METHODS FOR STORMWATER DATA COLLECTION & ANALYSIS

MONITORING LOCATIONS

CRWD collects water quality and quantity data at eighteen monitoring stations in the District: ten full water quality stations, three flow-only stations, and five level logger stations (Figure 1-1). Additionally, six precipitation gauges collect rainfall data across the watershed.

At each full water quality station, both water quality and quantity data are collected. The ten full water quality stations, their locations, and a description of each are detailed in Table 1-1 and Figure 1-1.

Table 1-1: CRWD full water quality monitoring station list.

	Station Name	Description
1	East Kittsondale	East Kittsondale subwatershed
2	Hidden Falls	Hidden Falls subwatershed
3	Phalen Creek	Phalen Creek subwatershed
4	St. Anthony Park	St. Anthony Park subwatershed
5	Trout Brook-East Branch	East Branch of the Trout Brook Storm Sewer Interceptor
6	Trout Brook-West Branch	West Branch of the Trout Brook Storm Sewer Interceptor
7	Trout Brook Outlet	Outlet of the Trout Brook Storm Sewer Interceptor
8	Villa Park Outlet	Lower portion of the Lake McCarrons subwatershed - Villa Park Wetland outlet
9	Como 3	Como 3 subwatershed
10	Como 7	Subsection of Como 7 subwatershed

From Table 1-1, five of the full water quality stations (1, 2, 3, 4, and 7) are positioned at or near the outlets of subwatersheds which drain directly to the Mississippi River. The remaining five full water quality stations are located within five minor subwatersheds which do not drain directly to the Mississippi River, but are still ultimately connected through downstream subwatersheds.

Two flow-only stations are operated at the outlets of Como Lake and Lake McCarrons to determine the total amount of discharge from the lakes into the Trout Brook Storm Sewer Interceptor. Additionally, a flow-only station is operated at Como Park Regional Pond to quantify the total amount of flow coming from that system into the Como 7 subwatershed. Water level monitoring stations are operated at four storm ponds in the Trout Brook subwatershed and the data is used to calibrate and update models for the Trout Brook Storm Sewer Interceptor. The storm ponds monitored are Arlington-Jackson, Sims-Agate, Westminster-Mississippi, and Willow Reserve (Figure 1-1).

Six precipitation gauges are positioned throughout the watershed. They are located at the CRWD office, the Villa Park Outlet monitoring station, Saint Paul Fire Station No. 1, the Metropolitan Mosquito Control District central office, Western District Police Station, and the Trout Brook-East Branch monitoring station (Figure 1-1). CRWD also obtains precipitation data reported by the Minnesota Climatology Working Group (MCWG) at the University of Minnesota-St. Paul (UMN) and by the National Weather Service (NWS) at the Minneapolis-St. Paul Airport.

Table 1-2: CRWD monitoring site descriptions and equipment.

Station Name	Subwatershed	Description	Data Collected	Equipment
East Kittsondale	East Kittsondale	Storm Sewer	L, V, Q, WQ, LD	ISCO 6712, 2150 module
Hidden Falls	Hidden Falls	Storm Sewer	L, V, Q, WQ, LD	ISCO 6712, 2150 module
Phalen Creek	Phalen Creek	Storm Sewer	L, V, Q, WQ, LD	ISCO 6712, 2150 module
St. Anthony Park	St. Anthony Park	Storm Sewer	L, V, Q, WQ, LD	ISCO 6712, 2150 module
Trout Brook-East Branch	Trout Brook	Storm Sewer	L, V, Q, WQ, LD	ISCO 6712, 2150 module
Trout Brook-West Branch	Trout Brook	Storm Sewer	L, V, Q, WQ, LD	ISCO 6712, 2150 module
Trout Brook Outlet	Trout Brook	Storm Sewer	L, V, Q, WQ, LD	ISCO 6712, 2150 module
Como 7	Como 7	Storm Sewer	L, V, Q, WQ, LD	ISCO 6712, 2150 module
Como Golf Course Pond Outlet	Como 7	Storm Sewer	L, V, Q, WQ, LD	ISCO 2150 module
Como 3	Como 3	Storm Sewer	L, V, Q, WQ	ISCO 6712, 2150 module
Bdale Outlet*	Lake McCarrons	Storm Sewer	L, Q, WQ	ISCO 6712, 750 module
Villa Park Inlet*	Lake McCarrons	Wetland	L, V, Q, WQ	ISCO 6712, 2150 module
Villa Park Outlet	Lake McCarrons	Wetland	L, V, Q, WQ, LD	ISCO 6712, 2150 module
Arlington-Jackson	Trout Brook	Stormwater Pond	L	Global Water Level Logger
Como Golf Course Pond	Como 7	Stormwater Pond	L	Global Water Level Logger
Sims-Agate	Trout Brook	Stormwater Pond	L	Global Water Level Logger
Westminster-Mississippi	Trout Brook	Stormwater Pond	L	Global Water Level Logger
Willow Reserve	Trout Brook	Stormwater Pond	L	Global Water Level Logger
Lake McCarrons	Lake McCarrons	Lake	L	Onset HOBO Level Logger
McCarrons Outlet	Lake McCarrons	Lake Outlet	L, V, Q	ISCO 2150 module
Como Lake	Como Lake	Lake	L	Onset HOBO Level Logger
Como Outlet	Como Lake	Lake Outlet	L, Q	Global Water Level Logger
Villa Park Pond*	Lake McCarrons	Wetland	L	Global Water Level Logger
St. Paul Fire Station RG*	West Seventh	Precipitation	Precip.	Onset HOBO Datalogging RG
Trout Brook - East Branch RG*	Trout Brook	Precipitation	Precip.	Onset HOBO Datalogging RG
Mosquito Control RG*	West Kittsondale	Precipitation	Precip.	Onset HOBO Datalogging RG
Western District Police Station*	East Kittsondale	Precipitation	Precip.	Onset HOBO Datalogging RG
CRWD Office RG*	St. Anthony Park	Precipitation	Precip.	Onset HOBO Datalogging RG
Villa Park RG*	Lake McCarrons	Precipitation	Precip.	Onset HOBO Datalogging RG

* Data not included in 2015 Monitoring Report

Key

L	Level (ft)
V	Velocity (ft/s)
Q	Discharge (cfs)
WQ	Water Quality (Nutrients, Solids, Metals, Bacteria)
LD	Pollutant Load (calculated loads & yields)
RG	Rain Gauge
Precip.	Precipitation (in)

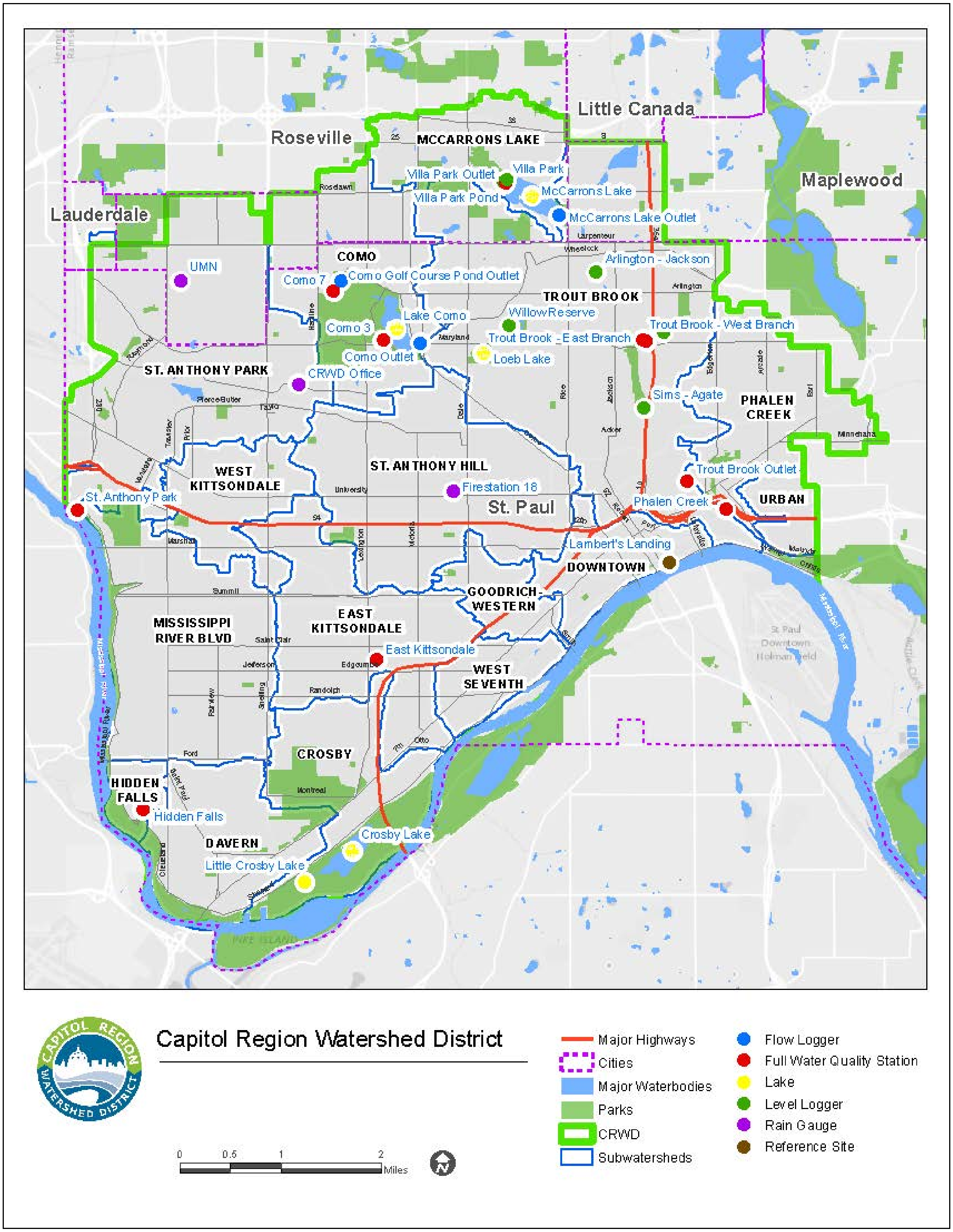

Figure 1-1: Monitoring locations by station type.

MONITORING METHODS AND ANALYSIS

PERIOD OF OPERATION

Six of the full water quality stations (St. Anthony Park, East Kittsondale, Phalen Creek, Trout Brook-East Branch, Trout Brook-West Branch, and Trout Brook Outlet) are monitored continuously (January 1 through December 31). Each station has a flow logger installed for the entire calendar year and an automatic sampler installed from April to November. All other full water quality, flow logger, level logger, and precipitation monitoring stations are generally operational from April to November (seasonally monitored stations). Table 1-3 lists the periods of station operation from install to uninstall (specific to 2015).

Table 1-3: Time Periods of operation for CRWD monitoring stations.

Continuously Monitored Sites	Install Date/Time*	Uninstall Date/Time*
East Kittsondale	01/01/2015 00:00	12/31/2015 23:59
Phalen Creek	01/01/2015 00:00	12/31/2015 23:59
St. Anthony Park	01/01/2015 00:00	12/31/2015 23:59
Trout Brook-East Branch	01/01/2015 00:00	12/31/2015 23:59
Trout Brook-West Branch	01/01/2015 00:00	12/31/2015 23:59
Trout Brook Outlet	01/01/2015 00:00	12/31/2015 23:59
Seasonally Monitored Sites		
Hidden Falls	04/13/2015 09:55	11/19/2015 09:04
Como 3	03/27/2015 12:05	11/13/2015 11:58
Como 7	03/31/2015 10:10	11/13/2015 11:22
Como Golf Course Pond Outlet	03/30/2015 15:30	11/23/2015 13:21
Villa Park Outlet	03/18/2015 09:41	11/23/2015 14:09
Arlington-Jackson	04/16/2015 09:37	11/03/2015 10:50
Sims-Agate	04/22/2015 11:34	11/03/2015 10:15
Westminster-Mississippi	04/16/2015 09:57	11/03/2015 10:44
Willow Reserve	04/16/2015 09:09	11/03/2015 09:33
McCarrons Outlet	04/27/2015 15:22	10/27/2015 10:00
Como Outlet	03/30/2015 15:30	11/23/2015 13:21

* Date/Time indicates period of operation for continuously monitored sites in 2015.

FULL WATER QUALITY STATIONS

Full water quality stations consist of an area-velocity sensor and an automated water sampler. The area-velocity sensors are secured to the base and center of a pipe or channel and are connected to the automated water sampler housed above ground. Area-velocity sensors measure and record water depth and velocity every 5 or 15 minutes. This data is used to calculate discharge or volumetric flow of water at the station by relating water depth in the pipe or channel to area (each pipe or channel has a unique relationship) and multiplying by the velocity reading.

When the flow of water reaches a specified depth or velocity, the sampler engages to collect water samples. Generally, samplers are programmed to capture storm events greater than or equal to the 0.5 inch precipitation event. Two different sampler sizes are used: a compact sampler and a full-size sampler. A compact sampler can collect up to 48- 200 milliliter (mL) samples (2 per bottle). A full-size sampler can collect 96- 200 mL samples (4 per bottle). A sample is collected after a specified volume of water passed through the station in order to collect samples over the entire hydrograph. These individual samples are combined and mixed to produce a single composite sample. This approach provides a better representation of stormwater quality throughout the entirety of a storm or base flow event as opposed to taking a single grab sample. To create a composite sample of a storm or base event at a given station, the individual sample bottles are first shaken until the sampled water became homogenous. The sample bottles are then poured together into a 14-Liter (L) churn sample splitter and thoroughly mixed to create a homogenous sample. Once mixed, 4 liters of the homogenous sample are distributed to a sample bottle provided by the Metropolitan Council Environmental Services (MCES) Laboratory.

Water quality samples are collected during storm events at the ten full water quality stations. With the exception of Como 7 and Como 3, monitoring stations have continuous baseflow during dry weather periods. Composite samples of dry weather baseflow are taken at the stations with continuous baseflow (East Kittsondale, Hidden Falls, Phalen Creek, St. Anthony Park, Trout Brook-East Branch, Trout Brook-West Branch, Trout Brook Outlet, Villa Park outlet) twice a month from April to November and once a month from December to March.

Bacteria grab samples for *Escherichia coli* (*E. coli*) are taken at all full water quality stations during storm events when runoff is generated. At stations with baseflow, bacteria base grab samples are collected once a month. When collected, bacteria grab samples for *E. coli* are sampled directly into sterilized containers during storm events and baseflow periods and delivered immediately to the lab for analysis due to the short sample holding time (6 hours).

Water quality samples are delivered to the MCES Laboratory for analysis. The chemical parameters, method of analysis, and holding times are listed in Table 1-4. If the lab analysis occurs after the holding time of a given chemical parameter had expired, that chemical parameter is not analyzed.

Table 1-4: Analysis method, reporting limits, and holding times for water chemistry parameters analyzed by Metropolitan Council Environmental Services (MCES).

Parameter	Abbreviation	Method	Reporting Limit	Holding Time
Cadmium	Cd	MET-ICPMSV_5	0.0002 mg/L	180 days
Carbonaceous BOD, 5 day	CBOD	BOD5_5	0.2 mg/L	48 hours
Chloride	Cl	CHLORIDE_AA_3	0.5 mg/L	28 days
Chromium	Cr	MET-ICPMSV_5	0.00008 mg/L	180 days
Copper	Cu	MET-ICPMSV_5	0.0003 mg/L	180 days
Escherichia Coli	*E. coli*	Colilert and Colilert-18 with Quanti-Tray/2000 method	N/A	6 hours
Fluoride	Fl	ANIONS_IC_3	0.02 mg/L	28 days
Hardness	Hardness	HARD-TITR_3	N/A	28 days
Lead	Pb	MET-ICPMSV_5	0.0001 mg/L	180 days
Nickel	Ni	MET-ICPMSV_5	0.0003 mg/L	180 days
Nitrate as N	NO3	N-N_AA_4	0.01 mg/L	28 days
Nitrite as N	NO2	N-N_AA_4	0.003 mg/L	28 days
Nitrogen, Ammonia	NH3	NH3_AA_3	0.005 mg/L	28 days
Nitrogen, Kjeldahl, Total	TKN	NUT_AA_3	0.03 mg/L	28 days
Orthophosphate as P	Ortho-P	ORTHO_P_1	0.005 mg/L	48 hours
pH at 25 Degrees C	pH	pH by electrochemical pH probe	N/A	N/A
Phosphorus, Dissolved	Dissolved P	P-AV	0.02 mg/L	28 days
Phosphorus, Total	TP	NUT_AA_3	0.02 mg/L	28 days
Potassium	K	MET-ICPMSV_5	.03 mg/L	180 days
Sulfate	SO4	SO4-IC	0.15 mg/L	28 days
Surfactants	MBAS$	SM 5540 C	0.10 mg/L	48 hours
Total Dissolved Solids	TDS	TDS180_1	5 mg/L	7 days
Total Suspended Solids	TSS	TSSVSS_3	N/A	7 days
Volatile Suspended Soilds	VSS	TSSVSS_3	N/A	7 days
Zinc	Zn	MET-ICPMSV_5	0.0008 mg/L	180 days

FLOW-ONLY AND LEVEL LOGGER STATIONS

The outlet of Como Lake is regulated by a wooden weir in a manhole. A level sensor is placed on the upstream side of the weir. When the water level exceeds the distance between the sensor and the weir, the structure is discharging. The volume is calculated based on the dimensions of the weir, the recorded level, and the periods of recorded outflow. At the Lake McCarrons outlet and Como Golf Course Pond outlet, an area-velocity sensor connected to a data logger water depth and velocity every fifteen minutes. This data is used to calculate discharge at the station with the known pipe dimensions.

Level logger stations are operated at four storm ponds within the Trout Brook subwatershed (Figure 3-1). The data collected at these stations is used to track pond elevation in relation to precipitation. The data is also used to calibrate the hydrologic and hydraulic model for the Trout Brook Storm Sewer Interceptor. A pressure transducer is secured at a known depth in the pond and connected to a data logger which continuously recorded stage every ten minutes. The logger locations are surveyed relative to a known benchmark in order to convert stage data to a true elevation.

PRECIPITATION STATIONS

Precipitation is measured using automatic and manual rain gauges (Figure 3-1). The Trout Brook-East Branch, Saint Paul Fire Station No. 1, Metropolitan Mosquito Control District central office, Western District Police Station, and Villa Park Outlet precipitation monitoring stations use automatic tipping bucket rain gauges which record precipitation amounts continuously during storm events in order to determine rainfall intensity. Manual rain gauges are used at the CRWD office and Villa Park. The manual rain gauge at the CRWD office is checked and emptied each workday at 7:30 AM. The manual rain gauge at Villa Park is checked and emptied after every storm event.

Precipitation data, recorded every 15 minutes at the UMN St. Paul campus, is used to determine daily, monthly, and annual rainfall amounts for the Capitol Region watershed. Precipitation data from the NWS at the Minneapolis-St. Paul International Airport is substituted for any gaps in the UMN data. It is acknowledged that some level of variability exists spatially and temporally for precipitation events within the District. However, previous watershed model calibration within the District has shown that the precipitation amount at the UMN station adequately represents the District as a whole.

MONITORING DATA QUALITY ASSURANCE

CRWD has developed a Quality Assurance Program Plan (QAPP) that guides water quality and quantity monitoring as well as data quality control/quality assurance (QA/QC) procedures. The QAPP outlines sample collection and data analysis processes to ensure high data quality. The QAPP is updated annually and is available on the CRWD website or under “User Guidance” in the Water Data Portal.

Flow data is quality checked and corrected by removing points with missing data or bad values and interpolating their values between good data points. If there are extended periods of missing or bad data no interpolation is performed and the data is left as missing. For storm events where velocity does not log accurately, but level is still logged, a stage to velocity relationship is created using level and velocity data from good periods of stormflow record. The relationship is then used to calculate an approximation of velocity for those periods of missing data. If this is not possible, the data is left as missing and not factored into discharge calculations.

The water quality sample data reported by the MCES lab is also rigorously checked for quality. The reported sample times and dates are compared with field notes as well as the lab chain of custody forms. Any abnormally high or low sample values are denoted and cross-checked with field notes and other parameters from the same sample to ensure the parameter value is commensurate with the conditions of the day in which the sample is taken. Sample concentration results that are identified as non-representative due to collection error or are reported incorrectly from the lab are considered outliers and removed from event load calculations.

TOTAL DISCHARGE AND POLLUTANT LOAD CALCULATIONS

For all full water quality monitoring stations, the stage, velocity, and water quality data collected are used to calculate total discharge and pollutant loads for total phosphorus (TP) and total suspended solids (TSS). Discharge and pollutant loads are calculated for each storm, snowmelt, and illicit discharge event at all stations. For stations with baseflow, monthly TP and TSS loads are calculated. At the stations monitored continuously, the totals represent annual discharges and loads. At Como 7, Como 3, Hidden Falls, and Villa Park, monitoring equipment cannot be operated during the winter months because equipment failure or damage can occur from freezing temperatures and ice. Subsequently, the reported discharge and loads for these stations are only representative of April through November.

Total discharge and pollutant loads for the Como 7 Subwatershed include combined data from the Como 7 monitoring station and the outlet for the Como Golf Course Pond. The outflow from the pond discharges into a storm sewer just downstream of the Como 7 monitoring station. No water quality samples are collected at the Como Golf Course Pond station. Loads are estimated using historical monthly median concentrations from the period of record. Analysis of the combined Como 7 and Como Golf Course Pond station data is done in the same manner as all other full water quality monitoring stations.

For Villa Park, total discharge and pollutant loads also include any discharge flowing through the emergency overflow near the outlet of the wetland system. Discharge is quantified by placing a secondary sensor in the overflow pipe and adding the measured event discharge total to the discharge measured at Villa Park Outlet station.

Total discharge and pollutant load calculations for all stations are performed in Kisters WISKI) software (referred to as WISKI from here on). WISKI is a data management software specifically designed for continuous and discrete water quality data. WISKI was implemented in 2014 by CRWD and will be utilized in the future for all stormwater data storage and analysis.

Flow Partitioning and Discharge Calculation

The final flow data for each station is separated into base and event (storm, snowmelt, illicit discharge) discharge. For stations without sustained baseflow, all events corresponding to a precipitation event are considered event intervals. For stations with year-round baseflow, separation of event flow and baseflow is necessary. Events are identified using an automated script in WISKI, which takes into account the rate of change in the hydrograph and a threshold above baseflow in the preceding period. Baseflow is considered continuous (but not constant) during storm events. Baseflow is estimated during an event by interpolating between the discharge at the beginning and end of the event interval. The baseflow amount calculated during the event is subtracted from the total interval discharge to determine the event discharge volume.

The total discharge for each interval is calculated using WISKI to integrate the flow rate data for baseflow and event flow. Discharge volumes are summed to calculate a total discharge for the monitoring period. Discharge subtotals are also calculated by flow type (base and event) for the monitoring period.

Overall, the total annual loads and discharges that are calculated are largely unaffected by this methodology. However, annual loads and discharge by flow type differ due to the estimation of baseflow discharge and load contribution during events. As a result, the relative contribution of event flow and baseflow loads and discharge volume to the totals between calendar years show differences compared to previous years' reports, though the annual total discharge remains the same.

Event Load Calculation

The TP and TSS concentrations (reported by the MCES lab) are used to calculate TP and TSS loads for each sampled event. A median historical monthly concentration is applied to events for which samples are not collected. The median concentration is calculated using the median of all event samples collected for a given monitoring station by month for the entire monitoring record.

All TP and TSS load calculations for each event are completed in WISKI using an automated script that followed the equation:

$$Event\ load\ (lbs) = Event\ Discharge\ (cf) * EMC_s(mg/L) * \left(\frac{28.316\ L}{1\ cf}\right) * \left(\frac{1lb}{453{,}592mg}\right)$$

The event mean concentration (EMC_s) is calculated using the following equation:

$$EMC_s = \frac{[EMC_{tot} - (C_b * f_b)]}{f_s}$$

Where,

- EMC_{tot} is the lab reported composite sample concentration if the event is sampled or the historical monthly median storm concentration if the event is not sampled
- C_b is the historical monthly median base concentration
- f_b is the base fraction of interval volume
- f_s is the storm fraction of interval volume

Base Load Calculation

Base loads are calculated on a monthly basis using historical monthly median baseflow concentrations. Baseflow samples collected are included in the historical median calculations.

All baseflow TP and TSS load calculations are completed in WISKI using an automated script that followed the equation:

$$Load\ (lbs) = Monthly\ Baseflow\ Discharge\ (cf) * C_b(mg/L) * \left(\frac{28.316\ L}{1\ cf}\right) * \left(\frac{1lb}{453{,}592mg}\right)$$

FLOW WEIGHTED AVERAGE (FWA) CONCENTRATION CALCULATIONS

A total flow weighted average (FWA) concentration, as well as a FWA concentration for each flow type, is calculated for TP and TSS for the entire monitoring period. The total FWA concentration takes into account the differences generally observed between flow types. This presents a more accurate representation than an average of all interval concentrations. At stations with baseflow for example, pollutant concentrations tend to be higher during storm events, but generally account for less of the total annual discharge. An overall average would be skewed toward the higher and more frequently sampled storm concentrations. In the same manner, FWA concentrations by flow type (e.g. event, base, illicit discharge) account for differences in the relative effect of individual intervals (flow events) on the average.

Total FWAs for TP and TSS for the entire monitoring season are calculated using the following equation:

$$Total\ FWA\ (mg/L) = \frac{total\ load\ (lbs) * \left(\frac{453{,}592mg}{lb}\right)}{total\ discharge\ (cf) * \left(\frac{28.316L}{cf}\right)}$$

FWA concentrations for TP and TSS for each flow type are calculated by dividing the total load associated with a given flow type by the total discharge associated with the flow type:

$$Flow\ Type\ FWA\ (mg/L) = \frac{\sum event\ loads\ (lbs) * \left(\frac{453{,}592mg}{lb}\right)}{subtotal\ discharge\ (cf) * \left(\frac{28.316L}{cf}\right)}$$

POLLUTANT YIELD

Annual yields for TP and TSS in pounds per acre (lb/ac) are calculated for each monitored subwatershed in order to normalize pollutant load by subwatershed drainage area size so that comparisons between all CRWD subwatersheds could be made. Annual yields are calculated using the following equation:

$$Yield\ (\text{lbs/ac}) = \frac{total\ load\ (lbs)}{drainage\ area\ (ac)}$$

CUMULATIVE DISCHARGE

Cumulative plots for total discharge are developed for each station. Cumulative discharge plots are useful for showing the rate and temporal distribution of discharge accumulation throughout the course of the monitoring season. Each point along the curve represents the accumulated discharge from the beginning of the period up to that point in time.

FEDERAL AND STATE SURFACE WATER QUALITY STANDARDS COMPARISON

Currently, there are no federal or state water quality standards for stormwater. The Minnesota Pollution Control Agency (MPCA) and the U.S. Environmental Protection Agency (EPA) have established surface water quality standards for only certain water quality parameters. Regardless, CRWD's stormwater flows into the Mississippi River, so it is useful to compare the stormwater data to surface water quality standards which serve as a benchmark to consider for each pollutant (Table 1-5).

TP and TSS Standards

Because the MPCA has not established stormwater standards for TSS and TP, the data is compared to the TP and TSS values of Lambert's Landing, a Mississippi River water quality monitoring station downstream of the Wabasha Bridge in St. Paul at river mile 839.1 (Table 1-5). Additionally, the TSS values are compared against the South Metro Mississippi Total Suspended Solids TMDL, and the TP values are compared against the Lake Pepin Excess Nutrient TMDL. When comparing CRWD TP and TSS concentrations to water quality standards, flow-weighted average concentrations are used.

Table 1-5: Surface water quality standards for Class 2B waters.

Parameter	Standard[a]	Units	Water Body	Source
Cl	230	mg/L	Surface	Minn. Stat. § 7050.0222
Cd	*	mg/L	Surface	Minn. Stat. § 7050.0222
Cr	*	mg/L	Surface	Minn. Stat. § 7050.0222
Cu	*	mg/L	Surface	Minn. Stat. § 7050.0222
E. coli	≤ 1,260	MPN/100 mL	Surface	Minn. Stat. § 7050.0222
NH_3	40	µg/L	Surface	Minn. Stat. § 7050.0222
Ni	*	mg/L	Surface	Minn. Stat. § 7050.0222
Pb	*	mg/L	Surface	Minn. Stat. § 7050.0222
TP	60	µg/L	Surface	Minn. Stat. § 7050.0222
TSS	30[b]	mg/L	Stream	Minn. Stat. § 7050.0222
Zn	*	mg/L	Surface	Minn. Stat. § 7050.0222

*The standard is dependent upon w ater hardness; See Appendix B

[a] Standards apply to Class 2B w aters in the North Central Hardw ood Forest ecoregion. Class 2B w aters are designated for aquatic life and recreational use. All standard concentrations apply to chronic exposure.

[b] Standard applies to Class 2B w aters in the Central River Nutrient Region. The standard may be exceeded no more than 10 percent of the time and applies April 1 through September 30.

Bacteria Standard

For *E. coli* bacteria, the MPCA has set the following two provisions as a standard:

1. With greater than five samples taken in a calendar month (April to November), the *E. coli* concentration geometric mean shall be less than 126 cfu/100mL.

2. No more than ten percent of all samples taken during a calendar month (April to November) shall exceed 1,260 cfu/100mL

CRWD collects *E. coli* samples each month from April to November (one base sample and storm samples when feasible), so the MPCA monitoring requirements of the *E. coli* geometric mean standard of 126 cfu/100mL cannot be typically met. Instead, CRWD compares individual *E. coli* monitoring results to the maximum value of the standard, 1,260 cfu/100mL. This comparison provides a benchmark only for comparing CRWD bacteria data and does not imply whether or not the full bacteria standard is being met. The MCES lab measures *E. coli* as the most probable number per 100 milliliters of water (mpn/100mL). Research shows that mpn/100mL is comparable to cfu/100mL (Massa et al., 2001).

NATIONAL URBAN STORMWATER QUALITY COMPARISONS

Researchers from the University of Alabama and the Center for Watershed Protection have created an extensive database of stormwater data from urbanized areas by assembling and evaluating stormwater monitoring data from a representative number of National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Phase I stormwater permit holders. The goals of the National Stormwater Quality Database (NSQD) are to describe the characteristics of national stormwater quality, to provide guidance for future sampling needs, and to enhance local stormwater management activities in areas having limited data.

NSQD (Version 3) includes stormwater quality data from 8,602 storm events from 104 municipalities, including a number in Minnesota (Pitt et al., 2008). The NSQD (Version 3) is extensively reviewed for quality assurance and control and statistical analyses are performed to characterize and understand the pollutant data.

Although the NSQD (Version 3) includes only a small set of data from the midwest and northeast portions of the country, which have similar climatic conditions, it still provides a useful comparison of how polluted stormwater in CRWD is compared to the rest of the country. The database includes stormwater quality data for various land use types. The predominant land uses in CRWD are mixed residential, commercial, and industrial with 42% of the land comprised of impervious surfaces. CRWD's stormwater quality data is compared to the NSQD's mixed residential land use category, which has a median impervious percentage of 34%. Table 1-6 presents the NSQD median data values for the mixed-residential land use category.

Table 1-6: NSQD stormwater pollutant median concentrations - mixed residential land use.

Parameter	Median Value
Area (acres)	102
% Impervious	35
Precipitation Depth (in.)	0.595
Escherichia coli (mpn/100mL)	810
Total Suspended Solids (mg/L)	72
Total Phosphorous (mg/L)	0.22
Ammonia (mg/L)	0.2545
Nitrate+Nitrite (mg/L)	0.61
Total Kjeldahl Nitrogen (mg/L)	1.3
Cadmium (mg/L)	0.001
Chromium (mg/L)	0.005
Copper (mg/L)	0.016
Lead (mg/L)	0.015
Nickel (mg/L)	0.005
Zinc (mg/L)	0.085