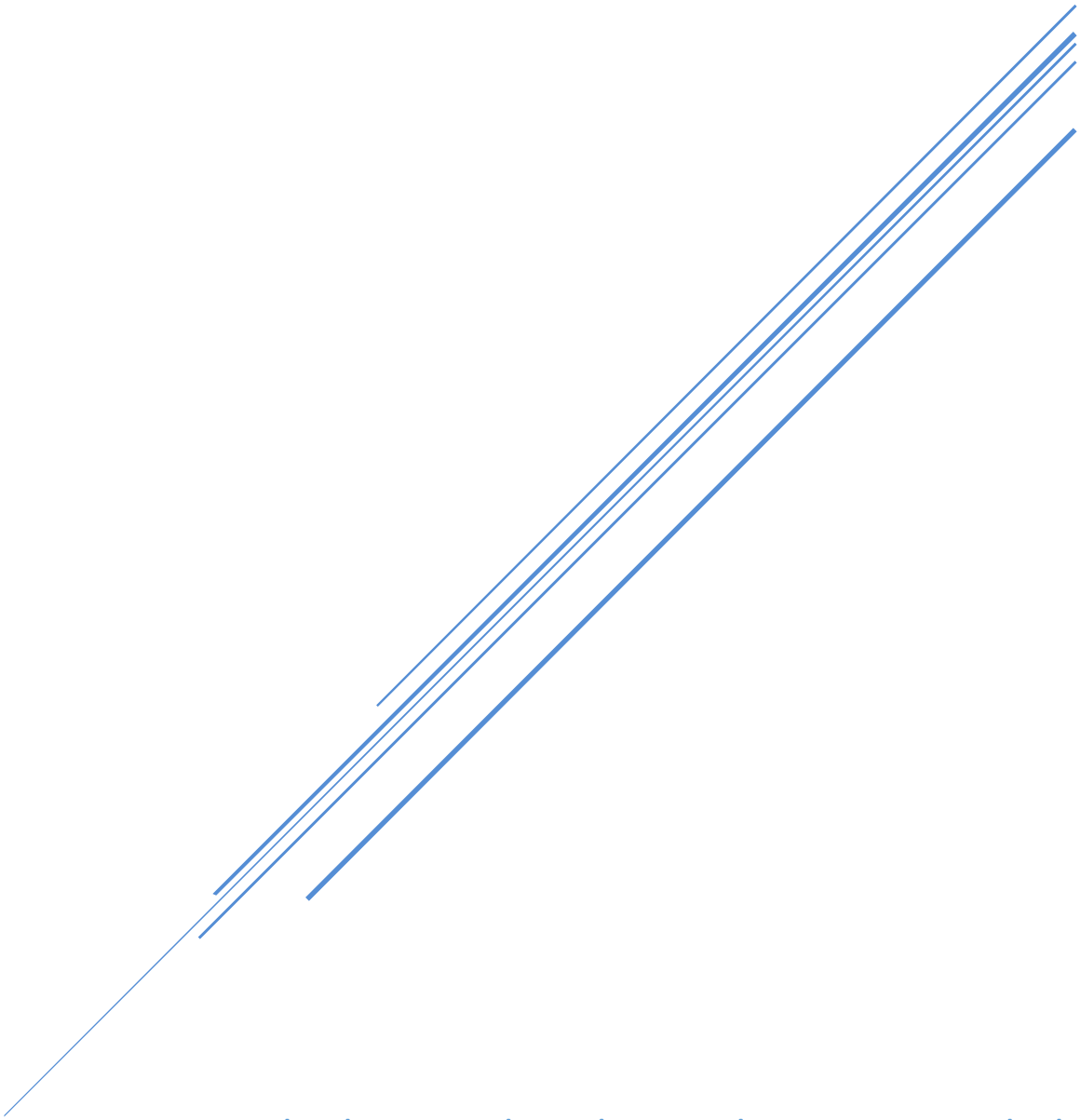
APPENDIX 4D

4th Quarter Data Download



Lower Charlotte Harbor Flatwoods Strategic Hydrologic Restoration Plan

Lower Charlotte Harbor Flatwoods Strategic Hydrologic Restoration Plan

4D – 4th 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 August 10, 2021
Re: 4th Quarter Data Download

BACKGROUND

Water Science Associates was contracted by the Coastal & Heartland 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, and a draft memorandum for Task 3a was submitted to CHNEP on August 10, 2020. Wet season field work was completed in November 2020 to measure water depths at the locations inventoried in the 2020 dry season.

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 4th Quarter (Task 4d) as described below.

DESCRIPTION OF DELIVERABLE REQUIREMENTS

The requirement for Task 4d is to provide monitoring well water level, flow gage, and rainfall data collected for the 4th 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	Downloading scheduled to begin early August
6th Quarter	August, 2021 – 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 May 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 four hours. 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 May, 2021 for the 4th quarter and will be uploaded to the CHNEP Water Atlas after being subjected to a quality assurance/quality control (QA/QC) review.

During the QA/QC process conducted after the 4th quarter data download, surveyed edge-of-ground elevations were compared to ground elevations obtained from the LiDAR data for the project area, and a number of differences were noted between surveyed edge-of-ground elevations and the LiDAR elevations. A detailed check was conducted to determine the source of the discrepancy. SED staff went through each point and the confirmed protocols were followed each morning and tied into existing FDOT Benchmarks before data collection commenced. Two reference stations were used during this period that showed that the equipment was taking accurate readings. However, during a follow-up survey in 2021, while elevations at some stations were essentially the same as elevations measured in 2020, other stations were significantly different. It was determined that the field error was introduced by the field technician during the initial surveying work conducted in 2020 (Table 2, May 2020 Top of PVC elevation). To rectify, all stations were then resurveyed by senior project staff to ensure the final elevations that are being used in the modeling and analysis are properly referenced to the North American Vertical Datum. (Table 2, July 2021 top of PVC**,** 2021 Ground). Additionally, all groundwater monitoring stations were re-surveyed in 2021, and elevations from May 2020 and July 2021 are presented below in **Table 2 and Table 3.** Extensive checks at nearby benchmarks were conducted during the July 2021 effort to assure that the updated elevations area as accurate as possible. A benchmark on Oil Well Road at U.S. 41 (BM DQ6211, elevation 22.84 ft.-NAVD) was checked multiple times during the July 2021 surveying effort, and the surveyed elevations of the benchmark were 22.93, 22.97, and 23.01. The differences between the surveyed elevation of the benchmark and the recorded benchmark elevation were 0.09, 0.13, and 0.17 feet, respectively.

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 4** 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 29 of 31 stations.

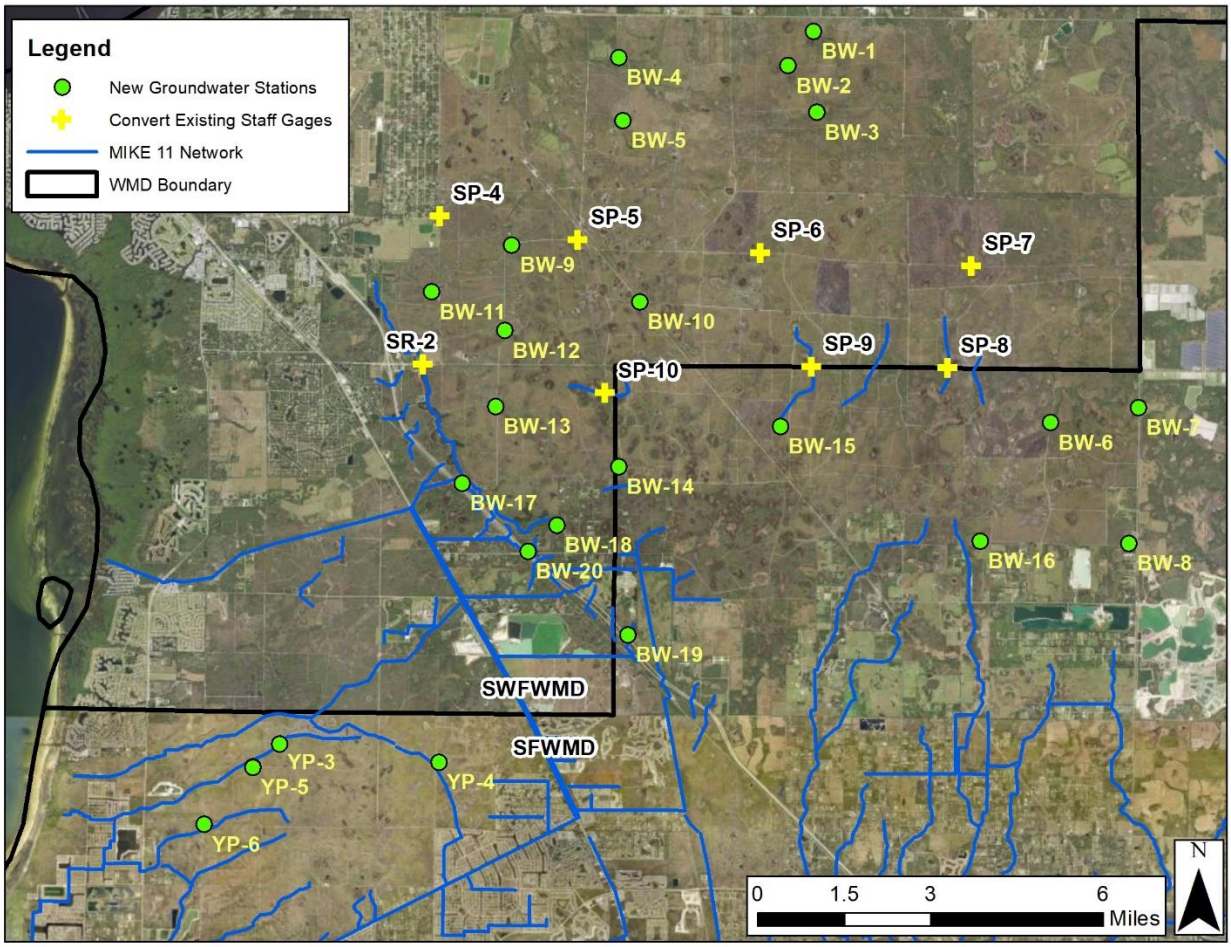


Figure 1 – Map of Surveyed New Groundwater Monitoring Stations and Existing Staff Gaging Station Upgrades

Table 2 – Groundwater Monitoring Well Elevations

Station	Top of PVC		Difference	May 2020	July 2021	From DEM
	May 2020 elevation	July 2021 elevation		Ground	Ground	Nearby
	ft.-NAVD	ft.-NAVD	ft.	ft.-NAVD	ft.-NAVD	Ground
BW-1	34.20	36.09	1.89	31.01	32.90	33.1
BW-2	34.30	36.24	1.94	30.90	32.84	32.9
BW-3	37.64	39.65	2.01	33.63	35.64	35.9
BW-4	26.70	28.85	2.15	22.92	25.07	25.0
BW-5	28.45	30.42	1.96	25.07	27.03	26.9
BW-6	33.87	34.34	0.47	30.16	30.63	30.7
BW-7	32.26	34.19	1.93	28.87	30.81	30.6
BW-8	29.56	31.50	1.94	25.97	27.96	28.5
BW-9	26.43	28.37	1.94	23.77	25.71	26.2
BW-10	29.80	31.80	2.00	26.63	28.63	28.8
BW-11	27.58	27.67	0.09	24.05	24.13	23.7
BW-12	27.33	29.25	1.93	23.88	25.80	25.9
BW-13	26.59	28.43	1.84	24.03	25.87	25.8
BW-14	27.49	29.53	2.04	23.86	25.90	26.0
BW-15	29.72	31.56	1.84	26.13	27.97	28.1
BW-16	31.68	31.78	0.10	28.09	28.19	28.7
BW-17	25.80	27.69	1.89	22.05	23.94	23.8
BW-18	26.85	28.84	1.99	23.19	25.18	25.1
BW-19	24.86	26.68	1.83	21.62	23.35	23.9
BW-20	25.87	27.74	1.86	22.42	24.10	25.0
YP-3	17.85	19.81	1.96	NR	16.12	16.4
YP-4	NR	20.29	N/A	NR	17.30	N/A
YP-5	16.11	18.07	1.96	13.03	15.18	15.3
YP-6	13.12	15.16	2.04	9.62	11.72	12.1

Note: NR indicates not recorded; N/A indicates not applicable**;** YP-4 was not surveyed initially since rock was encountered, and a temporary well was installed. A permanent well was drilled in May 2021.
Note: Elevations were revised based on new survey results

Table 3 – List of Coordinates and Elevations at Existing Staff Gages

Station	Description	Horizontal Coordinates		Top of PVC, ft.-NAVD	
		Y_STFLW_ft	X_SPFLW_ft	Old	New
SP-4	Cecil Webb, Alligator tributary	931175.41	670171.14	N/A	N/A
SP-5	Cecil Webb NW	929092.49	682847.77	30.7	30.99
SP-6	Cecil Webb N	928021.84	699639.13	33.13	33.18
SP-7	Cecil Webb NE	926985.27	719013.80	38.88	39.07
SR-2	Webb Lake, Tuckers Grade Rd	917556.96	668748.81	N/A	N/A
SP-8	Cecil Webb, TG, Telegraph HW	917606.91	716915.11	30.9	35.03
SP-9	Cecil Webb, TG, Gator HW	917642.90	704400.65	31.26	31.44
SP-10	Cecil Webb	915076.11	685486.06	30.1	29.84

Note: Elevations were revised based on new survey results. Initial elevations were determined from line-level measurements from the existing staff gages installed in 2011. Stations SP-4 and SR-2 have standing water, so data loggers were set to staff gage elevations.

Temporal trends in the recorded groundwater elevation for groundwater monitoring stations are presented in **Appendix 1**. The plotted data has been corrected to reflect the adjustments described above in Tables 2 and 3. Water levels in Babcock Webb increased approximately 3 feet in late May through early July 2020 in response to rainfall during that period. Water levels gradually declined in between early June and mid-July 2020 due to a lack of rainfall during the early summer. Water levels gradually increased from mid-July through September 2020 and remained at annual peak elevations until mid-November 2020 due to increased rainfall in the late summer and fall. 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. For example, 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 BW-20, which is located upstream of I-75 that acts as a dam.

Dry season recession rates between early January and early May of 2021 were generally in the range of 2 – 3 feet for most stations with the largest drop at SP-4, which is located just upstream of a gated discharge structure. 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.

Yucca Pens water levels increased by approximately 4 feet between late May and early June 2020. A dry period between mid-June to mid-July 2020 was experienced in Yucca Pens followed by higher water levels from mid-July until late December 2020. Yucca Pens water levels rise and fall by as much as 1.5 feet over a two-week period due to either high rates of groundwater movement or rapid drainage via eroded ATV trails. None of the Yucca Pens stations experienced increased water levels in March, 2021.

Table 4 – Manual and Data Logger Readings During May, 2021 Data Download

Station	Date	Manual Reading	Data Logger Reading	Difference
		ft.-NAVD	ft.-NAVD	ft.
BW-1	5/6/21	29.32	29.23	0.09
BW-2	5/6/21	29.82	30.10	-0.28
BW-3	5/6/21	32.85	32.86	-0.01
BW-4	5/6/21	21.28	21.32	-0.04
BW-5	5/6/21	23.23	23.26	-0.03
BW-6	5/7/21	27.09	26.94	0.15
BW-7	5/7/21	27.84	27.97	-0.13
BW-8	5/6/21	24.55	24.72	-0.17
BW-9	5/3/21	21.65	21.73	-0.08
BW-10	5/7/21	25.14	25.19	-0.05
BW-11	5/7/21	19.76	19.80	-0.04
BW-12	5/3/21	22.57	22.70	-0.13
BW-13	5/7/21	22.43	22.56	-0.13
BW-14	5/7/21	22.77	22.71	0.06
BW-15	5/3/21	24.62	24.59	0.02
BW-16	5/7/21	24.95	25.06	-0.11
BW-17	5/6/21	20.25	20.24	0.01
BW-18	5/3/21	20.94	21.04	-0.10
BW-19	5/3/21	20.81	20.87	-0.06
BW-20	5/3/21	21.07	21.03	0.04
YP-3	5/10/21	12.96	12.92	0.03
YP-4				
YP-5	5/10/21	11.77	11.77	0.00
YP-6	5/10/21	4.43	4.42	0.01
SR-2	5/3/21	20.68	20.53	0.15
SP-4	5/6/21	17.80	17.90	-0.10
SP-5	5/3/21	24.33	24.48	-0.15
SP-6	5/3/21	28.38	28.32	0.06
SP-7	5/3/21	33.19	33.15	0.04
SP-8	5/3/21	31.31	31.254	0.06
SP-9	5/3/21	27.66	27.59	0.07
SP-10	5/3/21	26.05	25.8	0.25

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 2**. Monthly rainfall totals from the three installed gages are shown in **Table 5**. 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 the lower accumulations were not expected. Data from SP-5 may or may not be used depending on comparisons to adjacent rain gages and to grid rainfall amounts.

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.

Rainfall at BW-18R for June and July, 2020 were below normal and were higher than normal during October and November.

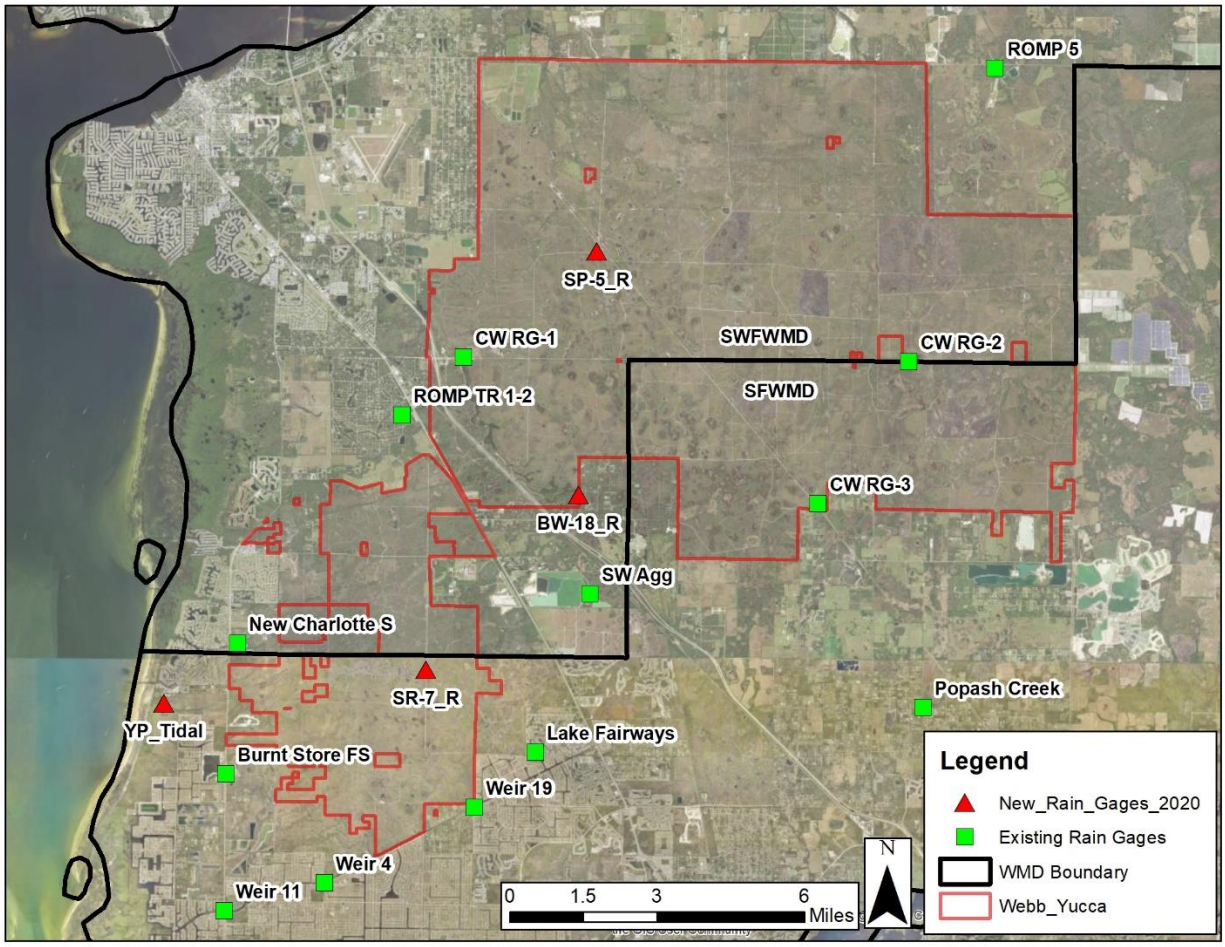


Figure 2 – Map of Newly Installed Rain Gages

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 3**. A summary of the flow measurements at all stations is presented in **Appendix 3**. 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 3**.

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.

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 varied the most, most likely due to the higher amount of development within the watershed. 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, 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 that moved monitoring station.

Relationships between stage and flow are also presented graphically in **Appendix 3** 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.**

Data files for all stations listed above have been provided to CHNEP.

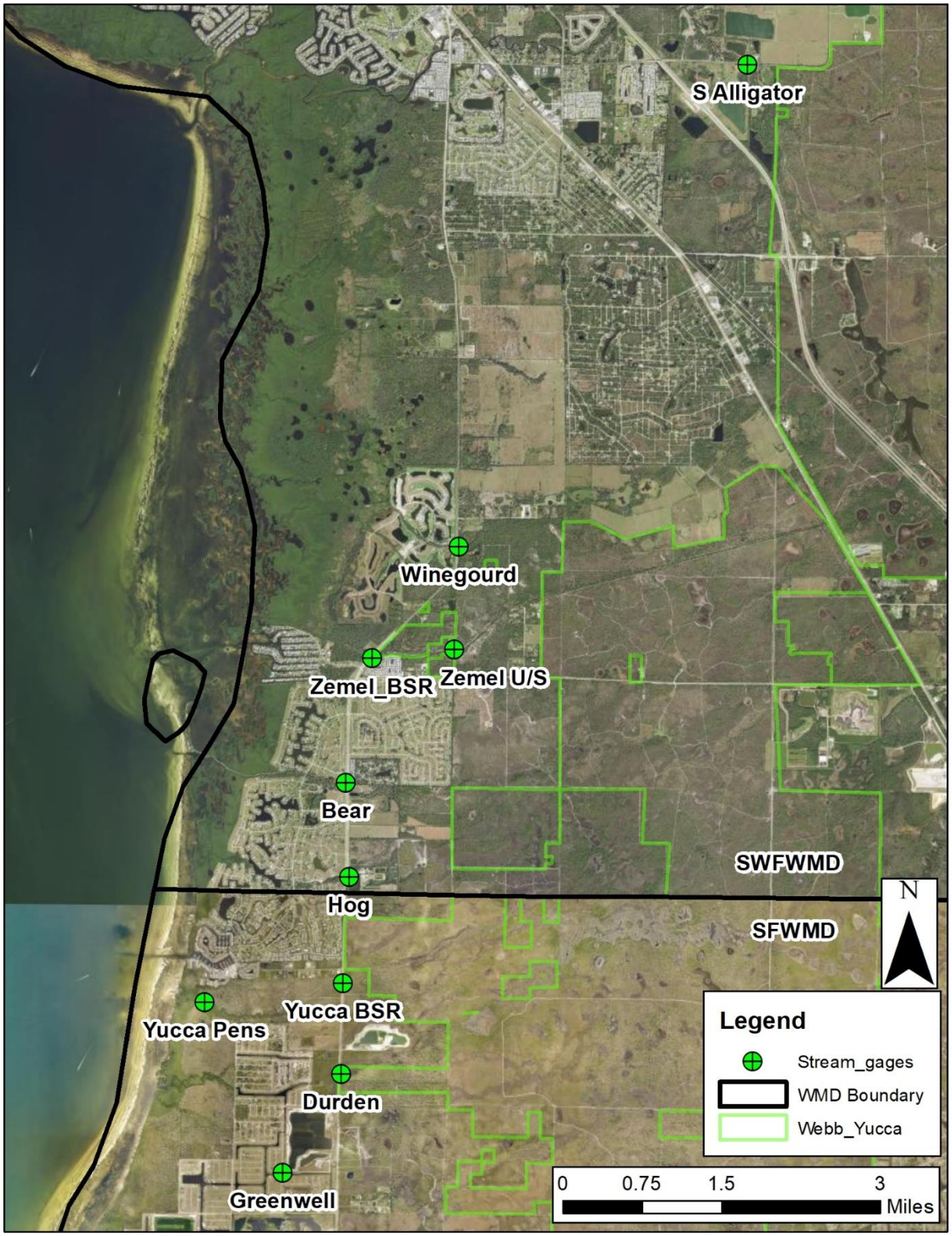


Figure 3 – Map of Installed Flow Monitoring Stations

REFERENCES

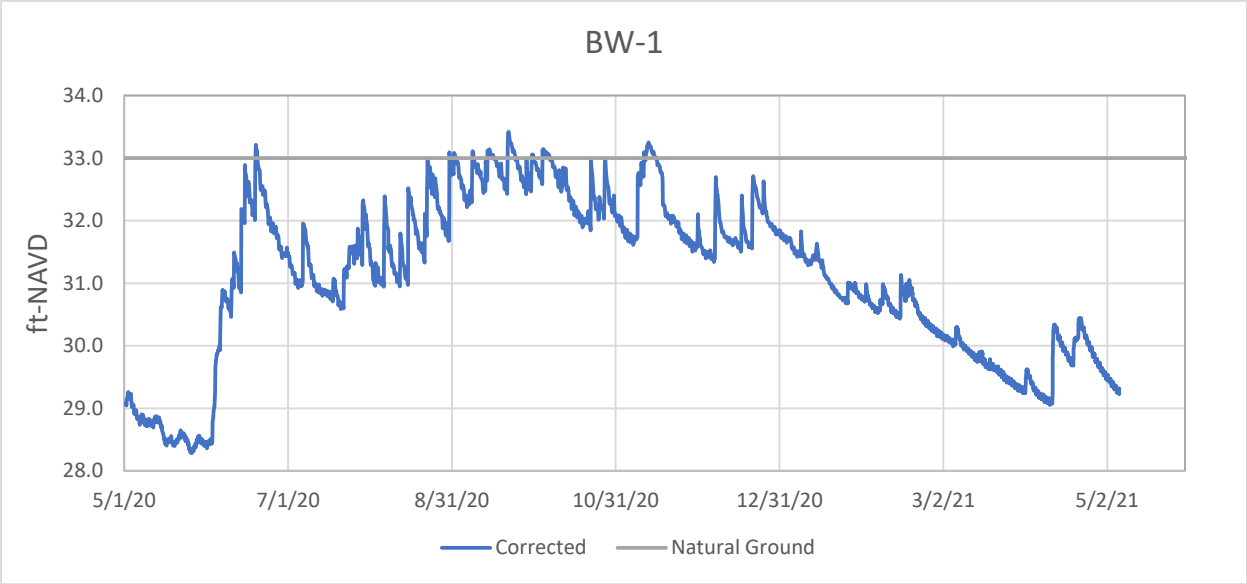
Water Science Associates. 2020. Lower Charlotte Harbor Flatwoods Hydrologic Modeling & Restoration – Groundwater Monitoring Plan. Prepared for Coastal and Heartlands National Estuary Partnership.

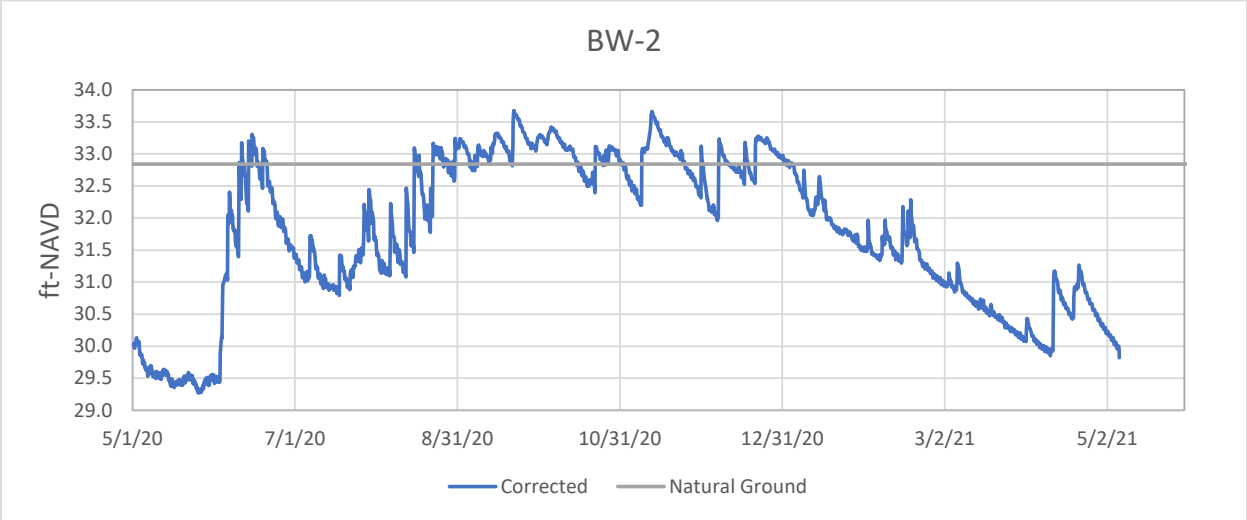
Water Science Associates. 2020. Lower Charlotte Harbor Flatwoods Hydrologic Modeling & Restoration – Flow Monitoring Plan. Prepared for Coastal and Heartlands National Estuary Partnership.

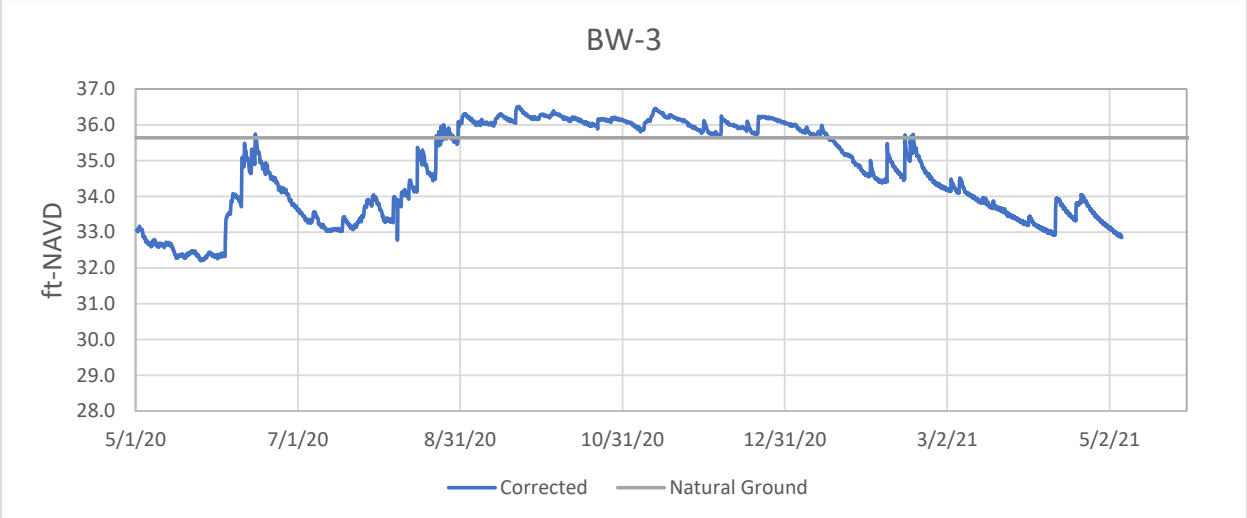
Appendix 1

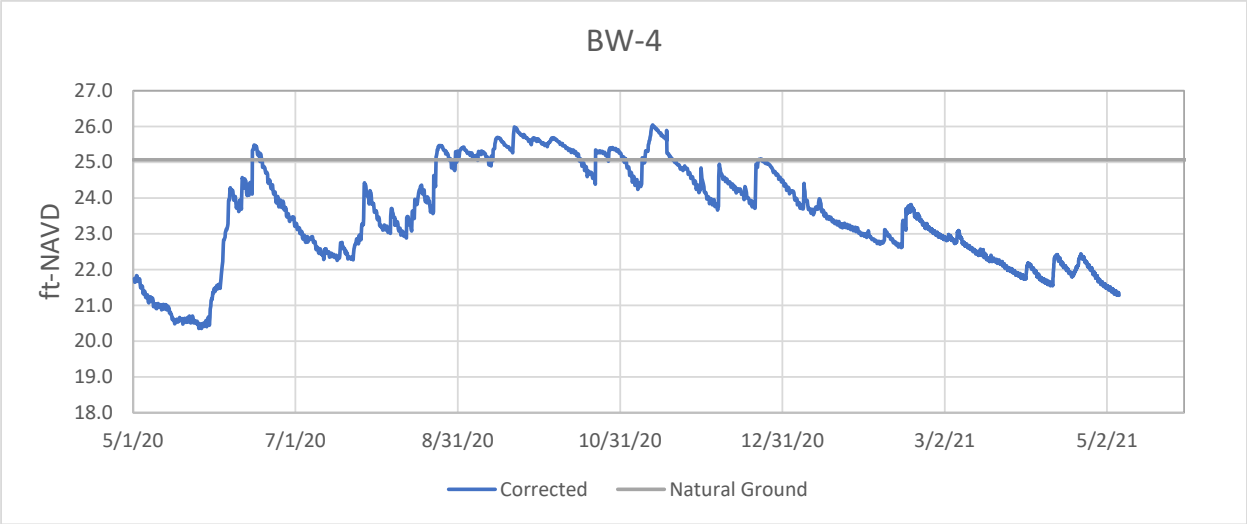
4th Quarter Groundwater Monitoring Station Data*

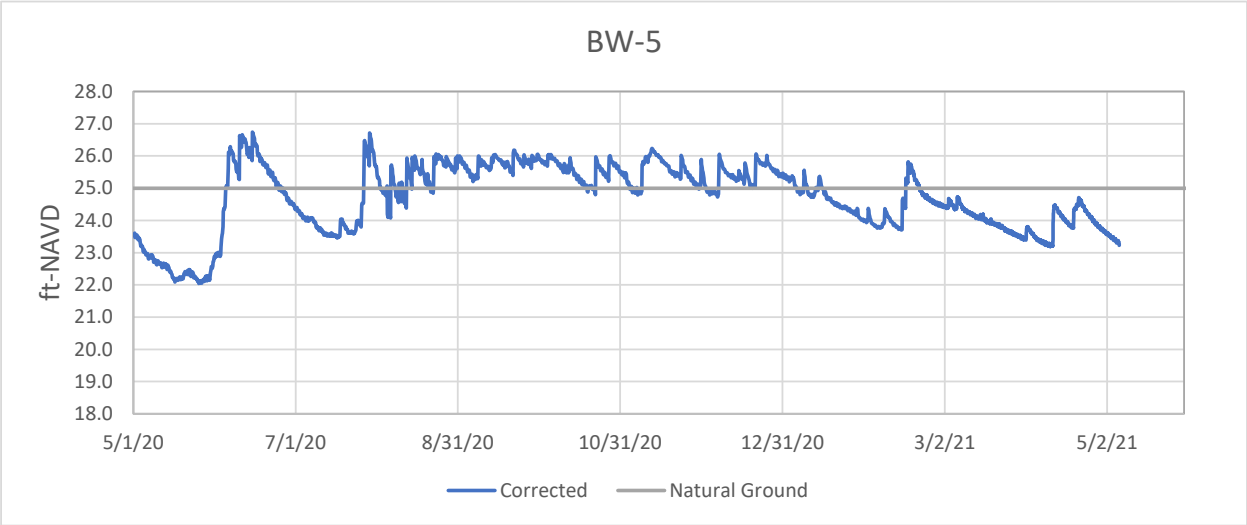
***Note:** The plotted data in Appendix A has been corrected to reflect the adjustments described above in Tables 2 and 3 for change in the edge-of-ground elevation. No adjustments were needed for stations with the legend indicating "Water Elevation" or "Collected Data".

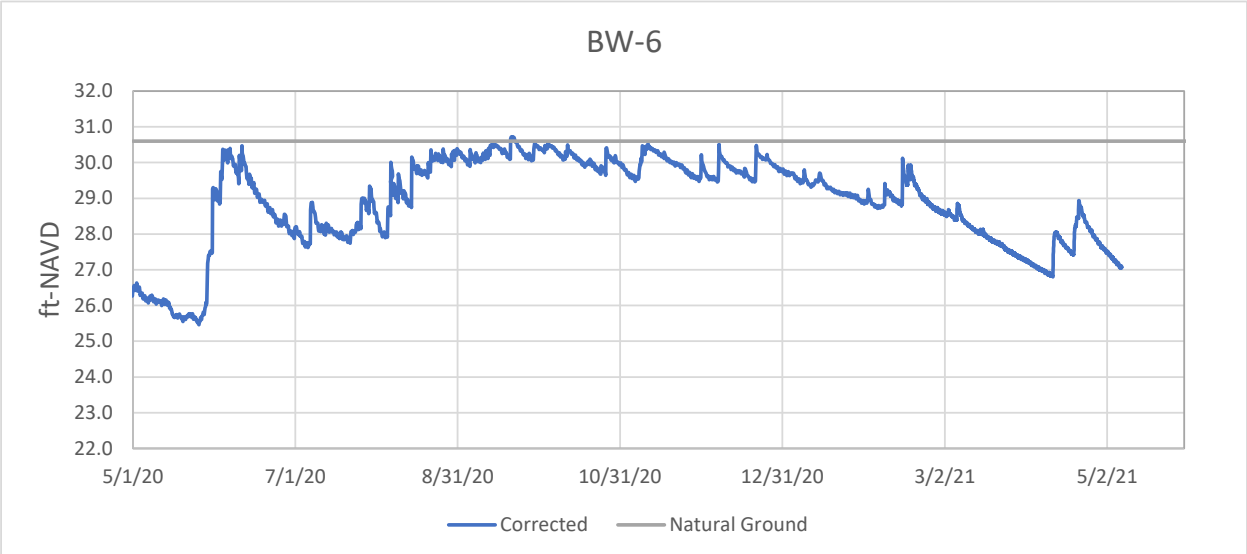

BW-1
34.0
33.0
32.0
31.0
30.0
29.0
28.0
ft-NAVD
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected
Natural Ground

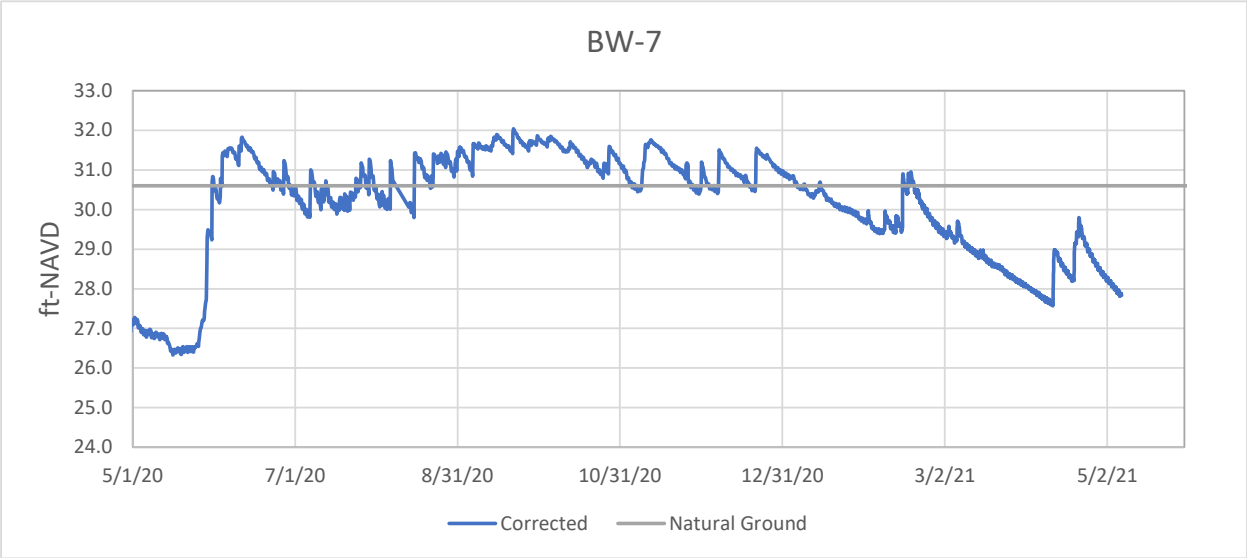

BW-2
34.0
33.5
33.0
32.5
32.0
31.5
31.0
30.5
30.0
29.5
29.0
ft-NAVD
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected
Natural Ground

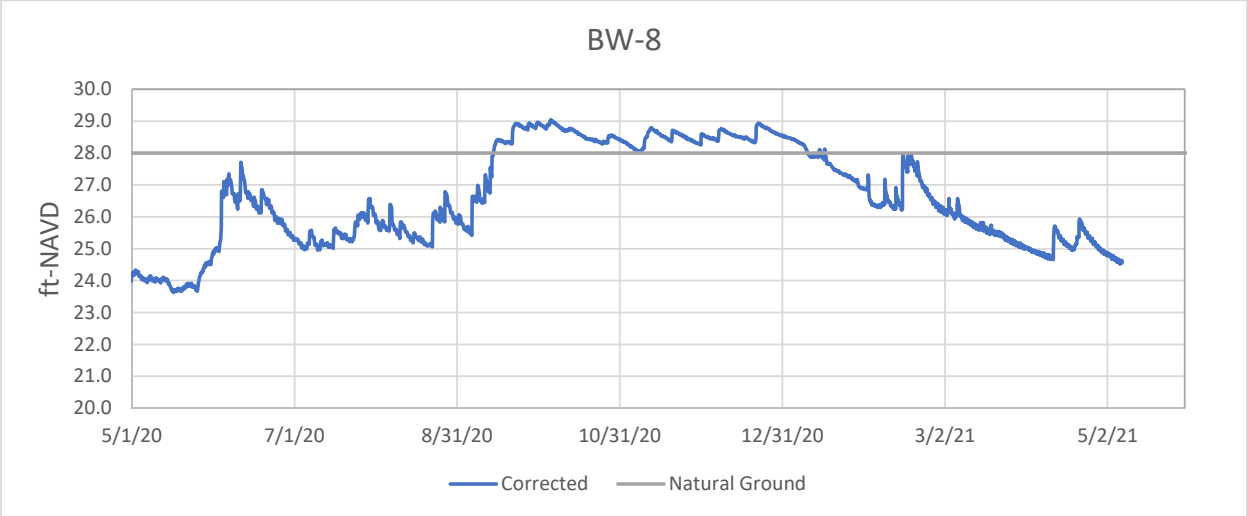

BW-3
37.0
36.0
35.0
34.0
33.0
32.0
31.0
30.0
29.0
28.0
ft-NAVD
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected
Natural Ground

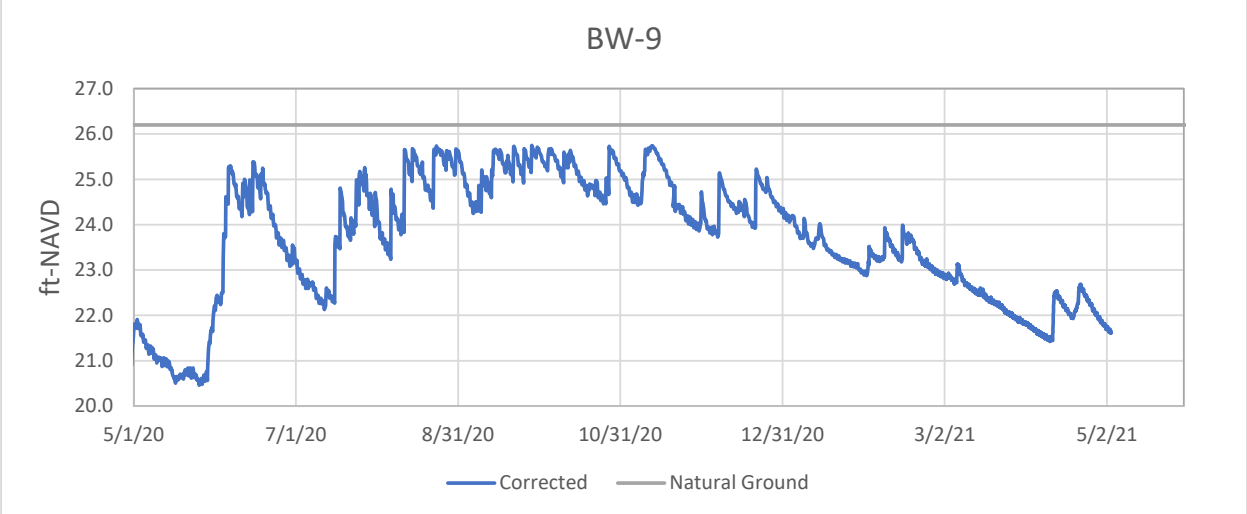

BW-4
ft-NAVD
27.0
26.0
25.0
24.0
23.0
22.0
21.0
20.0
19.0
18.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected
Natural Ground

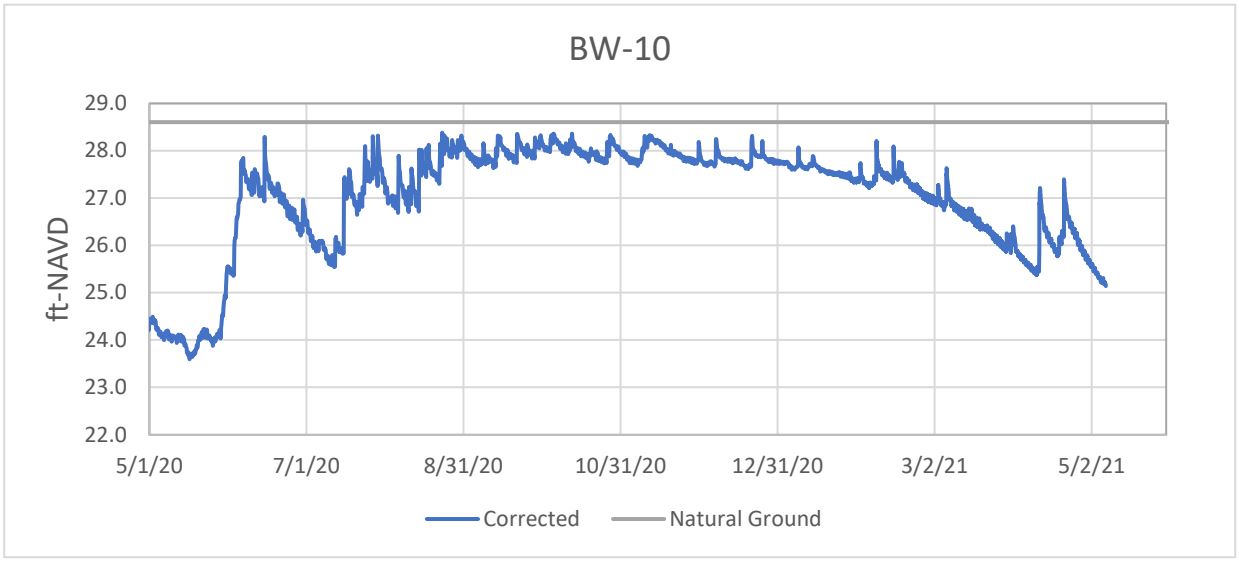

BW-5
ft-NAVD
28.0
27.0
26.0
25.0
24.0
23.0
22.0
21.0
20.0
19.0
18.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected
Natural Ground

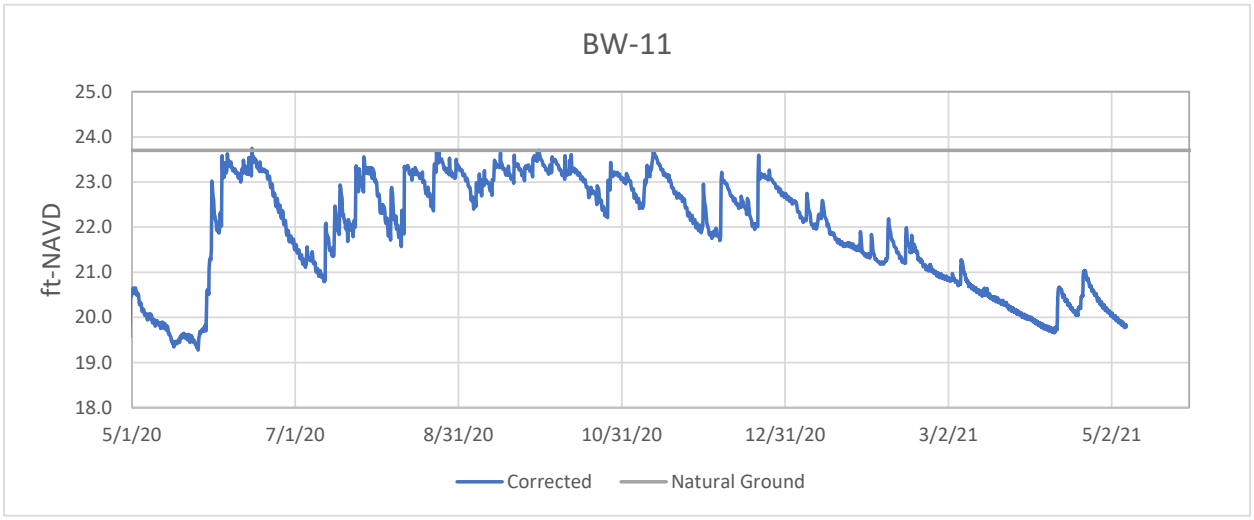

BW-6
ft-NAVD
32.0
31.0
30.0
29.0
28.0
27.0
26.0
25.0
24.0
23.0
22.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected
Natural Ground

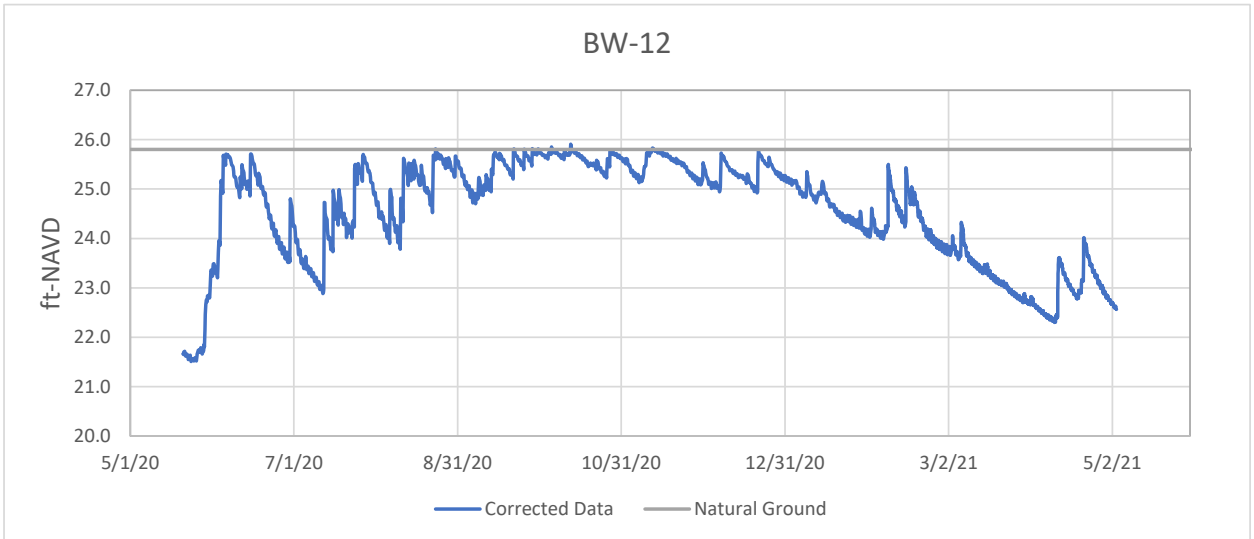

BW-7
ft-NAVD
33.0
32.0
31.0
30.0
29.0
28.0
27.0
26.0
25.0
24.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected
Natural Ground

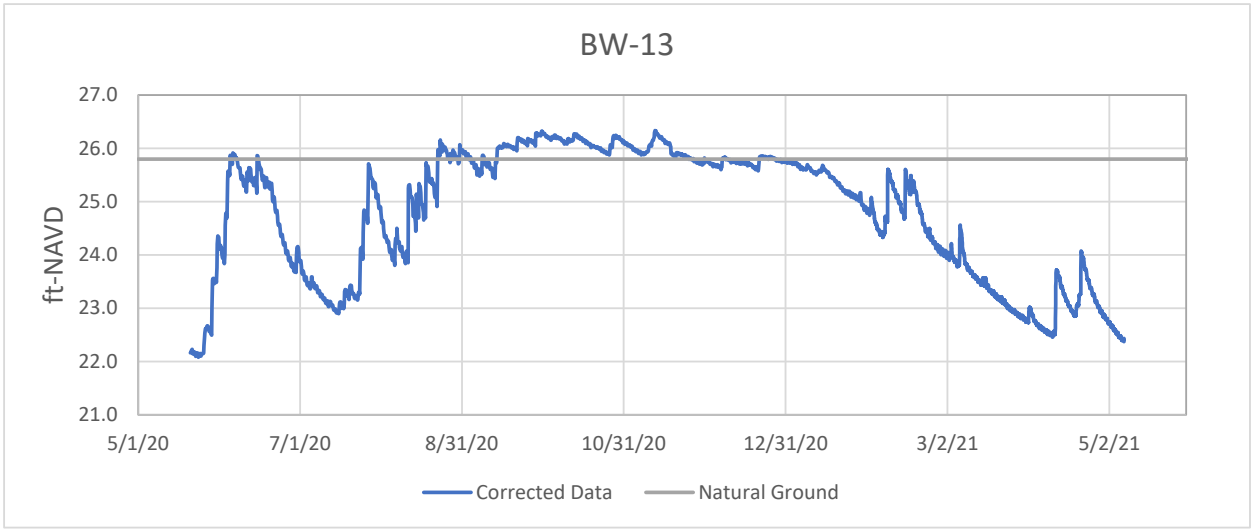

BW-8
ft-NAVD
30.0
29.0
28.0
27.0
26.0
25.0
24.0
23.0
22.0
21.0
20.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected
Natural Ground

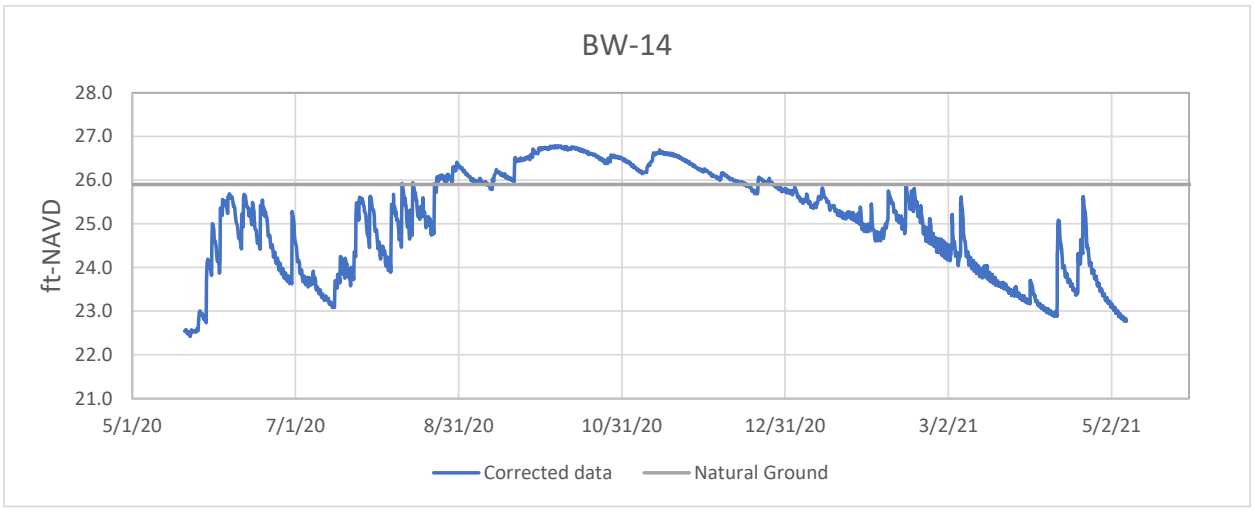

BW-9
ft-NAVD
27.0
26.0
25.0
24.0
23.0
22.0
21.0
20.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected
Natural Ground

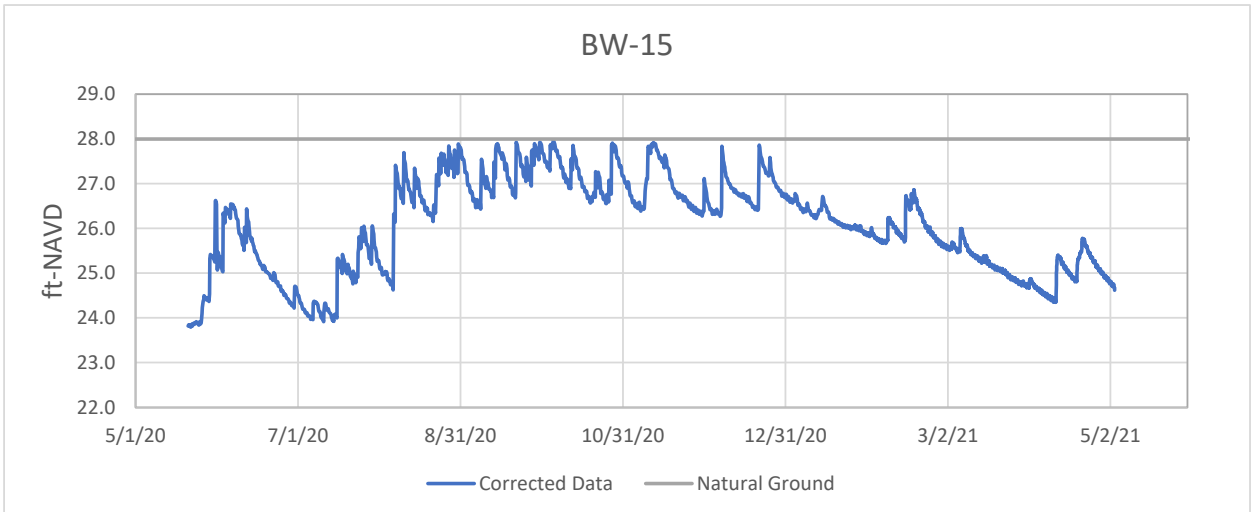

BW-10
29.0
28.0
27.0
26.0
25.0
24.0
23.0
22.0
ft-NAVD
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected
Natural Ground

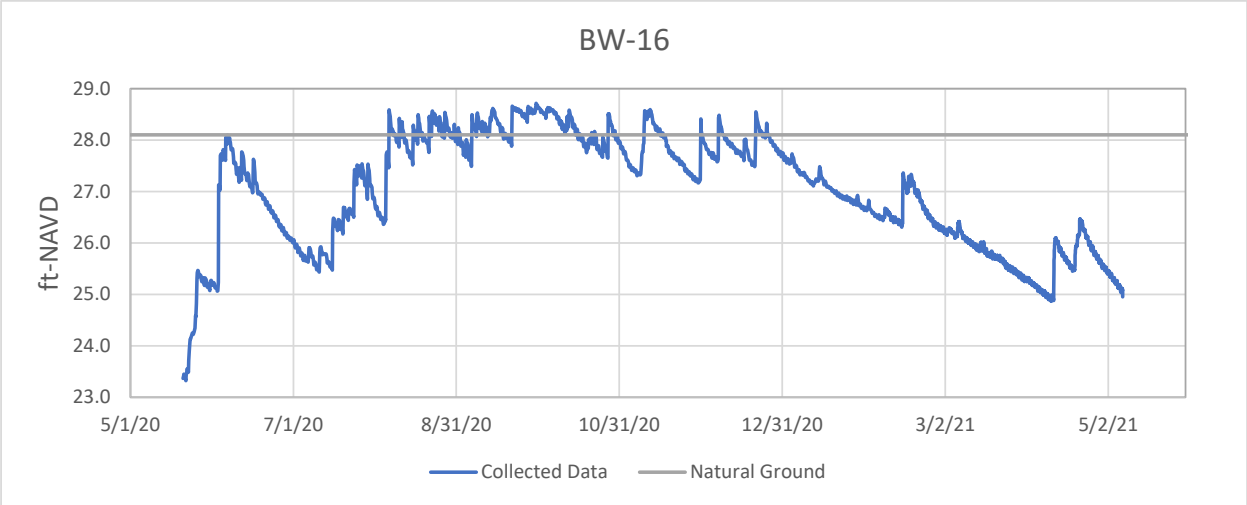

BW-11
25.0
24.0
23.0
22.0
21.0
20.0
19.0
18.0
ft-NAVD
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected
Natural Ground

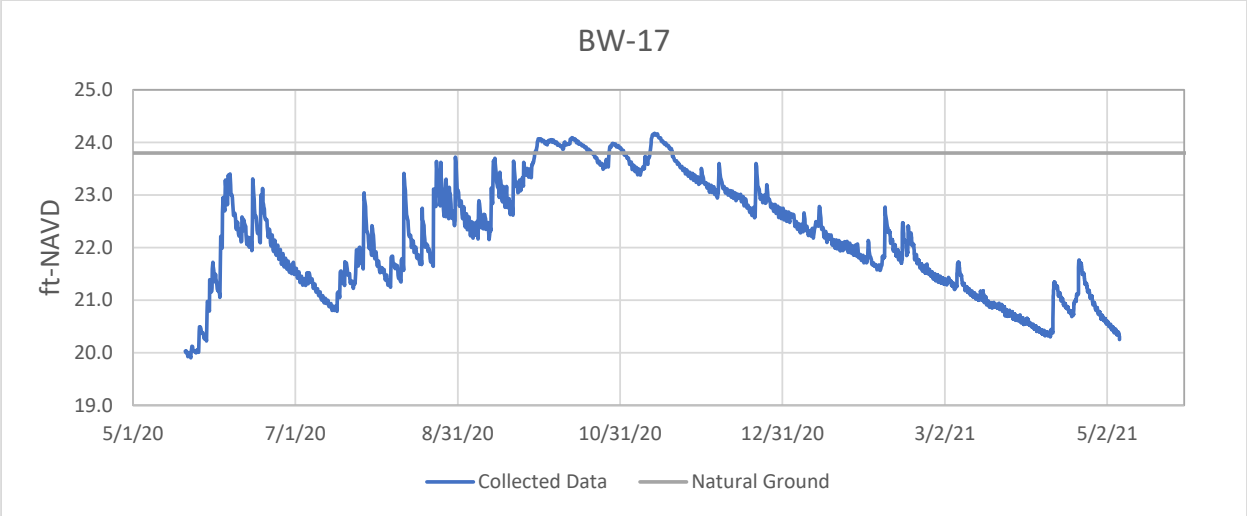

BW-12
27.0
26.0
25.0
24.0
23.0
22.0
21.0
20.0
ft-NAVD
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected Data
Natural Ground

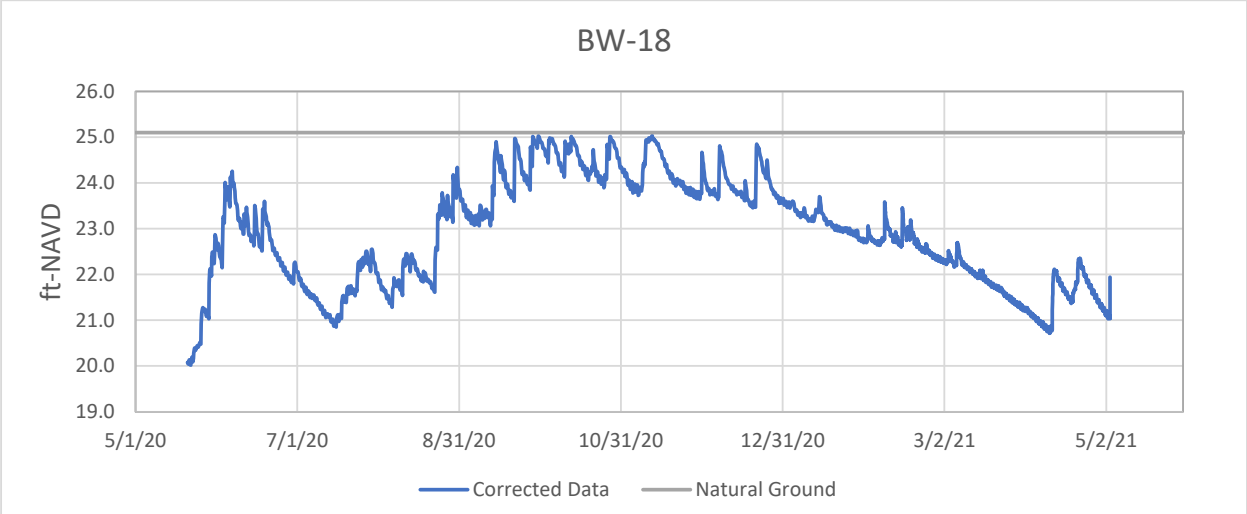

BW-13
ft-NAVD
27.0
26.0
25.0
24.0
23.0
22.0
21.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected Data
Natural Ground

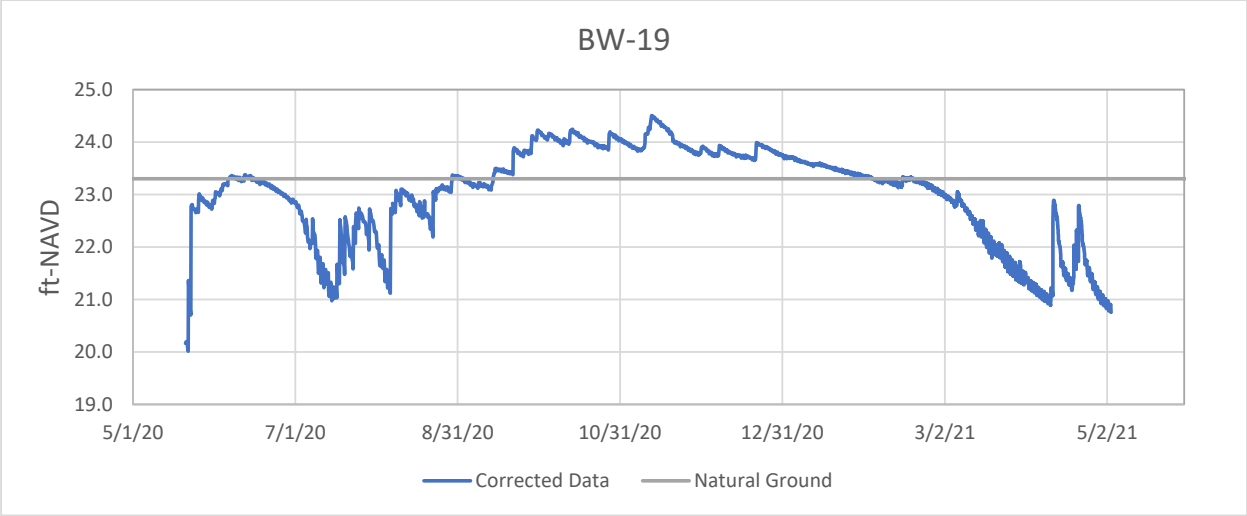

BW-14
ft-NAVD
28.0
27.0
26.0
25.0
24.0
23.0
22.0
21.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected data
Natural Ground

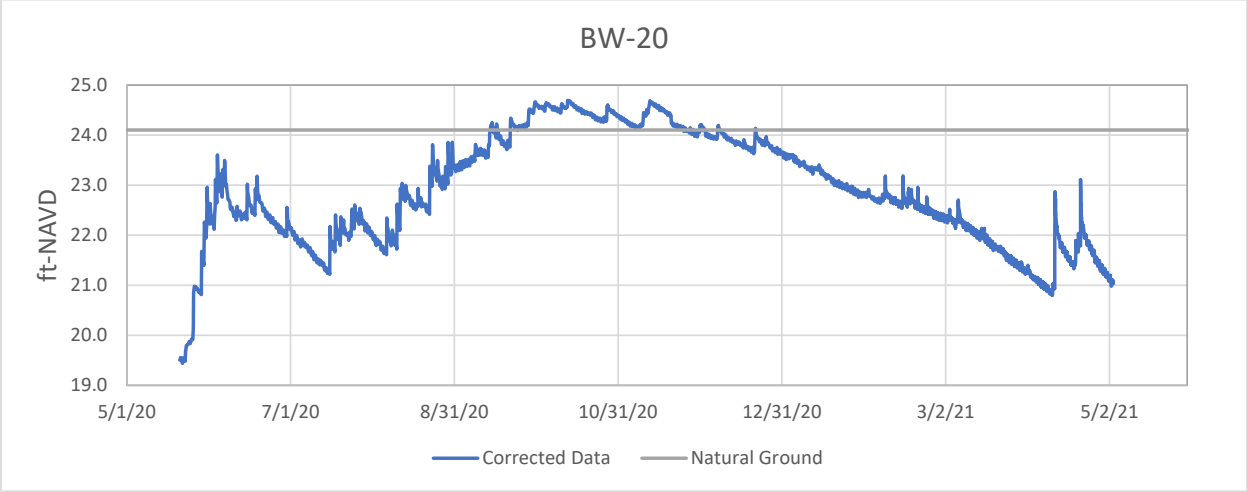

BW-15
ft-NAVD
29.0
28.0
27.0
26.0
25.0
24.0
23.0
22.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected Data
Natural Ground

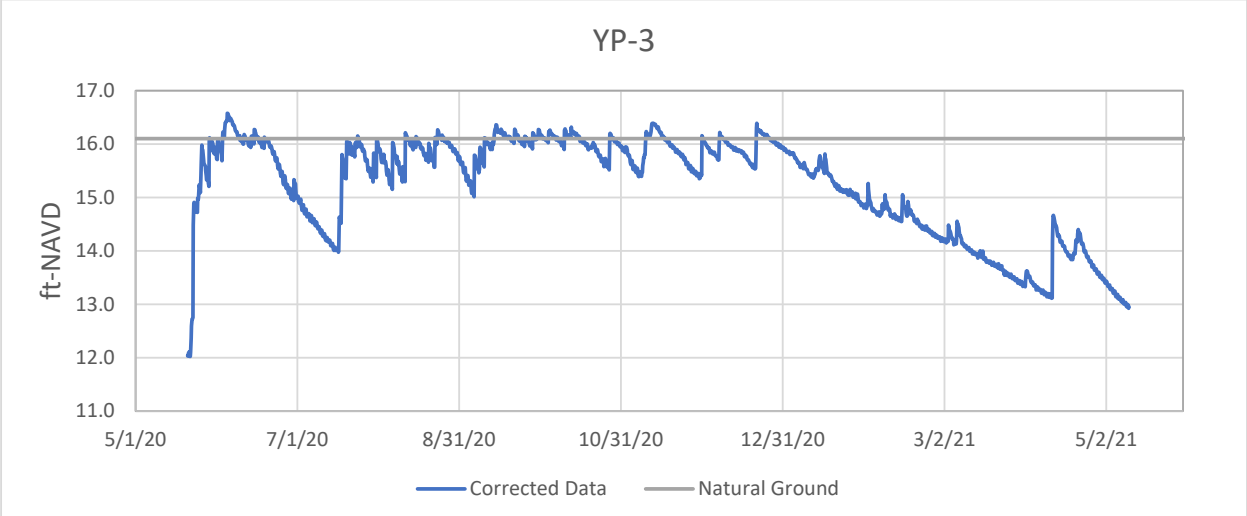

BW-16
ft-NAVD
29.0
28.0
27.0
26.0
25.0
24.0
23.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Collected Data
Natural Ground

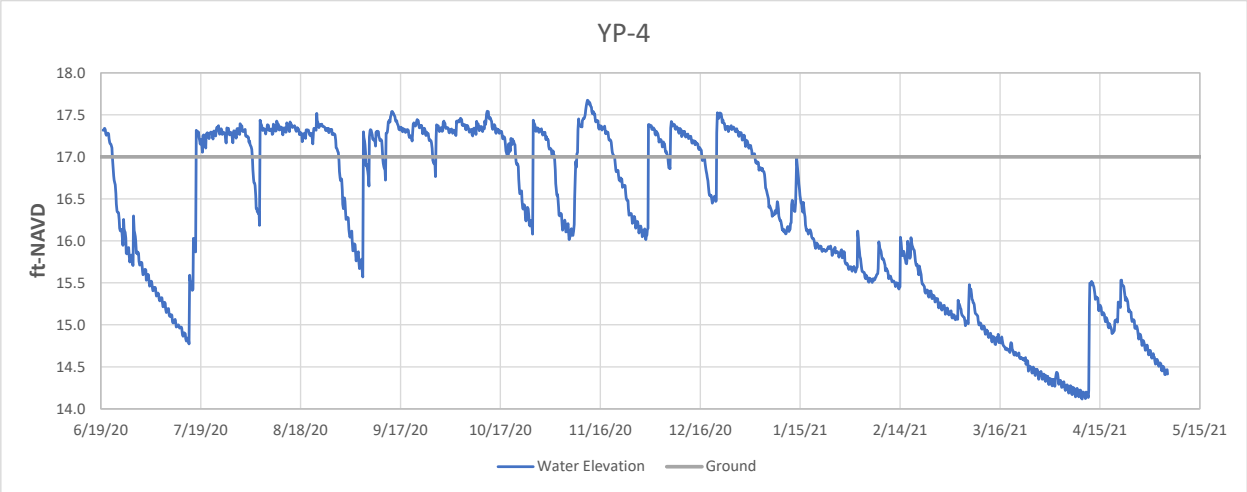

BW-17
ft-NAVD
25.0
24.0
23.0
22.0
21.0
20.0
19.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Collected Data
Natural Ground

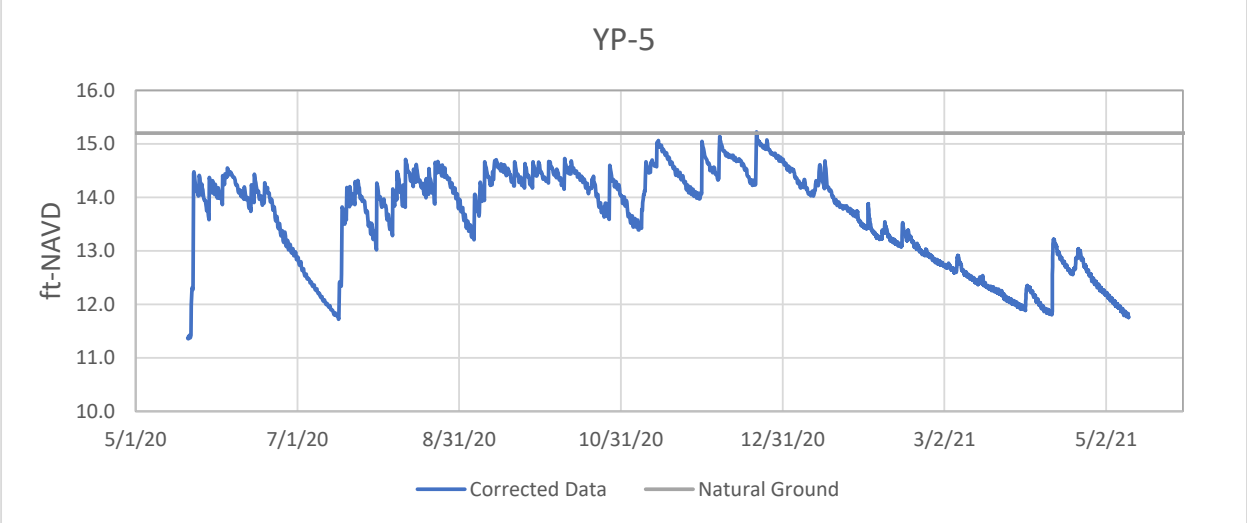

BW-18
ft-NAVD
26.0
25.0
24.0
23.0
22.0
21.0
20.0
19.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected Data
Natural Ground

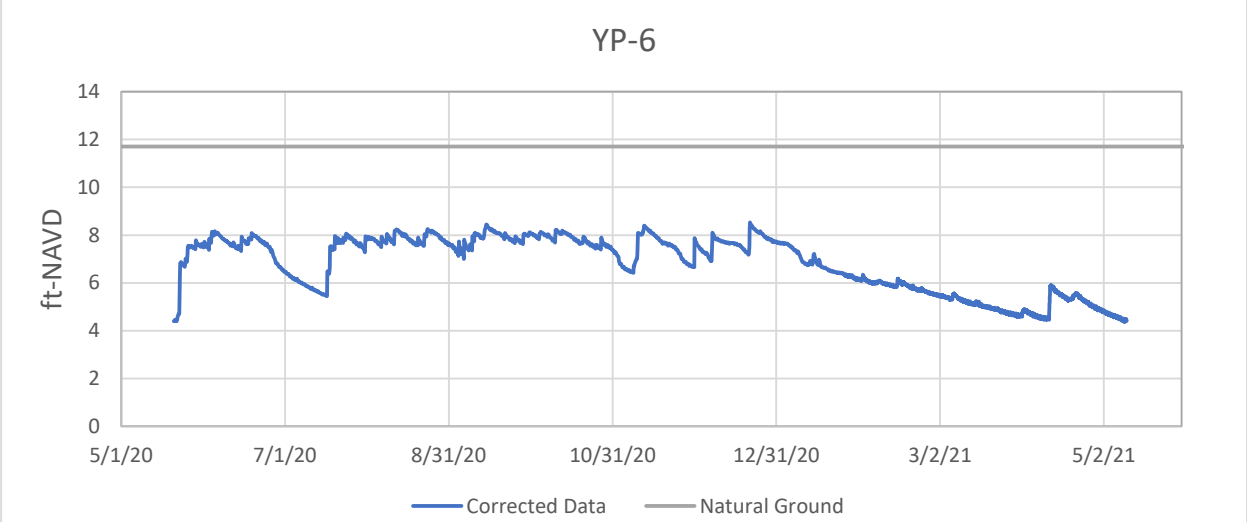

BW-19
25.0
24.0
23.0
22.0
21.0
20.0
19.0
ft-NAVD
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected Data
Natural Ground

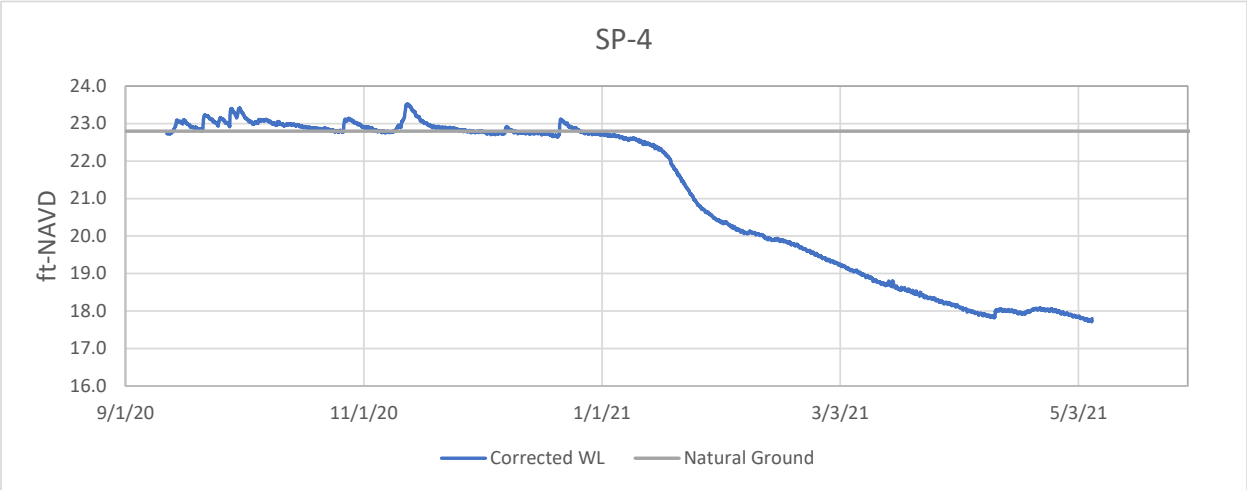

BW-20
25.0
24.0
23.0
22.0
21.0
20.0
19.0
ft-NAVD
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected Data
Natural Ground


YP-3
17.0
16.0
15.0
14.0
13.0
12.0
11.0
ft-NAVD
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected Data
Natural Ground

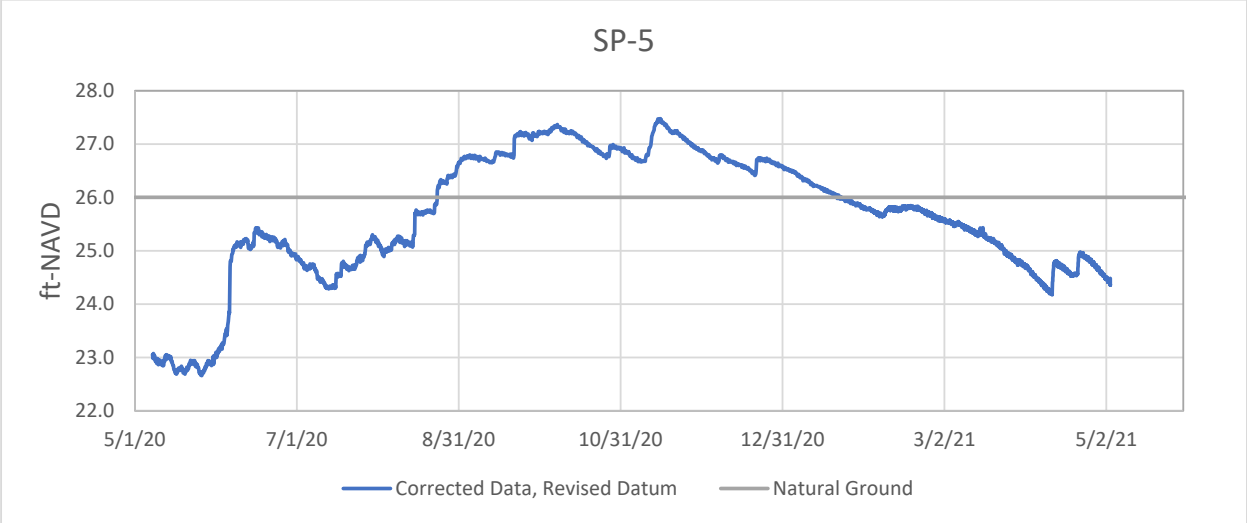

YP-4
ft-NAVD
18.0
17.5
17.0
16.5
16.0
15.5
15.0
14.5
14.0
6/19/20
7/19/20
8/18/20
9/17/20
10/17/20
11/16/20
12/16/20
1/15/21
2/14/21
3/16/21
4/15/21
5/15/21
Water Elevation
Ground

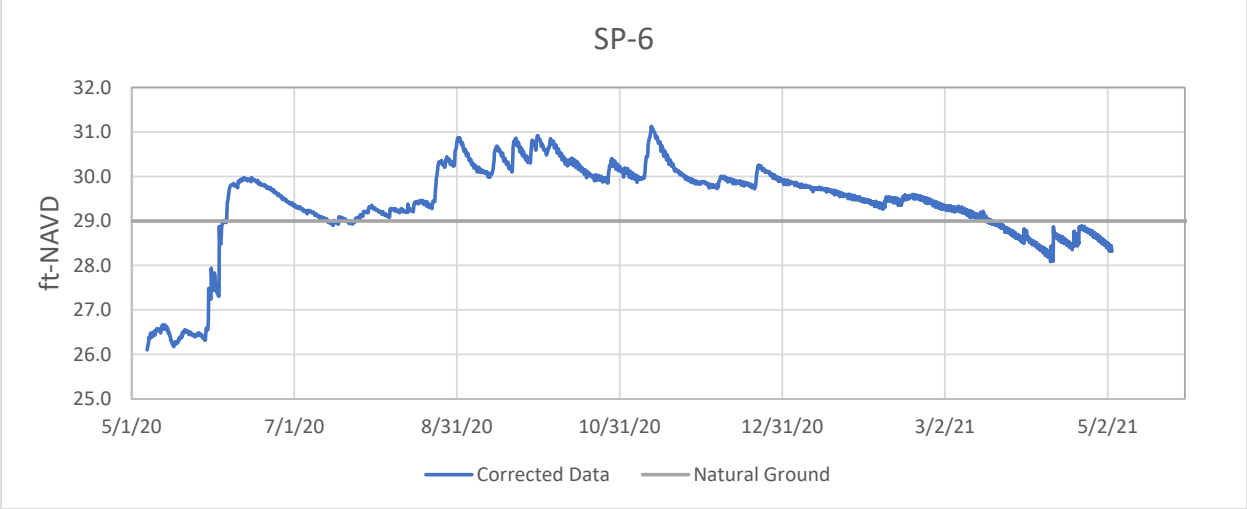

YP-5
ft-NAVD
16.0
15.0
14.0
13.0
12.0
11.0
10.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected Data
Natural Ground

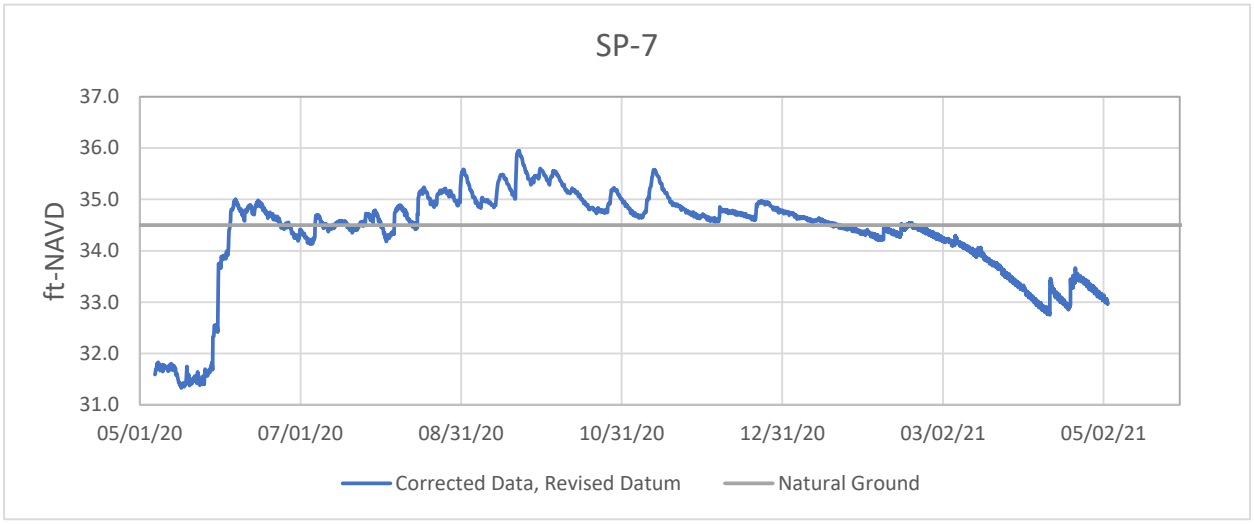

YP-6
ft-NAVD
14
12
10
8
6
4
2
0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected Data
Natural Ground

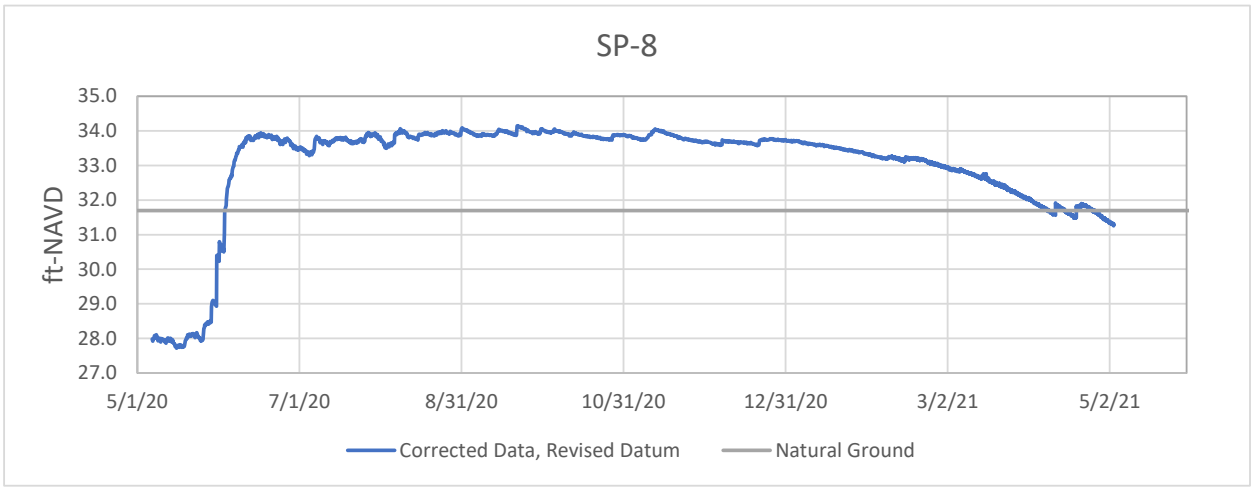


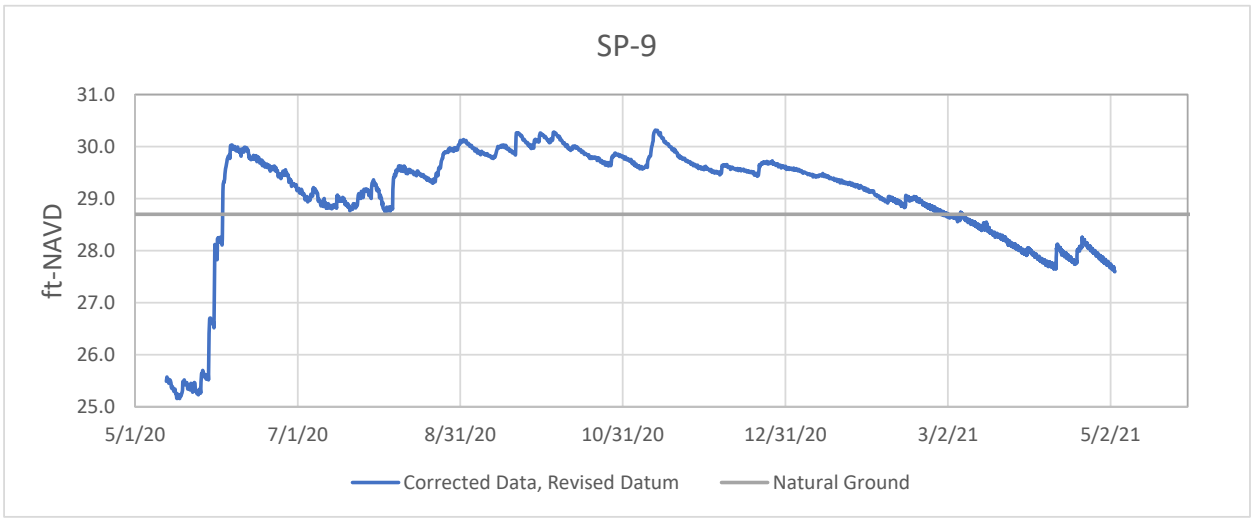
Note: The time series is shorter than at other stations because this station was vandalized

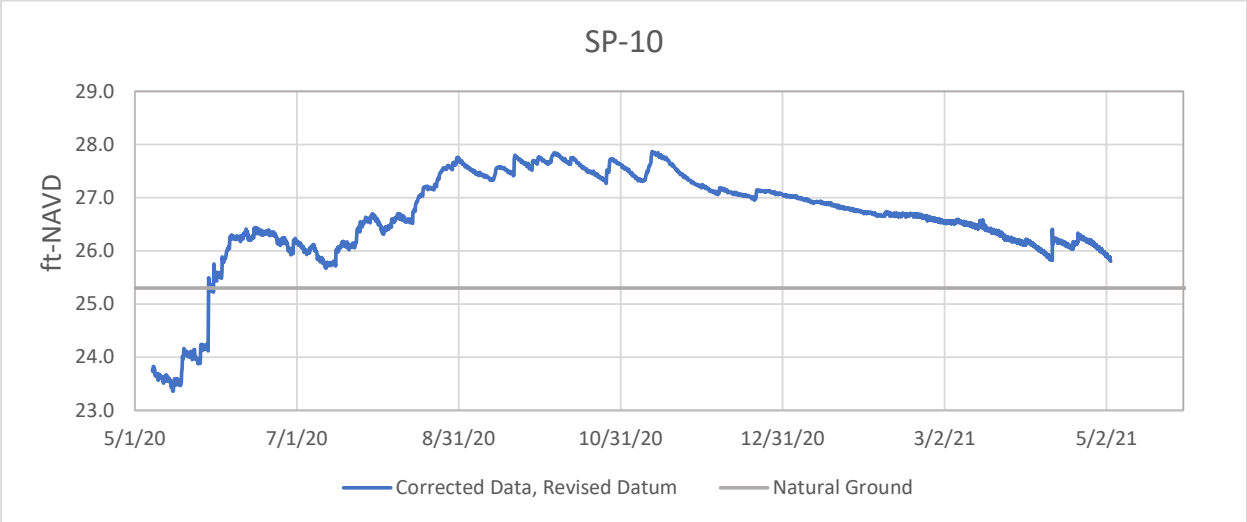


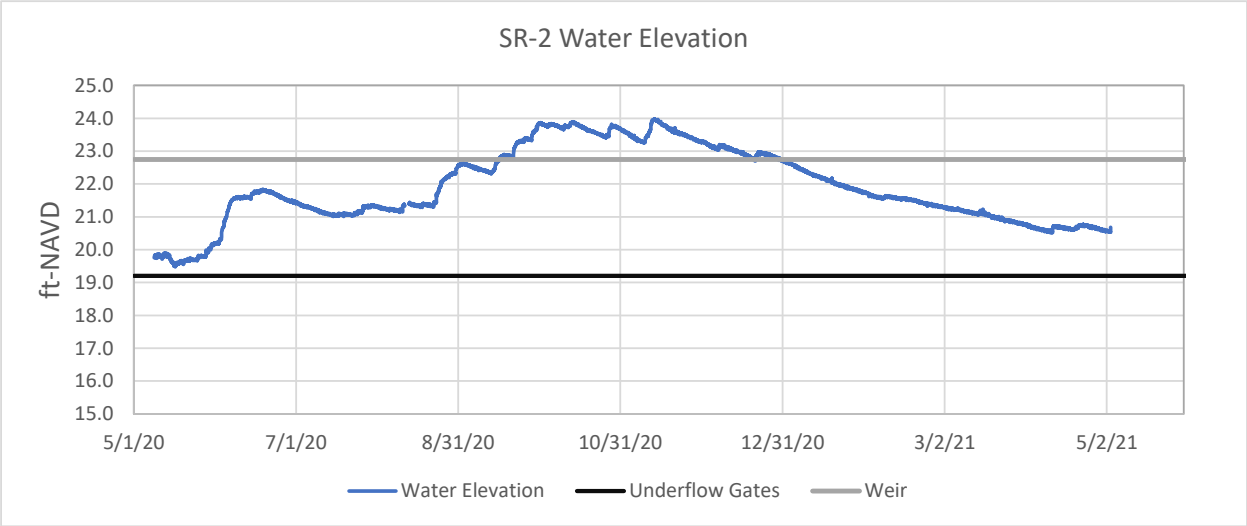



SP-7
37.0
36.0
35.0
34.0
33.0
32.0
31.0
ft-NAVD
05/01/20
07/01/20
08/31/20
10/31/20
12/31/20
03/02/21
05/02/21
Corrected Data, Revised Datum
Natural Ground


SP-8
35.0
34.0
33.0
32.0
31.0
30.0
29.0
28.0
27.0
ft-NAVD
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected Data, Revised Datum
Natural Ground

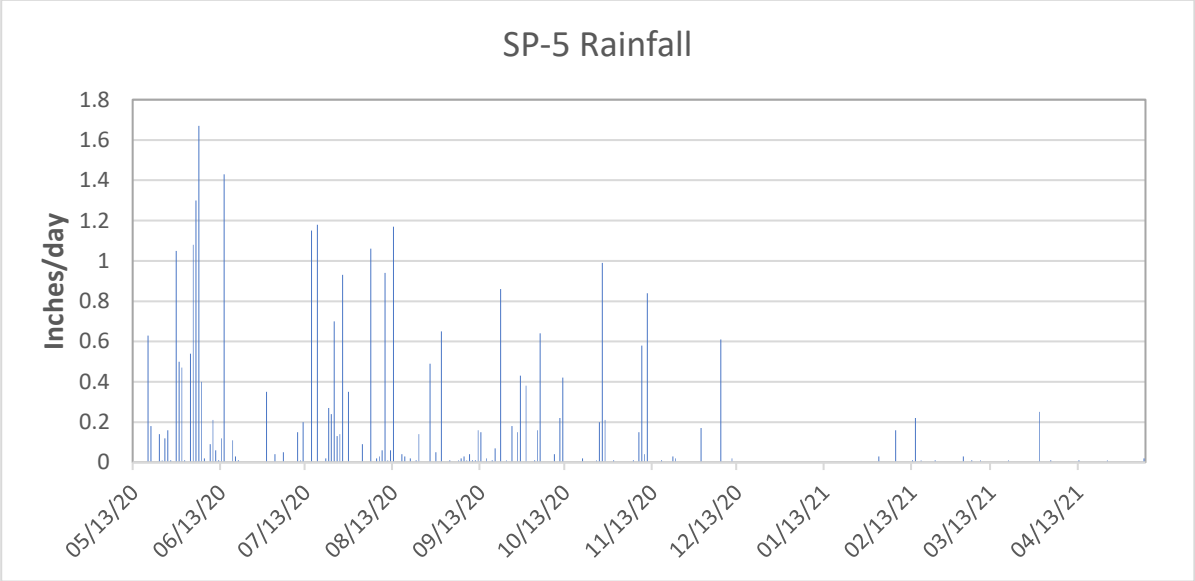

SP-9
31.0
30.0
29.0
28.0
27.0
26.0
25.0
ft-NAVD
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected Data, Revised Datum
Natural Ground

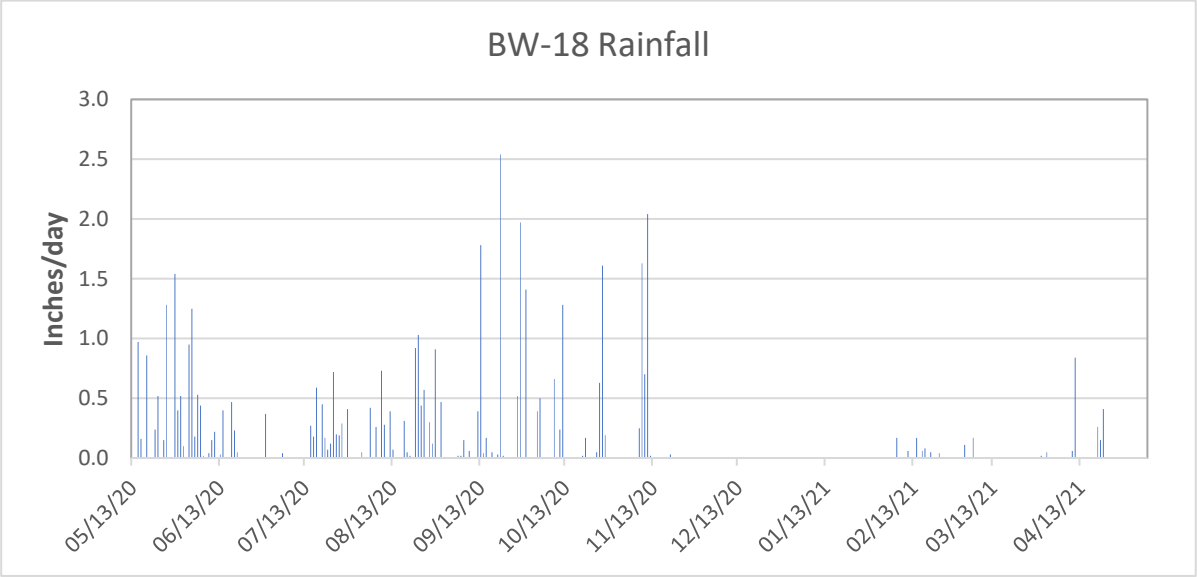

SP-10
ft-NAVD
29.0
28.0
27.0
26.0
25.0
24.0
23.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Corrected Data, Revised Datum
Natural Ground

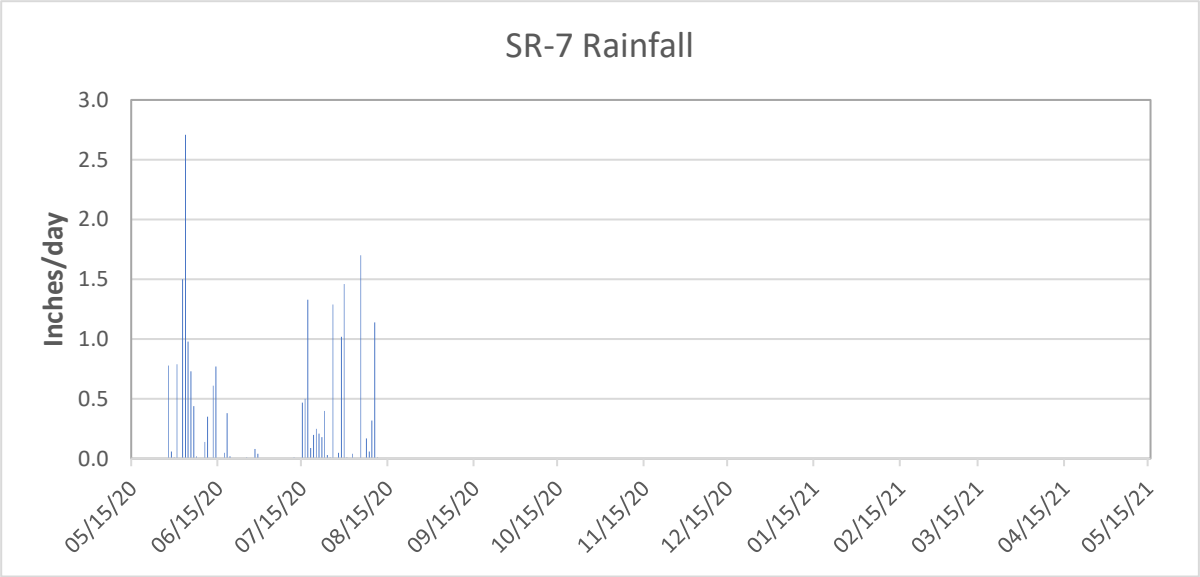

SR-2 Water Elevation
ft-NAVD
25.0
24.0
23.0
22.0
21.0
20.0
19.0
18.0
17.0
16.0
15.0
5/1/20
7/1/20
8/31/20
10/31/20
12/31/20
3/2/21
5/2/21
Water Elevation
Underflow Gates
Weir

Appendix 2

4th 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
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

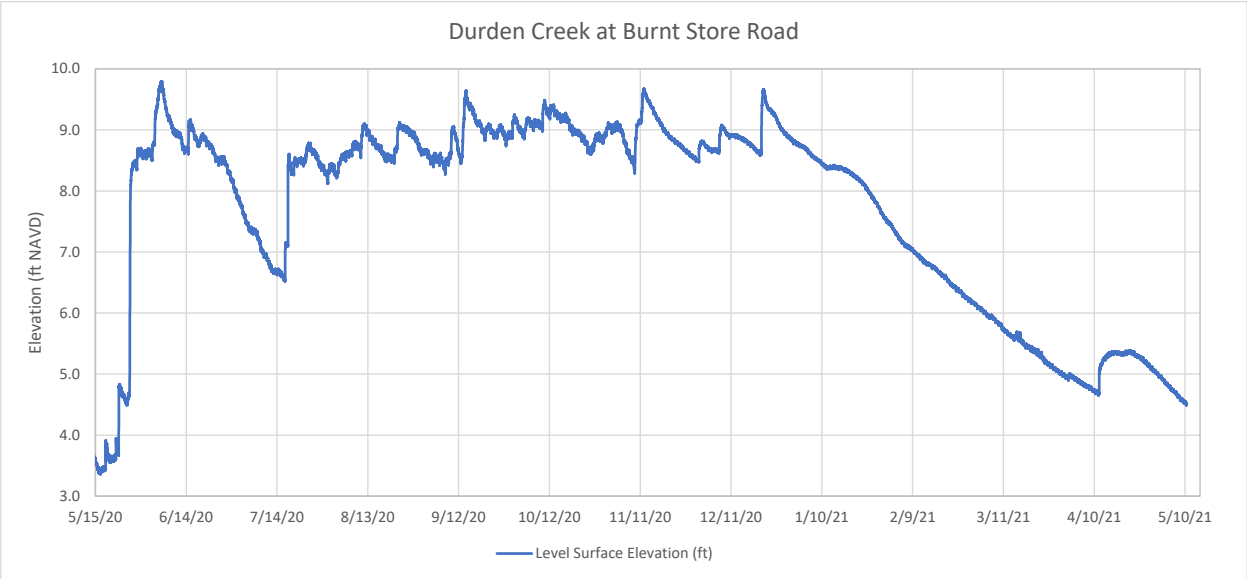

BW-18 Rainfall
Inches/day
3.0
2.5
2.0
1.5
1.0
0.5
0.0
05/13/20
06/13/20
07/13/20
08/13/20
09/13/20
10/13/20
11/13/20
12/13/20
01/13/21
02/13/21
03/13/21
04/13/21

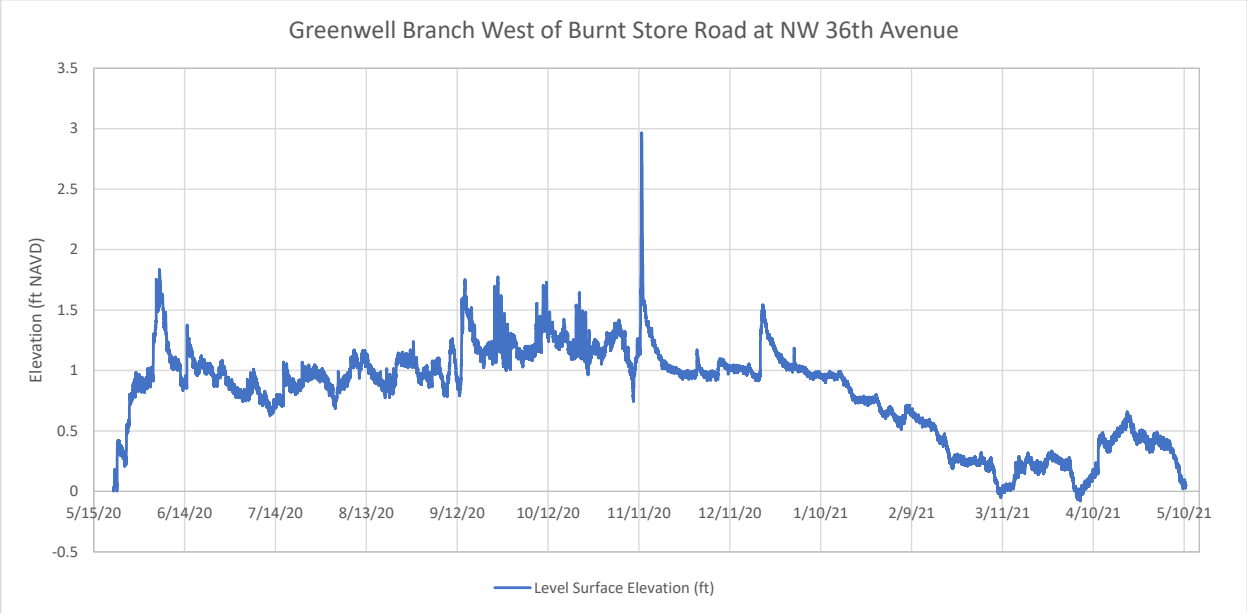

SR-7 Rainfall
Inches/day
3.0
2.5
2.0
1.5
1.0
0.5
0.0
05/15/20
06/15/20
07/15/20
08/15/20
09/15/20
10/15/20
11/15/20
12/15/20
01/15/21
02/15/21
03/15/21
04/15/21
05/15/21

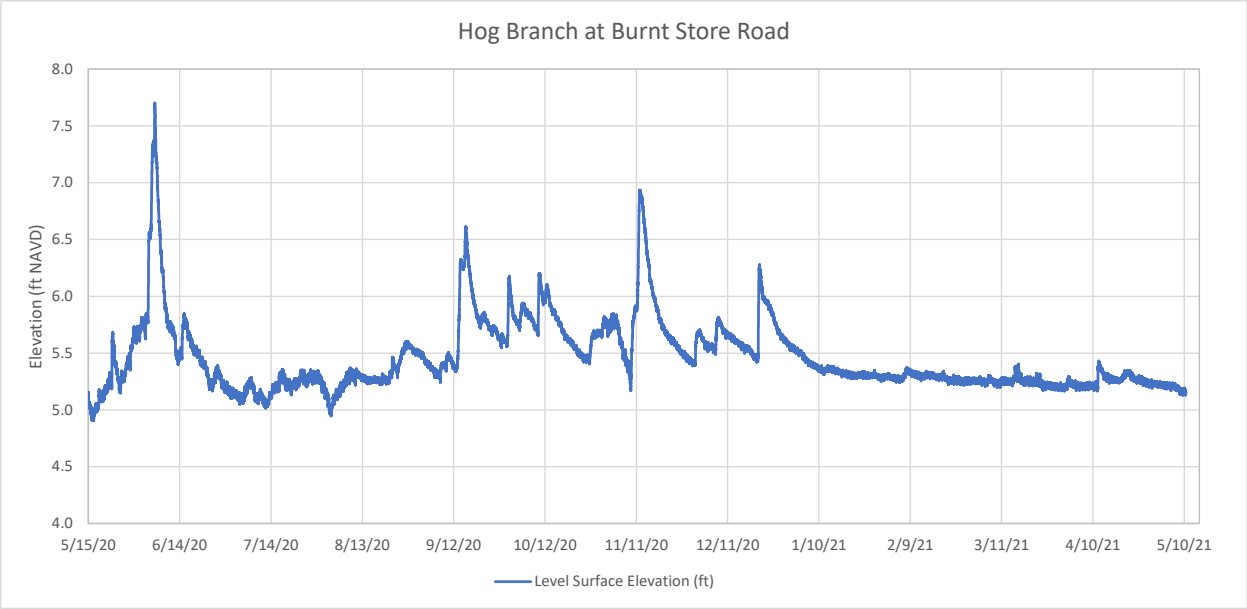
Appendix 3

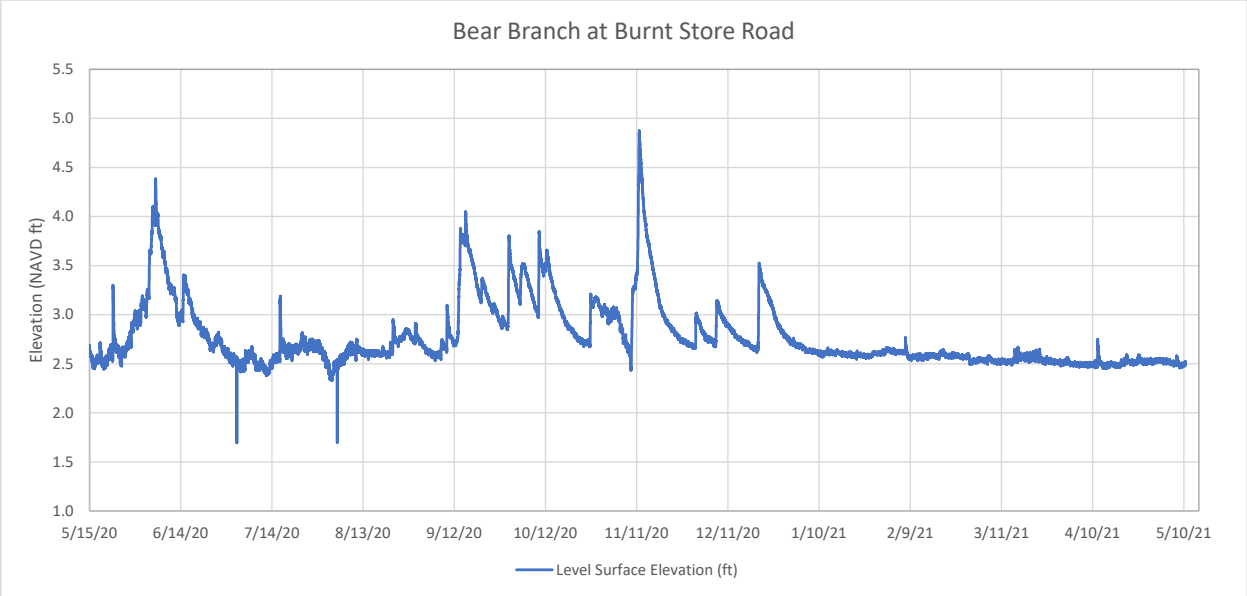
4th Quarter Flow Monitoring Station Data

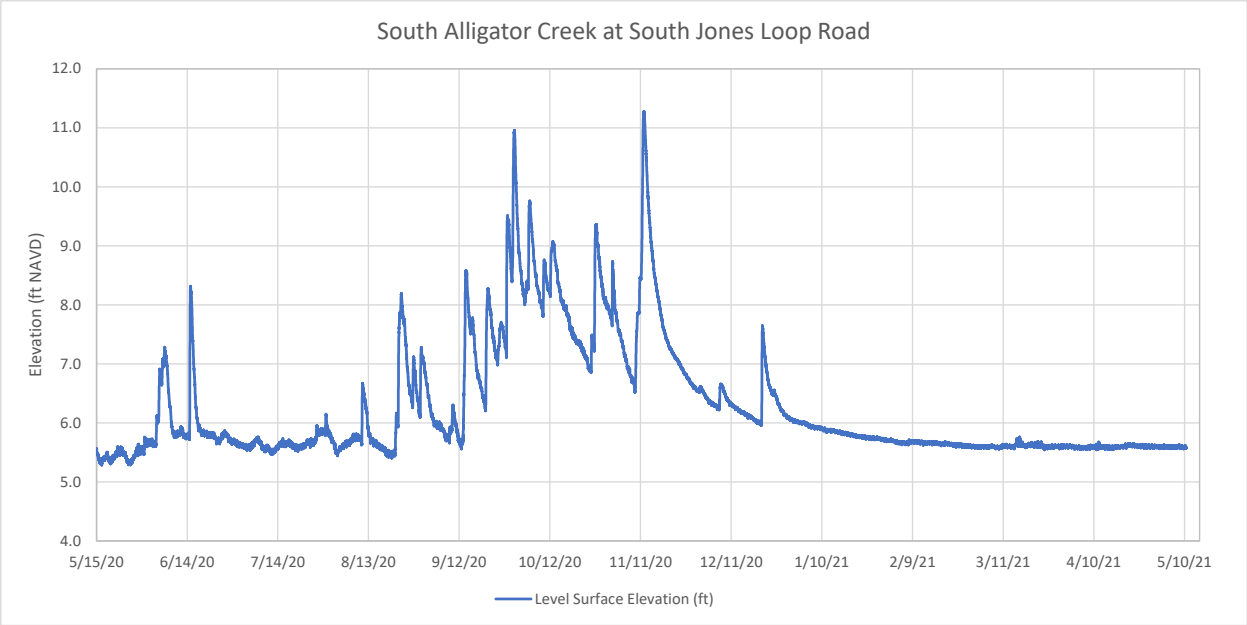
The graphs presented below provide measured water level data at flow monitoring stations. Measured water levels will be used with the final stage/discharge equations to estimate flows at the flow monitoring stations. The stage/discharge data collected to date are presented below in the table **CHNEP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



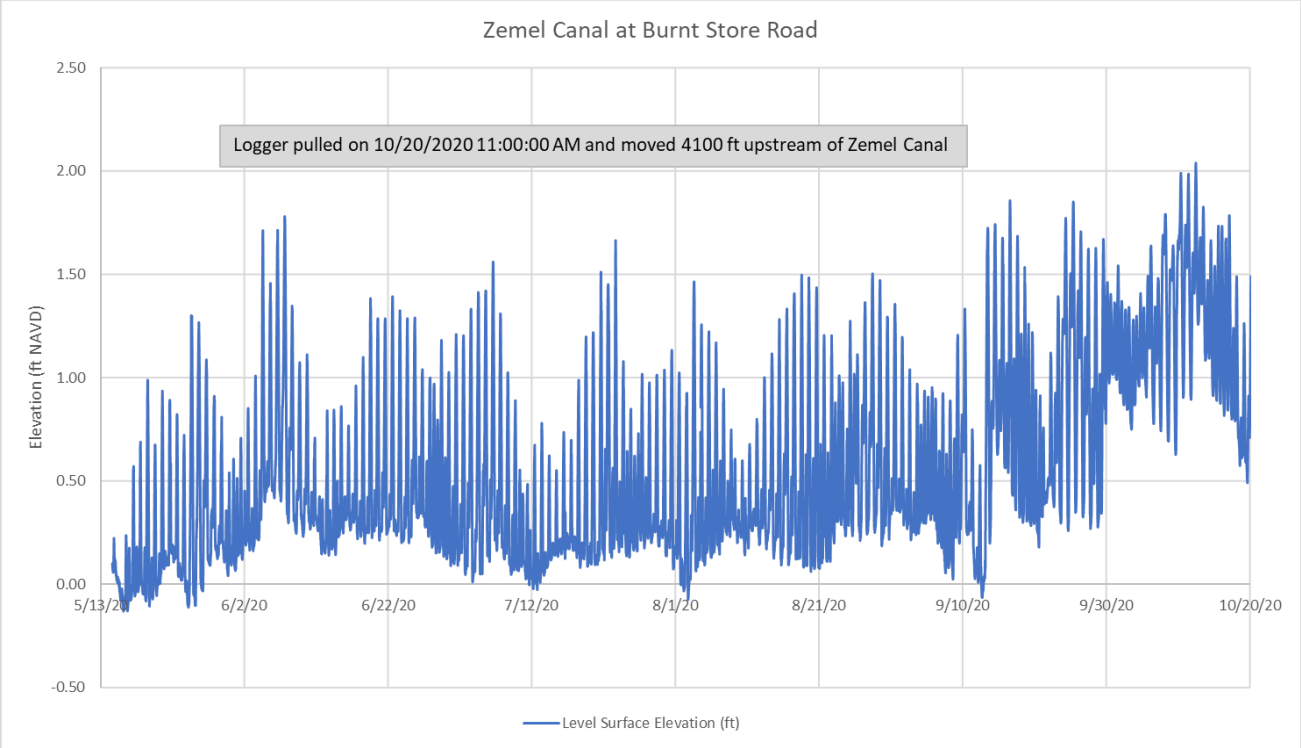


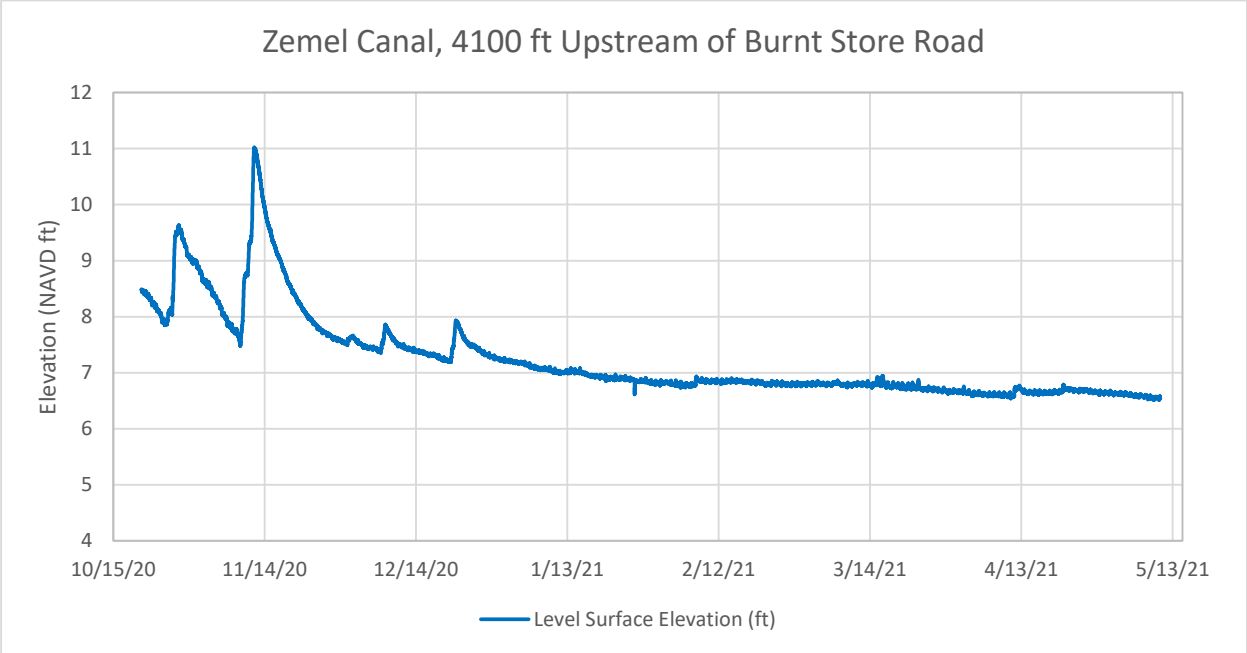

Hog Branch at Burnt Store Road
Elevation (ft NAVD)
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
5/15/20
6/14/20
7/14/20
8/13/20
9/12/20
10/12/20
11/11/20
12/11/20
1/10/21
2/9/21
3/11/21
4/10/21
5/10/21
Level Surface Elevation (ft)

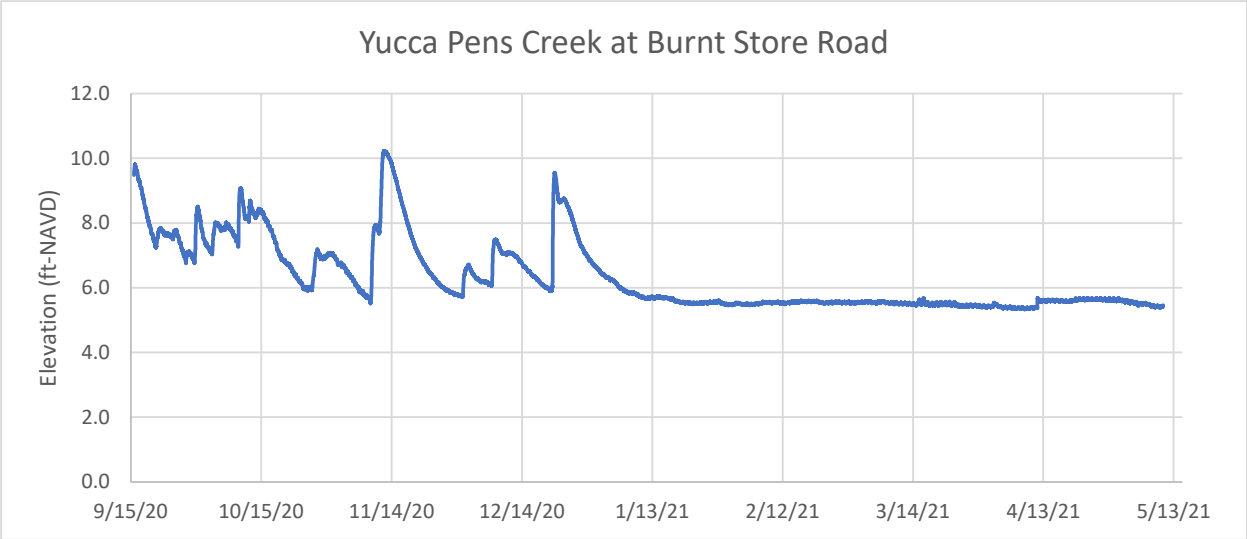

Bear Branch at Burnt Store Road
Elevation (NAVD ft)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
5/15/20
6/14/20
7/14/20
8/13/20
9/12/20
10/12/20
11/11/20
12/11/20
1/10/21
2/9/21
3/11/21
4/10/21
5/10/21
Level Surface Elevation (ft)

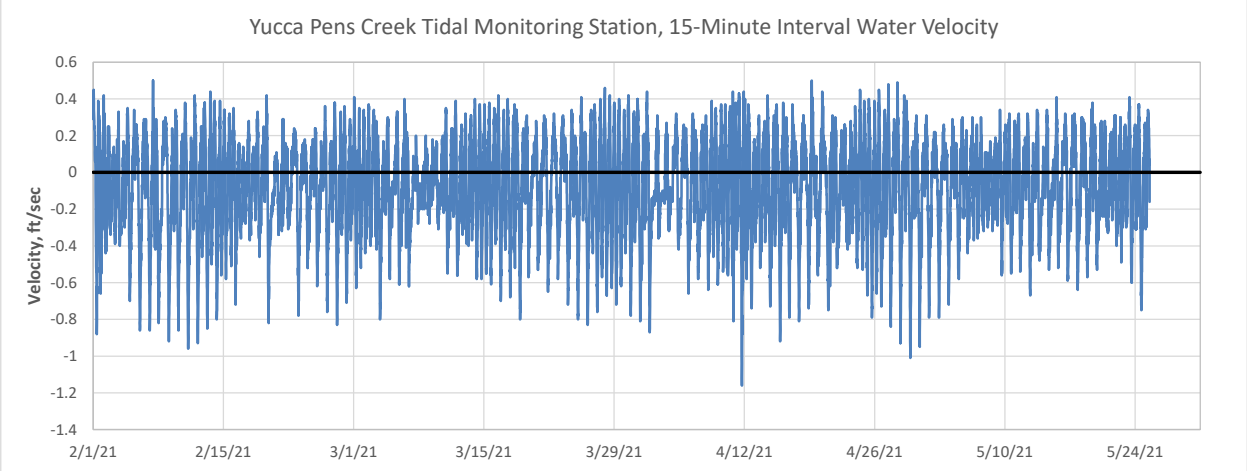

South Alligator Creek at South Jones Loop Road
Elevation (ft NAVD)
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
5/15/20
6/14/20
7/14/20
8/13/20
9/12/20
10/12/20
11/11/20
12/11/20
1/10/21
2/9/21
3/11/21
4/10/21
5/10/21
Level Surface Elevation (ft)

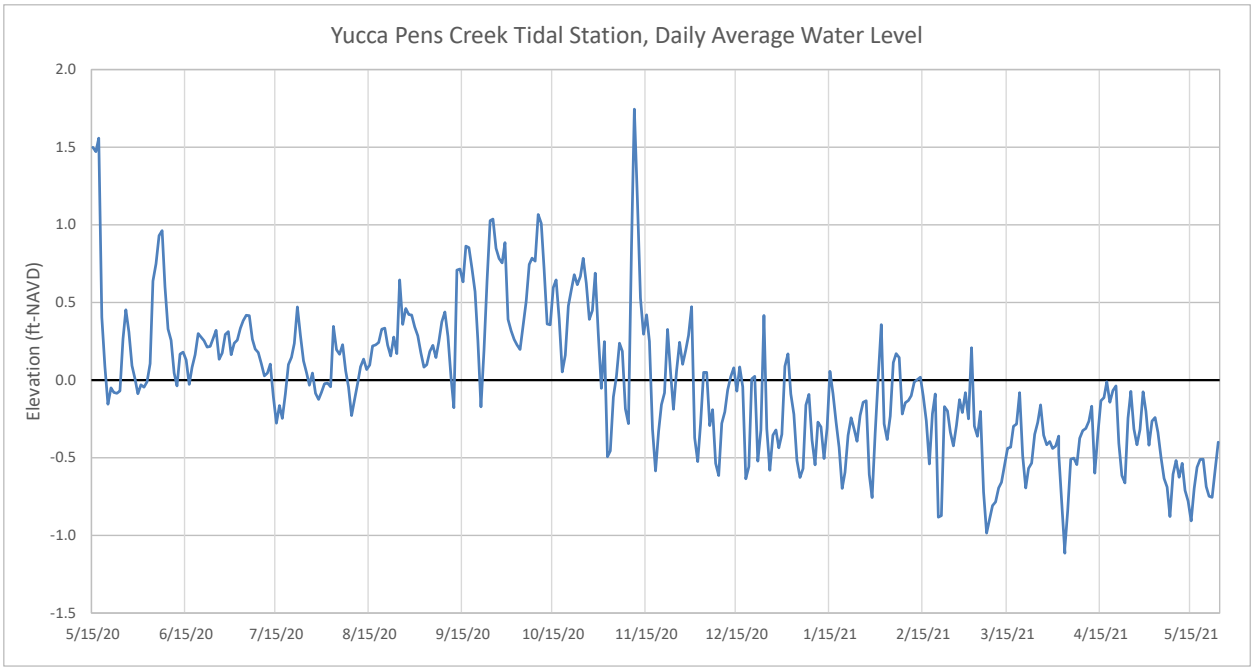

Winegourd Creek at Burnt Store Road
Elevation (ft NAVD)
15.0
14.5
14.0
13.5
13.0
12.5
12.0
11.5
11.0
10.5
10.0
5/13/20
6/2/20
6/22/20
7/12/20
8/1/20
8/21/20
9/10/20
9/30/20
Note: this station was abandoned on September 16, 2020 due to construction on Burnt Store Road that would have destroyed the station
Level Surface Elevation (ft)

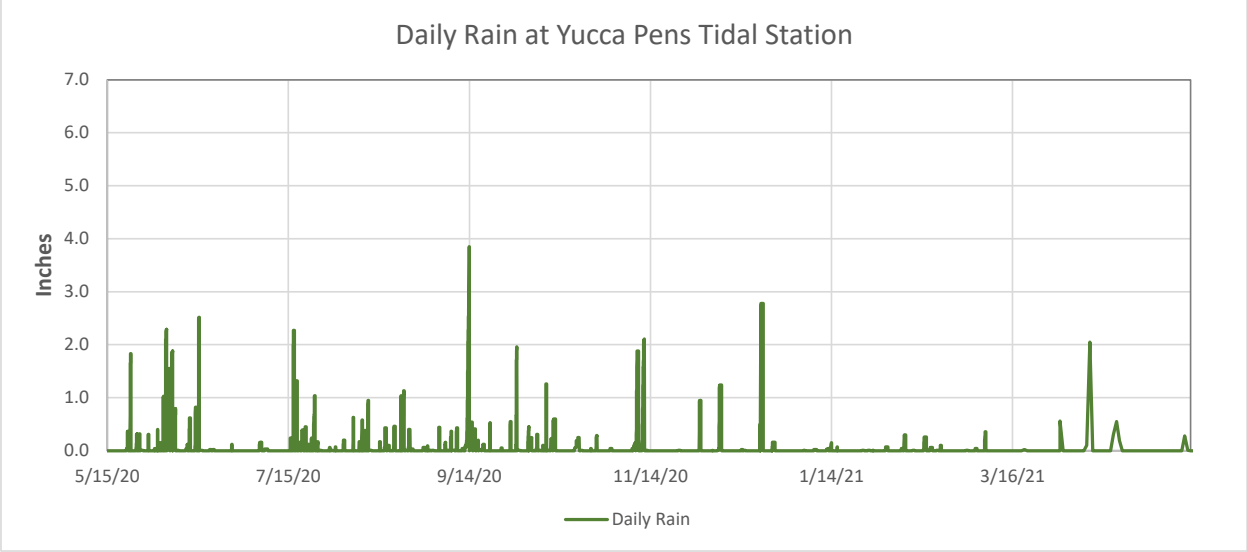

Zemel Canal at Burnt Store Road
Logger pulled on 10/20/2020 11:00:00 AM and moved 4100 ft upstream of Zemel Canal
Elevation (ft NAVD)
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
5/13/20
6/2/20
6/22/20
7/12/20
8/1/20
8/21/20
9/10/20
9/30/20
10/20/20
Level Surface Elevation (ft)


Zemel Canal, 4100 ft Upstream of Burnt Store Road
Elevation (NAVD ft)
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
Level Surface Elevation (ft)


Yucca Pens Creek at Burnt Store Road
Elevation (ft-NAVD)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
9/15/20
10/15/20
11/14/20
12/14/20
1/13/21
2/12/21
3/14/21
4/13/21
5/13/21


Yucca Pens Creek Tidal Monitoring Station, 15-Minute Interval Water Velocity
Velocity, ft/sec
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
2/1/21
2/15/21
3/1/21
3/15/21
3/29/21
4/12/21
4/26/21
5/10/21
5/24/21


Yucca Pens Creek Tidal Station, Daily Average Water Level
Elevation (ft-NAVD)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
5/15/20
6/15/20
7/15/20
8/15/20
9/15/20
10/15/20
11/15/20
12/15/20
1/15/21
2/15/21
3/15/21
4/15/21
5/15/21


Daily Rain at Yucca Pens Tidal Station
Inches
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
5/15/20
7/15/20
9/14/20
11/14/20
1/14/21
3/16/21
Daily Rain

Graphs of stage vs flow follow the tables

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

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

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

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

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

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

Flow Monitoring at the Yucca Pens Tidal Creek Monitoring Station

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 Mangroves (Estimated)
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 Mangroves (Estimated)
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 observed @ Constriction.
Upstr. @ Constriction	4b	8/10/2020	-0.62	4.66	P	Positive Flow - Outgoing Tide @ Gauging Station - Tidal Fluctuation observed @ Constriction.
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 observed @ Burnt Store Rd.
Upstr. @ Burnt Store Rd.	2	7/21/2020	5.91	0.72	F	Positive Flow - Outgoing Tide @ Gauging Station - No Tidal Fluctuation observed @ Burnt Store Rd.
Upstr. @ Burnt Store Rd.	3	8/10/2020	6.32	3.07	F	Positive Flow - Transistional Flow @ Gauging Station from Outgoing to Incoming - No Tidal Fluctuati
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
Upstr. @ Burnt Store Rd.	10	3/10/2021	5.50	Est. < 0.10	P	Observation
Upstr. @ Burnt Store Rd.	11	5/11/2021	5.42	Est. < 0.01	P	Observation - Trickle