Report of Shalda Creek Water Level Study 2017-2020

Little Traverse Lake Property Owners Association

Cleveland Township, Leelanau County, Michigan

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ATTACHMENTS

1.0 PURPOSE AND BACKGROUND

Gosling Czubak has been working for the Little Traverse Lake Property Owners Association (LTLPOA) since spring of 2014 investigating influences on Little Traverse Lake (LTL) water levels. Initial concerns revolved around the culverts at Traverse Lake Road and County Road 669 (CR 669) on Shalda Creek. Shalda Creek begins as the outlet of Little Traverse Lake and continues approximately 4 miles to Lake Michigan. A study was completed July 15, 2014 which focused on the culverts and what impacts they may have on the lake levels. Subsequent studies were completed in May 2015 and November 2015 which looked at the response of the Shalda Creek system to modifications to beaver dam restrictions that were present. Following review of the November 2015 report by the National Park Service (NPS) a new work plan was developed to continue study of the system in 2016 and 2017 and alleviate general concerns the NPS had with respect to data collection and analysis.

The major goals of the study were the following:

1. Continue observations of the Shalda Creek system response to beaver dam restrictions.
2. Verify a relationship between dam modifications and LTL water levels.
3. Identify the distance downstream where dam modifications do not significantly influence LTL levels.
4. Determine if maintaining a lower lake level at the end of summer will reduce property damage in the fall and spring.

2.0 SYSTEM OVERVIEW

2.1 Shalda Creek

Shalda Creek forms at the outlet of LTL at a culvert under Traverse Lake Road and continues meandering through Sleeping Bear Dunes National Park for approximately three miles towards Lake Michigan. A culvert at CR 669 and twin culverts at Lake Michigan Road are also along the route. The Overall Study Area map is included for reference as Attachment 1. This study is focused on the area extending downstream of LTL to just downstream of Beaver Dam 2. An aerial map titled “Shalda Creek Water Level Study Area” showing this immediate study area is included for reference as Attachment 2. The locations of dam modification points and water level gauge locations are pinned on this map.

2.2 Lime Lake

Lime Lake is an inland lake approximately the same size as LTL located approximately one mile to the south. An overall Lime Lake Area map is included for reference as Attachment 3. Shetland Creek forms at the outlet of Lime Lake and meanders northeast for nearly two miles where it enters LTL. There is a rock dam at the outlet of Lime Lake that "regulates" this lake level. There are monuments established on either side of the dam from which elevations can be referenced. After being escorted to the location of this dam by a member of the Lime Lake Association and interviewing them, it is understood there have not been any modifications to the dam in years. Input from Lime Lake into LTL are only what naturally occurs through the system. There is no reason to believe any large discharges from Lime Lake due to changing the dam level have occurred which could influence the data collected during this study.

3.0 DATA COLLECTION

In August 2016, the NPS deployed six data loggers at various locations within the Shalda Creek system to simultaneously record changes in water surface elevations in response to the experimental modifications of beaver dams conducted as part of the study. The data loggers were located at staff gauges previously located throughout the system. The locations of the data loggers were: 1) the upstream gauge in LTL; 2) the upstream gauge at CR 669; 3) the downstream gauge at CR 669; 4) the gauge just upstream of beaver dam 1; and 5) upstream of beaver dam 2 below the backwater influence of beaver dam 1. The sixth gauge was used to log barometric pressure and located along the east side of CR 669 about 125 feet north of Shalda Creek. A seventh data logger was deployed by the NPS on August 4, 2017 and placed at the downstream gauge of the LTL culvert.

The data loggers are noted by the NPS to record pressure at 15-minute intervals. Water surface elevations are calculated for each location by subtracting the barometric pressure from the recorded pressure and converting that pressure to a water depth. Each transducer was referenced to survey data and the water depths converted to a water surface elevation for each data logger location.

When Gosling Czubak received the data from the NPS in January, the referenced survey elevations in the data set were reviewed for correlation to the recorded water surface elevation records kept by the LTLPOA read from the staff gauges at each of the data logger locations. The reference elevations for each gauge were adjusted such that the data point logged at each location matched the LTLPOA reported elevation

for that time. Survey data was reviewed for water surface elevations at the dam gauge locations and correlation elevations for these points were determined. All the water surface elevation data points presented in this report are thus correlated to the NAVD 88 datum.

A common record of data for the initial data logger installation began on September 8, 2016. Following nearly 3 weeks of data logging to establish a base line, NPS authorized the removal of Dam 1. On September 28, 2016 representatives of the LTLPOA removed Dam 1. Following the installation of the seventh data logger on August 4, 2017, NPS authorized modifications to dam obstructions within Shalda Creek on August 5, 2017.

4.0 OBSERVATIONS

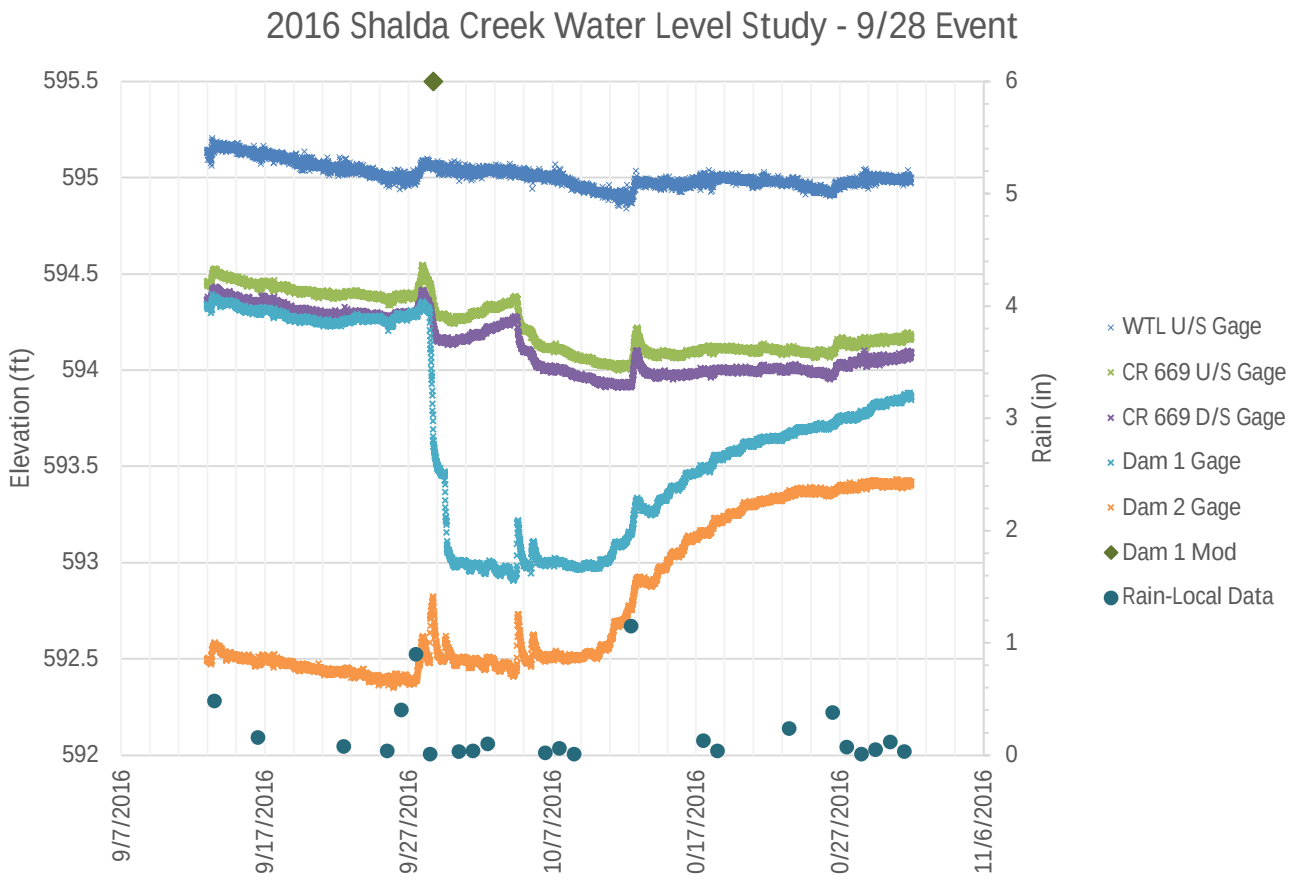
The NPS prepared a memo dated March 2, 2017 which presented the observations of the Fall 2016 study. That memo is included for reference as Attachment 4. A graph of that study data from September 13, 2016 to October 31, 2016 is shown in Figure 1. The general summary items as they are presented in that NPS memo are:

1) *Water surface levels were collected at five sites along Shalda Creek over the period of August 31, to October 27, 2016.*
2) *A beaver dam, Dam 1, was removed on September 28, 2016. This resulted in a relatively rapid water level decline immediately above the dam of about 0.4 meters 1.3 feet.*
3) *Water levels both up and downstream of County Road 669 gradually declined about 0.06 meters 0.2 feet over a period of five days.*
4) *The water surface measurements at Little Traverse Lake showed no discernable change related to the dam removal experiment.*

Figure 1 includes the precipitation data that was not included in the original NPS memo figures. The water surface elevation at Little Traverse Lake at the start of this study period is in the high range just above 595 and at the levels where erosion impacts are noticeable (595.2). Precipitation events of about .5 inches or more had the most visible effects in the system. An event of .48 inches on 9/13/2016 manifested in about a .1-inch rise in water surface elevation over 10 hours across the board. Just prior to the dam modification event, precipitation of .9 inches was measured that caused increases in the water surface elevations ranging from .14 to .22 inches over about 11 hours. A second large rain event two weeks later on 10/12/2016 of 1.15 inches was recorded and the water surface elevations responded by rising between .14 and .18 inches over 11 hours.

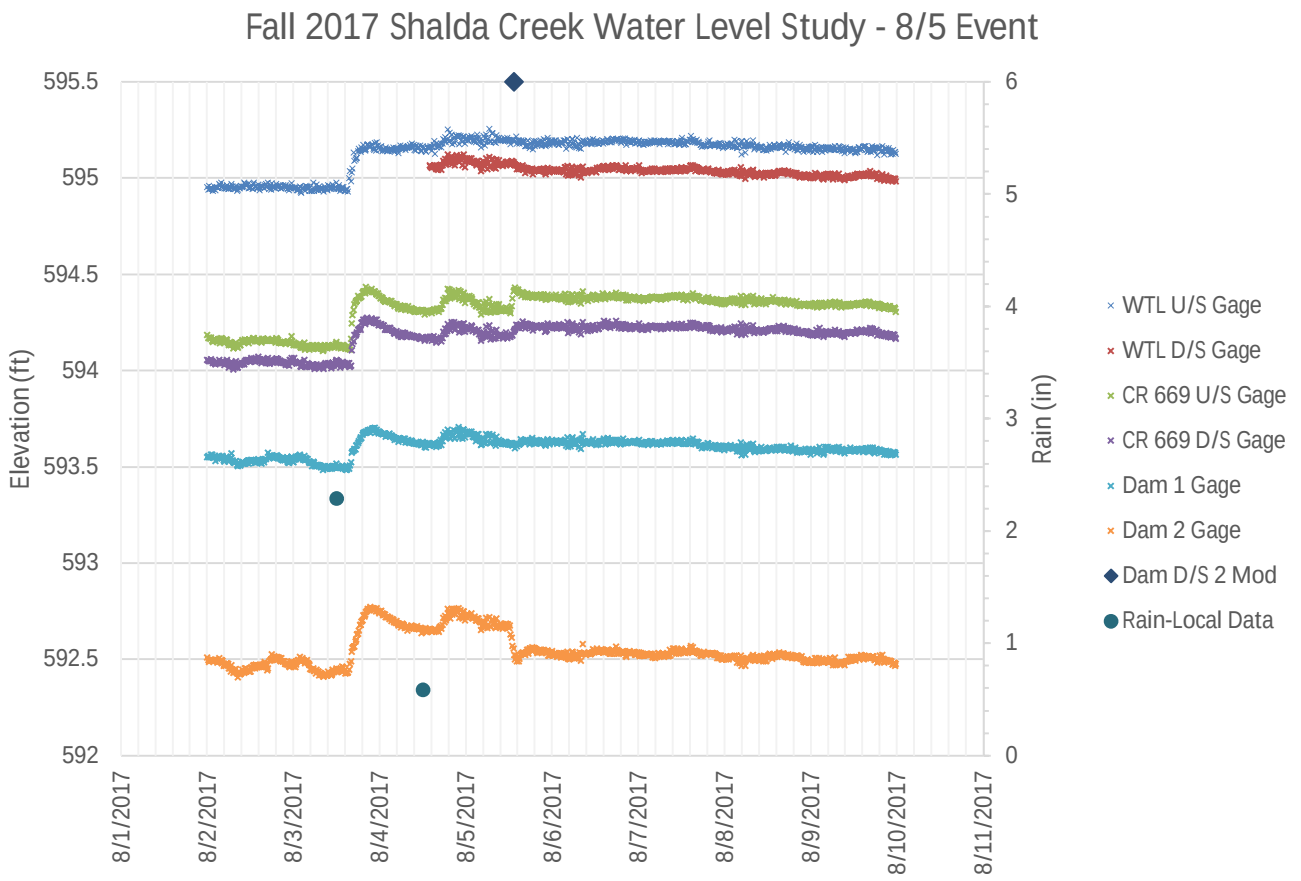
As noted by the NPS, the removal of Dam 1 showed water levels at the upstream gauge immediately drop 1.3 feet following dam removal and the water levels both up and downstream of County Road 669 gradually declined about 0.2 feet over a period of five days following the removal of the dam. The 1.3 feet of water level difference is indicative of a significant dam at this location. It should be noted that the decline does slow down and slightly rise following those first five days but does continue downward for another week and ends .4 feet lower before a rain event of 1.15 inches was recorded. The decline at Little Traverse Lake is less pronounced, however, it is still noticeable at .2 feet (2.2 inches) over the same two-week time period.

FIGURE 1.



The Fall 2017 study data presented in this report shows an overall graph of the water surface elevations beginning on July 29, 2017 one week before the first dam modification event on August 5, 2017. The overall graph continues through November 3, 2017 and is included as Attachment 5. Figure 2 below is a graph of the period surrounding the first dam modification event on August 5, 2017.

FIGURE 2.



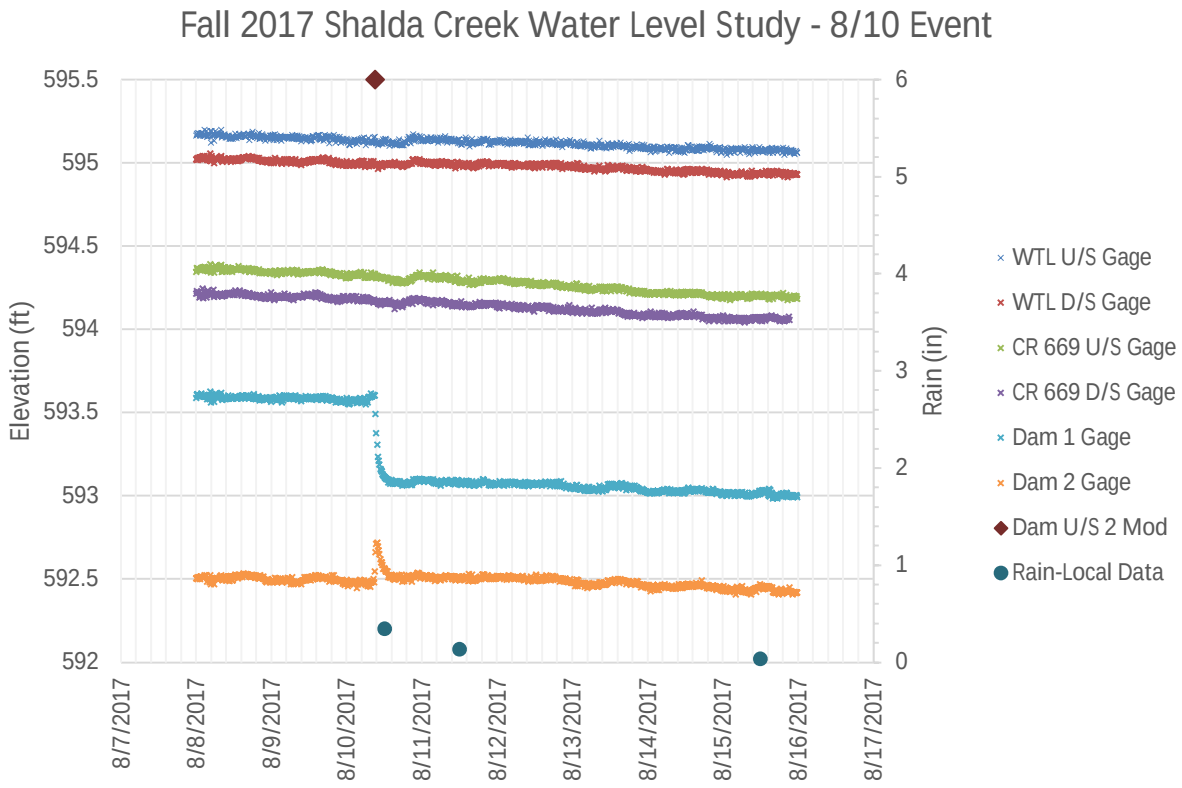
A description of the work conducted at the 8/5 dam modification event was prepared by the NPS and included for reference as Attachment 6. The location of this dam is just downstream approximately 200 feet of dam 2 and is noted as "Dam Mod D/S/ 2" on the Shalda Creek map. Prior to the 8/5/17 dam modification, significant rain events of 2.29 inches on 8/3/2017 and .59 inches on 8/4/2017 were recorded. Observations of the water surface elevations around these events are:

1) The 2.29-inch event pushed water levels up at the culvert gauges and dam 1 approximately .25 feet (3 inches) over 6 hours. The water level at dam 2 rose .33 feet (4 inches).
2) After the gauges peaked, all of them except the upstream LTL gauged trended down approximately .1 foot (1.2 inches) over 18 hours. The LTL gauge was relatively unchanged over this time period.
3) The .59-inch rain event produced a general increase of .1 foot (1.2 inches) over 6 hours.

4) Following the peak, LTL gauges remained relatively unchanged while the others trended down approximately .1 foot (1.2 inches) over 17 hours.
5) The removal of the dam downstream of dam 2 resulted in a drop in water surface elevation at the dam 2 gauge of .19 feet (2.28 inches) over approximately 3 hours. Gauges at CR 669 showed a small rise of .08 feet (1 inch) downstream and .12 feet (1.44 inches) upstream. The smaller 2.28-inch drop at the dam 2 gauge following removal of dam 2 is indicative of a smaller dam size. Noticeable drops upstream would not be expected, especially with dam 1 upstream.
6) The water surface elevation at LTL was relatively steady at 595.2 at the time of the dam modification and no significant change at the gauges was noticed.

Figure 3, below is a graph of the period surrounding the second dam modification event on 8/10/2017

FIGURE 3.

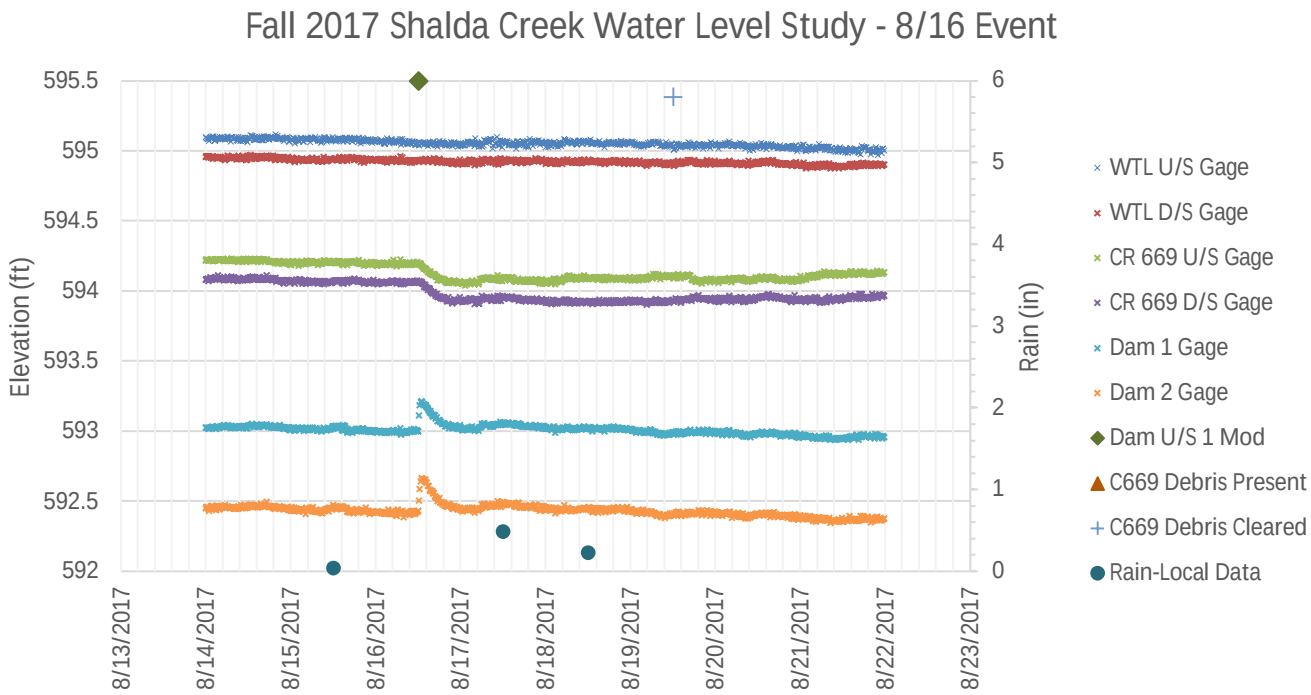


A description of the work conducted at the 8/10 dam modification event was prepared by the NPS and included for reference as Attachment 7. This event occurred at dam 1, also known as "Fishcamp", just upstream of dam 2 as shown on the Shalda Creek map. Dam 1 is approximately 4,000 feet downstream of CR 669. Observations of the water surface elevations around this modification event are:

1) The removal of dam 1 at this time resulted in a drop in water surface elevation at the dam 1 gauge upstream of .53 feet (6.4 inches) over approximately 6 hours. The 6.4-inch drop at the upstream dam 1 gauge is approximately half of what was observed the previous year.
2) The gauge upstream of dam 2 just downstream showed a rise of .25 feet (3 inches) over an hour and then returned to its relative starting point over the next 5 hours.
3) Gauges at CR 669 and LTL showed no significant change related to the dam modification event.
4) A rain event of .35 inches was recorded the same day of the dam modification. Small blips in the gauges less than .1 foot follow this rain event.
5) Smaller rain events (<.15 inch) occurred during this period which showed no noticeable changes in the gauges.

The period surrounding the third dam modification event is shown below in Figure 4. This dam is one that was found upstream of dam 1. Its location is noted on the Shalda Creek map as "Dam Mod U/S 1" and is located approximately 2,500 feet downstream of CR 669.

FIGURE 4.

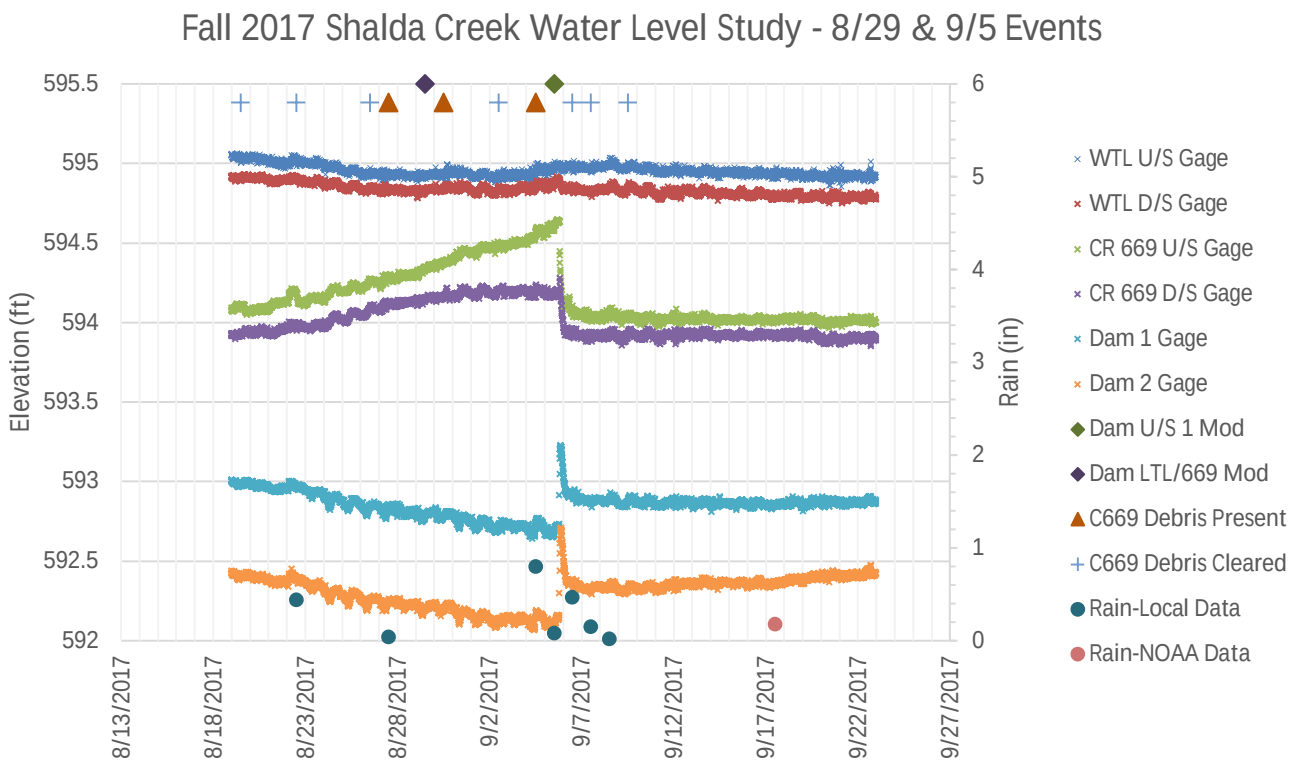


Observations of the water surface elevations around this modification event are:

1) The removal of the dam upstream of dam 1 at this time resulted in rises in both the gauges at dam 1 and dam 2 by about .2 feet (2.4 inches) over 2 hours followed by a return to their relative starting elevation over 12 hours.
2) The water surface elevations at CR 669 decreased .16 feet (1.92 inches) over the 12-14 hour period. This dam was located approximately 1,500 feet closer to CR 669 than dam 1 and the magnitude and duration of water level response at CR669 closely follows and is reflected in the downstream gauge patterns.
3) Water surface elevations at LTL showed no noticeable changes and the upstream lake level was 595.05 at the time of the dam modification.
4) A precipitation event of .49 inches was recorded on 8/17. Slight increases of approximately .05 feet (.6 inch) appear in the graphs.
5) Precipitation events on 8/15 and 8/18 were .04 inches and .23 inches respectively and resulted in no noticeable changes in measured water surface elevations.

The period surrounding the fourth and fifth dam modification events is shown below in Figure 5. The fourth event on 8/29 is the modification of a dam between LTL and CR 669. The fifth event on 9/5 is the same dam as the third event on 8/16.

FIGURE 5.



Observations of the water surface elevations around these two modification events are:

1) The modification of the dam between LTL and CR 669 showed no significant changes in water surface elevations at the gauges. The elevation at LTL upstream at this time was 594.9.
2) A presence of debris at the CR 669 upstream culvert is noted before and after the 8/29 event. A noticeable rise in water level at the upstream CR 669 gauge occurs while the downstream gauge is unchanged.
3) The removal of the dam upstream of dam 1 at this time resulted in rises in both the gauges at dam 1 and dam 2 by about .57 feet (6.84 inches) followed by a drop of .35 feet (4.2 inches) over 8 hours.
4) The water surface elevations at upstream CR 669 decreased .55 feet (6.6 inches) over a six-hour period. The water surface elevation at downstream CR 669 decreased .3 feet (3.6 inches) over the same period.
5) Water levels at upstream LTL were 595.0 at the time of this dam u/s 1 modification.
6) Five consecutive days of recorded precipitation occurred at the time of the dam u/s 1 modification event.

Two final modification events occurred for the Fall 2017 study. They were on 9/28/2017 and 10/28/2017. Figures 6 and 7 below show those events. No significant changes in water surface are noted from either the 9/28 or 10/28 event. Of note were two significant precipitation events on 10/23 and 10/24 of 1.63 and 3.08 inches, respectively. These events pushed the measured elevations up to the highest points measured during the study. During the period from 10/22 to 10/29, the water surface elevation of LTL rose .72 feet (8.64 inches) from 595.0 to 595.72.

FIGURE 6.

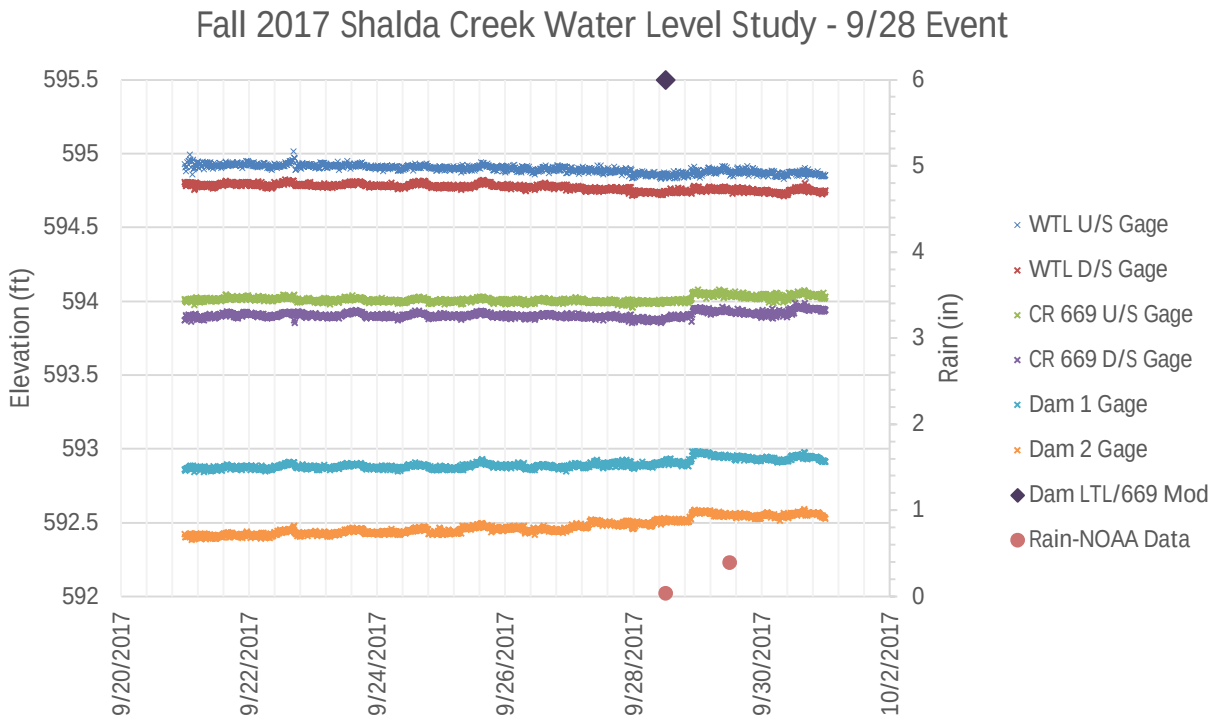
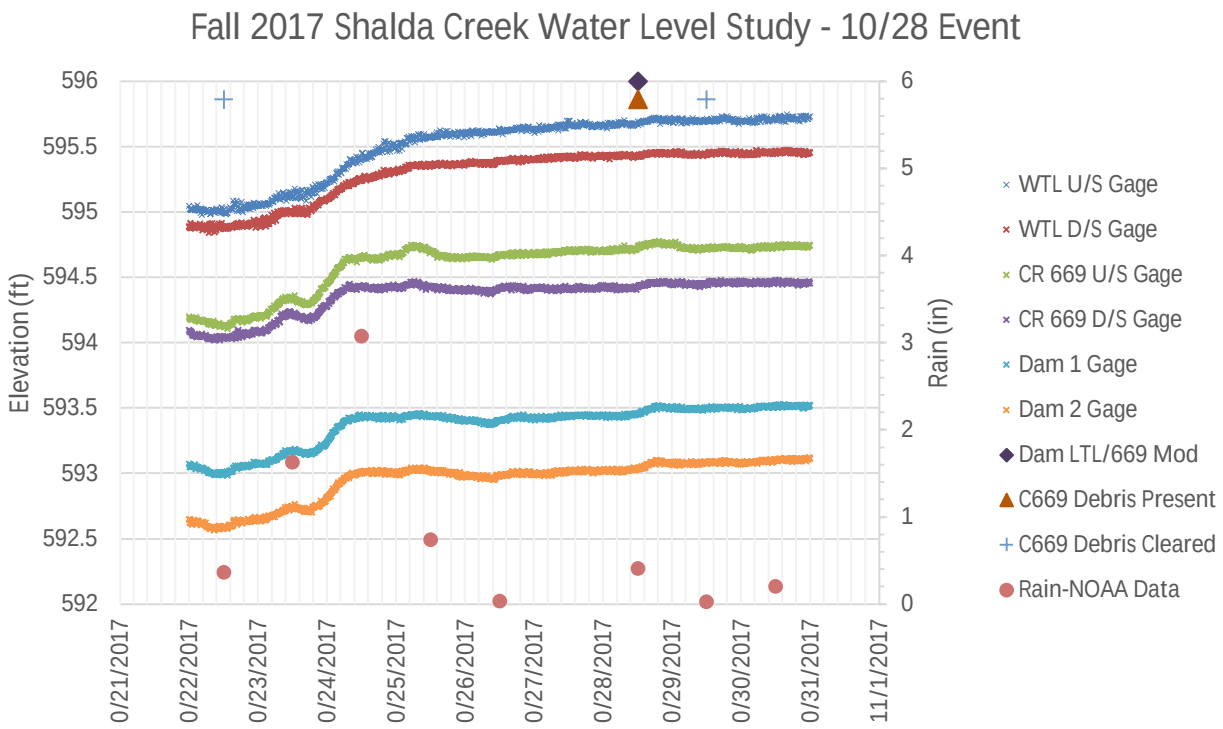


FIGURE 7.



In arriving at a conclusion regarding the impact of dam activity on water levels, it is important to take dam size into consideration. The dam 1 removal on 9/28/2016 led to an immediate 1.3 feet drop in water levels at the dam 1 gauge followed by smaller drops in both CR 699 and LTL levels. In comparison, the dam removal on 8/10/2017 led to a smaller 6.4-inch drop in water levels at the dam 1 gauge, with little impact on LTL levels. This dam was a reconstructed dam of smaller size than the original. Likewise, similar responses can be seen with the dam between CR 669 and LTL. The first recorded modification for the LTL/669 dam was on the 7/13/2016 event where a .75 feet water level drop at LTL was recorded. A modification of the same significant dam was completed almost a year later on 6/30/2017 where a .65 feet drop was recorded. The rebuilt dams at this location that were removed 8/29/2017, 9/28/2017, and 10/28/2017 were smaller in size with smaller observed water level impacts at the Little Traverse Lake culvert outlet side.

Prior to the Fall 2017 Study, there were previous studies completed as described earlier in this report with several significant data points worth including here again. Table 1 below summarizes the dam modification events referenced throughout this report. The first is the modification of dam 1 on

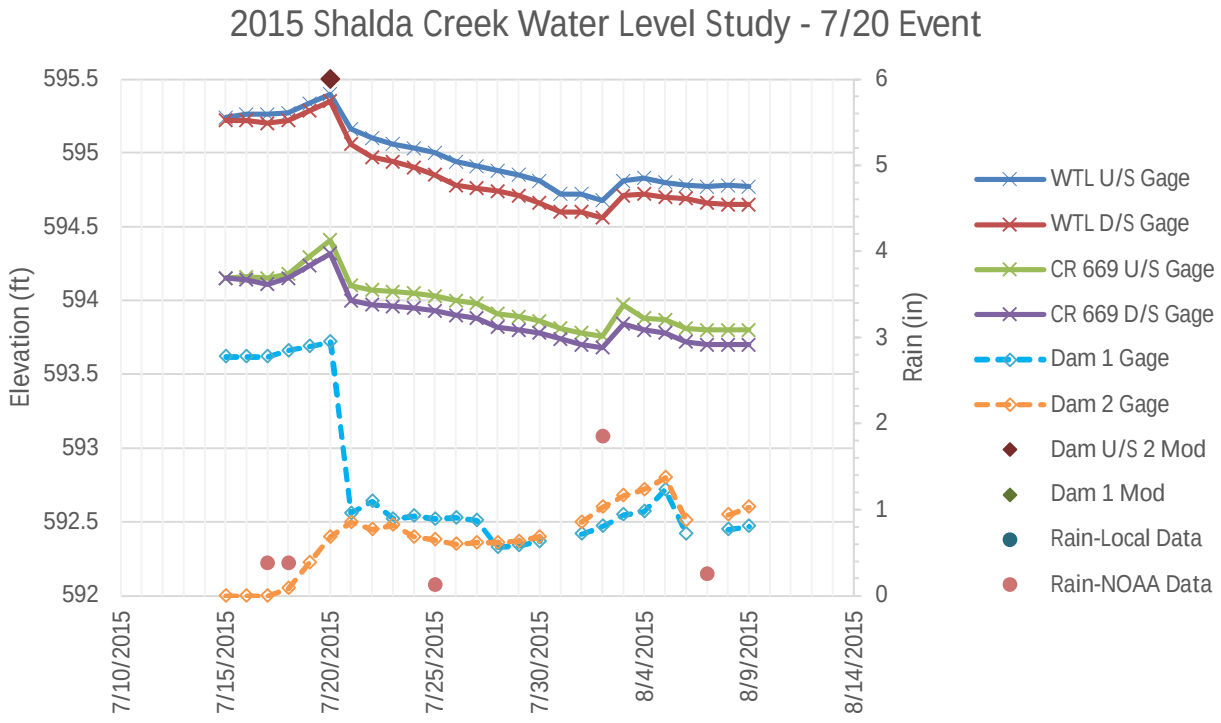
7/20/2015 shown below in Figure 8. The modification indicated the dam was of significant size impounding at least 1.16 feet of water when it was removed. At that point, the water level of LTL was at a high of 595.4. Following removal of the dam, it dropped .72 feet (8.64 inches) to a relative low of 594.68 over thirteen days when a significant rain event of 1.85 inches pushed levels up about .1 foot where the leveled off. The observed drop in water levels on at 669 were nearly the same magnitude. The downstream water level at CR 669 was 594.32 on 7/20 before the dam was modified and fell .64 feet (7.68 inches).

TABLE 1

Dam Modification Event Summary Table

		Date										
		7/20/2015	7/13/2016	9/28/2016	6/30/2017	8/5/2017	8/10/2017	8/16/2017	8/29/2017	9/5/2017	9/28/2017	10/28/2017
Dam	D/S Dam 2					X						
	Dam 1	X		X			X					
	U/S Dam 1							X		X		
	LTL/669		X		X				X		X	X
					= NPS data loggers in place							

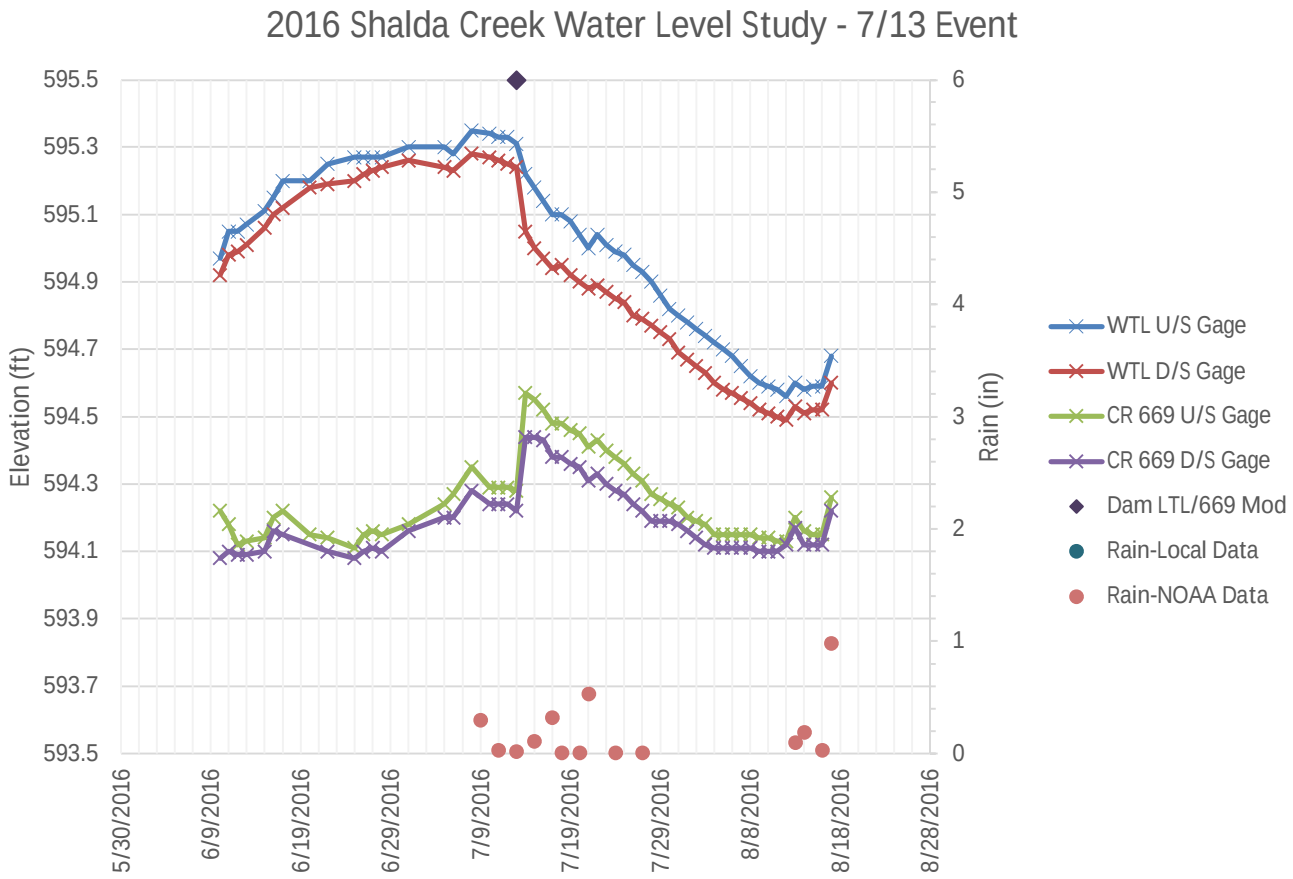
FIGURE 8.



A modification of the dam found between LTL and CR 669 was completed on 7/13/2016. This modification event is shown in Figure 9. At the time of this modification, the water level of LTL was again at a relative high of 595.3. Following the removal of the dam, it steadily dropped .75 feet (9 inches) over 30 days to 594.56.

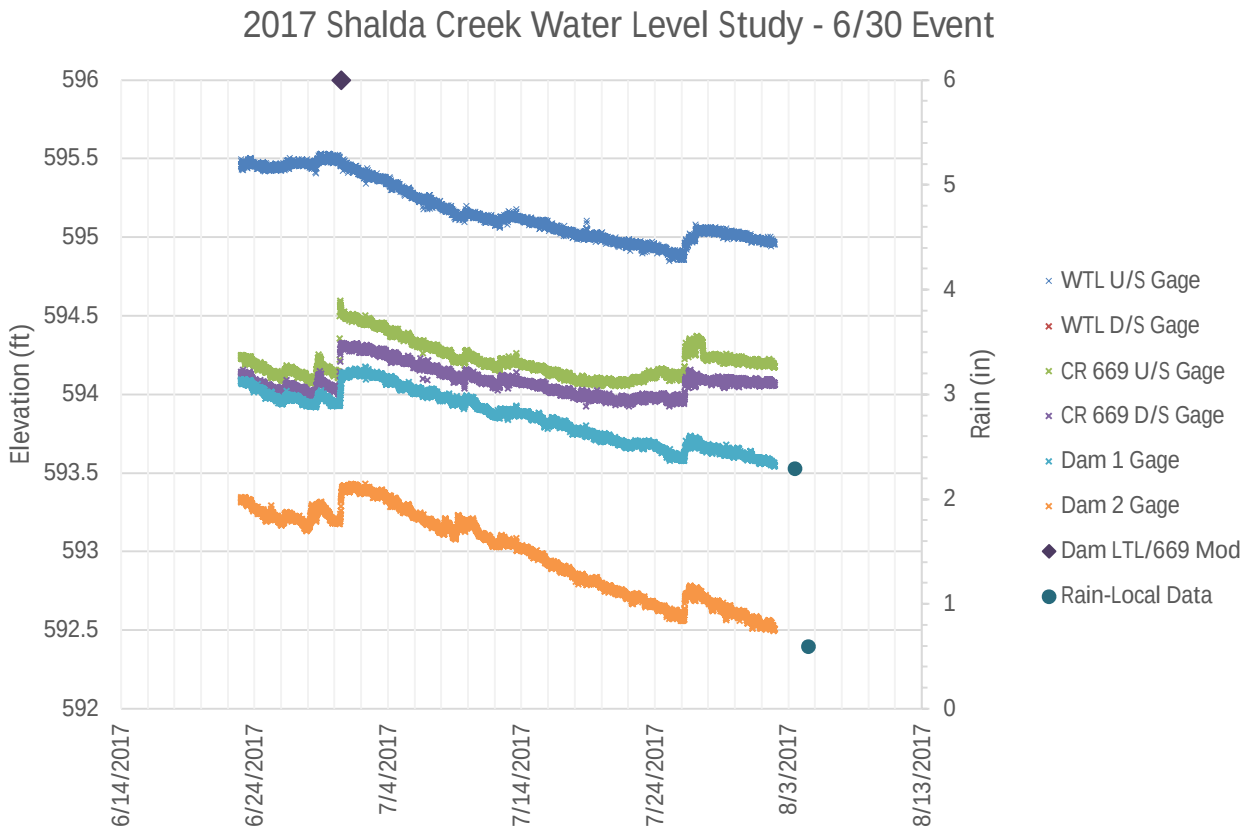
A comparison of the trend at the two culvert locations shows an important observation. LTL levels increase .36 feet from 6/10/2016 through 7/13/2016 while the U/S 669 levels decrease and ultimately only increase .07 feet over the same period of time. This observation suggests the presence of a beaver dam between the two locations interfering with the ability of water levels to respond normally.

FIGURE 9.



The final data set shown in Figure 10 is from data collected following a modification of the dam between LTL and CR 669 on 6/30/2017. Once again, the water surface elevation at LTL was relatively high at 595.5 when the dam was modified. LTL levels immediately prior to dam removal were steady while water levels at CR 669 were decreasing during this same time. Following its modification, there were quick upticks in elevation at the downstream gauges followed by steady decline of water levels over approximately 1 month. During this period, the LTL level declined .65 feet (7.8 inches).

FIGURE 10.



5.0 CONCLUSIONS – 2015 - 2017 STUDY DATA

Based on observing water levels at the various locations identified before and after the dam modification events, the following conclusions can be made:

1) Greatest response to modification events seemed to occur when LTL water levels were greater than 595.0

2) At LTL water levels at or below 595.0, modifications to dams 1 and 2 furthest downstream showed little effect to LTL water levels.
3) The size of a dam is a contributing factor on the impact of water level responses after dam removal, particularly downstream from CR669.
4) LTL water levels increase prior to removal of significant dams between LTL and CR669 followed by significant drops in LTL water levels following dam removal.
5) Keeping the section between LTL and CR669 clear of dam obstructions will help alleviate periods of high-water elevations above 595.0

6.0 POST 2017 - PRESENT DATA

The Little Traverse Lake Property Owners Association has kept records of water levels at both the Traverse Lake Road and County Road 669 crossings for many years. Water levels records were maintained following the termination of the deployment of the data logger data collection in conjunction with the National Park Service previously described in this report. Reported water levels were read from the staff gauges located at the inlets and outlets of both culverts and correlated to the NAVD 88 vertical elevation datum with previously documented correction factors of .8 added to readings at Traverse Lake Road and .7 added to readings at County Road 669. Raw gauge readings are published by the LTLPOA at http://www.littletraverselake.org/lake-levels.html. Graphs of the data for 2018 to present 2020 are attached as Figures 11-13. Enlarged graphs of the 2020 data are attached as Figures 14-15.

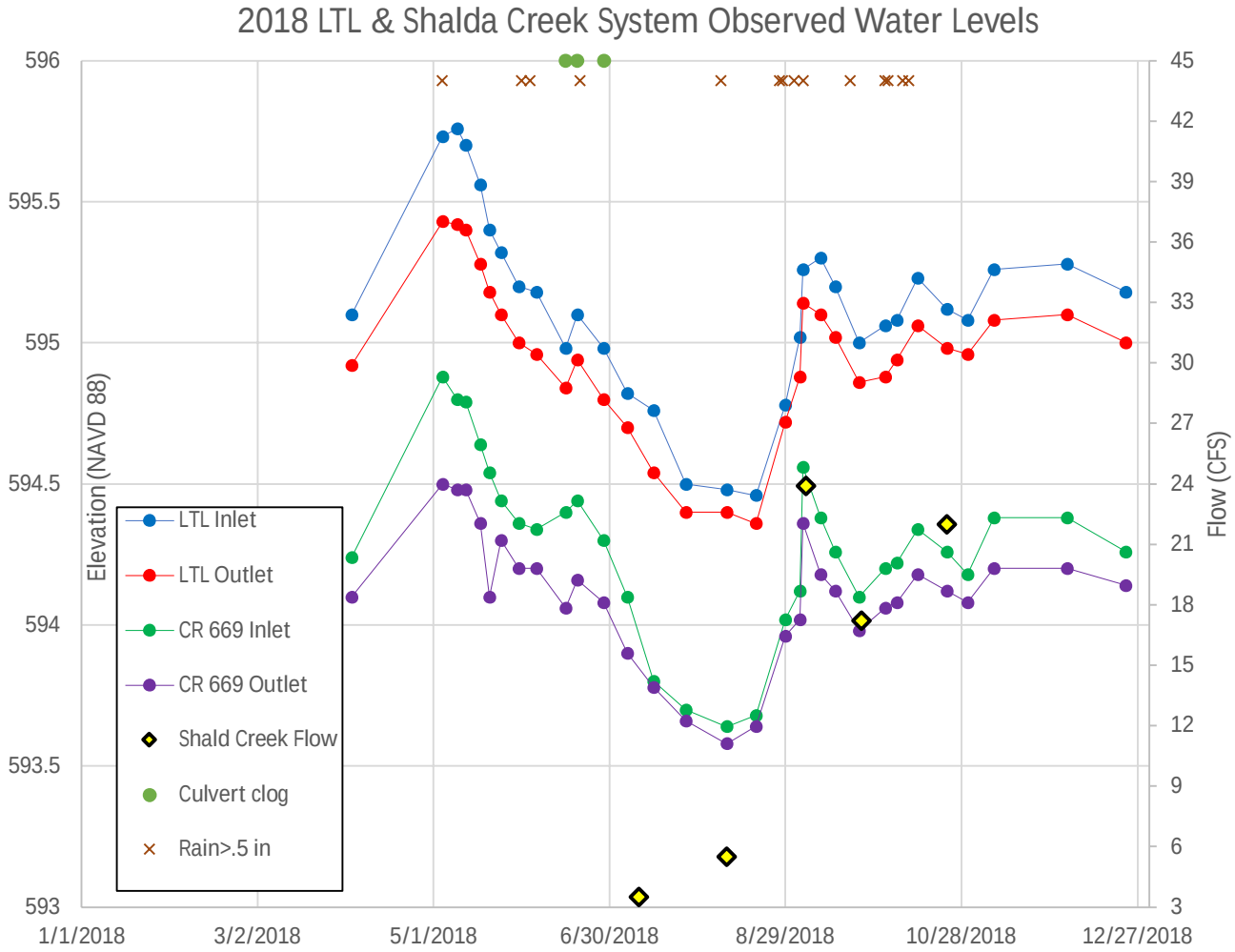
The Leelanau County Road Commission replaced the culvert at County Road 669 this summer with a 3-sided box culvert. During the course of recording water levels prior to the commencement of that work, stream flow data was provided by the Benzie Conservation District (BCD) that they have collected as part of their work within the larger watershed surrounding Little Traverse and Lime Lakes. Stream flow measurements they have collected at both Shalda Creek and Shetland Creek are attached as Figures 16-17. It is understood that stream flow measurements provided by the BCD were calculated from typical USGS methodology of dividing the channel into subsections, measuring the velocity within the subsections, and computing the discharge from the channel cross sectional area and the average velocity in the cross sections.

7.0 DISCUSSION POST 2017 - PRESENT DATA

Prior to the replacement of the County Road 669 culvert that began in July 2020, activity at the beaver dam between County Road 669 and Traverse Lake Road was noted. A technical memo dated June 25, 2020 was provided at that time and is attached to this report for reference. The memo was provided for NPS's consideration to allow modification of the dam prior to construction work on County Road 669. Data that was not available at the time of that memo and of significant importance is the flow measurements provided by the Benzie Conservation District. This data identifies Shetland Creek flows of just below 19 cfs and Shalda Creek flows of 28 cfs around date of dam modification that was allowed and conducted on June 28, 2020. Previous analysis provided by Gosling Czubak identified the Traverse Lake Road culvert operates under inlet control with flows above 60 cfs. The BCD data indicates flows in both Shetland and Shalda Creeks well below 60 cfs such that the Traverse Lake Culvert was not operating under inlet control. This is significant and indicates that downstream conditions such as a beaver dam are affecting water levels as opposed to the culvert being under inlet control conditions.

It was noted by LTLPOA that 2018 was an unusually quiet year for beaver activity with no new dams reported within the original study area. Figure 11 below is a graph of the 2018 data recorded by the LTLPOA. The data starts in early April when spring runoff is working its way through the system. The peak water level at Little Traverse Lake for the year was 595.76 and recorded on May 9. This followed 1.58 inches of rain recorded on May 4. That water level is .11 feet above the elevation of 595.65 identified in previous reports that lake residents experience adverse impacts to their property, such as flooded crawl spaces. Without beaver activity and significant rain, the water levels in the system generally drop over the summer season and that is what was observed in 2018. Table 2 below summarizes the monthly precipitation for 2018, 2019, and 2020 along with the normal monthly precipitation. The above normal precipitation through the winter and spring and below normal precipitation through June and July align with the high and low water level observations for the period.

FIGURE 11.



There were three reported instances of the County Road 669 culverts being partially clogged with woody debris on June 15, 19, and 28 2018. A rain event of 1.34 inches was recorded on June 20. The water levels at all locations are up slightly during this period but generally continue downward through mid-August with a low reading of 594.46 at Little Traverse Lake recorded on August 19. After this, several days of significant rain were experienced at the end of August with .52 inches on 8/27 and 2.04 inches on 8/28. A fall high water level of 595.3 was recorded on 9/10. The water level generally fluctuated between this level and 595 through the end of the year. These fall water levels are right at the 595 level where high-water erosion impacts are noticed. With the absence of beaver activity and the slightly below normal precipitation in the summer, the system water levels were able to drop to a level that the higher-than-normal precipitation experienced August through October was able to be passed

through the system without lake levels rising to above the 595.65 level where property damage is experienced.

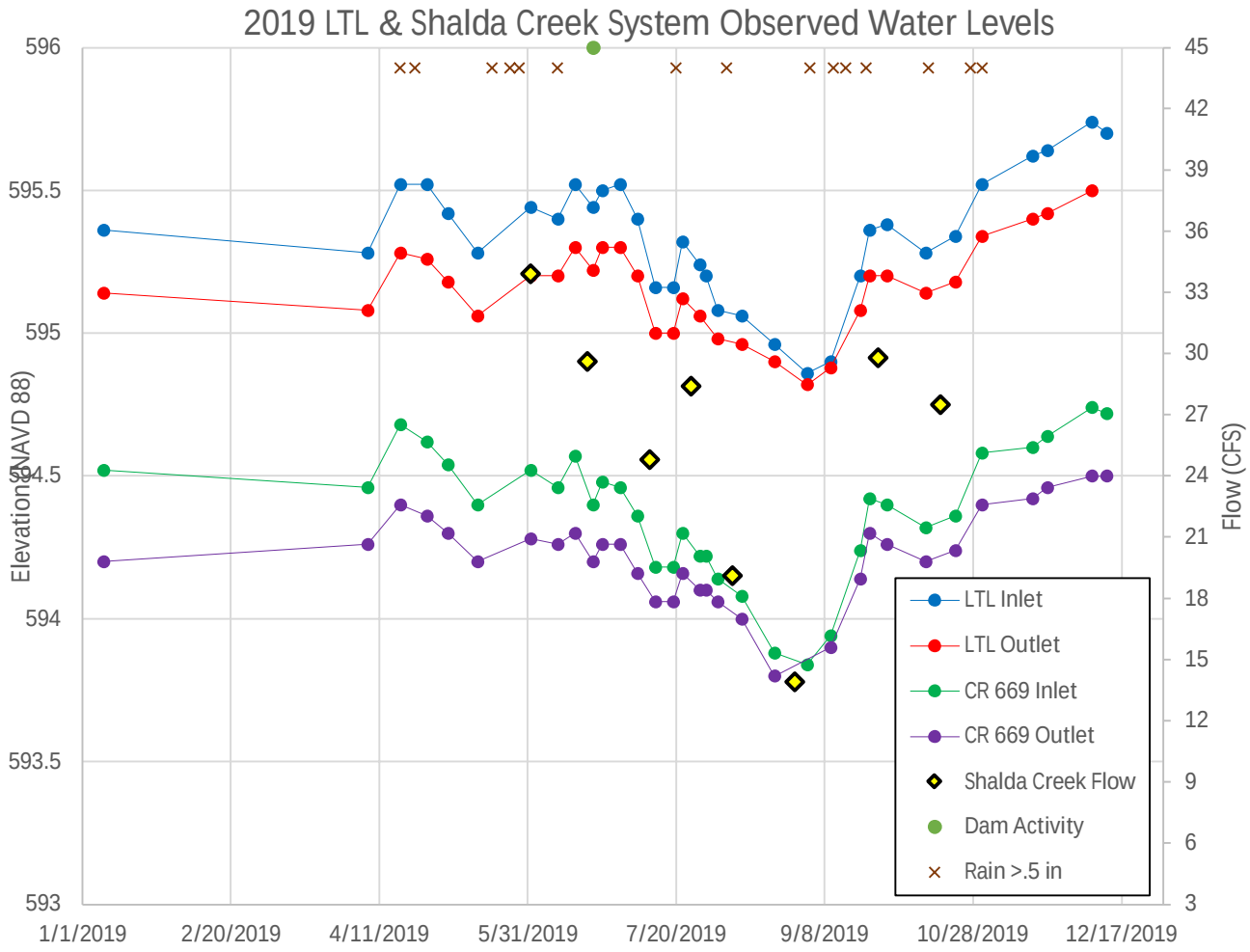
TABLE 2 – SUMMARY OF MONTHLY PRECIPITATION

Month	Normal Monthly Precipitation (in.)	2018 Precipitation (in.)	2019 Precipitation (in.)	2020 Precipitation (in.)
January	2.43	2.88	2.97	2.82
February	1.7	2.3	3.38	1.38
March	1.84	2.83	2.06	3.21
April	2.81	4.86	3.38	3.76
May	2.82	3.81	4.93	3.78
June	3.1	2.26	1.30	3.39
July	2.81	2.16	1.94	4.36
August	3.58	4.86	1.23	2.96
September	3.91	3.88	6.31	3.33
October	3.8	4.06	5.83	6.87
November	3.26	3.18	4.57	3.29
December	3.02	2.21	4.44	

Data source: NOAA Online Weather Data for MAPLE CITY 1E station
https://w2.weather.gov/climate/xmacis.php?wfo=apx

2019 data is shown in Figure 12 below and follows a similar trend as 2018 of water levels decreasing in the summer. However, dam activity at the Fish Camp location is noted in June. The total precipitation for May, June, July, and August is 9.4 inches and 2.91 inches below the normal total of 12.31 inches for this period of 2019. The decrease in water elevation measured at Little Traverse Lake from 595.42 on May 4, 2019 to 594.86 on September 2, 2019 is .56 feet (6.7 inches). If we compare the observations for the same period of 2018, it is noted the total precipitation is 13.09 inches which is .78 inches above normal for the period. The decrease in water elevation at Little Traverse Lake from 595.76 measured May 9, 2018 to 594.46 measured August 19, 2018 is 1.3 feet (15.6 inches). This is significant because the lake level dropped over 2.3 times as much in 2018 when there was no beaver dam activity noted but the total precipitation is above normal for the summer months. It would have been reasonable to expect a water level drop of the same magnitude over the similar time frame in 2019 especially with below normal precipitation. If you only look at June, July, and August, the precipitation is 47% below normal for this period. The meager drop of .58 feet during this time period of low precipitation is indicative of obstructive elements such as beaver dams within the system.

FIGURE 12.



The overall data for 2020 is shown in Figure 13 below and an enlarged graph of the data through mid-July is shown in Figure 14. 2020 data started with LTL water levels at 595.78 just above the 595.65 level where residents are affected. The level fluctuates through the winter and spring and only gets to a low of 595.38 on April 20. Activity at the beaver dam upstream of CR669 was noted on June 18 during a period of increasing Little Traverse Lake water levels and steady flows of 28 cfs at CR669 measured by the Benzie Conservation District. Following the permitted modification of this dam on June 28, 2020 the flow rapidly increases to 44 cfs and declines to 40.9 cfs the following day. This sudden increase in flow can be attributed to the removal of the beaver dam and release of the water. Over the course of two weeks, the water level declines .76 feet. During this period on July 7, 2020 the stream diversion was installed for the removal of the culvert being replaced at CR 669. The staff gages at CR669 were removed at this time. Several days of heavy rains occurred from July 15-19 and caused a brief water

level rise that leveled off from July 19-27. The overall water level trend continued downward after that to a low of 594.78 on 8/20. The measured flow at CR 669 continually declined after the dam modification through September 14 to 16 cfs on that day.

FIGURE 13.

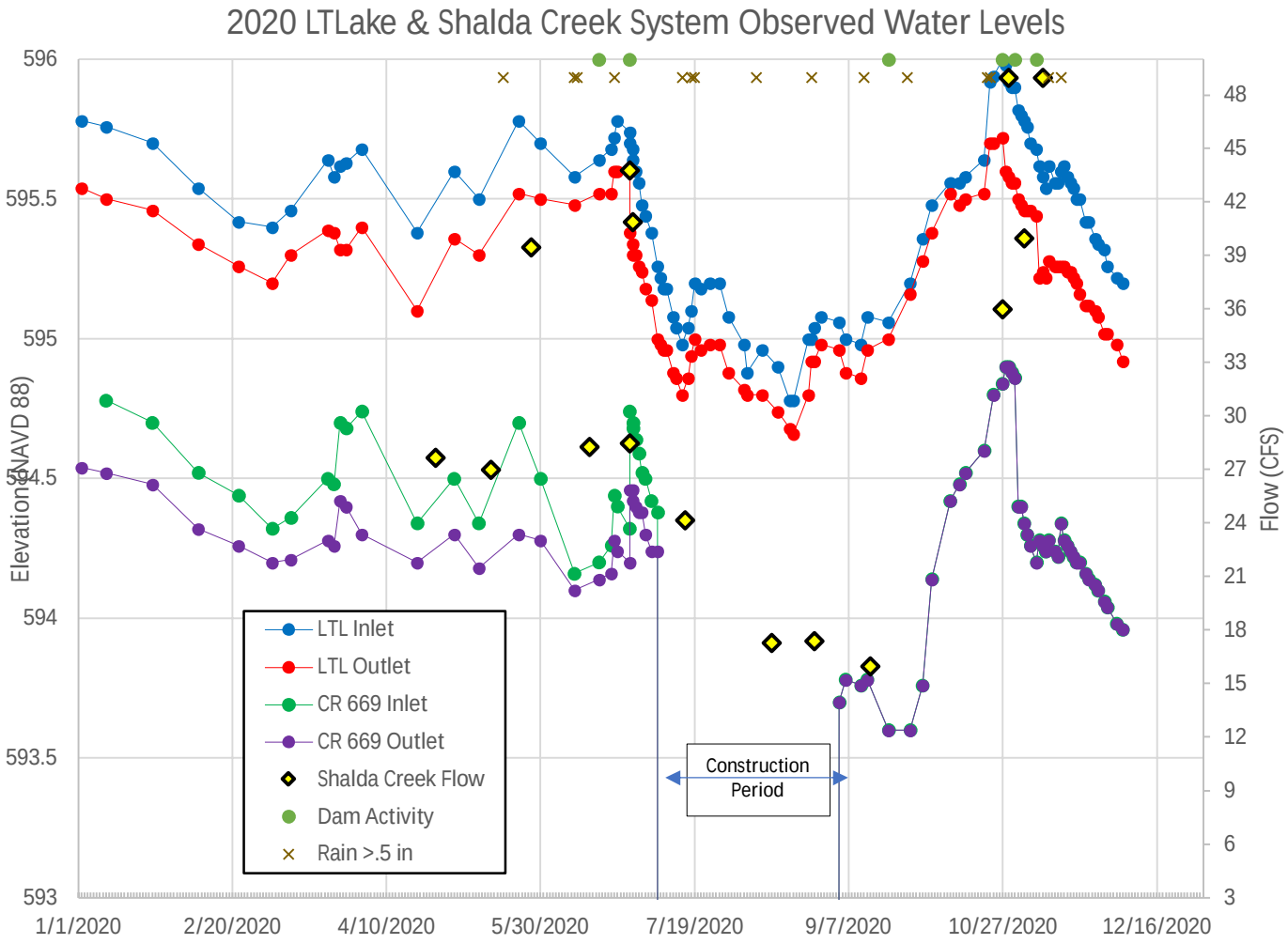
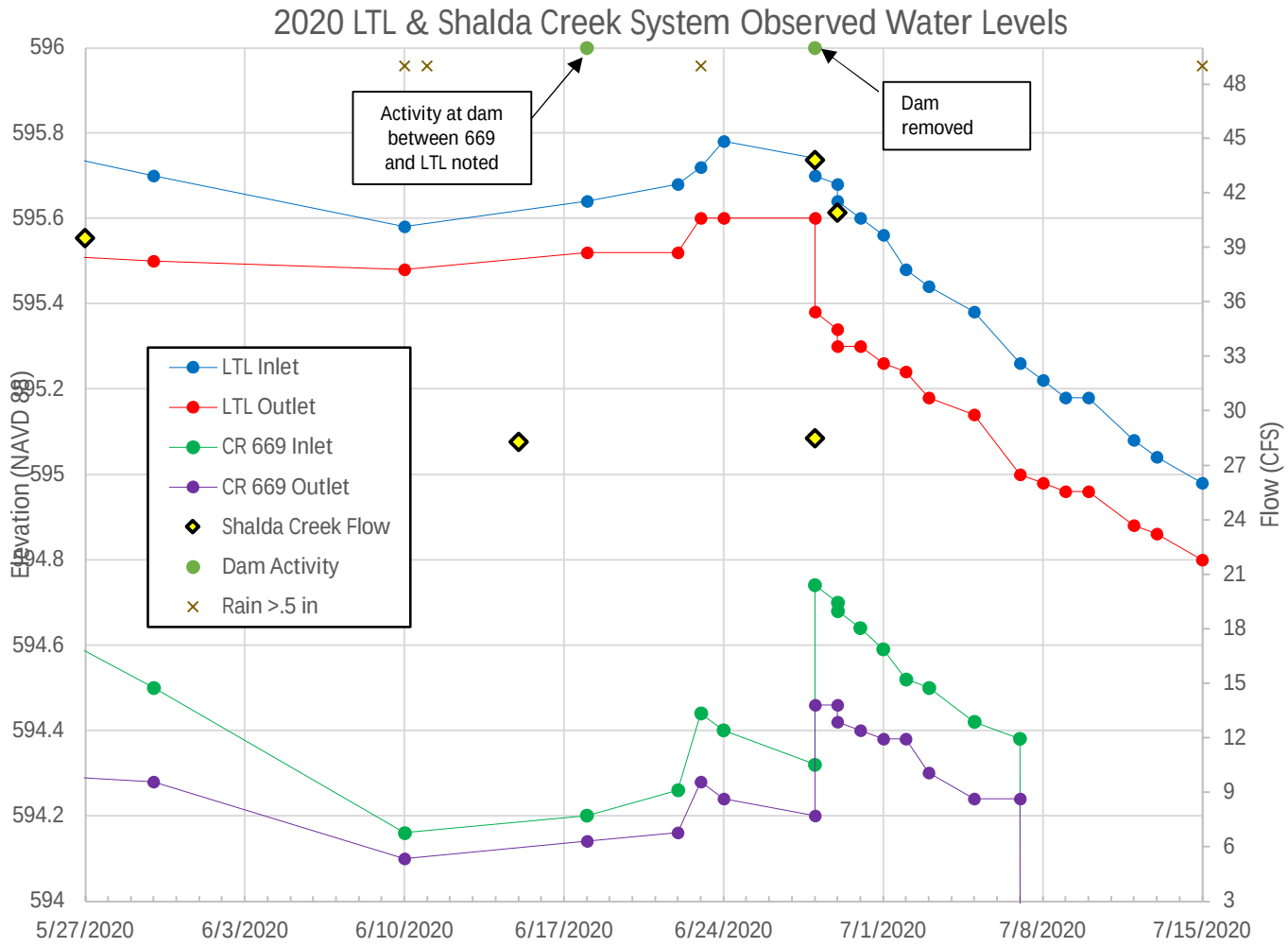


FIGURE 14.



The culvert replacement at County Road 669 was completed and the staff gages were replaced on September 4, 2020. The replacement structure is a 30'span concrete culvert and provides significantly more area to pass the stream flow than the original 71"x47" corrugated metal arch culvert. There is no longer any noticeable difference between the upstream and downstream gages.

Once the dam present between CR 669 and Little Traverse Lake was permitted for removal in June, the observed water level trend was quite similar to the observations of 2018 when no beaver activity was noted. Precipitation recorded for June and July were both above normal and what was recorded for those months in 2018. The low water elevation of 594.78 was measured for the year on August 20, 2020. This was .32 feet (3.8 inches) more than the 2018 level of 594.46 measured on August 19, 2018. Precipitation for August and September 2020 was below normal for both months and the water levels at

Little Traverse Lake were fairly consistent just above 595 from late August until September 20, 2020 when the presence of dams both at "Fishcamp" and between CR669 and Traverse Lake Road are noted. With below average precipitation for August and September, further water level decline at Little Traverse Lake through the dry period would have been expected. The presence of both dams at "Fishcamp" and between CR669 and Traverse Lake Road coupled with the above average October precipitation drastically impacted water levels and caused them to reach a high of 596.0 on October 27, 2020. It is also noted that a high-water level of 594.9 at the new CR669 culvert was observed on this date and was above the top of the new concrete culvert opening of 594.8.

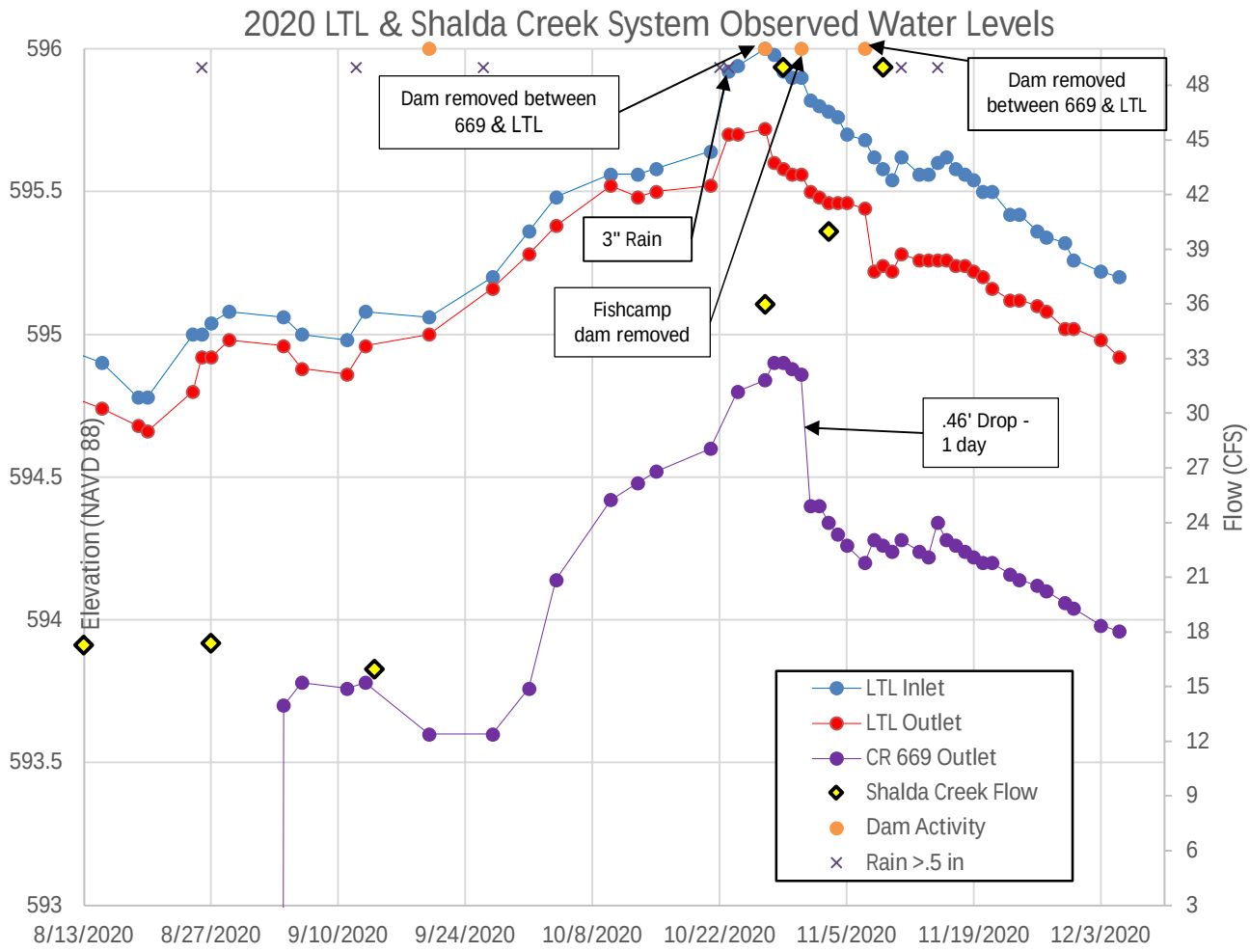
The National Park Service allowed an emergency removal of the dam between CR669 and Little Traverse Lake on October 27, 2020. A removal of the Fishcamp dam was authorized on October 31, 2020. Prior to and following these removals Gosling Czubak measured flow through the culvert at Little Traverse Lake. Flow was estimated by measuring velocity from the time for an apple to pass through the culvert and flow area from the water level readings. The flow estimations from several dates and locations within the system are summarized in Table 3 below.

TABLE 3

LOCATION	FLOW (CFS)			
	10/27/2020	10/29/2020	11/3/2020	11/9/2020
W. Traverse Lake Road	36	49	40	49
CR 669			53	47
M-22/Shetland Creek	36	33	29	

Figure 15 below shows an enlarged graph of the 2020 data from mid-August. Following removal of the dam between CR669 and LTL water levels dropped .1 ft at the LTL inlet, .16 ft at the outlet, and rose .06 feet a CR699. Once the downstream Fishcamp dam was removed, the system could "drain" and the water level at CR669 dropped .46 feet (5.5 inches) in one day. The dam between LTL and CR669 had been significantly rebuilt and was removed again on November 7, 2020. The LTL outlet quickly dropped .22 feet (2.64 inches) followed by a steady drop in the LTL water levels. The LTL outlet drop following this event was twice as much than the first removal event on October 27 due to the fish camp dam removal and lowering levels at CR669. Following these removal events, water levels at Little Traverse Lake have dropped from 595.9 to 595.2 as of December 5, 2020.

FIGURE 15.



The flow pattern in the system generally shows over the course of the year that higher water levels correspond to periods of higher flow rates and lower water levels correspond to periods of lower flow rates. The water level response from the latest dam modifications is significant with the drops occurring during periods of high flow. The flows at Little Traverse Lake are elevated, yet under the inlet control level, for at least over a week following the Fishcamp dam removal. Additional precipitation input is also observed in the system. The water levels have continued to trend downward during this high flow period further verifying the impacts of beaver dams on water levels.

8.0 RECOMMENDATIONS

The data from several years of beaver dam removals leads to the following conclusions:

1) Dams between LTL and CR669 can significantly reduce creek flow rates, reducing the ability of LTL to drain naturally. Removal of the dams has shown increased downstream flow rates.
2) Dams between Little Traverse Lake and CR669 can lead to increasing water levels at LTL leading up to dam removal in comparison to decreasing levels at CR669 during the same time.
3) Little Traverse Lake water levels have shown rapid and significant water level decline following removal of dams between LTL and CR669.
4) When no dams are present between LTL and CR669, water levels at LTL normally decrease following seasonal high-water levels in the early spring season even with continued rainfall.
5) Dam activity between LTL and CR669 can restrict flow more and have a greater impact on LTL water levels than culvert restrictions.
6) Allowing LTL water levels to naturally decrease without beaver dam obstructions is important to provide buffer capacity in the lake going into the higher rainfall fall season.
7) Significant dam activity downstream of CR669 during high water levels can elevate water levels at CR669, including increasing water levels above the top of the recently installed larger culvert. This new culvert reduced culvert restrictions to non-detectable levels under normal conditions. Removal of larger downstream dams showed water levels at CR669 greatly improved with large drops.
8) Dam activity, if significant during high water levels, can reduce the creek flow at CR669 and LTL, thus affecting the ability of LTL to naturally drain.

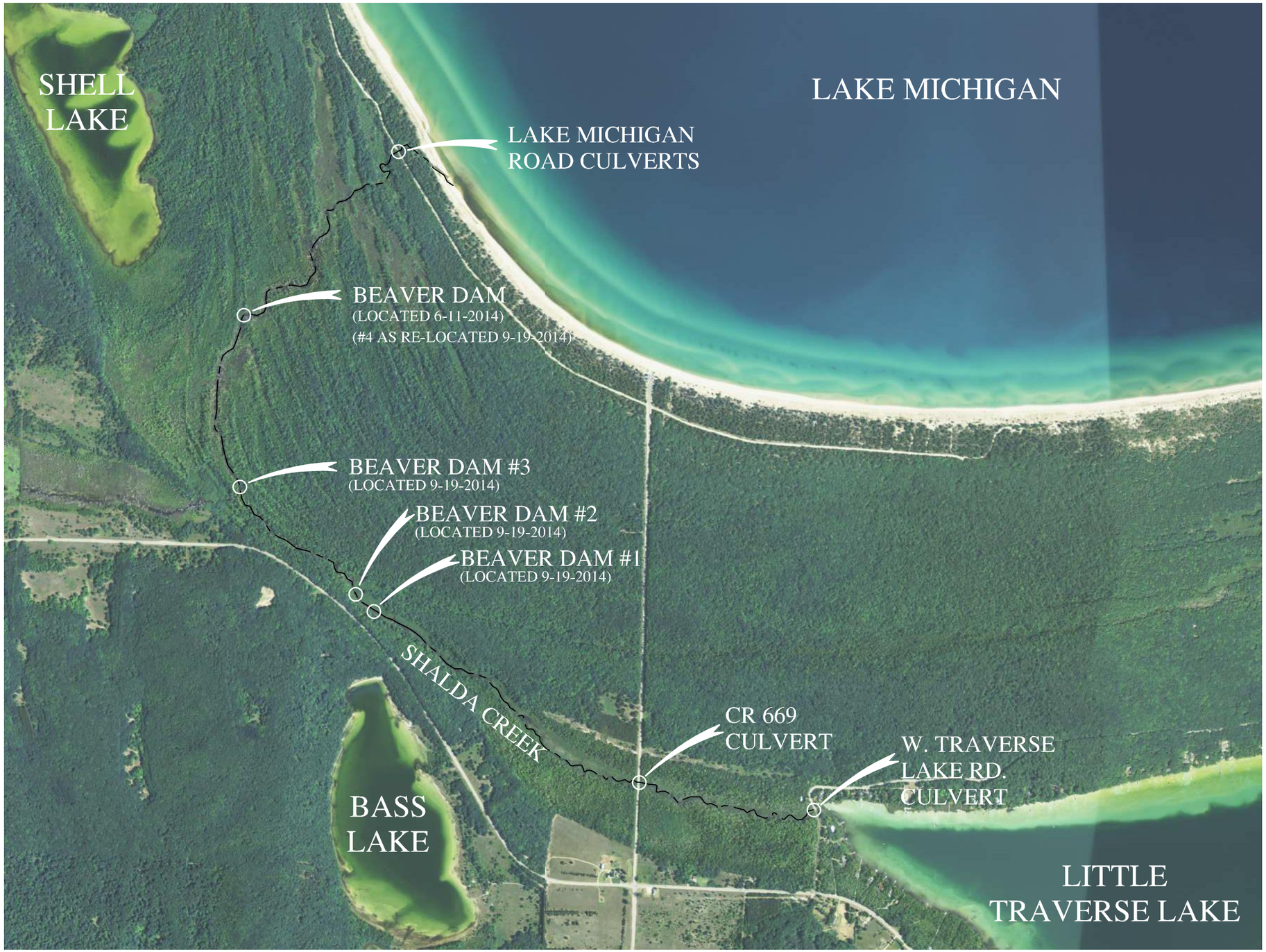
It was previously concluded from the 2016-2017 data that the greatest response to dam modification events occurred when Little Traverse Lake water levels were greater than 595.0. The two dam modifications allowed in 2020 both occurred when Little Traverse Lake water levels were just below or at 596. Significant decrease in water levels were noticed following the dam modifications allowed during these periods of high-water levels. Permitting of the following recommendations are requested:

1) Allow Little Traverse Lake Property Owners Association to maintain the section of Shalda Creek between LTL and CR669 free of dam obstructions at all times.

2) Monitor water level elevations at the County Road 669 crossing. If water levels at this culvert rise above 594.0, allow beaver dams downstream to "Fishcamp" to be cleared.
3) Consider a partnership with a local conservation organization to relocate nuisance beaver that may be encountered between Little Traverse Lake and Fishcamp and investigate natural deterrent measures that could be used in this area.
4) Allow creek maintenance and restoration at inactive and problem dam locations between Little Traverse Lake and Fishcamp.

While not the focus of this report, discussions are merited in regard to long term impact of any policy that does not allow dam modification downstream of CR669. Dams have been built further downstream of fishcamp which impounded over three feet of water as was seen back in 2014. If no maintenance or beaver management is allowed, it is feared that existing dams could continue to grow, could fill with silt, and create long term challenges for the creek to effectively transport drainage from the watershed. A buildup of debris from dams already exists and constricts the stream meriting channel width restoration. The impact to property has been experienced and could be even more significant over time without a long-term management policy partnership with Little Traverse Lake riparian owners.

Attachments



OVERALL STUDY AREA

SCALE: 1"=1/4 MILE (1320 FT)

Attachment 1

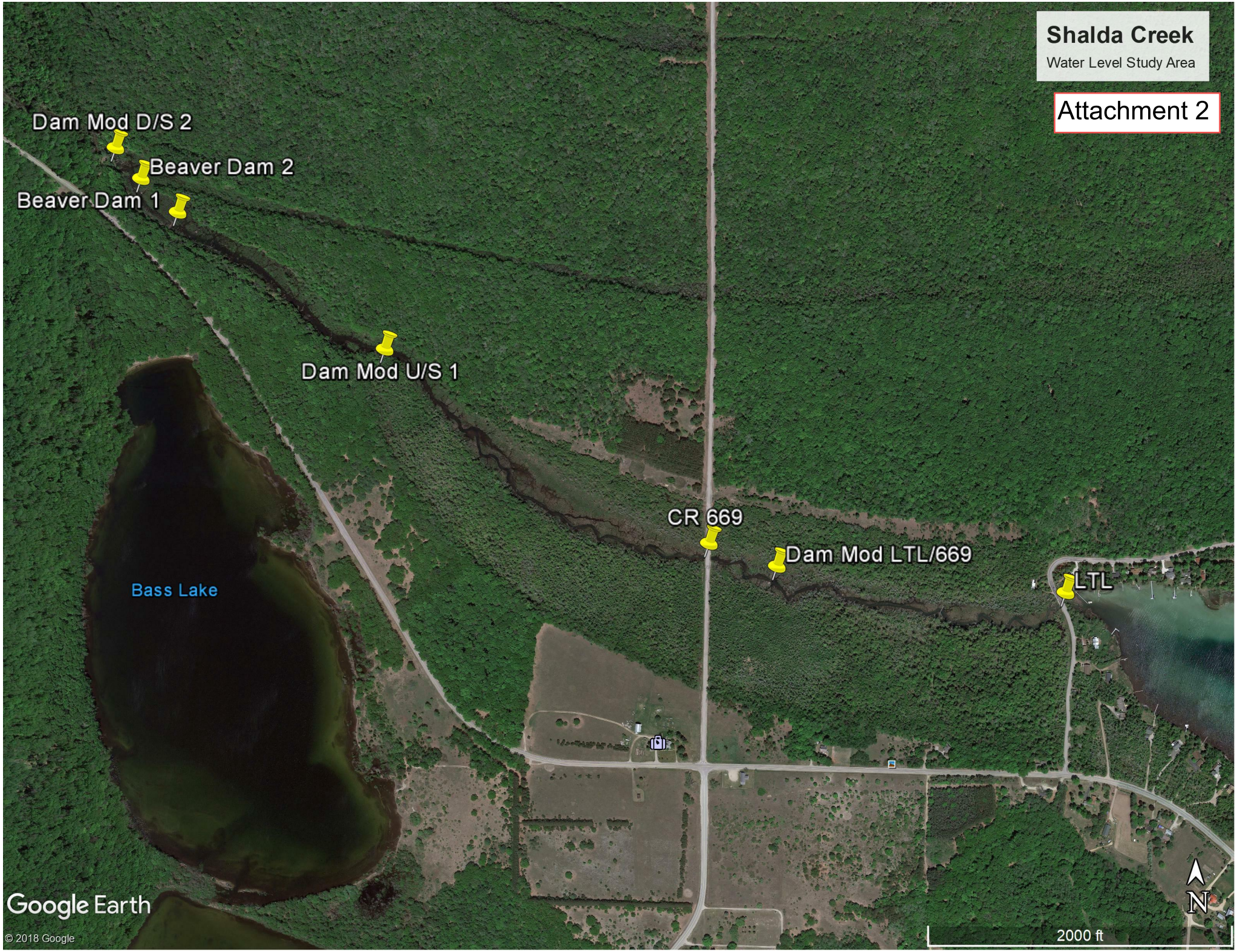
Gosling Czubak engineering sciences, inc.
1280 Business Park Drive
Traverse City, MI 49686-8607
231-946-9191 800-968-1062
Fax: 231-941-4603

• Engineers
• Surveyors
• Environmental Services
• Landscape Architecture

Job #: 2014462.01
Date: 06-03-2014
Scale: AS NOTED
Drawn: RMV
Chk'd.: DAC
Rev.: 09-20-2014

OVERALL STUDY AREA
LITTLE TRAVERSE LAKE P.O.A.
CULVERT STUDY

Location:
SECTIONS 9 AND 10
T29N, R13W
CLEVELAND TOWNSHIP
LEELANAU COUNTY, MICHIGAN
Sheet 1


Shalda Creek
Water Level Study Area
Attachment 2
Dam Mod D/S 2
Beaver Dam 2
Beaver Dam 1
Dam Mod U/S 1
CR 669
Dam Mod LTL/669
LTL
Bass Lake
Google Earth
© 2018 Google
N
2000 ft


CR 669
LTL
Shetland Creek Inlet
Lime Lake Outlet
Lime Lake
Proximity to Study
Attachment 3
Google Earth
© 2018 Google
1 mi
N

Attachment 4

United States Department of the Interior

NATIONAL PARK SERVICE
Water Resources Division
1201 Oakridge Drive, Suite 250
Fort Collins, Colorado 80525

March 2, 2017

Memorandum

To: Scott Tucker, Superintendent, Sleeping Bear Dunes National Park (SLBE)

Through: Alan C. Ellsworth, Chief, Aquatic Systems Branch (ASB)

From: Michael Martin, Hydrologist (WRD), Tae Wan Kim, Visiting Scientist, Geoscientists-In-the-Parks Program

Subject: Shalda Creek water level data comparison, September to October, 2016.

Executive Summary

This memo contains a comparison of relative water surface elevations for five sites along Shalda Creek in SLBE, collected between September 8, and October 27, 2016. This period contained one episode of beaver dam removal on September 28, 2016. These data are provided at this time to inform and support immediate and future management decisions regarding experiments of water level manipulation and beaver dam modification. Results suggest that removal of a beaver dam, Dam 1, on Sept 28 had no effect on the water level of Little Traverse Lake.

Project Overview

In August 2016, six data loggers, including a barometric pressure logger, were installed along Shalda Creek for the purpose of simultaneously recording changes in water surface elevations within the system, especially in response to the experimental removal of a beaver dam on park property, Dam 1. The four surface water sites were: 1) the upstream staff gauge in Little Traverse Lake (LTL); 2) the upstream staff gauge at Country Road 669 (CR669 us); 3) the downstream staff gauge at Country Road 669 (CR669 ds); 4) the upstream staff gage of beaver dam 1 (Dam 1); and 5) upstream of a second beaver dam (Dam 2) located below the backwater influence of Dam 1. The barometric pressure logger was located along the east side of Country Road 669 and about 40 meters (125 feet) north of Shalda Creek. These data loggers, which were referenced to previously surveyed benchmarks or reported elevations, recorded pressure (later

converted to depth of water) at 15-minute intervals with a common record beginning on September 8, 2017 and continuing until October 27, 2017.

In order to evaluate the possible effect Dam 1 could have on upstream surface water elevations, SLBE authorized removal of this structure. Consequently, on September 28, 2016 representatives from Gosling Czubak Engineering Sciences Inc. (GCE) in association with the Little Traverse Lake Property Owners Association (LTLPOA), experimentally removed Dam 1. This memo presents results of the water level data collected over the period of that experiment.

Results and Discussion

The pressure transducers and data loggers at the five surface water sites, as well as the barometric recorder, all appeared to function properly, measuring and recording pressure at 15-minute intervals throughout the near two-month study period (Figure 1). Water surface elevations at each site were derived by subtracting the barometric pressure from the total pressure and then converting the water pressure at each transducer to a depth of water. The transducers had been referenced to previously surveyed benchmarks at each site, and these benchmarks (or in the case of Dam 2, the reported elevation) were used to establish a relative water surface elevation for each data logger measurement.

On September 8, 2016 at about 9:00 in the morning, representatives from CGE and LTLPOA began modifying Dam 1 with complete removal achieved sometime thereafter. The data logger located above Dam 1 recorded a total drop in the surface water elevation of 0.4 meters (1.3 feet) over a period of about 36 hours beginning around 11:30 A.M on September 28 and continuing until around 12:00 A.M. September 29 (Figure 2).

The upstream effect of this surface water reduction was less pronounced and limited. Of the three upstream locations; CR669 US, CR669 DS, and LTL, only the loggers at the county road recorded any noticeable change (Figure 2). There was no discernable change in the water surface elevation at LTL over the period of the dam removal experiment (Figure 2). The water surface above and below County Road 669 dropped about 0.06 meters (0.2 feet) over the 5 days following dam removal. This decline may be related to the experiment; however, the overall trend suggests other watershed factors may have also played a role (Figures 1 and 2).

Summary

1) Water surface levels were collected at five sites along Shalda Creek over the period of August 31, to October 27, 2016.
2) A beaver dam, Dam 1, was removed on September 28, 2016. This resulted in a relatively rapid water level decline immediately above the dam of about 0.4 meters 1.3 feet.
3) Water levels both up and downstream of County Road 669 gradually declined about 0.06 meters 0.2 feet over a period of five days.
4) The water surface measurements at Little Traverse Lake showed no discernable change related to the dam removal experiment.

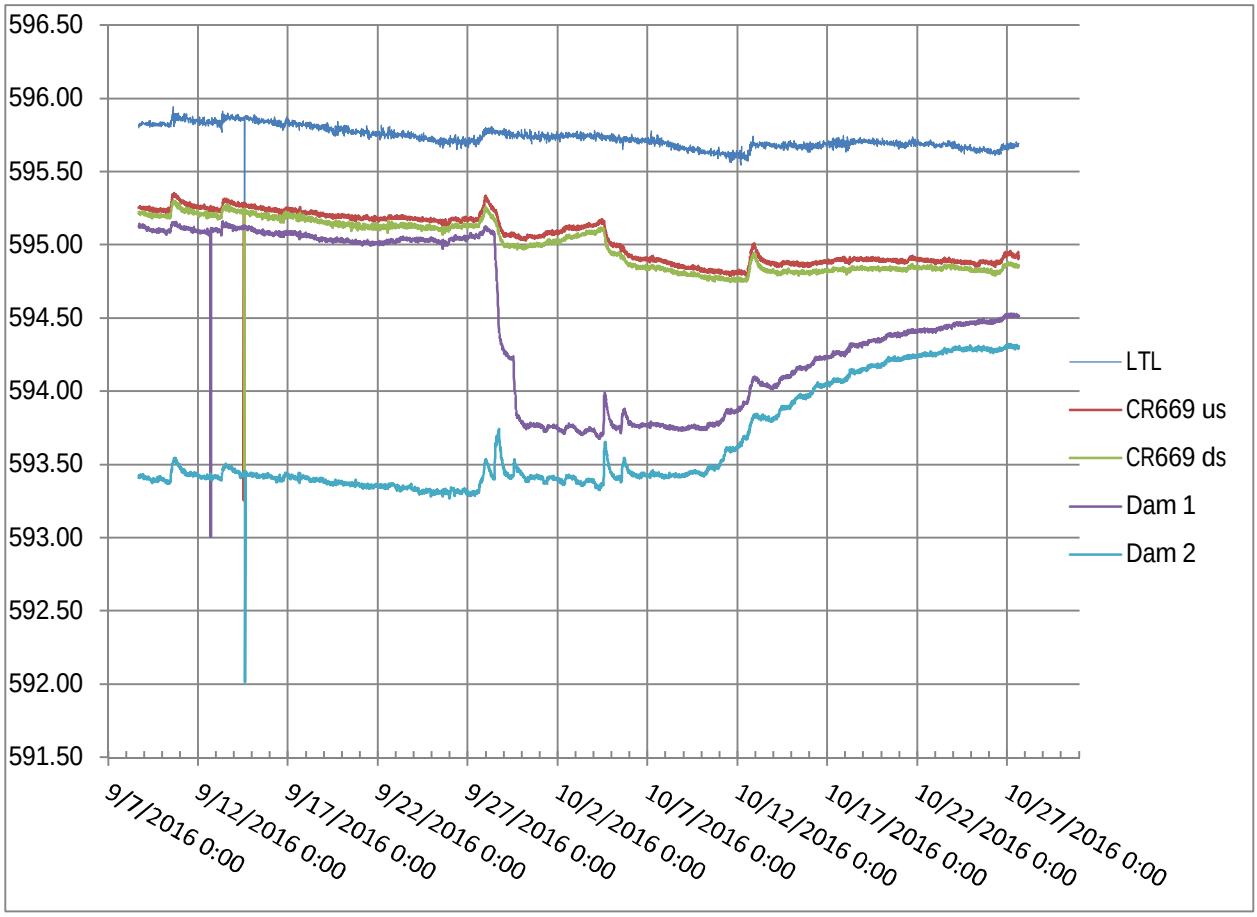


Figure 1. Relative water surface elevations at the five sites through the common data record, 9/8 to 10/27, 2016. The vertical drops near the beginning of the record were equipment checks. Removal of Dam 1 occurred on 9/28/16 and is evidenced by a 1.3 foot drop in the water level immediately above the dam (purple line). Note the lack of an obvious drop in the water level at LTL.

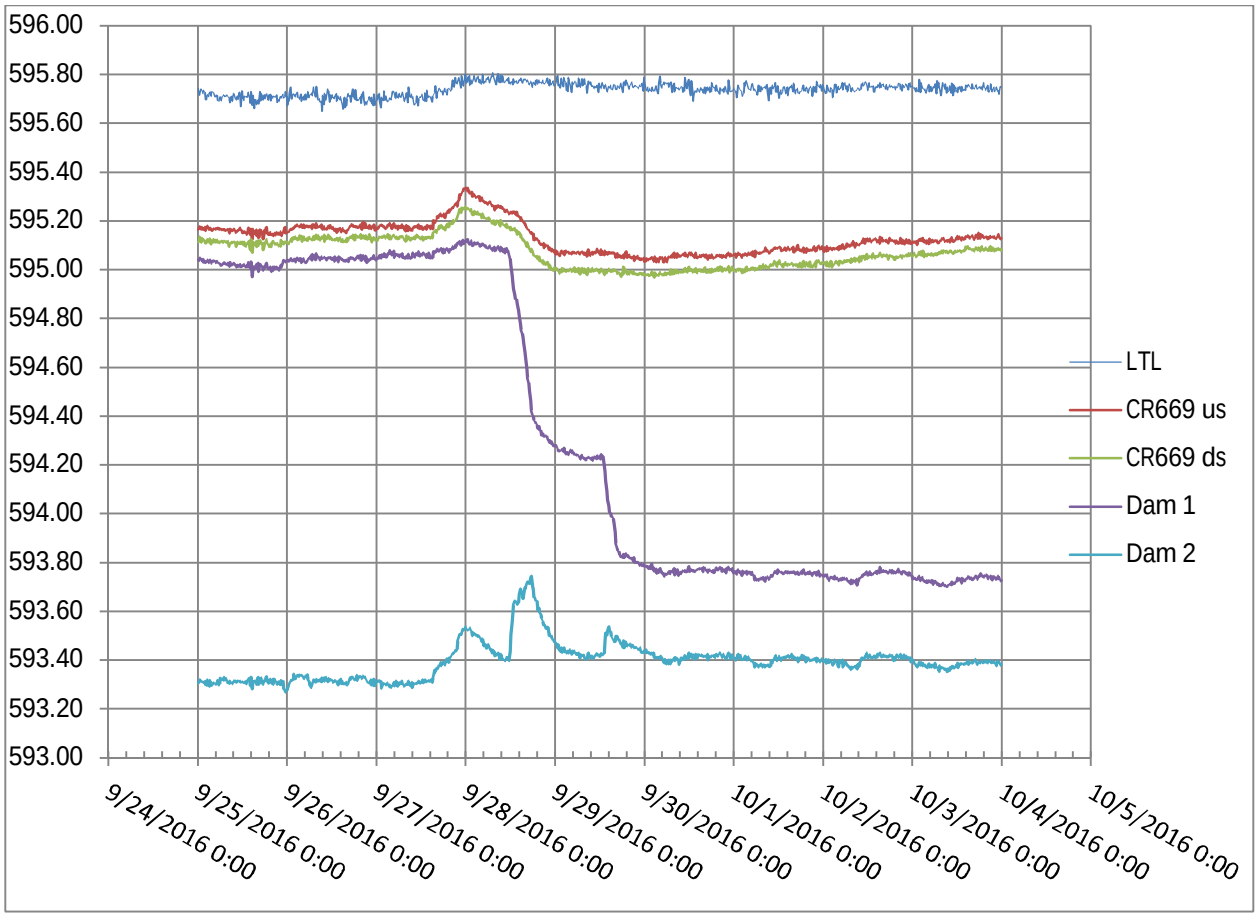
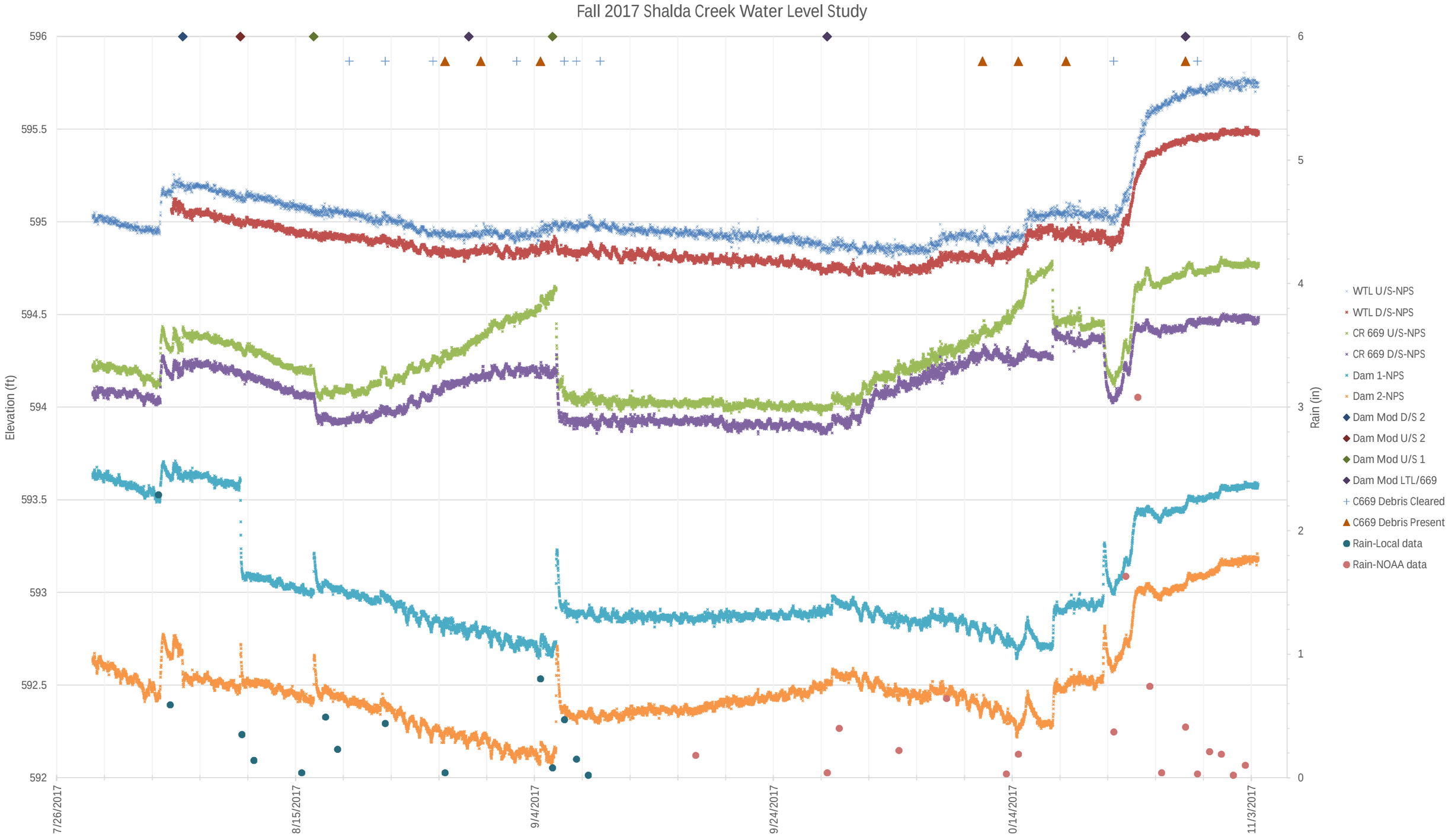


Figure 2. Relative surface water elevations at the five sites over the nine days surrounding the experiment, 9/25 to 10/3, 2016. Removal of Dam 1 occurred on 9/28/16 and is evidenced by a 1.3 foot drop in the water level immediately above the dam (purple line). Note the lack of an associated drop in the water level at LTL. It appears that there may have been a small drop of about 0.2 ft. at County Road 669 from the dam removal, although there may have been other associated watershed processes.

If you have any questions or comments, feel free to call or write Michael Martin at 970-225-3509. (mike_martin@nps.gov)

Attachment 5



Attachment 6

Dam Removal on Shalda Creek, Saturday, 8/5/2017

On 8/5/2017, Craig Young, acting chief of natural resources at SLBE, met two homeowners (Jeff S. and Jim M.) with the Little Traverse Lake Homeowners Association at 12 pm.

The three caravanned in separate vehicles to a site near the "beaver dam breach site" location shown in figure 1. Vehicle staging was on the M-22 westbound shoulder. The location is approximate (eye-balled, not GPS documented).

Jeff and Jim used rakes to remove smaller branches and debris and then removed larger stems by hand, piling them next to the dam on dry ground (figures 2-5). Jim use a bow saw to make two cuts to remove a 4- to 5-foot section of log that was 4" in diameter. Only two other large logs reaching this diameter were removed. Most material was 1" or less in diameter.

Jeff and Jim worked on the site for approximately 1 hour and 20 minutes. During this time they created an approximately 10 to 12 ft breach in the dam.

Figure 1. Approximate dam breach site on Shalda Creek, Sleeping Bear Dunes National Lakeshore. Project was conducted on August 5, 2017.

Figures 2-5. Breaching beaver dam on August 5, 2017 on Shalda Creek, Sleeping Bear Dunes National Lakeshore.

Attachment 7

Dam Removal on Shalda Creek, Thursday, 8/10/2017

On 8/10/2017, Craig Young, acting chief of natural resources at SLBE, Anna Rivera (plover crew), Sean Hollowell (veg crew), and Meghan Moore (veg crew) met to breach a beaver dam on Shalda Creek. This was a follow-up to a dam breaching that took place downstream on 8/5/2017. That project was conducted by two Little Traverse Lake property owners with Craig Young observing.

The "beaver dam breach site" location is shown in Figure 1. Vehicle staging was on the M-22 westbound shoulder. The location is approximate (eye-balled, not GPS recorded).

NPS staff used rakes to remove smaller branches and debris and then removed larger stems by hand, piling them next to the dam and adjacent to two mounds of material that was presumably removed during previous dam breaching projects. No cutting or lopping was needed.

Staff worked on the site for approximately 2 hours from 8:00 am -10:00 am. During this time the team created an approximately 10 ft. breach in the dam. Volume of removed branches and logs was approximately 10 ft (l) x 5 ft (w) x 3 ft (d).

Figure 1. Approximate dam breach site on Shalda Creek, Sleeping Bear Dunes National Lakeshore. Project was conducted on August 10, 2017.

Figure 2. Breaching involved removal of material between two large piles (one left, one center right) of woody debris. These piles presumably do not represent beaver activity, but rather storage areas for material removed from previous dam breaching efforts. Photograph is from a poor vantage point because of the lack of a waterproof camera for taking photos in the immediate vicinity of the dam removal. But the clear passage between mounds can be observed.

Attachment 8 – Photos

2 - Dam between Little Traverse Lake / CR669 prior to removal June 2020

1- Dam between Little Traverse Lake / CR669 prior to removal June 2020

Attachment 8 – Photos

3- Fishcamp dam prior to removal 10-24-2020

Attachment 8 – Photos

4- Little Traverse Lake property flooding fall 2020

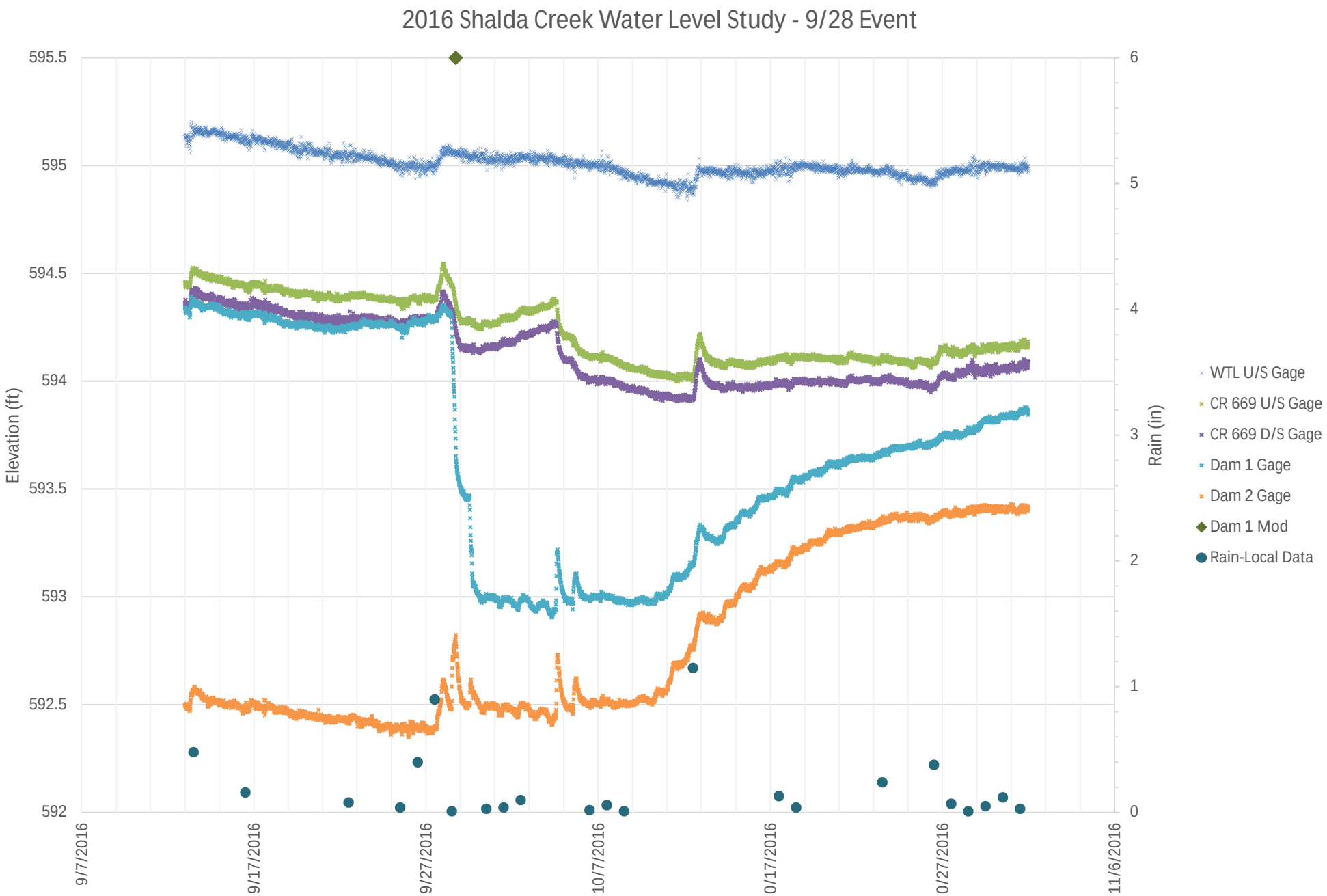
Attachment 8 – Photos

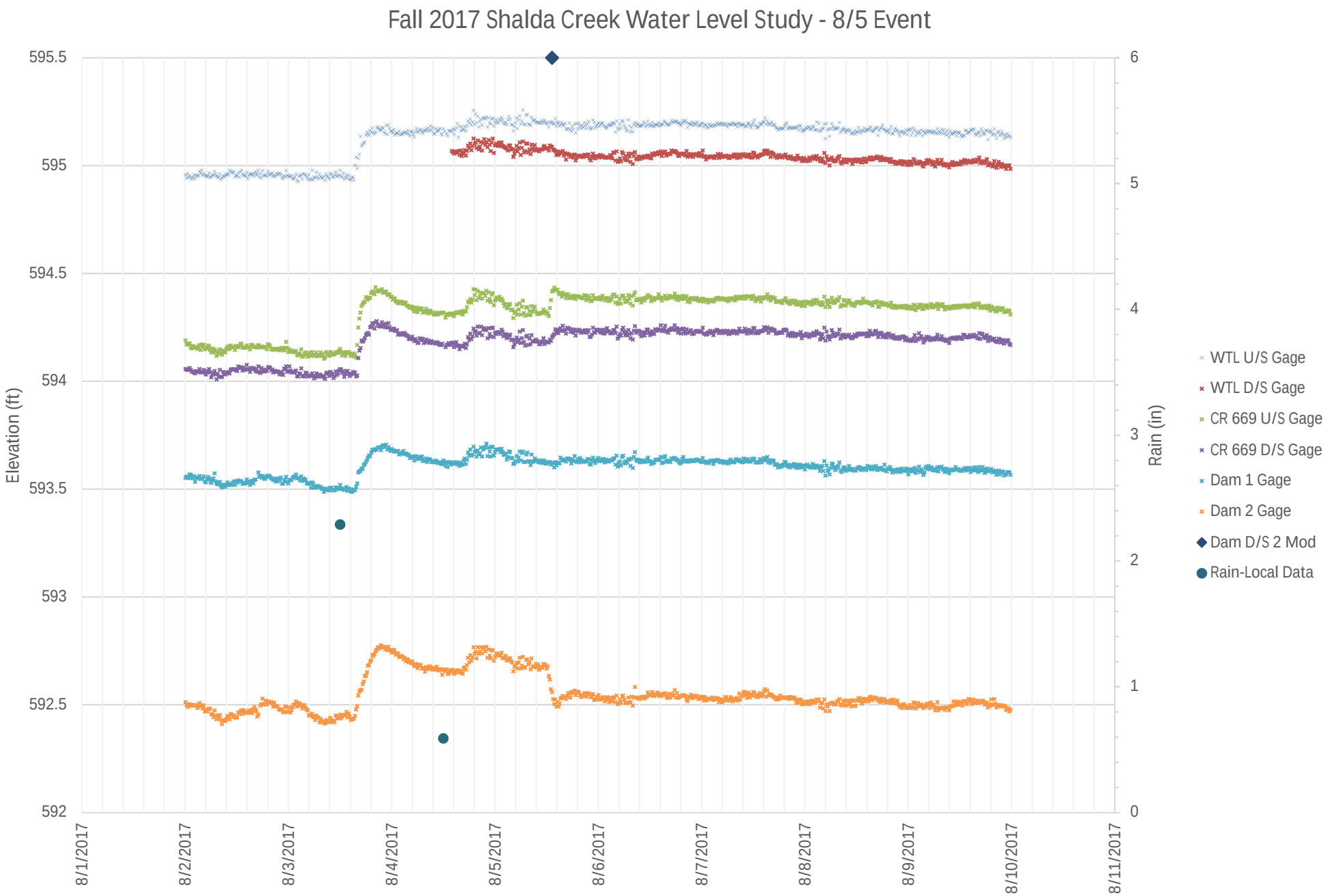
5- Little Traverse Lake property flooding fall 2020

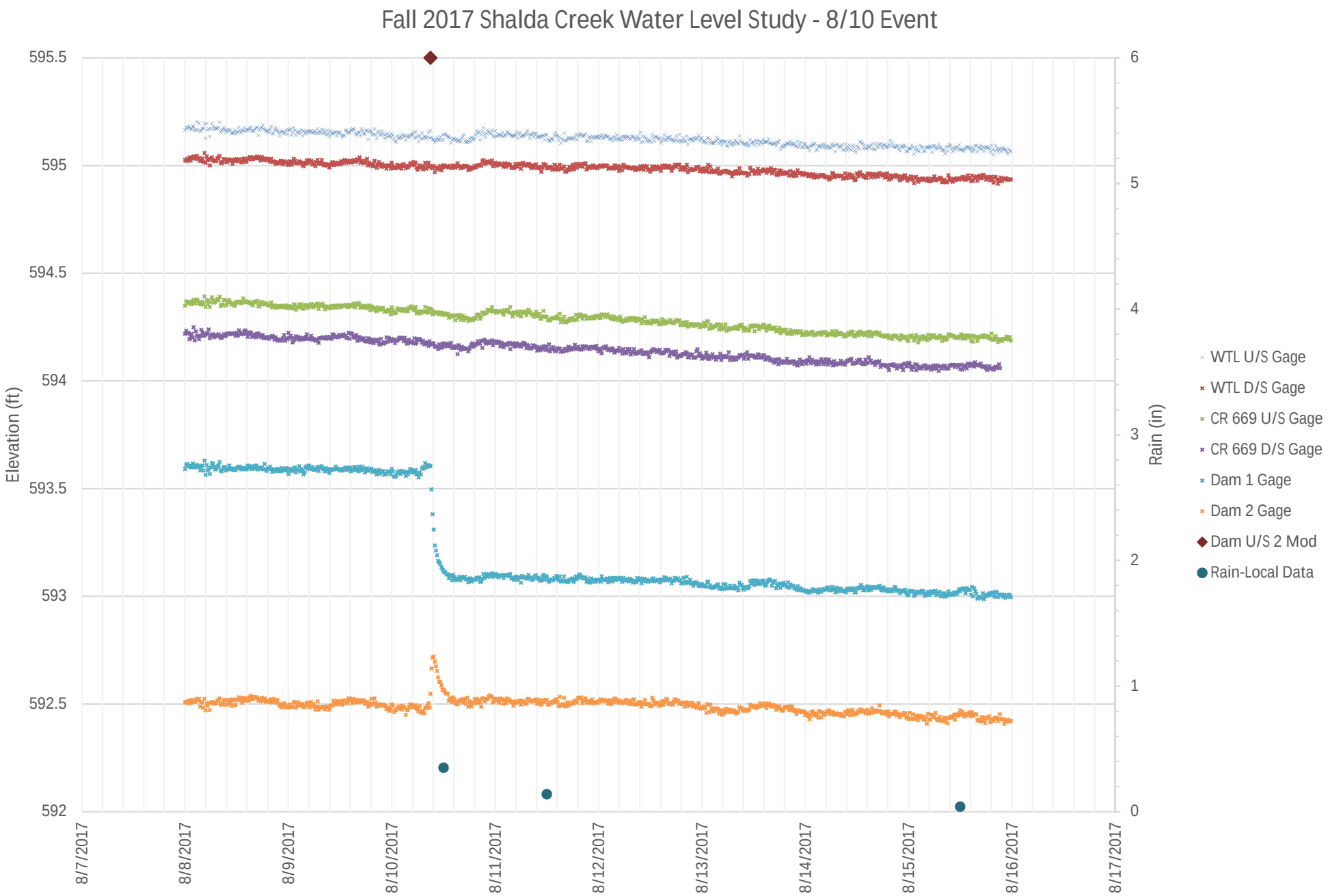
6- Little Traverse Lake property flooding fall 2020

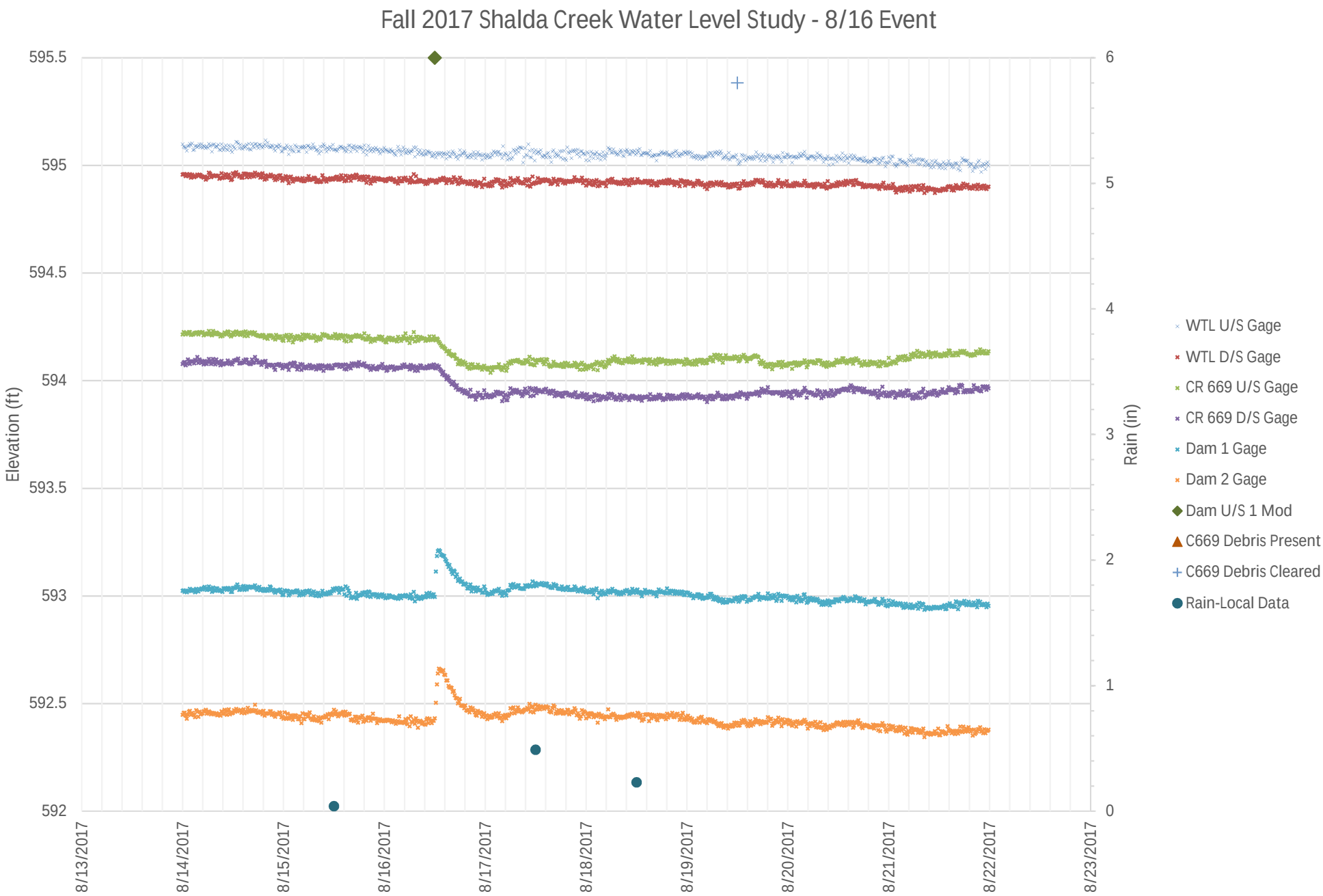
Attachment 9

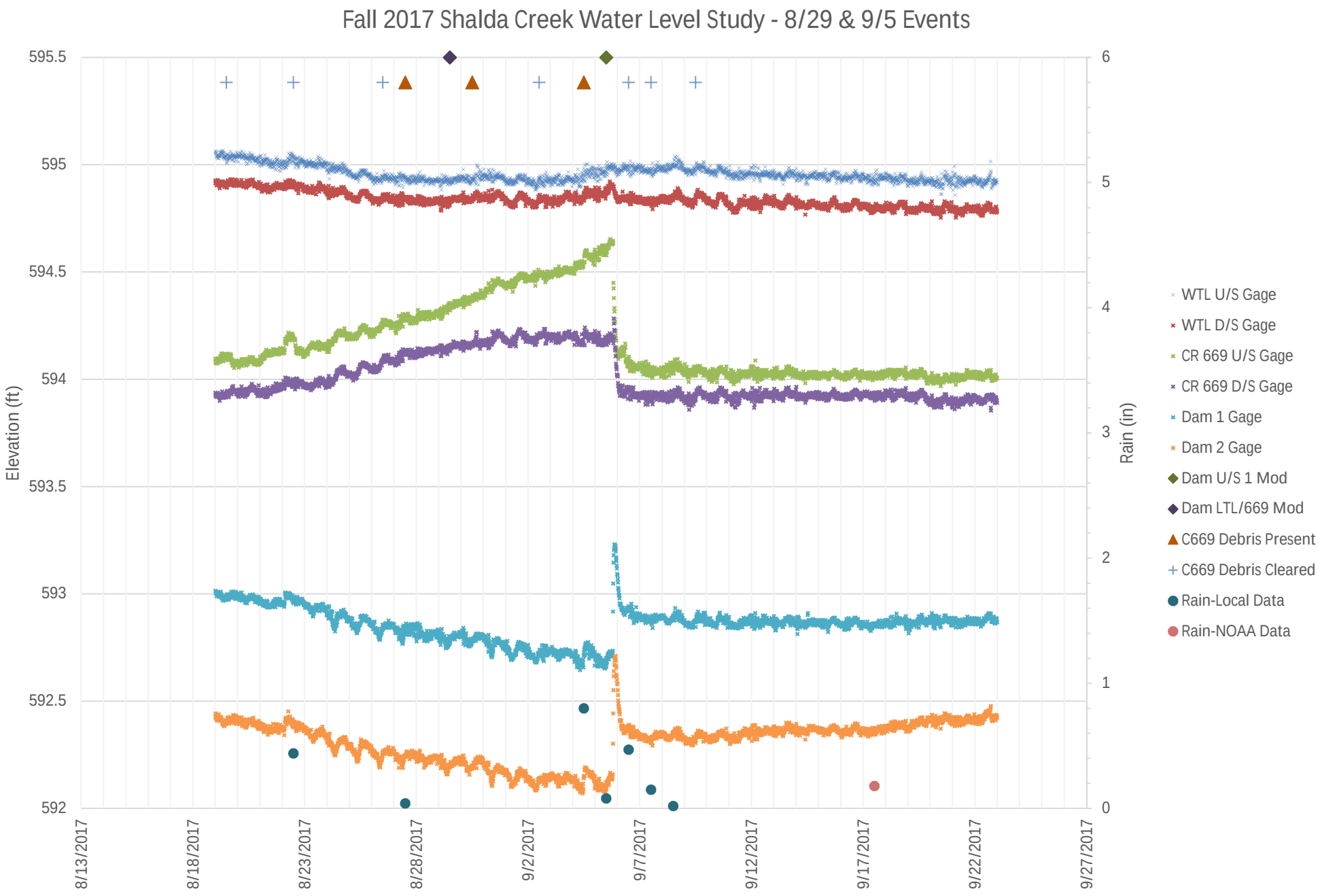
Enlarged Graphs of Figures 1-17

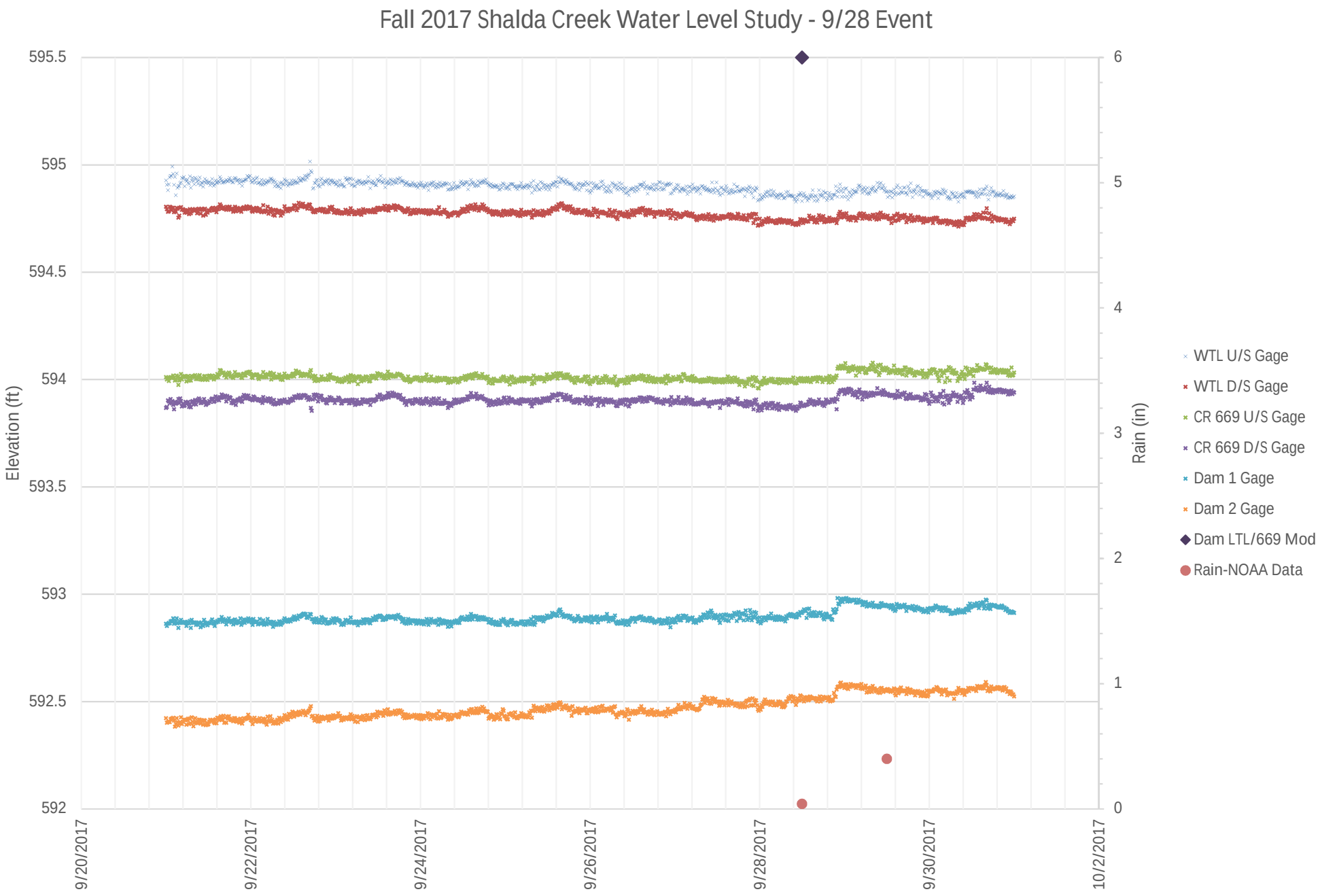

2016 Shalda Creek Water Level Study - 9/28 Event
Elevation (ft)
595.5
595
594.5
594
593.5
593
592.5
592
Rain (in)
6
5
4
3
2
1
0
9/7/2016
9/17/2016
9/27/2016
10/7/2016
0/17/2016
0/27/2016
11/6/2016
WTL U/S Gage
CR 669 U/S Gage
CR 669 D/S Gage
Dam 1 Gage
Dam 2 Gage
Dam 1 Mod
Rain-Local Data

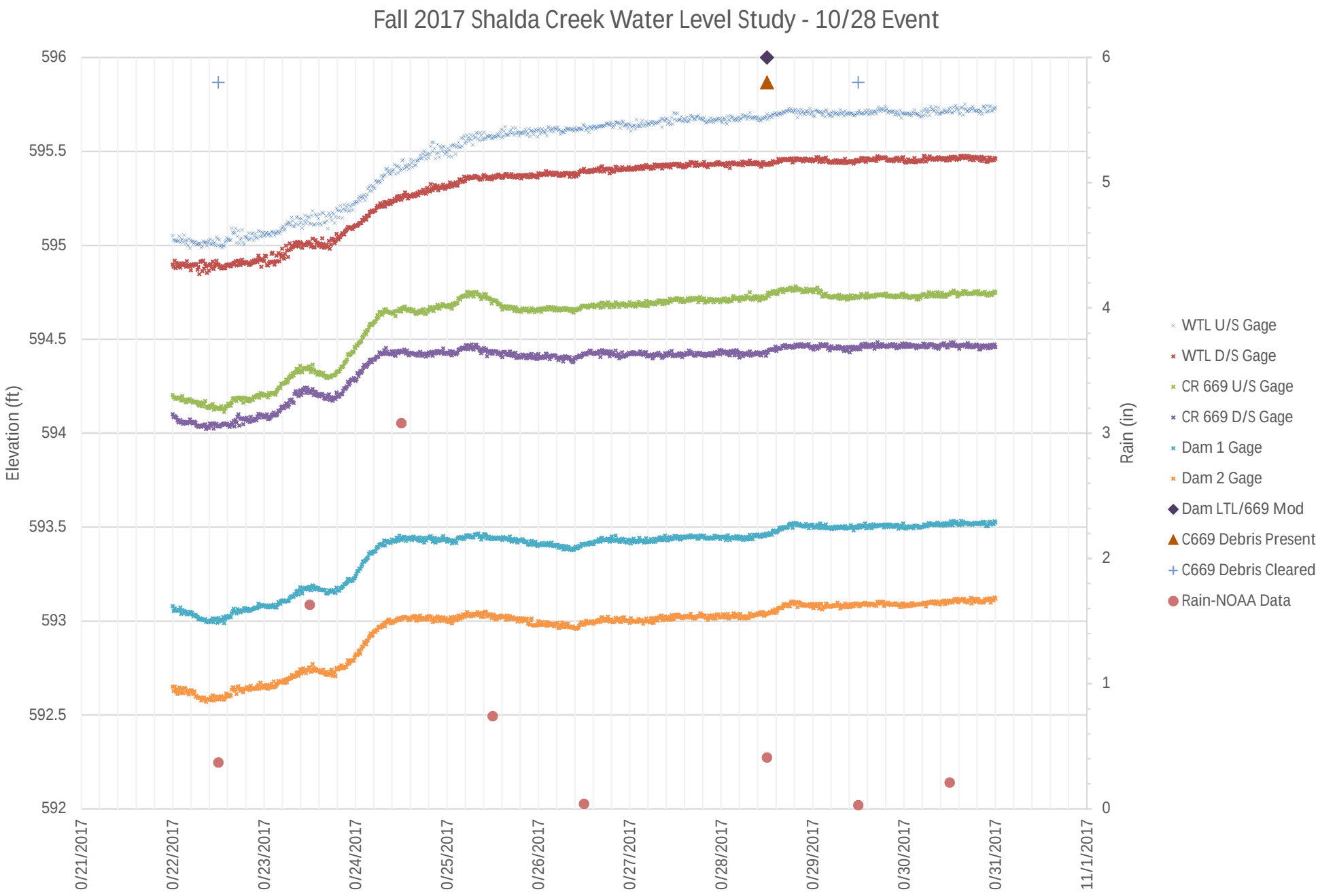

Fall 2017 Shalda Creek Water Level Study - 8/5 Event
Elevation (ft)
595.5
595
594.5
594
593.5
593
592.5
592
Rain (in)
6
5
4
3
2
1
0
8/1/2017
8/2/2017
8/3/2017
8/4/2017
8/5/2017
8/6/2017
8/7/2017
8/8/2017
8/9/2017
8/10/2017
8/11/2017
WTL U/S Gage
WTL D/S Gage
CR 669 U/S Gage
CR 669 D/S Gage
Dam 1 Gage
Dam 2 Gage
Dam D/S 2 Mod
Rain-Local Data

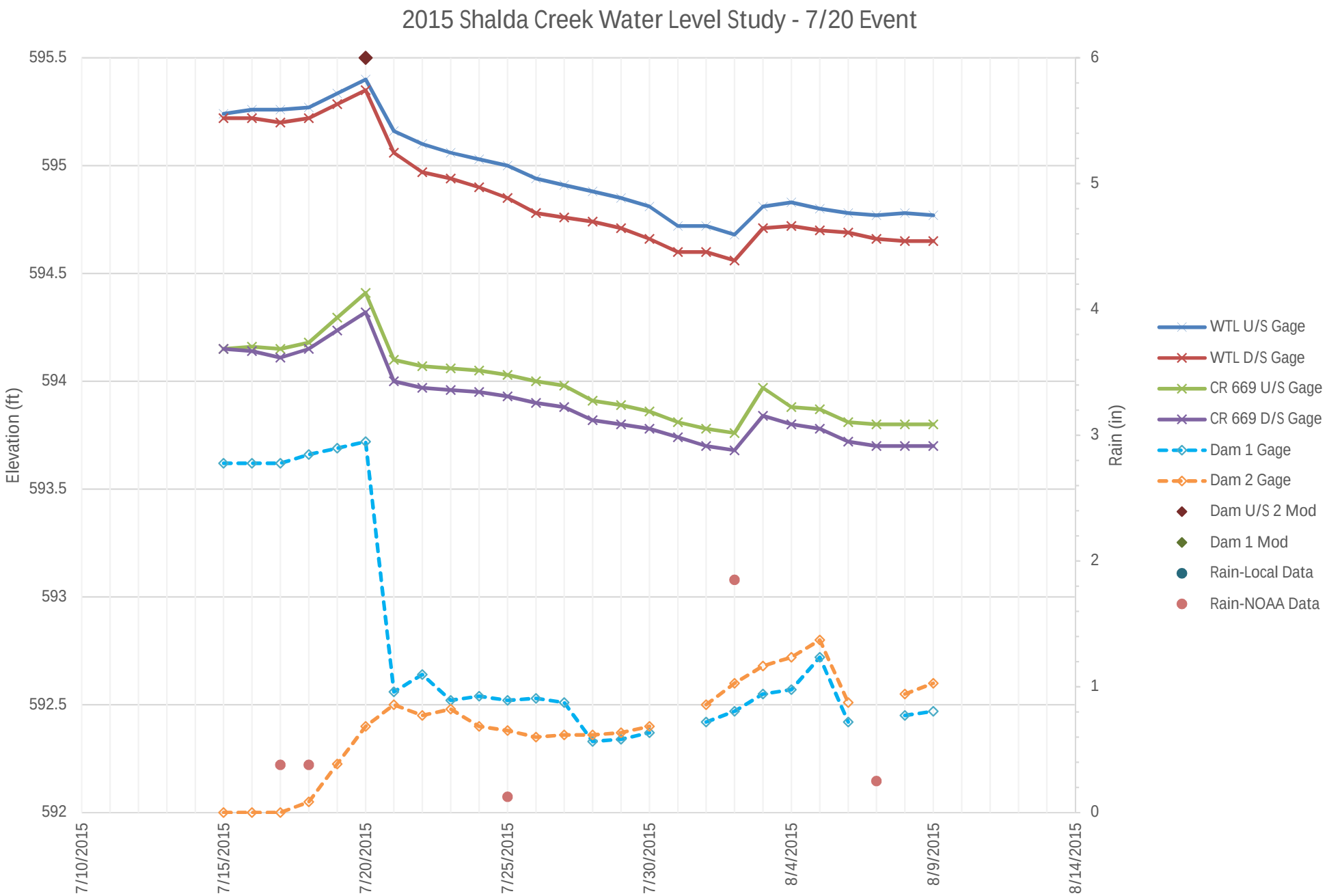

Fall 2017 Shalda Creek Water Level Study - 8/10 Event
Elevation (ft)
595.5
595
594.5
594
593.5
593
592.5
592
Rain (in)
6
5
4
3
2
1
0
8/7/2017
8/8/2017
8/9/2017
8/10/2017
8/11/2017
8/12/2017
8/13/2017
8/14/2017
8/15/2017
8/16/2017
8/17/2017
WTL U/S Gage
WTL D/S Gage
CR 669 U/S Gage
CR 669 D/S Gage
Dam 1 Gage
Dam 2 Gage
Dam U/S 2 Mod
Rain-Local Data

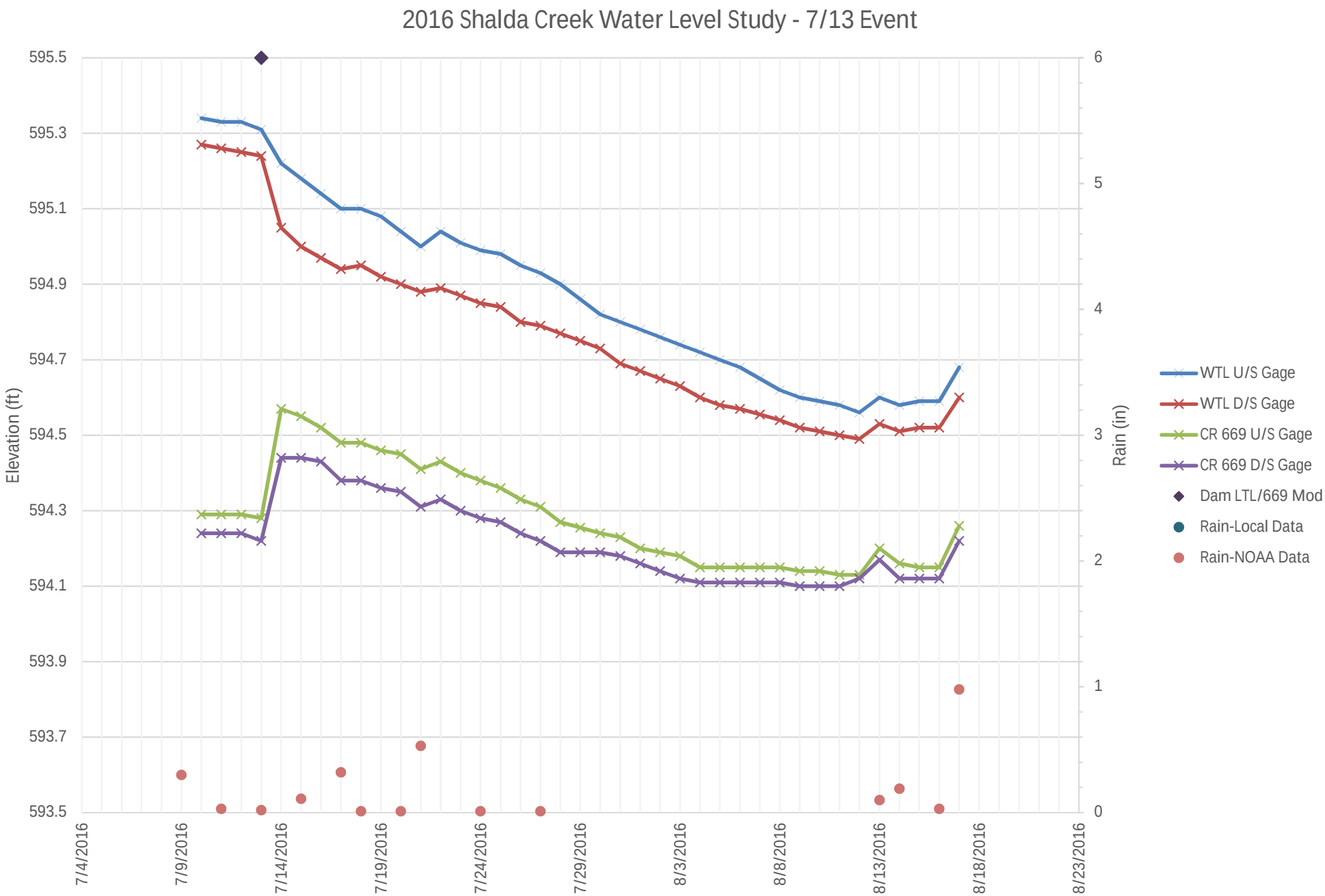

Fall 2017 Shalda Creek Water Level Study - 8/16 Event
Elevation (ft)
595.5
595
594.5
594
593.5
593
592.5
592
Rain (in)
6
5
4
3
2
1
0
8/13/2017
8/14/2017
8/15/2017
8/16/2017
8/17/2017
8/18/2017
8/19/2017
8/20/2017
8/21/2017
8/22/2017
8/23/2017
WTL U/S Gage
WTL D/S Gage
CR 669 U/S Gage
CR 669 D/S Gage
Dam 1 Gage
Dam 2 Gage
Dam U/S 1 Mod
C669 Debris Present
C669 Debris Cleared
Rain-Local Data


Fall 2017 Shalda Creek Water Level Study - 8/29 & 9/5 Events
Elevation (ft)
595.5
595
594.5
594
593.5
593
592.5
592
Rain (in)
6
5
4
3
2
1
0
8/13/2017
8/18/2017
8/23/2017
8/28/2017
9/2/2017
9/7/2017
9/12/2017
9/17/2017
9/22/2017
9/27/2017
WTL U/S Gage
WTL D/S Gage
CR 669 U/S Gage
CR 669 D/S Gage
Dam 1 Gage
Dam 2 Gage
Dam U/S 1 Mod
Dam LTL/669 Mod
C669 Debris Present
C669 Debris Cleared
Rain-Local Data
Rain-NOAA Data


Fall 2017 Shalda Creek Water Level Study - 9/28 Event
Elevation (ft)
595.5
595
594.5
594
593.5
593
592.5
592
Rain (in)
6
5
4
3
2
1
0
9/20/2017
9/22/2017
9/24/2017
9/26/2017
9/28/2017
9/30/2017
10/2/2017
WTL U/S Gage
WTL D/S Gage
CR 669 U/S Gage
CR 669 D/S Gage
Dam 1 Gage
Dam 2 Gage
Dam LTL/669 Mod
Rain-NOAA Data


Fall 2017 Shalda Creek Water Level Study - 10/28 Event
Elevation (ft)
Rain (in)
596
595.5
595
594.5
594
593.5
593
592.5
592
6
5
4
3
2
1
0
10/21/2017
10/22/2017
10/23/2017
10/24/2017
10/25/2017
10/26/2017
10/27/2017
10/28/2017
10/29/2017
10/30/2017
10/31/2017
11/1/2017
WTL U/S Gage
WTL D/S Gage
CR 669 U/S Gage
CR 669 D/S Gage
Dam 1 Gage
Dam 2 Gage
Dam LTL/669 Mod
C669 Debris Present
C669 Debris Cleared
Rain-NOAA Data


2015 Shalda Creek Water Level Study - 7/20 Event
Elevation (ft)
595.5
595
594.5
594
593.5
593
592.5
592
Rain (in)
6
5
4
3
2
1
0
7/10/2015
7/15/2015
7/20/2015
7/25/2015
7/30/2015
8/4/2015
8/9/2015
8/14/2015
WTL U/S Gage
WTL D/S Gage
CR 669 U/S Gage
CR 669 D/S Gage
Dam 1 Gage
Dam 2 Gage
Dam U/S 2 Mod
Dam 1 Mod
Rain-Local Data
Rain-NOAA Data


2016 Shalda Creek Water Level Study - 7/13 Event
Elevation (ft)
595.5
595.3
595.1
594.9
594.7
594.5
594.3
594.1
593.9
593.7
593.5
Rain (in)
6
5
4
3
2
1
0
7/4/2016
7/9/2016
7/14/2016
7/19/2016
7/24/2016
7/29/2016
8/3/2016
8/8/2016
8/13/2016
8/18/2016
8/23/2016
WTL U/S Gage
WTL D/S Gage
CR 669 U/S Gage
CR 669 D/S Gage
Dam LTL/669 Mod
Rain-Local Data
Rain-NOAA Data

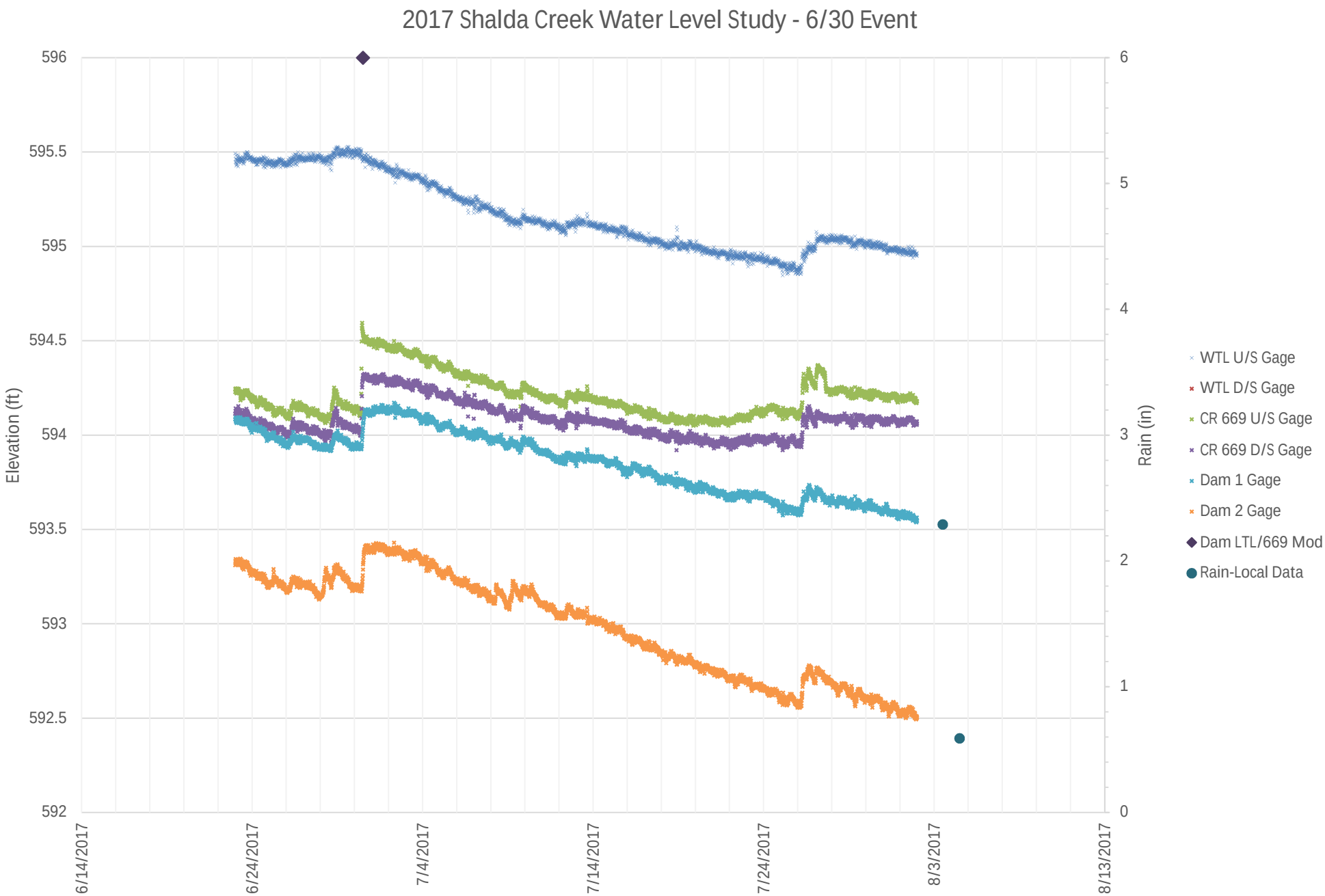

2017 Shalda Creek Water Level Study - 6/30 Event
Elevation (ft)
596
595.5
595
594.5
594
593.5
593
592.5
592
Rain (in)
6
5
4
3
2
1
0
6/14/2017
6/24/2017
7/4/2017
7/14/2017
7/24/2017
8/3/2017
8/13/2017
WTL U/S Gage
WTL D/S Gage
CR 669 U/S Gage
CR 669 D/S Gage
Dam 1 Gage
Dam 2 Gage
Dam LTL/669 Mod
Rain-Local Data

Figure 11 - 2018 Little Traverse Lake & Shalda Creek System Observed Water Levels

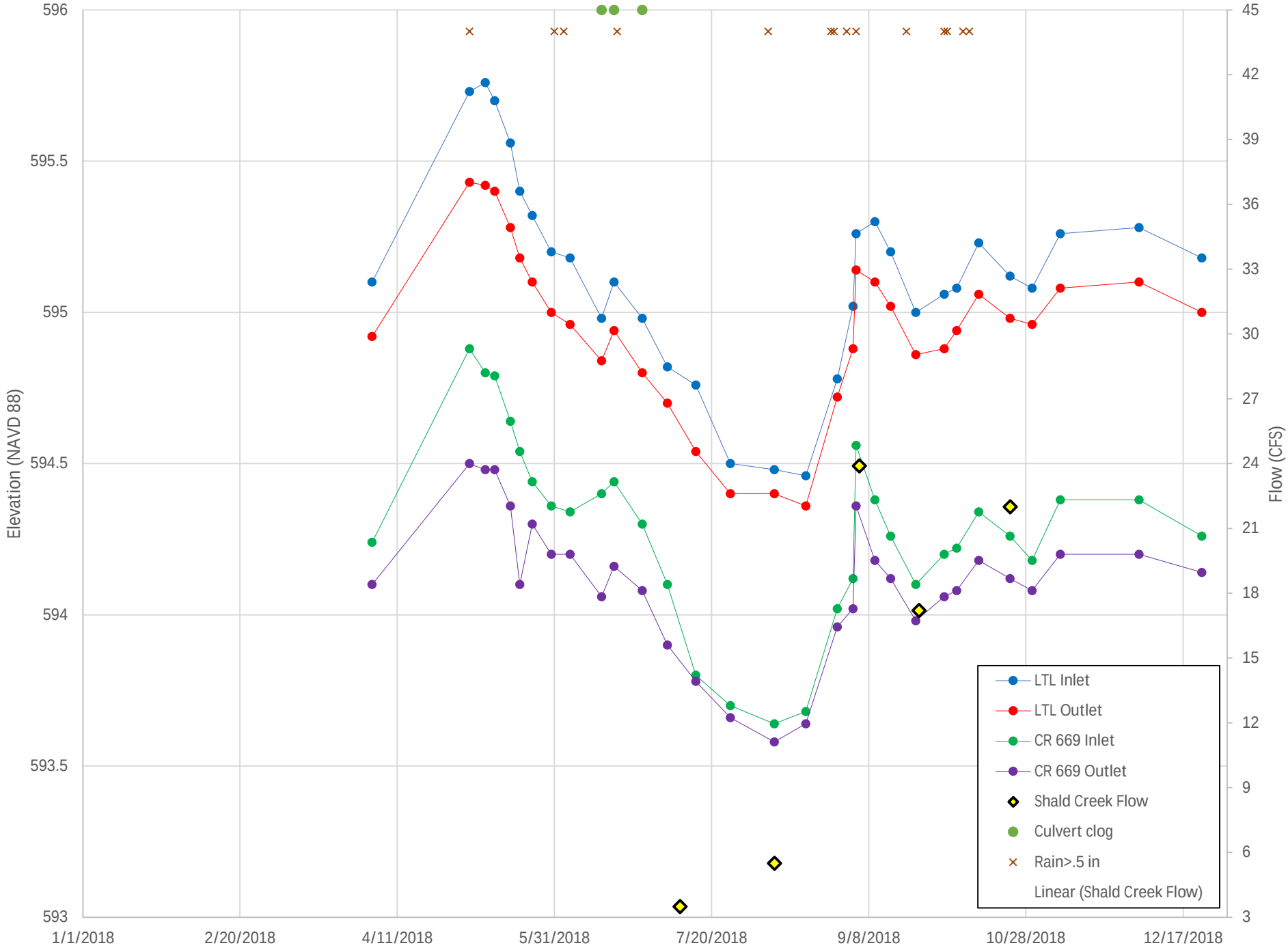


Figure 12 - 2019 Little Traverse Lake & Shalda Creek System Observed Water Levels

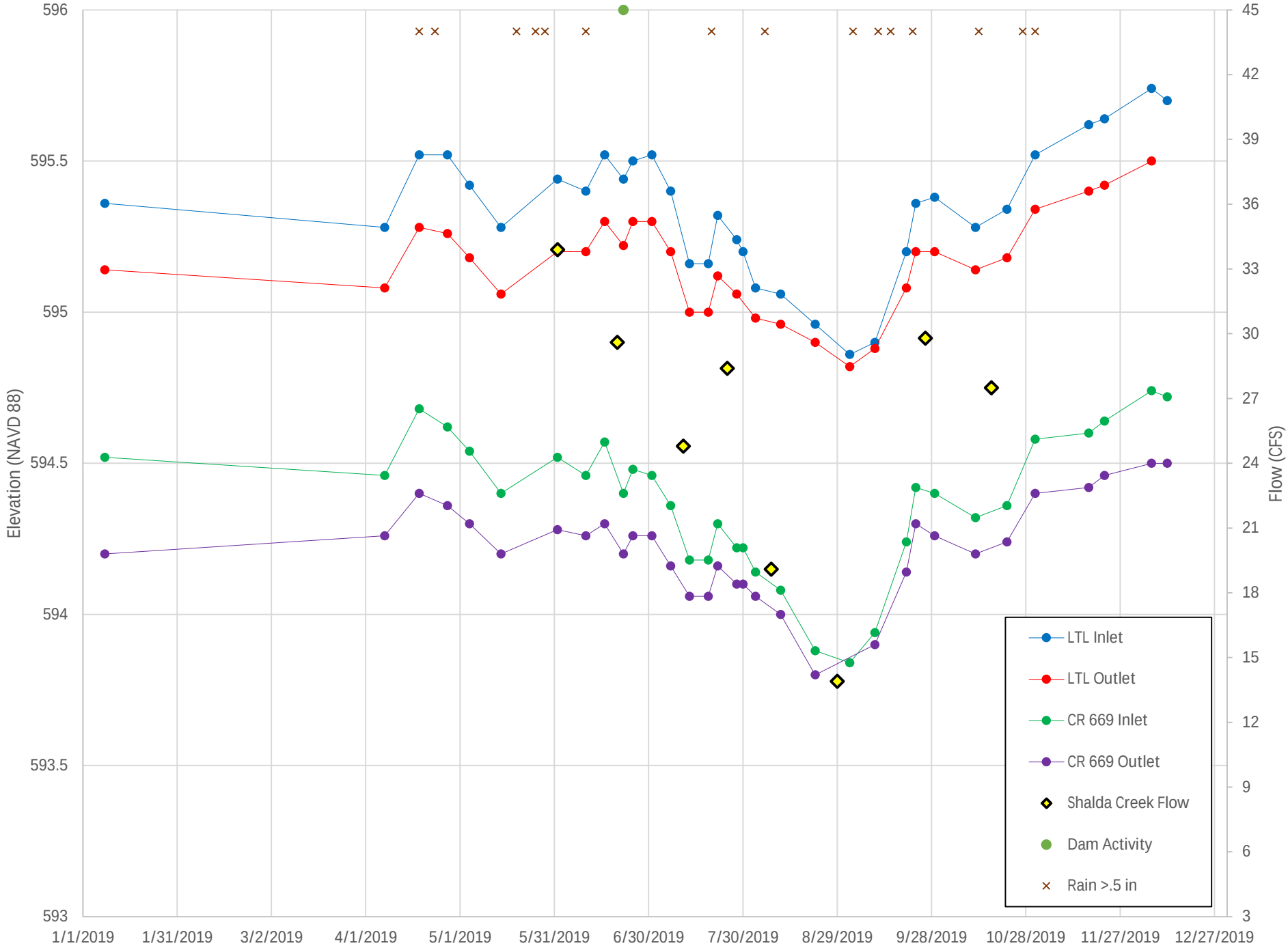


Figure 13 - 2020 Little Traverse Lake & Shalda Creek System Observed Water Levels

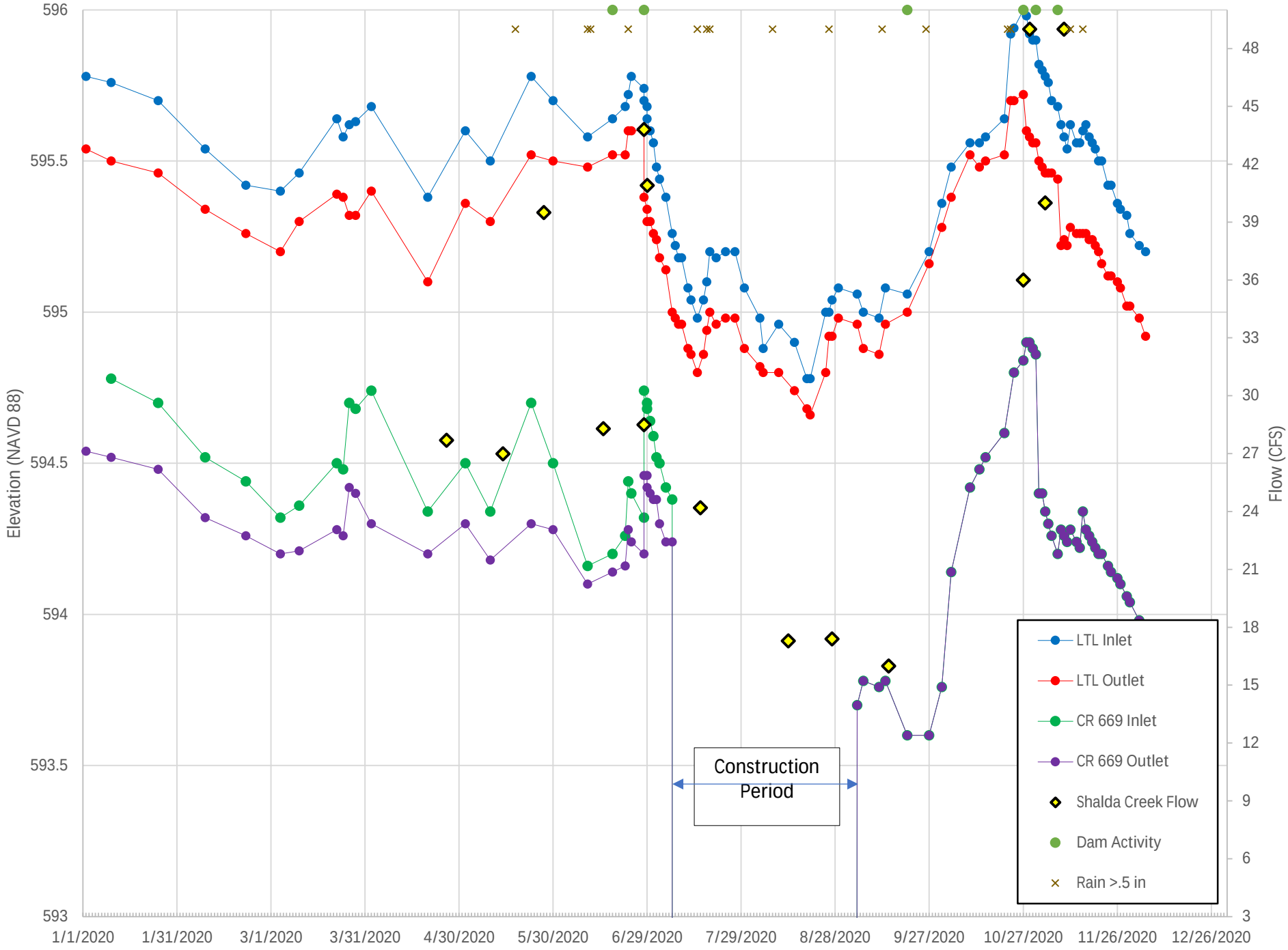


Figure 14 - 2020 Little Traverse Lake & Shalda Creek System Observed Water Levels

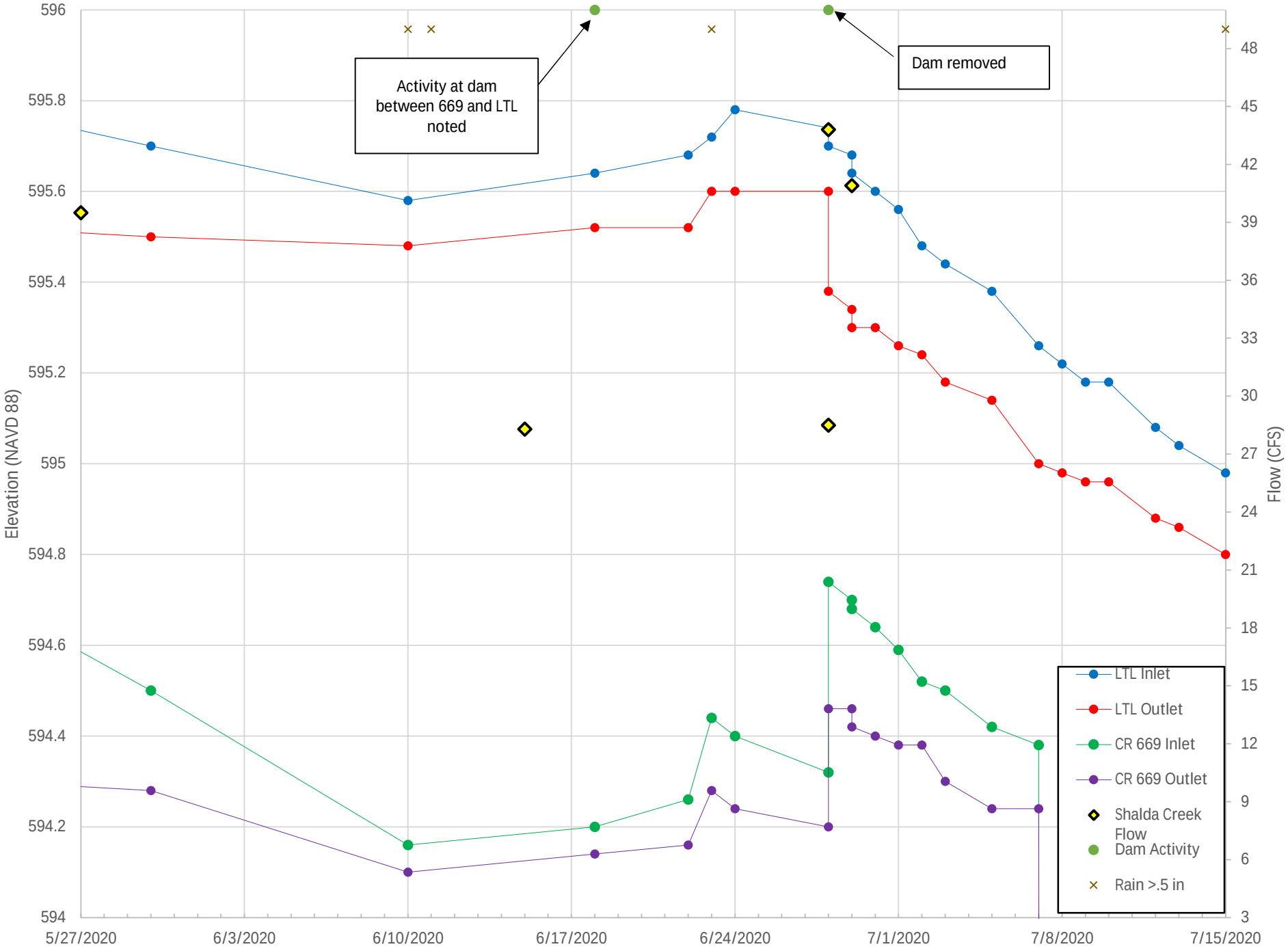


Figure 15 - 2020 Little Traverse Lake & Shalda Creek System Observed Water Levels

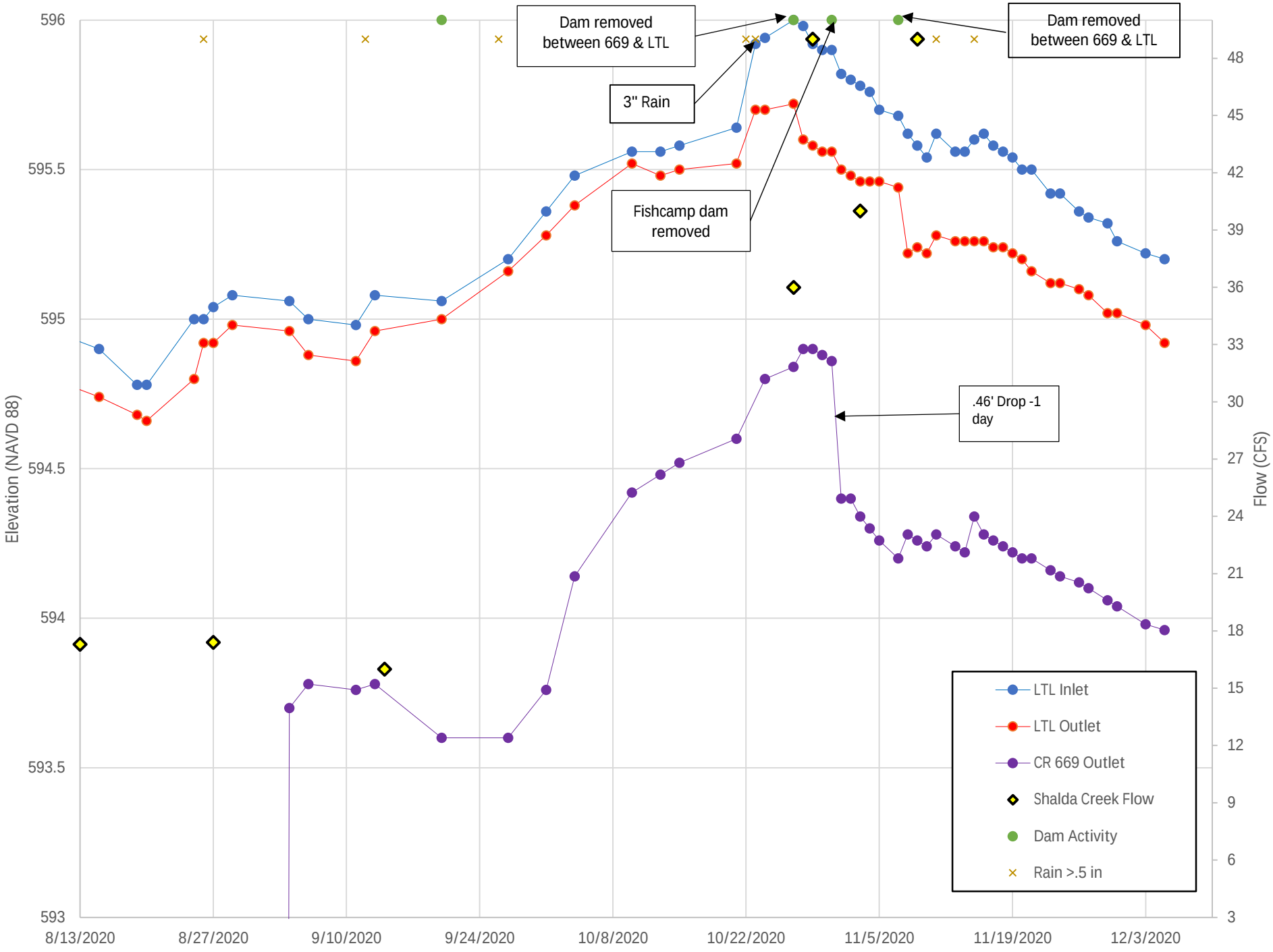


Figure 16 - Benzie Conservation District Shetland and Shalda Creek Flow Measurements			
Date	Shetland Flow (cfs)	Shalda Flow (cfs)	Notes
5/1/2013			
5/8/2013	18.36		
7/23/2013	13.77		
10/8/2013	16.94	12.00	
6/5/2014	26.12		
7/29/2014	21.18	26.48	
9/15/2014	21.53		
5/6/2015	23.30	38.83	
6/8/2015	18.71	18.36	
7/21/2015	11.65	15.89	
9/9/2015	25.77	29.30	
10/13/2015	13.77	36.01	
5/17/2016	12.61	22.99	
6/6/2016	17.36	13.76	
7/14/2016	11.02	22.11	
5/12/2017	18.06	31.13	
8/1/2017	17.32	18.7	
9/26/2017	8.75	15.31	
7/10/2018	8.28	3.475	
8/9/2018	11.29	5.532	
9/5/2018	12.326	23.89	
9/24/2018	14.538	17.17	
10/23/2018	25.75	22.039	
6/1/2019	20.04	33.9	
6/20/2019	19.14	29.58	
7/11/2019	12.43	24.79	
7/25/2019	14.39	28.43	
8/8/2019	17.72	19.06	
8/29/2019	9.26	13.91	
9/26/2019	21.89	29.84	
10/17/2019	18.63	27.45	
4/26/2020	18.22	27.73	
5/14/2020	17.83	27	
5/27/2020	24.793	39.47	
6/15/2020	18.408	28.34	
6/28/2020		28.51	Measured before dam U/S CR 669 modification this day
6/28/2020		43.79	Measured after dam U/S CR 669 modification this day
6/29/2020	18.906	40.87	
7/16/2020		24.23	
7/30/2020	16.24		
8/13/2020	14.862	17.29	
8/27/2020		17.4	
9/14/2020	18.074	16.047	

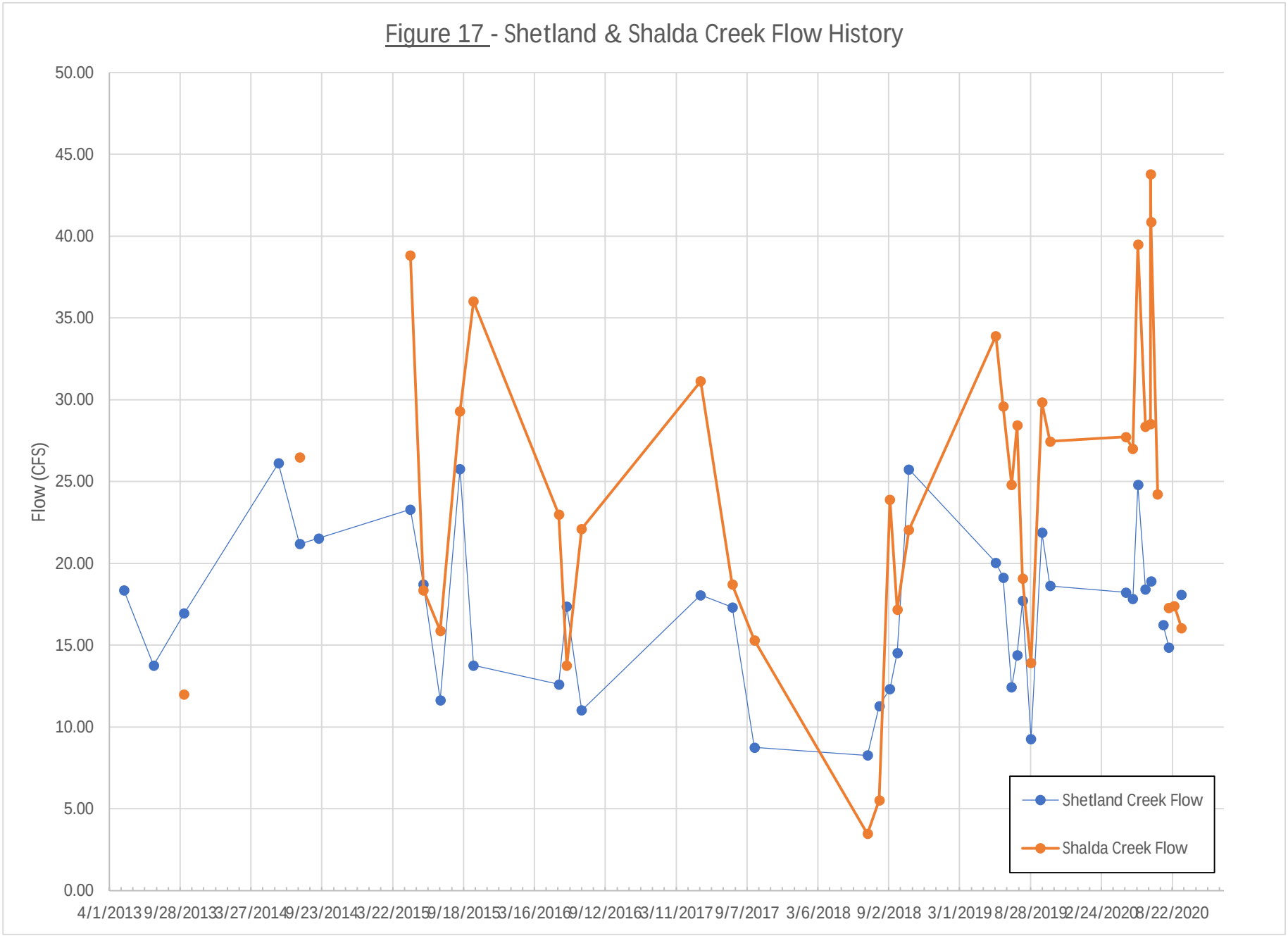


Figure 17 - Shetland & Shalda Creek Flow History
Flow (CFS)
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
4/1/2013
9/28/2013
3/27/2014
9/23/2014
3/22/2015
9/18/2015
3/16/2016
9/12/2016
3/11/2017
9/7/2017
3/6/2018
9/2/2018
3/1/2019
8/28/2019
2/24/2020
8/22/2020
Shetland Creek Flow
Shalda Creek Flow

Attachment 10

TECHNICAL MEMORANDUM

Little Traverse Lake Water Levels & Beaver Dam Modifications

To:	David Skjaerlund & LTLPOA	Date:	June 25, 2020
From:	Robert Verschaeve, P.E., Doug Coates, P.E.	Re:	Little Traverse Lake Water Levels & Beaver Dam Modifications
cc:			

1.0 INTRODUCTION

This memorandum is being provided as requested by you and Little Traverse Lake Property Owners Association (LTLPOA) to present to the National Park Service (NPS) for their consideration to allow a modification of a re-established beaver dam within Shalda Creek. This beaver dam is located between CR 669 and West Traverse Lake Road. GPS coordinates of the dam are: 44° 55' 30" N, 85° 52' 16" W. This memo presents the data and effects of water levels within the system from the modification of this beaver dam.

LTL residents are currently experiencing some of the highest recorded water levels similar to the levels surrounding the two separate dam modifications presented in this memorandum. Those modifications occurred just prior and during a yearlong data collection period from fall 2016 to fall 2017 for which a final report is currently being prepared. One of the goals of the larger study was to observe system water levels as beaver dams were modified downstream of the CR 669 culvert. This dam is the farthest upstream observed dam in the system and modification of it was necessary to access effects of the downstream dam modifications during the study. The data presented for the modifications of this beaver dam between CR 669 and West Traverse Lake Road provide a reasonable basis for the NPS to allow additional modifications of the beaver dam located within the Sleeping Bear Dunes National Lakeshore by LTLPOA.

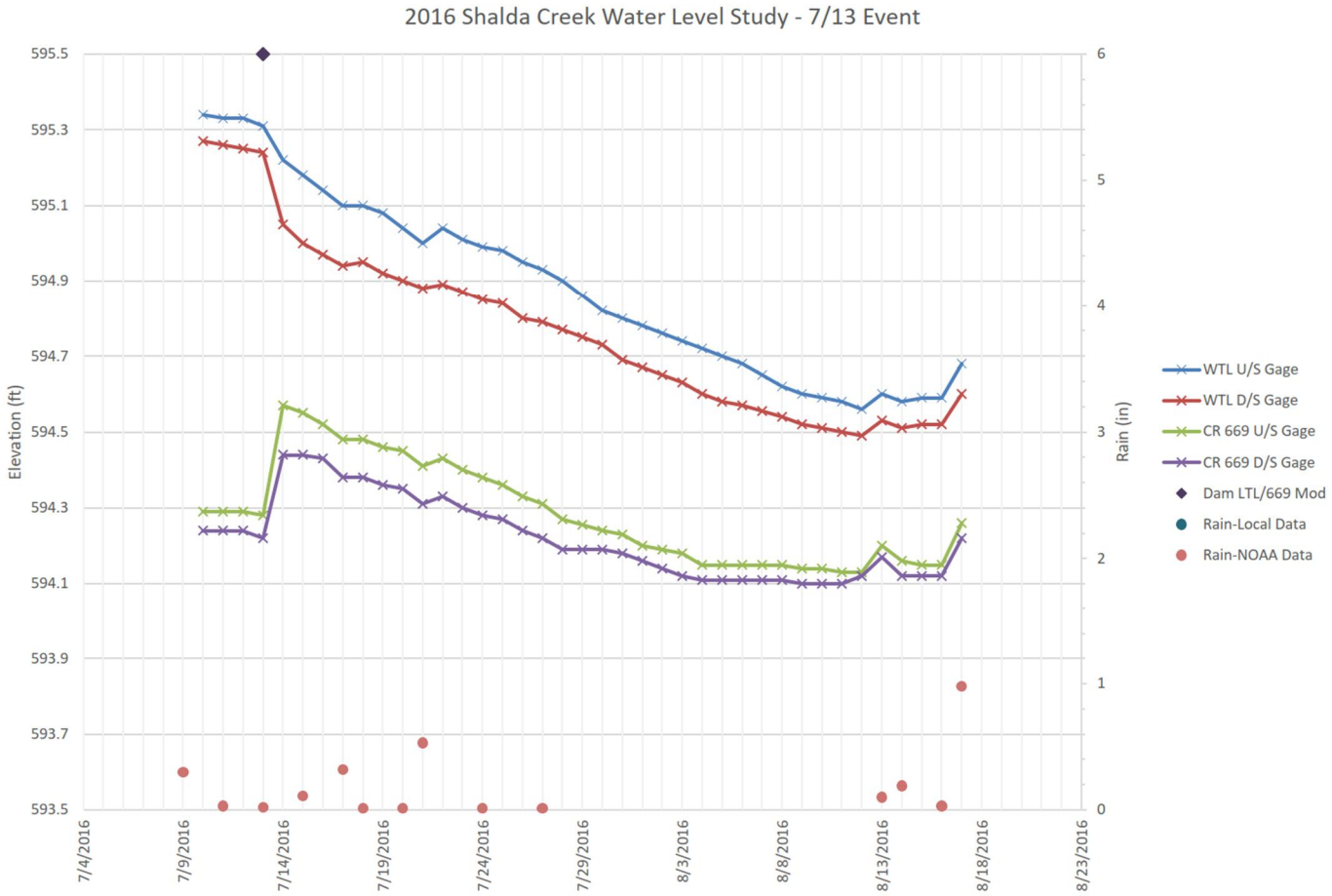
2.0 DATA

Prior to deploying data loggers throughout the Shalda Creek system for the larger study period, LTLPOA had recorded water levels from staff gauges located upstream and downstream of the culverts at CR 669 and West Traverse Lake Road. These gauges had been previously correlated to NAVD 88 vertical datum when Gosling Czubak first began studying the Shalda Creek system with LTLPOA.

On June 27, 2016 permission was received from SLBE Chief of Natural Resources Kevin Skerl to install a staff gauge at the dam located between CR 669 and West Traverse Lake Road, collect data for at least a week, and then modify the dam.

A modification of this dam was completed on 7/13/2016. This modification event and water level measurements following the modification area shown in the following Figure 1. At the time of this modification, the water level of LTL was at a relatively high level of 595.3. Following the removal of the dam, it steadily dropped .75 feet (9 inches) over 30 days to 594.56.

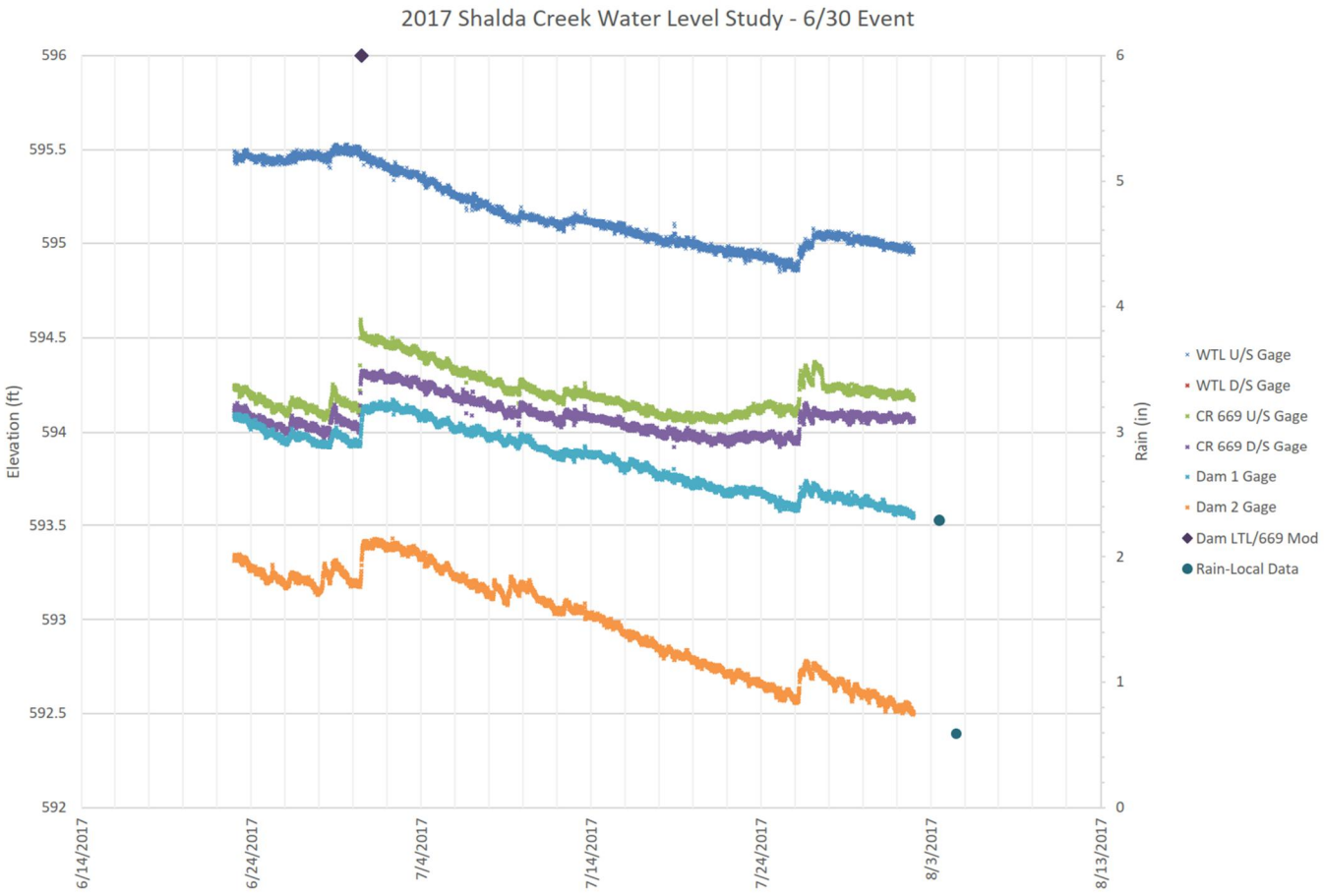
Figure 1



Another data set graph is shown in Figure 2 from data collected following a modification of the dam between LTL and CR 669 nearly a year later on 6/30/2017. This data was recorded by the data loggers that were deployed by NPS in August 2016. Once again, the water surface elevation at LTL was relatively high at 595.5 when the dam was modified. After the dam modification, there were quick upticks in elevation at

the gauges downstream of the dam followed by steady decline of water levels over approximately 1 month. During this period, the LTL level declined .65 feet (7.8 inches).

Figure 2



The water level readings from the staff gauges have been periodically read by LTLPOA members and logged in a spreadsheet available from the "Current & Historical Lake Levels" link on the LTLPOA website page at this address: http://www.littletraverselake.org/lake-levels.html. The levels noted in this spreadsheet are gauge readings and require a correlation factor added to be on the NAVD 88 datum of all other presented data. The gauge readings and converted NAVD 88 elevations for 6/24/2020 from this spreadsheet along with the readings before the 2016 and 2017 dam modifications are:

Current Water Level Readings - 6/24/2020

	TLR Inlet	TLR Outlet	669 Inlet	669 Outlet
Gauge Reading	594.98	594.8	593.6	593.44
NAVD 88 conversion	0.8	0.8	0.7	0.7
NAVD 88 Elevation	595.78	595.6	594.3	594.14
7/13/2016 (NAVD 88)	595.31	595.24	594.28	594.22
6/30/2017 (NAVD 88)	594.47	*	594.53	594.3

** The TLR Outlet data logger was not deployed until August 2017.*

It is noted that the LTL water elevation at the West Traverse Lake Road culvert inlet is nearly 6" higher now than the water surface elevation prior to the 7/13/2016 dam modification event and just over 3" higher now than the 6/30/2017 dam modification event. The current water elevations at the CR 669 culvert inlet location are nearly the same as prior to the 7/13/2016 dam modification event and 2.76" (.23 feet) lower than just prior to the 6/30/2017 dam modification event. This LTL water level corresponds to the highest recently recorded levels and suggests the re-established beaver dam is a significant contributing factor.

3.0 CONCLUSIONS

Modifications to the beaver dam located between CR 669 and West Traverse Lake Road that were completed as part of the larger Shalda Creek study have repeatedly shown a noticeable decrease in water level at Little Traverse Lake. The current water levels at Little Traverse Lake upstream of the beaver dam are greater than they were prior the past modifications while the downstream water levels are at or below the levels prior to the modifications. It is expected that similar changes to the water levels would occur with an allowed modification of the same dam by the National Park Service at this time. Water level readings of the staff gauges would still need to be recorded daily and added to the data set to document the water level changes if modification is permitted by the National Park Service.

Respectfully Submitted,

Robert M. Verschaeve, P.E.
Project Manager
rmverschaeve@goslingczubak.com

Doug A. Coates, P.E.
President
dacoates@goslingczubak.com

Attachment 11

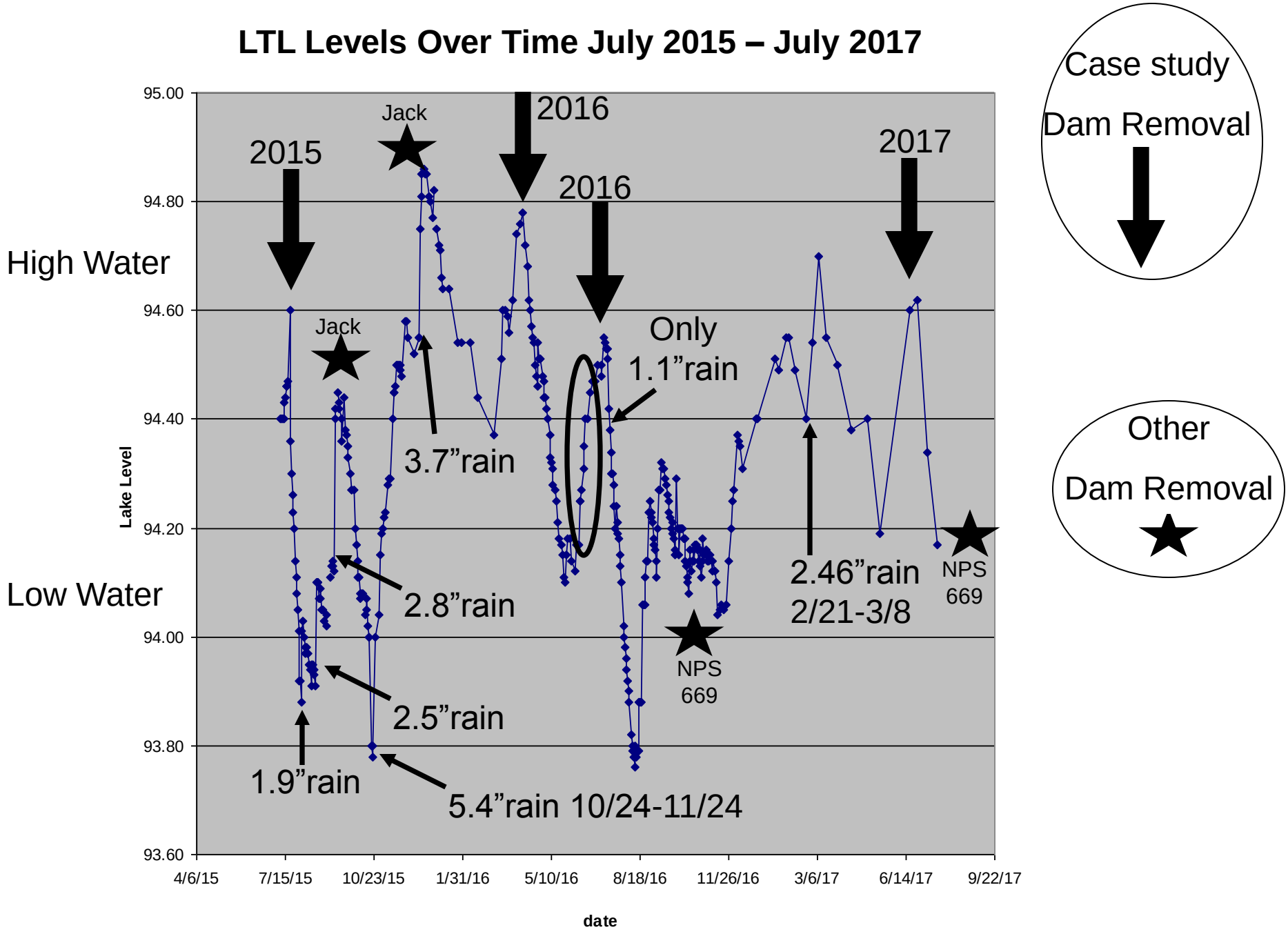
Little Traverse Lake
WATER LEVELS

Preliminary 2015-2017 data analysis

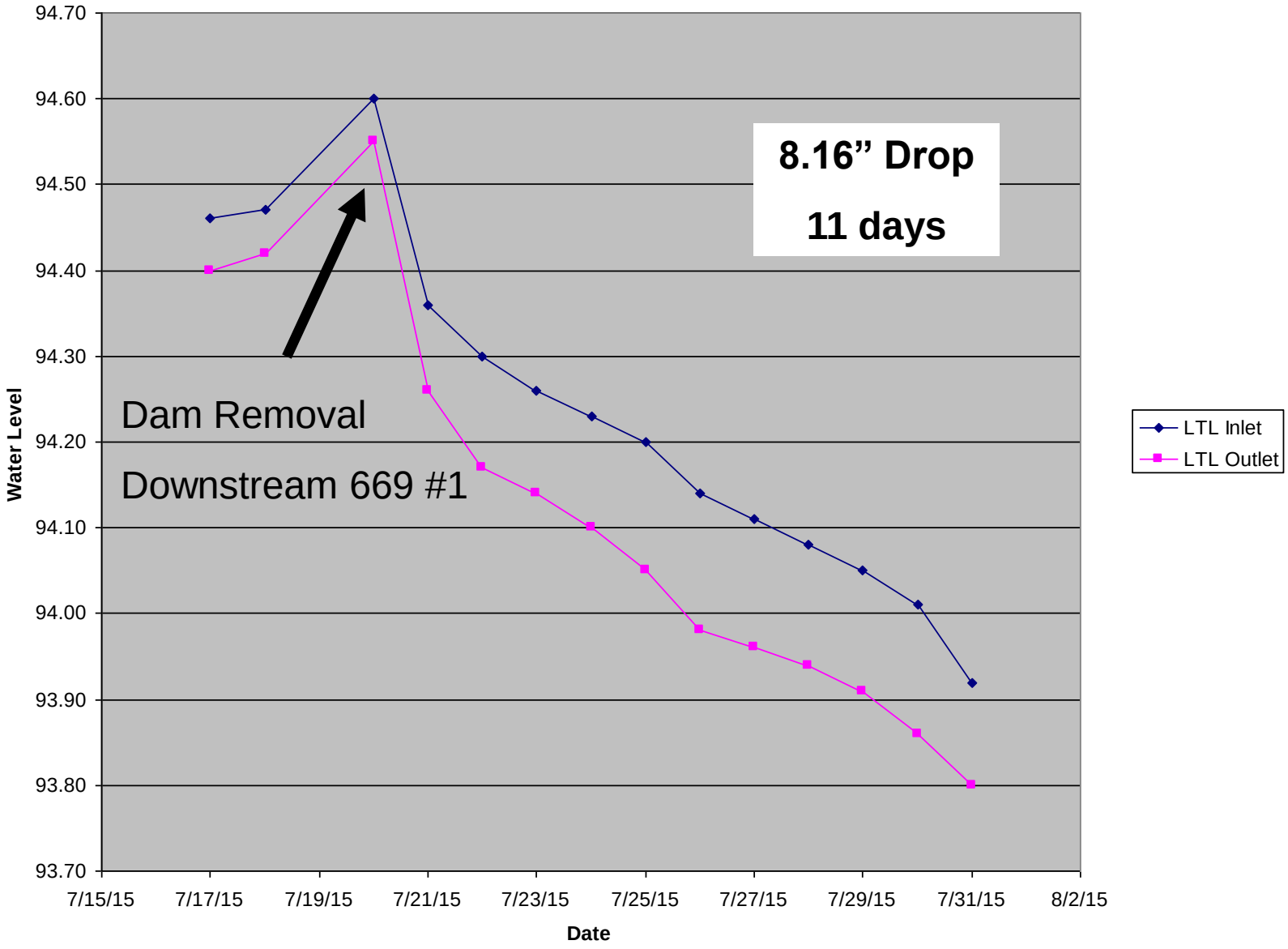
Summary presented at
LTLPOA Annual Meeting
August 5, 2017

Water Level Factors

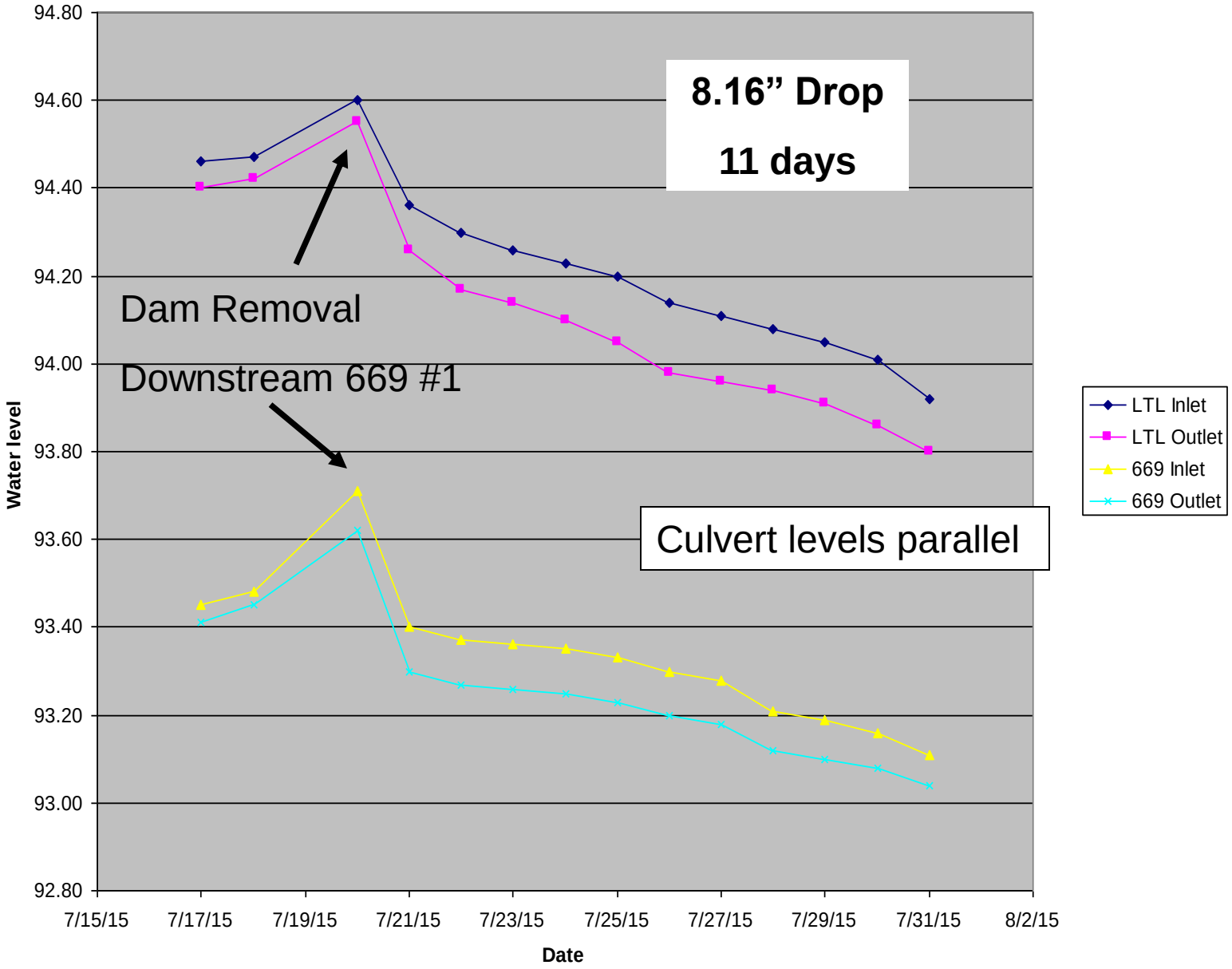
- BEAVER DAMS
  - Between Little Traverse Lake (LTL) and CR 669
  - Downstream from CR 669
- CULVERTS
  - CR 669
  - Traverse Lake Road (TLR)
- Seasonal Rain (100 or 500 year rain events)
  - *Historically never had past LTL flooding with regular dam clearing*
  - *No dams cleared for 3 years prior to fall 2013 heavy rain event – multiple dams including 4.0 feet dam had flooded area's water table)*
  - *Historic Rainfall Average September-December 14.0";*
    Sept-Dec 2013 21.7"; Sept-Dec 2015 19.5" (2013 only 11% higher)


LTL Levels Over Time July 2015 – July 2017
Case study
Dam Removal
Other
Dam Removal
High Water
Low Water
2015
2016
2016
2017
Jack
Jack
Only
1.1”rain
3.7”rain
2.8”rain
2.5”rain
1.9”rain
5.4”rain 10/24-11/24
2.46”rain
2/21-3/8
NPS
669
NPS
669
Lake Level
95.00
94.80
94.60
94.40
94.20
94.00
93.80
93.60
4/6/15
7/15/15
10/23/15
1/31/16
5/10/16
8/18/16
11/26/16
3/6/17
6/14/17
9/22/17
date

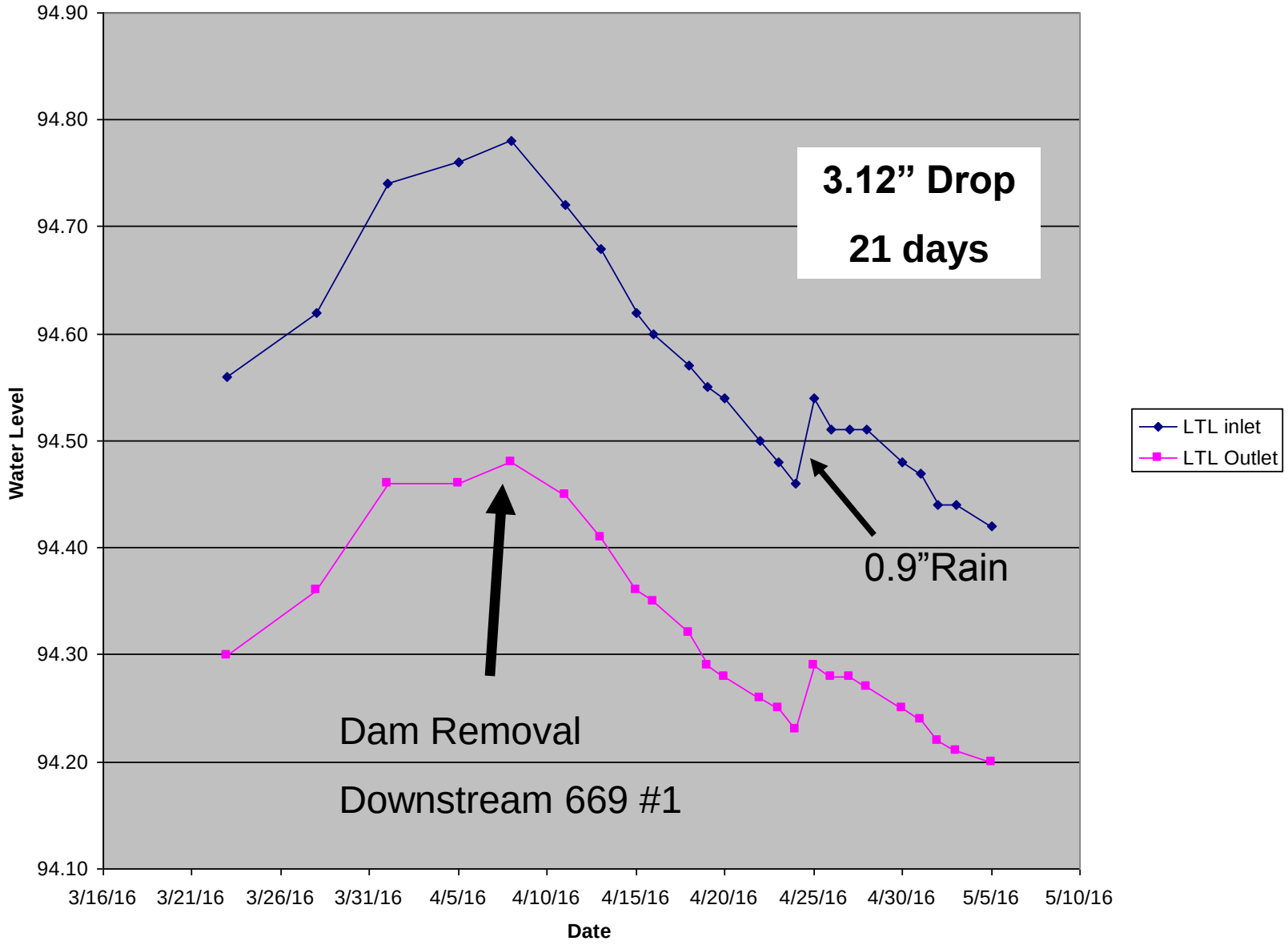
July 20, 2015 Dam Removal



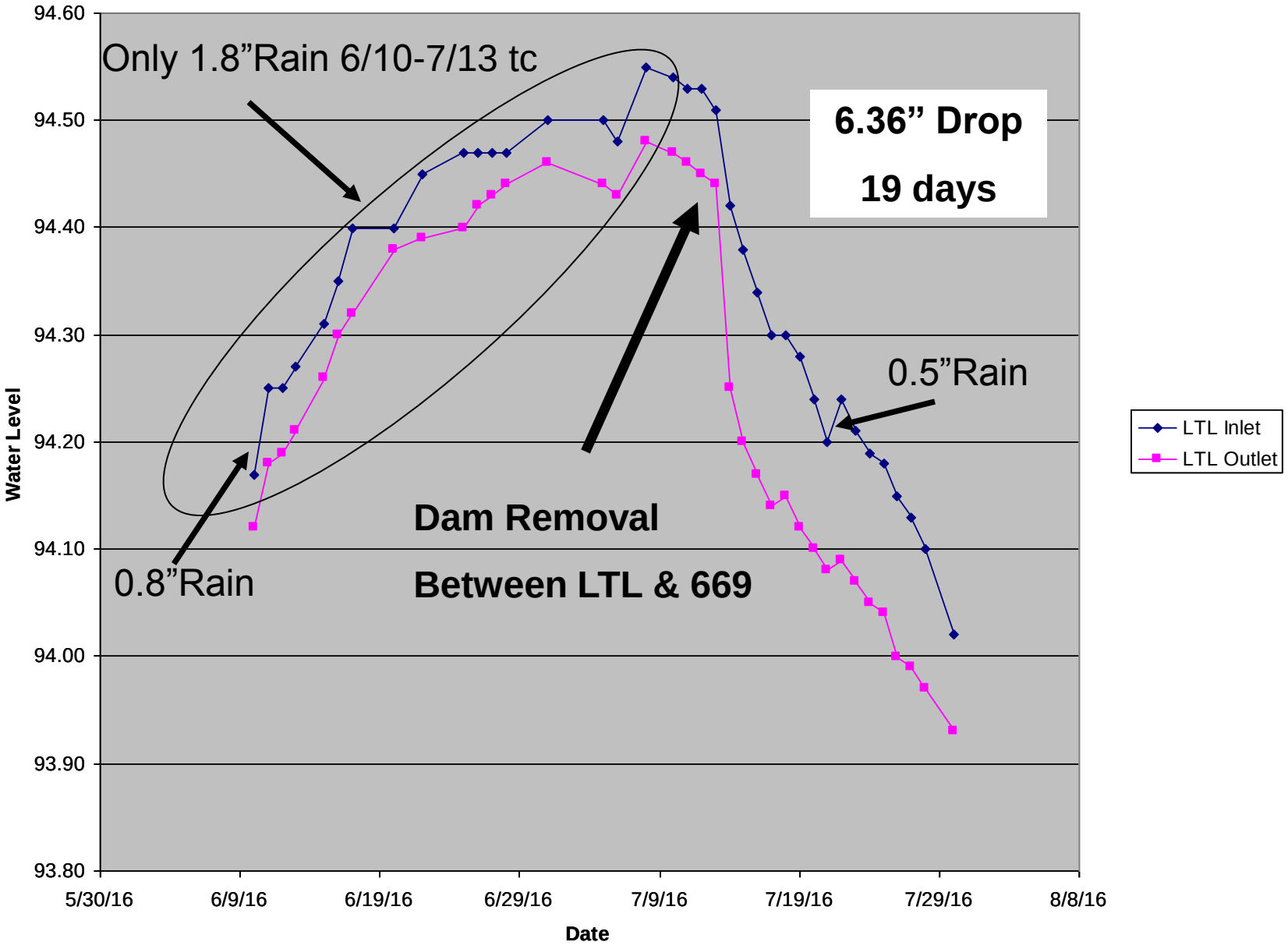
July 20, 2015 Dam Removal – 2 culvert comparison



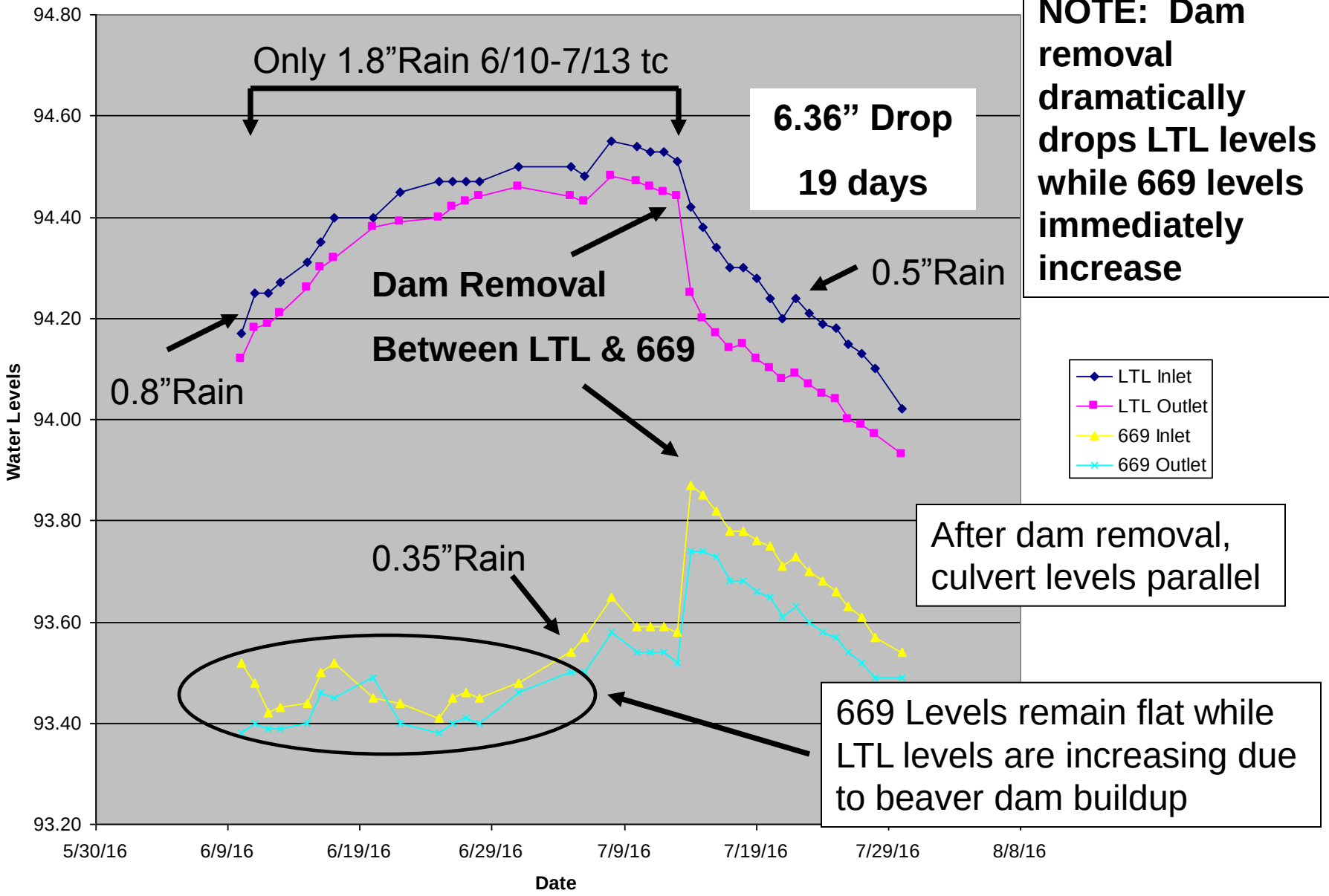
April 13, 2016 Dam Removal



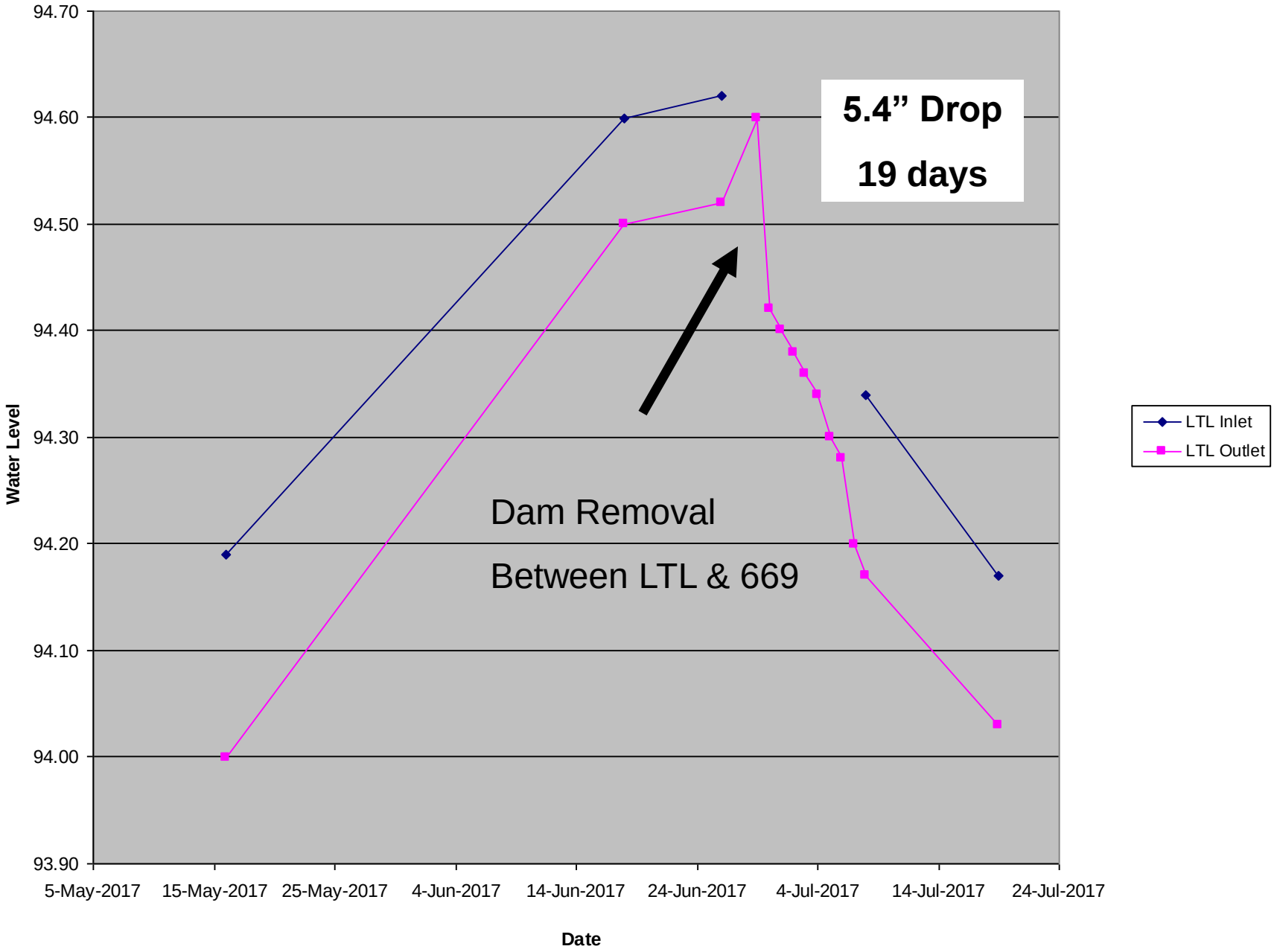
July 13, 2016 Dam Removal



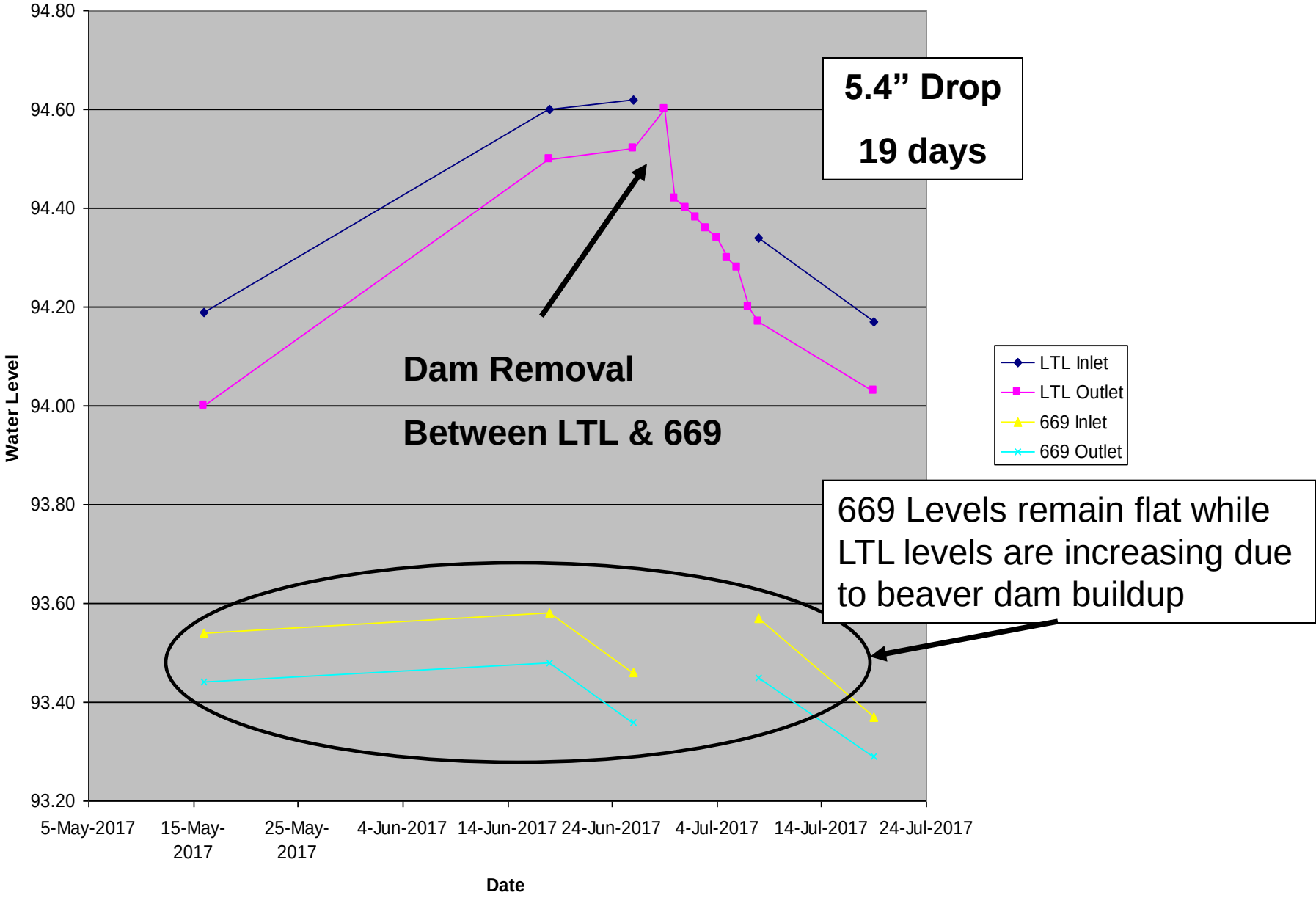
July 13, 2016 Dam Removal – 2 culvert comparison



June 29, 2017 Dam Removal



June 29, 2017 Dam Removal – 2 culvert comparison



Conclusion: LTL - CR669 Dams

- Dams between LTL and CR 669 increase water levels
- Removal of dams between LTL and CR 669 show dramatic and rapid drop in water levels
- TLR culvert is able to respond and lower water levels quickly – culvert not a restricting factor in dropping level
  - *Inlet and outlet parallel drop in water levels*
- This section of creek must remain free of beaver dam activity at all times

Dams Downstream CR 669

- NPS requiring additional studies
- Impact less predictable than between culverts
- Size and location of dams critical

  (Dam #1 impacts levels at CR 669 and also TLR)

- Seasonal timing of removal important
  - *Clear dams pre-fall rains & pre-spring rains to lower "bathtub level" and increase "bathtub capacity" of lake to handle seasonal rainfall events*

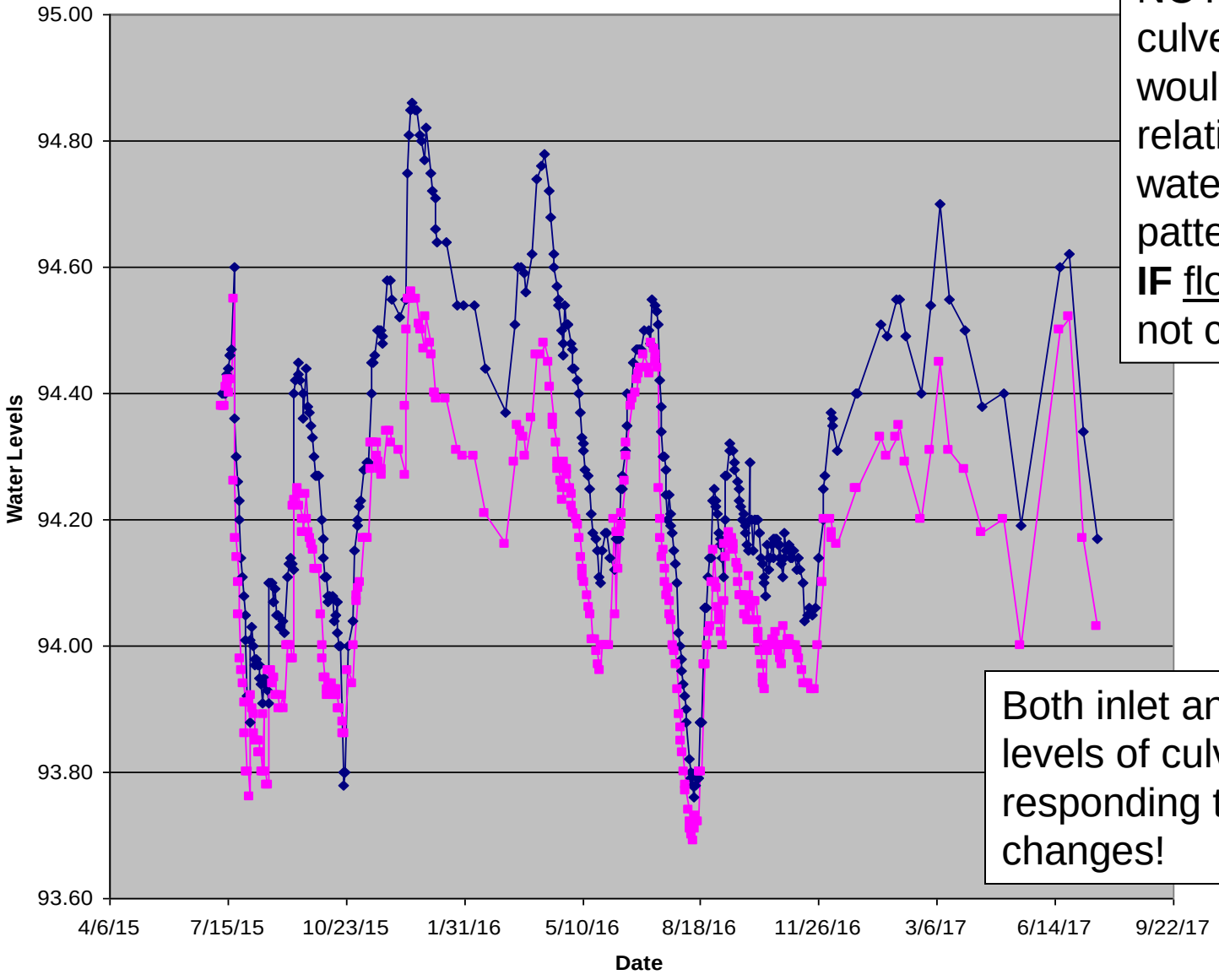
Culvert Restrictions

- The amount of culvert restriction should be reflected in the differential between inlet and outlet

- If culverts causing high water levels, then the inlet-outlet differential should be significant *(only small difference observed)*

- If restrictive, the inlet-outlet culvert differential should increase significantly after rain events *(only slight increase observed with rainfall events)*

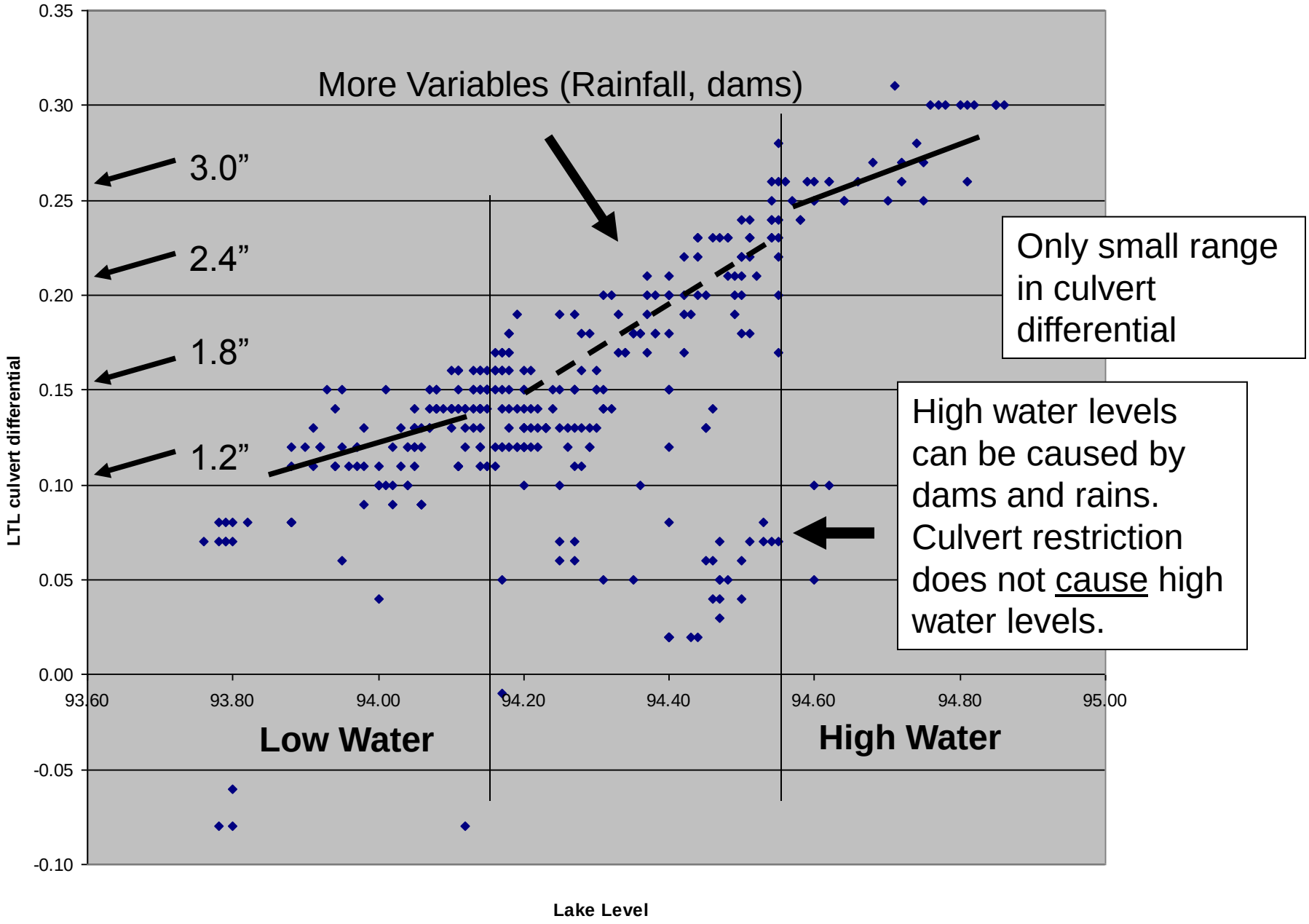
LTL Inlet vs Outlet water levels over time



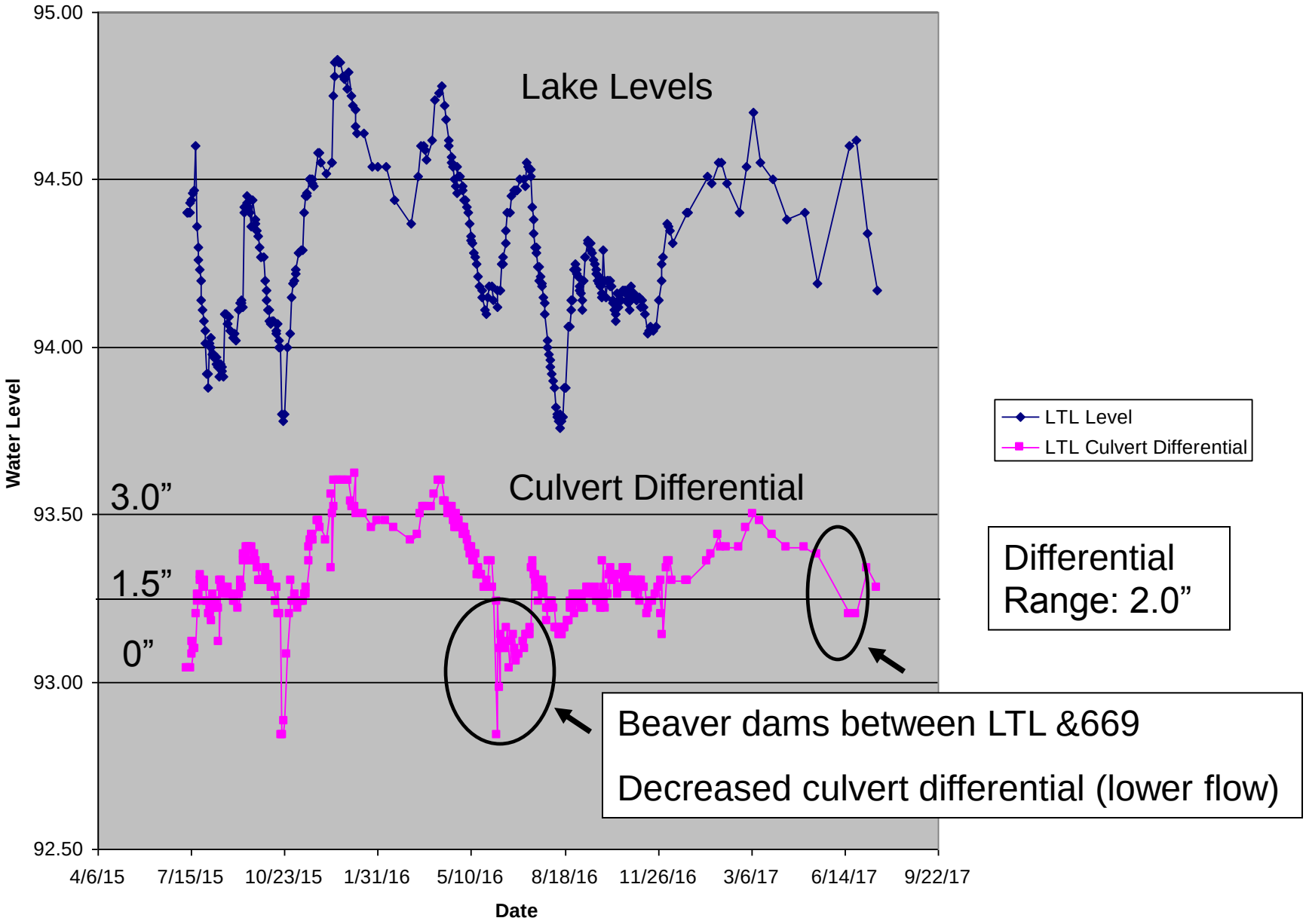
NOTE: If no culverts exist, would still see relatively same water level patterns (outlet) – **IF** flow volumes do not change

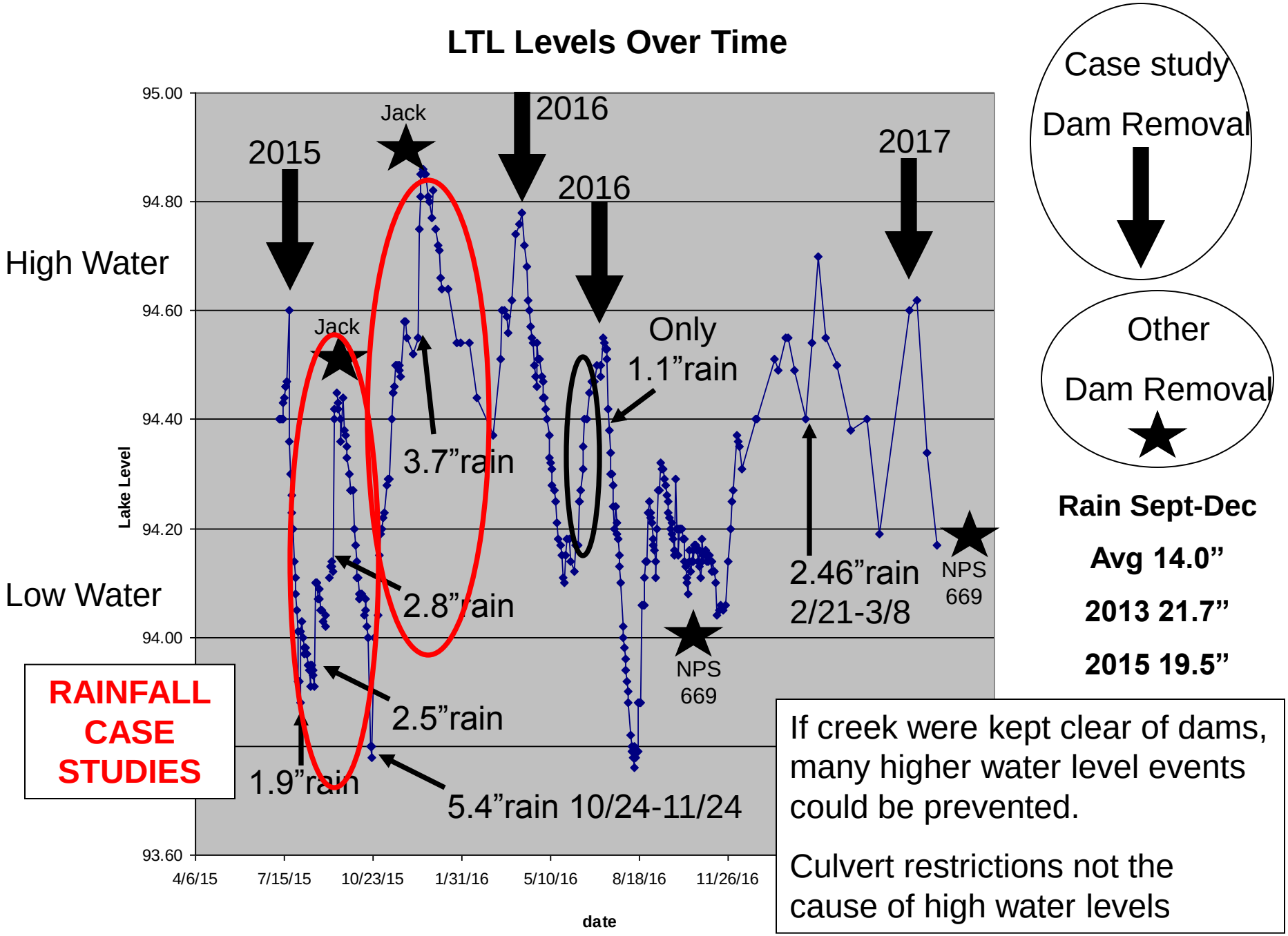
Both inlet and outlet levels of culvert responding to water changes!

LTL Culvert Differential: Inlet - Outlet

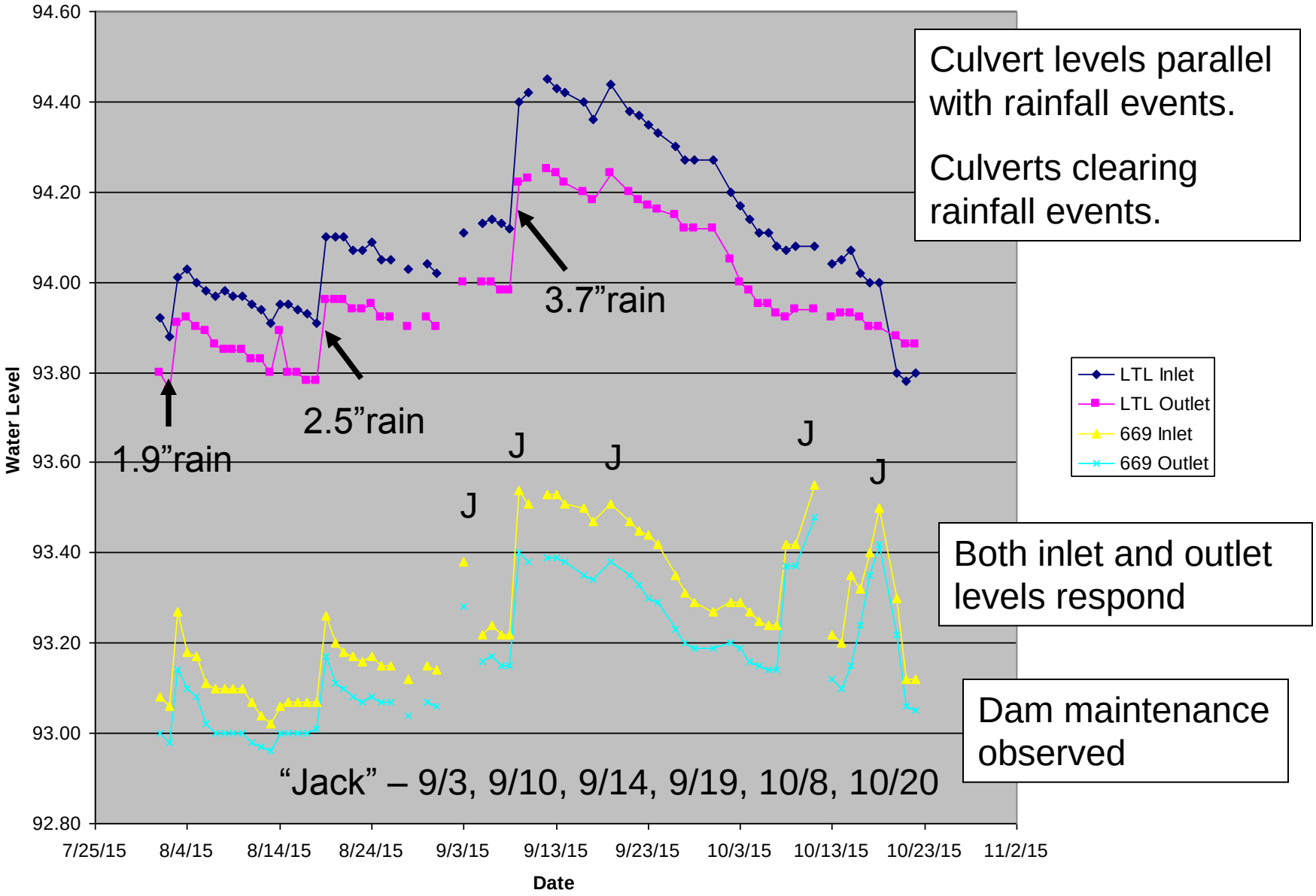


LTL Level vs Culvert Differential (inlet-outlet)




LTL Levels Over Time
Case study
Dam Removal
Other
Dam Removal
High Water
Low Water
95.00
94.80
94.60
94.40
94.20
94.00
93.60
Lake Level
4/6/15
7/15/15
10/23/15
1/31/16
5/10/16
8/18/16
11/26/16
date
2015
2016
2016
2017
Jack
Jack
3.7”rain
2.8”rain
2.5”rain
1.9”rain
5.4”rain 10/24-11/24
Only
1.1”rain
2.46”rain
2/21-3/8
NPS
669
NPS
669
Rain Sept-Dec
Avg 14.0”
2013 21.7”
2015 19.5”
RAINFALL
CASE
STUDIES
If creek were kept clear of dams, many higher water level events could be prevented.
Culvert restrictions not the cause of high water levels

Summer-Fall 2015 Rainfall – Culvert Comparisons



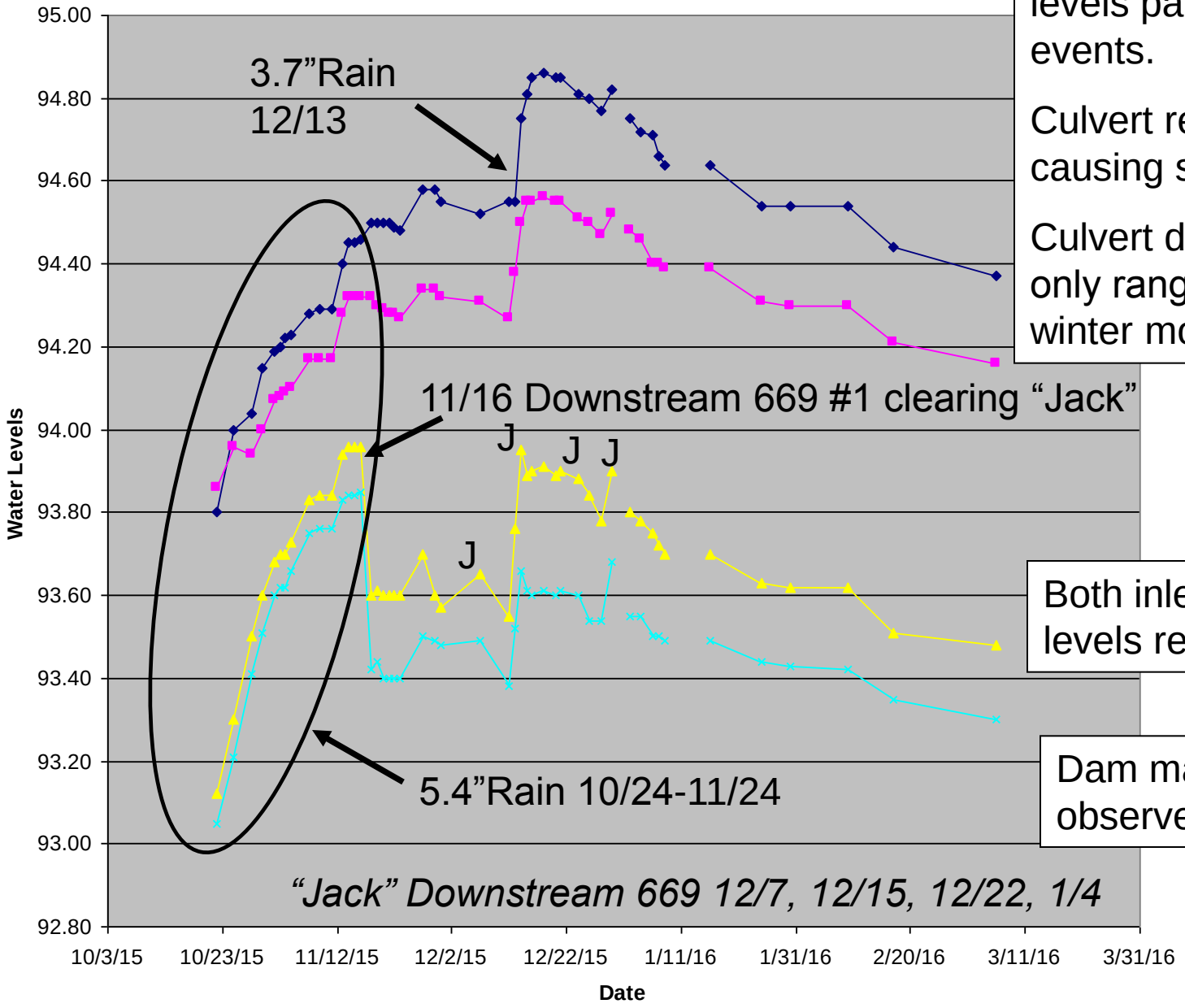
Culvert levels parallel with rainfall events.

Culverts clearing rainfall events.

Both inlet and outlet levels respond

Dam maintenance observed

Fall 2015-2016 Rainfall – Culvert Comparisons



Stream and culverts levels parallel rainfall events.

Culvert restriction not causing stream levels

Culvert differentials only range 1.5” - 3.5”, winter more than fall

Both inlet and outlet levels respond

Dam maintenance observed

Conclusions: Culvert Restriction

- Amount of TLR culvert restriction small (2” from inlet to outlet)
- Dam removal shows ability of culvert to lower lake levels 5” within 2 weeks - inlet and outlet drops parallel
- Culvert show ability to reduce lake levels following large rainfall events.
- High water levels have been caused by dams and rainfall events. Culvert inlet and outlet levels parallel resulting stream changes. *Current culvert restrictions not the <u>cause</u> of high water levels.*
- Benefit of culvert replacement may be minimal – if dams are clear, culverts could keep up with draining normal rainfall events

Gosling Predictions

LITTLE TRAVERSE LAKE
SUMMARY OF FLOOD LEVEL CONTROL ALTERNATIVES

Alternative	Advantages	Disadvantages
No Action	- No cost	-Doesn't relieve flooding
1. Install additional culverts next to existing culverts (multi-tube)	- Lower cost - No change to low water level - mimics full width flow	- Doesn't dramatically reduce high water -Generally not preferred by MDEQ
2. Remove existing culverts and replace with higher capacity culverts	- Provides less high flow restriction - mimics full width flow - lower cost than bridge	- May lower "normal" lake level - Doesn't dramatically reduce high water
3. Remove existing culverts and replace with clear span bridge	- Provides no high flow restriction - Provides full width flow - highest cost	- May lower "normal" lake level - Doesn't dramatically reduce high water -Lake levels may still be impacted by beaver dams
4. Keep existing culverts but remove all beaver dam restrictions	- Lower cost - Lower lake levels during normal flow	- May lower "normal" lake level - High water level difficult to predict, but culverts will still impede flow during high flow period -Lake levels may still be impacted by beaver dams in future - Requires regulatory approval from NPS
5. Replace all culverts with bridges and remove all beaver dam restrictions	- Provides no high flow restriction - Provides full width flow - highest cost	- May lower "normal" lake level - High water level difficult to predict -Lake levels may still be impacted by beaver dams in future - Requires regulatory approval from NPS

"Doesn't dramatically reduce high water" - May lower "normal" lake level

Culvert Unknowns

- What impact will replacing culvert have on “normal” water levels?
- What will be the impact on flow volumes and amount of water moved?
- Will lake levels go lower during summer, creating a new set of issues?
- What is the process to establish a minimum water level if needed to correct a new problem?
  - Court order? More studies? More money and permits?
- These questions should be answered *before* culvert replacement.

Possible Course of Action
Remove one variable at a time!

- Updated Gosling report coming out this fall
- (1) keep Shalda Creek clear of beaver dams between LTL & CR 669 (Need volunteers or $ donations)
- (2) monitor beaver dam activity and impact downstream from CR 669 – clear seasonally (NPS approval required)
- (3) replace culvert at CR 669 and study impact on water levels and changes in creek flow volumes (CR 669 grant)
- (4) determine need and impact of TLR culvert replacement after above action steps – and identify impact on low water level and ability to regulate

Lake and Stream Survey

Notes and References

INSTITUTE FOR FISHERIES RESEARCH
DIVISION OF FISHERIES
MICHIGAN DEPARTMENT OF CONSERVATION
COOPERATING WITH THE
UNIVERSITY OF MICHIGAN

County: Leelanau August, 1949
Lake or stream: Little Traverse Lake

Township Cleveland T 29N R 13W Sec 10-11 Inc.

Two rainbows were reported caught in summer of 1948. Reported trout streams enter the lake. An inlet enters from Lime Lake and rainbows are reported present in that lake. The outlet leads to Lake Michigan through a culvert across which it is reported boards are placed to raise the lake level. There are no screens.

Northern pike fishing is reported good in the winter.

Jason Day, I. A. Rodeheffer

Unfortunately, to establish a minimum water level today, the process requires extensive data from studies ($), petition by more than a majority of residents, and a court order ($)

C: Lansing, District, Region

Form 2760--8-50--5M

Summary presented August 5, 2017

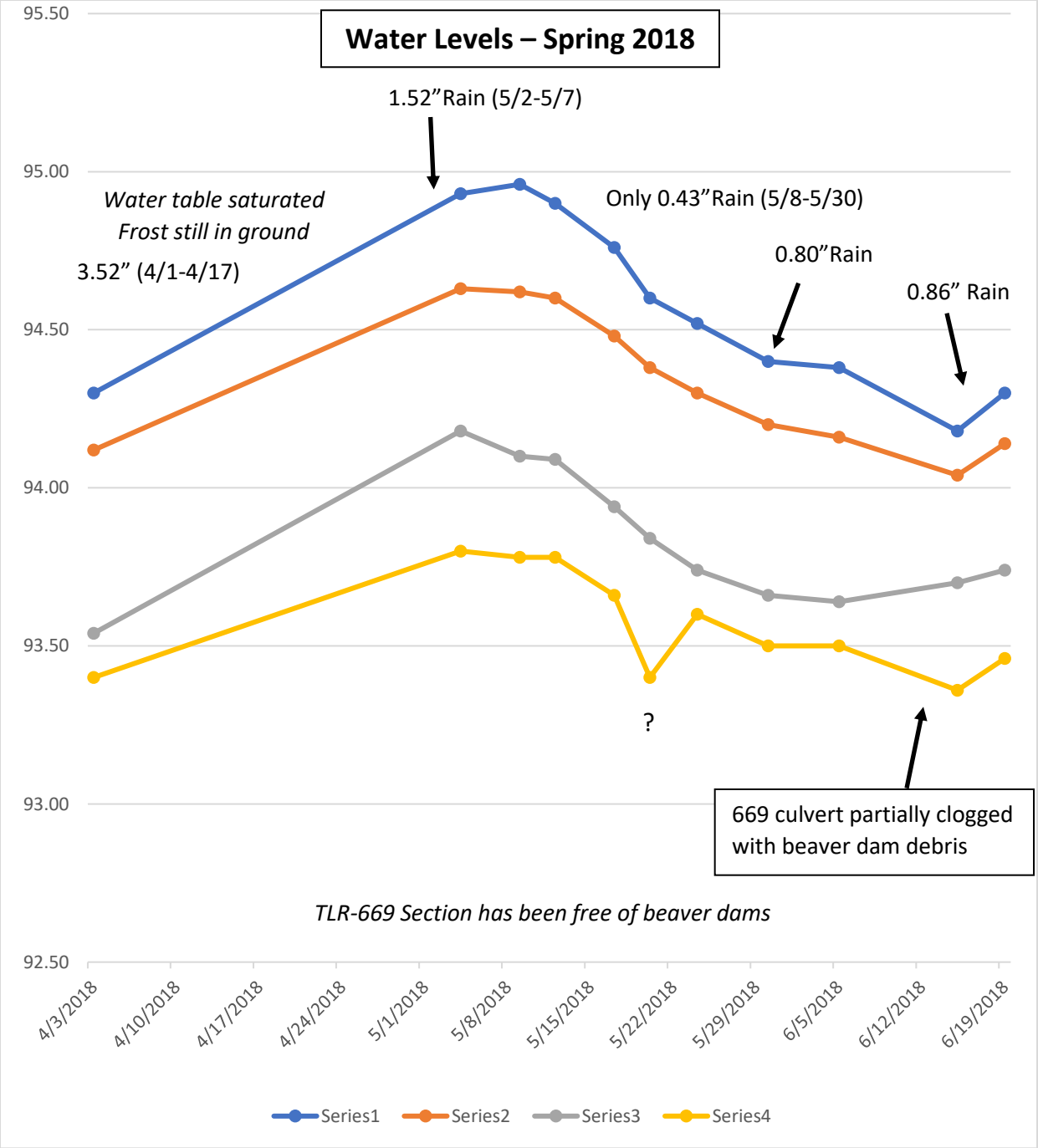
Little Traverse Lake Property Owners Association

Presentation: Jeff Schutz, Chairman, Water Level Committee

Preliminary Data Analysis: David Skjaerlund, PhD

Data is readings from inlet and outlet gauges at TLR and CR 669

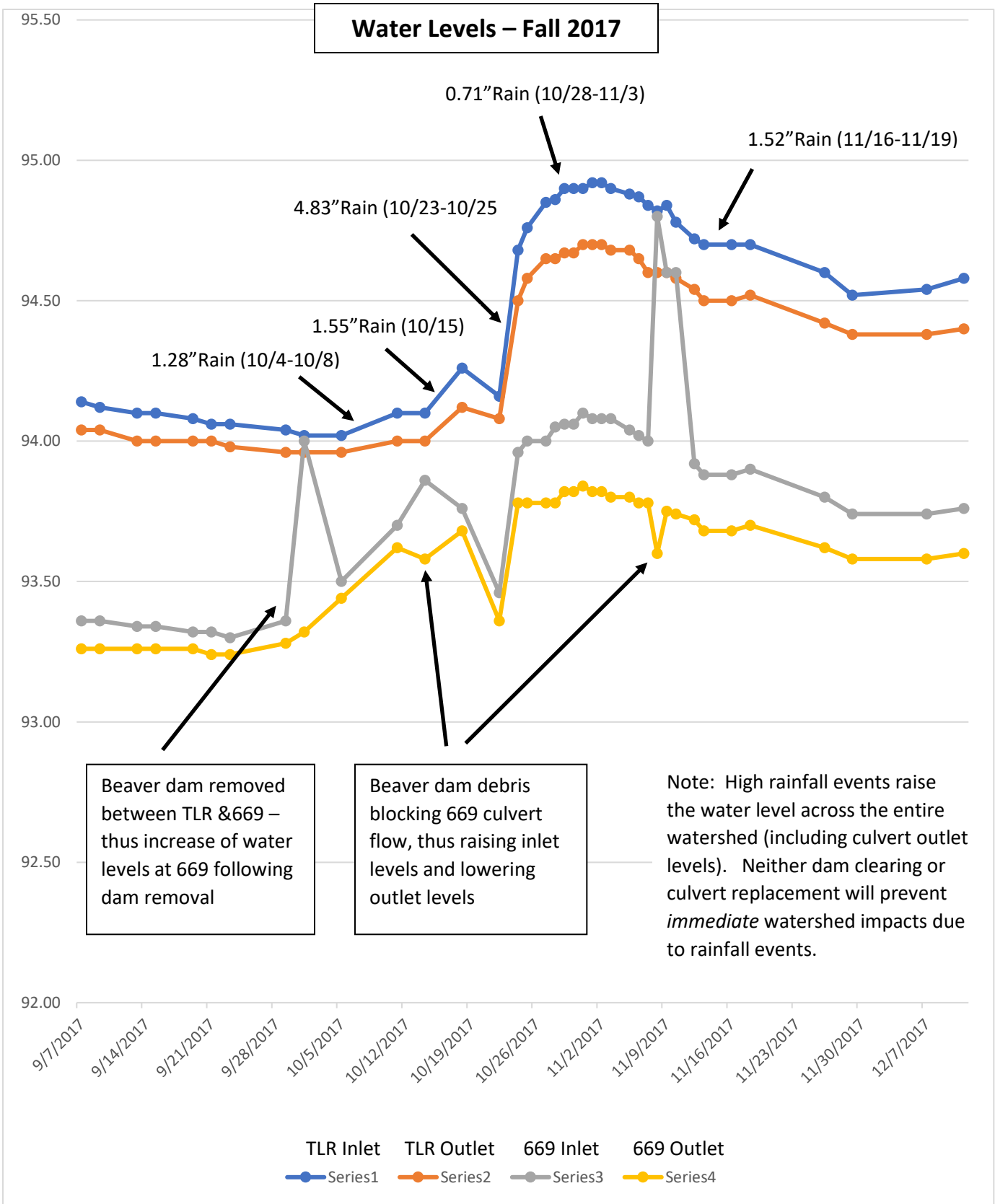
Rainfall data is Maple City data recorded by NOAA (except where noted, TC data used when Maple City data is incomplete)



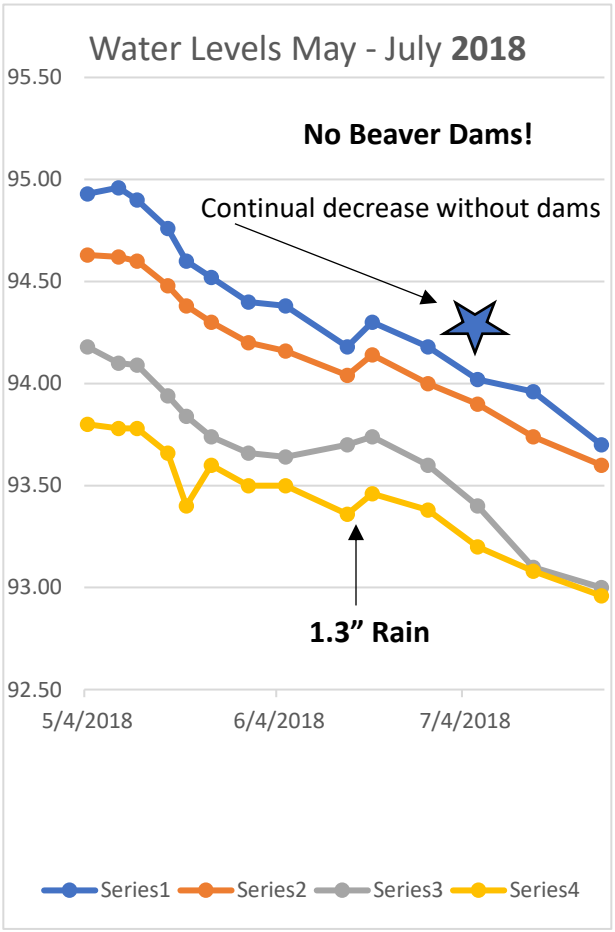
TLR Inlet TLR Outlet 669 Inlet 669 Outlet

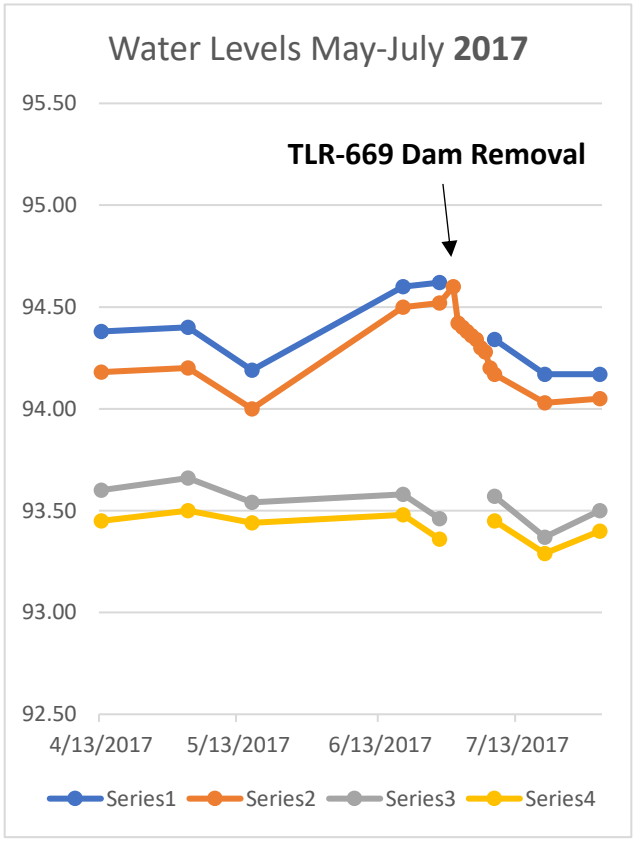
ACTION STEPS:

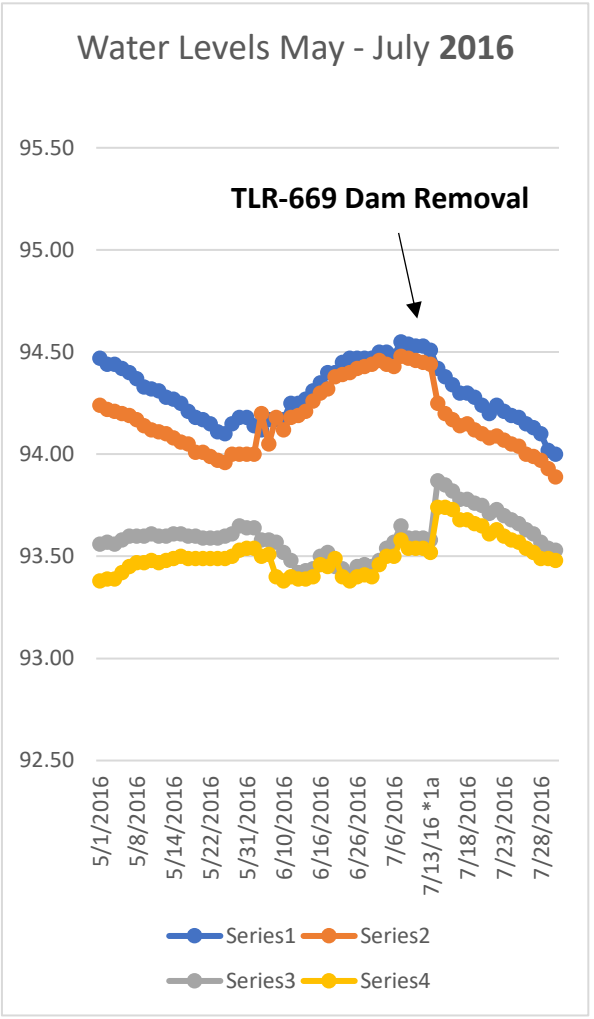
- Finish Gosling-Czubak report on data and meet with decision makers regarding dams & culverts
- Monitor and keep TLR-669 section free of beaver dams - Keep 669 culvert free of debris
- Monitor dams downstream 669 (size and location) and work with NPS on appropriate action steps
- Replace 669 culvert September 2019 - Monitor subsequent impact on water levels
- Continue exploring options for TLR culvert replacement

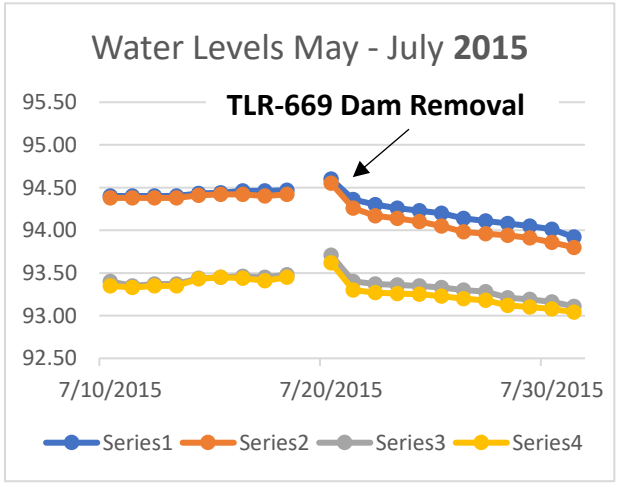

Water Levels – Fall 2017
0.71”Rain (10/28-11/3)
1.52”Rain (11/16-11/19)
4.83”Rain (10/23-10/25
1.55”Rain (10/15)
1.28”Rain (10/4-10/8)
95.50
95.00
94.50
94.00
93.50
93.00
92.50
92.00
9/7/2017
9/14/2017
9/21/2017
9/28/2017
10/5/2017
10/12/2017
10/19/2017
10/26/2017
11/2/2017
11/9/2017
11/16/2017
11/23/2017
11/30/2017
12/7/2017
Beaver dam removed between TLR &669 – thus increase of water levels at 669 following dam removal
Beaver dam debris blocking 669 culvert flow, thus raising inlet levels and lowering outlet levels
Note: High rainfall events raise the water level across the entire watershed (including culvert outlet levels). Neither dam clearing or culvert replacement will prevent *immediate* watershed impacts due to rainfall events.
TLR Inlet
TLR Outlet
669 Inlet
669 Outlet
Series1
Series2
Series3
Series4

SUMMER WATER LEVEL COMPARISONS 2015-2018









Series 1: TLR Inlet

Series 2: TLR Outlet

Series 3: 669 Inlet

Series 4: 669 Outlet

Conclusions:

2018 water levels have dropped to the lowest level in recent years – even though starting out with the highest spring levels – partly due to the creek flow not being impeded with beaver dams beginning earlier in the season (6" lower on July 4, 2018 than previous years)

Question: What impact will TLR culvert replacement have on low water levels?