Southeast Oakland County Wet Weather Sampling Report

January 2022

ECT No. 180209

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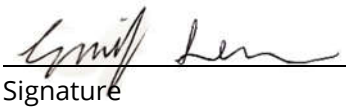	
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List of Acronyms and Abbreviations

ECT	Environmental Consulting & Technology, Inc.
EPA	U.S. Environmental Protection Agency
GWK RTB	George W. Kuhn Retention Treatment Basin
MPN	Most probable number
MS4	Municipal separate storm sewer system
MST	Microbial source tracking
PTD	Permitted treated discharge
QA/QC	Quality assurance/quality control
RTB	Retention treatment basin
TMDL	Total maximum daily load
WRC	Oakland County Water Resources Commissioner's Office
WQS	Water quality standards

Executive Summary

Environmental Consulting & Technology, Inc. (ECT) performed wet weather sampling at the outlets of several county storm drains within the southeast portion of Oakland County. The purpose of this sampling was to screen for the presence of illicit discharges, primarily during first flush conditions, to determine if the drains were being impacted by sanitary wastewater. All sites were screened for *E. coli* and a human fecal microbial source tracking (MST) marker to determine if any identified bacteria sources were from the human intestinal tract.

Although most *E. coli* values exceeded the state's partial body contact standards, human fecal sources were not significant on the Henry Graham (North and South), Wilson, Walker, and GWK (North and South) drains. Human fecal sources are suspected on the Kutchey and Sharkey drains and ECT recommends illicit discharge investigations on these drains.

The permitted treated discharge (PTD) from the George W. Kuhn Retention Treatment Basin (GWK RTB) had a much lower *E. coli* concentration than what was found concurrently in the receiving water, Red Run Drain at Dequindre Road. This phenomenon was also observed in previous wet weather investigations and indicates that stormwater, rather than the PTD, is generally driving any downstream *E. coli* impairments in the Red Run Drain. Furthermore, as indicated above, the source of the *E. coli* bacteria is more likely generated from nonpoint, rather than sewage sources.

1.0 Introduction

This report describes the results of wet weather sampling efforts completed between May and June 2021 within the separate storm drain portions of the GWK and Bear Creek drainage districts. The purpose of this sampling was to determine if illicit discharges containing sewage sources were impacting the subject county drains. Specifically, the sampling targeted first flush conditions to identify if stormwater from the start of rain events had elevated *E. coli* levels. Additionally, one rain event was sampled during high flow conditions to determine if there are high level overflows between the sanitary sewers to the storm drains.

Sampling was conducted based on the recommendations from the 2019 wet weather sampling efforts described in *George W. Kuhn Drainage District Wet Weather Outfall Sampling Report* (ECT 2020b). As in 2018, sampling was carried out by ECT under the direction of the Oakland County Water Resources Commissioner's Office (WRC) in collaboration with the City of Madison Heights.

This work supports Oakland County's municipal separate storm sewer system (MS4) permit. Specifically, the sampling supports the county's illicit discharge elimination and total maximum daily load (TMDL) programs, requiring the County to identify and correct illicit discharges entering their storm drains. In terms of illicit discharges, discharges impacted by fecal bacteria, and more specifically human fecal bacteria, are of the greatest concern because of the potential to carry viruses and other pathogenic bacteria, which could impact human health.

Drains within the Bear Creek and GWK drainage districts are tributary to the Red Run, which is impaired for *E. coli* as described in the Red Run Drain and Bear Creek *E. coli* TMDL Assessment.

1.1 Background

This sampling was performed following one of the recommendations of the 2019 wet weather sampling effort, which called for first flush sampling in the GWK Drainage District to determine if undetected sewage sources were impacting stormwater. During planning efforts, WRC added sampling locations within the Bear Creek Drainage District since it is also a tributary to the Red Run.

2.0 Methodology

2.1 Sampling Sites

Sampling sites were located along the major County Drains that drain Oakland County's portion of the Red Run watershed. Sites were either located near the drain outlets or near Dequindre Road, the jurisdictional boundary between Oakland and Macomb counties. Sampling locations were identified in the project sampling plan (ECT 2020a). However, during autosampler installation, three site locations were modified as follows:

- Sharkey Drain – this site was originally planned for MH074506, but it was moved a few hundred feet downstream. This was due to loose bricks in the manhole causing a confined space entry to install the flow meter to be deemed unsafe.
- Henry Graham North – this site was originally planned for MH04068. However, it was moved downstream in order to capture additional runoff from the businesses along Whitcomb St.
- Henry Graham South – this site was originally planned for MH04080. However, it moved because it was determined that the initial site was located offline of the main drain (due to an error in the GIS maps).

The resulting sampling sites are shown in Table 1 and Figures 1 & 2 with the site descriptions and coordinates provided in **Appendix A**.

Table 1. Sampling Locations

Drain	Manhole ID
Red Run at Dequindre Road	NA
GWK North (GWKN)	04039
GWK South (GWKS)	04028
Henry Graham North (HGN)	04075
Henry Graham South (HGS)	04071
Kutchey Drain (KUT)	119007
Sharkey Drain (SRK)	075503
Walker (WLK)	04011
Wilson (WIL)	01015

2.2 Sample Collection and Analytical Methods

At each sample location except the Red Run, an ISCO 6712 automatic sampler was installed[1] inside the manhole structure and programmed to collect sample aliquots at 10-to-20-minute intervals. The sample aliquots were composited by the automatic sampler into one 10-liter bottle. This same process was followed at the Red Run, except the automatic sampler was installed along the streambank near the GWK RTB outlet access road.

At each location except the Red Run, ISCO 2150 flow meters were installed along with the two cellular modems (one for each autosampler and one for each flow meter). ECT planned to use the real-time water levels to trigger the samplers to sample first flush conditions. However, reliable communications with the flow meters were not obtained despite changes in the programming and configurations of the flow meter modem antennas. Therefore, the autosamplers were generally triggered remotely based on rainfall amounts measured at the GWK RTB. Sometimes it was necessary to trigger an autosampler manually because of a lack of reliable communication with the sampler modem. Additional installation and programming details can be found in the project sampling plan (ECT 2020a).

The ECT field team retrieved the composite sample collection bottle following completion of the program. Up to 10 aliquots were collected at each site. The composite bottle was closed and mixed before distribution to the laboratory bottles. Additionally, sample collection information and flow data were downloaded from the automatic sampler. The composite bottle was replaced with a new liner, the program was reset and the sampler returned to the manhole structure for the next rain event.

All samples were documented on a chain-of-custody (COC) form before being placed in an ice-chilled cooler for shipment to the laboratories for analyses. The water samples were submitted to qualified analytical laboratories for *E. coli* and the human microbial source tracking (MST) marker – HF183.

No sample was collected for the final sample event from Henry Graham North because the sample tubing disconnected from the sampler prior to sampler initiation. Additionally, the samples collected at Henry Graham South and Wilson drains for the final sample event were grab samples, not composites due to errors in the programming of the samplers.

[1]During sampler installation, a sewage odor was coming from MH074506 on the Sharkey Drain. This was reported to WRC, but no sources were identified.

2.3 Microbial Source Tracking Method

The MST marker used for this project was HF183, which was analyzed by Oakland University. The marker is reported numerically, in gene copies/100 ml, indicating the relative amount of human fecal impact in each sample. This marker is useful in identifying bacteria from the human intestinal tract. Although not the only source of human *E. coli* in stormwater, an illicit discharge containing sanitary sewage is the most concerning source that may be indicated by the presence of the marker. Other non-sewage sources that may contain human bacteria include runoff from compost areas and leaky dumpsters that are contaminated by solid waste, such as used diapers.

The detection limit for HF183 is 95 gene copies/100 ml based on analysis of 100 ml of sample. A lack of detection indicates an absence of human fecal material, very low levels of fecal material, or sample matrix interference. Results at or above 95 gene copies/100 ml indicates that human fecal material contributed to the sample. Some municipalities have used a threshold of 1,000 gene copies/100 ml to determine when to conduct further investigations for human *E. coli* sources. Human fecal sources may be very difficult to locate in drains with less than 1,000 gene copies/100 ml. This is due to the variable quality of stormwater and the sensitivity of the method.

Unlike the *E. coli* analytical method which only enumerates live organisms, HF183 analysis enumerates both live and dead cells. This can result in discrepancies between the *E. coli* and HF183 results. A high HF183 level and a low *E. coli* concentration can occur when the sample includes disinfected volume from wastewater treatment facilities, including RTBs. This may also occur when the sample is impacted by an older illicit discharge. In both cases, the live organisms may not survive (due to treatment or natural die off), but the dead cells will be counted in the HF183 concentration.

Therefore, high HF183 and low *E. coli* on the Red Run Drain during a RTB overflow event, could be the result of the dead cells in the treated basin discharge rather than an illicit discharge from the storm drains or an impairment from the basin.

2.4 Wet Weather Events

ECT conducted sampling during four wet weather events as outlined in Table 2. For events 1 – 3, with few exceptions, sampling did occur within first flush as defined by the U.S. Environmental

Protection Agency (EPA)[2]. The reported rainfall amounts reflect the total volume from the 24 hours prior to the beginning of sample collection. The beginning of discharge is noted in Table 2 to demonstrate whether samples during Events 1, 2 and 3 were taken during first flush. More detail on the timing of the samples can be found in **Appendix B** which provides the hydrographs and sampling durations for each site.

Sampling during Event 4 purposely corresponded with a permitted treated discharge (PTD) from the GWK RTB which began at 15:58 on 6/25/21 and ended at 15:18 on 6/26/21. This sampling was carried out during a PTD because it was assumed that this would indicate when the sanitary sewers were surcharged enough to overflow into the storm drains if high level overflows existed between the sewers and drains.

Table 2. Sampling Dates, Times and Rainfall Amounts

Event	Sampling Date	Beginning of Rainfall	Beginning of Discharge**	Sampling Period	24-hour Rainfall Amount (in)***
1	5/3/21	05:45	07:00 – 13:00	10:15 – 13:18	0.12
2*	5/23/21	17:00	18:00 – 22:30	18:15 – 20:28	0.33
3	5/26/21	06:00	08:00 – 14:00	09:15 – 12:37	0.26
4	6/25/21	07:00	****	16:17 – 21:54	1.64

*Due to an autosampler error, sample collection was delayed at the SRK site during event 2. At this site, samples were collected on 5/24/21 from 11:28 to 13:38 with a 24-hr rainfall amount of 0.36".
**Estimated by when an increase in flow was sustained by at least 10% over base flow. Rounded to the nearest half-hour.
***Rainfall data provided from WRC for rain gage 0880 located at the George W. Kuhn Retention Treatment Basin (RTB).
****Flow meter batteries were dead, so flow data was not collected.

[2] For municipal sites complying with the Phase 1 MS4 requirements, the EPA defines first flush sampling as composite sampling that occurs over the first 3 hours of a stormwater discharge (EPA 1992). EPA also defines first flush sampling for industrial sites as sampling that occurs within 30 or 60 minutes of a discharge (EPA 1992). Although WRC is not a Phase 1 community, its MS4 is more like a Phase 1 community than an industrial site. Therefore, the former definition is most applicable to this project.

Figure 1. Sampling Locations: GWK Drainage District Sites

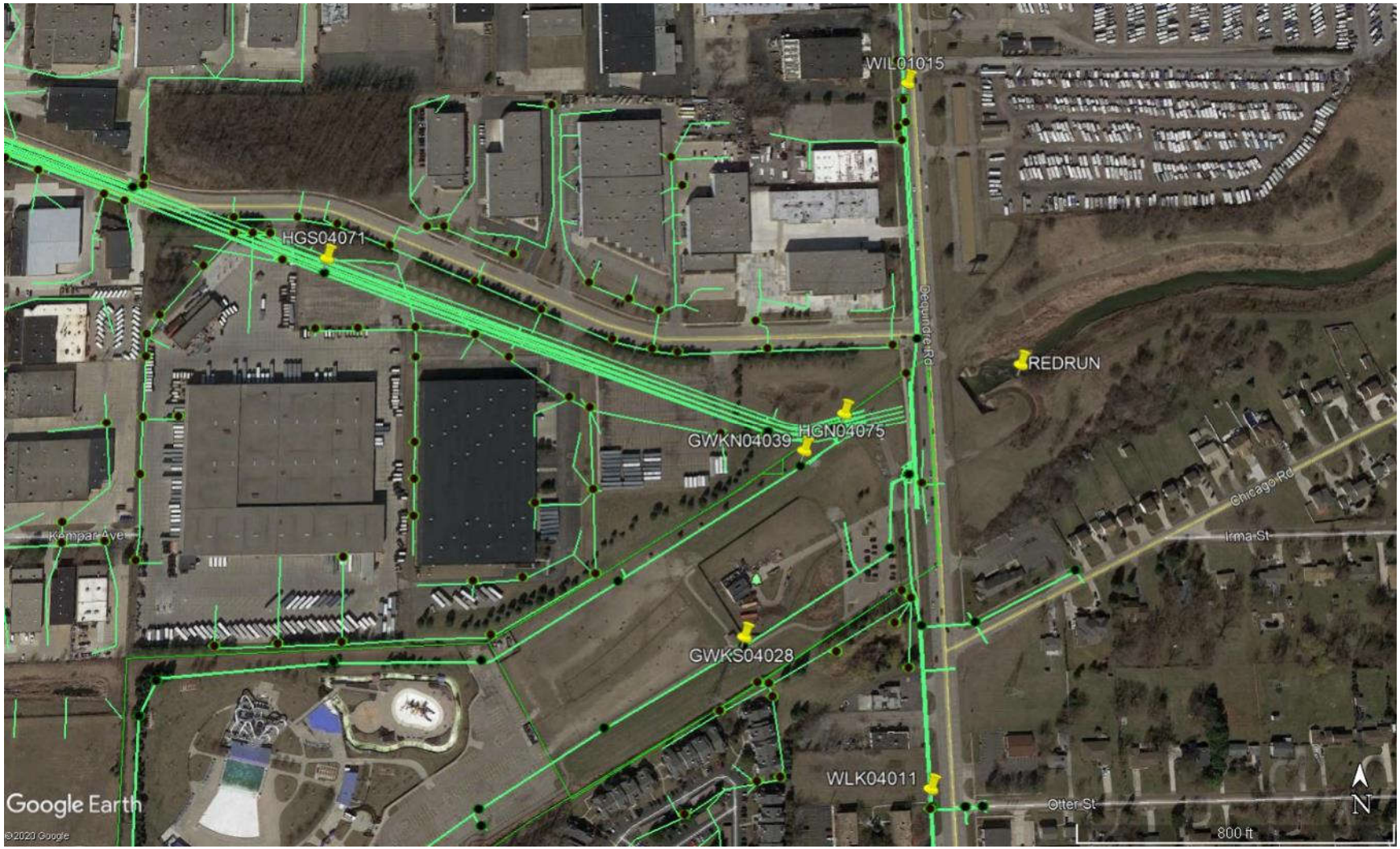

Figure 2. Sampling Locations: Bear Creek Drainage District Sites

3.0 Results

The *E. coli* and HF183 results for the first flush events (Events 1 – 3) are generally discussed separately from the Event 4 results due to the differing rainfall amounts during the events.

3.1 *E. coli* Concentrations

ECT observed a wide distribution of *E. coli* concentrations across the sites. However, none were below the state's full-body contact standard of 300 MPN/100 ml. Most of the samples had *E. coli* concentrations above 10,000 MPN/100 ml, with 82% of the results exceeding the state's partial body contact standard of 1,000 MPN/100 ml for *E. coli* (Table 3).

This assessment excludes the Event 4 concentrations for GWK South and the Red Run due to the unusually low *E. coli* concentrations of 1 MPN/100 ml reported for these sites. At the Red Run, it is anticipated that the GWK PTD impacted the results. In addition, the GWK South sampling location was likely impacted by backwater conditions from the RTB.

Table 3. E. coli Results Summary for Individual Samples

***E. coli* (MPN/100 ml)**	**Number of Samples**
< 300	0 (0%)
301 – 1,000	6 (18%)
1,001 – 10,000	10 (30%)
> 10,000	17(52%)

Based on the site geometric means for Events 1 – 3, ECT found the highest *E. coli* concentrations on the Kutchey and Sharkey drains, exceeding 11,000 MPN/100 ml. The lowest concentration was found on the Henry Graham South, where the geometric mean was 2,970 MPN/100 ml (Table 4). This is much different than what was found during Event 4 where the Henry Graham South had the highest *E. coli* concentration at 14,640 MPN/100 ml and the Wilson and Kutchey drains had the lowest concentrations.

Of the first flush events, the 0.12-inch event (Event 1) produced the lowest individual *E. coli* concentrations at all sites (Table 4). This was supported by the event geometric means which were lowest for Event 1.

The Red Run *E. coli* results were similar to the *E. coli* geometric mean of the tributary drains (Table 4). This indicates that the *E. coli* sources impacting the tributary drains and the Red Run are generally similar in nature regardless of the rainfall volume. This makes sense because many of the drains are tributary to the Red Run sampling site.

Table 4. E. coli Results (MPN/100 ml)

	Event 1	Event 2	Event 3	First Flush	Event 4
Date	**5/3/2021**	**5/23/2021**	**5/26/2021**	**Site Geomean**	**6/25/2021**
Rainfall (24 hr)	0.12"	0.33"	0.26"		1.02" to 1.64"
Kutchey	2,489	24,196	24,196	11,337	2,350
Sharkey	14,136	24,196	19,863	18,940	8,420
Henry Graham N	909	7,701	17,329	4,950	NS
Henry Graham S	865	2,142	14,136	2,970	14,640
Wilson	3,654	24,196	10,462	9,743	1,970
Walker	909	24,196	24,196	8,104	7,670
GWK North	933	24,196	11,199	6,323	5,560
GWK South	691	24,196	9,804	5,473	*
Red Run at Dequindre	934	19,863	24,196	7,657	*
Event Geometric (all sites)	**1,562**	**15,922**	**16,254**		**6,768**
Event Geometric (excluding the Red Run)	**1,666**	**15,487**	**15,465**		**N/A**

*See explanation in Section 3.1
The result was greater than the upper detection limit, so the upper detection limit was used for statistics.
N/A = Not applicable. NS = No sample was collected.

3.2 Human MST Results

Excluding the Red Run, three drains had individual HF183 concentrations that exceeded 1,000 gene copies/100 ml: Sharkey, Kutchey and Henry Graham North drains (Table 5). The Sharkey and Kutchey drains were consistently above 1,000 genes copies/100 ml during all rain events, but the Kutchey concentrations (individual and geometric mean) were generally an order of magnitude higher than the Sharkey concentrations.

This assessment excludes the results found at GWK South and Red Run during Event 4 which were 2,237,895 and 3,553,684 gene copies/100 ml, respectively. As discussed in Section 3.1, these sites were suspected to be impacted by treated water within and discharging from the GWK RTB. The high counts are due to the dead E. coli cells expected to be found in the PTD. This suspicion is supported by the August 1, 2018 wet weather sampling results which show elevated *Bacteroides* concentrations at both GWK South and the Red Run during a PTD (ECT 2020b).

HF183 concentrations were generally lower than *E. coli* concentrations. However, during 3 of the 4 events, the Kutchey Drain had higher HF183 concentrations than *E. coli* concentrations. This indicates that dead cells are likely being captured in HF183 result. This suggests that a human source is impacting this drain, although the source may be located further up the drain, allowing organisms to die off before reaching the sampling location at the drain outlet. Alternatively, the high HF183 and low *E. coli* could be the result of an older contamination event.

Table 5. HF183 Results (gene copies/100 ml)

	Event 1	Event 2	Event 3	First Flush Site Mean	Event 4
Date	**5/3/2021**	**5/23/2021**	**5/26/2021**		**6/25/2021**
Rainfall (24 hr)	0.12"	0.33"	0.26"		1.02" to 1.64"
Kutchey	81,747	5,221	39,221	42,063	16,000
Sharkey	7,158	3,200	1,768	4,042	2,926
Henry Graham N	2,800	743	95	1,213	NS
Henry Graham S	396	406	112	305	270
Wilson	95	95	109	100	427
Walker	469	103	606	393	926
GWK North	375	95	484	318	884
GWK South	246	396	493	378	*
Red Run at Dequindre	2,421	1,516	240	1,392	*
Event Mean (all sites)	**10,634**	**1,308**	**4,792**		**3,572**
Event Mean (excluding the Red Run)	**11,661**	**1,282**	**5,361**		**N/A**

*See explanation in Section 3.2

N/A = Not applicable. NS = No sample was collected.

3.3 Red Run Drain

The Red Run Drain at Dequindre Road was sampled between 4:17 pm and 15:46 pm during the final sampling event. Sampling occurred within 20 minutes of the beginning of the PTD from the GWK

RTB. The *E. coli* concentration in the Drain was < 1 MPN/100 ml (Table 6). The corresponding geometric mean *E. coli* concentration of the RTB discharge taken at 16:30 was 227 MPN/100 ml.

Table 6. Red Run Drain Results during Permitted Treated Discharge

Site	6/25/21
	E. coli
24-hr Rainfall	1.02"
Red Run at Dequindre Rd	< 1
GWK RTB PTD	227

E. coli (MPN/100 ml)

3.4 Quality Assurance Results

Duplicate samples from Events 1 and 2 did not pass the QA/QC assessment for *E. coli* analysis. Both samples did not fall within the IDEXX Confidence Limits as established by the manufacturer (Table 7). This is possibly due to deviation with repeat samples and the difference is increased when using a dilution factor. However, the reason for this large difference between regular and duplicate sample results is unclear.

Duplicate samples from Events 3 and 4 did pass the QA/QC assessment for *E. coli* analysis, as they fell within the IDEXX Confidence Limits as established by the manufacturer. This provided confidence that these sampling results accurately reflect the conditions of the sample streams at the time of sample collection.

In addition, all duplicate samples for human MST marker were the same order of magnitude as the regular sample results.

All blank samples had non-detectable levels for *E. coli* and the human MST marker. This not only indicated that the field staff was able to collect samples without cross contamination but also indicated that the laboratories processed samples in a clean environment without cross contamination.

Table 7. Quality Assurance Results

Event	Parameter*	Regular Sample Result	Duplicate Sample Result	IDEXX Confidence Limits (MPN/100 ml)		Was Duplicate Sample within Confidence Limits?
				Lower	Upper	
1	*E. coli*	14,136	24,196	9,249	21,016	No
2		7,701	17,329	5,490	10,940	No
3		19,863	17,329	12,220	33,002	Yes
4		7,670	9,330	5,490	10,940	Yes
1	HF183	7158	5648			
2		743	623			
3		1768	2204			
4		926	314			

**E. coli* (MPN/100 ml). HF183 (gene copies/100 ml)

4.0 Discussion

4.1 *E. coli* Assessment

Although generally higher, the first flush *E. coli* geometric means are the same order of magnitude as what was found previously in 2018 and 2019 (Table 8). This is despite being taken during different points of the hydrograph. The one exception to this is the 2019 mean for the Red Run which was an order of magnitude lower than 2018 and 2021. Only drains that were sampled at consistent locations were included in Table 8.

Table 8. Comparison of Historical E. coli Geometric Means

	Wet Weather Geometric Mean (MPN/100 ml)		
Drain	**2021**	**2019**	**2018**
Wilson	9,743		5,855
Walker	8,104	2,440	4,816
GWK North	6,323		8,291
GWK South	5,473	9,115	3,921
Red Run at Dequindre Rd	7,657	520	3,091

The data from Events 2 and 3 suggest that 0.25 to 0.33" storm events produced lower *E. coli* concentrations in the drains than a 0.1" event. Event 4 data also suggests that the Red Run Drain has lower *E. coli* concentrations during a PTD. This may be due to a combination of factors including: 1) the PTD is diluting the *E. coli* concentrations, 2) the increased volume of runoff from the tributary drain is diluting the *E. coli* concentrations, and 3) organism die off caused by the chlorinated PTD. However, given the high amount of HF183 in the Red Run and consistent amounts of HF183 in the tributary drains, it appears that PTD is the primary reason for the lower *E. coli*.

4.2 Source Assessment

To provide context to the results, the prevalent source of *E. coli* was assessed for each sampling site during each event based on the *E. coli* and HF183 concentrations. The criteria in Table 9 were used to determine if a source was Human, Indeterminate, Animal, or not present. Table 9 was slightly modified from the protocol used previously (ECT 2020b) to account for the lower detection limit provided by the HF183 method. Another change from the previous protocol is the relabeling of the

Human-smaller category with Indeterminate. This was done in consultation with the laboratory at Oakland University to acknowledge the uncertainty in interpreting limited HF183 data.

Table 9. Criteria for Prevalent Source Determination

Prevalent Source	*E. coli* Concentration (MPN/100 ml)		HF183 Concentration (gene copies/100 ml)
None	< 300	and	< 95
Animal	> 1,000	and	< 95
Undetermined	> 300	and	> 95
Human	> 1,000	and	> 1,000

Based on the protocol, the Kutchey and Sharkey drain samples were categorized as Human during all events, as shown in Table 10. However, most of the sites were classified as Indeterminate, indicating that *E. coli* concentrations were between 300 and 1,000 MPN/100 ml and HF183 concentrations were between 95 and 1,000 gene copies/100 ml. This indicates that although human fecal *E. coli* was found, the sources may be very difficult to locate given the variable quality of stormwater and the sensitivity of the HF183 test method. The source type only indicates the nature of the most prevalent source. It is not meant to indicate that less substantial sources are not impacting the drains during any given rain event.

Table 10. Prevalent Sources for each Site by Sampling Event

Drain	Event 1	Event 2	Event 3	Event 4
Kutchey	Human	Human	Human	Human
Sharkey	Human	Human	Human	Human
Henry Graham N	Indeterminate	Indeterminate	Animal	NS
Henry Graham S	Indeterminate	Indeterminate	Indeterminate	Indeterminate
Wilson	Animal	Animal	Indeterminate	Indeterminate
Walker	Indeterminate	Indeterminate	Indeterminate	Indeterminate
GWK North	Indeterminate	Animal	Indeterminate	Indeterminate
GWK South	Indeterminate	Indeterminate	Indeterminate	*

NS = No sample *Not assessed due to the suspected impacts from a PTD.

5.0 Conclusions and Recommendations

5.1 Conclusions

The 2021 wet weather sampling revealed that human fecal sources are likely impacting the Kutchey and Sharkey drains during first flush conditions. The Kutchey Drain also may have a high-level overflow from the sanitary sewer.

The Event 4 sampling was purposely targeted to occur when the sanitary sewers were at capacity to determine if high level overflows from the sanitary sewer existed within the storm drain system. Based on the HF183 data, no overflows were identified except perhaps on the Kutchey Drain.

Stormwater is generally driving the *E. coli* impairments on the Red Run rather than the discharge from the GWK RTB. This is based on two findings. First, during a PTD from the GWK RTB, the *E. coli* concentration in the Red Run was lower than when the RTB was not discharging. Second, the PTD had low *E. coli* concentrations as measured by WRC staff. This phenomenon was reported in previous investigations (ECT 2020b, ECT 2021), as well.

Lastly, despite high *E. coli* concentrations on the Henry Graham (North and South), Wilson, Walker, and GWK (North and South) drains, the MST results didn't show a strong sewage signature. Therefore, nonpoint sources of *E. coli* are more like driving the *E. coli* concentrations in these drains. This finding is consistent with previous findings for the GWK North, Henry Graham (North and South), Walker and Wilson drains (ECT 2021).

5.2 Recommendations

ECT recommends that Illicit discharge investigations be conducted on Kutchey and Sharkey drains upstream of the sampling locations. If it is necessary to prioritize one drain over the other, investigations should occur on the Kutchey Drain first due to the high relative concentration of HF183 during all rain events and the potential for a high-level overflow. Investigations may require coordination with Macomb County, as these are intercounty drains. In addition, coordination is suggested with the cities of Hazel Park and Madison Heights, since the extent of WRC's jurisdiction is limited west of Dequindre Road.

These investigations should consider the impacts of the siphons that are located under I-696. These siphons are constantly submerged with stormwater, and they could be acting as a sink for bacteria.

In addition, if sampling wet weather events > 1”, the GWK South sampling location should be moved upstream to avoid backwater effects from the GWK RTB.

Lastly, ECT recommends completing Tasks 3A and 3B from this project’s proposal. This would help meet a secondary goals of the sampling which were to determine pollutant loads associated with the drains and the GWK PTD and provide a better understanding of the water quality of the GWK PTD and in light of other RTBs in the region.

6.0 References

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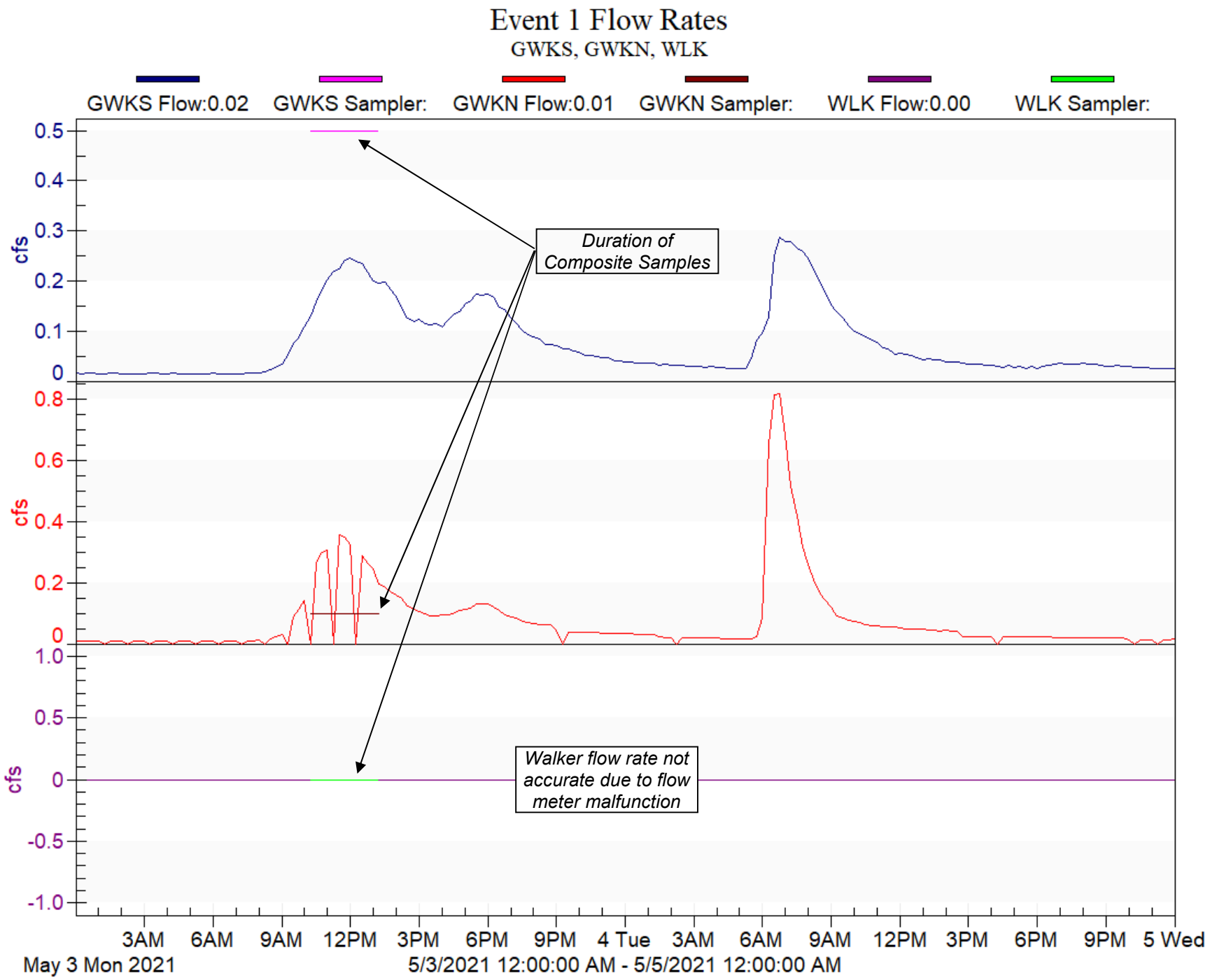
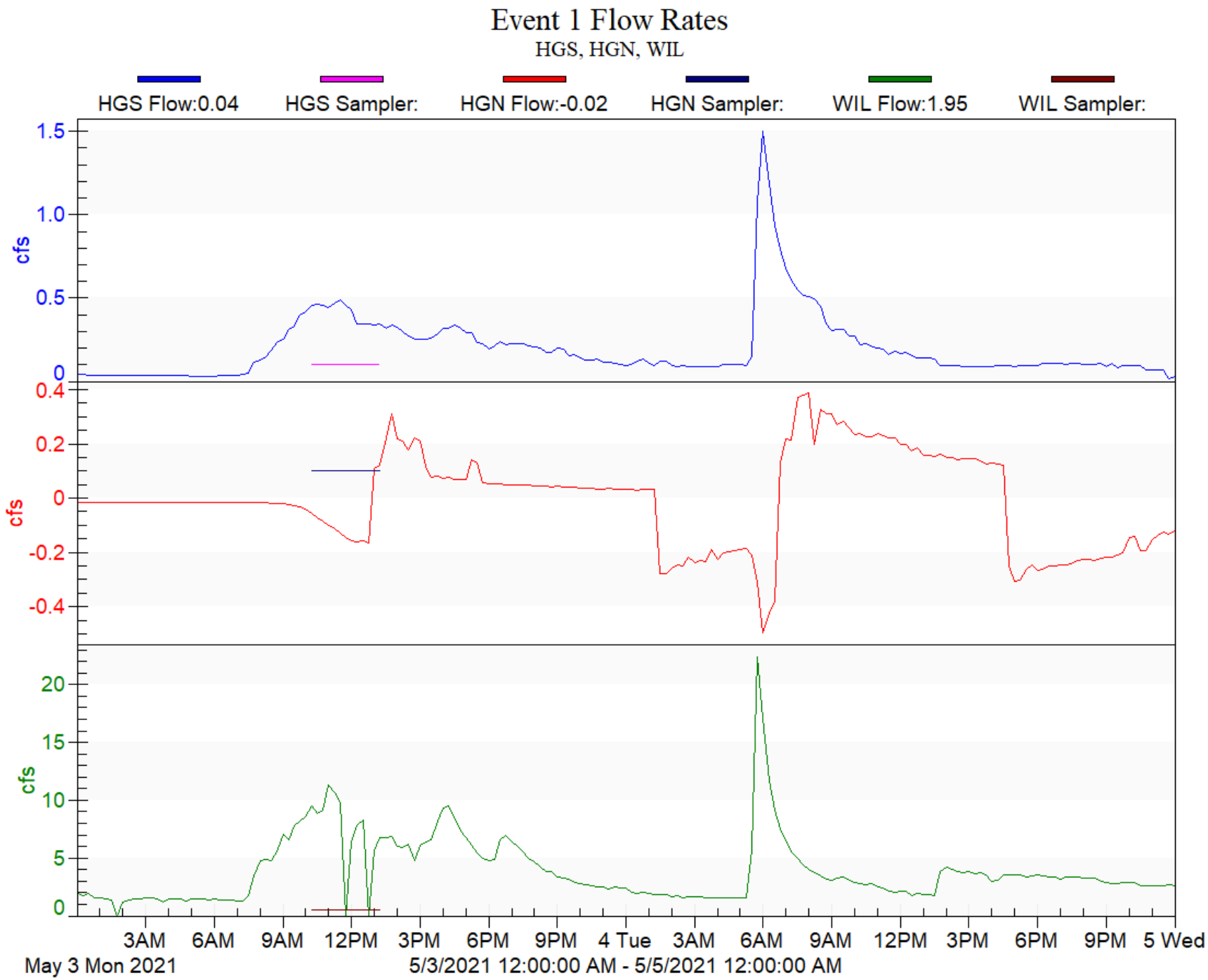
Appendix A Sampling Site Descriptions

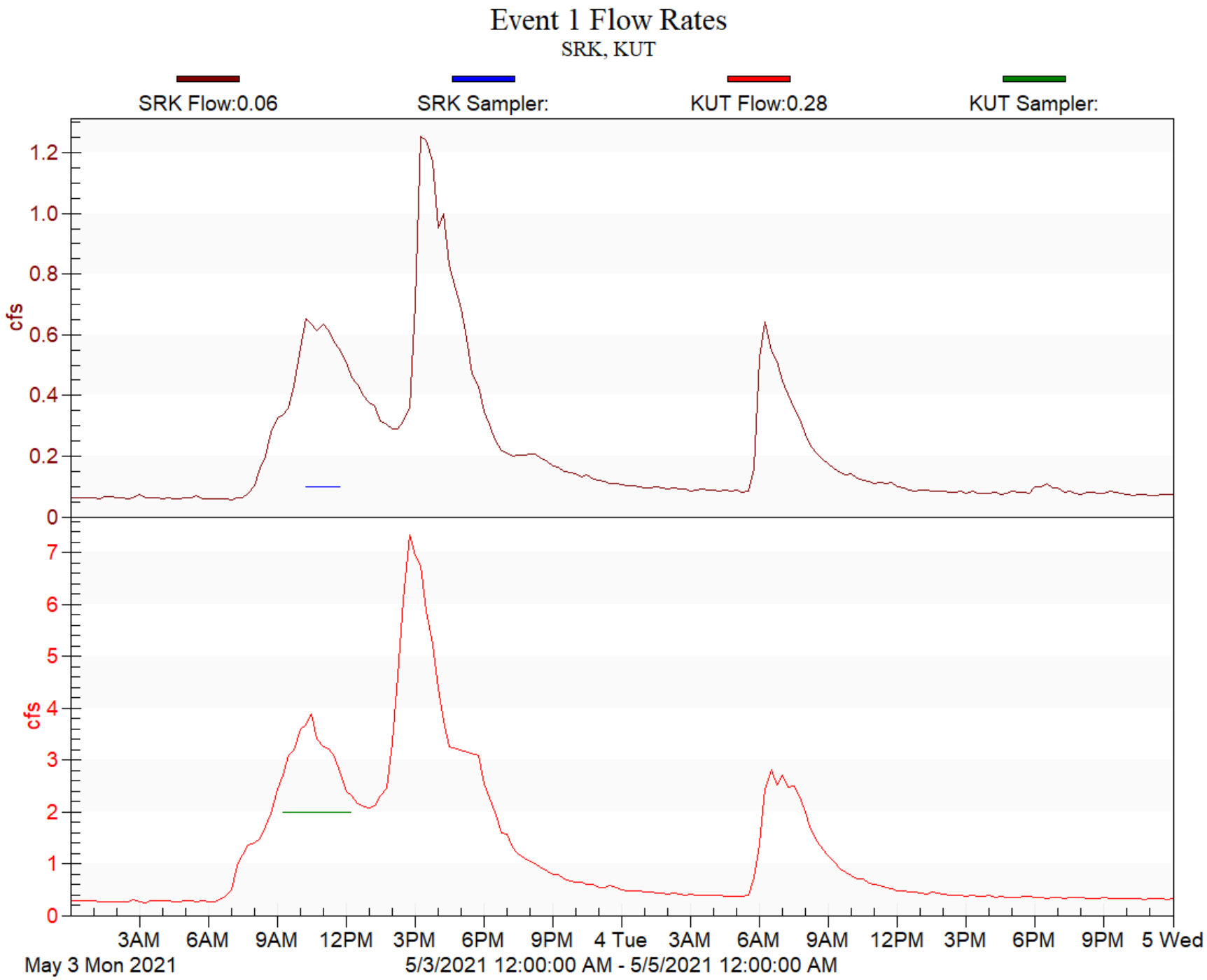
1. Red Run Drain – Red Run is located east of Dequindre Road on the south side of the GWK RTB outlet behind a locked fence. The sample site is approximately 140' downstream of the GWK RTB outlet. 42.5249794802, -83.0856413888
2. GWK Drain North Branch – GWKN04039 is located inside the dog park, east and south of the 4th pine tree west of Dequindre Road. It can be found by walking north from the gate entrance of Dog Run A. 42.5242860599, -83.0877071041
3. GWK Drain South Branch – GWKS04028 is located by the gazebo in the dog park west of the parking lot. 42.523026, -83.088310
4. Henry Graham Drain North – HGN04075[3] is located in the grass north of the fence between the dog park and the UPS parking lot. It can be found by walking west along the fence from Dequindre Road. 42.5246491912, -83.0872895188
5. Henry Graham Drain South– HGS04071[4] is located in the UPS Customer Center parking lot. It is marked off with traffic cones to prevent a vehicle from parking over it. 42.5257017226, -83.0922863424
6. Kutchey Drain – KUT119007 is located in the roadway in front of 2140 Stephens, Westview Baptist Church. 42.4690955711, -83.0817443878
7. Sharkey Drain – SRK075503[5] is located in the roadway in front of 2221 Frazho Road. 42.4838552777, -83.0814632465
8. Walker Drain – WLK04011 is located in the sidewalk space near the north corner of Cambridge Nursing Centre. 42.521885, -83.086546
9. Wilson Drain – WIL01015 is located in the southbound lane of Dequindre near the curb. It is at the southern driveway to East-Lind Heat Treat. 42.527018, -83.086621

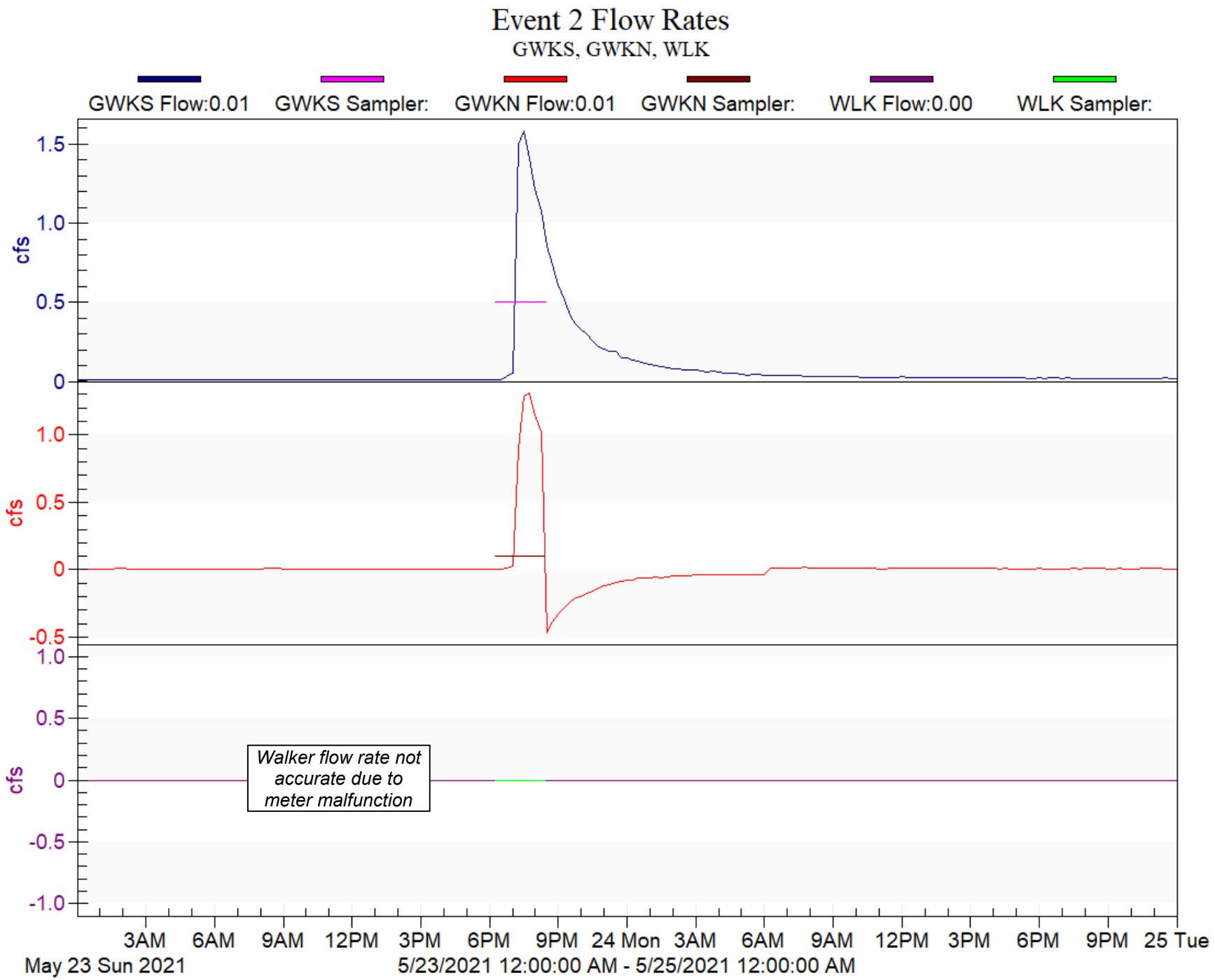
[3] Updated 11-23-20
[4] Updated 11-23-20
[5] Updated 11-23-20

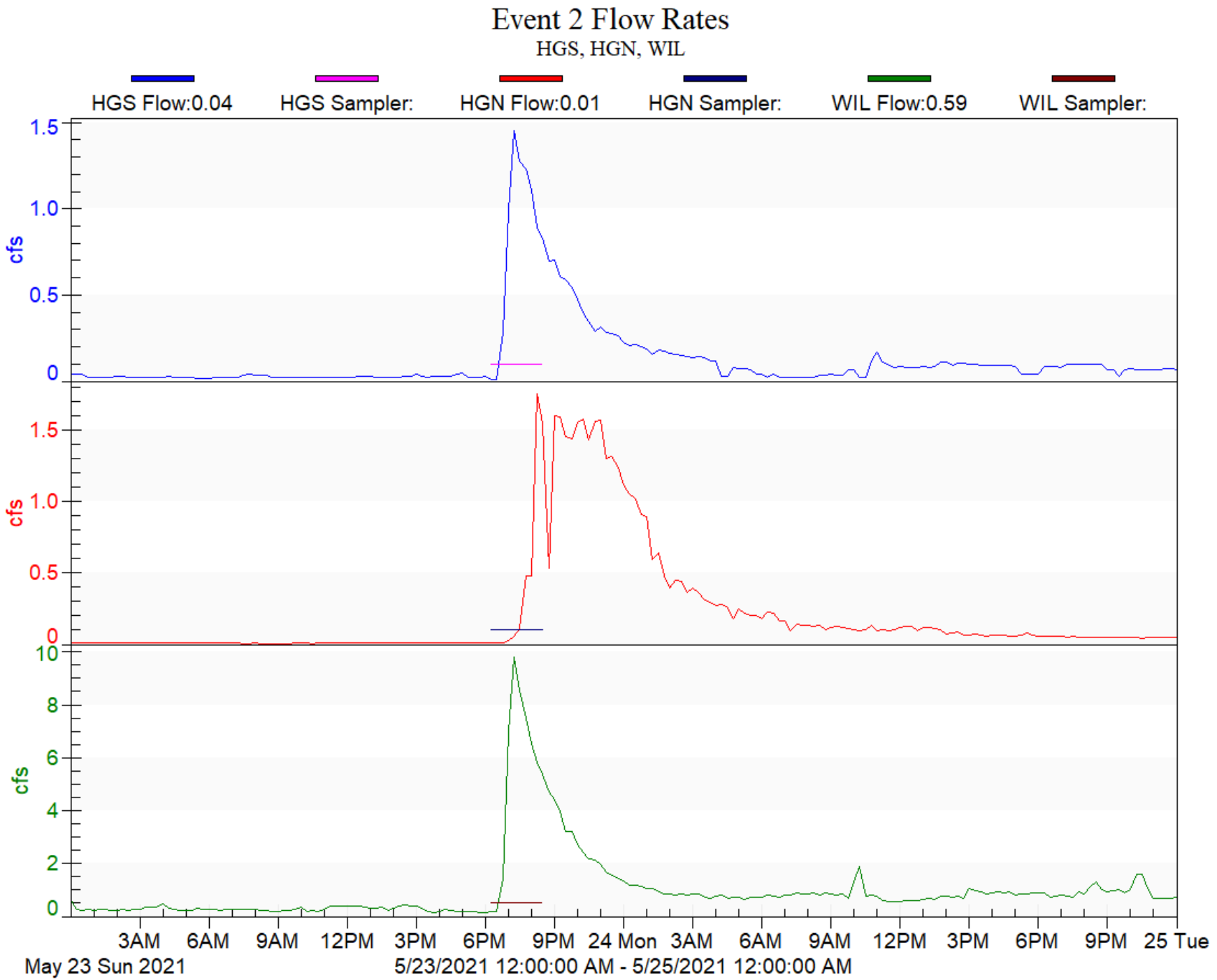
Appendix B Hydrographs and Sampling Durations

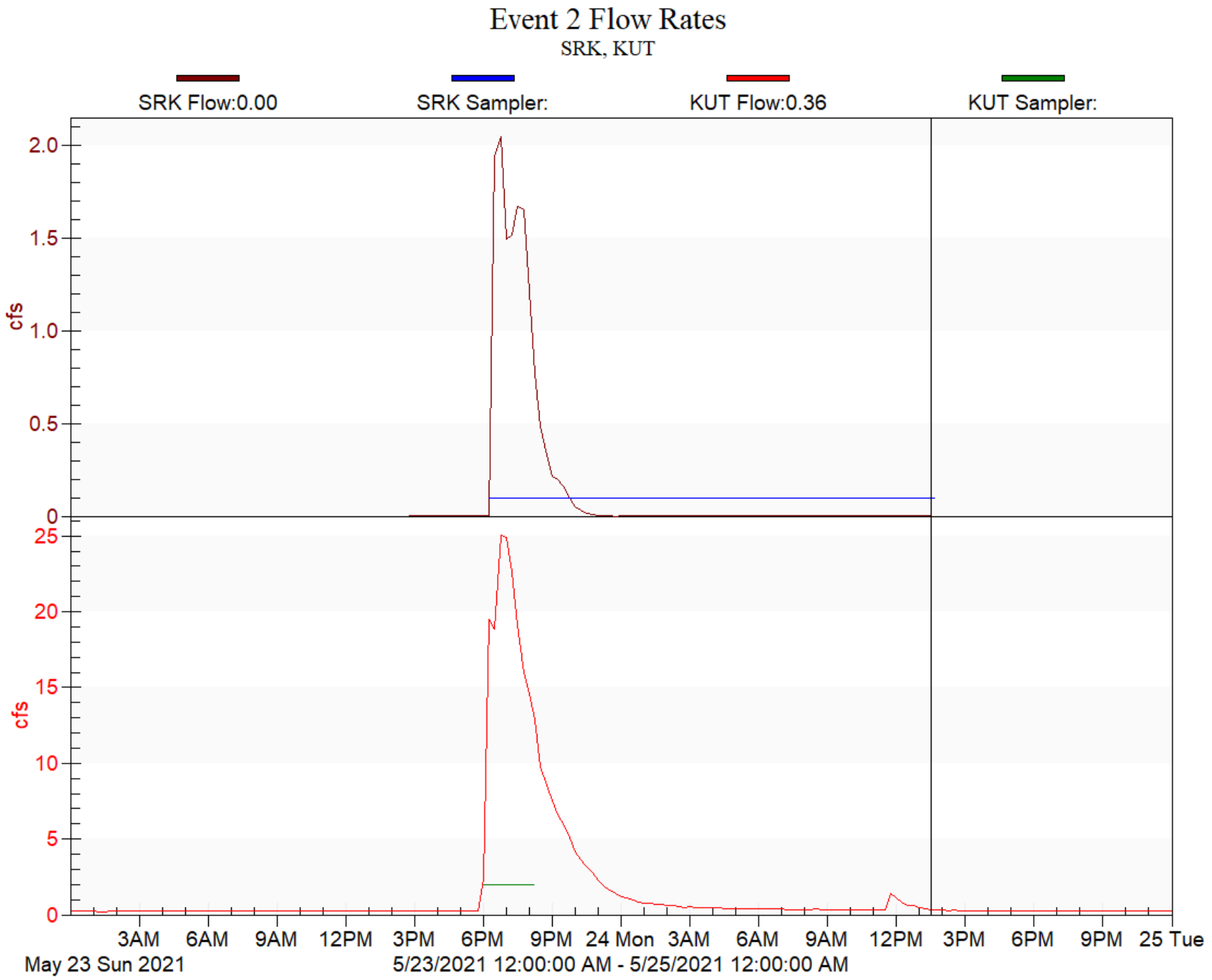

Event 1 Flow Rates
GWKS, GWKN, WLK
GWKS Flow:0.02
GWKS Sampler:
GWKN Flow:0.01
GWKN Sampler:
WLK Flow:0.00
WLK Sampler:
cfs
0.5
0.4
0.3
0.2
0.1
0
Duration of Composite Samples
cfs
0.8
0.6
0.4
0.2
0
cfs
1.0
0.5
0
-0.5
-1.0
Walker flow rate not accurate due to flow meter malfunction
3AM
6AM
9AM
12PM
3PM
6PM
9PM
4 Tue
3AM
6AM
9AM
12PM
3PM
6PM
9PM
5 Wed
May 3 Mon 2021
5/3/2021 12:00:00 AM - 5/5/2021 12:00:00 AM

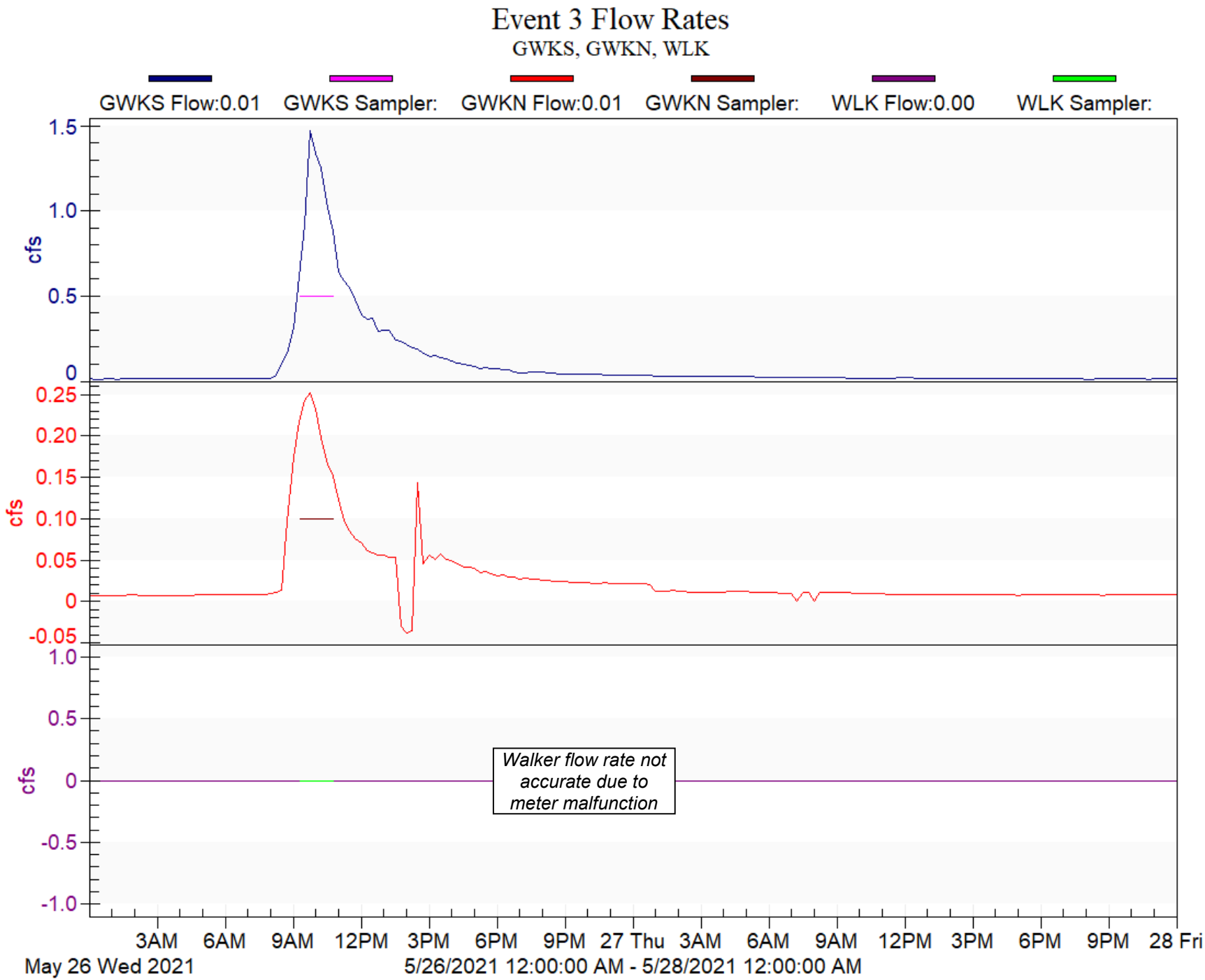

Event 1 Flow Rates
HGS, HGN, WIL
HGS Flow:0.04
HGS Sampler:
HGN Flow:-0.02
HGN Sampler:
WIL Flow:1.95
WIL Sampler:
cfs
1.5
1.0
0.5
0
0.4
0.2
0
-0.2
-0.4
20
15
10
5
0
3AM
6AM
9AM
12PM
3PM
6PM
9PM
4 Tue
3AM
6AM
9AM
12PM
3PM
6PM
9PM
5 Wed
May 3 Mon 2021
5/3/2021 12:00:00 AM - 5/5/2021 12:00:00 AM

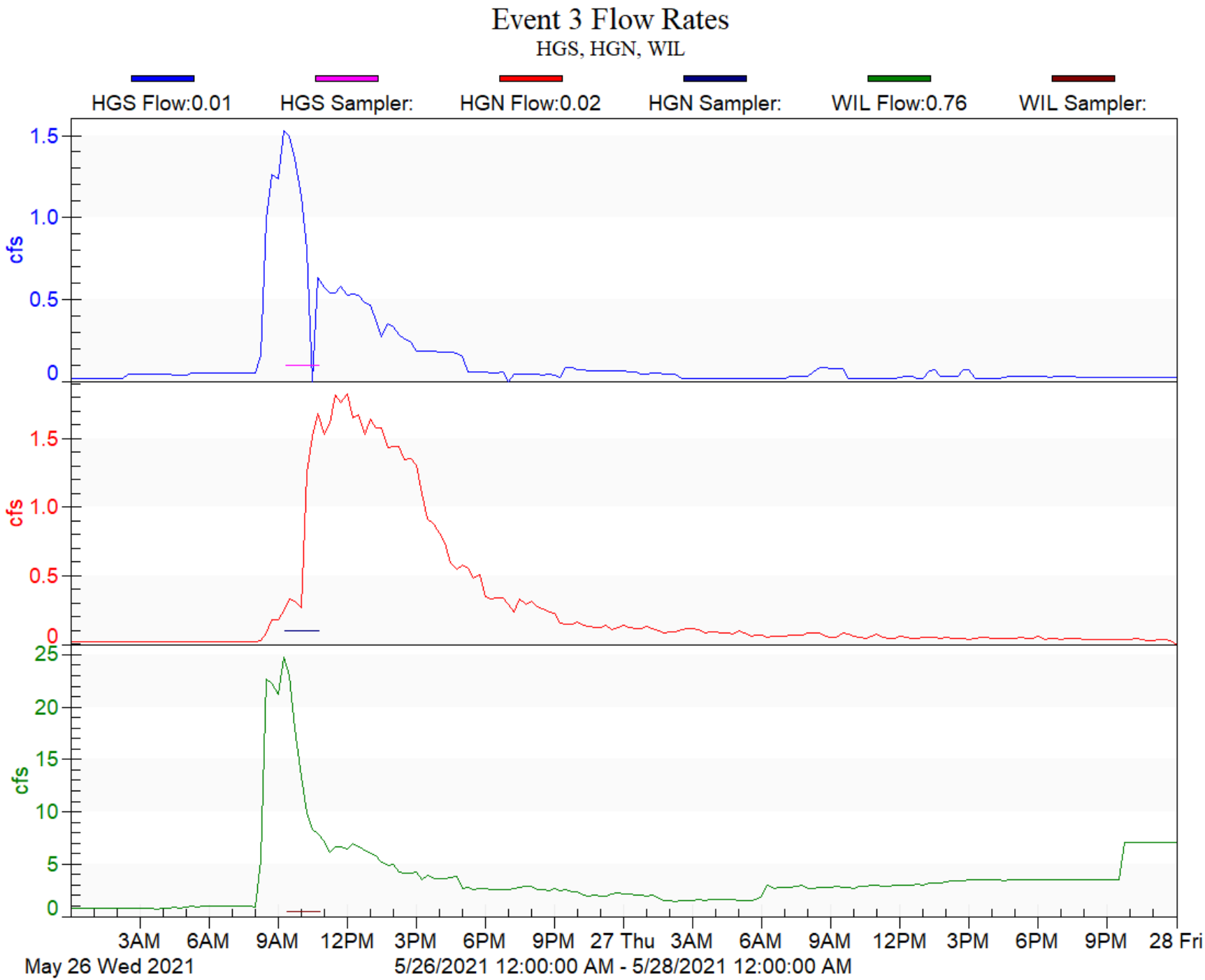

Event 1 Flow Rates
SRK, KUT
SRK Flow:0.06
SRK Sampler:
KUT Flow:0.28
KUT Sampler:
cfs
1.2
1.0
0.8
0.6
0.4
0.2
0
cfs
7
6
5
4
3
2
1
0
3AM
6AM
9AM
12PM
3PM
6PM
9PM
4 Tue
3AM
6AM
9AM
12PM
3PM
6PM
9PM
5 Wed
May 3 Mon 2021
5/3/2021 12:00:00 AM - 5/5/2021 12:00:00 AM

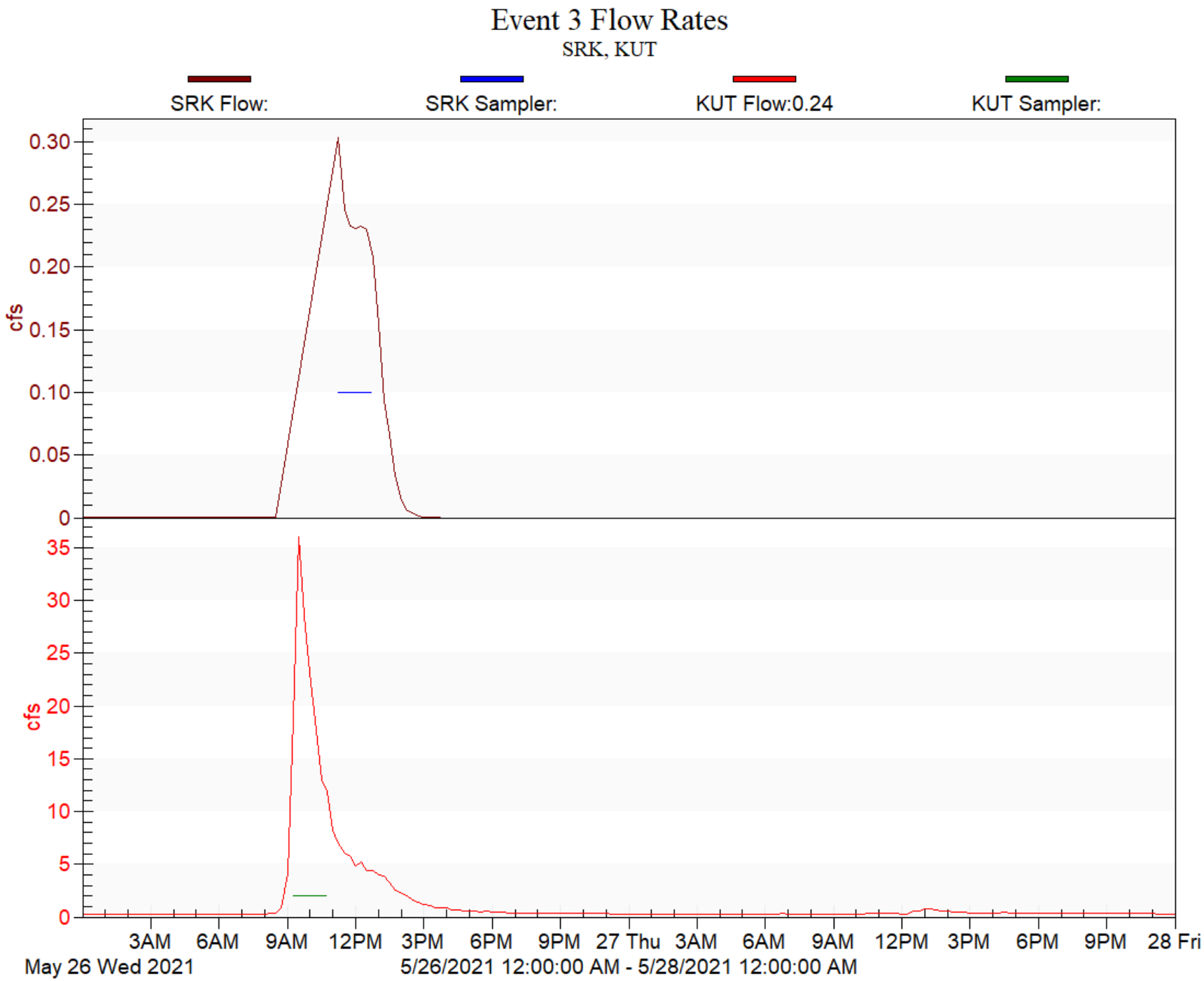

Event 2 Flow Rates
GWKS, GWKN, WLK
GWKS Flow:0.01
GWKS Sampler:
GWKN Flow:0.01
GWKN Sampler:
WLK Flow:0.00
WLK Sampler:
cfs
1.5
1.0
0.5
0
cfs
1.0
0.5
0
-0.5
cfs
1.0
0.5
0
-0.5
-1.0
Walker flow rate not accurate due to meter malfunction
3AM
6AM
9AM
12PM
3PM
6PM
9PM
24 Mon
3AM
6AM
9AM
12PM
3PM
6PM
9PM
25 Tue
May 23 Sun 2021
5/23/2021 12:00:00 AM - 5/25/2021 12:00:00 AM


Event 2 Flow Rates
HGS, HGN, WIL
HGS Flow:0.04
HGS Sampler:
HGN Flow:0.01
HGN Sampler:
WIL Flow:0.59
WIL Sampler:
cfs
1.5
1.0
0.5
0
cfs
1.5
1.0
0.5
0
cfs
10
8
6
4
2
0
3AM
6AM
9AM
12PM
3PM
6PM
9PM
24 Mon
3AM
6AM
9AM
12PM
3PM
6PM
9PM
25 Tue
May 23 Sun 2021
5/23/2021 12:00:00 AM - 5/25/2021 12:00:00 AM


Event 2 Flow Rates
SRK, KUT
SRK Flow:0.00
SRK Sampler:
KUT Flow:0.36
KUT Sampler:
cfs
2.0
1.5
1.0
0.5
0
cfs
25
20
15
10
5
0
3AM
6AM
9AM
12PM
3PM
6PM
9PM
24 Mon
3AM
6AM
9AM
12PM
3PM
6PM
9PM
25 Tue
May 23 Sun 2021
5/23/2021 12:00:00 AM - 5/25/2021 12:00:00 AM


Event 3 Flow Rates
GWKS, GWKN, WLK
GWKS Flow:0.01
GWKS Sampler:
GWKN Flow:0.01
GWKN Sampler:
WLK Flow:0.00
WLK Sampler:
cfs
1.5
1.0
0.5
0
0.25
0.20
0.15
0.10
0.05
0
-0.05
1.0
0.5
0
-0.5
-1.0
Walker flow rate not accurate due to meter malfunction
3AM
6AM
9AM
12PM
3PM
6PM
9PM
27 Thu
3AM
6AM
9AM
12PM
3PM
6PM
9PM
28 Fri
May 26 Wed 2021
5/26/2021 12:00:00 AM - 5/28/2021 12:00:00 AM


Event 3 Flow Rates
HGS, HGN, WIL
HGS Flow:0.01
HGS Sampler:
HGN Flow:0.02
HGN Sampler:
WIL Flow:0.76
WIL Sampler:
cfs
1.5
1.0
0.5
0
cfs
1.5
1.0
0.5
0
cfs
25
20
15
10
5
0
3AM
6AM
9AM
12PM
3PM
6PM
9PM
27 Thu
3AM
6AM
9AM
12PM
3PM
6PM
9PM
28 Fri
May 26 Wed 2021
5/26/2021 12:00:00 AM - 5/28/2021 12:00:00 AM


Event 3 Flow Rates
SRK, KUT
SRK Flow:
SRK Sampler:
KUT Flow:0.24
KUT Sampler:
cfs
0.30
0.25
0.20
0.15
0.10
0.05
0
cfs
35
30
25
20
15
10
5
0
3AM
6AM
9AM
12PM
3PM
6PM
9PM
27 Thu
3AM
6AM
9AM
12PM
3PM
6PM
9PM
28 Fri
May 26 Wed 2021
5/26/2021 12:00:00 AM - 5/28/2021 12:00:00 AM