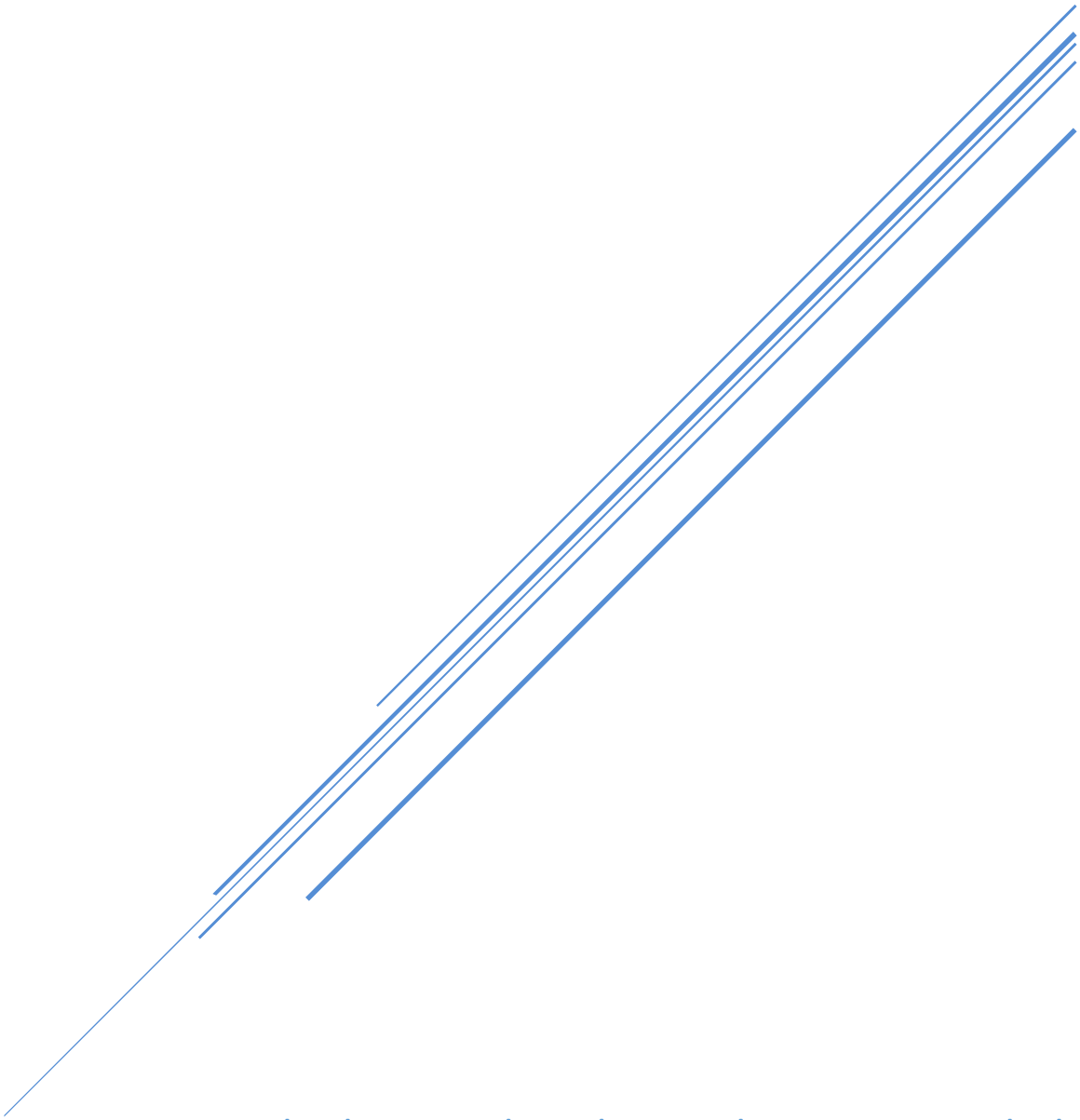
APPENDIX 4E

5th Quarter Data Download



Lower Charlotte Harbor Flatwoods Strategic Hydrologic Restoration Plan

Lower Charlotte Harbor Flatwoods Strategic Hydrologic Restoration Plan

4E – 5th Quarter Data Download

PREPARED FOR:

1050 Loveland Boulevard
Port Charlotte, Florida 33980

PREPARED BY:

IN CONJUNCTION WITH:

Lower Charlotte Harbor Flatwoods Hydrologic Modeling/Planning Project

Technical Memorandum – Task 4 Data Collection: Flow Rating Curves, Station Maintenance, and Data Downloading

To: Jennifer Hecker, Nicole Iadevaia
From: Roger Copp and Kirk Martin, P.G., Water Science Associates
Date January 12, 2022
Re: 5th Quarter Data Download

BACKGROUND

Water Science Associates was contracted by the Coastal and Heartlands National Estuary Partnership (CHNEP) to develop a hydrologic restoration plan for the Lower Charlotte Harbor Flatwoods that will promote sheet flow enhancement and restore wetland hydroperiods in Babcock Webb and Yucca Pens Wildlife Management Area (WMA) and improve the timing and magnitude of flows to tidal creeks west of Yucca Pens WMA.

Project tasks include:

1. Compilation of existing hydrologic data,
2. Installation of new surface and groundwater monitoring stations and rain gages,
3. Evaluation of vegetation indicators of wetland health,
4. Maintenance of the monitoring stations and downloading measured data,
5. Development of an existing conditions hydrologic model of the study area,
6. Evaluation of alternative management scenarios, and
7. Development of a Lower Charlotte Harbor Flatwoods Strategic Hydrological Restoration Planning Tool and Report.

The Task 1 - Data Discovery Memorandum and the Task 2 deliverables including the Groundwater Monitoring Plan, the Flow Monitoring Plan, and the Monitoring Equipment Acquisition and Installation Memoranda have been submitted to CHNEP. Groundwater and rainfall monitoring station locations were selected to complement existing monitoring stations and to address objectives identified during meetings of the Charlotte Harbor Flatwoods Initiative. The monitoring station locations were selected to provide water level data to define watershed boundaries on the eastern and northern portions of the study area, conveyances from Babcock Webb to Yucca Pens, and groundwater levels in Yucca Pens. Task 3 includes ecologic monitoring to determine average wet season water depths at more than 50 locations in Babcock Webb and Yucca Pens and Historical Hydroperiod Mapping. Dry season field work was completed in April and May 2020. Wet season field work was completed in November 2020 to measure water depths at the locations inventoried in the 2020 dry season. Task 3 memoranda describing dry and wet season conditions have been submitted to CHNEP.

Task 4 activities include maintenance of the monitoring stations and downloading on a quarterly basis for six quarters. This memorandum summarizes the completion of the 5th Quarter (Task 4e) as described below.

DESCRIPTION OF DELIVERABLE REQUIREMENTS

The requirement for Task 4e is to provide monitoring well water level, flow gage, and rainfall data collected for the 5th quarter after installation of monitoring stations and programming of data loggers. **Table 1** presents the quarterly download date ranges that are part of the CHNEP Contract project schedule. Per the contract with CHNEP, these quarterly data download memoranda were intended to present data collected during the prior three-month period, with analysis conducted after the completion of the data collection effort.

Table 1 – CHNEP Contract Download Schedule

Download	Period	Details
1st Quarter	May – August, 2020	Stations installed late April and early May, downloaded Aug 4 - 14
2nd Quarter	August 2020 – November, 2020	Downloaded Nov 13 - 20
3rd Quarter	November, 2020 – February, 2021	Downloaded Jan 18 – Feb 15
4th Quarter	February, 2020 – May, 2021	Downloaded May 3 – 10
5th Quarter	May, 2021 – August, 2021	Downloaded in early August, 2021
6th Quarter	August, 2021 0 November, 2021	Downloading scheduled to begin Nov 15, 2021

The station installation and programming were completed in May 2020 (Copp & Martin, 2020), therefore August 2020 was the first quarterly monitoring period. This memorandum summarizes the data downloaded in August 2021. Data provided includes the 24 new monitoring wells all equipped with recording data loggers, 8 new data loggers at existing Babcock Webb staff gages, 3 new rain gages, and 8 new flow monitoring gages. Data outputs are differentiated per their location within either the South Florida or the Southwest Florida Water Management Districts (SFWMD/SWFWMD).

DOCUMENTATION

New Groundwater Monitoring Stations and Existing Staff Gages

In-Situ Troll 100 water level data loggers were installed in May, 2020 in 24 newly established monitoring wells and 8 existing Babcock Webb stations with staff gages (**Figure 1)**. The data loggers record water elevations (in feet using the NAVD 88 datum) every one or four hours, depending on how the data loggers were programmed. The monitoring well installation methodology was described in the Groundwater Monitoring Plan (Water Science Associates, 2020). Rain gage locations are presented in **Figure 2**, and flow monitoring station locations are presented in **Figure 3**. Recorded data from the monitoring stations were downloaded in August, 2021 for the 5th quarter and will be uploaded to the CHNEP Water Atlas after being subjected to a quality assurance/quality control (QA/QC) review.

Manual readings of groundwater depth were recorded during the data download and were compared to water level measurements recorded by the water level data loggers. **Table 2** provides a comparison of manual and data logger water elevations. Differences between manual and data logger readings were generally small, with differences less than 0.2 feet at 28 of 31 stations. There were no discrepancies in water levels greater than 0.23 ft. One possible reason to explain why water levels at the stations had differences greater than 0.2 ft could be that there was a difference in barometric pressure between the time of the last data logger reading and the time of the manual depth measurement.

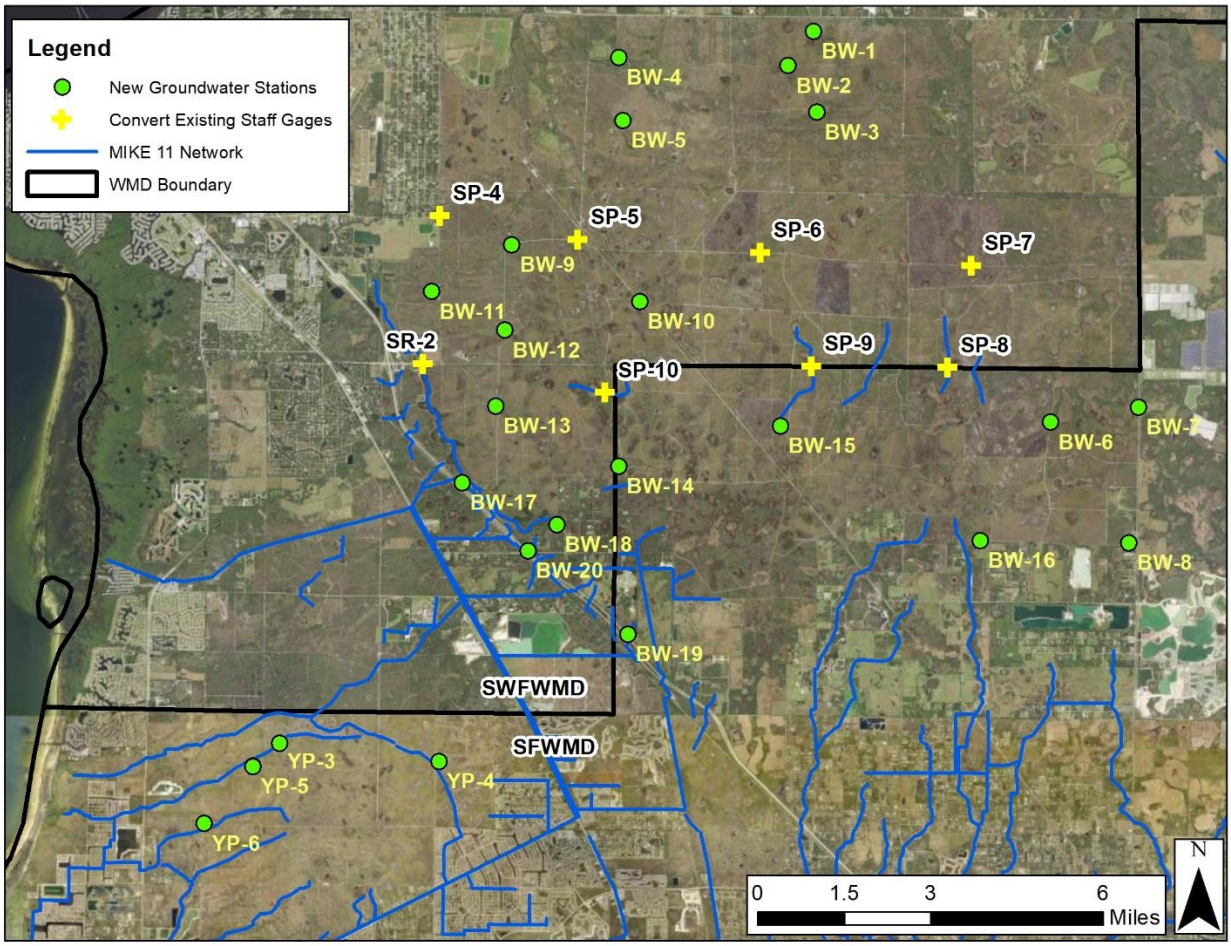


Figure 1 – Map of Surveyed New Groundwater Monitoring Stations and Existing Staff Gaging Station Upgrades

Table 2 – Manual and Data Logger Readings During August, 2021 Data Download

Station	Date	Manual Reading	Data Logger Reading	Difference
		ft-NAVD	ft-NAVD	ft
BW-1	8/4/21	32.13	32.10	0.03
BW-2	8/4/21	32.43	32.42	0.01
BW-3	8/4/21	35.76	35.80	-0.04
BW-4	8/4/21	24.70	24.83	-0.13
BW-5	8/4/21	26.31	26.32	-0.01
BW-6	8/4/21	30.62	30.64	-0.02
BW-7	8/4/21	31.46	31.52	-0.06
BW-8	8/4/21	28.77	28.82	-0.05
BW-9	8/4/21	25.75	25.79	-0.04
BW-10	8/5/21	28.02	28.09	-0.07
BW-11	8/4/21	23.78	23.77	0.01
BW-12	8/4/21	25.90	25.98	-0.08
BW-13	8/5/21	26.10	26.12	-0.02
BW-14	8/5/21	26.38	26.36	0.02
BW-15	8/5/21	27.78	27.78	0.00
BW-16	8/4/21	28.49	28.39	0.11
BW-17	8/5/21	23.93	23.94	-0.01
BW-18	8/5/21	24.87	24.92	-0.05
BW-19	8/4/21	24.28	24.14	0.14
BW-20	8/4/21	24.20	24.42	-0.22
YP-3	8/11/21	16.15	16.17	-0.02
YP-4	8/11/21	17.32	17.37	-0.05
YP-5	8/11/21	15.01	14.94	0.07
YP-6	8/11/21	11.58	11.57	0.01
SR-2	8/5/21	23.78	23.79	-0.01
SP-4	8/10/21	23.22	23.17	0.05
SP-5	8/5/21	27.65	27.44	0.21
SP-6	8/5/21	30.38	30.42	-0.04
SP-7	8/5/21	35.44	35.29	0.15
SP-8	8/5/21	34.04	33.86	0.18
SP-9	8/5/21	30.08	29.86	0.22
SP-10	8/5/21	26.93	27.16	-0.23

Temporal trends in the recorded groundwater elevation for groundwater monitoring stations are presented graphically in **Appendix A**. All of the graphs present the measured water levels along with a line representing the surveyed elevation of ground adjacent to the monitoring well. Most monitoring stations are located in the vicinity of wetlands, ditches, elevations of adjacent weirs and underflow gates, and the elevations of those features are provided in the graphs. The estimated wetland elevations presented in the graphs (as the yellow line) were derived from the digital elevation map that is being used in this project, with the elevations shown being based on field observations of the approximate mid-point between the wetland edge and the lowest point in the wetland. This line was added to graphs where the monitoring well was near wetlands, but installed outside and above them. The yellow line is meant to approximate the elevation that would be typically wet during the wet season (but is not an edge-of-wetland elevation.) This information was presented to provide context of the measured water level in relationship to nearby wetlands.

Peak stages during July and early August 2021 were similar to 2020 wet season peak stages, however the onset of the wet season was later in 2021 than in 2020. Water levels in 2020 increased significantly in late May and then declined into July due to lower than normal rainfall amounts in late June and July. A number of stations in Babcock Webb located upstream of water control structures or next to structures that control water levels demonstrated less wet season variability (e.g. SR-2, SP-8). Rapid water level changes were observed at BW-1 close to the edge of Babcock Webb and appear to be influenced by drainage canals under SR 74. In comparison, gradual water level changes were observed at SP-8, which is located at the outlet of a large water storage area upstream of the Big Island Weir (see photo below).

Big Island Weir, Station SP-8

Dry season water levels in Babcock Webb decreased the most at SP-4, which is located just upstream of a gated discharge structure (see adjacent photo). Leakage through the gate is most likely the reason for the steep recession rate at SP-4. Most stations experienced a rise in water levels in late February and late April 2021 due to rainfall events, except of stations 1, 10, 11, 18, 19, and 20. Interestingly, none of the staff gage stations at Babcock Webb corrugated metal riser structures (stations SP-5 through SP-10) experienced increased water levels for either of the dry season rainfall events.

N Alligator Ck, Station SP-4

Yucca Pens station YP-3 is located adjacent to a large cypress strand that contributes flows to Yucca Pens and Durden Creeks, and that station has the most stable wet season water levels, while stations YP-4, -5, and -6 all exhibit greater wet season water level variability. YP-6 is located at the western edge of Yucca Pens south of Durden Creek and is located adjacent to two eroded ATV trails that convey water offsite towards Greenwell Branch during the wet season. Measured water levels continue to be significantly lower than the ground surface and wetlands adjacent to this monitoring well. Wet season water levels are close to or above ground surface at all groundwater monitoring stations in Babcock Webb and Yucca Pens, while the approximate average wet season water levels at YP-6 are 4 feet below ground. The low groundwater levels are unexpected since surface outflows via ATV trails are evident less than 50 feet from this monitoring well. This station will be a focus during model calibration.

Rainfall Monitoring Stations

Three new rain gages were installed to augment existing rainfall monitoring stations. The purpose of the monitoring stations was to have data available to compare to grid-based NEXRAD rainfall data available from SFWMD. BW-18_R is located at the south end of Webb Lake in Babcock Webb WMA. SP-5_R is also located in Babcock Webb WMA on the North Grade just east of the SAL Grade (located approximately 2.2 miles north of Tuckers Grade). SR-7_R is located along the main access road adjacent to a powerline right-of-way in Yucca Pens approximately 2.3 miles south of Zemel Road. Daily and hourly rainfall totals from gages installed in Babcock Webb and Yucca Pens are presented in **Appendix B**. Monthly rainfall totals from the three installed gages are shown in **Table 5**. A bar graph of rainfall for rainfall stations SP-5_R, BW-18_R, and SR-7_R is presented along with average monthly rainfall amounts for other rain gages in the area. The other rain gages are Lee County rain gages Lake Fairways, Popash Creek, Yellow Fever Creek, Big Island Weir, Burnt Store Road Fire Station #7, Cecil Webb RG-1, RG-2, and RG-3; SWFWMD rain gages North Charlotte_S and ROMP TR 1-2; and Cape Coral rain gages Weir 4 and Weir 19 (see appendix B for data). Due to battery failure at all three stations, no rainfall data is available for the period between early May and late August, 2021. The batteries were all replaced and the stations are back operational as of August 27, 2021. There is a gap in data from rain gage SR-7_R from August 2020 to December 2020 due to the station not being able to be downloaded during that time frame. The battery died relatively quickly after installation, which was unexpected as all batteries were new at the beginning of the project. A rainfall total was not calculated for station SR-7_R because of the data gap. Rainfall accumulations were significantly less at SP-5 than at BW-18. The stations were installed in a similar manner, and there is no clear explanation for why rainfall station SP-5_R should receive lower rainfall accumulations than the other two stations. Monthly total rainfall amounts for SP-5_R were similar to the average of other rain gages for June and July, 2020, and were within the range of monthly rainfall amounts of other stations for August, 2020.

Lee County has three rain gages on Babcock Webb, and three rain gages in the vicinity of Yucca Pens. SWFWMD has two rain gages on the northeast and southwest side of Babcock Webb. Cape Coral has three rain gages on the south side of Yucca Pens. Data from these stations will be used in place of the rain gages installed as part of this project. The purpose of

the rain gage station data is to check the accuracy of grid rainfall data that will be used for the modeling effort. The rainfall data from other stations will be sufficient for this purpose.

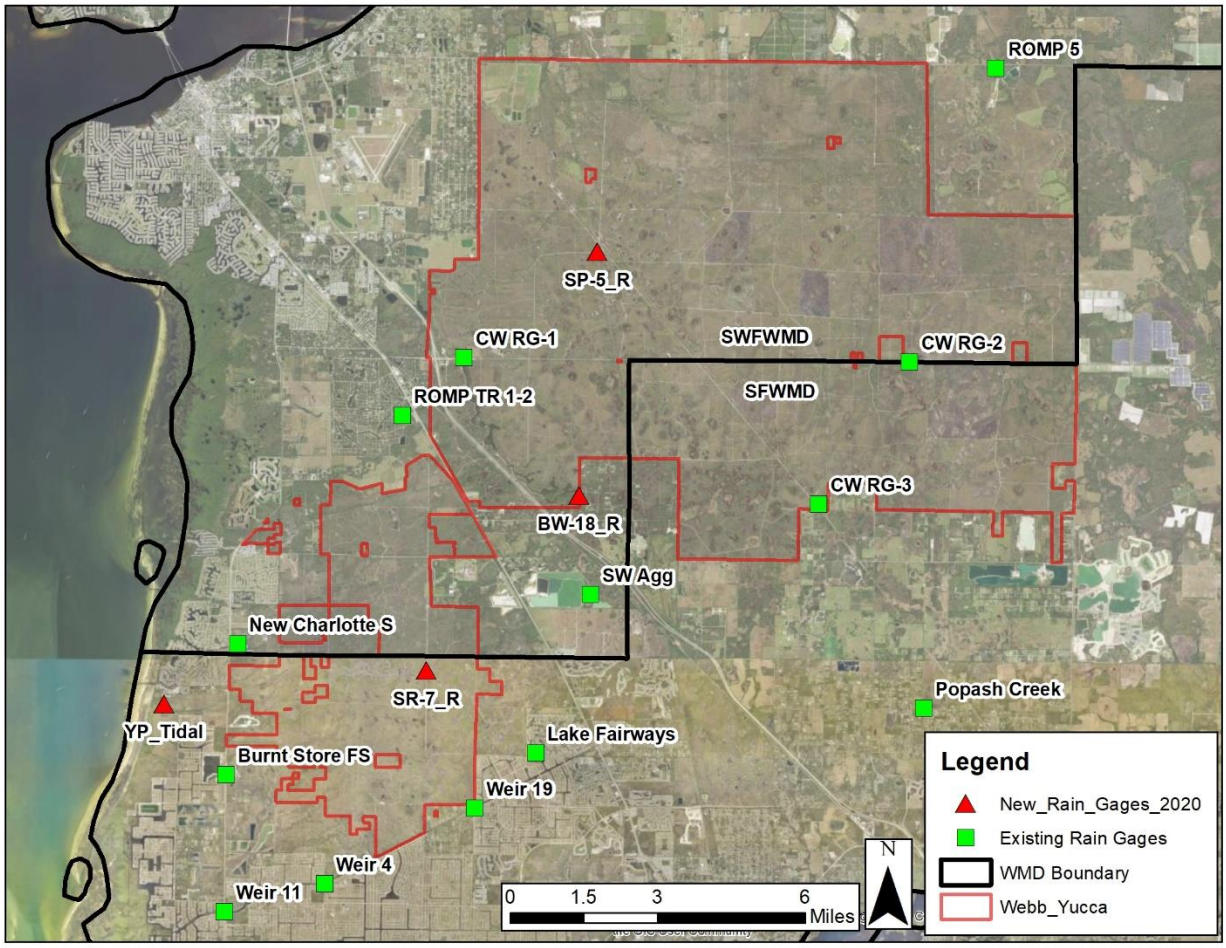
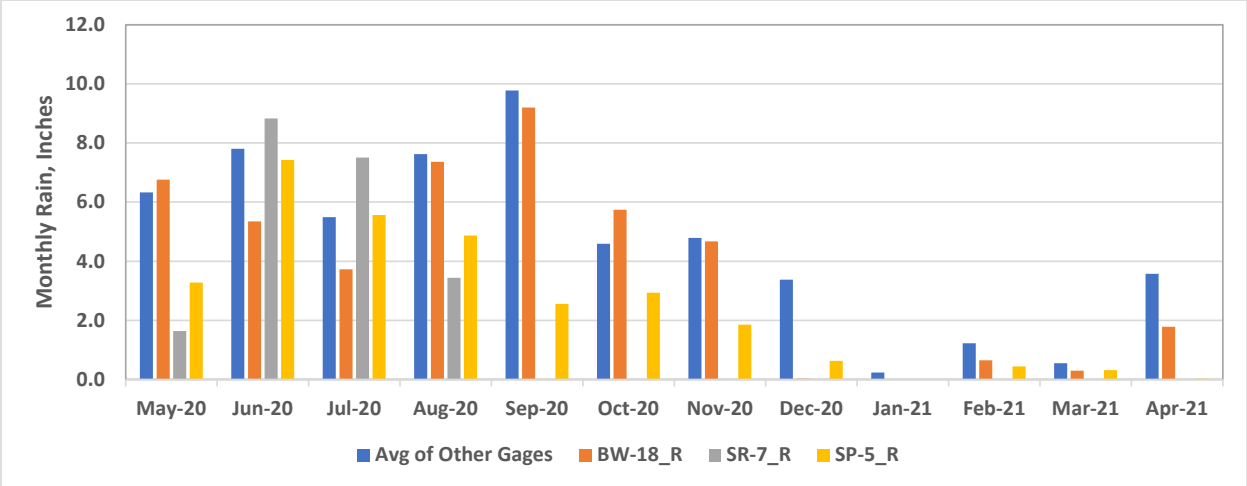


Figure 2 – Map of Newly Installed Rain Gages

Table 5 – Monthly Total Rainfall for Rain Gauges BW-18_R, SR-7_R, and SP-5_R

	Rainfall Total, Inches		
Month, 2020-2021	**BW-18R**	**SR-7_R**	**SP-5_R**
May 2020	6.76	1.64	3.28
Jun	5.35	8.83	7.43
Jul	3.73	7.51	5.56
Aug	7.36	3.44	4.87
Sep	9.2	N/A	2.56
Oct	5.74	N/A	2.93
Nov	4.67	N/A	1.85
Dec	0.03	N/A	0.63
Jan 2021	0.00	N/A	0.00
Feb 2021	0.65	NR	0.44
Mar 2021	0.30	NR	0.31
Apr 2021	1.78	NR	0.03
Grand Total	**45.57**	**Not calculated**	**29.89**

Note: Data for SR-7 in February through April are questionable and are not reported (NR)



Flow Monitoring Stations

The Flow Monitoring Plan described the location of proposed monitoring stations and flow monitoring activities. The stations were all installed in May 2020 and were operational as of May 15, 2020. Recorded water levels at the flow monitoring stations and flow measurements are presented in **Appendix C**. These water level data will be used along with finalized stage/discharge relationships to calculate flow time series files at each of the flow monitoring stations. A line representing 0 ft-NAVD was added to the Greenwell Branch and Yucca Pens tidal monitoring stations to clearly indicate when measured water levels dropped below that level. A summary of the flow measurements at all stations is also presented in **Appendix C**. A summary of flow measurements at the Yucca Pens tidal station as well as recorded rainfall amounts at the rain gage located at the Yucca Pens tidal flow monitoring station is also presented in **Appendix C**.

The flow measurements were made using standard USGS stream gaging techniques by personnel taking multiple velocity and depth measurements across the width of the streams/creeks. The flow monitoring equipment used at each station depended on the width and depth of the stream section. For narrow streams, a pygmy or Sontek FlowTracker meter with a top setting wading rod was used. For larger streams (Zemel Canal and the South Branch of Alligator Creek), a Teledyne RDI Stream Pro Acoustic Doppler Current Profiler was used.

The tidal flow monitoring station equipment includes a Sontek SL side-looking velocity meter that uses ultrasonic Doppler technology to measure incoming and outgoing water velocities, a KPSI pressure transducer to record water levels, a Campbell Scientific CR300 data logger, and a Sierra Wireless Cellular IP model kit. The Sontek SL side-looking velocity meter provides a measurement of water velocities at multiple locations across the stream channel, but is not necessarily an accurate method of the average velocity for the stream channel. Accordingly, the monitoring team also conducted velocity measurements with a Teledyne RDI Stream Pro Acoustic Doppler Current Profiler at four different dates and also upstream at Burnt Store Road on 11 different dates. These data will be used to better understand the influence of tidal fluctuations on discharges from the Yucca Pens tidal creek systems.

Water levels in Durden Creek at Burnt Store Road varied the least of the flow monitoring stations, most likely due to the relative lack of upstream development. Water levels in Greenwell Branch, Bear Branch, and Hog Branch varied the most, most likely due to the higher amount of development within the watershed. Note that Greenwell Branch is located within the City of Cape Coral, and is an excavated man-made channel with an invert elevation below mean sea level (0.0 ft-NAVD). Measured stages in Alligator Creek at South Jones Loop Road in July 2021 were much higher than any measured water levels in 2020, while water levels did not increase as much at the upstream monitoring station at the Webb Lake outfall SR-2. The difference in response at these two monitoring stations will be investigated during model calibration. More trends may become evident as the period of available information increases.

Field staff discovered that roadway construction crews were planning to demolish the Winegourd Creek monitoring station in September 2020, therefore the field staff removed the monitoring equipment from that station and installed a new monitoring station in Yucca Pens Creek at Burnt Store Road. This station provides reliable flow measurements upstream of the Yucca Pens Creek tidal flow monitoring station. The addition of the Yucca Pens Creek flow monitoring station at Burnt Store Road provides additional information that increases reliability of the flow monitoring program in Yucca Pens Creek. Moving this station solved challenges encountered during siting of the Yucca Pens Creek tidal flow monitoring station (described below). Establishing a reliable stage/discharge relationship has proven to be difficult at the tidal monitoring station for a number of reasons, as explained below:

- The station location was mandated by the landowner. An upstream location still within tidal influence was preferable due to the cross-section dimensions, however permission for the first alternative explored could not be obtained to utilize that location. An additional upstream location was established that still provides necessary information to assist the analysis.
- The tidal flow monitoring station is difficult to access during the wet season due to the presence of water levels above the ground surface at the tidal flow monitoring station.
- The cross-section is very wide at this location with much of the flow occurring outside of the main channel. Velocities are very low in the over-bank due to vegetation resistance.

The original flow monitoring station established for Zemel Canal at Burnt Store Road was found to be tidally influenced which inhibited the ability to develop an accurate relationship between canal stage and flow. Accordingly, that station was moved upstream approximately 4,100 feet to a location that is not subjected to tidal influences. **Figure 3** has been updated to show the location of the Zemel Canal monitoring station.

Relationships between stage and flow are also presented graphically in **Appendix C** following the tables of flow measurements. Most of the stations exhibit the typical exponential increase in flow as a function of stage except for South Alligator Creek and Greenwell Branch. Flow monitoring results from the Yucca Pens tidal station show a high degree of variability due to tidal influences. Yucca Pens Creek at Burnt Store Road is also tidal influenced. The graph for Yucca Pens Creek at Burnt Store Road only includes flow measurements at slack tide, and the results indicate the typical exponential increase in flow as a function of stage.

Data from the Yucca Pens tidal flow monitoring station are available on-line on a real-time basis at http://data.locherenv.com/vdv/. The login is: **yuccapens**, and the password is: **yp051820.**

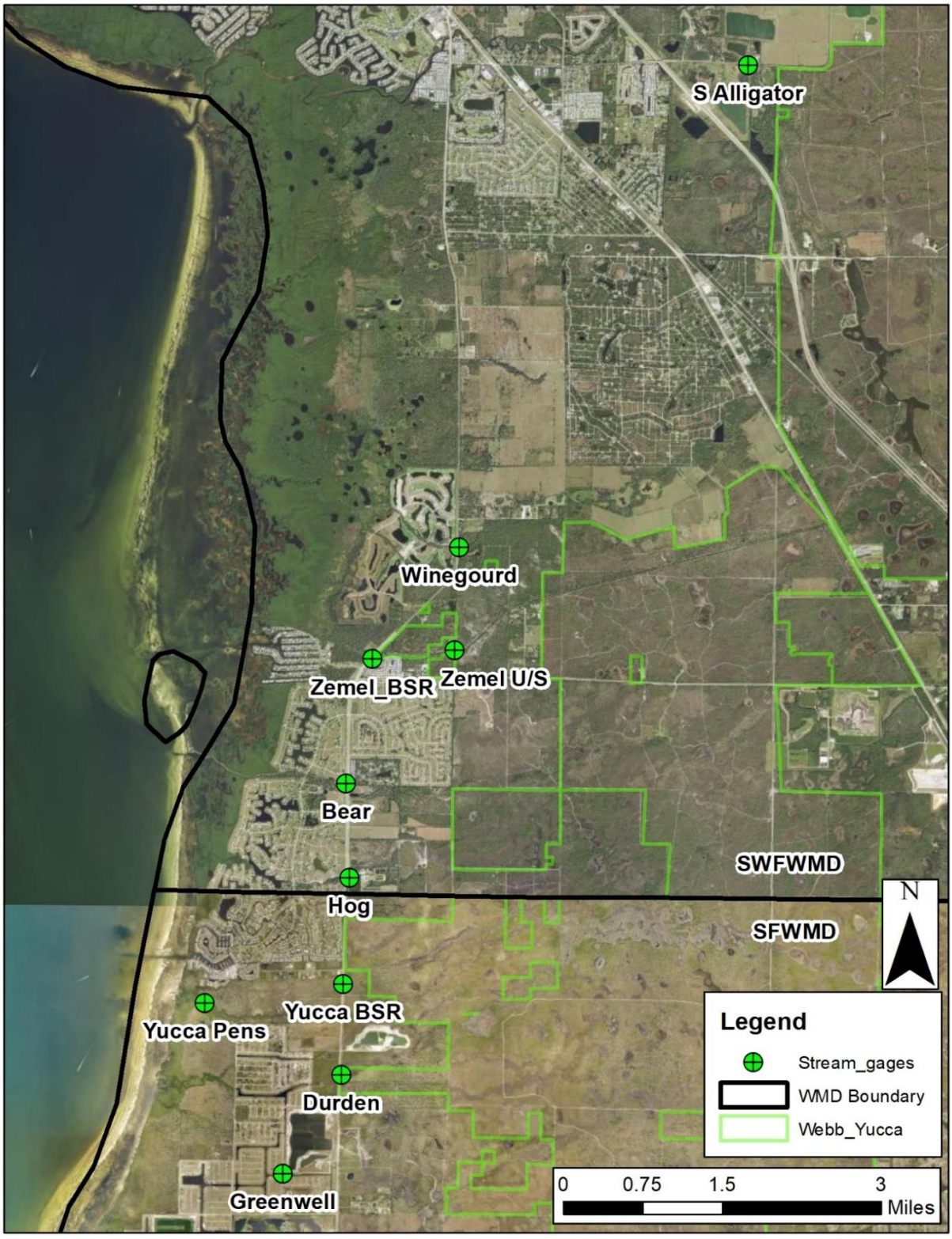


Figure 3 – Map of Installed Flow Monitoring Stations

REFERENCES

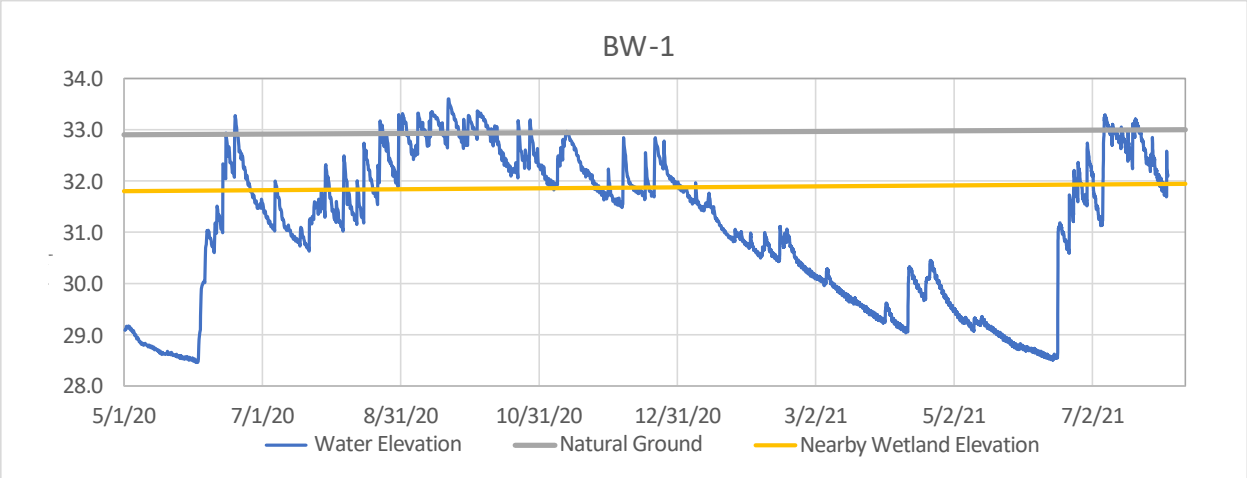
Water Science Associates. 2020. Lower Charlotte Harbor Flatwoods Hydrologic Modeling & Restoration – Groundwater Monitoring Plan. Prepared for Coastal and Heartlands National Estuary Partnership.

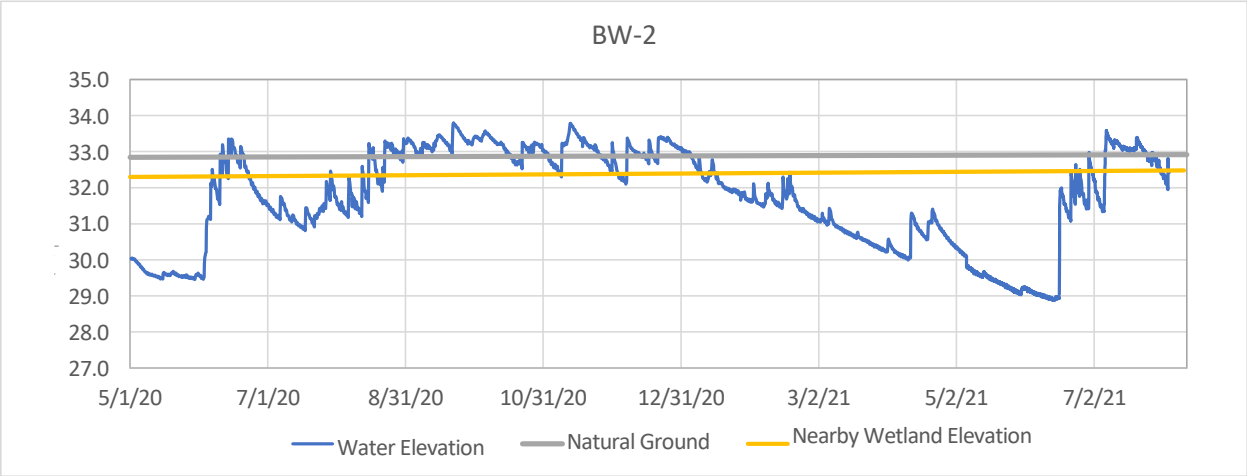
Water Science Associates. 2020. Lower Charlotte Harbor Flatwoods Hydrologic Modeling & Restoration – Flow Monitoring Plan. Prepared for Coastal and Heartlands National Estuary Partnership.

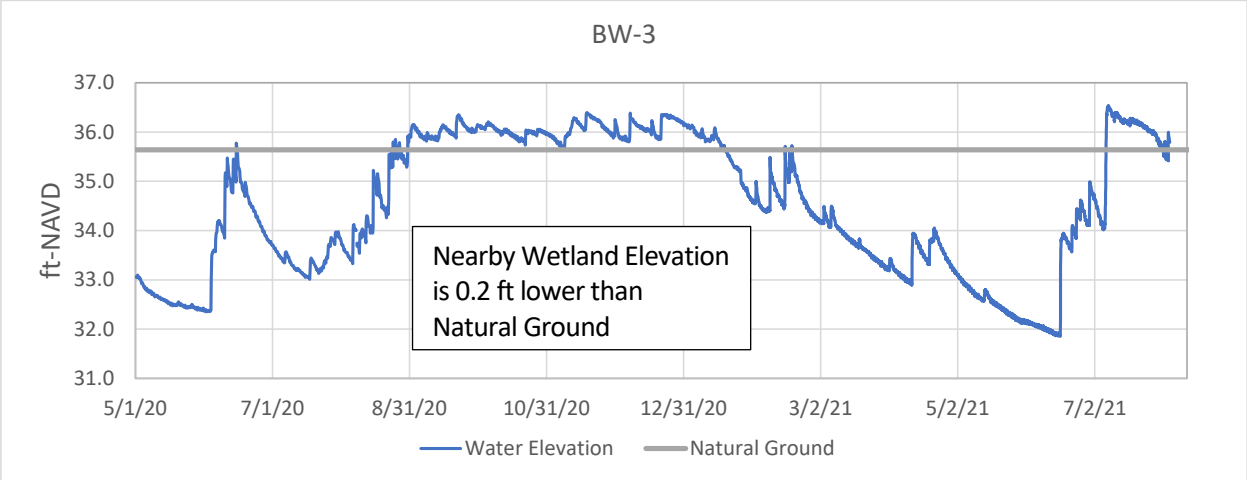
Appendix A

5th Quarter Groundwater Monitoring Station Data

Note: As mentioned on page 5. All of the graphs present the measured water levels along with a line representing the surveyed elevation of ground adjacent to the monitoring well. Most monitoring stations are located in the vicinity of wetlands, ditches, elevations of adjacent weirs and underflow gates, and the elevations of those features are provided in the graphs. The estimated wetland elevations presented in the graphs (as the yellow line) were derived from the digital elevation map that is being used in this project, with the elevations shown being based on field observations of the approximate mid-point between the wetland edge and the lowest point in the wetland. This line was added to graphs where the monitoring well was near wetlands, but installed outside and above them. The yellow line is meant to approximate the elevation that would be typically wet during the wet season (but is not an edge-of-wetland elevation.) This information was presented to provide context of the measured water level in relationship to nearby wetlands.



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Water Elevation
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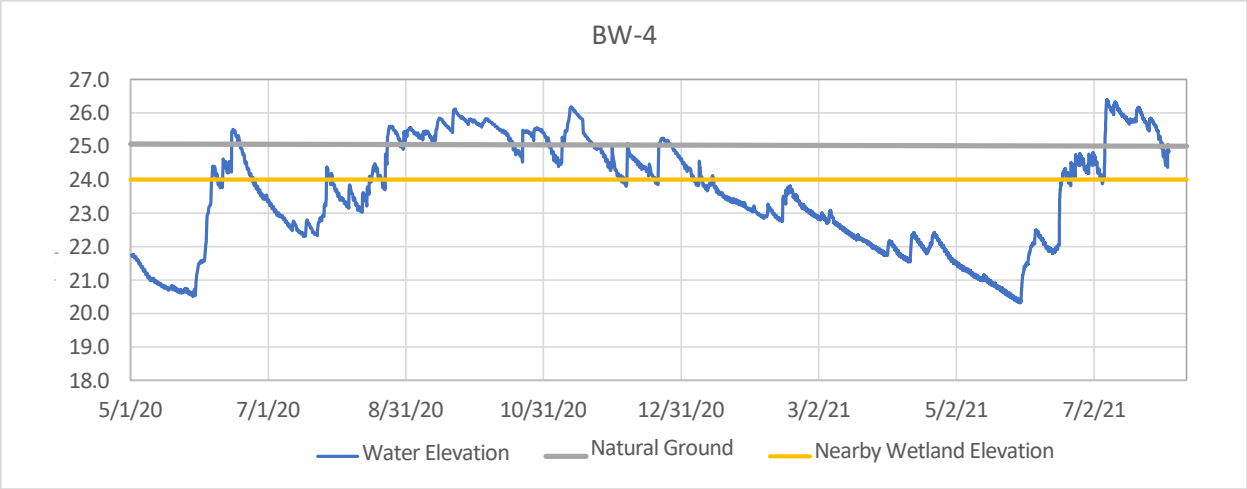
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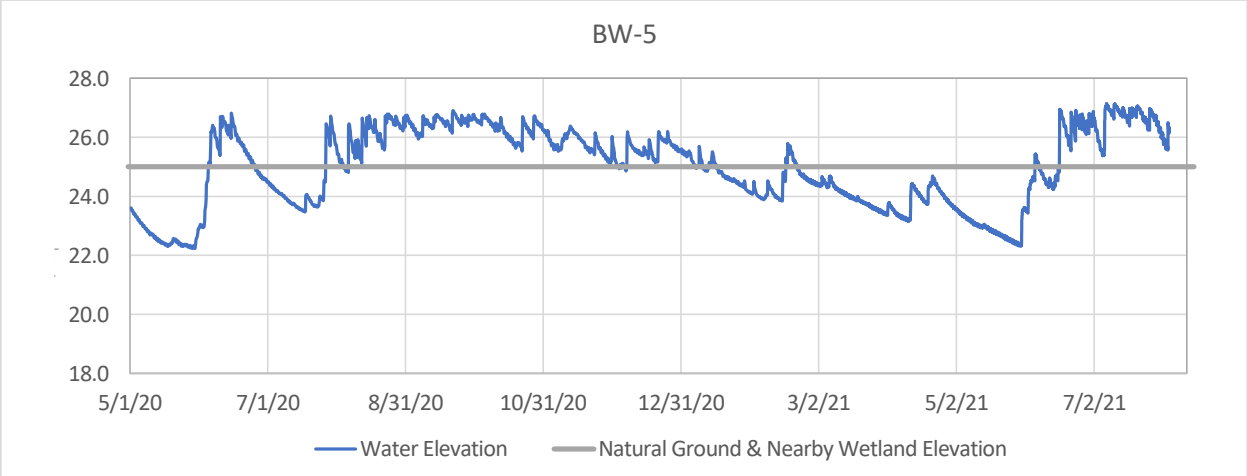
Water Elevation
Natural Ground
Nearby Wetland Elevation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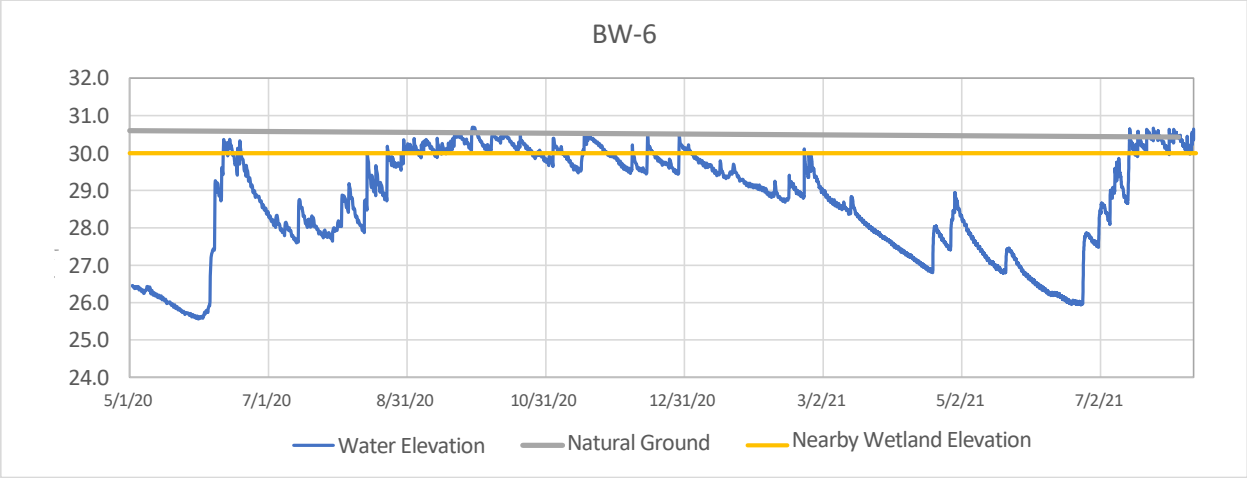
Water Elevation
Natural Ground & Nearby Wetland Elevation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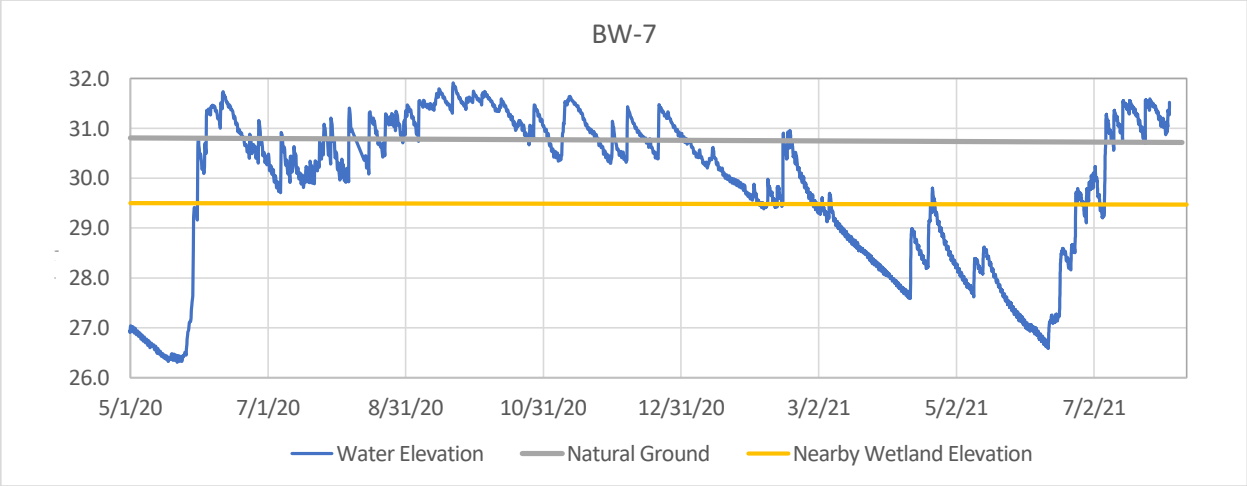
Water Elevation
Natural Ground
Nearby Wetland Elevation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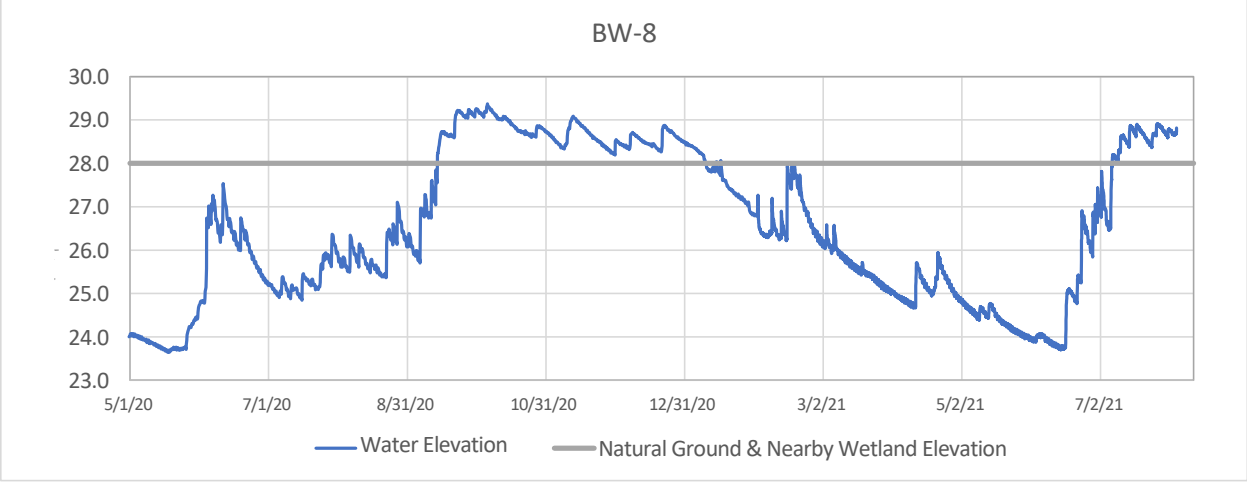
Natural Ground
Nearby Wetland Elevation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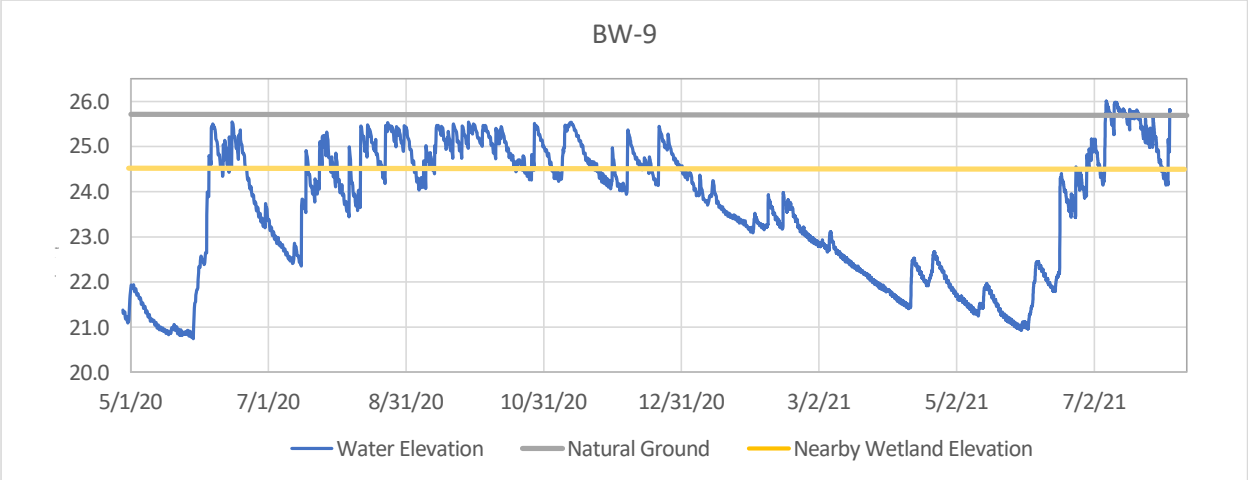
Water Elevation
Natural Ground & Nearby Wetland Elevation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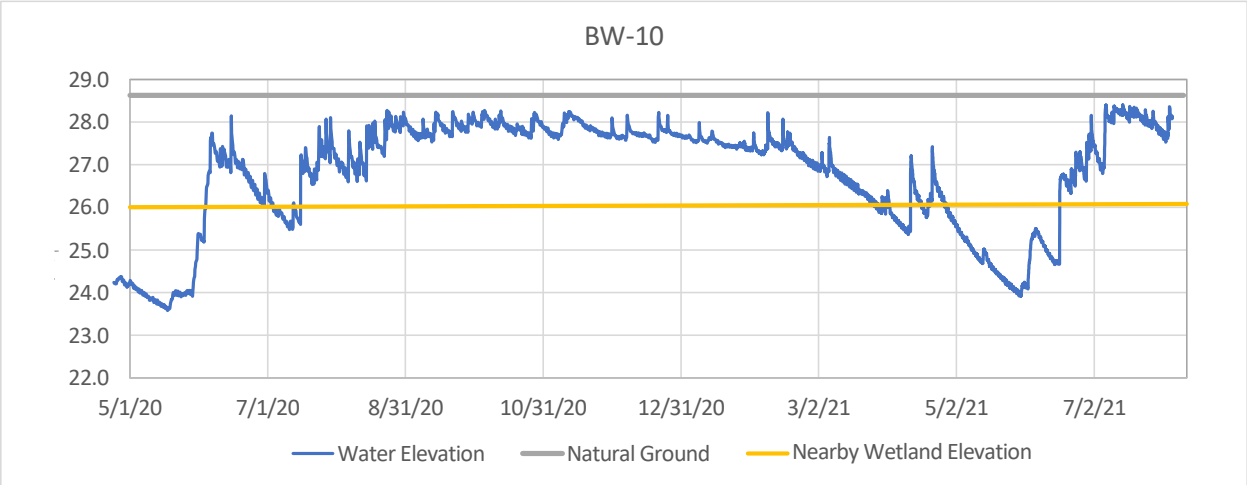
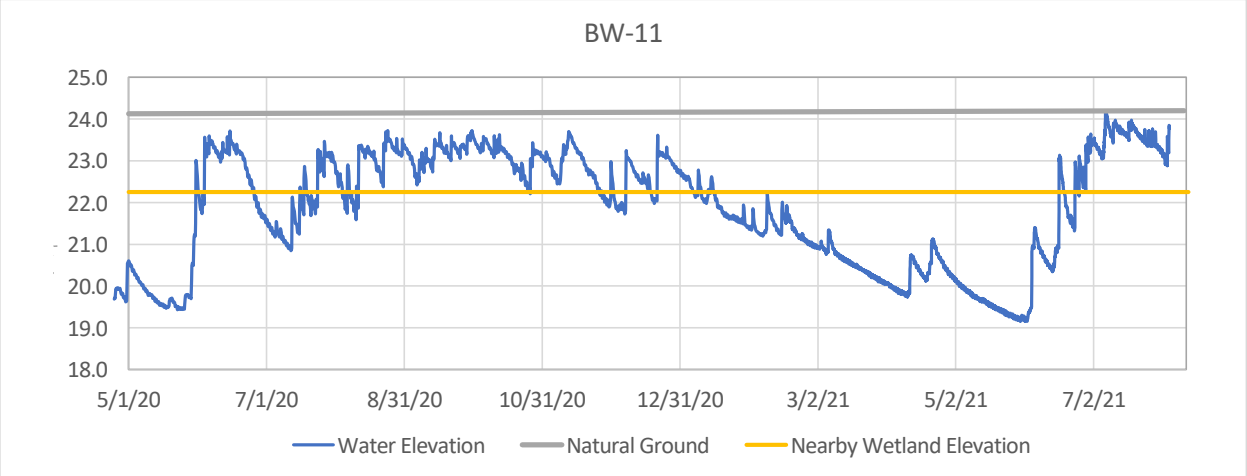
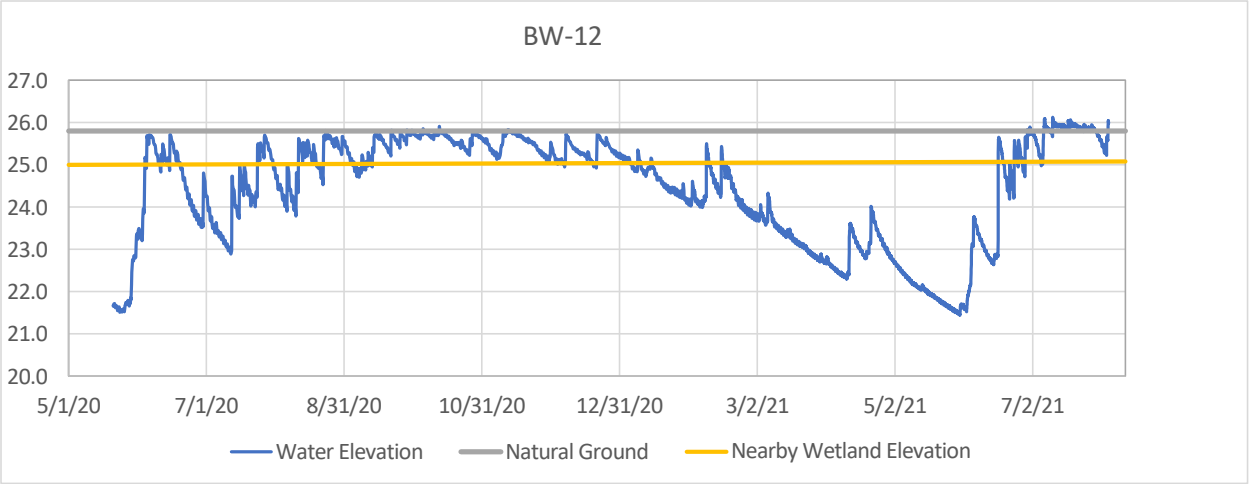
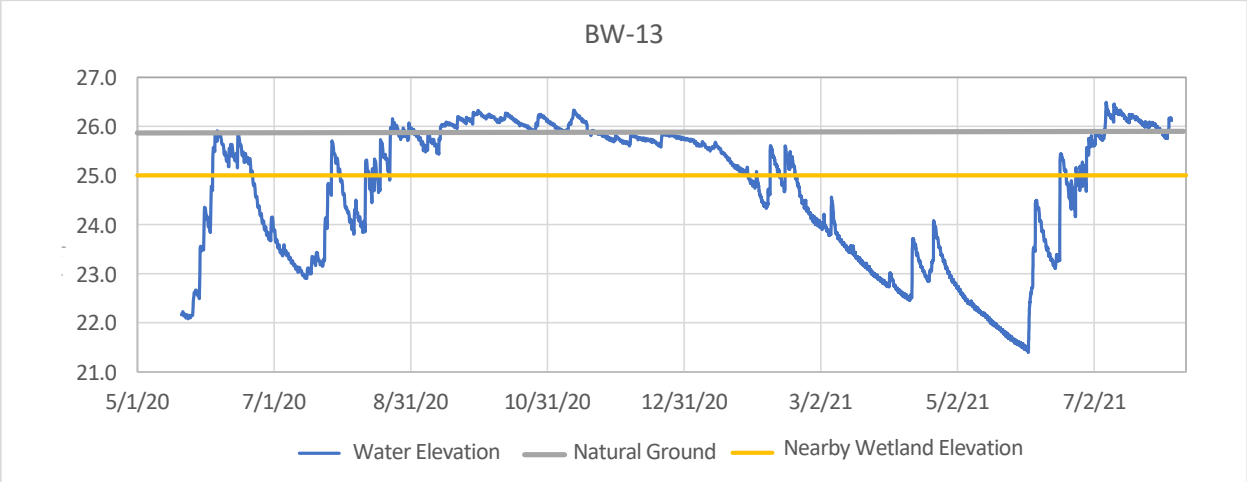
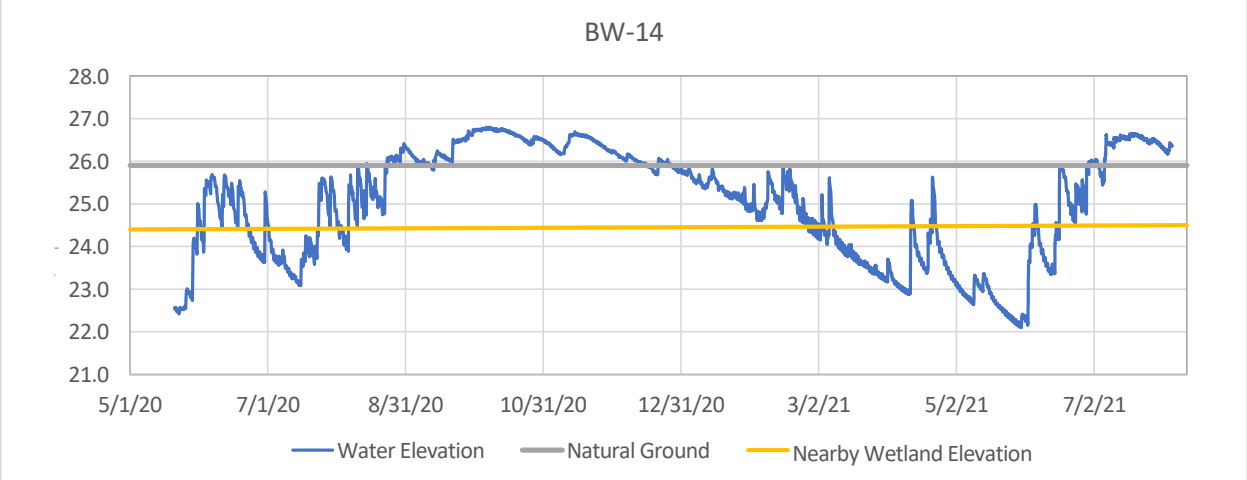
Water Elevation
Natural Ground
Nearby Wetland Elevation

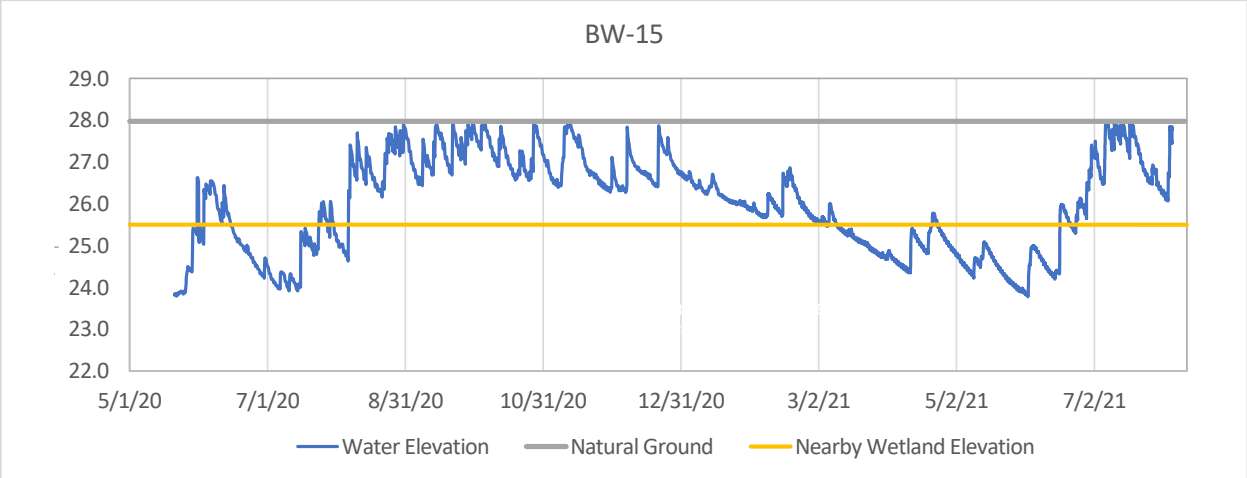

BW-10
29.0
28.0
27.0
26.0
25.0
24.0
23.0
22.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground
Nearby Wetland Elevation

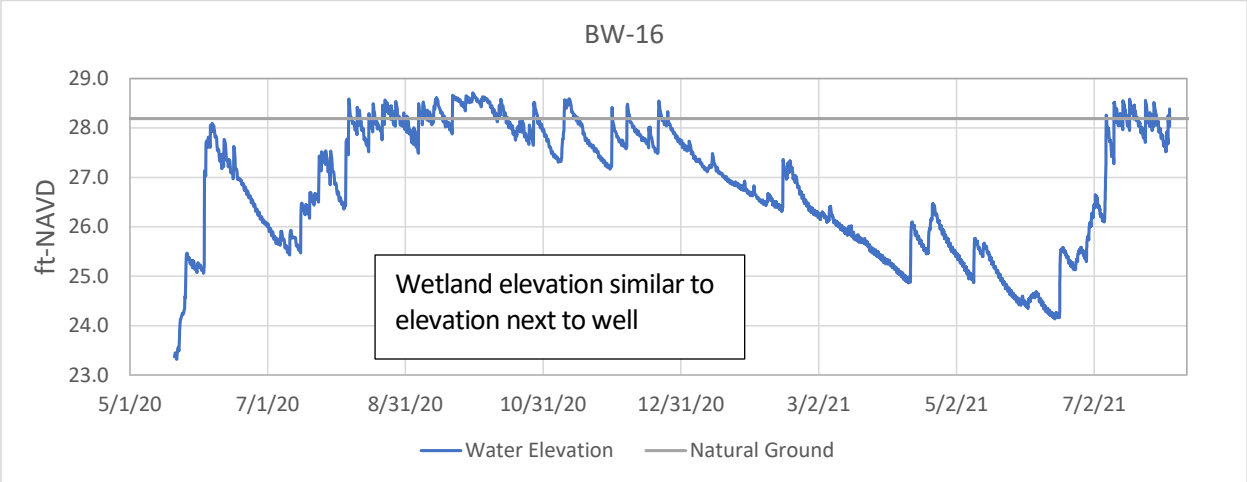

BW-11
25.0
24.0
23.0
22.0
21.0
20.0
19.0
18.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground
Nearby Wetland Elevation

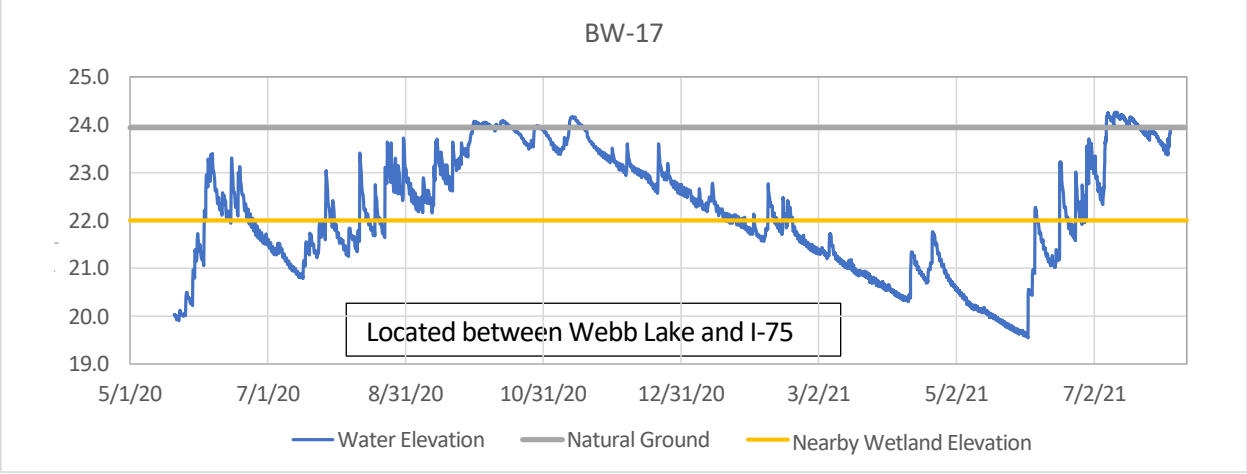

BW-12
27.0
26.0
25.0
24.0
23.0
22.0
21.0
20.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground
Nearby Wetland Elevation

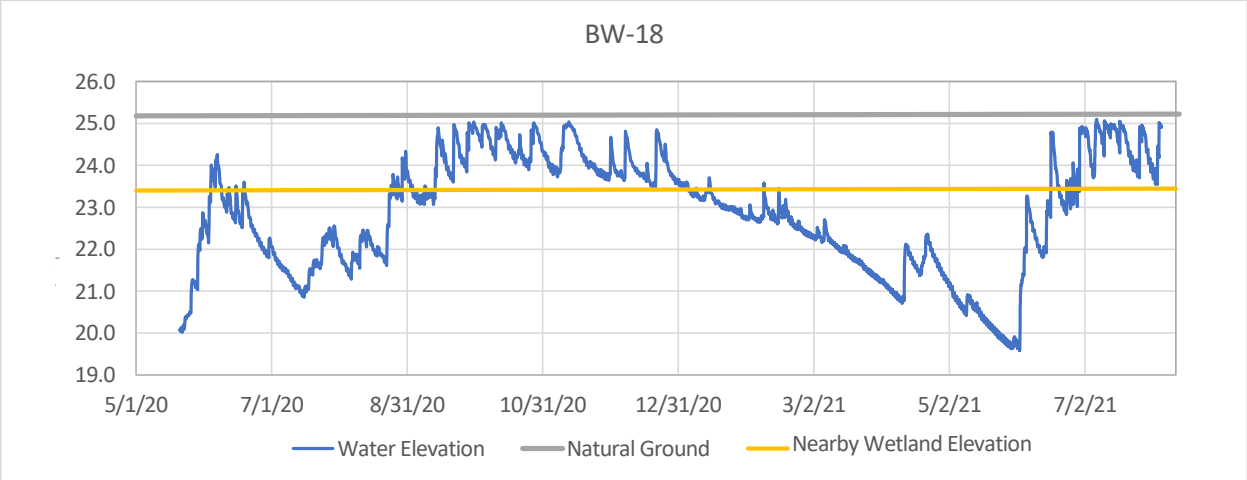

BW-13
27.0
26.0
25.0
24.0
23.0
22.0
21.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground
Nearby Wetland Elevation

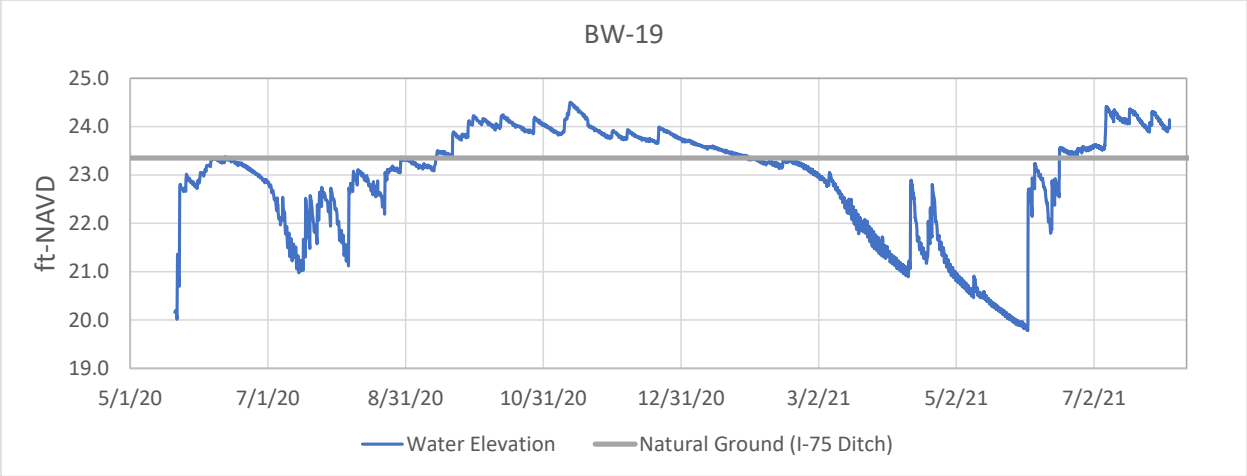

BW-14
28.0
27.0
26.0
25.0
24.0
23.0
22.0
21.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground
Nearby Wetland Elevation

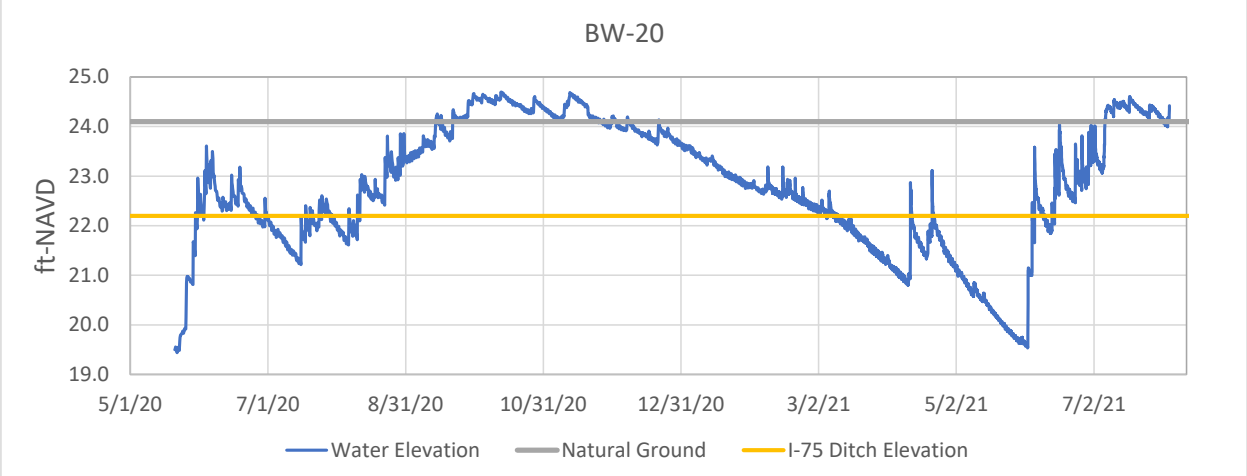

BW-15
29.0
28.0
27.0
26.0
25.0
24.0
23.0
22.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground
Nearby Wetland Elevation

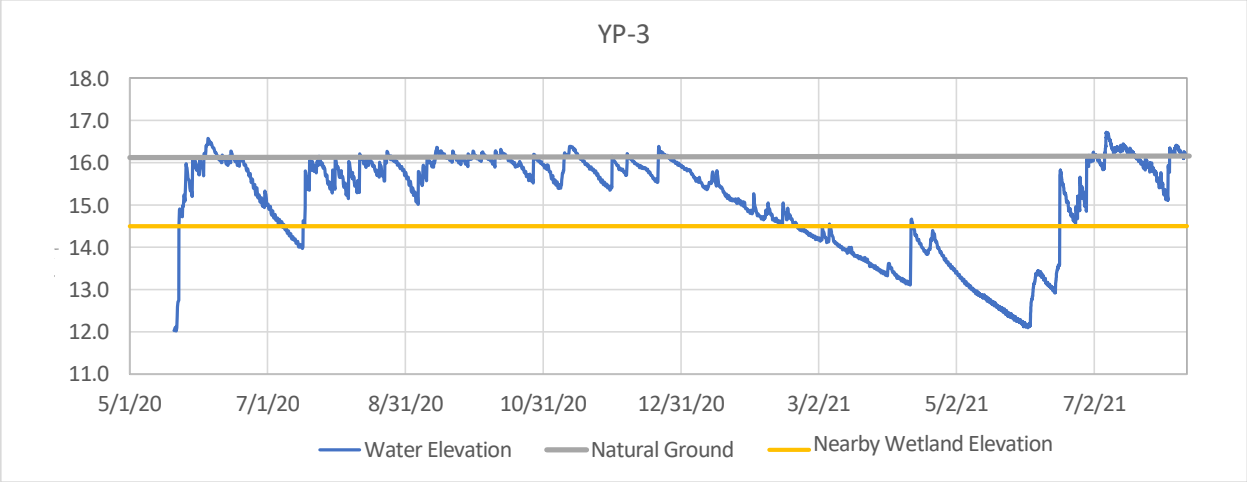

BW-16
ft-NAVD
29.0
28.0
27.0
26.0
25.0
24.0
23.0
Wetland elevation similar to elevation next to well
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground

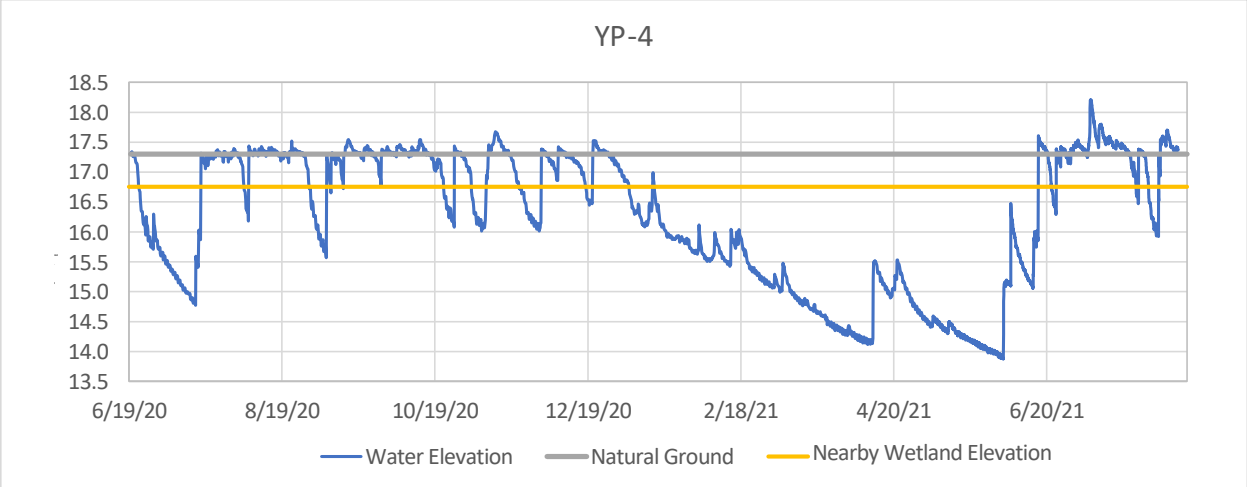

BW-17
25.0
24.0
23.0
22.0
21.0
20.0
19.0
Located between Webb Lake and I-75
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground
Nearby Wetland Elevation

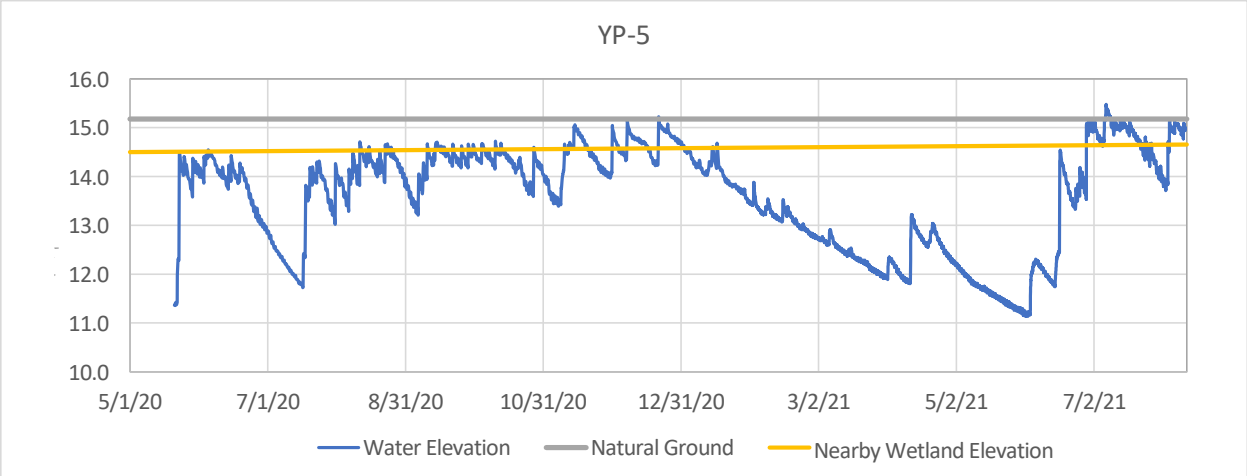

BW-18
26.0
25.0
24.0
23.0
22.0
21.0
20.0
19.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground
Nearby Wetland Elevation

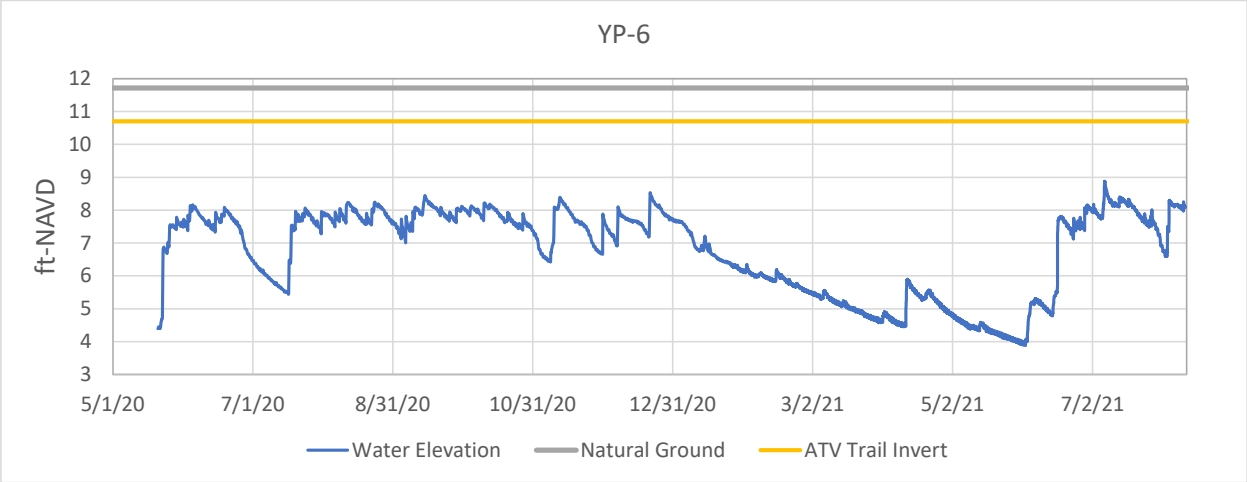

BW-19
ft-NAVD
25.0
24.0
23.0
22.0
21.0
20.0
19.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground (I-75 Ditch)


BW-20
ft-NAVD
25.0
24.0
23.0
22.0
21.0
20.0
19.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground
I-75 Ditch Elevation

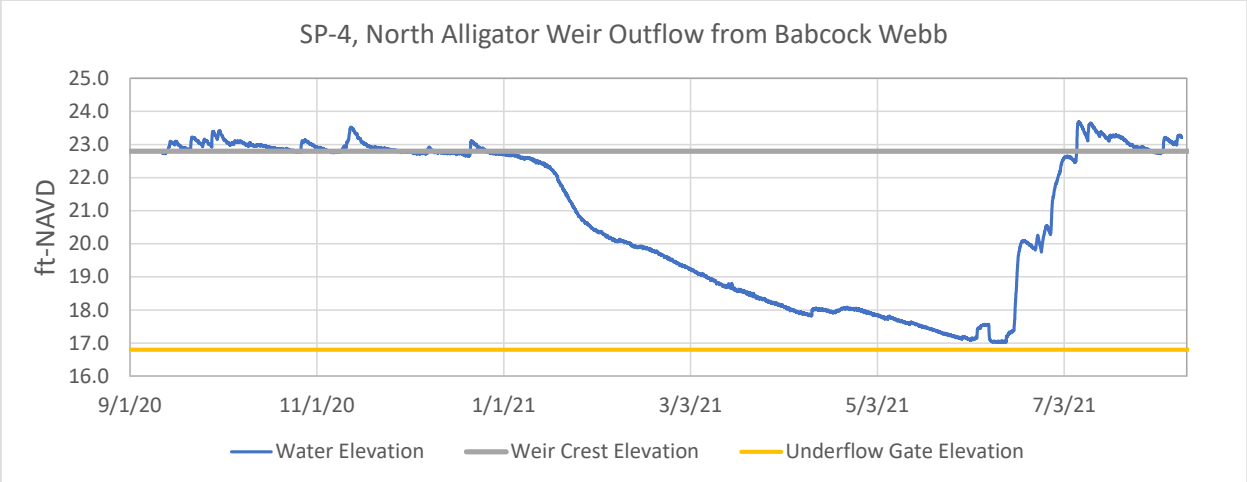

YP-3
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground
Nearby Wetland Elevation

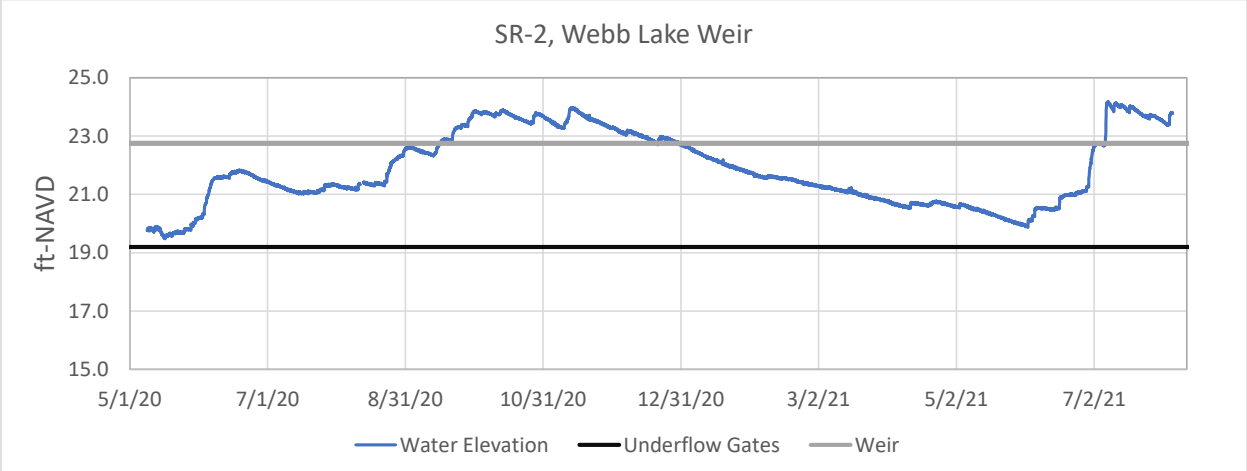

YP-4
18.5
18.0
17.5
17.0
16.5
16.0
15.5
15.0
14.5
14.0
13.5
6/19/20
8/19/20
10/19/20
12/19/20
2/18/21
4/20/21
6/20/21
Water Elevation
Natural Ground
Nearby Wetland Elevation

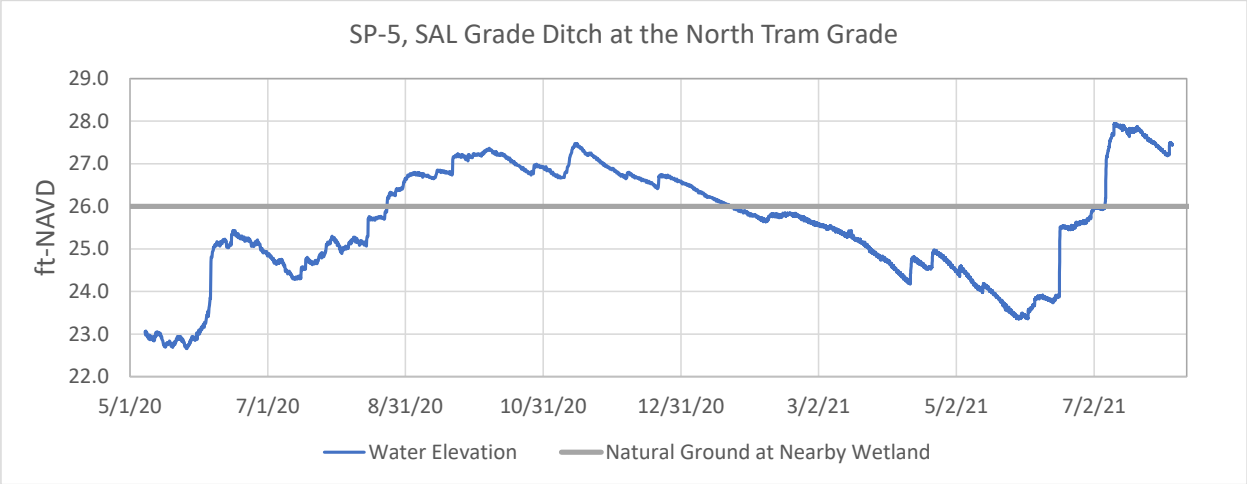

YP-5
16.0
15.0
14.0
13.0
12.0
11.0
10.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground
Nearby Wetland Elevation

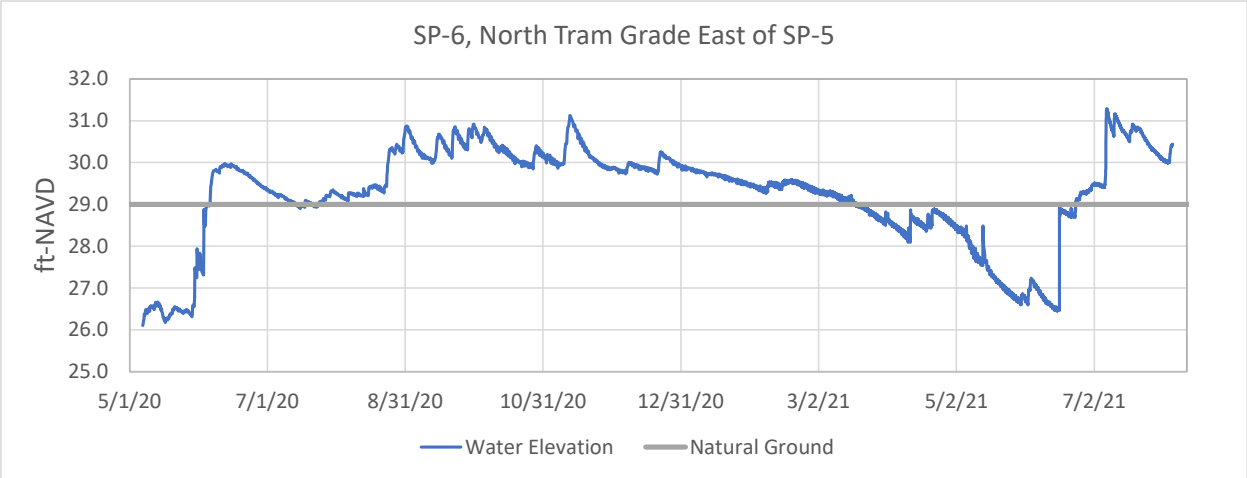


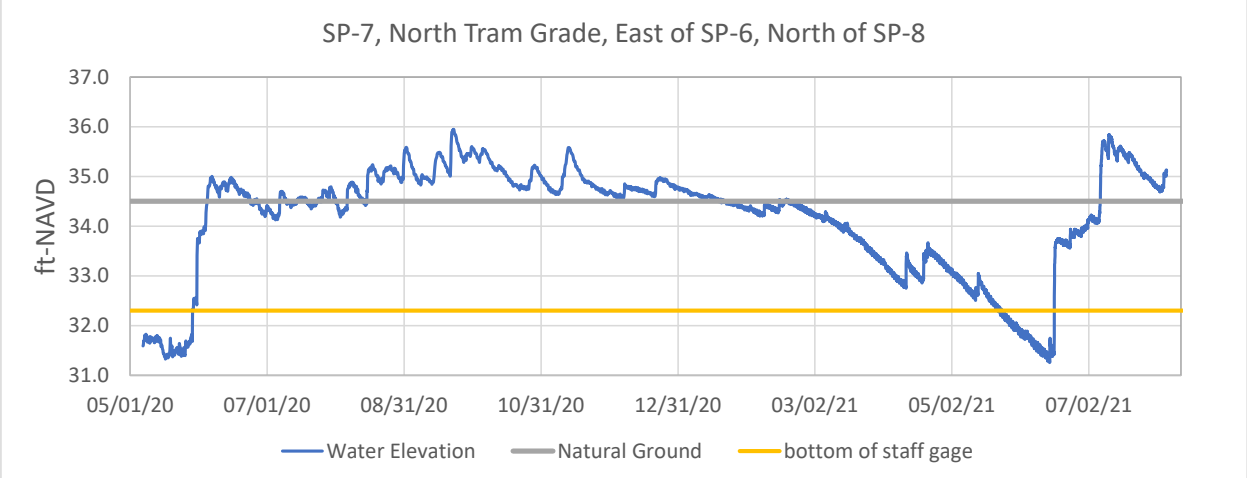
Note: The time series at SP-4 is shorter than at other stations because this station was vandalized

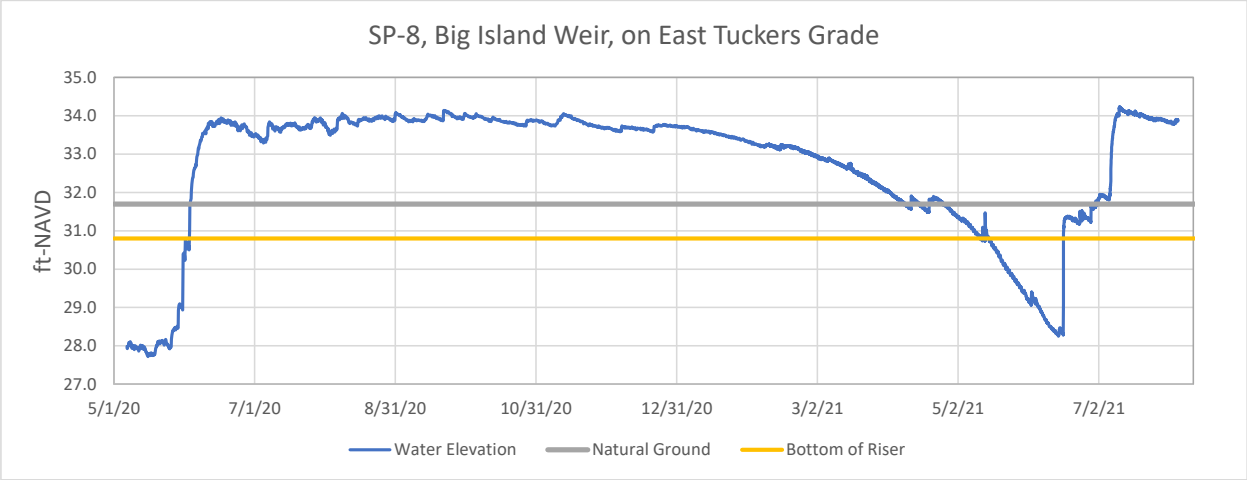


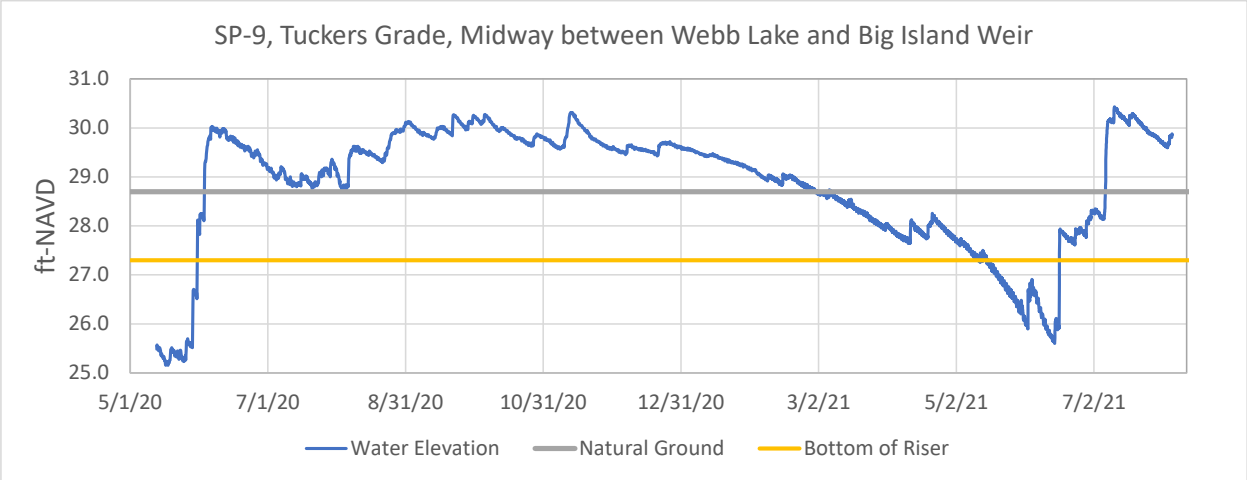


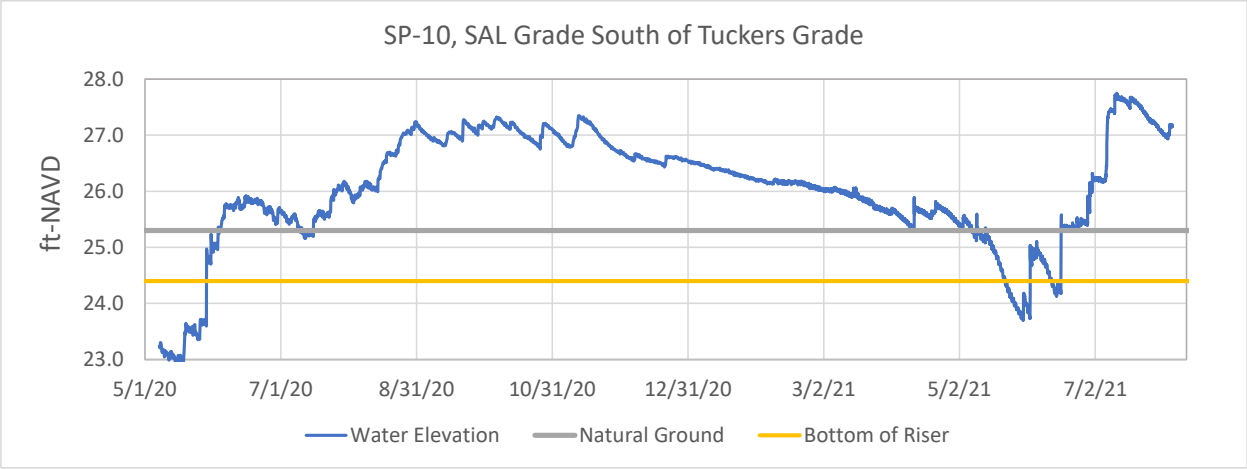

SP-5, SAL Grade Ditch at the North Tram Grade
ft-NAVD
29.0
28.0
27.0
26.0
25.0
24.0
23.0
22.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground at Nearby Wetland


SP-6, North Tram Grade East of SP-5
ft-NAVD
32.0
31.0
30.0
29.0
28.0
27.0
26.0
25.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground


SP-7, North Tram Grade, East of SP-6, North of SP-8
ft-NAVD
37.0
36.0
35.0
34.0
33.0
32.0
31.0
05/01/20
07/01/20
08/31/20
10/31/20
12/31/20
03/02/21
05/02/21
07/02/21
Water Elevation
Natural Ground
bottom of staff gage

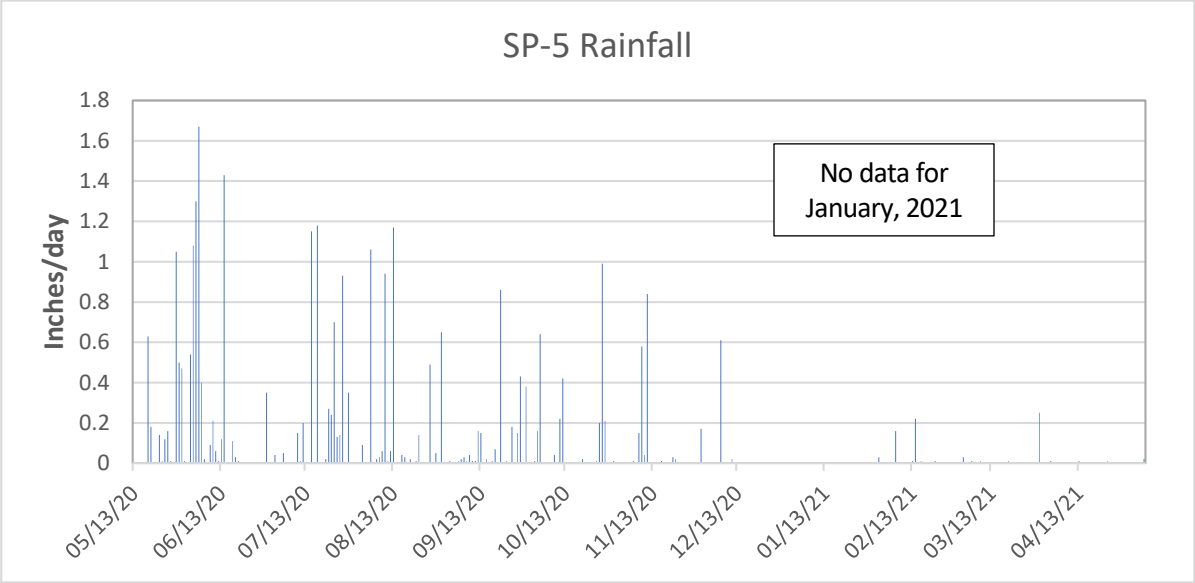

SP-8, Big Island Weir, on East Tuckers Grade
ft-NAVD
35.0
34.0
33.0
32.0
31.0
30.0
29.0
28.0
27.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground
Bottom of Riser

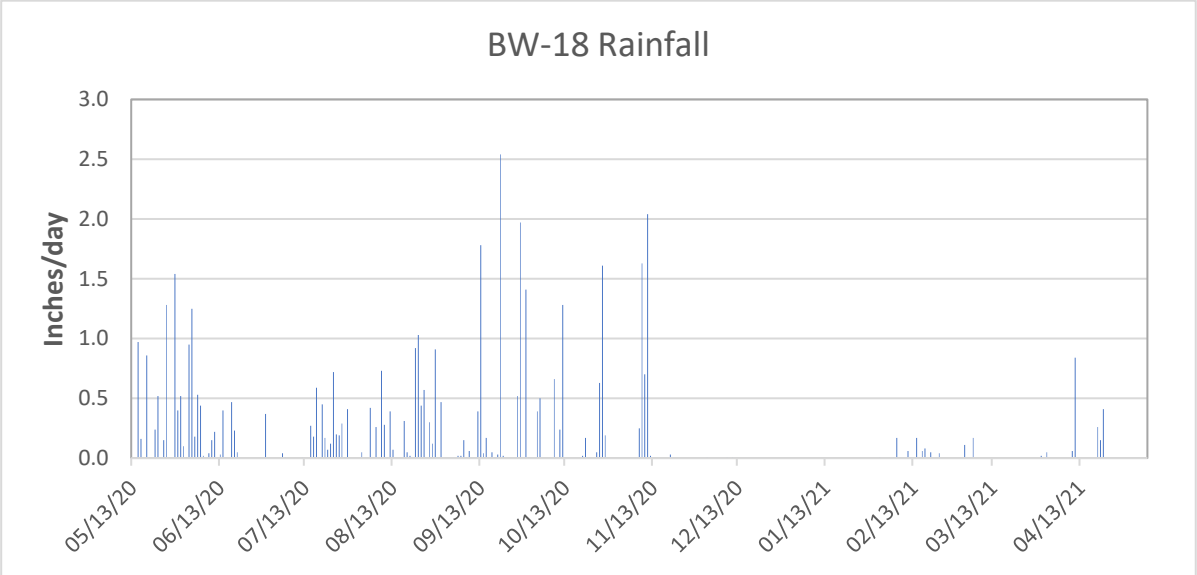

SP-9, Tuckers Grade, Midway between Webb Lake and Big Island Weir
ft-NAVD
31.0
30.0
29.0
28.0
27.0
26.0
25.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground
Bottom of Riser

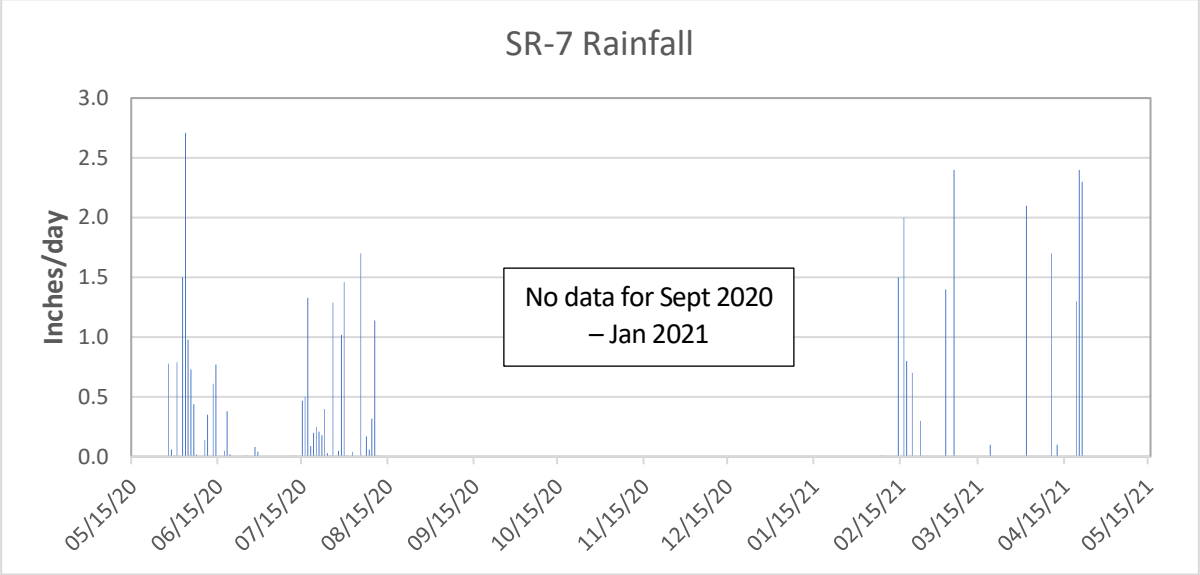

SP-10, SAL Grade South of Tuckers Grade
ft-NAVD
28.0
27.0
26.0
25.0
24.0
23.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
7/2/21
Water Elevation
Natural Ground
Bottom of Riser

Appendix B

5th Quarter Rain Gage Data


SP-5 Rainfall
Inches/day
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
No data for January, 2021
05/13/20
06/13/20
07/13/20
08/13/20
09/13/20
10/13/20
11/13/20
12/13/20
01/13/21
02/13/21
03/13/21
04/13/21


BW-18 Rainfall
Inches/day
3.0
2.5
2.0
1.5
1.0
0.5
0.0
05/13/20
06/13/20
07/13/20
08/13/20
09/13/20
10/13/20
11/13/20
12/13/20
01/13/21
02/13/21
03/13/21
04/13/21


SR-7 Rainfall
Inches/day
3.0
2.5
2.0
1.5
1.0
0.5
0.0
No data for Sept 2020 – Jan 2021
05/15/20
06/15/20
07/15/20
08/15/20
09/15/20
10/15/20
11/15/20
12/15/20
01/15/21
02/15/21
03/15/21
04/15/21
05/15/21

Comparison of Monthly Rainfall Amounts from Other Rainfall Stations to Rainfall Data for BW-18_R, SR-7_R, and SP-5_R

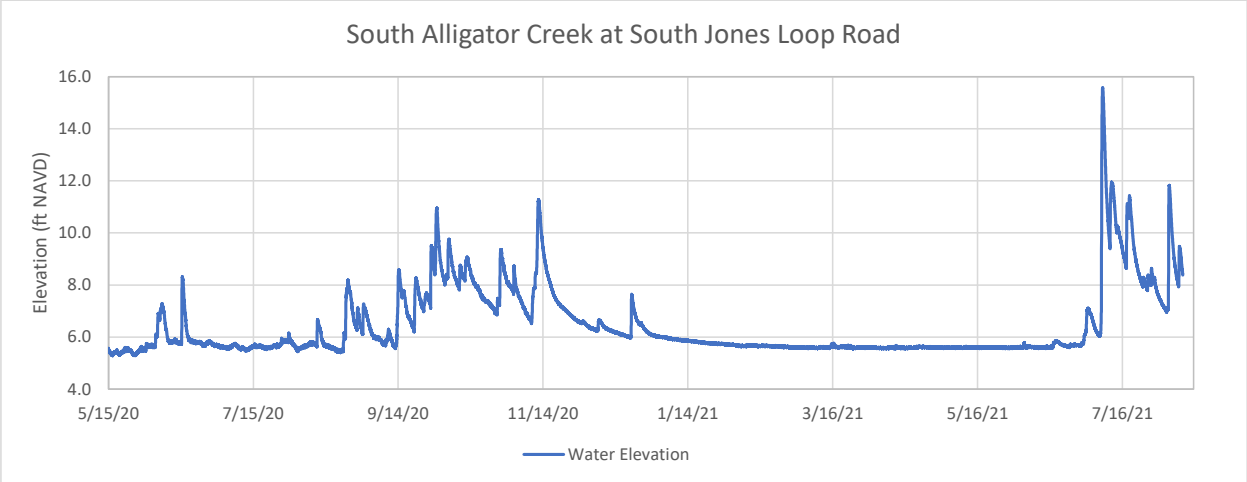
Month	Lake Fairways	Popash Ck	Yellow Fev Ck	Big Is Weir	BSR FS #7	CW RG-1	CW RG-2	CW RG-3	N_Char	ROMP TR 1-2	Weir 19	Weir 4
5/31/2020	9.06	5.88	3.99	5.53	7.11	7.59	6.11	6.55	8.03	5.6	7.99	2.49
6/30/2020	9.73	5.96	8.48	5.18	11.21	7.26	7.89	6.48	8.05	6.94	8.7	N/A
7/31/2020	5.39	5.38	4.59	3.82	5.71	6.37	6.43	5.81	4.57	4.34	8	N/A
8/31/2020	7.9	6.11	7.93	7.32	4.89	8.99	9.73	8.23	4.86	9.41	8.51	N/A
9/30/2020	8.26	16.75	10.03	10.42	9.78	8.23	8.37	11.29	9.89	5.73	8.8	N/A
10/31/2020	5.02	5.23	3.73	3.94	3.44	6.32	4.31	4.8	4.26	4.97	5.13	3.98
11/30/2020	6.72	6.76	5.37	4.44	4.53	4.5	4.33	3.97	5.18	4.48	7.08	0.11
12/31/2020	4.5	4.29	2.55	2.81	4.08	3.07	2.63	3.37	4.19	3.06	4.7	1.24
1/31/2021	0.25	0.22	0.22	0.18	0.19	0.39	0.24	0.2	0.13	0.33	0.21	0.19
2/28/2021	1.32	2.13	1.05	1.85	0.39	1.23	2.04	1.32	0.81	1.09	0.83	0.65
3/31/2021	0.87	0.89	0.47	0.58	0.28	0.47	0.45	0.44	0.42	0.37	0.84	0.55
4/30/2021	4.1	3.74	2.9	4.87	3.14	3.62	3.44	3.31	3.61	3.2	3.95	3.01

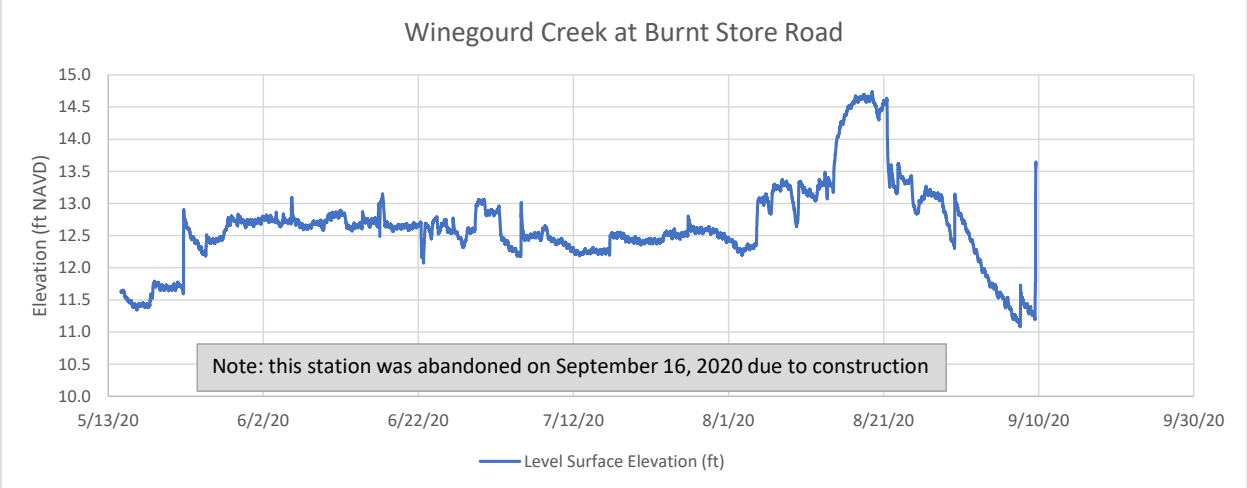
Month	Avg of Other Gages	BW-18_R	SR-7_R	SP-5_R
5/31/2020	6.33	6.76	1.64	3.28
6/30/2020	7.81	5.35	8.83	7.43
7/31/2020	5.49	3.73	7.51	5.56
8/31/2020	7.63	7.36	3.44	4.87
9/30/2020	9.78	9.20	N/A	2.56
10/31/2020	4.59	5.74	N/A	2.93
11/30/2020	4.79	4.67	N/A	1.85
12/31/2020	3.37	0.03	N/A	0.63
1/31/2021	0.23	0.00	N/A	N/A
2/28/2021	1.23	0.65	NR	0.44
3/31/2021	0.55	0.30	NR	0.31
4/30/2021	3.57	1.78	NR	0.03

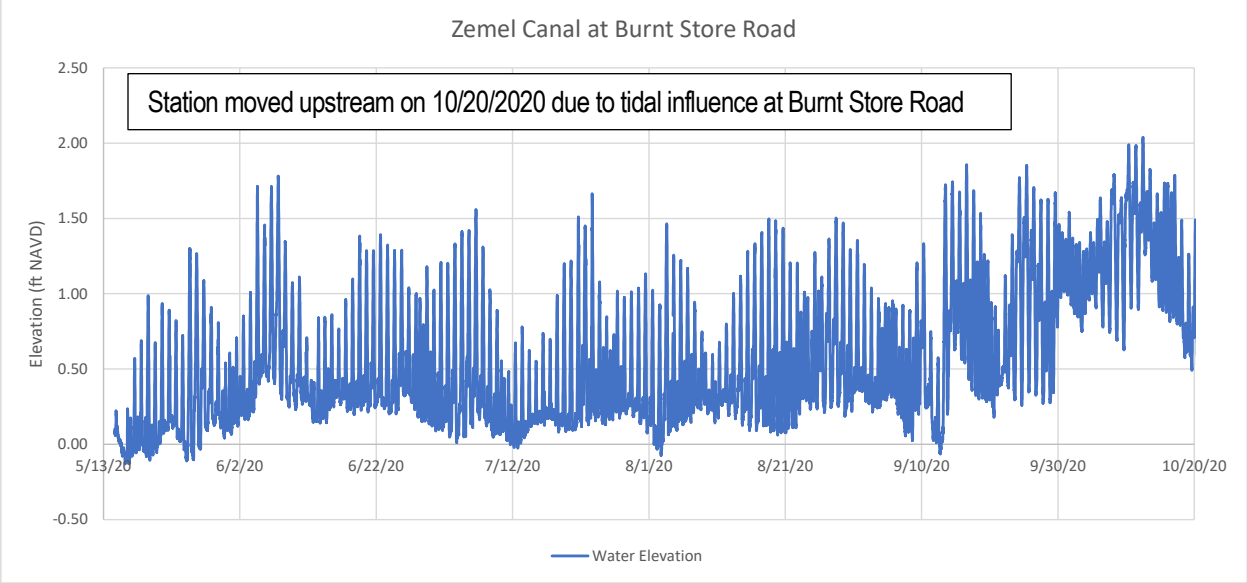
Appendix C

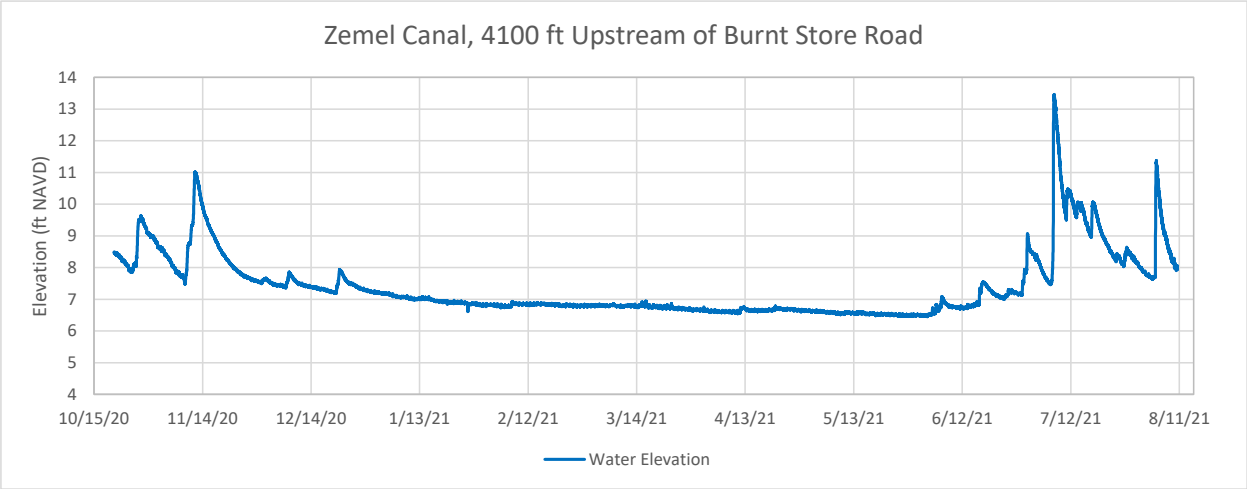
5th Quarter Flow Monitoring Station Data

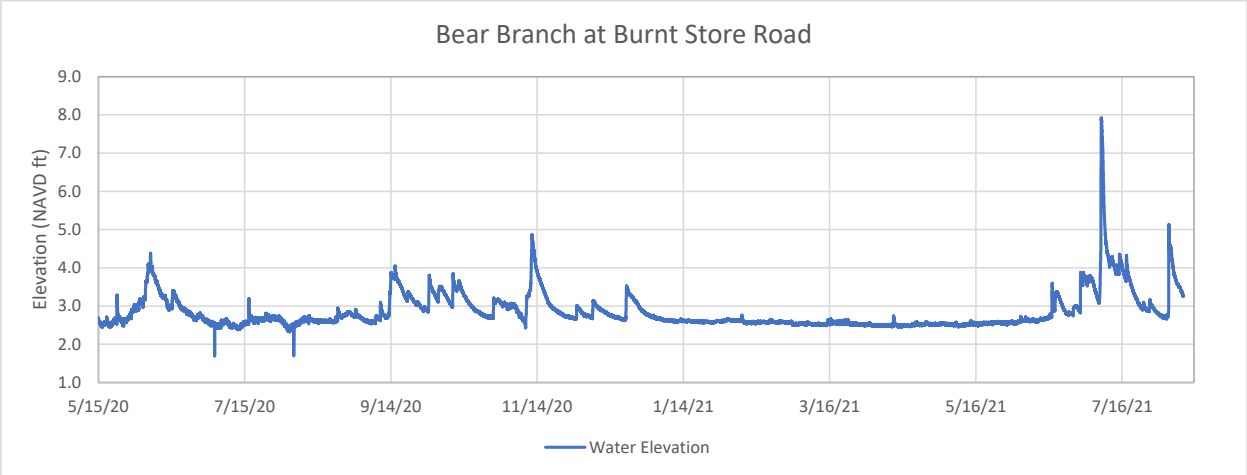
The graphs presented below provide measured water level data at flow monitoring stations. Measured water levels will be used with the final stage/discharge equations to estimate flows at the flow monitoring stations. Provisional flow rating curves are presented in graphs following the graphs of measured stage data. The stage/discharge data collected to date are presented below in the table **CHNEP – Discharge Measurement Summary**.

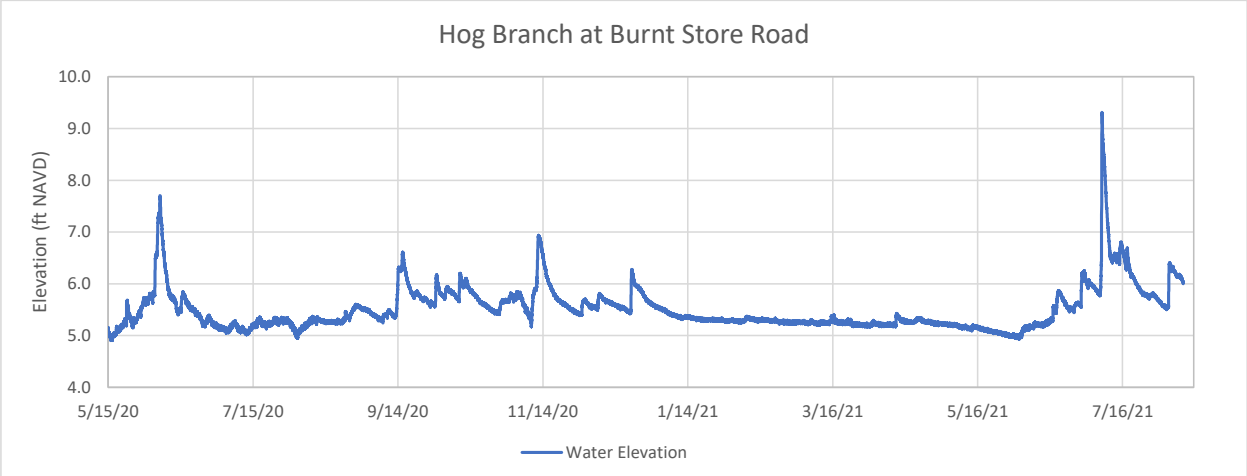




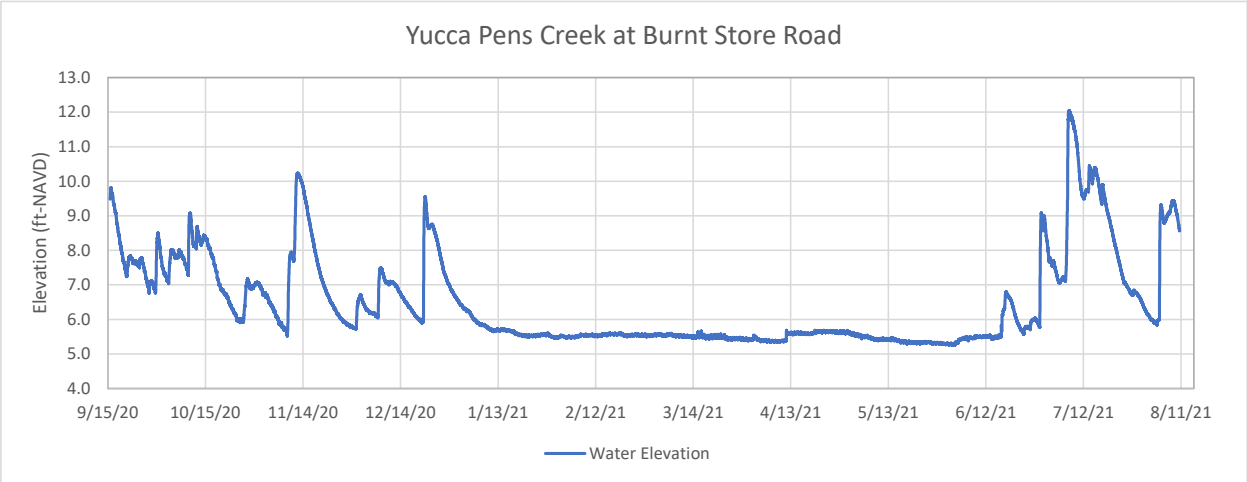


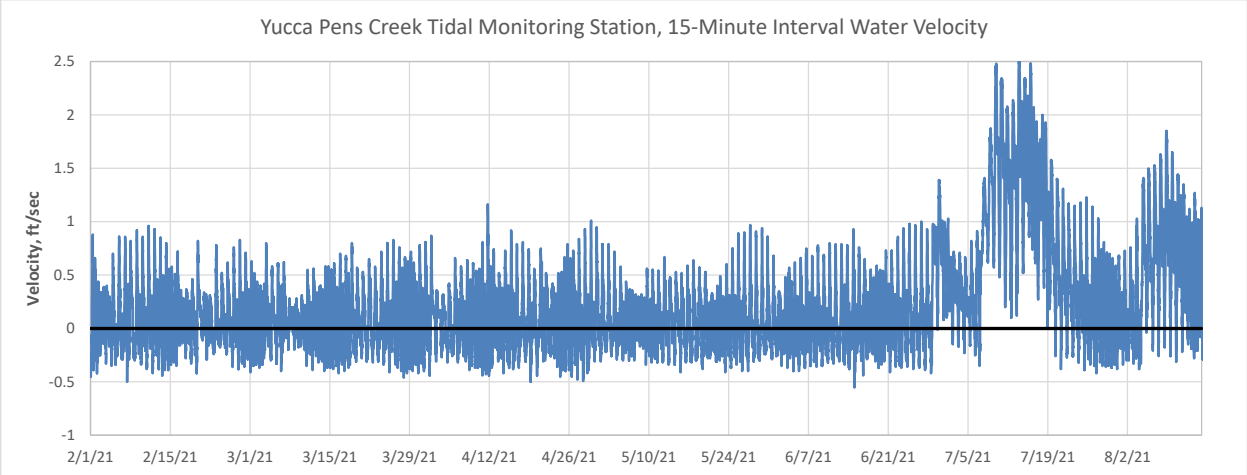

Zemel Canal, 4100 ft Upstream of Burnt Store Road
Elevation (ft NAVD)
14
13
12
11
10
9
8
7
6
5
4
10/15/20
11/14/20
12/14/20
1/13/21
2/12/21
3/14/21
4/13/21
5/13/21
6/12/21
7/12/21
8/11/21
Water Elevation

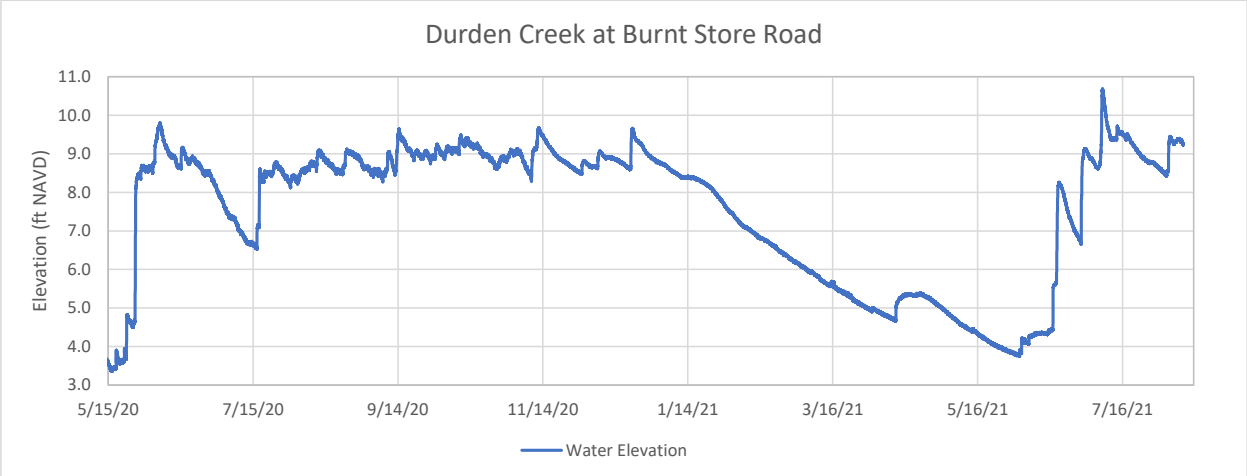

Bear Branch at Burnt Store Road
Elevation (NAVD ft)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
5/15/20
7/15/20
9/14/20
11/14/20
1/14/21
3/16/21
5/16/21
7/16/21
Water Elevation

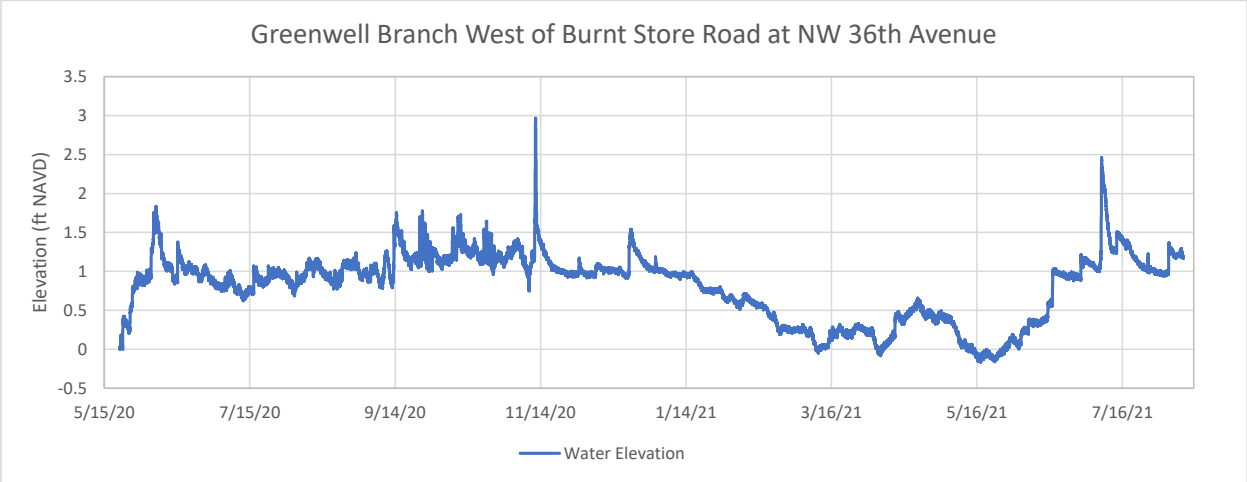

Hog Branch at Burnt Store Road
Elevation (ft NAVD)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
5/15/20
7/15/20
9/14/20
11/14/20
1/14/21
3/16/21
5/16/21
7/16/21
Water Elevation

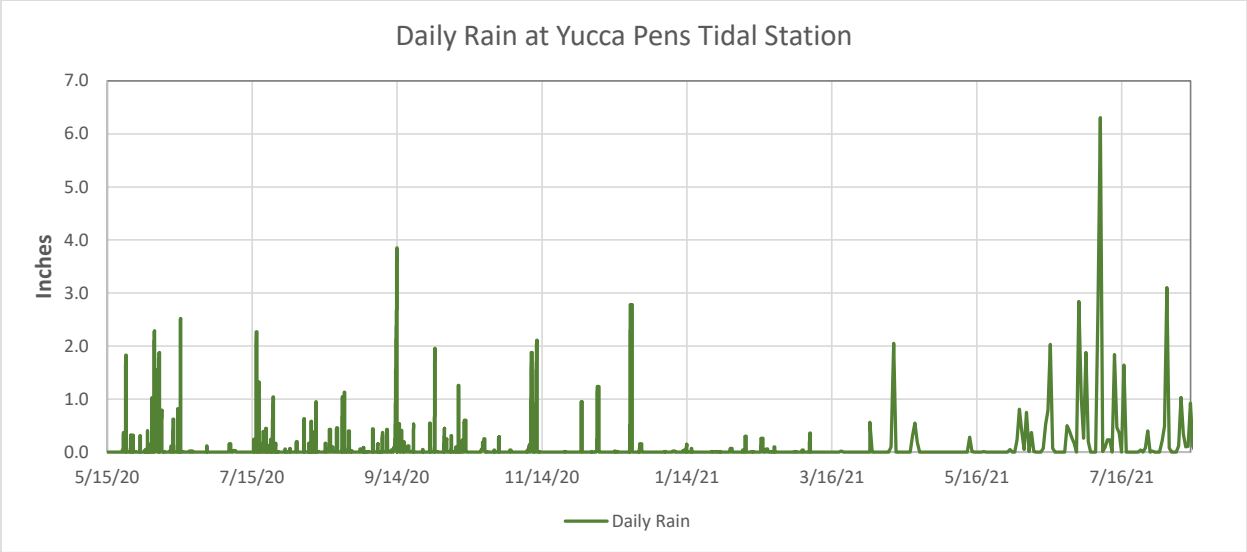
Note that the period of record for Yucca Pens Creek at Burnt Store Road is shorter than for other stations since this station was established using equipment that was at Winegourd Creek.



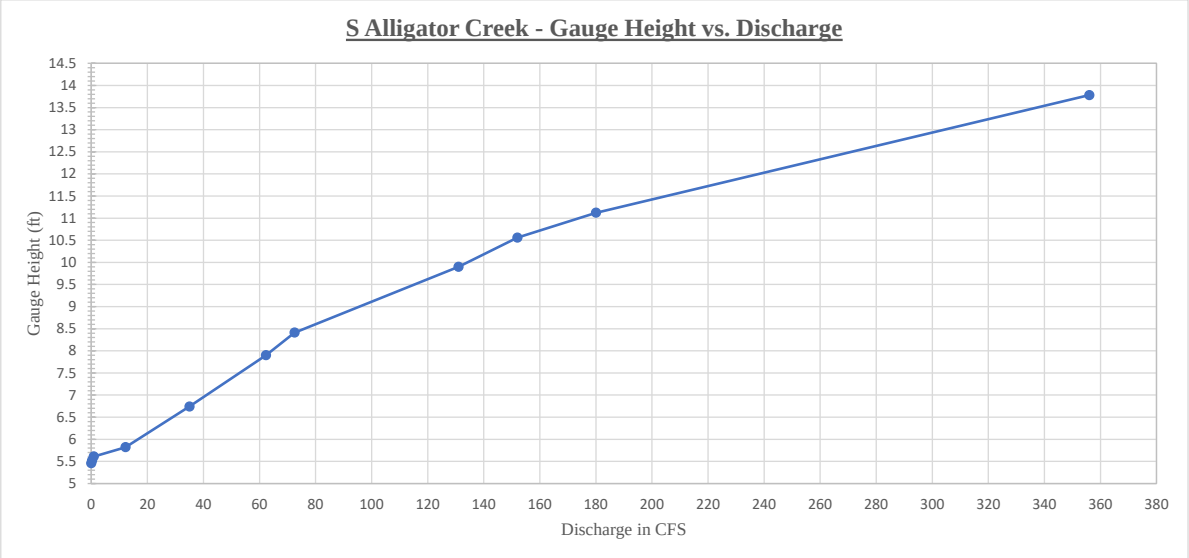


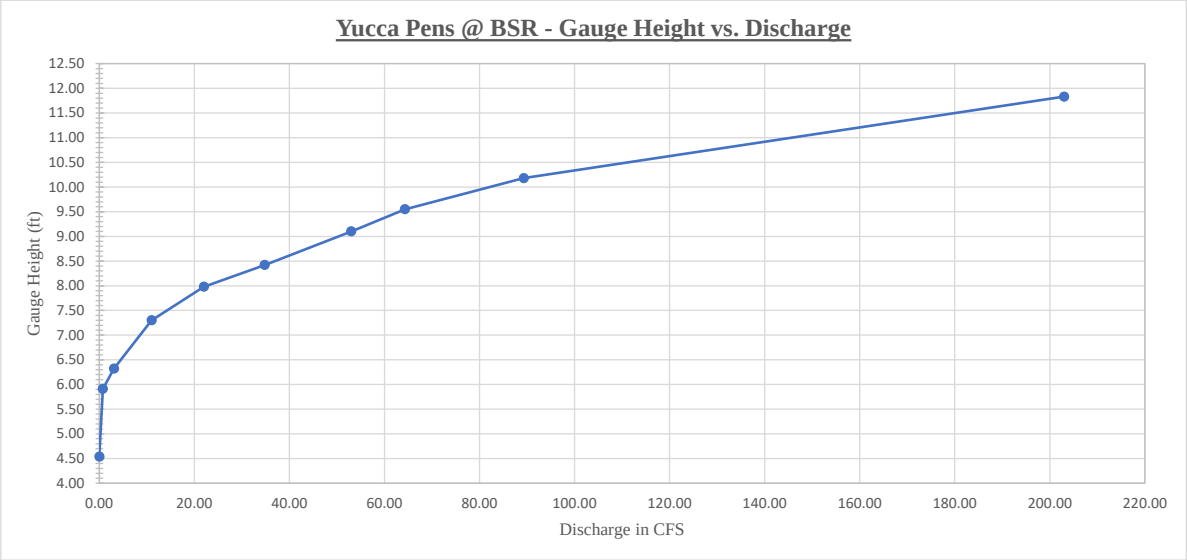


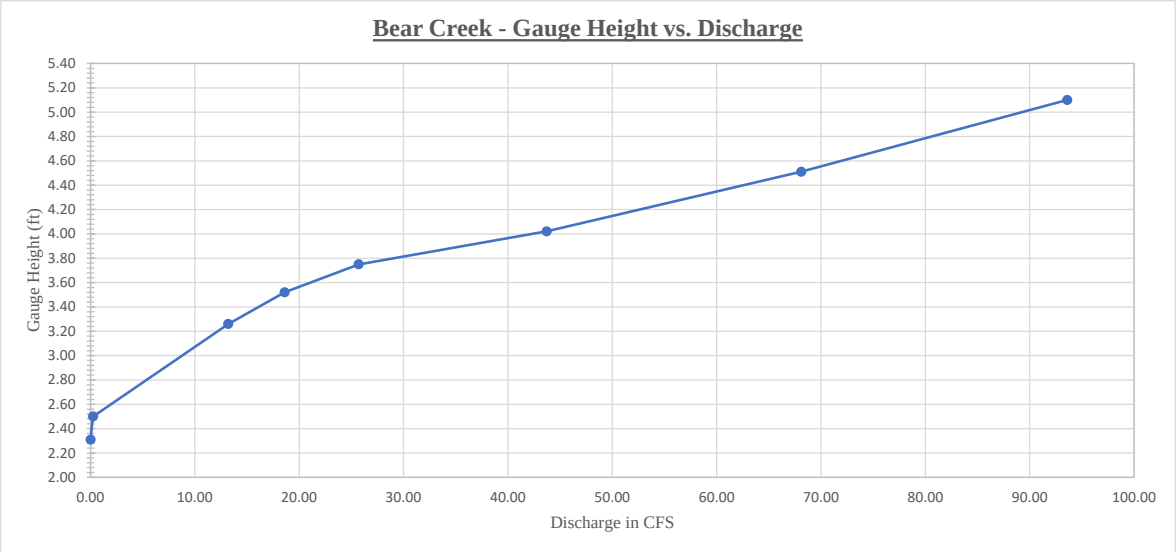


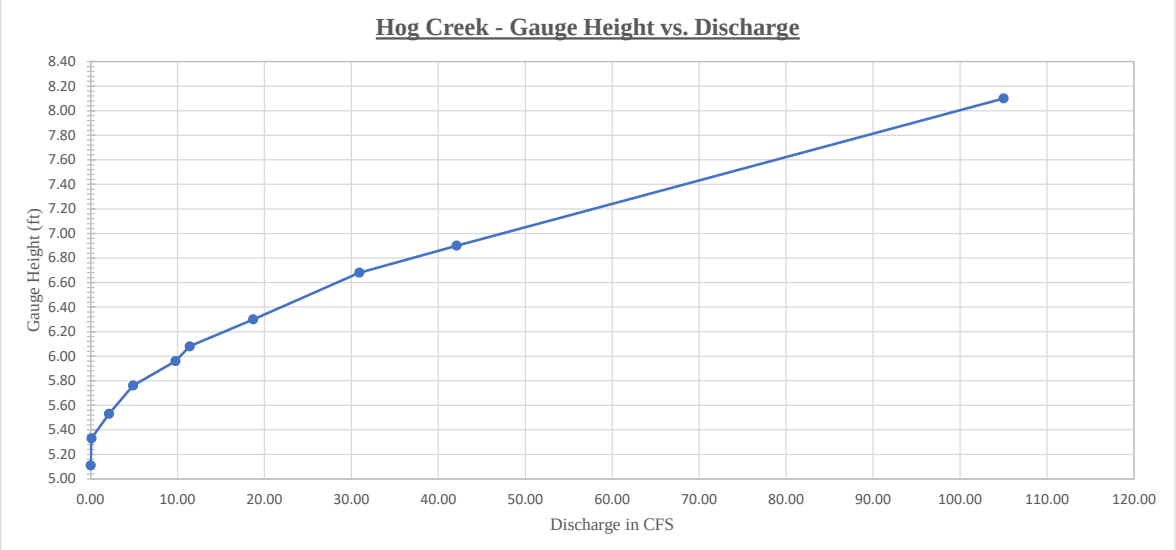


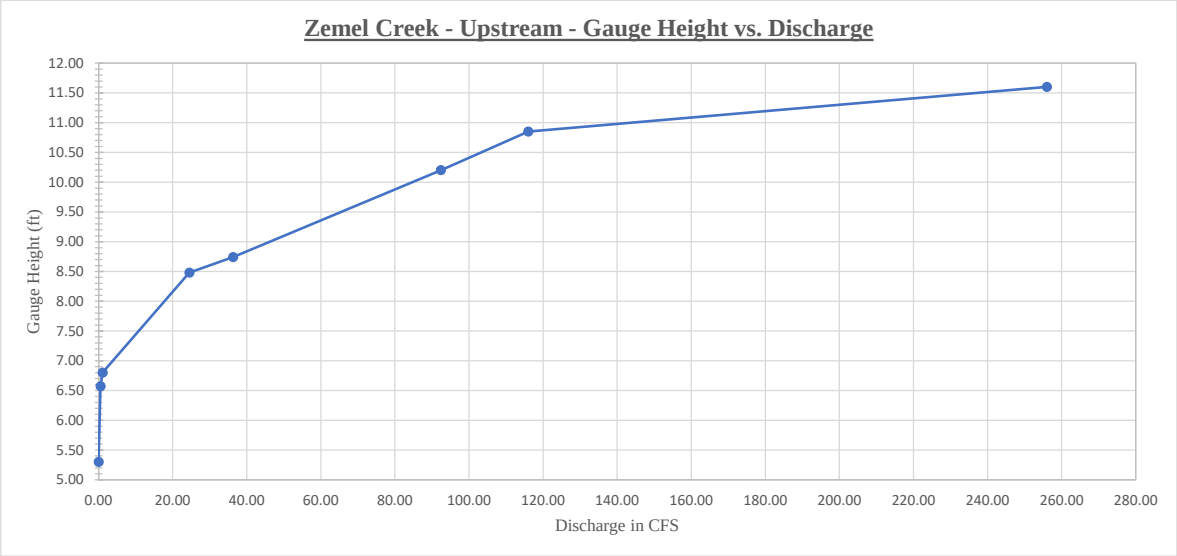
Provisional Flow Rating Curves

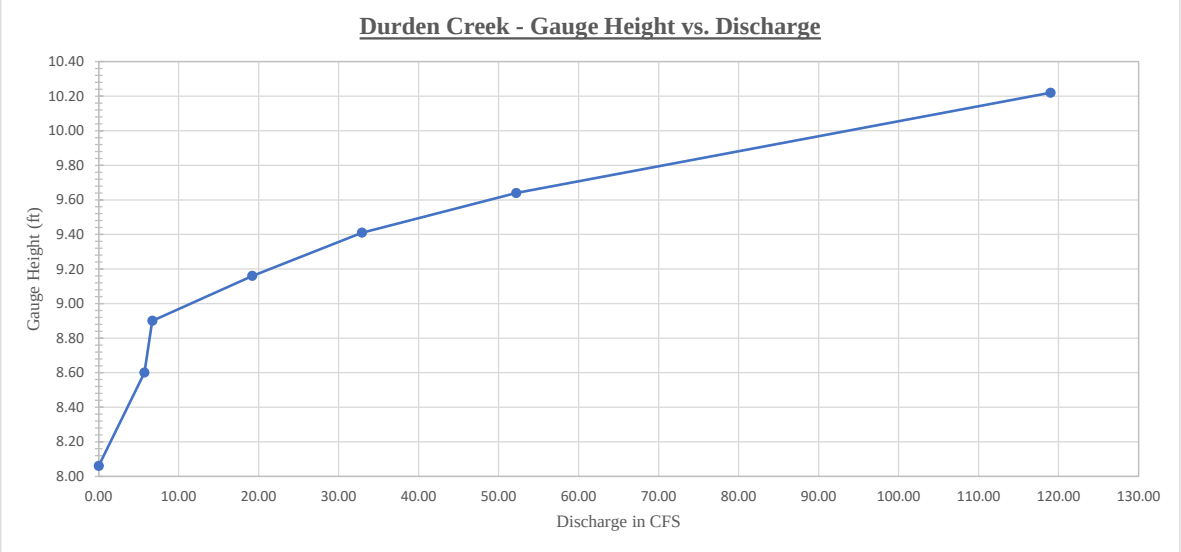


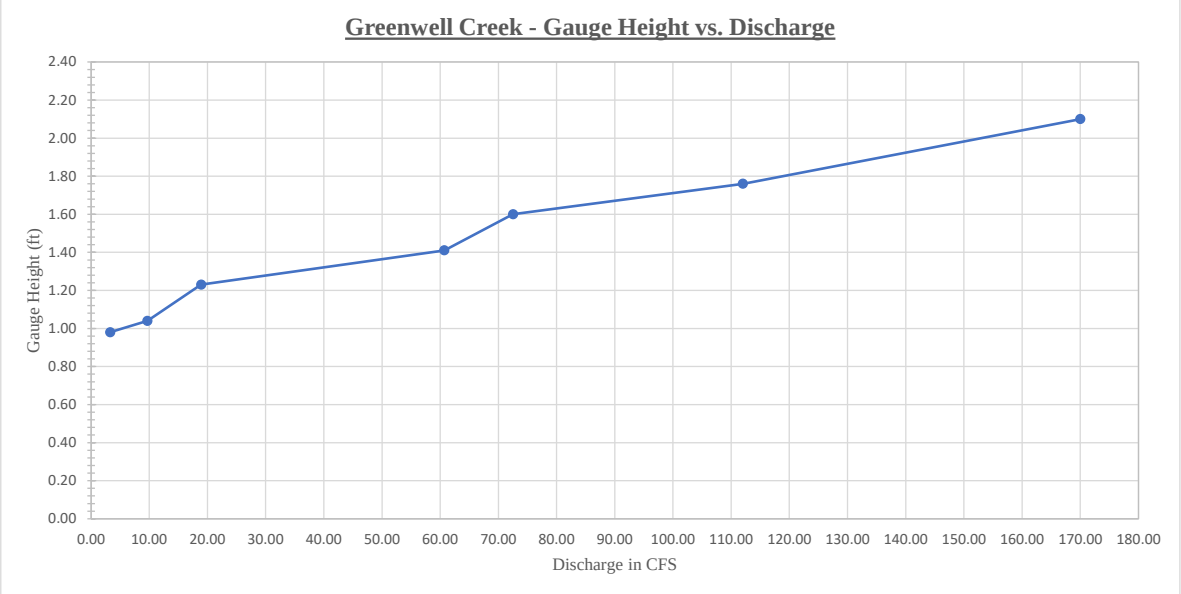

Yucca Pens @ BSR - Gauge Height vs. Discharge
Gauge Height (ft)
12.50
12.00
11.50
11.00
10.50
10.00
9.50
9.00
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
200.00
220.00
Discharge in CFS


Bear Creek - Gauge Height vs. Discharge
Gauge Height (ft)
5.40
5.20
5.00
4.80
4.60
4.40
4.20
4.00
3.80
3.60
3.40
3.20
3.00
2.80
2.60
2.40
2.20
2.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
Discharge in CFS


Hog Creek - Gauge Height vs. Discharge
Gauge Height (ft)
8.40
8.20
8.00
7.80
7.60
7.40
7.20
7.00
6.80
6.60
6.40
6.20
6.00
5.80
5.60
5.40
5.20
5.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
120.00
Discharge in CFS


Zemel Creek - Upstream - Gauge Height vs. Discharge
Gauge Height (ft)
12.00
11.50
11.00
10.50
10.00
9.50
9.00
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
200.00
220.00
240.00
260.00
280.00
Discharge in CFS


Durden Creek - Gauge Height vs. Discharge
Gauge Height (ft)
10.40
10.20
10.00
9.80
9.60
9.40
9.20
9.00
8.80
8.60
8.40
8.20
8.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
120.00
130.00
Discharge in CFS


Greenwell Creek - Gauge Height vs. Discharge
Gauge Height (ft)
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
110.00
120.00
130.00
140.00
150.00
160.00
170.00
180.00
Discharge in CFS

CHNEP - Discharge Measurement Summary

S. Alligator Creek	Meas. #	Date:	Stage	Discharge (cfs)	Rated:	Remarks:
	1a	5/21/2020	5.46	0.00	G	PZF - Point of Zero Flow
	1b	5/21/2020	5.52	0.244	F	Very low velocities
	2	6/10/2020	5.82	12.20	G	Box culverts mostly clear
	3	8/24/2020	7.90	62.30	E	Box culverts mostly clear
	4	8/28/2020	6.74	35.00	G	Box culverts mostly clear
	5	9/14/2020	8.41	72.50	G	Box culverts mostly clear
	6	9/30/2020	10.56	152.00	E	Box culverts mostly clear
	7	11/12/2020	11.12	180.00	E	Box culverts mostly clear
	8	11/13/2020	9.90	131.00	E	Box culverts mostly clear
	9	3/10/2021	5.61	0.84	G	Box culverts mostly clear
	11	7/8/2021	13.78	356.00	G	Box culverts mostly clear - Est. 30 cfs through ByPass Culvert W of Main Ch

Bear Creek	Meas. #	Date:	Stage	Discharge (cfs)	Rated:	Remarks:
	1a	5/21/2020	2.31	0.00	G	PZF - Point of Zero Flow
	1b	5/21/2020	2.68	0.145	F-P	Low Velocities
	2	6/9/2020	3.52	18.60	G	Mod - High Velocities
	3	9/14/2020	3.75	25.70	G	ADCP Meas. @ Upstr. Side of Culverts (600' Dstr.)
	4	10/2/2020	3.26	13.20	G	Culverts Dstr. Clear
	5	11/12/2020	4.51	68.10	E	Culverts Dstr. Clear
	6	11/13/2020	4.02	43.70	E	Culverts Dstr. Clear
	7	5/11/2021	2.50	0.25	F	Low Velocities
	8	7/8/2021	5.10	93.60	G	Culverts Dstr. Clear

Durden Creek	Meas. #	Date:	Stage	Discharge (cfs)	Rated:	Remarks:
	1	6/9/2020	9.16	19.20	P	Culverts Totally Submerged - Eddy on LEW
	2	7/21/2020	8.60	5.72	p	Culverts Totally Submerged - Eddy on LEW
	3	8/28/2020	8.90	6.70	P	Culverts Totally Submerged
	4a	9/9/2020	8.06	0.00	G	PZF @ Western Easement Fenceline
	4	9/14/2020	9.64	52.20	G	Culverts Totally Submerged
	5	9/16/2020	9.41	32.90	F	Culverts Totally Submerged
	6	7/8/2021	10.22	119.00	E	Culverts Totally Submerged

Greenwell	Meas. #	Date:	Stage	Discharge (cfs)	Rated:	Remarks:
	1	6/9/2020	1.23	18.90	G	Culverts Clear
	2a	7/21/2020	0.98	3.26	P	Culverts Clear
	2b	7/21/2020	0.98	0.33	F	Pygmy Meter Meas. - Greenwell @ Burnt Store Rd.
	3	8/10/2020	1.04	9.67	G	Culverts Clear
	4	9/14/2020	1.76	112.00	E	Culverts Clear
	5	9/16/2020	1.41	60.70	G	Culverts Clear
	6	11/12/2020	1.60	72.50	E	Culverts Clear
	7	7/8/2021	2.10	170.00	E	Culverts Clear

Hog Creek	Meas. #	Date:	Stage	Discharge (cfs)	Rated:	Remarks:
	1a	5/21/2020	5.11	0.00	E	PZF - Point of Zero Flow
	1b	5/21/2020	5.33	0.095	F-P	Low Velocities - Light/Mod Veg. in Box Culvert
	2	6/9/2020	5.96	9.77	G-F	Low-Mod. Velocities
	3	8/28/2020	5.53	2.11	G	Low-Mod. Velocities
	4	9/14/2020	6.30	18.70	G	Light/Mod. Moss & Algae on Box Culvert Lip
	5	9/30/2020	6.08	11.40	F	Light/Mod. Moss & Algae on Box Culvert Lip
	6	10/2/2020	5.76	4.88	G	Light/Mod. Moss & Algae on Box Culvert Lip
	7	11/12/2020	6.90	42.10	E	Light/Mod. Moss & Algae on Box Culvert Lip
	8	11/13/2020	6.68	30.90	G	Light/Mod. Moss & Algae on Box Culvert Lip
	9	7/8/2021	8.10	105.00	G	Culvert Clear

Winegourd	Meas. #	Date:	Stage	Discharge (cfs)	Rated:	Remarks:
	1a	6/9/2020	12.55	0.00	F	PZF - Sand bar control may shift with higher flows
	1b	6/9/2020	12.77	0.143	F-P	Very Low Velocity - Hvy. Debris downstream in channel - Hvy Construction
	2	8/24/2020	13.47	0.547	P	Very Low Velocity - Hvy. Debris downstream in channel - Hvy Construction
	2a	8/24/2020	13.07	0.000	F	PZF - Sand bar control may shift with higher flows
		9/9/2020				Removed Gauge per Hvy Construction Contractor & WSA (Roger Copp) - R

CHNEP - Discharge Measurement Summary

Yucca Pens	Meas. #	Date:	Stage	Discharge (cfs)	Rated:	Remarks:
Gauging Station	1a	5/21/2020	0.60	-21.60	G	Negative flow - Incoming Tide @ Gauging Station - LEW is undefined due to
Gauging Station	2a	6/10/2020	0.42	16.60	P	Positive Flow - Incoming Tide @ Gauging Station
Gauging Station	4a	8/10/2020	-0.54	12.80	G	Positive Flow - Outgoing Tide @ Gauging Station
Gauging Station	5a	9/15/2020	1.31	-12.20	P	Negative flow - Incoming Tide @ Gauging Station - LEW is undefined due to
Upstr. @ Constriction	1b	5/21/2020	0.74	-6.56	F	Negative flow - Incoming Tide @ Gauging Station & Constriction Upstream
Upstr. @ Constriction	2b	6/10/2020	0.59	22.10	G	Positive Flow - Incoming Tide @ Gauging Station - No Tidal Fluctuation obs
Upstr. @ Constriction	4b	8/10/2020	-0.62	4.66	P	Positive Flow - Outgoing Tide @ Gauging Station - Tidal Fluctuation observe
Upstr. @ Constriction	5b	9/15/2020	0.14	42.90	G	Positive Flow with Incoming Tide
Upstr. @ Constriction	6	11/12/2020	0.37	88.50	G	Positive Flow with Outgoing Tide
Yucca Pens @ BSR						
Upstr. @ Burnt Store Rd.	1	6/10/2020	7.98	22.00	P	Positive Flow - Incoming Tide @ Gauging Station - No Tidal Fluctuation obs
Upstr. @ Burnt Store Rd.	2	7/21/2020	5.91	0.72	F	Positive Flow - Outgoing Tide @ Gauging Station - No Tidal Fluctuation obs
Upstr. @ Burnt Store Rd.	3	8/10/2020	6.32	3.07	F	Positive Flow - Transistional Flow @ Gauging Station from Outgoing to Inco
Upstr. @ Burnt Store Rd.	4	9/15/2020	9.10	53.00	G	Positive Flow - No Tidal Fluctuation Observed
Upstr. @ Burnt Store Rd.	5	9/16/2020	9.55	64.30	G	Positive Flow - No Tidal Fluctuation Observed
Upstr. @ Burnt Store Rd.	6	9/30/2020	8.42	34.80	G	Positive Flow - No Tidal Fluctuation Observed
Upstr. @ Burnt Store Rd.	7	10/2/2020	7.30	11.00	G	Positive Flow - No Tidal Fluctuation Observed
Upstr. @ Burnt Store Rd.	8	11/10/2020	4.54	0.00	G	PZF 10' (+/-) Upstr. of Fenceline on Western BSR Easement
Upstr. @ Burnt Store Rd.	9	11/12/2020	10.18	89.30	G	Positive Flow - No Tidal Fluctuation Observed
	11	7/8/2021	11.83	203.00	E	Culverts Clear
	10	3/10/2021	5.50	<0.10	G	Est. / Observation

Zemel Canal	Meas. #	Date:	Stage	Discharge (cfs)	Rated:	Remarks:
	1a	5/21/2020	-0.14	0.00	P	PZF - Estimated (Site is Tidal)
	1b	5/21/2020	0.46	3.020	F	Box Culverts Clear - Tidally influenced - Outgoing Tide
	2	9/14/2020	1.52	28.70	G	Box Culverts Clear - Tidally influenced - Incoming Tide
	3	9/16/2020	0.92	19.10	G	Box Culverts Clear - Tidally influenced - Incoming Tide
		10/20/2020				Moved gauge upstream out of tidal influence
Zemel_Upstream	1	10/20/2020	8.48	24.50	G	Re-located Gauge Upstream where it is not tidally influenced
	2	11/10/2020	8.74	36.30	G	Channel Mostly Clear - Mod. Veg on LEW / REW
	2b	11/10/2020	5.30	0.00	F	Estimated PZF
	3	11/12/2020	10.85	116.00	E	Mod. Veg. LEW / REW
	4	11/13/2020	10.20	92.40	G	Mod. Veg. LEW / REW
	5	3/10/2021	6.80	1.07	G-F	Channel Mostly Clear - Mod. Veg on LEW / REW
	6	5/11/2021	6.57	0.50	G	Channel Mostly Clear - Mod. Veg on LEW / REW
	7	7/8/2021		256.00	E	O.S. Destroyed by Hurricane Elsa. Disch Meas. at BSR Box Culverts - Clear

Discharge Measurement Rating: (Excellent (+/- 2%) / Good (+/- 5%) Fair (+/- 8%) Poor (> 8%))