Appendix C
2018 Tributary Recovery Time Monitoring

Recovery Time Monitoring Events, 2018: Results and Salient Findings

Prepared for Onondaga County Department of Water Environment Protection

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Introduction

In 2015, 2016, and 2017 Onondaga County conducted a Post Construction Compliance Monitoring (PCCM) program on Onondaga Creek and Harbor Brook to meet the following primary objectives:

- characterize spatial and temporal patterns of selected water quality constituents during runoff events
- evaluate compliance with ambient water quality standards (AWQS)
- determine if CSOs are causing or contributing to violations of water quality standards in the receiving waters
- evaluate the effectiveness of CSO controls
- quantify upstream sources of pollution to further identify targets for remediation and provide context for downstream conditions

A total of 12 PCCM events were completed during 2015-2017, five on Onondaga Creek and seven on Harbor Brook. These monitoring events consisted of high frequency sampling at four locations before, during, and after significant runoff events. Rainfall events with an intensity of > 0.35 inches per hour were targeted for PCCM events. Although measurements were taken for a suite of water quality parameters, including total phosphorus, turbidity, and ammonia-N, the focus of the PCCM was on concentrations of fecal coliform bacteria (FCOLI). Salient findings from the PCCM program have been presented in annual ACJ reports and selected highlights are summarized here:

- CSOs are not contributing significantly to floatables in Onondaga Creek or Harbor Brook
- despite completion of most ACJ abatement projects, CSOs continue to contribute to elevated FCOLI and exceedances of AWQS in Onondaga Creek and Harbor Brook during wet weather
- event mean FCOLI concentrations for the 12 PCCM events ranged from 2,575 to 443,271 cfu/100 mL
- there is evidence of dry weather fecal coliform sources along the lower portion of Harbor Brook

- a single recovery time monitoring event in August 2017 indicated that FCOLI concentrations in Onondaga Creek and Harbor Brook remained elevated for at least one week following a storm event

In 2018, Onondaga County's Post Construction Compliance Monitoring (PCCM) program transitioned to a focus on Recovery Time Monitoring (RTM) to specifically address the length of time required for FCOLI concentrations to decrease to pre-storm levels. This data collected during RTM events is intended to inform discussions regarding a potential SPDES permit variance for FCOLI during wet weather. The objectives of the 2018 CSO Recovery Time Monitoring program are listed here:

- Characterize temporal patterns of fecal coliform bacteria (FCOLI) in Onondaga Creek and Harbor Brook during runoff events
- Evaluate compliance with AWQS and effectiveness of CSO controls
- Determine if CSOs are causing or contributing to violations of the AWQS for FCOLI
- Document the time-course of FCOLI recovery following significant wet weather events

In 2018, tributary recovery time monitoring was initiated by OCDWEP staff near the mouths of Onondaga Creek (Figure A-1) and Harbor Brook (Figure A-2) on four occasions. The goal of the monitoring was to evaluate the time required for fecal coliform concentrations to return to pre-storm levels following significant runoff events. Due to a variety of logistical issues (e.g., storms that didn't materialize, intervening rainfall), only two of these monitoring events provided useful information on recovery times. Even these two useful events included multiple intervals of rainfall and multiple flow and fecal coliform responses that complicated the evaluation of recovery time. Recovery time monitoring results for Onondaga Creek and Harbor Brook are presented here for the events of August 17-22, 2018 and October 2-7, 2018.

August 17-22, 2018 RTM Event – Onondaga Creek

Monitoring was initiated at the Spencer Street location on Onondaga Creek at 07:30 on August 17 and continued until 08:00 on August 22 (Figure 1). A total of 20 samples were collected for fecal coliform analysis over this five-day period. Rainfall began at 07:00 on August 17, and 0.36 inches of rain was recorded at Metro by 08:15 (Figure 1a). Following an eight hour dry period, an additional 0.20 inches of rain was recorded between 16:15 and 18:25 on August 17. These distinct intervals of intense rainfall resulted in two conspicuous flow peaks at Spencer Street (Figure 1b). A broader peak in stream flow, associated with hydrologic contributions from the larger upstream watershed, occurred during the afternoon of August 18. Four additional brief periods of rainfall contributed a total of 0.05 inches between 04:10 on August 18 and 05:55 on August 22.

Fecal coliform concentrations in Onondaga Creek were elevated relative to the AWQS at 07:30 on August 17 (3,300 cfu/100 mL). The fecal coliform concentration increased to 200,000 cfu/100 mL at 08:00 on August 17, decreased to 11,100 cfu/100mL at 13:40, and increased again to 93,000 cfu/100 mL at 21:35 (Figure 1c). This second increase in fecal coliform levels was associated with the period of

rainfall between 16:15 and 18:25. By 08:05 on August 20 fecal coliform concentrations decreased to 3,200 cfu/100 mL, consistent with pre-storm levels. The recovery time for this event was 72 hours following the initial fecal coliform increase and 59 hours following the second fecal coliform maxima. However, it is important to note that fecal coliform concentrations were elevated above the AWQS in the first sample (3,300 CFU/mL), collected 30 minutes after the first rainfall, and following the recovery period (also 3,300 CFU/mL).

Approximately 4.7 million gallons of CSO volume was measured on August 17 at metered CSOs discharging to Onondaga Creek (Figure 2). CSO volume was dominated by contributions from CSO 021 (Figure 2e); however, CSOs 052, 060, 027, 020, 066, and 075 also discharged during this runoff event. Note that measured flows from CSO 075 may be overstated according to the Jacobs memo dated May 16, 2019. As expected, the timing of these CSOs coincided with the two periods of the most intense rainfall. The estimated CSO volume of 4.7 million gallons does not include additional contributions that may have been discharged from unmetered CSOs. SWMM simulations for modeled storms with rainfall intensities similar to the August 17, 2018 event suggest the potential for additional discharge from CSO 029.

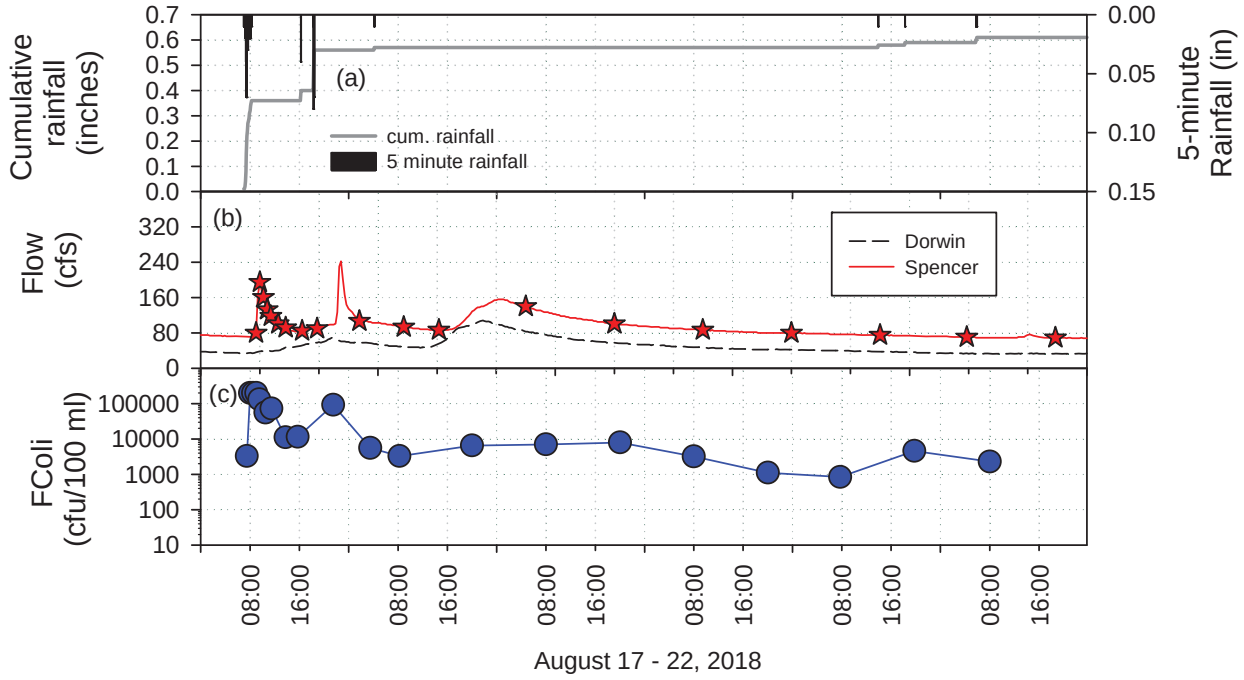

Figure 1. RTM results for Onondaga Creek, August 17-22, 2018: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data for Onondaga Creek at Dorwin Ave. and Spencer St. with sampling times indicated, (c) FCOLI results from Spencer St.

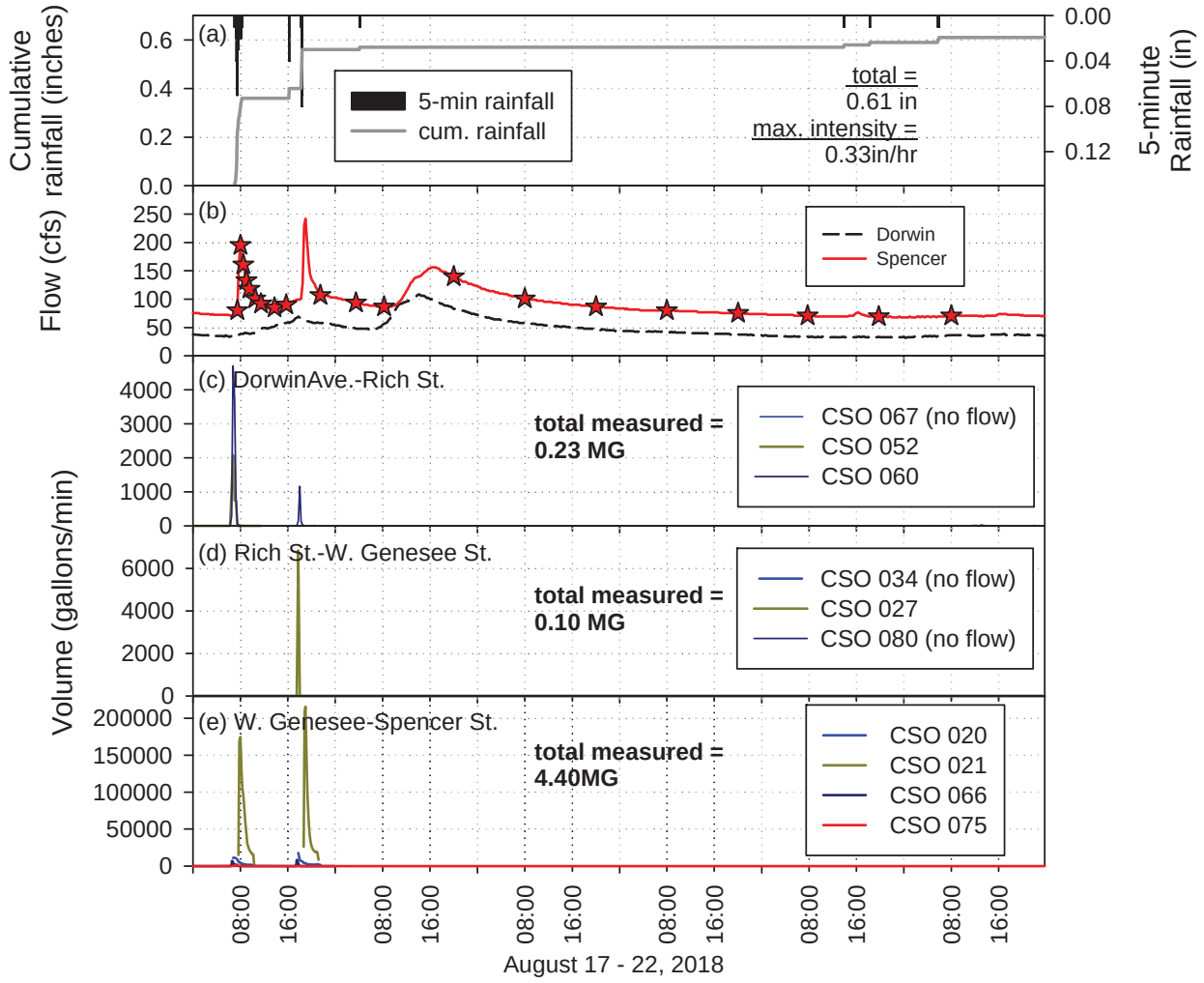

Figure 2. RTM results for Onondaga Creek, August 17-22, 2018: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data for Onondaga Creek at Dorwin Ave. and Spencer St. with sampling times indicated, (c) total measured CSO flow for the Dorwin Ave. to Rich St. reach, (d) total measured CSO flow for the Rich St. to W. Genesee St. reach, and (e) total measured CSO flow for the W. Genesee St. to mouth reach. Note that this is the total CSO flow as measured by *in-situ* flow monitoring devices only and is not equivalent to the total CSO flow for the event. Refer to Figure A-1 for locations of individual CSOs and creek reaches.

August 17-22, 2018 RTM Event – Harbor Brook

Monitoring was initiated at the Hiawatha Blvd. location on Harbor Brook at 07:30 on August 17 and continued until 07:50 on August 22 (Figure 3). A total of 20 samples were collected for fecal coliform analysis over this five-day period. Rainfall began at 07:00 on August 17, and 0.36 inches of rain was recorded at Metro by 08:15 (Figure 3a). Following an eight hour dry period, an additional 0.20 inches of rain was recorded between 16:15 and 18:25 on August 17. These distinct intervals of intense rainfall resulted in two conspicuous flow peaks at both Velasko Rd. and Hiawatha Blvd. (Figure 3b). Four additional brief periods of rainfall contributed a total of 0.05 inches between 04:10 on August 18 and 05:55 on August 22.

Fecal coliform concentrations in Harbor Brook were elevated relative to the AWQS at 07:30 (1,680 cfu/100 mL) and 08:00 (1,410 cfu/100 mL) on August 17 Figure 3c). The fecal coliform concentration increased to 200,000 cfu/100 mL at 10:30 on August 17, decreased to 17,700 cfu/100mL at 13:30, and increased again to 200,000 cfu/100 mL at 21:25 (Figure 3c). This second increase in fecal coliform levels was associated with the period of rainfall between 16:15 and 18:25. By 19:55 on August 19 fecal coliform concentrations decreased to 892 cfu/100 mL, consistent with levels measured at the beginning of the event. The recovery time for this event was 59 hours following the initial fecal coliform increase and 47 hours following the second fecal coliform maxima. However, it is important to note that fecal coliform concentrations were elevated above the AWQS in the first sample (1,680 CFU/mL), collected 30 minutes after the first rainfall, and following the recovery period (892 CFU/mL).

Approximately 0.06 million gallons of CSO volume was measured on August 17 at metered CSOs discharging to Harbor Brook (Figure 4). CSO 078 was the only metered CSO with measured flow during this event (Figure 4c). As expected, the timing of CSO discharges coincided with the two periods of the most intense rainfall. The estimated CSO volume of 0.06 million gallons does not include additional contributions that may have been discharged from unmetered CSOs. SWMM simulations for modeled storms with rainfall intensities similar to the August 17, 2018 event suggest the potential for discharge from CSOs 005, 006, 007, 010, and 011.

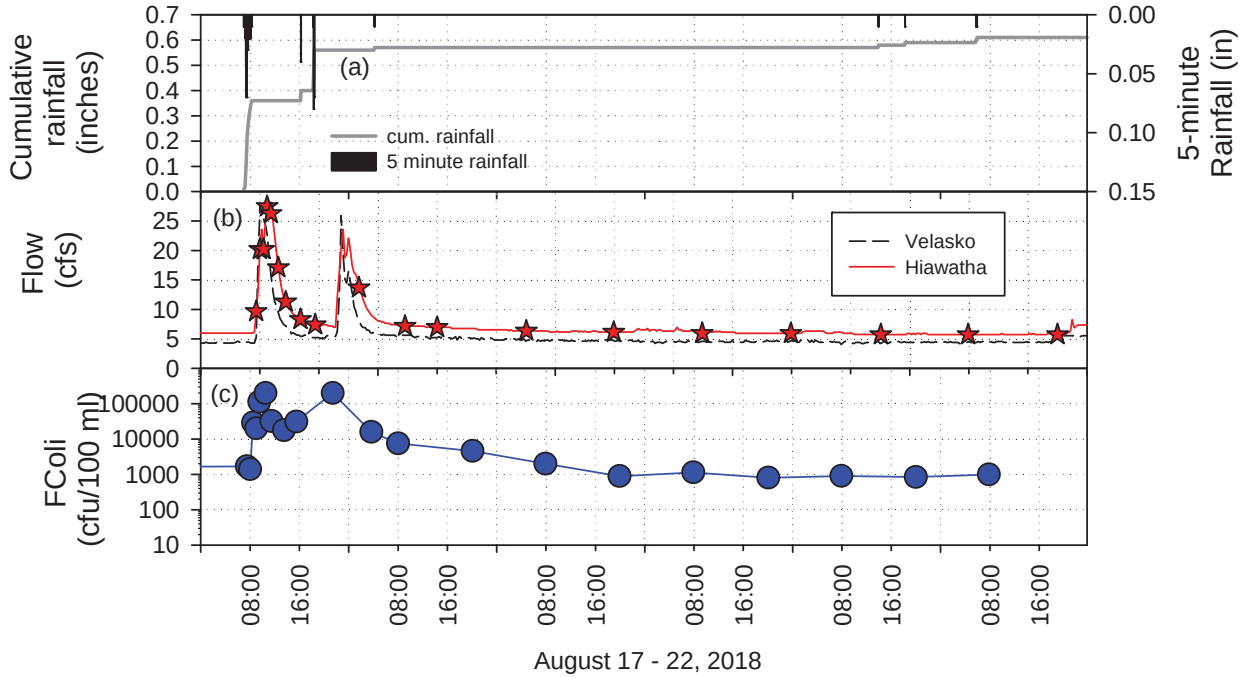

Figure 3. RTM results for Harbor Brook, August 17-22, 2018: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data for Harbor Brook at Velasko Rd. and Hiawatha Blvd. with sampling times indicated, (c) FCOLI results from Hiawatha Blvd.

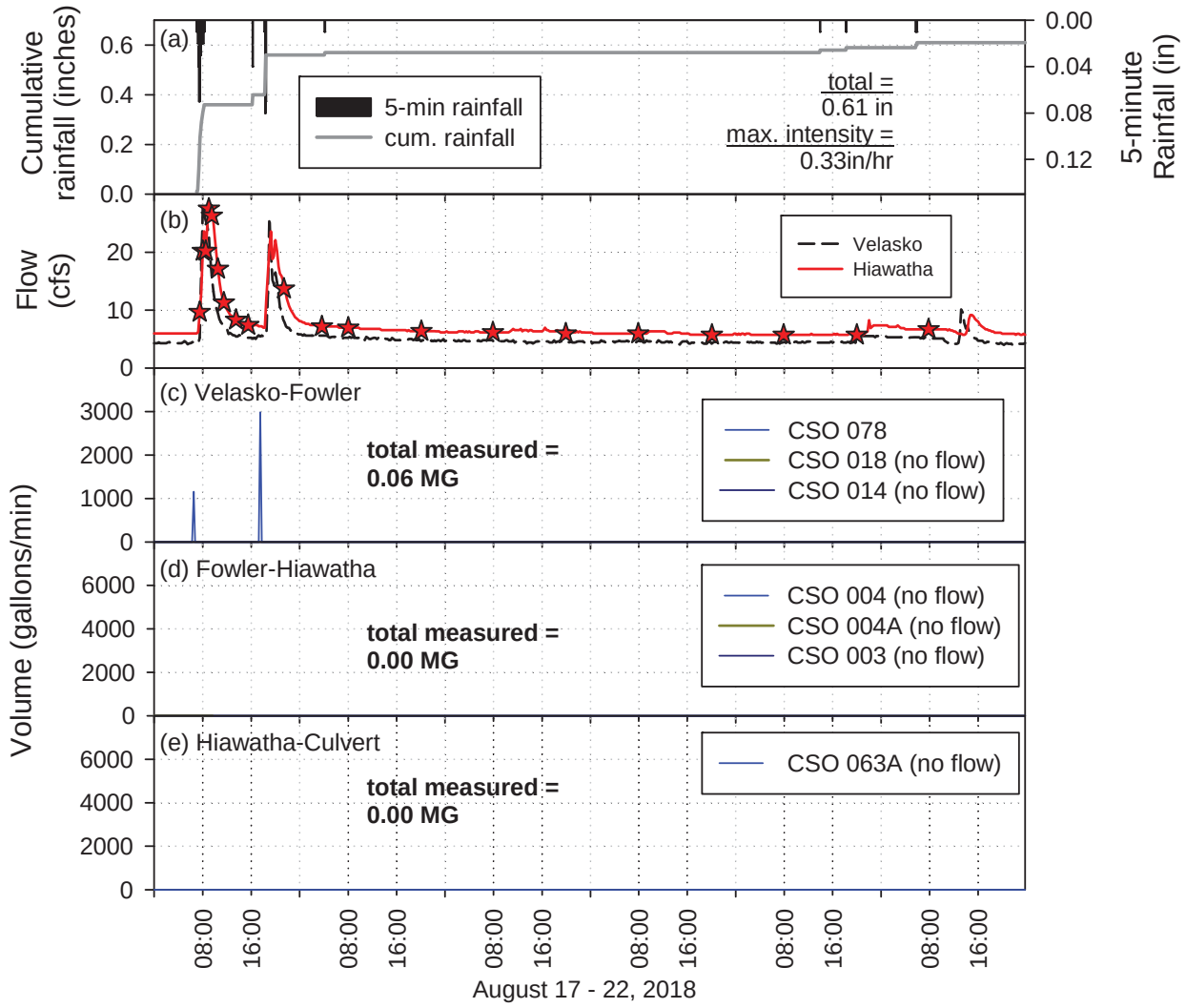

Figure 4. RTM results for Harbor Brook, August 17-22, 2018: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Harbor Brook at Velasko Rd. and Hiawatha Blvd, (c) total measured CSO flow for the Velasko Rd. to Fowler High School reach, (d) total measured CSO flow for the Fowler High School to Hiawatha Blvd. reach and (e) total measured CSO flow for the Hiawatha Blvd. to Culvert (near Onondaga Lake) reach. Note that this is the total CSO flow as measured by *in-situ* flow monitoring devices only and is not equivalent to the total CSO flow for the event. Refer to Figure A-2 for locations of individual CSOs and creek reaches.

October 2-7, 2018 RTM Event – Onondaga Creek

Another round of recovery time monitoring was initiated at the Spencer Street location on Onondaga Creek at 08:25 on October 2 that continued until 06:20 on October 7 (Figure 5b). A total of 20 samples were collected for fecal coliform analysis over this five-day period. Rainfall began at 07:50 on October 2, and by 21:40 0.77 inches of rain was recorded at Metro (Figure 5a). Following a 36 hour dry period, an additional 0.13 inches of rain was recorded between 10:20 and 11:45 on October 4. These distinct intervals of rainfall resulted in multiple flow peaks at Spencer Street (Figure 5b). The broader peaks in stream flow observed during the morning of October 3 and the evening of October 4 were associated with hydrologic contributions from the larger upstream watershed. Additional intermittent rainfall contributed a total of 0.23 inches between 10:45 on October 6 and 09:45 on October 7. This rainfall caused a very modest increase in stream flow at Spencer Street.

Prior to the rainfall event, fecal coliform concentrations in Onondaga Creek were similar to the value of the AWQS: 320 cfu/100mL at 08:25 on October 2 and 250 cfu/100 mL at 08:35 on October 2 (Figure 5c). The fecal coliform concentration increased to 128,000 cfu/100 mL at 09:05 on October 2 and reached a peak concentration of 188,000 at 10:05 (Figure 5c). Despite a rapid decrease from this peak, fecal coliform concentrations remained approximately 4,000 cfu/100 mL through 05:55 on October 5. The fecal coliform concentration decreased to 225 cfu/100 mL at 18:10 on October 5 but increased to 1,000-4,200 cfu/100 mL in the final three samples, which were collected during intermittent rainfall. Based on the available data, and assuming that the single low fecal coliform concentration of 225 cfu/100 mL on October 5 is representative, the recovery time for this event was 81 hours following the initial fecal coliform increase on October 2.

Approximately 8.2 million gallons of CSO volume was measured between October 2 and October 7 at metered CSOs discharging to Onondaga Creek (Figure 6). CSO volume was dominated by contributions from CSOs 020 and 021 (Figure 5e); however, CSOs 052, 066, and 075 also discharged during this runoff event. Note that measured flows from CSO 075 may be overstated according to the Jacobs memo dated May 16, 2019. As expected, the timing of these CSOs coincided with periods of the most intense rainfall. However, certain CSOs (020, 021, 052) triggered as the result of relatively modest rainfall intensity. The estimated CSO volume of 8.2 million gallons does not include additional contributions that may have been discharged from unmetered CSOs. SWMM simulations for modeled storms with rainfall intensities similar to the October 2-7, 2018 event suggest the potential for additional discharge from CSO 029.

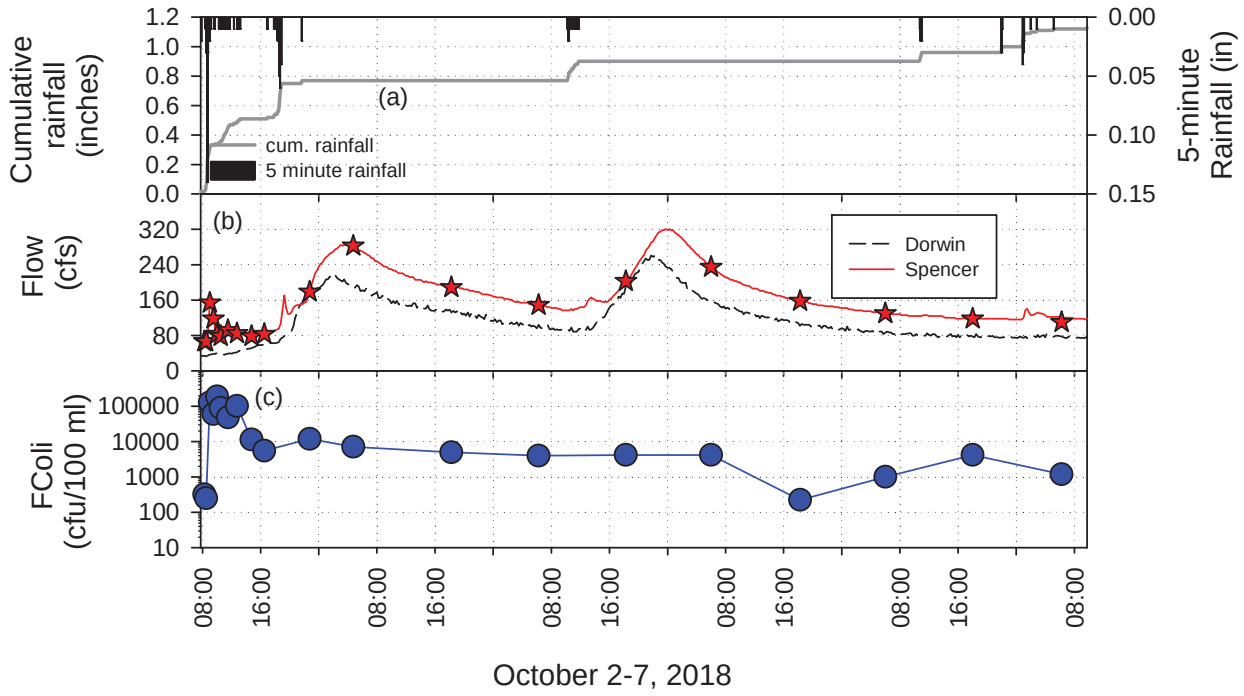

Figure 5. RTM results for Onondaga Creek, October 2-7, 2018: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data for Onondaga Creek at Dorwin Ave. and Spencer St. with sampling times indicated, (c) FCOLI results from Spencer St.

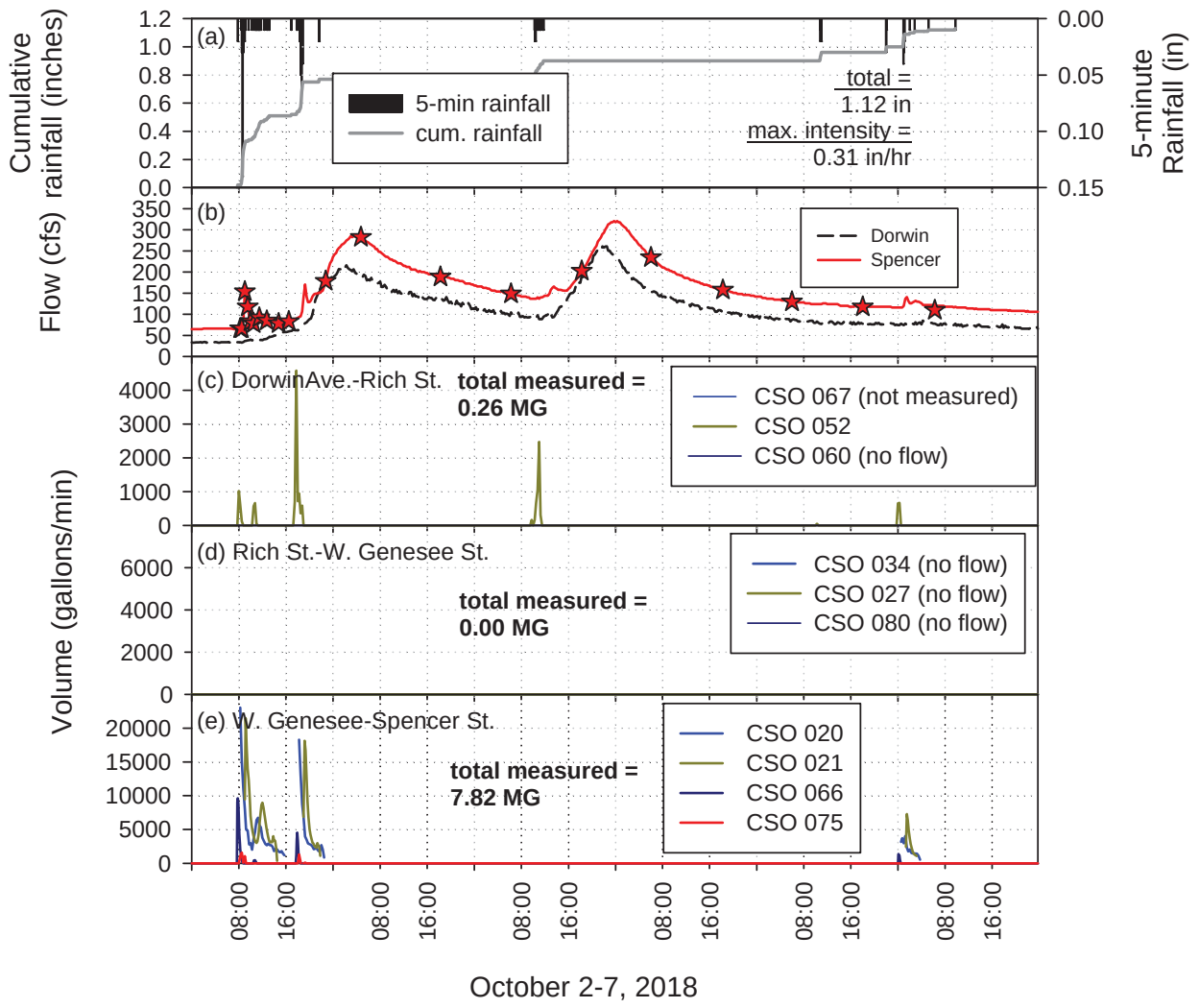

Figure 6. RTM results for Onondaga Creek, October 2-7, 2018: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data for Onondaga Creek at Dorwin Ave. and Spencer St. with sampling times indicated, (c) total measured CSO flow for the Dorwin Ave. to Rich St. reach, (d) total measured CSO flow for the Rich St. to W. Genesee St. reach, and (e) total measured CSO flow for the W. Genesee St. to mouth reach. Note that this is the total CSO flow as measured by *in-situ* flow monitoring devices only and is not equivalent to the total CSO flow for the event. Refer to Figure A-1 for locations of individual CSOs and creek reaches.

October 2-7, 2018 RTM Event – Harbor Brook

Recovery time monitoring was also initiated at the Culvert location on Harbor Brook on October 7 (Figure 7b). Sampling was conducted from 08:35 on October 2 through continued 06:10 on October 7. A total of 20 samples were collected for fecal coliform analysis over this five-day period. Rainfall began at 07:50 on October 2, and by 21:40 0.77 inches of rain was recorded at Metro (Figure 7a). Following a 36 hour dry period, an additional 0.13 inches of rain was recorded between 10:20 and 11:45 on October 4. These distinct intervals of rainfall resulted in multiple flow peaks at both Velasko Road and Hiawatha Blvd. (Figure 7b). Additional intermittent rainfall contributed a total of 0.23 inches between 10:45 on October 6 and 09:45 on October 7. This rainfall caused very modest increases in stream flow at both Velasko Road and Hiawatha Blvd.

Fecal coliform concentrations in the initial three samples collected from Harbor Brook on October 2 were similar to the value of the AWQS: 350 cfu/100mL at 08:20, 250 cfu/100 mL at 08:35, and 270 cfu/100 mL at 09:05 (Figure 5c). The fecal coliform concentration increased to 3,500 cfu/100 mL at 09:35 and reached a peak concentration of 49,000 at 11:35 (Figure 7c). Despite a rapid decrease from this peak, fecal coliform concentrations remained elevated (>700 cfu/100 mL) through 06:05 on October 5. The fecal coliform concentration decreased to 210 cfu/100 mL at 18:00 on October 5 but increased to 340-1,500 cfu/100 mL in the final three samples, which were collected during intermittent rainfall. Based on the available data, and assuming that the single low fecal coliform concentration of 210 cfu/100 mL on October 5 is representative, the recovery time for this event was 80 hours following the initial fecal coliform increase on October 2.

Zero CSO volume was measured between October 2 and October 7 at metered CSOs discharging to Harbor Brook (Figure 8). However, this does not include contributions from unmetered CSOs. SWMM simulations for modeled storms with rainfall intensities similar to the October 2-7, 2018 event indicate the potential for discharge from CSOs 005, 006, 007, 010, and 011. Based on the elevated fecal coliform concentrations measured during this event, it's likely that CSOs occurred.

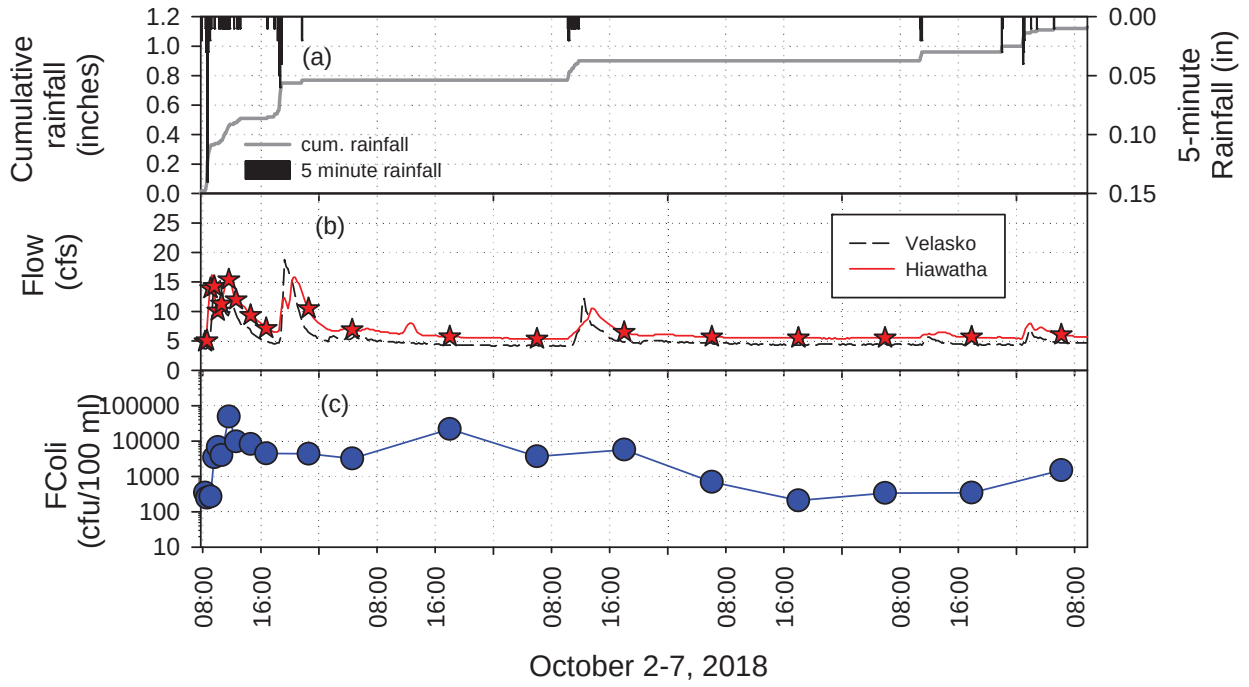

Figure 7. RTM results for Harbor Brook, October 2-7, 2018: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data for Harbor Brook at Velasko Rd. and Hiawatha Blvd. with sampling times indicated, (c) FCOLI results from Hiawatha Blvd.

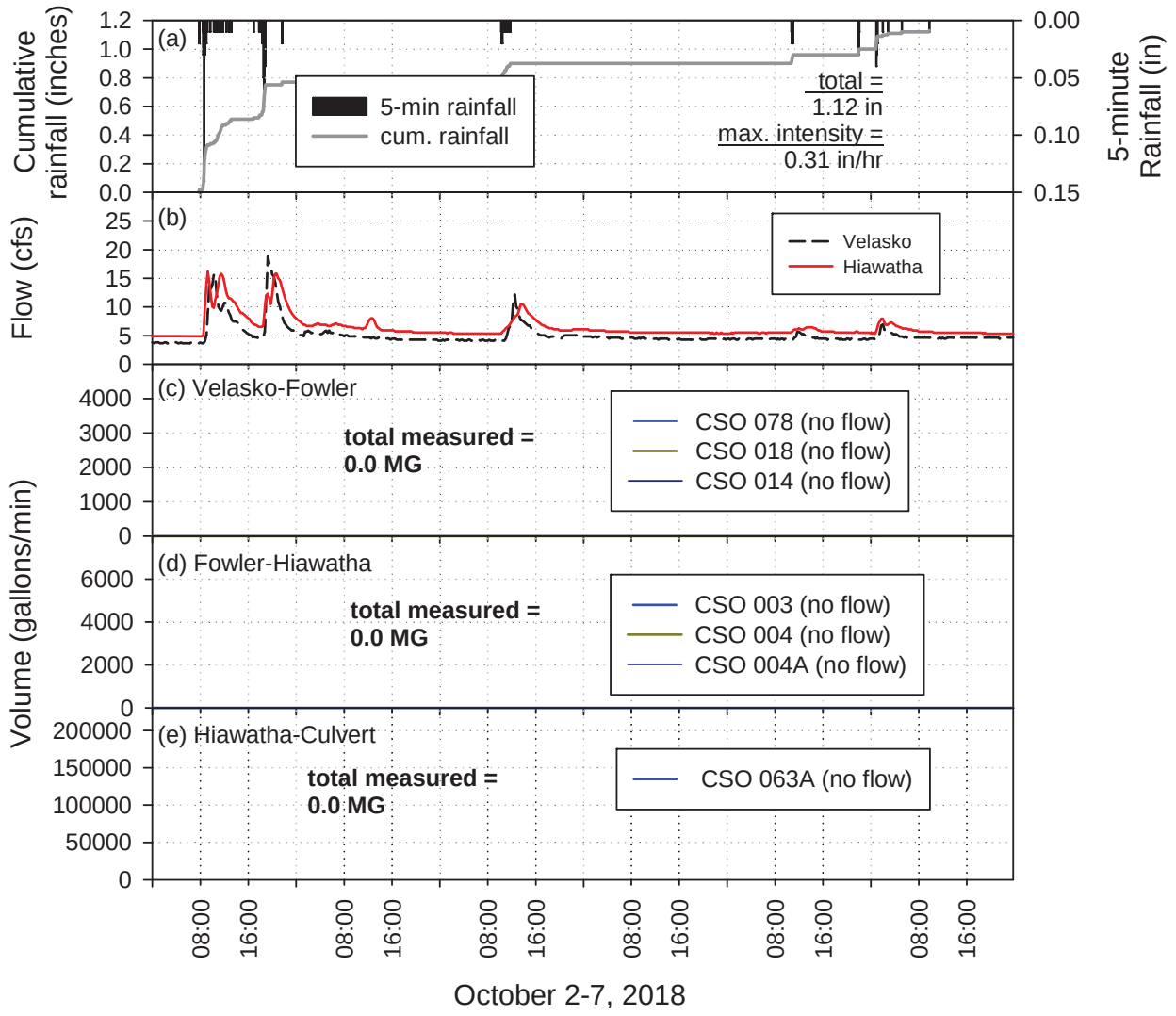

Figure 8. RTM results for Harbor Brook, October 2-7, 2018: (a) cumulative and five-minute rainfall from Metro, (b) 15-minute flow data from Harbor Brook at Velasko Rd. and Hiawatha Blvd, (c) total measured CSO flow for the Velasko Rd. to Fowler High School reach, (d) total measured CSO flow for the Fowler High School to Hiawatha Blvd. reach and (e) total measured CSO flow for the Hiawatha Blvd. to Culvert (near Onondaga Lake) reach. Note that this is the total CSO flow as measured by *in-situ* flow monitoring devices only and is not equivalent to the total CSO flow for the event. Refer to Figure A-2 for locations of individual CSOs and creek reaches.

Salient Findings from the 2018 Recovery Time Monitoring Events

- Two of the four recovery time monitoring (RTM) events initiated at the mouths of Onondaga Creek and Harbor Brook during 2018 produced useful results for estimating recovery times.
- There was a total of 0.61 inches of rainfall during the August 17-22 RTM event with a maximum intensity of 0.33 inches per hour.
- There was a total of 1.12 inches of rainfall during the October 2-7 RTM event with a maximum intensity of 0.31 inches per hour.
- Estimates of recovery times are complicated by the occurrence of multiple intervals of rainfall and multiple stream responses within a single event
- Estimated recovery times for the August 17-22 event were 59-72 hours for Onondaga Creek and 47-59 hours for Harbor Brook. However, fecal coliform concentrations did not return to levels consistent with the AWQS in either stream following this event.
- Estimated recovery times for the October 2-7 event were 81 hours for Onondaga Creek and 80 hours for Harbor Brook. These estimates were based on single sample results from both streams that indicated fecal coliform concentrations similar to the value of the AWQS (200 cfu/100 mL). Fecal coliform concentrations subsequently increased in both streams in response to intermittent rainfall.
- CSOs 020 and 021 contributed the majority of the metered CSO flow to Onondaga Creek during the August 17-22 and October 2-7 events. The following metered CSOs also triggered for at least one of the events: 052, 060, 027, 066, and 075.
- CSO 078 contributed measurable flow to Harbor Brook during the August 17-22 event. Zero CSO volume was measured during the October 2-7 event at metered CSOs discharging to Harbor Brook. However, it's likely that additional CSO volume was delivered to the stream via unmetered CSOs.

Appendix

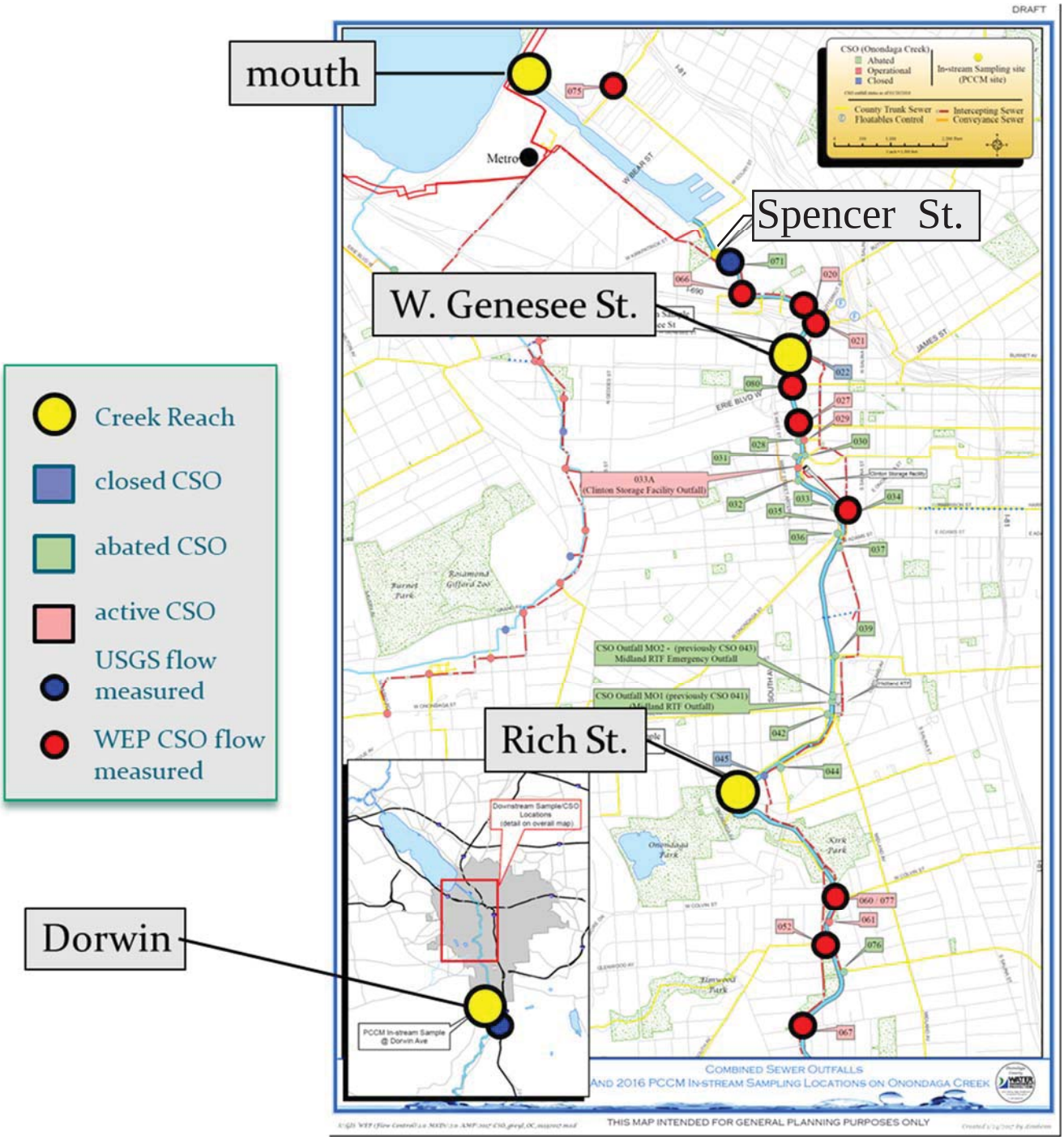

Figure A-1. Onondaga Creek site map with sampling locations and closed, active and abated CSO's identified. Recovery time monitoring occurred only occurred at Spencer St. in 2018.

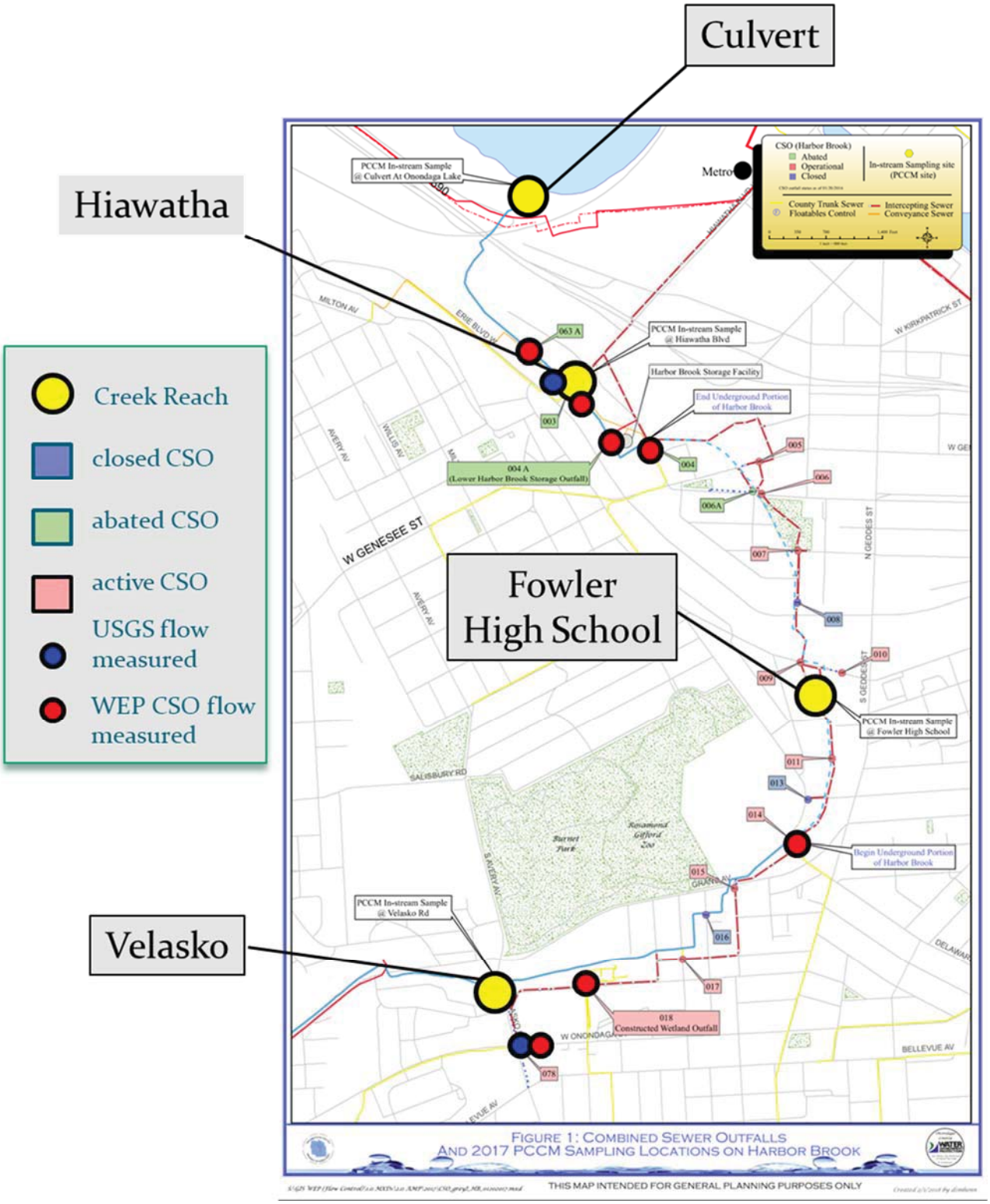

Figure A-2. Harbor Brook site map with sampling locations and closed, active and abated CSO's identified. Recovery time monitoring occurred only occurred at the Culvert in 2018.