



Monitoring Water Quality Response of a Pheasant Branch Creek Tributary to Restoration of the Acker Farm

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This report summarizes water quality and streamflow data collected during the period August 30 – October 25, 2019 at Pheasant Branch Conservancy downstream of the Acker Farm in Dane County, Wisconsin. There were eight rain events during this period that produced measureable runoff through the Conservancy. Data were collected during seven of these events at two locations: PB3, which is at the southern boundary of the farm, and PB4, which is at the access road to the Conservancy, downstream of two sedimentation ponds. This report focuses on PB3 because flow measurements are needed to build a rating curve for PB4.

Water quality samples were collected by the “grab” method, dipping a sample bottle near the center of flow. Water samples were analyzed for total Kjeldahl nitrogen (TKN), $\text{NO}_3 + \text{NO}_2$ nitrogen (NO_3), total phosphorus (TP), dissolved orthophosphate (DOP), and total suspended solids (TSS) by the Wisconsin State Lab of Hygiene. Water quality data are stored in the WDNR Surface Water Integrated Monitoring System (SWIMS) data base. Discharge was estimated by measuring cross sectional area of flow with a marked rod and by estimating velocity by timing a floating object across a measured length of channel. Stream stage was recorded at 15-minute intervals with an Onset HOBO pressure transducer at sites PB3 and PB4. Rainfall was recorded at site PB3 with an Onset RG3 tipping bucket rain gauge.

At PB3, seven discharge measurements were made and correlated to water depth with a rating curve (Figure 1). The fit of the rating curve is very good, and can be used to convert 15-minute interval depth records to discharge. The stage at the highest measured discharge was 0.66 ft, and the highest recorded stage was 0.99 ft, so the rating curve had to be extrapolated to estimate some higher flows. The flow volume in this extrapolated range was ~20% of the total flow volume during the report period. Total phosphorus concentrations at PB3 were relatively consistent (Table 2) and there was no relationship between flow and TP. Therefore, TP concentration was assumed to remain constant at the sampled value for the duration of each runoff event.

The rain gauge at PB3 recorded 11.71 inches of rain during the report period. Of this total, 9.48 inches fell during the eight runoff-producing events. The events ranged from 0.57 to 2.43 inches, and lasted from 1.6 to 13.5 hours (Table 1). Based on the flow at PB3, all but the largest of these events produced relatively little runoff (< 0.1 inch) when averaged across the watershed area. This is probably due to a combination of interception by vegetation, storage in depressions, and infiltration. Because the 10/2/19 event produced much more runoff than the other events, it also delivered the majority of the phosphorus flux for this period. It is notable that even though phosphorus concentrations were high during all events, most events did not

contribute very much phosphorus flux because runoff yields were so low. Antecedent soil moisture appears to have affected runoff yield; the events of 9/10, 9/22, and 9/29 occurred on dry soils, and produced relatively little runoff. Crops were harvested on the Acker farm by 9/26, so the runoff yield of the events after that date may have been higher because of the lack of interception.

The 2019 water quality samples indicate that TP and TKN concentrations have decreased at both sites PB3 and PB4 relative to samples collected in 2010-12 (Figure 2); however, TP is still very high relative to other streams in agricultural watersheds in Wisconsin. There is no evidence that TSS concentrations have changed since 2010-12, although TSS concentrations are strongly related to flow, and the 2010-12 data were from all seasons and the 2019 data are only from fall. Nitrate concentrations may have increased since 2010-12, but most samples are still relatively low concentration. DOP averaged 76% of TP at PB3 and 71% of TP at PB4 in 2019, which is a high proportion of dissolved P. DOP was not collected prior to 2019.

Figure 1. Stage-discharge rating curve for PB3. Discharge was measured using the Water Action Volunteer protocol. Stage was recorded by an Onset Hobo Water Level Logger at 15-minute intervals. The curve is extrapolated to the maximum stage recorded during the report period.

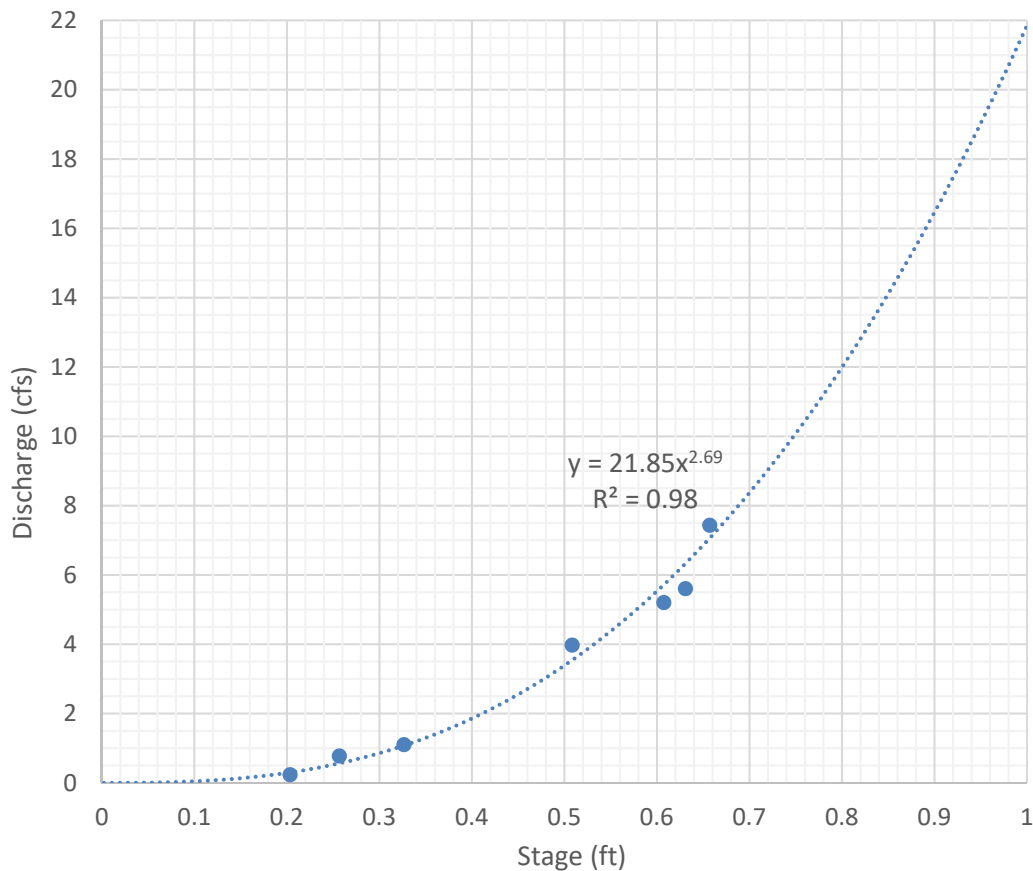


Table 1. Summary of runoff-producing rain events at Pheasant Branch Conservancy, September 10 – October 5, 2019. Numbers in parentheses are the duration of 90% of the rainfall and runoff for each event.

Event	Date	Rainfall Depth (in)	Rainfall Duration (hrs)	Runoff Depth (in)	Runoff Duration (hrs)	Total Phosphorus Flux (lb)
1	9/10/2019	1.33	5.5 (4.8)	0.00	9.0 (3.0)	2.1
2	9/12/2019	1.01	11.2 (9.8)	0.02	22.5 (11.5)	7.6
3	9/13/2019	0.98	1.6 (0.8)	0.03	22.0 (6.0)	13.2
4	9/22/2019	0.91	10.3 (4.8)	0.03	25.3 (6.8)	14.2
5	9/29/2019	1.02	13.5 (7.3)	0.01	24.2 (7.8)	5.5
6	10/1/2019	1.23	3.4 (2.0)	0.08	10.0 (5.5)	35.2
7	10/2/2019	2.43	9.0 (7.0)	0.54	87.8 (30.3)	152.8
8	10/5/2019	0.57	4.7 (2.6)	0.03	49.3 (17.0)	6.8

Table 2. Water quality sample results for site PB3.

Date/Time	Q	TP	DOP	TKN	NO ₃	TSS
9/10/2019 8:45	0.30	4.70	4.02	8.31	10.10	15
9/12/2019 9:20	0.44	4.97	4.36	6.03	0.37	19
9/13/2019 8:50	0.12	4.15	3.67	3.12	0.21	11
9/22/2019 10:30	3.40	5.00	3.81	8.62	2.26	65
9/29/2019 10:30	1.08	4.52	3.70	5.44	3.24	28
10/1/2019 11:45	7.07	5.01	2.76	6.90	1.32	716
10/2/2019 8:30	6.19	3.18	2.21	2.47	0.52	166
10/2/2019 13:30	5.72	2.88	1.87	2.80	0.47	142

Table 3. Water quality sample results for site PB4.

Date/Time	TP	DOP	TKN	NO ₃	TSS
9/12/2019 9:55	2.87	1.71	6.32	13.20	258
9/13/2019 9:45	4.19	3.32	4.12	0.46	21
9/22/2019 10:45	2.82	2.39	4.15	1.67	159
9/29/2019 11:00	4.15	3.25	3.38	0.70	30
10/1/2019 12:05	5.48	3.88	5.45	0.34	28
10/1/2019 15:45	5.24	3.28	4.31	1.16	386
10/2/2019 9:30	3.14	2.07	2.87	0.51	218
10/2/2019 14:00	3.01	2.02	2.64	0.49	112

Figure 2. Plots of water quality samples from 2003-06, 2010-12, and 2019 (note log scales).

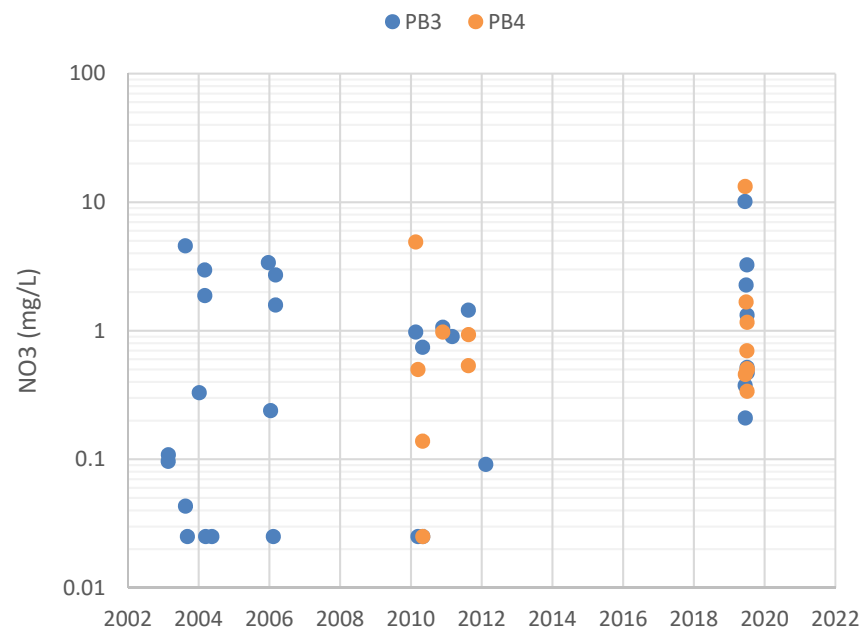
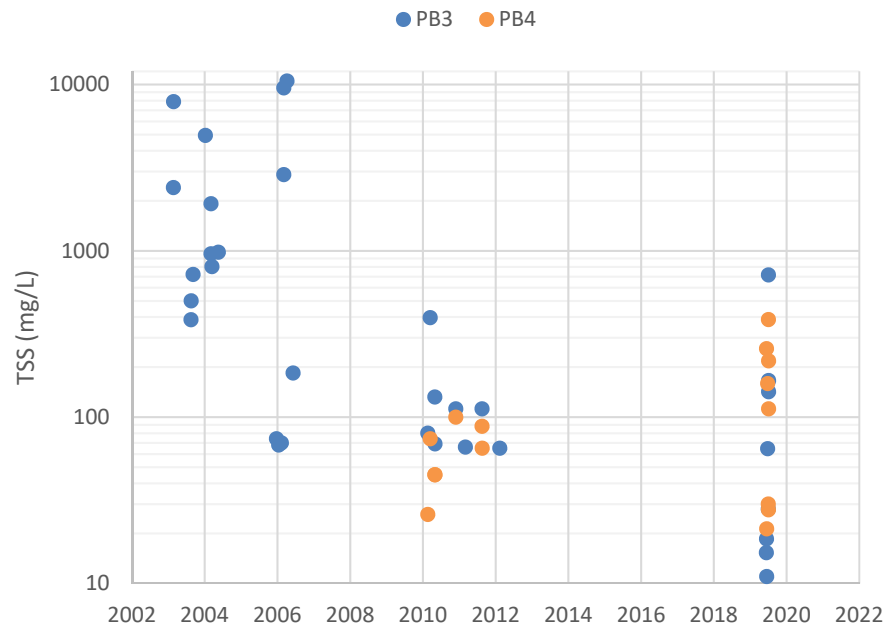
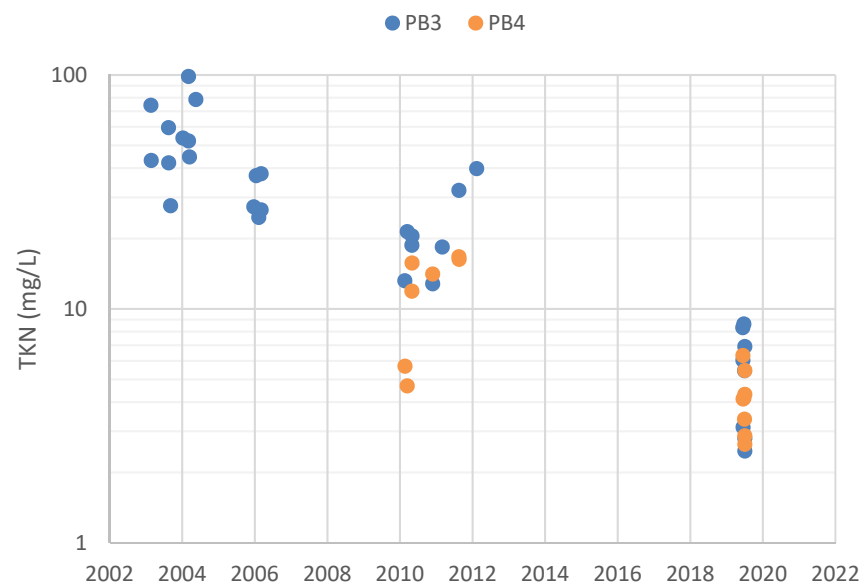
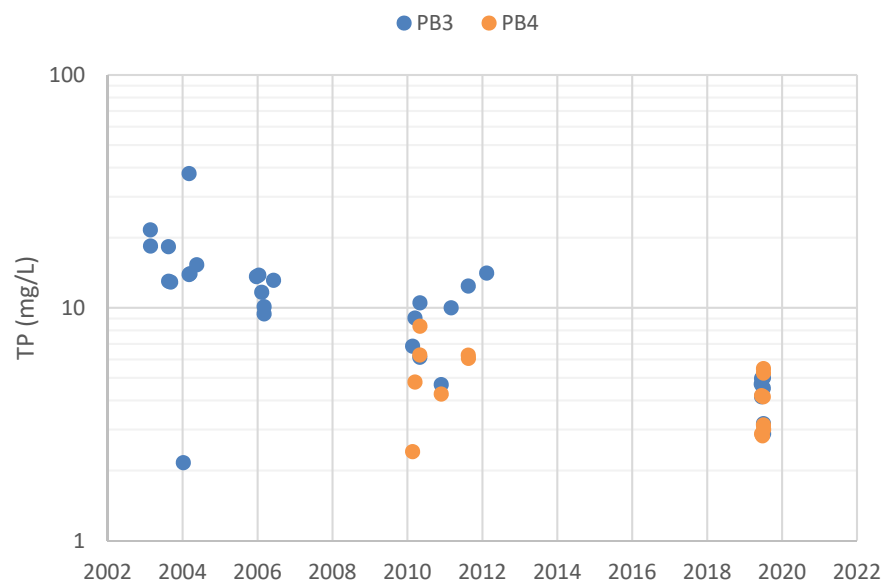


Figure 3. Rainfall, stream stage, and flow measurements at site PB3 across the eight runoff-producing rain events in Sep-Oct 2019.

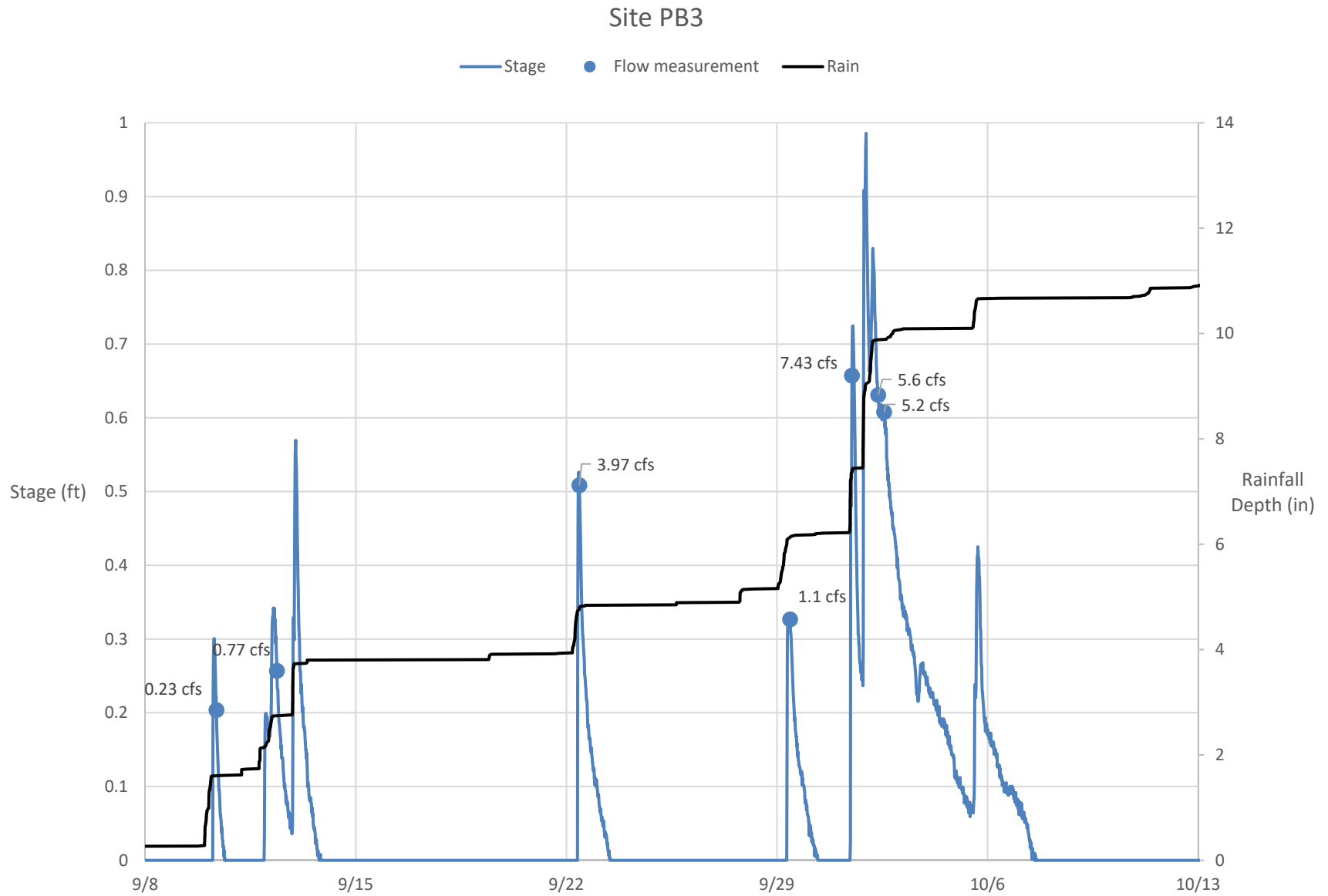


Figure 4. Rainfall, flow measurements, and flow estimated from the stage-flow rating curve at site PB3 across the eight runoff-producing rain events in Sep-Oct 2019.

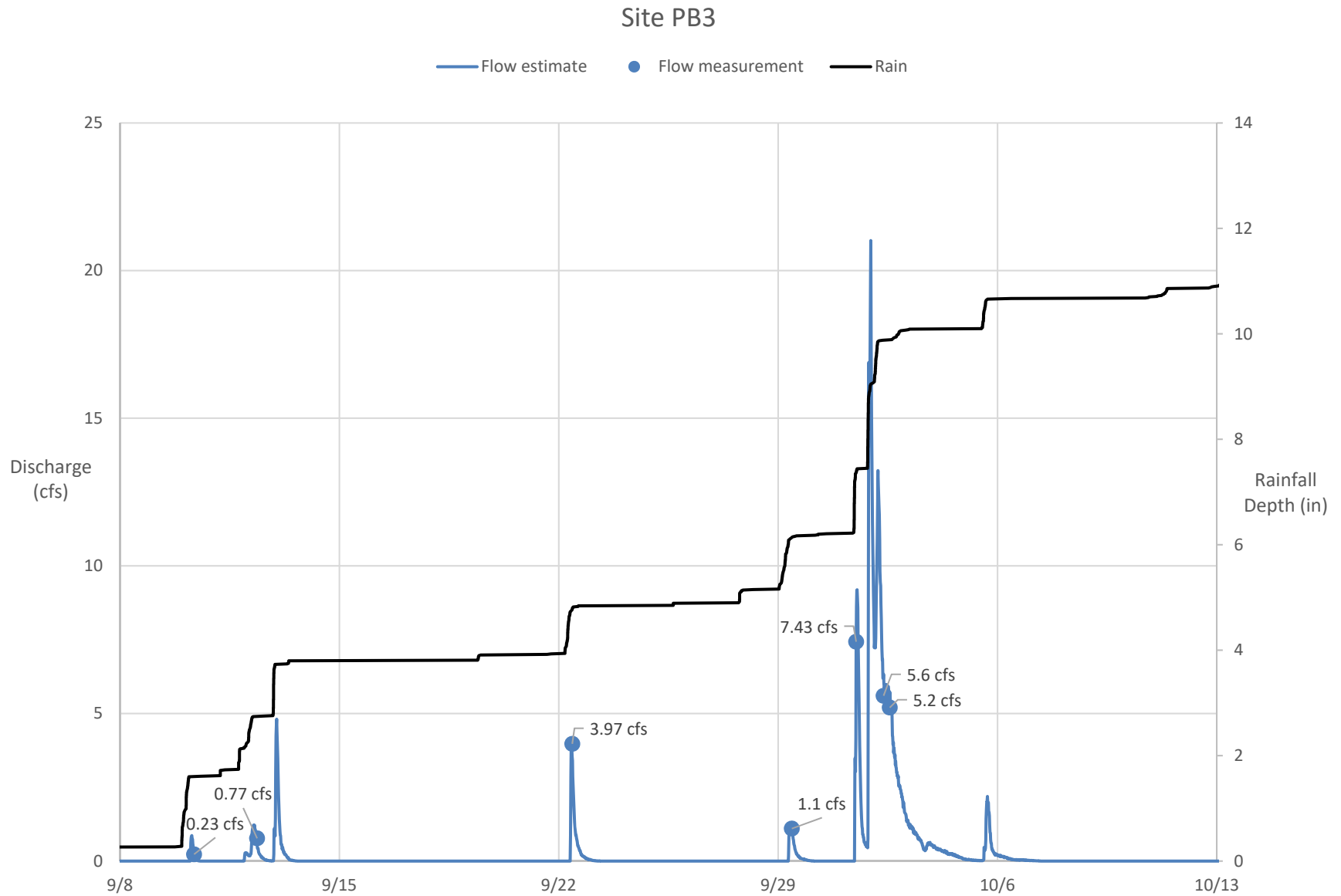


Figure 5. Rainfall, flow measurements, and flow estimated from the stage-flow rating curve at site PB3 for event 1.

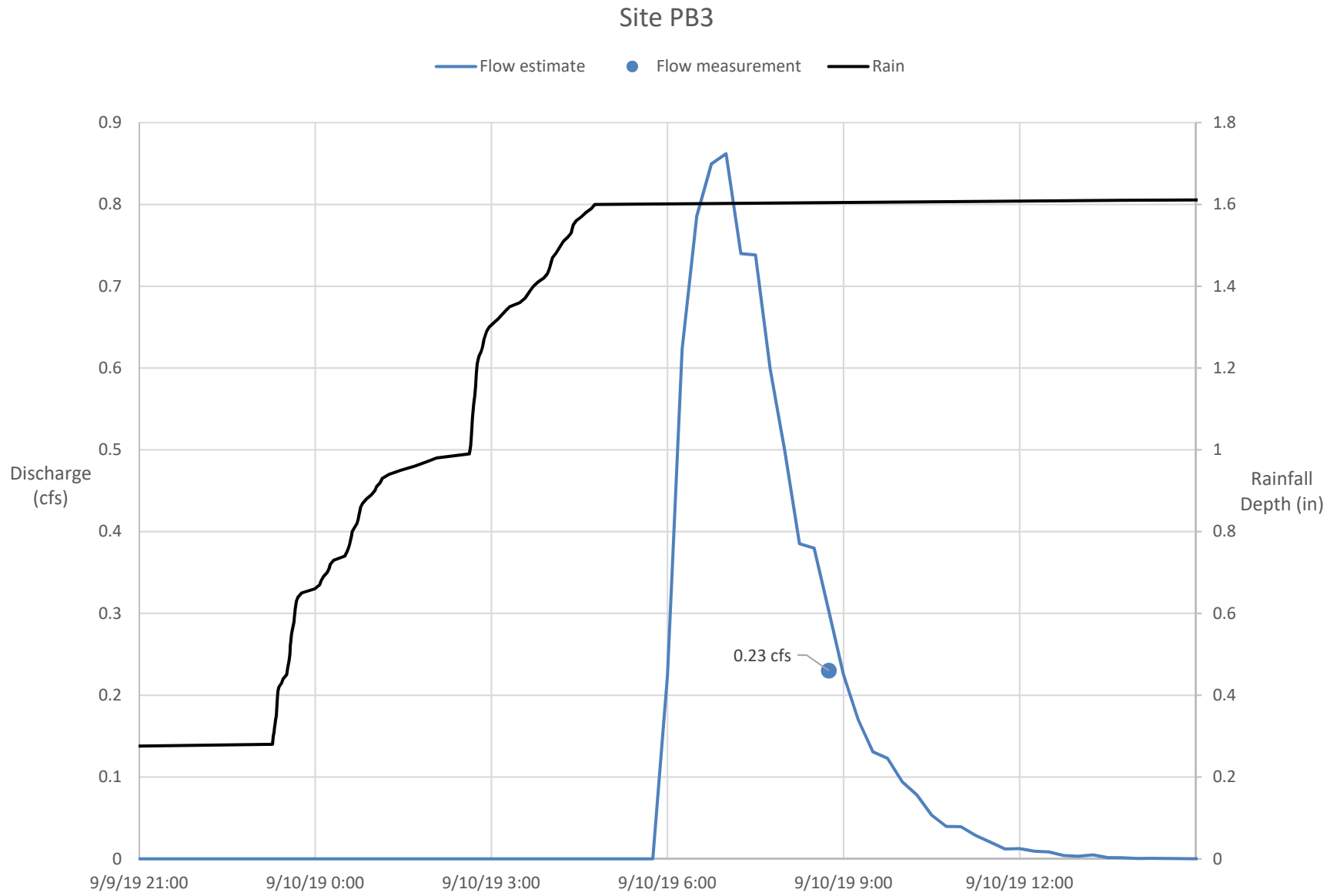


Figure 6. Rainfall, flow measurements, and flow estimated from the stage-flow rating curve at site PB3 for event 2.

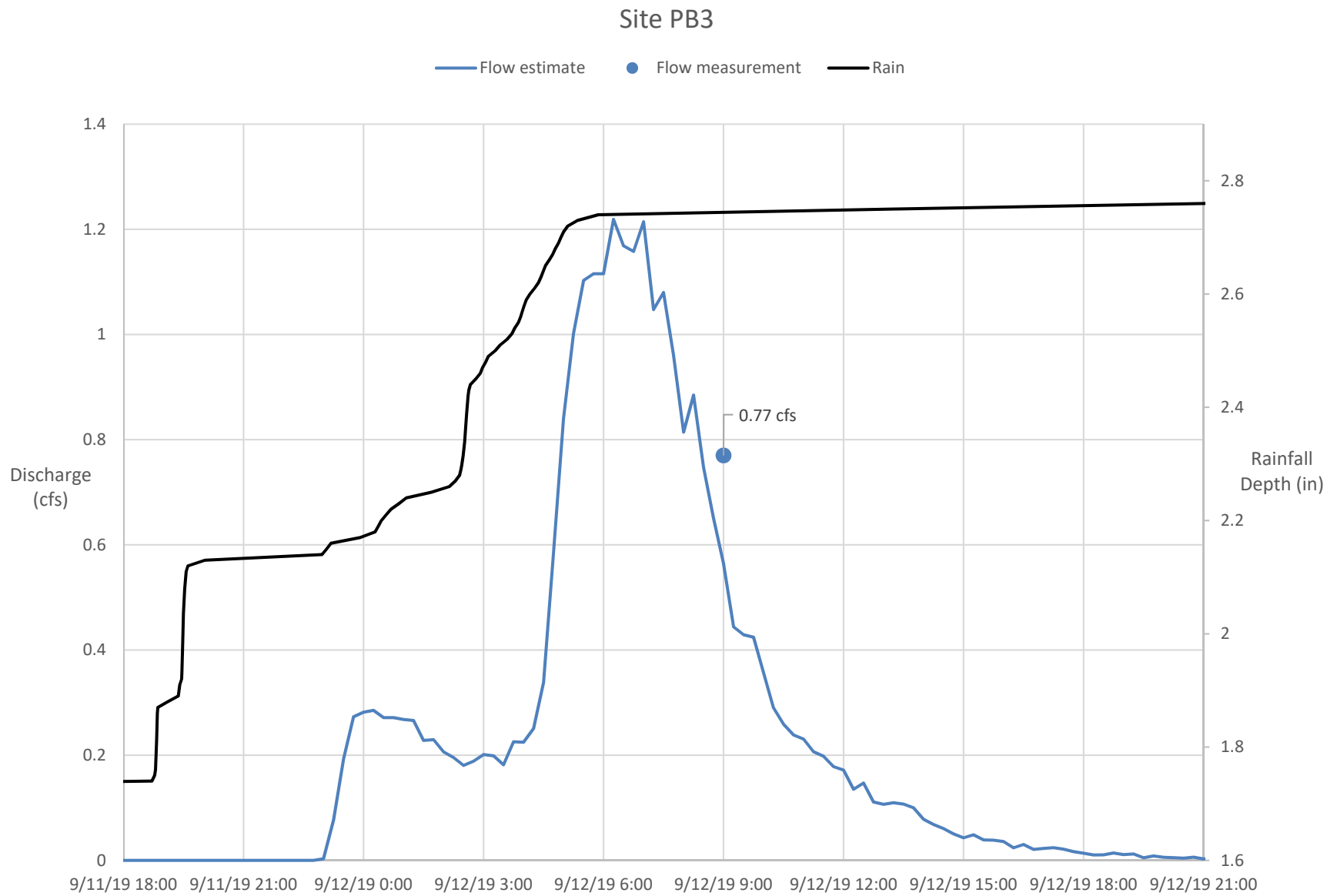


Figure 7. Rainfall, flow measurements, and flow estimated from the stage-flow rating curve at site PB3 for event 3.

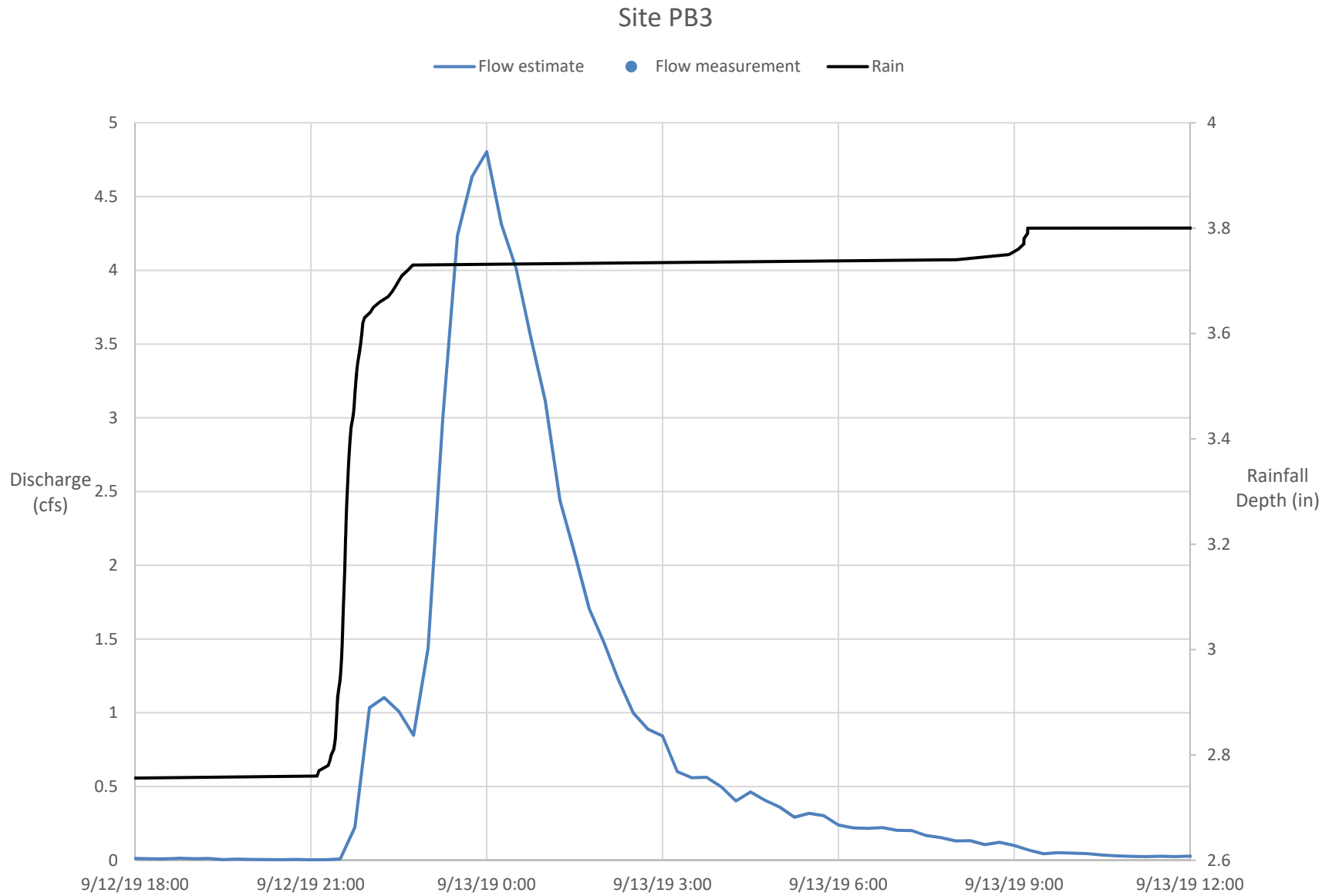


Figure 8. Rainfall, flow measurements, and flow estimated from the stage-flow rating curve at site PB3 for event 4.

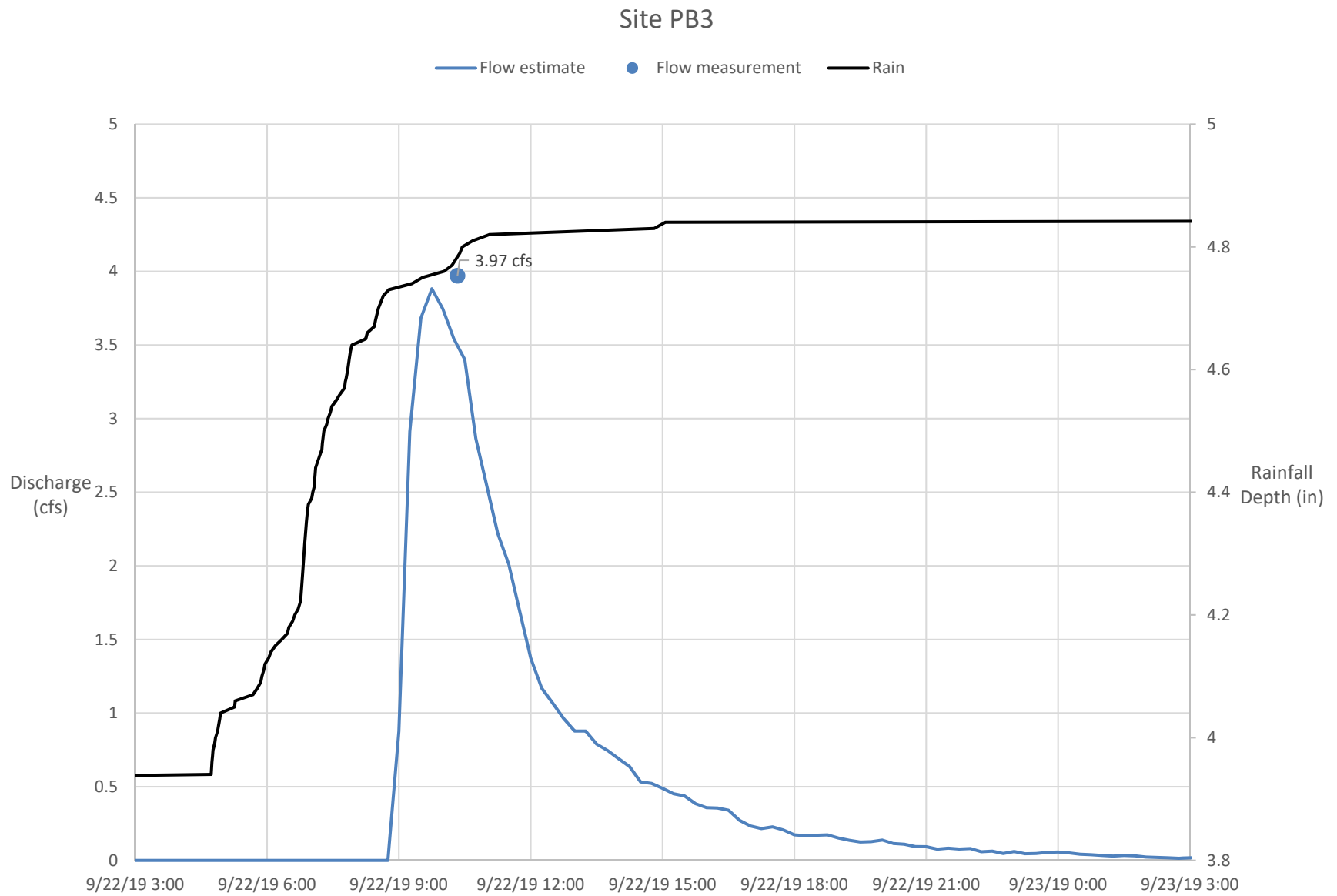


Figure 9. Rainfall, flow measurements, and flow estimated from the stage-flow rating curve at site PB3 for event 5.

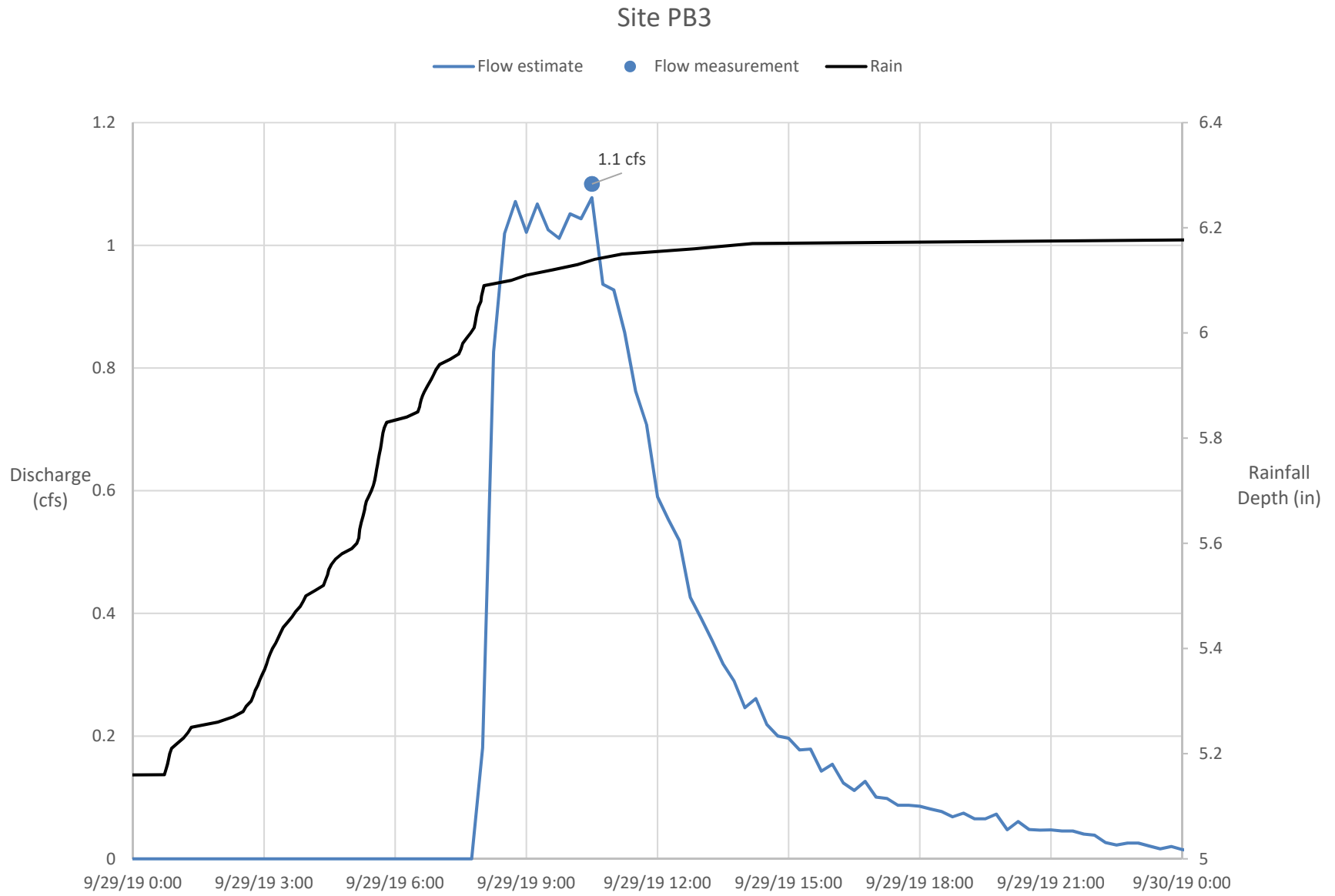


Figure 10. Rainfall, flow measurements, and flow estimated from the stage-flow rating curve at site PB3 for events 6 and 7.

