Consultant Agreement P-2721
Baseline Water Quality Monitoring, Milwaukee River Watershed, Phase One

2020 Final Report

Prepared for:

MMSD
PARTNERS FOR A CLEANER ENVIRONMENT

Milwaukee Metropolitan Sewerage District
260 West Seeboth Street
Milwaukee, Wisconsin 53204- 1446

Prepared by:

GLEC
Great Lakes Environmental Center

Contact: Tyler Linton
238 Kusilek Street
River Falls, WI 54022
Cell: (715) 821-9540
E-mail: tlinton@glec.com

Draft Final Report Date:

March 31, 2020

Report Summary

This final report summarizes all the information collected and analyses performed for a phase one water quality monitoring project to produce baseline information in portions of the Milwaukee River watershed located in Ozaukee and Washington Counties. It is responsive to Milwaukee Metropolitan Sewerage District (MMSD) Consultant Agreement P-2721 and divided into the five main project elements: selection of monitoring sites, collection of stage and discharge measurements, collection of water samples and field measurements, development of site-specific rating curves and estimation of daily stream flow rates, and calculation of pollutant loads.

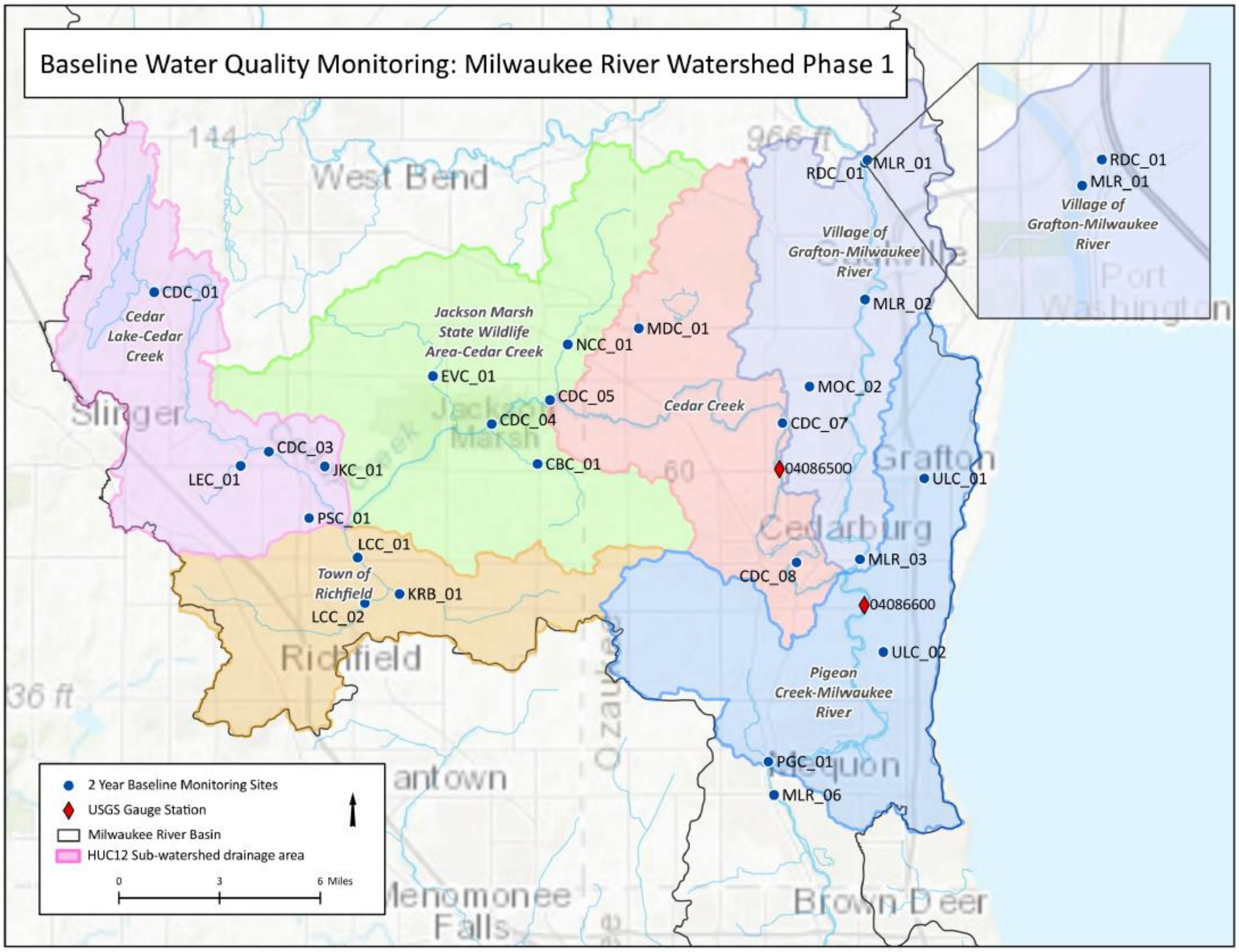
Background

The baseline information collected and summarized under this phase one project is intended to address areas within the Milwaukee River watershed where there is limited historical monitoring information. Several impairments have been identified as preventing achievement of water use objectives by surface waterbodies in the Milwaukee River watershed. These impairments include degraded biological communities, degraded habitat, elevated water temperatures, low concentrations of dissolved oxygen (DO), recreational use restrictions, and water quality use restrictions. The impairments are all related to one or more of the following pollutants: sediment, total suspended solids (TSS), total phosphorus (TP), and fecal indicator bacteria (fecal coliform, or FC and *Escherichia coli*, or *E. coli*), and several stream reaches within the watershed are impacted by one or more of these impairments.

Objective

The objective of the project was to collect surface water quality data (TSS, TP, FC, *E. coli*, DO, pH, specific conductance, water temperature and turbidity) and continuous stage and discharge measurements[1] at 25 sites representative of portions of the Milwaukee River watershed located in Ozaukee and Washington Counties where monitoring information is lacking (see map insert below). These data and this baseline monitoring report will be used to determine the representative state of surface water quality in the area at present and serve as a baseline to evaluate whether water quality in these relatively uncharacterized portions of the watershed changes over time. The MMSD intends to provide the data to municipalities and organizations to aid water quality management efforts. Ultimately, the goal is to track progress toward delisting specific stream reaches for water quality impairments from the Wisconsin Department of Natural Resources' 303(d) list.

[1] Note that for this report, the word convention "discharge" is used when referring to a measurement and "flow" as a more generic description of moving water.



Scope and Approach

The contract scope of work included design, installation, sample collection, analysis, and data reporting, and summary of a two-plus-year water quality sampling and discharge monitoring for baseline data. Pre-proposed sites were visited and either confirmed or re-located to include 25 representative sites in the project focus area (in portions of the Milwaukee River watershed located in Ozaukee and Washington Counties). Continuous monitoring stream stage equipment was installed at approved locations. Monthly water samples (grab) were collected, *in situ* measurements taken, and stage and discharge measured at the 25 sites September through November 2017, and March through November 2018 and 2019, as flow conditions allowed (N=525 total possible measurements). Water samples were collected and *in situ* measurements were also taken at four of the 25 sites seven times during wet weather events (N=28 total possible measurements). In this report, water samples collected on a monthly basis are referred to as "scheduled" monitoring samples, while water samples collected during wet weather, high-flow events are referred to as "high-flow" monitoring samples. All water samples were analyzed for TSS, TP, FC, *E. coli* and the analyte[2], *in situ*, and stage and discharge data compiled and reduced to calculate pollutant loads of each analyte at all 25 sites throughout the two-plus-year period. The total number of water samples collected was 577 out of 578 possible. Percent completion of valid, quantified concentrations of TSS, TP, FC and *E. coli* achieved during scheduled sampling was: 99.6, 99.8, 98.7, and 97.1, respectively. Due to an extra sample being taken in October of 2019, the percent completion of valid, quantified analyte concentrations achieved during high-flow sampling was >100. The total number of stream flow rate (discharge) measurements taken and recorded was 475 out of 525 possible (excluding the months of December through February 2017, 2018, and 2019), for a percent completion achieved of 90.5.

Results

Review of the data compiled and analyses performed under this project revealed the following broad trends. The trends are relevant to understanding the representative state of surface water quality management efforts in portions of Ozaukee and Washington Counties lacking sufficient monitoring information. The data collection efforts revealed:

Water Quality Data:

- A strong seasonal pattern of elevated values during summer (July, August, September) exists at all sites for FC and *E. coli*, and to a lesser degree TSS followed by TP; high flow (wet weather and seasonal) is a strong determinant of elevated FC and *E. coli* at all sites;
- Variability in TSS and TP concentrations amongst tributary versus mainstem is similar, but greater in tributary sites for FC and *E. coli* concentrations compared to mainstem sites;
- The highest wet weather maximum concentrations were generally observed at: CDC03, CDC05, MLR06b and LCC01. These were the sites where wet weather sampling was conducted in addition to routine monthly sampling. It should be noted however, that by chance some routine monitoring took place during wet weather;
- With the exception of turbidity and specific conductance, overall variability in the physical chemical parameters measured within tributary versus mainstem sites is equivalent; wet weather, high-flow events do not appear to strongly affect maximum physical chemical values.

Stream Discharge and Pollutant Loadings:

- 2018 and 2019 were "wet" years, especially in the fall. In September-November 2018 the daily Milwaukee River discharge exceeded the 90th percentile daily flow 42 times, exceeded the 95th percentile daily flow 32 times, and exceeded the maximum recoded daily flow on 15 days (data going back to 1981). In 2019, the September-November daily Milwaukee River flow rates were higher: discharge exceeded the 90th percentile daily

[2] The term "analyte" is used in the report to distinguish a substance whose chemical constituents are analytically-quantified in the laboratory (i.e., TSS, TP, FC and *E. coli*) versus other water quality parameters measured *in situ* in the field (DO, pH, specific conductance, water temperature and turbidity).

flow 76 times, exceeded the 95^{th} percentile daily flow 49 times, and exceeded the maximum recoded daily flow on 24 days. The USGS also reported exceptionally high discharges at the Cedar Creek gauge in the fall of 2018 and especially 2019. 2019 was the wettest year ever across Wisconsin and the Midwest since record keeping began in 1895;

- The instantaneous (measured) pollutant loadings from minor tributaries were relatively small compared to sites along the mainstem of Cedar Creek and the Milwaukee River;
- On Cedar Creek, the instantaneous TSS loadings increased from the upper reaches (CDC01b and CDC03) to the middle reach (CDC04b and CDC05) commensurate with increased stream flow. In the lower river reaches (CDC07b and CDC08c), TSS loadings generally fell in between the upper and middle reach values. Instantaneous TP loadings on Cedar Creek also increased from the sites on the upper reaches to the middle reach. However, TP loadings in the middle and lower reaches were generally comparable. For both FC and *E. coli* the instantaneous loadings in the upper reaches increased from CDC01b to CDC03, and also increased from the upper reaches to middle and lower reaches. In the middle and lower reaches the spatial trends in FC and *E. coli* loading was less consistent;
- On the Milwaukee River, the instantaneous TSS and TP loadings exhibit more seasonal than spatial trends, with the highest loadings in spring and fall. In general, the TSS and TP loadings on the Milwaukee River are much higher compared to all other sites. For FC and *E. coli* instantaneous loadings on the Milwaukee River, there is also more of a seasonal than spatial trend;
- Pollutant loadings increased substantially during wet weather. This is not unexpected, given the proportionality between stream discharge (flow rate) and loading. However, the loading increases during wet weather were often greater than the increase in discharge;
- Mean daily pollutant mass loadings were estimated on an annual basis for the 2017-2019 project period using the flow-stratified Beale's Ratio Estimator (BRE);
- Mean daily annual loadings of the four pollutants display fairly consistent patterns in terms of the loading variations between sites and years. The loadings were generally higher in 2018 and 2019 compared to 2017, consistent with the trends in annual discharge;
- In terms of the magnitude of pollutant loadings, the monitoring sites fall into three groups: Cedar Creek, Milwaukee River, and the other "minor" tributaries, which is expected given the drainage area and the corresponding flow contributions at each site.

<u>Pollutant Yields</u>:

- The mean daily annual loadings were normalized by the drainage areas contributing to each site to produce pollutant yields;
- Unlike pollutant loadings, the pollutant yields do not suggest that the sites fall into any grouping by water body (e.g., Cedar Creek, Milwaukee River);
- For TSS and TP, pollutant yields were lower in 2017 than in 2018 or 2019, except at ULC02 where the TSS yields were about equal;

- TSS pollutant yields mostly fell in the range of 1-10 $kg/km^2/d$. TSS pollutant yields were an order of magnitude higher than this range at site CDC03, and were at the lower end of this range at CDC01b and MDC01;
- Pollutant yields for TP mostly fell in the range of 0.01-0.1 $kg/km^2/d$. TP pollutant yields were order-of-magnitude higher than this range at site CDC03 and RDC01 (in 2018 and 2019). TP pollutant yields were at the lower end of this range at CDC01b and MDC01;
- For FC and *E. coli*, there were no consistent trends in pollutant yields from one year to another; and
- Pollutant yields for *E. coli* mostly fell in the range of 10^9-10^{10} $MPN/km^2/d$. *E. coli* pollutant yields were again an order-of-magnitude higher than this range at site CDC03 and NCC01b. *E. coli* pollutant yields were at the lower end of this range at CDC01b and MDC01.

Recommendations and Value Added by Project

For the microbial pollutants (FC and *E. coli*) additional insight regarding sources of water quality impairment may be gained by using this monitoring data to construct concentration-duration and load-duration curves for each site.

Normalization of pollutant loads by drainage area allows for identification of most prominent contributing sources, and thus, opportunities for mitigation through implementation and of best management practices and continued monitoring, including biological parameters such as stream diatom community[3].

[3] In 2006, after evaluation and consideration of other indices, the Wisconsin Department of Natural Resources (DNR) decided to develop a new method that is specific to phosphorus and calibrated to Wisconsin diatom data, herein referred to as the Diatom Phosphorus Index (DPI) – see Water Quality Standards Rule Packages Technical Support Document (dated 3 June 2016; DNR 2016). The DPI can be used to determine whether the diatom community at an assessment site resembles the community that is typically found at sites meeting the stream total phosphorus (TP) criterion. The TP criterion is based on breakpoints in the relationships between TP and diatom (and other biological) metrics. The TP criterion represents the level of TP where the diatom community changes the most. As such, it is believed that the DPI may actually be a more accurate reflection of prevailing phosphorus conditions than direct stream TP measurements.

Table of Contents

List of Tables

List of Figures

Consultant Agreement P-2721
Baseline Water Quality Monitoring, Milwaukee River Watershed, Phase One
Final Report

Background

This phase one water quality monitoring project was initiated to produce baseline information in portions of the Milwaukee River watersheds located in Ozaukee and Washington Counties. The baseline information is designed to assist in stormwater management planning for capital and water quality improvement projects within the watershed. The project was intended to address areas within the watershed where there is limited historical monitoring information within the boundaries of the Milwaukee River. The Total Maximum Daily Loads (TMDL) report addresses several impairments preventing achievement of water use objectives by surface waterbodies in the Milwaukee River watershed. These impairments include degraded biological communities, degraded habitat, elevated water temperatures, low concentrations of dissolved oxygen (DO), recreational use restrictions, and water quality use restrictions. These impairments are all related to one or more of the following pollutants: sediment, total suspended solids (TSS), total phosphorus (TP), and fecal indicator bacteria (fecal coliform, or FC and *Escherichia coli*, or *E. coli*). Several stream reaches within the watershed are impacted by one or more of these impairments.

Objective

The objective of the project was to collect surface water quality data (TSS, TP, FC, *E. coli*, DO, pH, specific conductance, water temperature and turbidity) and continuous stage and discharge measurements at several sites representative of portions of the Milwaukee River watersheds located in Ozaukee and Washington Counties. These data and the baseline report will be used to determine the *representative state* of surface water quality in the area at present and serve as a baseline to evaluate whether water quality in these relatively uncharacterized portions of the watershed changes over time. The Milwaukee Metropolitan Sewerage District (MMSD, hereafter referred to as the District) intends to provide the data to municipalities and organizations to aid their water quality management efforts. Ultimately, the goal is to aid watershed stakeholders in tracking incremental progress toward delisting focus area stream reaches for water quality impairments from the Wisconsin Department of Natural Resources' 303(d) list.

The project involved the following elements:

A. Selection of monitoring sites,
B. Collection of stage and discharge measurements,
C. Collection of water samples and field measurements,
D. Development of site-specific rating curves and estimation of daily discharge rates, and
E. Calculation of pollutant loads.

This final report summarizes all the information collected and analyses performed according to Consultant Agreement P-2721.

Technical Approach to Project and Methods

Activity on the project commenced formally on 2 August 2017 (designated contract start date) when the District and contractor (Great Lakes Environmental Center, Inc., or GLEC) project management staff held an initial *Notice to Proceed* kick-off meeting to review the project contract and initial activities and deliverables due in 2017. The kick-off meeting included video conference and in-person attendance.

Prior to the *Notice to Proceed* kick-off meeting, GLEC delivered an equipment purchase list with justifications for certain models and manufacturers (deliverable 1a) and a list of standard operating procedures (SOPs) to fulfill contract deliverables (deliverable 1b) to the District project manager (PM). The SOPs include procedures for taking stage and discharge measurements; sampling and field measurements; and sample collection, storage, handling, and delivery methods. The SOPs also include basic safety, quality assurance, and data management procedures. Drafts of the following six project-specific GLEC SOPs were delivered to the District PM on 14 August 2017 for initial review and comment:

- SOP FLD 6033 Determination of Turbidity by Nephelometry.pdf;
- SOP FLD 6034 Measuring Velocity and Discharge with an OTT MF Pro Flow Meter.pdf;
- SOP FLD 6035 Use of the YSI® Professional Plus Multiparameter Meter.pdf;
- SOP FLD 6036 Use of Solinst® Levelogger Series data loggers.pdf;
- SOP FLD 6037 Determining Wet Weather Events.pdf; and
- SOP FLD 6038 Field Sampling for Milwaukee Metropolitan Sewerage District (MMSD).pdf.

The draft SOPs were reviewed and implemented during the September 2017 preliminary sampling event for evaluation of clarity and utility in the field. The District also shared the initial draft SOPs with the Wisconsin Department of Natural Resources (DNR - Craig Helker) on 16 August 2017 for review and comment and provided their own comments and feedback for GLEC consideration on 21 August 2017. Draft SOPs were revised and updated as comments were received and discussed. Final GLEC signed (and the District and DNR-approved) SOPs were completed and archived at GLEC between 10 October and 14 November 2017. SOPs FLD 6033, 6035, 6036, and 6037 were formally updated and re-approved 14 November 2018.

For the purpose of implementation and reporting, this project was partitioned into the project tasks listed below. The description under each task includes a brief summary of the technical approach used to achieve the goals of the tasks. Final results are summarized in tables, figures, and appendices within this report.

<u>A. Select monitoring sites</u>

GLEC collected *in situ* water quality data (DO, pH, specific conductance, water temperature and turbidity) and ambient surface samples for quantitation of TSS, TP, FC, and *E. coli* at 25 sites within the Milwaukee River watershed Phase 1 area in Washington and Ozaukee Counties, specifically Cedar Creek 04000030301-304, Pigeon and Ulao Creeks 040400030604, and Mole Creek 040400030603 sub-watersheds, differentiated by twelve-digit Hydraulic Unit Codes, or HUC12s).

Thirty (30) sampling sites were initially identified in a Southeastern Wisconsin Regional Planning Commission (SEWRPC) Letter Report "*Milwaukee River Watershed Monitoring Plan: Phase 1*" based on the project's monitoring objectives. Experienced GLEC field staff conducted field reconnaissance of all 30 SEWRPC sites from 14-16 August 2017, and prepared and submitted (on 24 August 2017) a memorandum recommending the final 25 sites where surface water discharge monitoring and sample collection occurred through November 2019 (project deliverable 2a). The final decision for site selection was based on safety, accessibility, and other considerations regarding continuous data logging sensor deployment and capture of representative samples.

Appendix A provides a table with sample site codes, location descriptions, latitudinal and longitudinal coordinates, and other relevant notations and site descriptors (see also the map inserted in the *Executive Summary* for a graphical depiction of the site locations). Each site included a fixed post with housings to attach data logging sensors for continuous recording of water pressure during the project. The continuous data logging sensors were used to measure water level (stage) and for estimating stream discharge (flow rate) at each site, as described below. The posts also served as markers where water samples and *in situ* water quality and stream discharge measurements were collected and taken. One fixed sample site (MLR03c) was relocated to MLR03d in March 2018 (i.e., start of the 2018 monitoring season) due to the inability of field staff to consistently collect representative samples during naturally-occurring high stream stage and flow. The marker posts at four additional sites were slightly adjusted from original stream coordinates to improve sample and data collection under the ambient flow conditions encountered fall 2017 and spring 2018 (e.g., CDC07b, ULC02), or because of other issues occurring during the 2018 sampling season (e.g., CDC08c, RDC01) – see details provided under notations in **Appendix A**.

B. Collect stage and discharge measurements

Having identified up to 25 sites (approved by the District) for surface water discharge monitoring and water sample collection and *in situ* measurement, continuous in-stream monitoring sensors (Solinst® Leveloggers[4]) were installed at each site to measure stream stage (water level) during ice-off conditions (March-November). Monthly stream discharge (flow rate) was directly measured using flow meters (OTT® MF Pro) and used together with the stage data to develop rating curves of stage versus discharge, as presented in Section D below. In 2017, field staff collected stage and discharge measurements three times from September through November, and in 2018 and 2019, up to eight times each year from March through November – safe levels and conditions allowing (see **Table 1** below for summary statics of measured stream discharge and

[4] Continuous measurements of water level were made using Solinst® Levelogger Edge M5 self-contained water level dataloggers, deployed at each location (5 meter absolute range, ± 3 mm accuracy). A second instrument (Barologger) was used to measure barometric pressure compensation in the local area (approximately a 20 mile / 30 km radius). Recording frequency of measurement was set to every 10 minutes during the time of deployment (21 months; September to November 2017, and March through November 2018 and 2019). The deployment of Leveloggers at each site allowed for unattended collection of near-real time water level (stage), the development of site-specific rating curves, and estimation of daily discharge rates at each site.

Appendix B for graphical presentation of stream flow rate measurements taken in Cedar Creek and Milwaukee River mainstem and tributary sites by HUC 12 watershed).

Table 1. Summary statistics for stream discharge measured on Cedar Creek and the Milwaukee River mainstem and tributary sites. See site map inserted in the Executive Summary for a graphical depiction of locations.

			Stream flow (cfs)					
HUC	Site	Site Description	Median	Min	10th P	90th P	Max	N
040400030301	LCC02	Little Cedar Cr. at Pioneer Rd. near intersection with Rocky Lane	10.5	2.2	4.6	25.7	36.4	18
040400030301	LCC01	Little Cedar Cr. at Western Ave.	7.0	1.9	3.3	15.4	17.3	19
040400030301	KRB01b	Kressin Br. at CTH G	4.3	0.4	1.0	20.5	22.0	18
040400030302	CDC01b	Cedar Cr. at CTH NN	7.0	0.9	2.4	24.8	39.8	20
040400030302	CDC03	Cedar Cr. downstream of Mayfield R.	18.8	5.0	10.0	33.8	78.3	19
040400030302	LEC01b	Lehner Cr. Upstream from STH 60	3.4	2.0	2.1	4.6	6.3	20
040400030302	PSC01	Polk Springs Cr. At CTH P	2.7	0.6	1.3	7.2	11.0	20
040400030302	JKC01	Jackson Cr. downstream of STH 60	1.2	0.0	0.1	2.5	6.1	20
040400030303	CDC04b	Cedar Cr. at S. Church Rd.	45.4	11.2	21.4	81.1	152.8	17
040400030303	CDC05	Cedar Cr. at CTH M	45.2	11.1	21.1	127.4	170.4	19
040400030303	CBC01	Cedarburg Cr. downstream of CTH M	2.7	0.0	0.2	14.2	20.8	20
040400030303	EVC01	Evergreen Cr. downstream of Pleasant Valley Dr.	1.5	0.0	0.5	7.8	19.5	20
040400030303	NCC01b	N. Branch of Cedar Cr. upstream of CTH NN	5.0	0.4	0.8	21.8	36.5	20
040400030304	CDC07b	Cedar Cr. at STH 60	65.6	12.6	29.8	184.8	256.7	19
040400030304	CDC08c	Cedar Cr. at Green Bay Rd.	67.1	12.3	26.0	160.4	242.1	18
040400030304	MDC01	Mud Creek south of Cedar Sauk Rd.	6.9	0.1	1.0	23.0	33.5	20
040400030603	MLR01	Milwaukee R. downstream of Riverside Dr. at Evergreen Ln.	280.0	63.8	127.9	623.0	776.3	20
040400030603	MLR02	Milwaukee R. downstream of Saukville WWTP	236.0	65.6	112.4	301.5	385.1	17
040400030603	MLR03c-d[A]	Milwaukee R. at HWY T	305.6	84.0	129.8	705.5	902.6	17
040400030603	RDC01	Riverside Drive Cr. at Evergreen Ln.	1.5	0.0	0.3	5.7	11.2	20
040400030603	MOC02	Mole Cr. at Maple Rd.	4.9	0.5	1.5	16.4	25.6	20
040400030604	MLR06b	Milwaukee R. at STH 167	339.2	68.6	173.7	468.2	533.3	17
040400030604	ULC01	Ulao Cr. at STH 60 east of I-43	2.3	0.0	0.2	14.2	17.3	20
040400030604	ULC02	Ulao Cr. at Bonniwell Rd.	5.7	0.0	0.8	23.2	42.1	18
040400030604	PGC01c	Pigeon Cr. at pedestrian footbridge upstream of Green Bay Rd.	5.3	0.8	1.2	21.9	29.9	18

[A] Per the text above, one fixed sample site (MLR03c) was relocated in March 2018 (i.e., start of the 2018 monitoring season) due to the inability of field staff to consistently collect representative samples during naturally-occurring high stream stage and flow. The site was renamed to MLR03c-d and reflects combined data collected at both MLR03c and MLR03d.

The summary statistics provided for measured[5] discharge (stream flow) rates in **Table 1** show:

1) Measured median discharges ranging from 1.2 (JKC01) to 10.5 cfs (LCC02) for tributaries to Cedar Creek and from 1.5 (EVC01 and RDC01) to 5.7 (ULC02) cfs for tributaries to the Milwaukee River;
2) Measured median discharges ranging from 7.0 cfs at the headwaters of Cedar Creek (CDC01b) to 67.1 cfs on Cedar Creek near the confluence with the Milwaukee River (CDC08c);
3) Measured median discharges ranging from 280.0 cfs at the northernmost Milwaukee River site (MLR01) to 339.2 cfs at the southernmost site (MLR06b);
4) Measured maximum discharges ranging from 6.1 (JKC01) to 36.5 (NCC01b) cfs for tributaries to Cedar Creek and from 11.2 (RDC01) to 29.9 (PGC01c) cfs for tributaries to the Milwaukee River; and

[5] Note: Values represent those that could be measured safely by wading with a flow meter over the course of the project. In several instances, particularly on the Milwaukee River, flow could not safely be measured due to dangerous high flow conditions or other safety concerns (ice).

5) Measured maximum discharges ranging from 39.8 (CDC01b) to 256.7 (CDC07b) cfs for sites on Cedar Creek and from 385.1 (MLR02) to 902.6 (MLR03c-d) cfs for sites on the Milwaukee River.

Raw and corrected stream discharge data for September – November 2017 and March – November 2018 and 2019 were provided to the District in the form of a Microsoft Excel® spreadsheet file. It was not possible to take and record stream discharge measurements January – February 2018 and 2019 due to winter, ice-on conditions. Additionally, over the course of the 2018 and 2019 monitoring seasons (March -November), it was not possible to take and record stream discharge measurements at several sites during collection of water samples and field measurements due to unsafe flow conditions affecting personal safety, although several sites were re-visited for stream discharge measurement at earlier or later dates to fulfill contract requirements.

The total number of stream discharge measurements taken and recorded was 475 out of 525 possible (excluding the months of December through February 2017, 2018, and 2019), for a percent completion achieved of 90.5.

C. Collect water samples and field measurements

Surface water samples were collected at all 25 sites, approximately every 30 days, for nine months of the year (March through November), when ice conditions and stream flow allowed. Water samples were analyzed by the District for TP, TSS, FC, and *E. coli*. During water sample collection, field staff also recorded *in situ* field measurements for water temperature, DO, specific conductance, pH, and turbidity. In 2017, water samples were collected and *in situ* measurements recorded at all 25 sites in September, October and November. In 2018 and 2019, water samples were collected and *in situ* measurements recorded monthly from March through November, with only a single exception. The total number of water (grab) samples collected was 577 out of 578 possible. Percent completion of valid, quantified concentrations of TSS, TP, FC, and *E. coli* achieved during scheduled monitoring was: 99.6, 99.8, 98.7, and 97.1. Due to an extra sample being taken in October of 2019, the percent completion of valid, quantified analyte concentrations achieved during high-flow monitoring was >100. **Figures 1 through 6** show the TP, TSS, FC and *E. coli* concentrations measured during scheduled monitoring at each site for the project, according to HUC 12 watershed. Overlaid in the figures for CDC03, CDC05, MLR06b, and LCC01 are TP, TSS, FC and *E. coli* concentrations measured during high-flow monitoring sampled once in 2017 (11 October), three times in 2018 (3 May, 29 August, 20 September), and four times in 2019 (23 April, 28 May, 12 September, 2 October – see also **Appendix C.1 and C.2** for individual site data by sample date). High flow conditions, as defined in GLEC SOP FLD 6037 (*Determining Wet Weather Events*), were developed specifically for the project. **Tables 2 and 3** provide summary statistics for TSS, TP, FC, and *E. coli*, by site. **Table 2** provides summary statistics for all Cedar Creek and Milwaukee River Mainstem sites. **Table 3** provides summary statistics for all tributary sites. **Appendix D** provides the same information in graphical form according to HUC 12 watershed.

The following "general" observations regarding monthly analytical results for TP, TSS, FC, and *E. coli* are made:

- A strong seasonal pattern of elevated values during summer (July, August, September) exists at all sites for FC and *E. coli*, and to a lesser degree TSS followed by TP (See **Figures 1-6**);
- High flow (wet weather and seasonal) is a strong determinant of elevated FC and *E. coli* at all sites;
- Variability (as indicated by the average ratio of maximum to minimum values) in TSS and TP concentrations amongst tributary versus mainstem (Cedar Creek and Milwaukee River) is similar, but greater in tributary sites for FC and *E. coli* concentrations compared to mainstem sites by 2.8 and 3.9 times, respectively;

- Range of maximum values amongst tributary versus mainstem sites is:
  - TSS:
    - Tributary sites – 14 to 250 mg/L,
    - Mainstem sites – 8.7 to 260 mg/L,
  - TP:
    - Tributary sites – 0.049 to 0.900 mg/L,
    - Mainstem sites – 0.023 to 0.610 mg/L,
  - FC:
    - Tributary sites – 2,100 to >60,000 CFU/100 ml,
    - Mainstem sites – 1,100 to 73,000 CFU/100 ml,
  - *E. coli*:
    - Tributary sites – 930 to 98,000 MPN/100 ml,
    - Mainstem sites – 1,085 to 13,000 MPN/100 ml,
- Tributary and mainstem sites with higher or much higher than average maximum values are:
  - TSS:
    - Tributary sites – LCC01, ULC01 and ULC02,
    - Mainstem sites – CDC05 and MLR06b,
  - TP:
    - Tributary sites – LCC01, NCC01b, RDC01 and ULC01,
    - Mainstem sites – MLR06b,
  - FC:
    - Tributary sites – JKC01 and NCC01b,
    - Mainstem sites – CDC05 and MLR06b,
  - *E. coli*:
    - Tributary sites – LCC01 and NCC01b,
    - Mainstem sites – CDC03, CDC05, MLR01 and MLR06b.

- The highest wet weather maximum values were generally observed at: CDC03, CDC05, MLR06b and LCC01. These were the sites where high-flow monitoring was conducted in addition to routine scheduled monitoring. It should be noted however, that some routine monitoring took place during high flow by chance;

- The correlations between TSS and TP concentrations measured in samples collected concurrently varied by site from weak (e.g., $R^2 = 0.1$ at CDC03 to 0.15 at CDC05) to moderate (R^2 = 0.4 at LCC01) to strong (R^2 = 0.9 at MLR06); and

- The correlations between FC and *E. coli* concentrations measured concurrently were consistently strong at most sites (e.g., R^2 =0.7 to >0.95).

Appendix E provides summary statistics for water temperature, DO, specific conductance, pH, and turbidity, by site. The following observations are made:

- With the exception of turbidity and specific conductance, overall variability (again, as indicated by the average ratio of maximum to minimum values) in the physical chemical parameters measured within tributary versus mainstem sites is equivalent;
- Average maximum turbidity at tributary sites is 33 NTU (27.8 NTU excluding LCC01), whereas it is 20 NTU at mainstem sites;
- Specific conductance amongst tributary sites is higher than mainstem sites with maximum specific conductance at 7 of 15 tributary sites exceeding 1,000 µS/cm;
- Maximum temperatures are slightly higher in mainstem sites compared to tributary sites where maximum temperatures at CDC01b, MLR03c-d, and MLR06b all exceed 25°C whereas maximum temperature only exceeds 25°C at JKC01;
- Minimum DO concentrations less than 2.0 mg/L occurred at three tributary sites (LCC01, MDC01, and ULC02), but only one mainstem site (CDC05);
- Maximum DO concentrations (indicative of super-saturation) exceed 15 mg/L at most sites (mainstem and tributary);
- Maximum pH does not exceed 9 at any site; and
- With the possible exception of turbidity at MLR06b, wet weather high-flow events do not appear to strongly affect maximum values.

Raw and corrected analytical data for TP, TSS, FC, and *E. coli* monthly samples collected September – November 2017 and March – November 2018 and 2019 were provided to the District in the form of a Microsoft Excel® spreadsheet file. Data correction included averaging (arithmetic) field duplicates and use of replacement values for censored data (i.e., values equal to one half the detection limit). Included with the analytical results were the recorded *in situ* measurements taken at each site during the same time. Detailed field notes and pictures from each site visit are organized and provided as separate deliverables.

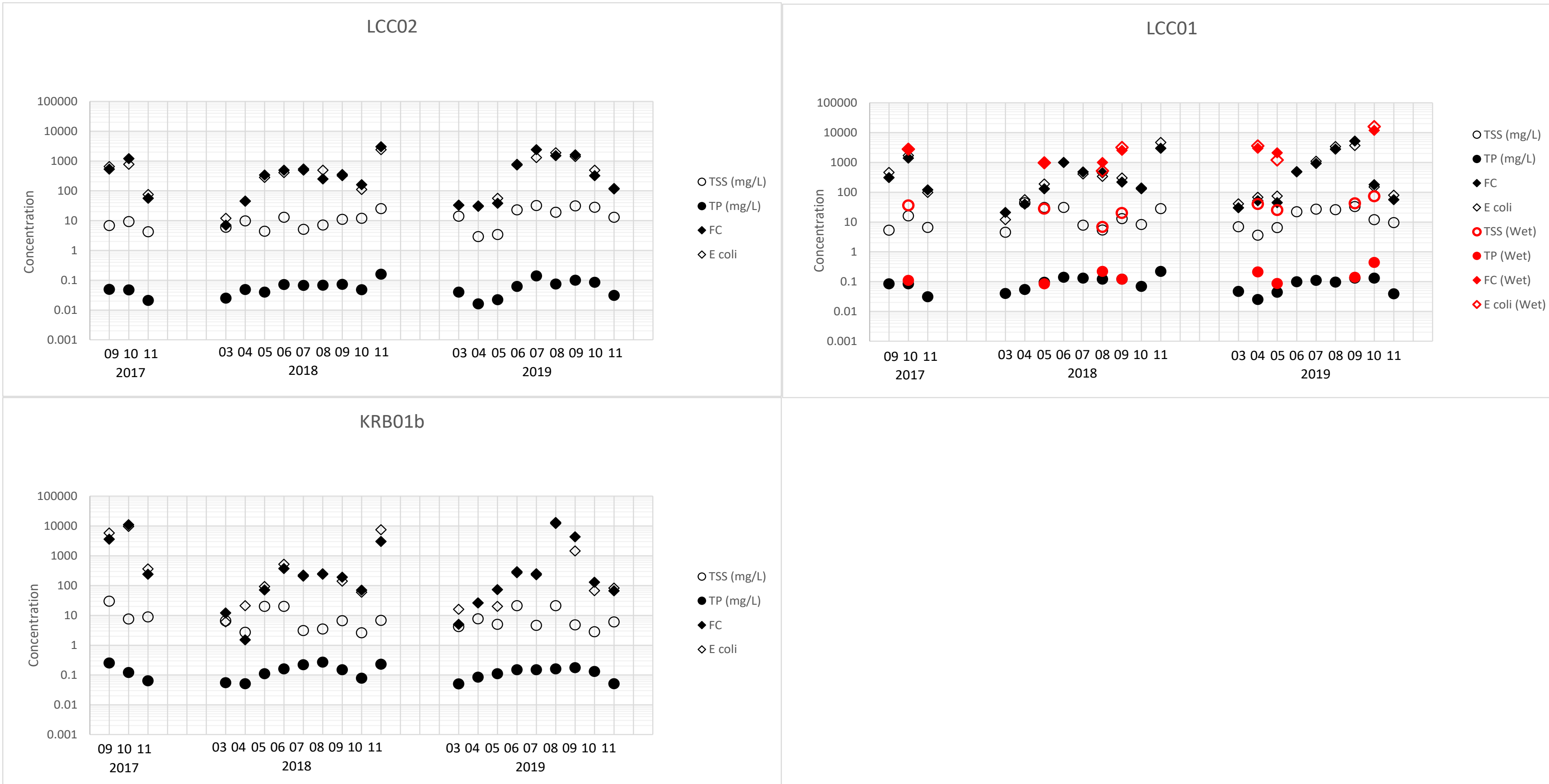


Figure 1. TP, TSS, FC and *E. coli* concentrations measured on tributaries to Cedar Creek in HUC 12 watershed 040400030301 (sites LCC02, LCC01, and KRB01b) for the project (September – November 2017 and March - November 2018 and 2019).

Overlaid in the figure displaying data for LCC01 are TP, TSS, FC and *E. coli* concentrations measured during high-discharge, wet weather (storm) events sampled once in 2017 (October), three times in 2018 (May, August, September) and four times in 2019 (April, May, September and October).

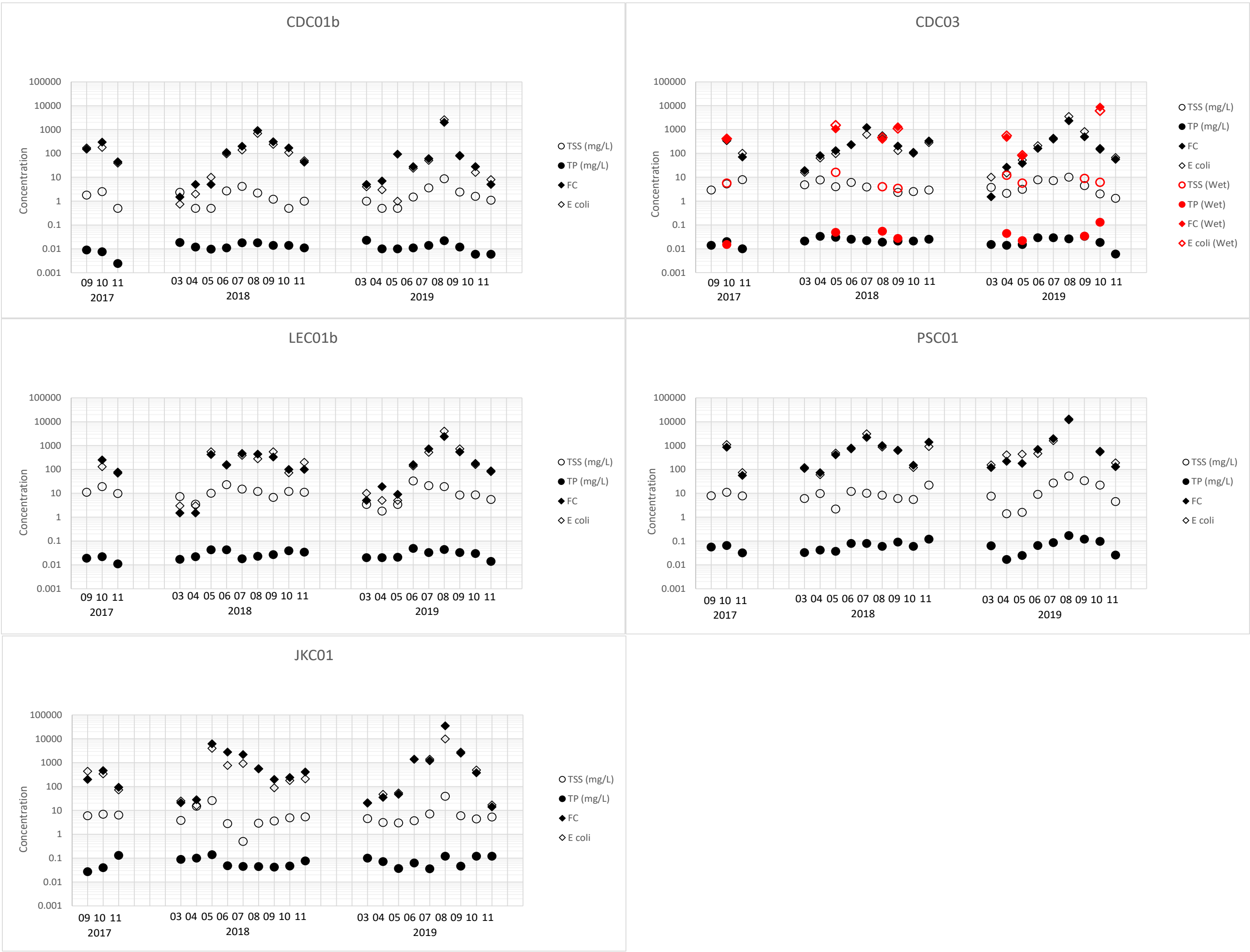


Figure 2. TP, TSS, FC and *E. coli* concentrations measured on mainstem Cedar Creek and its tributaries in HUC 12 watershed 040400030302 (sites CDC01b, CDC03, LEC01b, PSC01, and JKC01) for the project (September – November 2017 and March - November 2018 and 2019).

Overlaid in the figure displaying data for CDC03 are TP, TSS, FC and *E. coli* concentrations measured during high-flow, wet weather (storm) events sampled once in 2017 (October), three times in 2018 (May, August, September) and four times in 2019 (April, May, September and October).

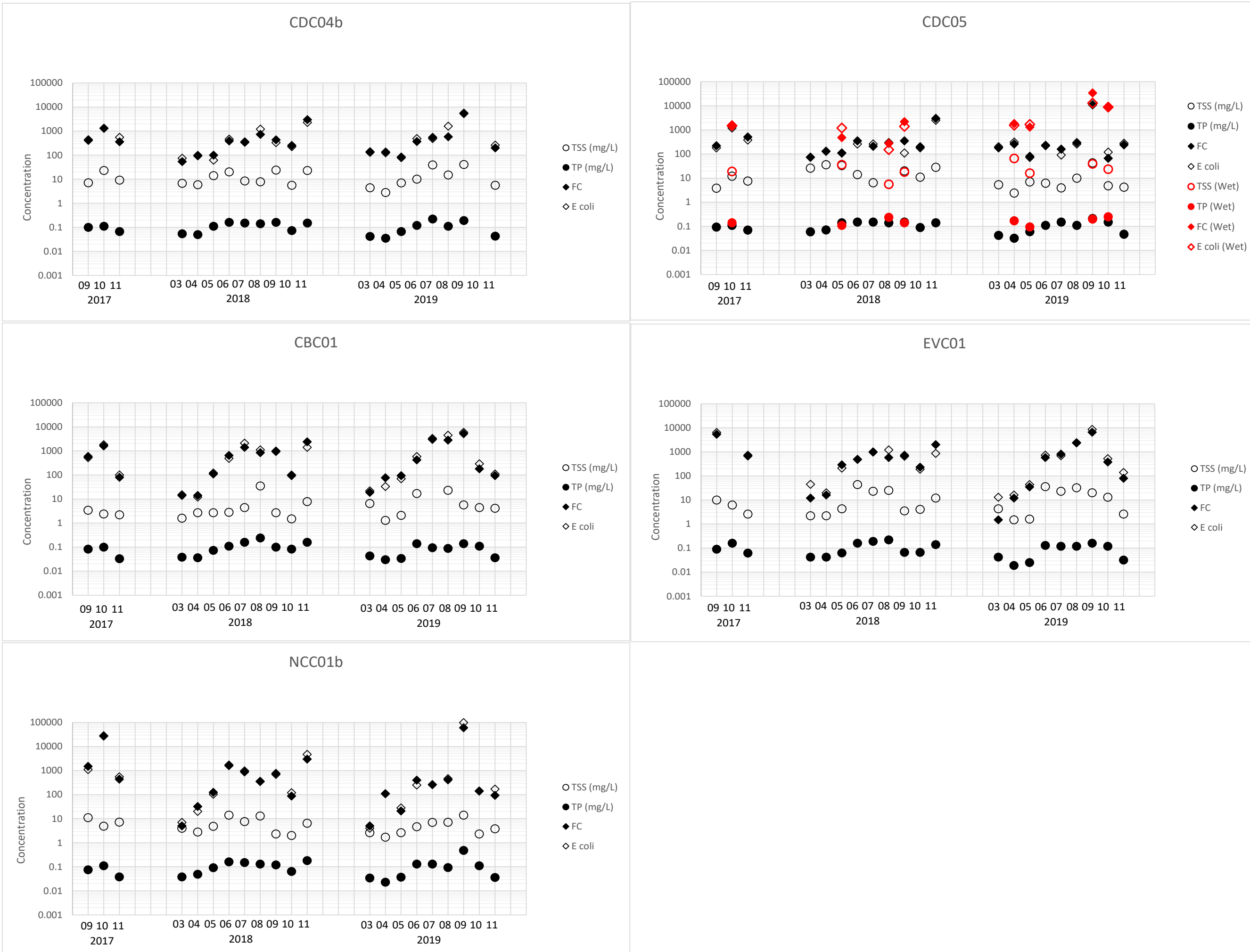


Figure 3. TP, TSS, FC and *E. coli* concentrations measured on mainstem Cedar Creek and its tributaries in HUC 12 watershed 040400030303 (sites CDC04b, CDC05, CBC01, EVC01, and NCC01b) for the project (September – November 2017 and March - November 2018 and 2019).

Overlaid in the figure displaying data for CDC05 are TP, TSS, FC and *E. coli* concentrations measured during high-flow, wet weather (storm) events sampled once in 2017 (October), three times in 2018 (May, August, September) and four times in 2019 (April, May, September and October).

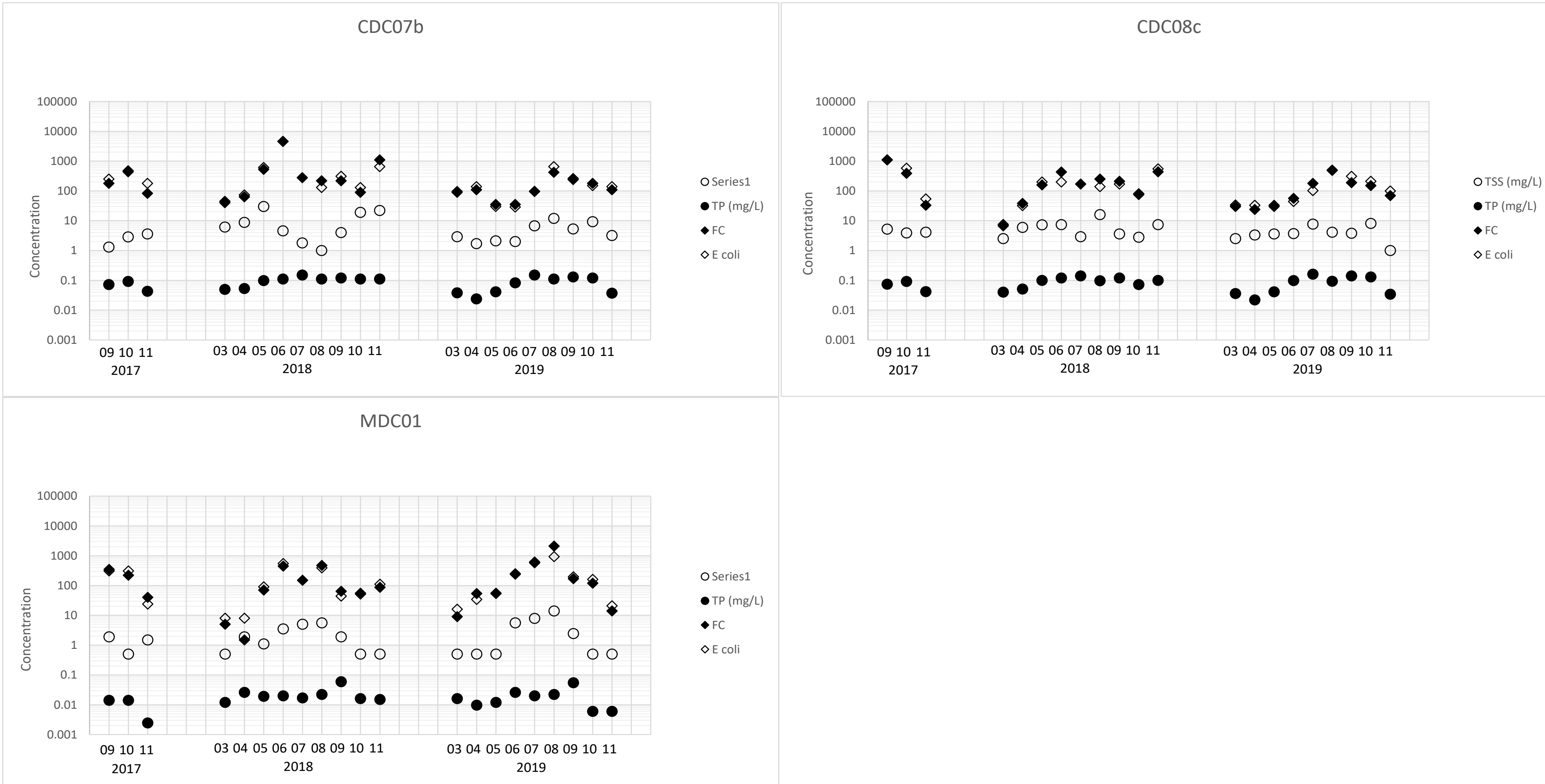


Figure 4. TP, TSS, FC and *E. coli* concentrations measured on mainstem Cedar Creek and a tributary in HUC-040400030304 (sites CDC07b, CDC08c, and MDC01) for the project (September – November 2017 and March - November 2018 and 2019).

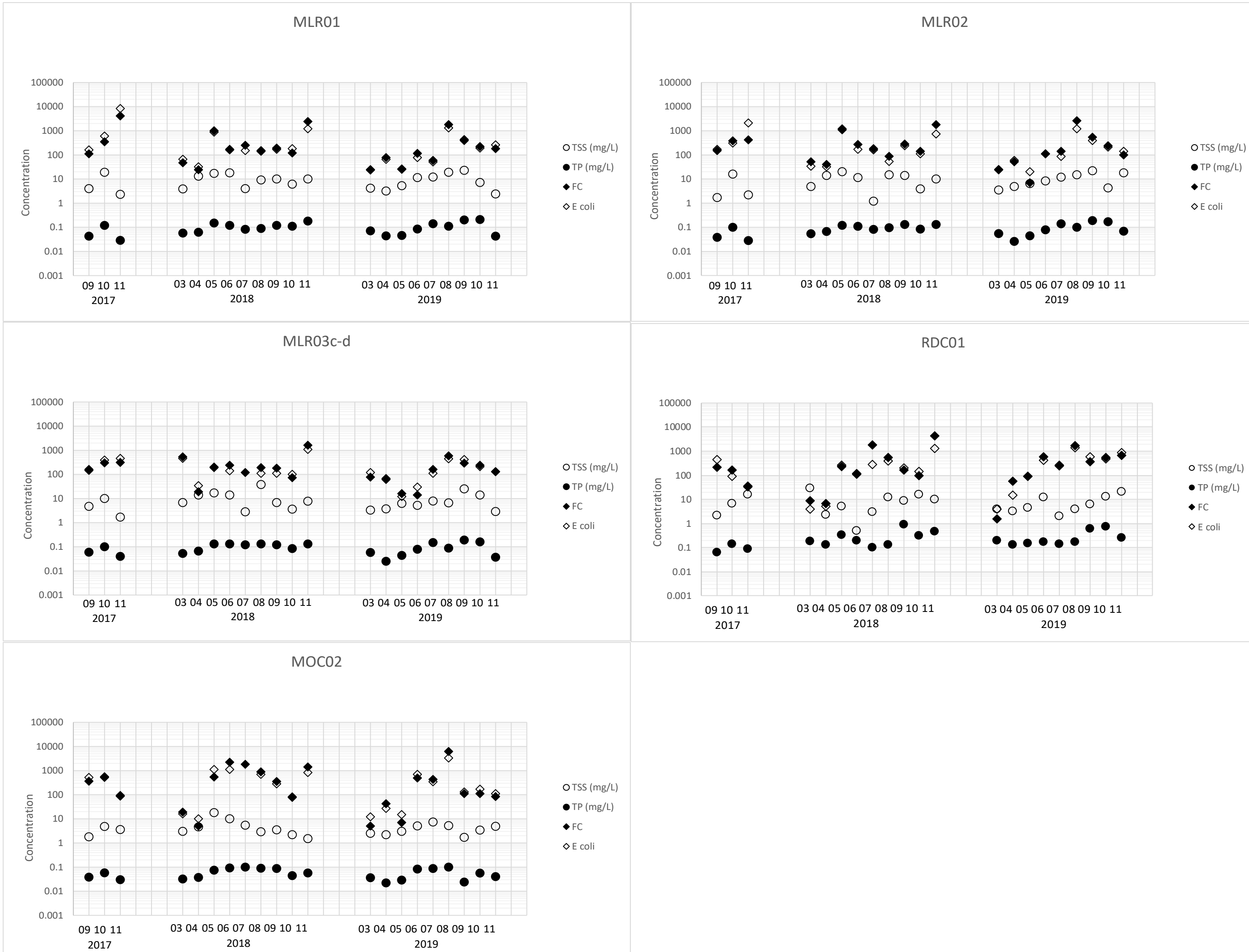


Figure 5. TP, TSS, FC and *E. coli* concentrations measured on mainstem Milwaukee River and its tributaries in HUC 12 watershed 040400030603 (sites MLR01, MLR02, MLR03c-d, RDC01, and MOC02) for the project (September – November 2017 and March - November 2018 and 2019).

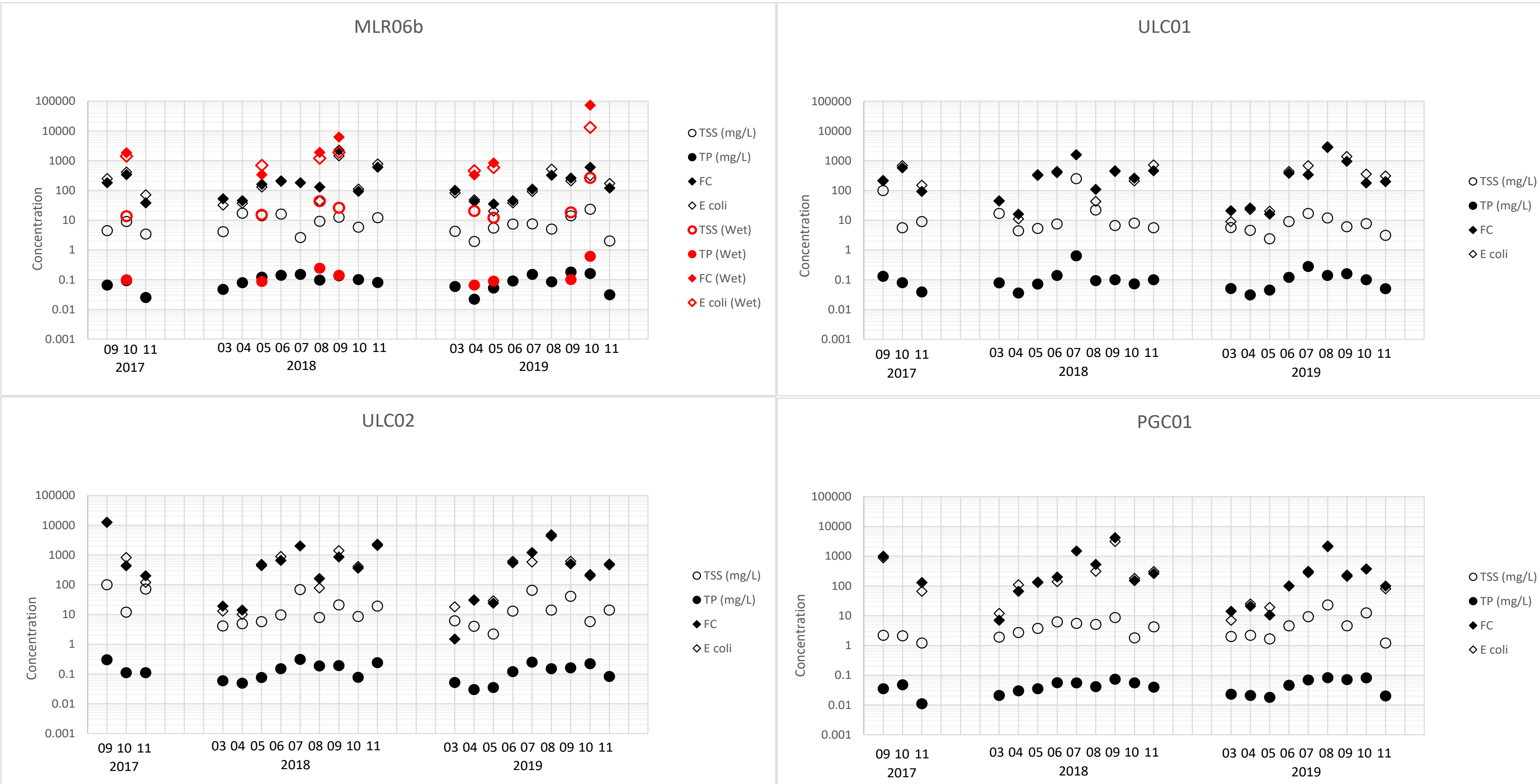


Figure 6. TP, TSS, FC and *E. coli* concentrations measured on mainstem Milwaukee River and its tributaries in HUC 12 watershed 040400030604 (sites MLR06b, ULC01, ULC02, and PGC01) for the project (September – November 2017 and March - November 2018 and 2019).
Overlaid in the figure displaying data for MLR06b are TP, TSS, FC and *E. coli* concentrations measured during high-flow, wet weather (storm) events sampled once in 2017 (October), three times in 2018 (May, August, September) and four times in 2019 (April, May, September and October).

Table 2. Summary statistics for TSS, TP, FC and *E. coli* concentrations measured on Cedar Creek and the Milwaukee River mainstem sites for the duration of the project (September – November 2017 and March - November 2018 and 2019). The summary statistics under "scheduled" and "high-flow" designations for a site are distinguished from the summary statistics for all data measured from the site ("all"). Monthly sample event data provided in **Appendix C.1**.

	TSS (mg/L)						TP (mg/L)						FC (CFU/100 ml)						*E. coli* (MPN/100 ml)					
Site	**Median**	**Min**	**10th P**	**90th P**	**Max**	**N**	**Median**	**Min**	**10th P**	**90th P**	**Max**	**N**	**Median**	**Min**	**10th P**	**90th P**	**Max**	**N**	**Median**	**Min**	**10th P**	**90th P**	**Max**	**N**
CDC01b	1.5	0.5	0.5	3.6	8.7	21	0.011	0.002	0.006	0.019	0.023	21	61	2	5	310	2000	21	50	1	2	240	2600	21
CDC03 (all)	4.4	1.3	2.3	9.1	16.0	29	0.022	0.006	0.014	0.045	0.130	29	230	2	33.2	1240	8600	27	230	10	38	1260	6000	27
CDC03 (scheduled)	4.0	1.3	-	-	10.0	21	0.021	0.006	-	-	0.033	21	160	2	-	-	2300	20	138	10	-	-	3500	20
CDC03 (high-flow)	5.9	3.4	-	-	16.0	8	0.039	0.015	-	-	0.130	8	460	75	-	-	8600	7	550	84	-	-	6000	7
CDC04b	8.9	2.8	5.4	25.5	41.0	20	0.110	0.035	0.043	0.163	0.220	20	365	54	92	1470	5600	20	390	62	83	1670	5300	20
CDC05 (all)	12.0	2.4	4.1	36.6	65.5	29	0.140	0.032	0.057	0.202	0.250	29	300	66	104	4120	34000	29	260	72	106	3770	13000	29
CDC05 (scheduled)	7.6	2.4	-	-	43.0	21	0.110	0.032	-	-	0.210	21	220	66	-	-	11000	21	230	72	-	-	13000	21
CDC05 (high-flow)	21.3	5.6	-	-	65.5	8	0.155	0.094	-	-	0.250	8	1725	280	-	-	34000	8	1525	150	-	-	13000	8
CDC07b	4.0	1.0	1.7	19.0	30.0	21	0.098	0.024	0.038	0.130	0.150	21	180	35	45	530	4600	21	145	29	39	650	4600	20
CDC08c	3.9	0.5	2.5	7.7	16.0	21	0.093	0.022	0.036	0.140	0.160	21	160	7	30	440	1100	21	122	8	33	553	1100	20
MLR01	9.1	2.3	3.2	19.0	23.0	21	0.089	0.029	0.043	0.180	0.210	21	160	24	26	1800	4100	21	170	25	32	1200	8300	21
MLR02	10.0	1.2	2.2	18.0	22.0	21	0.084	0.026	0.038	0.140	0.190	21	150	7	40	1100	2600	21	160	20	32	1200	2100	21
MLR03d	6.8	1.7	2.9	17.0	38.0	21	0.088	0.025	0.040	0.150	0.190	21	180	14	19	530	1600	21	135	12	34	460	1085	20
MLR06b (all)	12.0	1.9	3.2	23.6	260.0	29	0.093	0.022	0.044	0.164	0.610	29	190	35	44	2005	73000	28	210	20	38	1420	13000	27
MLR06b (scheduled)	7.3	1.9	-	-	23.0	21	0.090	0.022	-	-	0.180	21	130	35	-	-	2250	21	120	20	-	-	1450	20
MLR06b (high-flow)	19.0	12.0	-	-	260.0	8	0.100	0.065	-	-	0.610	8	1850	330	-	-	73000	7	1200	460	-	-	13000	7

Table 3. Summary statistics for TSS, TP, FC and *E. coli* concentrations measured at sites on tributary streams to Cedar Creek and the Milwaukee River mainstem for the duration of the project (September – November 2017 and March - November 2018 and 2019).
The summary statistics under "scheduled" and "high-flow" designations for a site are distinguished from the summary statistics for all data measured from the site ("all"). Monthly sample event data provided in **Appendix C.2**.

	TSS (mg/L)						TP (mg/L)						FC (CFU/100 ml)						*E. coli* (MPN/100 ml)					
Site	**Median**	**Min**	**10th P**	**90th P**	**Max**	**N**	**Median**	**Min**	**10th P**	**90th P**	**Max**	**N**	**Median**	**Min**	**10th P**	**90th P**	**Max**	**N**	**Median**	**Min**	**10th P**	**90th P**	**Max**	**N**
LEC01b	10.0	1.8	3.4	21.0	33.0	21	0.023	0.011	0.017	0.043	0.049	21	160	2	5	559	2400	20	145	3	5	568	4000	20
PSC01	8.3	1.4	2.2	27.0	53.0	21	0.064	0.017	0.026	0.120	0.170	21	540	56	103	2000	12000	19	490	60	111	1900	13000	19
JKC01	4.9	0.5	2.9	15.0	39.0	21	0.063	0.027	0.037	0.120	0.140	21	380	14	21	2800	35000	21	340	16	20	2800	9900	21
KRB01b	6.5	2.6	2.8	21.0	30.0	21	0.130	0.050	0.051	0.230	0.270	21	225	2	12	4300	12000	21	205	6	20	7500	13000	21
LCC02	11.0	2.9	4.2	28.0	32.0	21	0.049	0.016	0.022	0.100	0.160	21	340	7	33	1600	3000	21	410	12	33	1400	2400	21
LCC01 (All)	20.0	3.6	5.4	40.4	73.0	29	0.099	0.025	0.040	0.212	0.440	29	480	21	44	3000	12000	28	477.5	12	64	3630	16000	28
LCC01 (scheduled)	12.0	3.6	-	-	44.0	21	0.095	0.025	-	-	0.220	21	220	21	-	-	5200	21	300	12	-	-	4700	21
LCC01 (high-flow)	32.0	6.8	-	-	73.0	8	0.130	0.084	-	-	0.440	8	2550	1000	-	-	12000	7	2800	520	-	-	16000	7
EVC01	6.2	1.5	2.2	32.0	44.0	21	0.090	0.019	0.032	0.160	0.220	21	535	2	12	2655	6600	20	585	13	20	2800	8600	20
CBC01	3.1	1.3	1.6	17.6	35.0	20	0.089	0.030	0.034	0.160	0.240	21	420	14	19	2800	5200	21	490	12	22	3300	5900	21
NCC01b	4.9	1.7	2.3	13.0	14.0	21	0.093	0.023	0.036	0.160	0.480	21	350	5	21	3000	60000	21	260	4	20	4700	98000	21
RDC01	6.3	0.5	2.1	16.0	30.0	21	0.175	0.064	0.098	0.590	0.900	21	220	2	9	1650	4400	21	260	4	5	870	1400	21
MDC01	1.5	0.5	0.5	5.6	14.0	21	0.016	0.002	0.006	0.026	0.059	21	87	2	9	470	2100	21	100.5	8	15	553	930	20
MOC02	3.5	1.5	1.8	7.4	18.0	21	0.056	0.022	0.029	0.092	0.100	21	350	5	7	1800	6200	21	225	10	15	1100	3300	20
ULC01	7.5	2.4	4.4	22.0	250.0	21	0.094	0.031	0.039	0.160	0.640	21	260	16	21	960	2800	21	320	9	20	1400	3000	21
ULC02	12.0	2.2	4.1	69.0	100.0	21	0.120	0.030	0.049	0.250	0.310	21	480	2	19	2300	12500	21	452.5	10	18	2320	12500	20
PGC01c	3.8	1.2	1.7	9.3	23.0	21	0.041	0.011	0.020	0.073	0.083	21	175	7	14	1570	4200	20	140	7	18	1124	3100	19

Summary of QA/QC Review and Evaluation of Data
A summary of GLEC's QA/QC review and evaluation of the *in situ* and analytical data quality associated with the District's baseline study to evaluate water quality changes in portions of the Milwaukee River watershed over time is provided in **Appendix F**. It is responsive to all applicable elements specified for the study, and the statements regarding data use or limitations contained herein are intended to support the findings generated to date for the study.

D. Develop site-specific rating curves and estimate daily discharge rates

Discharge Estimation Methods
Several different methods were used to estimate daily discharge (stream flow) rates at each site. These three methods (rating curves, drainage area ratios, and conveyance-slope method) and their application are described in the sections below. At each site, the results from the available methods were compared, and an overall approach to estimate daily discharges was selected. At some of the sites, a single method was used to estimate daily discharges for the entire monitoring period, while at others, a combination of methods was used. The comparison of results and selection of overall approach is also presented below for each of the 25 sites.

Rating curves – Between 17 and 21 discharge measurements were made at each site. These were calculated as the product of current velocities and cross-section areas measured in 10-20 equal intervals across the stream width. The discharge measurements were compared to the water level elevations recorded at the same times and locations. Stage (water level) was calculated from pressure measured and recorded by the Levelogger at each site, corrected for barometric pressure (measured by the nearest Barologger) and the elevation change between the Levelogger and the Barologger location. Water level elevation (WLE) was then calculated as the sum of Levelogger stage and elevation (EL), which was surveyed by the District at each site near the beginning of each field year. **Table 4** provides a summary of this data for each site, including elevations, and the ranges of WLE and discharge measurements. At two sites, CDC03 and LEC01b, small (0.05-0.2 ft.) adjustments (shifts) were made to the WLEs in specific years due to apparent changes in the elevation-discharge relationship at these sites. At a third site, MLR03c-d, a much larger adjustment (19 ft.) was applied to the WLEs measured in 2017, to compensate for the relocation of this site and its Levelogger.

A variety of graphical and statistical methods are available to fit rating curves to the elevation vs. discharge data (USGS, 1982). We used the Linsley et al. (1982) procedure to fit a parabolic curve to the discharge-elevation data. The rating curve equations for each site are shown in **Table 4**, along with the range of elevations and discharge measured at each site and the root-mean square error (RMSE[6]) of the rating curve discharge estimates. The parabolic rating curves

---

[6] Root-mean square error (RMSE) was the loss function that was minimized to fit the rating curves to the discharge-elevation data. RMSE was used to quantify the residuals between the measured discharges and the rating curve predictions of the discharges. In the absence of prediction bias, the RMSE is analogous to the standard deviation. A high RMSE can reflect a higher range of measured discharges at a location (e.g., the rating curve for CDC08c has a high RMSE [32.0] because the discharges measured at this location were generally large [12 – 240 cfs]), unexplained variability in the measured discharges, or a lack of fit in the rating curve.

provided reasonable fits of the discharge-elevation data, and could be used to predict discharges for most of the days in the monitoring period. However, using rating curves to extrapolate to discharge values more than twice the greatest measured discharge is not recommended (USGS, 1982). For this reason, we applied two other methods to estimate discharges under high flow conditions.

Drainage area ratios – When flood stages are produced over a large area by an intense storm, the peak discharges can often be estimated, at sites where they are lacking, from the known peak discharges at surrounding gauging stations (USGS, 1982). Assuming relatively little difference in storm intensity over the area affected, peak discharge per unit area may be correlated with drainage area (DA) alone. USGS also cautions that the peak discharges estimated by the drainage area method should be used only as a guide in extrapolating the rating curve at a gauging station.

In the case of this project, discharges including those during peak/high flow were measured at two USGS gauges in the Milwaukee River watershed:

- USGS 04086600 Milwaukee River near Cedarburg, WI; DA=600 sq. mi.
- USGS 04086500 Cedar Creek near Cedarburg, WI; DA=120 sq. mi.

We used the discharges reported at the USGS gauges to estimate discharges at the 25 sites under high-flow conditions (i.e., days when water level elevations exceeded the upper range of the rating curve data), based on the drainage area ratios:

$$Q_n = \left(\frac{DA_n}{DA_{USGS}}\right) Q_{USGS} \quad \text{(Equation 1)}$$

where: DA_n and DA_{USGS} are the drainage areas of site *n* and the corresponding USGS gauge, and
Q_n and Q_{USGS} are the high-flow discharges at site *n* and the USGS gauge

For all sites except those on the Milwaukee River, we used the USGS 04086500 Cedar Creek discharges to estimate discharge rates using Equation 1. For the Milwaukee River sites, we used the USGS 04086600 Milwaukee River discharges. DAs for each site (**Table 4**) were calculated using a Geographic Information System (GIS; ESRI ArcHydro) and a 10-m resolution Digital Elevation Model (DEM). We retrieved USGS discharge data in December 2019; at that time, the discharges for dates after September 30, 2018 were reported as provisional data (subject to Agency review and revision). There is greater uncertainty associated with using provisional data because it may change; however, this was unavoidable given the project completion date of February 15, 2020. At each site, the DA ratios were compared to the measured discharge ratios in order to judge the adequacy of these estimates. For each site, **Table 4** shows the discharge ratios for the 4-5 highest flows (i.e., high-flow ratio), which can be compared to the DA ratio for that site.

Leveloggers were removed to prevent damage from ice during the over-winter periods (mid-November through February). Stream discharge rates were not calculated in these periods.

However, DA ratio estimates were used to extend the daily discharge record at each site by one week at the end of the 2019 monitoring period, from November 13-18, 2019. The Leveloggers were removed on November 12, but discharge estimates were needed to calculate pollutant loadings from water quality samples collected on November 18. Similarly, we used DA ratio estimates to extend the daily discharge record at each site by one day (November 14) at the end of the 2017 monitoring period.

The Leveloggers were installed as early as possible in each annual monitoring period. Ideally, this would have been prior to the commencement of water quality sampling, in September (2017) and March (2018 and 2019). However, conditions in the field delayed Levelogger installation in 2017 and 2019. Because discharge estimates were needed to calculate pollutant loadings from water quality samples collected on September 20 and 21, 2017, and March 25 and 26 in 2019, DA ratio estimates were again used to extend the daily discharge record to the entire monitoring period at each site.

Conveyance-slope method – We also used the conveyance-slope method to estimate discharge rates at 12 sites under high-flow conditions. This method is based on equations of steady flow, usually the Manning equation (USGS, 1982):

$$Q = KS^{1/2} \text{ (Equation 2)}$$

where: K is conveyance of the channel (described below), and
S is slope of the energy grade line

The conveyance K equals $\frac{1.486}{n}AR^{2/3}$, when English units are used. Values of cross-section area (A) and hydraulic radius (R) versus water level elevation were obtained from field surveys of the channel and flood plain cross sections at each site, and values of the roughness coefficient n were estimated from digital photos taken in the field.

The conveyance-slope method assumes that the geometry of the cross-section used for discharge measurements is fairly representative of that of a long reach of downstream channel (USGS, 1982). The need to meet this assumption immediately eliminates from consideration those sites where discharge measurements are made at constricted cross sections, such as occur at many bridges. The method also assumes that slope tends to become constant (uniform flow) at the higher stages. That is strictly true only for long, straight channels of uniform cross section, so sites on streams with significant bends or other irregularities are also eliminated from consideration. Based on these constraints, cross sections were surveyed at 12 sites (identified in **Table 4** under “Cross-section surveyed for slope-conveyance curve?”) and the method was applied at those same sites.

The slope S at high flow is determined from a slope-stage relationship, which ideally attains a vertical line at the upper stages (USGS, 1982). However, our discharge measurements usually did not identify a limiting slope-stage relationship, or the limiting slope produced non-optimal discharge predictions. In either case, slope was calibrated by comparison of high-flow predictions made using drainage area ratios.

Discharge estimation method considerations, the comparison of discharge results, and the selection of overall approach for estimating discharge at each site are presented below, in alphabetical order:

CBC01 (Cedarburg Creek Downstream of CTH M)

Figure 7 presents the water level elevation vs. discharge measurements at site CBC01. At this site, all three methods were used to fit the rating curve to estimate daily discharge rate. The parabolic rating curve (red line) was fitted to the elevation-discharge data (red symbols). The conveyance-slope curve is shown as the blue line. The blue symbols are the daily discharge rates estimated from the USGS Cedar Creek gauge and the DA ratio; only approved USGS discharges (pre-October 2018) are used with DA ratios in this and subsequent plots. At this site, the flow ratios approach the DA ratio at high flow (compare high-flow ratio range [17-39] to DA ratio [18.6] in **Table 4**).

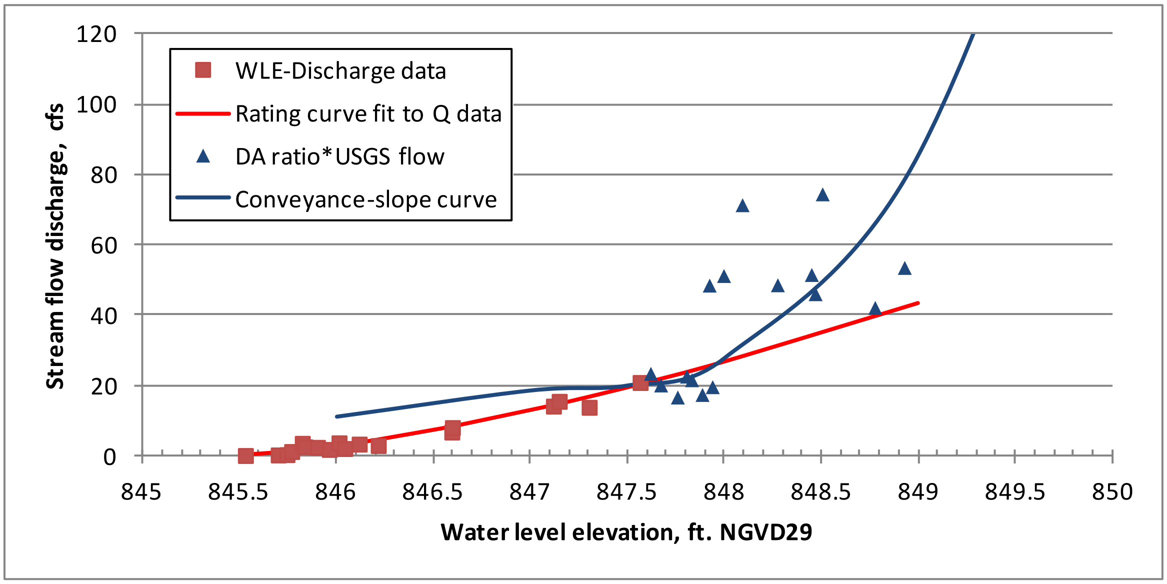


Figure 7. Water level elevation vs. stream flow discharge at site CBC01.

The daily discharge rates at this site were calculated using a composite of the available methods. The parabolic rating curve was used for water level elevations up to 847.55', where the curve intersects with the conveyance-slope curve, which was used for elevations above 847.55'. The discharge rates based on DA ratio•USGS flow confirm the trend of discharge rates at higher water level elevations calculated by the conveyance-slope curve.

CDC01b (Cedar Creek at CTH NN)
The water level elevation vs. discharge measurements at site CDC01b are presented in **Figure 8**. At this site, the parabolic rating curve (red line) was fitted to the elevation-discharge data (red symbols). The conveyance-slope method could not be applied at this site, because the channel and flood plain did not conform to the assumptions of the method noted above. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the drainage area (DA) ratio. Although the flow ratios approached the DA ratios at high flow, there was considerable scatter in the flow ratios.

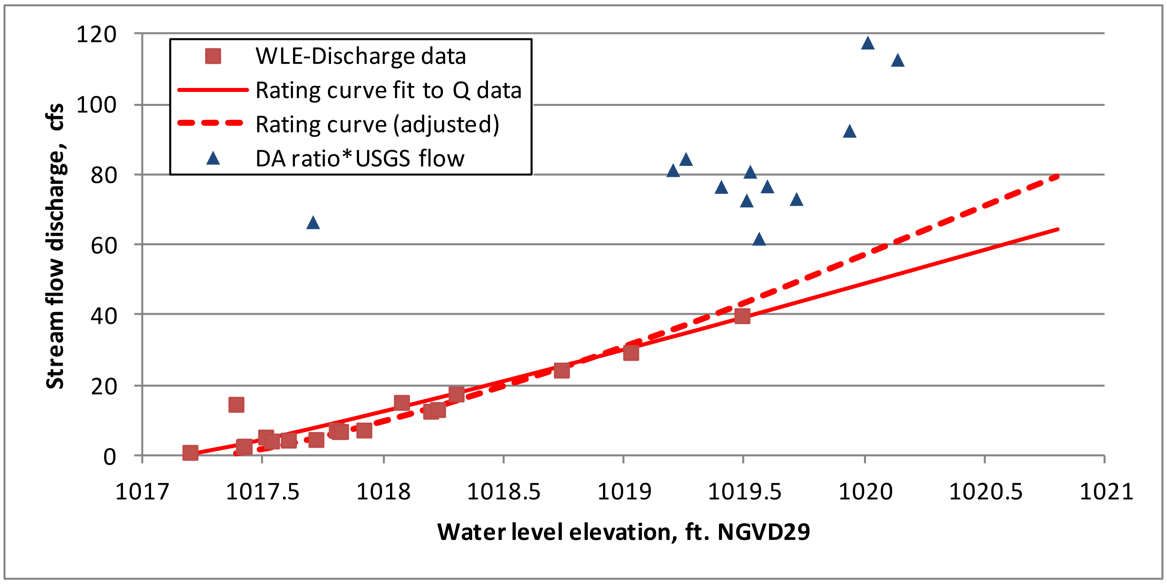


Figure 8. Water level elevation vs. stream flow discharge at site CDC01b.

The daily discharge rates at this site were calculated using the parabolic rating curve, which was adjusted to predict slightly higher discharges at elevations above 1019' (i.e., beyond the range of measured WLEs and discharges), as suggested by the discharge rates based on DA ratio•USGS flows. Further adjustment of the rating curve was not possible without losing an acceptable fit of the WLE vs. discharge measurements.

CDC03 (Cedar Creek Downstream of Mayfield Road)
Water level elevation vs. discharge measurements at site CDC03 are presented in **Figure 9**. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope method could not be applied at this site. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the drainage area (DA) ratio. The flow ratios approached the DA ratios at high flow, as shown in **Table 4**.

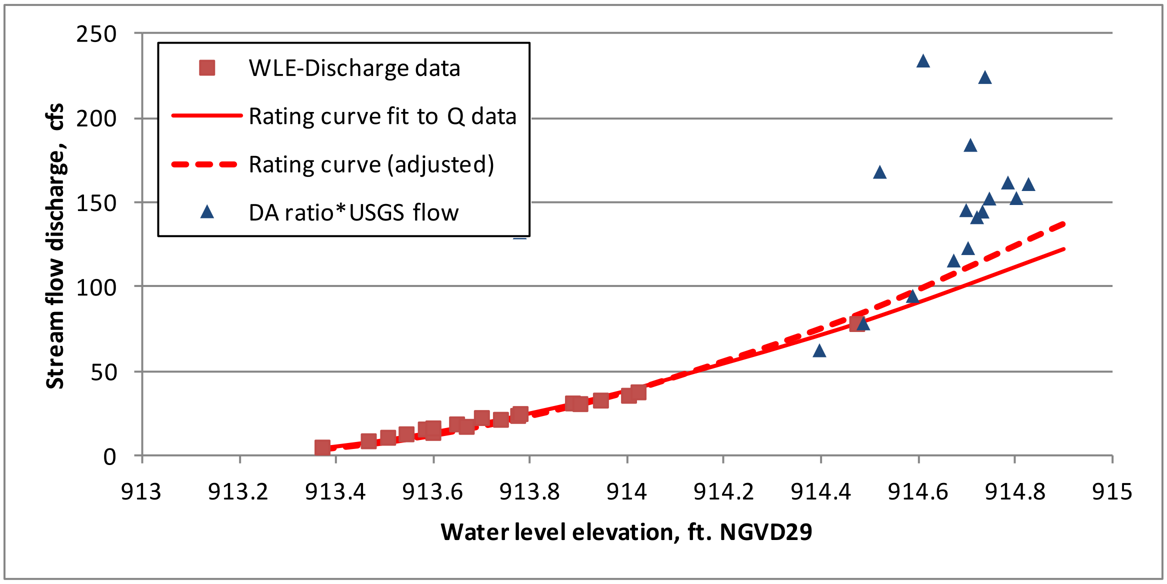


Figure 9. Water level elevation vs. stream flow discharge at site CDC03.

The daily discharge rates at this site were calculated using the parabolic rating curve, which was adjusted to predict slightly higher discharges at elevations above 914.6'. The adjusted rating curve agreed favorably with the discharge rates based on DA ratio•USGS flows, which supported extending the adjusted rating curve to high flows.

CDC04b (Cedar Creek at S. Church Road)

Figure 10 presents the water level elevation vs. discharge measurements at site CDC04b. At this site, all three methods were used to fit the rating curve to estimate discharge rate. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope curve is shown as the blue line. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios approach the DA ratios at high flow.

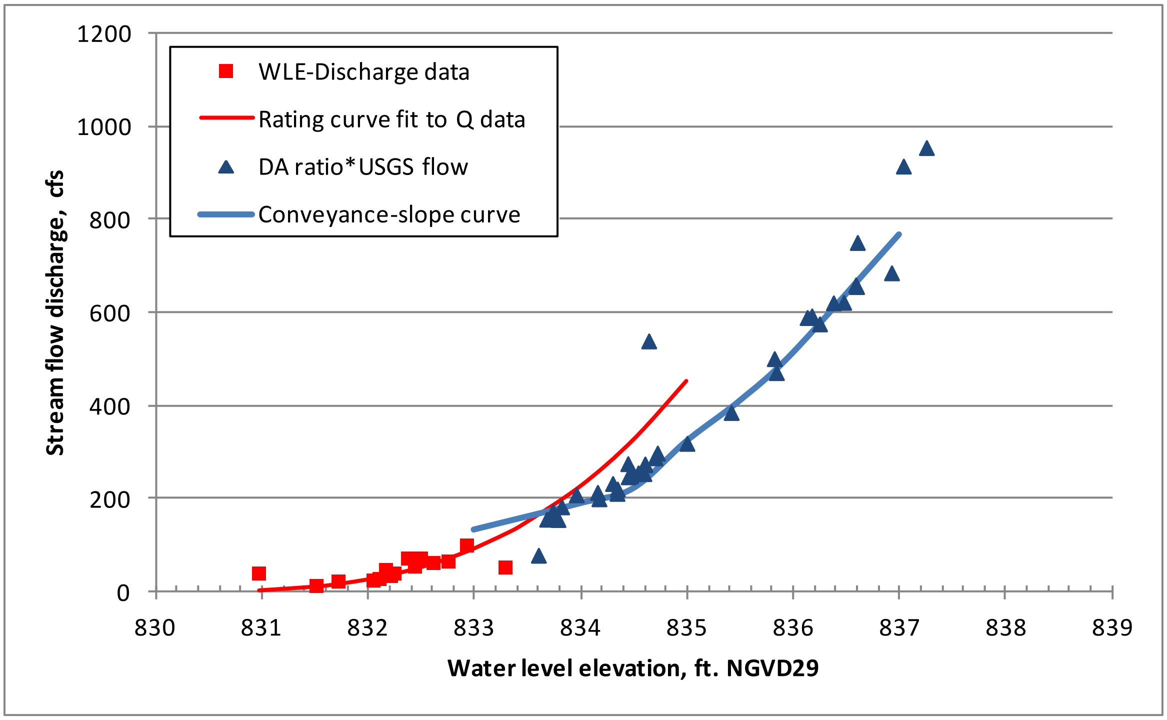


Figure 10. Water level elevation vs. stream flow discharge at site CDC04b.

The daily discharge rates at this site were calculated using a composite of the available methods, the same approach used at site CBC01. The parabolic rating curve was used for water level elevations up to 833.7', where the curve intersects with the conveyance-slope curve, which was used for elevations above 833.7'. The discharge rates based on DA ratio·USGS flows confirm the trend of discharge rates at higher elevations calculated by the conveyance-slope curve. On three days, water level elevations were too high for the slope-conveyance curve (a constraint due to the survey elevation data) so for those days discharge rates were calculated using the DA ratio•USGS flow.

CDC05 (Cedar Creek at CTH M)

Water level elevation vs. discharge measurements at site CDC05 are presented in **Figure 11**. At this site, all three methods were used to fit the rating curve to estimate daily discharge rates. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope curve is shown as the blue line. The blue symbols are the daily discharges calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios approach the DA ratios at high flow.

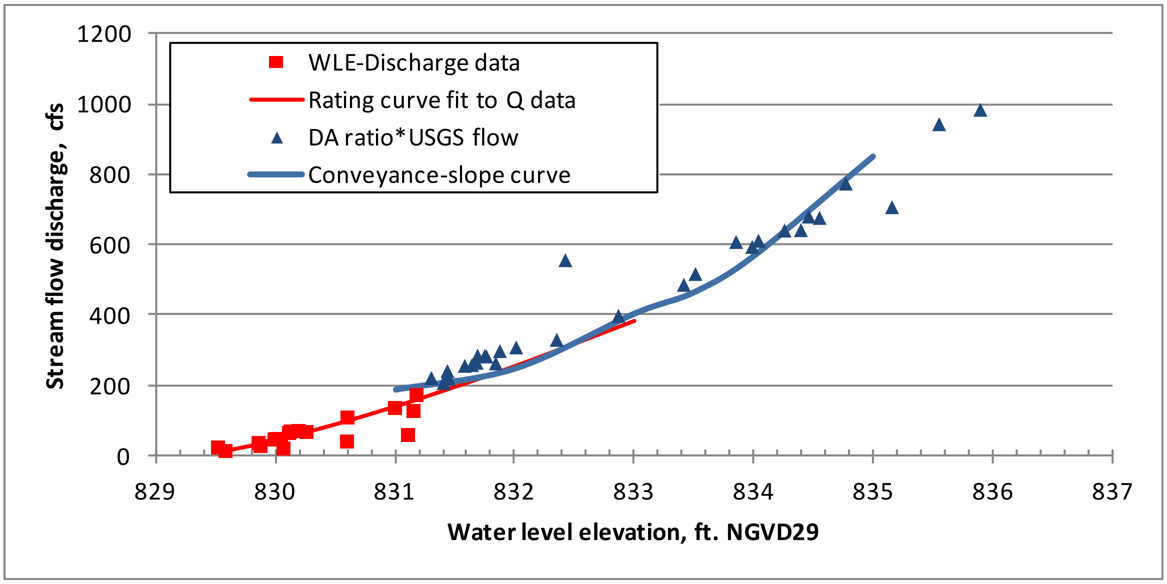


Figure 11. Water level elevation vs. stream flow discharge at site CDC05

The daily discharge rates at this site were again calculated using a composite of the available methods. The parabolic rating curve was used for water level elevations up to 832.4', where the curve intersects with the conveyance-slope curve, which was used for elevations above 832.4'. The discharge rates based on DA ratio·USGS flows confirm the trend of discharges at higher elevations calculated by the conveyance-slope curve. On five days, water level elevations were too high for the slope-conveyance curve so discharges were calculated using the DA ratio•USGS flow.

CDC07b (Cedar Creek at Cedar Creek Road)

Figure 12 presents the water level elevation vs. discharge measurements at site CDC07b. As with the previous two sites, all three methods were used to fit the rating curve to estimate daily discharge rates at this site. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope curve is shown as the blue line. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios approach the DA ratios at high flow.

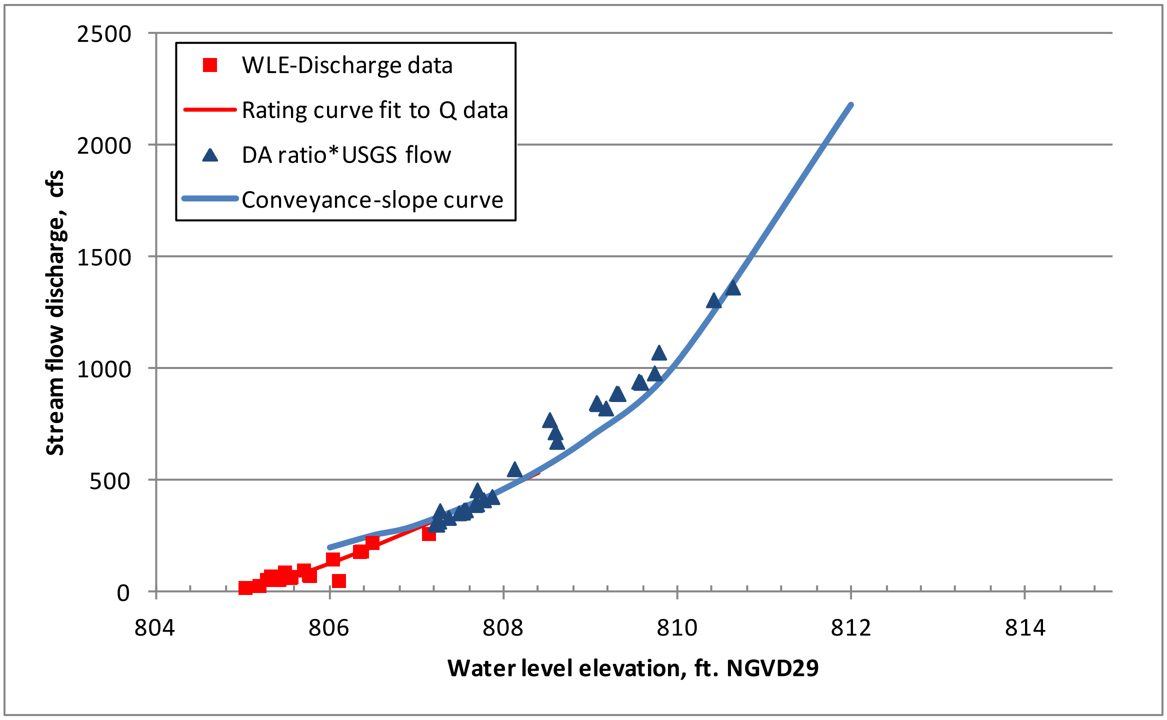


Figure 12. Water level elevation vs. stream flow discharge at site CDC07b.

The daily discharge rates at this site were again calculated using a composite of the available methods. The parabolic rating curve, which was adjusted to predict slightly higher discharges at elevations above 807', was used for water level elevations up to 808', where the curve intersected with the conveyance-slope curve, which was used for elevations above 808'. The discharge rates based on DA ratio•USGS flows confirm the trend of discharge rates at higher elevations calculated by the conveyance-slope curve.

<u>*CDC08c (Cedar Creek at Cedarburg WWTP)*</u>

Water level elevation vs. discharge measurements at site CDC08c are presented in **Figure 13**. At this site, all three methods were used to fit the rating curve to estimate daily discharge rates. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope curve is shown as the blue line. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios approach the DA ratios at high flow.

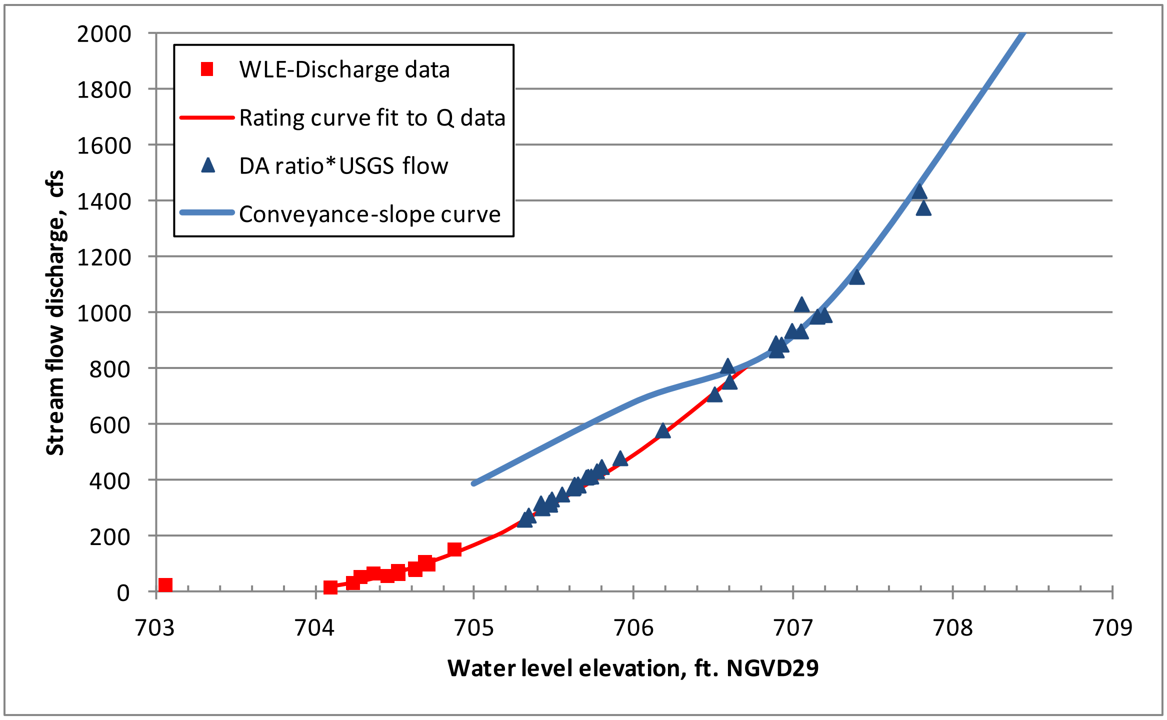


Figure 13. Water level elevation vs. stream flow discharge at site CDC08c.

The daily discharge rates at this site were again calculated using a composite of the available methods. The parabolic rating curve was used for water level elevations up to 706.7, where the curve intersects with the conveyance-slope curve, which was used for elevations above 706.7. The discharge rates based on DA ratio•USGS flows confirm the trend of discharge rates at higher elevations calculated by the conveyance-slope curve.

<u>*EVC01 (Evergreen Creek Downstream of Pleasant Valley Drive)*</u>
The water level elevation vs. discharge measurements at site EVC01 are presented in **Figure 14**. At this site, the parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope method could not be applied at this site. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the drainage area (DA) ratio. Although the flow ratios approached the DA ratios at high flow, there was considerable scatter in the flow ratios.

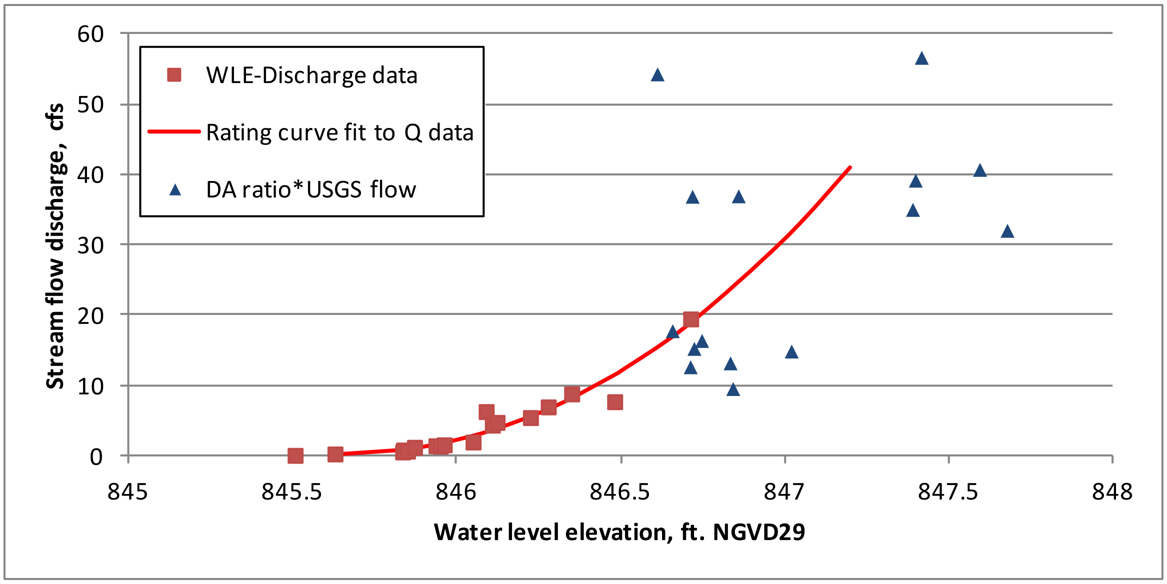


Figure 14. Water level elevation vs. stream flow discharge at site EVC01.

The daily discharge rates at this site were calculated using the parabolic rating curve up to two times the highest measured discharge (40 cfs). On eight days, water level elevations were too high for the rating curve so discharge rates were calculated using the DA ratio•USGS flow. Given the USGS guidance cited above, this approach was considered to produce the least uncertain discharge estimates, given the available data. Concern regarding this uncertainty is mitigated to a degree by the relatively few (1%) days in which this “last resort” approach was used to estimate discharge at this site.

JKC01 (Jackson Creek Downstream of STH 60)

Figure 15 presents the water level elevation vs. discharge measurements at site JKC01. At this site, all three methods were used to fit the rating curve to estimate daily discharge rates. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope curve is shown as the blue line. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the drainage area (DA) ratio. The flow ratios approach the DA ratios at high flow, although there is some scatter in the flow ratios.

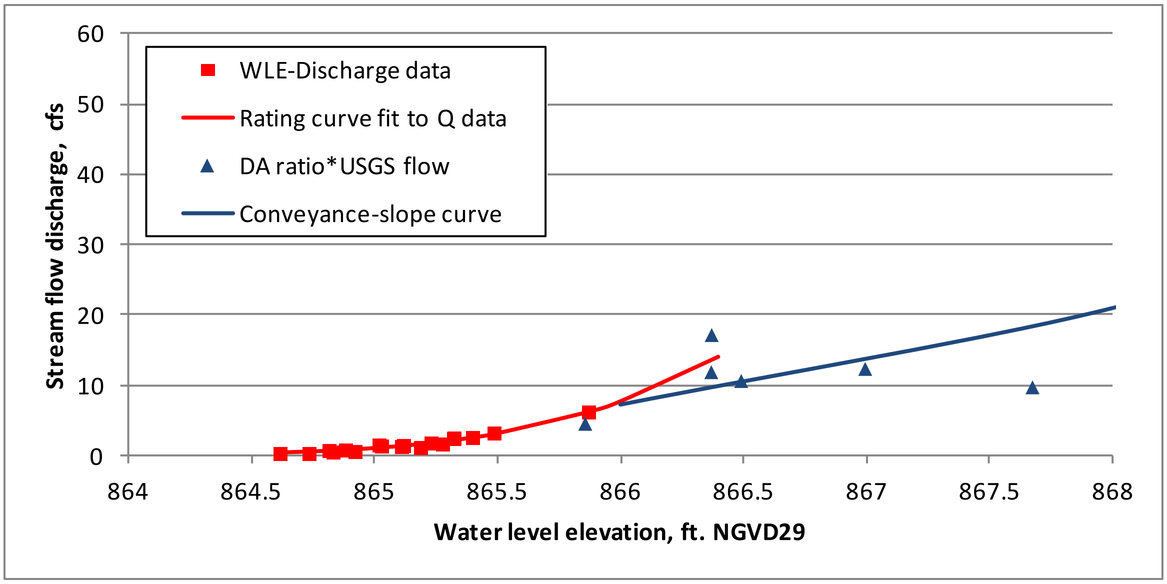


Figure 15. Water level elevation vs. stream flow discharge at site JKC01.

The daily discharge rates at this site were calculated using a composite of the available methods. The parabolic rating curve was used for water level elevations up to 866', where the curve intersects with the conveyance-slope curve, which was used for higher water level elevations. The discharge rates based on DA ratio•USGS flows generally confirm the trend of discharge rates at higher elevations calculated by the conveyance-slope curve.

KRB01b (Cedar Creek at Maple Road DS Kressin Branch)

Figure 16 presents the water level elevation vs. discharge measurements at site KRB01b. As at the previous site, all three methods were used to fit the rating curve to estimate daily discharge rates at this site. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope curve is shown as the blue line. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios are in good agreement with the DA ratios at high flow.

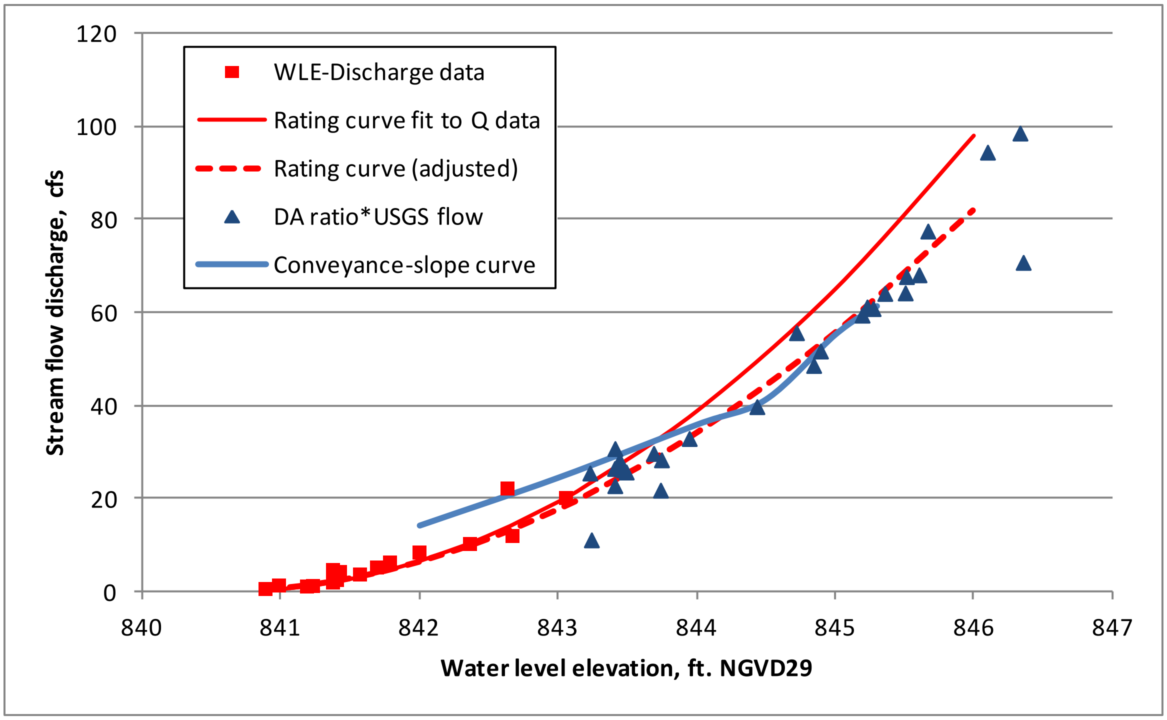


Figure 16. Water level elevation vs. stream flow discharge at site KRB01b.

The daily discharge rates at this site were calculated using the parabolic rating curve, which was adjusted to predict slightly lower discharges at elevations above 845'. The adjusted rating curve agreed favorably with the conveyance-slope curve as well as the discharge rates based on DA ratio•USGS flows. This agreement supported extending the adjusted rating curve to high flows.

LCC01 (Little Cedar Creek at Western Avenue)

The water level elevation vs. discharge measurements at site LCC01 are presented in **Figure 17**. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). As noted for other sites above, the conveyance-slope method could not be applied at this site. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios are in good agreement the DA ratios at high flow.

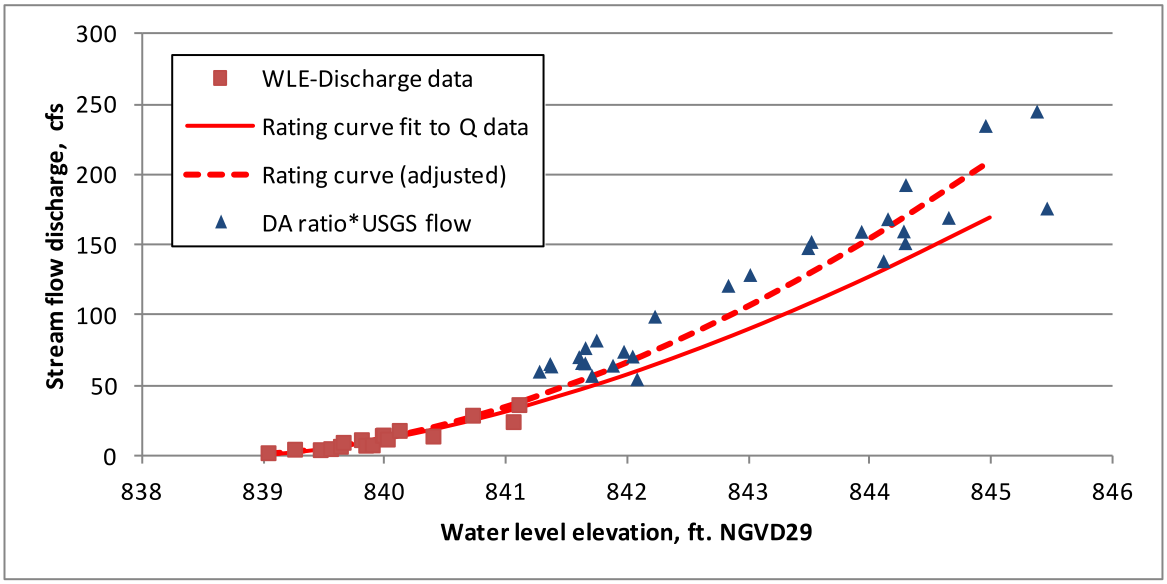


Figure 17. Water level elevation vs. stream flow discharge at site LCC01.

The daily discharge rates at this site were calculated using the parabolic rating curve, which was adjusted to predict higher discharges at elevations above 841'. The adjusted rating curve agreed favorably with the discharge rates based on DA ratio•USGS flows, which supported extending the adjusted rating curve to high flows.

LCC02 (Little Cedar Creek at Pioneer Road)

Figure 18 presents the water level elevation vs. discharge measurements at site LCC02. All three methods were used to fit the rating curve to estimate daily discharge rates at this site. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope curve is shown as the blue line, and the blue symbols are the daily discharge rates calculated from the DA ratio and the USGS Cedar Creek gauge flow. The high flow ratios at this site were scattered and did not approach the DA ratios, so these did not support extending the rating curve to high flow rates.

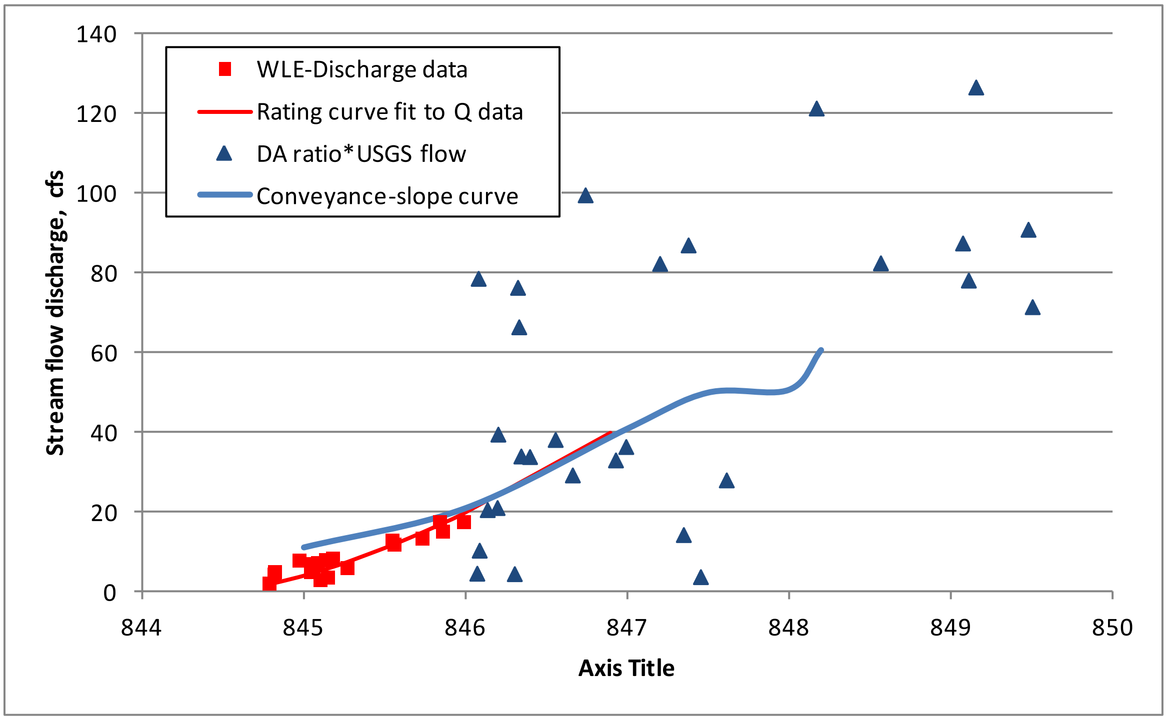


Figure 18. Water level elevation vs. stream flow discharge at site LCC02.

The daily discharge rates at this site were calculated using a composite of the available methods. The parabolic rating curve was used for water level elevations up to 846.2’, where the curve intersects with the conveyance-slope curve, which was used for higher water level elevations. On ten days, water level elevations were too high for the conveyance-slope curve, so for those days discharge rates were calculated using the DA ratio•USGS flow.

LEC01b (Lehner Creek Upstream from STH 60)

The water level elevation vs. discharge measurements at site LEC01b are presented in **Figure 19**. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope method could not be applied at this site. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios at this site were scattered at high flow, so did not support extending the rating curve to high flow rates.

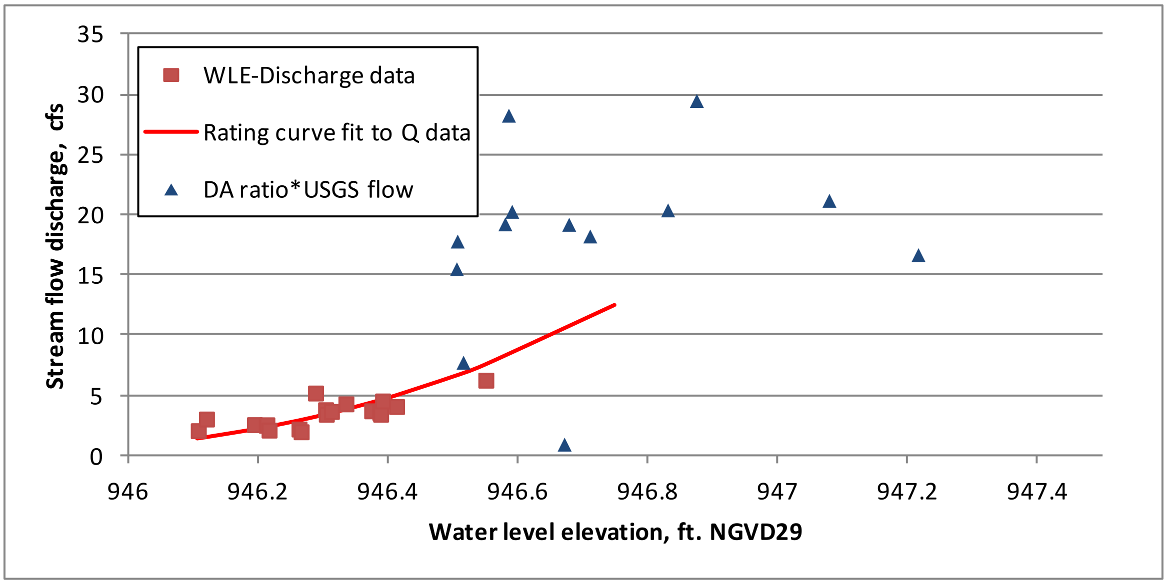


Figure 19. Water level elevation vs. stream flow discharge at site LEC01b.

The daily discharge rates at this site were calculated using the parabolic rating curve, up to two times the highest measured discharge (12.5 cfs). On seven days, water level elevations were too high for the rating curve, so discharge rates for those days were calculated using the DA ratio•USGS flow.

MDC01 (Mud Creek South of Cedar Sauk Road)

Figure 20 presents the water level elevation vs. discharge measurements at site MDC01. All three methods were used to fit the rating curve to estimate daily discharge rates at this site. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope curve is shown as the blue line. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios are in good agreement the DA ratios at high flow.

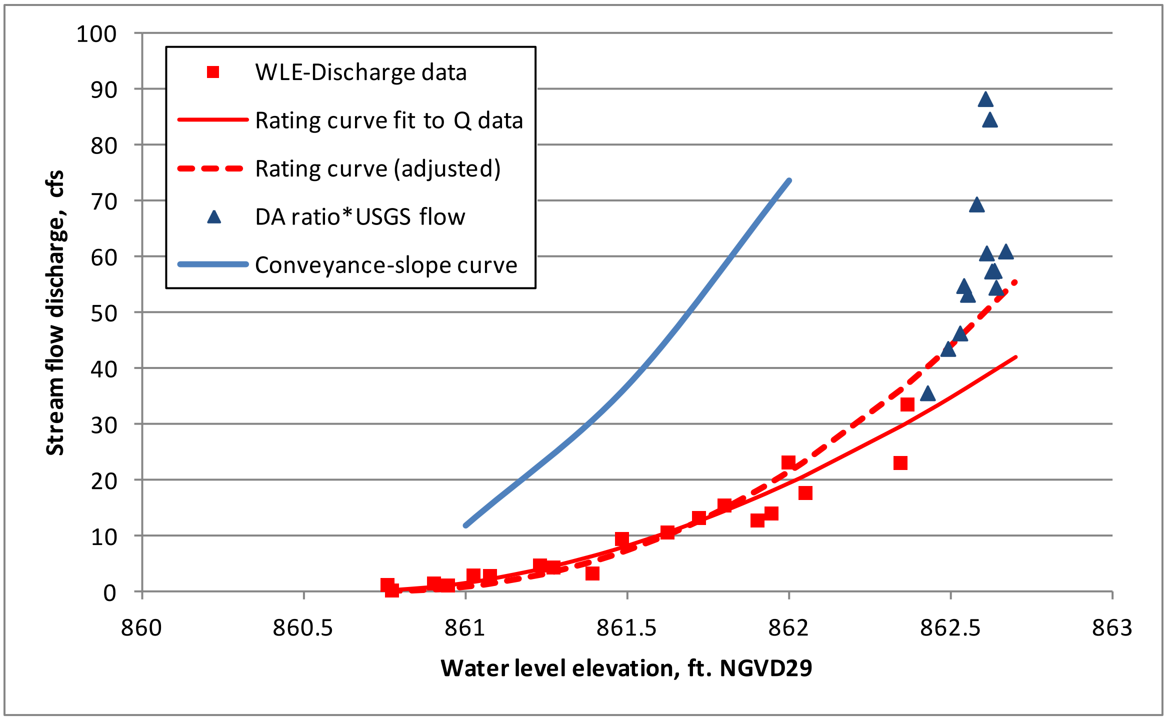


Figure 20. Water level elevation vs. stream flow discharge at site MDC01.

The daily discharge rates at this site were calculated using the parabolic rating curve, which was adjusted to predict higher discharges at elevations above 862'. The adjusted rating curve agreed favorably the discharge rates based on DA ratio•USGS flows, which supported extending the adjusted rating curve to high flows. At this site, the conveyance-slope curve predicted substantially higher discharge rates over a fairly narrow range of elevations that did not agree with the discharge data. Review of the survey data, site photos, and Google Earth imagery suggested that this site was marginal in term of conforming to the conveyance-slope method assumptions. The imagery and photos confirmed that the channel was fairly straight for only ~60 yds downstream, while the channel width appeared constant but brush-covered.

MLR01 (Milwaukee River Downstream of Riverside Drive)

Water level elevation vs. discharge measurements at site MLR01 are presented in **Figure 21**. At this site, all three methods were used to fit the rating curve to estimate daily discharge rates. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope curve is shown as the blue line. The blue symbols are the daily discharge rates calculated from the USGS Milwaukee River gauge and the DA ratio. The flow ratios approach the DA ratios at high flow.

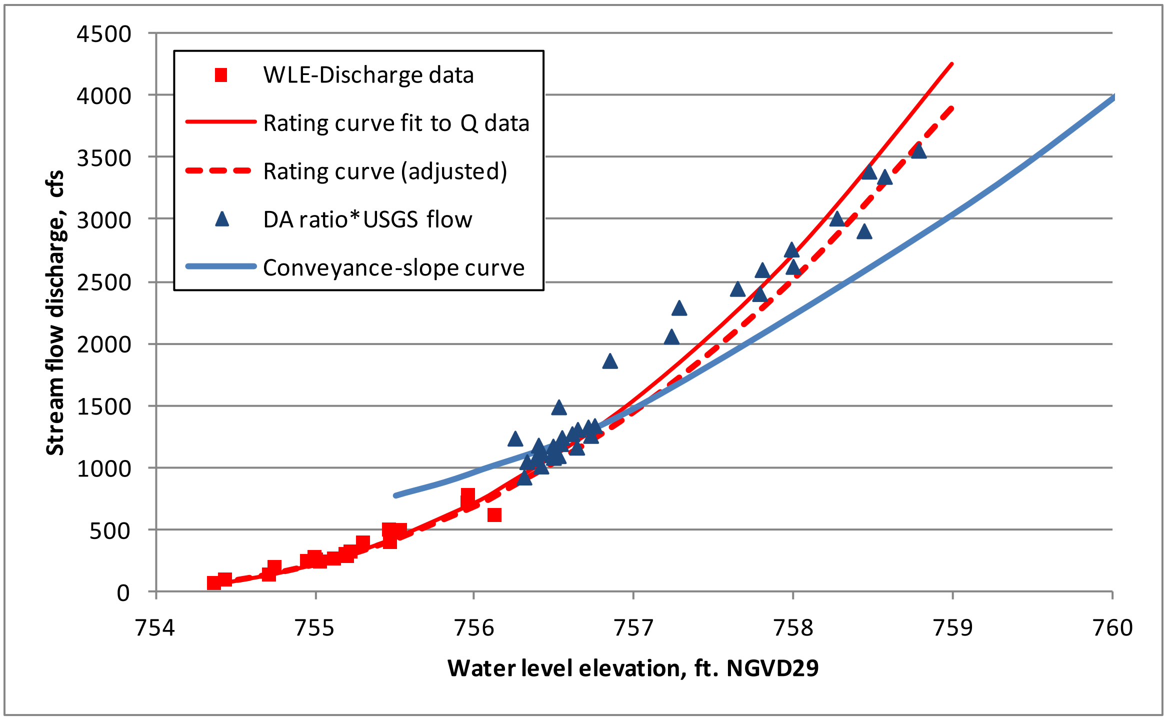


Figure 21. Water level elevation vs. stream flow discharge at site MLR01.

The daily discharge rates at this site were again calculated using the parabolic rating curve, which was adjusted to predict lower discharges at elevations above 758'. The adjusted rating curve agreed favorably with the DA ratio•USGS flows, which supported extending the adjusted rating curve to high flows. At this site, the conveyance-slope curve predicted a "flatter" rating curve that did not agree with the data across the range of water level elevations.

MLR02 (Milwaukee River Downstream of Saukville WWTP)

Water level elevation vs. discharge measurements at site MLR02 are presented in **Figure 22**. At this site, all three methods were used to fit the rating curve to estimate daily discharge rates. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope curve is shown as the blue line. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios approach the DA ratios at high flow.

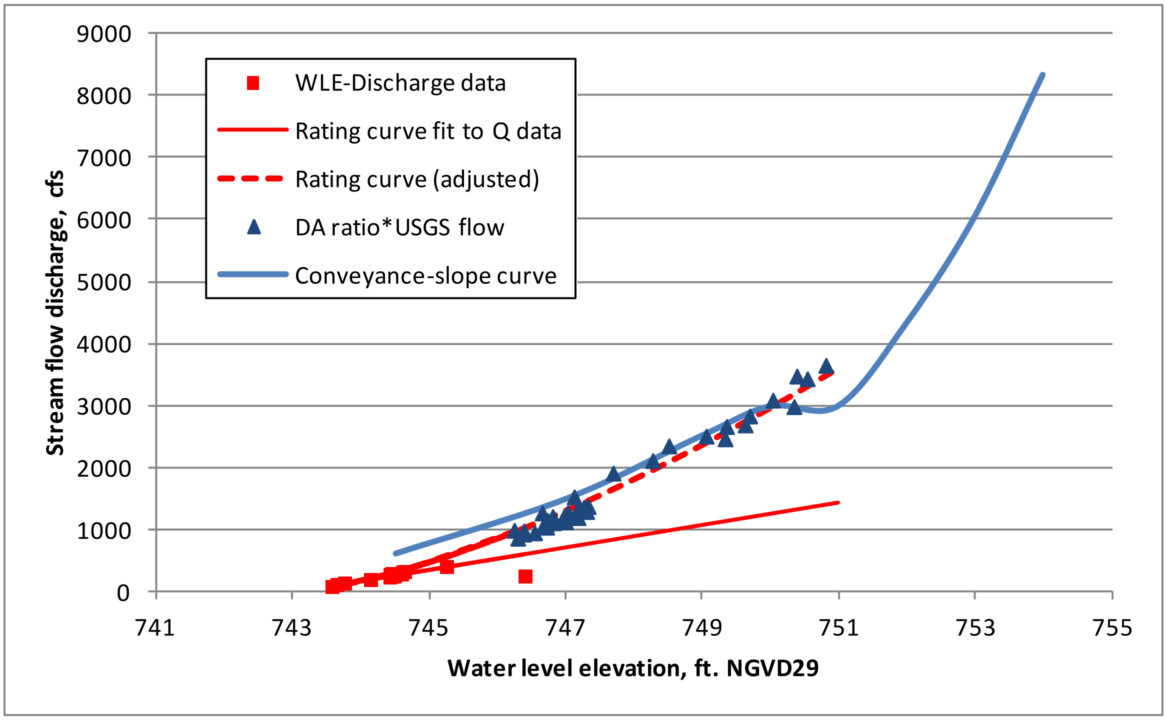


Figure 22. Water level elevation vs. stream flow discharge at site MLR02.

The daily discharge rates at this site were again calculated using a composite of the available methods. The parabolic rating curve was adjusted to predict higher discharges at elevations above 745’ and was used for water level elevations up to 750’, where the curve intersects with the conveyance-slope curve, which was used for elevations above 750’. The discharge rates based on DA ratio•USGS flows confirm the trend of discharge rates at moderate elevations calculated by both the adjusted rating curve and the conveyance-slope curve.

<u>*MLR03c-d (Milwaukee River Middle of Lime Kiln Park/ Downstream of CTH T)*</u>
The water level elevation vs. discharge measurements at site MLR03c-d are presented in **Figure 23**. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope method could not be applied at this site. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios are in good agreement the DA ratios at high flow.

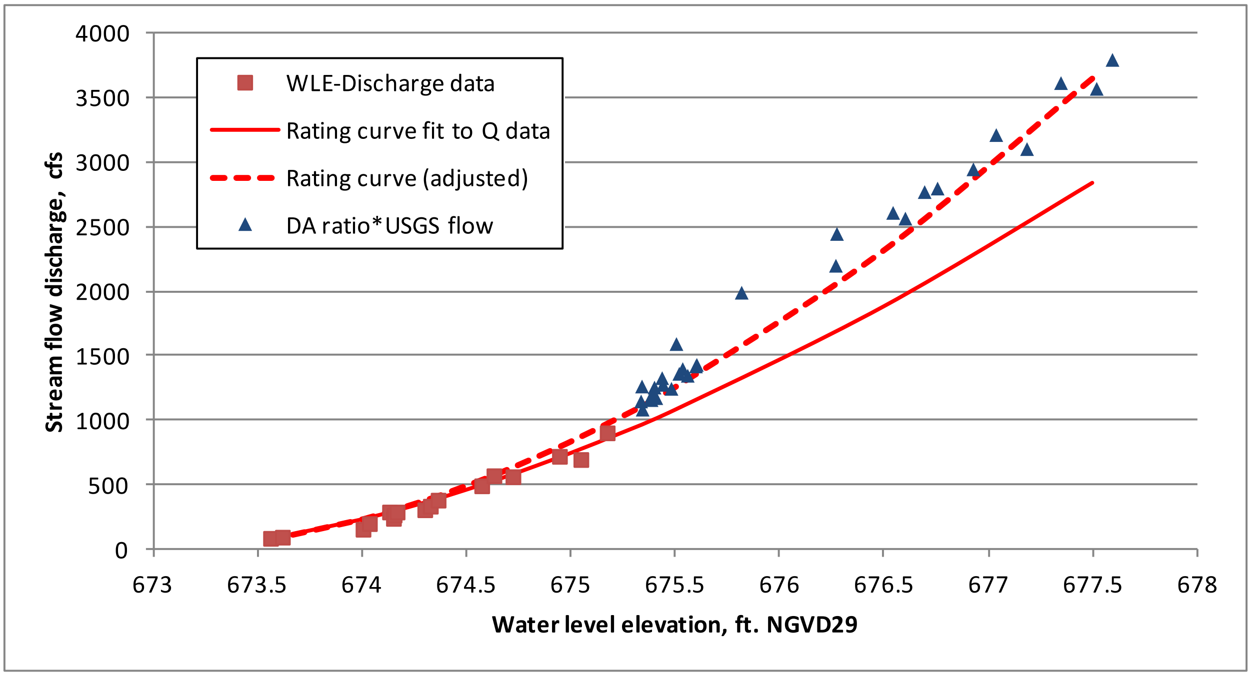


Figure 23. Water level elevation vs. stream flow discharge at site MLR03c-d.

The daily discharge rates at this site were calculated using the parabolic rating curve, which was adjusted to predict higher discharges at elevations above 675'. The adjusted rating curve agreed favorably with the DA ratio•USGS flows, which supported extending the adjusted rating curve to high flows.

MLR06b (Milwaukee River at STH 167)

Water level elevation vs. discharge measurements at site MLR06b are presented in **Figure 24**. At this site, all three methods were used to fit the rating curve to estimate daily discharge rates. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope curve is shown as the blue line. The blue symbols are the daily discharge rates calculated from the USGS Milwaukee River gauge and the DA ratio. The flow ratios approach the DA ratios at high flow.

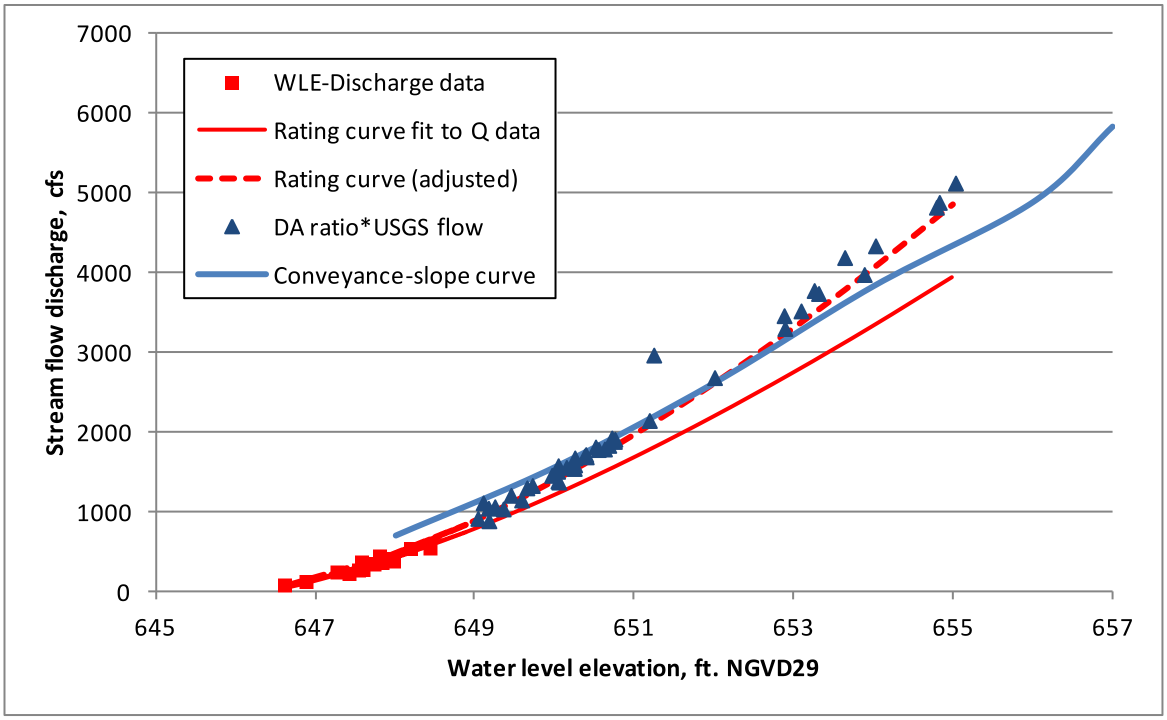


Figure 24. Water level elevation vs. stream flow discharge at site MLR06b.

The daily discharge rates at this site were again calculated using the parabolic rating curve, which was adjusted to predict higher discharges at elevations above 649'. The adjusted rating curve agreed favorably with the DA ratio•USGS flows, which supported extending the adjusted rating curve to high flows. At this site, the conveyance-slope curve was somewhat "flatter" than the adjusted rating curve and did not agree as well with the data across the range of water level elevations.

MOC02 (Mole Creek at Maple Road)

The water level elevation vs. discharge measurements at site MOC02 are presented in **Figure 25**. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope method could not be applied at this site, due to reasons explained for other sites above. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios approached the DA ratio at high flow, although there was considerable scatter in the DA ratio•USGS flows.

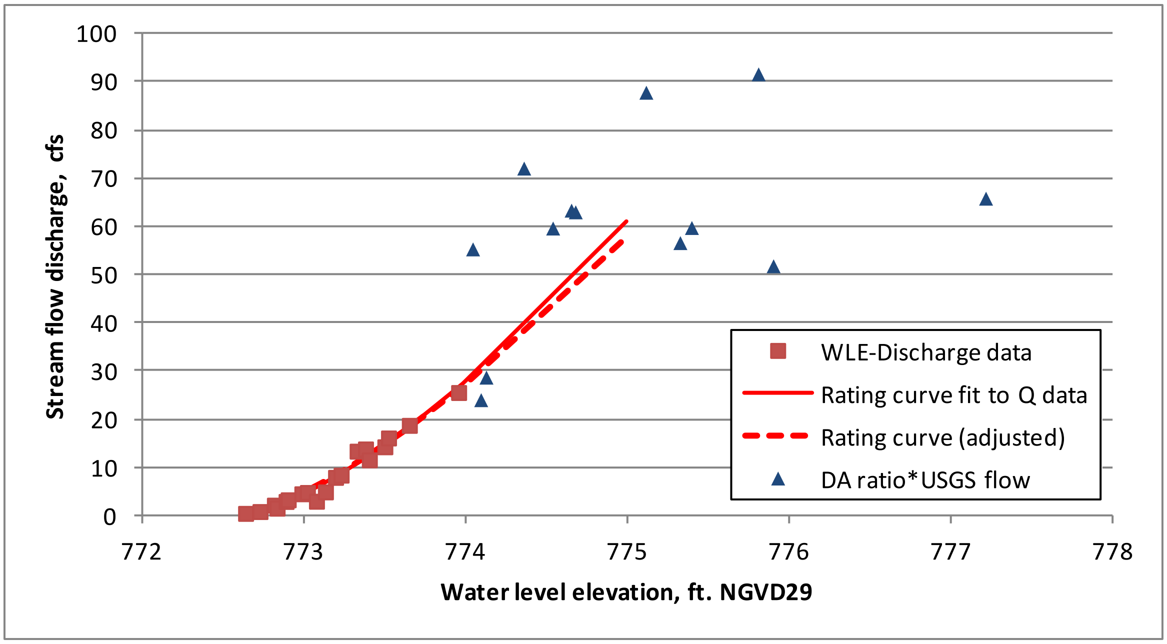


Figure 25. Water level elevation vs. stream flow discharge at site MOC02.

The daily discharge rates at this site were calculated using the parabolic rating curve, which was adjusted to predict lower discharges at elevations above 776’, up to two times the highest measured discharge (52 cfs). On nine days, water level elevations were too high for the rating curve, so flow rates on those days were calculated using the DA ratio•USGS flow.

<u>*NCC01b (North Branch of Cedar Creek Upstream of CTH NN)*</u>
The water level elevation vs. discharge measurements at site NCC01b are presented in **Figure 26**. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope method could not be applied at this site. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios approached the DA ratio at high flow, although there was some scatter in the DA ratio•USGS flows.

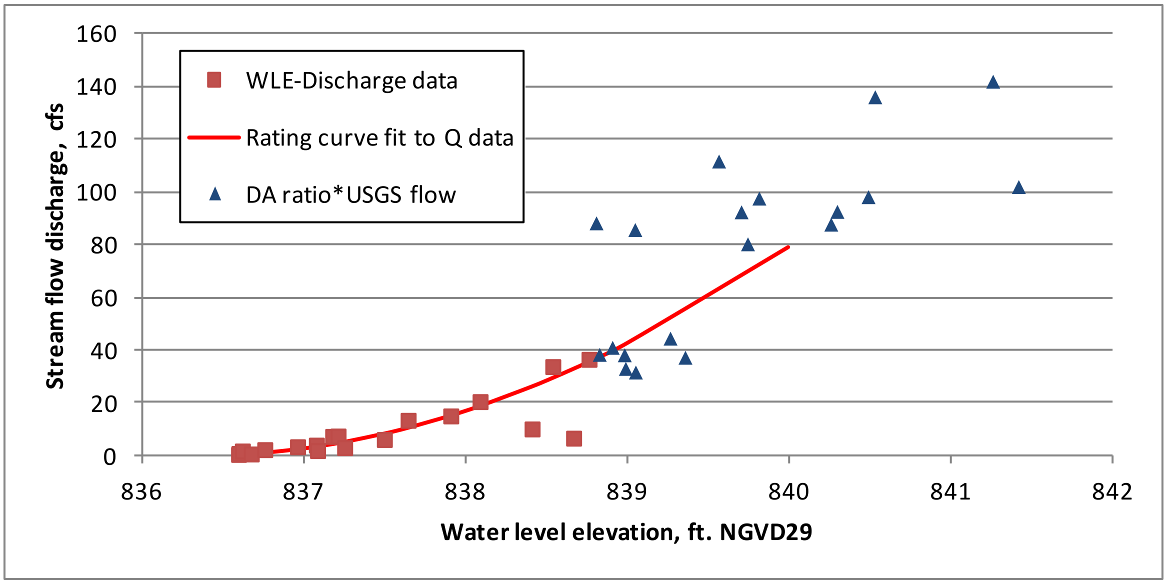


Figure 26. Water level elevation vs. stream flow discharge at site NCC01b.

The daily discharge rates at this site were calculated using the parabolic rating curve, up to 76 cfs (two times the highest measured discharge). On nine days, water level elevations were too high for the rating curve, so discharge rates on those days were calculated using the DA ratio•USGS flow.

PGC01c (Pigeon Creek at Pedestrian footbridge upstream of Green Bay Road)
Figure 27 presents the water level elevation vs. discharge measurements at site PGC01c. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope method could not be applied at this site, due to reasons explained for other sites above. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios are in good agreement the DA ratios at high flow.

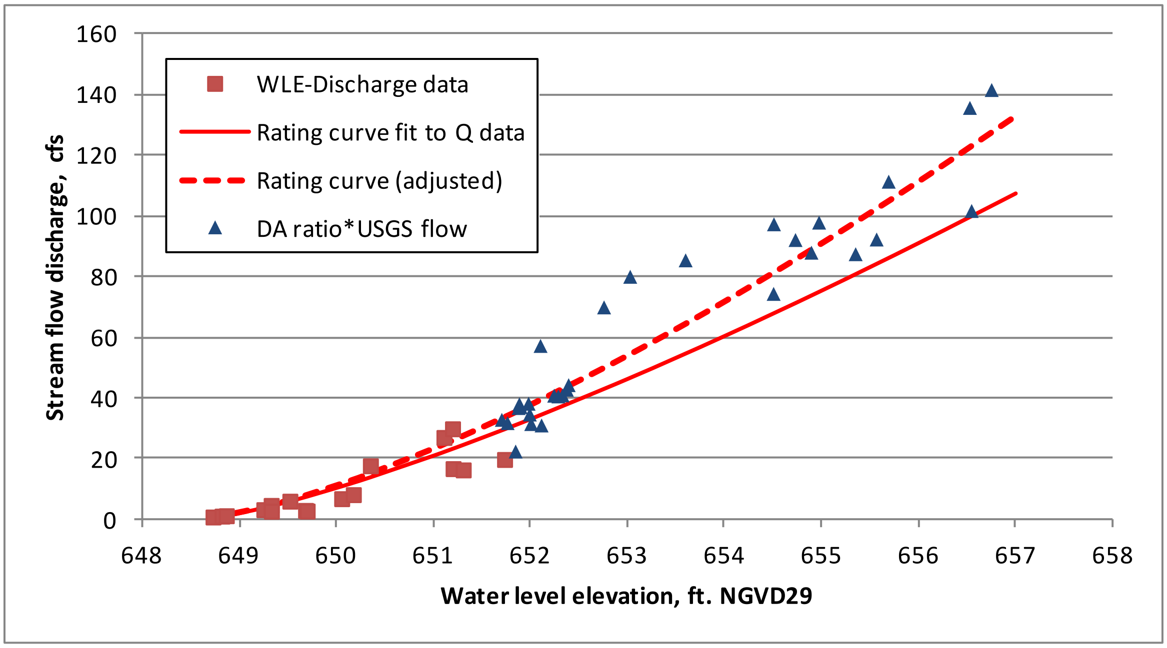


Figure 27. Water level elevation vs. stream flow discharge at site PGC01c

The daily discharge rates at this site were calculated using the parabolic rating curve, which was adjusted to predict higher discharges at elevations above 652'. The adjusted rating curve agreed favorably with the DA ratio•USGS flows, which supported extending the adjusted rating curve to high flows.

<u>*PSC01 (Polk Springs Creek at CTH P)*</u>
The water level elevation vs. discharge measurements at site PSC01 are presented in **Figure 28**. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope method could not be applied at this site, due to reasons explained for other sites above. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios approached the DA ratio at high flow, although there was some scatter in the flow ratios.

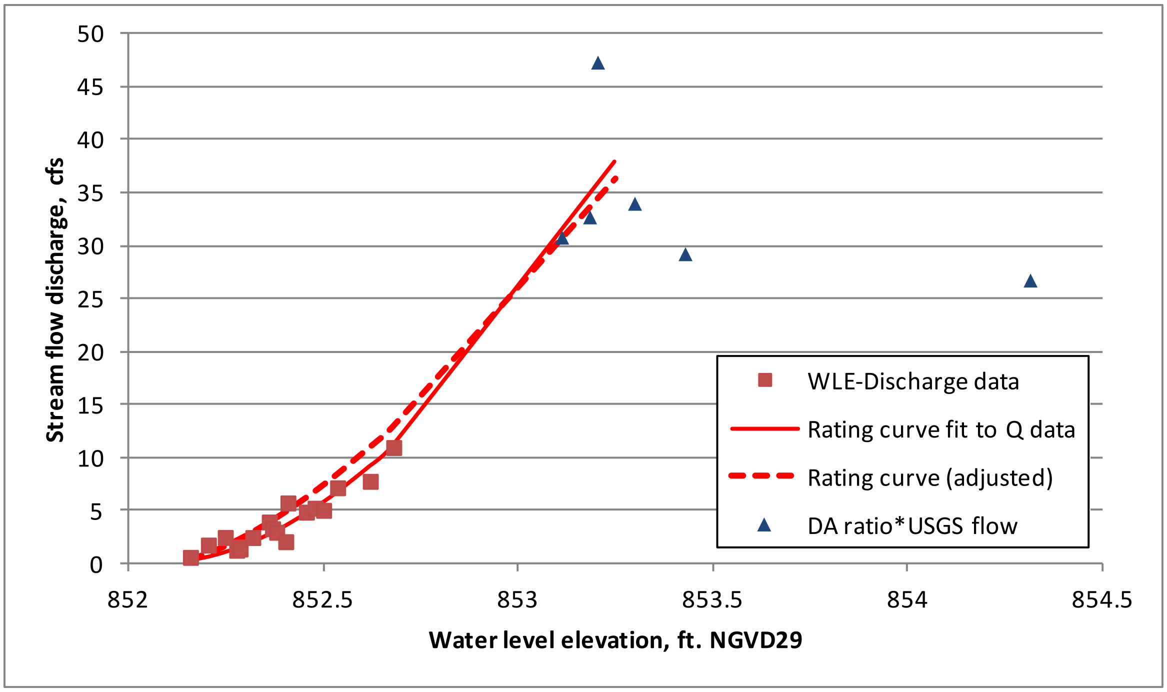


Figure 28. Water level elevation vs. stream flow discharge at site PSC01.

The daily discharge rates at this site were calculated using the parabolic rating curve, which was adjusted to predict lower discharges at elevations above 853', up to 26 cfs (two times the highest measured discharge). On eleven days, water level elevations were too high for the rating curve, so discharge rates on those days were calculated using the DA ratio•USGS flow.

RDC01 (Riverside Drive Creek at Evergreen Lane)

Figure 29 presents the water level elevation vs. discharge measurements at site RDC01. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope method could not be applied at this site. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios are in good agreement the DA ratios at high flow.

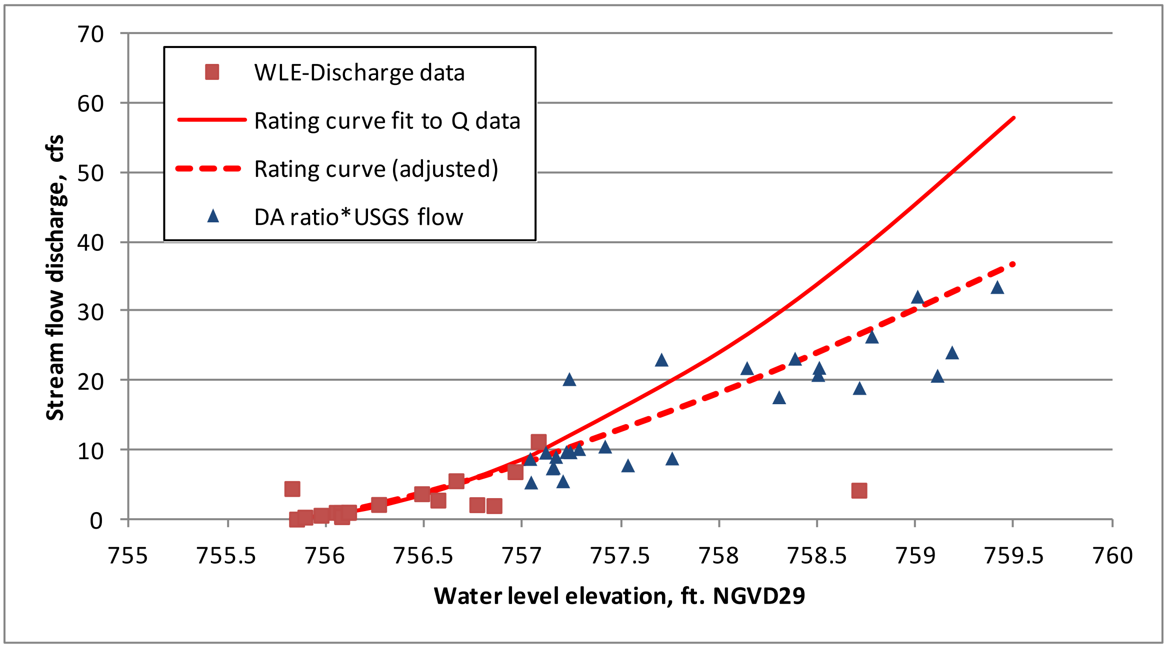


Figure 29. Water level elevation vs. stream flow discharge at site RDC01.

The daily discharge rates at this site were calculated using the parabolic rating curve, which was adjusted to predict lower discharges at elevations above 757’. The adjusted rating curve agreed favorably with the DA ratio•USGS flows, which supported extending the adjusted rating curve to high flows.

<u>*ULC01 (Ulao Creek at STH 60 east of I-43)*</u>
The water level elevation vs. discharge measurements at site ULC01 are presented in **Figure 30**. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope method could not be applied at this site, due to reasons explained for other sites above. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios approached the DA ratio at high flow, although there was considerable scatter in the flow ratios.

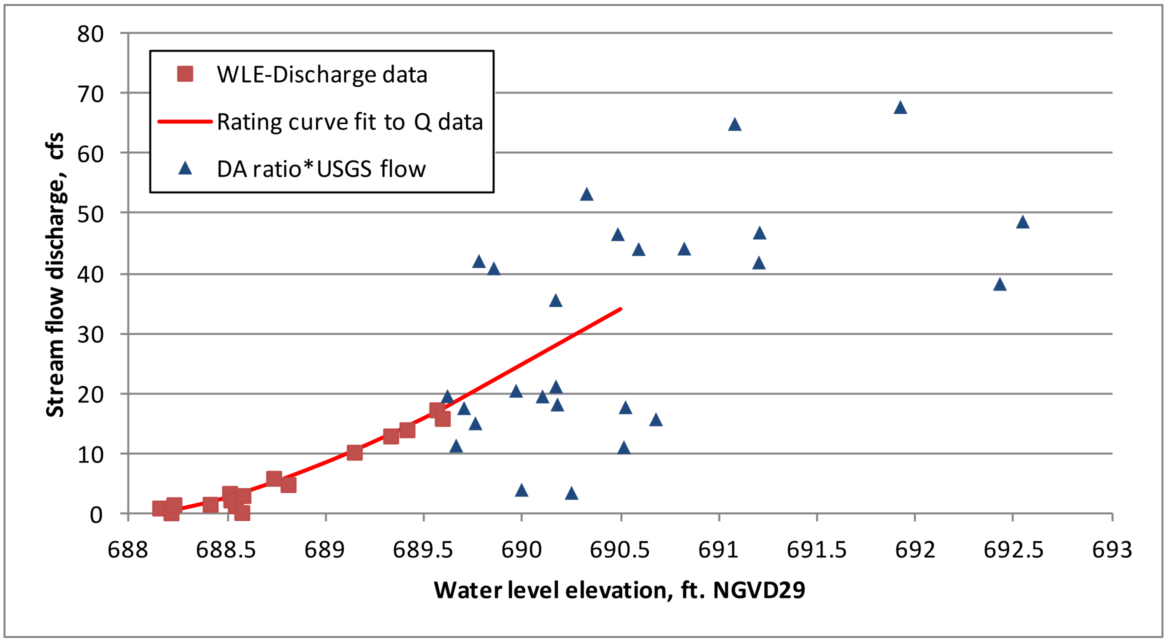


Figure 30. Water level elevation vs. stream flow discharge at site ULC01.

The daily discharge rates at this site were calculated using the parabolic rating curve, up to 34 cfs (two times the highest measured discharge). On sixteen days, water level elevations were too high for the rating curve, so discharge rates on those days were calculated using the DA ratio•USGS flow.

ULC02 (Ulao Creek at Bonniwell Road)

Figure 31 presents the water level elevation vs. discharge measurements at site ULC02. The parabolic rating curve (red line) is fitted to the elevation-discharge data (red symbols). The conveyance-slope method could not be applied at this site, due to reasons explained for other sites above. The blue symbols are the daily discharge rates calculated from the USGS Cedar Creek gauge and the DA ratio. The flow ratios are in good agreement the DA ratios at high flow.

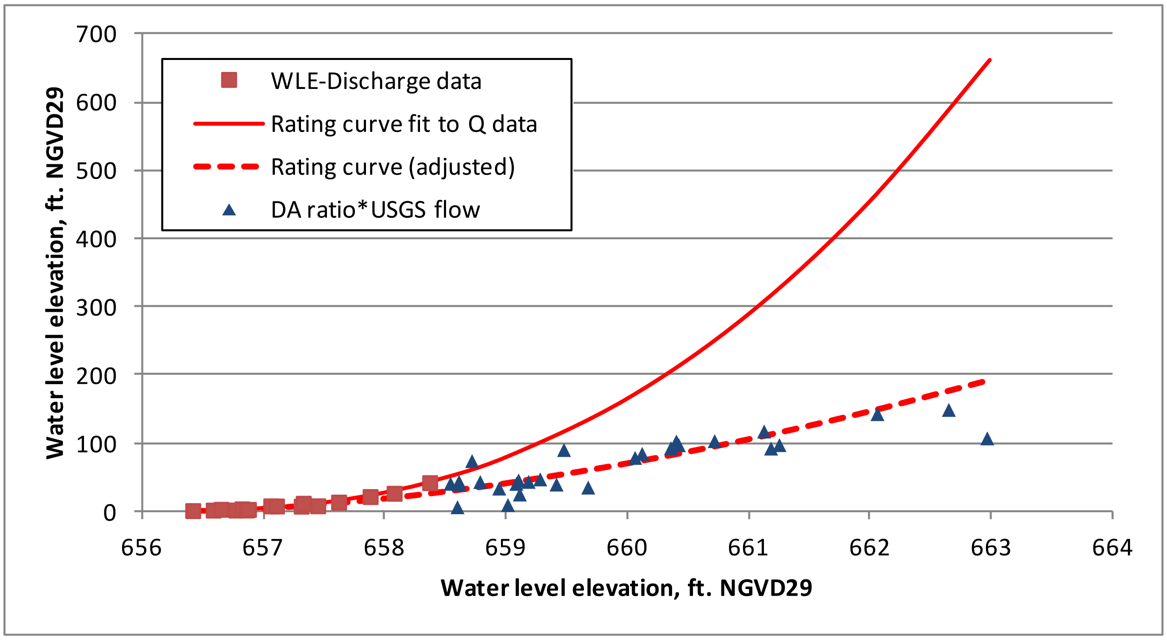


Figure 31. Water level elevation vs. stream flow discharge at site ULC02.

The daily discharge rates at this site were calculated using the parabolic rating curve, which was adjusted to predict lower discharges at elevations above 658'. The adjusted rating curve agreed favorably with the DA ratio•USGS flows, which supported extending the adjusted rating curve to high flows. At this site, the Levelogger stopped recording water levels on June 11, 2019. For the remainder of the monitoring period, daily discharges at this site were calculated from the USGS Cedar Creek gauge and the DA ratio.

Table 4. Summary of elevation-discharge data from 25 sites, initial and adjusted rating curves, drainage area ratios, and elevation range of conveyance-slope (C-S) data.
Q: Discharge; DA: drainage area

Site	Levelogger elevations (EL, ft. NGVD29)			Water level elevation (WLE) range (ft., daily avg.)	Q (cfs)	Rating curve	Root-mean square error (RMSE)	DA (sq. mi.)	DA Ratio	High-flow ratio	Adjusted Rating curve	Cross-section surveyed for C-S curve?	Elevation range (C-S curve)
	2017	2018	2019										
CBC01	845.11	845.10	845.18	845.20 - 849.18	0 - 21	Q=7.029*[(EL+LL)-845.5)^1.45	1.12	6.4	18.61	17-39		yes	846 - 851
CDC01b	1017.13	1017.20	1017.24	1017.10 - 1020.14	0.89 - 40	Q=15.58*[(EL+LL)-1017.2)^1.11	3.34	10.2	11.76	6.4-15	Q=15.58*[(EL+LL)-1017.3)^1.3	no	
CDC03	912.90	913.37	913.09	913.13 - 914.83	5.0 - 78	Q=50.05*[(EL+LL)-913.2)^1.60	1.72	20.3	5.91	5.3-7.8	Q=50.05*[(EL+LL)-913.2)^1.80	no	
CDC04b	830.41	830.80	830.99	831.02 - 837.25	11 - 150	Q=3.08*[(EL+LL)-830.0)^3.10	22.8	83.0	1.45	1.4-1.6		yes	832 - 837
CDC05	828.17	828.28	827.90	827.93 - 835.90	11 - 170	Q=69.8*[(EL+LL)-829.3)^1.3	28.8	85.4	1.41	1.4-1.8		yes	830 - 835
CDC07b	804.56	804.028[1]	803.87	803.94 - 810.63	13 - 260	Q=121.9*[(EL+LL)-805.0)^1.10	27.1	118.6	1.01	1.0-1.2	Q=121.9*[(EL+LL)-805.0)^1.20	yes	806 - 812
CDC08c	703.07	703.492[1]	703.63	703.21 - 707.81	12 - 240	Q=118.1*[(EL+LL)-703.8)^1.80	32.0	124.9	0.96	1.1-1.4		yes	704 - 712
EVC01	845.14	845.10	845.16	845.12 - 848.59	0.03 - 19	Q=14.9*[(EL+LL)-845.6)^2.15	1.22	4.9	24.44	12-45		no	
JKC01	864.34	864.16	864.28	864.34 - 868.24	-0.04[1] - 6.1	Q=0.249*[(EL+LL)-863.6)^3.94	0.266	1.5	80.89	38-148		yes	866 - 872
KRB01b	840.04	840.20	840.13	840.16 - 846.36	0.39 - 22	Q=3.33*[(EL+LL)-840.6)^2.10	2.30	8.6	14.00	11-16	Q=3.33*[(EL+LL)-840.6)^1.90	yes	842 - 845.3
LCC01	838.49	838.43	838.33	838.36 - 845.47	2.2 - 36	Q=8.63*[(EL+LL)-838.8)^1.63	3.29	21.2	5.65	5.1-6.2	Q=8.63*[(EL+LL)-838.8)^1.75	no	
LCC02	844.24	844.10	844.13	844.17 - 849.82	1.9 - 17	Q=10.7*[(EL+LL)-844.5)^1.50	2.04	11.0	10.90	18-23		yes	845 - 848.2
LEC01b	945.54	945.91	945.70	945.78 - 947.22	2.0 - 6.3	Q=8.67*[(EL+LL)-945.6)^2.64	0.863	2.6	46.97	28-79		no	
MDC01	860.22	860.52	860.45	860.62 - 862.67	0.06 - 33	Q=12.1*[(EL+LL)-860.7)^1.80	2.61	7.7	15.63	11-13	Q=12.1*[(EL+LL)-860.7)^2.20	yes	860 - 862
MLR01	753.87	753.82	754.42	753.87 - 760.45	64 - 780	Q=104.1*[(EL+LL)-753.6)^2.20	59.6	443.7	1.35	1.2-1.5	Q=104.1*[(EL+LL)-753.6)^2.15	yes	755.5 - 760.25
MLR02	743.25	743.23	743.94	743.26 - 752.28	66 - 390	Q=180.0*[(EL+LL)-743.1)^1.0	92.0	454.8	1.32	1.4-1.7	Q=180.0*[(EL+LL)-743.1)^1.45	yes	744.5 - 754
MLR03c-d	692.33	672.903[1]	673.76	672.98 - 678.81	84 - 900	Q=265.2*[(EL+LL)-673.1)^1.60	37.2	472.4	1.27	1.2-1.3	Q=265.2*[(EL+LL)-673.1)^1.77	no	
MLR06b	646.45	646.12	646.52	646.13 - 656.01	69 - 530	Q=186.2*[(EL+LL)-646.2)^1.40	34.2	638.8	0.94	0.9-2.4	Q=186.2*[(EL+LL)-646.2)^1.50	yes	648 - 657

Site	Levelogger elevations (EL, ft. NGVD29)			Water level elevation (WLE) range (ft., daily avg.)	Q (cfs)	Rating curve	Root-mean square error (RMSE)	DA (sq. mi.)	DA Ratio	High-flow ratio	Adjusted Rating curve	Cross-section surveyed for C-S curve?	Elevation range (C-S curve)
	2017	2018	2019										
MOC02	772.30	772.34	772.36	772.40 - 777.22	0.45 - 26	Q=17.0*[(EL+LL)-772.6)^1.46	1.20	7.9	15.10	13-17	Q=17.0*[(EL+LL)-772.6)^1.40	no	
NCC01b	836.17	836.32	836.04	836.07 - 841.42	0.44 - 37	Q=6.92*[(EL+LL)-836.4)^1.90	7.45	12.3	9.75	6.2-12		no	
PGC01c	647.42	647.56	648.32[3]	647.60 - 658.30	0.78 - 30	Q=6.73*[(EL+LL)-648.6)^1.30	4.80	12.3	9.77	8.0-15	Q=6.73*[(EL+LL)-648.6)^1.40	no	
PSC01	851.65	851.70	851.62	851.65 - 854.81	0.58 - 11	Q=29.5*[(EL+LL)-852.1)^1.80	0.930	4.1	29.24	22-85	Q=29.5*[(EL+LL)-852.1)^1.50	no	
RDC01	755.12	755.043[4]	755.68	755.04 - 760.89	0.04 - 11	Q=6.27*[(EL+LL)-755.8)^1.70	8.09	2.9	41.30	31-44	Q=6.27*[(EL+LL)-755.8)^1.35	no	
ULC01	687.16	687.27	687.25	687.25 - 692.55	-0.06[1] - 17	Q=9.80*[(EL+LL)-688.1)^1.42	1.08	5.9	20.40	16-24		no	
ULC02	655.61	655.158[1]	655.79	655.20 - 662.97	-0.05[1] - 42	Q=7.59*[(EL+LL)-656.3)^2.35	2.11	12.9	9.33	5.5-8.3	Q=7.59*[(EL+LL)-656.3)^1.70	no	

notes:

1) Negative discharges likely reflect errors in velocity measurement at near-zero flow, and were replaced with zero flow in pollutant loading calculations
2) Leveloggers relocated in 2018
3) PGC01c levelogger raised 0.69 ft. on June 19, 2019
4) RDC01 levelogger raised 0.53 ft. on September 17, 2018

Summary of Daily Discharge

Figures 32 and 33 show stream discharge profiles (hydrographs) as well as long-term averages (36- and 80-yr median daily statistic) at USGS gauging stations on the Milwaukee River near Cedarburg, WI (USGS 04086600, **Figure 32**) and Cedar Creek near Cedarburg, WI (USGS 04086500, **Figure 33**) from September 2017 to December 2019. The USGS discharge data presented in these figures offer useful hydrologic summaries for the Milwaukee River watershed over the project period. Both USGS stream gauge discharge profiles show:

1) lower than average discharge from March through April 2018 (due to extended ice cover);
2) historically lower than average (Milwaukee River) discharges in August 2018, due to unusually dry and hot conditions;
3) higher than average discharge in the fall of 2017 and May and June 2018 (Milwaukee River) and May through August 2018 (Cedar Creek) – in the latter cases due to heavy rains in May through June, and;
4) much higher than average discharges in both Cedar Creek and the Milwaukee River gauging stations beginning fall 2018 through December 2019 (due again to greater than historic average rainfall).

In fact 2019 was the wettest year ever across Wisconsin and the Midwest since record keeping began in 1895. Wisconsin received 41.75 inches of precipitation through November of 2019. The amount of rain and snow received in 2019 surpassed the previous record of 40.09 inches set in 1938 (WPR, 2019). The months of September and October were exceptionally wet across the Upper Midwest in 2019, with four states (Iowa, Minnesota, Wisconsin and Michigan) in the top 10 percent of precipitation for both September and October. Across the Midwest, the precipitation recorded in 2019 was about 25 percent above normal (WPR, 2019).

The record amounts of precipitation noted above are reflected in the stream flow discharges. In September-November 2018, the daily Milwaukee River discharge exceeded the 90th percentile daily flow 42 times, exceeded the 95th percentile daily flow 32 times, and exceeded the maximum recoded daily flow on 15 days (data going back to 1981). In 2019, the September-November daily Milwaukee River flow rates were even higher: discharge exceeded the 90th percentile daily flow 76 times, exceeded the 95th percentile daily flow 49 times, and exceeded the maximum recoded daily flow on 24 days. Even more remarkably in September-November 2019, the daily Milwaukee River discharge exceeded the 90th percentile daily flow for 66 consecutive days and exceeded the 95th percentile daily flow for 30 consecutive days. The USGS also reported exceptionally high discharge at the Cedar Creek gauge in the fall of 2018 and especially 2019.

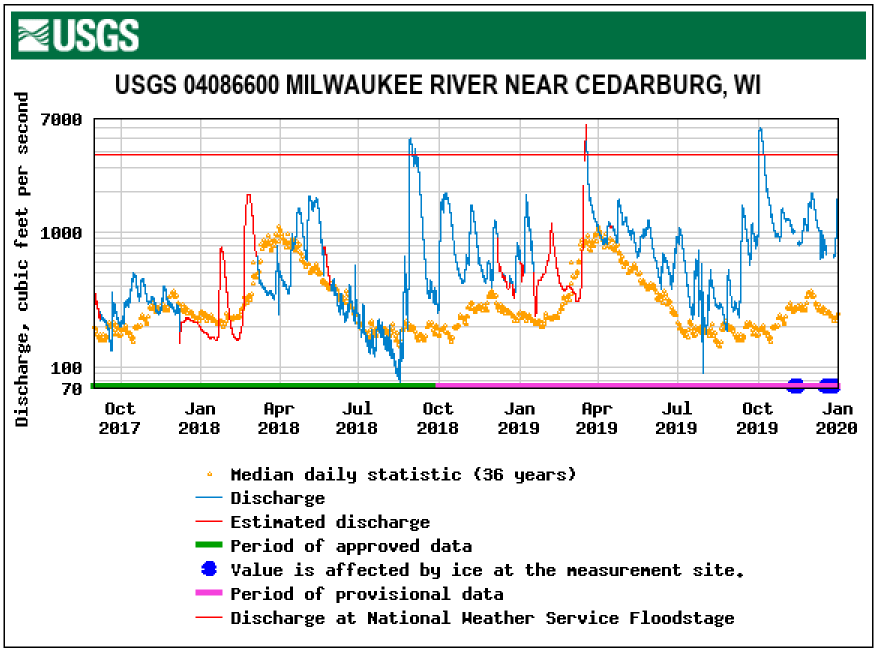


Figure 32. Hydrograph and long-term averages at USGS 04086600 (Milwaukee River near Cedarburg, WI) from September 2017 through December 2019.

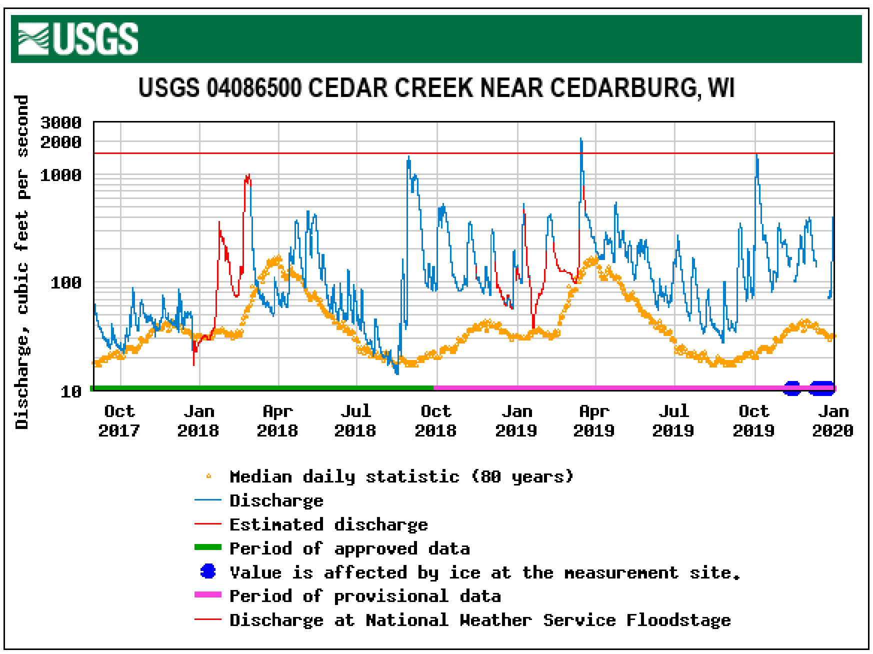


Figure 33. Hydrograph and long-term averages at USGS 04086500 (Cedar Creek near Cedarburg, WI) from September 2017 through December 2019.

Figures 34 and 35 show final hydrographs for the four project sites on the Milwaukee River (**Figure 34**) and four of the six project sites on Cedar Creek (**Figure 35**) calculated as described above during ice-off months from September 2017 through November 2019. The hydrographs at these 8 project sites agree favorably with the hydrographs from the USGS gauging stations on the Milwaukee River and Cedar Creek near Cedarburg, WI (**Figures 32 and 33**), in terms of seasonality, occurrence of high-flow events and magnitudes of stream discharges. The USGS Milwaukee River gauge (04086600) is downstream from MLR03d. The USGS Cedar Creek gauge (04086500) is near CDC07b. This agreement is not surprising since many comparisons to the USGS gauge discharges were made during development of the rating curves and calculation of daily discharge rates.

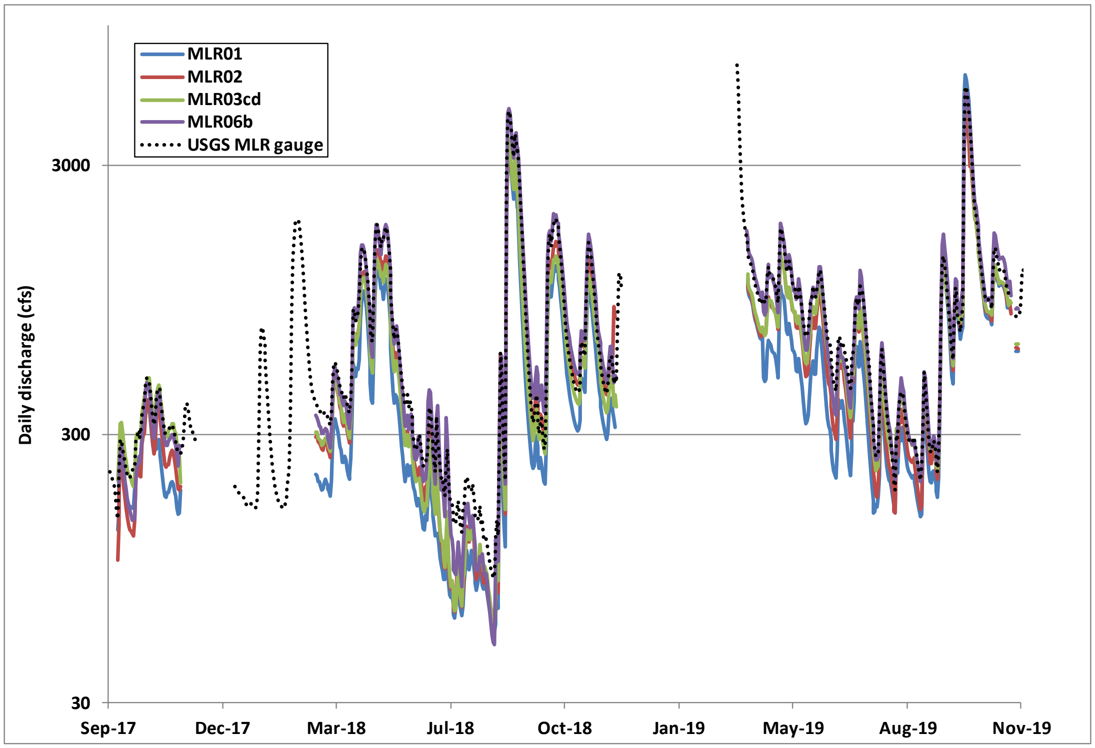


Figure 34. Stream discharge profiles of four project sites on the Milwaukee River, WI from September 2017 through November 2019.

USGS Milwaukee River gauge (04086600) discharge added for comparison.

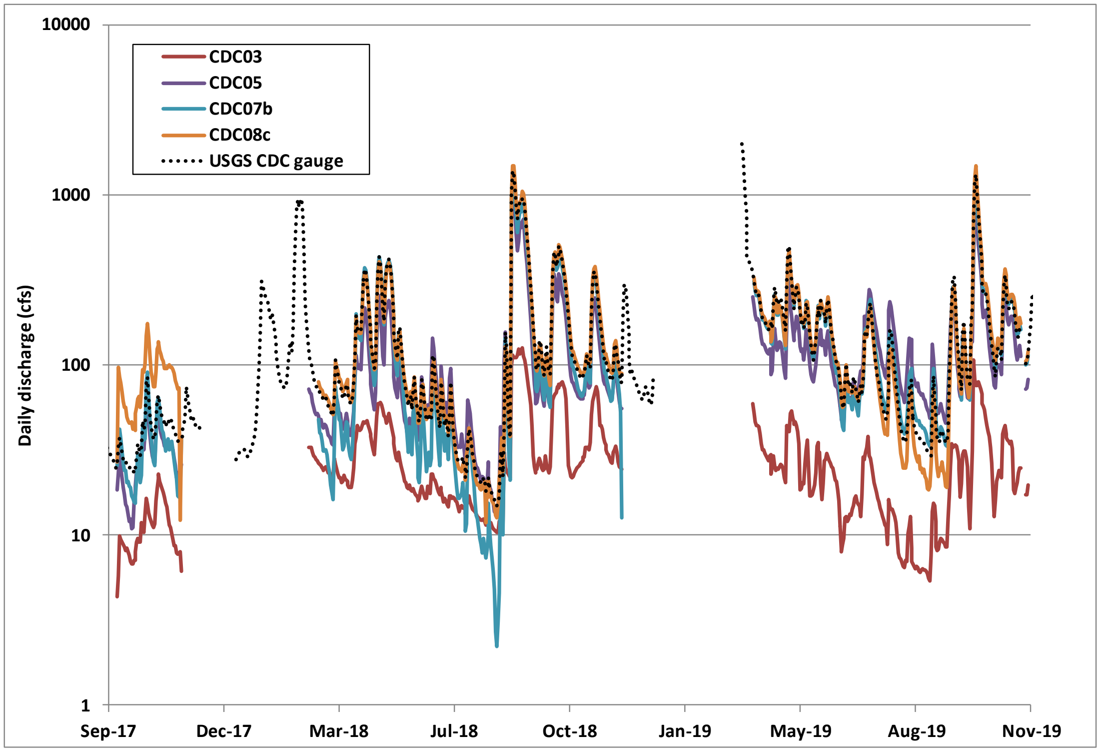


Figure 35. Stream discharge profiles at four of six project sites on Cedar Creek, WI from September 2017 through November 2019.
USGS Cedar Creek gauge (04086500) discharge added for comparison.

Annual mean (average) daily discharges are also presented in a column graph (**Figure 36**) by site and calendar year. Annual mean daily discharges are an order-of-magnitude higher at the lower Cedar Creek (CDC04b through CDC08c) and all Milwaukee River sites compared to tributary sites, and discharge increases with downstream distance in each water body. At each site, a consistent trend in annual mean daily discharges are observed between years: discharges in 2019 were slightly higher than 2018 (average 16% higher at all sites, 15% higher sites on Cedar Creek and 37% higher at Milwaukee River sites), and discharges in 2018 and 2019 both appeared to be much higher than in 2017 (although flow monitoring did not begin until September of that year). The greatest contrasts in annual discharges occurred in the fall (September-November). Annual discharges in the fall of 2019 were an average of 8.5 times higher than in 2017 (all sites), 4.3 times higher (Cedar Creek sites), and 5.0 times higher (Milwaukee River sites).

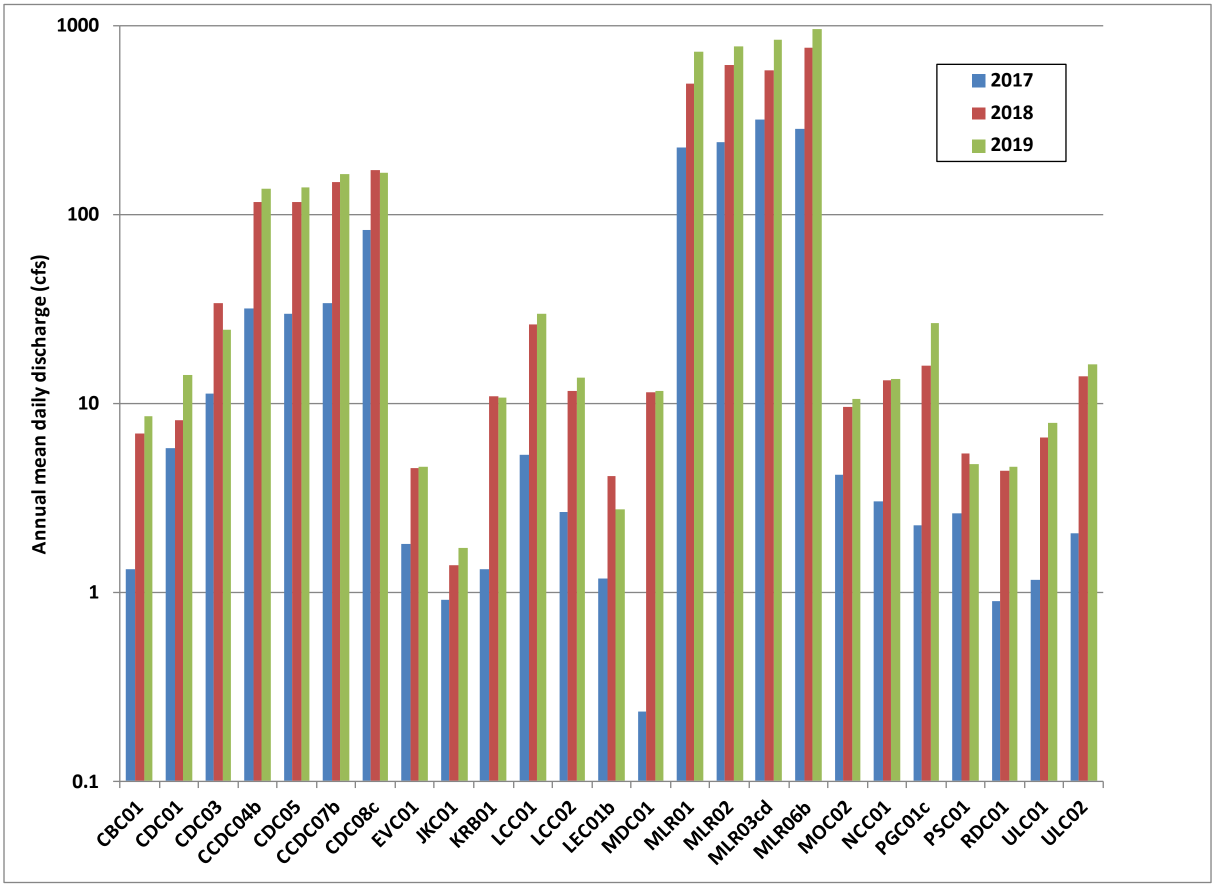


Figure 36. Annual mean (average) daily discharge at each site and calendar year.

E. Calculate pollutant loads

Determining the loading of pollutants at the monitoring sites located throughout the Milwaukee River watersheds in Ozaukee and Washington Counties was a primary objective of this monitoring project. This can be done in several ways. First, pollutant mass loadings can be calculated directly for the days when sampling was conducted in 2017-2019. The mass loading W (in units of kilograms/day) for TSS and TP can be calculated as:

$$W\left(\frac{kg}{d}\right) = Q\left(\frac{ft^3}{s}\right) \cdot C\left(\frac{mg}{L}\right) \cdot \left(\frac{28.317\ L}{ft^3}\right) \cdot \left(\frac{1\ kg}{1E6\ mg}\right) \cdot \left(\frac{86{,}400\ s}{d}\right)$$

where:

Q	=	Stream discharge (ft^3/s or cfs)
C	=	TSS or TP concentration (mg/L)

When stream discharge was measured at a site nearly concurrent (i.e., within 1 day) of the collection of water samples for laboratory analyses, we used the discharge measurement as Q. However, during high stage and stream flow it was not always possible to measure discharge concurrently with water sampling, as previously discussed. In those instances, daily discharge estimates (calculated as described above) were used instead as Q.

For the microbiological pollutants, FC and *E. coli*, loadings must be expressed in terms of bacterial density instead of mass:

$$W\left(\frac{n}{d}\right) = Q\left(\frac{ft^3}{s}\right) \cdot C\left(\frac{n}{100mL}\right) \cdot \left(\frac{28.317\ L}{ft^3}\right) \cdot \left(\frac{1000\ mL}{L}\right) \cdot \left(\frac{86{,}400\ s}{d}\right)$$

where:

n = *E. coli* (most probable number, MPN) or FC (colony forming units, CFU)

As discussed in **Appendix F** (*Summary of QA/QC Review and Evaluation of Data*), a limited number of pollutant concentration values were censored or otherwise flagged. These values were treated in the following manner for loading calculations:

- Values reported as less than the Method Detection Limit (MDL) were replaced with one-half the MDL;
- Values reported as a greater than a specified limit were replaced with the limiting value;
- Values flagged as "J" (estimated concentration above the adjusted MDL and below the adjusted reporting limit) were not replaced (the estimated value was used).

In addition, field duplicate sample values were not considered in the loading computations.

The loadings based on instantaneous measurements of pollutant concentration and daily discharge are presented for each site in **Appendix G**. These tabulations are essentially "snapshots" of pollutant loadings based on monthly sampling at each site, as well as high-flow (wet weather event) sampling at four of the sites (CDC03, CDC05, LCC01 and MLR06b). Time series graphs of the instantaneous pollutant loadings are plotted in **Figures 37-40** for the four sites where both scheduled and high-flow sampling was conducted. The loadings plotted in **Figures 37-40** correspond to sites where mean daily discharges ranged from moderately low (CDC03 and LCC01), to moderate (CDC05) to high (MLR06b). Daily discharges measured at the USGS Cedar Creek gauge is plotted on the secondary axis in these figures, providing a visual sense of how pollutant loadings at each site respond to changes in discharge.

The pollutant loadings from minor tributaries were relatively small compared to sites along the mainstem of Cedar Creek and the Milwaukee River (**Appendix G**). On Cedar Creek, the TSS loadings increased from the upper reaches (CDC01b and CDC03) to the middle reach (CDC04b and CDC05) commensurate with increased discharge. In the lower river reaches (CDC07b and CDC08c), TSS loadings generally fell in-between the upper and middle reach values. TP loadings on Cedar Creek also increased from the sites on the upper reaches to the middle reach. However, TP loadings in the middle and lower reaches were generally comparable. For both FC and *E. coli* the loadings in the upper reaches increased from CDC01b to CDC03, and also increased from the upper reaches to middle and lower reaches. In the middle and lower reaches the spatial trends in FC and *E. coli* loading were less consistent.

On the Milwaukee River, the TSS and TP loadings exhibit more seasonal than spatial trends, with the highest loadings in spring and fall. In general, the TSS and TP loadings on the Milwaukee River are much higher compared to all other sites. FC and *E. coli* loadings on the Milwaukee River are also higher than other sites and exhibit more of a seasonal than spatial trend.

Pollutant loadings increased substantially during wet weather, as shown in **Figures 37-40**. This is not unexpected, given the proportionality between discharge rate and loading. However, the loading increases during wet weather were often greater than the increase in discharge rate. For example, comparison between monitoring results from scheduled and high-flow sampling at site CDC03 in May of 2018 shows that discharge rates increase by 80% (1.8 times), but pollutant loading increase by 5.5 (for TP) to 64 (*E. coli*) times (**Figure 37**). At site LCC01, comparison between monitoring results from scheduled and high-flow sampling in April of 2019 shows that discharge rates increase by 2.5 times, but pollutant loading increase by 21 (TP) to 140 (FC) times (**Figure 39**). And at MLR06b, comparison between scheduled and high-flow monitoring results in late September/early October of 2019 shows that discharge rates increase by 2.8 times, but pollutant loading increase by 9.6 (for TP) to 800 (FC) times (**Figure 40**).

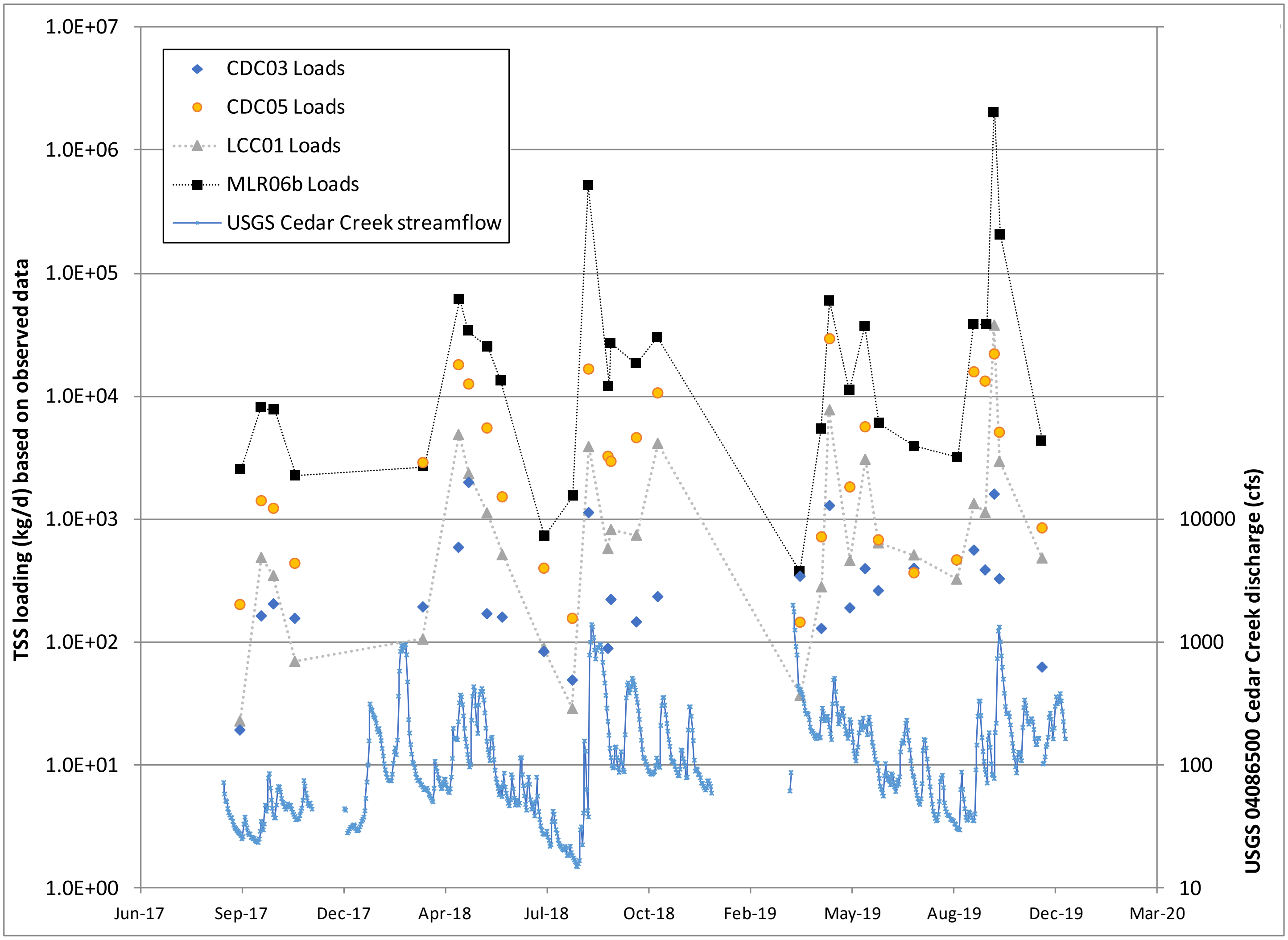


Figure 37. Instantaneous loading of TSS (kg/d) at four sites monitored during scheduled + high flow; USGS Cedar Creek daily discharge (cfs) plotted on secondary axis.

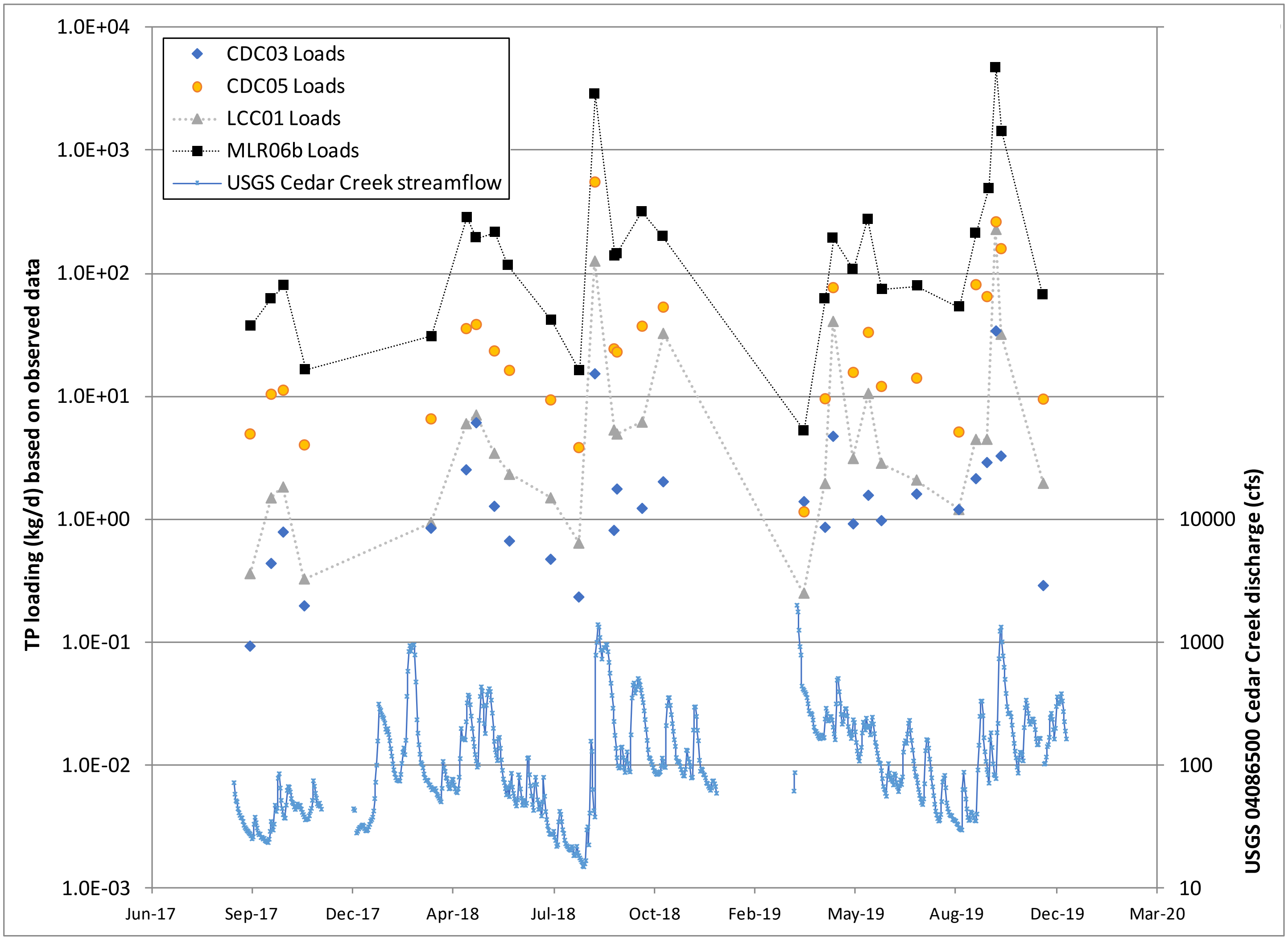


Figure 38. Instantaneous loading of TP (kg/d) at four sites monitored during scheduled + high flow; USGS Cedar Creek daily discharge (cfs) plotted on secondary axis.

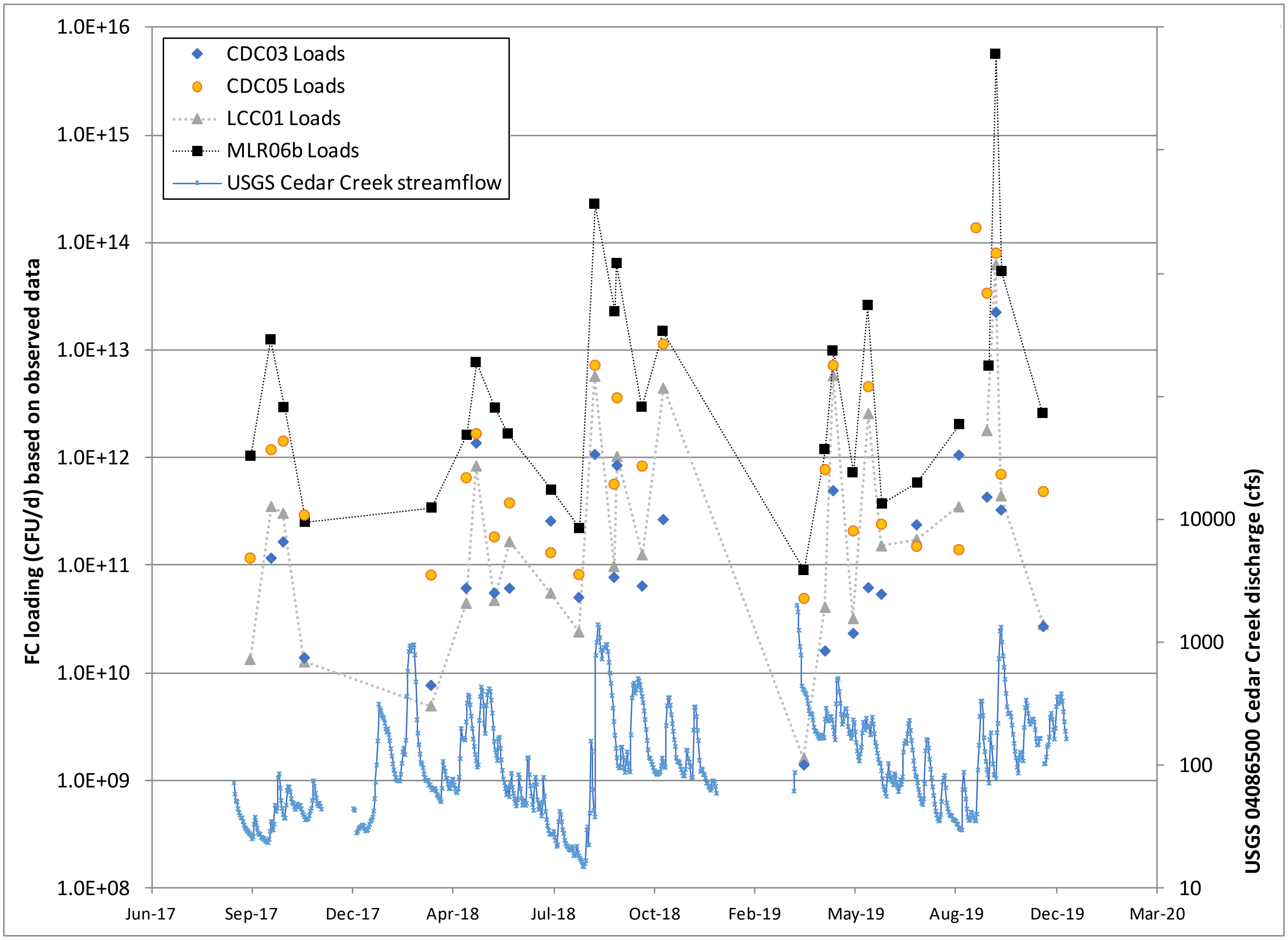


Figure 39. Instantaneous loading of FC (CFU/d) at four sites monitored during scheduled + high flow; USGS Cedar Creek daily discharge (cfs) plotted on secondary axis.

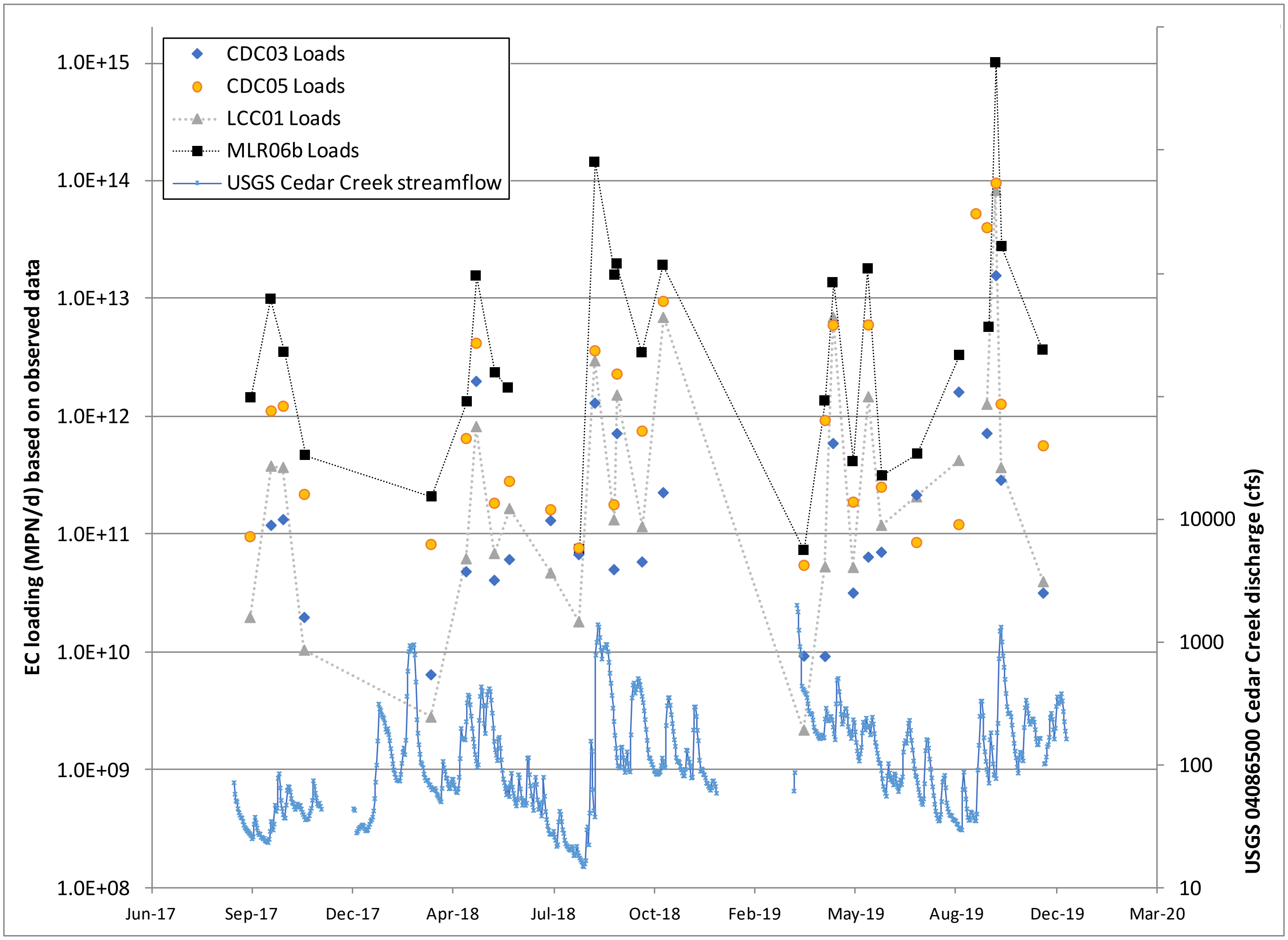


Figure 40. Instantaneous loading of *E. coli* (MPN/d) at four sites monitored during scheduled + high flow; USGS Cedar Creek daily discharge (cfs) plotted on secondary axis.

Pollutant mass loadings can also be estimated on an annual basis for the 2017-2019 project period. To do so, mean daily pollutant loadings were calculated at each site, using the Beale's Ratio Estimator (BRE; Dolan et al., 1981; Dolan and McGunagle, 2005). The mean daily load is calculated for the days of the year for which chemical observations are available, adjusted for differences in average discharge between the days on which chemical observations were made and the year as a whole, and corrected for bias which results from the correlation between discharge and load. The results include both an average daily load and a root mean square error (RMSE) for that load. Annual loads are then obtained by multiplying these results by the number of days in the year.

We used the BRE in a stratified mode. That is, discharge strata were developed to better describe the relationship between pollutant concentrations and discharge (Dolan and McGunagle, 2005). Because of the difficulty of identifying the best stratification scheme for a given set of data, we used the current version of the BRE loading program that contains an algorithm that seeks to identify the optimal stratification (Maccoux et al., 2016). The criterion used is that the optimal stratification is the one that has the smallest pooled mean square error. Most sites had 2-3 flow strata to better estimate load. We also selected the genetic algorithm (instead of the rapid setting algorithm) to reduce the MSE of the predicted load.

The BRE assumes that there is a positive correlation between discharge and instantaneous load (flux) within each stratum, and that the variance of the flux must also increase with increasing discharge. This is usually approximately true of non-point pollutants. For the pollutants monitored in this project, positive correlations were observed between the fluxes of TSS and TP and discharge at all sites, and at some of the sites for FC and *E. coli*. Although the ratio-based correction may be inaccurate if pollutant flux and discharge are not positively correlated, experience has shown that the BRE is generally more robust against deviations from its assumptions than other alternatives (Richards, 1998). Given the constraints of this monitoring dataset (i.e., n~20), we believe that the BRE is the most appropriate method of generating loading estimates.

The results of the pollutant loading calculations are presented in **Appendix H** for TSS, TP, FC and *E. coli*, respectively. In each table, daily and annual pollutant loading are presented by site and calendar year. The tables also indicate the number of strata selected by the BRE loading program and the number of measured values used in each year's load estimate. There was insufficient discharge in 2017 to produce a non-zero estimate for TP load at sites LEC01b and MDC01. The average discharges at these sites were quite small in 2017: 1.2 and 0.26 cfs, respectively. For the other parameters (TSS, FC and *E. coli*) the concentrations are large enough (unlike TP) to produce a non-zero (although still relatively small) load estimates.

Mean daily annual loadings of the four pollutants are displayed as column graphs by site and calendar year in **Figures 41-44**. The following general observations regarding pollutant loadings for TP, TSS, FC, and *E. coli* are made:

- In general, the column graphs for loadings of the different pollutants display fairly consistent patterns in terms of the loading variations between sites and years.
- Mean daily annual loadings were generally higher in 2018 and 2019 compared to 2017. This is consistent with the trends in annual stream flow (**Figure 36**).
- In terms of pollutant loadings, the sites fall into three groups: Cedar Creek (CDC03-CDC08c), Milwaukee River, and the other "minor" tributaries. This is expected given the drainage area and the corresponding flow contributions at each site.
- TSS and TP loadings (**Figures 41 and 42**) were over a magnitude (Cedar Creek) to two orders of magnitude (Milwaukee River) higher than loadings at minor tributary sites.
- The differences in loading between the three groups of sites were evident but less pronounced for fecal coliform (**Figure 43**) and *E. coli* (**Figure 44**).

There were a number of exceptions to the general characterization of pollutant loadings above:

- TSS loadings were very low at MDC01.
- TP loadings were the lowest at CDC01b, JKC01, LEC01b and MDC01.
- LCC01 TSS loadings nearly as high as Cedar Creek. TP, FC and EC loadings were also high at LCC01.
- FC and EC loadings were also high at LNC01b.

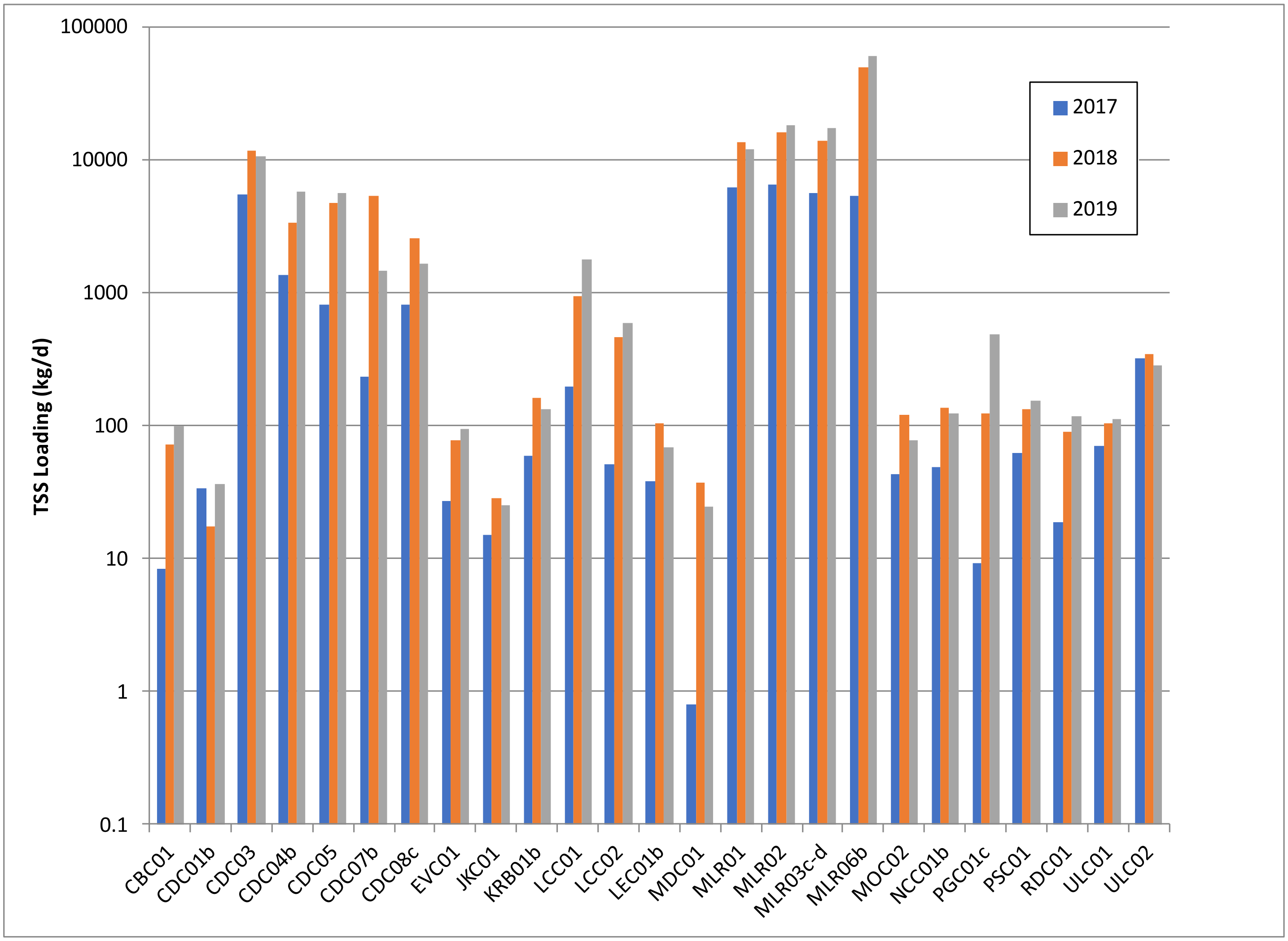


Figure 41. Total Suspended Solids (TSS) Mean Annual Daily Loading by Site and Calendar Year.

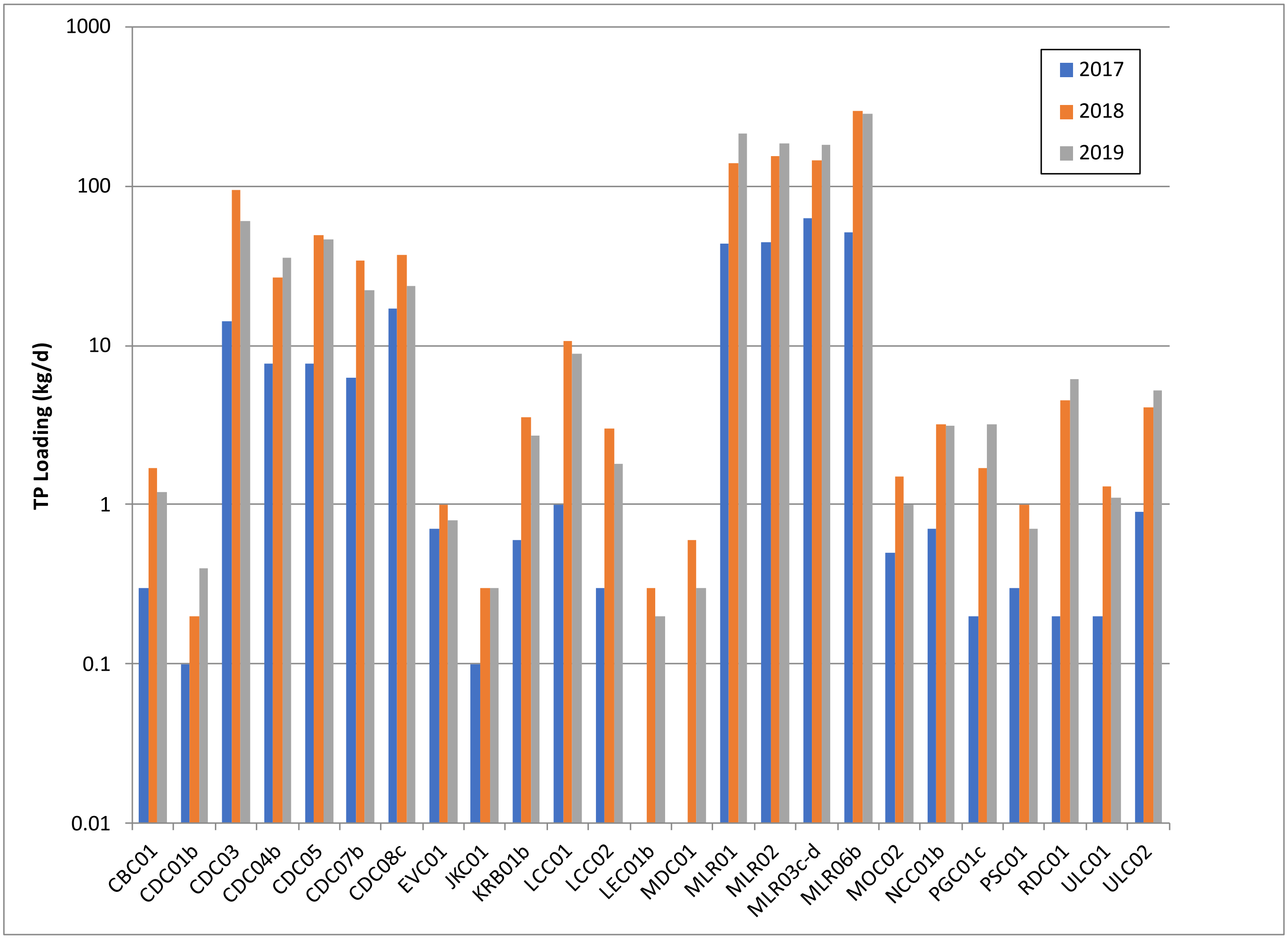


Figure 42. Total Phosphorus (TP) Mean Annual Daily Loading by Site and Calendar Year.

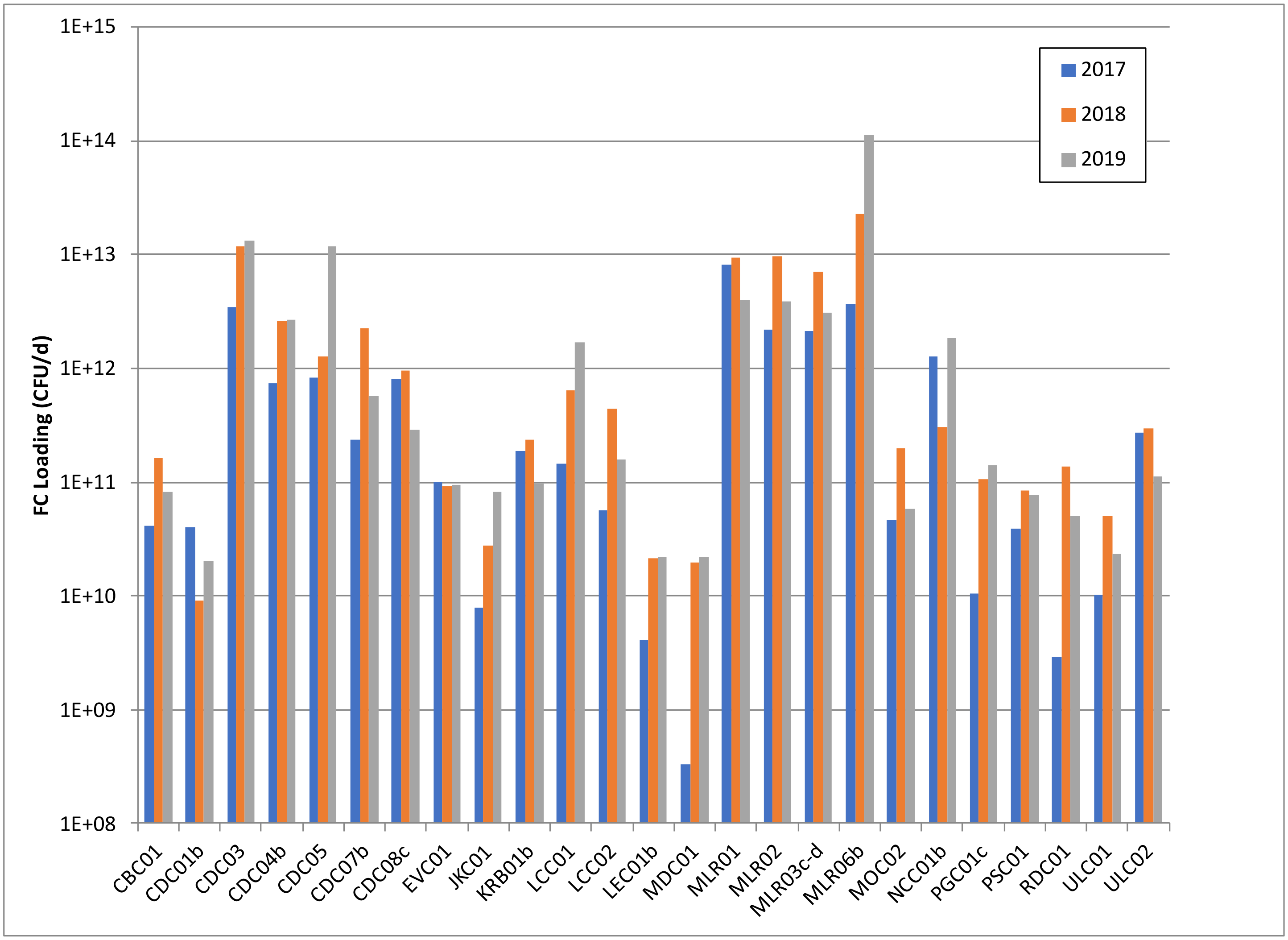


Figure 43. Fecal Coliform (FC) Mean Annual Daily Loading by Site and Calendar Year.

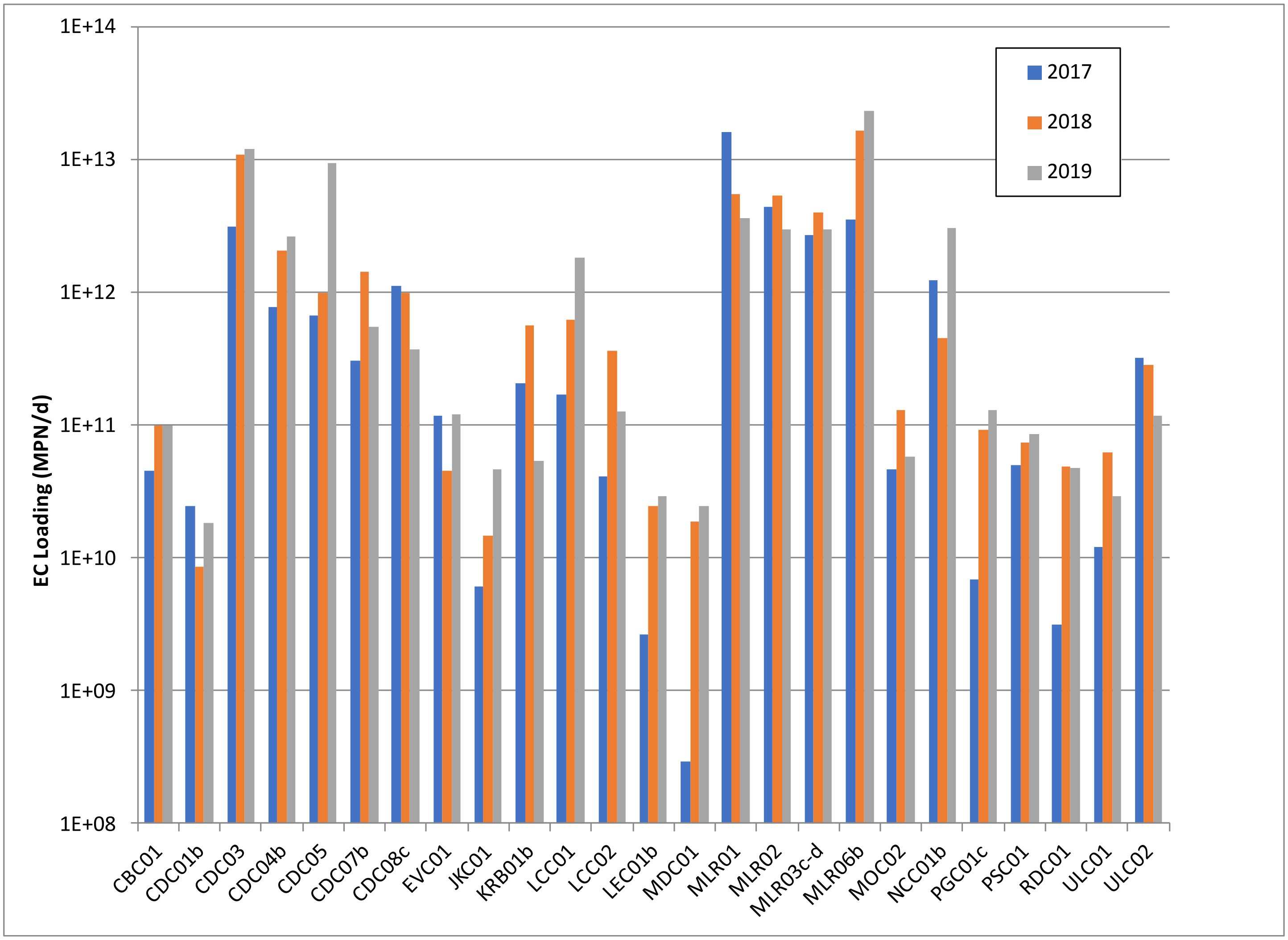


Figure 44. *E. coli* (EC) Mean Annual Daily Loading by Site and Calendar Year.

To gain additional insight regarding pollutant loadings at the different sites, we normalized the mean daily annual loadings by the drainage areas to produce pollutant yields ($kg/km^2/d$ and CFU or $MPN/km^2/d$). These are displayed as column graphs by site and calendar year in **Figures 45-48**. The following observations regarding pollutant yields are offered:

- Unlike pollutant loadings, the pollutant yields do not suggest that the sites fall into any grouping by water body (e.g., Cedar Creek, Milwaukee River)
- For TSS and TP, pollutant yields were lower in 2017 than in 2018 or 2019, except at ULC02 where the TSS yields were about equal.
- TSS pollutant yields mostly fell in the range of 1-10 $kg/km^2/d$. TSS pollutant yields were an order of magnitude higher than this range at site CDC03 and were at the lower end of this range at CDC01b and MDC01.

- Pollutant yields for TP mostly fell in the range of 0.01-0.1 kg/km^2/d. TP pollutant yields were order-of-magnitude higher than this range at site CDC03 and RDC01 (in 2018 and 2019). TP pollutant yields were at the lower end of this range at CDC01b and MDC01.
- For FC and EC, there were no consistent trends in pollutant yields from one year to another.
- Pollutant yields for EC mostly fell in the range of 10^9-10^{10} MPN/km^2/d. EC pollutant yields were again order-of-magnitude higher than this range at site CDC03 and NCC01b. And, as was the case for the previous pollutants, EC pollutant yields were at the lower end of this range at CDC01b and MDC01.

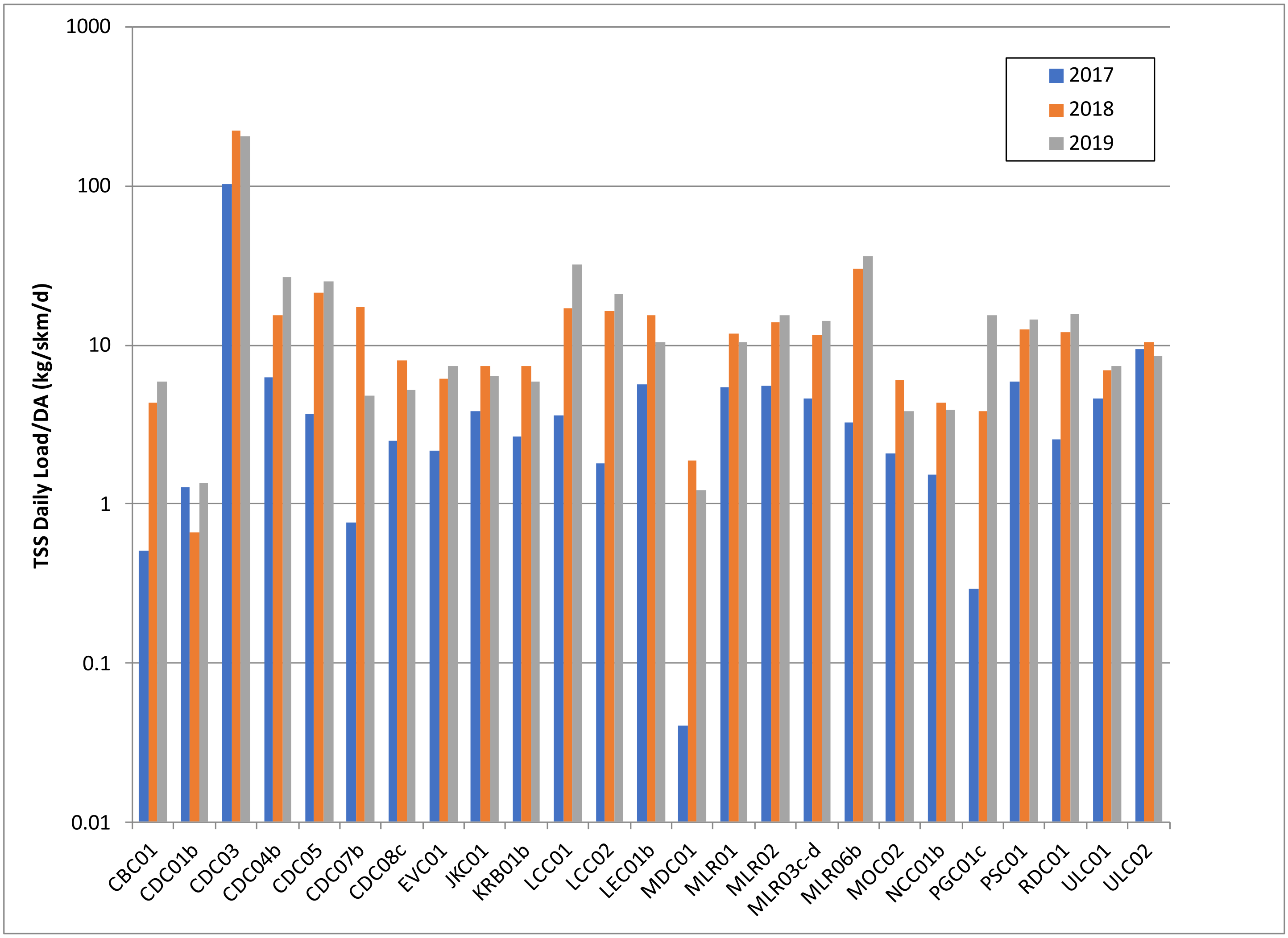


Figure 45. Total Suspended Solids (TSS) Pollutant Yield (kg/km2/d) by Site and Calendar Year.

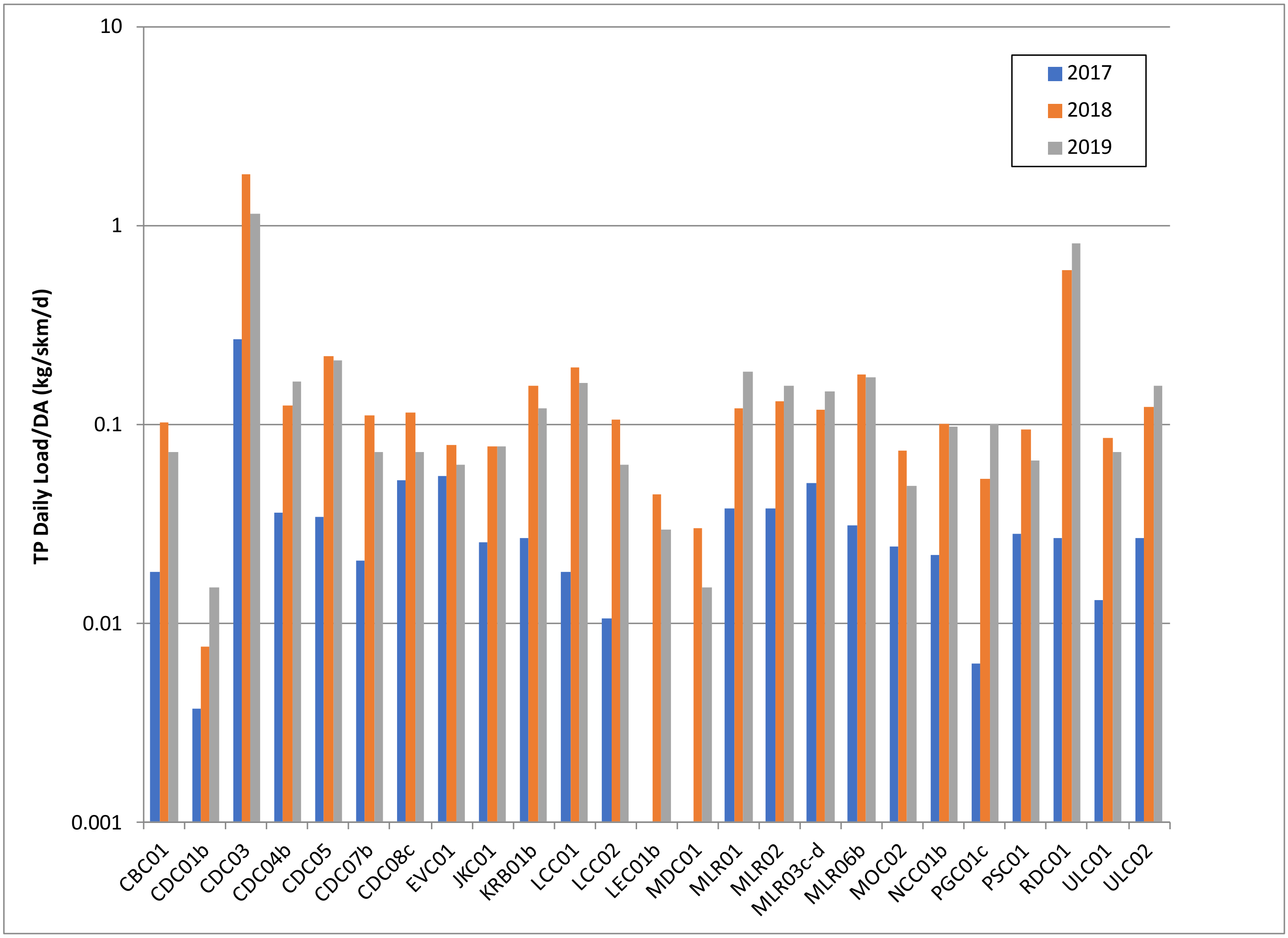


Figure 46. Total Phosphorus (TP) Pollutant Yield (kg/km2/d) by Site and Calendar Year.

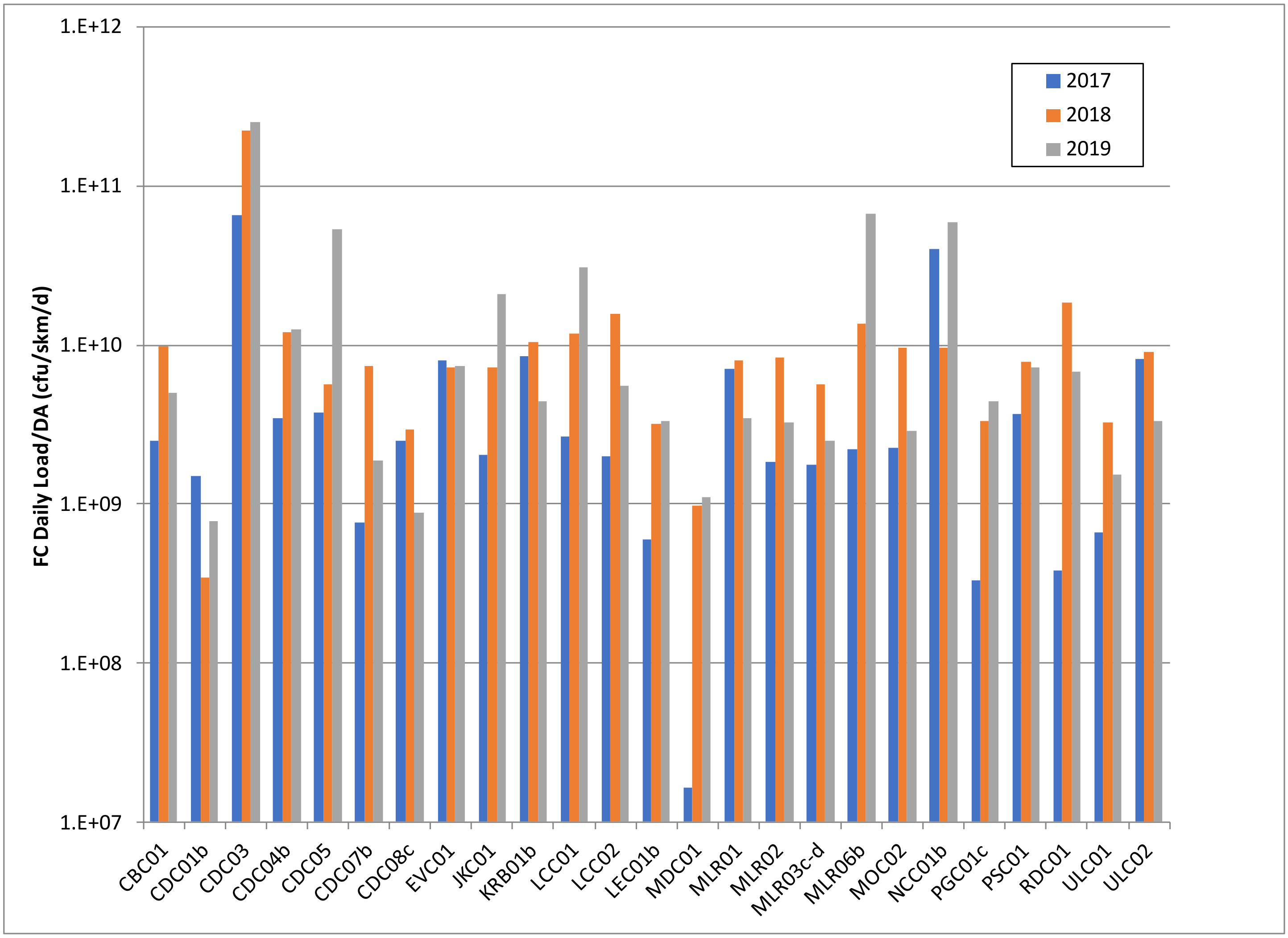


Figure 47. Fecal Coliform (FC) Pollutant Yield (CFU/km2/d) by Site and Calendar Year.

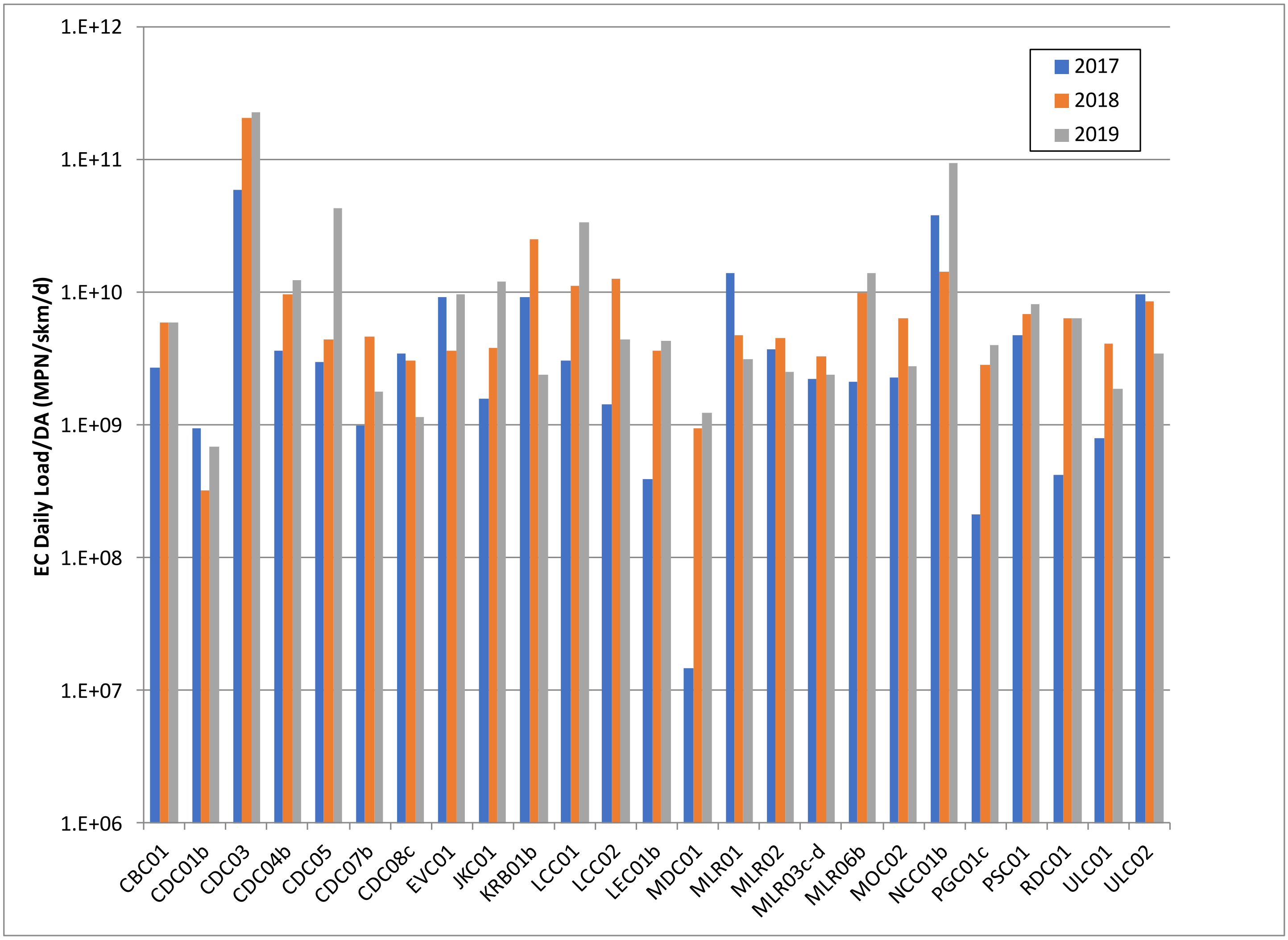


Figure 48. *E. coli* (EC) Pollutant Yield (MPN/km2/d) by Site and Calendar Year.

References

CDM Smith. 2018. Total Maximum Daily Loads for Total Phosphorus, Total Suspended Solids, and Fecal Coliform Milwaukee River Basin, Wisconsin. Final Report. EPA Grants 00E00591-2, 00E00592-2, 00E00593-2, and 00E00594-2. USEPA Region 5, March 19, 2018. 147 p.

DNR (Department of Natural Resources, Wisconsin). 2016. Water Quality Standards Rule Packages Technical Support Document: Designated Uses and Associated Water Quality Criteria (Rule No. WY-25-13); Biocriteria, Combined Criteria for Phosphorus, and Processes for Waterbody Assessments (Rule No. WY-23-13); Site-Specific Criteria for Phosphorus (Rule No. WT-17-12). 3 June 2016, Draft. 136 pp.

Dolan, D.M., Yui, A.K., Geist, R.D., 1981. Evaluation of river load estimation methods for total phosphorus. J. Great Lakes Res. 7, 207–214.

Dolan, D.M., McGunagle, K.P., 2005. Lake Erie total phosphorus loading analysis and update: 1996–2002. J. Great Lakes Res. 31, 11–22.

Linsley, R.K., Kohlor, M.A. and J.L.H. Paulhus.1982. Hydrology for Engineers. McGraw-Hill.
Maccoux, M.J., Dove, A., Backus, S.M. and D.M. Dolan. 2016. Total and soluble reactive phosphorus loadings to Lake Erie; A detailed accounting by year, basin, country, and tributary. Journal of Great Lakes Research 42(2016) 1151–1165.

Sonzogni, W., Monteith, T., Bach, W., and V. G. Hughes, 1978. United States Great Lakes Tributary Loadings, Great Lakes Basin Commission, Ann Arbor, Michigan, 200p.

Richards, P. 1998. Estimation of Pollutant Loads in Rivers and Streams: A Guidance Document for NPS Programs. Grant X998397-01-0. U.S. Environmental Protection Agency, Region VIII. Denver, CO.

USGS. 1982 Measurement and Computation of Streamflow: Volume 2. Computation of Discharge. By S. E. Rantz and others. Geological Survey Water-Supply Paper 2175.United States Government Printing Office, Washington: 1982.

WPR (Wisconsin Public Radio). 2019. 2019 Is The Wettest Year Ever Recorded For Wisconsin And The Midwest; Wisconsin Public Radio, December 16, 2019. Accessed January 29, 2020 from https://www.wpr.org/2019-wettest-year-ever-recorded-wisconsin-and-midwest.

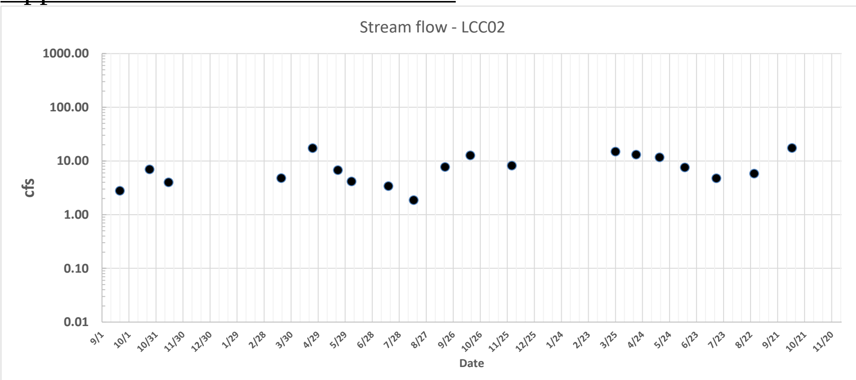
Appendix A. Project sample site codes, location descriptions, latitudinal and longitudinal coordinates, and other relevant notations and site descriptors, according to HUC 12 watershed.

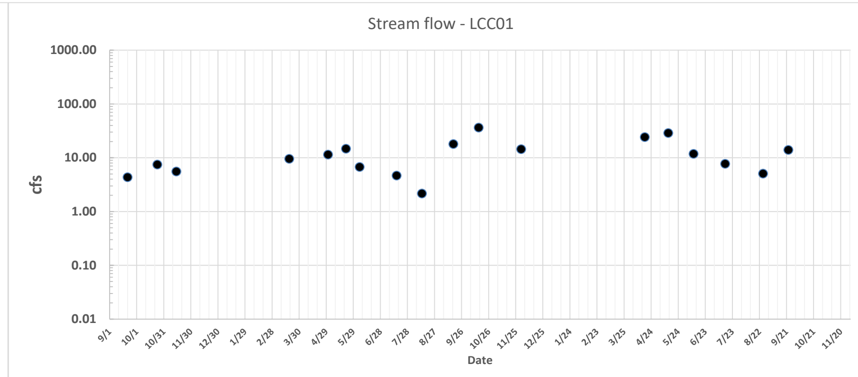
HUC	Site Code	Location Description	Latitude	Longitude	Notations
040400030301	LCC02	Little Cedar Creek at Pioneer Road near Intersection with Rocky Lane	43.2809147375	-88.1573528897	
	LCC01	**Little Cedar Creek at Western Avenue**	**43.2952159695**	**-88.1604846224**	**Wet Weather Station**
	KRB01b	Kressin Branch at Maple Road	43.2838031325	-88.1424292709	
040400030302	CDC01b	Cedar Creek at CTH NN	43.3784431562	-88.2481676144	
	CDC03	**Cedar Creek Downstream of Mayfield Road**	**43.3285128896**	**-88.1987857604**	**Wet Weather Station**
	LEC01b	Lehner Creek Upstream from STH 60	43.3240852889	-88.2109299592	
	PSC01	Polk Springs Creek at CTH P	43.3077146687	-88.1812882838	
	JKC01	Jackson Creek Downstream of STH 60	43.3239165359	-88.1746251586	**Barologger**
040400030303	CDC04b	Cedar Creek at S. Church Road	43.3371575817	-88.1026567688	
	CDC05	**Cedar Creek at CTH M (Hickory Road)**	**43.3446929497**	**-88.0775377523**	**Wet Weather Station**
	CBC01	Cedarburg Creek Downstream of CTH M (North Country Aire Drive)	43.3246694034	-88.0828690258	
	EVC01	Evergreen Creek Downstream of Pleasant Valley Drive	43.3521474193	-88.1280176264	
	NCC01b	North Branch of Cedar Creek Upstream of CTH NN	43.3620926213	-88.0698425418	
040400030304	CDC07b	Cedar Creek at Cedar Creek Road West of Stone Ridge Lane	43.3374087064	-87.9772429620	Post re-located March 2018 approx. 25' downstream from prior location due to difficulty sampling
	CDC08c	Cedar Creek at County Hwy T	43.2936165270	-87.9715355675	Post re-located September 2018 approx. 320' downstream from prior location due to susceptibility of being hit by floating debris
	MDC01	Mud Creek South of Cedar Sauk Road	43.3671364586	-88.0392297321	
040400030603	MLR01	Milwaukee River Downstream of Riverside Drive at Evergreen Lane	43.4188868070	-87.9421896714	
	MLR02	Milwaukee River downstream of Saukville WWTP	43.3761920291	-87.9421475453	

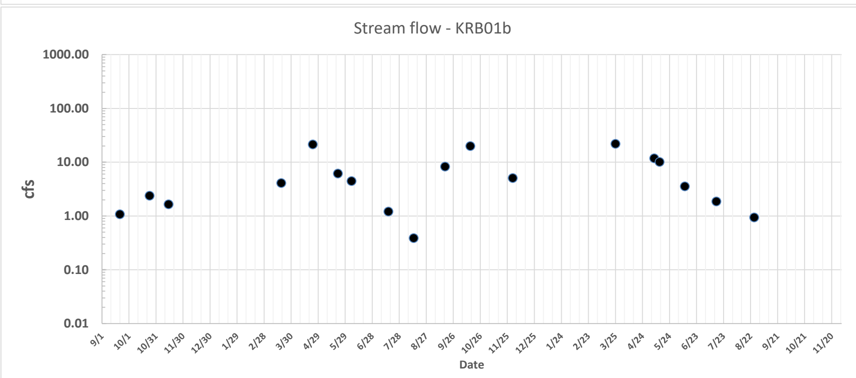
HUC	Site Code	Location Description	Latitude	Longitude	Notations
	MLR03c-d	Milwaukee River at Hwy T	43.2945539174	-87.9444890589	Back up wet weather station. Original station (MLR03c) relocated to MLR03d in March 2018
	RDC01	Riverside Drive Creek at Evergreen Lane	43.4198743184	-87.9410778005	**Barologger**; Post re-located September 2018 approx. 12' upstream from prior location due to excessive sand coverage
	MOC02	Mole Creek at Maple Road	43.3489151587	-87.9656211012	
040400030604	**MLR06b**	**Milwaukee River at STH 167**	**43.2210999685**	**-87.9808978966**	**Wet Weather Station;** formerly MLR03c, Milwaukee River middle of Lime Kiln Park; site re-located March 2018 to south side of CTH "T" approx. 50' downstream from bridge due to difficulty sampling
	ULC01	Ulao Creek at STH 60 east of I-43	43.3201420041	-87.9166107800	
	ULC02	Ulao Creek at Bonniwell Road	43.2656151873	-87.9339929736	**Barologger**; Post re-located March 2018 approx. 10' downstream from prior location due to difficulty sampling
	PGC01c	Pigeon Creek at Pedestrian footbridge Upstream of Green Bay Rd.	43.2315501764	-87.9832243088	

Appendix B. Graphical display of stream discharge measurements measured on Cedar Creek and the Milwaukee River mainstem and tributary sites for the project, according to HUC 12 watershed (monthly scheduled monitoring data from September – November 2017 and March - November 2018 and 2019 - sample size (N) 17 – 20, refer to Table 1).

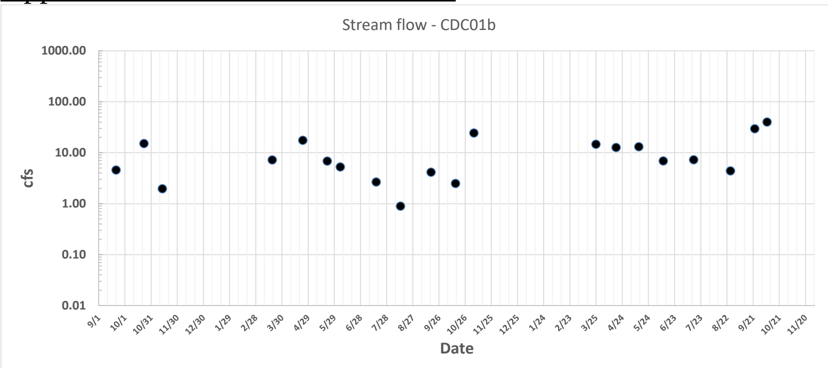
Appendix B.1 HUC 040400030301

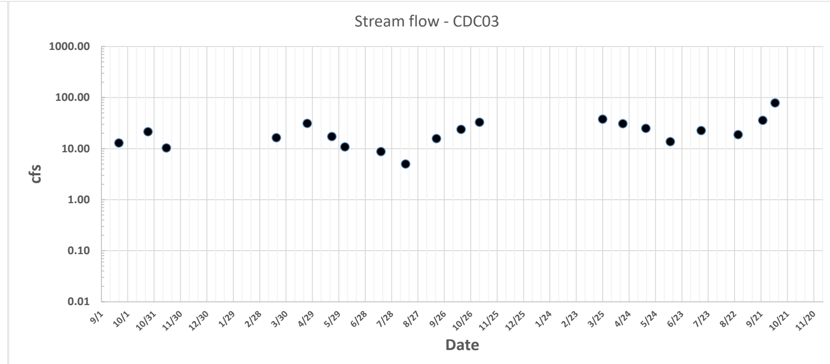


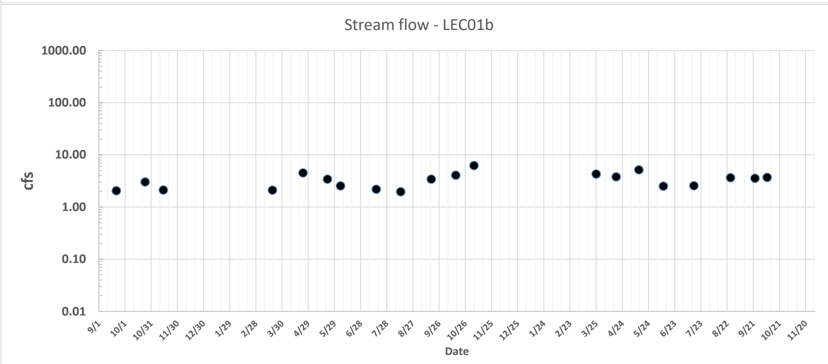


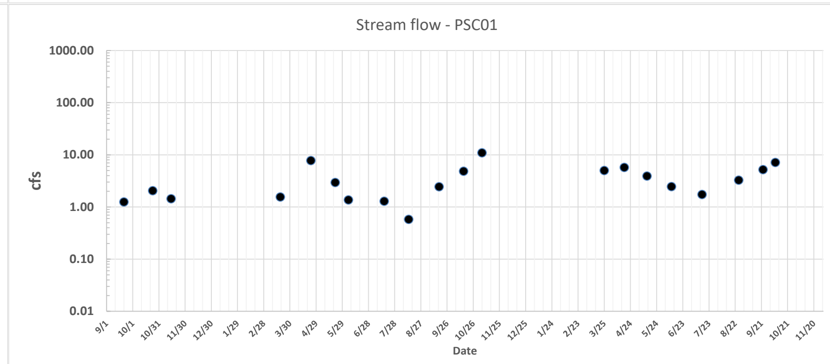


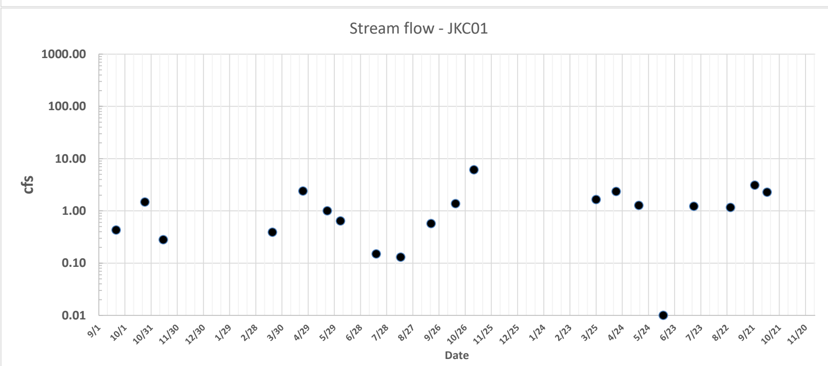
Appendix B.2 HUC 040400030302



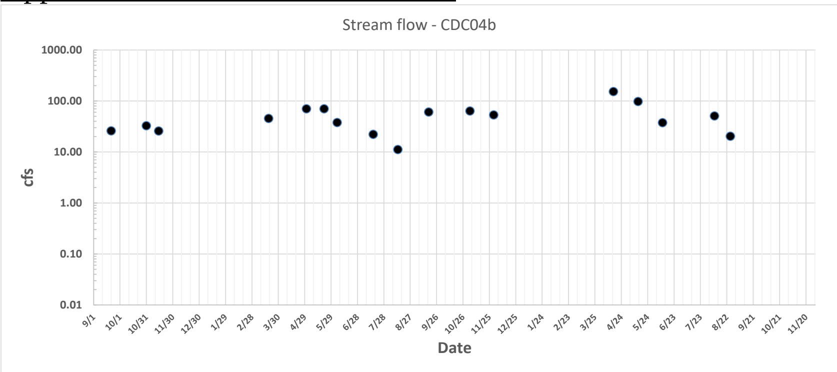


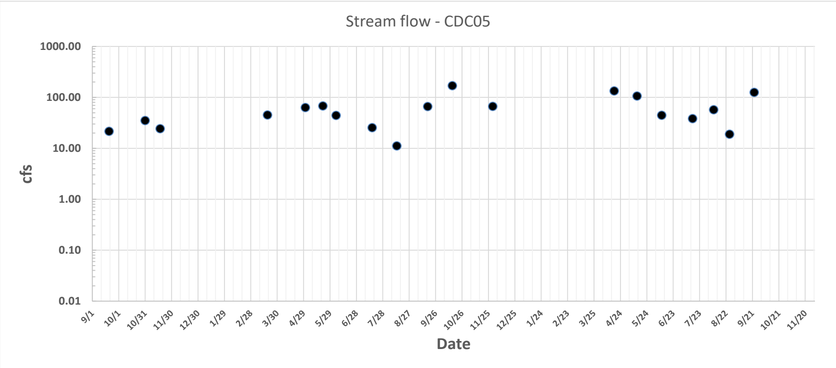


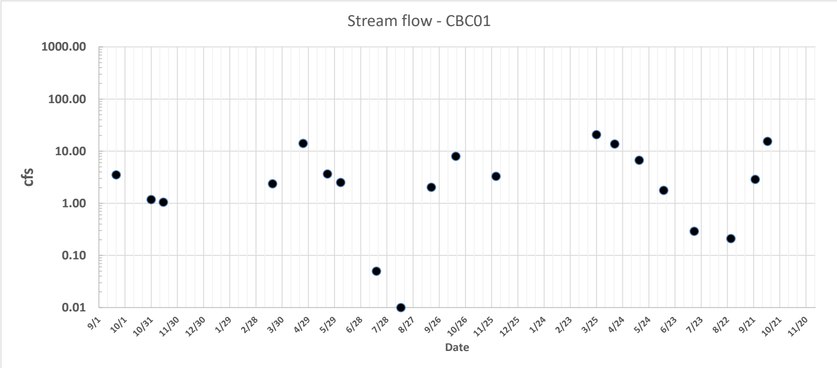


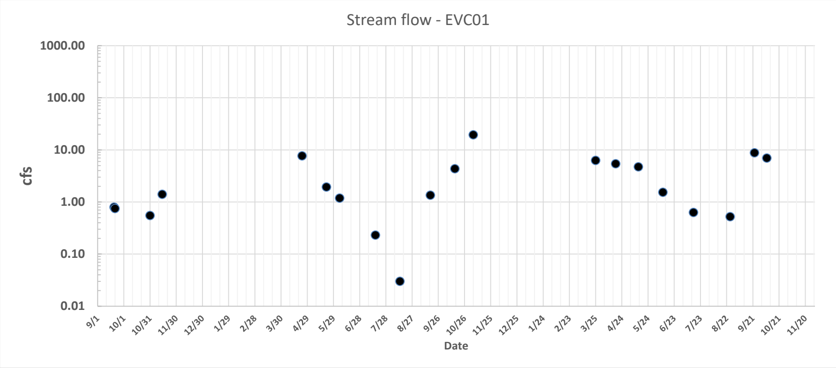


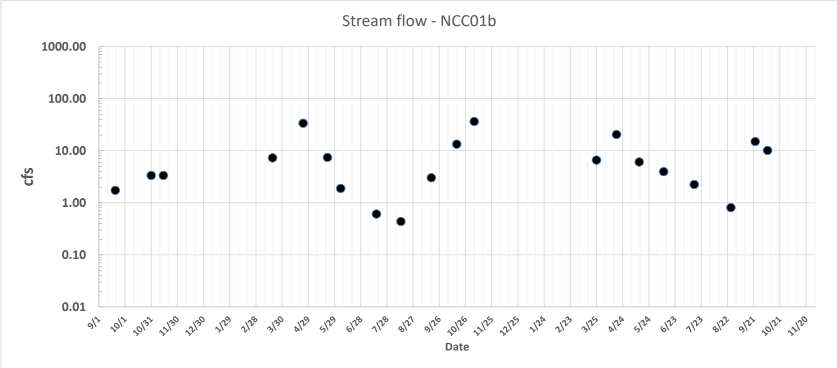
<u>Appendix B.3 HUC 040400030303</u>



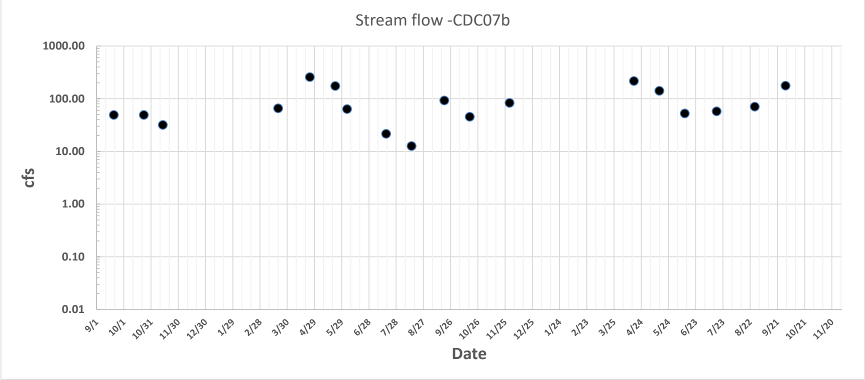


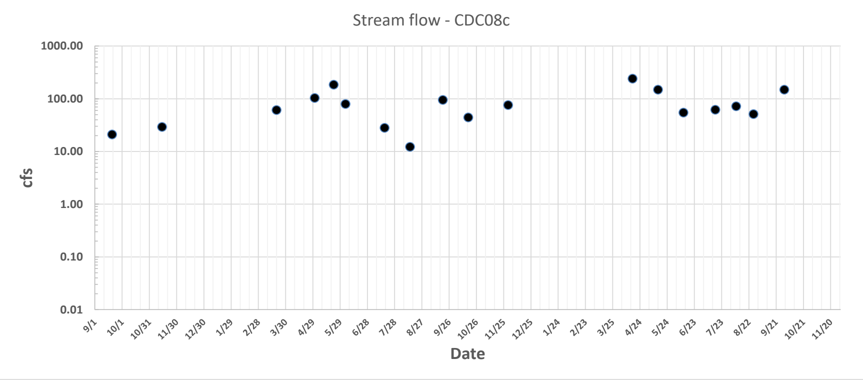


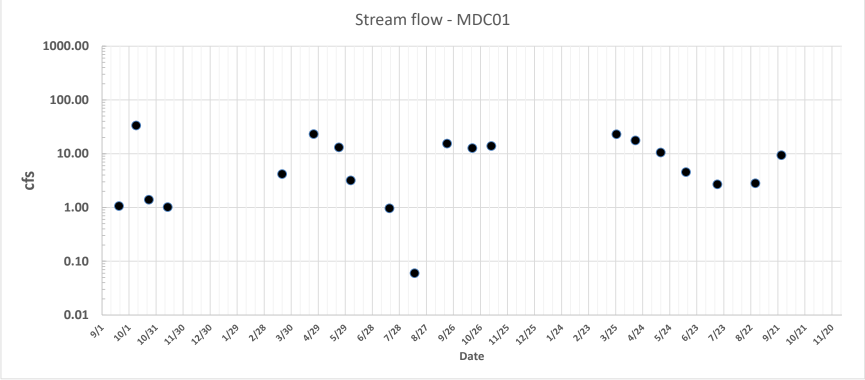




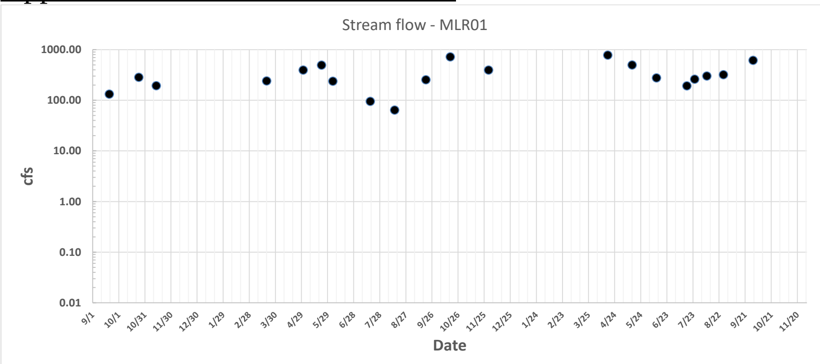
Appendix B.4 HUC 040400030304

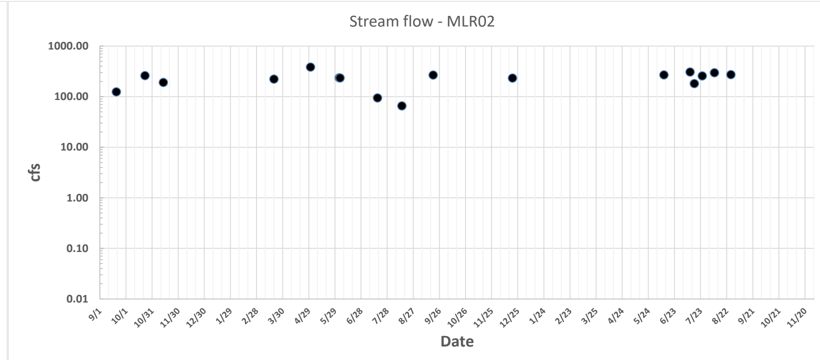


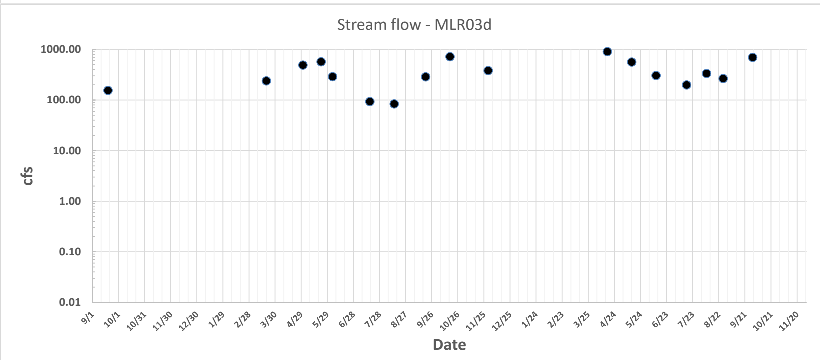


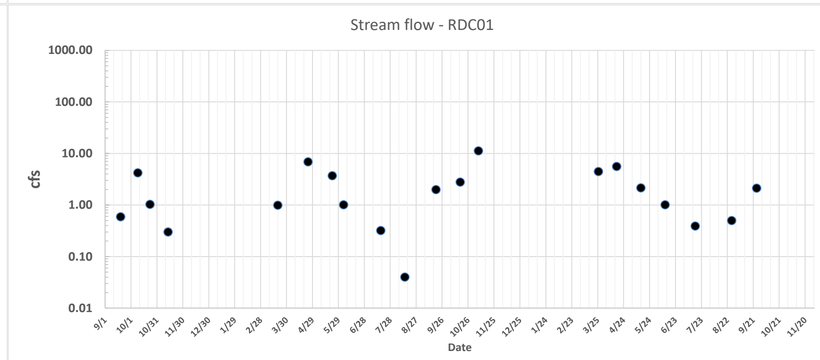


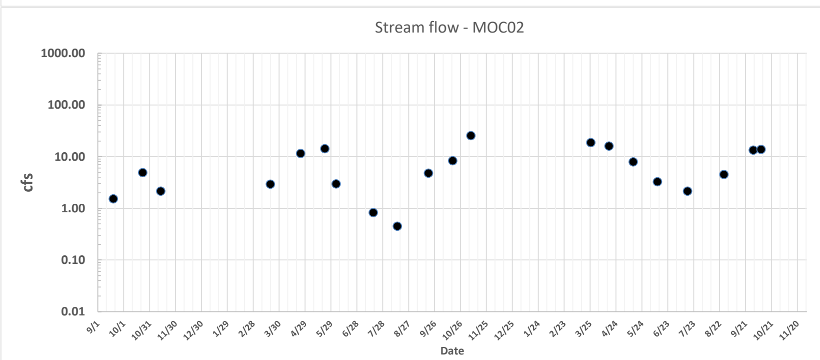
<u>Appendix B.5 HUC 040400030603</u>



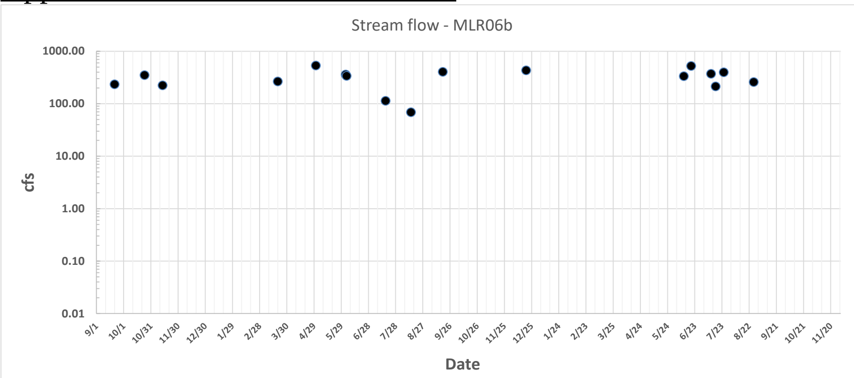


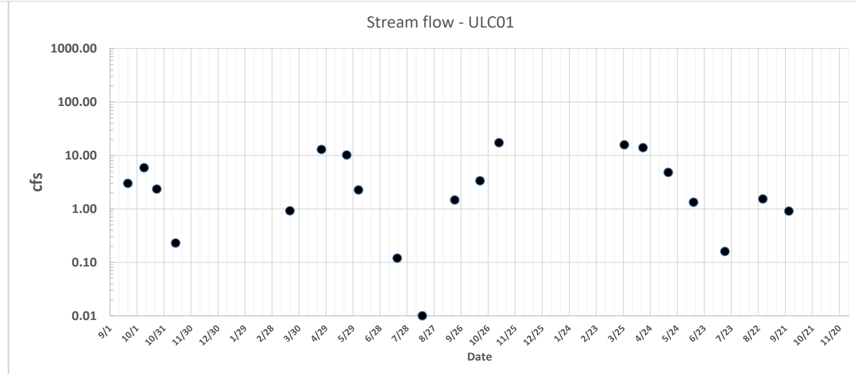


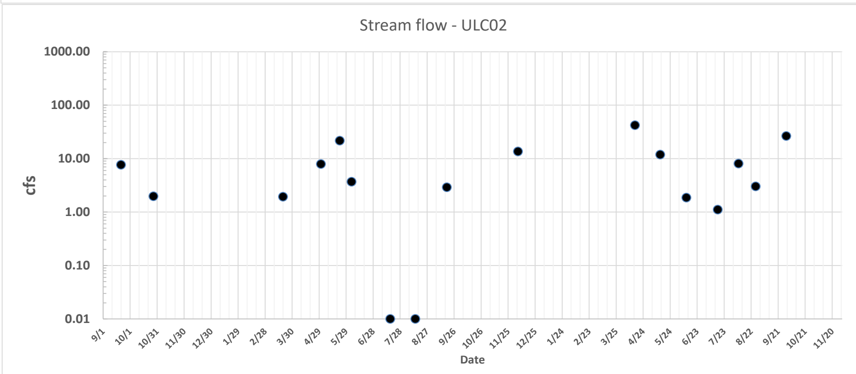


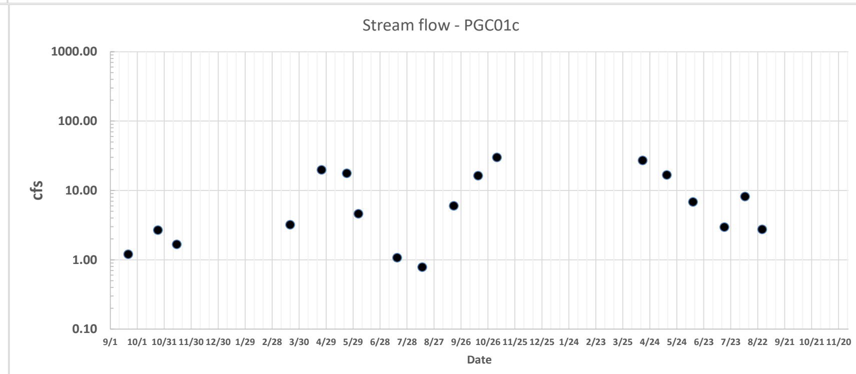


Appendix B.6 HUC 040400030604









Appendix C. Tabular display of TP, TSS, FC and *E. coli* concentrations measured at sites on Cedar Creek and the Milwaukee River and their tributaries for the project (September – November 2017 and March - November 2018 and 2019).

Light gray shading indicates data collected during wet weather (storm) events. Laboratory flag descriptions include: AO: Additional Explanation - other; Dup: field duplicate sample collected; D1: laboratory duplicate control limit exceeded; J: estimated concentration above the adjusted MDL and below the adjusted reporting limit; M2: sample incubation period outside method requirement; M7: micro sample received without adequate headspace; RV: replacement value; "<": Value reported as less than the method detection limit; ">": values reported as greater than specified limit.

C.1. Mainstem sites on Cedar Creek and the Milwaukee River.

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
CDC01b												
9/21/17 8:18 AM		1.8			0.009			150			170	
10/23/17 9:00 AM		2.5			0.008			300			180	
11/13/17 9:11 AM	<	1.0	0.50	<	0.005	0.0025		45			39	
3/19/18 7:56 AM	Dup <	2.4		J	0.019		<	3	1.5	Dup <	0.75	
4/23/18 7:42 AM	<	1.0	0.50	J	0.012			5			2	
5/21/18 8:42 AM	<	1.0	0.50	J	0.010		<	10	5.0		10	
6/5/18 8:53 AM		2.7		J	0.011			110			96	
7/16/18 9:55 AM		4.2		J	0.018			200			140	
8/13/18 8:55 AM		2.2		J	0.018			920			690	
9/17/18 9:15 AM		1.2		J	0.014			310			240	
10/15/18 9:13 AM	<	1.0	0.50	J	0.014			170			110	
11/5/18 8:56 AM	D1	1.0		J	0.011			43			50	
3/25/19 9:00 AM		1.0			0.023			5			4	
4/15/19 8:53 AM	<	1.0	0.5	J	0.010			7			3	
5/13/19 9:07 AM	<	1.0	0.5	J	0.010			93			1	
6/10/19 8:30 AM		1.5		J	0.011			28			24	
7/15/19 8:49 AM		3.6		J	0.014			61			51	
8/26/19 8:49 AM		8.7			0.022			2000			2600	
9/23/19 9:50 AM		2.4		J	0.012			83			78	

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
10/7/19 8:45 AM		1.6		<	0.012	0.006		28			16	
11/18/19 9:53 AM		1.1		<	0.012	0.006		5			8	
CDC03												
9/20/17 10:47 AM		2.9			0.014		M7			M7		
10/11/17 10:28 AM		5.6			0.015			400			410	
10/23/17 9:35 AM		5.2			0.020			420			340	
11/13/17 10:02 AM		7.9		J	0.010			70			100	
3/19/18 8:36 AM		4.8			0.021			19			16	
4/23/18 8:14 AM		7.7			0.033			80			63	
5/3/18 8:27 AM		16.0			0.049			1050			1500	
5/21/18 9:05 AM		4.0			0.030			130			96	
6/5/18 9:15 AM		6.0			0.025			230			230	
7/16/18 10:51 AM		3.9			0.022			1200			610	
8/13/18 9:40 AM		4.0		J	0.019			410			550	
8/29/18 12:36 PM		4.0			0.054			380			460	
9/17/18 10:38 AM		2.3			0.021			200			130	
9/20/18 10:20 AM		3.4			0.027			1300			1100	
10/15/18 9:44 AM		2.5			0.021			110			100	
11/5/18 9:28 AM		2.9			0.025			330			280	
3/25/19 9:31 AM		3.7		J	0.015		<	3	1.5		10	
4/15/19 9:31 AM		2.1		J	0.014			26			15	
4/23/19 9:00 AM		12.0			0.044			460			550	
5/13/19 9:41 AM		3.1		J	0.015			38			52	
5/28/19 10:42 AM		5.7			0.022			75			83.5	
6/10/19 9:06 AM		7.8			0.029			160			210	
7/15/2019 9:32		7.2			0.029			430			390	
8/26/19 9:22 AM		10.0			0.026			2300			3500	
9/12/2019 8:20		8.9			0.034		M7			M7		

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
9/23/19 10:28 AM		4.4			0.033			490			820	
10/2/19 9:10 AM	D1	6.1			0.130			8600			6000	
10/7/19 9:18 AM		2.0			0.019			160			145	
11/18/19 10:15 AM		1.3		<	0.012	0.006		56			66	
					CDC04b							
9/20/17 9:43 AM		7.1			0.100			410			440	
10/23/17 11:55 AM		23.0			0.110			1300			1300	
11/13/17 8:30 AM		9.2			0.067			360			550	
3/19/18 11:25 AM		6.7			0.054			54			74	
4/23/18 11:05 AM		5.9			0.050			93			98	
5/21/18 8:08 AM		14.0			0.110			100			62	
6/5/18 8:12 AM		20.0			0.160			390			460	
7/16/18 9:08 AM		8.5			0.150			360			340	
8/13/18 8:17 AM		7.8			0.140			730			1200	
9/17/18 8:30 AM		24.0			0.160			430			330	
10/15/18 8:25 AM		5.6			0.073			255			225	
11/5/18 7:55 AM		23.0			0.150		>	3000			2300	
3/25/19 8:20 AM		4.4			0.042			130			140	
4/15/19 8:17 AM		2.8			0.035			125			135	
5/13/19 8:22 AM		7.0			0.067			78			84	
6/10/19 7:46 AM		10.0			0.120			370			490	
7/15/19 8:04 AM	AO	39.0			0.220			550			490	
8/26/19 8:04 AM		15.0			0.110			580			1600	
9/23/19 9:05 AM		41.0			0.190			5600			5300	
10/7/19 9:18 AM												
11/18/19 9:06 AM		5.6		J	0.043			200			260	
						CDC05						
9/20/17 8:13 AM		3.8			0.093			220			180	

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
10/11/17 9:58 AM		19.0			0.140			1600			1500	
10/23/17 12:20 PM		12.0			0.110			1400			1200	
11/13/17 7:58 AM		7.6			0.070			510			380	
3/19/18 11:58 AM		26.0			0.059			73			74	
4/23/18 10:48 AM		36.0			0.071			130			130	
5/3/18 7:47 AM		36.0			0.110			480			1200	
5/21/18 7:35 AM		33.0			0.140			110			110	
6/5/18 7:40 AM		14.0			0.150			350			260	
7/16/18 8:25 AM		6.4			0.150			210			260	
8/13/18 7:40 AM		5.7			0.140			300			280	
8/29/18 12:12 PM		5.6			0.235			280			150	
9/17/18 7:47 AM		20.0			0.150			350			110	
9/20/18 9:53 AM		18.0			0.140			2200			1400	
10/15/18 7:48 AM		11.0			0.089			200			180	
11/5/18 7:30 AM		28.0			0.140		>	3000			2500	
3/25/19 7:43 AM		5.3			0.042			180			200	
4/15/19 7:45 AM		2.4			0.032			260			310	
4/23/19 9:25 AM		65.5			0.170			1850			1550	
5/13/19 7:47 AM		7.0			0.060			80			72	
5/28/19 11:13 AM		16.0			0.094			1300			1700	
6/10/19 7:12 AM		6.2			0.110			220			230	
7/15/2019 7:25	AO	3.9			0.150			160			91	
8/26/19 7:24 AM		10.0			0.110			300			260	
9/12/2019 7:45		39.0			0.200			34000			13000	
9/23/19 8:15 AM		43.0			0.210			11000			13000	
10/2/19 10:15 AM		23.5			0.250			8600			8850	
10/7/19 7:37 AM		4.8			0.150			66			120	
11/18/19 8:38 AM		4.2		J	0.047			240			280	

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
CDC07b												
9/20/17 10:32 AM		1.3			0.072			180			250	
10/24/17 9:17 AM		2.9			0.092			440			475	
11/14/17 9:06 AM		3.6			0.043			83			180	
3/20/18 9:54 AM		6.1			0.050			45			40	
4/24/18 10:01 AM		8.8			0.053			63			73	
5/22/18 9:01 AM		30.0			0.098			530			610	
6/4/18 9:13 AM		4.6			0.110			4600			4600	
7/17/18 9:04 AM		1.8			0.150			280		M2		
8/14/18 8:59 AM		1.0			0.110			220			130	
9/19/18 9:13 AM		4.0			0.120			220			310	
10/17/18 9:07 AM		19.0			0.110			90			130	
11/7/18 8:49 AM		22.0			0.110			1100			650	
3/26/19 9:30 AM		2.9			0.038			90			96	
4/16/19 9:10 AM		1.7			0.024			110			140	
5/14/19 9:10 AM		2.1			0.041			35			30	
6/11/19 9:40 AM		2.0			0.083			35			29	
7/16/2019 8:49		6.7			0.150			97			96	
8/27/19 8:46 AM		12.0			0.110			420			650	
9/25/19 10:03 AM		5.3			0.130			260			240	
10/8/19 9:28 AM	D1	9.3			0.120			180			150	
11/18/19 10:33 AM		3.2		J	0.037			110			140	
CDC08c												
9/20/17 11:41 AM		5.2			0.074			1100			1100	
10/24/17 10:22 AM		3.9			0.092			390			580	
11/14/17 9:54 AM		4.1			0.042			33			54	
3/20/18 10:18 AM		2.5			0.040		Dup <	6.75			8	

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
4/24/18 10:21 AM		6.0			0.051			38			32	
5/22/18 9:15 AM		7.3			0.100			160			200	
6/4/18 9:35 AM		7.4			0.120			430			200	
7/17/18 9:21 AM		2.9			0.140			170		M2		
8/14/18 9:20 AM		16.0			0.097			250			140	
9/19/18 9:43 AM		3.6			0.120			210			170	
10/17/18 9:28 AM		2.8			0.072			80			75	
11/7/18 9:08 AM		7.4			0.100			440			550	
3/26/19 9:53 AM		2.5			0.036			30			34	
4/16/19 9:33 AM		3.3			0.022			24			33	
5/14/19 9:36 AM		3.6			0.041			30			33	
6/11/19 10:08 AM		3.7			0.098			56			44	
7/16/19 9:12 AM		7.7			0.160			180			103	
8/27/19 9:12 AM		4.1			0.093			500			490	
9/25/19 10:28 AM		3.8			0.140			190			310	
10/8/19 9:52 AM		8.1			0.130			150			210	
11/18/19 11:03 AM	<	1.0	0.5	J	0.034			70			100	
MLR01												
9/20/17 9:38 AM		4.0			0.043			110			160	
10/24/17 8:12 AM		19.0			0.120			350			600	
11/14/17 8:06 AM		2.3			0.029			4100			8300	
3/20/18 8:25 AM		3.9			0.057			47			66	
4/24/18 8:03 AM		13.0			0.062			24			32	
5/22/18 8:13 AM		17.0			0.150			1000			870	
6/4/18 8:21 AM		18.0			0.120			160			170	
7/17/18 8:07 AM		4.0			0.082			250			150	
8/14/18 7:35 AM		9.1			0.089			150			140	
9/19/18 8:05 AM		10.0			0.120			190			170	

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
10/17/18 7:30 AM		6.1			0.110			120			180	
11/7/18 7:38 AM		10.0			0.180			2400			1200	
3/26/19 7:34 AM		4.2			0.071			23.5			24.5	
4/16/19 7:32 AM	D1	3.2			0.044			77			65	
5/14/19 7:55 AM		5.3			0.046			26			25	
6/11/19 8:11 AM		11.5			0.084			115			77	
7/16/19 7:37 AM		12.0			0.140			59			51	
8/27/19 7:32 AM		19.0			0.110			1800			1300	
9/25/19 8:48 AM		23.0			0.200			430			390	
10/8/19 8:08 AM		7.2			0.210			220			190	
11/18/19 8:55 AM		2.4		J	0.043			180			260	
MLR02												
9/20/17 9:56 AM		1.7			0.038			150			170	
10/24/17 8:37 AM		16.0			0.100			380			310	
11/14/17 8:20 AM		2.2			0.028			420			2100	
3/20/18 8:56 AM		4.9			0.054			52			34	
4/24/18 8:57 AM		14.0			0.067			40			32	
5/22/18 8:30 AM		20.0			0.120			1100			1200	
6/4/18 8:39 AM		11.5			0.110			270			170	
7/17/18 8:17 AM		1.2			0.082			180			160	
8/14/18 8:00 AM		15.0			0.096			87			53	
9/19/18 8:30 AM		14.0			0.130			280			240	
10/17/18 7:53 AM		3.9			0.084			140			110	
11/7/18 8:00 AM		10.0			0.130			1800			730	
3/26/19 8:02 AM		3.5			0.055		D1	24			25	
4/16/19 7:52 AM		4.9			0.026			52			59	
5/14/19 8:16 AM		6.5			0.044			7			20	
6/11/19 8:35 AM		8.3			0.079			110			110	

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
7/16/19 7:57 AM		12.0			0.140			140			86	
8/27/19 7:51 AM		15.0			0.100			2600			1200	
9/25/19 9:05 AM		22.0			0.190			540			390	
10/8/19 8:29 AM		4.3			0.170			240			210	
11/18/19 9:27 AM		18.0			0.069			100			140	
MLR03c												
9/20/17 11:24 AM		4.70			0.060			160			145	
10/24/17 9:55 AM		10.0			0.100			300			390	
11/14/17 9:42 AM		1.7			0.040			310			460	
3/20/18 10:43 AM		6.8			0.053			530			460	
4/24/18 10:31 AM		14.0			0.066			19			34	
5/22/18 9:34 AM		17			0.130			190			200	
6/4/18 10:00 AM		14			0.130			240			140	
7/17/18 9:39 AM		2.8			0.120			120		M2		
8/14/18 9:38 AM		38			0.130			190			110	
9/19/18 10:08 AM		6.8			0.120			180			110	
10/17/18 9:40 AM		3.6			0.084			73			100	
11/7/18 9:20 AM		7.7			0.130			1600			1085	
3/26/19 10:07 AM	D1	3.3			0.058			77			120	
4/16/19 10:02 AM		3.7			0.025			61			67	
5/14/19 9:58 AM		6.3			0.044			16			12	
6/11/19 10:21 AM		5.2			0.079			14			30	
7/16/2019 9:27		7.9			0.150			160			110	
8/27/19 9:28 AM		6.6			0.088			580			440	
9/25/19 10:43 AM		25			0.190			290			410	
10/8/19 10:04 AM		14			0.160			240			210	
11/18/19 11:25 AM		2.9		J	0.037			130			130	
MLR06b												
9/21/17 7:52 AM		4.4			0.065			180			250	
10/11/17 9:17 AM		13.5			0.099			1850			1400	

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
10/24/17 11:29 AM		9.0			0.093			340			410	
11/14/17 10:59 AM		3.4			0.025			38			71	
3/20/18 11:45 AM		4.1			0.047			52			32	
4/24/18 11:27 AM		17.0			0.079			45			37	
5/3/18 7:10 AM		15.0			0.086			340			690	
5/22/18 10:49 AM		14.0			0.120			160			130	
6/4/18 11:00 AM		16.0			0.140			200			210	
7/17/18 11:52 AM		2.6			0.150			180		M2		
8/14/18 10:42 AM		9.1			0.096			130			44	
8/29/2018		43.0			0.240			1900			1200	
9/18/18 9:29 AM		12.5			0.135			2250			1450	
9/20/18 9:15 AM		26.0			0.140			6200			1900	
10/15/18 12:00 PM		5.8			0.100			93			110	
11/5/18 11:39 AM		12.0			0.080			600			770	
3/25/19 12:03 PM		4.2			0.059			100			82	
4/15/19 12:02 PM		1.9			0.022			42			48	
4/23/19 9:54 AM		20.0			0.065			330			460	
5/13/19 12:10 PM		5.4			0.052			35			20	
5/28/19 11:42 AM		12.0			0.089			840			580	
6/11/19 11:18 AM		7.3			0.090			45			38	
7/16/2019 11:03		7.4			0.150			110			91	
8/27/19 10:05 AM		5.0			0.084			320			520	
9/12/2019 9:15		18.0			0.100		M7			M7		
9/25/19 11:35 AM		14.0			0.180			260			210	
10/2/19 10:52 AM		260.0			0.610			73000			13000	
10/8/19 11:07 AM		23.0			0.160			600			310	
11/18/19 12:27 PM		2.0		J	0.031			120			170	

C.2. Tributary sites to Cedar Creek and the Milwaukee River.

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
LEC01b												
9/20/17 11:00 AM		11.0			0.019		M7			M7		
10/23/17 9:49 AM		19.0			0.022			250			130	
11/13/17 10:16 AM		9.8		J	0.011			77			70	
3/19/18 8:18 AM		7.3		J	0.017		<	3	1.5		3	
4/23/18 8:01 AM		3.5			0.022		<	3	1.5		3	
5/21/18 9:42 AM		10.0			0.043			420			550	
6/5/18 9:43 AM		23.0			0.043			160			150	
7/16/18 10:34 AM		15.0		J	0.018			470			390	
8/13/18 9:22 AM		12.0			0.023			440			280	
9/17/18 9:37 AM		6.7			0.027			330			550	
10/15/18 9:33 AM		12.0			0.039			100			72	
11/5/18 9:16 AM		11.0			0.034			100			200	
3/25/19 9:20 AM		3.4			0.020			5			10	
4/15/19 9:16 AM		1.8		J	0.020			19			5	
5/13/19 9:28 AM		3.4			0.021			9		D1	5	
6/10/19 8:51 AM		33.0			0.049			160			140	
7/15/19 9:17 AM		21.0			0.033			730			520	
8/26/19 9:10 AM		19.0			0.044			2400			4000	
9/23/19 10:16 AM		8.5			0.033			540			730	
10/7/19 9:08 AM		8.6		J	0.030			180			160	
11/18/19 10:05 AM		5.5		J	0.014			87			81	
PSC01												
9/20/17 11:19 AM		7.9			0.056		M7			M7		
10/23/17 10:31 AM		11.0			0.065			850			1100	
11/13/17 10:33 AM		7.8			0.032			56			74	
3/19/18 9:17 AM		6.1			0.033			110			120	
4/23/18 8:52 AM		9.8			0.042			73			60	

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
5/21/18 10:02 AM		2.2			0.037			410			490	
6/5/18 10:19 AM		12.0			0.080			790			730	
7/16/18 11:40 AM		10.0			0.079			2200			3100	
8/13/18 10:15 AM		8.3			0.060			1000			870	
9/17/18 9:55 AM		6.1			0.091			620			650	
10/15/18 10:10 AM		5.5			0.060			150			120	
11/5/18 10:00 AM		22.0			0.120			1400			920	
3/25/19 10:09 AM		7.7			0.064			120			155	
4/15/19 10:11 AM		1.4		J	0.017			220			410	
5/13/19 10:21 AM		1.6			0.025			180			440	
6/10/19 9:46 AM		9.0			0.065			690			460	
7/15/19 10:29 AM		27.0			0.086			1950			1600	
8/26/19 10:03 AM		53.0			0.170			12000			13000	
9/23/19 11:15 AM		34.0			0.120		M7			M7		
10/7/19 10:03 AM		22.0			0.097			540			580	
11/18/19 10:55 AM		4.5		J	0.026			130			190	
JKC01												
9/20/17 10:31 AM		6.0			0.027			200			440	
10/23/17 10:05 AM		6.9			0.040			470			340	
11/13/17 9:50 AM		6.4			0.130			93			72	
3/19/18 8:54 AM		3.8			0.089			21			25	
4/23/18 8:30 AM		15.0			0.100			28			16	
5/21/18 9:25 AM		26.0			0.140			6200			4000	
6/5/18 10:00 AM		2.8			0.048			2800			770	
7/16/18 11:15 AM	<	1.0	0.5		0.045			2200			920	
8/13/18 9:54 AM		2.9			0.045			550			565	
9/17/18 10:12 AM		3.6			0.042			200			88	
10/15/18 9:56 AM		4.9			0.047			240			180	
11/5/18 9:42 AM		5.4			0.077			410			210	
3/25/19 9:54 AM		4.5			0.100			21			20	

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
4/15/19 9:45 AM		3.1			0.072			35			47	
5/13/19 9:54 AM		3.0			0.037			47			54	
6/10/19 9:20 AM		3.7			0.063			1400			1400	
7/15/19 10:04 AM		7.1			0.036			1200			1400	
8/26/19 9:36 AM		39.0			0.120			35000			9900	
9/23/19 10:48 AM		6.0			0.046			2500			2800	
10/7/19 9:37 AM		4.4			0.120			380			490	
11/18/19 10:29 AM		5.3			0.120			14			17	
KRB01b												
9/21/17 11:18 AM		30.0			0.250			3600			5800	
10/23/17 11:23 AM		7.5			0.120			11000			9600	
11/13/17 11:20 AM		8.9			0.064			240			360	
3/19/18 10:36 AM		6.5			0.055			12			6	
4/23/18 9:48 AM		2.7			0.051		<	3	1.5		21	
5/21/18 10:30 AM		20.0			0.110			71			93	
6/5/18 10:51 AM		20.0			0.160			370			520	
7/16/18 12:15 PM		3.1			0.220			225			205	
8/13/18 10:57 AM		3.5			0.270			250			240	
9/17/18 11:10 AM		6.6			0.150			190			140	
10/15/18 10:54 AM		2.6			0.078			70			60	
11/5/18 10:38 AM		6.8			0.230		>	3000			7500	
3/25/19 10:58 AM		4.2			0.050			5			16	
4/15/19 10:40 AM		7.6			0.084			26			26	
5/13/19 11:11 AM		5.0			0.110			73			20	
6/10/19 10:35 AM		21.0			0.150			290			270	
7/15/19 11:21 AM		4.6			0.150			230			250	
8/26/19 10:54 AM		21.0			0.160			12000			13000	
9/23/19 11:52 AM		4.8			0.175			4300			1450	
10/7/19 10:51 AM		2.8			0.130			130			67	
11/18/19 11:44 AM		6.0			0.051			66			82	

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
LCC02												
9/21/17 10:29 AM		6.8			0.049			530			650	
10/23/17 11:07 AM		9.2			0.047			1200			770	
11/13/17 11:03 AM		4.2			0.021			56			75	
3/19/18 10:13 AM		6.0			0.025			7			12	
4/23/18 9:25 AM		9.8			0.049			45			44.5	
5/21/18 10:45 AM		4.4			0.040			340			280	
6/5/18 11:40 AM		13.0			0.071			490			410	
7/16/18 12:09 PM		5.1			0.067			540			490	
8/13/18 10:41 AM		7.1			0.068			250			490	
9/17/18 11:26 AM		11.0			0.072			350			320	
10/15/18 10:37 AM		12.0			0.048			160			110	
11/5/18 10:23 AM		25.0			0.160		>	3000			2400	
3/25/19 10:40 AM		14.0			0.040			33			33	
4/15/19 10:58 AM		2.9		J	0.016			30			31	
5/13/19 10:53 AM		3.4			0.022			38			56	
6/10/19 10:19 AM		23.0			0.062			730			770	
7/15/19 11:02 AM		32.0			0.140			2400			1300	
8/26/19 10:37 AM		19.0			0.074			1500			1900	
9/23/19 12:13 PM		31.0			0.100			1600			1400	
10/7/19 10:36 AM		28.0			0.085			320			490	
11/18/19 11:25 AM		13.0		J	0.031			115			120	
LCC01												
9/20/17 11:41 AM		5.3			0.084			310			460	
10/11/17 10:52 AM		36.0			0.110			2600			2800	
10/23/17 10:50 AM		16.0			0.084			1400			1700	
11/13/17 10:50 AM		6.6			0.031			120			99	
3/19/18 9:51 AM		4.5			0.040			21			12	

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
4/23/18 9:09 AM		44.0			0.054			40			56	
5/3/18 8:12 AM		28.0			0.084			1000			980	
5/21/18 10:10 AM		31.0			0.095			130			190	
6/5/18 10:35 AM		31.0			0.140			1000			1000	
7/16/18 11:55 AM		7.8			0.130			480			410	
8/13/18 10:30 AM		5.4			0.120			450			340	
8/29/18 12:58 PM		6.8			0.220			1000			520	
9/17/18 10:56 AM		13.0			0.120			220			300	
9/20/18 10:48 AM		20.0			0.120			2550			3200	
10/15/18 10:24 AM		8.3			0.069			140			130	
11/5/18 10:10 AM		28.0			0.220		>	3000			4700	
3/25/19 10:28 AM		6.9			0.047			30			41	
4/15/19 10:27 AM		3.6			0.025			52			68	
4/23/19 8:30 AM		40.0			0.210			3000			3600	
5/13/19 10:38 AM		6.5			0.044			45			74	
5/28/2019 10:24		25.0			0.086			2100			1200	
6/10/2019 10:04		22.0			0.099			480			495	
7/15/2019 10:47		27.0			0.110			920			1100	
8/26/19 10:19 AM		26.0			0.096			2800			3400	
9/12/2019 8:40		42.0			0.140		M7			M7		
9/23/19 11:35 AM		33.0			0.130			5200			3700	
10/2/19 9:46 AM		73.0			0.440			12000			16000	
10/7/19 10:23 AM		12.0			0.130			180			150	
11/18/19 11:10 AM		9.6		J	0.039			56			79	
EVC01												
9/20/17 10:07 AM		10.000			0.090			5400			6400	
10/23/17 11:45 AM		6.200			0.160		M7			M7		
11/13/17 8:46 AM		2.600			0.063			730			670	
3/19/18 11:03 AM		2.200			0.042			12			45	
4/23/18 10:14 AM		2.200			0.042			16			20	

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
5/21/18 8:20 AM		4.300			0.063			290			210	
6/5/18 8:25 AM		44.000			0.160			490			490	
7/16/18 9:25 AM		23.000			0.190			1000			980	
8/13/2018 8:30 AM		25.000			0.220			580			1200	
9/17/18 8:48 AM		3.500			0.066			730			650	
10/15/18 8:43 AM		4.100			0.066			230			190	
11/5/18 8:30 AM		12.000			0.140			2000			870	
3/25/19 8:33 AM		4.300			0.042		< D1	3	1.5		13	
4/15/19 8:30 AM		1.500			0.019			12			16	
5/13/19 8:40 AM		1.600			0.025			35			44	
6/10/19 8:06 AM		36.000			0.130			580			730	
7/15/19 8:20 AM		23.000			0.120			810			690	
8/26/19 8:19 AM		32.000			0.120			2350			2400	
9/23/19 9:22 AM		20.000			0.160			6600			8600	
10/7/19 8:17 AM		13.000			0.120			380			520	
11/18/19 9:22 AM		2.600		J	0.032			80			140	
CBC01												
9/20/17 8:44 AM		3.4			0.083			590			520	
10/23/17 12:30 PM		2.4			0.100			1600			1800	
11/13/17 8:10 AM		2.2			0.033			80			100	
3/19/18 12:11 PM		1.6			0.038			14			15	
4/23/18 11:21 AM		2.7			0.036			14			12	
5/21/18 7:51 AM		2.7			0.073			110			120	
6/5/18 7:56 AM	D1	2.8			0.110			650			490	
7/16/18 8:50 AM		4.4			0.160			1400			2100	
8/13/18 7:56 AM		35.0			0.240			850			1100	
9/17/18 8:05 AM		2.7			0.100			935			990	
10/15/18 8:03 AM		1.5			0.083			100			93	

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
11/5/18 8:11 AM		7.8			0.160			2400			1400	
3/25/19 7:57 AM		6.5			0.043			19			22	
4/15/19 7:59 AM		1.3			0.030			77			33	
5/13/19 8:01 AM		2.1			0.034			93			70	
6/10/19 7:26 AM		17.0			0.140			420			580	
7/15/19 7:41 AM	M (LA)				0.095			3000			3300	
8/26/19 7:41 AM		23.0			0.089			2800			4500	
9/23/19 8:35 AM		5.7			0.140			5200			5900	
10/7/19 7:51 AM		4.4			0.110			180			290	
11/18/19 8:45 AM		4.1		J	0.036			93			110	
NCC01b												
9/20/17 9:06 AM		11.0			0.075			1500			1100	
10/23/17 12:07 PM		4.9			0.110			28000			27000	
11/13/17 7:37 AM		7.2			0.038			440			550	
3/19/18 11:48 AM		4.0			0.038			5			7	
4/23/18 10:31 AM		2.8			0.049			32			20	
5/21/18 7:15 AM		4.9			0.092			125			103	
6/5/18 7:25 AM		14.0			0.160			1600			1700	
7/16/18 8:01 AM	D1	7.6			0.150			880			980	
8/13/18 7:16 AM		13.0			0.130			350			360	
9/17/18 7:25 AM	D1	2.3			0.120			770			690	
10/15/18 7:15 AM		2.0			0.064			87			120	
11/5/2018 7:20		6.5			0.180		>	3000			4700	
3/25/2019 7:29		2.6			0.034			5			4	
4/15/2019 7:28		1.7			0.023			110			110	
5/13/2019 7:27		2.6			0.037			21			28	
6/10/2019 7:00		4.6			0.130			400			250	
7/15/2019 7:09		7.0			0.130			260			260	
8/26/19 7:06 AM		7.1			0.093			410			460	

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
9/23/19 7:33 AM		14.0			0.480		>	60000			98000	
10/7/19 7:10 AM	D1	2.3			0.110			140			140	
11/18/19 8:10 AM		3.8		J	0.036			93			170	
RDC01												
9/20/17 9:22 AM		2.1			0.064			220			460	
10/24/17 8:00 AM		6.5			0.140			160			88	
11/14/17 7:53 AM		16.0			0.090			35			33	
3/20/18 8:12 AM		30.0			0.180			9			4	
4/24/18 7:17 AM		2.4			0.130		Dup <	6.75	6.75		5	
5/22/18 7:56 AM		5.0			0.330			230			260	
6/4/18 8:10 AM	<	1.0	0.5		0.200			110			120	
7/17/18 7:30 AM		3.0			0.098			1800			280	
8/14/18 7:28 AM		12.0			0.130			560			390	
9/19/18 7:37 AM		9.0			0.900			160			200	
10/17/18 7:18 AM		16.0			0.310			97			140	
11/7/18 7:28 AM		9.8			0.480			4400			1300	
3/26/19 7:21 AM		4.0			0.190		<	3	1.5		4	
4/16/19 7:22 AM		3.3		AO	0.130			57.5			14.5	
5/14/19 7:40 AM		4.4			0.150			90			88	
6/11/19 7:49 AM		12.0			0.170			600			410	
7/16/19 7:27 AM		2.0			0.140			250			260	
8/27/19 7:20 AM		4.0			0.175			1650			1400	
9/25/19 8:36 AM		6.3			0.590			360			580	
10/8/19 7:50 AM		13.0			0.760			560			490	
11/18/19 8:38 AM		21.0			0.250			650			870	
MDC01												
9/20/17 8:50 AM		1.9			0.014			350			310	
10/24/17 8:56 AM	<	1.0	0.5		0.014			220			310	
11/14/17 8:49 AM		1.5		<	0.005	0.00245		40			24	
3/20/18 9:21 AM	<	1.0	0.5	J	0.012			5		D1	8	

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
4/24/18 9:34 AM		1.9			0.026		<	3	1.5		8	
5/22/18 7:32 AM		1.1		J	0.019			70			91	
6/4/18 7:48 AM		3.5			0.020			450			550	
7/17/18 11:10 AM		5.0		J	0.017			150		M2		
8/14/2018 8:23		5.6			0.022			470			390	
9/19/18 10:40 AM	Dup D1	1.9			0.059			64			44	
10/17/18 8:15 AM	<	1.0	0.5	J	0.016			52			55	
11/7/18 8:35 AM	<	1.0	0.5	J	0.015			87			110	
3/26/19 8:38 AM	<	1.0	0.5	J	0.016			9			16	
4/16/19 8:16 AM	<	1.0	0.5	J, AO	0.010			54			34	
5/14/19 8:41 AM	<	1.0	0.5	J	0.012			54			55	
6/11/19 8:57 AM		5.6			0.026			240			250	
7/16/19 8:17 AM		7.9			0.020			620			580	
8/27/19 8:10 AM		14.0			0.022			2100			930	
9/25/19 9:49 AM		2.5			0.055			170			195	
10/8/19 8:54 AM	<	1.0	0.5	<	0.012	0.006		120			160	
11/18/19 9:50 AM	<	1.0	0.5	<	0.012	0.006		14			21	
MOC02												
9/20/17 10:14 AM		1.8			0.038			360			520	
10/24/17 9:30 AM		4.8			0.058			550			520	
11/14/17 9:21 AM		3.6			0.030			87			93	
3/20/18 9:40 AM		3.0			0.032			19			16	
4/24/18 9:52 AM		4.6			0.037			5			10	
5/22/18 8:46 AM		18.0			0.074			540			1100	
6/4/18 8:59 AM		10.0			0.092			2200			1100	
7/17/18 8:36 AM		5.4			0.100			1800		M2		
8/14/18 8:44 AM		2.9			0.089			880			690	
9/19/18 8:56 AM		3.5			0.087			350			280	
10/17/18 8:30 AM		2.2			0.044			76.5			81	
11/7/18 8:15 AM		1.5			0.057			1400			820	
3/26/19 9:16 AM		2.5			0.036			5			12	

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
4/16/19 8:37 AM		2.2		AO	0.022			42			27	
5/14/19 8:58 AM		3.0			0.029			7			15	
6/11/19 9:22 AM		5.1			0.083			490			690	
7/16/19 8:37 AM		7.4			0.087			430			340	
8/27/19 8:31 AM		5.2			0.100			6200			3300	
9/25/19 9:28 AM		1.7			0.024			110			130	
10/8/19 9:13 AM		3.4			0.056			110			170	
11/18/19 10:12 AM		4.9		J	0.040			83			110	
ULC01												
9/20/17 10:58 AM		100.0			0.130			210			220	
10/24/17 7:37 AM		5.6			0.080			580			690	
11/14/17 7:32 AM		9.0			0.039			93			150	
3/20/18 7:44 AM		17.0			0.079			45			45	
4/24/18 6:55 AM		4.4			0.036			16			11	
5/22/18 7:00 AM		5.3			0.072			340			320	
6/4/18 7:14 AM		7.5			0.140			400			440	
7/17/18 7:10 AM		250.0			0.640			1600			1600	
8/14/18 7:10 AM		22.0			0.094			110			43	
9/19/18 7:05 AM		6.7			0.100			460			440	
10/17/18 7:00 AM		8.0			0.073			260			210	
11/7/18 7:00 AM		5.6			0.100			460			730	
3/26/19 7:03 AM		5.7			0.051			21			9	
4/16/19 7:00 AM		4.6		AO	0.031			26			23	
5/14/19 7:10 AM		2.4			0.045			16			20	
6/11/19 7:10 AM		9.0			0.120			380			440	
7/16/19 7:07 AM		17.0			0.280			340			690	
8/27/19 7:02 AM		12.0			0.140			2800			3000	
9/25/19 8:18 AM		6.1			0.160			960			1400	
10/8/19 7:30 AM		7.7			0.100			180			360	
11/18/19 8:10 AM		3.1		J	0.050			200			310	
ULC02												

Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
9/21/17 9:00 AM		100.0			0.300			12500			12500	
10/24/17 10:37 AM		12.0			0.110			430			820	
11/14/17 10:22 AM		71.0			0.110			200			120	
3/20/18 11:07 AM		4.1			0.059			19			13	
4/24/18 10:53 AM		4.9			0.049			14			10	
5/22/18 10:16 AM		5.7			0.076			480			440	
6/4/18 10:25 AM		9.7			0.150			650			890	
7/17/18 10:01 AM		69.0			0.310			2000		M2		
8/14/18 10:03 AM		7.9			0.185			161.5			77	
9/18/18 7:36 AM		21.0			0.190			850			1400	
10/15/18 11:24 AM		8.6			0.077			360			410	
11/5/18 11:10 AM		19.0			0.240			2300			2100	
3/25/19 10:54 PM		6.1			0.052		<	3	1.5		18	
4/15/19 11:29 AM		4.0			0.030			30			31	
5/13/19 11:40 AM		2.2			0.035			24			29	
6/11/19 10:46 AM		13.0			0.120			540			610	
7/16/19 10:11 AM		65.0			0.250			1200			580	
8/27/19 9:44 AM		14.0			0.150			4800			4300	
9/25/19 11:08 AM		41.0			0.160			500			610	
10/8/19 10:25 AM		5.7			0.220			200			220	
11/18/19 11:50 AM		14.0			0.083			495			465	
PGC01c												
9/21/17 9:54 AM	D1	2.2			0.035			1000			880	
10/24/17 10:55 AM		2.1			0.048		M7			M7		
11/14/17 10:45 AM		1.2		J	0.011			130			66	
3/20/18 11:29 AM		1.9			0.021			7			12	
4/24/18 11:12 AM		2.7			0.030			66			110	
5/22/18 10:35 AM		3.8			0.035			130			135	
6/4/18 10:48 AM		6.2			0.056			200			140	
7/17/18 10:42 AM		5.5			0.055			1500		M2(dup		

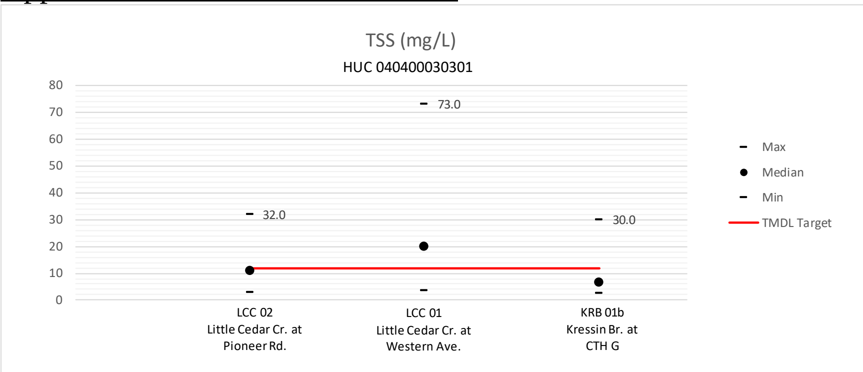
Date/Time	TSS Flag	TSS (mg/L)	TSS w/RV (mg/L)	TP Flag	TP (mg/L)	TP w/RV (mg/L)	FC Flag	FC (CFU/ 100 ml)	FC w/RV (CFU/ 100 ml)	*E coli* Flag	*E coli* (MPN/ 100 ml)	*E coli* w/RV (MPN/ 100 ml)
										M2)		
8/14/18 10:25 AM		5.1			0.041			530			310	
9/18/18 8:15 AM		8.7			0.073			4200			3100	
10/15/18 11:45 AM		1.8			0.055			150			180	
11/5/18 11:26 AM		4.2			0.040			260			305	
3/25/19 11:47 AM		2.0			0.023			14			7	
4/15/19 11:49 AM		2.2			0.021			21			25	
5/13/19 11:57 AM		1.7			0.018			10.5			19	
6/11/19 11:03		4.6			0.046			100			100	
7/16/19 10:31 AM		9.3			0.069			310			280	
8/27/19 10:19 AM		23.0			0.083			2200			2100	
9/25/19 11:24 AM		4.6			0.071			230			210	
10/8/19 10:52 AM		12.5			0.082			370			375	
11/18/19 12:14 PM		1.2		J	0.020			100			81	

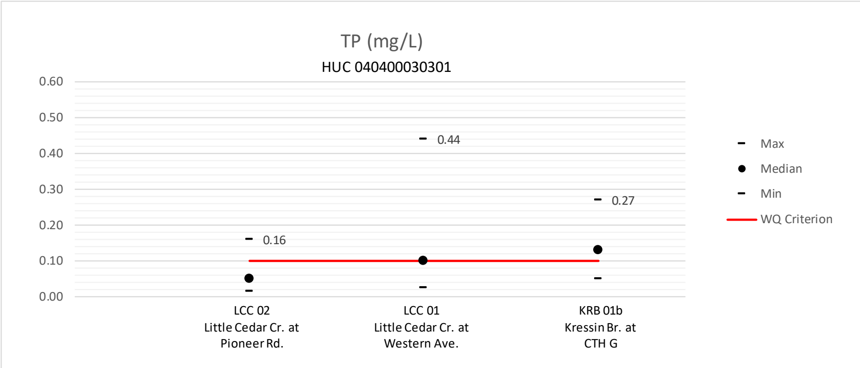
Appendix D. Summary statistics for TP, TSS, FC and *E. coli* concentrations measured at sites on the mainstem and in tributary streams to Cedar Creek and the Milwaukee River for the project, according to HUC 12 watershed (monthly data from September – November 2017 and March - November 2018 and 2019; sample size (N) 9–21, excluding 8 wet weather events).

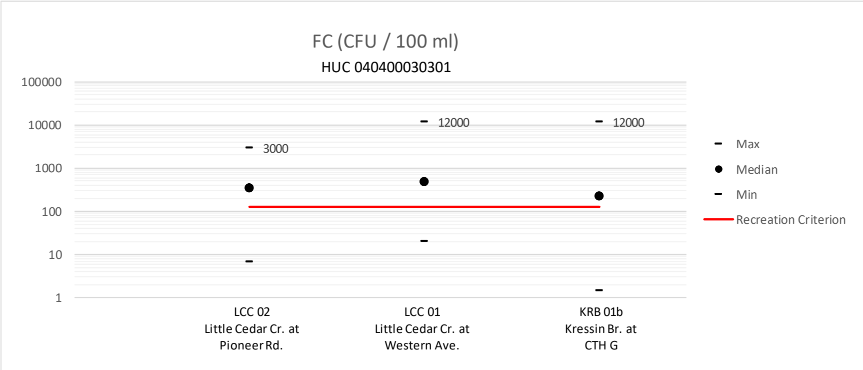
The solid red line in plots of TSS data indicates the TMDL target of 12 mg/L, expressed as the median of monthly samples collected between May and October, established in the March 19, 2018 report by CDM Smith, *Total Maximum Daily Loads for Total Phosphorus, Total Suspended Solids, and Fecal Coliform Milwaukee River Basin, Wisconsin* (CDM Smith 2018). The solid red line in plots of TP data indicate the total phosphorus water quality (WQ) criterion of 0.1 mg/L for rivers in Wisconsin according to Section NR 102.06, Wis. Adm. Code (not shown due to proximity is the criterion for Wisconsin streams of 0.075 mg/L). The solid red line in plots of FC and *E. coli* data indicate the proposed recreation criterion[7] for full contact recreational use of 126 counts per 100 mL as a geometric mean per Section NR102.04(6), as described in: Order of the State Of Wisconsin Natural Resources Board Repealing, Renumbering, Amending, Repealing and Recreating and Creating Rules, WY-17-15, which includes revisions to the recreational use, updated recreational water quality criteria, and newly developed impaired waters listing protocols to be promulgated pursuant to ss. 281.12, 281.13, and 281.15, Wis. Stats., dated 13 September 2019. Maximum values are provided next to maximum markers to improve transparency.

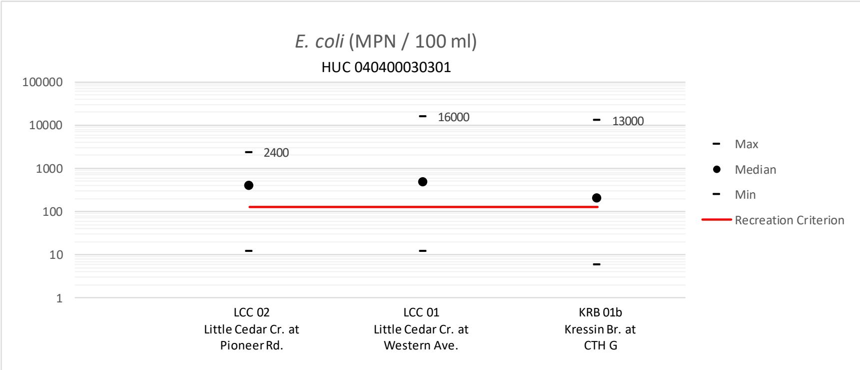
[7] To accomplish the goal to revise Wisconsin's bacteria water quality criteria to be consistent with EPA's latest recommendations, the department proposed to revise the bacteria water quality criteria for recreation in ch. NR 102, Wis. Adm. Code, which includes removing fecal coliform criteria for individual waters from ch. NR 104.

Appendix D.1 HUC 040400030301

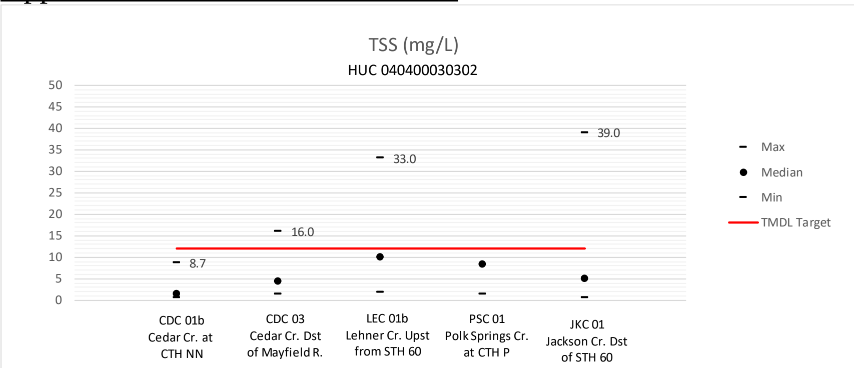


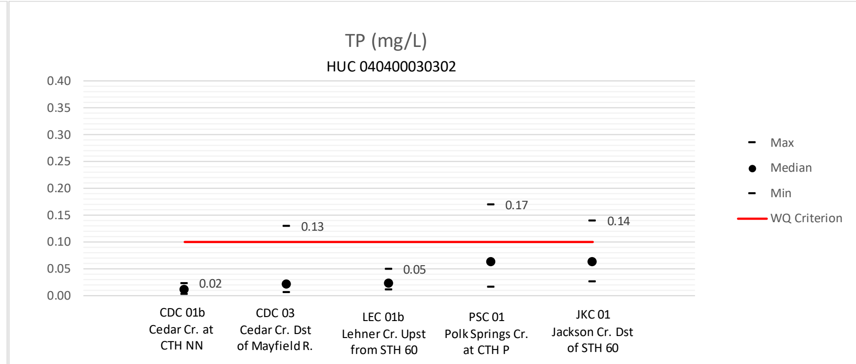


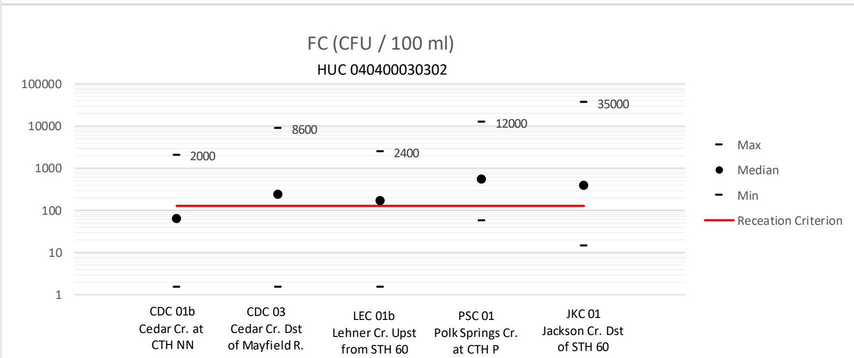


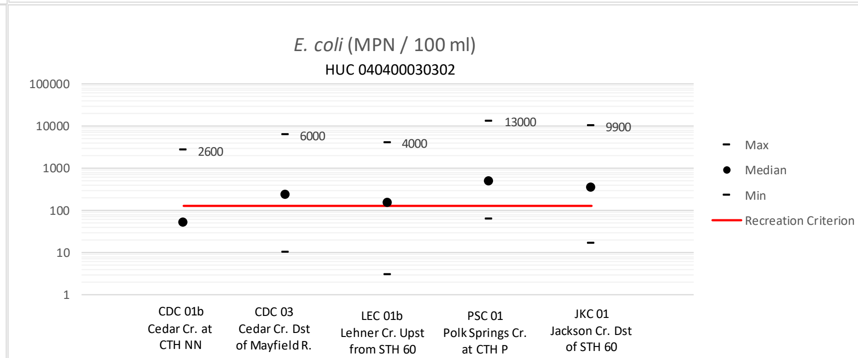


Appendix D.2 HUC 040400030302

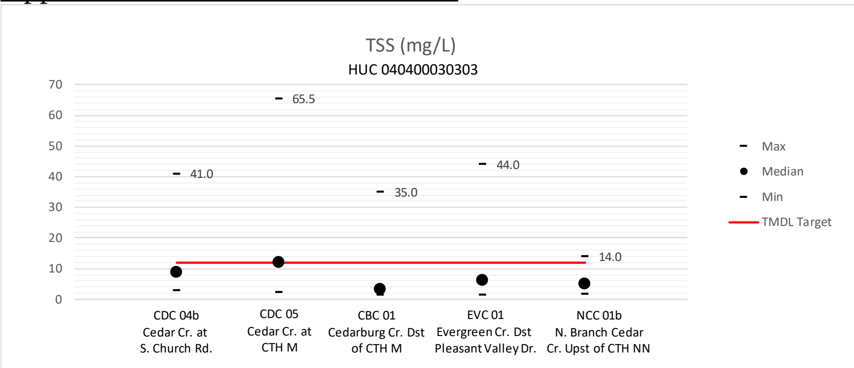


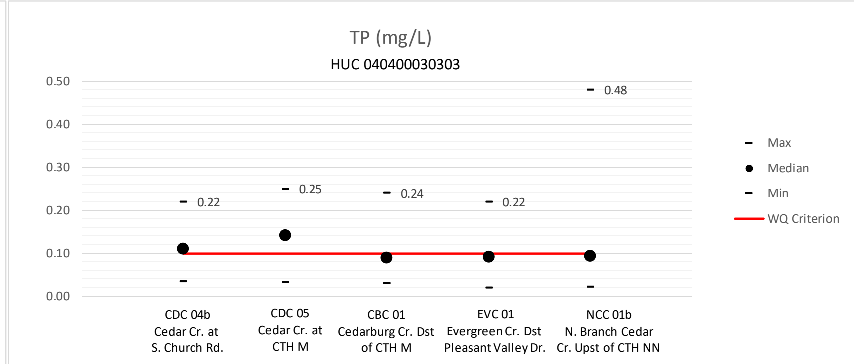


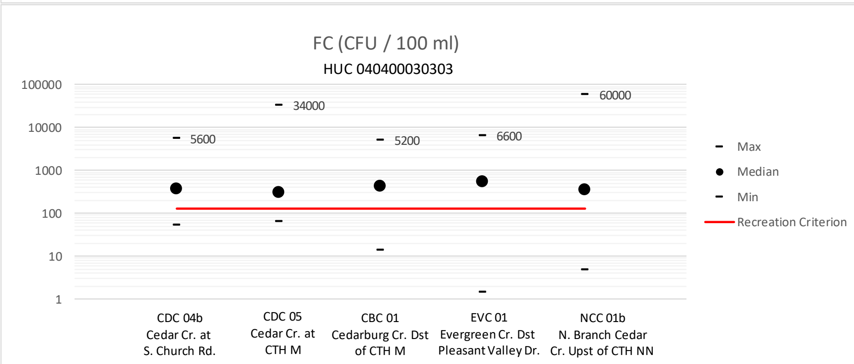


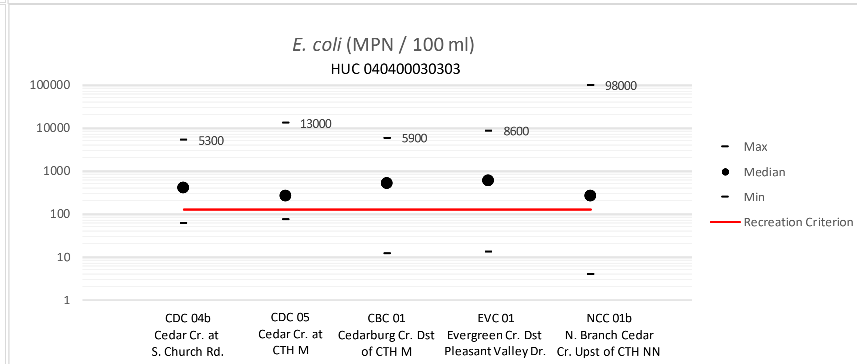


Appendix D.3 HUC 040400030303

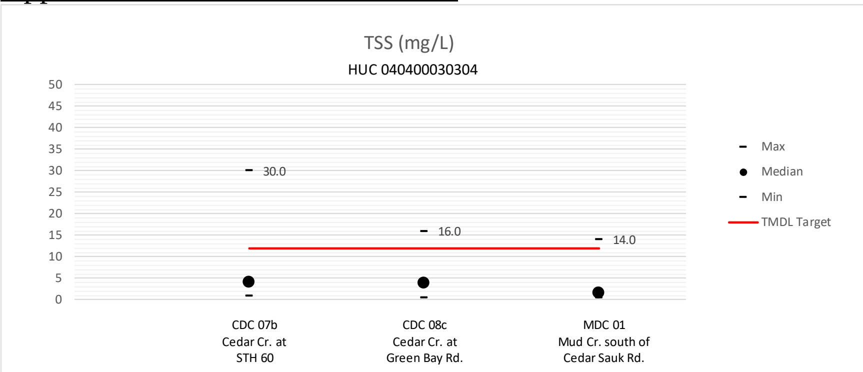


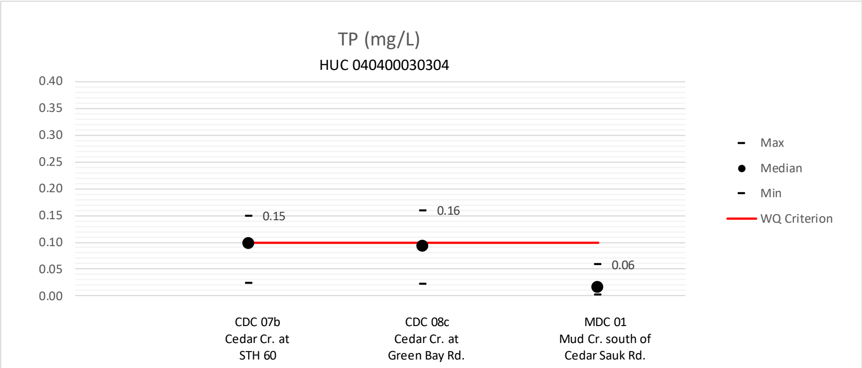


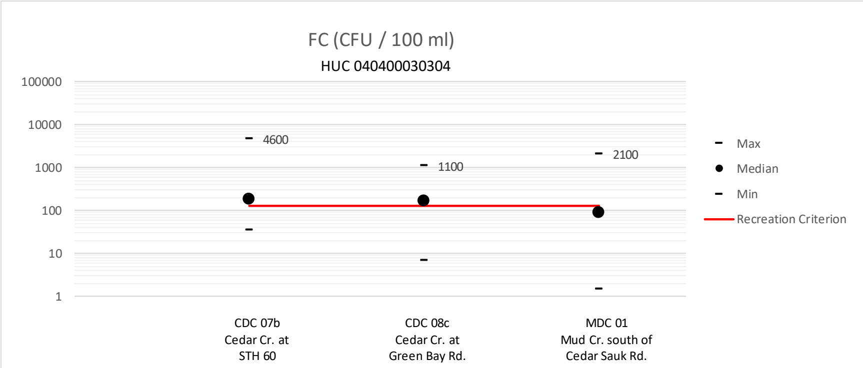


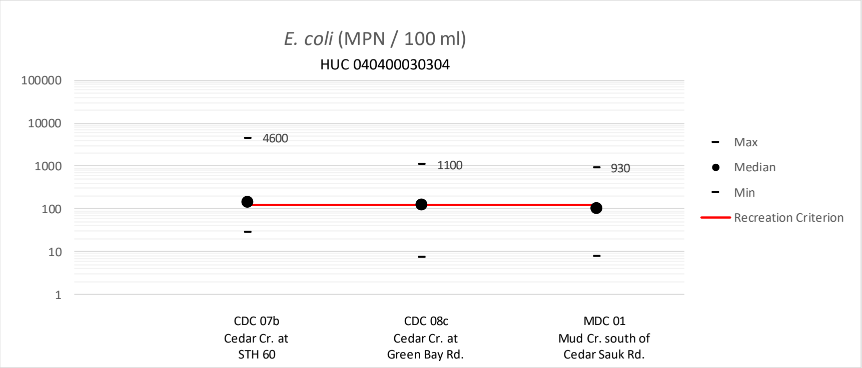


Appendix D.4 HUC 040400030304

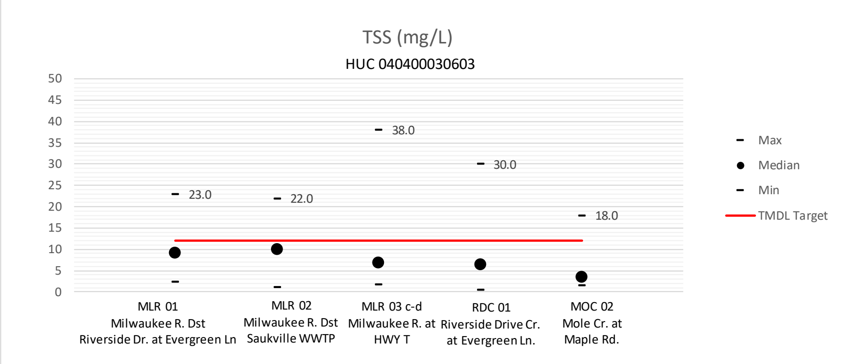


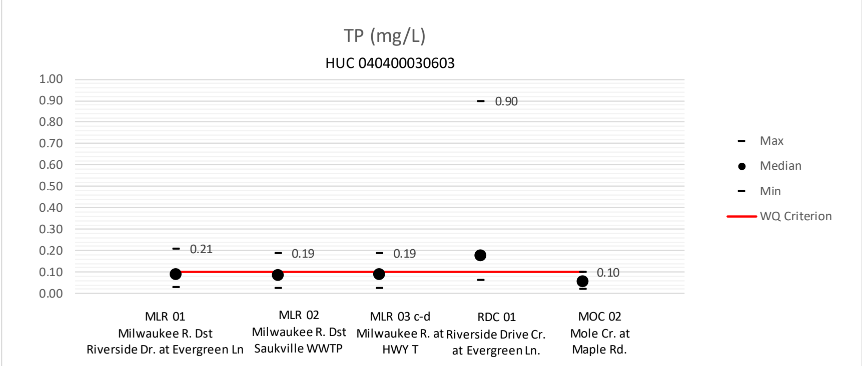


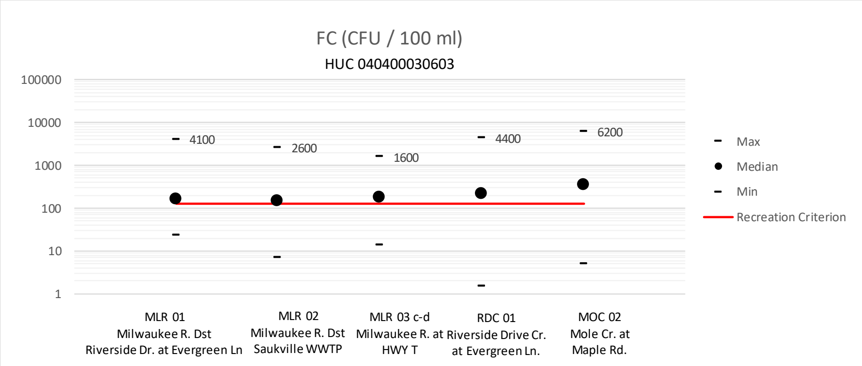


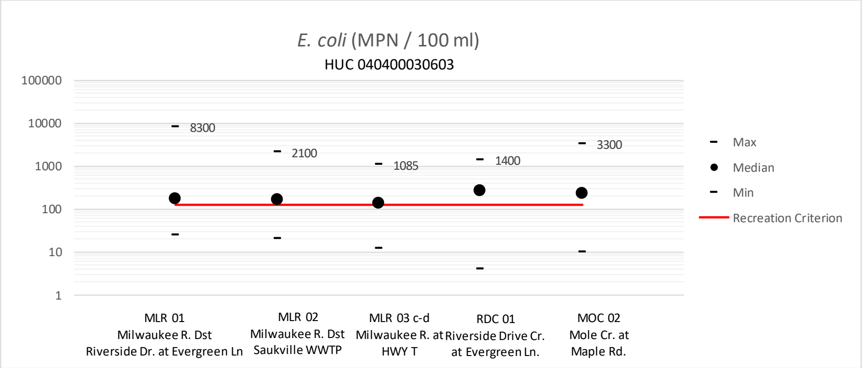


<u>Appendix D.5 HUC 040400030603</u>

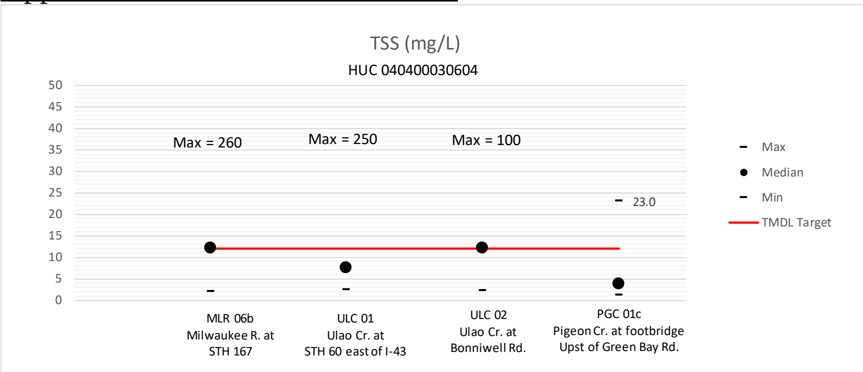


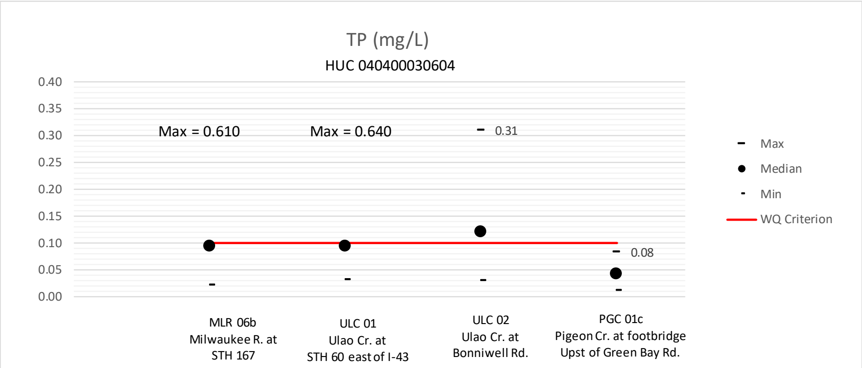


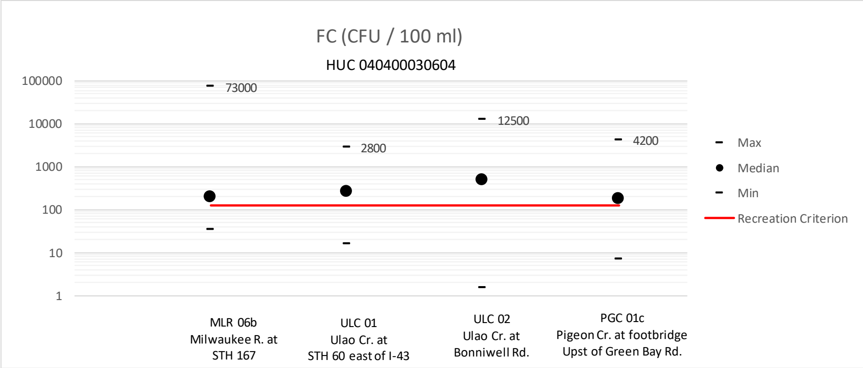


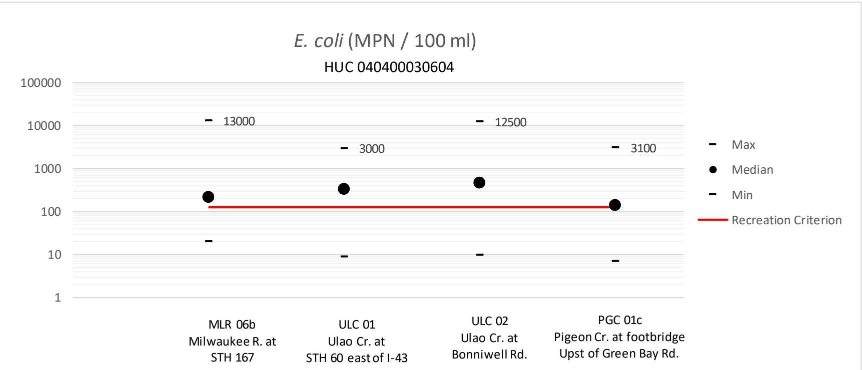


Appendix D.6 HUC 040400030604









Appendix E. Summary statistics for *in situ* water temperature, dissolved oxygen, specific conductance, pH, and turbidity measured on Cedar Creek and the Milwaukee River mainstem and tributary sites for the project (September – November 2017 and March - November 2018 and 2019).

Sample size (N) of 21 in nearly all cases, plus 8 at wet weather sites (i.e., CDC03, CDC05, MLR06b, LCC01).

			Water temperature (°c)					Dissolved oxygen (mg/L)					Specific conductance (μs/cm)					pH (s.u.)					Turbidity (NTU)				
HUC	Site	Site Description	Median	Min	10th P	90th P	Max	Median	Min	10th P	90th P	Max	Median	Min	10th P	90th P	Max	Median	Min	10th P	90th P	Max	Median	Min	10th P	90th P	Max
040400030301	LCC02	Little Cedar Cr. at Pioneer Rd. near intersection with Rocky Lane	12.0	1.8	2.8	19.5	22.8	10.2	7.2	8.1	14.7	16.2	896	629	729	1015	1022	7.96	7.55	7.71	8.24	8.32	8.37	0.50	2.60	20.10	40.58
040400030301	LCC01	Little Cedar Cr. at Western Ave.	12.7	1.5	2.9	20.1	23.9	8.4	1.9	5.9	12.6	15.6	832	217	598	913	996	7.80	6.32	7.54	8.13	8.29	13.35	1.58	5.07	25.53	111.00
040400030301	KRB01b	Kressin Br. at CTH G	11.5	1.2	3.3	22.1	25.9	7.4	3.1	4.2	13.3	13.6	739	472	632	844	872	7.65	7.25	7.44	8.05	8.19	7.63	0.00	0.82	19.71	23.57
040400030302	CDC01b	Cedar Cr. at CTH NN	14.5	2.8	4.3	22.5	26.7	9.9	6.5	7.6	13.9	14.8	553	408	491	577	585	8.16	7.67	7.95	8.35	8.58	0.13	0.00	0.00	2.00	9.69
040400030302	CDC03	Cedar Cr. downstream of Mayfield R.	13.8	2.9	3.7	20.0	23.1	9.7	6.8	8.3	14.3	15.3	663	373	548	748	871	8.03	6.93	7.72	8.32	8.41	2.22	0.00	0.00	7.98	17.39
040400030302	LEC01b	Lehner Cr. Upstream from STH 60	11.7	2.2	3.1	19.5	23.8	11.4	7.5	8.0	14.9	15.2	871	777	798	898	946	7.96	7.69	7.77	8.23	8.35	3.73	0.03	0.28	12.20	16.99
040400030302	PSC01	Polk Springs Cr. At CTH P	11.5	1.8	2.6	18.3	22.3	11.2	8.5	9.3	15.3	16.8	823	714	739	855	896	8.07	7.73	7.82	8.44	8.56	7.97	0.21	1.82	23.65	40.05
040400030302	JKC01	Jackson Cr. downstream of STH 60	14.3	3.2	3.8	23.0	27.7	9.3	5.3	6.2	14.0	18.0	846	211	646	1011	1116	7.98	7.77	7.82	8.29	8.36	3.93	1.20	1.51	18.69	27.60
040400030303	CDC04b	Cedar Cr. at S. Church Rd.	12.5	1.9	2.9	20.6	24.2	8.7	4.9	5.8	13.2	15.7	805	652	721	900	1032	7.76	7.12	7.48	8.07	8.14	9.32	0.58	1.92	20.03	27.24
040400030303	CDC05	Cedar Cr. at CTH M	13.6	1.7	2.6	21.5	24.3	7.1	1.9	4.1	12.0	16.3	788	275	547	900	970	7.67	6.32	7.35	8.04	8.22	11.76	0.00	1.58	25.36	37.27
040400030303	CBC01	Cedarburg Cr. downstream of CTH M	11.8	0.0	1.0	17.9	21.2	9.1	3.7	4.9	14.4	18.4	804	589	612	1003	1048	7.76	7.37	7.56	8.09	8.14	3.14	0.00	0.16	13.27	25.85
040400030303	EVC01	Evergreen Cr. downstream of Pleasant Valley Dr.	11.8	0.3	1.2	19.0	23.1	11.7	3.7	8.1	15.6	19.0	758	622	673	794	810	7.94	7.68	7.74	8.30	8.52	7.78	0.00	1.74	25.85	27.05
040400030303	NCC01b	N. Branch of Cedar Cr. upstream of CTH NN	11.0	0.0	0.5	18.0	21.8	8.0	3.1	5.2	14.2	16.6	713	516	564	762	790	7.65	7.28	7.36	8.10	8.22	3.78	0.19	0.23	8.94	17.98
040400030304	CDC07b	Cedar Cr. at STH 60	11.8	2.2	2.4	23.2	24.2	8.7	4.0	5.5	12.8	15.2	745	524	623	893	958	7.87	7.34	7.53	8.14	8.45	4.09	0.00	0.70	9.52	18.13
040400030304	CDC08c	Cedar Cr. at Green Bay Rd.	12.9	1.2	3.2	23.4	24.8	11.0	6.8	7.5	15.4	17.5	745	514	629	884	905	8.13	7.72	7.86	8.51	8.56	3.73	0.22	0.58	9.14	11.37
040400030304	MDC01	Mud Creek south of Cedar Sauk Rd.	11.6	0.6	1.9	20.6	24.4	7.1	1.9	5.1	10.4	19.1	317	259	266	400	776	7.76	6.94	7.36	8.18	8.66	0.19	0.00	0.00	2.73	4.11
040400030603	MLR01	Milwaukee R. downstream of Riverside Dr. at Evergree Ln.	12.5	1.6	2.6	23.1	24.3	8.7	3.2	4.8	12.7	15.8	738	421	558	826	916	7.92	7.53	7.69	8.24	8.34	9.30	0.00	1.94	16.28	16.80
040400030603	MLR02	Milwaukee R. downstream of Saukville WWTP	12.3	0.1	3.0	24.1	24.6	8.6	3.4	4.7	13.2	19.7	738	407	557	832	874	8.03	7.54	7.75	8.29	8.38	6.38	0.23	2.82	14.56	17.22
040400030603	MLR03c-d	Milwaukee R. at HWY T	13.4	0.5	3.6	25.5	26.3	13.4	7.3	8.8	15.0	17.3	751	409	559	844	956	8.24	7.67	7.93	8.52	8.64	5.70	0.33	1.03	15.12	22.18
040400030603	RDC01	Riverside Drive Cr. at Evergreen Ln.	10.4	1.1	3.4	15.9	16.1	7.3	3.8	4.8	9.3	25.6	801	504	548	1014	1066	7.53	7.21	7.23	8.10	8.43	8.44	0.80	2.60	21.47	45.41
040400030603	MOC02	Mole Cr. at Maple Rd.	10.7	0.6	1.9	19.4	21.4	9.0	4.5	6.5	12.2	18.5	739	314	633	851	863	7.81	7.44	7.46	8.11	8.29	2.81	0.00	0.00	8.64	12.39
040400030604	MLR06b	Milwaukee R. at STH 167	16.1	0.7	4.1	23.2	28.7	9.0	4.9	7.3	14.6	16.5	741	340	541	849	987	8.16	7.54	7.83	8.49	8.74	9.16	0.00	1.75	17.37	125.00
040400030604	ULC01	Ulao Cr. at STH 60 east of I-43	10.4	-0.1	1.2	18.8	21.5	7.0	2.8	3.5	9.5	11.2	893	488	619	1304	3481	7.52	7.22	7.26	7.85	8.80	7.84	1.45	1.64	19.00	25.27
040400030604	ULC02	Ulao Cr. at Bonniwell Rd.	11.7	1.3	1.5	19.5	22.3	8.8	1.7	4.4	13.4	14.5	1004	527	721	1340	1395	7.83	7.20	7.61	8.14	8.40	13.82	1.84	2.94	32.35	72.00
040400030604	PGC01c	Pigeon Cr. at pedestrian footbridge upstream of Green Bay Rd.	11.9	2.9	3.6	21.0	21.5	9.8	7.2	7.8	14.9	17.0	823	721	745	910	1037	7.98	7.57	7.80	8.26	8.57	2.76	0.00	0.09	8.49	11.01

Appendix F. Summary of QA/QC Review and Evaluation of Data

This appendix provides a summary of GLEC's QA/QC review and evaluation of the *in situ* and analytical data quality associated with the District's baseline study to evaluate water quality changes in portions of the Milwaukee River watershed over time. It is responsive to all applicable elements specified for the study, and the statements regarding data use or limitations contained herein are intended to support the findings generated to date for the study.

GLEC was responsible for measuring monthly *in situ* water quality data (DO, pH, specific conductance, water temperature and turbidity) and collecting ambient surface samples September through November 2017 and March through November 2018 and 2019 for quantitation of total suspended solids (TSS), total phosphorous (TP), fecal coliform (FC), and *E. coli* at 25 sites within the Milwaukee River watershed Phase 1 area in Washington and Ozaukee Counties. Additionally, GLEC collected *in situ* water quality data and ambient surface samples at four of the 25 locations (CDC03, CDC05, MLR06b, and LCC01) during high-flow, wet weather (storm) events sampled once in 2017 (11 October), three times in 2018 (3 May, 29 August, 20 September), and four times in 2019 (23 April, 28 May, 12 September, 2 October). *In situ* water quality data and ambient surface water samples were collected according to GLEC project-specific SOPs FLD 6035, 6036, and 6038, as indicated above. GLEC was also responsible for creating a comprehensive analytical database for this study, as well as analytical data quality reduction and summary, including calculation of QA/QC performance.

MMSD laboratory managers were responsible for the QC/QA of their own chemical analyses and for providing that data electronically to GLEC in a format suitable for insertion into the electronic analytical database developed for the study. The MMSD laboratory operated independently during the study and was assumed as:

- having an acceptable laboratory QA program in place to ensure all data meet state requirements;
- having laboratory SOPs in place to ensure that method performance meets or exceeds the requirements specified in the analytical methods;
- providing qualified sampling personnel and laboratory analysts;
- verifying receipt and condition of sample shipments by the field sampling crews; and
- resolving any analytical problems and implementing any necessary corrective actions;

<u>Analytical QA/QC</u>
The MMSD laboratory did not provide GLEC with any specific laboratory QC information (laboratory replicates, matrix spike (MS)/matrix spike duplicate (MSD) samples, laboratory blanks, etc.), and thus, this written statement of data quality does not include an evaluation of the laboratory MS/MSD samples, laboratory control samples, or laboratory blanks. The analytical methods used by MMSD for quantitation of TSS, TP, FC, and *E. coli* were:

- TSS – SM 2540 D (1997);
- TP – EPA 365.1
- FC – SM 9222 D (1997);
- *E. coli* – SM 9223 B (2004)

One hundred percent of all electronic analytical data from MMSD was also checked for accuracy. The imported results were compared with hard-copy PDF reports that the laboratory provided. The QA check revealed no errors in analytical results.

The following laboratory flags, their descriptions, and number of instances of each are provided for the analytical data:

Censored value - Value reported as less than the Method Detection Limit or MDL; Value one-half the MDL (N=38 samples; refer to Tables C.1 and C.2, values flagged "<").

Censored value - Value reported as a greater than value; Estimated value (N=7 samples; refer to Tables C.1 and C.2, values flagged ">").

Value flagged J - estimated concentration above the adjusted MDL and below the adjusted reporting limit; Estimated value (N=52 samples; refer to Tables C.1 and C.2).

Value flagged D1 - Duplicate precision control limit was exceeded; Estimated value (N=15 samples; refer to Tables C.1 and C.2).

Value flagged AO - Other - flag requires additional explanation- detection in field blank (N=11 samples; refer to Tables C.1 and C.2).

Value flagged M2 - Sample incubation period outside method requirement; No value (N=8 samples; refer to Tables C.1 and C.2).

Value flagged M7 - Micro sample received without adequate head space; No value (N=18 samples; refer to Tables C.1 and C.2).

Conclusion: Fifteen *E. coli*, seven (7) FC, two TSS, and one TP sample were excluded out of 525 samples quantified per analyte during scheduled monitoring; three FC and *E. coli* samples excluded out of 32 quantified during high-flow monitoring.

Sampling QA/QC

Per GLEC project-specific FLD SOP 6038 [*Field Sampling for Milwaukee Metropolitan Sewerage District (MMSD)*], field quality control samples and acceptability criteria were as follows:

Field blanks were collected at a rate of one per day (per parameter), or two per sampling event (per parameter). Field blank results should be less than the reporting limit (<RL) for each parameter. If a field blank had a result that was equal to or above the RL, the data set was reviewed to determine if the amount of blank contamination could have affected the sample data. If the field blank value was less than 5% of the lowest sample value in the batch, the data was likely not compromised.

Conclusion: All field blanks were less than the RL for all analytes with the exception of a field blank collected at CDC07b on 17 July 2018 and CDC08c on 16 April 2019, both analyzed for TP. At CDC07b on 17 July, the concentration of TP in the field blank was estimated (flagged J) to be 0.014 mg/L. At CDC08c on 16 April, the concentration of TP in the field blank was 0.044

mg/L. These values exceeded 5% of the lowest sample value in the batch, thus, the TP data is likely compromised and the TP concentrations from samples taken from other locations on 17 July 2018 and 16 April 2019 are qualified. Note that due to the inexplicable high TP concentration in the field blank on 16 April 2018, a trip blank was included for all remaining sampling events: April 2019 through November 2019. No TP was detected in any trip blanks.

Field duplicate samples were collected at a rate of 8% of sampling sites or two per sampling event. The site at which duplicates were taken were randomly chosen each event by MMSD. Precision of field duplicate results was calculated by the relative percent deviation (RPD), using the following equation, where X1 and X2 represent replicate results:

RPD ={ (X1 - X2)/ [(X1+X2)/2] }* 100

RPD should not exceed 50%. If the RPD exceeded 50% for a duplicate set of samples, the data set was qualified with the appropriate QC qualifier code and is bolded in the tables below.

Mainstem sites.

Date	Sampling Location	TSS Field Dup RPD	TP Field Dup RPD	FC Field Dup RPD	*E. coli* Field Dup RPD
3/19/2018	CDC01b	**157%**	16%	0%	**67%**
5/3/2018	CDC03	0%	2%	10%	13%
5/28/2019	CDC03	12%	9%	21%	6%
10/7/2019	CDC03	30%	16%	13%	7%
10/15/2018	CDC04b	16%	3%	4%	22%
4/15/2019	CDC04b	7%	6%	40%	22%
8/29/2018	CDC05	49%	4%	14%	0%
4/23/2019	CDC05	11%	12%	16%	19%
10/2/2019	CDC05	21%	0%	23%	6%
10/24/2017	CDC07b	4%	3%	14%	6%
5/14/2019	CDC07b	10%	0%	40%	0%
3/20/2018	CDC08c	24%	5%	**156%**	**67%**
7/16/2019	CDC08c	0%	0%	22%	14%
11/14/2017	MLR01	0%	4%	5%	7%
3/26/2019	MLR01	2%	3%	21%	29%
6/11/2019	MLR01	9%	2%	9%	23%
6/4/2018	MLR02	9%	0%	7%	24%
9/20/2017	MLR03c	4%	2%	13%	48%
11/7/2018	MLR03d	0%	0%	0%	40%
10/11/2017	MLR06b	7%	2%	16%	29%
9/18/2018	MLR06b	8%	7%	4%	21%

Tributary sites.

Date	Sampling Location	TSS Field Dup RPD	TP Field Dup RPD	FC Field Dup RPD	*E. coli* Field Dup RPD
9/17/2018	CBC01	7%	0%	35%	2%

Date	Sampling Location	TSS Field Dup RPD	TP Field Dup RPD	FC Field Dup RPD	*E. coli* Field Dup RPD
11/13/2017	EVC01	15%	2%	11%	18%
8/26/2019	EVC01	63%	0%	21%	0%
8/13/2018	JKC01	7%	7%	18%	16%
7/16/2018	KRB01b	13%	0%	40%	5%
9/23/2019	KRB01b	42%	6%	23%	7%
9/20/2018	LCC01	0%	0%	4%	31%
6/10/2019	LCC01	0%	2%	17%	34%
9/12/2019	LCC01	0%	0%	**na**	**na**
4/23/2018	LCC02	4%	6%	0%	20%
11/18/2019	LCC02	0%	0%	9%	0%
9/19/2018	MDC01	21%	3%	9%	18%
9/25/2019	MDC01	29%	**108%**	35%	46%
10/17/2018	MOC02	9%	0%	17%	17%
5/21/2018	NCC01b	14%	0%	8%	14%
5/22/2018	PGC01c	13%	0%	0%	7%
7/17/2018	PGC01c	7%	4%	13%	**na**
11/5/2018	PGC01c	10%	3%	23%	**69%**
5/13/2019	PGC01c	6%	11%	**105%**	**95%**
10/8/2019	PGC01c	24%	1%	11%	19%
6/5/2018	PSC01	17%	9%	15%	0%
3/25/2019	PSC01	7%	2%	17%	13%
7/15/2019	PSC01	0%	2%	26%	38%
4/24/2018	RDC01	21%	0%	**156%**	40%
4/16/2019	RDC01	15%	0%	19%	21%
8/27/2019	RDC01	23%	6%	30%	0%
9/21/2017	ULC02	0%	0%	24%	8%
10/24/2017	ULC02	0%	0%	9%	12%
8/14/2018	ULC02	6%	16%	**85%**	23%
11/18/2019	ULC02	0%	0%	6%	11%

na = not applicable due to no value (see values flagged M2 and M7 above)

Conclusion: On mainstem sites, the field duplicate RPD for TSS (CDC01b, 19 March 2018) and FC (CDC08c, 20 March 2018) was exceeded once each, while the field duplicate RPD for *E. coli* was exceeded twice (same two sites and dates). On tributary sites, the field duplicate RPD for TP was exceeded once at MDC01 on 25 September 2018, while the field duplicate RPDs for FC was exceeded three times: PGC01c on 13 May 2019, RDC01 on 24 April 2018, and ULC02 on 14 August 2018, and *E. coli* twice: PGC01c on 5 November 2018 and again on 13 May 2019. All TSS, FC and *E. coli* concentrations from samples taken from other locations on these dates are qualified.

<u>QA/QC *in situ* Measurements</u>

GLEC field staff calibrated the YSI Pro Plus (multiparameter sonde) and TB400 turbidity meters each morning before use following protocols outlined in GLEC SOPs FLD 6035 and FLD 6033. GLEC field staff also performed a post-sampling calibration (drift) check for specific conductance (1409 µS/cm), pH (7), and DO (% saturation based on current barometric pressure) towards the end of each sample day and reported the results of the drift checks in the meter's logbook. The parameter-specific allowable drift was as follows:

Parameter:	**Allowable Drift Range:**
Specific conductance - within 5% of standard (1409 µS/cm)	1339 to 1479 µS/cm
pH - for pH 7.0	6.65 to 7.35 pH units
% DO	within 5% of expected percent saturation for current barometric pressure

- ***Conclusion***: Percentage drift based on pre- and post-sampling calibration of % DO, pH and specific conductance was within the allowable drift range per GLEC SOP FLD 6035 for all sampling events with the following exceptions:
- On 13 November 2017, % DO fell out of acceptable range by 3% (expected 99%, measured 107%) for the meter used to take *in situ* measurements at the Washington County sites.
- On 19 March 2018, % DO fell out of acceptable range by 3% (expected 97%, measured 105%) for the meter used to take *in situ* measurements at the Washington County sites.
- On 20 March 2018, % DO fell out of acceptable range by 4% (expected 97%, measured 106%) for the meter used to take *in situ* measurements at the Ozaukee County sites.
- On 3 May 2018 (wet event), % DO fell out of acceptable range by 1% (expected 96%, measured 102%).
- On 16 July 2018, the drift check was not performed for pH on the meter used to take *in situ* measurements at the Washington County sites.
- On 10 June 2019, % DO fell out of acceptable range by 7% (expected 99%, measured 111%) for the meter used to take *in situ* measurements at the Washington County sites.
- On 8 October 2019, Specific conductance fell out of acceptable range by 81 µS/cm (acceptable range for 1409 µS/cm is 1339 to 1479 µS/cm, measured 1560 µS/cm) for the meter used to take *in situ* measurements at the Ozaukee County sites.

We flagged the appropriate data with a J qualifier (estimated value) in the Excel data file for those sites with out-of-range drift checks.

All *in situ* water quality data (dissolved oxygen, pH, specific conductance, water temperature and turbidity) was hand-entered into electronic format from field data sheets and received a 100% check for accuracy of transcription upon entry and via independent review. Any discrepancies found were resolved.

Other QA/QC Issues:
Based on the measured concentrations, it appears that two QA samples for TSS were mistakenly switched during the June 2018 sampling event. The blank collected at ULC01 (TSS=12 mg/L) and the field duplicate collected at MLR02 (TSS<1 mg/L) are the samples in question. Review of the TSS data from all sites sampled in June suggests that the samples in question above were

switched. Results in the summary data spreadsheet maintained for this project were amended accordingly.

Appendix G. Summary of Pollutant Concentrations, Measured Stream Discharge, and Calculated Pollutant Loads for All Sites Evaluated for the Project (September – November 2017 and March - November 2018 and 2019). Includes Tables G.1-G.25.

Table G.1. Pollutant Concentrations and Discharge Measured at Site CBC01 and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	3.4	0.083	590	520	0	0	0	0	0
10/23/2017	2.4	0.1	1600	1800	3.2	19	0.79	1.3E+11	1.4E+11
11/13/2017	2.2	0.033	80	100	0.76	4.1	0.06	1.5E+09	1.9E+09
3/19/2018	1.6	0.038	14	15	2.4	9.3	0.22	8.1E+08	8.7E+08
4/23/2018	2.7	0.036	14	12	14	93	1.2	4.8E+09	4.1E+09
5/21/2018	2.7	0.073	110	120	3.7	24	0.65	9.9E+09	1.1E+10
6/5/2018	2.8	0.11	650	490	2.5	17	0.68	4E+10	3E+10
7/16/2018	4.4	0.16	1400	2100	0.05	0.54	0.02	1.7E+09	2.6E+09
8/13/2018	35	0.24	850	1100	0	0	0	0	0
9/17/2018	2.8	0.1	770	1000	2	14	0.5	3.8E+10	5E+10
10/15/2018	1.5	0.083	100	93	8	29	1.6	2E+10	1.8E+10
11/5/2018	7.8	0.16	2400	1400	24	460	9.3	1.4E+12	8.2E+11
3/25/2019	6.5	0.043	19	22	21	330	2.2	9.7E+09	1.1E+10
4/15/2019	1.3	0.03	77	33	13	42	0.96	2.5E+10	1.1E+10
5/13/2019	2.1	0.034	93	70	6.7	35	0.56	1.5E+10	1.2E+10
6/10/2019	17	0.14	420	580	1.8	74	0.61	1.8E+10	2.5E+10
7/15/2019	NA	0.095	3000	3300	0.29	NA	0.07	2.1E+10	2.3E+10
8/26/2019	23	0.089	2800	4500	0.21	12	0.05	1.4E+10	2.3E+10
9/23/2019	5.7	0.14	5200	5900	2.9	40	0.99	3.7E+11	4.2E+11
10/7/2019	4.4	0.11	180	290	15	170	4.2	6.8E+10	1.1E+11
11/18/2019	4.1	0.036	93	110	6.2	62	0.55	1.4E+10	1.7E+10
				mean	6.1	71	1.2	1.1E+11	8.2E+10

Table G.2. Pollutant Concentrations and Discharge Measured at Site CDC01b and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/21/2017	1.8	0.009	150	170	4.6	20	0.1	1.7E+10	1.9E+10
10/23/2017	2.5	0.0076	300	180	19	120	0.35	1.4E+11	8.4E+10
11/13/2017	0.5	0.00245	45	39	1.8	2.2	0.01	2E+09	1.7E+09
3/19/2018	0.5	0.02	3	1	7.2	8.8	0.35	5.3E+08	1.8E+08
4/23/2018	0.5	0.012	5	2	18	21	0.51	2.1E+09	8.6E+08
5/21/2018	0.5	0.0098	10	10	6.8	8.4	0.16	1.7E+09	1.7E+09
6/5/2018	2.7	0.011	110	96	5.3	35	0.14	1.4E+10	1.2E+10
7/16/2018	4.2	0.018	200	140	2.7	27	0.12	1.3E+10	9.1E+09
8/13/2018	2.2	0.018	920	690	0.89	4.8	0.04	2E+10	1.5E+10
9/17/2018	1.2	0.014	310	240	4.1	12	0.14	3.1E+10	2.4E+10
10/15/2018	0.5	0.014	170	110	2.5	3.1	0.09	1E+10	6.7E+09
11/5/2018	1	0.011	43	50	24	60	0.65	2.6E+10	3E+10
3/25/2019	1	0.023	5	4	15	36	0.82	1.8E+09	1.4E+09
4/15/2019	0.5	0.01	7	3	13	16	0.33	2.3E+09	9.8E+08
5/13/2019	0.5	0.01	93	1	13	16	0.32	3E+10	3.2E+08
6/10/2019	1.5	0.011	28	24	6.9	25	0.18	4.7E+09	4E+09
7/15/2019	3.6	0.014	61	51	7.3	64	0.25	1.1E+10	9.1E+09
8/26/2019	8.7	0.022	2000	2600	4.4	93	0.24	2.1E+11	2.8E+11
9/23/2019	2.4	0.012	83	78	29	170	0.86	6E+10	5.6E+10
10/7/2019	1.6	0.006	28	16	40	160	0.58	2.7E+10	1.6E+10
11/18/2019	1.1	0.012	5	8	9.8	26	0.29	1.2E+09	1.9E+09
				mean	11	44	0.31	3E+10	2.7E+10

Table G.3. Pollutant Concentrations and Discharge Measured at Site CDC03 and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	2.9	0.014	NA	NA	2.7	19	0.09	NA	NA
10/11/2017	5.6	0.015	400	410	12	160	0.44	1.2E+11	1.2E+11
10/23/2017	5.2	0.02	420	340	16	200	0.78	1.6E+11	1.3E+11
11/13/2017	7.9	0.01	70	100	8	160	0.2	1.4E+10	2E+10
3/19/2018	4.8	0.021	19	16	16	190	0.84	7.6E+09	6.4E+09
4/23/2018	7.7	0.033	80	63	31	590	2.5	6.1E+10	4.8E+10
5/3/2018	16	0.049	1100	1600	51	2000	6.1	1.4E+12	2E+12
5/21/2018	4	0.03	130	96	17	170	1.3	5.5E+10	4.1E+10
6/5/2018	6	0.025	230	230	11	160	0.66	6.1E+10	6.1E+10
7/16/2018	3.9	0.022	1200	610	8.7	83	0.47	2.6E+11	1.3E+11
8/13/2018	4	0.019	410	550	5	49	0.23	5E+10	6.7E+10
8/29/2018	4	0.054	380	460	120	1100	15	1.1E+12	1.3E+12
9/17/2018	2.3	0.021	200	130	16	89	0.81	7.7E+10	5E+10
9/20/2018	3.4	0.027	1300	1100	27	220	1.8	8.5E+11	7.2E+11
10/15/2018	2.5	0.021	110	100	24	150	1.2	6.4E+10	5.8E+10
11/5/2018	2.9	0.025	330	280	33	230	2	2.7E+11	2.3E+11
3/25/2019	3.7	0.015	1.5	10	38	340	1.4	1.4E+09	9.2E+09
4/15/2019	2.1	0.014	26	15	25	130	0.86	1.6E+10	9.2E+09
4/23/2019	12	0.044	460	550	44	1300	4.7	4.9E+11	5.9E+11
5/13/2019	3.1	0.015	38	52	25	190	0.91	2.3E+10	3.2E+10
5/28/2019	5.3	0.021	83	86	30	390	1.6	6.2E+10	6.4E+10
6/10/2019	7.8	0.029	160	210	14	260	0.97	5.4E+10	7E+10
7/15/2019	7.2	0.029	430	390	23	400	1.6	2.4E+11	2.2E+11
8/26/2019	10	0.026	2300	3500	19	460	1.2	1.1E+12	1.6E+12
9/12/2019	8.9	0.034	NA	NA	26	560	2.1	NA	NA
9/23/2019	4.4	0.033	490	820	36	380	2.9	4.3E+11	7.2E+11
10/2/2019	6.1	0.13	8600	6000	110	1600	34	2.2E+13	1.6E+13
10/7/2019	1.7	0.017	170	150	78	330	3.3	3.3E+11	2.9E+11
11/18/2019	1.3	0.006	56	66	20	62	0.29	2.7E+10	3.2E+10
				mean	30	410	3.1	1.1E+12	9E+11

Table G.4. Pollutant Concentrations and Discharge Measured at Site CDC04b and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	7.1	0.1	410	440	17	300	4.2	1.7E+11	1.9E+11
10/23/2017	23	0.11	1300	1300	47	2600	13	1.5E+12	1.5E+12
11/13/2017	9.2	0.067	360	550	24	550	4	2.1E+11	3.3E+11
3/19/2018	6.7	0.054	54	74	34	560	4.5	4.5E+10	6.2E+10
4/23/2018	5.9	0.05	93	98	220	3100	27	5E+11	5.2E+11
5/21/2018	14	0.11	100	62	57	2000	15	1.4E+11	8.7E+10
6/5/2018	20	0.16	390	460	39	1900	15	3.7E+11	4.4E+11
7/16/2018	8.5	0.15	360	340	30	620	11	2.6E+11	2.5E+11
8/13/2018	7.8	0.14	730	1200	12	220	4	2.1E+11	3.4E+11
9/17/2018	24	0.16	430	330	62	3600	24	6.5E+11	5E+11
10/15/2018	5.1	0.072	260	250	190	2400	34	1.2E+12	1.2E+12
11/5/2018	23	0.15	3000	2300	190	11000	69	1.4E+13	1.1E+13
3/25/2019	4.4	0.042	130	140	6	64	0.61	1.9E+10	2E+10
4/15/2019	2.9	0.034	100	150	110	810	9.5	2.8E+11	4.2E+11
5/13/2019	7	0.067	78	84	90	1500	15	1.7E+11	1.8E+11
6/10/2019	10	0.12	370	490	65	1600	19	5.9E+11	7.8E+11
7/15/2019	39	0.22	550	490	160	16000	88	2.2E+12	2E+12
8/26/2019	15	0.11	580	1600	21	780	5.7	3E+11	8.3E+11
9/23/2019	41	0.19	5600	5300	150	15000	68	2E+13	1.9E+13
11/18/2019	5.6	0.043	200	260	80	1100	8.4	3.9E+11	5.1E+11
				mean	81	3200	22	2.2E+12	2E+12

Table G.5. Pollutant Concentrations and Discharge Measured at Site CDC05 and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	3.8	0.093	220	180	22	200	4.9	1.2E+11	9.5E+10
10/11/2017	19	0.14	1600	1500	30	1400	10	1.2E+12	1.1E+12
10/23/2017	12	0.11	1400	1200	42	1200	11	1.4E+12	1.2E+12
11/13/2017	7.6	0.07	510	380	23	440	4	2.9E+11	2.2E+11
3/19/2018	26	0.059	73	74	45	2900	6.5	8.1E+10	8.2E+10
4/23/2018	36	0.071	130	130	200	18000	35	6.5E+11	6.5E+11
5/3/2018	36	0.11	480	1200	140	13000	38	1.7E+12	4.2E+12
5/21/2018	33	0.14	110	110	68	5500	23	1.8E+11	1.8E+11
6/5/2018	14	0.15	350	260	44	1500	16	3.8E+11	2.8E+11
7/16/2018	6.4	0.15	210	260	25	400	9.3	1.3E+11	1.6E+11
8/13/2018	5.7	0.14	300	280	11	160	3.8	8.2E+10	7.6E+10
8/29/2018	6.9	0.23	300	150	980	17000	550	7.2E+12	3.6E+12
9/17/2018	20	0.15	350	110	66	3200	24	5.7E+11	1.8E+11
9/20/2018	18	0.14	2200	1400	67	2900	23	3.6E+12	2.3E+12
10/15/2018	11	0.089	200	180	170	4600	37	8.3E+11	7.5E+11
11/5/2018	28	0.14	3000	2500	150	11000	53	1.1E+13	9.5E+12
3/25/2019	5.3	0.042	180	200	11	140	1.1	4.9E+10	5.5E+10
4/15/2019	2.4	0.032	260	310	120	710	9.5	7.7E+11	9.2E+11
4/23/2019	69	0.18	1700	1400	170	29000	76	7.2E+12	5.9E+12
5/13/2019	7	0.06	80	72	110	1800	16	2.1E+11	1.9E+11
5/28/2019	16	0.094	1300	1700	140	5600	33	4.6E+12	6E+12
6/10/2019	6.2	0.11	220	230	45	680	12	2.4E+11	2.5E+11
7/15/2019	3.9	0.15	160	91	38	360	14	1.5E+11	8.5E+10
8/26/2019	10	0.11	300	260	19	460	5.1	1.4E+11	1.2E+11
9/12/2019	39	0.2	34000	13000	170	16000	81	1.4E+14	5.3E+13
9/23/2019	43	0.21	11000	13000	130	13000	65	3.4E+13	4E+13
10/2/2019	21	0.25	7600	9100	430	22000	260	8E+13	9.6E+13
10/7/2019	4.8	0.15	66	120	430	5100	160	7E+11	1.3E+12
11/18/2019	4.2	0.047	240	280	82	850	9.5	4.8E+11	5.6E+11
				mean	140	6100	55	1E+13	7.9E+12

TableG.6. Pollutant Concentrations and Discharge Measured at Site CDC07 and Calculated Pollutant Loads.

Date	**TSS (mg/L)**	**TP (mg/L)**	**FC (CFU/100 mL)**	***E. coli*** **(MPN/100 mL)**	**Q (cfs)**	**TSS (kg/d)**	**TP (kg/d)**	**FC (CFU/d)**	***E. coli*** **(MPN/d)**
9/20/2017	1.3	0.072	180	250	26	83	4.6	1.1E+11	1.6E+11
10/24/2017	2.9	0.093	410	490	60	420	14	6E+11	7.2E+11
11/14/2017	3.6	0.043	83	180	36	320	3.8	7.3E+10	1.6E+11
3/20/2018	6.1	0.05	45	40	32	480	3.9	3.5E+10	3.1E+10
4/24/2018	8.8	0.053	63	73	320	6800	41	4.9E+11	5.6E+11
5/22/2018	30	0.098	530	610	150	11000	37	2E+12	2.3E+12
6/4/2018	4.6	0.11	4600	4600	66	740	18	7.4E+12	7.4E+12
7/17/2018	1.8	0.15	280	NA	16	70	5.8	1.1E+11	NA
8/14/2018	1	0.11	220	130	2.7	6.7	0.73	1.5E+10	8.7E+09
9/19/2018	4	0.12	220	310	70	680	20	3.8E+11	5.3E+11
10/17/2018	19	0.11	90	130	140	6600	38	3.1E+11	4.5E+11
11/7/2018	22	0.11	1100	650	340	18000	92	9.2E+12	5.5E+12
3/26/2019	2.9	0.038	90	96	13	90	1.2	2.8E+10	3E+10
4/16/2019	1.7	0.024	110	140	200	820	12	5.3E+11	6.8E+11
5/14/2019	2	0.041	28	30	130	620	13	8.7E+10	9.3E+10
6/11/2019	2	0.083	35	29	43	210	8.8	3.7E+10	3.1E+10
7/16/2019	6.7	0.15	97	96	61	990	22	1.4E+11	1.4E+11
8/27/2019	12	0.11	420	650	74	2200	20	7.6E+11	1.2E+12
9/25/2019	5.3	0.13	260	240	120	1500	38	7.6E+11	7E+11
10/8/2019	9.3	0.12	180	150	450	10000	130	2E+12	1.7E+12
11/18/2019	3.2	0.037	110	140	110	890	10	3.1E+11	3.9E+11
				mean	120	3000	26	1.2E+12	1.1E+12

Table G.7. Pollutant Concentrations and Discharge Measured at Site CDC08c and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	5.2	0.074	1100	1100	21	270	3.8	5.7E+11	5.7E+11
10/24/2017	3.9	0.092	390	580	120	1200	28	1.2E+12	1.8E+12
11/14/2017	4.1	0.042	33	54	38	380	3.9	3.1E+10	5E+10
3/20/2018	2.2	0.039	6.75	10	61	330	5.9	1E+10	1.5E+10
4/24/2018	6	0.051	38	32	300	4300	37	2.8E+11	2.3E+11
5/22/2018	7.3	0.1	160	200	190	3300	45	7.3E+11	9.1E+11
6/4/2018	7.4	0.12	430	200	80	1400	23	8.4E+11	3.9E+11
7/17/2018	2.9	0.14	170	NA	28	200	9.7	1.2E+11	NA
8/14/2018	16	0.097	250	140	12	480	2.9	7.5E+10	4.2E+10
9/19/2018	3.6	0.12	210	170	95	840	28	4.9E+11	4E+11
10/17/2018	2.8	0.072	80	75	44	300	7.8	8.7E+10	8.2E+10
11/7/2018	7.4	0.1	440	550	370	6700	90	4E+12	5E+12
3/26/2019	2.5	0.036	30	34	12	75	1.1	9E+09	1E+10
4/16/2019	3.3	0.022	24	33	240	2000	13	1.4E+11	2E+11
5/14/2019	3.6	0.041	30	33	150	1300	15	1.1E+11	1.2E+11
6/11/2019	3.7	0.098	56	44	55	500	13	7.5E+10	5.9E+10
7/16/2019	7.7	0.16	200	110	62	1200	24	3E+11	1.7E+11
8/27/2019	4.1	0.093	500	490	51	510	12	6.3E+11	6.1E+11
9/25/2019	3.8	0.14	190	310	120	1100	41	5.6E+11	9.1E+11
10/8/2019	8.1	0.13	150	210	520	10000	170	1.9E+12	2.7E+12
11/18/2019	0.5	0.034	70	100	120	150	10	2.1E+11	3E+11
				mean	130	1800	28	5.9E+11	7.2E+11

Table G.8. Pollutant Concentrations and Discharge Measured at Site EVC01 and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	10	0.09	5400	6400	0.03	0.73	0.01	4E+09	4.7E+09
10/24/2017	6.2	0.16	NA	NA	12	180	4.7	NA	NA
11/13/2017	2.4	0.063	690	730	0.03	0.18	0	5.1E+08	5.4E+08
3/19/2018	2.2	0.042	12	45	1.5	8	0.15	4.4E+08	1.6E+09
4/23/2018	2.2	0.042	16	20	13	70	1.3	5.1E+09	6.4E+09
5/21/2018	4.3	0.063	290	210	3.2	34	0.49	2.3E+10	1.6E+10
6/5/2018	44	0.16	490	490	0.91	97	0.35	1.1E+10	1.1E+10
7/16/2018	23	0.19	1000	980	0.02	1.1	0.01	4.6E+08	4.5E+08
8/13/2018	25	0.22	580	1200	0.03	1.8	0.02	4.3E+08	8.8E+08
9/17/2018	3.5	0.066	730	650	1.8	15	0.29	3.2E+10	2.8E+10
10/15/2018	4.1	0.066	230	190	3.8	38	0.61	2.1E+10	1.8E+10
11/5/2018	12	0.14	2000	870	19	570	6.7	9.5E+11	4.2E+11
3/25/2019	4.3	0.042	1.5	13	0.03	0.32	0	1.1E+06	9.5E+06
4/15/2019	1.5	0.019	12	16	4.3	16	0.2	1.3E+09	1.7E+09
5/13/2019	1.6	0.025	35	44	3.9	15	0.24	3.3E+09	4.2E+09
6/10/2019	36	0.13	580	730	1.6	140	0.5	2.3E+10	2.8E+10
7/15/2019	23	0.12	810	690	0.71	40	0.21	1.4E+10	1.2E+10
8/26/2019	22	0.12	2100	2400	0.72	39	0.21	3.7E+10	4.2E+10
9/23/2019	20	0.16	6600	8600	9.4	460	3.7	1.5E+12	2E+12
10/7/2019	13	0.12	380	520	7.1	230	2.1	6.6E+10	9E+10
11/18/2019	2.6	0.032	80	140	4.7	30	0.37	9.3E+09	1.6E+10
				mean	4.2	94	1.1	1.4E+11	1.3E+11

Table G.9. Pollutant Concentrations and Discharge Measured at Site JKC01 and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	6	0.027	200	440	0.37	5.4	0.02	1.8E+09	4E+09
10/24/2017	6.9	0.04	470	340	1.5	25	0.14	1.7E+10	1.2E+10
11/13/2017	6.4	0.13	93	72	0.87	14	0.28	2E+09	1.5E+09
3/19/2018	3.8	0.089	21	25	0.39	3.6	0.08	2E+08	2.4E+08
4/23/2018	15	0.1	28	16	2.4	88	0.59	1.6E+09	9.4E+08
5/21/2018	26	0.14	6200	4000	1	64	0.34	1.5E+11	9.8E+10
6/5/2018	2.8	0.048	2800	770	0.64	4.4	0.08	4.4E+10	1.2E+10
7/16/2018	0.5	0.045	2200	920	0.15	0.18	0.02	8.1E+09	3.4E+09
8/13/2018	2.8	0.043	500	610	0.13	0.89	0.01	1.6E+09	1.9E+09
9/17/2018	3.6	0.042	200	88	0.57	5	0.06	2.8E+09	1.2E+09
10/15/2018	4.9	0.047	240	180	1.4	16	0.16	8E+09	6E+09
11/5/2018	5.4	0.077	410	210	6.1	80	1.2	6.1E+10	3.1E+10
3/25/2019	4.5	0.1	21	20	1.7	18	0.4	8.5E+08	8.1E+08
4/15/2019	3.1	0.072	35	47	1.7	13	0.3	1.5E+09	2E+09
5/13/2019	3	0.037	47	54	1.3	9.3	0.11	1.5E+09	1.7E+09
6/10/2019	3.7	0.063	1400	1400	0	0	0	0	0
7/15/2019	7.1	0.036	1200	1400	1.2	21	0.11	3.6E+10	4.2E+10
8/26/2019	39	0.12	35000	9900	1.2	110	0.34	9.9E+11	2.8E+11
9/23/2019	6	0.046	2500	2800	3.1	45	0.35	1.9E+11	2.1E+11
10/7/2019	4.4	0.12	380	490	2.3	24	0.67	2.1E+10	2.7E+10
11/18/2019	5.3	0.12	14	17	1.4	19	0.42	4.9E+08	6E+08
				mean	1.4	27	0.27	7.4E+10	3.5E+10

Table G.10. Pollutant Concentrations and Discharge Measured at Site KRB01 and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/21/2017	30	0.25	3600	5800	1.1	79	0.66	9.5E+10	1.5E+11
10/23/2017	7.5	0.12	11000	9600	2	37	0.59	5.4E+11	4.7E+11
11/13/2017	8.9	0.064	240	360	1.1	25	0.18	6.7E+09	1E+10
3/19/2018	6.5	0.055	12	6	4.1	65	0.55	1.2E+09	6E+08
4/23/2018	2.7	0.051	1.5	21	22	140	2.7	7.9E+08	1.1E+10
5/21/2018	20	0.11	71	93	6.2	300	1.7	1.1E+10	1.4E+10
6/5/2018	20	0.16	370	520	4.5	220	1.8	4.1E+10	5.7E+10
7/16/2018	2.9	0.22	270	200	1.2	8.6	0.65	8E+09	5.9E+09
8/13/2018	3.5	0.27	250	240	0.39	3.3	0.26	2.4E+09	2.3E+09
9/17/2018	6.6	0.15	190	140	8.3	130	3.1	3.9E+10	2.9E+10
10/15/2018	2.6	0.078	70	60	20	130	3.8	3.4E+10	2.9E+10
11/5/2018	6.8	0.23	3000	7500	25	410	14	1.8E+12	4.5E+12
3/25/2019	4.2	0.05	5	16	22	230	2.7	2.7E+09	8.6E+09
4/15/2019	7.6	0.084	26	26	12	220	2.4	7.4E+09	7.4E+09
5/13/2019	5	0.11	73	20	10	120	2.7	1.8E+10	5E+09
6/10/2019	21	0.15	290	270	3.6	180	1.3	2.5E+10	2.4E+10
7/15/2019	4.6	0.15	230	250	1.9	21	0.69	1.1E+10	1.1E+10
8/26/2019	21	0.16	12000	13000	0.94	48	0.37	2.8E+11	3E+11
9/23/2019	3.8	0.17	4800	1500	5.1	48	2.1	6E+11	1.9E+11
10/7/2019	2.8	0.13	130	67	46	320	15	1.5E+11	7.6E+10
11/18/2019	6	0.051	66	82	8.3	120	1	1.3E+10	1.7E+10
				mean	9.8	140	2.8	1.8E+11	2.8E+11

Table G.11. Pollutant Concentrations and Discharge Measured at Site LCC01 and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	5.3	0.084	310	460	1.8	23	0.36	1.3E+10	2E+10
10/11/2017	36	0.11	2600	2800	5.5	490	1.5	3.5E+11	3.8E+11
10/23/2017	16	0.084	1400	1700	8.9	350	1.8	3E+11	3.7E+11
11/13/2017	6.6	0.031	120	99	4.3	69	0.33	1.3E+10	1E+10
3/19/2018	4.5	0.04	21	12	9.6	110	0.94	4.9E+09	2.8E+09
4/23/2018	44	0.054	40	56	45	4900	6	4.4E+10	6.2E+10
5/3/2018	28	0.084	1000	980	34	2300	7	8.4E+11	8.2E+11
5/21/2018	31	0.095	130	190	15	1100	3.4	4.7E+10	6.9E+10
6/5/2018	31	0.14	1000	1000	6.8	510	2.3	1.7E+11	1.7E+11
7/16/2018	7.8	0.13	480	410	4.7	89	1.5	5.5E+10	4.7E+10
8/13/2018	5.4	0.12	450	340	2.2	29	0.64	2.4E+10	1.8E+10
8/29/2018	6.8	0.22	1000	520	230	3900	130	5.7E+12	3E+12
9/17/2018	13	0.12	220	300	18	570	5.3	9.7E+10	1.3E+11
9/20/2018	20	0.12	2500	3700	17	820	4.9	1E+12	1.5E+12
10/15/2018	8.3	0.069	140	130	36	740	6.2	1.3E+11	1.2E+11
11/5/2018	28	0.22	3000	4700	60	4100	32	4.4E+12	6.9E+12
3/25/2019	6.9	0.047	30	41	2.2	37	0.25	1.6E+09	2.2E+09
4/15/2019	3.6	0.025	52	68	32	280	2	4.1E+10	5.3E+10
4/23/2019	40	0.21	3000	3600	79	7700	41	5.8E+12	7E+12
5/13/2019	6.5	0.044	45	74	29	460	3.1	3.2E+10	5.2E+10
5/28/2019	25	0.086	2100	1200	50	3100	11	2.6E+12	1.5E+12
6/10/2019	22	0.098	520	410	12	640	2.9	1.5E+11	1.2E+11
7/15/2019	27	0.11	920	1100	7.7	510	2.1	1.7E+11	2.1E+11
8/26/2019	26	0.096	2800	3400	5.1	320	1.2	3.5E+11	4.2E+11
9/12/2019	42	0.14	NA	NA	13	1300	4.4	NA	NA
9/23/2019	33	0.13	5200	3700	14	1100	4.5	1.8E+12	1.3E+12
10/2/2019	73	0.44	12000	16000	210	38000	230	6.2E+13	8.3E+13
10/7/2019	12	0.13	180	150	100	2900	32	4.4E+11	3.7E+11
11/18/2019	9.6	0.039	56	79	20	480	2	2.8E+10	4E+10
				mean	37	2600	18	3.1E+12	3.8E+12

Table G.12. Pollutant Concentrations and Discharge Measured at Site LCC02 and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/21/2017	6.8	0.049	530	650	2.8	46	0.33	3.6E+10	4.4E+10
10/23/2017	9.2	0.047	1200	770	4.9	110	0.56	1.4E+11	9.2E+10
11/13/2017	4.2	0.021	56	75	2	20	0.1	2.7E+09	3.6E+09
3/19/2018	6	0.025	7	12	4.8	70	0.29	8.2E+08	1.4E+09
4/23/2018	9.6	0.05	45	49	17	400	2.1	1.9E+10	2.1E+10
5/21/2018	4.4	0.04	340	280	6.7	73	0.66	5.6E+10	4.6E+10
6/5/2018	13	0.071	490	410	4.1	130	0.72	5E+10	4.1E+10
7/16/2018	5.1	0.067	540	490	3.4	42	0.56	4.5E+10	4.1E+10
8/13/2018	7.1	0.068	250	490	1.9	32	0.31	1.1E+10	2.2E+10
9/17/2018	11	0.072	350	320	7.7	210	1.4	6.6E+10	6E+10
10/15/2018	12	0.048	160	110	13	370	1.5	5E+10	3.4E+10
11/5/2018	25	0.16	3000	2400	43	2600	17	3.1E+12	2.5E+12
3/25/2019	14	0.04	33	33	15	510	1.5	1.2E+10	1.2E+10
4/15/2019	2.9	0.016	30	31	14	100	0.56	1.1E+10	1.1E+10
5/13/2019	3.4	0.022	38	56	12	97	0.63	1.1E+10	1.6E+10
6/10/2019	23	0.062	730	770	7.6	430	1.2	1.4E+11	1.4E+11
7/15/2019	32	0.14	2400	1300	4.7	370	1.6	2.8E+11	1.5E+11
8/26/2019	19	0.074	1500	1900	5.8	270	1.1	2.1E+11	2.7E+11
9/23/2019	31	0.1	1600	1400	15	1100	3.6	5.7E+11	5E+11
10/7/2019	28	0.085	320	490	17	1200	3.6	1.4E+11	2.1E+11
11/18/2019	13	0.031	120	120	11	340	0.8	3.1E+10	3.1E+10
				mean	10	410	1.9	2.4E+11	2E+11

Table G.13. Pollutant Concentrations and Discharge Measured at Site LEC01b and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	11	0.019	NA	NA	0.42	11	0.02	NA	NA
10/23/2017	19	0.022	250	130	1.5	69	0.08	9.1E+09	4.7E+09
11/13/2017	9.8	0.011	77	70	2	47	0.05	3.7E+09	3.4E+09
3/19/2018	7.3	0.017	1.5	3	2.1	38	0.09	7.7E+07	1.6E+08
4/23/2018	3.5	0.022	1.5	3	4.5	39	0.24	1.7E+08	3.3E+08
5/21/2018	10	0.043	420	550	3.4	84	0.36	3.5E+10	4.6E+10
6/5/2018	23	0.043	160	150	2.6	140	0.27	1E+10	9.4E+09
7/16/2018	15	0.018	470	390	2.2	81	0.1	2.5E+10	2.1E+10
8/13/2018	12	0.023	440	280	2	58	0.11	2.1E+10	1.4E+10
9/17/2018	6.7	0.027	330	550	3.4	56	0.23	2.8E+10	4.6E+10
10/15/2018	12	0.039	100	72	4.1	120	0.39	1E+10	7.2E+09
11/5/2018	11	0.034	100	200	6.3	170	0.52	1.5E+10	3.1E+10
3/25/2019	3.4	0.02	5	10	4.3	36	0.21	5.3E+08	1.1E+09
4/15/2019	1.8	0.02	19	5	2.7	12	0.13	1.2E+09	3.3E+08
5/13/2019	3.4	0.021	9	5	5.2	43	0.27	1.1E+09	6.4E+08
6/10/2019	33	0.049	160	140	2.5	200	0.3	9.8E+09	8.6E+09
7/15/2019	21	0.033	730	520	2.6	130	0.21	4.6E+10	3.3E+10
8/26/2019	19	0.044	2400	4000	3.7	170	0.39	2.2E+11	3.6E+11
9/23/2019	8.5	0.033	540	730	3.6	74	0.29	4.7E+10	6.4E+10
10/7/2019	8.6	0.03	180	160	3.7	78	0.27	1.6E+10	1.5E+10
11/18/2019	5.5	0.014	87	81	2.5	33	0.08	5.2E+09	4.9E+09
				mean	3.1	81	0.22	2.5E+10	3.3E+10

Table G.14. Pollutant Concentrations and Discharge Measured at Site MDC01 and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	1.9	0.014	350	310	1.1	5	0.04	NA	NA
10/24/2017	0.5	0.014	220	310	0.53	0.65	0.02	2.9E+09	4.1E+09
11/14/2017	1.5	0.00245	40	24	2.3	8.6	0.01	2.3E+09	1.4E+09
3/20/2018	0.5	0.012	5	8	4.2	5.1	0.12	5.1E+08	8.2E+08
4/24/2018	1.9	0.026	1.5	8	23	110	1.5	8.5E+08	4.5E+09
5/22/2018	1.1	0.019	70	91	13	35	0.61	2.3E+10	2.9E+10
6/4/2018	3.5	0.02	450	550	3.2	27	0.16	3.5E+10	4.3E+10
7/17/2018	5	0.017	150	NA	0.96	12	0.04	3.5E+09	NA
8/14/2018	5.6	0.022	470	390	0.06	0.82	0	6.9E+08	5.7E+08
9/19/2018	1.7	0.06	61	40	15	64	2.3	2.3E+10	1.5E+10
10/17/2018	0.5	0.016	52	55	13	16	0.5	1.6E+10	1.7E+10
11/7/2018	0.5	0.015	87	110	14	17	0.51	3E+10	3.7E+10
3/26/2019	0.5	0.016	9	16	23	28	0.9	5.1E+09	9.0E+09
4/16/2019	0.5	0.0097	54	34	18	22	0.42	2.3E+10	1.5E+10
5/14/2019	0.5	0.012	54	55	10	13	0.31	1.4E+10	1.4E+10
6/11/2019	5.6	0.026	240	250	4.5	62	0.29	2.7E+10	2.8E+10
7/16/2019	7.9	0.02	620	580	2.7	52	0.13	4.1E+10	3.8E+10
8/27/2019	14	0.022	2100	930	2.8	96	0.15	1.4E+11	6.4E+10
9/25/2019	2.8	0.084	200	240	9.3	64	1.9	4.6E+10	5.5E+10
10/8/2019	0.5	0.006	120	160	40	49	0.59	1.2E+11	1.6E+11
11/18/2019	0.5	0.006	14	21	7.4	9.1	0.11	2.5E+09	3.8E+09
				mean	9.9	33	0.5	2.8E+10	2.8E+10

Table G.15. Pollutant Concentrations and Discharge Measured at Site MLR01 and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	4	0.043	110	160	130	1300	14	3.5E+11	5.1E+11
10/24/2017	19	0.12	350	600	260	12000	77	2.3E+12	3.9E+12
11/14/2017	2.3	0.029	4200	8600	190	1000	13	1.9E+13	3.9E+13
3/20/2018	3.9	0.057	47	66	240	2300	34	2.8E+11	3.9E+11
4/24/2018	13	0.062	24	32	1000	32000	150	6E+11	8E+11
5/22/2018	17	0.15	1000	870	490	20000	180	1.2E+13	1.1E+13
6/4/2018	18	0.12	160	170	240	10000	70	9.3E+11	9.9E+11
7/17/2018	4	0.082	250	150	95	930	19	5.8E+11	3.5E+11
8/14/2018	9.1	0.089	150	140	64	1400	14	2.3E+11	2.2E+11
9/19/2018	10	0.12	190	170	250	6200	75	1.2E+12	1.1E+12
10/17/2018	6.1	0.11	120	180	720	11000	190	2.1E+12	3.2E+12
11/7/2018	10	0.18	2400	1200	1100	26000	460	6.2E+13	3.1E+13
3/26/2019	4.2	0.07	21	28	110	1100	19	5.7E+10	7.6E+10
4/16/2019	3.2	0.044	77	65	780	6100	84	1.5E+12	1.2E+12
5/14/2019	5.3	0.046	26	25	500	6400	56	3.2E+11	3E+11
6/11/2019	11	0.083	120	68	280	7400	56	8.1E+11	4.6E+11
7/16/2019	12	0.14	59	51	190	5600	66	2.8E+11	2.4E+11
8/27/2019	19	0.11	1800	1300	320	15000	86	1.4E+13	1E+13
9/25/2019	23	0.2	430	390	980	55000	480	1E+13	9.3E+12
10/8/2019	7.2	0.21	220	190	3500	62000	1800	1.9E+13	1.6E+13
11/18/2019	2.4	0.043	180	260	610	3600	64	2.7E+12	3.9E+12
				mean	570	14000	190	7.2E+12	6.4E+12

Table G.16. Pollutant Concentrations and Discharge Measured at Site MLR02 and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	1.7	0.038	150	170	100	420	9.4	3.7E+11	4.2E+11
10/24/2017	16	0.1	380	310	350	14000	85	3.2E+12	2.6E+12
11/14/2017	2.2	0.028	420	2100	190	1000	13	2E+12	9.8E+12
3/20/2018	4.9	0.054	52	34	220	2700	29	2.8E+11	1.9E+11
4/24/2018	14	0.067	40	32	1200	41000	200	1.2E+12	9.5E+11
5/22/2018	20	0.12	1100	1200	610	30000	180	1.6E+13	1.8E+13
6/4/2018	11	0.11	280	150	230	6300	63	1.6E+12	8.6E+11
7/17/2018	1.2	0.082	180	160	95	280	19	4.2E+11	3.7E+11
8/14/2018	15	0.096	87	53	66	2400	15	1.4E+11	8.5E+10
9/19/2018	14	0.13	280	240	270	9100	85	1.8E+12	1.6E+12
10/17/2018	3.9	0.084	140	110	920	8800	190	3.1E+12	2.5E+12
11/7/2018	10	0.13	1800	730	1300	33000	430	5.9E+13	2.4E+13
3/26/2019	3.5	0.055	24	25	190	1700	26	1.1E+11	1.2E+11
4/16/2019	4.9	0.026	52	59	930	11000	59	1.2E+12	1.4E+12
5/14/2019	6.5	0.044	7	20	600	9500	64	1E+11	2.9E+11
6/11/2019	8.3	0.079	110	110	270	5500	52	7.3E+11	7.3E+11
7/16/2019	12	0.14	140	86	180	5300	62	6.2E+11	3.8E+11
8/27/2019	15	0.1	2600	1200	270	10000	67	1.7E+13	8E+12
9/25/2019	22	0.19	540	390	1100	57000	490	1.4E+13	1E+13
10/8/2019	4.3	0.17	240	210	3000	31000	1200	1.8E+13	1.5E+13
11/18/2019	18	0.069	100	140	620	27000	110	1.5E+12	2.1E+12
				mean	610	15000	170	6.8E+12	4.8E+12

Table G.17. Pollutant Concentrations and Discharge Measured at Site MLR03c-d and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	4.6	0.059	170	110	200	2300	29	8.4E+11	5.4E+11
10/24/2017	10	0.1	300	390	420	10000	100	3.1E+12	4E+12
11/14/2017	1.7	0.04	310	460	200	820	19	1.5E+12	2.2E+12
3/20/2018	6.8	0.053	530	460	240	4000	31	3.1E+12	2.7E+12
4/24/2018	14	0.066	19	34	1100	39000	190	5.3E+11	9.5E+11
5/22/2018	17	0.13	190	200	570	24000	180	2.7E+12	2.8E+12
6/4/2018	14	0.13	240	140	290	9900	92	1.7E+12	9.9E+11
7/17/2018	2.8	0.12	120	NA	93	640	27	2.7E+11	NA
8/14/2018	38	0.13	190	110	84	7800	27	3.9E+11	2.3E+11
9/19/2018	6.8	0.12	180	110	290	4800	85	1.3E+12	7.8E+11
10/17/2018	3.6	0.084	73	100	720	6300	150	1.3E+12	1.8E+12
11/7/2018	7.7	0.13	1600	870	1200	22000	370	4.6E+13	2.5E+13
3/26/2019	3.3	0.058	77	120	180	1400	25	3.4E+11	5.3E+11
4/16/2019	3.7	0.025	61	67	900	8200	55	1.4E+12	1.5E+12
5/14/2019	6.3	0.044	16	12	560	8700	61	2.2E+11	1.7E+11
6/11/2019	5.2	0.079	14	30	310	3900	59	1.1E+11	2.2E+11
7/16/2019	7.9	0.15	160	110	200	3800	73	7.8E+11	5.3E+11
8/27/2019	6.6	0.088	580	440	260	4300	57	3.8E+12	2.9E+12
9/25/2019	25	0.19	290	410	1000	64000	480	7.4E+12	1E+13
10/8/2019	14	0.16	240	210	3400	120000	1300	2E+13	1.8E+13
11/18/2019	2.9	0.037	130	130	650	4600	59	2.1E+12	2.1E+12
				mean	620	17000	170	4.7E+12	3.9E+12

Table G.18. Pollutant Concentrations and Discharge Measured at Site MLR06b and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/21/2017	4.4	0.065	180	250	230	2500	37	1E+12	1.4E+12
10/11/2017	13	0.1	2000	1600	250	8000	62	1.2E+13	9.9E+12
10/24/2017	9	0.093	340	410	350	7700	79	2.9E+12	3.5E+12
11/14/2017	3.4	0.025	38	71	270	2200	16	2.5E+11	4.7E+11
3/20/2018	4.1	0.047	52	32	270	2700	31	3.4E+11	2.1E+11
4/24/2018	17	0.079	45	37	1500	61000	280	1.6E+12	1.3E+12
5/3/2018	15	0.086	340	690	920	34000	190	7.7E+12	1.6E+13
5/22/2018	14	0.12	160	130	730	25000	220	2.9E+12	2.3E+12
6/4/2018	16	0.14	200	210	340	13000	120	1.7E+12	1.7E+12
7/17/2018	2.6	0.15	180	NA	110	720	42	5E+11	NA
8/14/2018	9.1	0.096	130	44	69	1500	16	2.2E+11	7.4E+10
8/29/2018	43	0.24	1900	1200	4900	510000	2900	2.3E+14	1.4E+14
9/18/2018	12	0.14	2300	1600	400	12000	140	2.3E+13	1.6E+13
9/20/2018	26	0.14	6200	1900	420	27000	140	6.4E+13	2E+13
10/15/2018	5.8	0.1	93	110	1300	18000	320	2.9E+12	3.5E+12
11/5/2018	12	0.08	600	770	1000	30000	200	1.5E+13	1.9E+13
3/25/2019	4.2	0.059	100	82	36	370	5.2	8.8E+10	7.3E+10
4/15/2019	1.9	0.022	42	48	1200	5400	62	1.2E+12	1.4E+12
4/23/2019	20	0.065	330	460	1200	59000	190	9.8E+12	1.4E+13
5/13/2019	5.4	0.052	35	20	840	11000	110	7.2E+11	4.1E+11
5/28/2019	12	0.089	840	580	1300	37000	270	2.6E+13	1.8E+13
6/11/2019	7.3	0.09	45	38	330	6000	74	3.7E+11	3.1E+11
7/16/2019	7.4	0.15	110	91	210	3900	79	5.8E+11	4.8E+11
8/27/2019	5	0.084	320	520	260	3200	53	2E+12	3.3E+12
9/12/2019	18	0.1	NA	NA	860	38000	210	NA	NA
9/25/2019	14	0.18	260	210	1100	38000	490	7.1E+12	5.7E+12
10/2/2019	260	0.61	73000	13000	3200	2000000	4700	5.6E+15	1E+15
10/8/2019	23	0.16	600	310	3600	200000	1400	5.3E+13	2.8E+13
11/18/2019	2	0.031	120	170	880	4300	66	2.6E+12	3.7E+12
				mean	1100	140000	550	3E+14	6.8E+13

Table G.19. Pollutant Concentrations and Discharge Measured at Site MOC02 and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	1.8	0.038	360	520	2.2	9.9	0.21	2E+10	2.9E+10
10/24/2017	4.8	0.058	550	520	6.3	74	0.9	8.5E+10	8.1E+10
11/14/2017	3.6	0.03	87	93	2.4	21	0.18	5.1E+09	5.5E+09
3/20/2018	3	0.032	19	16	2.9	22	0.23	1.4E+09	1.2E+09
4/24/2018	4.6	0.037	5	10	12	130	1.1	1.4E+09	2.8E+09
5/22/2018	18	0.074	540	1100	14	630	2.6	1.9E+11	3.8E+11
6/4/2018	10	0.092	2200	1100	3	73	0.67	1.6E+11	8E+10
7/17/2018	5.4	0.1	1800	NA	0.83	11	0.2	3.7E+10	NA
8/14/2018	2.9	0.089	880	690	0.45	3.2	0.1	9.7E+09	7.6E+09
9/19/2018	3.5	0.087	350	280	4.8	41	1	4.1E+10	3.3E+10
10/17/2018	2.1	0.044	83	88	8.4	43	0.9	1.7E+10	1.8E+10
11/7/2018	1.5	0.057	1400	820	26	94	3.6	8.8E+11	5.1E+11
3/26/2019	2.5	0.036	5	12	19	110	1.7	2.3E+09	5.5E+09
4/16/2019	2.2	0.022	42	27	16	87	0.87	1.7E+10	1.1E+10
5/14/2019	3	0.029	7	15	7.9	58	0.56	1.4E+09	2.9E+09
6/11/2019	5.1	0.083	490	690	3.3	41	0.66	3.9E+10	5.5E+10
7/16/2019	7.4	0.087	430	340	2.2	39	0.46	2.3E+10	1.8E+10
8/27/2019	5.2	0.1	6200	3300	4.5	58	1.1	6.9E+11	3.7E+11
9/25/2019	1.7	0.024	110	130	6.9	29	0.4	1.9E+10	2.2E+10
10/8/2019	3.4	0.056	110	170	16	140	2.2	4.4E+10	6.8E+10
11/18/2019	4.9	0.04	83	110	7.7	92	0.75	1.6E+10	2.1E+10
				mean	7.9	86	0.97	1.1E+11	8.6E+10

Table G.20. Pollutant Concentrations and Discharge Measured at Site NCC01b and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	11	0.075	1500	1100	1.7	47	0.32	6.4E+10	4.7E+10
10/23/2017	4.9	0.11	28000	27000	5.1	61	1.4	3.5E+12	3.3E+12
11/13/2017	7.2	0.038	440	550	2.1	38	0.2	2.3E+10	2.9E+10
3/19/2018	4	0.038	5	7	7.3	71	0.68	8.9E+08	1.3E+09
4/23/2018	2.8	0.049	32	20	34	230	4.1	2.6E+10	1.7E+10
5/21/2018	5.2	0.092	130	110	7.4	94	1.7	2.4E+10	2E+10
6/5/2018	14	0.16	1600	1700	1.9	65	0.74	7.4E+10	7.9E+10
7/16/2018	7.6	0.15	880	980	0.61	11	0.22	1.3E+10	1.5E+10
8/13/2018	13	0.13	350	360	0.44	14	0.14	3.8E+09	3.9E+09
9/17/2018	2.3	0.12	770	690	3	17	0.89	5.7E+10	5.1E+10
10/15/2018	2	0.064	87	120	13	65	2.1	2.9E+10	3.9E+10
11/5/2018	6.5	0.18	3000	4700	37	580	16	2.7E+12	4.2E+12
3/25/2019	2.6	0.034	5	4	6.6	42	0.55	8.1E+08	6.5E+08
4/15/2019	1.7	0.023	110	110	16	66	0.9	4.3E+10	4.3E+10
5/13/2019	2.6	0.037	21	28	6.1	39	0.55	3.1E+09	4.2E+09
6/10/2019	4.6	0.13	400	250	4	45	1.3	3.9E+10	2.4E+10
7/15/2019	7	0.13	260	260	2.3	39	0.72	1.4E+10	1.4E+10
8/26/2019	7.1	0.093	410	460	0.81	14	0.18	8.1E+09	9.1E+09
9/23/2019	14	0.48	60000	98000	15	520	18	2.2E+13	3.6E+13
10/7/2019	2.3	0.11	140	140	10	57	2.7	3.5E+10	3.5E+10
11/18/2019	3.8	0.036	93	170	12	110	1	2.7E+10	4.9E+10
				mean	8.9	110	2.6	1.4E+12	2.1E+12

Table G.21. Pollutant Concentrations and Discharge Measured at Site PGC01c and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/21/2017	2.2	0.035	1000	880	1.2	6.5	0.1	2.9E+10	2.6E+10
10/24/2017	2.1	0.048	NA	NA	3.6	19	0.43	NA	NA
11/14/2017	1.2	0.011	130	66	3.7	11	0.1	1.2E+10	6E+09
3/20/2018	1.9	0.021	7	12	3.2	15	0.16	5.5E+08	9.4E+08
4/24/2018	2.7	0.03	66	110	20	130	1.5	3.2E+10	5.3E+10
5/22/2018	3.5	0.035	130	140	18	150	1.5	5.6E+10	6.1E+10
6/4/2018	6.2	0.056	200	140	4.6	70	0.63	2.3E+10	1.6E+10
7/17/2018	5.3	0.054	1400	NA	1.1	14	0.14	3.7E+10	NA
8/14/2018	5.1	0.041	530	310	0.78	9.7	0.08	1E+10	5.9E+09
9/18/2018	8.7	0.073	4200	3100	6	130	1.1	6.2E+11	4.6E+11
10/15/2018	1.8	0.055	150	180	16	72	2.2	6E+10	7.2E+10
11/5/2018	4.4	0.039	230	410	30	320	2.9	1.7E+11	3E+11
3/25/2019	2	0.023	14	7	0.78	3.8	0.04	2.7E+08	1.3E+08
4/15/2019	2.2	0.021	21	25	0.78	4.2	0.04	4E+08	4.8E+08
5/13/2019	1.6	0.017	5	28	17	65	0.7	2.1E+09	1.2E+10
6/11/2019	4.6	0.046	100	100	6.8	77	0.77	1.7E+10	1.7E+10
7/16/2019	9.3	0.069	310	280	3	67	0.5	2.2E+10	2E+10
8/27/2019	23	0.083	2200	2100	2.7	150	0.56	1.5E+11	1.4E+11
9/25/2019	4.6	0.071	230	210	31	350	5.4	1.8E+11	1.6E+11
10/8/2019	14	0.082	390	340	100	3500	21	9.9E+11	8.6E+11
11/18/2019	1.2	0.02	100	81	12	35	0.58	2.9E+10	2.4E+10
				mean	14	250	1.9	1.2E+11	1.2E+11

Table G.22. Pollutant Concentrations and Discharge Measured at Site PSC01 and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	7.9	0.056	NA	NA	0.58	11	0.08	NA	NA
10/23/2017	11	0.065	850	1100	4.5	120	0.72	9.4E+10	1.2E+11
11/13/2017	7.8	0.032	56	74	3	57	0.24	4.1E+09	5.5E+09
3/19/2018	6.1	0.033	110	120	1.6	23	0.13	4.2E+09	4.6E+09
4/23/2018	9.8	0.042	73	60	7.8	190	0.8	1.4E+10	1.1E+10
5/21/2018	2.2	0.037	410	490	3	16	0.27	3E+10	3.5E+10
6/5/2018	11	0.083	730	730	1.4	37	0.28	2.5E+10	2.5E+10
7/16/2018	10	0.079	2200	3100	1.3	32	0.25	6.9E+10	9.8E+10
8/13/2018	8.3	0.06	1000	870	0.58	12	0.09	1.4E+10	1.2E+10
9/17/2018	6.1	0.091	620	650	2.5	37	0.55	3.7E+10	3.9E+10
10/15/2018	5.5	0.06	150	120	4.9	65	0.71	1.8E+10	1.4E+10
11/5/2018	22	0.12	1400	920	11	590	3.2	3.8E+11	2.5E+11
3/25/2019	7.4	0.064	110	150	5	91	0.79	1.4E+10	1.8E+10
4/15/2019	1.4	0.017	220	410	3.8	13	0.16	2.1E+10	3.9E+10
5/13/2019	1.6	0.025	180	440	3.9	15	0.24	1.7E+10	4.2E+10
6/10/2019	9	0.065	690	460	2.5	54	0.39	4.2E+10	2.8E+10
7/15/2019	27	0.087	2200	1900	1.7	110	0.37	9.4E+10	8.1E+10
8/26/2019	53	0.17	12000	13000	3.3	430	1.4	9.6E+11	1E+12
9/23/2019	34	0.12	NA	NA	5.2	430	1.5	NA	NA
10/7/2019	22	0.097	540	580	7.2	380	1.7	9.5E+10	1E+11
11/18/2019	4.5	0.026	130	190	4	44	0.25	1.3E+10	1.8E+10
				mean	3.7	130	0.67	1E+11	1E+11

Table G.23. Pollutant Concentrations and Discharge Measured at Site RDC01 and Calculated Pollutant Loads.

Date	**TSS (mg/L)**	**TP (mg/L)**	**FC (CFU/100 mL)**	***E. coli* (MPN/100 mL)**	**Q (cfs)**	**TSS (kg/d)**	**TP (kg/d)**	**FC (CFU/d)**	***E. coli* (MPN/d)**
9/20/2017	2.1	0.064	220	460	0.71	3.7	0.11	3.8E+09	8E+09
10/24/2017	6.5	0.14	160	88	1.1	18	0.39	4.5E+09	2.5E+09
11/14/2017	16	0.09	35	33	0.88	35	0.19	7.6E+08	7.1E+08
3/20/2018	30	0.18	9	4	0.99	73	0.44	2.2E+08	9.7E+07
4/24/2018	2.1	0.13	12	6	6.9	35	2.2	2E+09	1E+09
5/22/2018	5	0.33	230	260	3.7	45	3	2.1E+10	2.4E+10
6/4/2018	0.5	0.2	110	120	1	1.2	0.49	2.7E+09	3E+09
7/17/2018	3	0.098	1800	280	0.32	2.4	0.08	1.4E+10	2.2E+09
8/14/2018	12	0.13	560	390	0.04	1.2	0.01	5.5E+08	3.8E+08
9/19/2018	9	0.9	160	200	2	44	4.4	7.8E+09	9.7E+09
10/17/2018	16	0.31	97	140	2.8	110	2.1	6.6E+09	9.5E+09
11/7/2018	9.8	0.48	4400	1300	11	270	13	1.2E+12	3.6E+11
3/26/2019	4	0.19	1.5	4	4.5	44	2.1	1.6E+08	4.4E+08
4/16/2019	3	0.13	63	16	5.6	41	1.8	8.6E+09	2.2E+09
5/14/2019	4.4	0.15	90	88	2.2	23	0.79	4.7E+09	4.6E+09
6/11/2019	12	0.17	600	410	1	30	0.42	1.5E+10	1E+10
7/16/2019	2	0.14	250	260	0.39	1.9	0.13	2.4E+09	2.5E+09
8/27/2019	3.5	0.18	1400	1400	0.5	4.3	0.22	1.7E+10	1.7E+10
9/25/2019	6.3	0.59	360	580	2.1	33	3.1	1.9E+10	3E+10
10/8/2019	13	0.76	560	490	32	1000	60	4.4E+11	3.8E+11
11/18/2019	21	0.25	650	870	2.8	140	1.7	4.5E+10	6E+10
				mean	3.9	94	4.6	8.7E+10	4.4E+10

Table G.24. Pollutant Concentrations and Discharge Measured at Site ULC01 and Calculated Pollutant Loads.

Date	TSS (mg/L)	TP (mg/L)	FC (CFU/100 mL)	*E. coli* (MPN/100 mL)	Q (cfs)	TSS (kg/d)	TP (kg/d)	FC (CFU/d)	*E. coli* (MPN/d)
9/20/2017	100	0.13	210	220	0	0	0	0	0
10/24/2017	5.6	0.08	580	690	2.4	33	0.47	3.4E+10	4E+10
11/14/2017	9	0.039	93	150	1.8	39	0.17	4.1E+09	6.6E+09
3/20/2018	17	0.079	45	45	0.92	38	0.18	1.0E+09	1.0E+09
4/24/2018	4.4	0.036	16	11	13	140	1.1	5.1E+09	3.5E+09
5/22/2018	5.3	0.072	340	320	10	130	1.8	8.5E+10	8E+10
6/4/2018	7.5	0.14	400	440	2.3	41	0.77	2.2E+10	2.4E+10
7/17/2018	250	0.64	1600	1600	0.12	73	0.19	4.7E+09	4.7E+09
8/14/2018	22	0.094	110	43	0	0	0	0	0
9/19/2018	6.7	0.1	460	440	1.5	24	0.36	1.7E+10	1.6E+10
10/17/2018	8	0.073	260	210	3.4	66	0.6	2.1E+10	1.7E+10
11/7/2018	5.6	0.1	460	730	17	240	4.2	2E+11	3.1E+11
3/26/2019	5.7	0.051	21	9	16	220	2	8.2E+09	3.5E+09
4/16/2019	4.6	0.031	26	23	14	160	1.1	8.9E+09	7.9E+09
5/14/2019	2.4	0.045	16	20	4.8	28	0.53	1.9E+09	2.4E+09
6/11/2019	9	0.12	380	440	1.3	29	0.39	1.2E+10	1.4E+10
7/16/2019	17	0.28	340	690	0.16	6.7	0.11	1.3E+09	2.7E+09
8/27/2019	12	0.14	2800	3000	1.5	45	0.53	1.1E+11	1.1E+11
9/25/2019	6.1	0.16	960	1400	0.91	14	0.36	2.1E+10	3.1E+10
10/8/2019	7.7	0.1	180	360	7.3	140	1.8	3.2E+10	6.5E+10
11/18/2019	3.1	0.05	200	310	5.7	43	0.69	2.8E+10	4.3E+10
				mean	5	72	0.83	2.9E+10	3.7E+10

Table G.25. Pollutant Concentrations and Discharge Measured at Site ULC02 and Calculated Pollutant Loads.

Date	**TSS (mg/L)**	**TP (mg/L)**	**FC (CFU/100 mL)**	***E. coli* (MPN/100 mL)**	**Q (cfs)**	**TSS (kg/d)**	**TP (kg/d)**	**FC (CFU/d)**	***E. coli* (MPN/d)**
9/21/2017	100	0.3	11000	13000	7.7	1900	5.6	2.1E+12	2.4E+12
10/24/2017	12	0.11	410	770	4.6	130	1.2	4.6E+10	8.6E+10
11/14/2017	71	0.11	200	120	3.9	680	1.1	1.9E+10	1.2E+10
3/20/2018	4.1	0.059	19	13	1.9	19	0.28	9.0E+08	6.2E+08
4/24/2018	4.9	0.049	14	10	24	280	2.8	8.1E+09	5.8E+09
5/22/2018	5.7	0.076	480	440	22	300	4	2.6E+11	2.3E+11
6/4/2018	9.7	0.15	650	890	3.7	88	1.4	5.9E+10	8.1E+10
7/17/2018	69	0.31	2000	NA	0	0	0	0	NA
8/14/2018	7.6	0.17	93	68	0	0	0	0	0
9/18/2018	21	0.19	850	1400	2.9	150	1.4	6E+10	9.9E+10
10/15/2018	8.6	0.077	360	410	8.2	170	1.5	7.2E+10	8.2E+10
11/5/2018	19	0.24	2300	2100	28	1300	16	1.6E+12	1.4E+12
3/25/2019	6.1	0.052	1.5	18	0	0	0	0	0
4/15/2019	4	0.03	30	31	18	170	1.3	1.3E+10	1.4E+10
5/13/2019	2.2	0.035	24	29	12	64	1	7E+09	8.4E+09
6/11/2019	13	0.12	540	610	1.9	59	0.55	2.5E+10	2.8E+10
7/16/2019	65	0.25	1200	580	1.1	180	0.68	3.3E+10	1.6E+10
8/27/2019	14	0.15	4800	4300	3	100	1.1	3.6E+11	3.2E+11
9/25/2019	41	0.16	500	610	15	1500	5.8	1.8E+11	2.2E+11
10/8/2019	5.7	0.22	200	220	53	740	29	2.6E+11	2.9E+11
11/18/2019	14	0.083	510	490	12	420	2.5	1.6E+11	1.5E+11
				mean	11	390	3.7	2.5E+11	2.8E+11

Appendix H. Summary of Daily and Annual Loadings of TSS, TP, FC, and *E. coli* by Site and Calendar Year. Includes Tables H.1-H.4.

Table H.1. Daily and Annual Loading of Total Suspended Solids (TSS) by Site and Calendar Year.
Stratified BRE loading estimates including number of strata, number of samples per strata; MTA= metric tons/annum (or year), RMSE=root mean square error, FWMC=flow-weighted mean concentration.

Tributary	Calendar Year	Num Strata	Num Samples	Daily Load (kg/d)	Annual Load (MTA)	RMSE (MTA)	Avg Daily Flow (cfs)	FWMC (mg/L)
CBC01	2017	1	3	8.4	3.1	0.39	1.3	2.6
	2018	3	9	72	26	9.1	6.9	4.3
	2019	3	8	98	36	5	8.6	4.7
CDC01b	2017	1	3	34	12	2.3	5.8	2.4
	2018	1	9	18	6.4	1.1	8.1	0.89
	2019	3	9	36	13	2.5	14	1
CDC03	2017	2	4	5400	2000	170	400	5.6
	2018	3	12	12000	4300	390	1200	4
	2019	3	13	11000	3900	590	870	5
CDC04b	2017	1	3	1400	500	180	32	17
	2018	3	9	3300	1200	46	120	12
	2019	1	8	5700	2100	910	140	17
CDC05	2017	2	4	820	300	59	30	11
	2018	3	12	4700	1700	390	120	16
	2019	3	13	5600	2000	370	140	16
CDC07b	2017	1	3	230	85	16	34	2.8
	2018	3	9	5400	2000	460	150	15
	2019	3	9	1500	540	120	160	3.7
CDC08c	2017	1	3	810	300	22	82	4
	2018	3	9	2600	940	93	170	6.1
	2019	3	9	1700	610	120	170	4.1
EVC01	2017	1	3	27	9.9	1.2	1.8	6.2
	2018	3	9	77	28	11	4.6	6.9
	2019	3	9	94	34	10	4.6	8.3
JKC01	2017	1	3	15	5.4	0.21	0.92	6.6
	2018	1	9	28	10	3.7	1.4	8.4

Tributary	Calendar Year	Num Strata	Num Samples	Daily Load (kg/d)	Annual Load (MTA)	RMSE (MTA)	Avg Daily Flow (cfs)	FWMC (mg/L)
	2019	1	9	25	9.1	2.5	1.7	6
KRB01b	2017	1	3	60	22	11	1.3	18
	2018	3	9	160	59	12	11	6.1
	2019	3	9	130	48	6	11	5.1
LCC01	2017	2	4	200	72	26	5.3	15
	2018	3	12	940	340	95	26	15
	2019	3	13	1800	650	150	30	24
LCC02	2017	1	3	52	19	3.8	2.6	7.9
	2018	3	9	470	170	47	12	16
	2019	3	9	600	220	44	14	18
LEC01b	2017	1	2	38	14	4.6	1.2	13
	2018	1	9	100	38	5.5	4.1	10
	2019	3	9	70	25	4.8	2.8	10
MDC01	2017	1	3	0.8	0.29	0.077	0.25	1.3
	2018	3	9	37	14	3.2	11	1.3
	2019	3	9	24	8.9	1.3	12	0.86
MLR01	2017	1	3	6200	2300	1400	230	11
	2018	3	9	13000	4900	560	490	11
	2019	3	9	12000	4400	1200	730	6.7
MLR02	2017	1	3	6500	2400	1400	240	11
	2018	3	9	16000	6000	910	620	11
	2019	3	9	18000	6600	1300	780	9.5
MLR03c-d	2017	1	3	5700	2100	880	320	7.3
	2018	3	9	14000	5100	1000	580	9.9
	2019	3	9	17000	6300	1300	840	8.4
MLR06b	2017	1	4	5400	2000	530	280	7.8
	2018	3	12	50000	18000	4300	770	26
	2019	3	13	60000	22000	14000	970	25
MOC02	2017	1	3	43	16	3.7	4.2	4.2
	2018	3	9	120	44	22	9.5	5.2
	2019	3	9	79	29	2.5	10	3.1
NCC01b	2017	1	3	49	18	5	3	6.7

Tributary	Calendar Year	Num Strata	Num Samples	Daily Load (kg/d)	Annual Load (MTA)	RMSE (MTA)	Avg Daily Flow (cfs)	FWMC (mg/L)
	2018	3	9	140	50	13	13	4.3
	2019	3	9	120	46	13	13	3.8
PGC01c	2017	1	3	9.3	3.4	0.74	2.3	1.7
	2018	3	9	120	45	5.1	16	3.2
	2019	3	9	490	180	66	26	7.6
PSC01	2017	1	3	63	23	3.3	2.6	9.8
	2018	3	9	130	49	12	5.4	10
	2019	3	9	150	56	16	4.8	13
RDC01	2017	1	3	19	6.9	3	0.88	8.8
	2018	1	9	90	33	8.5	4.4	8.4
	2019	3	9	120	43	10	4.6	11
ULC01	2017	1	3	70	26	23	1.2	25
	2018	3	9	110	38	4.5	6.6	6.5
	2019	3	9	110	41	4	7.9	5.8
ULC02	2017	1	3	320	120	47	1.8	72
	2018	3	9	350	130	45	14	11
	2019	3	9	280	100	25	15	7.9

Table H.2. Daily and Annual Loading of Total Phosphorus (TP) by Site and Calendar Year.
Stratified BRE loading estimates including number of strata, number of samples per strata; MTA= metric tons/annum (or year), RMSE=root mean square error, FWMC=flow-weighted mean concentration. NA= flow too small to estimate loading (see text).

Tributary	Calendar Year	Num Strata	Num Samples	Daily Load (kg/d)	Annual Load (MTA)	RMSE (MTA)	Avg Daily Flow (cfs)	FWMC (mg/L)
CBC01	2017	1	3	0.3	0.11	0	1.2	0.092
	2018	3	9	1.7	0.62	0.21	6.9	0.1
	2019	3	9	1.2	0.44	0.1	7.8	0.057
CDC01b	2017	1	3	0.099	0.036	0	5.3	0.007
	2018	3	9	0.2	0.073	0	8.2	0.01
	2019	3	9	0.4	0.15	0	14	0.012
CDC03	2017	2	4	14	5.2	0.56	11	0.015
	2018	3	12	95	35	3.6	33	0.033
	2019	3	13	60	22	4.6	23	0.028
CDC04b	2017	1	3	7.7	2.8	0.41	31	0.099
	2018	3	9	27	9.8	0.71	120	0.095
	2019	1	8	35	13	4.2	130	0.11
CDC05	2017	2	4	7.6	2.8	0.27	28	0.11
	2018	3	12	49	18	3.3	120	0.17
	2019	3	13	46	17	1.9	130	0.14
CDC07b	2017	1	3	6.3	2.3	0.53	33	0.076
	2018	3	9	34	12	1.7	140	0.094
	2019	3	9	22	8.1	1.7	150	0.056
CDC08c	2017	1	3	17	6.2	1.3	77	0.084
	2018	3	9	37	13	1.6	170	0.087
	2019	3	9	24	8.6	2.2	150	0.058
EVC01	2017	1	3	0.7	0.26	0.045	1.3	0.16
	2018	3	9	1	0.37	0.1	4.6	0.09
	2019	3	9	0.8	0.29	0.077	4	0.071
JKC01	2017	1	3	0.099	0.036	0.032	0.85	0.044
	2018	1	9	0.3	0.11	0	1.4	0.089
	2019	2	9	0.3	0.11	0	1.5	0.073
KRB01b	2017	1	3	0.6	0.22	0.071	1.2	0.18
	2018	3	9	3.5	1.3	0.4	11	0.13

Tributary	Calendar Year	Num Strata	Num Samples	Daily Load (kg/d)	Annual Load (MTA)	RMSE (MTA)	Avg Daily Flow (cfs)	FWMC (mg/L)
	2019	3	9	2.7	0.99	0.14	9.7	0.1
LCC01	2017	2	4	1	0.37	0.063	4.9	0.077
	2018	3	12	11	3.9	0.063	26	0.17
	2019	3	13	8.9	3.2	0.67	27	0.12
LCC02	2017	1	3	0.3	0.11	0	2.5	0.047
	2018	3	9	3	1.1	0.36	12	0.11
	2019	3	9	1.8	0.66	0.13	12	0.054
LEC01b	2017			NA			1.2	
	2018	1	9	0.3	0.11	0	12	0.03
	2019	3	9	0.2	0.073	0	12	0.03
MDC01	2017			NA			0.25	
	2018	3	9	0.6	0.22	0.032	12	0.021
	2019	3	9	0.3	0.11	0.032	12	0.011
MLR01	2017	1	3	43	16	7.2	12	0.078
	2018	3	9	140	51	10	12	0.12
	2019	3	9	210	78	13	12	0.12
MLR02	2017	1	3	45	16	6.8	12	0.075
	2018	3	9	150	56	6.8	12	0.1
	2019	3	9	190	68	11	12	0.097
MLR03c-d	2017	1	3	62	23	6.2	12	0.08
	2018	3	9	140	53	7	12	0.1
	2019	3	9	180	66	10	12	0.088
MLR06b	2017	1	4	51	19	4.5	12	0.074
	2018	3	12	290	110	26	12	0.16
	2019	3	13	280	100	28	12	0.12
MOC02	2017	1	3	0.5	0.18	0.045	12	0.049
	2018	3	9	1.5	0.55	0.045	12	0.065
	2019	3	9	1	0.37	0.045	12	0.039
NCC01b	2017	1	3	0.7	0.26	0.063	12	0.095
	2018	3	9	3.2	1.2	0.43	12	0.1
	2019	3	9	3.1	1.1	0.53	12	0.095
PGC01c	2017	1	3	0.2	0.073	0.032	12	0.036

Tributary	Calendar Year	Num Strata	Num Samples	Daily Load (kg/d)	Annual Load (MTA)	RMSE (MTA)	Avg Daily Flow (cfs)	FWMC (mg/L)
	2018	3	9	1.7	0.62	0.077	12	0.044
	2019	3	9	3.2	1.2	0.25	12	0.049
PSC01	2017	1	3	0.3	0.11	0.032	12	0.047
	2018	3	9	1	0.37	0.084	12	0.075
	2019	3	9	0.7	0.26	0.032	12	0.06
RDC01	2017	1	3	0.2	0.073	0	12	0.093
	2018	3	9	4.5	1.6	0.49	12	0.42
	2019	3	9	6.1	2.2	0.55	12	0.55
ULC01	2017	1	3	0.2	0.073	0.032	12	0.07
	2018	1	9	1.3	0.47	0.1	12	0.08
	2019	3	9	1.1	0.4	0.063	12	0.057
ULC02	2017	1	3	0.9	0.33	0.13	12	0.2
	2018	3	9	4.1	1.5	0.6	12	0.12
	2019	3	9	5.2	1.9	0.6	12	0.15

Table H.3. Daily and Annual Loading of Fecal Coliform (FC) by Site and Calendar Year.
Stratified BRE loading estimates including number of strata, number of samples per strata; RMSE=root mean square error, FWMC=flow-weighted mean concentration.

Tributary	Calendar Year	Num Strata	Num Samples	Daily Load (CFU/d)	Annual Load (CFU/y)	RMSE (CFU/y)	Avg Daily Flow (cfs)	FWMC (CFU/100 mL)
CBC01	2017	1	3	4.1E+10	1.5E+13	6.6E+22	1.3	1300
	2018	3	9	1.6E+11	5.9E+13	4.5E+23	6.9	960
	2019	3	9	8.3E+10	3.0E+13	1.2E+23	8.6	390
CDC01b	2017	1	3	4.0E+10	1.5E+13	3.7E+22	5.8	280
	2018	3	9	9.0E+09	3.3E+12	1.1E+22	8.1	46
	2019	3	9	2.0E+10	7.5E+12	5.1E+22	14	59
CDC03	2017	1	3	3.4E+12	1.2E+15	3.5E+24	400	350
	2018	3	12	1.2E+13	4.3E+15	1.1E+25	1200	400
	2019	3	12	1.3E+13	4.8E+15	2.8E+25	870	620
CDC04b	2017	1	3	7.4E+11	2.7E+14	1.2E+24	32	950
	2018	3	9	2.6E+12	9.4E+14	4E+24	120	910
	2019	3	8	2.7E+12	9.8E+14	6.3E+24	140	800
CDC05	2017	2	4	8.3E+11	3.0E+14	2.2E+23	30	1100
	2018	3	12	1.3E+12	4.6E+14	1.3E+24	120	440
	2019	3	13	1.2E+13	4.3E+15	1.8E+25	140	3500
CDC07b	2017	1	3	2.4E+11	8.6E+13	3.8E+23	34	290
	2018	3	9	2.3E+12	8.3E+14	4.2E+24	150	620
	2019	2	9	5.7E+11	2.1E+14	4E+23	160	140
CDC08c	2017	1	3	8.1E+11	2.9E+14	1.2E+24	82	400
	2018	2	9	9.4E+11	3.4E+14	1.4E+24	170	220
	2019	3	9	2.9E+11	1.0E+14	2.8E+23	170	70
EVC01	2017	1	2	1.0E+11	3.7E+13	3.3E+23	1.8	2300
	2018	3	9	9.2E+10	3.3E+13	2.3E+23	4.6	820
	2019	3	9	9.4E+10	3.4E+13	3.4E+23	4.6	830
JKC01	2017	1	3	7.8E+09	2.9E+12	1.4E+22	0.92	350
	2018	2	9	2.8E+10	1.0E+13	7.8E+22	1.4	830
	2019	1	9	8.1E+10	3.0E+13	2.3E+23	1.7	2000
KRB01b	2017	1	3	1.9E+11	6.9E+13	3.7E+23	1.3	5700
	2018	3	9	2.3E+11	8.5E+13	7.3E+23	11	880
	2019	3	9	9.8E+10	3.6E+13	1.6E+23	11	380
LCC01	2017	2	4	1.5E+11	5.3E+13	1.6E+23	5.3	1100
	2018	3	12	6.4E+11	2.4E+14	7.2E+23	26	1000
	2019	3	12	1.7E+12	6.2E+14	2.7E+24	30	2300

Tributary	Calendar Year	Num Strata	Num Samples	Daily Load (CFU/d)	Annual Load (CFU/y)	RMSE (CFU/y)	Avg Daily Flow (cfs)	FWMC (CFU/100 mL)
LCC02	2017	1	3	5.7E+10	2.1E+13	9.8E+22	2.6	880
	2018	3	9	4.5E+11	1.6E+14	1E+24	12	1600
	2019	3	9	1.6E+11	5.8E+13	1.7E+23	14	480
LEC01b	2017	1	2	4.0E+09	1.5E+12	8.4E+21	1.2	140
	2018	3	9	2.1E+10	7.8E+12	1.8E+22	4.1	210
	2019	2	9	2.2E+10	8.1E+12	4.6E+22	2.8	330
MDC01	2017	1	3	3.3E+08	1.2E+11	1E+21	0.25	55
	2018	3	9	2.0E+10	7.1E+12	2.3E+22	11	70
	2019	3	9	2.2E+10	8.1E+12	2.5E+22	12	78
MLR01	2017	1	3	8.1E+12	3.0E+15	2.6E+25	230	1500
	2018	3	9	9.3E+12	3.4E+15	2.3E+25	490	770
	2019	3	9	4.0E+12	1.4E+15	4.4E+24	730	220
MLR02	2017	1	3	2.2E+12	7.9E+14	1.2E+24	240	370
	2018	3	9	9.7E+12	3.6E+15	2E+25	620	650
	2019	3	9	3.9E+12	1.4E+15	5.2E+24	780	200
MLR03c-d	2017	1	3	2.2E+12	7.9E+14	1.1E+24	320	280
	2018	3	9	7.0E+12	2.5E+15	1.7E+25	580	490
	2019	3	9	3.1E+12	1.1E+15	2.1E+24	840	150
MLR06b	2017	2	4	3.7E+12	1.3E+15	7.5E+24	280	530
	2018	3	12	2.2E+13	8.2E+15	3.1E+25	770	1200
	2019	3	12	1.1E+14	4.1E+16	4.1E+26	970	4700
MOC02	2017	1	3	4.6E+10	1.7E+13	6E+22	4.2	450
	2018	3	9	2.0E+11	7.2E+13	2.7E+23	9.5	850
	2019	3	9	5.9E+10	2.1E+13	1.7E+23	10	230
NCC01b	2017	1	3	1.3E+12	4.7E+14	3.4E+24	3	17000
	2018	3	9	3.1E+11	1.1E+14	9.6E+23	13	960
	2019	3	9	1.9E+12	6.8E+14	6.2E+24	13	5700
PGC01c	2017	1	2	1.1E+10	3.9E+12	4.6E+22	2.3	190
	2018	3	9	1.1E+11	3.9E+13	1.7E+23	16	270
	2019	3	9	1.4E+11	5.2E+13	1.9E+23	26	220
PSC01	2017	1	2	3.9E+10	1.4E+13	1.1E+23	2.6	610
	2018	3	9	8.4E+10	3.1E+13	1.4E+23	5.4	630
	2019	3	8	7.7E+10	2.8E+13	1.9E+23	4.8	660
RDC01	2017	1	3	2.9E+09	1.0E+12	3.9E+21	0.88	130
	2018	3	9	1.4E+11	5.0E+13	4.2E+23	4.4	1300
	2019	1	9	5.1E+10	1.9E+13	5.7E+22	4.6	460
ULC01	2017	1	3	1.0E+10	3.7E+12	1.9E+22	1.2	350

Tributary	Calendar Year	Num Strata	Num Samples	Daily Load (CFU/d)	Annual Load (CFU/y)	RMSE (CFU/y)	Avg Daily Flow (cfs)	FWMC (CFU/100 mL)
	2018	3	9	5.0E+10	1.8E+13	6.1E+22	6.6	310
	2019	3	9	2.3E+10	8.5E+12	1.6E+22	7.9	120
ULC02	2017	1	3	2.7E+11	1.0E+14	7.7E+23	1.8	6200
	2018	3	9	3.0E+11	1.1E+14	7E+23	14	900
	2019	3	9	1.1E+11	4.1E+13	1.2E+23	15	310

Table H.4. Daily and Annual Loading of *E. coli* (EC) by Site and Calendar Year.
Stratified BRE loading estimates including number of strata, number of samples per strata; RMSE=root mean square error, FWMC=flow-weighted mean concentration.

Tributary	Calendar Year	Num Strata	Num Samples	Daily Load (MPN/d)	Annual Load (MPN/y)	RMSE (MPN/y)	Avg Daily Flow (cfs)	FWMC (MPN/100 mL)
CBC01	2017	1	3	4.6E+10	1.7E+13	8E+22	1.3	1400
	2018	3	9	1.0E+11	3.6E+13	2.6E+23	6.9	590
	2019	3	9	9.9E+10	3.6E+13	1.3E+23	8.6	470
CDC01b	2017	1	3	2.5E+10	9.1E+12	1.2E+22	5.8	180
	2018	3	9	8.6E+09	3.1E+12	1.3E+22	8.1	43
	2019	3	9	1.8E+10	6.6E+12	6.2E+22	14	53
CDC03	2017	1	3	3.1E+12	1.1E+15	2.7E+24	400	320
	2018	3	12	1.1E+13	4.0E+15	1E+25	1200	380
	2019	3	12	1.2E+13	4.4E+15	2.1E+25	870	570
CDC04b	2017	1	3	7.8E+11	2.8E+14	9.9E+23	32	1000
	2018	3	9	2.1E+12	7.6E+14	3.1E+24	120	730
	2019	3	8	2.7E+12	9.7E+14	5.9E+24	140	790
CDC05	2017	2	4	6.7E+11	2.5E+14	2.6E+23	30	930
	2018	3	12	9.8E+11	3.6E+14	1E+24	120	340
	2019	3	13	9.5E+12	3.5E+15	1.5E+25	140	2800
CDC07b	2017	1	3	3.0E+11	1.1E+14	3.6E+23	34	370
	2018	3	8	1.4E+12	5.2E+14	2.2E+24	150	390
	2019	3	9	5.5E+11	2.0E+14	2.9E+23	160	140
CDC08c	2017	1	3	1.1E+12	4.1E+14	1.3E+24	82	550
	2018	3	8	1.0E+12	3.7E+14	1.9E+24	170	240
	2019	3	9	3.7E+11	1.4E+14	4E+23	170	92
EVC01	2017	1	2	1.2E+11	4.3E+13	3.9E+23	1.8	2700
	2018	3	9	4.6E+10	1.7E+13	9.8E+22	4.6	410
	2019	3	9	1.2E+11	4.5E+13	4.5E+23	4.6	1100
JKC01	2017	1	3	6.1E+09	2.2E+12	8.5E+21	0.92	270
	2018	2	9	1.5E+10	5.4E+12	4.9E+22	1.4	440
	2019	1	9	4.7E+10	1.7E+13	9.6E+22	1.7	1100
KRB01b	2017	1	3	2.1E+11	7.5E+13	2.7E+23	1.3	6300
	2018	3	9	5.6E+11	2.0E+14	1.8E+24	11	2100

Tributary	Calendar Year	Num Strata	Num Samples	Daily Load (MPN/d)	Annual Load (MPN/y)	RMSE (MPN/y)	Avg Daily Flow (cfs)	FWMC (MPN/100 mL)
	2019	3	9	5.4E+10	2.0E+13	1.2E+23	11	210
LCC01	2017	2	4	1.7E+11	6.2E+13	1.5E+23	5.3	1300
	2018	3	12	6.2E+11	2.3E+14	1.3E+24	26	980
	2019	3	12	1.8E+12	6.7E+14	3.4E+24	30	2500
LCC02	2017	1	3	4.1E+10	1.5E+13	4.9E+22	2.6	640
	2018	3	9	3.6E+11	1.3E+14	8.1E+23	12	1300
	2019	3	9	1.3E+11	4.7E+13	1.8E+23	14	380
LEC01b	2017	1	2	2.7E+09	9.7E+11	3E+21	1.2	93
	2018	3	9	2.5E+10	9.0E+12	2.6E+22	4.1	240
	2019	2	9	2.9E+10	1.1E+13	7.2E+22	2.8	430
MDC01	2017	1	3	3.0E+08	1.1E+11	1.4E+21	0.25	49
	2018	3	8	1.9E+10	6.9E+12	3.1E+22	11	67
	2019	3	9	2.5E+10	9.0E+12	3.3E+22	12	88
MLR01	2017	1	3	1.6E+13	5.9E+15	5.3E+25	230	2900
	2018	3	9	5.5E+12	2.0E+15	1.1E+25	490	460
	2019	3	9	3.6E+12	1.3E+15	3.9E+24	730	200
MLR02	2017	1	3	4.4E+12	1.6E+15	1.2E+25	240	750
	2018	3	9	5.4E+12	2.0E+15	9.2E+24	620	360
	2019	3	9	3.0E+12	1.1E+15	3E+24	780	160
MLR03c-d	2017	1	3	2.7E+12	9.9E+14	2.6E+24	320	350
	2018	3	8	4.0E+12	1.5E+15	9.3E+24	580	280
	2019	3	9	2.9E+12	1.1E+15	2.1E+24	840	140
MLR06b	2017	2	4	3.5E+12	1.3E+15	6.1E+24	280	510
	2018	3	11	1.7E+13	6.1E+15	1.7E+25	770	880
	2019	3	12	2.3E+13	8.6E+15	7.3E+25	970	990
MOC02	2017	1	3	4.6E+10	1.7E+13	4.9E+22	4.2	450
	2018	3	8	1.3E+11	4.8E+13	1.6E+23	9.5	560
	2019	3	9	5.8E+10	2.1E+13	9E+22	10	230
NCC01b	2017	1	3	1.2E+12	4.5E+14	3.3E+24	3	17000
	2018	3	9	4.6E+11	1.7E+14	1.5E+24	13	1400
	2019	3	9	3.0E+12	1.1E+15	1E+25	13	9300
PGC01c	2017	1	2	6.9E+09	2.5E+12	3.7E+22	2.3	120

Tributary	Calendar Year	Num Strata	Num Samples	Daily Load (MPN/d)	Annual Load (MPN/y)	RMSE (MPN/y)	Avg Daily Flow (cfs)	FWMC (MPN/100 mL)
	2018	3	8	9.2E+10	3.4E+13	1.5E+23	16	240
	2019	3	9	1.3E+11	4.7E+13	1.7E+23	26	200
PSC01	2017	1	2	5.1E+10	1.8E+13	1.4E+23	2.6	790
	2018	3	9	7.3E+10	2.7E+13	9.7E+22	5.4	550
	2019	3	8	8.6E+10	3.1E+13	2E+23	4.8	740
RDC01	2017	1	3	3.1E+09	1.1E+12	8E+21	0.88	150
	2018	3	9	4.9E+10	1.8E+13	1.2E+23	4.4	450
	2019	1	9	4.8E+10	1.7E+13	4.5E+22	4.6	430
ULC01	2017	1	3	1.2E+10	4.4E+12	2.2E+22	1.2	430
	2018	3	9	6.3E+10	2.3E+13	1E+23	6.6	390
	2019	3	9	2.9E+10	1.1E+13	2E+22	7.9	150
ULC02	2017	1	3	3.2E+11	1.2E+14	9E+23	1.8	7400
	2018	3	8	2.9E+11	1.0E+14	6.4E+23	14	860
	2019	3	9	1.2E+11	4.3E+13	1.3E+23	15	330