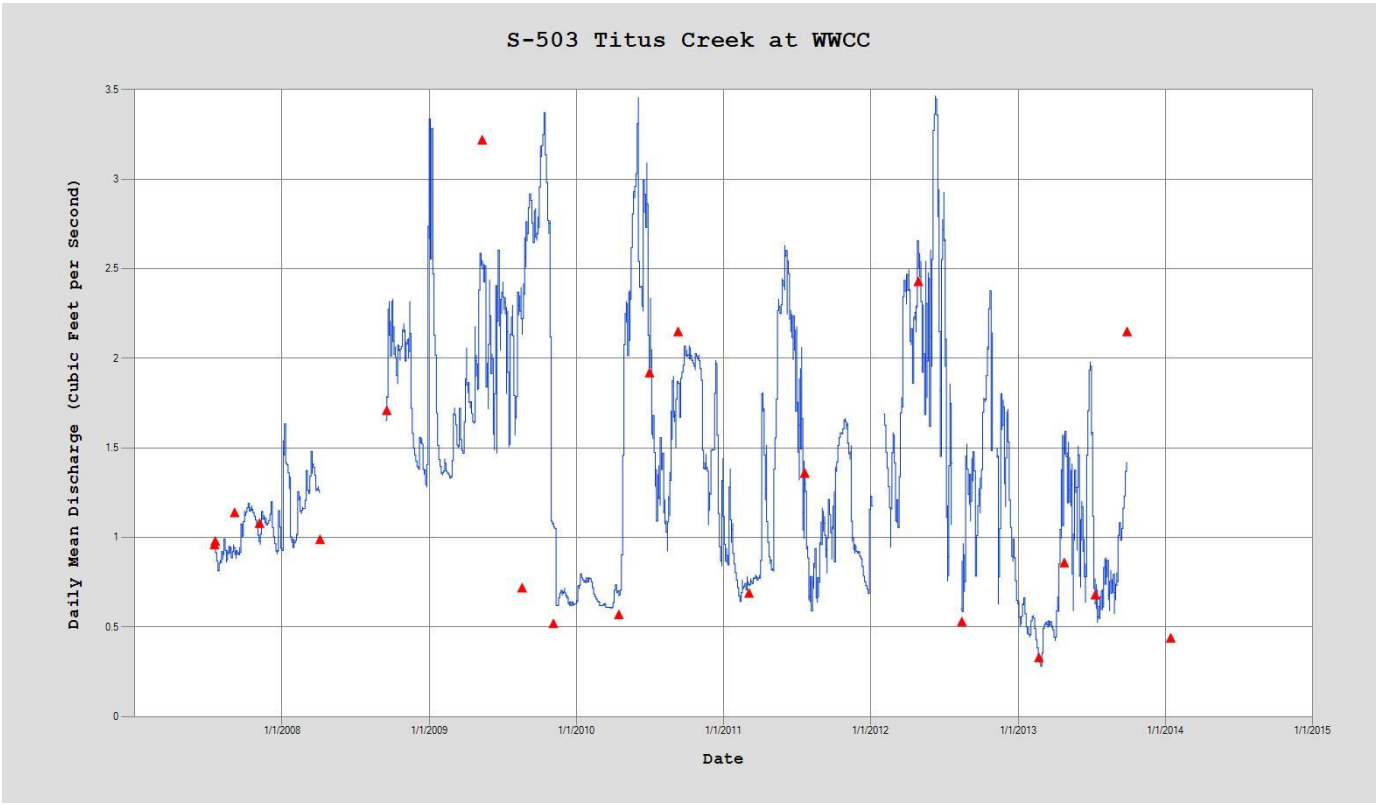

S-409 HBDIC Overflow at Grabner
Daily Mean Discharge (Cubic Feet per Second)
0
2
4
6
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

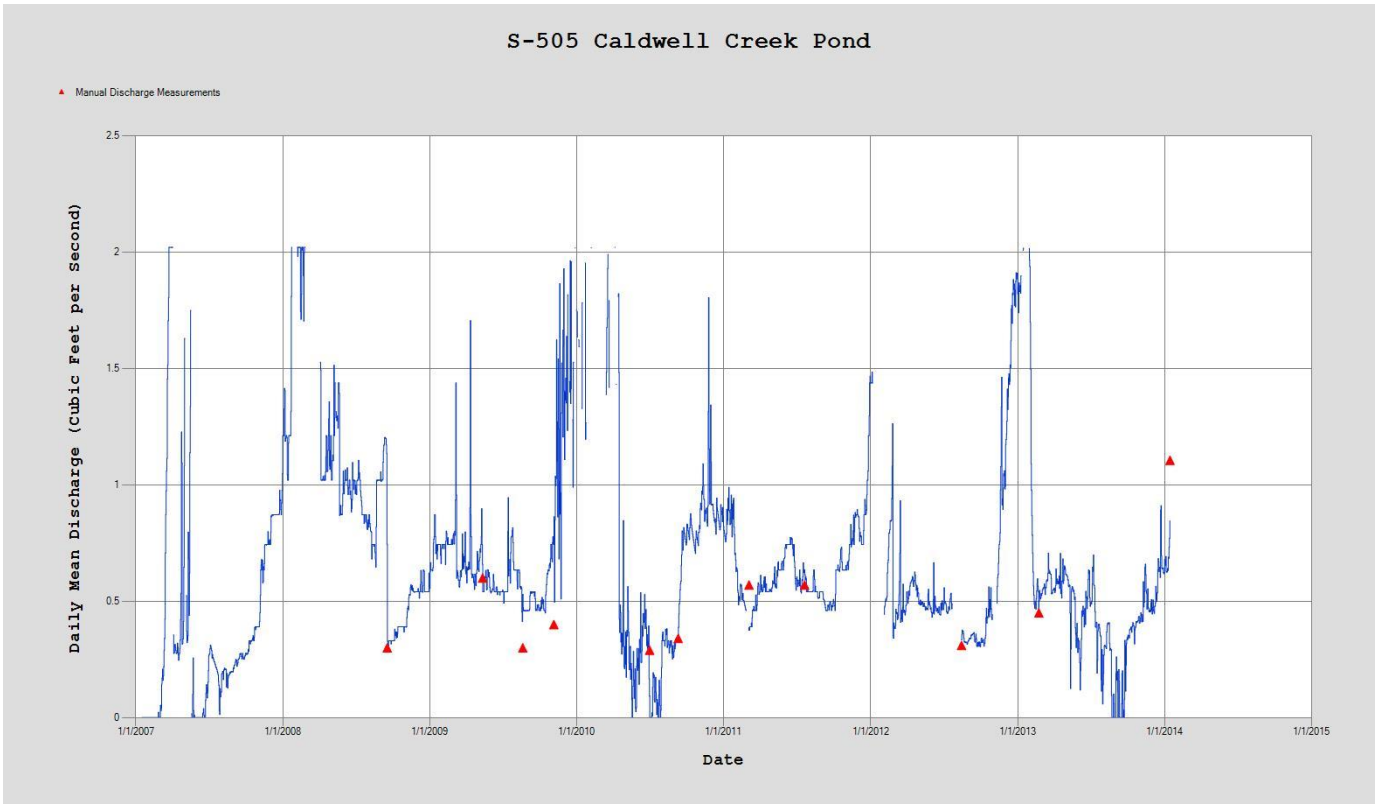

S-410 Johnson Creek Pipe
Daily Mean Discharge (Cubic Feet per Second)
0
2
4
6
8
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

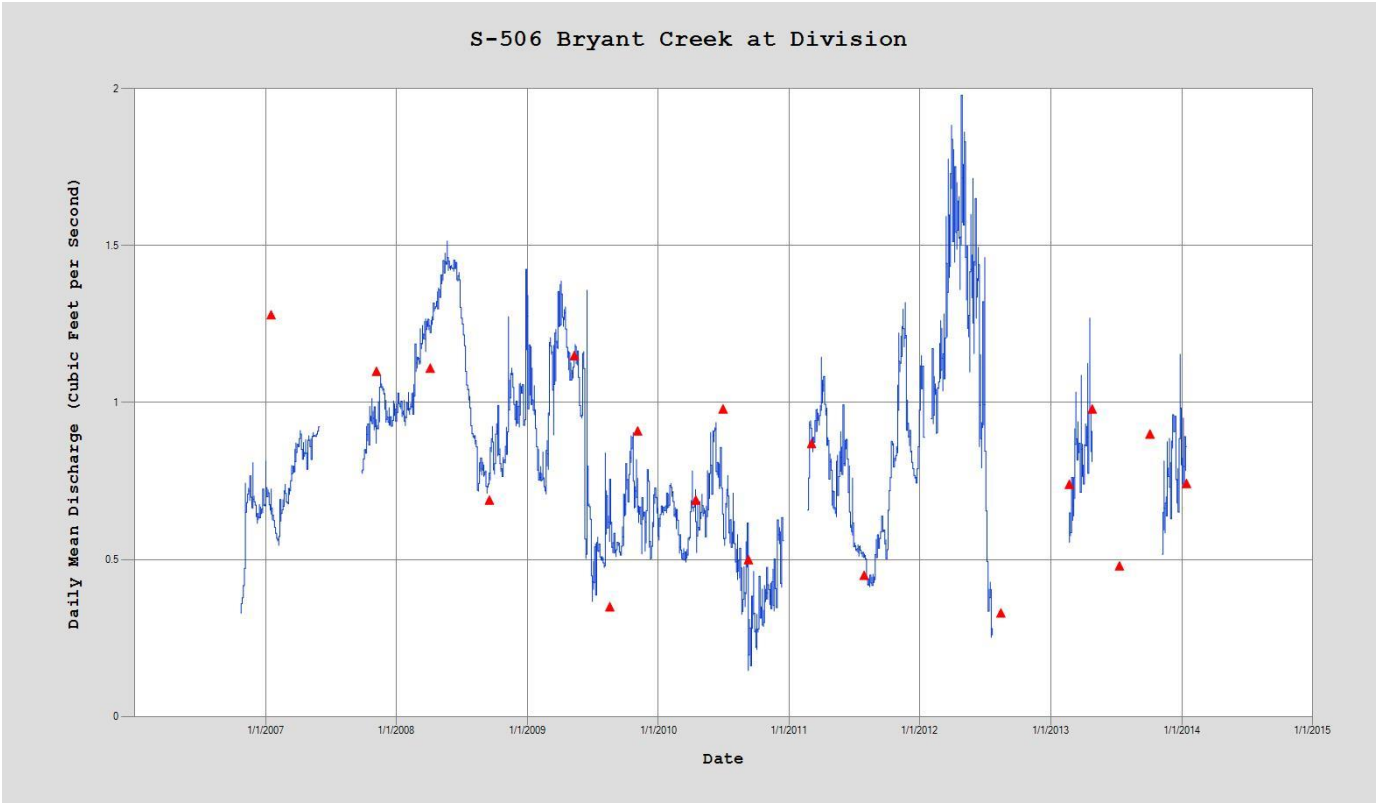

S-411 Swartz Creek
Daily Mean Discharge (Cubic Feet per Second)
0
1
2
3
4
5
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

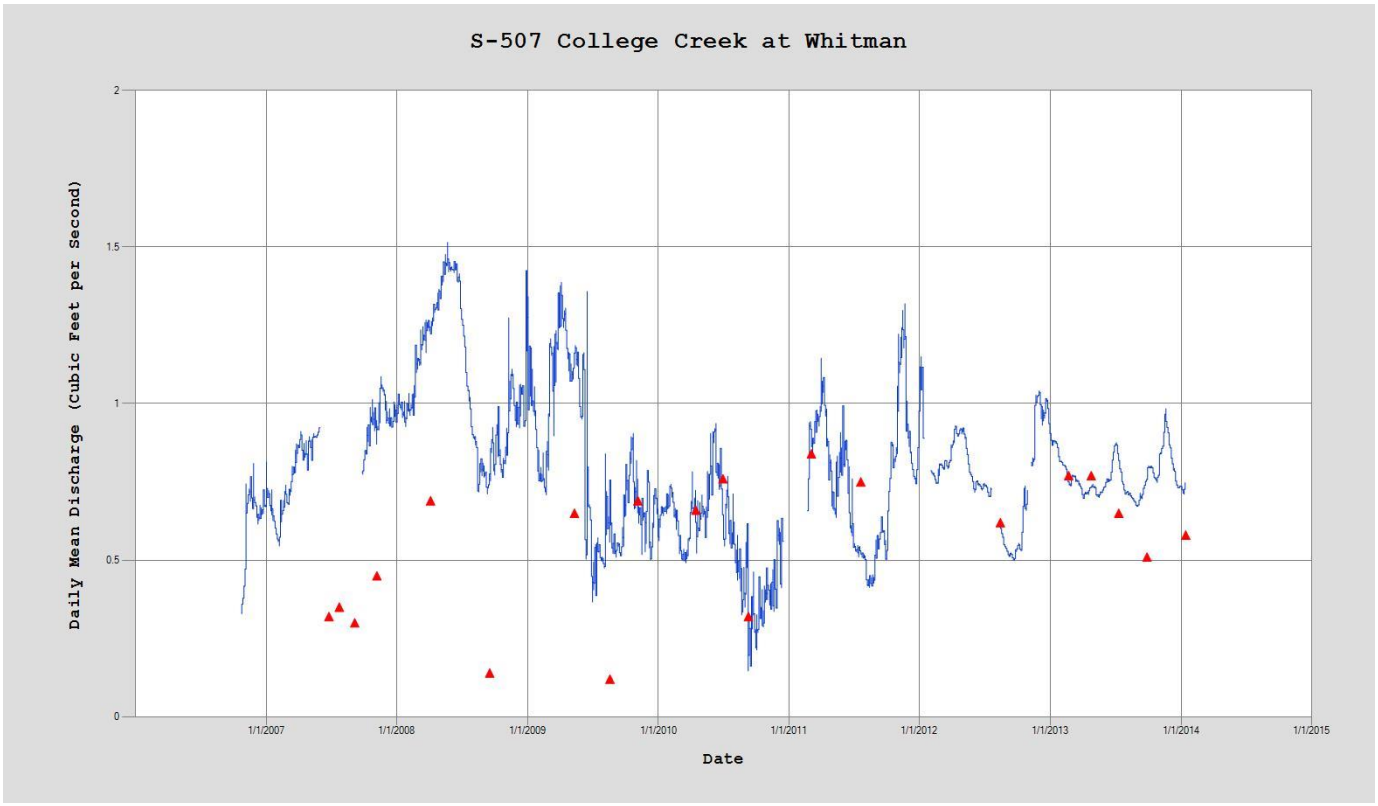

S-413 White Ditch at Hodgen
Daily Mean Discharge (Cubic Feet per Second)
60
40
20
0
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

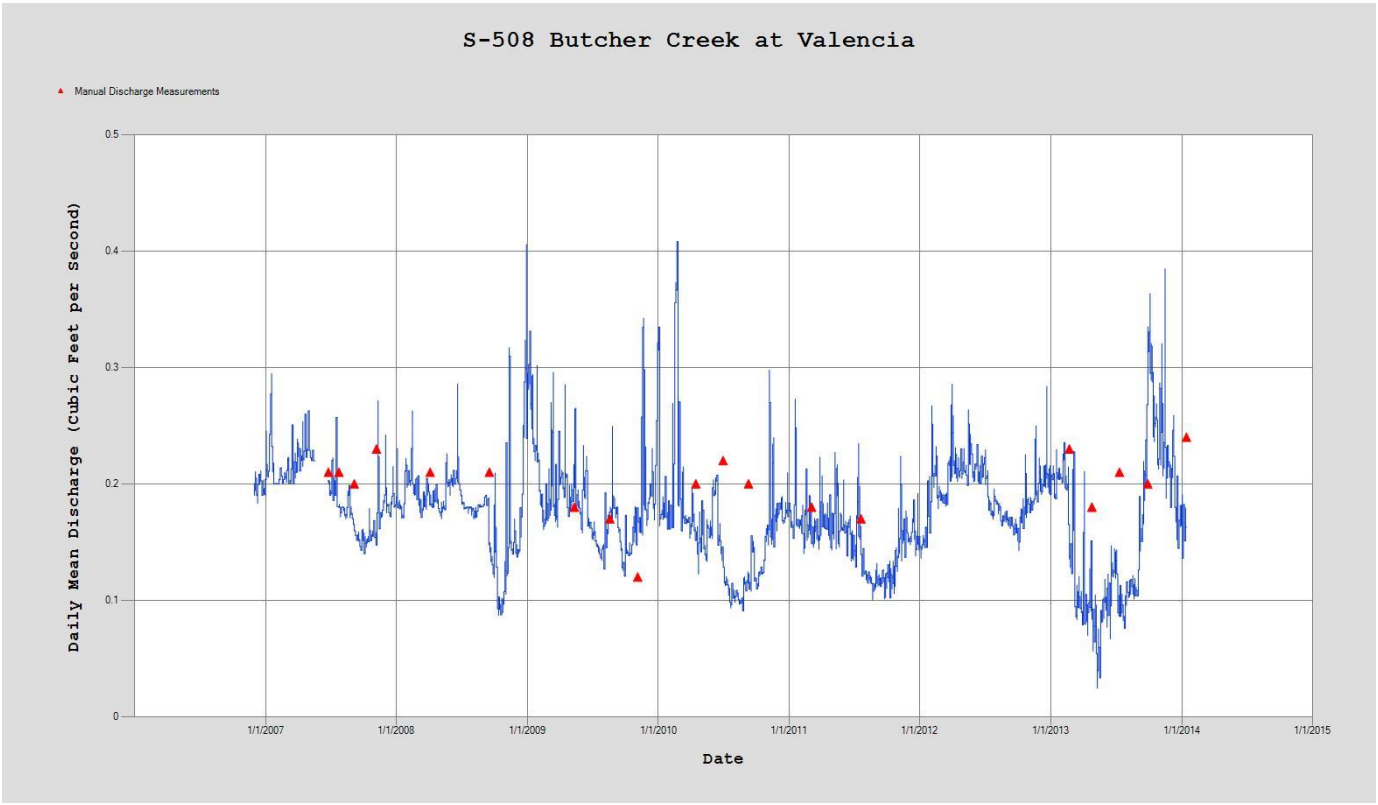

S-415 Dry Creek at Seven Hills Rd
Daily Mean Discharge (Cubic Feet per Second)
120
100
80
60
40
20
0
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

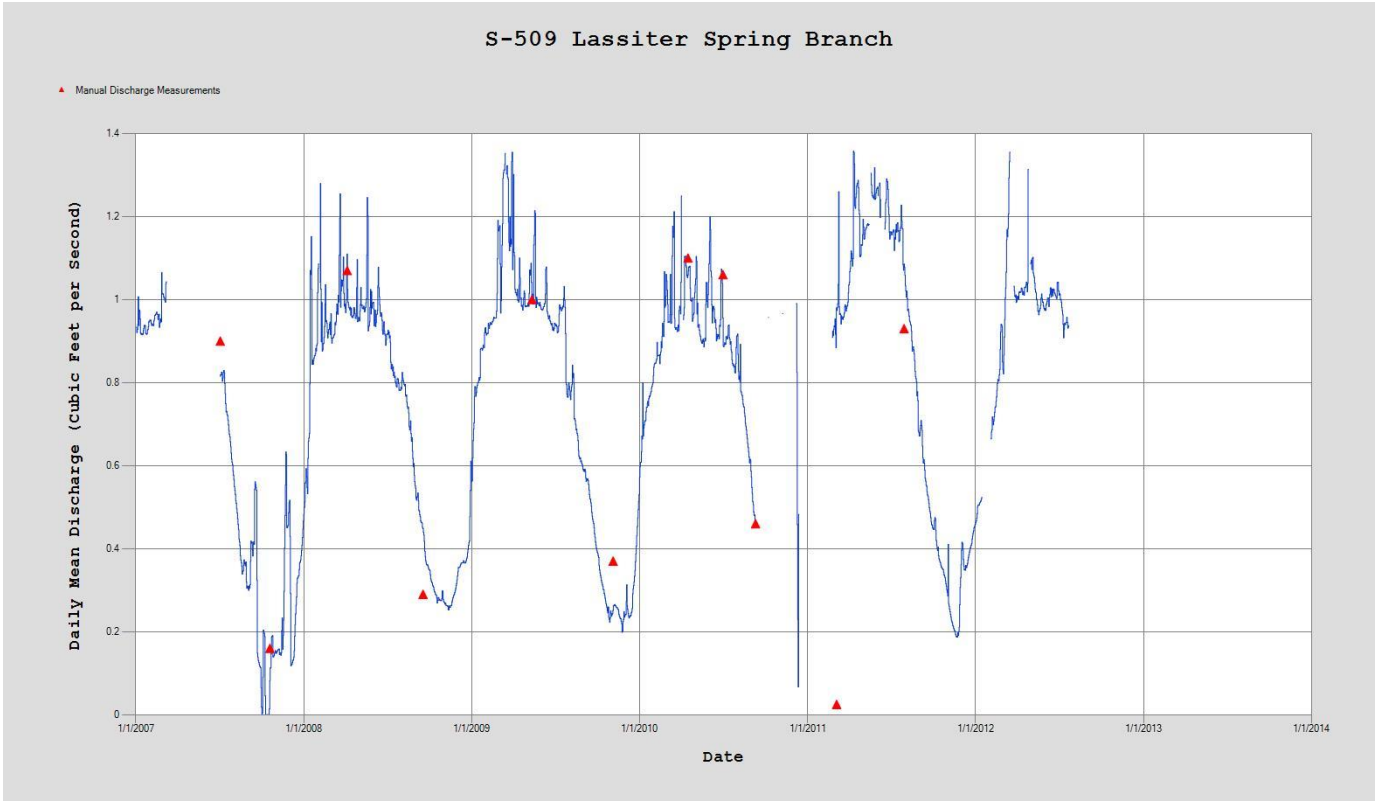

S-503 Titus Creek at WWCC
Daily Mean Discharge (Cubic Feet per Second)
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

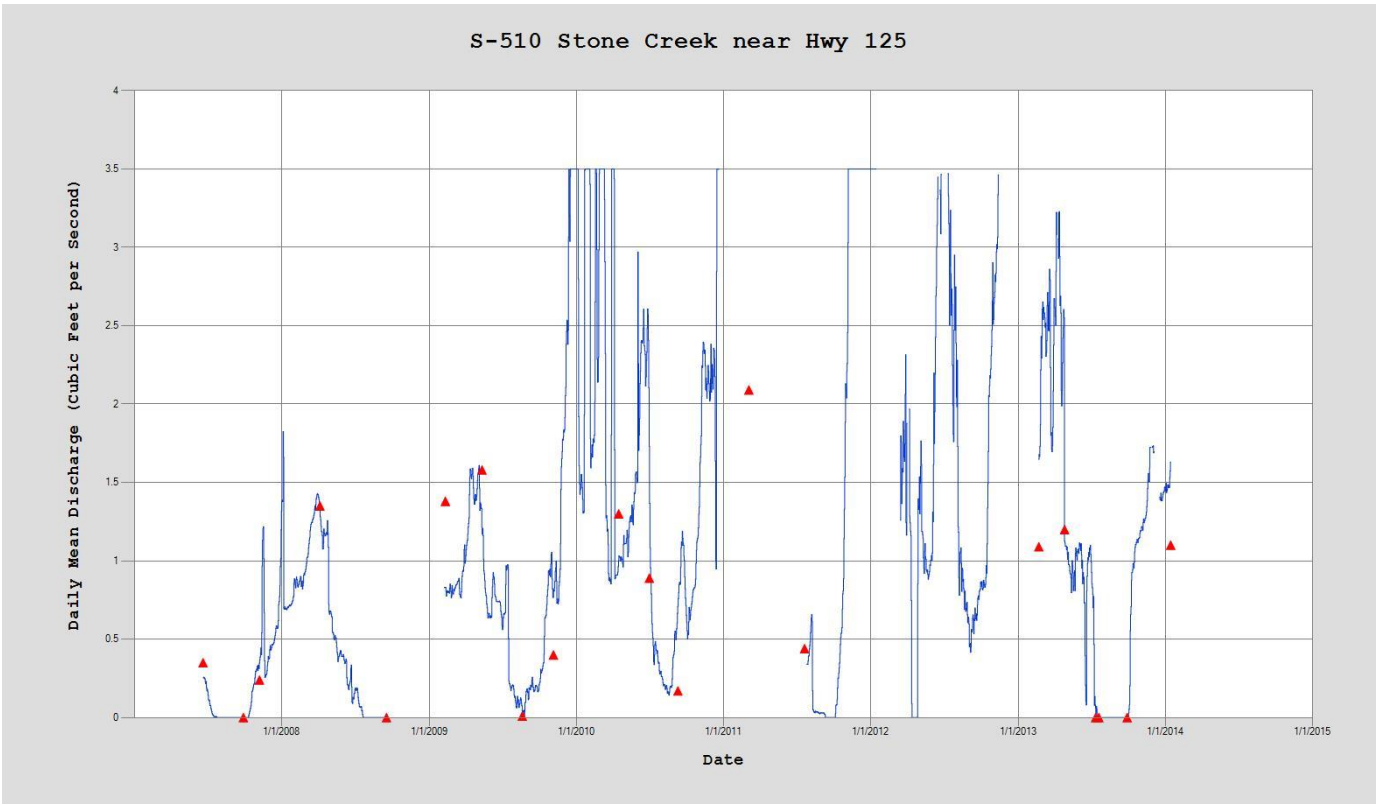

S-505 Caldwell Creek Pond
Manual Discharge Measurements
Daily Mean Discharge (Cubic Feet per Second)
2.5
2
1.5
1
0.5
0
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

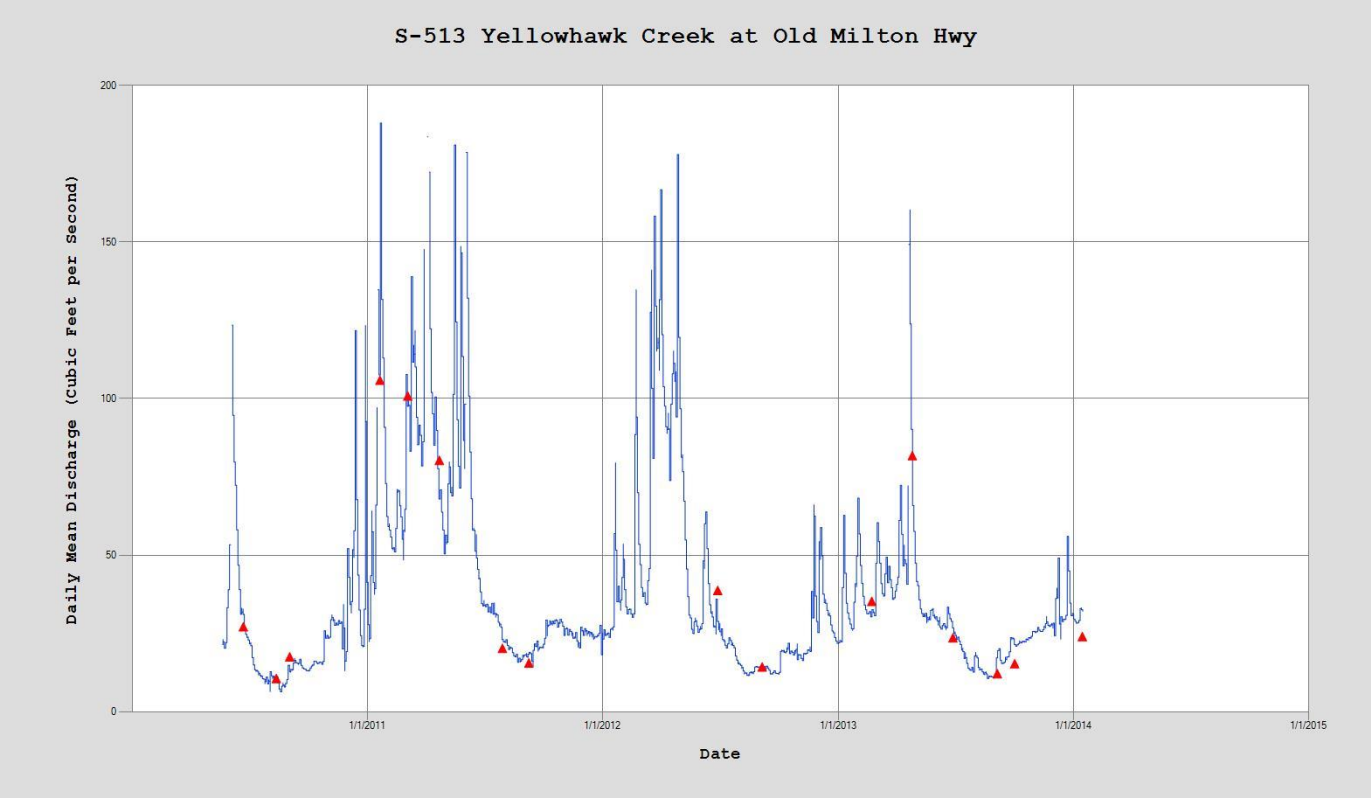

S-506 Bryant Creek at Division
Daily Mean Discharge (Cubic Feet per Second)
2
1.5
1
0.5
0
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

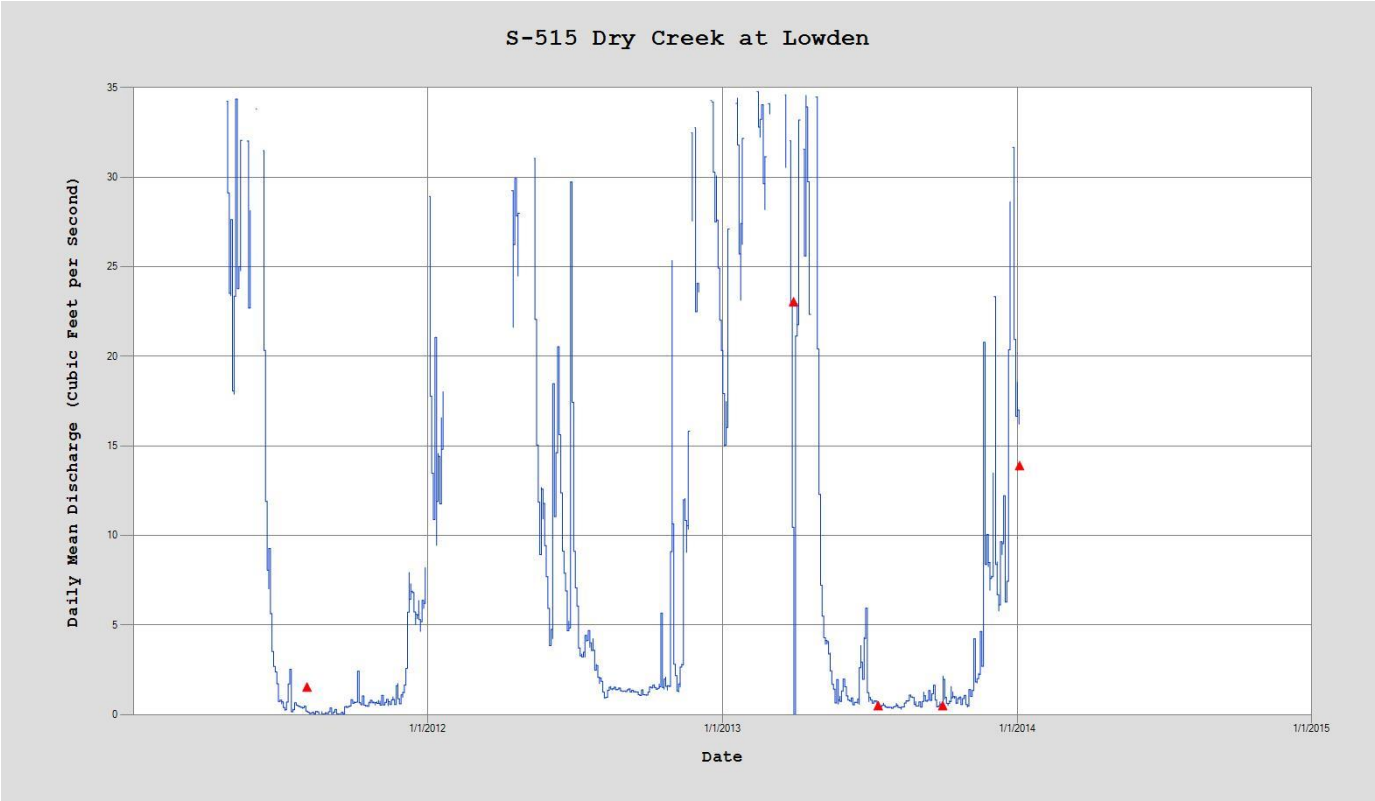

S-507 College Creek at Whitman
Daily Mean Discharge (Cubic Feet per Second)
2
1.5
1
0.5
0
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

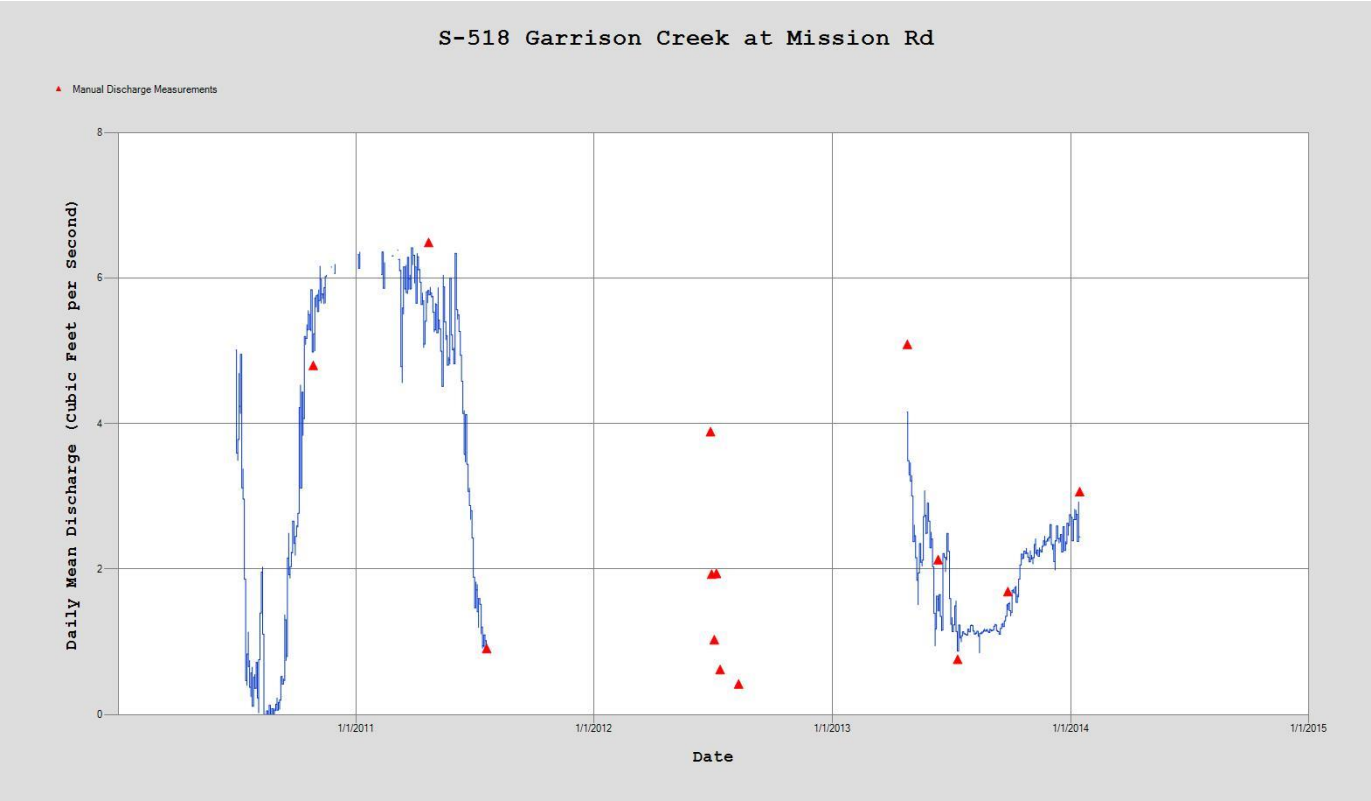

S-508 Butcher Creek at Valencia
Manual Discharge Measurements
Daily Mean Discharge (Cubic Feet per Second)
0.5
0.4
0.3
0.2
0.1
0
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date


S-509 Lassiter Spring Branch
Manual Discharge Measurements
Daily Mean Discharge (Cubic Feet per Second)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
Date


S-510 Stone Creek near Hwy 125
Daily Mean Discharge (Cubic Feet per Second)
4
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date


S-513 Yellowhawk Creek at Old Milton Hwy
Daily Mean Discharge (Cubic Feet per Second)
200
150
100
50
0
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date


S-515 Dry Creek at Lowden
Daily Mean Discharge (Cubic Feet per Second)
35
30
25
20
15
10
5
0
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date


S-518 Garrison Creek at Mission Rd
Manual Discharge Measurements
Daily Mean Discharge (Cubic Feet per Second)
8
6
4
2
0
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Date

Appendix C

Explanation of Data Gaps 2012-2013

S-103 Seasonal gauge, removed during high flows

S-104 Seasonal gauge, removed during high flows

S-105 August 2012-May 2013: Gauge temporarily removed for levee repairs

S-106 2012-2013 Erratic gaps caused by datalogger malfunction (freezing, failure to log data)

S-107 January 2012-May 2013 Logger not deployed.

S-119 Gauge installed in July 2013

S-125 Gauge installed in May 2013

S-203 August –September 2012: Logger memory full. Stopped logging.

S-205 July 2012- January 2013: Logger memory full. Stopped logging.

S-208 July-November 2012: Logger memory full. Stopped logging.

S-209 July-November 2012: Logger memory full. Stopped logging.

S-210 July-November 2012: Logger memory full. Stopped logging.

S-211 July-November 2012: Logger memory full. Stopped logging.

S-212 July-November 2012: Logger memory full. Stopped logging.

S-214 March-November 2012: Logger memory full. Stopped logging.

January-May 2013: Logger failure: flooded due to debris accumulation.

S-215 July-November 2012: Logger memory full. Stopped logging.

S-216 July-November 2012: Logger memory full. Stopped logging.

S-217 February-July 2012: Logger produced erratic data, which has been excluded from outputs.

July-November 2012: Logger memory full. Stopped logging.

S-218 January-February 2012: Logger memory full. Stopped logging.

July-November 2012: Logger memory full. Stopped logging.

S-219 January-February 2012: Station damaged, redeployment necessary.

July-November 2012: Logger memory full. Stopped logging.

S-220 July-November 2012: Logger memory full. Stopped logging.

S-221 July-November 2012: Logger memory full. Stopped logging.

S-222 January-February 2012: Logger batteries died.

August-November 2012: Logger memory full. Stopped logging.

S-223 January-February 2012: Logger failure.

S-225 January-February 2012: Logger memory full. Stopped logging.

July-November 2012: Logger memory full. Stopped logging.

S-227 April-August 2012: Logger memory full. Stopped logging.

November 2012-May 2013: Logger memory full. Stopped logging.

S-228 January-February 2012: Logger memory full. Stopped logging.

July-November 2012: Logger memory full. Stopped logging.

S-302 July-August 2012: Logger memory full. Stopped logging.

S-303 December 2011-February 2012: Logger memory full. Stopped logging.

July-December 2012: Logger memory full. Stopped logging.

S-304 January 2012: Installed new logger after county road crew finished 2011 construction project.

August-December 2013: Logger frozen in pipe during Jan 2014 visit, couldn't download.

S-404 January-November 2012: Logger memory full. Stopped logging.

S-405 January-February 2012: Logger memory full. Stopped logging.

July-August 2012: Logger memory full. Stopped logging.

S-406 January-August 2012: Logger memory full. Stopped logging.

S-407 January-February 2012: Logger batteries died.

July-August 2012: Logger memory full. Stopped logging.

S-408 January-February 2012: Logger memory full. Stopped logging.

July-August 2012: Logger memory full. Stopped logging.

S-409 January-February 2012: Logger memory full. Stopped logging.

July-August 2012: Logger memory full. Stopped logging.

S-410 January-February 2012: Logger memory full. Stopped logging.

July-August 2012: Logger memory full. Stopped logging.

S-411 January-February 2012: Logger memory full. Stopped logging.

Feb-July 2012: Data excluded because discharge values exceed measurements used to develop our rating curve. When we can take high flow discharge mmts at this site, data from this time period will be included.

July-August 2012: Logger memory full. Stopped logging.

October-November 2012: Logger memory full. Stopped logging.

S-413 January-February 2012: Logger memory full. Stopped logging.

July-November 2012: Logger memory full. Stopped logging.

S-415 January-June 2012: Data excluded because discharge values exceed measurements used to develop our rating curve. When we can take high flow discharge mmts at this site, data from this time period will be included.

S-503 January-February 2012: Logger memory full. Stopped logging.

September-December 2013: Logger malfunction.

S-505 January-February 2012: Logger memory full. Stopped logging.

July-August 2012: Logger memory full. Stopped logging.

S-506 January-February 2012: Logger memory full. Stopped logging.

July 2012-April 2013: Logger memory full. Stopped logging.

S-507 January-February 2012: Logger memory full. Stopped logging.

July 2012-August 2012: Logger memory full. Stopped logging.

October-November 2012: Logger memory full. Stopped logging.

S-509 January-February 2012: Logger memory full. Stopped logging.

July 2012-Dec 2013: Landowner removed logger, decommissioned site.

S-510 January-February 2012: Logger memory full. Stopped logging.

November 2012-Februar 2013: Data excluded because discharge values exceed measurements used to develop our rating curve for this site.

S-515 January-April 2012: Data excluded because discharge values exceed measurements used to develop our rating curve for this site.

S-517 2012-2013: Rating curve requires modification (including additional manual measurements)before reliable data can be published.

S-518 July 2011-April 2013: Logger memory full. Stopped logging.

Appendix D

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
106	Walla Walla below Nursery Bridge	392614.098	5089124.466	295.684
107	Walla Walla at Tum-A-Lum Bridge	393379.143	5092358.706	258.833
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
202	Crockett Branch at Frog	391966.541	5088893.205	301.327
203	Ford Branch at Frog	391964.518	5088893.761	301.581
205	Ford Branch East of Old Milton	391951.326	5088894.137	301.265
208	East Ford Branch at Sunnyside	391791.236	5090036.505	288.008
209	West Ford Branch at Sunnyside	390953.661	5090789.966	275.951
210	East Crockett Branch at Appleton	390917.692	5090787.295	276.007
211	Crockett Branch End at Crocket	392039.328	5091564.326	271.057
212	West Branch of West Crockett at Appleton	391547.979	5091982.015	264.104
214	Ford Branch End	390378.735	5091813.259	262.498
215	West Little Walla Walla Spring	390209.021	5092174.434	259.15
216	Downing Spring	390655.662	5092581.588	253.655
217	Ferndale Spring	391258.105	5092614.479	255.958
218	Big Spring at Ballou	391550.822	5092807.999	255.024
219	Big Spring at Yates	391581.087	5093667.729	244.931
220	East Little Walla Walla at Stateline	391870.217	5094063.686	241.877
221	Walsh/Lewis at Stateline	390958.38	5095101.22	232.8672
222	West Little Walla Walla at Stateline	389707.303	5095126.496	227.447
223	East LWW ds of Big Spring Confluence	388955.338	5095057.412	223.971
224	West LWW at Valley Chapel	388416.901	5096389.529	211.044
225	McEvoy Spring	390123.736	5096740.998	215.997
226	East LWW near Mouth	390740.26	5097038.44	214.5792
227	West LWW near Mouth	386102.18	5098925.316	184.757
228	West Ford Branch at Appleton	390502.228	5091569.543	265.319
302	Crystal Spring Pond	389351.455	5092436.239	249.408
303	Mud Creek at Stateline	386764.8	5095185.27	212.1408
304	Mud Creek at McDonald	379670.65	5098398.568	158.871
305	Mud Creek at Barney	375056.723	5099997.266	140.835
318	Beginning of Fruitvale System	390306.00	5091815.00	263
401	White Ditch at Prunedale	388758.267	5090009.825	264.494
402	Johnson Recharge Inflow	388515.847	5090245.689	261.58
403	Johnson Recharge Outflow	388347.557	5090354.229	259.248

404	Dugger Spring	386889.25	5090918.98	241.4016
405	Little Mud Creek at Brown Lane	387635.84	5092038.733	241.452
406	Johnson Spring	386899.386	5091235.063	238.642
407	Dugger Creek Diversion	385903.342	5090873.007	229.578
408	Johnson Creek	385332.785	5092105.096	220.147
409	HBDIC Overflow at Grabner	384852.315	5092354.698	214.199
410	Johnson Creek Pipe	384442.426	5092321.672	210.603
411	Swartz Creek	380132.786	5094092.534	170.421
412	White Ditch at Hodgen	380112.181	5094146.066	170.902
415	Dry Creek at Seven Hills Rd	386378.00	5089244.00	254
503	Titus Creek at WWCC	401403.771	5103565.739	355.738
505	Caldwell Creek Pond	399121.785	5100252.294	303.998
506	Bryant Creek at Division	397399.428	5103389.687	304.246
507	College Creek at Whitman	397431.91	5102826.123	303.311
508	Butcher Creek at Valencia	397904.865	5101961.318	306.366
509	Lassiter Spring Branch	395802.641	5097092.873	262.547
510	Stone Creek near Hwy 125	394926.779	5099586.013	260.623
513	Yellowhawk Creek at Old Milton Hwy	391968.112	5088876.244	300.996
515	Dry Creek at Lowden	376931.06	5101548.76	147
517	Stone Creek at Bussel Rd	390410.52	5097990.72	214
518	Garrison Creek at Mission Rd	389360.00	5098128.00	208