

Technical Memorandum

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Project: Eel River Groundwater Assessment

Subject: Surface Water Monitoring in the Eel River Valley Basin

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1. Introduction

1.1 Summary

This technical memorandum describes surface water elevation and discharge data within the Eel River Valley Basin (ERVB) collected by Thomas Gast & Associated Environmental Consultants (TGAEC) to assist the development of the Eel River Valley Groundwater Sustainability Plan (GSP).

A total of ten streamflow monitoring sites were established in Eel River and Van Duzen River, with continuous records beginning in Fall 2020 for three sites and June 2021 for all remaining sites. Discharge was calculated for each site using continuous water level data records and routine discharge measurements. This data will support the development of a water budget and calibration of hydrologic models in the ERVB.

1.2 Surface Water Elevation Monitoring Locations

In the Fall of 2020, two water level loggers were deployed in Eel River to record continuous water level records at sites R-2, and R-5 by TGAEC. SHN has maintained water level logger R-3 since 2016. In addition to these stations, seven more sites were established in June of 2021 by TGAEC in Eel River and Van Duzen River (Figure 1, Appendix A; Table 1, Appendix B). All sites established by TGAEC were equipped with HOBO U20L-04 pressure transducer data loggers to record water levels every 15-minutes. Three locations (R-2, SW-2, and SW-7) were also equipped with barometric pressure transducers that were deployed in the air to measure atmospheric pressure. This barometric pressure record was later used to compensate data to determine the depth of water above the in-stream loggers. All loggers except R-2 and R-5 (maintained by TGAEC) and R-3 were removed in the end of November 2021.

1.3 Discharge Measurement Locations

Calibration discharge measurements were conducted near the logger, generally at the hydraulic control for the pool in which the level loggers were installed (Figure 2, Appendix A). The exception was ERB SW-5 where the discharge was conducted upstream of the logger due to the distance to the downstream control.

2. Methods

2.1 Field Procedures

Water level loggers were housed in camouflaged PVC, mounted to a studded T-post, and were driven into the stream bed in a stable location. In June 2021, an elevation survey was conducted at all sites using an auto-level to determine the relative elevations of the water level loggers, benchmarks, and the stage of zero flow. This elevation survey was used in performing quality control on collected data, verifying that the sensor position was stable over the entire collection period.

At the end of the data collection period (November 2021), an additional survey was conducted of the water level logger, water surface elevation, and established benchmarks using a Hemisphere S321 Real-Time Kinematic (RTK) GNSS antenna connected to the California Real Time Network (CRTN). The location of each benchmark was determined using the average of 180 collected points and water surface elevation was averaged from ten points. This survey was used to determine precise locations of sites in NAD83 horizontal datum (Table 1, Appendix B) and elevations in the NAVD88 vertical datum (Table 3, Appendix B). Due to poor reception at sites SW-2 and SW-3, an RTK survey of benchmarks and water level was not completed. An arbitrary elevation was used to develop water surface records at these sites.

Calibration discharge measurements were conducted over the data collection period, with a focus on low-flow conditions during the summer of 2021. A total of three discharge measurements were collected at each site and were used to develop rating curves for each monitoring location. Discharge was measured using either a USGS Mini Current Meter, USGS Cup Style AA Current Meter, or an Acoustic Doppler Current Profiler (ADCP), depending on stream size and flow conditions.

2.2 Data Processing Procedures

Raw data collected from in-stream pressure transducers were processed in HOBOWare Pro version 3.7.23 to determine water depth over the observation period. Data was processed using the Barometric Compensation Assistant in HOBOWare Pro and nearby barometric loggers (Table 2, Appendix B). Using RTK-survey data, water depth records were converted into water surface elevations and reported in NAVD88 vertical datum.



Three discharge measurements at each site were used to develop a rating curve to determine the relationship between stage and discharge (Table 4, Appendix B). Over the 2021 data collection period, discharge was measured once at the beginning of the low-flow season (June 4th, 10th, 11th), in the middle (July 21st – 23rd), and near peak low-flow conditions (August 18th, 25th – 26th). Discharge was measured using a USGS Mini Current Meter, a Cup Style AA meter, or using an ADCP, depending on what flow conditions allowed. Quality control was performed on all discharge measurements by comparing to nearby USGS streamflow gauges.

3. Results

3.1 RTK Survey

A survey of benchmarks and water surface elevations in November 2021 (Table 3, Appendix B) were used to develop a continuous record of water surface elevations at each site (Attachments 1 -10). Of the sites surveyed, the lowest-elevation site was R-5, located on the Eel River near Palmer Blvd, at which the water surface elevation was at 11.065 ft. on November 24, 2021. The highest water surface elevation was at SW-4 (Van Duzen River near Fischer Rd), which was at 90.332 ft. on November 29, 2021.

3.2 Calibration Flows

Discharge measurements conducted at each monitoring site that were used to create rating curves are summarized in Table 4 (Appendix B). Measurements were compared with reported discharge values at nearby USGS streamflow stations # 11477000 (Eel at Scotia) and # 11478500 (Van Duzen near Bridgeville).

3.3 Rating Curves

Table 5 (Appendix B) summarizes rating curves that were used to determine discharge records at each monitoring location for the 2021 low-flow period. Rating curves relate water level observations to discharge and are expressed as:

Equation 1. Generalized Rating Equation.

$$Q = C(stage - offset)^n$$

Where Q is discharge (cfs) and stage is the observed water level (ft.). C and n are rating curve constants. The offset is a datum correction or “stage at zero flow” (SZF). Table 5 summarizes each component of the rating equation, but it is recommended to use the values with complete significant digits (provided in Attachments 1-10) to calculate discharge values, as rounding may alter estimates. Rating curves are generally valid between 0.4 of the low calibration flows to 2.5 times the high calibration flow. Confidence in the relationship of stage to discharge diminishes outside of this range.

3.4 Streamflow Discharge

Using respective rating curves, discharge was calculated for each monitoring site (Attachments 1-10). Water level records began at most sites in June 2021, at the onset of the low-flow season. A series of precipitation events in late October caused a sharp increase in streamflow. Based on the confidence interval of each rating curve, discharge records end at the onset of these high-flow events when the discharge values exceed 2.5 times the highest calibration flow at each site. High flows likely change stream geomorphology and alter the hydraulic control, making the low-flow rating curve unreliable after large storm events.

A summary of discharge at each monitoring site are presented in Table 6 (Appendix B). Over the 2021 low-flow season, QM-2 (Yager Creek) was the only site that reached a flow of 0 cfs. Van Duzen River near Pamplin Grove (QM-3) came close to drying, with a minimum discharge value of 0.09 cfs on Sept. 17th. Most sites experienced minimum discharge levels in mid- to late-September.

A spatial examination of minimum discharge values observed over the season indicate a decrease in streamflow with distance downstream. For example, site QM-6 (Eel River at Scotia) had a minimum discharge value of 20.46 cfs over the observed season. The furthest-

downstream site, R-5, had a minimum discharge value at 3.76 cfs, with a general decreasing trend moving from upstream to downstream. A sharp drop in minimum surface discharge values occurs near QM-5 (Eel River upstream of the River Lodge Pool), where minimum discharge observations drop from 16.05 cfs at QM-3 to 3.90 cfs at QM-5. These observations can be used in addition with other data to provide insight on the water budget and support the development of the Eel River Valley GSP.

Appendix A: Figures

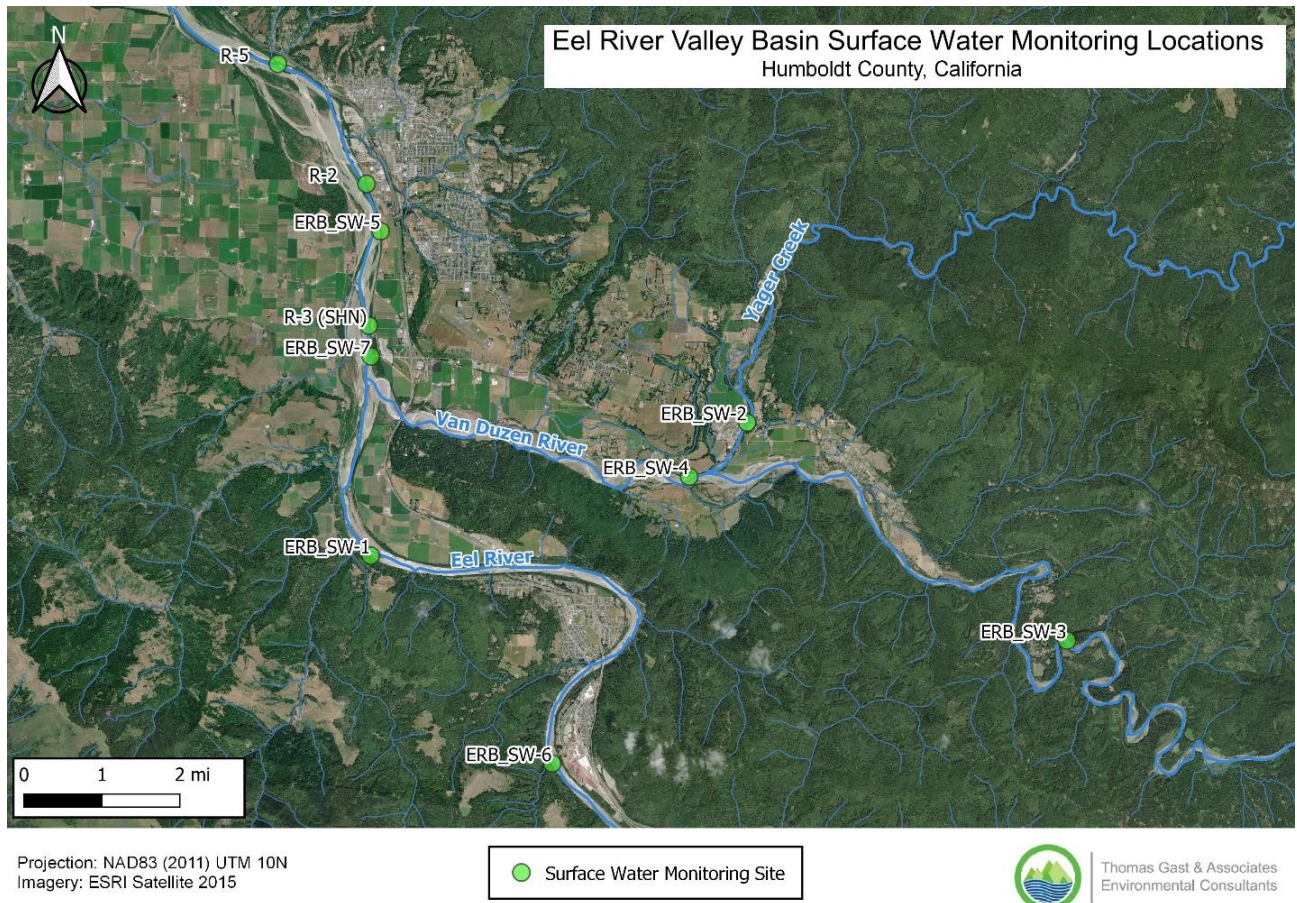


Figure 1: Water level monitoring locations established in the ERVB

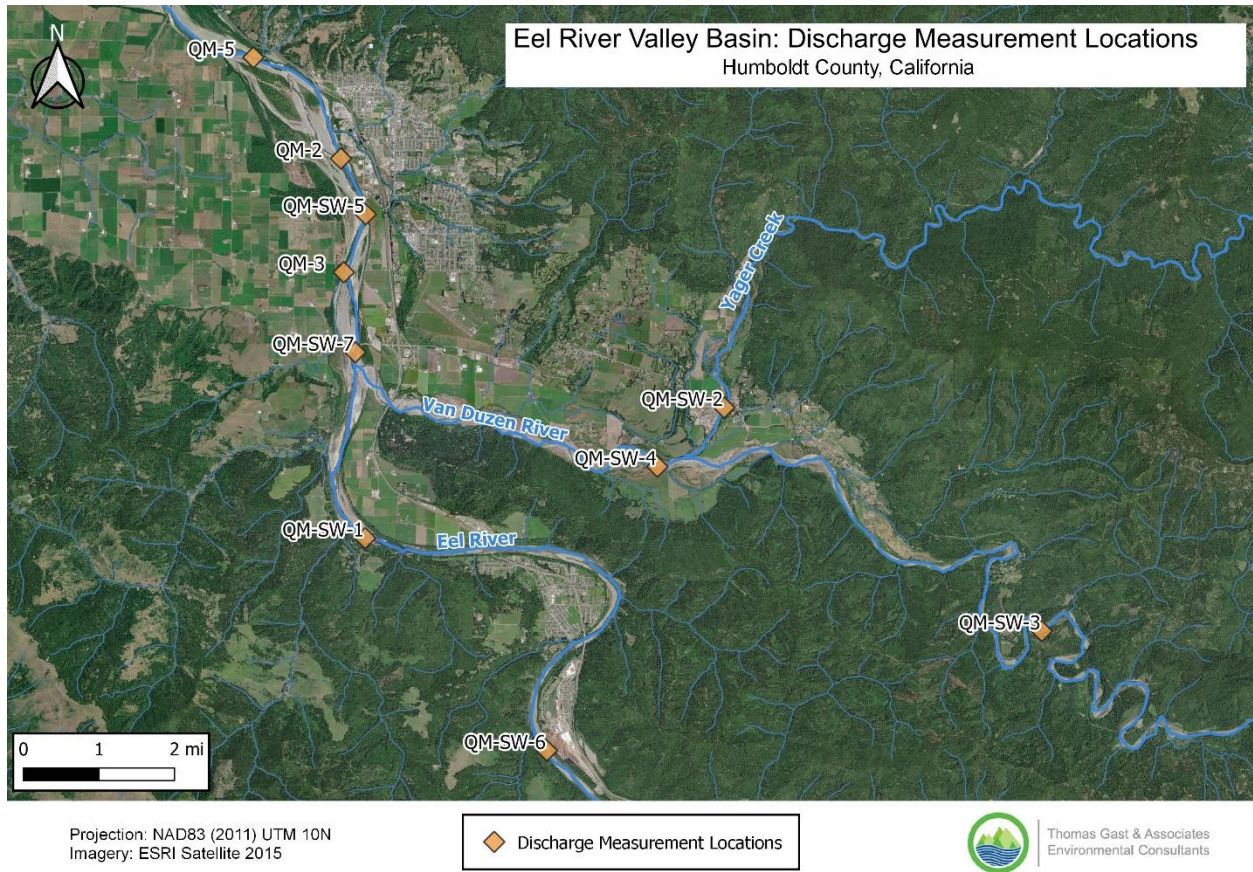


Figure 2: Discharge measurement locations established in the ERVB

Appendix B: Tables

Table 1: Latitude, longitude, and descriptions of surface water monitoring sites. Latitude and longitude reported in NAD83 horizontal datum

Site ID	Latitude	Longitude	Site Description
R-5	40.60302669	-124.1788315	Eel near Palmer Blvd
R-2	40.58067829	-124.1566954	River Lodge Pool
R-3	40.55545276	-124.1559563	Eel near E Ferry Rd
ERB_SW-1	40.5116449	-124.1545231	Eel near Metropolitan Rd
ERB_SW-2	40.537298	-124.0629661	Yager Creek
ERB_SW-3	40.49742499	-123.9846423	Pamplin Grove
ERB_SW-4	40.5270873	-124.0771716	Van Duzen River near Fischer Rd
ERB_SW-5	40.5720043	-124.1531466	Head of River Lodge Pool
ERB_SW-6	40.47343476	-124.1096759	Eel River near Scotia
ERB_SW-7	40.54869029	-124.1551344	Eel River downstream of Van Duzen

Table 2: Location of barometric data logger used to determine water depth at each surface water monitoring location. Data from monitoring site R-3 are collected by SHN

Surface Water Monitoring Site	Barometer Location
R-5	R-2
R-2	R-2
R-3	N/A
ERB_SW-1	SW-7
ERB_SW-2	SW-2
ERB_SW-3	SW-2
ERB_SW-4	SW-2
ERB_SW-5	R-2
ERB_SW-6	SW-7
ERB_SW-7	SW-7

Table 3: Water surface elevations measured by RTK in November 2021

Surface Water Monitoring Site	Description	Water Surface Elevation, NAVD88 (ft.)	Date / Time (GMT-07:00)
R-5	Eel near Palmer Blvd	11.065	24 Nov 2021 / 11:44
R-2	Eel at River Lodge Pool	19.264	24 Nov 2021 / 12:21
ERB_SW-5	Head of River Lodge Pool	19.183	24 Nov 2021 / 12:50
ERB_SW-7	Eel River downstream of Van Duzen	24.853	24 Nov 2021 / 13:38
ERB_SW-1	Eel near Metropolitan Rd	37.363	24 Nov 2021 / 14:12
ERB_SW-6	Eel River near Scotia	51.931	24 Nov 2021 / 15:26
ERB_SW-4	Van Duzen River near Fischer Rd	90.332	29 Nov 2021 / 12:12

Table 4: Measured discharge values (cfs) at each discharge measurement location over the 2021 low-flow season and discharge reported by nearby USGS gauging stations.

Site	Date	Time	Measured Discharge (cfs)
QM-2	6/25/2021	8:50	175.084
	7/23/2021	9:30	43.50
	8/26/2021	12:43	8.81
QM -3	6/11/2021	13:42	299.03
	7/21/2021	13:45	51.87
	8/25/2021	14:06	22.09
QM -5	6/25/2021	9:52	189.347
	7/23/2021	11:50	49.96
	8/26/2021	15:38	13.95
QM-SW-1	6/25/2021	7:45	168.706
	7/21/2021	9:55	49.05
	8/25/2021	9:30	27.51
QM-SW-2	6/10/2021	10:15	6.98
	7/22/2021	13:00	2.26
	8/18/2021	11:45	0.09
QM-SW-3	6/4/2021	13:32	32.73
	7/22/2021	10:55	7.16
	8/18/2021	10:12	3.44
QM-SW-4	6/10/2021	13:27	44.53
	7/22/2021	14:20	7.71
	8/18/2021	13:30	5.05
QM-SW-5	6/11/2021	15:28	298.31
	7/23/2021	8:11	44.91
	8/25/2021	15:00	12.63
QM-SW-6	6/11/2021	12:17	261.93
	7/22/2021	9:00	54.04
	8/26/2021	10:43	25.15
QM-SW-7	6/11/2021	11:01	293.86
	7/21/2021	11:30	55.67
	8/25/2021	10:45	27.23
USGS Site #11478500 (Van Duzen near Bridgeville)	6/4/2021	13:30	34.4 ^P
	7/22/2021	11:00	6.24 ^P
	8/18/2021	10:15	3.44 ^P
USGS Site # 11477000 (Eel at Scotia)	6/11/2021	12:15	233 ^A
	7/22/2021	9:00	57.9 ^A
	8/26/2021	10:45	26.3 ^A

Note: ^A USGS-accepted value, ^P USGS provisional value



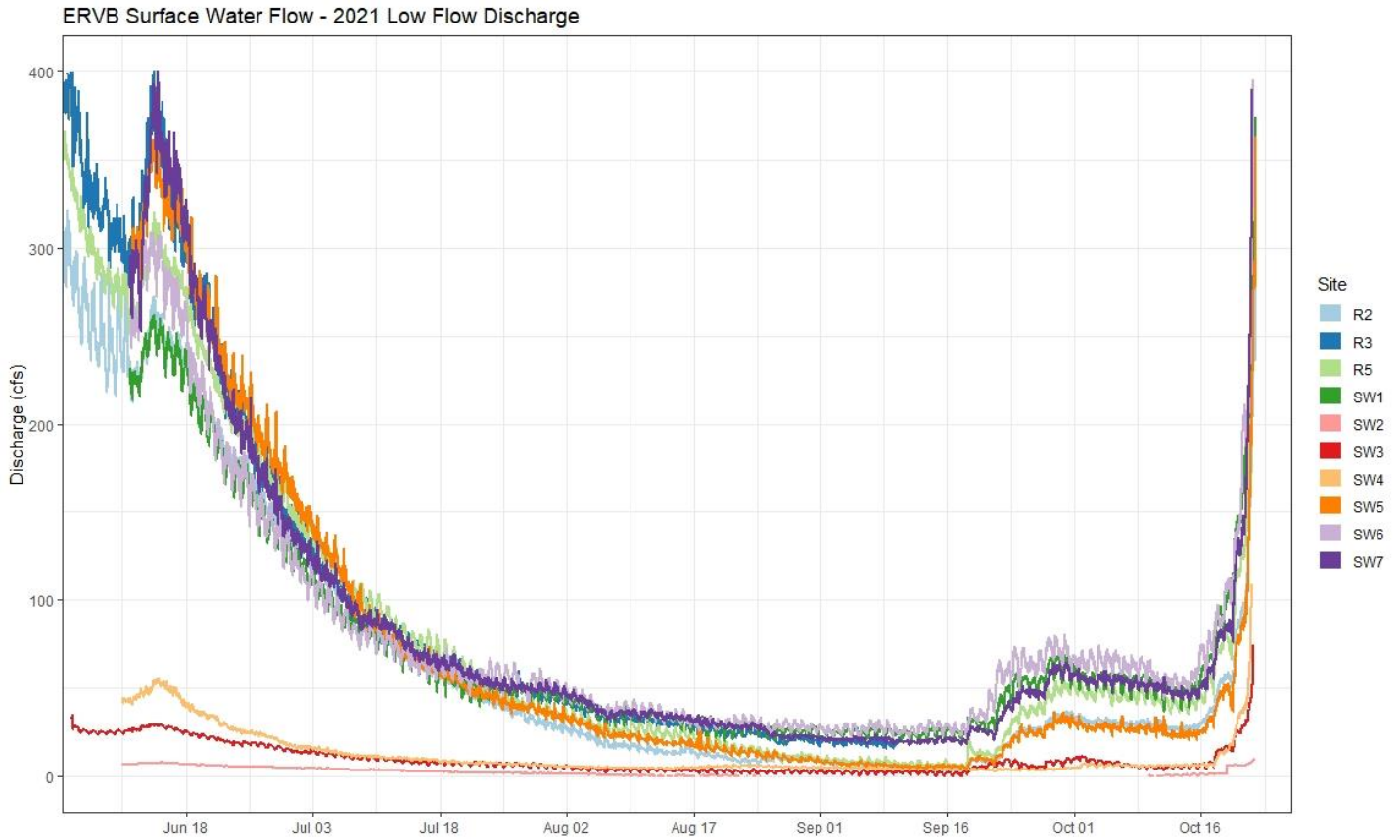
Table 5: 2021 Low-flow rating curve equations and associated standard errors for each discharge measurement location.

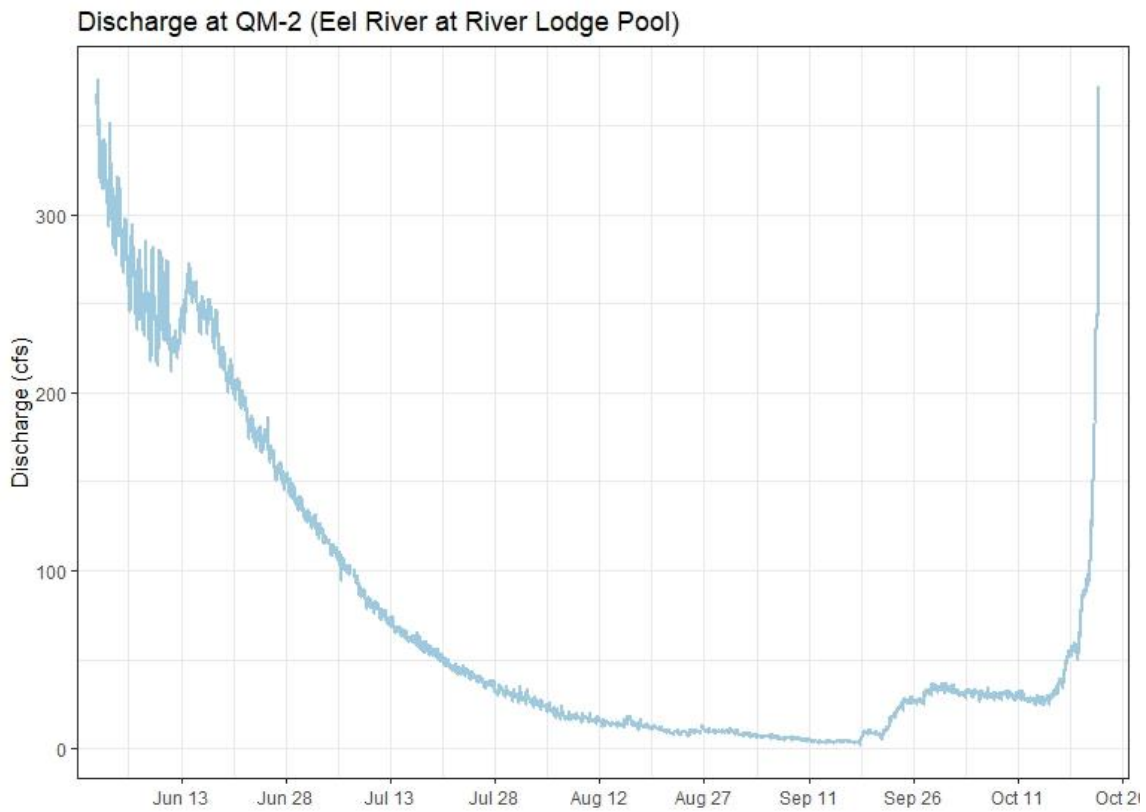
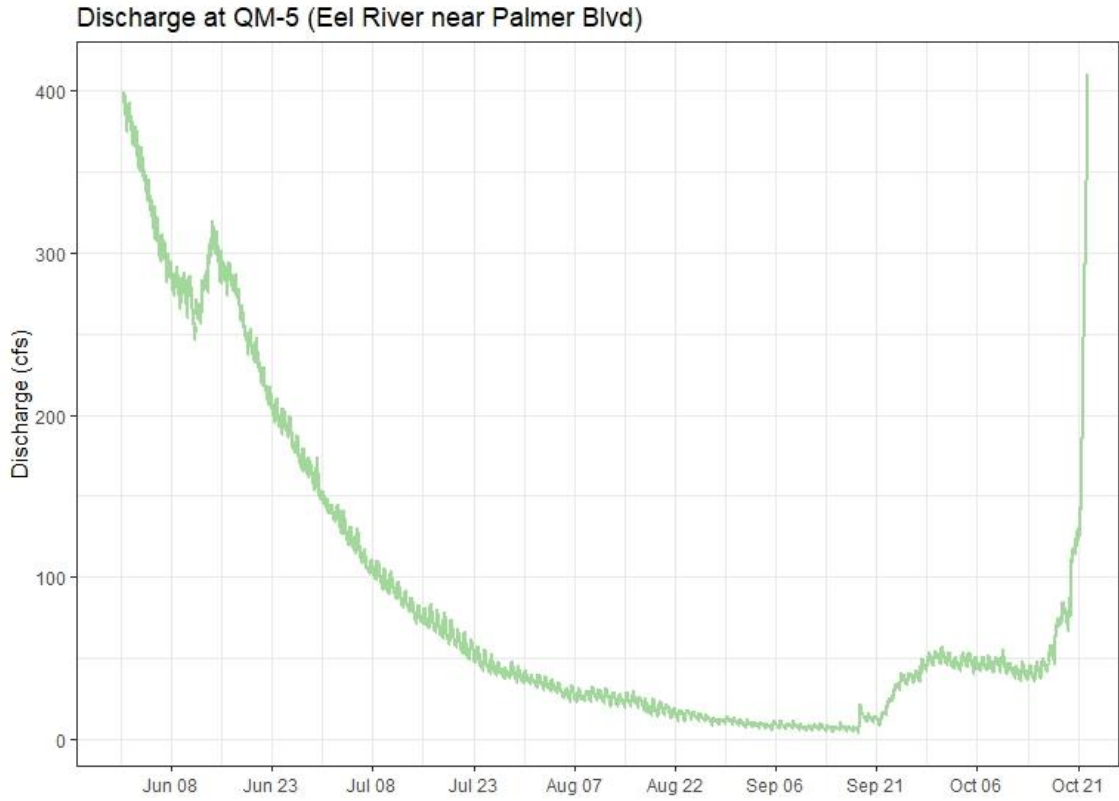
Surface Water Monitoring Site	Rating Curve			Standard Error (%)
	C	Offset	n	
QM-5	213.304	0.59	1.769	0.001
QM-2	174.36	0.24	2.044	0.000
QM-3	2.404	20.782	5.895	0.005
QM-SW-1	28.535	-0.335	3.043	0.000
QM-SW-2	11.264	1.041	0.693	0.300
QM-SW-3	49.316	1.89	1.08	0.029
QM-SW-4	49.773	0.88	2.85	0.045
QM-SW-5	106.623	0.77	3.043	0.004
QM-SW-6	41.876	0.65	3.724	0.000
QM-SW-7	0.001	-1.80	9.9	0.000

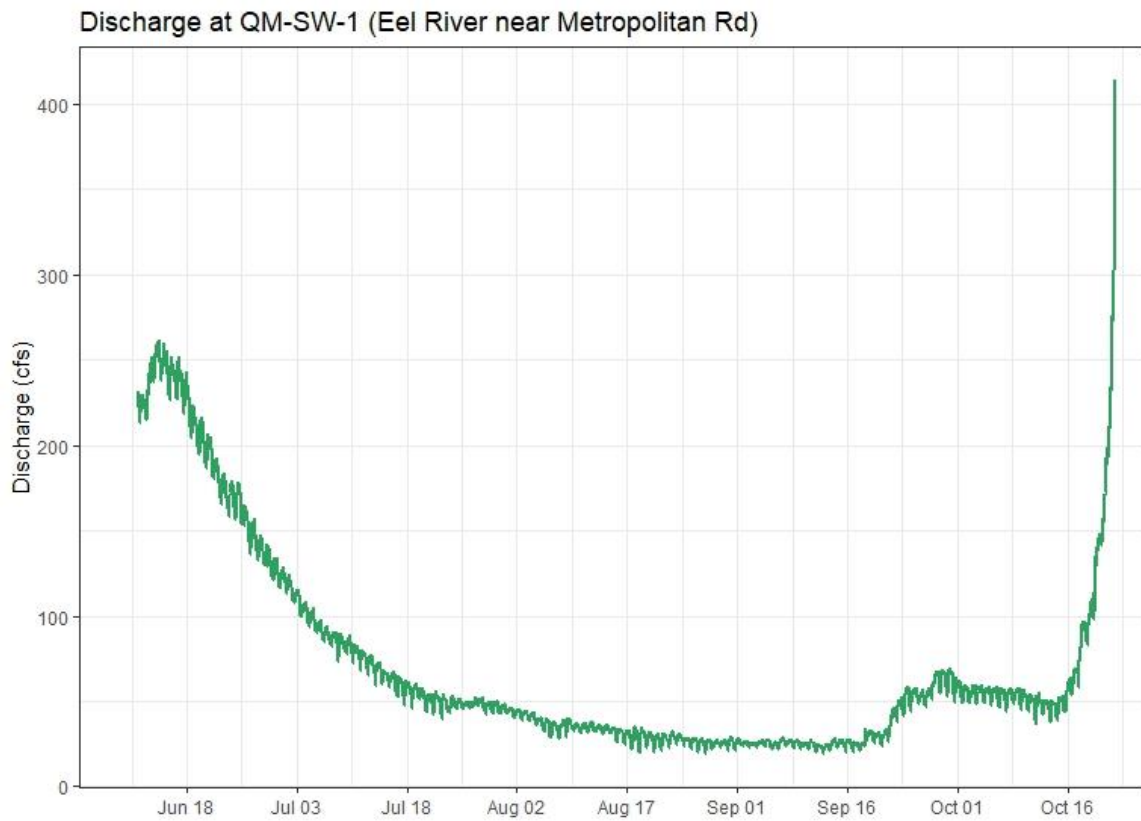
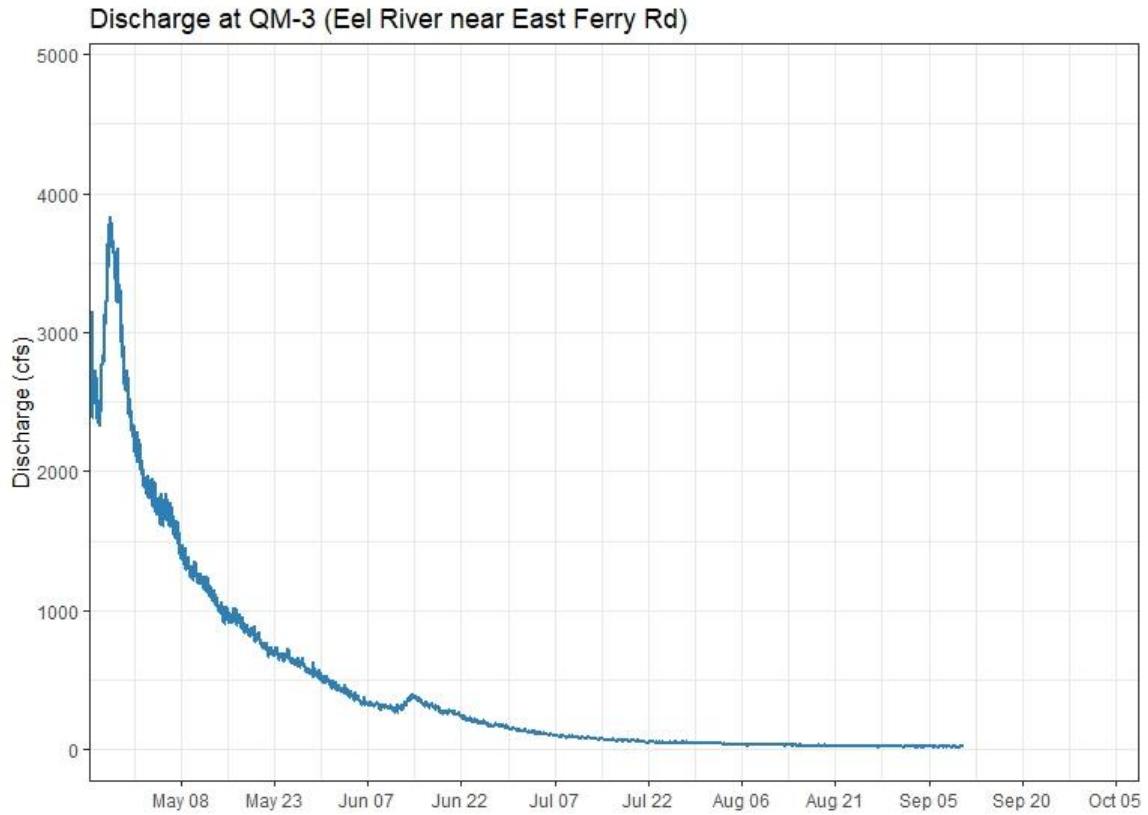
Table 6: Summary statistics (minimum and mean) of discharge records at each discharge measurement location over the 2021 low-flow season.

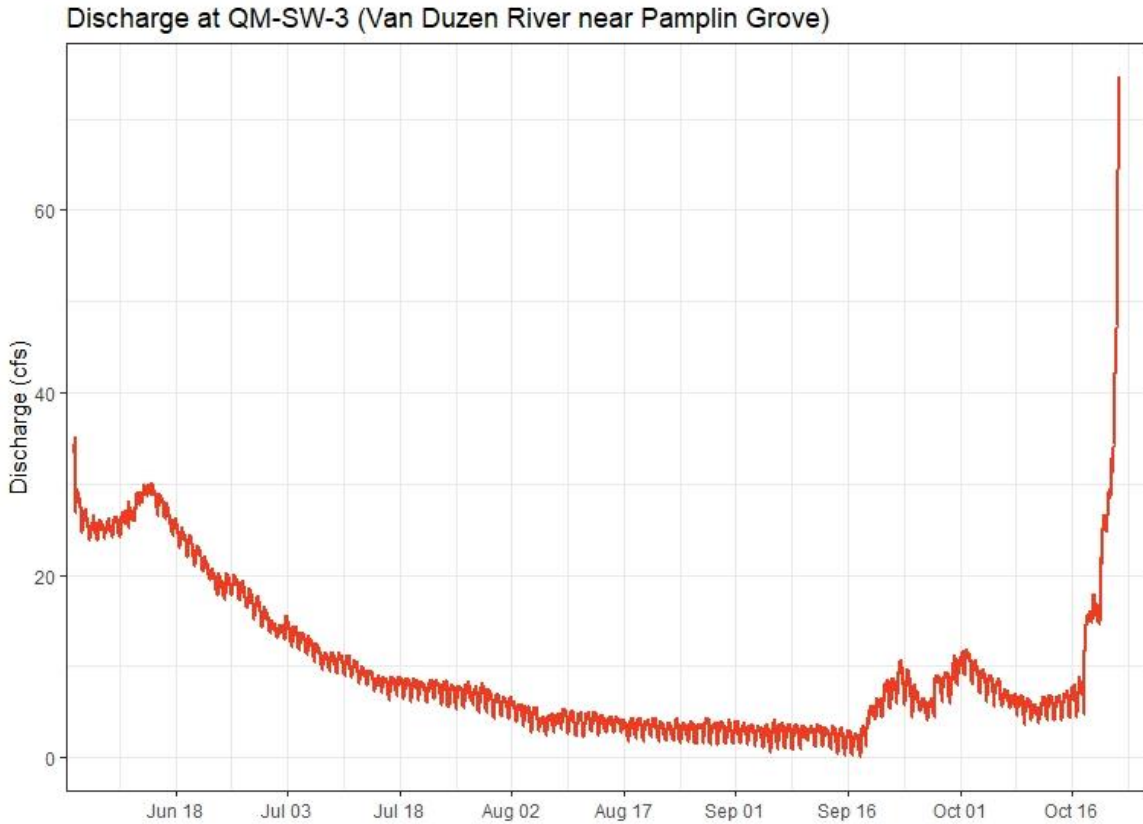
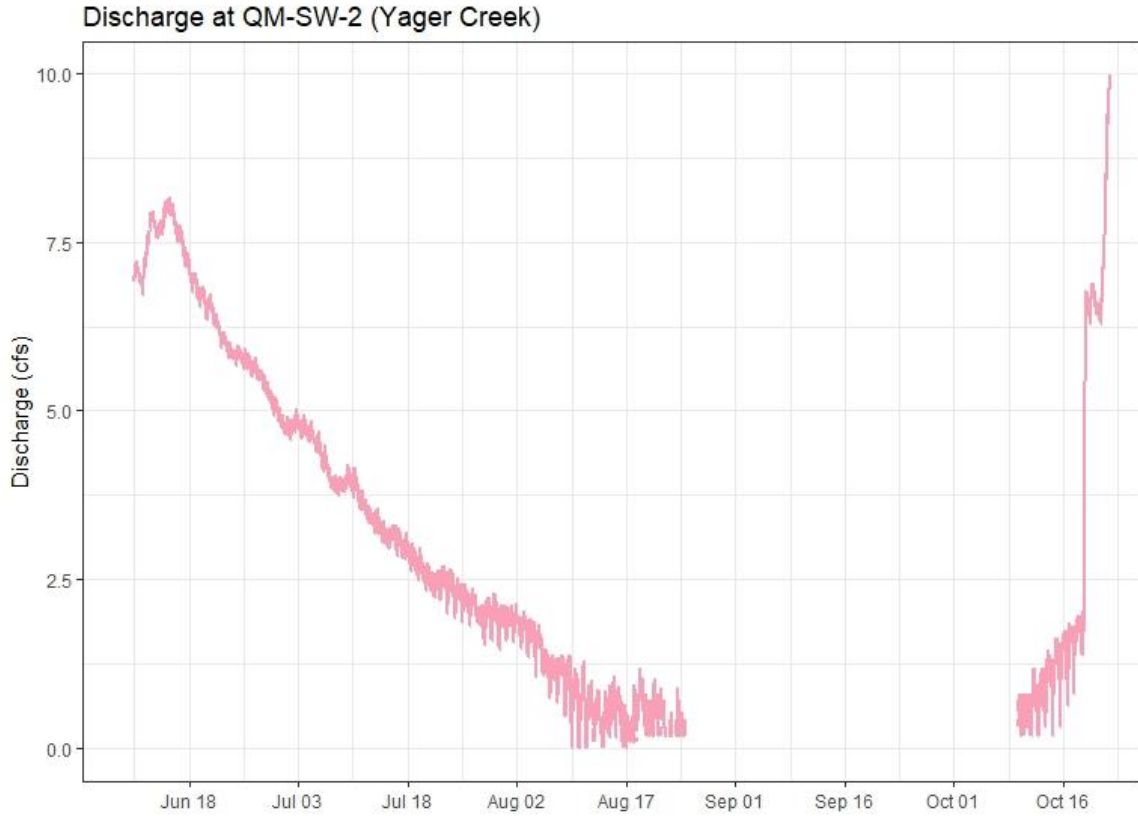
Site	Beginning of Record	End of Record	Minimum Discharge (cfs)	Date of Minimum	Mean Discharge (cfs)
QM-5	6/3/2021	10/22/2021	3.76	9/18/2021	84.89
QM-2	6/3/2021	10/22/2021	2.14	9/18/2021	70.07
QM-3	6/3/2021	9/10/2021	16.05	9/9/2021	112.22
QM-SW-1	6/11/2021	10/22/2021	19.27	8/27/2021	71.70
QM-SW-2	6/10/2021	10/22/2021	0.00	8/9/2021	3.39
QM-SW-3	6/4/2021	10/22/2021	0.09	9/17/2021	9.85
QM-SW-4	6/10/2021	10/22/2021	2.79	9/21/2021	11.76
QM-SW-5	6/11/2021	10/22/2021	3.90	9/18/2021	68.38
QM-SW-6	6/11/2021	10/22/2021	20.46	9/11/2021	77.27
QM-SW-7	6/11/2021	10/22/2021	17.83	9/17/2021	80.46

Appendix C: Hydrographs

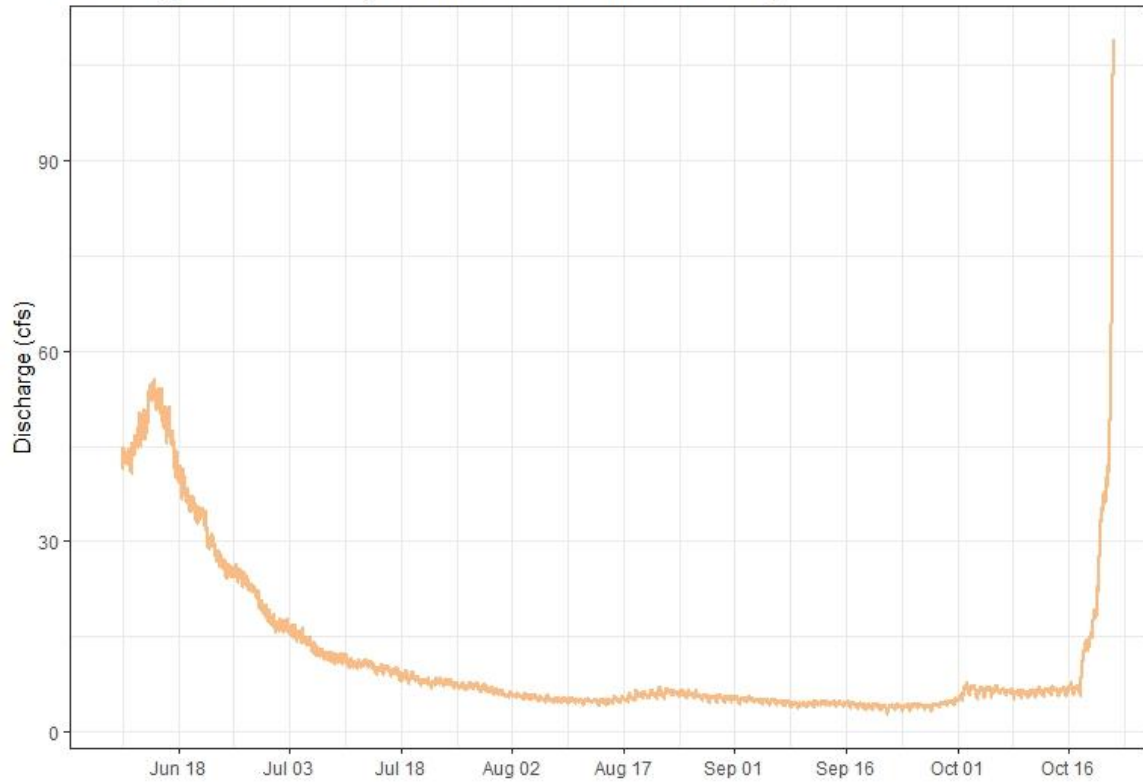




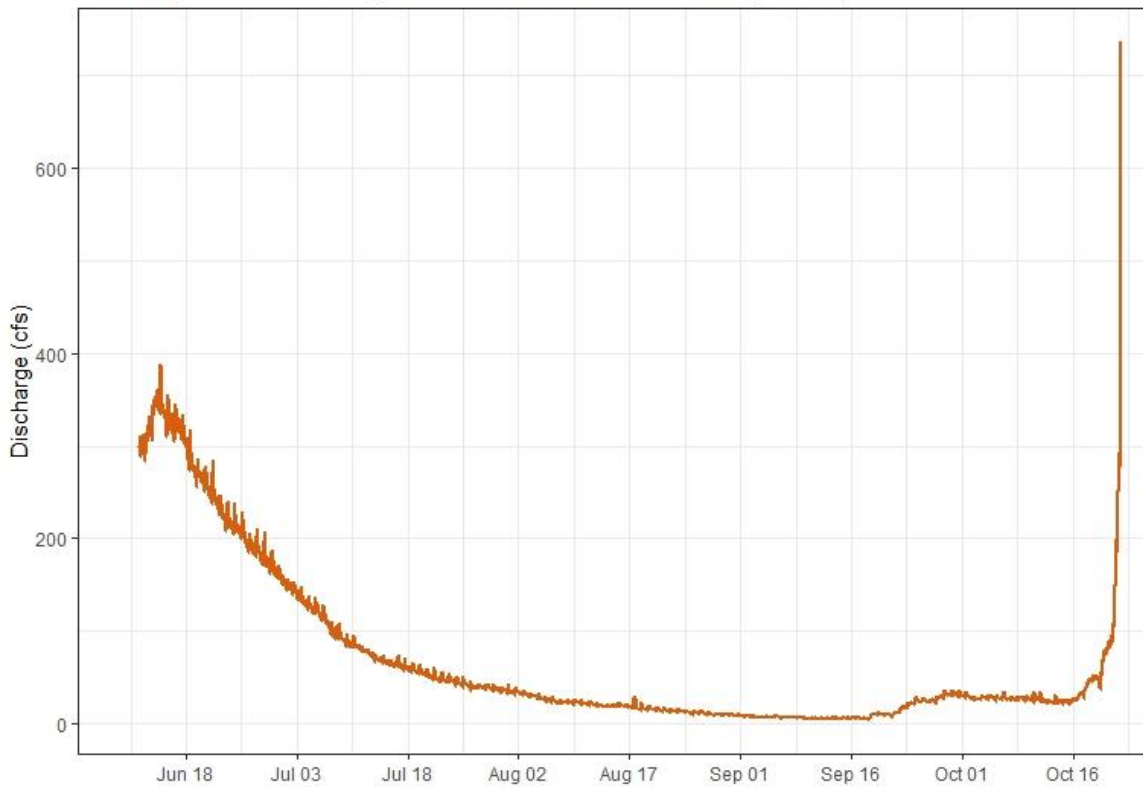


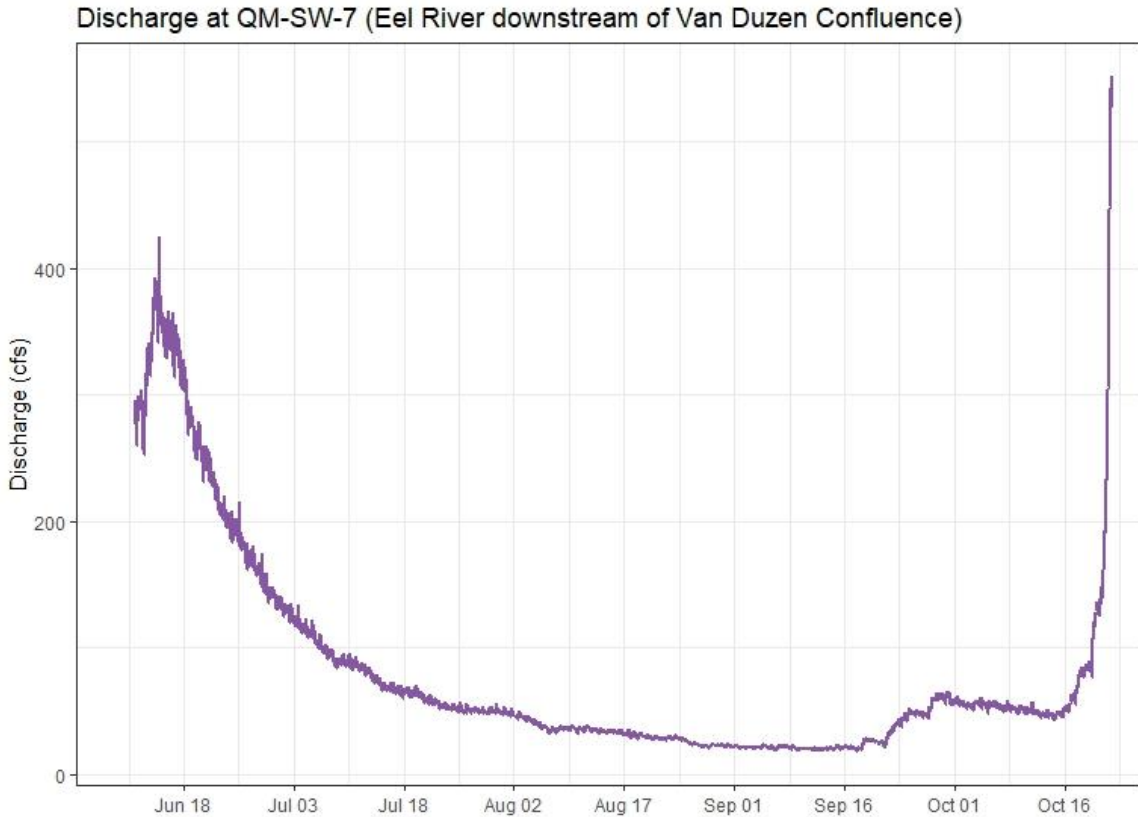
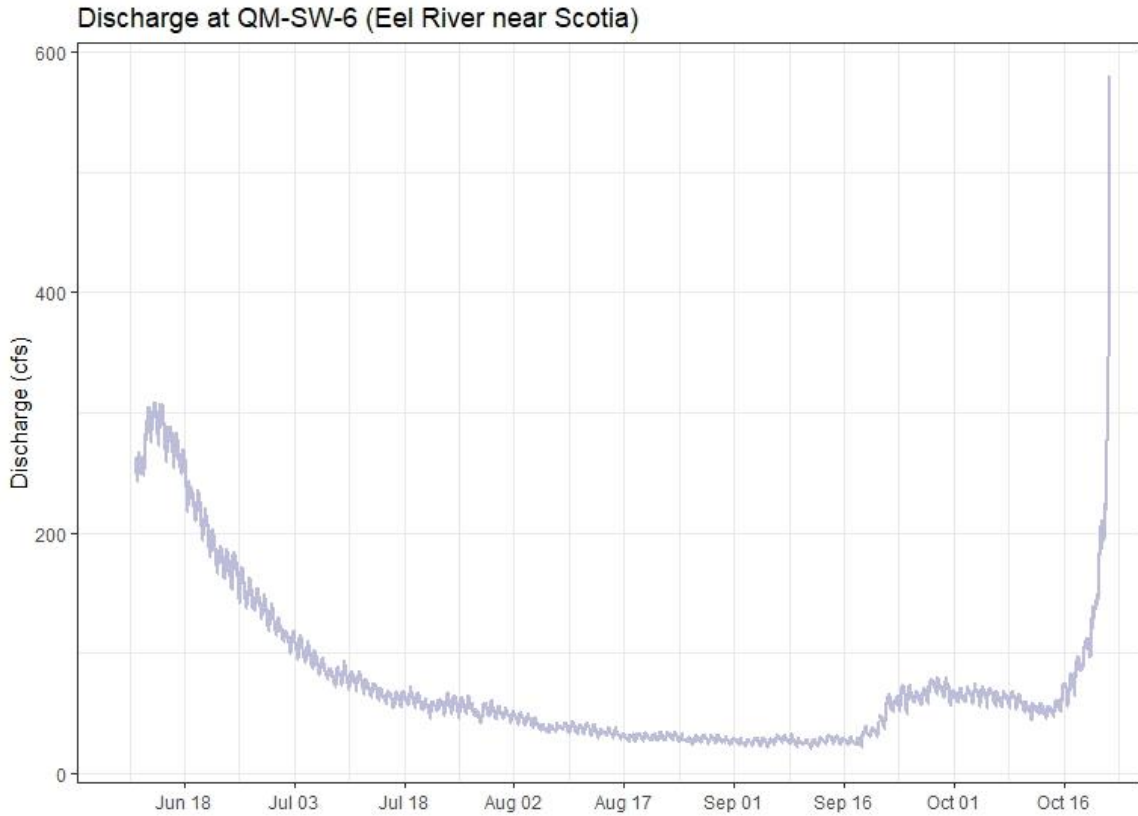


Discharge at QM-SW-4 (Van Duzen River near Fischer Rd)



Discharge at QM-SW-5 (Eel River at Head of River Lodge Pool)





Attachments

Attachment 1 - R-2_12-21-2020_11-24-2021.xlsx

Attachment 2 - R3_10-31-2016_9-10-2021.xlsx

Attachment 3 - R-5_12-21-2020_11-24-2021.xlsx

Attachment 4 - SW1_06-11-2020_11-24-2021.xlsx

Attachment 5 - SW2_06-10-2020_11-01-2021.xlsx

Attachment 6 - SW3_06-04-2020_11-01-2021.xlsx

Attachment 7 - SW4_06-10-2020_11-01-2021.xlsx

Attachment 8 - SW5_06-11-2020_11-24-2021.xlsx

Attachment 9 - SW6_06-11-2020_11-24-2021.xlsx

Attachment 10 - SW7_06-11-2020_11-24-2021.xlsx

Raw data (attachements 1-10) available on the Humboldt County Groundwater website:

<https://humboldt.gov/2820/Eel-River-Valley-Groundwater-Basin-Resou>

