2015 Stormwater Monitoring Report

APRIL 2016

Prepared By: CAPITOL REGION WATERSHED DISTRICT

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May 19, 2016

Dear Stakeholders and Interested Parties:

I am pleased to provide to you a copy of our *2015 Stormwater Monitoring Report*. Capitol Region Watershed District's (CRWD) 2015 monitoring program was enhanced by the contributions of other agencies and individuals including St. Paul Public Works, Anne Weber and Pat Cahanes.

CRWD established a water quality monitoring program in 2004. Prior to this, there were limited data on stormwater in CRWD. These data are necessary to assess achievement of water quality standards, evaluate BMP programs, identify water quality problem areas, calibrate computer models, determine pollutant loads and perform trend analysis. In addition, all of the stormwater in CRWD flows to the Mississippi River or District Lakes, where it affects surface water quality and aquatic life. Monitoring stormwater allows CRWD to determine what subwatersheds are exporting to the Mississippi River and District Lakes. Data contained in this report supports ongoing watershed management decisions.

I would also like to recognize staff who assisted with the preparation of this report. Britta Suppes, Joe Sellner, Sarah Wein, Maddie Vargo, Wyatt Behrends, and Lauren Haydon had a major role in collecting, analyzing, and reporting the data. Gustavo Castro created and contributed maps to the report.

All of the supporting data are stored and maintained by CRWD. The *2015 Stormwater Monitoring Report*, along with previous years' reports are available at the District's website: www.capitolregionwd.org/press/crwd-reports. If you have any questions pertaining to the enclosed report, contact District Monitoring Coordinator, Britta Suppes at (651) 644-8888 or britta@capitolregionwd.org.

Sincerely,

Bob Fossum
Water Resource Program Coordinator

enc: Capitol Region Watershed District's *2015 Stormwater Monitoring Report*

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ACRONYMS AND ABBREVIATIONS

ac	Acre
AHUG	Arlington Hamline Underground Infiltration Facility
BMP	Best Management Practice
cBOD	5-day Carbonaceous Biochemical Oxygen Demand
Cd	Cadmium
cf	Cubic feet
cfs	Cubic feet per second
cfu	Colony forming unit
Chl-a	Chlorophyll-a
Cl-	Chloride
Cr	Chromium
CRWD	Capitol Region Watershed District
CS	Chronic standard
Cu	Copper
DO	Dissolved Oxygen
E. coli	*Escherichia coli*
EK	East Kittsondale
EMC	Event Mean Concentration
EPA	Environmental Protection Agency
ft	Foot
GP	Gottfried's Pit
ha	Hectare
Hg	Mercury
FWA	Flow-Weighted Average
IBI	Index of Biological Integrity
IDDE	Illicit Discharge Detection and Elimination
in	Inch
kg	Kilogram
L	Liter
lb	Pound
m	Meter
MCES	Metropolitan Council Environmental Services
MCWG	Minnesota Climatological Working Group
mg	Milligram
mL	Milliliter
MnDOT	Minnesota Department of Transportation
MPCA	Minnesota Pollution Control Agency
MPN	Most probable number
MS4	Municipal Separate Storm Sewer System

MSP	Minneapolis-St. Paul International Airport
NA	Not Available
NCHF	North Central Hardwood Forest
NH3	Ammonia
Ni	Nickel
NO2	Nitrite
NO3	Nitrate
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
NSQD	National Stormwater Quality Database
Ortho-P	Orthophosphate
Pb	Lead
PC	Phalen Creek
PCBs	Polychlorinated biphenyls
PFOS	perfluorooctane sulfonate
QAPP	Quality Assurance Program Plan
RCD	Ramsey Conservation District
RCPW	Ramsey County Public Works
s	Second
SAP	St. Anthony Park
TB	Trout Brook
TB-EB	Trout Brook East Branch
TBI	Trout Brook Storm Sewer Interceptor
TBO	Trout Brook Outlet
TB-WB	Trout Brook West Branch
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
UMN	University of Minnesota-St. Paul Campus
VPO	Villa Park Outlet
VSS	Volatile Suspended Solids
Zn	Zinc

DEFINITIONS

Acute exposure – in water quality standards, the maximum concentration of a chemical to which an organism may be exposed for a short time period without experiencing adverse effects.

Baseflow – the sustained non-storm event flow in a channel or pipe dominated by subsurface flows (i.e. groundwater) that is usually at a relatively constant, slow velocity.

Best Management Practice – technique, measure, or structural control that is used for a given set of conditions to manage the quantity and improve the quality of stormwater runoff in the most cost effective manner.

Bioaccumulation – the accumulation of a toxic substance within an organism, occurring when the substance is absorbed faster than it is lost or expelled. This can lead to chronic poisoning, even if concentrations in the environment are relatively low.

Chronic exposure – in water quality standards, the maximum concentration of a chemical to which an organism may be exposed for an extended period of time without experiencing adverse effects.

Composite sample – a water sample that is made up of several samples taken at spaced intervals.

Contaminants of emerging concern – substances that have been released to, found in, or have potential to enter waters; and present a known or perceived threat to human or environmental health, have new or changing exposure information, or have limited information on the effects of exposure. These often occur at low concentrations and may include pharmaceuticals, pesticides, and personal care products, among others.

Designated use – the water quality standards regulation requires that States and authorized Indian Tribes specify appropriate water uses to be achieved and protected. Appropriate uses are identified by taking into consideration the use and value of the water body for public water supply, for protection of fish, shellfish, and wildlife, and for recreational, agricultural, industrial, and navigational purposes.

Discharge – volumetric rate of flow in pipe or stream, expressed as a volume per unit time, most commonly cubic feet per second (cfs).

Eutrophic – a water body with high nutrient concentrations and primary biological productivity. Eutrophic lakes have murky water and an extensive macrophyte population. Algal blooms are common.

Event Flow – any discharge generated by a storm, snowmelt, or illicit discharge event.

Flow-weighted concentration – the total pollutant load divided by total flow, often expressed as mg/L.

Grab sample – a water sample that is obtained by taking a single sample.

Hardness – the concentration of calcium and magnesium salts (e.g. calcium carbonate, magnesium carbonate) in a water sample.

Illicit Discharge – any discharge to the municipal separate storm sewer system that is not composed entirely of stormwater, except for discharges allowed under a NPDES permit or water used for firefighting operations (EPA).

Impaired Waters – waters that are not meeting their designated uses because of excess pollutants violating water quality standards.

Impervious surface – a surface covered by materials that are impenetrable by water. These are primarily artificial structures, such as pavements and rooftops.

Load – the total amount of pollutant, often expressed in lbs or kg.

Normalized Pollutant Yield – this normalized yield accounts for temporal and spatial precipitation differences by dividing the pollutant yield by the number of inches of water runoff (water yield) in a subwatershed over a given period of time. It is expressed as pounds per acre per inch of runoff.

Stormflow – water flowing through the pipe during storm events resulting from precipitation. Storm flow usually occurs for a short amount of time, and has a high velocity.

Stormwater – water that becomes runoff during a precipitation event.

Subwatershed – a delineated area of land within a larger watershed where surface waters and runoff drain to a single point before ultimately discharging from the encompassing watershed.

Total Maximum Daily Load – the maximum amount of a substance that can be received by a water body while still meeting water quality standards. This may also refer to the allocation of acceptable portions of this load to different sources.

Turbidity – a measure of the relative clarity of a liquid. Turbidity measurements can provide a simple indicator of potential pollution in a sample. Turbid water will appear cloudy or hazy.

Watershed – a delineated area of land where surface waters and runoff drain to a single point at a lower elevation.

Yield – the amount of pollutant produced per land area, often expressed as lbs/acre or kg/ha.

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1 EXECUTIVE SUMMARY

1.1 CAPITOL REGION WATERSHED DISTRICT

The Capitol Region Watershed District (CRWD) represents a small urban watershed nested in the Upper Mississippi River basin, located entirely in Ramsey County, Minnesota. All runoff from the watershed eventually discharges to the Mississippi River along a 13-mile reach in St. Paul, Minnesota through 42 storm tunnel outfall pipes. All surface water and stormwater runoff in the watershed is managed by CRWD, a special purpose unit of government founded in 1998 with the goal of managing, protecting, and improving all water resources within the watershed. CRWD contains portions of five cities, including: Falcon Heights, Lauderdale, Maplewood, Roseville, and Saint Paul (Figure 2-1). CRWD is highly developed and urbanized with a population of 245,000 and 42%+ impervious surfaces.

1.2 PURPOSE OF REPORT

A goal of CRWD is to understand and address the presence of stormwater pollutants and their impacts on water quality within the District in order to better protect and manage local water resources. Therefore, CRWD established a monitoring program in 2004 to: (1) identify water quality problem areas; (2) quantify subwatershed runoff pollutant loadings; (3) evaluate the effectiveness of stormwater best management practices (BMPs); (4) provide data for the calibration of hydrologic, hydraulic, and water quality models; and (5) promote understanding of District water resources and water quality. To achieve these objectives, CRWD collects continuous flow data and stormwater quality data from major subwatersheds, lakes, ponds, and stormwater BMPs.

This annual report presents the stormwater quality and quantity data collected during the 2015 monitoring year (January 1, 2015 to December 31, 2015) and provides analysis of results for all monitored subwatersheds. The purpose of this report is to use the data to characterize overall watershed health and water quality trends over time, which in turn will inform management decisions for continued improvement of District water resources. Previous annual stormwater monitoring reports (2005-2014) are available on the CRWD website (www.capitolregionwd.org).

1.3 STORMWATER MONITORING METHODS

Within CRWD, there are sixteen major subwatersheds, seven of which are currently monitored for water quantity and quality (Como, East Kittsondale, Hidden Falls, McCarrons, Phalen Creek, St. Anthony Park, and Trout Brook). Within the seven monitored subwatersheds, CRWD collected water quality and/or quantity data at nineteen monitoring sites in 2015, including: ten “full water quality” stations with automatic samplers and water level and velocity sensors; three

“flow-only” stations with water level and velocity sensors; and four water level sites. In addition, six precipitation gauges collected rainfall data across the watershed.

Samples were collected during baseflow, stormflow, and snowmelt periods and were analyzed to determine pollutant concentrations for a suite of water quality parameters including nutrients, sediment, metals, and bacteria. At each monitoring site, the flow data and pollutant concentrations data were used to calculate total annual pollutant loads and yields from each subwatershed.

1.4 2015 MONITORING RESULTS & CONCLUSIONS

1.4.1 CLIMATOLOGICAL RESULTS

The total amount of precipitation for the 2015 calendar year was 35.21 inches, which was 4.60 inches greater than the 30-year normal. The snowpack was minimal in winter 2015 with 34.31 inches, which was 20.1 inches less than the 30-year normal. July 2015 was the wettest month of 2015, capturing the two largest storms recorded for the year: 1.95 inches on July 6 and 1.97 inches on July 12. Only two summer months of May and July were above the monthly normal value for precipitation by 1.71 inches and 2.19 inches, respectively. Also, all months from September to December recorded precipitation totals above the monthly normal values. An abnormal 1.73 inch storm on November 11 was recorded as the fifth largest daily precipitation value for November in state records. The wet months in 2015 generated the majority of stormflow and pollutant loading from all CRWD subwatersheds.

1.4.2 DISCHARGE RESULTS

For discharge, the Trout Brook subwatershed exported the greatest amount of water (516,898,878 cf) in 2015 because it has the largest drainage area in CRWD (5,028 acres). Trout Brook subwatershed also recorded the greatest volume of total annual baseflow (454,737,971 cf) due to its large drainage area and connection to groundwater and surface waters (e.g. Como Lake, Lake McCarrons, Arlington-Jackson Pond). For total annual water yield, Trout Brook-West Branch recorded the highest (136,582 cf/ac) in comparison to all other continuously monitored stations in 2015. For the seasonally monitored stations, Villa Park had the highest annual water yield (18,780 cf/ac), which is due to the presence of baseflow (unlike Como 3 or Como 7).

1.4.3 POLLUTANT LOAD RESULTS

At the stations with continuous monitoring (East Kittsondale, Phalen Creek, St. Anthony Park, Trout Brook-East Branch, Trout Brook-West Branch, and Trout Brook Outlet), event flow was the largest contributor to the annual total suspended solids (TSS) load in 2015, even though baseflow accounted for the majority of the total discharge. Of the continuously monitored stations, Trout Brook Outlet had the largest total annual TSS load (2,692,807 lbs) in 2015. For the seasonally monitored stations, the Como 3 subwatershed had the largest total annual TSS load (39,398 lbs), which was all transported by event flow. Trout Brook-West Branch exported the highest annual TSS load on a per acre basis in 2015 (1,059 lbs/ac).

The majority of total phosphorus (TP) loads at all monitored subwatersheds in 2015 was the result of event flow, even though baseflow accounted for the majority or a large portion of the total discharge. For the continuously monitored stations, Trout Brook Outlet exported the largest total annual TP load (4,951 lbs) in 2015. For seasonally monitored stations, Villa Park had the largest total annual TP load (203 lbs). Trout Brook-West Branch exported the highest annual TP yield on a per acre basis in 2015 (1.46 lbs/ac).

1.4.4 METALS RESULTS

In 2015, the average storm concentrations of lead at all stations (except Villa Park) exceeded the Minnesota Pollution Control Agency (MPCA) toxicity standards. Also, the average storm concentrations of copper at all stations (except Trout Brook-East Branch and Villa Park) exceeded the MPCA toxicity standards. Average storm concentrations of zinc exceeded the toxicity standard at East Kittsondale, Phalen Creek, St. Anthony Park, Como 3, and Como 7. For all stations, average toxicity of cadmium, chromium, and nickel for all flow types (base, snowmelt, storm, and yearly) did not exceed the MPCA toxicity standards in 2015.

1.4.5 BACTERIA RESULTS

Bacteria levels during 2015 stormflow events exceeded the MPCA *E. coli* maximum numeric standard (1,260 cfu/100 mL) for the majority (88%) of samples at all stations. The highest bacteria count observed was at Como 7 on 7/6/15 with 1,119,900 cfu/100 mL. Baseflow bacteria samples typically did not exceed the MPCA surface water maximum numeric standard in 2015, with the exception of some occurrences (East Kittsondale, Hidden Falls, Phalen Creek, Trout Brook-East Branch, and Trout Brook-West Branch).

1.4.6 WATER QUALITY COMPARISONS TO WATER BODIES AND STANDARDS

CRWD stormwater concentrations and yields were compared to local surface waters for points of comparison, though it is acknowledged that water flowing in natural stream channels has a different composition than stormwater. Results showed CRWD stormwater runoff to be significantly more concentrated in pollutants than the Mississippi River at Lamberts Landing in Saint Paul in 2015. Average concentrations for TP, TSS, and ammonia observed at CRWD subwatershed outlets all exceeded Lambert's Landing and the State standards for the Mississippi River Navigational Pool 2.

The 2015 median stormwater concentrations for nutrients, solids, metals, and bacteria were compared to other urbanized areas in the United States using data reported in the National Stormwater Quality Database (NSQD). When comparing to NSQD's mixed residential land use category, most CRWD monitored subwatersheds exceeded median stormwater concentrations for TSS, TP, and *E. coli*.

1.5 2016 RECOMMENDATIONS

Based on the results and findings of the *2015 Stormwater Monitoring Report*, CRWD has several goals and recommendations for 2016 to continue improving the monitoring program and the water quantity and quality dataset. Specifically, CRWD aims to complete the following in 2016:

- Change reporting approach to better serve the needs of the District, such as:
    - Improve accessibility to data and results;
    - Simplify presentation of data and results for increased understanding;
    - Provide meaningful analysis to better characterize subwatersheds and identify trends;
    - Create short technical memos that focus data analysis towards research that supports other District projects and programs.
- Establish solar power at remote monitoring stations for continuous power.
- At stations with solar power, implement remote data access for two-way communication to remote stations.
- Develop and implement a CRWD Monitoring Quality Assurance Program Plan (QAPP) in to ensure data quality.
- Enhance partnerships with the City of Saint Paul, Ramsey County, other local urban watershed districts, and research groups (e.g. University of Minnesota) to broaden our understanding of urban hydrology and pollutant loading.
- Document illicit discharges throughout the watershed and work with District municipalities to eliminate other potential sources of pollution.
- Consider analyzing water quality samples for additional parameters not currently analyzed, such as: bacteria/microbial source tracking, oil/grease, trash, PAHs, contaminants of emerging concern.

2 INTRODUCTION

2.1 CRWD BACKGROUND

The Capitol Region Watershed District (CRWD) represents a small urban watershed nested in the Upper Mississippi River basin, located entirely in Ramsey County, Minnesota (Figure 2-1). All runoff from the watershed eventually discharges to the Mississippi River along a 13-mile reach in St. Paul, Minnesota through 42 storm tunnel outfall pipes. All surface water and stormwater runoff in the watershed is managed by CRWD, a special purpose unit of government founded in 1998 with the goal of managing, protecting, and improving all water resources within the watershed. CRWD contains portions of five cities, including: Falcon Heights, Lauderdale, Maplewood, Roseville, and Saint Paul (Figure 2-1). CRWD is highly developed and urbanized with a population of 245,000 and 42%+ impervious surfaces. Land use in CRWD is primarily residential and commercial with areas of industrial use and parkland.

2.2 CRWD WATER QUALITY CONCERNS

Over time, urban development and anthropogenic activity in the watershed have significantly impacted the water quality of the Mississippi River and CRWD lakes, ponds, wetlands, and streams. The expansion of impervious surfaces (streets, sidewalks, parking lots, roofs) through development has increased stormwater runoff from the landscape, which carries polluted water to local water bodies, subsequently declining water quality. Additionally, higher volumes of runoff causes increased storm peak flows, greater potential for local flooding, decreased groundwater recharge, and the degradation of biological habitat in water bodies. Stormwater runoff from impervious surfaces can carry nutrients, sediment, fertilizers, pesticides, bacteria, heavy metals, and other contaminants of concern, which is why it is the most significant source of pollution to CRWD water resources. In CRWD, all stormwater runoff within the watershed boundaries is collected and conveyed through an extensive network of underground storm sewer pipes that eventually drain to the Mississippi River.

Both historical and current water quality data of CRWD lakes, ponds, and the Mississippi River indicate that these water bodies are impaired for various pollutants including nutrients, turbidity, metals, bacteria, and/or chloride and are not meeting the standards for their designated uses of fishing, aquatic habitat, and recreation. The Mississippi River and Como Lake are listed on the Minnesota Pollution Control Agency's (MPCA) 2012 303(d) list of impaired waters (MPCA, 2012a) and the 2014 Proposed Impaired Waters List (MPCA, 2015). Water bodies identified as impaired require a total maximum daily load (TMDL) study for pollutants of concern.

The nutrient of primary concern in CRWD is phosphorus. Phosphorus is the biological nutrient which limits the growth of algae in most freshwater ecosystems and is often found in high concentrations in stormwater. Phosphorus is naturally present in all water bodies, but in high concentrations can cause the overgrowth of algae and aquatic plants in freshwater lakes and rivers. This can reduce dissolved oxygen and increase turbidity of the water column. Common

sources of phosphorous include fertilizers, leaves and grass clippings, pet and wildlife waste, atmospheric deposition, septic and sanitary seepage, and wastewater treatment plant discharges.

Sediment is another major constituent of stormwater runoff. Excessive amounts of sediment can reduce water clarity, bury benthic aquatic habitat, and damage fish gills. The reduction or removal of sediment from stormwater is essential because other pollutants, such as phosphorus, adhere to sediment particles and are transported in suspension. Sediment originates from erosion of soil particles from construction sites, lawns, stream banks, and lake shores as well as sand application to roadways and parking lots for traction in the winter.

Heavy metals, such as lead and copper, are also pollutants of concern in CRWD because they can be toxic in high concentrations. Also, heavy metals can bioaccumulate in organisms, which is of concern to wildlife and humans. Potential sources of metals from road surface runoff include roofs, auto exhaust, tire wear, brakes, and some winter de-icing agents.

Pathogens, which include bacteria and viruses, also contribute to the water quality degradation of CRWD water resources. They impact recreation and pose potential health risks to humans. Sources of pathogens include illicit sanitary connections to storm drains and animal waste.

Chloride in water bodies is a contaminant of growing concern for CRWD. High concentrations of chloride can harm fish and plant life by creating a saline environment. Also, once in dissolved form, chloride cannot be removed from a water body. Chloride is primarily sourced from road salt application for de-icing in the winter months.

2.3 CRWD MONITORING GOALS

CRWD was formed to understand and address water quality impacts and to better protect and manage local water resources. In 2004, CRWD established a monitoring program to assess water quality and quantity of various District subwatersheds and stormwater best management practices (BMPs). Prior to the CRWD monitoring program, limited data was available on stormwater quantity and quality in the watershed. The objectives of the program are to identify water quality problem areas, quantify subwatershed runoff pollutant loadings, evaluate the effectiveness of BMPs, provide data for the calibration of hydrologic, hydraulic, and water quality models, and promote understanding of District water resources and water quality.

CRWD collects water quality and continuous flow data from major subwatersheds, stormwater ponds, lakes, and stormwater BMPs. There are sixteen major subwatersheds in CRWD and monitoring is conducted in seven major subwatersheds (Figure 2-1), including: Como, East Kittsondale, Hidden Falls, McCarrons, Phalen Creek, St. Anthony Park, and Trout Brook. Five of the major subwatershed sites monitored by CRWD directly outlet to the Mississippi River.

The *2015 CRWD Stormwater Monitoring Report* presents results of annual stormwater quantity and quality data for major CRWD subwatersheds and stormwater ponds. Previous annual monitoring reports (2005-2014) are available on the CRWD website (www.capitolregionwd.org). Results and analysis of CRWD lakes and stormwater BMPs are discussed in separate reports (CRWD, 2016; CRWD, 2012), which are also available on the CRWD website.

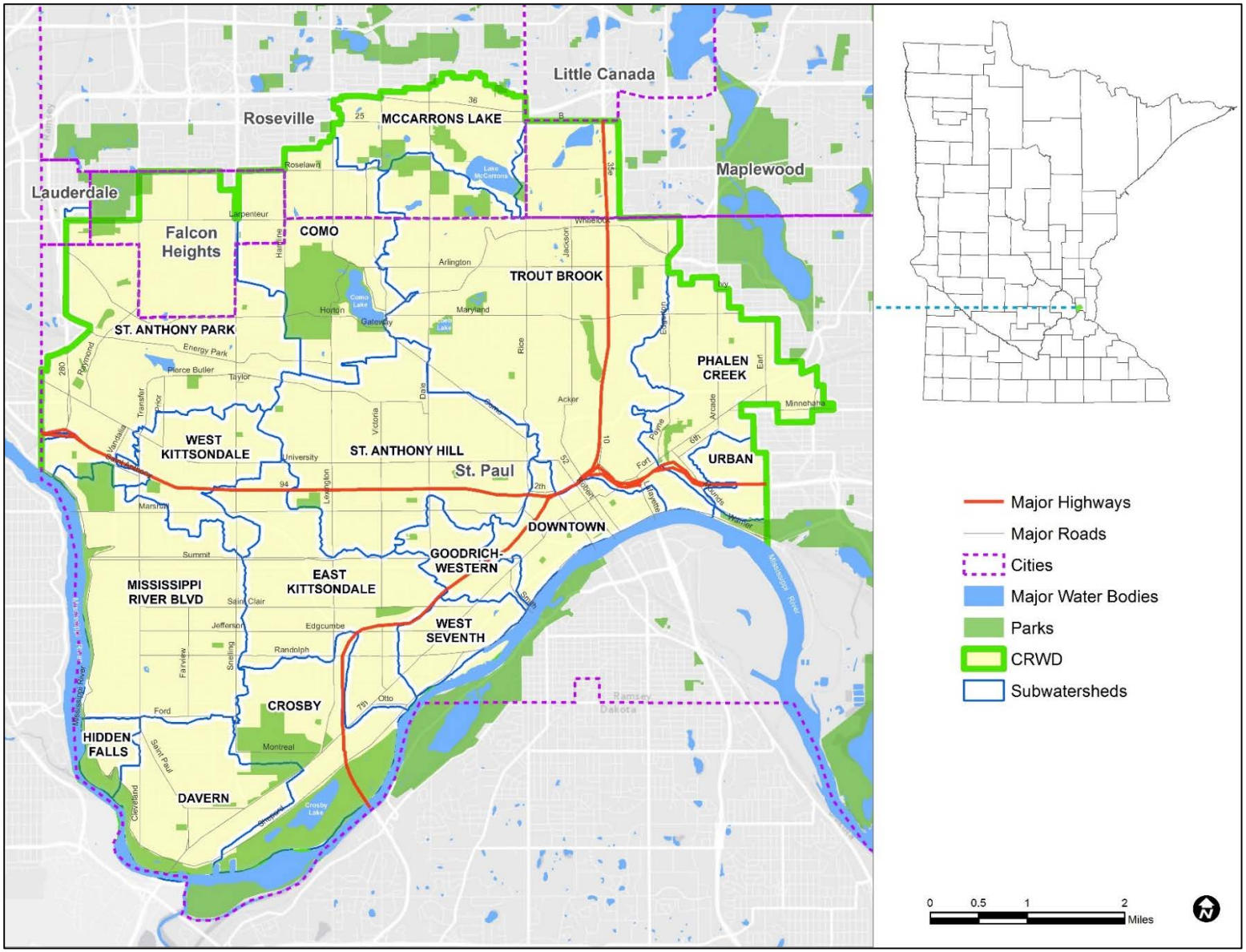

Figure 2-1: Capitol Region Watershed District in Ramsey County, Minnesota.

3 METHODS

3.1 MONITORING LOCATIONS

In 2015, CRWD collected 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 3-1). Additionally, six precipitation gauges collected rainfall data across the watershed.

At each full water quality station, both water quality and quantity data were collected. The ten full water quality stations, their locations, and a description of each are detailed in Table 3-1 and Figure 3-1.

Table 3-1: CRWD 2015 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 3-1, 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 was 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 3-1).

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 3-1). 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 3-2: CRWD 2015 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)

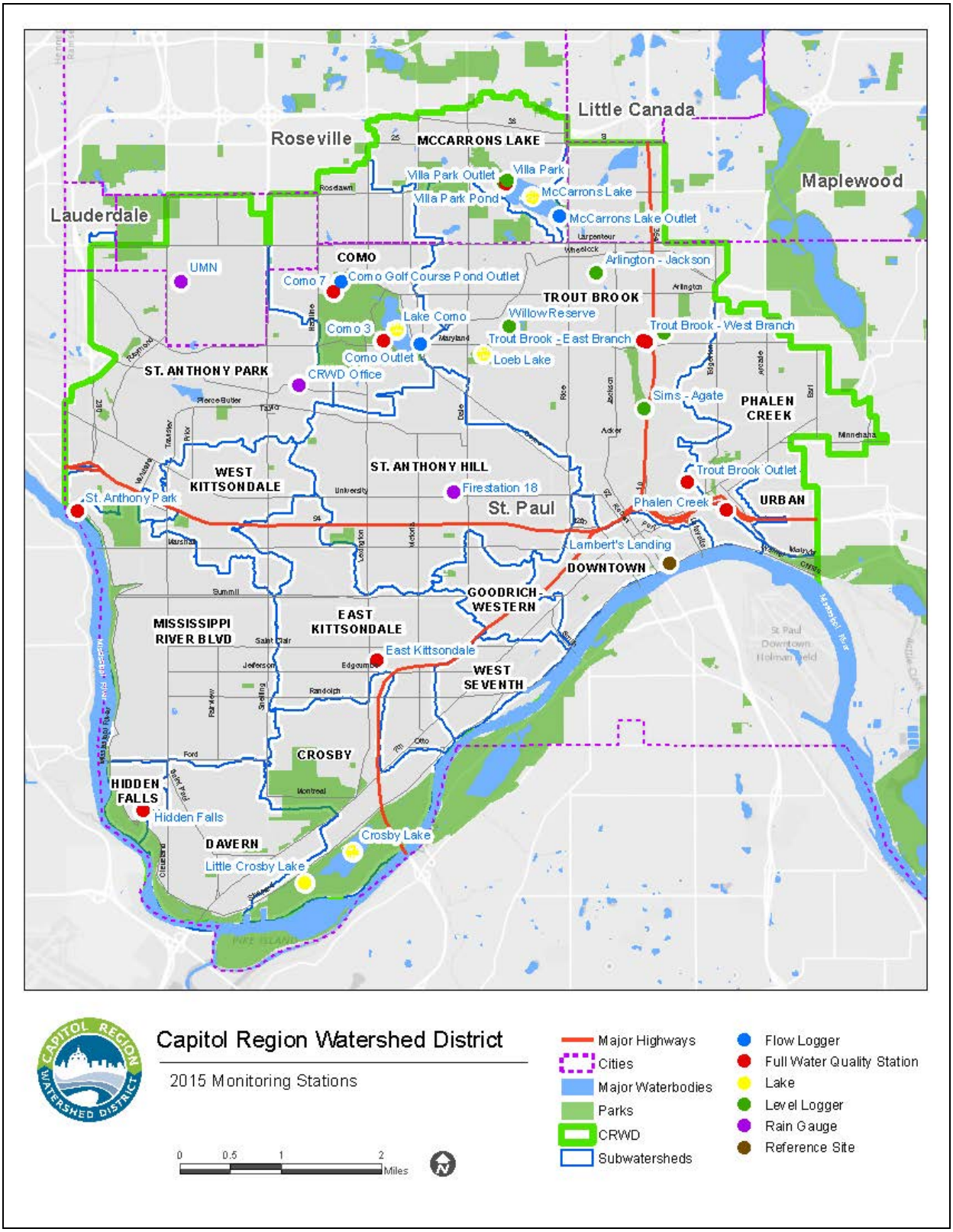

Figure 3-1: 2015 Monitoring locations by station type.

3.2 MONITORING METHODS AND ANALYSIS

3.2.1 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) were monitored continuously in 2015 (January 1 through December 31). Each station had 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 were generally operational from April to November 2015 (seasonally monitored stations). Table 3-3 lists the periods of station operation from install to uninstall for 2015.

Table 3-3: Time Periods of operation for 2015 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.

3.2.2 FULL WATER QUALITY STATIONS

Full water quality stations in 2015 consisted of an area-velocity sensor and an automated water sampler. The area-velocity sensors were secured to the base and center of the pipe or channel and were connected to the automated water sampler housed above ground. Area-velocity sensors measured and recorded water depth and velocity every 5 or 15 minutes. This data was 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 reached a specified depth or velocity, the sampler engaged to collect water samples. Generally, samplers were programmed to capture storm events greater than or equal to the 0.5 inch precipitation event. Two different sampler sizes were 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 was collected after a specified volume of water passed through the station in order to collect samples over the entire hydrograph. These individual samples were 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 were first shaken until the sampled water became homogenous. The sample bottles were 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 were distributed to a sample bottle provided by the Metropolitan Council Environmental Services (MCES) Laboratory.

Water quality samples were collected during storm events at the ten full water quality stations. With the exception of Como 7 and Como 3, monitoring stations had continuous baseflow during dry weather periods. Composite samples of dry weather baseflow were 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*) were taken at all full water quality stations during storm events when runoff was generated, and staff were able to visit the stations. At stations with baseflow, bacteria base grab samples were collected once a month. When collected, bacteria grab samples for *E. coli* were 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 were delivered to the Metropolitan Council Environmental Services (MCES) Laboratory for analysis. The chemical parameters, method of analysis, and holding times are listed in Table 3-4. If the lab analysis occurred after the holding time of a given chemical parameter had expired, that chemical parameter was not analyzed.

Table 3-4: 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

3.2.3 FLOW-ONLY AND LEVEL LOGGER STATIONS

The outlet of Como Lake is regulated by a wooden weir in a manhole. A level sensor was placed on the upstream side of the weir. When the level recorded exceeded the distance between the sensor and the weir, the structure was discharging. The volume was 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 collected and recorded water depth and velocity every fifteen minutes. This data was used to calculate discharge at the station with the known pipe dimensions.

Level logger stations were 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 was secured at a known depth in the pond and connected to a data logger which continuously recorded stage every ten minutes. The logger

locations were surveyed relative to a known benchmark in order to convert stage data to a true elevation.

3.2.4 PRECIPITATION STATIONS

Precipitation was 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 used automatic tipping bucket rain gauges which record precipitation amounts continuously during storm events in order to determine rainfall intensity. Manual rain gauges were used at the CRWD office and Villa Park. The manual rain gauge at the CRWD office was checked and emptied each workday at 7:30 AM. The manual rain gauge at Villa Park was checked and emptied after every storm event.

Precipitation data, recorded every 15 minutes at the UMN St. Paul campus, was 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 was 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.

3.2.5 MONITORING DATA QUALITY ASSURANCE

Full water quality stations that were installed for the entire year in 2015 collected data for an average of 352 days. CRWD achieved an average monitoring efficiency of 97% at the continuously monitored full water quality stations in 2015, meaning that 97% of all potential data was collected during the calendar year (Appendix B; Table B-1). Missing data accounted for the remaining 3% and was due to equipment failure or power failure. Monitoring at Villa Park, Hidden Falls, Como 3 and Como 7 was 100% efficient during the periods they were installed from March to November 2015. All level logger and flow only stations were 100% efficient for the period they were installed with the exception of Como Golf Course Pond Outlet, which achieved 96% efficiency.

After the 2015 monitoring season was complete, flow data was quality checked and corrected by removing points with missing data or bad values and interpolating their values between good data points. If there were extended periods of missing or bad data no interpolation was performed and the data was left as missing. For storm events where velocity did not log accurately, but level was still logged, a stage to velocity relationship was developed using level and velocity data from good periods of stormflow record. The relationship was then used to calculate an approximation of velocity for those periods of missing data. If this was not possible, the data was left as missing and not factored into discharge calculations.

The 2015 water quality sample data reported by the MCES lab was also rigorously checked for quality. The reported sample times and dates were compared with field notes as well as the lab chain of custody forms. Any abnormally high or low sample values were denoted and cross-checked with field notes and other parameters from the same sample to ensure the parameter

value was commensurate with the conditions of the day in which the sample was taken. Sample concentration results that were identified as non-representative due to collection error or were reported incorrectly from the lab were considered outliers and removed from event load calculations.

3.2.6 TOTAL DISCHARGE AND POLLUTANT LOAD CALCULATIONS

For all full water quality monitoring stations, the stage, velocity, and water quality data collected were used to calculate total discharge and pollutant loads for total phosphorus (TP) and total suspended solids (TSS). Discharge and pollutant loads were calculated for each storm, snowmelt, and illicit discharge event at all stations. For stations with baseflow, monthly TP and TSS loads were 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 2015 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. In 2015 no water quality samples were collected at the Como Golf Course Pond station. Loads were estimated using historical monthly median concentrations from the period of record. Analysis of the combined Como 7 and Como Golf Course Pond station data was 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 was 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.

In 2015, total discharge and pollutant load calculations for all stations were performed in Kisters WISKI (Version 7.4.3) 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 2015 final flow data for each station was separated into base and event (storm, snowmelt, illicit discharge) discharge. For stations without sustained baseflow, all events corresponding to a precipitation event were considered event intervals. For stations with year-round baseflow, separation of event flow and baseflow was necessary. Events were identified using an automated script in WISKI, which took into account the rate of change in the hydrograph and a threshold above baseflow in the preceding period. Baseflow was considered continuous (but not constant) during storm events. Baseflow was 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 was subtracted from the total interval discharge to determine the event discharge volume.

The total discharge for each interval was calculated using WISKI to integrate the flow rate data for baseflow and event flow. Discharge volumes were summed to calculate a total discharge for the 2015 monitoring period. Discharge subtotals were also calculated by flow type (base and event) for the monitoring period.

The method of baseflow and event flow separation described above is different from methods used prior to 2014. Prior to 2014, baseflow was unaccounted for during events. This resulted in higher annual event flow and lower annual baseflow.

Overall, the total annual loads and discharges that were calculated for 2015 are largely unaffected by the new 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 for 2014 and 2015 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) were used to calculate TP and TSS loads for each sampled event. A median historical monthly concentration was applied to events for which samples were not collected. The median concentration was 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 were 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) was 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 was sampled or the historical monthly median storm concentration if the event was 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 were calculated on a monthly basis using historical monthly median baseflow concentrations. Baseflow samples collected in 2015 were included in the historical median calculations.

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

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

3.2.7 FLOW WEIGHTED AVERAGE (FWA) CONCENTRATION CALCULATIONS

A total flow weighted average (FWA) concentration, as well as a FWA concentration for each flow type, was calculated for TP and TSS for the entire monitoring period in 2015. 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 were 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 were calculated by dividing the total load associated with a given flow type by the total discharge associated with the flow type:

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

3.2.8 POLLUTANT YIELD

Annual yields for TP and TSS in pounds per acre (lb/ac) were 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:

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

3.2.9 CUMULATIVE DISCHARGE

Cumulative plots for total discharge were 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.

3.2.10 METAL TOXICITY

The toxicity of a metal is a function of water hardness. For CRWD watersheds, the chronic toxicity standard is used, as defined in Minnesota Rules 7050.0222 for each of the 6 metals (Cr, Cd, Cu, Pb, Ni, and Zn). Equations for the chronic standard for each metal in μg/L are listed in Appendix A. Average 2015 metal concentrations from event flow and baseflow were compared to the chronic standard (Table A-1).

3.2.11 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 3-5).

TP and TSS Standards

Because the MPCA has not established stormwater standards for TSS and TP, the data was 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 5-5). Additionally, the TSS values were compared against the South Metro Mississippi Total Suspended Solids TMDL, and the TP values were compared against the Lake Pepin Excess Nutrient TMDL. When comparing CRWD TP and TSS concentrations to water quality standards, flow-weighted average concentrations were used.

Table 3-5: 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 water hardness; See Appendix B

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

[b] Standard applies to Class 2B waters 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.

Chronic Metals Standards

State water quality standards for chronic exposure to metals are based on a function of hardness as outlined in Minnesota Statute 7050.0222 for Class 2B waters (ORS, 2012). Class 2B waters are waters used for the purpose of aquatic life and recreation that are not protected for drinking water. These standards are set at the lowest concentration of a chemical for which chronic exposure will cause harm to aquatic organisms. In order to make comparisons between CRWD metals data to state standards and other reference locations, calculation of the state standards was completed (Appendix A).

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).

3.2.12 MISSISSIPPI RIVER REFERENCE STATION AND TWIN CITIES METRO-AREA TRIBUTARIES COMPARISONS

In addition to comparing CRWD results to state surface water quality standards, CRWD total TP and TSS FWA concentrations were compared to the average TP and TSS concentrations of the Mississippi River at Lambert's Landing (Table 5-5). MCES monitors the Mississippi River at Lambert's Landing at river mile 839.1, which is downstream from the Wabasha Street Bridge in St. Paul.

3.2.13 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) was extensively reviewed for quality assurance and control and statistical analyses were 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 was compared to the NSQD's mixed residential land use category, which has a median impervious percentage of 34%. Table 3-6 presents the NSQD median data values for the mixed-residential land use category.

Table 3-6: 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

4 CLIMATOLOGICAL SUMMARY

4.1 PRECIPITATION DATA COLLECTION METHODS

CRWD utilizes climatological data collected by the Minnesota Climatology Working Group (MCWG) at the University of Minnesota-St. Paul and National Weather Service (NWS) at the Minneapolis-St. Paul International Airport (MSP) to assist in calculating annual precipitation, runoff, and loading.

MCWG records precipitation every fifteen minutes from an automatic rain gauge located approximately two miles west of the CRWD office. The MCWG rain gauge was used as CRWD's primary precipitation monitoring station for rainfall because of the gauge's close proximity to the District. The data is reported on a public website (http://climate.umn.edu/). Rainfall totals (15-minute and daily) were recorded by CRWD from the MCWG website (MCWG, 2015). Snow and ice totals were not accurately reported by MCWG due to equipment limitations.

The NWS weather station at MSP, located approximately ten miles south of the CRWD office, records many climate variables for each day, including: maximum, minimum, and average temperature; rainfall; snowfall and snow water equivalent; and depth of snowpack. Data is reported on a public website (http://www.weather.gov/mpx/mspclimate). If a snow or ice event occurred, the NWS daily precipitation totals were utilized by CRWD since their measurement equipment more accurately measures snow-water and ice-water equivalents than the MCWG gauge.

4.2 2015 PRECIPITATION RESULTS

Table 4-1 and Figure 4-1 compare the monthly precipitation totals to the 30-year monthly normal (NOAA, 2015). Table 4-2 lists 2015 daily precipitation totals, 2015 monthly precipitation totals, the 30-year monthly normal (1981-2010) (NOAA, 2015), and the 2015 departure from historical monthly normals.

In 2015, NWS data was used for the months of January, February, March, April, November and part of December, as the events during this time period exhibited frozen precipitation (Table 4-2). MCWG data was used for the remaining period (May through October and part of December), as rainfall events occurred during this time.

Annual precipitation data from 2005-2015 was compared to the 30-year normal for the Minneapolis-St. Paul region (Table 4-1; Figure 4-3). The 30-year normal is recalculated every 10 years. In 2010, the 30-year normal was recalculated for 1981-2010 to be 30.61 inches (formerly 29.41 inches (1971-2000)).

The total amount of precipitation recorded in CRWD in 2015 was 35.21 inches, which was 4.60 inches above the 30-year normal (Table 4-1 and 4-2; Figure 4-3). Figure 4-2 is a cumulative precipitation plot for 2015 which shows the total accumulated amount of precipitation throughout the entire year as well as fluctuations in precipitation trends and significant precipitation events. After a dry initial four months of 2015, precipitation steadily increased throughout the remainder of the year, producing a moderately wet summer and a fall with above normal precipitation.

Table 4-1: CRWD annual precipitation totals and departure from the 30-year normal.

Year	Precipitation (inches)[a]	Departure from 30-Year Normal
2005	35.98	(+) 5.37"
2006	31.69	(+) 1.08"
2007	29.72	(-) 0.89"
2008	21.67	(-) 8.94"
2009	23.34	(-) 7.27"
2010	36.32	(+) 5.71"
2011	33.62	(+) 3.01"
2012	30.26	(-) 0.35"
2013	36.36	(+) 5.75"
2014	35.66	(+) 5.05"
2015	35.21	(+) 4.60"
30-Year Normal	30.61	--

[a] Annual precipitation reported by the Minnesota Climatology Working Group (MCWG) and National Weather Service (NWS)

Very little snowfall was recorded from January to March 2015, amounting to only 4% of the total precipitation recorded for 2015. In total, 34.31 inches of snow fell during the winter of 2015, which was 20.1 inches less than the 30-year normal (Table 4-4; Figure 4-4). This resulted in a less robust snowpack which did not contribute as much to spring groundwater recharge and surface runoff as previous winters.

July 2015 was the wettest month of 2015, capturing the two largest storms recorded for the year: 1.95 inches on July 6 and 1.97 inches on July 12. Only two summer months of May and July were above the monthly normal value for precipitation by 1.71 inches and 2.19 inches, respectively.

All months from September to December recorded precipitation totals above the monthly normal values. An abnormal 1.73 inch storm on November 11 was recorded as the fifth largest daily precipitation value for November in state records. This storm and a few other rain events in subsequent weeks caused November to report the most positive departure from the normal monthly temperatures in 2015.

Table 4-2: Daily and monthly precipitation totals for 2015 compared to the 30-year normal.

Day	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	
1	0.00	0.02	0.00	0.26	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.09	
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	
3	0.00	0.06	0.13	0.00	0.25	0.94	0.00	0.00	0.00	0.00	0.00	0.00	
4	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5	0.06	0.00	0.00	0.00	0.01	0.00	0.04	0.00	0.00	0.00	0.01	0.00	
6	0.00	0.00	0.00	0.18	0.00	0.64	1.95	0.22	0.69	0.00	0.00	0.00	
7	0.00	0.00	0.00	0.01	0.66	0.02	0.00	0.27	0.00	0.00	0.00	0.00	
8	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.37	0.00	0.08	
9	0.00	0.00	0.00	0.63	0.00	0.01	0.00	0.11	0.53	0.00	0.00	0.00	
10	0.00	0.13	0.00	0.08	0.79	0.00	0.00	0.00	0.06	0.00	0.00	0.16	
11	0.00	0.01	0.00	0.00	0.20	0.29	0.00	0.00	0.00	0.00	1.73	0.00	
12	0.00	0.00	0.00	0.65	0.07	0.00	1.97	0.00	0.00	0.00	0.37	0.00	
13	0.02	0.00	0.00	0.01	0.00	0.04	0.02	0.06	0.00	0.00	0.00	0.12	
14	0.01	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.63	
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	
16	0.00	0.01	0.00	0.00	0.19	0.01	0.12	0.64	0.08	0.00	0.17	0.37	
17	0.00	0.00	0.00	0.00	0.05	0.11	0.50	0.12	1.27	0.00	1.21	0.00	
18	0.00	0.00	0.00	0.07	0.00	0.00	0.37	0.96	0.34	0.00	0.50	0.00	
19	0.01	0.00	0.00	0.14	0.01	0.00	0.00	0.15	0.00	0.00	0.00	0.00	
20	0.05	0.07	0.00	0.02	0.00	0.43	0.00	0.00	0.05	0.00	0.00	0.00	
21	0.01	0.01	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	
22	0.00	0.00	0.20	0.00	0.00	0.43	0.00	0.34	0.00	0.00	0.00	0.00	
23	0.00	0.00	0.03	0.00	0.02	0.00	0.00	0.00	0.11	1.00	0.00	0.38	
24	0.00	0.01	0.12	0.34	0.53	0.00	0.18	0.00	0.21	0.18	0.00	0.00	
25	0.03	0.02	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.01	0.00	0.00	
26	0.00	0.00	0.00	0.00	0.73	0.00	0.00	0.00	0.00	0.02	0.12	0.09	
27	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.39	0.00	0.00	
28	0.00	0.00	0.00	0.00	0.00	0.11	1.08	0.00	0.02	0.52	0.00	0.21	
29	0.00		0.19	0.00	1.13	0.39	0.00	0.00	0.00	0.05	0.00	0.15	
30	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.41	0.00	
31	0.00		0.00		0.00		0.00	0.00		0.33		0.01	**Total**
Monthly Total	0.34	0.35	0.67	2.42	5.07	3.72	6.23	2.87	3.81	2.89	4.52	2.32	35.21
Monthly Normal	0.90	0.77	1.89	2.66	3.36	4.25	4.04	4.30	3.08	2.43	1.77	1.16	30.61
Departure from Normal	-0.56	-0.42	-1.22	-0.24	1.71	-0.53	2.19	-1.43	0.73	0.46	2.75	1.16	4.60

	Data supplied by NWS-MSP
	Data supplied by UMN Climatological Observatory
	No Date

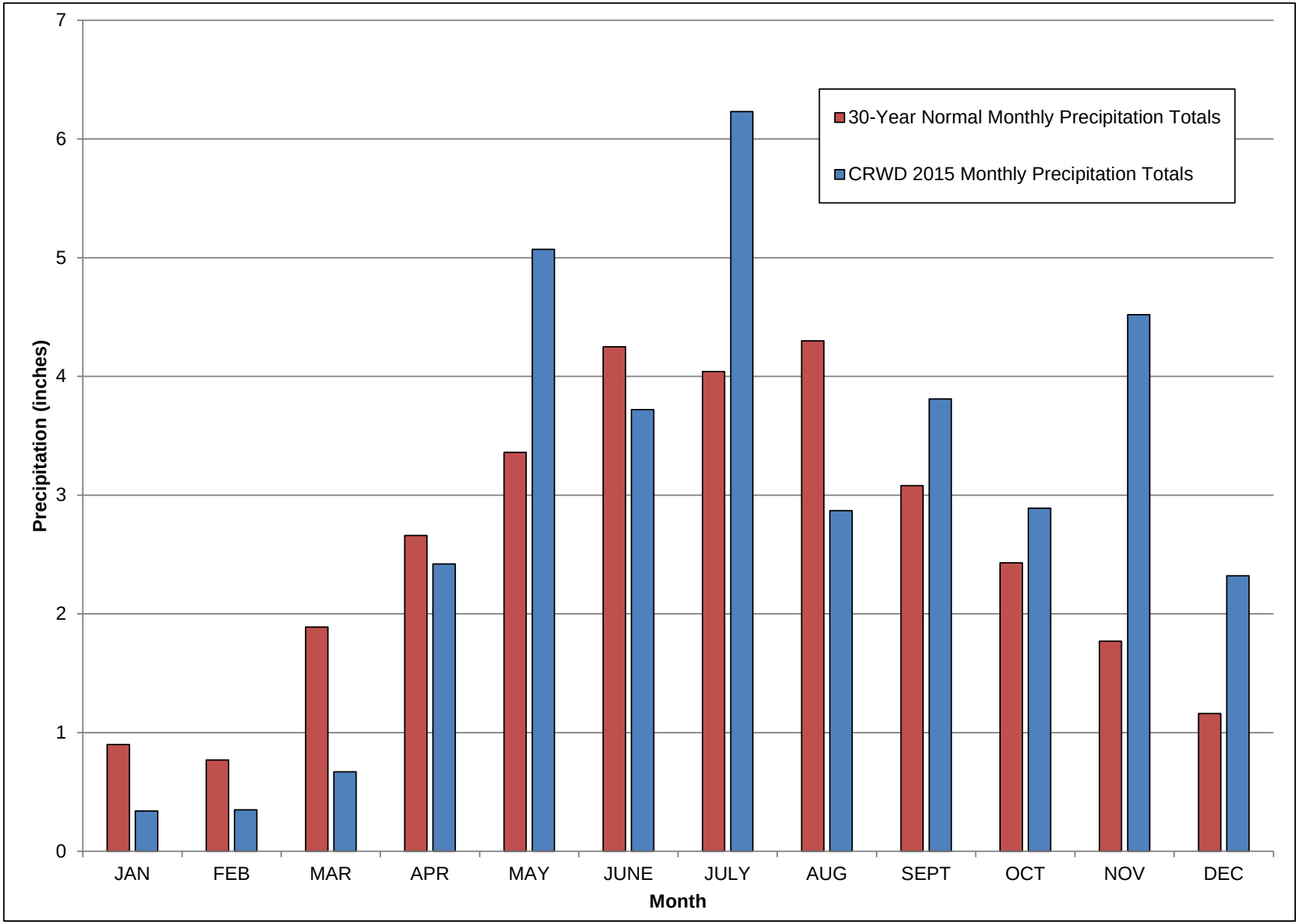

Figure 4-1: 30-year normal and 2015 monthly precipitation totals for CRWD.

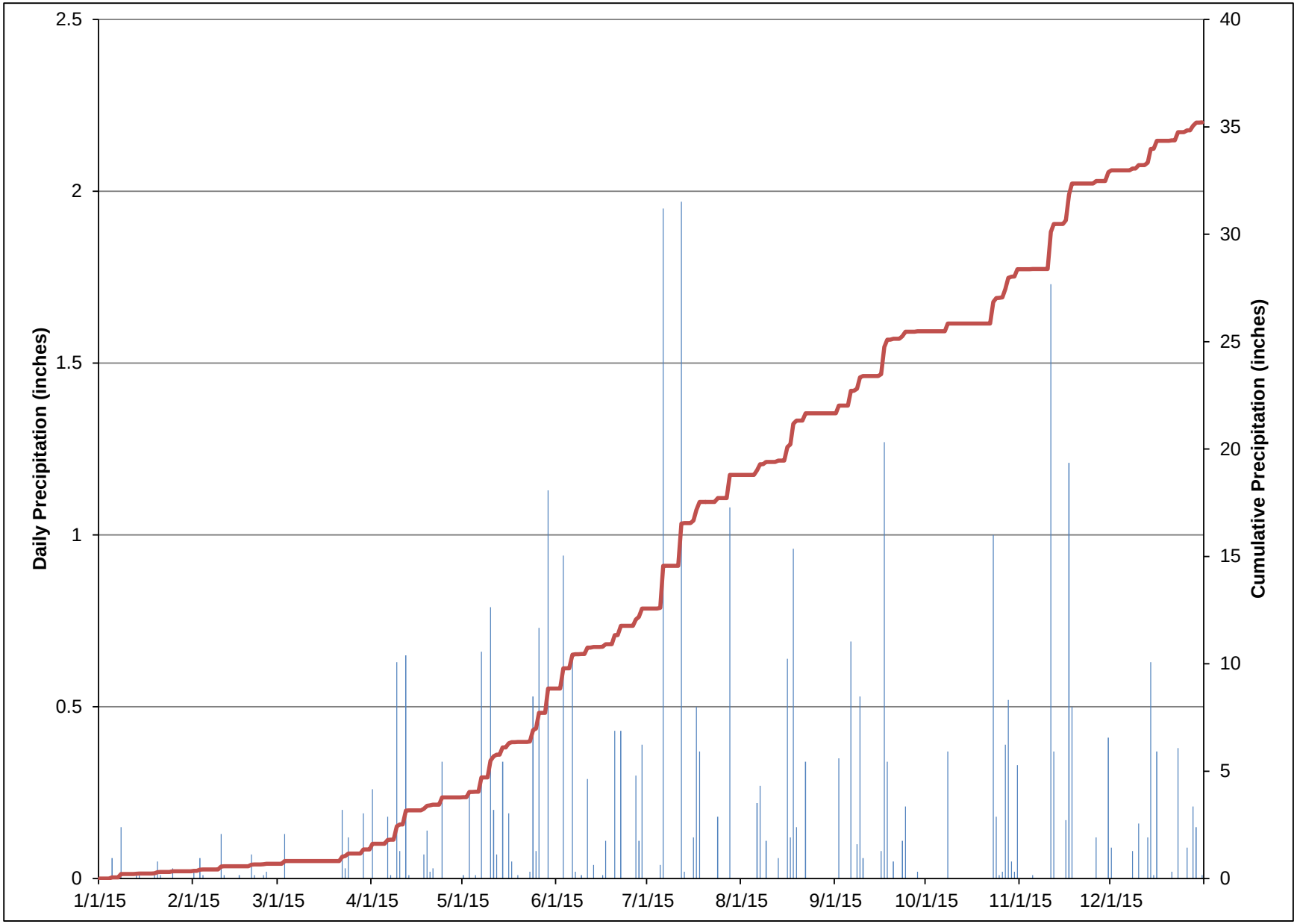

Figure 4-2: Daily precipitation totals and cumulative precipitation for January to December 2015.

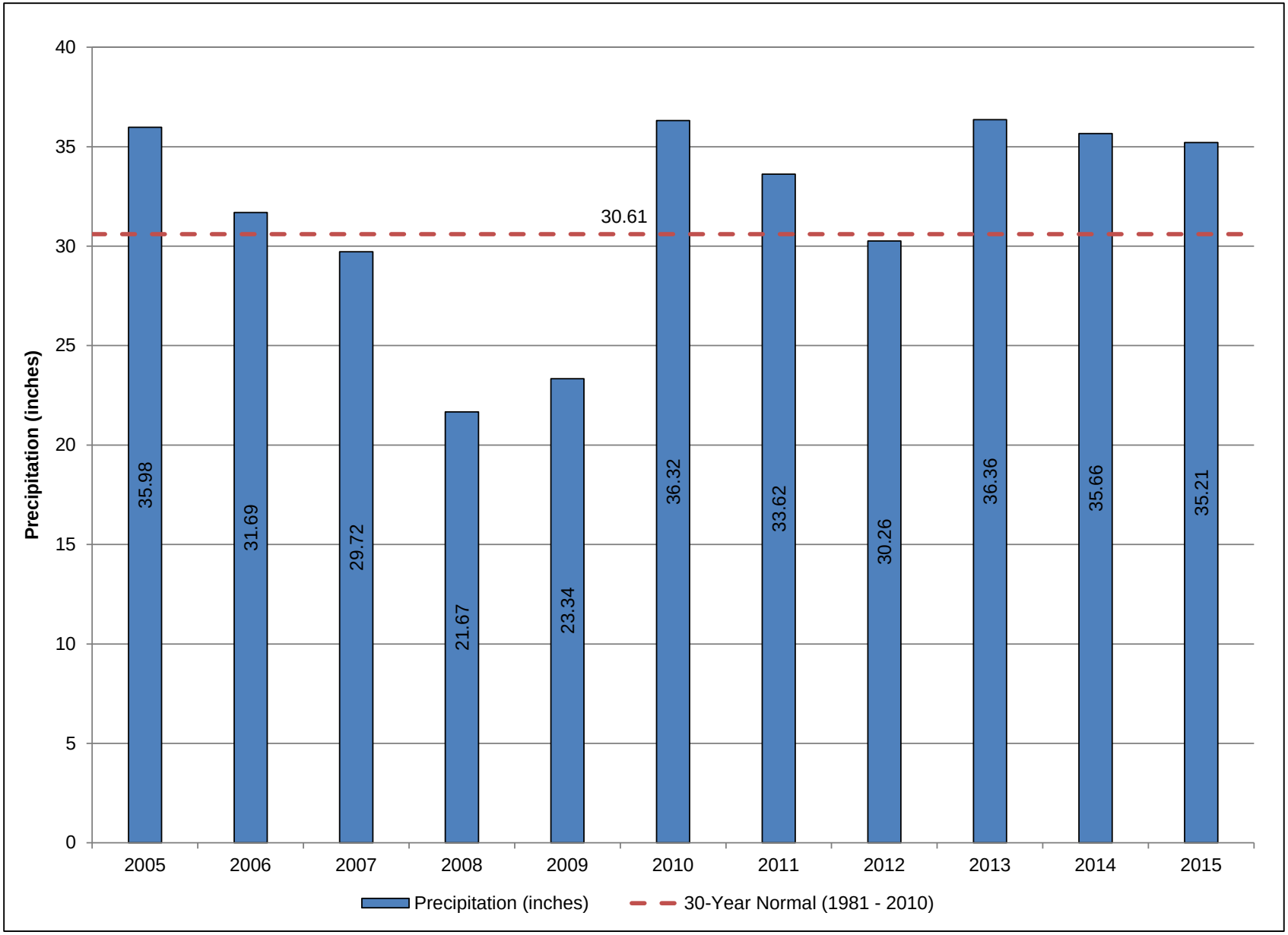

Figure 4-3: Annual precipitation totals (2005-2015) observed in CRWD by MCWG.

4.3 2015 NOTABLE CLIMATOLOGICAL EVENTS

While extrapolated data indicates a rather normal climatic year, 2015 exhibited unique seasonality by beginning with a dry winter, an unseasonably warm spring, and an extremely wet fall. There were very few notable summer rain and winter snow events. Also, the snowpack experienced four complete melt cycles before completely melting for the spring.

Table 4-3 shows the most intense rain events in 15-minute, 1-, 6-, and 24-hour intervals during 2015 as well as the corresponding Atlas 14 precipitation frequency ratings (NOAA, 2016). The precipitation event that occurred on July 12, 2015 produced the most intense 15-minute, 1-, 6-, and 24-hour intervals for the entire year (Table 4-3). During this event, 1.99 inches fell in 2.5 hours, with three 15-minute intervals recording over a quarter-inch of rain. When observed on a 1-hour interval, the July 12 storm categorized as a five-year rain event.

Table 4-3: Rainfall intensity statistics for 2015 from MCWG rain gauge data.

Rainfall Intensity			Atlas 14 Rating
Time Period	Date & Event End Time	Amount (in)	Frequency (yr)
15-minute	7/12/15 22:45	0.78	2
	7/17/15 0:00	0.5	1
	7/28/15 6:15	0.44	1
1-hour	7/12/15 23:00	1.7	5
	7/28/15 6:45	0.95	1
	7/18/15 0:45	0.73	1
6-Hour	7/13/15 0:30	1.99	1
	7/6/15 6:00	1.69	1
	11/11/15 21:15	1.56	1
24-Hour	7/6/15 12:00	1.99	1
	7/13/15 0:30	1.99	1
	11/11/15 22:45	1.79	1

Snowpack in CRWD was a less significant climatic variable in 2015 than in previous years. The 2015 snowfall total of 34.31 inches measured at MSP was 20.1 inches lower than the 30-year normal of 54.5 inches (Table 4-4). The last date with a 1 inch snowpack measured at MSP was March 25 (NWS, 2015), 8 days earlier than the normal date of March 31 (DNR, 2015) (Figure 4-4).

Daily snowpack depths recorded at MSP were plotted against daily high temperature in Figure 4-4 (NWS, 2015). Three distinct periods of complete melt were observed from January 26 to March 1, each reset by three snowfall events. Another extensive melt period lasted from March 4 to March 22, during which temperatures rose to 70 degrees F. A four inch snowfall event occurred on March 23, resulting in a three day period of snowpack before melting away permanently for the spring. Snowpack reached a maximum depth of 5 inches on January 9, and

only stayed at a depth of 4 inches for a total of 8 days. Significant snowfall events for the year occurred on January 8 (3.0 inches) and March 22 (3.1 inches).

Snowmelt is a significant driver of hydrology in late winter and early spring and is dependent upon many factors such as the amount of snowpack and temperature. Snowpack levels remained at seasonally low levels as a result of record high spring temperatures and an overall lack of precipitation early in the winter months. Therefore, there was little hydrological storage on the landscape to contribute to spring snowmelt and runoff.

Table 4-4: Summary of 2015 climatological events in CRWD.

2015 Climate Summary			
Variable	**2015**	**Average**	**Notes**
Total Precipitation (inches)	35.21	30.61	4.60" higher than 30-yr normal
Total Snow (inches)	34.31	54.4	20.1" lower than 30-yr normal
Last Significant Snowfall	3/24 (1.2")	N/A	Variable - No data on averages
Last Spring date with greater than 1" snowpack	3/25	4/2	8 days earlier than normal
Spring Ice Out	3/27	4/5	9 days earlier than normal
Fall Leaf Off	10/21	N/A	Later than normal

With record high March temperatures, ice out on CRWD lakes occurred generally one week earlier than normal in 2015. Historical median ice out dates have not been established for any of the five CRWD lakes, nor were any observations made by CRWD on the lakes in 2014 (DNR, 2016a; DNR, 2016b). However, the DNR has collected annual and historical median ice out dates for lakes nearby CRWD, including the five observed in Table 4-5.

Table 4-5: Summary of ice out dates for Twin Cities lakes nearby CRWD (DNR, 2016a; DNR, 2016b).

Lake Name	2015 Ice Out Date	Historical Median Ice Out Date
Lake Nokomis	March 25	April 5
Powderhorn Lake	March 25	April 4
Lake Josephine	N/A	April 7
Lake Owasso	N/A	April 6
Lake Phalen	April 1	April 5

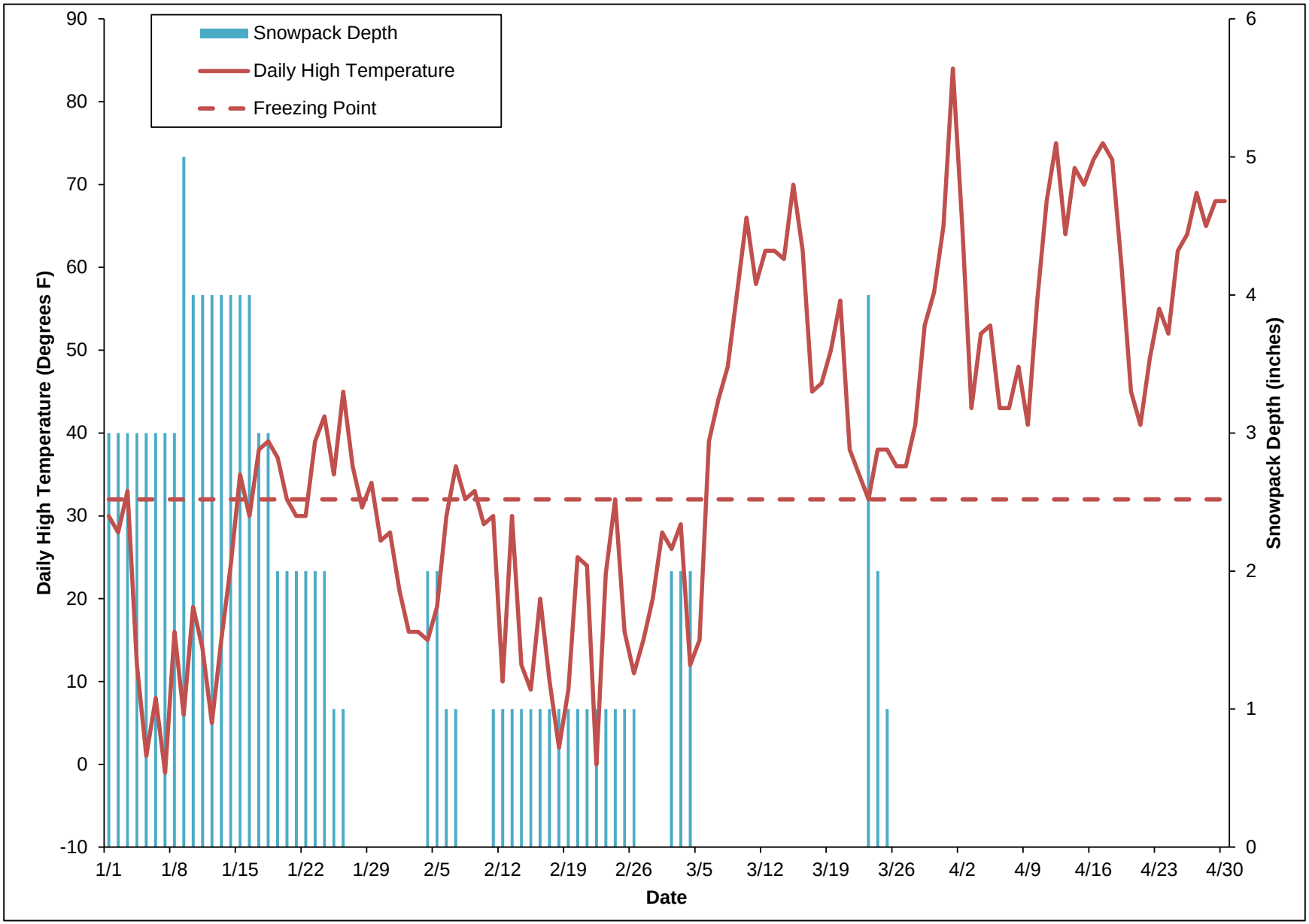

Figure 4-4: Daily temperature highs and snowpack depths from January to April 2015 as observed at MSP (NWS, 2015)

5 CRWD WATER QUALITY RESULTS SUMMARY

5.1 OVERALL TRENDS AND STATION COMPARISONS

Table 5-1 summarizes all 2015 data for monitored CRWD subwatersheds by station, including: drainage area; total annual precipitation; number of monitoring days; number of sampling events; discharge totals and yields (baseflow, event flow); total suspended solids (TSS) flow-weighted averages, loads, and yields (baseflow, event flow); and total phosphorus (TP) flow-weighted averages, loads, and yields (baseflow, event flow).

Of the monitored subwatersheds reported in Table 5-1, six stations are monitored for flow continuously year-round (East Kittsondale, Phalen Creek, St. Anthony Park, Trout Brook-East Branch, Trout Brook-West Branch, and Trout Brook Outlet). The other four that are reported upon (Hidden Falls, Villa Park, Como 3, and Como 7 subwatershed) are monitored for flow seasonally, which generally spans from April to November. Both Como 3 and Como 7 subwatersheds do not have baseflow and discharge during events only. Due to the differences between stations in duration of the monitoring period and the presence or absence of baseflow, the total annual discharges reported in Table 5-1 are drastically different between monitored stations.

Discharge is the primary driver of pollutant loading. While baseflow discharges show relatively minor fluctuations at the continuously monitored stations, event flow discharges are episodic and directly related to climate and seasonality. Additionally, event flows carry the majority of the annual load for most pollutants of concern.

5.1.1 WATER QUANTITY

Total Discharge (cf)

Total annual discharge is primarily related to watershed drainage area. In 2015, the Trout Brook subwatershed exported the greatest amount of water (516,898,878 cf) because it has the largest drainage area in CRWD (5,028 acres) (Figure 5-1; Table 5-1). Total discharges from the remainder of the monitored subwatersheds are summarized in Figure 5-1 and Table 5-1.

For the continuously monitored stations (St. Anthony Park, Phalen Creek, Trout Brook-East Branch, Trout Brook-West Branch, and Trout Brook Outlet), baseflow comprised the majority of the total annual discharge, with the exceptions of East Kittsondale (which is the only subwatershed that is not connected to surface water)(Figure 5-1; Table 5-1). Event flow accounted for less of the total annual discharge at the continuously monitored stations because precipitation is episodic and seasonal, whereas baseflow is constant and perennial. At Como 3

and Como 7, event flow comprised the entire total annual discharge because these stations do not have baseflow (Figure 5-1).

Water Yield (cf/ac)

Water yield was calculated for each monitoring station by dividing the total annual discharge by subwatershed drainage area in order to make subwatershed comparisons possible. From this calculation, Trout Brook-West Branch recorded the highest annual water yield (136,582 cf/ac) in comparison to all other continuously monitored stations in 2015 (Figure 5-2; Table 5-1).

For the seasonally monitored stations, Villa Park had the highest annual water yield (18,780 cf/ac), which is due to the presence of baseflow (unlike Como 3 or Como 7) (Figure 5-2; Table 5-1). Como 7 had the lowest annual water yield (9,728 cf/ac) of the seasonally monitored stations, which could be due to the fact that this subwatershed has the highest total watershed area treated by BMP practices.

Table 5-1: 2015 Monitoring results summary, all stations.

Parameter	East Kittsondale	Hidden Falls	Phalen Creek	St. Anthony Park	Trout Brook-East Branch	Trout Brook-West Branch	Trout Brook Outlet	Villa Park	Como 3	Como 7 Subwatershed
Subwatershed Area (acres)	1,116	167	1,433	3,418	932	2,379	5,028	753	517	793
Total Precipitation (inches)	35.21	29.18	35.08	35.21	34.77	34.71	33.74	31.54	29.66	31.54
Number of Monitoring Days	361	219	347	365	339	354	343	252	241	241
Number of Base Sampling Events	13	16	13	11	15	13	13	13	NA	NA
Number of Storm Sampling Events	27	10	31	19	19	28	25	20	30	24
Number of Snowmelt Sampling Events	1	1	1	1	1	1	1	1	1	1
Number of Illicit Discharge Sampling Events	1	0	0	4	0	0	0	0	0	0
Discharge										
Baseflow Subtotal (Cubic Feet)	11,830,658	3,302,748	104,834,836	87,211,811	26,489,178	253,071,163	454,737,971	5,834,922	NA	NA
Event Flow Subtotal (Cubic Feet)	39,464,438	4,955,324	37,755,070	51,380,765	15,447,896	71,961,493	62,728,812	8,302,496	5,322,022	7,714,404
Total Discharge (Cubic Feet)	51,328,515	8,258,523	142,574,422	138,995,124	41,935,628	324,928,226	516,898,878	14,141,358	5,322,022	7,714,404
Baseflow Water Yield (cf/ac)	10,601	19,777	73,158	25,515	28,422	106,377	90,441	7,749	NA	NA
Event Water Yield (cf/ac)	35,362	29,673	26,347	15,032	16,575	30,249	12,476	11,026	10,294	9,728
Total Water Yield (cf/ac)	45,993	49,452	99,494	40,666	44,995	136,582	102,804	18,780	10,294	9,728
Total Suspended Solids										
Base FWA TSS (mg/L)	4	9	3	15	11	12	9	8	NA	NA
Event FWA TSS (mg/L)	154	220	207	108	115	520	623	17	119	46
Total FWA TSS (mg/L)	119	136	57	49	49	124	83	13	119	46
Baseflow TSS Load (lbs)	2,908	1,786	20,996	80,668	18,131	183,830	252,617	3,085	NA	NA
Event TSS Load (lbs)	378,600	68,147	488,125	346,632	111,375	2,335,080	2,440,190	8,705	39,398	21,933
Total TSS Load (lbs)	381,508	69,933	509,121	427,300	129,506	2,518,910	2,692,807	11,790	39,398	21,933
Total TSS Yield (lb/ac)	342	419	355	125	139	1,059	536	16	76	28
Total Phosphorus										
Base FWA TP (mg/L)	0.05	0.04	0.06	0.07	0.09	0.07	0.06	0.24	NA	NA
Event FWA TP (mg/L)	0.31	0.29	0.42	0.22	0.38	0.51	0.84	0.23	0.26	0.24
Total FWA TP (mg/L)	0.25	0.19	0.15	0.12	0.20	0.17	0.15	0.23	0.26	0.24
Base TP Load (lbs)	39	9	378	363	142	1,165	1,658	86	NA	NA
Event TP Load (lbs)	762	90	985	713	371	2,313	3,293	117	87	113
Total TP Load (lbs)	800	99	1,363	1,076	512	3,478	4,951	203	87	113
Total TP Yield (lb/ac)	0.72	0.59	0.95	0.31	0.55	1.46	0.98	0.27	0.17	0.14

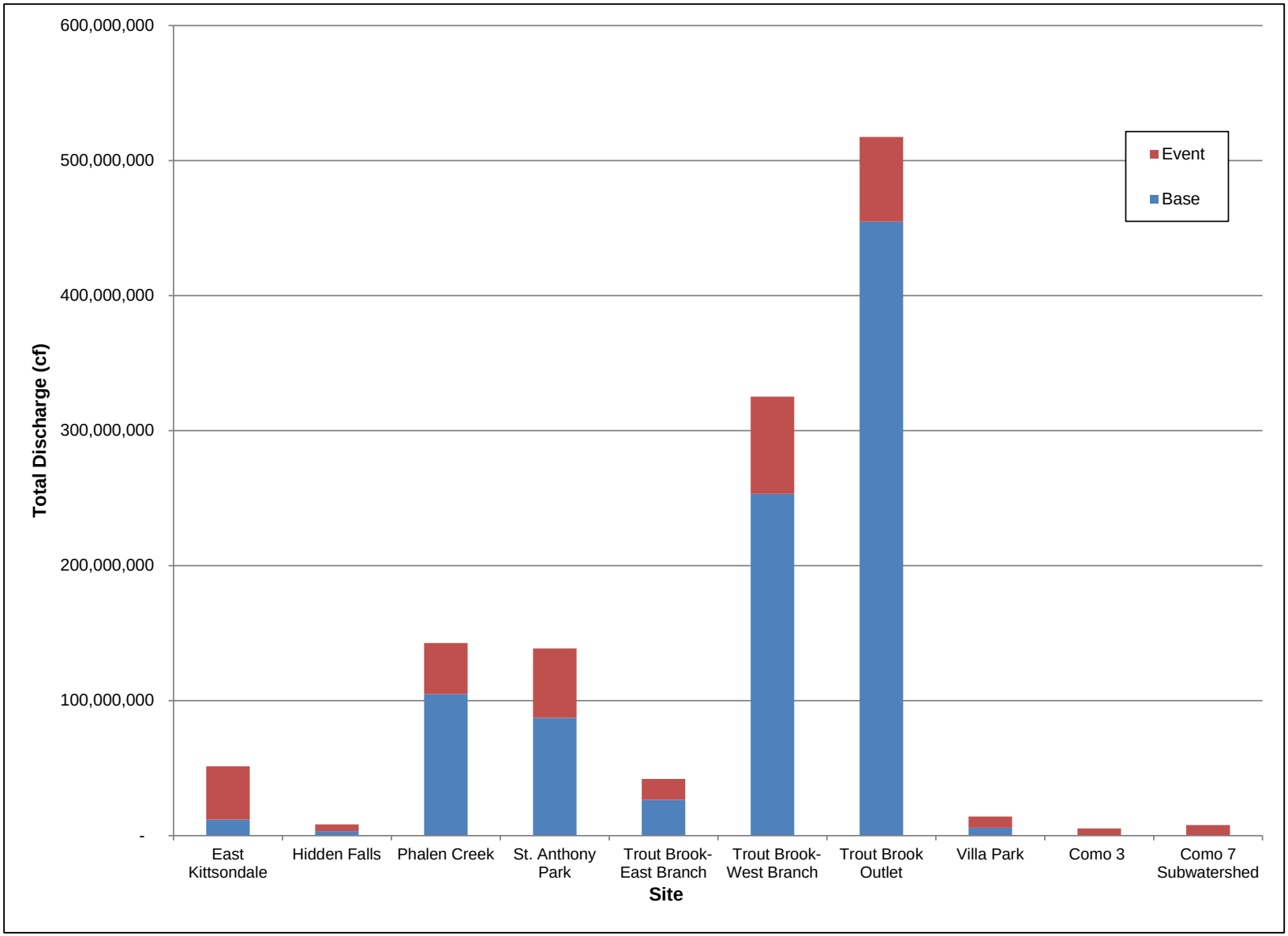

Figure 5-1: Total discharge at CRWD monitoring stations by flow type, 2015.

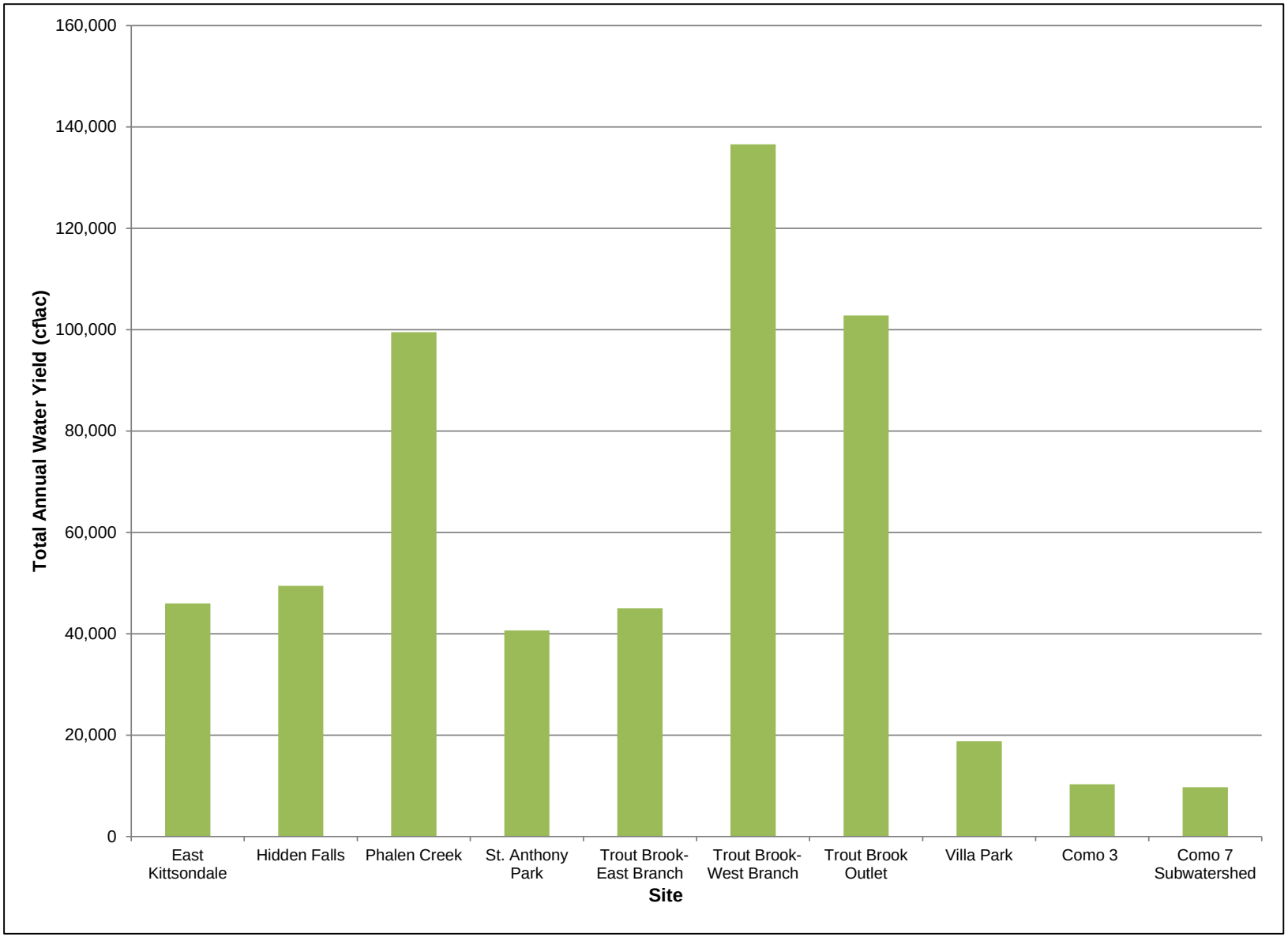

Figure 5-2: Total annual water yield at CRWD monitoring stations, 2015.

5.1.2 TOTAL SUSPENDED SOLIDS (TSS)

TSS Loads (lbs)

At the stations with continuous monitoring (East Kittsondale, Phalen Creek, St. Anthony Park, Trout Brook-East Branch, Trout Brook-West Branch, and Trout Brook Outlet), event flow was the largest contributor to the annual TSS load (Figure 5-3), even though baseflow accounted for the majority of the total discharge (Table 5-1). Baseflow generally has lower TSS concentrations because it includes flow contributions from groundwater, surface water, and permitted industrial discharges. In addition, velocity and flow volumes are lower during baseflow periods, so water does not have as much ability to carry solids. Event flow contains more TSS because it washes off impervious surfaces.

Of the continuously monitored stations, Trout Brook Outlet had the largest total annual TSS load (2,692,807 lbs) in 2015 (Figure 5-3; Table 5-1). For the seasonally monitored stations, the Como 3 subwatershed had the largest total annual TSS load (39,398 lbs), which was all transported by event flow (Figure 5-3; Table 5-1)).

TSS Yields (lbs/ac)

In order to compare subwatersheds of differing sizes, annual TSS loads were divided by the subwatershed area to calculate an annual yield. Trout Brook-West Branch exported the highest annual TSS load on a per acre basis in 2015 (1,059 lbs/ac) (Figure 5-4; Table 5-1). TSS yields for the remainder of the monitored subwatersheds are summarized in Figure 5-4 and Table 5-1.

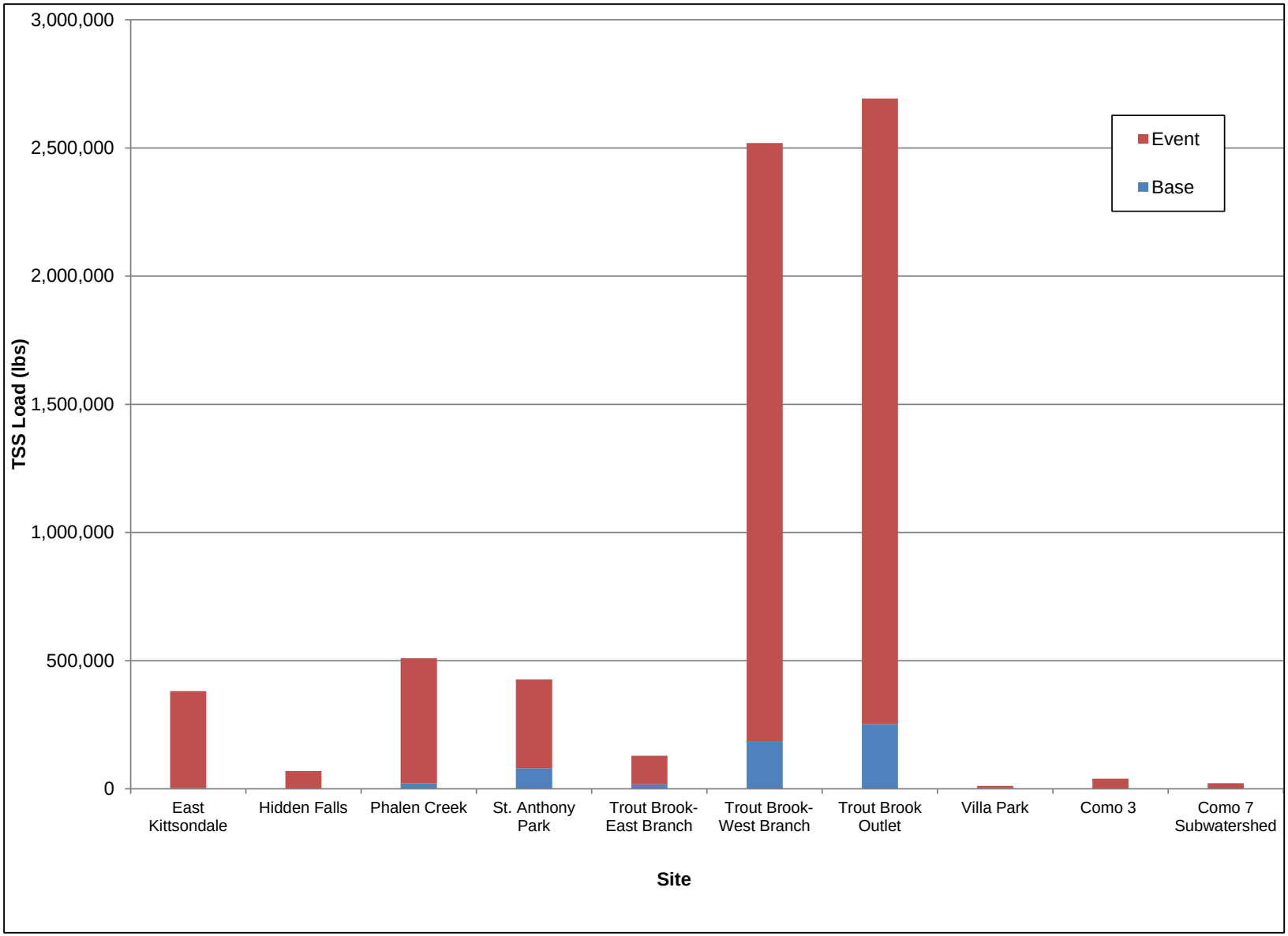

Figure 5-3: Event flow and baseflow TSS load totals at CRWD monitoring stations, 2015.

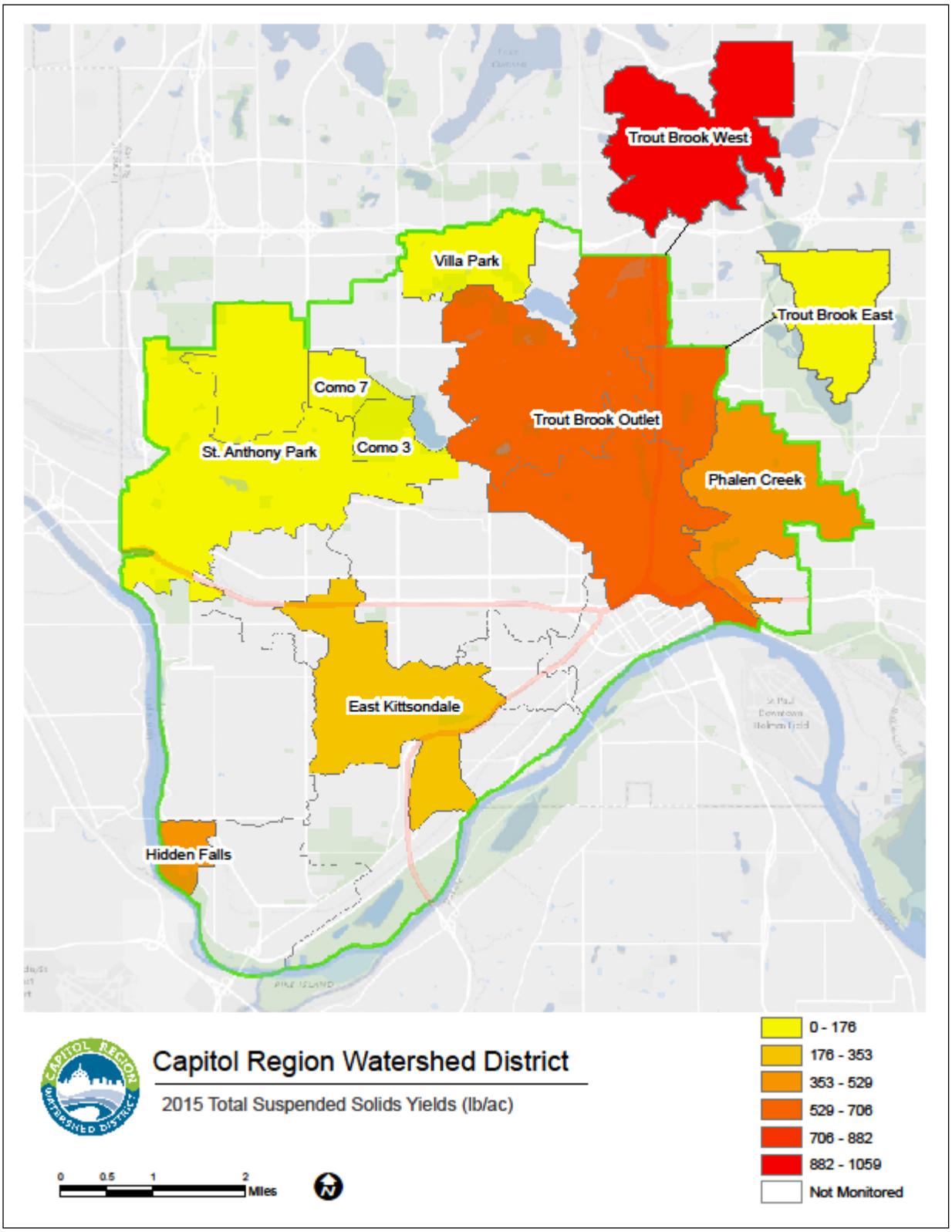

Figure 5-4: Annual TSS yields by monitored CRWD subwatershed, 2015.

5.1.3 TOTAL PHOSPHORUS (TP)

TP Loads (lbs)

The majority of the TP load at all monitored subwatersheds in 2015 was the result of event flow (Figure 5-5), even though baseflow accounted for the majority or a large portion of the total discharge (Table 5-1). Baseflow periods generally have lower TP concentrations because the discharge is driven by groundwater or surface water.

For the continuously monitored stations, Trout Brook Outlet exported the largest total annual TP load (4,951 lbs) in 2015 (Figure 5-5; Table 5-1). Trout Brook-West Branch had the next highest total annual TP load in 2015 (3,478 lbs). In comparing the seasonally monitored stations, Villa Park had the largest total annual TP load (203 lbs).

TP Yields (lbs/ac)

In order to compare subwatersheds of differing sizes, annual TP loads were divided by the subwatershed area to calculate an annual yield. Trout Brook-West Branch exported the highest annual TP load on a per acre basis in 2015 (1.46 lbs/ac) (Figure 5-6; Table 5-1). TP yields for the remainder of the monitored subwatersheds are summarized in Figure 5-6 and Table 5-1.

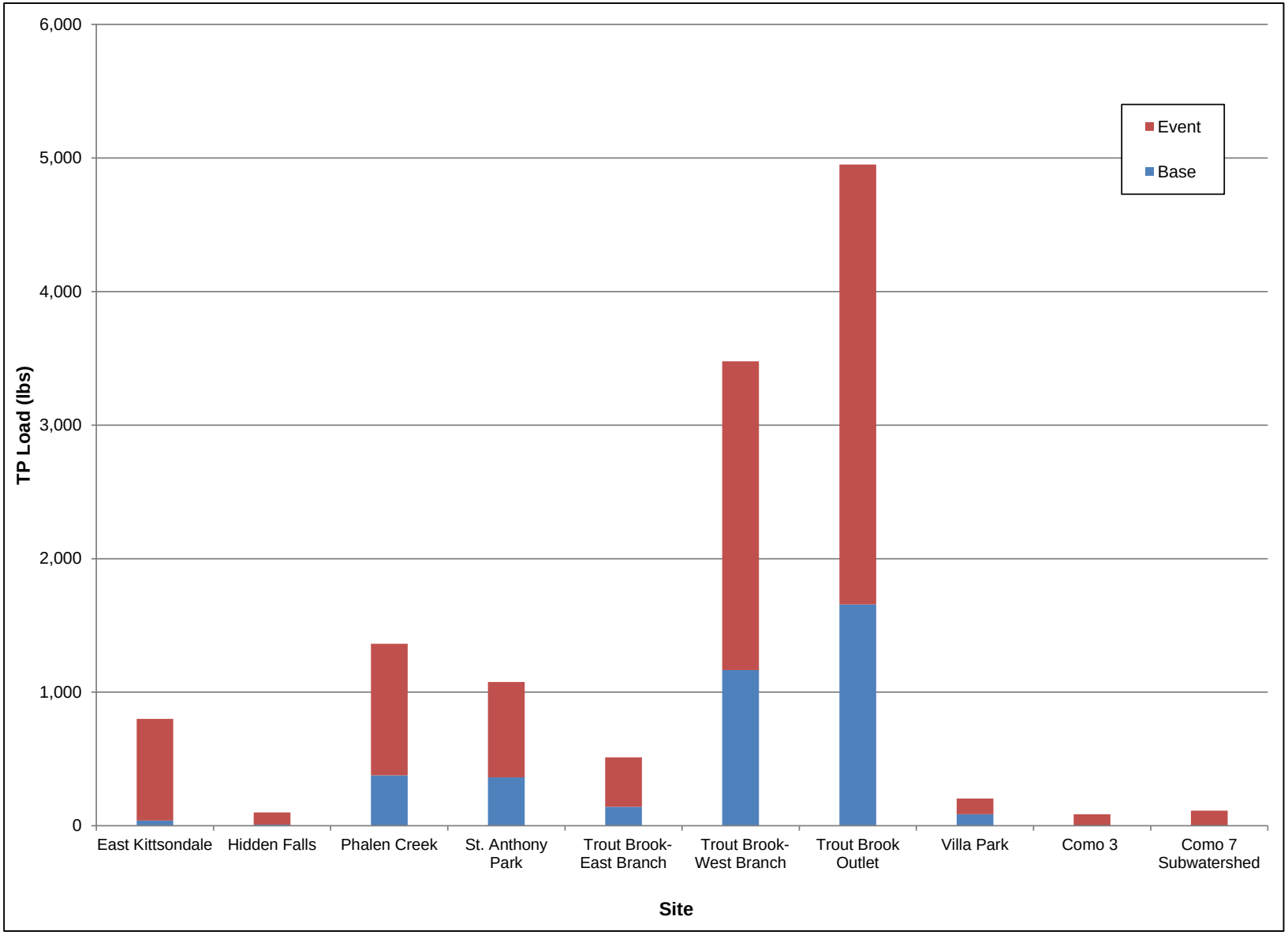

Figure 5-5: Event flow and baseflow TP load totals at CRWD monitoring stations, 2015.

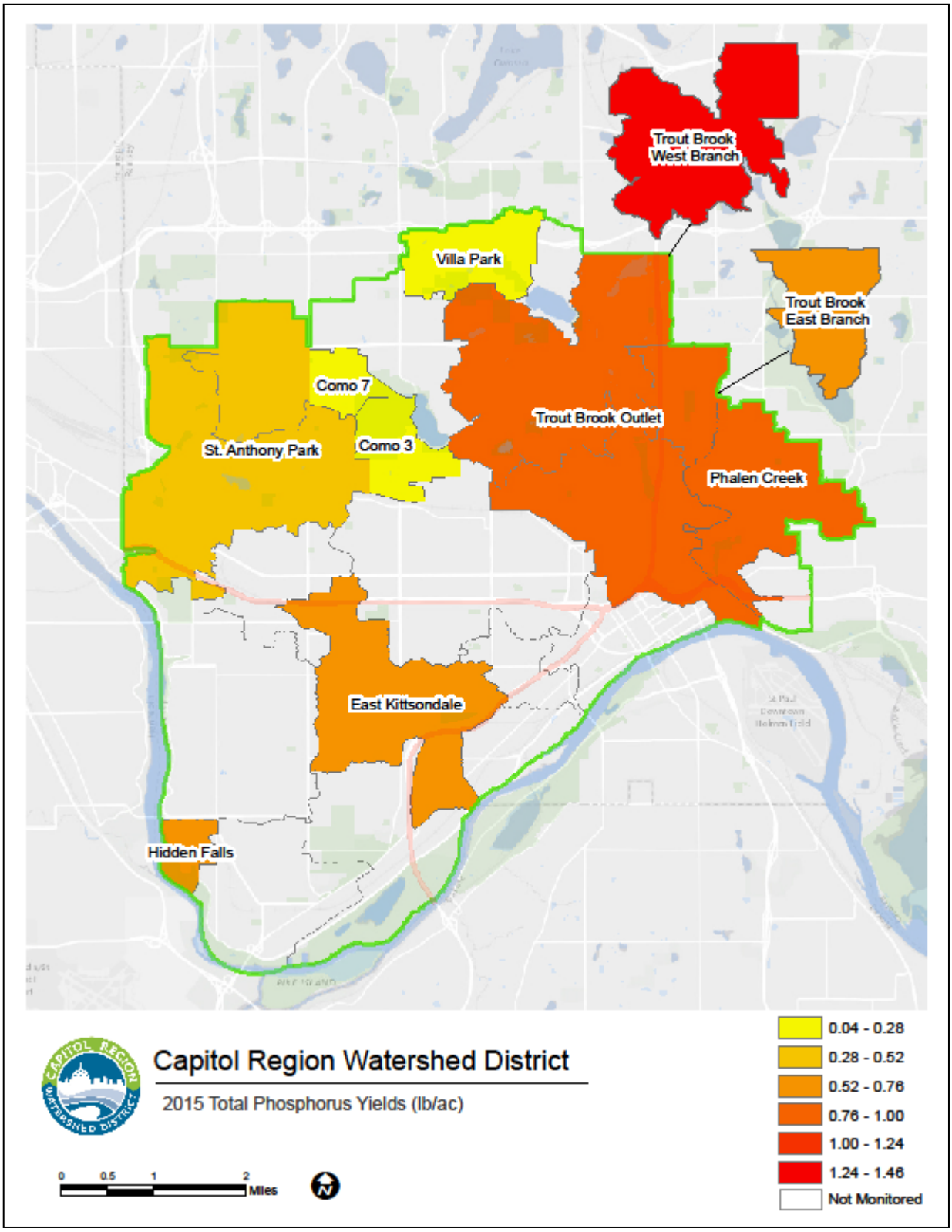

Figure 5-6: Annual TP yields by monitored CRWD subwatershed, 2015.

5.1.4 METALS

The MPCA surface water standards for metals toxicity are a function of the water hardness of a sample; therefore, the standard is not a set value and is instead based on the water hardness measured at an individual monitoring station. Appendix A lists the equations used by MPCA to calculate metal standards as a function of hardness for cadmium, chromium, copper, lead, nickel, and zinc. Table A-1 lists the calculated standards for each individual station for all metals. The chronic toxicity standard exceedances for all monitored subwatersheds for baseflow, event flow (storm and snowmelt), and yearly average for the six analyzed metals are shown in Table 5-2.

For all stations, metal toxicity for average baseflow periods never exceeded the MPCA toxicity standard in 2015 for any of the 6 metals analyzed (Table 5-2). Toxicity exceedances are uncommon during baseflow periods because the hardness of the water is much higher since it is primarily groundwater driven. Increased hardness in water buffers heavy metals and reduces toxicity.

In 2015, the average storm concentrations of lead at all stations (except Villa Park) exceeded the MPCA toxicity standards (Table 5-2). Also, the average storm concentrations of copper at all stations (except Trout Brook-East Branch and Villa Park) exceeded the MPCA toxicity standards. Average storm concentrations of zinc exceeded the toxicity standard at East Kittsondale, Phalen Creek, St. Anthony Park, Como 3, and Como 7. For all stations, average toxicity of cadmium, chromium, and nickel for all flow types (base, snowmelt, storm, and yearly) did not exceed the MPCA toxicity standards in 2015.

Table 5-2: Metals toxicity and chronic toxicity standard exceedances at CRWD monitoring stations, 2015.

Parameter	Average	Lambert's Landing	East Kittsondale	Hidden Falls	Phalen Creek	St. Anthony Park	Trout Brook - East Branch	Trout Brook - West Branch	Trout Brook Outlet	Villa Park Out	Como 3	Como 7
Cadmium	Base	--	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	--	--
	Snowmelt	--	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002
	Storm	--	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003
	Yearly	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003
Chromium	Base	--	0.0049	0.0014	0.0007	0.0052	0.0026	0.0005	0.0006	0.0003	--	--
	Snowmelt	--	0.0075	0.0030	0.0074	0.0084	0.0113	0.0046	0.0041	0.0009	0.0062	0.0065
	Storm	--	0.0073	0.0060	0.0089	0.0053	0.0064	0.0053	0.0070	0.0007	0.0093	0.0048
	Yearly	0.0014	0.0066	0.0031	0.0064	0.0054	0.0049	0.0038	0.0047	0.0006	0.0092	0.0049
Copper	Base	--	0.0097	0.0035	0.0039	0.0048	0.0052	0.0026	0.0024	0.0023	--	--
	Snowmelt	--	0.0226	0.0120	0.0259	0.0121	0.0262	0.0116	0.0123	0.0022	0.0266	0.0176
	Storm	--	0.0215	0.0107	0.0241	0.0138	0.0112	0.0131	0.0157	0.0035	0.0162	0.0124
	Yearly	0.0024	0.0178	0.0063	0.0182	0.0105	0.0090	0.0098	0.0109	0.0030	0.0166	0.0127
Lead	Base	--	0.0044	0.0015	0.0009	0.0016	0.0047	0.0012	0.0011	0.0005	--	--
	Snowmelt	--	0.0160	0.0063	0.0217	0.0037	0.0289	0.0081	0.0101	0.0007	0.0134	0.0073
	Storm	--	0.0234	0.0210	0.0417	0.0108	0.0094	0.0118	0.0212	0.0010	0.0151	0.0108
	Yearly	0.0010	0.0172	0.0085	0.0292	0.0073	0.0079	0.0084	0.0138	0.0008	0.0150	0.0107
Nickel	Base	--	0.0062	0.0029	0.0008	0.0262	0.0060	0.0010	0.0015	0.0011	--	--
	Snowmelt	--	0.0080	0.0042	0.0057	0.0270	0.0109	0.0038	0.0040	0.0019	0.0064	0.0058
	Storm	--	0.0051	0.0068	0.0059	0.0065	0.0051	0.0036	0.0061	0.0012	0.0058	0.0035
	Yearly	0.0030	0.0055	0.0043	0.0044	0.0142	0.0057	0.0028	0.0044	0.0011	0.0058	0.0036
Zinc	Base	--	0.0173	0.0110	0.0112	0.0386	0.0202	0.0077	0.0084	0.0091	--	--
	Snowmelt	--	0.1040	0.0418	0.1230	0.0474	0.1110	0.0374	0.0401	0.0140	0.0993	0.0939
	Storm	--	0.1100	0.0501	0.1348	0.0832	0.0436	0.0638	0.0669	0.0145	0.0776	0.0760
	Yearly	0.0066	0.0805	0.0257	0.0980	0.0662	0.0353	0.0458	0.0456	0.0124	0.0783	0.0767

Site exceeded the MPCA chronic standard for surface waters

-- No data available

5.1.5 BACTERIA

E. coli samples were collected during baseflow, stormflow, snowmelt, and illicit discharge periods. Grab samples were extracted using a sterile 100 mL plastic bag. For all flow types, the MPCA surface water maximum numeric standard for *E. coli* is 1,260 cfu/100 mL.

For baseflow periods, *E. coli* concentrations generally did not exceed the MPCA maximum numeric standard (1,260 cfu/100mL), with the exception of some occurrences (East Kittsondale, Hidden Falls, Phalen Creek, Trout Brook-East Branch, and Trout Brook-West Branch) (Table 5-3). Most notably, Hidden Falls frequently exceeded the *E. coli* standard during baseflow periods. *E. coli* in baseflow is typically low since the discharge is primarily groundwater driven or sourced from lakes or stormwater ponds. Therefore, the observance of high *E. coli* in baseflow could be indicative of an illicit discharge source, such as a sanitary misconnection.

During stormflow events, the majority (88%) of *E. coli* samples for all stations exceeded the MPCA maximum numeric standard (1,260 cfu/100 mL) in 2015 (Table 5-4). The highest bacteria count observed was at Como 7 on 7/6/15 with 1,119,900 cfu/100 mL. The next highest was observed at Como 3 on 7/6/2015 with 86,000 cfu/100 mL.

Table 5-3: Baseflow grab sample E. coli concentrations at CRWD monitoring stations, 2015.

Base Grab Sample Date	Station							
	East Kittsondale	Hidden Falls	Phalen Creek	St. Anthony Park	Trout Brook-East Branch	Trout Brook-West Branch	Trout Brook Outlet	Villa Park
01/15/2015	2	--	1	--	276	1,733	921	6
02/13/2015	2	--	79	166	387	1,986	488	67
03/19/2015	1	5,200	2	2	8	135	160	5
04/15/2015	7	152	4	5	5	86	119	43
05/13/2015	203	31	12	24	62	58	78	113
06/02/2015	365	210	15	37	5,200	194	225	17
06/18/2015	1,986	1,733	--	--	3,100	--	--	--
06/30/2015	1,120	411	210	260	1,414	355	411	980
07/08/2015	--	--	--	--	951	--	--	--
07/30/2015	99	3,100	1,553	105	291	238	135	461
08/14/2015	--	1,046	--	--	--	--	--	--
08/27/2015	980	54	64	102	276	248	201	411
09/15/2015	--	32	--	--	--	--	--	--
09/22/2015	517	727	32	98	259	142	138	201
10/09/2015	--	7,500	--	--	--	--	--	--
10/19/2015	29	1,200	15	49	--	--	64	60
10/20/2015	--	--	--	--	11	131	--	--
11/10/2015	--	1,770	--	--	--	--	--	--
12/21/2015	435	28	411	46	53	308	88	17

Value exceeds MPCA maximum numeric standard (1,260 cfu/100mL).

-- No sample collected

Table 5-4: Stormflow grab sample E. coli concentrations at CRWD monitoring stations, 2015.

Storm Grab Sample Date	Station									
	East Kittsondale	Hidden Falls	Phalen Creek	St. Anthony Park	Trout Brook-East Branch	Trout Brook-West Branch	Trout Brook Outlet	Villa Park	Como 3	Como 7
04/09/2015	575	1,120	1,553	2,420	173	6,300	2,420	111	5,200	5,200
06/11/2015	--	2,000	--	--	--	--	--	--	--	--
06/22/2015	4,100	2,203	--	20,100	11,000	7,500	5,200	6,300	8,500	54,500
07/06/2015	3,100	7,400	2,420	27,500	6,300	1,000	6,300	7,500	86,000	1,119,900
07/28/2015	9,800	6,300	9,700	25,900	30,500	13,400	11,000	2,420	9,700	9,700
08/19/2015	--	--	--	--	--	2,420	--	1,203	--	--
11/17/2015	866	2,000	1,553	1,733	2,420	6,300	2,420	1,733	4,100	5,200

Value exceeds MPCA maximum numeric standard (1,260 cfu/100mL).

-- No sample collected

5.2 COMPARISON OF CRWD DATA TO MISSISSIPPI RIVER

Average annual pollutant concentrations observed in 2015 at CRWD subwatershed outlet stations were compared to state water quality standards and average annual concentrations observed at Lambert's Landing on the Mississippi River in St. Paul, Minnesota (Table 5-5). The Metropolitan Council monitors the Mississippi River at Lambert's Landing and reports the data online (MCES, 2015). When comparing CRWD storm tunnel outlets to the Mississippi River, it is acknowledged that both systems are inherently different. However, the Lambert's Landing is the only station operated by Metropolitan Council that is within CRWD and is downstream of all CRWD monitoring stations, so it was determined to be a point for comparison.

Average nitrate concentrations at CRWD subwatershed outlet stations was the only parameter that did not exceed average nitrate concentrations observed at Lambert's Landing in 2015 (Table 5-5). Average nitrite concentrations observed at all CRWD subwatershed outlets were less than those observed at Lambert's Landing with the exception of Hidden Falls. Average concentrations for TP, TSS, and ammonia observed at CRWD subwatershed outlets all exceeded Lambert's Landing and the State standards for the Mississippi River Navigational Pool 2 (Table 5-5).

Table 5-5: Pollutant standards and average concentrations at CRWD stations and the Mississippi River at Lamberts Landing, 2015.

	Standard (mg/L)	Metropolitan Council Site	2015 CRWD Monitoring Stations				
		Lamberts Landing	East Kittsondale	Hidden Falls	Phalen Creek	St. Anthony Park	Trout Brook Outlet
TP[a]	0.125	0.11	0.30	0.27	0.34	0.18	0.42
TSS[b]	32	39	110	75	188	69	181
Ammonia[c]	0.04	0.04	0.05	0.12	0.11	0.06	0.05
TKN[d]	N/A	1.02	1.45	0.94	1.90	1.00	1.60
Nitrate[d]	N/A	1.92	0.17	0.22	0.24	0.27	0.26
Nitrite[d]	N/A	0.03	0.03	0.04	0.03	0.03	0.03
Cadmium	*	0.00020	0.00020	0.00020	0.00021	0.00020	0.00020
Chromium	*	0.00051	0.00705	0.00580	0.00715	0.00340	0.00690
Copper	*	0.00163	0.02060	0.01040	0.01780	0.00900	0.01490
Lead	*	0.00040	0.01895	0.01090	0.03085	0.00620	0.02170
Nickel	*	0.00154	0.00460	0.00680	0.00420	0.00610	0.00590
Zinc	*	0.00623	0.09625	0.04080	0.10500	0.04760	0.06450
Chloride[e]	230	27	5	10	12	21	36

* The standard is dependent on water hardness; See Appendix B

[a] The Mississippi River is subject to site specific State standards for specified reaches. Capitol Region Watershed District discharges into two of these reaches. The TP standard for Mississippi River Navigational Pool 2 (river miles 847.7 to 815.2 reach from Ford Dam to Hastings Dam) was chosen for comparison to the TP standard of 0.125 mg/L to be consistent among all sites.

[b] The TSS State standard is a summer average that applies to Mississippi River Navigation Pools 2 - 4 (below Ford Dam) from April 1 through September 30. This standard may be exceeded not more than 50% of the time.

[c] Ammonia standard is based on un-ionized ammonia, which varies and is dependent on temperature and pH

[d] There is no nitrate, nitrite, or TKN State standard for surface water.

[e] Chloride standards are from the MPCA.

All numbers are in mg/L.

Key	
Red	Exceed/equal Lambert's Landing concentrations and the standard
Yellow	Exceed/equal Lambert's Landing concentrations, but not the standard

5.3 COMPARISON OF CRWD STORMWATER DATA AND NSQD DATA

Table 5-6 compares 2015 annual stormwater pollutant median concentrations for nutrients, solids, metals, and bacteria from CRWD monitoring stations to the National Stormwater Quality Database (NSQD) (Version 3) for mixed residential land use. The NSQD median concentrations (Version 3) are listed in Table 3-6.

When comparing CRWD's annual event flow pollutant median concentrations to the NSQD's mixed residential land use category, most CRWD monitored subwatersheds exceeded median NSQD stormwater concentrations for *E. coli* in 2015 (Table 5-6). For TP and TSS, all stations exceeded the NSQD median concentrations in 2015, except for St. Anthony Park and Villa Park. Median TKN concentrations exceeded the NSQD median concentration at East Kittsondale, Phalen Creek, Trout Brook-East Branch, Trout Brook-West Branch, and Trout Brook Outlet. All monitored subwatersheds did not exceed the NSQD median concentrations for ammonia and Nitrate+Nitrite.

The median storm concentrations for some heavy metals exceeded the NSQD concentrations at several CRWD subwatersheds in 2015, including East Kittsondale (Cr, Cu, Pb, Ni, Zn), Hidden Falls (Cr, Ni), Phalen Creek (Cr, Cu, Pb, Zn), St. Anthony Park (Ni), Trout Brook-East Branch (Cr), Trout Brook Outlet (Cr, Pb, Ni) and Como 3 (Cr) (Table 5-6). The median storm concentrations for all metals did not exceed the NSQD medians at Villa Park and Como 7 in 2015. None of the CRWD monitoring stations exceed the NSQD median for cadmium.

Table 5-6: CRWD 2015 median stormflow concentrations compared to NSQD median concentrations.

Parameters	NSQD - Mixed Residential*	East Kittsondale	Hidden Falls	Phalen Creek	St. Anthony Park	Trout Brook - East Branch	Trout Brook - West Branch	Trout Brook Outlet	Villa Park	Como 3	Como 7
Area (acre)	102	1,116	167	1,433	3,418	932	2,379	5,028	753	517	793
% Impervious	35	46	69	50	48	--	--	40	--	--	--
Escherichia coli (mpn/100mL)	810	3,600	2,102	1,987	20,100	6,300	6,153	5,200	2,077	8,500	9,700
Total Suspended Solids	72	110	75	188	69	71	103	181	10	89	88
Total Phosphorous (mg/L)	0.220	0.295	0.270	0.340	0.180	0.340	0.353	0.420	0.200	0.255	0.295
Ammonia (mg/L)	0.25	0.05	0.12	0.11	0.06	0.04	0.13	0.05	0.17	0.13	0.06
Nitrate+Nitrite (mg/L)	0.61	0.20	0.25	0.27	0.30	0.26	0.36	0.29	0.08	0.31	0.17
Total Kjeldahl Nitrogen (mg/L)	1.30	1.45	0.94	1.90	1.00	1.40	1.84	1.60	1.10	1.30	1.45
Cadmium (mg/L)	0.0010	0.0002	0.00020	0.00021	0.00020	0.00020	0.00022	0.00020	0.0002	0.0002	0.00020
Chromium (mg/L)	0.0050	0.0071	0.00580	0.00715	0.00340	0.00635	0.00527	0.00690	0.0004	0.0081	0.00310
Copper (mg/L)	0.0160	0.0206	0.01040	0.01780	0.00900	0.01035	0.01314	0.01490	0.0026	0.0119	0.00900
Lead (mg/L)	0.0150	0.01895	0.01090	0.03085	0.00620	0.00870	0.01175	0.02170	0.0008	0.0111	0.00780
Nickel (mg/L)	0.0050	0.00460	0.00680	0.00420	0.00610	0.00475	0.00363	0.00590	0.0011	0.0034	0.00250
Zinc (mg/L)	0.0850	0.09625	0.04080	0.10500	0.04760	0.03570	0.06381	0.06450	0.0132	0.0626	0.06070

Value Exceeds NSQD Value

-- No data available

6 COMO LAKE SUBWATERSHED RESULTS

DESCRIPTION

CRWD monitors two of the eight minor subwatersheds within the greater Como Lake subwatershed: Como 7 and Como 3.

Como 7

The Como 7 subwatershed includes portions of the cities of St. Paul, Roseville, and Falcon Heights. Como 7 is located west of Como Lake (Figure 6-2). The subwatershed north of Como 7 drains to Gottfried's Pit, a stormwater retention pond. When the water level in Gottfried's Pit reaches a specific level, a lift station pumps the water via storm sewer to the Como Golf Course Pond (part of the Como 7 subwatershed) before being discharged to Como Lake (Figure 6-1).

CRWD monitors the Como 7 subwatershed to determine the aggregated or combined improvements to water quality based on the BMPs constructed as part of the Arlington-Pascal Stormwater Improvement Project. Started in 2005, the project included four stormwater BMP types: 1) eight infiltration trenches, 2) eight raingardens, 3) an underground infiltration and storage facility (Arlington-Hamline Underground Storage Facility), and 4) a stormwater pond at the Como Golf Course. These BMPs treat and infiltrate stormwater runoff, minimize localized flooding, and reduce stormwater volumes in the storm sewer system. Three of the four BMPs (the Arlington-Hamline Underground Stormwater Storage Facility, eight in-street infiltration trenches, and eight neighborhood raingardens), became operational in 2006 and 2007. The last BMP of the project, a storage and retention pond on the Como Park Golf Course (Como Golf Course Pond) became operational in October 2007.

Figure 6-1: The Como 7 monitoring station (left) and the Como Golf Course Pond Outlet (right).

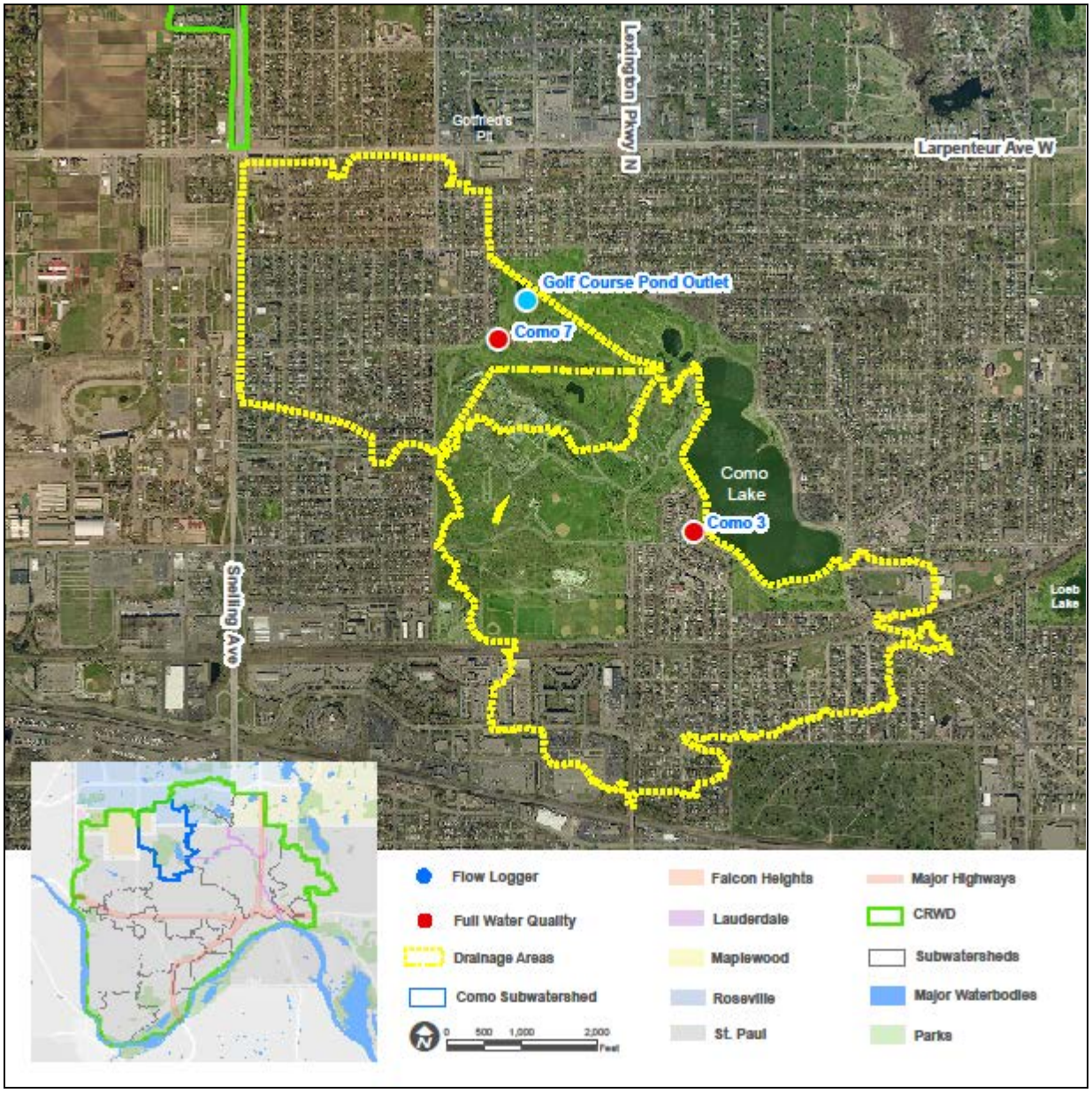

Figure 6-2: Map of the Como subwatershed and monitoring locations.

Como 3

The 458.2 acre Como 3 subwatershed is located entirely within the City of Saint Paul just west of Como Lake (Figure 6-2). It consists of park areas and single-family homes (located off of the southwest corner of the lake). All stormwater from the Como 3 subwatershed is directed to Como Lake via an inlet to the lake located off of Como Blvd W. just north of the intersection with Gateway Drive (Figure 6-3). This inlet has been monitored since 2009 for flow. A full water quality monitoring station was installed in 2012.

In 2002, CRWD developed the Como Lake Strategic Management Plan, which was written to address management concerns of Como Lake and develop goals to improve the water quality of the lake. One important goal included reducing the amount of phosphorus entering the lake from the surrounding watershed. CRWD monitors the Como 3 inlet to Como Lake to determine the amount of phosphorus entering the lake via this specific part of the overall Como subwatershed, and to determine if any improvements to water quality are observed as a result of BMPs constructed within the subwatershed that aim to reduce phosphorus runoff.

Figure 6-3: The Como 3 monitoring station in summer (left) and during winter snowmelt grab sampling (right).

2015 MONITORING SUMMARY – COMO 7 SUBWATERSHED

The Como 7 subwatershed has been monitored for discharge and water quality from 2005-2015. Flow and water quality monitoring at this location generally occurs between the months of April to November. During the winter months, snowmelt grab samples are taken when possible, but neither level nor flow are recorded during this period.

Summaries of 2015 monitoring data collected and observed at Como 7 subwatershed are listed below. Monitoring efficiency at Como 7 is explained in Appendix B (Table B-1). All lab data for Como 7 can be found in Appendix C (Table C-1).

6.1.1 DISCHARGE – COMO 7 SUBWATERSHED

Level, velocity, and discharge were monitored at Como 7 subwatershed during event flow in 2015 (Figures 6-4 & 6-5; Tables 5-1 & 6-1). Discharge totals represent the summed event totals measured at Como 7 monitoring station and the Golf Course Pond Outlet monitoring station.

- Total event flow discharge: 7,714,404 cubic feet
- Total annual discharge: 7,714,404 cubic feet

6.1.2 TOTAL SUSPENDED SOLIDS (TSS) – COMO 7 SUBWATERESHED

Event flow samples were analyzed for TSS concentrations in mg/L (Figure 6-6) in order to calculate event-based and total annual loads (Figure 6-4; Tables 5-1 & 6-1). The 2015 TSS loading table for Como 7 is reported in Appendix D (Table D-1).

- Event flow weighted average concentration: 46 mg/L
- Total event flow TSS load: 21,933 lbs
- Total annual TSS load: 21,933 lbs

6.1.3 TOTAL PHOSPHORUS (TP) – COMO 7 SUBWATERSHED

Event flow samples were analyzed for TP concentrations in mg/L (Figure 6-7) in order to calculate event-based and total annual loads (Figure 6-5; Tables 5-1 & 6-1). The 2015 TP loading table for Como 7 is reported in Appendix D (Table D-1).

- Event flow weighted average concentration: 0.24 mg/L
- Total event flow TP load: 113 lbs
- Total annual TP load: 113 lbs

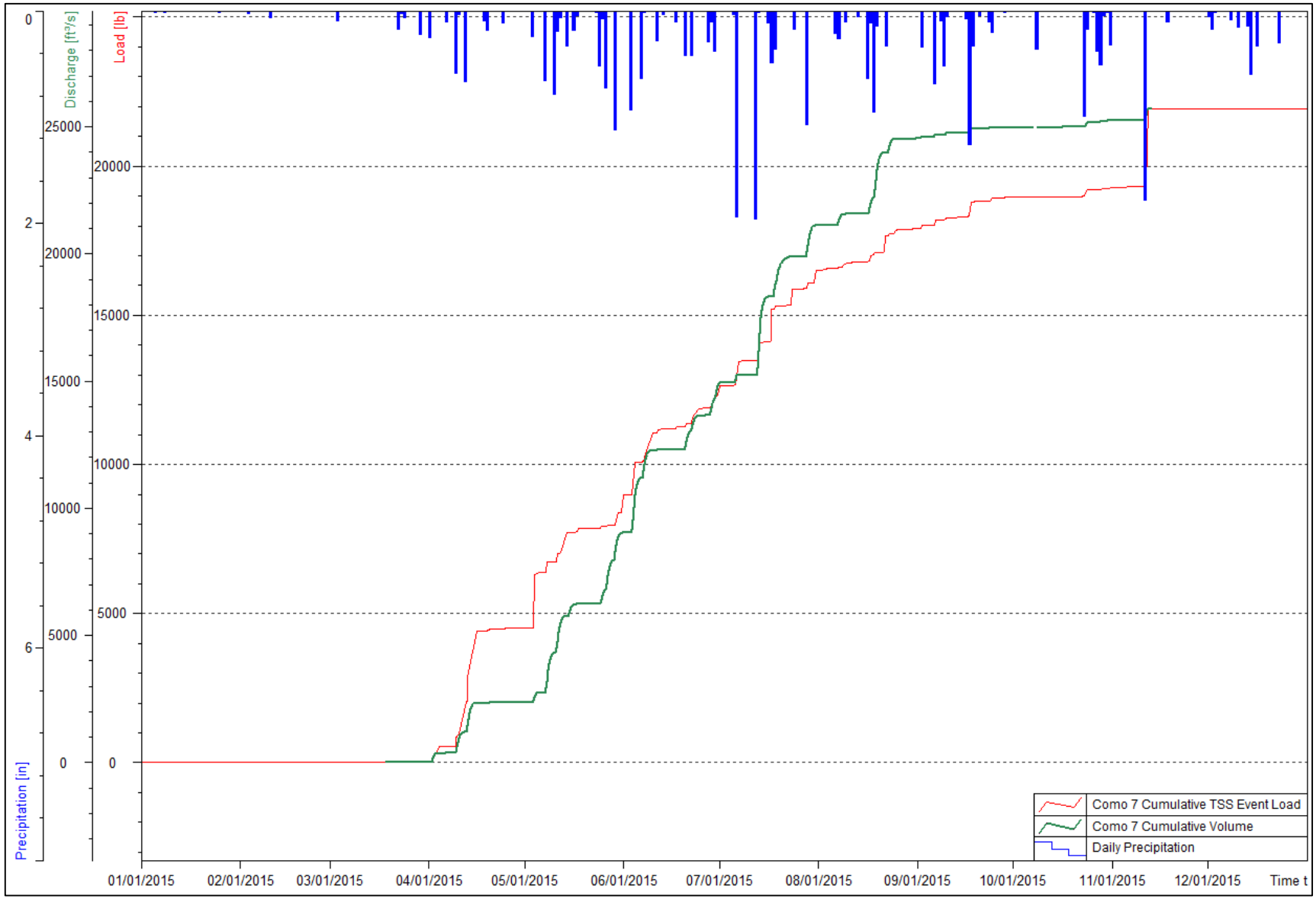

Figure 6-4: Como 7 subwatershed cumulative volume, cumulative TSS event load, and daily precipitation.

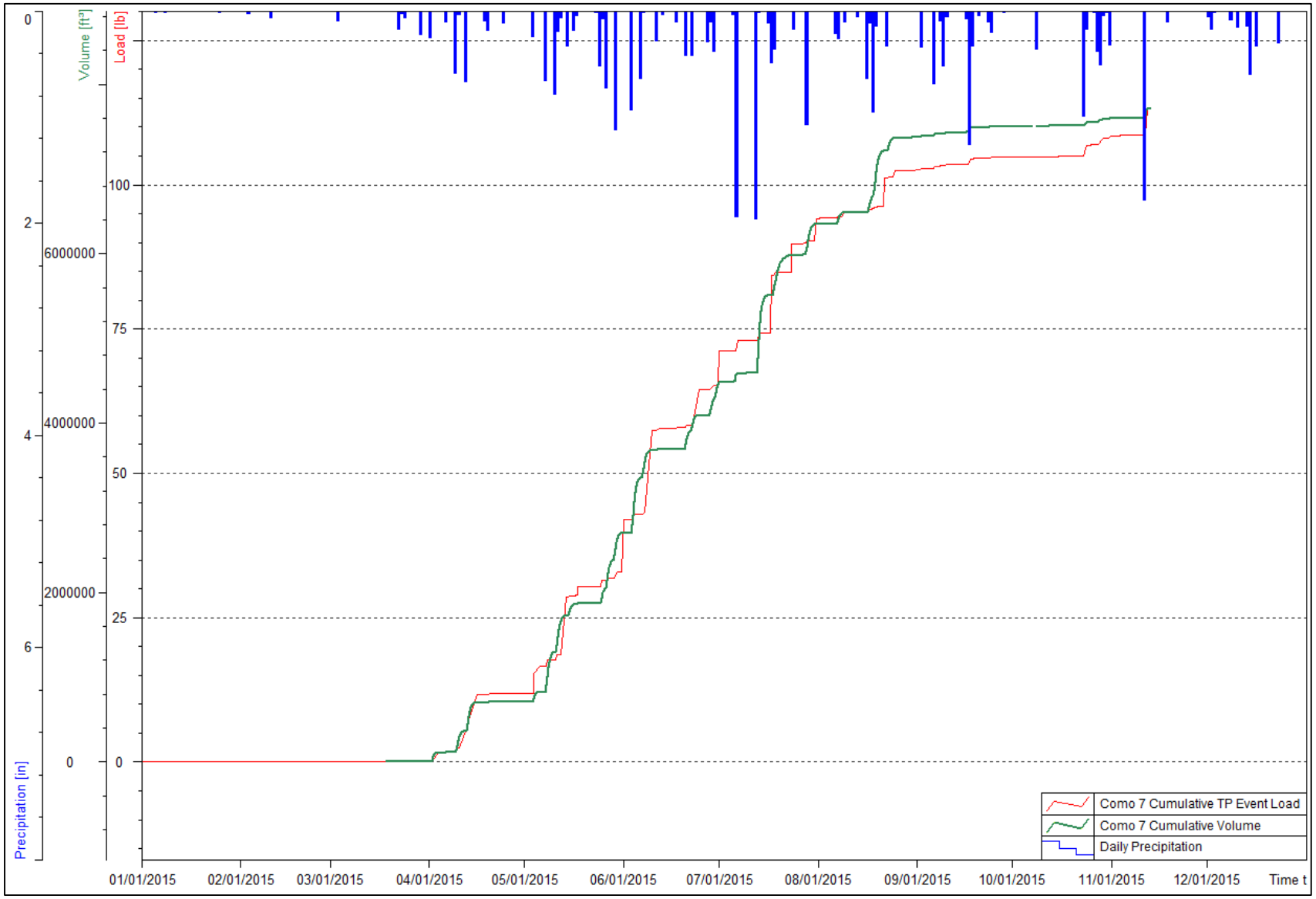

Figure 6-5: Como 7 subwatershed cumulative volume, cumulative TP event load, and daily precipitation.

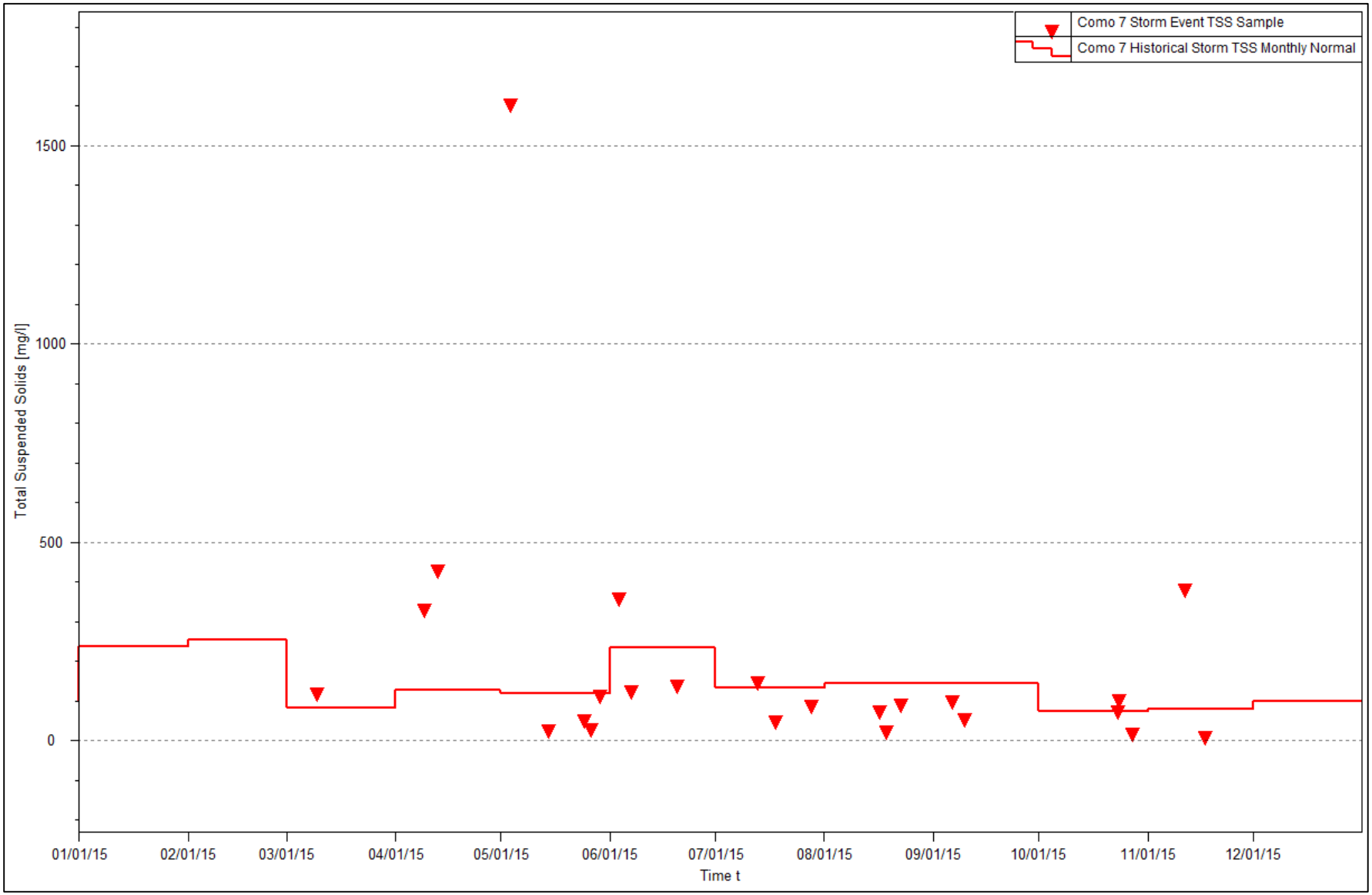

Figure 6-6: 2015 Como 7 TSS samples and historical monthly normal.

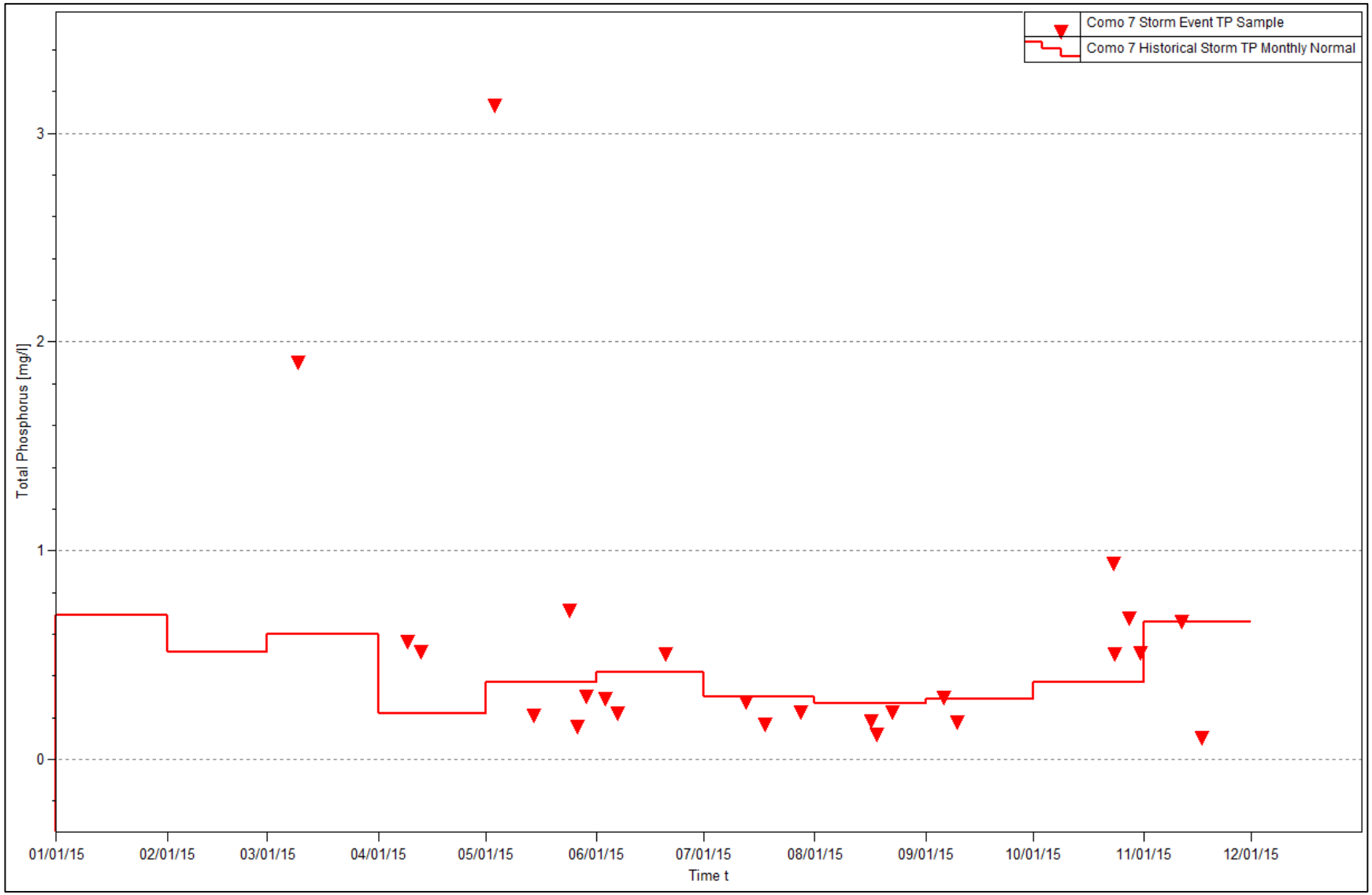

Figure 6-7: 2015 Como 7 TP samples and historical monthly normal.

Table 6-1: 2015 Como 7 subwatershed summary table.

Parameter	
Subwatershed Area (acres)	793
Total Precipitation (inches)	32
Number of Monitoring Days	241
Number of Base Sampling Events	NA
Number of Storm Sampling Events	24
Number of Snowmelt Sampling Events	1
Number of Illicit Discharge Sampling Events	0

Discharge	
Baseflow Subtotal (Cubic Feet)	NA
Event Flow Subtotal (Cubic Feet)	7,714,404
Total Discharge (Cubic Feet)	7,714,404
Baseflow Water Yield (cf/ac)	NA
Event Water Yield (cf/ac)	9,728
Total Water Yield (cf/ac)	9,728

Total Suspended Solids	
Base FWA TSS (mg/L)	NA
Event FWA TSS (mg/L)	46
Total FWA TSS (mg/L)	46
Baseflow TSS Load (lbs)	NA
Event TSS Load (lbs)	21,933
Total TSS Load (lbs)	21,933
Total TSS Yield (lb/ac)	28

Total Phosphorus	
Base FWA TP (mg/L)	NA
Event FWA TP (mg/L)	0.24
Total FWA TP (mg/L)	0.24
Base TP Load (lbs)	NA
Event TP Load (lbs)	113
Total TP Load (lbs)	113
Total TP Yield (lb/ac)	0.14

2015 MONITORING SUMMARY – COMO 3

The Como 3 subwatershed has been monitored for discharge and water quality from 2012-2015. Flow and water quality monitoring at this location generally occurs between the months of April to November. During the winter months, snowmelt grab samples are taken when possible, but neither level nor flow are recorded during this period.

Summaries of 2015 monitoring data collected and observed at Como 3 are listed below. Monitoring efficiency at Como 3 is explained in Appendix B (Table B-1). All lab data for Como 3 can be found in Appendix C (Table C-2).

6.1.4 DISCHARGE – COMO 3

Level, velocity, and discharge were monitored at Como 3 during event flow in 2015 (Figures 6-8 & 6-9, Tables 5-1 & 6-2).

- Total event flow discharge: 5,322,022 cubic feet
- Total annual discharge: 5,322,022 cubic feet

6.1.5 TOTAL SUSPENDED SOLIDS (TSS) – COMO 3

Event flow samples were analyzed for TSS concentrations in mg/L (Figure 6-10) in order to calculate event-based and total annual loads (Figure 6-8; Tabled 5-1 & 6-2). The 2015 TSS loading table for Como 3 is reported in Appendix D (Table D-2).

- Event flow weighted average concentration: 119 mg/L
- Total event flow TSS load: 39,398 lbs
- Total annual TSS load: 39,398 lbs

6.1.6 TOTAL PHOSPHORUS (TP) – COMO 3

Event flow samples were analyzed for TP concentrations in mg/L (Figure 6-11) in order to calculate event-based and total annual loads (Figure 6-9; Tables 5-1 & 6-2). The 2015 TP loading table for Como 3 is reported in Appendix D (Table D-2).

- Event flow weighted average concentration: 0.26 mg/L
- Total event flow TP load: 87 lbs
- Total annual TP load: 87 lbs

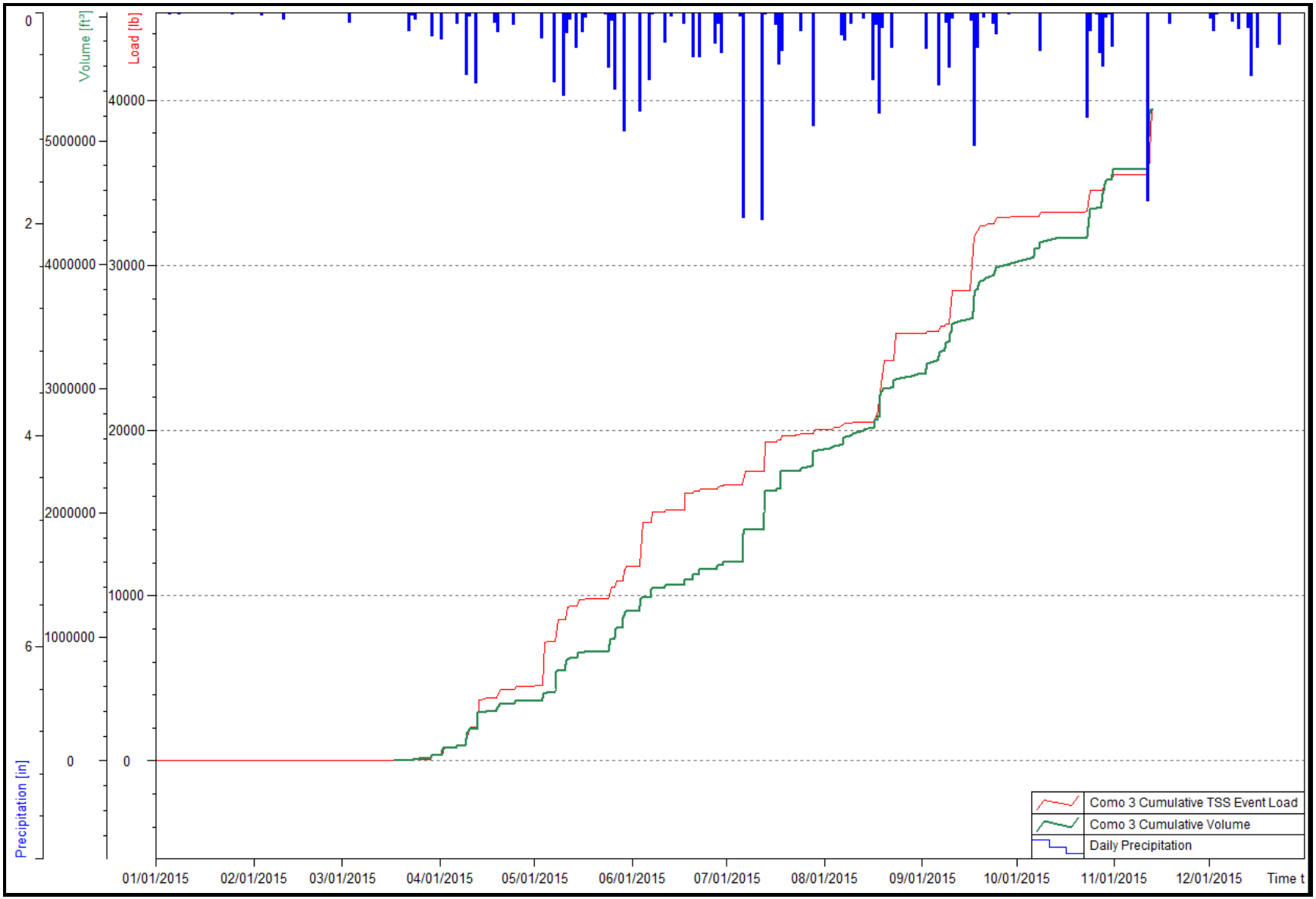

Figure 6-8: Como 3 cumulative volume, cumulative TSS event load, and daily precipitation.

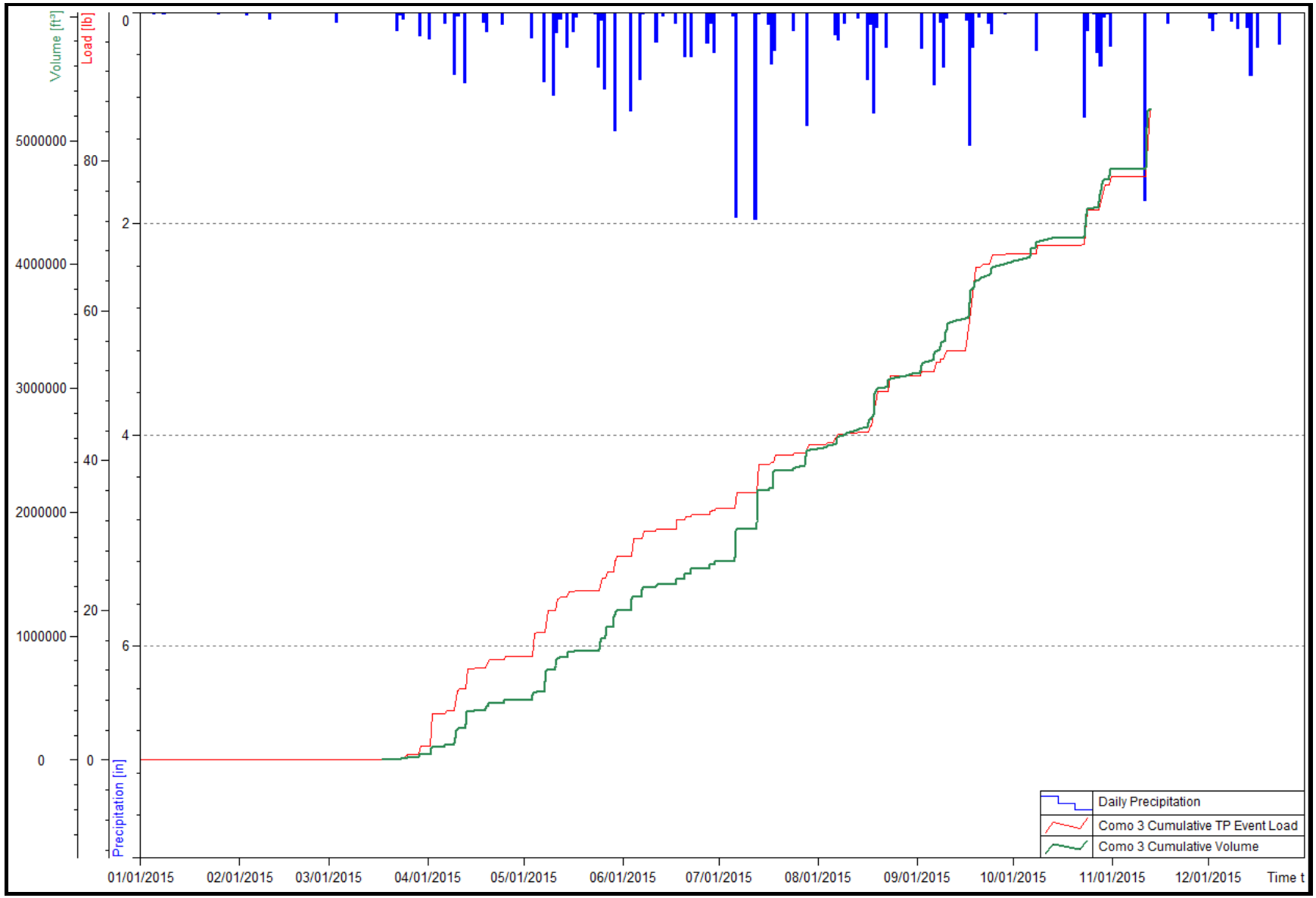

Figure 6-9: Como 3 cumulative volume, cumulative TP event load, and daily precipitation.

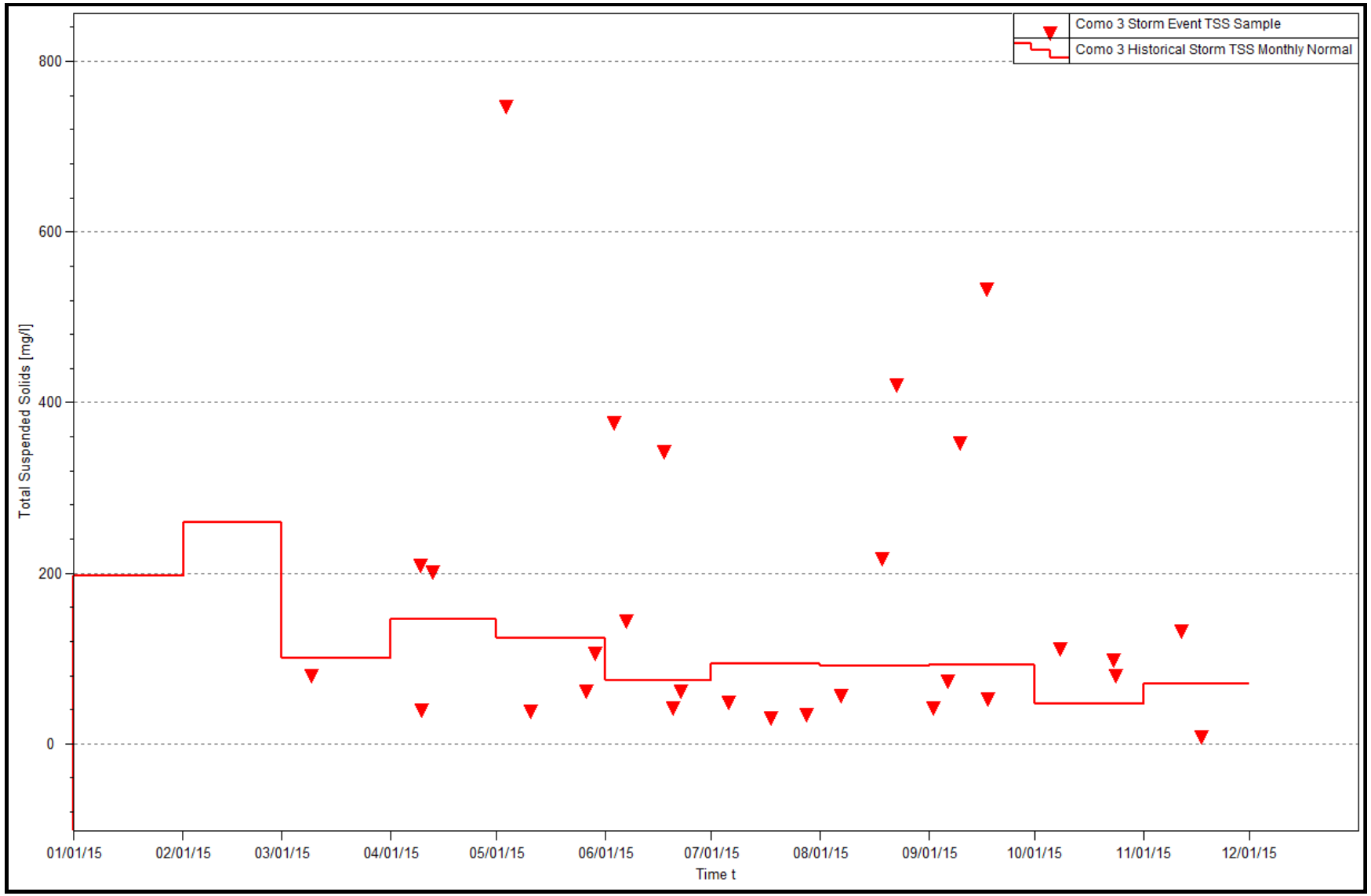

Figure 6-10: 2015 Como 7 TSS samples and historical monthly normal.

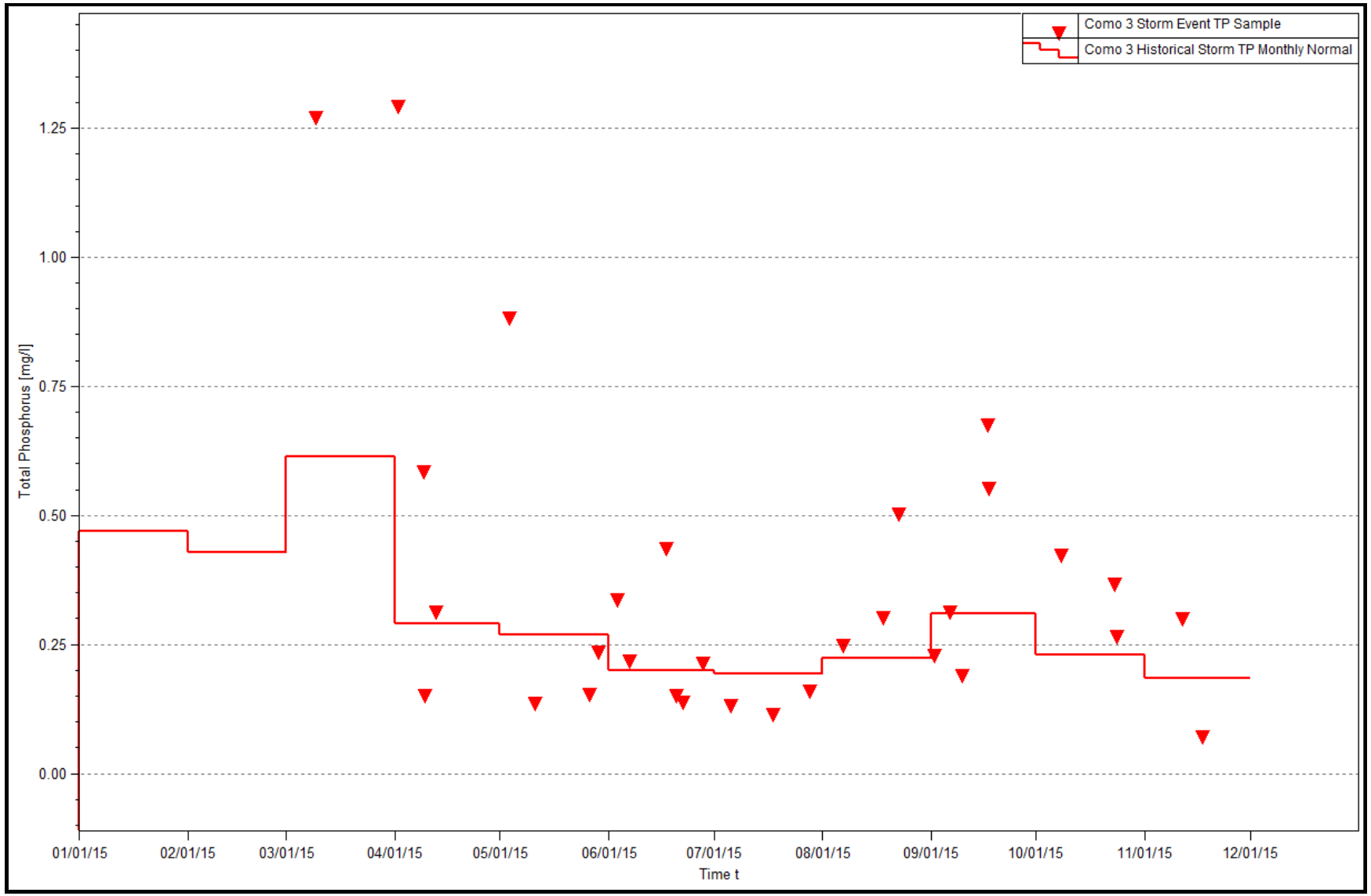

Figure 6-11: 2015 Como 7 TP samples and historical monthly normal.

Table 6-2: 2015 Como 3 summary table.

Parameter	
Subwatershed Area (acres)	517
Total Precipitation (inches)	30
Number of Monitoring Days	241
Number of Base Sampling Events	NA
Number of Storm Sampling Events	30
Number of Snowmelt Sampling Events	1
Number of Illicit Discharge Sampling Events	0

Discharge	
Baseflow Subtotal (Cubic Feet)	NA
Event Flow Subtotal (Cubic Feet)	5,322,022
Total Discharge (Cubic Feet)	5,322,022
Baseflow Water Yield (cf/ac)	NA
Event Water Yield (cf/ac)	10,294
Total Water Yield (cf/ac)	10,294

Total Suspended Solids	
Base FWA TSS (mg/L)	NA
Event FWA TSS (mg/L)	119
Total FWA TSS (mg/L)	119
Baseflow TSS Load (lbs)	NA
Event TSS Load (lbs)	39,398
Total TSS Load (lbs)	39,398
Total TSS Yield (lb/ac)	76

Total Phosphorus	
Base FWA TP (mg/L)	NA
Event FWA TP (mg/L)	0.26
Total FWA TP (mg/L)	0.26
Base TP Load (lbs)	NA
Event TP Load (lbs)	87
Total TP Load (lbs)	87
Total TP Yield (lb/ac)	0.17

7 EAST KITTSONDALE SUBWATERSHED RESULTS

7.1 DESCRIPTION

The East Kittsondale subwatershed is located in the southern portion of CRWD and drains 1,116 acres of St. Paul (Figure 7-2). East Kittsondale is the smallest of the four major subwatersheds monitored by CRWD. The subwatershed empties into the Mississippi River downstream of the confluence of the Minnesota and Mississippi Rivers. There are no surface water bodies in the subwatershed. Land use in the subwatershed is largely residential, with 46% impervious surface cover. CRWD operates a full water quality monitoring station in the East Kittsondale subwatershed. Flow monitoring equipment is installed year-round while a water quality sampler is only installed for the non-winter monitoring period (April to early November). The station is not located at the true outlet to the river because the depth of the storm sewer beneath the ground surface makes it difficult to access any farther downstream.

Figure 7-1: The East Kittsondale monitoring station location (top, bottom left) and flow-logging and sampling equipment installed inside storm tunnel (bottom right).

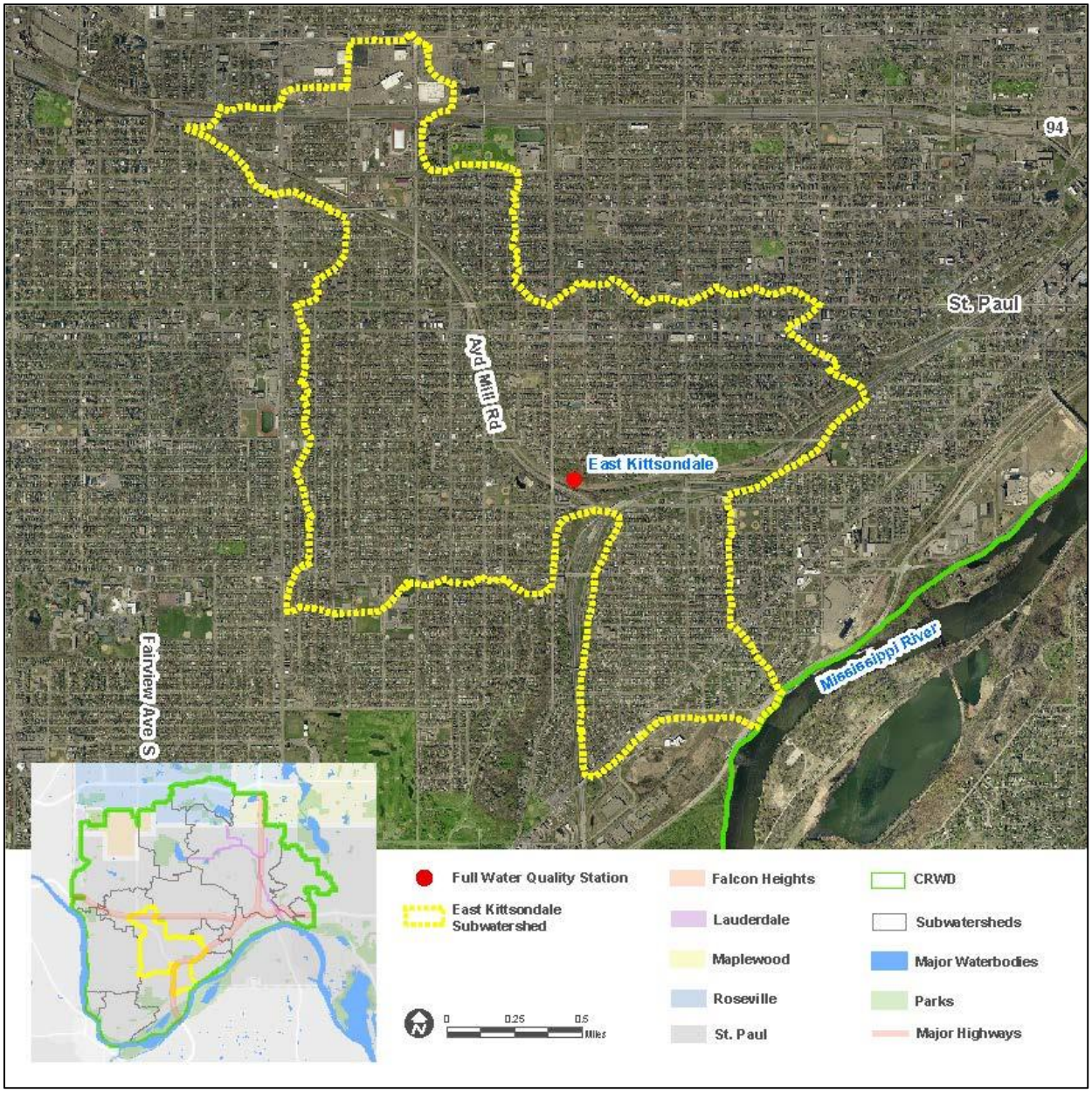

Figure 7-2: Map of the East Kittsondale subwatershed and monitoring station location.

7.2 2015 MONITORING SUMMARY

The East Kittsondale subwatershed has been monitored for flow and water quality since 2005. From 2005-2009, monitoring only occurred during the spring, summer, and fall. Since 2010, the station has been monitored for the full calendar year with continuous flow data recorded and one full water quality sampling event per month.

The East Kittsondale monitoring station has a history of illicit discharges. In 2010, an illicit connection was identified and corrected. In 2012 possible illicit discharges were noticed during a dry period of the year.

Summaries of 2015 monitoring data collected and observed at East Kittsondale are listed below. Monitoring efficiency at East Kittsondale is explained in Appendix B (Table B-1). All 2015 lab data for East Kittsondale can be found in Appendix C (Table C-3).

7.2.1 DISCHARGE

Level, velocity, and discharge were monitored at East Kittsondale for both baseflow and event flow in 2015 (Figures 7-3 & 7-4; Tables 5-1 & 7-1).

- Total baseflow discharge: 11,830,658 cubic feet
- Total event flow discharge: 39,464,438 cubic feet
- Total annual discharge: 51,328,515 cubic feet

7.2.2 TOTAL SUSPENDED SOLIDS (TSS)

Baseflow and event flow samples were analyzed for TSS concentrations in mg/L (Figure 7-5) in order to calculate event-based and total annual loads (Figure 7-3; Tables 5-1 & 7-1). The 2015 TSS loading table for East Kittsondale is reported in Appendix D (Table D-3).

- Base flow weighted average concentration: 4 mg/L
- Event flow weighted average concentration: 154 mg/L
- Total baseflow TSS load: 2,908 lbs
- Total event flow TSS load: 378,600 lbs
- Total annual TSS load: 381,508 lbs

7.2.3 TOTAL PHOSPHORUS (TP)

Baseflow and event flow samples were analyzed for TP concentrations in mg/L (Figure 7-6) in order to calculate event-based and total annual loads (Figure 7-4; Tables 5-1 & 7-1). The 2015 TP loading table for East Kittsondale is reported in Appendix D (Table D-3).

- Base flow weighted average concentration: 0.05 mg/L
- Event flow weighted average concentration: 0.31 mg/L
- Total baseflow TP load: 39 lbs
- Total event flow TP load: 762 lbs
- Total annual TP load: 800 lbs

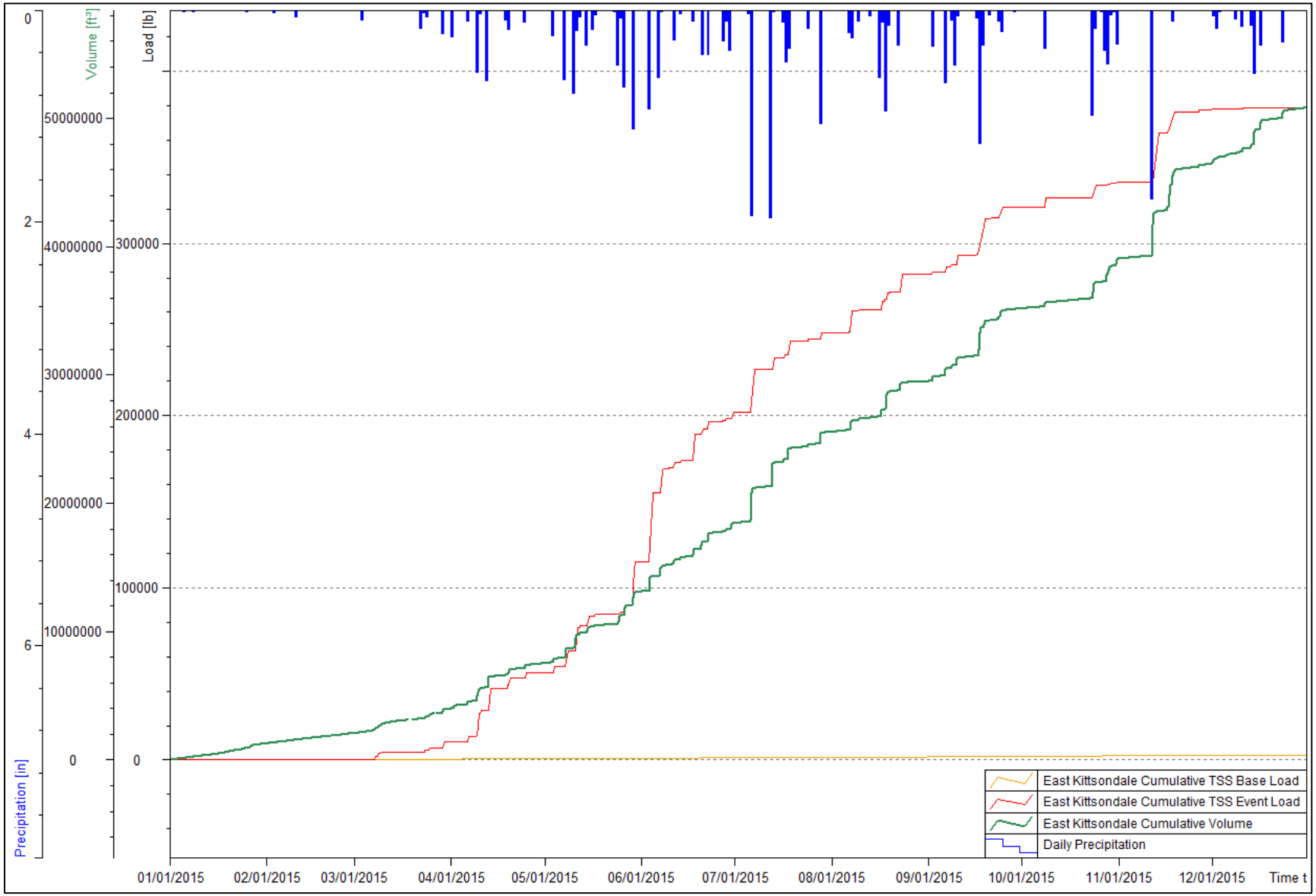

Figure 7-3: East Kittsondale subwatershed cumulative discharge, TSS base load, and TSS event load, and daily precipitation.

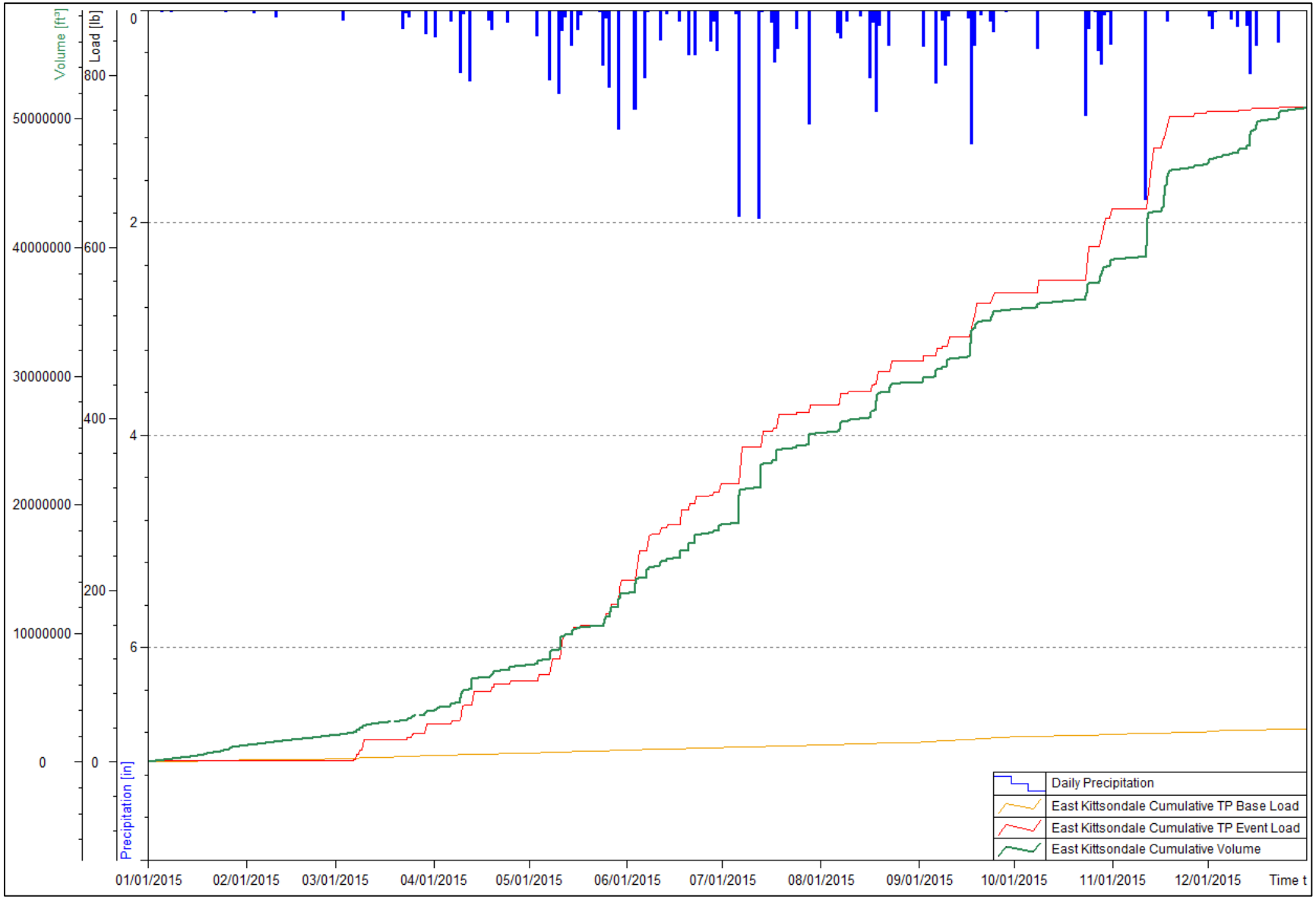

Figure 7-4: East Kittsondale subwatershed cumulative discharge, TP base load, and TP event load, and daily precipitation.

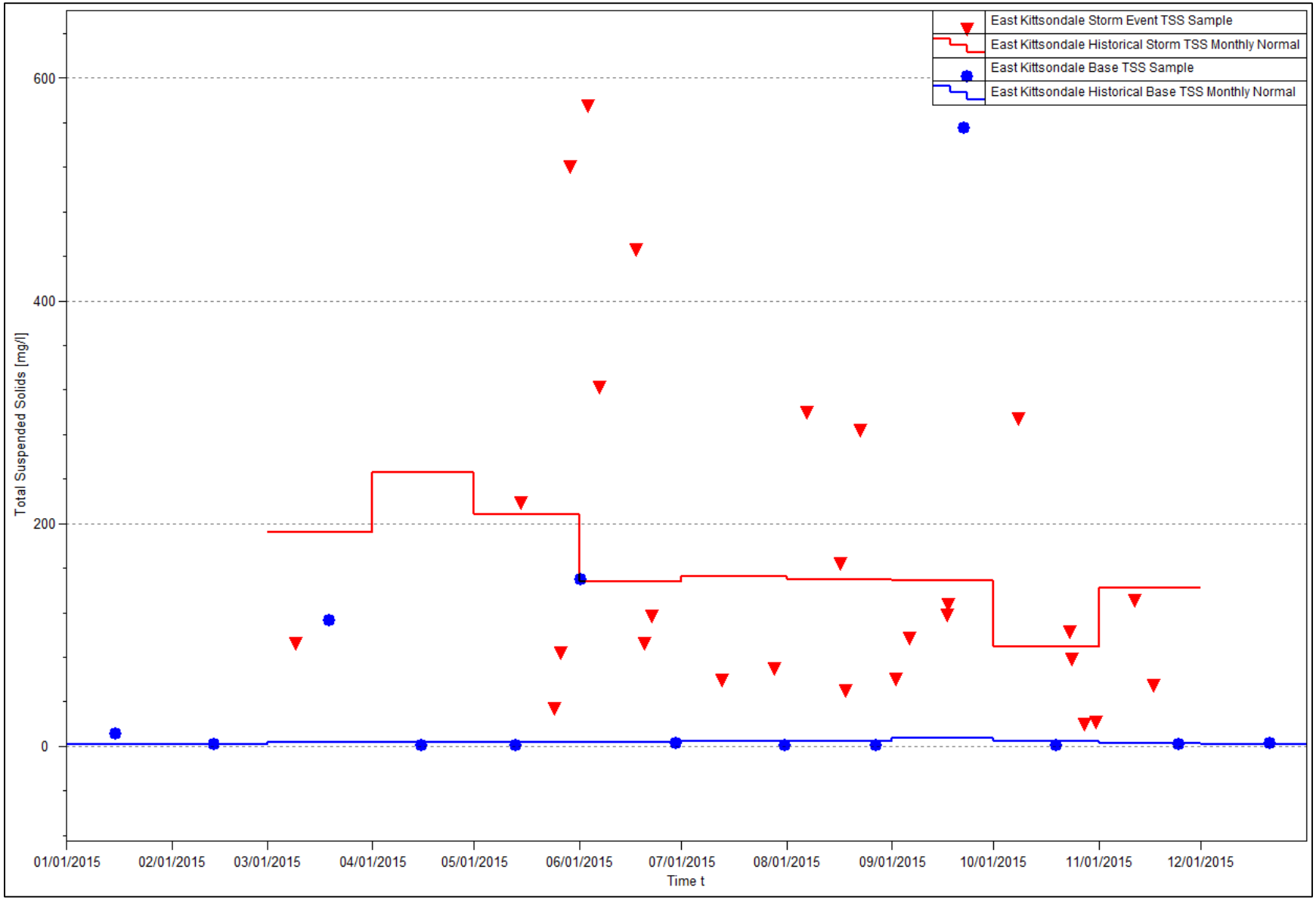

Figure 7-5: 2015 East Kittsondale TSS samples and historical monthly normal.

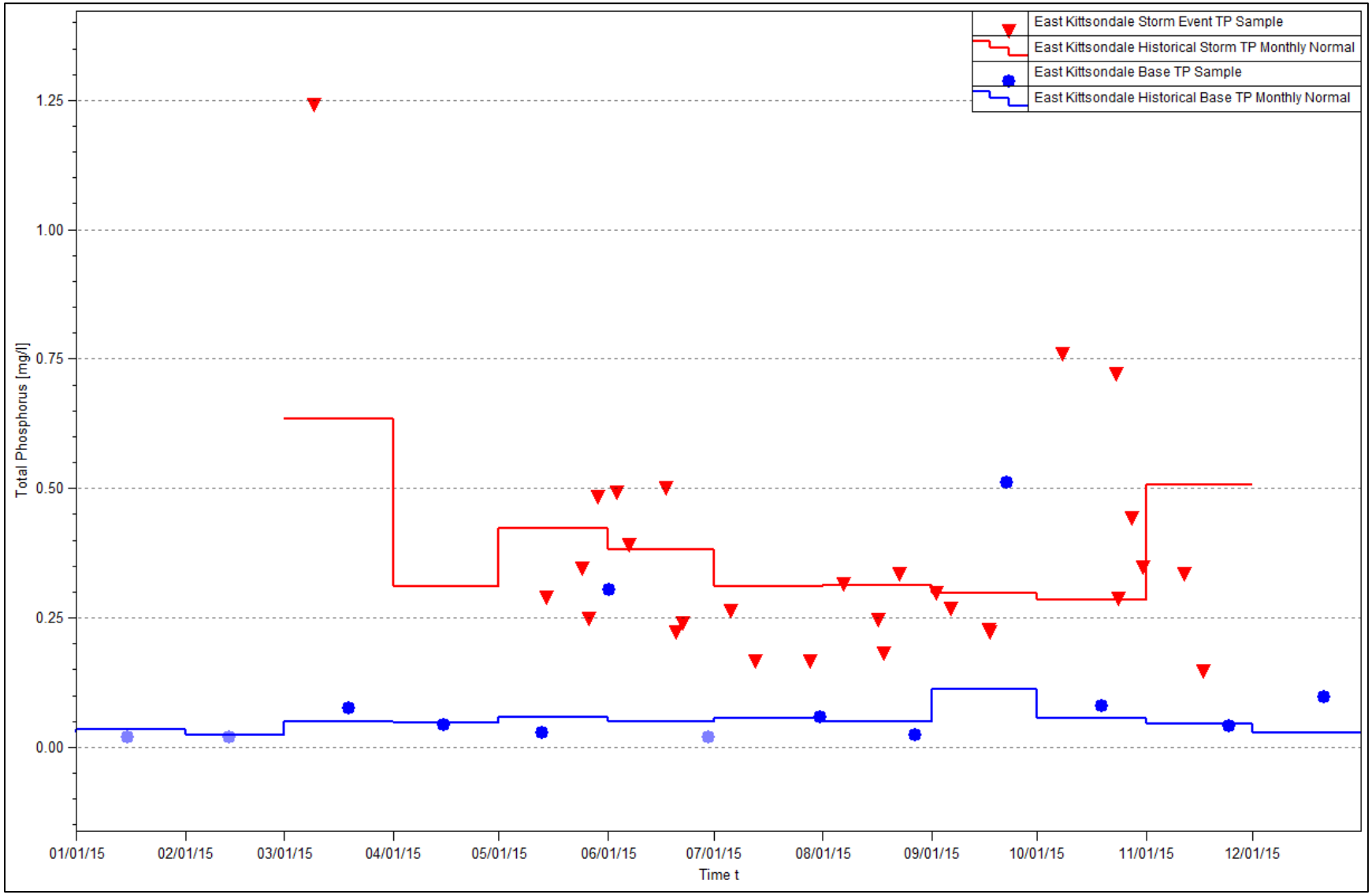

Figure 7-6: 2015 East Kittsondale TP samples and historical monthly normal.

Table 7-1: 2015 East Kittsondale subwatershed summary table.

Parameter	
Subwatershed Area (acres)	1,116
Total Precipitation (inches)	35
Number of Monitoring Days	361
Number of Base Sampling Events	13
Number of Storm Sampling Events	27
Number of Snowmelt Sampling Events	1
Number of Illicit Discharge Sampling Events	1

Discharge	
Baseflow Subtotal (Cubic Feet)	11,830,658
Event Flow Subtotal (Cubic Feet)	39,464,438
Total Discharge (Cubic Feet)	51,328,515
Baseflow Water Yield (cf/ac)	10,601
Event Water Yield (cf/ac)	35,362
Total Water Yield (cf/ac)	45,993

Total Suspended Solids	
Base FWA TSS (mg/L)	4
Event FWA TSS (mg/L)	154
Total FWA TSS (mg/L)	119
Baseflow TSS Load (lbs)	2,908
Event TSS Load (lbs)	378,600
Total TSS Load (lbs)	381,508
Total TSS Yield (lb/ac)	342

Total Phosphorus	
Base FWA TP (mg/L)	0.05
Event FWA TP (mg/L)	0.31
Total FWA TP (mg/L)	0.25
Base TP Load (lbs)	39
Event TP Load (lbs)	762
Total TP Load (lbs)	800
Total TP Yield (lb/ac)	0.72

8 HIDDEN FALLS SUBWATERSHED RESULTS

8.1 DESCRIPTION

The Hidden Falls subwatershed is a small subwatershed (166 acres), which encompasses the former Ford Motor Company Twin Cities Assembly Plant (Figures 8-1 & 8-2). The former assembly plant site makes up approximately 70% of the watershed's total area while the remainder of the land area is residential. Monitoring of the Hidden Falls subwatershed began in April 2014, one year after demolition of the Ford site began in May 2013. The primary goal of monitoring the subwatershed is to characterize the water quality over time as the Ford site is demolished and redeveloped.

Figure 8-1: The Hidden Falls monitoring station (top); Hidden Falls, downstream of monitoring station (bottom).

Figure 8-2: Map of Hidden Falls subwatershed and monitoring station location.

8.2 2015 MONITORING SUMMARY

The Hidden Falls subwatershed was monitored for discharge and water quality for the 2015 monitoring season. Flow and water quality monitoring at this location generally occurs between the months of April and October. During the winter months, ice accumulation and freezing temperatures prevents monitoring activities.

Summaries of 2015 monitoring data collected and observed at Hidden Falls are listed below. Monitoring efficiency at Hidden Falls is explained in Appendix B (Table B-1). All 2015 lab data for Hidden Falls can be found in Appendix C (Table C-4).

8.2.1 DISCHARGE

Level, velocity, and discharge were monitored at Hidden Falls for both baseflow and event flow in 2015 (Figures 8-3 & 8-4; Tables 5-1 & 8-1).

- Total baseflow discharge: 3,302,748 cubic feet
- Total event flow discharge: 4,955,324 cubic feet
- Total annual discharge: 8,258,523 cubic feet

8.2.2 TOTAL SUSPENDED SOLIDS (TSS)

Baseflow and event flow samples were analyzed for TSS concentrations in mg/L (Figure 8-5) in order to calculate event-based and total annual loads (Figure 8-3; Tables 5-1 & 8-1). The 2015 TSS loading table for Hidden Falls is reported in Appendix D (Table D-4).

- Base flow weighted average concentration: 9 mg/L
- Event flow weighted average concentration: 220 mg/L
- Total baseflow TSS load: 1,786 lbs
- Total event flow TSS load: 68,147 lbs
- Total annual TSS load: 69,933 lbs

8.2.3 TOTAL PHOSPHORUS (TP)

Baseflow and event flow samples were analyzed for TP concentrations in mg/L (Figure 8-6) in order to calculate event-based and total annual loads (Figure 8-4; Tables 5-1 & 8-1). The 2015 TP loading table for Hidden Falls is reported in Appendix D (Table D-4).

- Base flow weighted average concentration: 0.04 mg/L
- Event flow weighted average concentration: 0.29 mg/L
- Total baseflow TP load: 9 lbs
- Total event flow TP load: 90 lbs
- Total annual TP load: 99 lbs

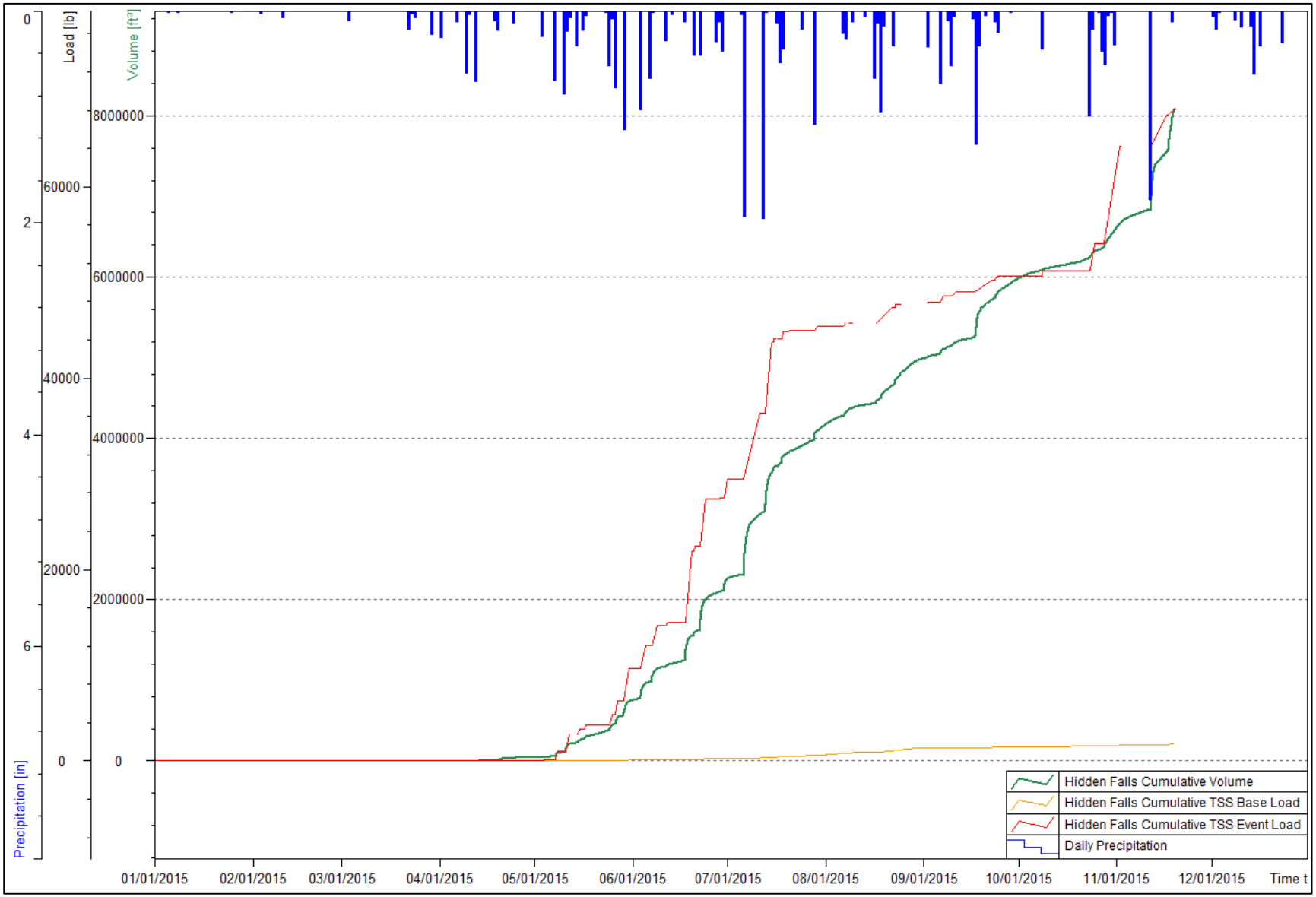

Figure 8-3: Hidden Falls subwatershed cumulative discharge, TSS base load, and TSS event load, and daily precipitation.

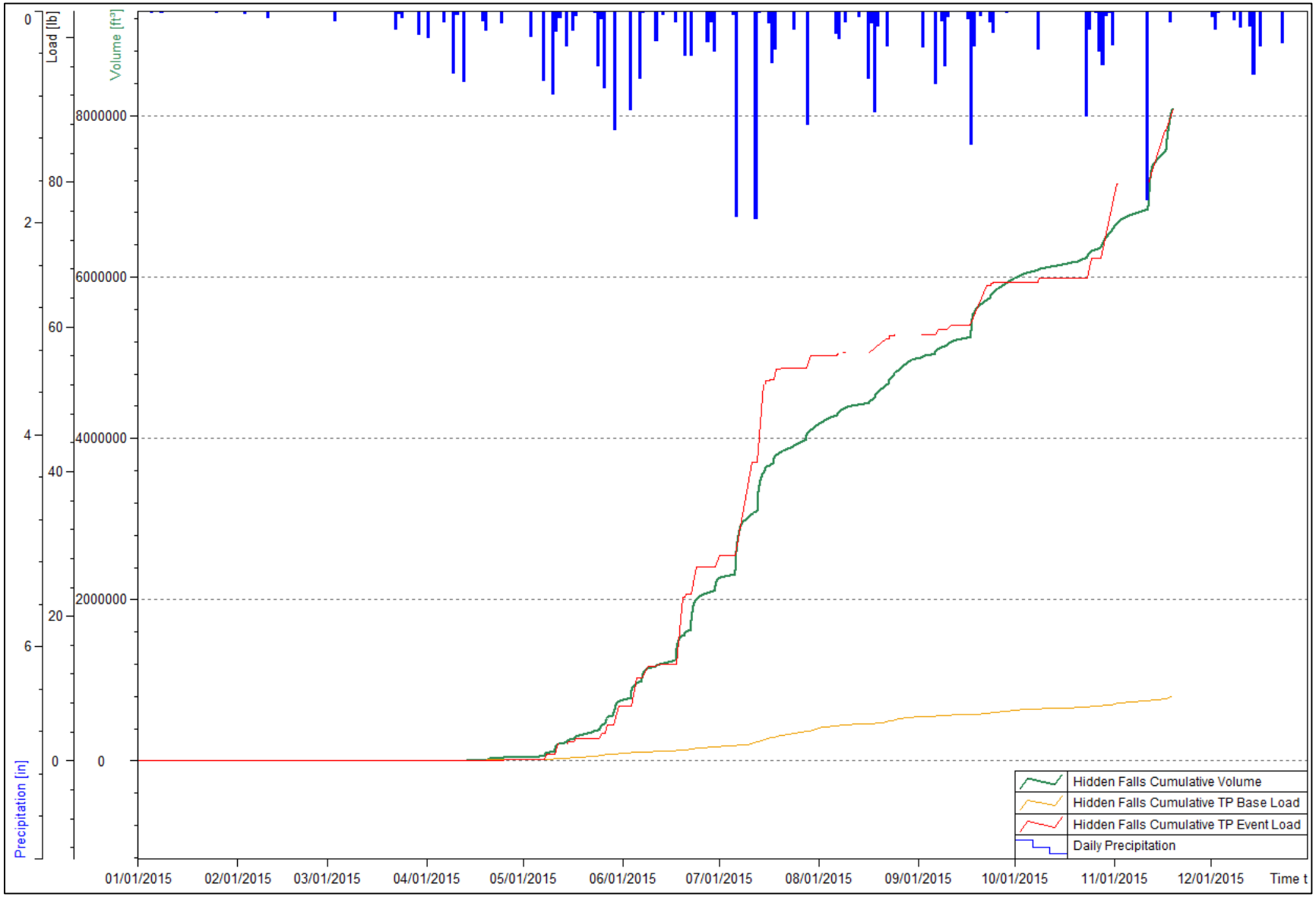

Figure 8-4: Hidden Falls subwatershed cumulative discharge, TP base load, and TP event load, and daily precipitation.

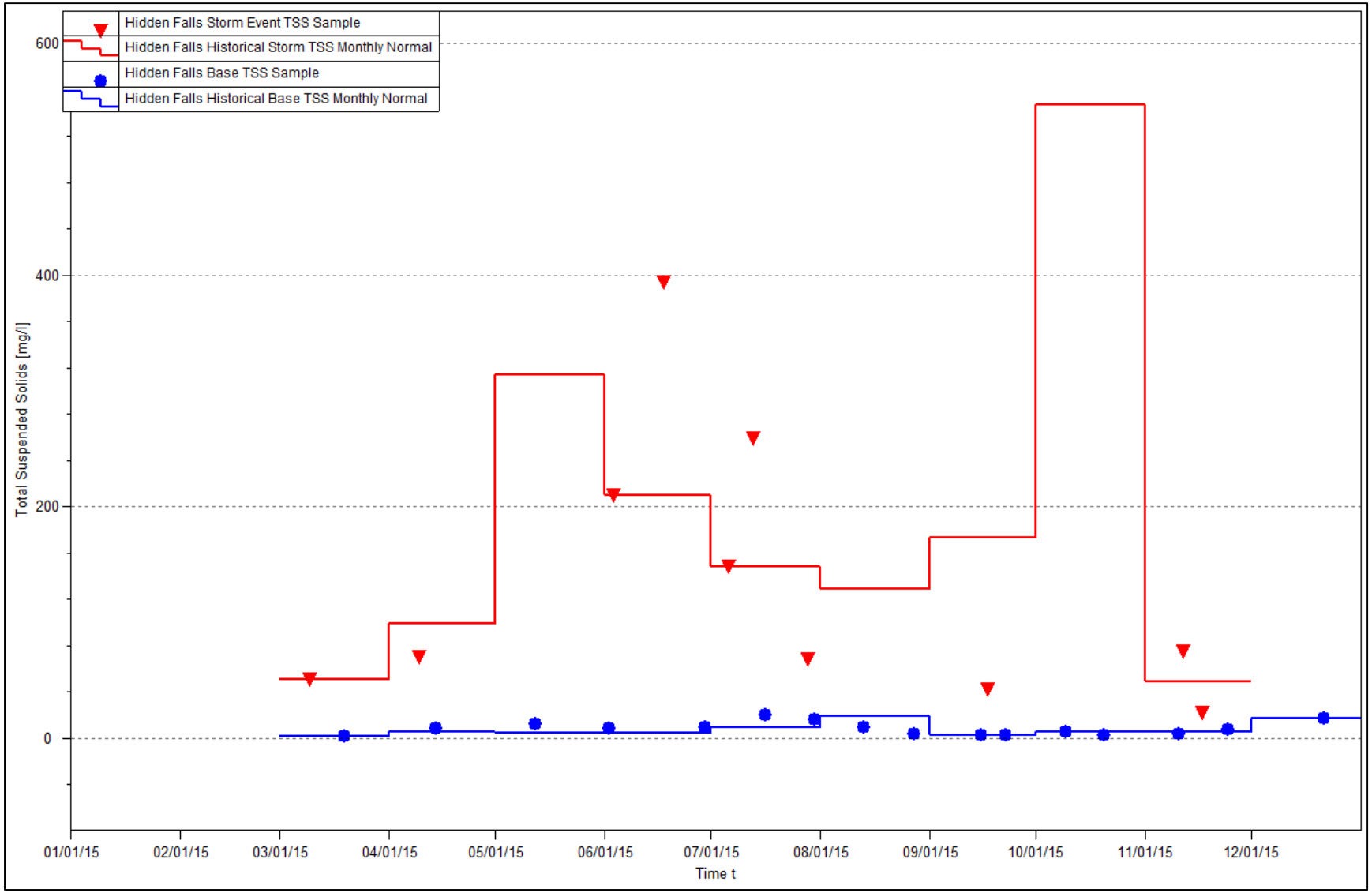

Figure 8-5: 2015 Hidden Falls TSS samples and historical monthly normal.

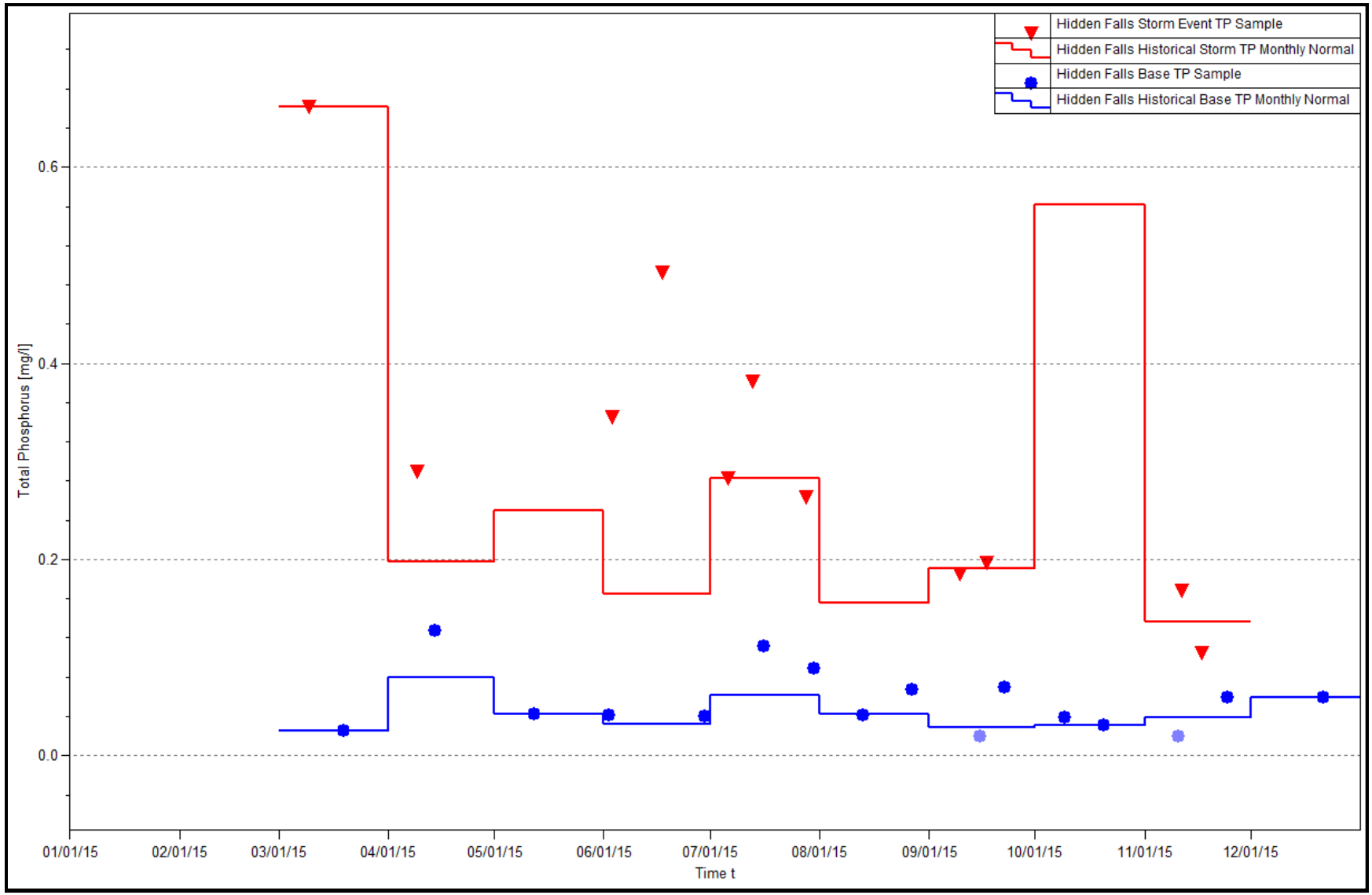

Figure 8-6: 2015 Hidden Falls TP samples and historical monthly normal.

Table 8-1: 2015 Hidden Falls subwatershed summary table.

Parameter	
Subwatershed Area (acres)	167
Total Precipitation (inches)	29
Number of Monitoring Days	219
Number of Base Sampling Events	16
Number of Storm Sampling Events	10
Number of Snowmelt Sampling Events	1
Number of Illicit Discharge Sampling Events	0

Discharge	
Baseflow Subtotal (Cubic Feet)	3,302,748
Event Flow Subtotal (Cubic Feet)	4,955,324
Total Discharge (Cubic Feet)	8,258,523
Baseflow Water Yield (cf/ac)	19,777
Event Water Yield (cf/ac)	29,673
Total Water Yield (cf/ac)	49,452

Total Suspended Solids	
Base FWA TSS (mg/L)	9
Event FWA TSS (mg/L)	220
Total FWA TSS (mg/L)	136
Baseflow TSS Load (lbs)	1,786
Event TSS Load (lbs)	68,147
Total TSS Load (lbs)	69,933
Total TSS Yield (lb/ac)	419

Total Phosphorus	
Base FWA TP (mg/L)	0.04
Event FWA TP (mg/L)	0.29
Total FWA TP (mg/L)	0.19
Base TP Load (lbs)	9
Event TP Load (lbs)	90
Total TP Load (lbs)	99
Total TP Yield (lb/ac)	0.59

9 LAKE MCCARRONS SUBWATERSHED RESULTS

9.1 DESCRIPTION

The Lake McCarrons subwatershed drains 1,070 acres and is the northernmost subwatershed in CRWD, located entirely within the city limits of Roseville (Figure 9-2). Land use in the subwatershed is predominantly residential and parkland. The largest subwatershed within the Lake McCarrons subwatershed is the Villa Park subwatershed (753 acres), which flows through the Villa Park Wetland System before discharging into the lake. The Villa Park Wetland System is designed to capture and treat stormwater runoff from the Villa Park subwatershed before entering Lake McCarrons.

CRWD operates a monitoring station at the outlet of the Villa Park Wetland System (called Villa Park Outlet) in order to quantify and characterize the water exiting the wetland system to Lake McCarrons (Figures 9-1 & 9-2). CRWD also operates a flow-only station at the outlet of Lake McCarrons (called McCarrons Outlet) to determine total discharge from the lake during storm events (the lake only discharges when water levels are higher than normal) (Figures 9-1 & 9-2). When it overflows, water flowing from the outlet of Lake McCarrons enters the Trout Brook Storm Sewer System which eventually discharges to the Mississippi River. For more information on Lake McCarrons water quality, refer to the *CRWD 2015 Lakes Monitoring Report* (CRWD, 2016).

Figure 9-1: The Lake McCarrons Outlet monitoring site location (left); and Villa Park Wetland System (Villa Park Outlet) monitoring site location (right).

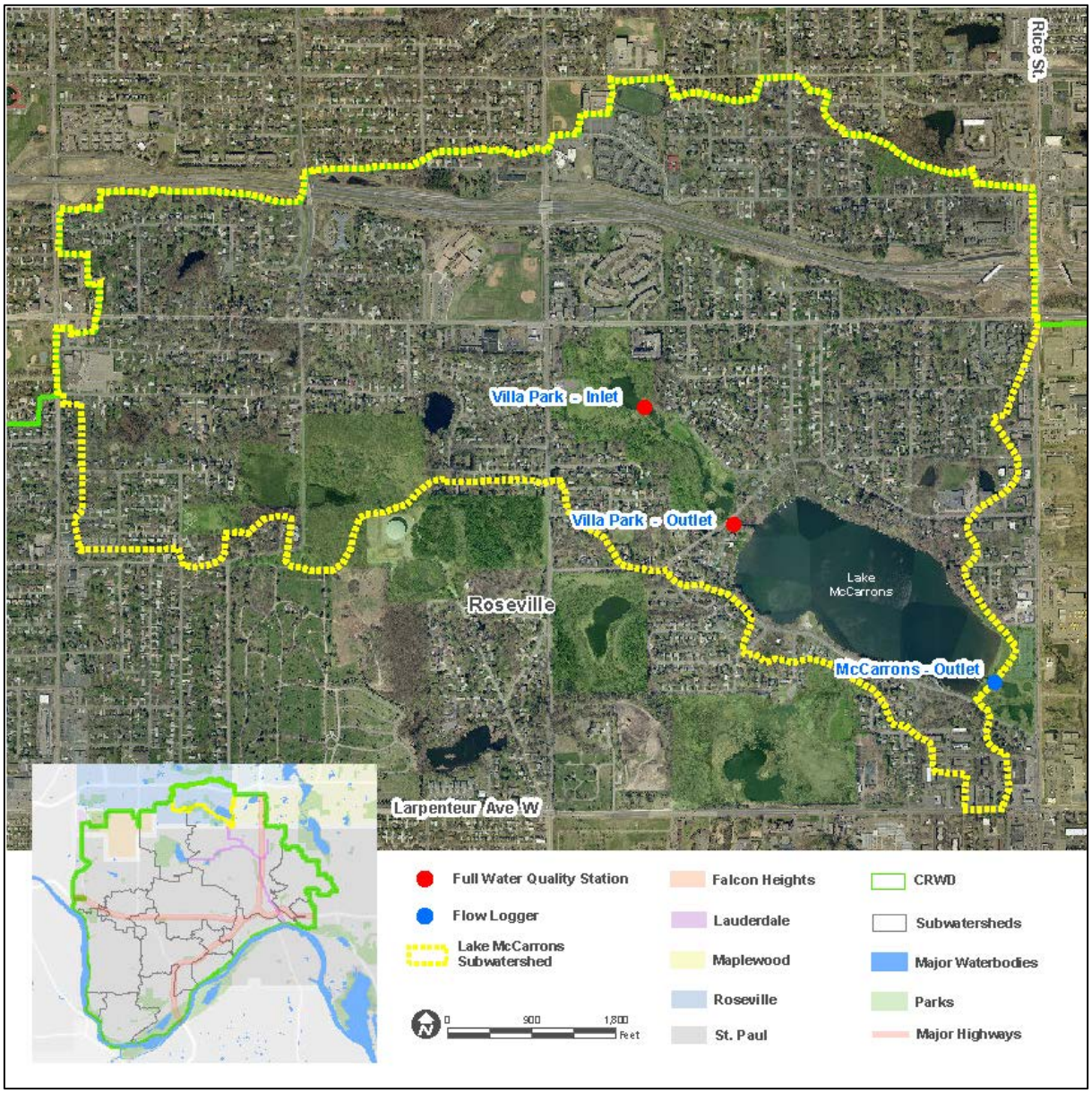

Figure 9-2: Map of the Lake McCarrons subwatershed and monitoring station locations.

9.2 2015 MONITORING SUMMARY – VILLA PARK OUTLET

The Lake McCarrons subwatershed has been monitored for discharge and water quality at the Villa Park Outlet from 2006-2015. Flow and water quality monitoring at this location generally occurs between the months of April to November. During the winter months, baseflow grab samples are taken once a month, but neither level nor flow are recorded during this period.

Summaries of 2015 monitoring data collected and observed at Villa Park Outlet are listed below. Monitoring efficiency at Villa Park Outlet is explained in Appendix B (Table B-1). All lab data for Villa Park Outlet can be found in Appendix C (Table C-5).

A summary of the historical (2006-2012) performance data collected at Villa Park Wetland System is included in the *2014 Stormwater Monitoring Report*, Appendix D: *Analysis of Nutrient Loading and Performance of the Villa Park Wetland, 2006-2012* (CRWD, 2015).

9.2.1 DISCHARGE

Level, velocity, and discharge were monitored at Villa Park Outlet for both baseflow and event flow in 2015 (Figures 9-3 & 9-4; Tables 5-1 & 9-1).

- Total baseflow discharge: 5,834,922 cubic feet
- Total event flow discharge: 8,302,496 cubic feet
- Total annual discharge: 14,141,358 cubic feet

9.2.2 TOTAL SUSPENDED SOLIDS (TSS)

Baseflow and event flow samples were analyzed for TSS concentrations in mg/L (Figure 9-5) in order to calculate event-based and total annual loads (Figure 9-3; Tables 5-1 & 9-1). The 2015 TSS loading table for Villa Park Outlet is reported in Appendix D (Table D-5).

- Base flow weighted average concentration: 8 mg/L
- Event flow weighted average concentration: 17 mg/L
- Total baseflow TSS load: 3,085 lbs
- Total event flow TSS load: 8,705 lbs
- Total annual TSS load: 11,790 lbs

9.2.3 TOTAL PHOSPHORUS (TP)

Baseflow and event flow samples were analyzed for TP concentrations in mg/L (Figure 9-6) in order to calculate event-based and total annual loads (Figure 9-4; Tables 5-1 & 9-1). The 2015 TP loading table for Villa Park Outlet is reported in Appendix D (Table D-5).

- Base flow weighted average concentration: 0.24 mg/L
- Event flow weighted average concentration: 0.23 mg/L
- Total baseflow TP load: 86 lbs
- Total event flow TP load: 117 lbs
- Total annual TP load: 203 lbs

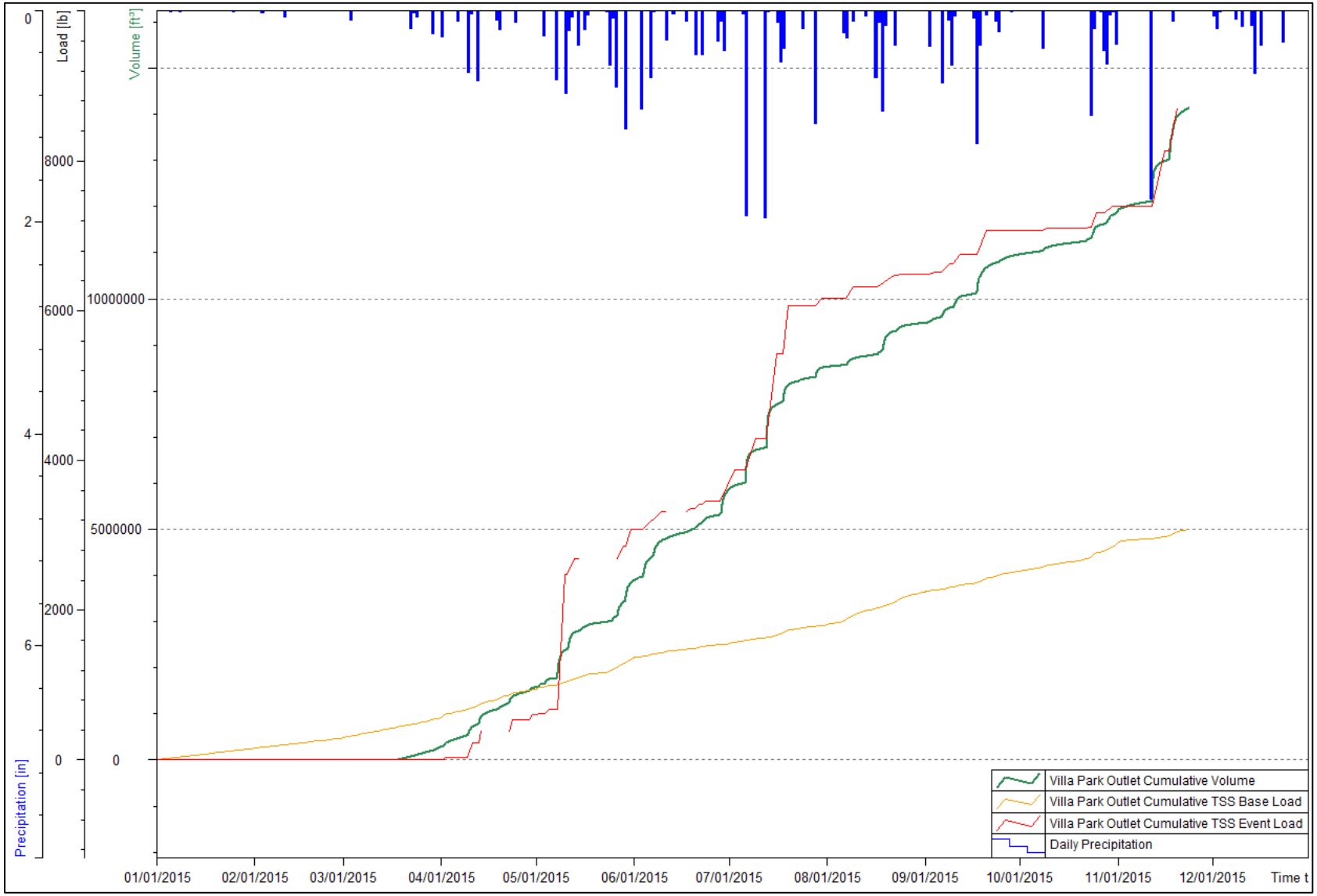

Figure 9-3: Villa Park Outlet cumulative discharge, TSS base load, and TSS event load, and daily precipitation.

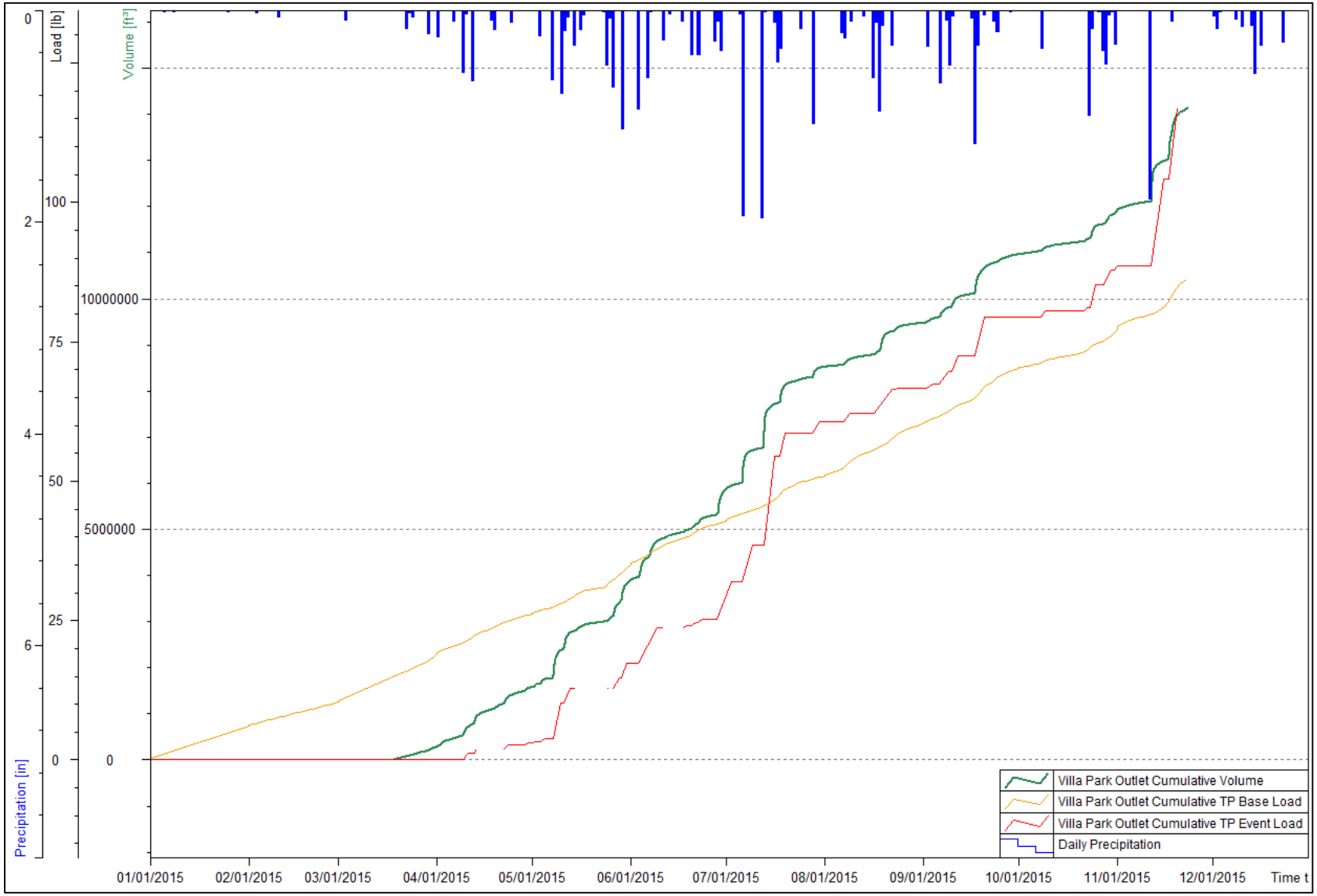

Figure 9-4: Villa Park Outlet cumulative discharge, TP base load, and TP event load, and daily precipitation.

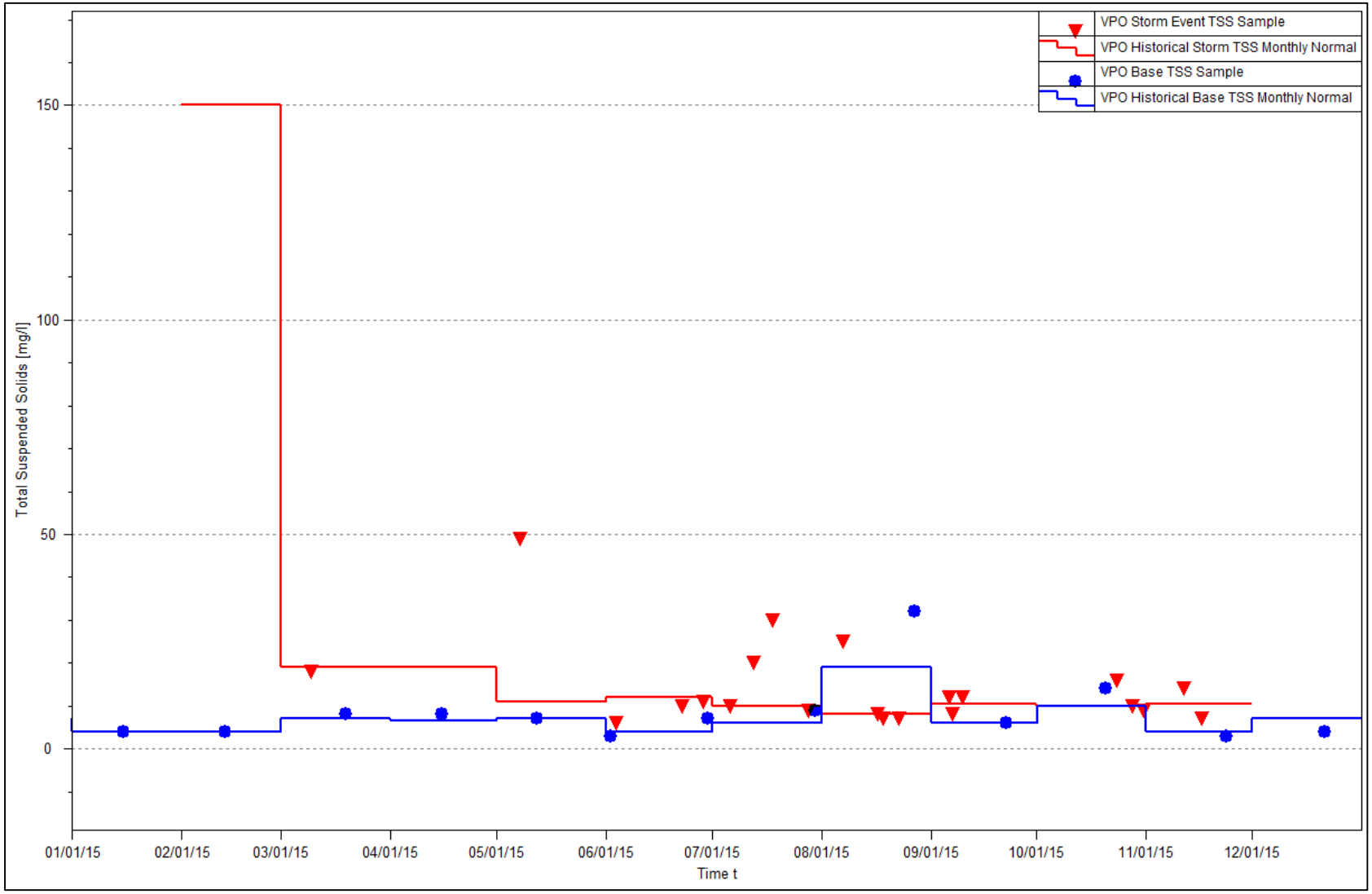

Figure 9-5: 2015 Villa Park Outlet TSS samples and historical monthly normal.

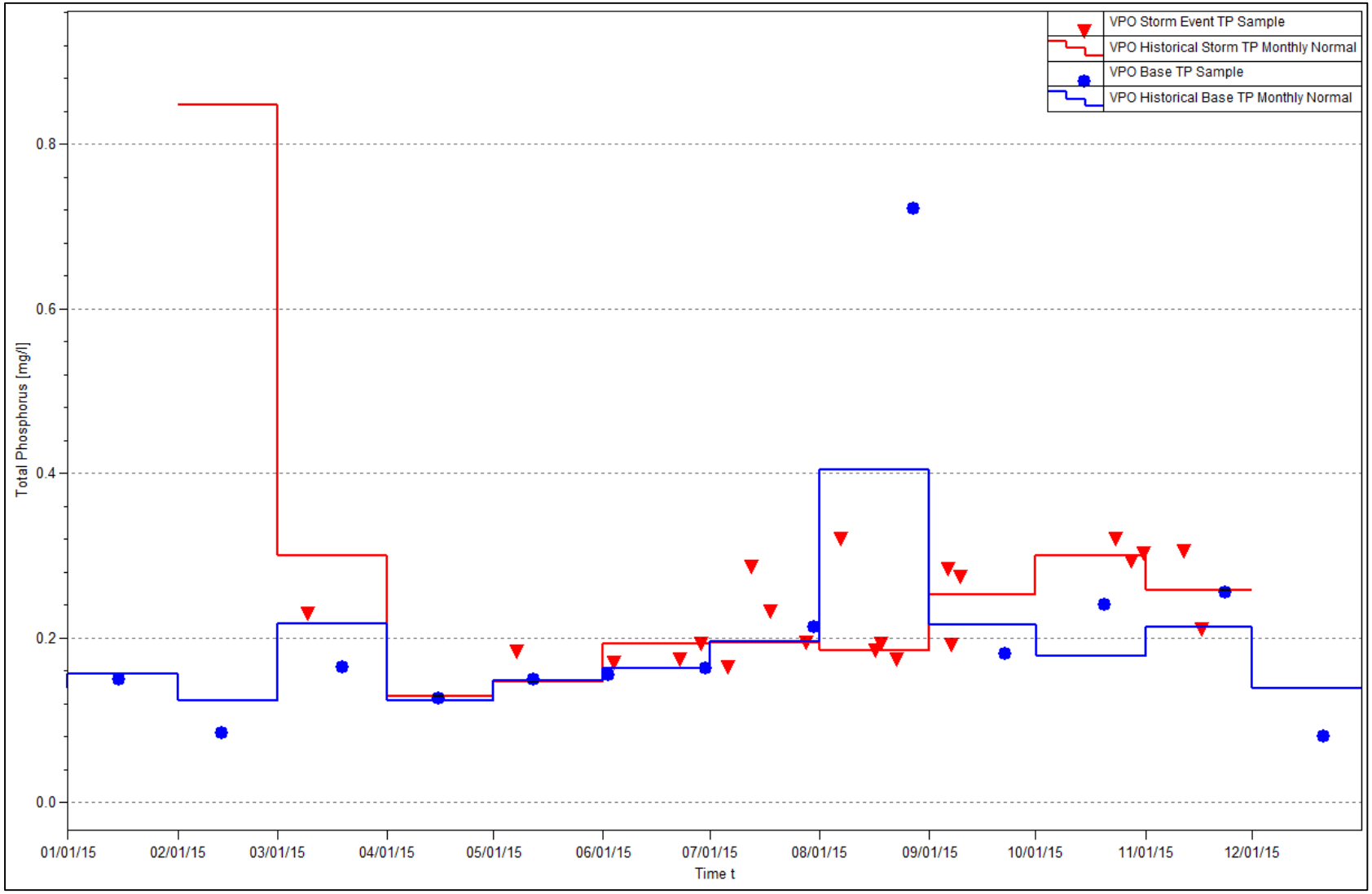

Figure 9-6: 2015 Villa Park Outlet TP samples and historical monthly normal.

Table 9-1: 2015 Villa Park Outlet subwatershed summary table.

Parameter	
Subwatershed Area (acres)	753
Total Precipitation (inches)	32
Number of Monitoring Days	252
Number of Base Sampling Events	13
Number of Storm Sampling Events	20
Number of Snowmelt Sampling Events	1
Number of Illicit Discharge Sampling Events	0

Discharge	
Baseflow Subtotal (Cubic Feet)	5,834,922
Event Flow Subtotal (Cubic Feet)	8,302,496
Total Discharge (Cubic Feet)	14,141,358
Baseflow Water Yield (cf/ac)	7,749
Event Water Yield (cf/ac)	11,026
Total Water Yield (cf/ac)	18,780

Total Suspended Solids	
Base FWA TSS (mg/L)	8
Event FWA TSS (mg/L)	17
Total FWA TSS (mg/L)	13
Baseflow TSS Load (lbs)	3,085
Event TSS Load (lbs)	8,705
Total TSS Load (lbs)	11,790
Total TSS Yield (lb/ac)	16

Total Phosphorus	
Base FWA TP (mg/L)	0.24
Event FWA TP (mg/L)	0.23
Total FWA TP (mg/L)	0.23
Base TP Load (lbs)	86
Event TP Load (lbs)	117
Total TP Load (lbs)	203
Total TP Yield (lb/ac)	0.27

9.3 2015 MONITORING SUMMARY – LAKE MCCARRONS OUTLET

The discharge at the outlet of Lake McCarrons has been monitored from 2006-2015. Flow monitoring at this location generally occurs between the months of April to November. During the winter months, level and flow are not recorded. However, outflow during this time period is rare because the lake is frozen.

A summary of the 2015 monitoring data collected and observed at McCarrons Outlet is listed below. Monitoring efficiency at McCarrons Outlet is reported in Appendix B.

9.3.1 DISCHARGE

Level, velocity, and discharge were monitored at McCarrons Outlet in 2015. Total annual discharge for 2015 was 30,780,145 cf and was commensurate with the historical average.

10 PHALEN CREEK SUBWATERSHED RESULTS

10.1 DESCRIPTION

The Phalen Creek subwatershed is the eastern-most subwatershed in CRWD (Figure 10-2). Located entirely within the city limits of St. Paul, Phalen Creek drains 1,433 acres and outlets to the Mississippi River. CRWD monitors the Phalen Creek storm sewer near its outlet to the Mississippi River at the Bruce Vento Nature Sanctuary (Figure 10-1). Land use in the Phalen Creek subwatershed is a mix of industrial, commercial, and residential with approximately 50% impervious surfaces (CRWD, 2000).

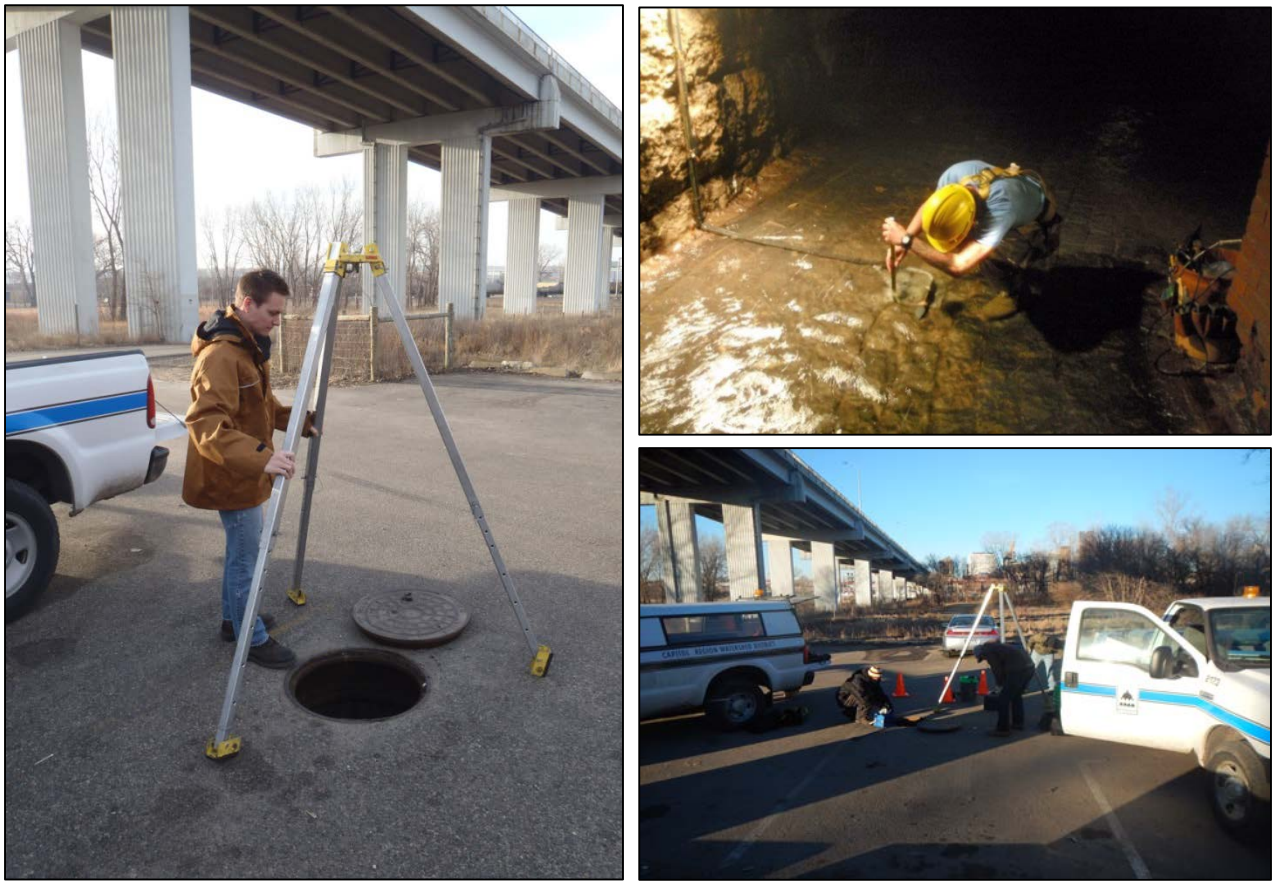

Figure 10-1: The Phalen Creek monitoring station location (left), flow-logging and sampling equipment installed inside storm tunnel (top right), and installation setup (bottom right).

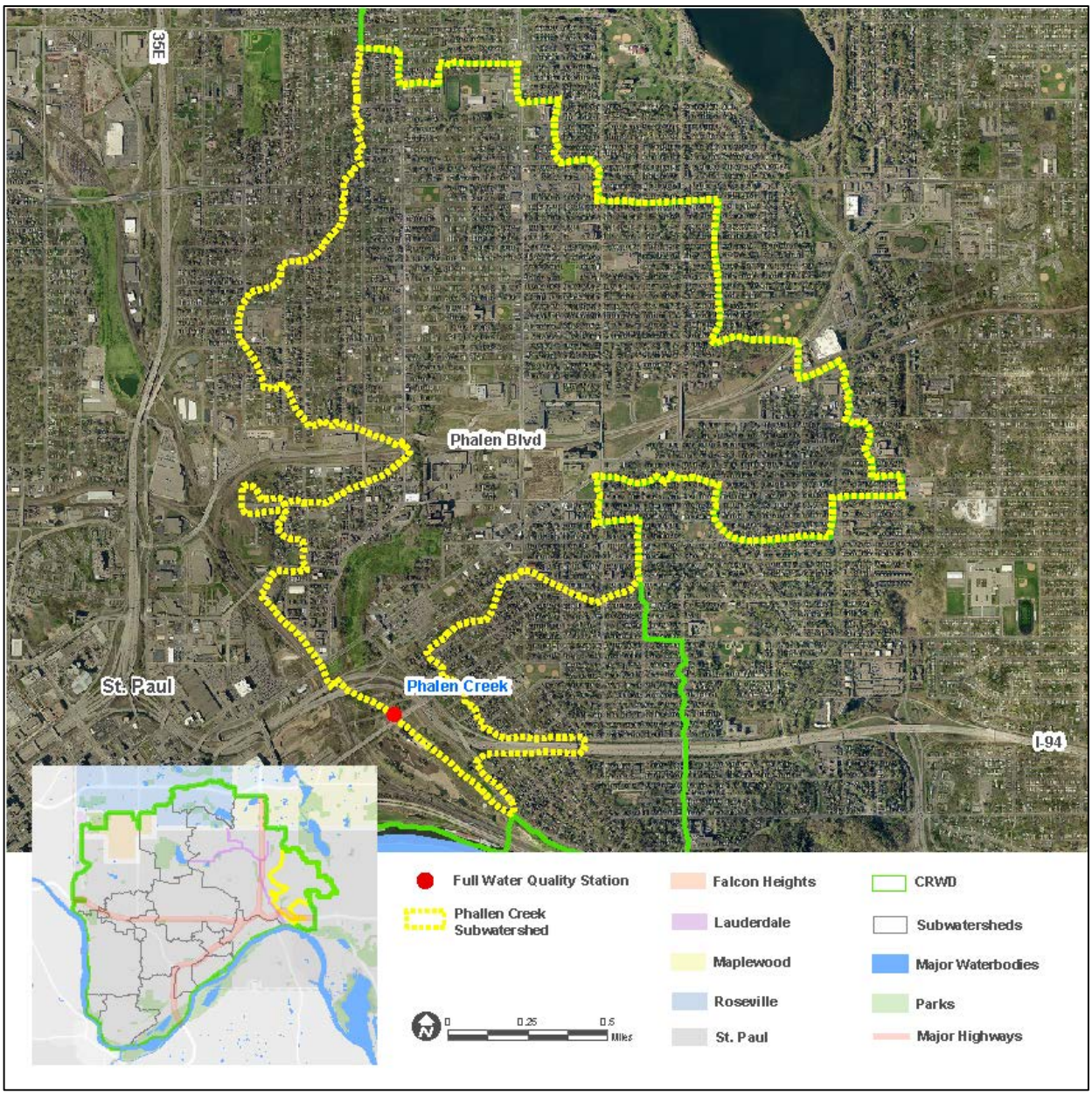

Figure 10-2: Map of the Phalen Creek subwatershed and monitoring station location.

10.2 2015 MONITORING SUMMARY

The Phalen Creek subwatershed has been monitored for flow and water quality since 2005. From 2005 to 2009, monitoring only occurred during the spring, summer, and fall. Beginning in 2010 (to present), year-round monitoring of continuous flow monitoring began at Phalen Creek. The Phalen Creek monitoring station is located in the storm sewer near the outfall to the Mississippi River. The river occasionally backs up into the pipe with tail water.

Summaries of 2015 monitoring data collected and observed at Phalen Creek are listed below. Monitoring efficiency at Phalen Creek is explained in Appendix B (Table B-1). All lab data for Phalen Creek can be found in Appendix C (Table C-6).

10.2.1 DISCHARGE

Level, velocity, and discharge were monitored at Phalen Creek for both baseflow and event flow in 2015 (Figures 10-3 & 10-4; Tables 5-1 & 10-1).

- Total baseflow discharge: 104,834,836 cubic feet
- Total event flow discharge: 37,755,070 cubic feet
- Total annual discharge: 142,574,422 cubic feet

10.2.2 TOTAL SUSPENDED SOLIDS (TSS)

Baseflow and event flow samples were analyzed for TSS concentrations in mg/L (Figure 10-5) in order to calculate event-based and total annual loads (Figure 10-3; Tables 5-1 & 10-1). The 2015 TSS loading table for Phalen Creek is reported in Appendix D (Table D-6).

- Base flow weighted average concentration: 3 mg/L
- Event flow weighted average concentration: 207 mg/L
- Total baseflow TSS load: 20,996 lbs
- Total event flow TSS load: 488,125 lbs
- Total annual TSS load: 509,121 lbs

10.2.3 TOTAL PHOSPHORUS (TP)

Baseflow and event flow samples were analyzed for TP concentrations in mg/L (Figure 10-6) in order to calculate event-based and total annual loads (Figure 10-4; Tables 5-1 & 10-1). The 2015 TP loading table for Phalen Creek is reported in Appendix D (Table D-6).

- Base flow weighted average concentration: 0.06 mg/L
- Event flow weighted average concentration: 0.42 mg/L
- Total baseflow TP load: 378 lbs
- Total event flow TP load: 985 lbs
- Total annual TP load: 1,363 lbs

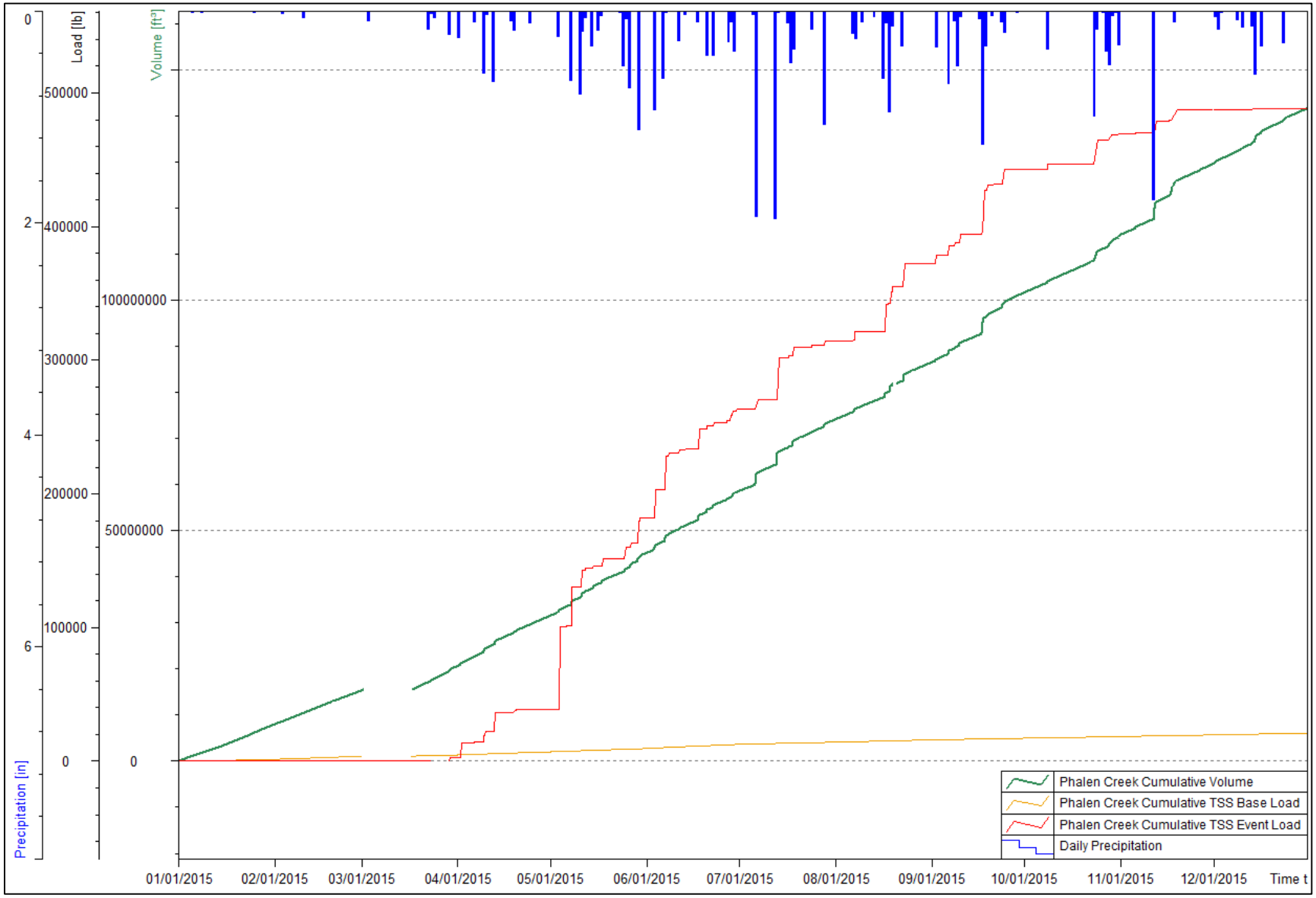

Figure 10-3: Phalen Creek cumulative discharge, TSS base load, and TSS event load, and daily precipitation.

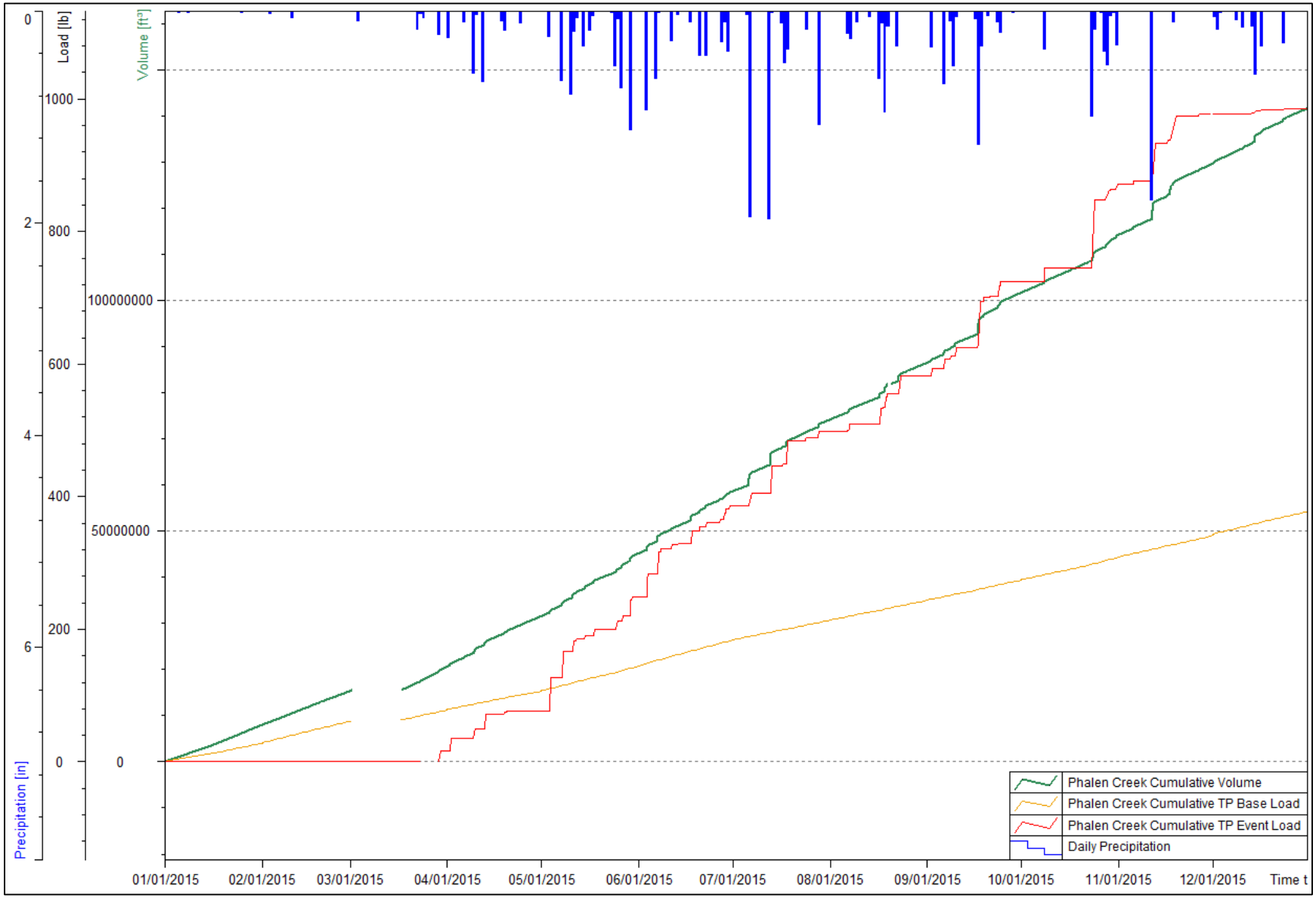

Figure 10-4: Phalen Creek cumulative discharge, TP base load, and TP event load, and daily precipitation.

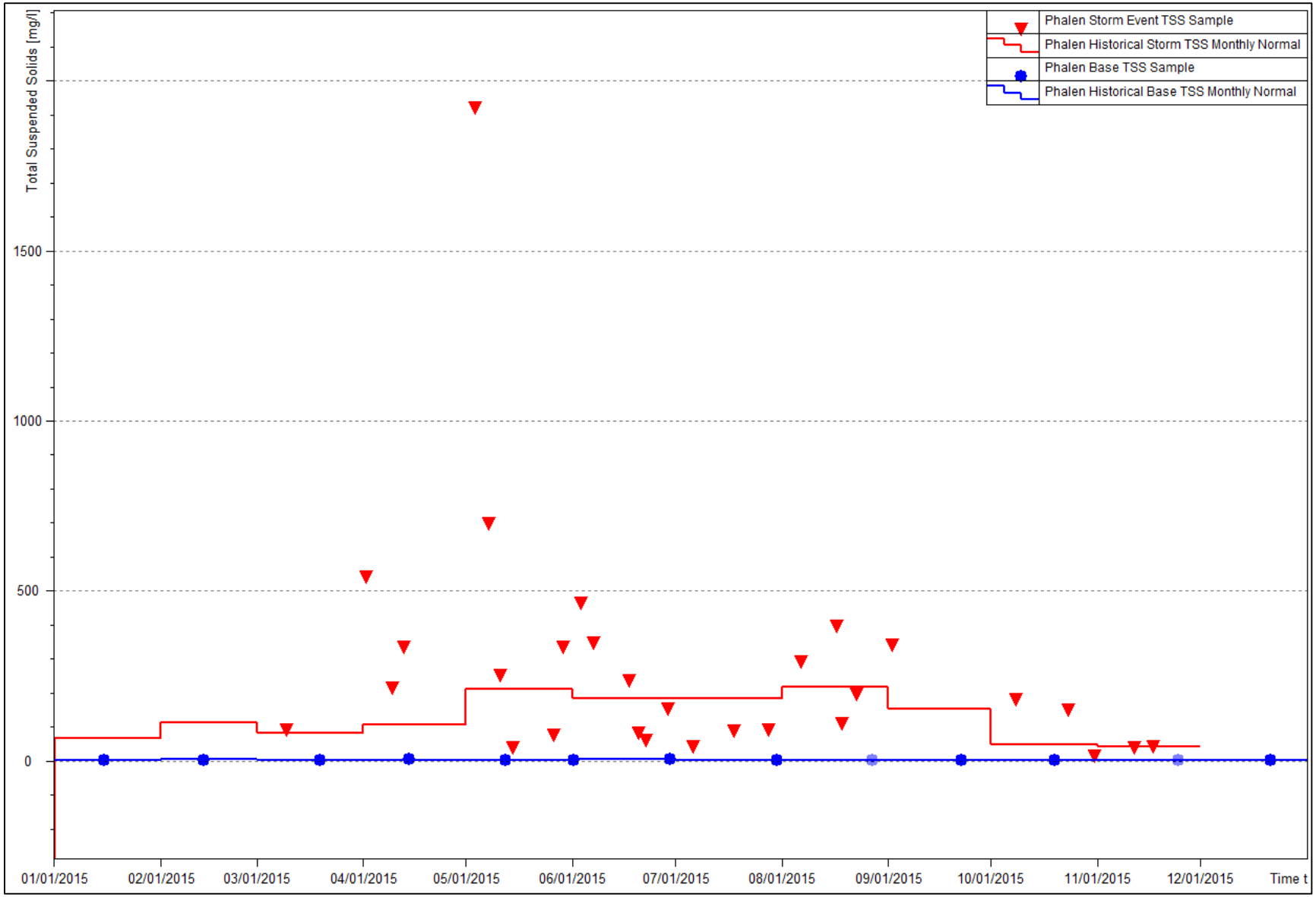

Figure 10-5: 2015 Phalen Creek TSS samples and historical monthly normal.

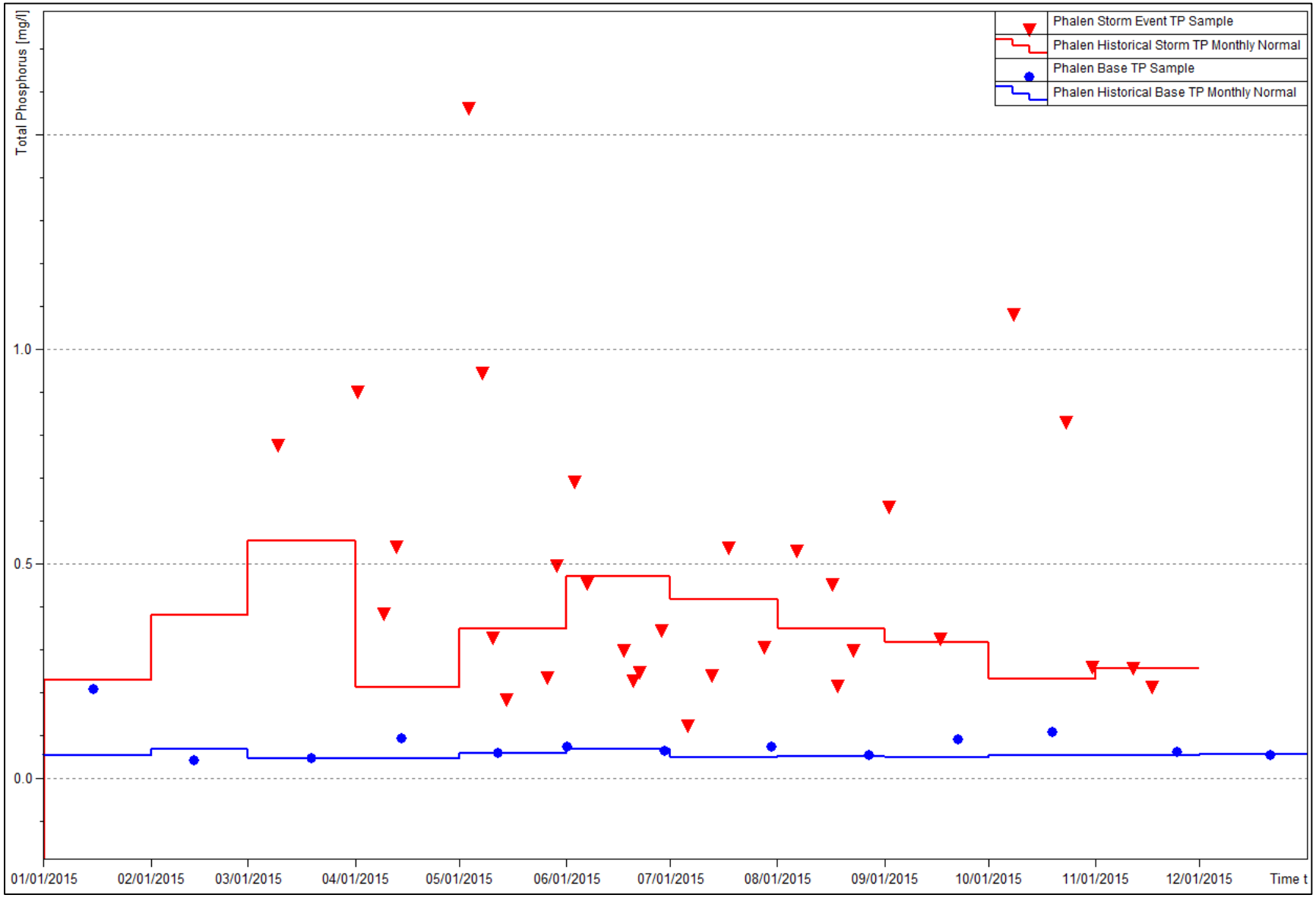

Figure 10-6: 2015 Phalen Creek TP samples and historical monthly normal.

Table 10-1: 2015 Phalen Creek subwatershed summary table.

Parameter	
Subwatershed Area (acres)	1,433
Total Precipitation (inches)	35
Number of Monitoring Days	347
Number of Base Sampling Events	13
Number of Storm Sampling Events	31
Number of Snowmelt Sampling Events	1
Number of Illicit Discharge Sampling Events	0

Discharge	
Baseflow Subtotal (Cubic Feet)	104,834,836
Event Flow Subtotal (Cubic Feet)	37,755,070
Total Discharge (Cubic Feet)	142,574,422
Baseflow Water Yield (cf/ac)	73,158
Event Water Yield (cf/ac)	26,347
Total Water Yield (cf/ac)	99,494

Total Suspended Solids	
Base FWA TSS (mg/L)	3
Event FWA TSS (mg/L)	207
Total FWA TSS (mg/L)	57
Baseflow TSS Load (lbs)	20,996
Event TSS Load (lbs)	488,125
Total TSS Load (lbs)	509,121
Total TSS Yield (lb/ac)	355

Total Phosphorus	
Base FWA TP (mg/L)	0.06
Event FWA TP (mg/L)	0.42
Total FWA TP (mg/L)	0.15
Base TP Load (lbs)	378
Event TP Load (lbs)	985
Total TP Load (lbs)	1,363
Total TP Yield (lb/ac)	0.95

11 ST. ANTHONY PARK SUBWATERSHED RESULTS

11.1 DESCRIPTION

The St. Anthony Park subwatershed has a drainage area of 3,418 acres and is the western-most subwatershed monitored by CRWD. CRWD monitors the storm sewer outlet of the St. Anthony Park subwatershed where it directly flows into the Mississippi River at Desnoyer Park in St. Paul (Figures 11-1 & 11-2). The subwatershed is primarily comprised of industrial and residential land uses with 48% impervious surface land coverage.

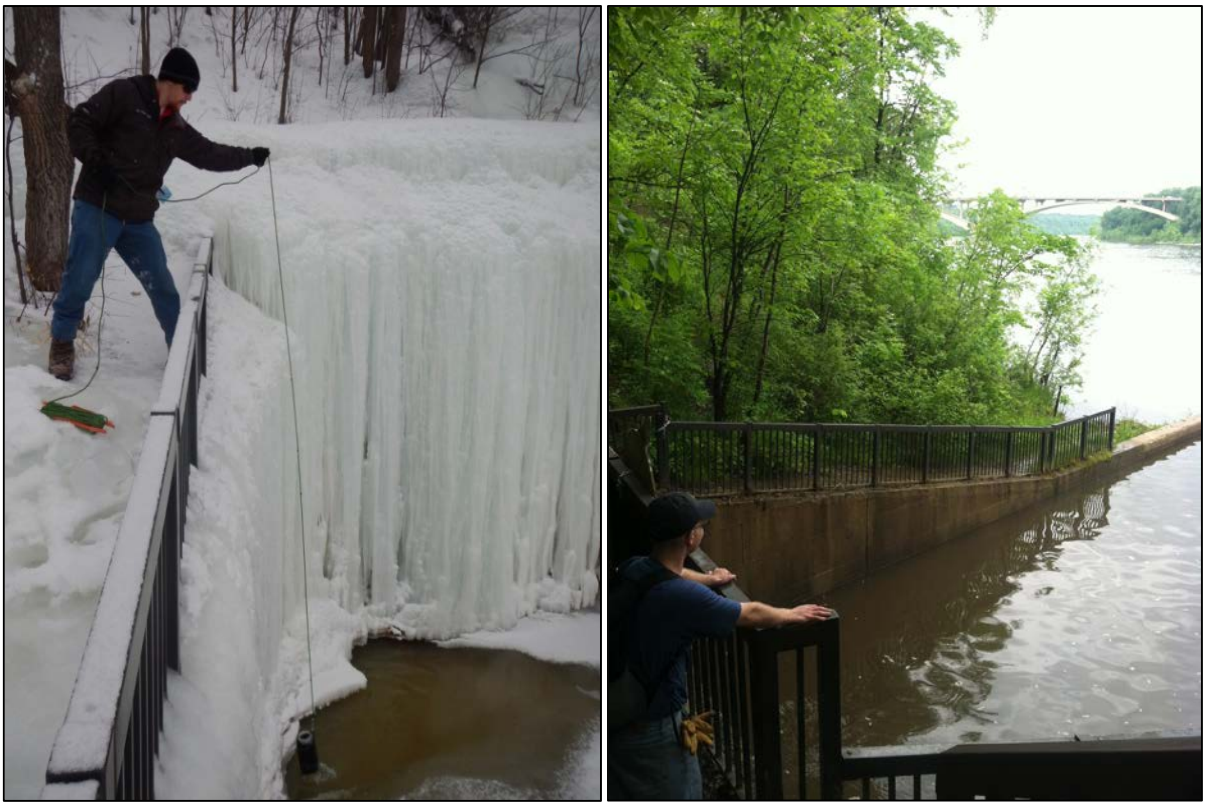

Figure 11-1: The St. Anthony Park monitoring station location.

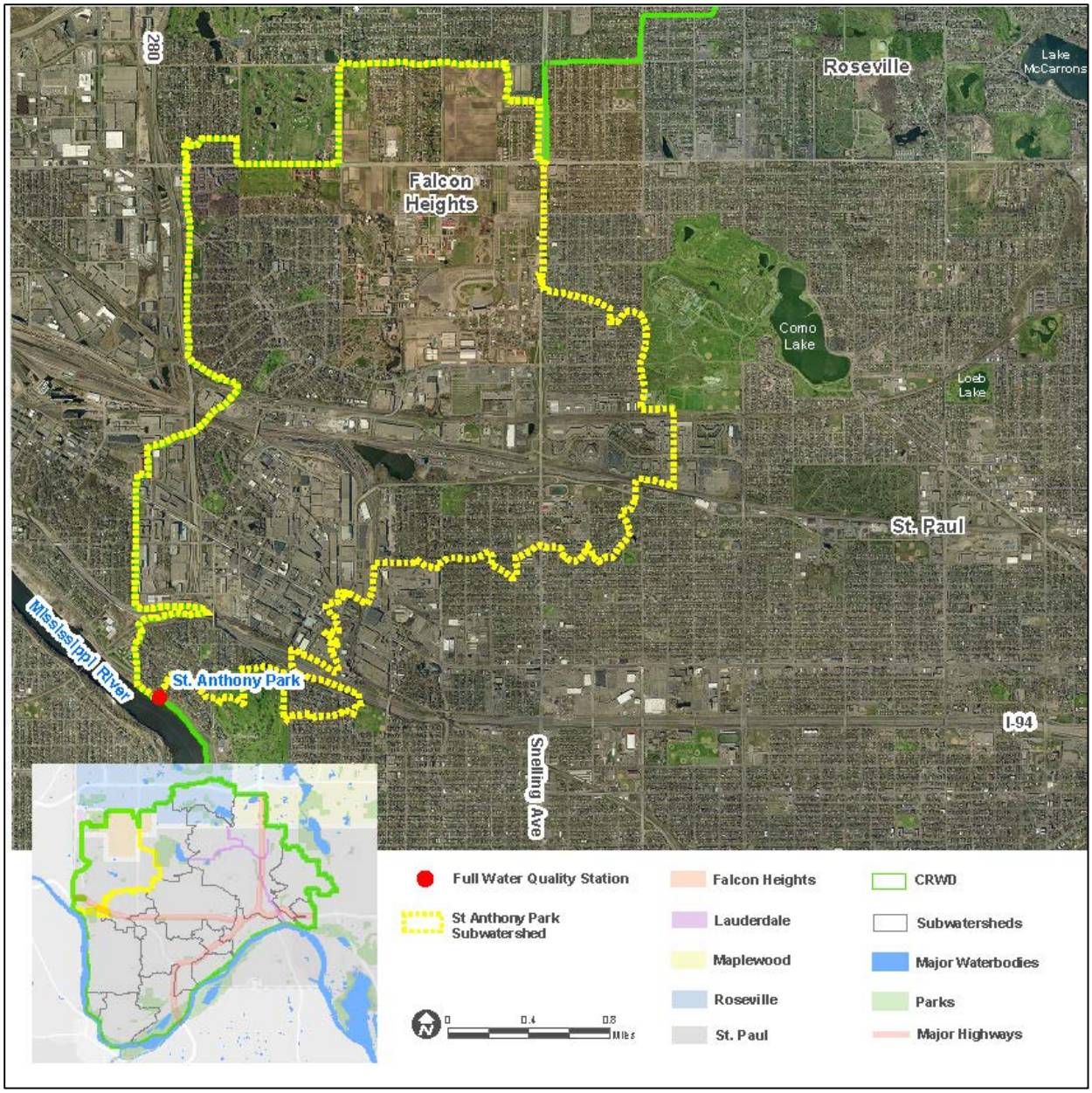

Figure 11-2: Map of the St. Anthony Park subwatershed and monitoring station location.

11.2 2015 MONITORING SUMMARY – ST. ANTHONY PARK

The St. Anthony Park site has been monitored for flow and water quality since 2005. Beginning in 2009 (to present), year-round continuous flow monitoring began at St. Anthony Park.

The St. Anthony Park monitoring site is located directly at the storm tunnel outfall to the Mississippi River. Because of close proximity of the monitoring equipment to the river, the St. Anthony Park monitoring station flow data can be influenced by tail water from the Mississippi River back flowing in to the tunnel, particularly during floods or baseflow periods.

Summaries of 2015 monitoring data collected and observed at St. Anthony Park are listed below. Monitoring efficiency at St. Anthony Park is explained in Appendix B (Table B-1). All lab data for St. Anthony Park can be found in Appendix C (Table C-7).

11.2.1 DISCHARGE – ST. ANTHONY PARK

Level, velocity, and discharge were monitored at St. Anthony Park for baseflow and event flow in 2015 (Figures 11-3 & 11-4; Tables 5-1 & 11-1).

- Total baseflow discharge: 87,211,811 cubic feet
- Total event flow discharge: 51,380,765 cubic feet
- Total annual discharge: 138,995,124 cubic feet

11.2.2 TOTAL SUSPENDED SOLIDS (TSS) – ST. ANTHONY PARK

Baseflow and event flow samples were analyzed for TSS concentrations in mg/L (Figure 11-5) in order to calculate event-based and total annual loads (Figure 11-3; Tables 5-1 & 11-1). The 2015 TSS loading table for St. Anthony Park is reported in Appendix D (Table D-7).

- Base flow weighted average concentration: 15 mg/L
- Event flow weighted average concentration: 108 mg/L
- Total baseflow TSS load: 80,668 lbs
- Total event flow TSS load: 346,632 lbs
- Total annual TSS load: 427,300 lbs

11.2.3 TOTAL PHOSPHORUS (TP) – ST. ANTHONY PARK

Baseflow and event flow samples were analyzed for TP concentrations in mg/L (Figure 11-6) in order to calculate event-based and total annual loads (Figure 11-4; Tables 5-1 & 11-1). The 2015 TP loading table for St. Anthony Park is reported in Appendix D (Table D-7).

- Base flow weighted average concentration: 0.07 mg/L
- Event flow weighted average concentration: 0.22 mg/L
- Total baseflow TP load: 363 lbs
- Total event flow TP load: 713 lbs
- Total annual TP load: 1,076 lbs

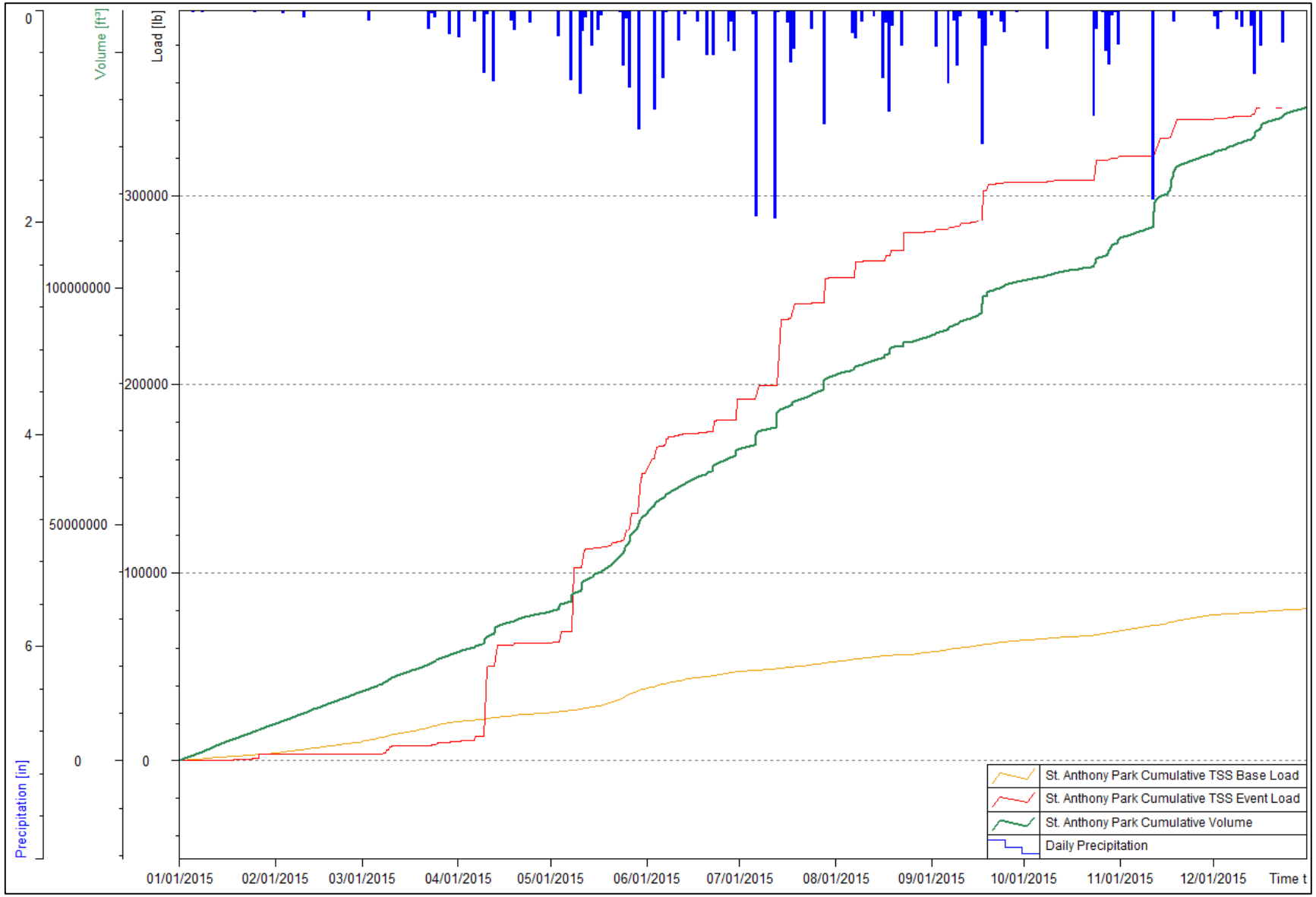

Figure 11-3: St. Anthony Park cumulative discharge, TSS base load, and TSS event load, and daily precipitation.

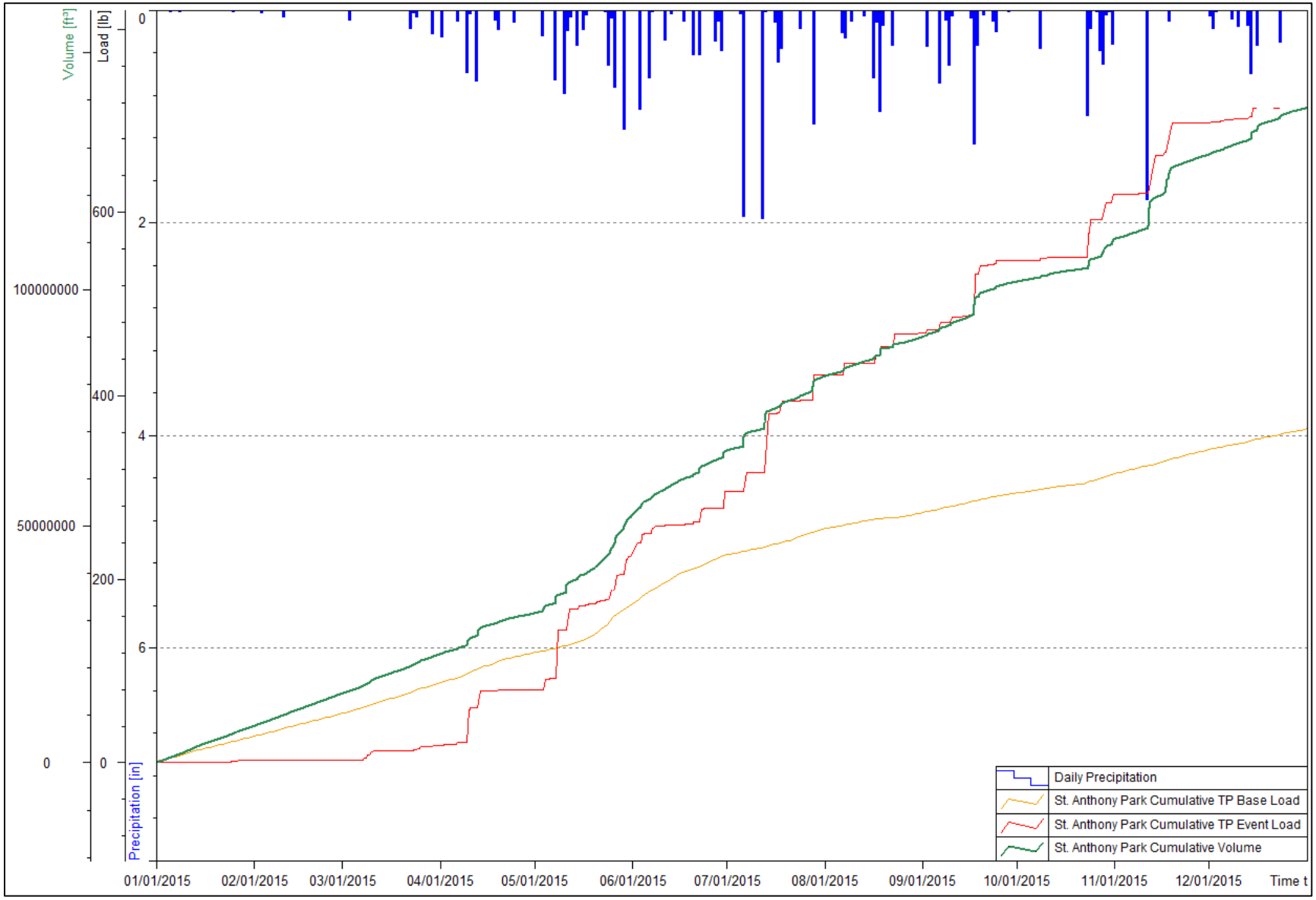

Figure 11-4: St. Anthony Park cumulative discharge, TP base load, and TP event load, and daily precipitation.

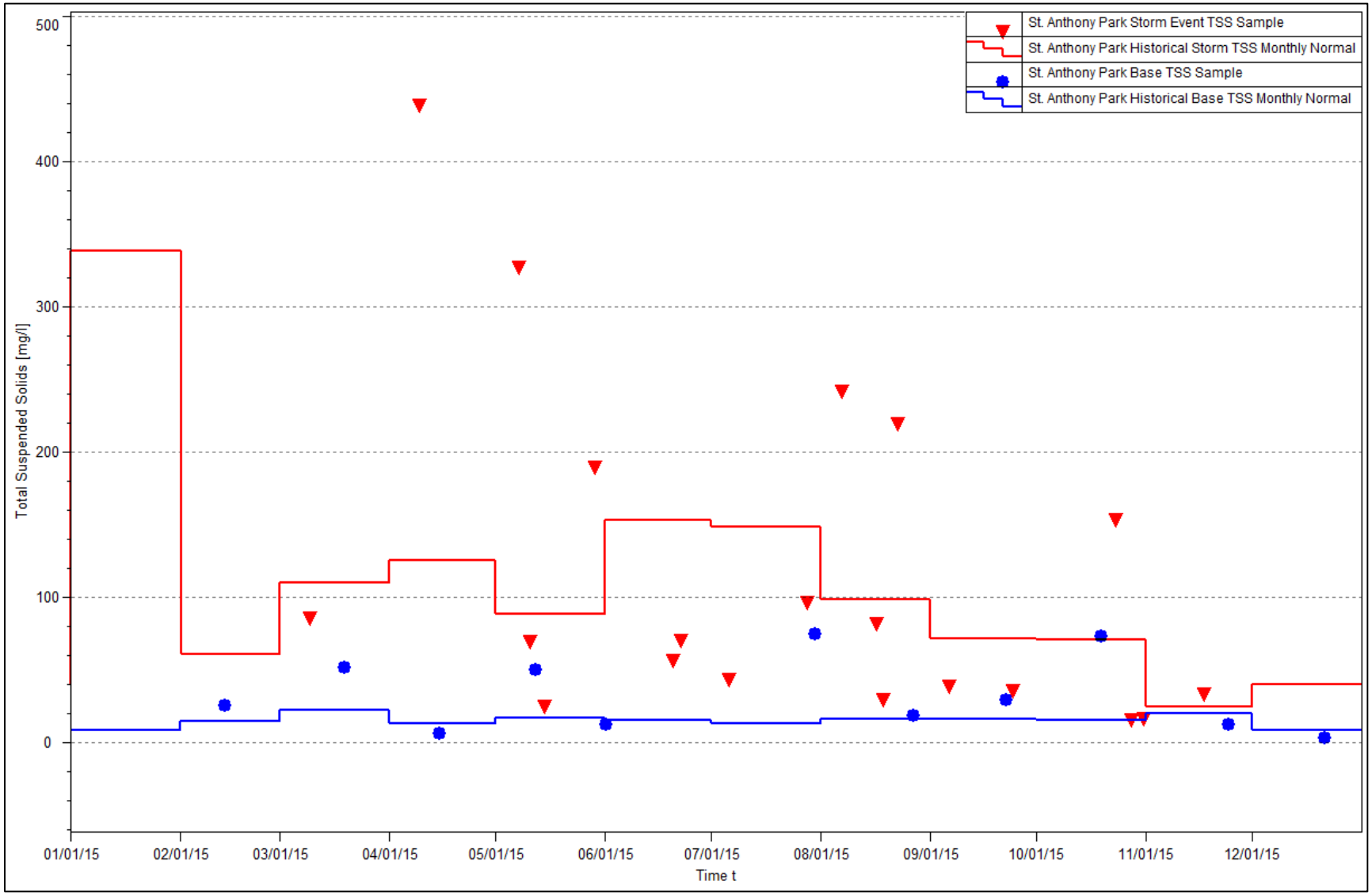

Figure 11-5: 2015 St. Anthony Park TSS samples and historical monthly normal.

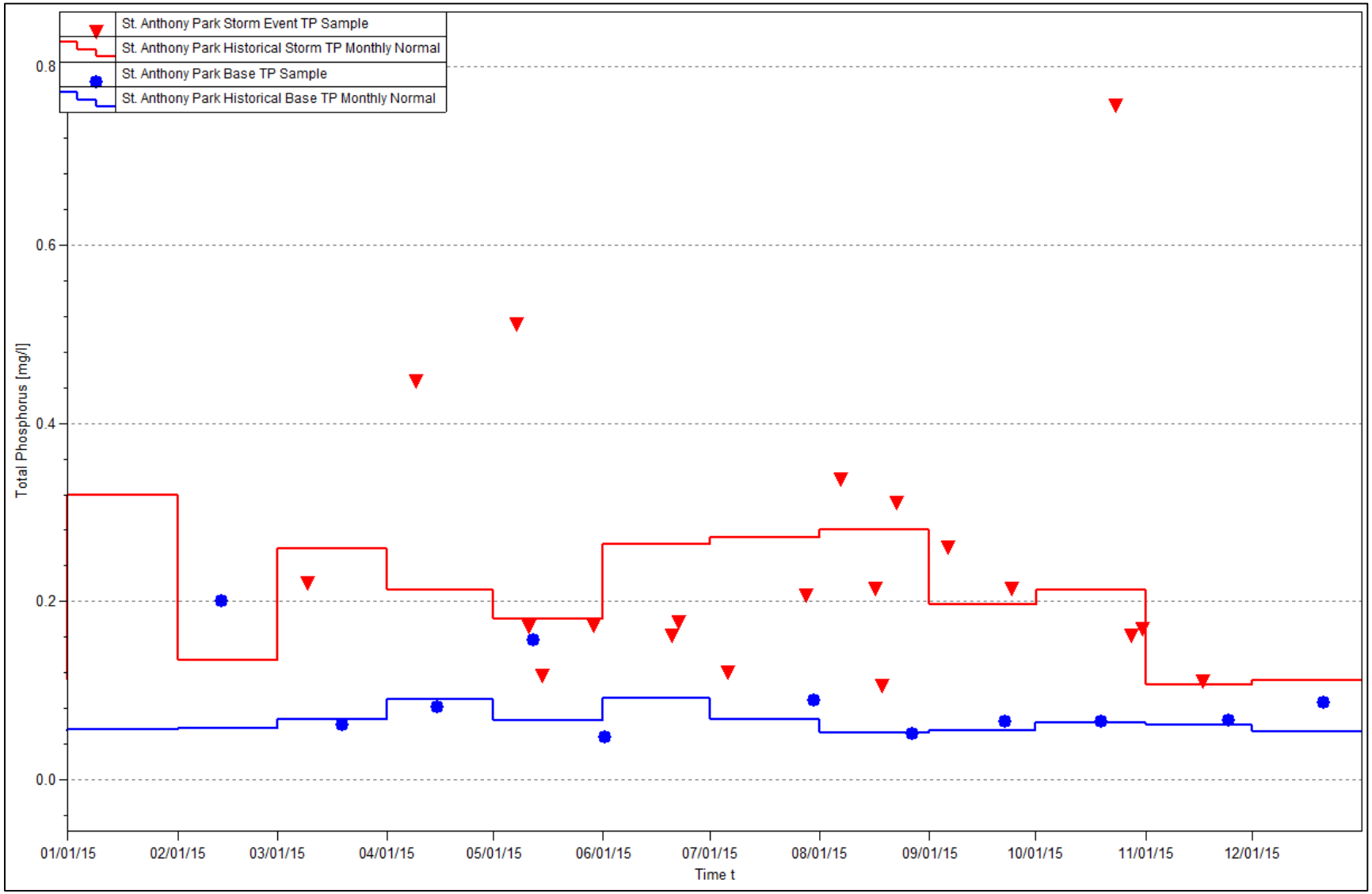

Figure 11-6: St. Anthony Park TP samples and historical monthly normal.

Table 11-1: 2015 St. Anthony Park subwatershed summary table.

Parameter	
Subwatershed Area (acres)	3,418
Total Precipitation (inches)	35
Number of Monitoring Days	365
Number of Base Sampling Events	11
Number of Storm Sampling Events	19
Number of Snowmelt Sampling Events	1
Number of Illicit Discharge Sampling Events	4

Discharge	
Baseflow Subtotal (Cubic Feet)	87,211,811
Event Flow Subtotal (Cubic Feet)	51,380,765
Total Discharge (Cubic Feet)	138,995,124
Baseflow Water Yield (cf/ac)	25,515
Event Water Yield (cf/ac)	15,032
Total Water Yield (cf/ac)	40,666

Total Suspended Solids	
Base FWA TSS (mg/L)	15
Event FWA TSS (mg/L)	108
Total FWA TSS (mg/L)	49
Baseflow TSS Load (lbs)	80,668
Event TSS Load (lbs)	346,632
Total TSS Load (lbs)	427,300
Total TSS Yield (lb/ac)	125

Total Phosphorus	
Base FWA TP (mg/L)	0.07
Event FWA TP (mg/L)	0.22
Total FWA TP (mg/L)	0.12
Base TP Load (lbs)	363
Event TP Load (lbs)	713
Total TP Load (lbs)	1,076
Total TP Yield (lb/ac)	0.31

12 TROUT BROOK SUBWATERSHED RESULTS

12.1 DESCRIPTION

The Trout Brook subwatershed is the largest subwatershed in CRWD, draining 8,000 acres in portions of St. Paul, Maplewood, Falcon Heights, and Roseville (Figure 12-4). The Trout Brook subwatershed contains Como Lake, Lake McCarrons, Loeb Lake, and five major stormwater ponds. Land use in the Trout Brook subwatershed is a mix of residential, industrial, and commercial, with 40% impervious surface. Runoff in the subwatershed drains to CRWD's Trout Brook Storm Sewer Interceptor (TBI), which connects to the City of St. Paul's storm sewer interceptor before eventually discharging to the Mississippi River, just downstream of Lambert's Landing in St. Paul. The upper section of TBI is comprised of two branches, East and West, which converge near the intersection of Maryland Avenue and I-35E in St. Paul (Figure 12-4).

Trout Brook–West Branch

Trout Brook-West Branch (TB-WB) subwatershed drains 2,379 acres in St. Paul, Roseville, and Falcon Heights. It has the third largest drainage area of the full water quality monitoring sites. Within the boundaries of TB-WB are the Arlington-Jackson Stormwater Pond, Willow Reserve Stormwater Pond, Como Lake, Lake McCarrons, and Loeb Lake (Figure 12-4). However, it should be noted that the lakesheds of Como Lake and Lake McCarrons are not included in the total drainage area calculation for TB-WB because each lake behaves as its own subwatershed and does not consistently contribute runoff to the Trout Brook subwatershed. The TB-WB monitoring site is located just upstream of the convergence with the east branch of the TBI in the northwest quadrant of the intersection of Maryland Avenue and I-35E (Figure 12-1).

Figure 12-1: The Trout Brook-West Branch monitoring station location.

Trout Brook–East Branch

Trout Brook-East Branch (TB-EB) subwatershed drains 932 acres in St. Paul and Maplewood and includes two stormwater ponds, Westminster-Mississippi and Arlington-Arkwright. First established in 2006, this monitoring station was moved slightly downstream in 2007 from its original location to a manhole located between L'Orient Street and the I-35E ramp (Figures 12-2 & 12-4). The TB-EB subwatershed receives direct runoff from the I-35E corridor, which strongly influences the water quality measured at this monitoring station.

Figure 12-2: The Trout Brook-East Branch monitoring station location.

Trout Brook Outlet

The Trout Brook Outlet (TBO) monitoring station receives water from 5,028 acres of the Trout Brook subwatershed, which includes the combined discharge from TB-EB and TB-WB. Like TB-WB, the TBO subwatershed does not include the lakeshed drainage areas of Como Lake and Lake McCarrons in its total drainage area (Figures 12-3 & 12-4).

Figure 12-3: The Trout Brook Outlet monitoring station location.

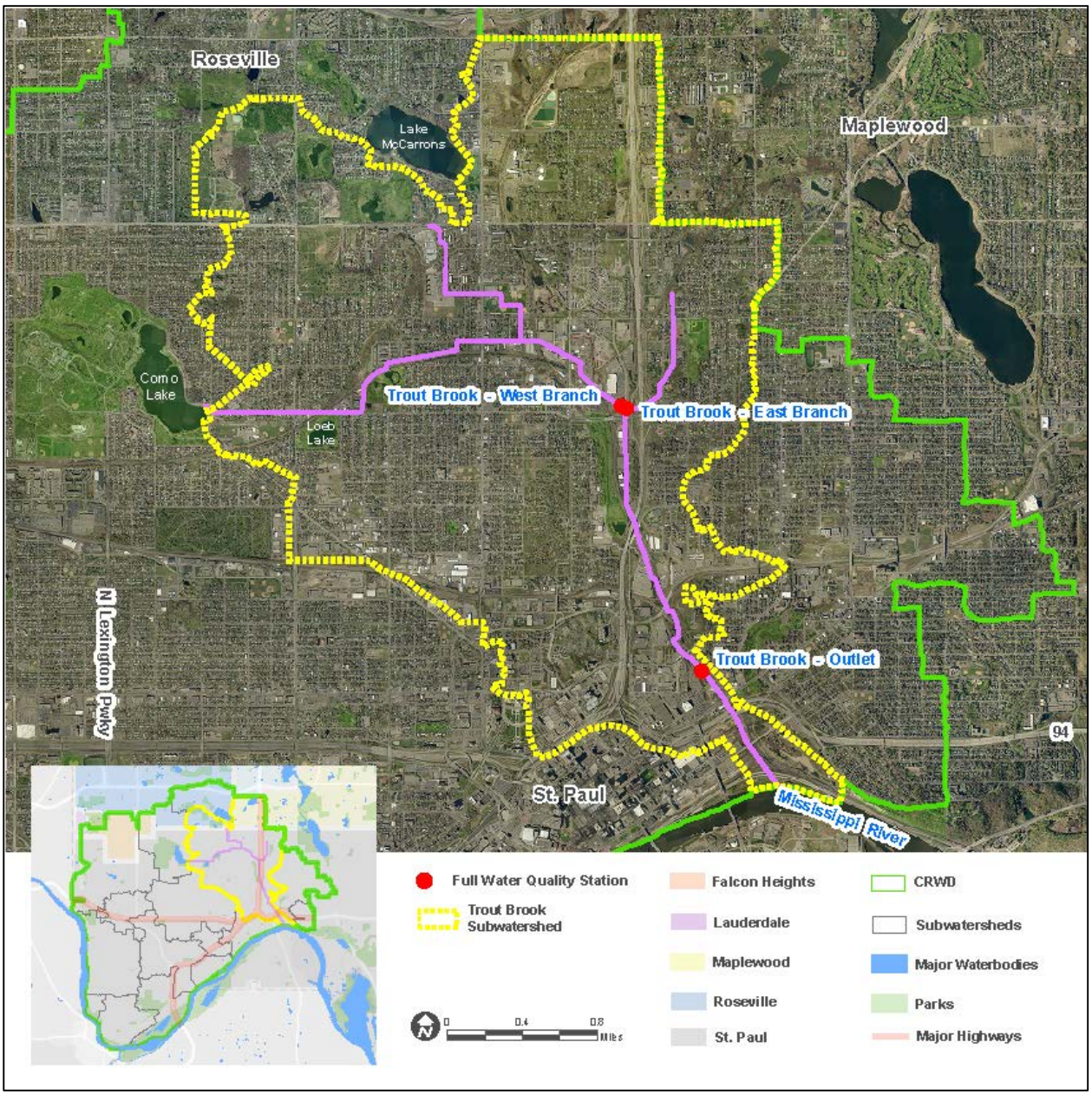

Figure 12-4: Map of the Trout Brook subwatershed and monitoring station locations.

12.2 2015 MONITORING SUMMARY – TROUT BROOK-EAST BRANCH

The Trout Brook-East Branch subwatershed has been monitored for discharge and water quality since 2006. Flow and water quality monitoring at this location generally occurred between the months of April to November from 2006-2009. Since 2010, continuous flow monitoring has been conducted year-round.

Summaries of 2015 monitoring data collected and observed at Trout Brook-East Branch are listed below. Monitoring efficiency at Trout Brook-East Branch is explained in Appendix B (Table B-1). All lab data for Trout Brook-East Branch can be found in Appendix C (Table C-8).

12.2.1 DISCHARGE – TROUT BROOK-EAST BRANCH

Level, velocity, and discharge were monitored at Trout Brook-East Branch for baseflow and event flow in 2015 (Figure 12-5 & 12-6; Tables 5-1 & 12-1).

- Total baseflow flow discharge: 26,489,178 cubic feet
- Total event flow discharge: 15,447,896 cubic feet
- Total annual discharge: 41,935,628 cubic feet

12.2.2 TOTAL SUSPENDED SOLIDS (TSS) – TROUT BROOK-EAST BRANCH

Baseflow and event flow samples were analyzed for TSS concentrations in mg/L (Figure 12-7) in order to calculate event-based and total annual loads (Figure 12-5; Tables 5-1 & 12-1). The 2015 TSS loading table for Trout Brook-East Branch is reported in Appendix D (Table D-8).

- Baseflow flow weighted average concentration: 11 mg/L
- Event flow weighted average concentration: 115 mg/L
- Total baseflow TSS load: 18,131 lbs
- Total event flow TSS load: 111,375 lbs
- Total annual TSS load: 129,506 lbs

12.2.3 TOTAL PHOSPHORUS (TP) – TROUT BROOK-EAST BRANCH

Baseflow and event flow samples were analyzed for TP concentrations in mg/L (Figure 12-8) in order to calculate event-based and total annual loads (Figure 12-6; Tables 5-1 & 12-1). The 2015 TP loading table for Trout Brook-East Branch is reported in Appendix D (Table D-8).

- Baseflow flow weighted average concentration: 0.09 mg/L
- Event flow weighted average concentration: 0.38 mg/L
- Total baseflow TP load: 142 lbs
- Total event flow TP load: 371 lbs
- Total annual TP load: 512 lbs

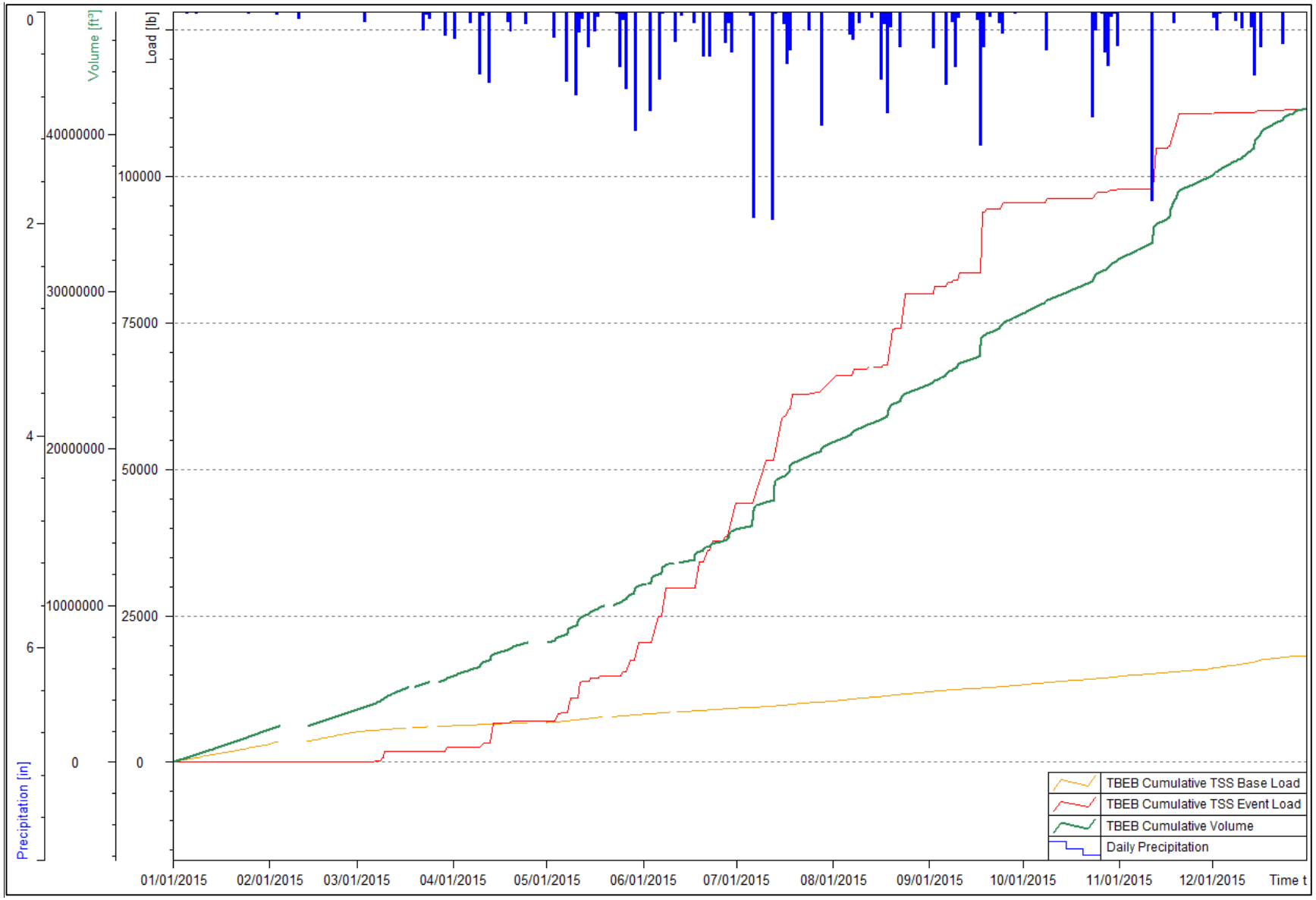

Figure 12-5: Trout Brook-East Branch cumulative volume, TSS event load, and TSS base load, and daily precipitation.

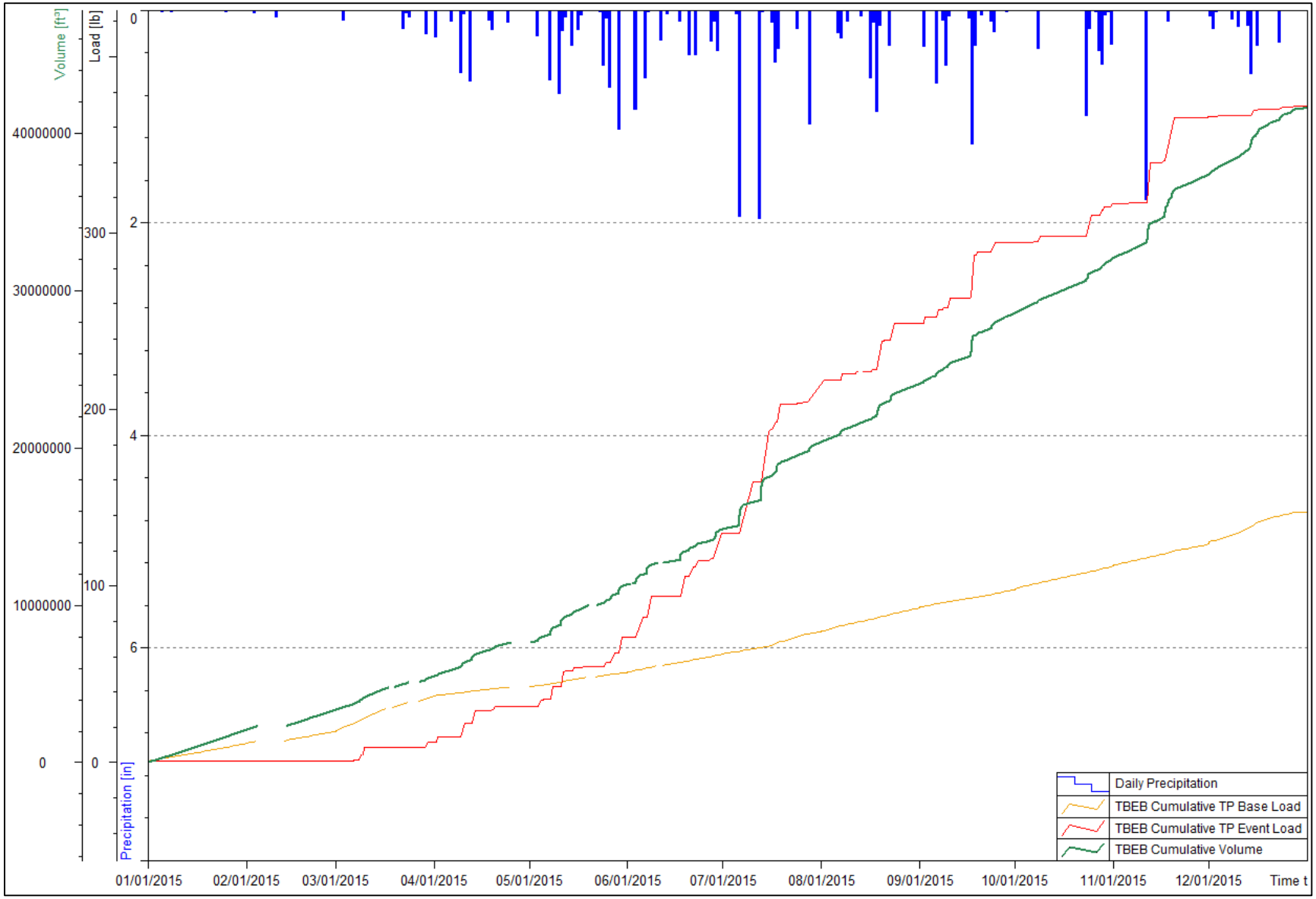

Figure 12-6: Trout Brook-East Branch cumulative volume, TP event load, and TP base load, and daily precipitation.

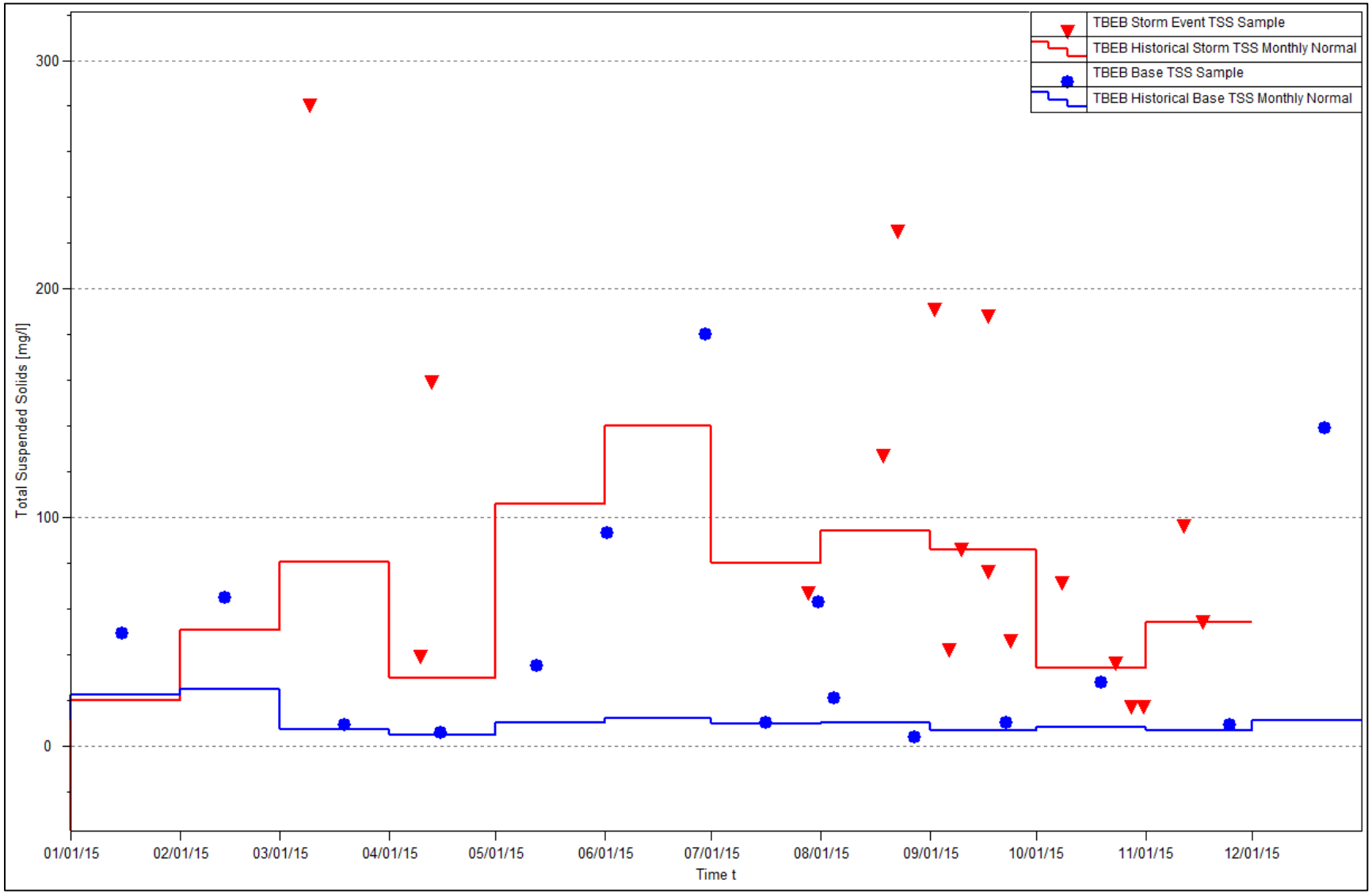

Figure 12-7: 2015 Trout Brook-East Branch TSS samples and historical monthly normal.

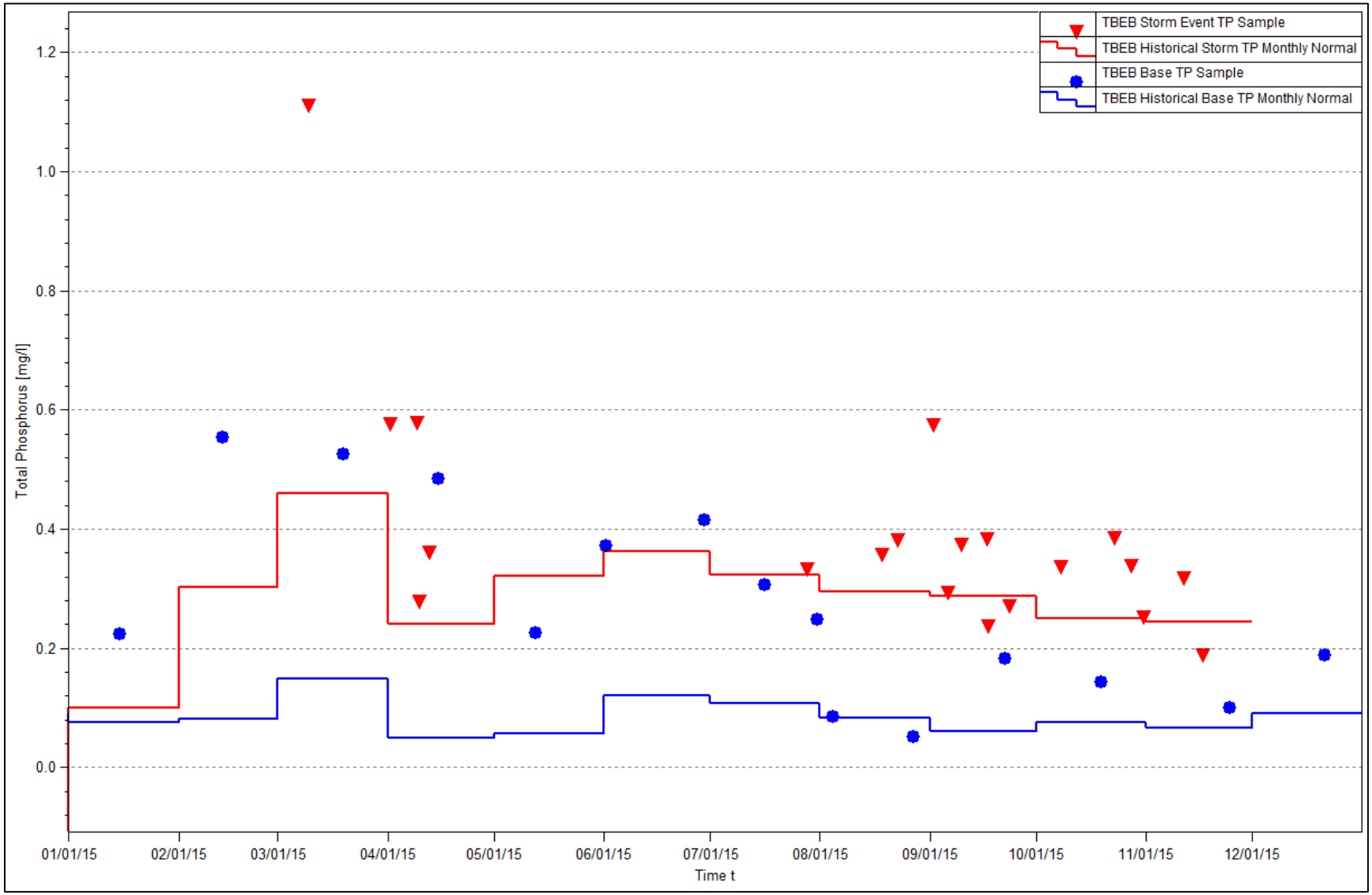

Figure 12-8: 2015 Trout Brook-East Branch TP samples and historical monthly normal.

Table 12-1: 2015 Trout Brook-East Branch subwatershed summary table.

Parameter	
Subwatershed Area (acres)	932
Total Precipitation (inches)	35
Number of Monitoring Days	339
Number of Base Sampling Events	15
Number of Storm Sampling Events	19
Number of Snowmelt Sampling Events	1
Number of Illicit Discharge Sampling Events	0

Discharge	
Baseflow Subtotal (Cubic Feet)	26,489,178
Event Flow Subtotal (Cubic Feet)	15,447,896
Total Discharge (Cubic Feet)	41,935,628
Baseflow Water Yield (cf/ac)	28,422
Event Water Yield (cf/ac)	16,575
Total Water Yield (cf/ac)	44,995

Total Suspended Solids	
Base FWA TSS (mg/L)	11
Event FWA TSS (mg/L)	115
Total FWA TSS (mg/L)	49
Baseflow TSS Load (lbs)	18,131
Event TSS Load (lbs)	111,375
Total TSS Load (lbs)	129,506
Total TSS Yield (lb/ac)	139

Total Phosphorus	
Base FWA TP (mg/L)	0.09
Event FWA TP (mg/L)	0.38
Total FWA TP (mg/L)	0.20
Base TP Load (lbs)	142
Event TP Load (lbs)	371
Total TP Load (lbs)	512
Total TP Yield (lb/ac)	0.55

12.3 2015 MONITORING SUMMARY – TROUT BROOK-WEST BRANCH

The Trout Brook-West Branch subwatershed has been monitored for discharge and water quality since 2005. Flow and water quality monitoring at this location generally occurred between the months of April to November from 2005-2009. Since 2010, continuous flow monitoring has been conducted year-round.

Summaries of 2015 monitoring data collected and observed at Trout Brook-West Branch are listed below. Monitoring efficiency at Trout Brook-West Branch is explained in Appendix B (Table B-1). All lab data for Trout Brook-West Branch can be found in Appendix C (Table C-9).

12.3.1 DISCHARGE – TROUT BROOK-WEST BRANCH

Level, velocity, and discharge were monitored at Trout Brook-West Branch for baseflow and event flow in 2015 (Figure 12-9 & 12-10; Tables 5-14 & 12-2).

- Total baseflow discharge: 253,071,163 cubic feet
- Total event flow discharge: 71,961,493 cubic feet
- Total annual discharge: 324,928,226 cubic feet

12.3.2 TOTAL SUSPENDED SOLIDS (TSS) – TROUT BROOK-WEST BRANCH

Baseflow and event flow samples were analyzed for TSS concentrations in mg/L (Figure 12-11) in order to calculate event-based and total annual loads (Figure 12-9; Tables 5-1 & 12-2). The 2015 TSS loading table for Trout Brook-West Branch is reported in Appendix D (Table D-9).

- Baseflow flow weighted average concentration: 12 mg/L
- Event flow weighted average concentration: 520 mg/L
- Total baseflow TSS load: 183,830 lbs
- Total event flow TSS load: 2,335,080 lbs
- Total annual TSS load: 2,518,910 lbs

12.3.3 TOTAL PHOSPHORUS (TP) – TROUT BROOK-WEST BRANCH

Baseflow and event flow samples were analyzed for TP concentrations in mg/L (Figure 12-12) in order to calculate event-based and total annual loads (Figure 12-10; Tables 5-1 & 12-2). The 2015 TP loading table for Trout Brook-West Branch is reported in Appendix D (Table D-9).

- Baseflow flow weighted average concentration: 0.07 mg/L
- Event flow weighted average concentration: 0.51 mg/L
- Total baseflow TP load: 1, 165 lbs
- Total event flow TP load: 2,313 lbs
- Total annual TP load: 3,478 lbs

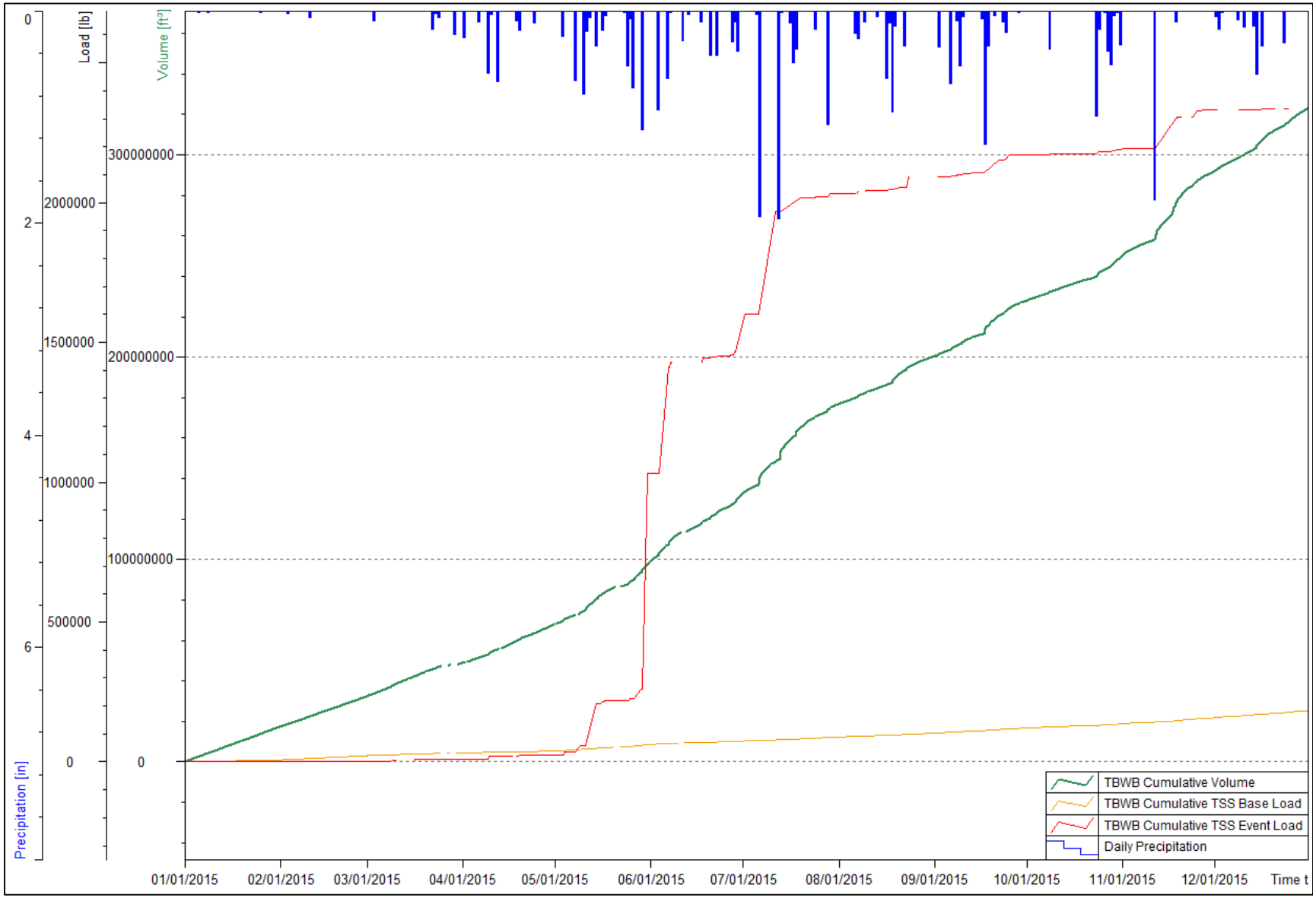

Figure 12-9: Trout Brook-West Branch cumulative volume, TSS event load, and TSS base load, and daily precipitation.

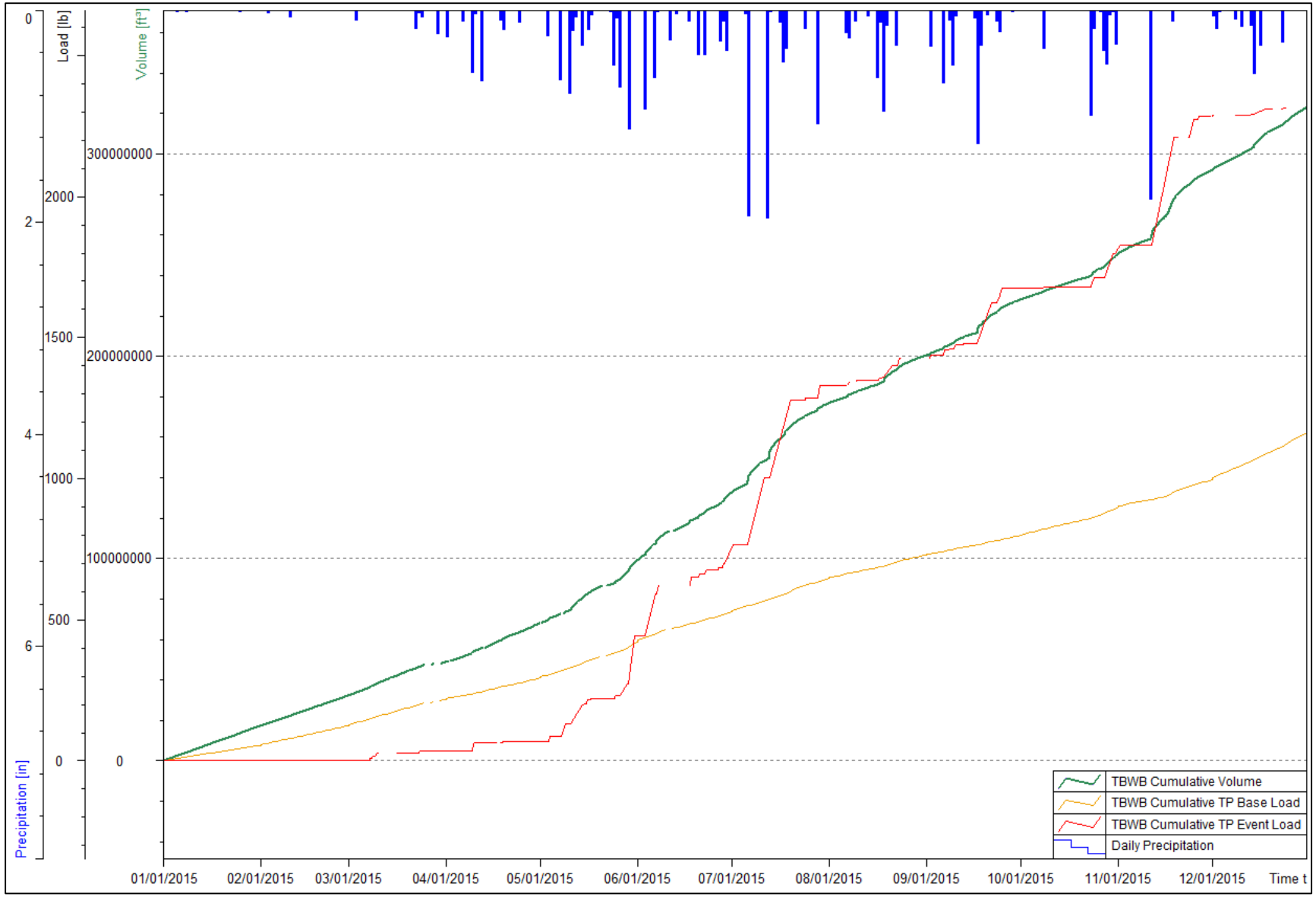

Figure 12-10: Trout Brook-West Branch cumulative volume, TP event load, and TP base load, and daily precipitation.

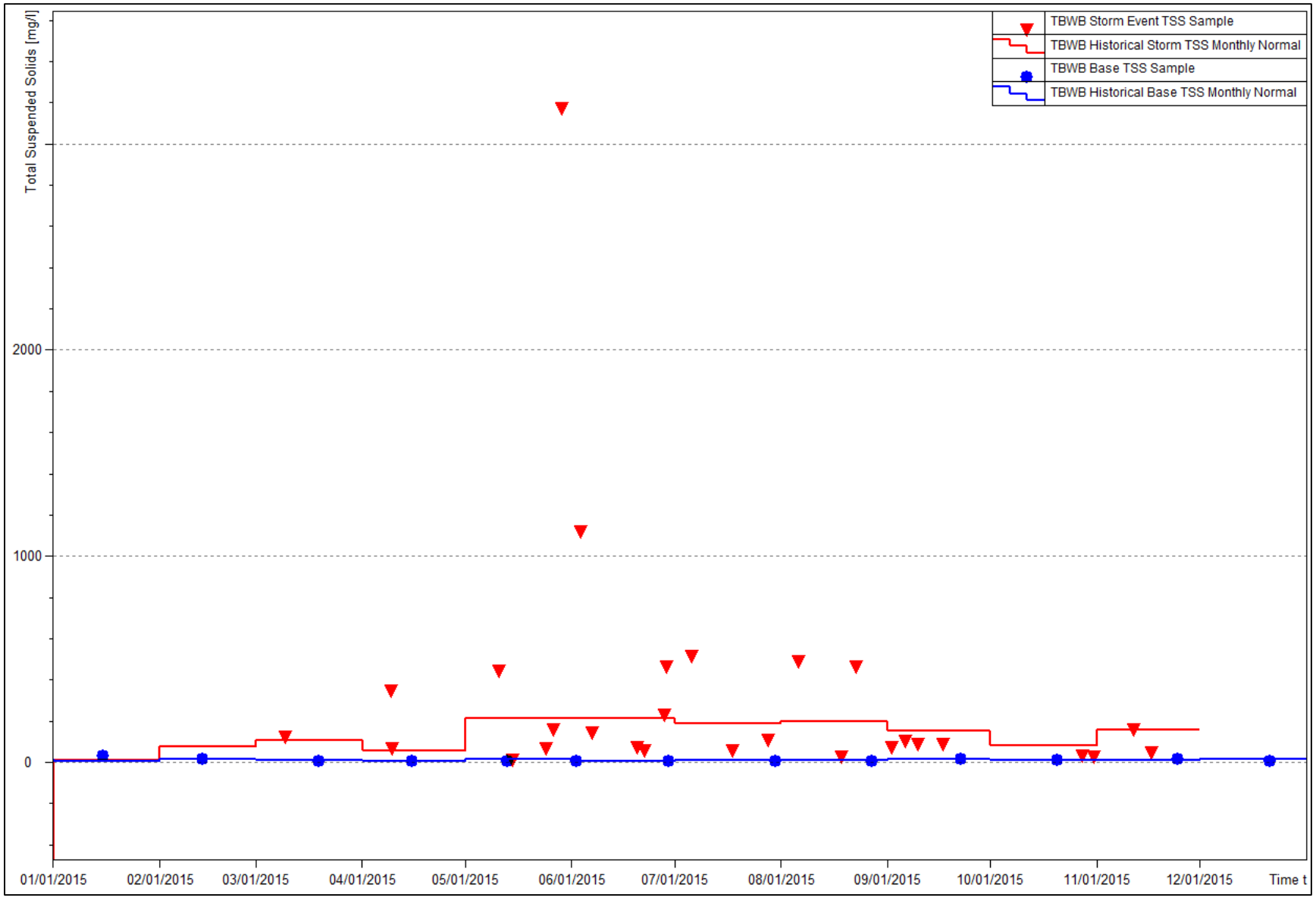

Figure 12-11: 2015 Trout Brook-West Branch TSS samples and historical monthly normal.

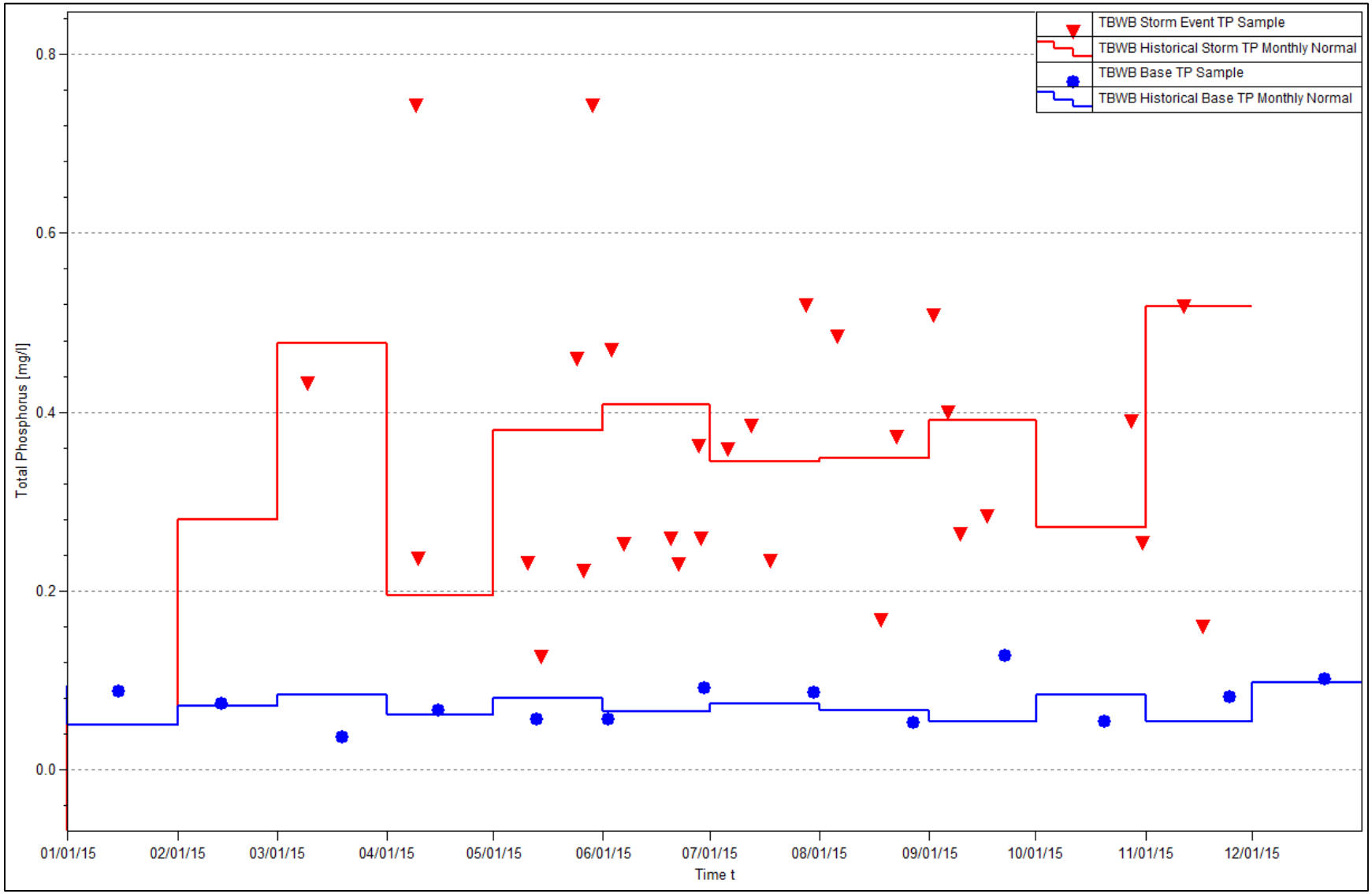

Figure 12-12: 2015 Trout Brook-West Branch TP samples and historical monthly normal.

Table 12-2: 2015 Trout Brook-West Branch subwatershed summary table.

Parameter	
Subwatershed Area (acres)	2,379
Total Precipitation (inches)	35
Number of Monitoring Days	354
Number of Base Sampling Events	13
Number of Storm Sampling Events	28
Number of Snowmelt Sampling Events	1
Number of Illicit Discharge Sampling Events	0

Discharge	
Baseflow Subtotal (Cubic Feet)	253,071,163
Event Flow Subtotal (Cubic Feet)	71,961,493
Total Discharge (Cubic Feet)	324,928,226
Baseflow Water Yield (cf/ac)	106,377
Event Water Yield (cf/ac)	30,249
Total Water Yield (cf/ac)	136,582

Total Suspended Solids	
Base FWA TSS (mg/L)	12
Event FWA TSS (mg/L)	520
Total FWA TSS (mg/L)	124
Baseflow TSS Load (lbs)	183,830
Event TSS Load (lbs)	2,335,080
Total TSS Load (lbs)	2,518,910
Total TSS Yield (lb/ac)	1,059

Total Phosphorus	
Base FWA TP (mg/L)	0.07
Event FWA TP (mg/L)	0.51
Total FWA TP (mg/L)	0.17
Base TP Load (lbs)	1,165
Event TP Load (lbs)	2,313
Total TP Load (lbs)	3,478
Total TP Yield (lb/ac)	1.46

12.4 2015 MONITORING SUMMARY – TROUT BROOK OUTLET

The Trout Brook Outlet subwatershed has been monitored for discharge and water quality since 2005. Flow and water quality monitoring at this location generally occurred between the months of April to November from 2005-2009. Since 2010, continuous flow monitoring has been conducted year-round.

Summaries of 2015 monitoring data collected and observed at Trout Brook Outlet are listed below. Monitoring efficiency at Trout Brook Outlet is explained in Appendix B (Table B-1). All lab data for Trout Brook Outlet can be found in Appendix C (C-10).

12.4.1 DISCHARGE – TROUT BROOK OUTLET

Level, velocity, and discharge were monitored at Trout Brook Outlet for baseflow and event flow in 2015 (Figure 12-13 & 12-14; Tables 5-1 & 12-3).

- Total baseflow discharge: 454,737,971 cubic feet
- Total event flow discharge: 62,728,812 cubic feet
- Total annual discharge: 516,898,878 cubic feet

12.4.2 TOTAL SUSPENDED SOLIDS (TSS) – TROUT BROOK OUTLET

Baseflow and event flow samples were analyzed for TSS concentrations in mg/L (Figure 12-15) in order to calculate event-based and total annual loads (Figure 12-13; Tables 5-1 & 12-3). The 2015 TSS loading table for Trout Brook Outlet is reported in Appendix D (Table D-10).

- Baseflow flow weighted average concentration: 9 mg/L
- Event flow weighted average concentration: 623 mg/L
- Total baseflow TSS load: 252,617 lbs
- Total event flow TSS load: 2,440,190 lbs
- Total annual TSS load: 2,692,807 lbs

12.4.3 TOTAL PHOSPHORUS (TP) – TROUT BROOK OUTLET

Baseflow and event flow samples were analyzed for TP concentrations in mg/L (Figure 12-16) in order to calculate event-based and total annual loads (Figure 12-14; Tables 5-1 & 12-3). The 2015 TP loading table for Trout Brook Outlet is reported in Appendix D (Table D-10).

- Baseflow flow weighted average concentration: 0.06 mg/L
- Event flow weighted average concentration: 0.84 mg/L
- Total baseflow TP load: 1,658 lbs
- Total event flow TP load: 3,293 lbs
- Total annual TP load: 4,951 lbs

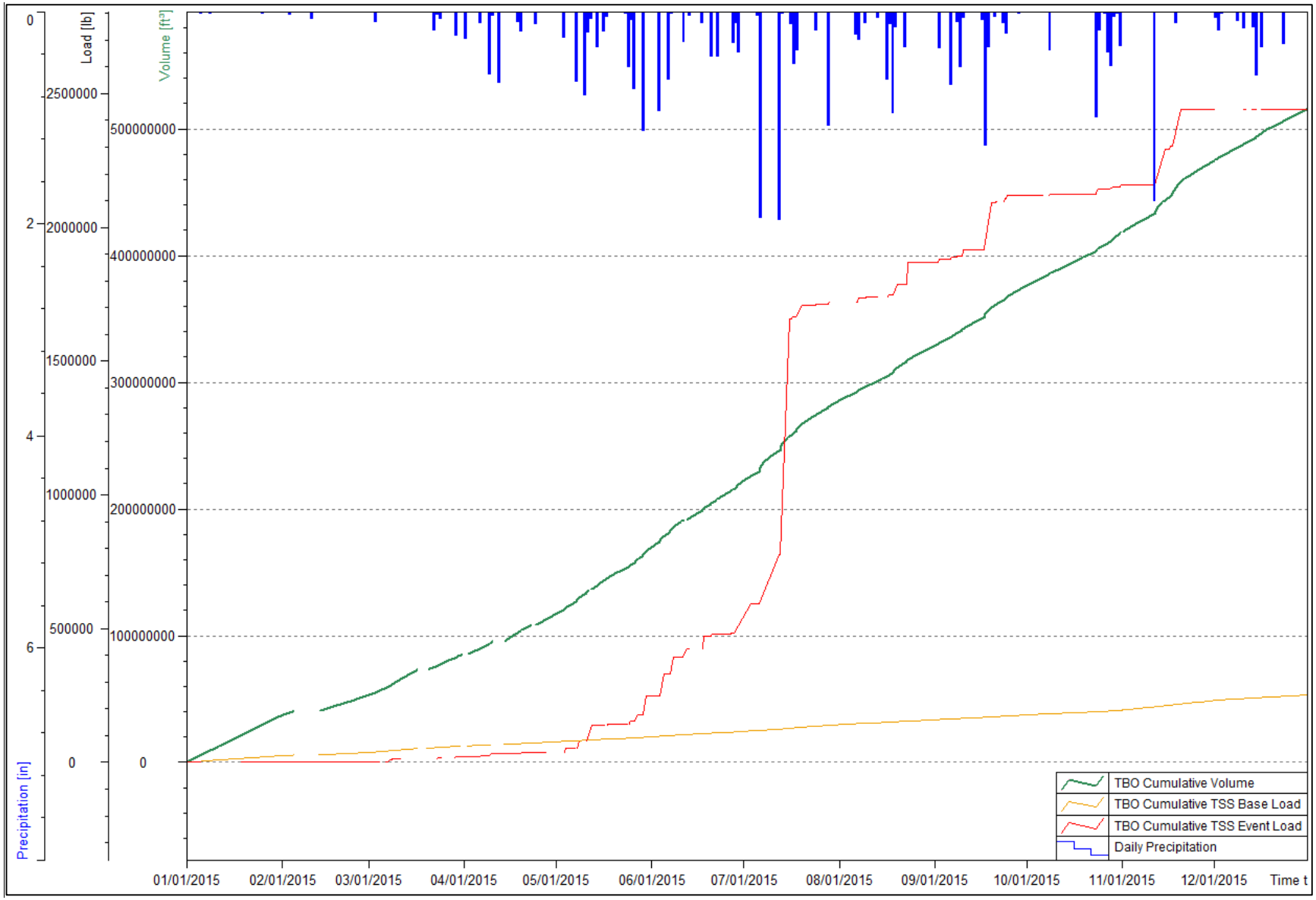

Figure 12-13: Trout Brook Outlet cumulative volume, TSS event load, and TSS base load, and daily precipitation.

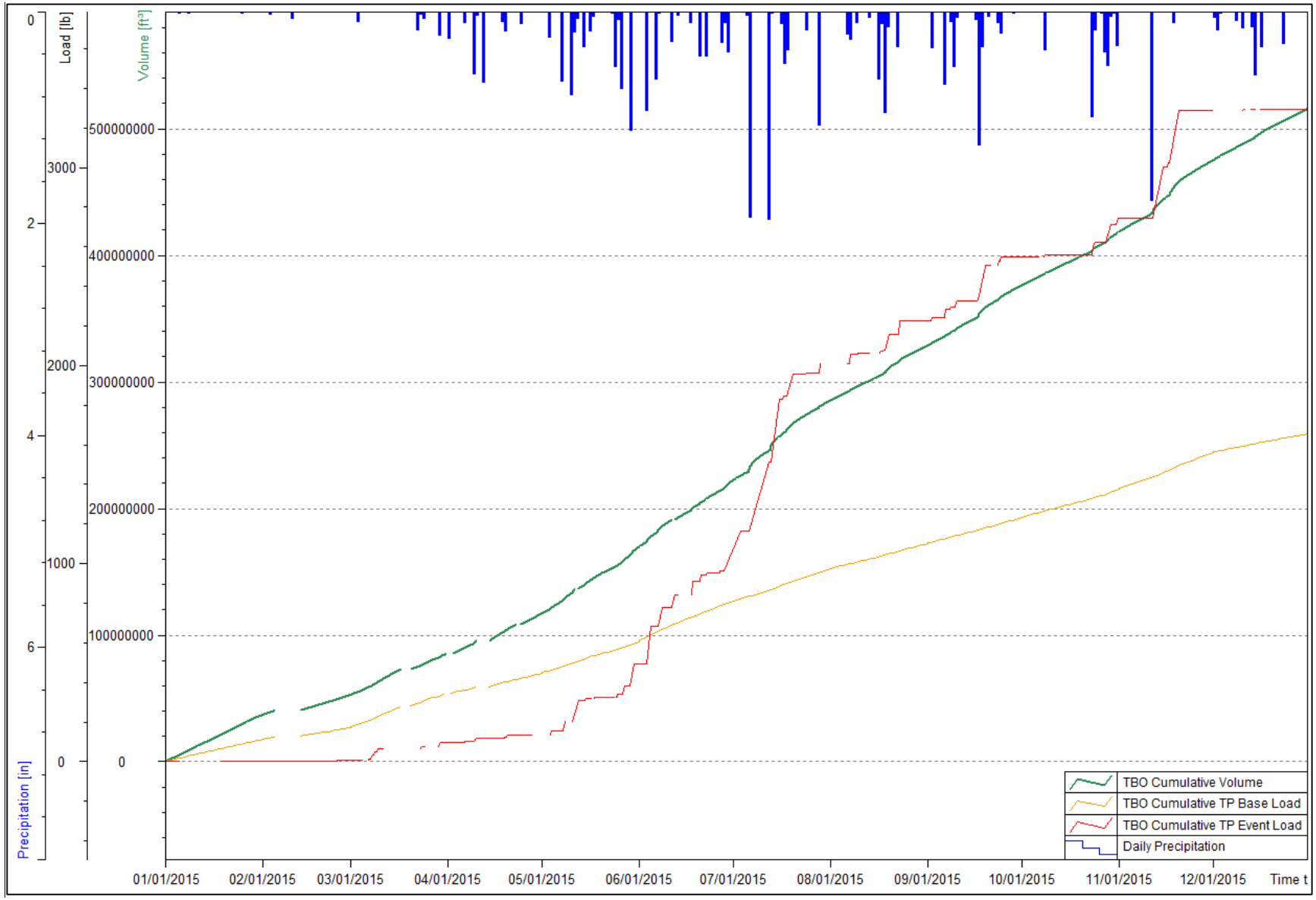

Figure 12-14: Trout Brook Outlet cumulative volume, TP event load, and TP base load, and daily precipitation.

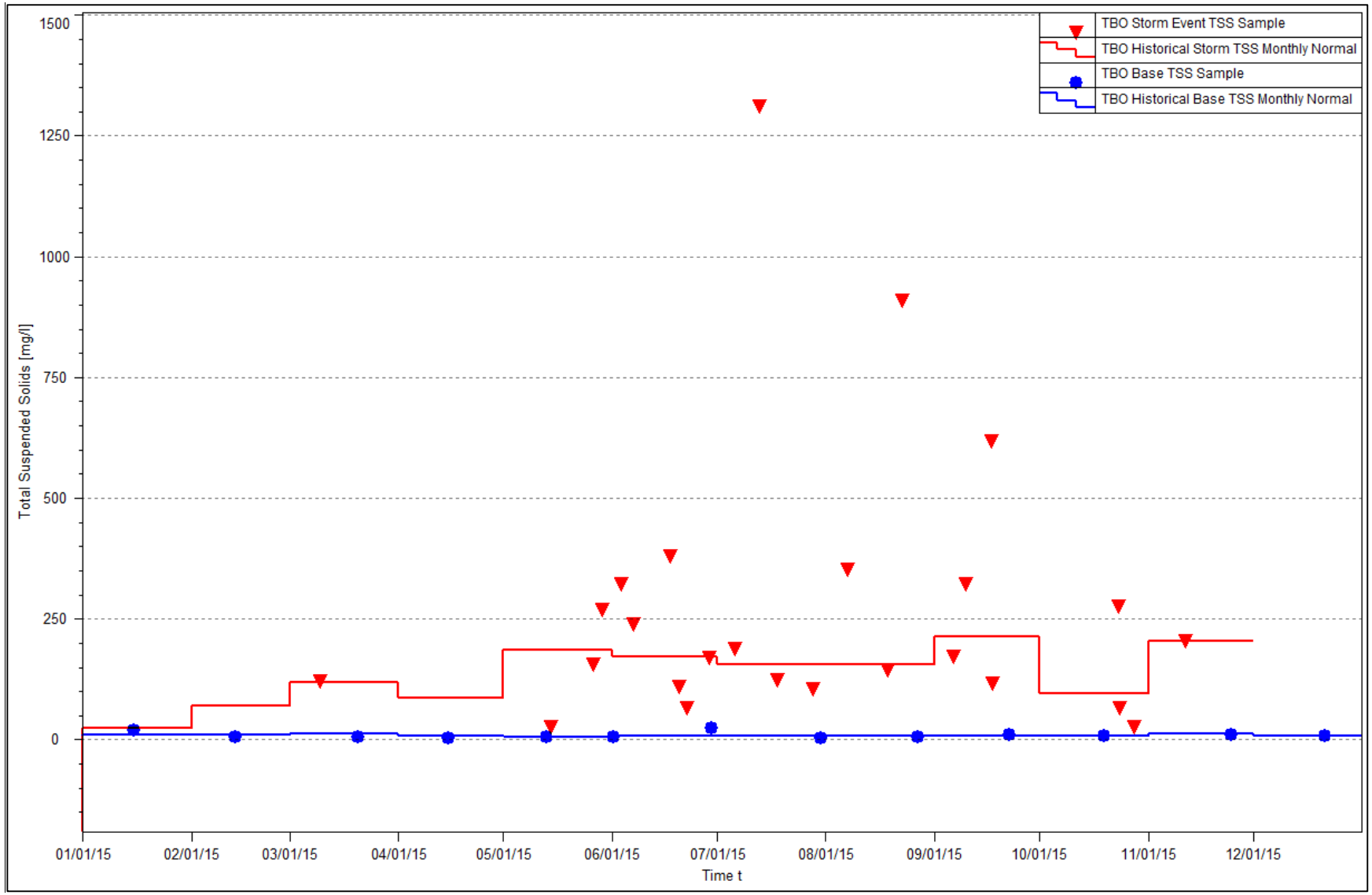

Figure 12-15: 2015 Trout Brook Outlet TSS samples and historical monthly normal.

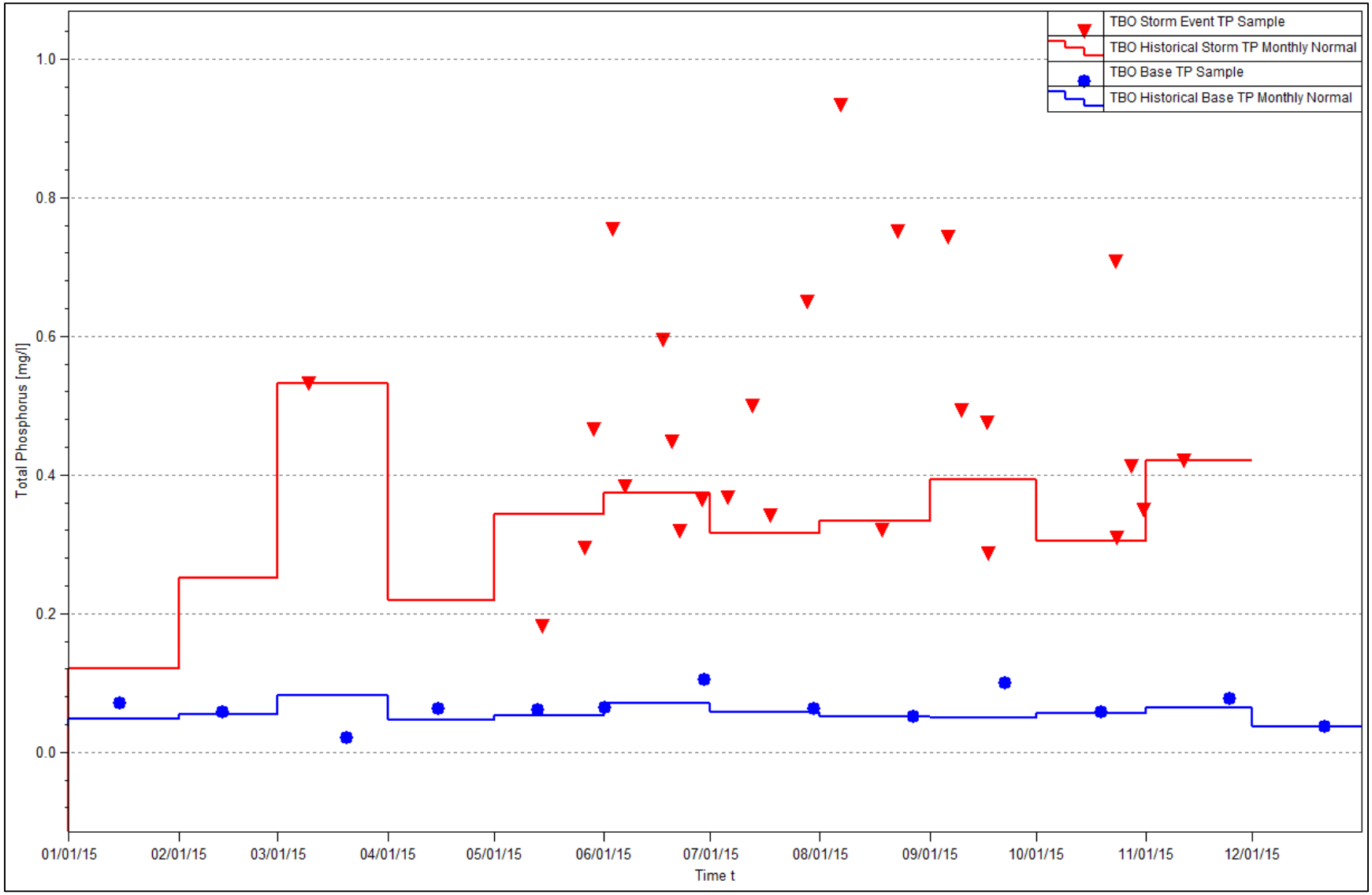

Figure 12-16: 2015 Trout Brook Outlet TP samples and historical monthly normal.

Table 12-3: 2015 Trout Brook Outlet subwatershed summary table.

Parameter	
Subwatershed Area (acres)	5,028
Total Precipitation (inches)	34
Number of Monitoring Days	343
Number of Base Sampling Events	13
Number of Storm Sampling Events	25
Number of Snowmelt Sampling Events	1
Number of Illicit Discharge Sampling Events	0

Discharge	
Baseflow Subtotal (Cubic Feet)	454,737,971
Event Flow Subtotal (Cubic Feet)	62,728,812
Total Discharge (Cubic Feet)	516,898,878
Baseflow Water Yield (cf/ac)	90,441
Event Water Yield (cf/ac)	12,476
Total Water Yield (cf/ac)	102,804

Total Suspended Solids	
Base FWA TSS (mg/L)	9
Event FWA TSS (mg/L)	623
Total FWA TSS (mg/L)	83
Baseflow TSS Load (lbs)	252,617
Event TSS Load (lbs)	2,440,190
Total TSS Load (lbs)	2,692,807
Total TSS Yield (lb/ac)	536

Total Phosphorus	
Base FWA TP (mg/L)	0.06
Event FWA TP (mg/L)	0.84
Total FWA TP (mg/L)	0.15
Base TP Load (lbs)	1,658
Event TP Load (lbs)	3,293
Total TP Load (lbs)	4,951
Total TP Yield (lb/ac)	0.98

12.5 2014 MONITORING SUMMARY – TROUT BROOK STORMWATER PONDS

CRWD has monitored the elevation of 4 stormwater ponds within the Trout Brook subwatershed since 2006: Arlington-Jackson, Westminster-Mississippi, Willow Reserve, and Sims-Agate. Monitoring at these location generally occurs between the months of April to November.

Summaries of 2015 monitoring data collected and observed at the Trout Brook stormwater ponds are listed below (Table 12-4).

12.5.1 ELEVATION – ARLINGTON-JACKSON

- Average elevation: 118.7 feet (Table 12-4)

12.5.2 ELEVATION – WESTMINSTER-MISSISSIPPI

- Average elevation: 107.2 feet (Table 12-4)

12.5.3 ELEVATION – WILLOW RESERVE

- Average elevation: 150.1 feet (Table 12-4)

12.5.4 ELEVATION – SIMS-AGATE

- Average elevation: 83.2 feet (Table 12-4)

Table 12-4: Historical average elevations for Trout Brook subwatershed stormwater ponds from 2006-2015.

Pond	Elevation (feet)										Average Elevation
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Arlington-Jackson	118.8	119.0	118.8	118.8	118.8	118.8	118.8	119.2	NA	118.7	118.9
Westminster-Mississippi	107.3	107.6	107.6	107.6	108.1	108.1	109.3	107.4	107.2	107.2	107.7
Willow Reserve	149.6	150.1	149.8	149.7	NA	150.2	149.8	150.6	NA	150.1	150.0
Sims-Agate	83.7	83.5	83.5	83.4	83.6	83.6	83.4	84.1	83.5	83.2	83.5

13 CONCLUSIONS & RECOMMENDATIONS

13.1 CONCLUSIONS

The 2015 stormwater monitoring data collected from ten monitoring stations in Capitol Region Watershed District was analyzed for total discharge, pollutant loads, metals toxicity, and bacteria. The data reported herein represents annual water quality results from seven of the sixteen major subwatersheds in CRWD.

The 2015 monitoring season was the sixth consecutive year since 2010 that six CRWD monitoring stations (East Kittsondale, Phalen Creek, St. Anthony Park, Trout Brook-East Branch, Trout Brook-West Branch, and Trout Brook Outlet) continuously collected data year-round from January through December. Therefore, the total recorded annual discharge and pollutant loads for these sites were higher from 2010-2015 in comparison to their historical records from 2005-2009.

CLIMATE

The climatic trends in 2015 were unique and not in line with annual or monthly historical normal, particularly during the winter months. During winter 2015, the total snowpack (34.31 in) was 20.1 inches below average. Ice out on lakes occurred 9 days earlier than normal on 3/27/15. The total amount of precipitation for the 2015 calendar year was 35.21 inches, which was 4.60 inches greater than the 30-year normal (NOAA, 2015). July 2015 was the wettest month of 2015, capturing the two largest storms recorded for the year: 1.95 inches on July 6 and 1.97 inches on July 12. Only two summer months of May and July were above the monthly normal value for precipitation by 1.71 inches and 2.19 inches, respectively. All months from September to December recorded precipitation totals above the monthly normal values. A 1.73 inch storm on November 11 was recorded as the fifth largest daily precipitation value for November in state records. December was abnormally warm with above average temperatures and precipitation.

Large precipitation events accounted for the majority of stormflow at all CRWD monitoring stations. Large storm events contributed a significant portion of the annual yield of TSS and TP.

DISCHARGE

The Trout Brook subwatershed exported the greatest amount of water (516,898,878 cf) in 2015 because it has the largest drainage area in CRWD (5,028 acres). Trout Brook subwatershed also recorded the greatest volume of total annual baseflow (454,737,971 cf) due to its large drainage area and connection to surface waters (e.g. Como Lake, Lake McCarrons, Arlington-Jackson Pond). Trout Brook-West Branch subwatershed produced the greatest total annual water yield (136,582 cf/ac), which is also likely related to this subwatershed being connected to Como Lake and Lake McCarrons.

POLLUTANT LOADS

In 2015, Trout Brook-West Branch produced the highest total annual TSS load on a per acre basis (1,059 lbs/ac). Trout Brook Outlet had the largest total annual TSS load (2,692,807 lbs) in 2015, of which 90% of the total load was transported by event flow.

Trout Brook-West Branch produced the highest total annual TP load on a per acre basis (1.46 lb/ac). Como 3 (0.17 lbs/ac) and Como 7 (0.14 lbs/ac) had the lowest annual TP yields of all subwatersheds in 2015. Overall, in 2015 Trout Brook Outlet produced the largest total annual TP load (4,951 lbs). TP loading in 2015 primarily occurred during storm events at all continuously monitored stations, even though baseflow accounted for the majority of the total discharge.

METALS

The 2015 average stormflow toxicity of lead exceeded the Minnesota Pollution Control Agency (MPCA) toxicity standards at all stations, except Villa Park. Stormflow copper toxicity was also exceeded at all monitored subwatersheds in 2015, except Trout Brook-East Branch and Villa Park. Average stormflow toxicity of zinc exceeded the MPCA toxicity standard at East Kittsondale, Phalen Creek, St. Anthony Park, Como 3, and Como 7. For all sites, average concentrations of cadmium, chromium, and nickel for all flow types (base, snowmelt, storm, and yearly) did not exceed the MPCA toxicity standards in 2015.

BACTERIA

During stormflow events, the majority (88%) of *E. coli* samples for all stations exceeded the MPCA maximum numeric standard (1,260 cfu/100 mL) in 2015. The highest bacteria count observed was at Como 7 on July 6, 2015 with 1,119,900 cfu/100 mL. Baseflow bacteria samples typically did not exceed the standard in 2015.

WATER QUALITY STANDARDS & COMPARISONS

In 2015, stormwater discharging from CRWD was measured to be more polluted than the Mississippi River at Lambert's Landing. High stormwater pollutant levels contribute to the various water quality impairments found in CRWD lakes and the Mississippi River.

The 2015 median stormwater concentrations for nutrients, solids, metals, and bacteria were compared to other urbanized areas in the United States using data reported in the National Stormwater Quality Database (NSQD). When comparing to NSQD's mixed residential land use category, all CRWD monitored subwatersheds exceeded median stormwater concentrations for *E. coli* and most exceeded median TP and TSS concentrations.

STORMWATER PONDS

CRWD stormwater ponds were able to provide adequate water storage while maintaining surface levels commensurate with previous monitoring years. Stormwater ponds experienced slight

increases in water levels during large storm events; however, excess water generally drained within 72 hours.

13.2 ACCOMPLISHMENTS & RECOMMENDATIONS

It is the goal of CRWD to continually improve the monitoring program with new ideas in order to advance the program in quality, efficiency, and data application. The monitoring program aims to collect and analyze high quality data from multiple locations to better understand the water quality in individual subwatersheds as well as the watershed as a whole. Data collection and analysis through the monitoring program helps to further CRWD's mission "to protect, manage and improve the water resources of the Capitol Region Watershed District."

ACCOMPLISHMENTS IN 2015

In 2015, CRWD achieved many of the goals stated in both the *2014 Monitoring Report* and the *Monitoring Program Review & Recommendations (2014-2016)*, including:

- CRWD implemented many of the functions included in the newly acquired monitoring database software (Kisters WISKI) in order to improve efficiency, accuracy, and consistency, including: data organization, data access, data analysis, and automation of data QA/QC, including:
    - Data migration and organization—all stormwater data migrated into the database;
    - Automated some QA/QC processes;
    - Automated baseflow and event flow interval identification;
    - Automated pollutant loading calculations;
    - Recalculated discharge, baseflow, event flow and pollutant loads for historical data using automated scripts in order to streamline calculations and eliminate year-to-year subjectivity;
    - Developed data outputs for table and figure creation;
    - Incorporated statistical functions in the software to compute data.

- CRWD established AC power connection and remote data access to Trout Brook-East Branch and Trout Brook-West Branch in 2015 in order to increase data collection efficiency and data quality.

- CRWD partnered with the University of Minnesota by collecting and analyzing water quality samples.

- CRWD identified an illicit discharge observed at St Anthony Park using IDDE protocols and worked with the City of St. Paul to determine the source.

RECOMMENDATIONS FOR 2016

For 2016, CRWD has developed several goals and recommendations aimed at improving the monitoring program's overall effectiveness in collecting and analyzing CRWD' water quantity and quality dataset. Goals for 2016 are:

1. Change reporting approach to better serve the needs of the District, such as:
    a. Improve accessibility to data and results;
    b. Simplify presentation of data and results for increased understanding;
    c. Provide meaningful analysis to better characterize subwatersheds and identify trends;
    d. Create short technical memos that focus data analysis towards research that supports other District projects and programs.

2. Establish solar power at remote monitoring stations for continuous power.

3. At stations with solar power, implement remote data access for two-way communication to remote stations.

4. Develop and implement a CRWD Monitoring Quality Assurance Program Plan (QAPP) in to ensure data quality. The QAPP will act as a primary guidance document to:
    a. Define field and laboratory quality assurance goals and procedures;
    b. Summarize monitoring program goals, design, sampling methods, analytical procedures, and data review protocols.

5. Enhance partnerships with the City of Saint Paul, Ramsey County, other local urban watershed districts, and research groups (e.g. University of Minnesota) to broaden our understanding of urban hydrology and pollutant loading.

6. Document illicit discharges throughout the watershed and work with District municipalities to eliminate other potential sources of pollution.

7. Consider analyzing water quality samples for additional parameters not currently analyzed, such as: bacteria/microbial source tracking, oil/grease, trash, PAHs, contaminants of emerging concern.

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APPENDIX A: 2015 METAL TOXICITY AND STANDARDS

APPENDIX A METAL STANDARDS BASED ON HARDNESS

Metals standards for cadmium, chromium, copper, lead, nickel, and zinc were calculated on an individual site basis for the entire monitoring season (yearly) as well as for base, storm, and illicit discharge event types (Table A-1). Listed below are the equations used to calculate the event type and yearly metals standards for cadmium, chromium, copper, lead, and zinc. Average hardness concentrations for each individual monitoring site were used in the calculations, which is why each site has a different standard. To convert from micrograms (µg) to milligrams (mg), the standard was multiplied by the conversion factor of $\frac{1mg}{1{,}000\mu g}$.

$$Cadmium\ Standard\ \left({}^{\mu g}/_{L}\right) = e^{0.7852*\ln\left[Average\ Hardness\left({}^{mg}/_{L}\right)\right]-3.49}$$

$$Chromium\ Standard\left({}^{\mu g}/_{L}\right) = e^{0.819*\ln\left[Average\ Hardness\left({}^{mg}/_{L}\right)\right]+1.561}$$

$$Copper\ Standard\left({}^{\mu g}/_{L}\right) = e^{0.620*\ln\left[Average\ Hardness\left({}^{mg}/_{L}\right)\right]-0.57}$$

$$Lead\ Standard\left({}^{\mu g}/_{L}\right) = e^{1.273*\ln\left[Average\ Hardness\left({}^{mg}/_{L}\right)\right]-4.705}$$

$$Zinc\ Standard\left({}^{\mu g}/_{L}\right) = e^{0.8473*\ln\left[Average\ Hardness\left({}^{mg}/_{L}\right)\right]+0.7615}$$

The Minnesota Rules also states that for waters with hardness values greater than 212 mg/L, the chronic standard for nickel shall not exceed 0.297 mg/L. For those event types or yearly averages which have average hardness values which exceed 212 mg/L, the nickel standard for those event types or year was set equal to the state standard of 0.297 mg/L. If the average hardness value was less than 212 mg/L, the following equation was used to calculate the nickel standard:

$$Nickel\ Standard\left({}^{\mu g}/_{L}\right) = e^{0.846*\ln\left[Average\ Hardness\left({}^{mg}/_{L}\right)\right]+1.1645}$$

Table A-1: Metals standards based on average hardness, 2015.

Parameter	Average	Lambert's Landing	East Kittsondale	Hidden Falls	Phalen Creek	St. Anthony Park	Trout Brook - East Branch	Trout Brook - West Branch	Trout Brook Outlet	Villa Park	Como 3	Como 7
Hardness	Base	--	400*	288	400*	355	400*	194	329	232	--	--
	Snowmelt	--	184	144	304	432	272	232	312	492	128	92
	Storm	--	55	87	48	58	141	76	110	179	30	26
	Yearly	246	184	212	172	175	294	106	188	201	29	24
Cadmium	Base	--	0.0034	0.0026	0.0034	0.0031	0.0034	0.0019	0.0029	0.0022	--	--
	Snowmelt	--	0.0018	0.0015	0.0027	0.0036	0.0025	0.0022	0.0028	0.0040	0.0014	0.0011
	Storm	--	0.0007	0.0010	0.0006	0.0007	0.0015	0.0009	0.0012	0.0018	0.0004	0.0004
	Yearly	0.0023	0.0018	0.0020	0.0017	0.0018	0.0026	0.0012	0.0019	0.0020	0.0004	0.0004
Chromium	Base	--	0.6442	0.4922	0.6442	0.5838	0.6442	0.3566	0.5484	0.4126	--	--
	Snowmelt	--	0.3411	0.2790	0.5145	0.6861	0.4697	0.4124	0.5256	0.7632	0.2534	0.1933
	Storm	--	0.1272	0.1847	0.1135	0.1325	0.2745	0.1652	0.2231	0.3336	0.0772	0.0677
	Yearly	0.4326	0.3408	0.3828	0.3227	0.3270	0.5011	0.2169	0.3473	0.3664	0.0759	0.0647
Copper	Base	--	0.0232	0.0189	0.0232	0.0215	0.0232	0.0148	0.0205	0.0166	--	--
	Snowmelt	--	0.0143	0.0123	0.0196	0.0243	0.0183	0.0166	0.0199	0.0264	0.0115	0.0093
	Storm	--	0.0068	0.0090	0.0062	0.0070	0.0122	0.0083	0.0104	0.0141	0.0047	0.0042
	Yearly	0.0172	0.0143	0.0157	0.0138	0.0139	0.0192	0.0102	0.0145	0.0151	0.0046	0.0041
Lead	Base	--	0.0186	0.0122	0.0186	0.0159	0.0186	0.0074	0.0145	0.0093	--	--
	Snowmelt	--	0.0069	0.0051	0.0131	0.0205	0.0114	0.0093	0.0135	0.0242	0.0044	0.0029
	Storm	--	0.0015	0.0027	0.0012	0.0016	0.0049	0.0022	0.0036	0.0067	0.0007	0.0006
	Yearly	0.0100	0.0069	0.0083	0.0063	0.0065	0.0126	0.0034	0.0071	0.0077	0.0007	0.0005
Nickel	Base	--	0.5094	0.3858	0.5094	0.4602	0.5094	0.2766	0.4314	0.3215	--	--
	Snowmelt	--	0.2641	0.2146	0.4039	0.5437	0.3676	0.3213	0.4128	0.6069	0.1943	0.1469
	Storm	--	0.0954	0.1401	0.0847	0.0994	0.2111	0.1249	0.1704	0.2582	0.0569	0.0497
	Yearly	0.3377	0.2639	0.2975	0.2495	0.2529	0.3930	0.1654	0.2691	0.2844	0.0559	0.0474
Zinc	Base	--	0.3431	0.2598	0.3431	0.3099	0.3431	0.1861	0.2905	0.2164	--	--
	Snowmelt	--	0.1777	0.1444	0.2719	0.3662	0.2475	0.2163	0.2780	0.4089	0.1307	0.0988
	Storm	--	0.0641	0.0942	0.0569	0.0668	0.1420	0.0839	0.1146	0.1737	0.0382	0.0334
	Yearly	0.2273	0.1775	0.2002	0.1678	0.1701	0.2646	0.1112	0.1811	0.1914	0.0375	0.0318

*For hardness values greater than 400mg/L, 400 mg/L is used as the value for metals standards calculations (MPCA)

-- No data available

APPENDIX B: MISCELLANEOUS REFERENCE TABLES

APPENDIX B MISCELLANEOUS REFERENCE TABLES

Table B-1: Data collection efficiency at CRWD monitoring stations, 2015.

Site	Possible Days	Possible Hours	Hours Missing	Efficiency
East Kittsondale	365	8,760	38	**100%**
Hidden Falls	220	5,279	0	**100%**
Phalen Creek	365	8,760	398	**95%**
St. Anthony Park	365	8,760	0	**100%**
Trout Brook-East Branch	365	8,760	583	**93%**
Trout Brook-West Branch	365	8,760	233	**97%**
Trout Brook Outlet	365	8,760	506	**94%**
Villa Park	250	6,004	0	**100%**
Como 3	231	5,544	0	**100%**
Como 7	227	5,449	20	**100%**
Como Golf Course Pond	238	5,710	202	**96%**
Arlington-Jackson	201	4,825	0	**100%**
Sims-Agate	195	4,679	0	**100%**
Westminster-Mississippi	201	4,825	0	**100%**
Willow Reserve	201	4,824	0	**100%**
McCarrons Outlet	183	4,387	0	**100%**
Como Outlet	238	5,710	0	**100%**
Total	**4,575**	**109,796**	**1,979**	**98%**

Table B-2: Total rainfall during monitoring days at CRWD stations, 2005-2015.

Site	Rainfall (inches)										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
East Kittsondale	29.05	24.67	24.25	18.89	20.95	35.61	33.62	30.26	36.36	35.66	35.21
Hidden Falls										28.37	29.18
Phalen Creek	29.28	24.13	13.96	17.73	20.34	36.32	33.62	29.73	31.20	35.44	35.08
St. Anthony Park	28.27	24.13	23.99	9.95	18.72	26.84	29.24	29.71	34.00	33.60	35.21
Trout Brook-East Branch		23.87	23.92	17.91	20.63	36.27	33.43	30.01	36.36	35.66	34.77
Trout Brook-West Branch	28.78	24.67	24.25	18.99	20.63	36.32	33.62	29.72	36.36	35.46	34.71
Trout Brook Outlet	29.28	24.67	24.23	15.54	20.95	36.32	24.53	30.26	36.36	35.50	33.74
Villa Park		24.66	24.16	19.45	19.11	31.32	28.90	26.38	26.00	29.38	31.54
Como 3								26.02	24.70	28.37	29.66
Como 7	28.96		24.16	17.40	18.82	30.92	28.90	26.02	24.70	28.37	31.54

NWS 30-Year Normal Precipitation (January-December)	30.61
Total 2015 Precipitation at UMN Climatological Observatory[a]	35.21

[a]Total Includes data from National Weather Service for Missing periods at UMN and snow water equivalent for snowfall

Table B-3: Number of possible monitoring days for continuously monitored stations, 2005-2015.

Site	Monitoring Days										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
East Kittsondale	200	210	225	218	277	365	365	366	365	364	365
Hidden Falls										196	220
Phalen Creek	197	194	134	210	262	365	365	366	342	344	365
St. Anthony Park	191	192	215	126	218	230	269	366	351	345	365
Trout Brook-East Branch		191	217	212	273	365	349	366	365	365	365
Trout Brook-West Branch	191	212	228	220	273	365	365	366	365	356	365
Trout Brook Outlet	198	211	226	198	277	365	344	366	365	363	365
Villa Park		204	228	223	220	212	211	232	197	206	250
Como 3								220	190	196	231
Como 7	195		222	209	217	209	205	223	194	195	227

APPENDIX C:
2015 LAB TABLES

Table C-1: 2015 Como 7 subwatershed laboratory data.

Como 7

Sample Type	Sampling Start Date/Time	Sampling End Date/Time	Cd mg/L	CBOD mg/L	Cl mg/L	Cr mg/L	Cu mg/L	Dissolved P mg/L	*E. coli* mpn/100 mL	Hardness mg/L	Pb mg/L	Ni mg/L	NO_3 mg/L	NO_2 mg/L	NH_3 mg/L	Ortho-P mg/L	pH	SO_4 mg/L	TDS mg/L	TKN mg/L	Total P mg/L	TSS mg/L	VSS mg/L	Zn mg/L
Snow melt Grab	3/9/2015 13:15	3/9/2015 13:15	0.00021		868.0	0.00650	0.01760	1.510		92	0.00730	0.00580	0.23	0.12	1.82	1.440	7.10		1580	6.20	1.90	116	57	0.09390
Storm Grab	4/9/2015 8:25	4/9/2015 8:25							5200															
Storm Composite	4/9/2015 8:32	4/9/2015 9:16	0.00062		40.2	0.01080	0.02340	0.111		6	0.01960	0.00920	0.38	0.03		0.111				2.40	0.56	326	108	0.15200
Storm Composite	4/12/2015 21:36	4/13/2015 1:16	0.00033		17.4	0.00790	0.01970	0.057		44	0.01570	0.00600	0.33	0.04	0.33		7.20		72	2.90	0.51	425	128	0.11300
Storm Composite	5/3/2015 17:46	5/3/2015 18:02	0.00081		24.6	0.02800	0.06890	0.057		56	0.07920	0.02020	0.46	0.03	0.20	0.005			120	7.70	3.13	1600	497	0.41400
Storm Composite	5/14/2015 16:16	5/14/2015 20:30	0.00020		8.7	0.00330	0.00700	0.093		30	0.00210	0.00200	0.26	0.03	0.20	0.067	7.60		50	1.10	0.21	22	15	0.03350
Storm Composite	5/24/2015 14:46	5/24/2015 19:46	0.00020		8.3	0.00300	0.01280	0.309		68	0.00350	0.00280	0.06	0.03	0.02		7.00		91	3.60	0.71	47	38	0.06160
Storm Composite	5/26/2015 17:31	5/26/2015 19:45	0.00020		3.5	0.00190	0.00530	0.046		10	0.00240	0.00130	0.05	0.03	0.02		7.50			0.92	0.16	25	15	0.03180
Storm Composite	5/29/2015 3:46	5/29/2015 5:01	0.00020		3.6	0.00300	0.00830	0.100		12	0.00820	0.00240	0.14	0.03	0.07	0.059	7.00		30	1.70	0.30	111	44	0.04870
Storm Composite	6/3/2015 13:16	6/3/2015 13:46	0.00020		2.8	0.00430	0.00740	0.040		12	0.01280	0.00210	0.10	0.03	0.02		6.60		22	1.50	0.29	356	181	0.05000
Storm Composite	6/7/2015 0:16	6/7/2015 1:45	0.00020		2.9	0.00310	0.00880	0.076		12	0.00940	0.00280	0.19	0.03	0.28		7.50		33	1.50	0.22	121	49	0.06220
Storm Composite	6/20/2015 6:01	6/20/2015 8:15	0.00030		4.9	0.00260	0.00920	0.155		18	0.00540	0.00250	0.14	0.03	1.24		7.00		54	3.90	0.50	137	73	0.07830
Storm Grab	6/22/2015 8:20	6/22/2015 8:20							54500															
Storm Grab	7/6/2015 8:15	7/6/2015 8:15							1119900															
Storm Composite	7/12/2015 23:16	7/12/2015 23:59	0.00020	5.0	4.2	0.00450	0.01240	0.037		10	0.01260	0.00350	0.16	0.03	0.02	0.025	7.60	1.2	32	1.40	0.28	144	44	0.07600
Storm Composite	7/18/2015 1:01	7/18/2015 3:00	0.00020		3.0	0.00200	0.00660	0.072		12	0.00590	0.00170	0.34	0.03	0.27		7.50		33	1.20	0.16	45	16	0.04060
Storm Composite	7/28/2015 7:00	7/28/2015 8:16	0.00020		4.3	0.00540	0.01010	0.056		14	0.00820	0.00320	0.14	0.03	0.02		7.10	1.3	26	0.82	0.22	86	19	0.05460
Storm Grab	7/28/2015 9:05	7/28/2015 9:05							9700															
Storm Composite	8/16/2015 18:31	8/16/2015 21:45	0.00020		5.0	0.00410	0.00900	0.044		12	0.00860	0.00290	0.31	0.03	0.09	0.041	6.70		31	1.10	0.18	71	19	0.06070
Storm Composite	8/18/2015 12:46	8/18/2015 16:31	0.00020	2.2	2.3	0.00220	0.00460	0.036		14	0.00310	0.00120	0.12	0.03	0.02	0.047	7.40	1.1	20	0.55	0.12	20	6	0.02650
Storm Composite	8/22/2015 21:00	8/22/2015 21:30	0.00020		2.1	0.00320	0.00860	0.044		10	0.00780	0.00210	0.17	0.03	0.02		7.30		19	1.20	0.22	88	38	0.05030
Storm Composite	9/6/2015 7:01	9/6/2015 12:15	0.00020		2.6	0.00430	0.01270	0.063		20	0.01040	0.00330	0.25	0.03	0.25				50	2.00	0.30	97	34	0.08990
Storm Composite	9/9/2015 21:16	9/9/2015 23:00	0.00020		2.2	0.00200	0.00830	0.052		18	0.00400	0.00170	0.30	0.03	0.35	0.037			46	1.30	0.18	50	22	0.04750
Storm Composite	10/23/2015 13:15	10/23/2015 16:45	0.00020		6.0	0.00280	0.01170	0.596		20	0.00340	0.00250	0.05	0.03	0.02		7.30		93	2.20	0.94	72	37	0.06340
Storm Composite	10/23/2015 23:00	10/24/2015 2:45	0.00020		2.3	0.00290	0.00950	0.219		40	0.00750	0.00240	0.05	0.03	0.02		7.00		38	1.50	0.50	99	38	0.06080
Storm Composite	10/27/2015 20:16	10/28/2015 2:15						0.540					0.05	0.03	0.02		7.00			0.99	0.68	15	12	
Storm Composite	10/31/2015 5:16	10/31/2015 8:45	0.00020		3.9	0.00200	0.00490	0.439		16	0.00150	0.00097	0.05	0.03	0.02	0.413	7.90			0.73	0.51			0.03050
Storm Composite	11/11/2015 16:16	11/12/2015 19:17	0.00028	21.0	3.3	0.00630	0.01190	0.391		28	0.01630	0.00350	0.05	0.03	0.28	0.350	6.80	1.8	48	2.30	0.66	379	143	0.08960
Storm Grab	11/17/2015 8:15	11/17/2015 8:15	0.00020		2.0	0.00130	0.00500	0.075	5200	6	0.00150	0.00066	0.12	0.03	0.06	0.072			21	0.37	0.10	7	4	0.01220
		Snow melt Average	0.00021	-	868.0	0.00650	0.01760	1.510	-	92	0.00730	0.00580	0.23	0.12	1.82	1.440	7.10	-	1580	6.20	1.90	116	57	0.09390
		Storm Average	0.00026	9.4	7.0	0.00482	0.01244	0.155	238900	21	0.01083	0.00352	0.18	0.03	0.17	0.112	7.21	1.3	46	1.87	0.49	189	69	0.07599
		Annual Average	0.00026	9.4	42.8	0.00489	0.01265	0.209	238900	24	0.01068	0.00361	0.18	0.03	0.24	0.222	7.21	1.3	119	2.04	0.54	186	68	0.07673
		Annual Maximum	0.00081	21.0	868.0	0.02800	0.06890	1.510	1119900	92	0.07920	0.02020	0.46	0.12	1.82	1.440	7.90	1.8	1580	7.70	3.13	1600	497	0.41400
		Annual Minimum	0.00020	2.2	2.0	0.00130	0.00460	0.036	5200	6	0.00150	0.00066	0.05	0.03	0.02	0.005	6.60	1.1	19	0.37	0.10	7	4	0.01220
		Annual Median	0.00020	5.0	3.8	0.00315	0.00910	0.075	9700	15	0.00765	0.00250	0.14	0.03	0.07	0.063	7.15	1.2	38	1.50	0.30	93	38	0.06075

Actual number less than value (<)
Actual number greater than value (>)
Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
Not collected

Table C-2: 2015 Como 3 subwatershed laboratory data.

Como 3

Sample Type	Sampling Start Date/Time	Sampling End Date/Time	Cd mg/L	CBOD mg/L	Cl mg/L	Cr mg/L	Cu mg/L	Dissolved P mg/L	*E. coli* mpn/100 mL	Hardness mg/L	Pb mg/L	Ni mg/L	NO_3 mg/L	NO_2 mg/L	NH_3 mg/L	Ortho-P mg/L	pH	SO_4 mg/L	TDS mg/L	TKN mg/L	Total P mg/L	TSS mg/L	VSS mg/L	Zn mg/L
Snow melt Grab	3/9/2015 13:25	3/9/2015 13:25	0.00020		1061.6	0.0062	0.0266	0.859		128	0.0134	0.0064	0.33	0.19	2.17	0.820	7.0		1990	6.60	1.27	79	39	0.0993
Storm Composite	4/1/2015 21:01	4/1/2015 21:02			137.7			0.175					0.97	0.09		0.113				7.30	1.29			
Storm Grab	4/9/2015 8:38	4/9/2015 8:38							5200															
Storm Composite	4/9/2015 8:46	4/9/2015 10:01	0.00021		53.7	0.0153	0.0260	0.122		28	0.0190	0.0072	0.28	0.03	0.19	0.077			88	1.80	0.58	208	68	0.1620
Storm Composite	4/9/2015 18:16	4/9/2015 20:01	0.00020		34.0	0.0089	0.0124			44	0.0067	0.0034	0.41	0.04						0.94	0.15	39	19	0.0686
Storm Composite	4/12/2015 21:46	4/13/2015 1:46	0.00020		22.8	0.0084	0.0215	0.056		56	0.0192	0.0060	0.33	0.04	0.41		7.3		87	2.00	0.31	201	70	0.1180
Storm Composite	5/3/2015 17:46	5/3/2015 18:46	0.00053		35.3	0.0272	0.0577	0.027		52	0.0628	0.0153	0.69	0.03	0.24	0.005			136	5.00	0.88	746	246	0.3310
Storm Composite	5/10/2015 22:32	5/11/2015 2:32	0.00020		5.7	0.0021	0.0071	0.067		28	0.0058	0.0018	0.31	0.03	0.63	0.044			41	0.97	0.14	38	13	0.0346
Storm Composite	5/26/2015 13:46	5/26/2015 19:16	0.00020		7.6	0.0083	0.0113	0.030		48	0.0076	0.0029	0.20	0.03	0.06		7.4		38	0.98	0.15	61	27	0.0630
Storm Composite	5/29/2015 4:02	5/29/2015 6:16	0.00020		3.8	0.0037	0.0104	0.075		20	0.0122	0.0030	0.22	0.03	0.13	0.056	7.4		39	1.30	0.24	105	32	0.0497
Storm Composite	6/3/2015 13:16	6/3/2015 14:01	0.00020		4.1	0.0121	0.0165	0.054		14	0.0219	0.0051	0.18	0.03	0.02		7.0		39	1.70	0.34	376	91	0.0852
Storm Composite	6/7/2015 0:31	6/7/2015 1:46	0.00020		4.0	0.0041	0.0104	0.049		18	0.0120	0.0032	0.25	0.03	0.34		7.3		41	1.40	0.22	144	41	0.0522
Storm Composite	6/17/2015 14:31	6/17/2015 15:46	0.00023		6.9	0.0145	0.0216	0.036		24	0.0327	0.0066	0.34	0.04		0.018				2.80	0.43	342	140	0.1180
Storm Composite	6/20/2015 6:31	6/20/2015 8:16	0.00020		5.9	0.0033	0.0069	0.045		50	0.0051	0.0020	0.33	0.03	0.48		7.3			1.10	0.15	41	16	0.0360
Storm Composite	6/22/2015 8:16	6/22/2015 9:31	0.00020		4.2	0.0078	0.0084	0.020		26	0.0066	0.0025	0.12	0.03	0.03		7.0		38	0.88	0.14	61	23	0.0469
Storm Grab	6/22/2015 8:35	6/22/2015 8:35							8500															
Storm Composite	6/28/2015 0:02	6/28/2015 2:01	0.00020			0.0046	0.0135	0.046		26	0.0101	0.0035	0.33	0.04	0.13	0.036	7.2			1.90	0.21			0.0786
Storm Composite	7/6/2015 1:16	7/6/2015 6:47	0.00020		3.3	0.0026	0.0081	0.020		16	0.0077	0.0020	0.12	0.03	0.03	0.006			23	0.94	0.13	48	15	0.0384
Storm Grab	7/6/2015 8:25	7/6/2015 8:25							86000															
Storm Composite	7/18/2015 1:22	7/18/2015 4:31	0.00020		3.6	0.0022	0.0069	0.054		12	0.0065	0.0016	0.41	0.03	0.31		7.1		36	1.00	0.11	30	9	0.0310
Storm Composite	7/28/2015 7:02	7/28/2015 10:16	0.00020		3.3	0.0065	0.0077	0.057		12	0.0061	0.0018	0.23	0.03	0.02		7.5	2.0	35	0.65	0.16	34	10	0.0416
Storm Grab	7/28/2015 9:30	7/28/2015 9:30							9700															
Storm Composite	8/7/2015 1:31	8/7/2015 3:01	0.00020		3.4	0.0043	0.0124	0.070		16	0.0145	0.0032	0.27	0.03	0.03	0.036	7.0		35	1.10	0.25	56	15	0.0724
Storm Composite	8/18/2015 12:47	8/18/2015 16:01	0.00020	1.4	4.0	0.0125	0.0173	0.062		18	0.0194	0.0088	0.13	0.04	0.02	0.036	7.4	1.8	68	0.98	0.30	217	42	0.0621
Storm Composite	8/22/2015 21:01	8/22/2015 21:17	0.00020		5.7	0.0158	0.0298	0.053		20	0.0315	0.0129	0.22	0.03	0.06		7.4		67	1.70	0.50	420	80	0.0962
Storm Composite	9/2/2015 3:47	9/2/2015 7:01	0.00020		6.1	0.0029	0.0110	0.065		26	0.0055	0.0030	0.61	0.04	0.10		6.8		69	1.40	0.23	41	19	0.0553
Storm Composite	9/6/2015 7:16	9/6/2015 13:16	0.00020		6.4	0.0044	0.0109	0.059		28	0.0069	0.0034	0.49	0.05	0.30				70	1.30	0.31	73	18	0.0579
Storm Composite	9/9/2015 21:31	9/9/2015 23:16	0.00020		6.6	0.0162	0.0232	0.055		30	0.0215	0.0129	0.29	0.04	0.33	0.048			106	0.75	0.19	352	54	0.0773
Storm Composite	9/17/2015 5:16	9/17/2015 8:46	0.00023		5.3	0.0234	0.0329	0.042		26	0.0286	0.0205	0.34	0.03	0.22	0.039	7.4	2.6	95	1.80	0.68	532	76	0.1040
Storm Composite	9/17/2015 13:16	9/17/2015 15:31	0.00020		10.2	0.0217	0.0287	0.049		28	0.0207	0.0181	0.26	0.04	0.21	0.035	8.0	4.8	127	1.90	0.55	52	22	0.0846
Storm Composite	10/8/2015 4:46	10/8/2015 5:31			12.4			0.341					0.57	0.03		0.184	6.5			2.30	0.42	111	27	
Storm Composite	10/23/2015 13:16	10/23/2015 16:47	0.00020		4.9	0.0125	0.0167	0.097		20	0.0077	0.0038	0.10	0.03	0.02		6.8		51	1.90	0.37	98	31	0.0834
Storm Composite	10/23/2015 23:01	10/24/2015 3:31	0.00020		2.4	0.0043	0.0102	0.079		16	0.0065	0.0028	0.05	0.03	0.02		7.2		46	0.98	0.26	79	24	0.0511
Storm Composite	11/11/2015 16:32	11/12/2015 20:17	0.00020	6.8	2.1	0.0092	0.0104	0.133		14	0.0136	0.0033	0.20	0.03	0.31	0.123	7.4	1.8	30	1.30	0.30	132	40	0.0566
Storm Grab	11/17/2015 8:30	11/17/2015 8:30	0.00020		2.0	0.0018	0.0050	0.100	4100	8	0.0046	0.0010	0.16	0.03	0.09	0.100			20	0.43	0.07	8	3	0.0161
		Snow melt Average	0.00020	-	1061.6	0.0062	0.0266	0.859	-	128	0.0134	0.0064	0.33	0.19	2.17	0.820	7.0	-	1990	6.60	1.27	79	39	0.0993
		Storm Average	0.00021	4.1	14.0	0.0093	0.0162	0.074	22700	26	0.0151	0.0058	0.31	0.04	0.18	0.060	7.2	2.6	59	1.68	0.34	166	45	0.0776
		Annual Average	0.00021	4.1	49.0	0.0092	0.0166	0.100	22700	29	0.0150	0.0058	0.31	0.04	0.26	0.104	7.2	2.6	137	1.84	0.37	163	45	0.0783
		Annual Maximum	0.00053	6.8	1061.6	0.0272	0.0577	0.859	86000	128	0.0628	0.0205	0.97	0.19	2.17	0.820	8.0	4.8	1990	7.30	1.29	746	246	0.3310
		Annual Minimum	0.00020	1.4	2.0	0.0018	0.0050	0.020	4100	8	0.0046	0.0010	0.05	0.03	0.02	0.005	6.5	1.8	20	0.43	0.07	8	3	0.0161
		Annual Median	0.00020	4.1	5.7	0.0078	0.0124	0.057	8500	26	0.0120	0.0034	0.28	0.03	0.13	0.044	7.3	2.0	46	1.30	0.26	79	27	0.0630

Actual number less than value (<)
Actual number greater than value (>)
Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
Not collected

Table C-3: 2015 East Kittsondale subwatershed laboratory data.

East Kittsondale

Sample Type	Sampling Start Date/Time	Sampling End Date/Time	Cd mg/L	CBOD mg/L	Cl mg/L	Cr mg/L	Cu mg/L	Dissolved P mg/L	*E. coli* mpn/100 mL	Hardness mg/L	Pb mg/L	Ni mg/L	NO_3 mg/L	NO_2 mg/L	NH_3 mg/L	Ortho-P mg/L	pH	SO_4 mg/L	TDS mg/L	TKN mg/L	Total P mg/L	TSS mg/L	VSS mg/L	Zn mg/L
Illicit Discharge Grab	06/09/2015 11:10	06/09/2015 11:10							261															
		IDDE Average	-	-	-	-	-	-	261	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Base Grab	01/15/2015 09:20	01/15/2015 09:20	0.00020	2.1	1857.0	0.00094	0.00500	0.020	2	600	0.00025	0.00300	1.28	0.03	0.02	0.006		99.0	3570	0.45	0.02	11	2	0.00960
Base Grab	02/13/2015 09:10	02/13/2015 09:10	0.00020		816.1	0.00042	0.00110	0.020	2	576	0.00017	0.00410	1.29	0.03	0.02	0.006			1600	0.44	0.02	2	1	0.00430
Base Grab	03/19/2015 09:35	03/19/2015 09:35							1															
Base Composite	03/19/2015 10:02	03/20/2015 08:15	0.00025		642.7	0.00091	0.00310	0.044		600	0.00330	0.00220	1.35	0.03	0.04	0.031			1350	0.85	0.08	113	43	0.01670
Base Grab	04/15/2015 09:35	04/15/2015 09:35	0.00020	1.2	447.2	0.00049	0.00099	0.027	7	580	0.00016	0.00210	1.86	0.03	0.02	0.015	8.3	94.0	1230	0.57	0.04	1	1	0.00630
Base Grab	05/13/2015 09:25	05/13/2015 09:25	0.00020		383.0	0.00094	0.00160	0.020	203	548	0.00016	0.00280	1.05	0.03	0.02	0.014	8.3		1070	0.41	0.03	1	1	0.00620
Base Composite	06/01/2015 10:02	06/02/2015 03:02	0.00020		326.7	0.00560	0.01270	0.027		412	0.00860	0.00610	1.49	0.03	0.06	0.025	8.2		873	1.10	0.31	150	36	0.03100
Base Grab	06/02/2015 09:35	06/02/2015 09:35							365															
Base Grab	06/18/2015 10:30	06/18/2015 10:30							1986															
Base Composite	06/29/2015 11:16	06/29/2015 19:16	0.00020		340.2	0.00045	0.00500	0.020		364	0.00044	0.00180	1.11	0.03	0.02	0.005	8.0		912	0.44	0.02	3	1	0.00350
Base Grab	06/30/2015 10:10	06/30/2015 10:10							1120															
Base Grab	07/30/2015 09:15	07/30/2015 09:15							99															
Base Grab	07/31/2015 09:10	07/31/2015 09:10	0.00020	0.6	372.1	0.00062	0.00170	0.044		484	0.00043	0.00180	1.66	0.03	0.02	0.044	8.2	84.6	953	0.88	0.06	1	1	0.00910
Base Grab	08/27/2015 09:25	08/27/2015 09:25	0.00020		369.1	0.00034	0.00100	0.020	980	488	0.00024	0.00180	1.62	0.03	0.02	0.019	8.0		1040	0.48	0.02	1	1	0.00560
Base Grab	09/22/2015 09:45	09/22/2015 09:45	0.00036		121.0	0.05180	0.08230	0.020	517	412	0.04210	0.04870	1.56	0.03	0.02	0.014	7.9	84.7	976	0.79	0.51	555	43	0.10600
Base Grab	10/19/2015 09:25	10/19/2015 09:25							29															
Base Composite	10/19/2015 09:29	10/19/2015 11:25	0.00020	1.0	303.1	0.00072	0.00500	0.079		544	0.00048	0.00200	1.93	0.03	0.02	0.059	8.1	88.3	945	0.68	0.08	1	2	0.01070
Base Grab	11/24/2015 09:35	11/24/2015 09:35	0.00020		396.9	0.00050	0.00500	0.020		508	0.00018	0.00170	2.07	0.03	0.02	0.020	7.8		1030	0.52	0.04	2	1	0.00500
Base Grab	12/21/2015 09:15	12/21/2015 09:15			361.3	0.00047	0.00140	0.043	435	528	0.00026	0.00190	1.94	0.03	0.02	0.015	7.8	96.2	1040	0.59	0.10	3	1	0.0109
		Base Average	0.00022	1.2	518.2	0.00494	0.00968	0.031	442	511	0.00437	0.00615	1.55	0.03	0.02	0.021	8.1	91.1	1276	0.63	0.10	65	10	0.01730
Snow melt Grab	03/09/2015 14:35	03/09/2015 14:35	0.00020		977.7	0.00750	0.02260	0.929		184	0.01600	0.00800	0.50	0.12	1.87	0.960	7.2		1580	6.50	1.24	92	51	0.10400
Storm Grab	04/09/2015 09:50	04/09/2015 09:50							575															
Storm Composite	05/14/2015 16:17	05/14/2015 20:48	0.00020		22.2	0.00790	0.02420	0.061		52	0.01640	0.00410	0.34	0.04	0.24	0.047	7.5		89	1.90	0.29	219	59	0.10700
Storm Composite	05/24/2015 14:17	05/25/2015 04:01	0.00020		16.0	0.00430	0.01350	0.101		32	0.00500	0.00250	0.12	0.03	0.02		7.1		100	1.80	0.35	34	22	0.05900
Storm Composite	05/26/2015 13:32	05/26/2015 20:46	0.00026		14.0	0.00970	0.03100	0.037		30	0.02850	0.00510	0.23	0.03	0.02		7.3		71	1.30	0.25	84	34	0.14000
Storm Composite	05/29/2015 03:47	05/29/2015 06:31	0.00021		6.5	0.00790	0.02400	0.111		14	0.03180	0.00660	0.26	0.03	0.09	0.079	7.1		61	2.70	0.48	520	92	0.12600
Storm Composite	06/03/2015 13:02	06/03/2015 14:46	0.00039		5.8	0.01230	0.03200	0.020		28	0.04920	0.00870	0.15	0.03	0.02		6.8		54	2.50	0.49	575	166	0.15800
Storm Composite	06/07/2015 00:02	06/07/2015 02:31	0.00027		8.1	0.00890	0.02380	0.050		28	0.03350	0.00740	0.15	0.03	0.10		7.2		63	1.80	0.39	322	114	0.10900
Storm Composite	06/17/2015 14:01	06/17/2015 17:01	0.00042		10.2	0.01800	0.04800	0.028		30	0.05930	0.01240	0.26	0.03	0.03	0.007			67	2.60	0.50	446	116	0.24500
Storm Composite	06/20/2015 06:16	06/20/2015 09:16	0.00020		10.9	0.00520	0.01510	0.025		32	0.01450	0.00380	0.13	0.03	0.14		7.0		65	1.50	0.22	92	39	0.08040
Storm Composite	06/22/2015 07:50	06/22/2015 10:31	0.00020		6.5	0.00690	0.01470	0.020		20	0.01740	0.00340	0.05	0.03	0.15		7.0		47	1.40	0.24	117	44	0.07270
Storm Grab	06/22/2015 09:30	06/22/2015 09:30							4100															
Storm Composite	07/06/2015 01:02	07/06/2015 05:26	0.00026		4.2	0.00720	0.02630	0.020		20	0.03030	0.00510	0.06	0.03	0.02	0.005	6.6		44	2.20	0.26	4350	388	0.15800
Storm Grab	07/06/2015 09:05	07/06/2015 09:05							3100															
Storm Composite	07/12/2015 23:32	07/13/2015 01:44	0.00020	6.0	3.2	0.00390	0.01380	0.020		14	0.02970	0.00320	0.26	0.03	0.10	0.005	7.2	1.9	34	1.00	0.17	59	18	0.07150
Storm Composite	07/28/2015 07:04	07/28/2015 09:31	0.00020		3.5	0.00660	0.01470	0.046		14	0.01590	0.00320	0.09	0.03	0.02		7.3	1.7	31	0.72	0.17	70	22	0.08650
Storm Grab	07/28/2015 09:20	07/28/2015 09:20							9800															
Storm Composite	08/07/2015 01:31	08/07/2015 06:01	0.00039		3.5	0.00860	0.03020	0.050		16	0.05760	0.00760	0.25	0.03	0.13	0.052	7.6		61	1.50	0.32	300	84	0.18100
Storm Composite	08/16/2015 21:01	08/16/2015 23:16	0.00020		4.4	0.00800	0.01940	0.036		24	0.01700	0.00640	0.37	0.03	0.06	0.036	7.3		65	0.93	0.25	164	35	0.09420
Storm Composite	08/18/2015 12:46	08/18/2015 19:46	0.00020	2.7	4.2	0.00860	0.02190	0.027		16	0.01960	0.00440	0.12	0.03	0.02	0.026	7.2	2.1	119	0.90	0.18	50	12	0.10100
Storm Composite	08/22/2015 21:01	08/23/2015 00:31	0.00028		5.4	0.01080	0.02680	0.037		28	0.02940	0.00770	0.22	0.03	0.02		7.4		61	1.50	0.34	284	72	0.13100
Storm Composite	09/02/2015 04:02	09/02/2015 06:31	0.00020		11.1	0.00370	0.01830	0.088		28	0.01050	0.00400	0.56	0.05	0.09		7.7		86	1.80	0.30	60	26	0.08980
Storm Composite	09/06/2015 07:01	09/06/2015 09:46	0.00020		4.7	0.00480	0.01610	0.062		28	0.01470	0.00430	0.34	0.03	0.20				58	1.60	0.27	97	29	0.09560
Storm Composite	09/17/2015 05:48	09/17/2015 11:45	0.00020		2.8	0.00650	0.01860	0.094		22	0.02700	0.00450	0.33	0.03	0.20	0.088	7.4	2.2	40	1.30	0.23	118	30	0.09600
Storm Composite	09/17/2015 12:01	09/17/2015 19:01	0.00022		5.3	0.00880	0.02390	0.036		28	0.02440	0.00580	0.30	0.03	0.09	0.041	7.3	2.6	42	1.00	0.22	127	27	0.09650
Storm Composite	10/08/2015 04:32	10/08/2015 05:46	0.00020		12.8	0.00670	0.02670	0.432		36	0.01830	0.00800	0.76	0.04	0.81	0.339	7.0		110	3.90	0.76	294	133	0.15300
Storm Composite	10/23/2015 13:01	10/23/2015 18:01	0.00020		8.2	0.00760	0.02770	0.355		32	0.01700	0.00480	0.05	0.03	0.02		7.0		109	2.20	0.72	103	56	0.13800
Storm Composite	10/23/2015 23:01	10/24/2015 04:01	0.00020		4.3	0.00340	0.01470	0.112		24	0.01200	0.00280	0.05	0.03	0.02		7.1		56	1.10	0.29	78	38	0.08270
Storm Composite	10/27/2015 20:47	10/28/2015 03:01	0.00020		2.2	0.00590	0.01280	0.339		32	0.00680	0.00250	0.05	0.03	0.02		7.2	4.4	100	0.97	0.44	20	15	0.06590
Storm Composite	10/31/2015 03:02	10/31/2015 11:01	0.00020		14.2	0.00230	0.00960	0.234		36	0.00600	0.00190	0.05	0.03	0.02	0.186	7.0		97	0.86	0.35	22	17	0.04700
Storm Composite	11/11/2015 16:17	11/11/2015 21:17	0.00021	13.0	2.6	0.00950	0.02180	0.143		22	0.02750	0.00470	0.19	0.03	0.18	0.125	7.1	1.7	35	1.40	0.33	131	55	0.11600
Storm Composite	11/17/2015 04:46	11/17/2015 12:33	0.00020		3.2	0.00390	0.01110	0.052		22	0.01370	0.00260	0.09	0.03	0.02	0.034	7.2		29	0.91	0.15	55	24	0.06980
Storm Grab	11/17/2015 10:00	11/17/2015 10:00							866															
		Snow melt Average	0.00020	-	22.2	0.00750	0.02260	0.929	-	184	0.01600	0.00800	0.50	0.12	1.87	0.960	7.2	-	1580	6.50	1.24	92	51	0.10400
		Storm Average	0.00024	7.2	6.8	0.00733	0.02151	0.098	3688	26	0.02344	0.00509	0.22	0.03	0.11	0.076	7.2	2.4	66	1.60	0.33	171	65	0.11002
		Annual Average	0.00023	7.2	7.4	0.00658	0.01779	0.097	1287	184	0.01721	0.00550	0.65	0.03	0.12	0.082	7.4	43.3	487	1.41	0.28	134	48	0.08048
		Annual Maximum	0.00042	13.0	22.2	0.05180	0.08230	0.929	9800	600	0.05930	0.04870	2.07	0.12	1.87	0.960	8.3	99.0	3570	6.50	1.24	575	388	0.24500
		Annual Minimum	0.00020	2.7	2.2	0.00034	0.00099	0.020	1	14	0.00016	0.00170	0.05	0.03	0.02	0.005	6.6	1.7	29	0.41	0.02	1	1	0.00350
		Annual Median	0.00020	6.0	5.4	0.00590	0.01510	0.043	435	32	0.01590	0.00410	0.30	0.03	0.02	0.029	7.3	4.4	89	1.10	0.25	88	30	0.08650

Actual number less than value (<)
Actual number greater than value (>)
Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
Outlier statistically determined to be outside the standard range of data
Not collected

Table C-4: 2015 Hidden Falls subwatershed laboratory data.

Hidden Falls

Sample Type	Sampling Start Date/Time	Sampling End Date/Time	Cd mg/L	CBOD mg/L	Cl mg/L	Cr mg/L	Cu mg/L	Dissolved P mg/L	*E. coli* mpn/100 mL	Hardness mg/L	Pb mg/L	Ni mg/L	NO_3 mg/L	NO_2 mg/L	NH_3 mg/L	Ortho-P mg/L	pH	SO_4 mg/L	TDS mg/L	TKN mg/L	Total P mg/L	TSS mg/L	VSS mg/L	Zn mg/L
Base Grab	3/19/2015 9:00	3/19/2015 9:00	0.00020		127.2	0.00033	0.00150	0.022	5200	164	0.00140	0.00210	0.63	0.03	0.24	0.017	7.2		578	0.65	0.03	2	1	0.01620
Base Composite	4/14/2015 9:16	4/14/2015 20:15	0.00020	1.5	135.5	0.00120	0.00350	0.020		344	0.00180	0.00210	0.58	0.03	0.12	0.005	8.0	111.0	577	0.64	0.13	8	3	0.01990
Base Grab	4/15/2015 8:50	4/15/2015 8:50							152															
Base Composite	5/12/2015 9:01	5/13/2015 8:15	0.00020		85.1	0.00110	0.00510	0.020		300	0.00440	0.00180	0.32	0.03	0.04	0.005	8.3		491	0.49	0.04	12	4	0.01590
Base Grab	5/13/2015 8:50	5/13/2015 8:50							31															
Base Grab	6/2/2015 8:45	6/2/2015 8:45	0.00020		75.5	0.00110	0.00140	0.020	210	320	0.00083	0.00160	0.32	0.03	0.08	0.005	8.0		506	0.73	0.04	8	4	0.00710
Base Grab	6/18/2015 9:50	6/18/2015 9:50							1733															
Base Composite	6/29/2015 10:16	6/29/2015 18:45	0.00020		62.1	0.00120	0.00500	0.025		368	0.00100	0.00240	0.57	0.06	0.07	0.005	8.0		585	0.47	0.04	9	2	0.01170
Base Grab	6/30/2015 9:20	6/30/2015 9:20							411															
Base Grab	7/16/2015 8:50	7/16/2015 8:50	0.00020	0.8	39.0	0.00500	0.00500	0.020		264	0.00430	0.00520	0.52	0.05	0.07	0.007	7.7	89.4	433	0.44	0.11	20	3	0.01320
Base Composite	7/30/2015 8:50	7/31/2015 7:45	0.00020	3.0	46.7	0.00180	0.00320	0.024		244	0.00170	0.00290	0.44	0.04	0.08	0.019	8.0	104.0	410	0.58	0.09	16	3	0.01780
Base Grab	7/30/2015 8:55	7/30/2015 8:55							3100															
Base Composite	8/13/2015 9:16	8/14/2015 5:30	0.00020	2.2	68.4	0.00081	0.00350	0.036		328	0.00120	0.00280	0.38	0.03	0.02	0.008	8.1	130.0	527	0.56	0.04	9	3	0.01740
Base Grab	8/14/2015 9:00	8/14/2015 9:00							1046															
Base Grab	8/27/2015 8:50	8/27/2015 8:50	0.00020		44.8	0.00160	0.00250	0.020	54	212	0.00084	0.00320	0.29	0.04	0.10	0.012	7.8		357	0.83	0.07	4	1	0.00530
Base Grab	9/15/2015 10:10	9/15/2015 10:10	0.00020		70.9	0.00045	0.00150	0.020	32	304	0.00038	0.00250	0.40	0.04	0.17	0.006	7.5		510	0.53	0.02	3	1	0.01010
Base Grab	9/22/2015 9:30	9/22/2015 9:30	0.00020		34.9	0.00230	0.00330	0.026	727	220	0.00150	0.00350	0.34	0.06	0.14	0.012	7.8	70.7	352	0.62	0.07	3	1	0.01180
Base Grab	10/9/2015 9:15	10/9/2015 9:15	0.00020		66.6	0.00067	0.00200	0.020	7500	328	0.00066	0.00320	0.38	0.06	0.24	0.007	7.5		532	0.81	0.04	6	2	0.00270
Base Grab	10/19/2015 8:55	10/19/2015 8:55							1200															
Base Grab	10/20/2015 9:10	10/20/2015 9:10	0.00020	1.0	80.4	0.00035	0.00500	0.020		400	0.00044	0.00340	0.46	0.04	0.18	0.008	7.6	163.0	651	0.70	0.03	3	2	0.00310
Base Grab	11/10/2015 9:30	11/10/2015 9:30	0.00020		53.6	0.00093	0.00500	0.020	1770	268	0.00071	0.00330	0.22	0.04	0.12	0.007	7.7		446	0.67	0.02	4	1	0.00500
Base Grab	11/24/2015 9:00	11/24/2015 9:00	0.00020		40.5	0.00200	0.00500	0.020		240	0.00150	0.00290	0.27	0.07	0.12	0.006	7.9		380	0.55	0.06	7	2	0.00670
Base Grab	12/21/2015 8:55	12/21/2015 8:55	0.00020		65.5	0.00160	0.00320	0.020	28	304	0.00160	0.00300	0.48	0.10	0.15	0.005	7.6	117.0	514	0.72	0.06	17	3	0.01220
		Base Average	0.00020	1.7	68.5	0.00140	0.00348	0.022	1546	288	0.00152	0.00287	0.41	0.05	0.12	0.008	7.8	112.2	491	0.62	0.06	8	2	0.01101
Snow melt Grab	3/9/2015 14:05	3/9/2015 14:05	0.00020		451.9	0.00300	0.01200	0.404		144	0.00630	0.00420	0.39	0.09	1.01	0.424	7.1		936	4.80	0.66	51	23	0.04180
Storm Grab	4/9/2015 9:25	4/9/2015 9:25	0.00022		26.0	0.00820	0.01180	0.079	1120	76	0.06500	0.00680	0.20	0.08	0.13	0.071	8.4		149	0.80	0.29	70	14	0.07410
Storm Composite	6/3/2015 13:16	6/3/2015 13:45																		1.40	0.35	210	31	
Storm Grab	6/11/2015 13:26	6/11/2015 13:26							2000															
Storm Composite	6/17/2015 14:16	6/17/2015 15:31	0.00029		8.8	0.01130	0.01620	0.039		56	0.03620	0.01300	0.29	0.04		0.024				1.60	0.49	394	74	0.09760
Storm Grab	6/22/2015 9:05	6/22/2015 9:05							2203															
Storm Composite	7/6/2015 3:16	7/6/2015 12:30	0.00020		10.2	0.00780	0.01040	0.025		58	0.01290	0.00810	0.19	0.08	0.02	0.012	7.7		150	0.88	0.28	148	18	0.04740
Storm Grab	7/6/2015 8:45	7/6/2015 8:45							7400															
Storm Composite	7/13/2015 0:01	7/13/2015 0:45	0.00024		6.0	0.00960	0.01220	0.054		40	0.03440	0.01000	0.22	0.03	0.12	0.023	7.7		110	0.99	0.38	259	33	0.06830
Storm Grab	7/28/2015 8:50	7/28/2015 8:50	0.00020	2.6	38.4	0.00580	0.00770	0.073	6300	168	0.01090	0.00600	0.54	0.03	0.04	0.071	7.7	56.5	284	0.76	0.26	68	8	0.02670
Storm Composite	9/9/2015 21:46	9/9/2015 23:00	0.00020			0.00240	0.02050	0.070			0.00700	0.00790				0.025	7.3			1.30	0.19			0.04070
Storm Composite	9/17/2015 5:46	9/17/2015 9:30	0.00020		4.9	0.00340	0.00670	0.041		32	0.01020	0.00300	0.28	0.03	0.16	0.036	7.4	6.7	67	1.00	0.20	42	10	0.04080
Storm Composite	11/11/2015 15:31	11/12/2015 0:30	0.00020	4.6	8.8	0.00340	0.00580	0.062		46	0.00850	0.00350	0.21	0.03	0.15	0.052	7.0	17.0	106	0.83	0.17	75	19	0.03770
Storm Composite	11/17/2015 5:01	11/18/2015 8:00	0.00020		11.5	0.00240	0.00500	0.026		68	0.00430	0.00250	0.12	0.05	0.06	0.014	7.4		192	0.52	0.11	22	6	0.01760
Storm Grab	11/17/2015 9:25	11/17/2015 9:25							2000															
		Snow melt Average	0.00020	-	451.9	0.00300	0.01200	0.404	-	144	0.00630	0.00420	0.39	0.09	1.01	0.424	7.1	-	936	4.80	0.66	51	23	0.04180
		Storm Average	0.00022	3.6	14.3	0.00603	0.01070	0.052	3504	68	0.02104	0.00676	0.26	0.05	0.10	0.036	7.6	26.7	151	1.01	0.27	143	24	0.05010
		Annual Average	0.00021	2.2	66.5	0.00307	0.00631	0.047	2106	212	0.00846	0.00427	0.36	0.05	0.15	0.034	7.7	86.5	410	0.92	0.16	57	10	0.02572
		Annual Maximum	0.00029	4.6	451.9	0.01130	0.02050	0.404	7500	400	0.06500	0.01300	0.63	0.10	1.01	0.424	8.4	163.0	936	4.80	0.66	394	74	0.09760
		Annual Minimum	0.00020	0.8	4.9	0.00033	0.00140	0.020	28	32	0.00038	0.00160	0.12	0.03	0.02	0.005	7.0	6.7	67	0.44	0.02	2	1	0.00270
		Annual Median	0.00020	2.2	46.7	0.00190	0.00500	0.025	1200	240	0.00175	0.00320	0.34	0.04	0.12	0.012	7.7	96.7	440	0.72	0.09	14	3	0.01680

Actual number less than value (<)
Actual number greater than value (>)
Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
Not collected

Table C-5: 2015 Villa Park Outlet laboratory data.

Villa Park Outlet

Sample Type	Sampling Start Date/Time	Sampling End Date/Time	Cd mg/L	CBOD mg/L	Cl mg/L	Cr mg/L	Cu mg/L	Dissolved P mg/L	*E. coli* mpn/100 mL	Hardness mg/L	Pb mg/L	Ni mg/L	NO_3 mg/L	NO_2 mg/L	NH_3 mg/L	Ortho-P mg/L	pH	SO_4 mg/L	TDS mg/L	TKN mg/L	Total P mg/L	TSS mg/L	VSS mg/L	Zn mg/L
Base Grab	1/15/2015 12:20	1/15/2015 12:20	0.00020	1.0	305.9	0.00009	0.00500	0.064	6	540	0.00013	0.00140	0.40	0.03	0.77	0.046		38.9	968	1.70	0.15	4	2	0.00230
Base Grab	2/13/2015 9:45	2/13/2015 9:45	0.00020		371.7	0.00010	0.00030	0.020	67	424	0.00018	0.00140	0.38	0.03	0.79	0.018			996	1.50	0.08	4	2	0.00240
Base Grab	3/19/2015 10:25	3/19/2015 10:25							5															
Base Composite	3/19/2015 10:46	3/20/2015 1:15	0.00020		106.8	0.00036	0.00150	0.020		188	0.00079	0.00099	0.05	0.03	0.37	0.006			348	1.30	0.17	8	4	0.01570
Base Grab	4/15/2015 11:45	4/15/2015 11:45	0.00020	3.7	198.9	0.00043	0.00110	0.020	43	296	0.00037	0.00130	0.05	0.03	0.02	0.006	8.0	24.1	570	1.20	0.13	8	6	0.00550
Base Composite	5/12/2015 10:46	5/13/2015 9:45	0.00020		93.0	0.00055	0.00210	0.032		192	0.00055	0.00150	0.09	0.03	0.23	0.019	8.1		292	1.10	0.15	7	5	0.01340
Base Grab	5/13/2015 9:50	5/13/2015 9:50							113															
Base Grab	6/2/2015 8:05	6/2/2015 8:05	0.00020		77.2	0.00028	0.00100	0.047	17	172	0.00039	0.00096	0.05	0.03	0.11	0.038	7.6		290	0.77	0.16	3	3	0.00500
Base Composite	6/29/2015 18:01	6/29/2015 19:01	0.00020		60.7	0.00039	0.00500	0.097		148	0.00058	0.00110	0.05	0.04	0.41	0.063	7.9		236	1.10	0.16	7	4	0.01060
Base Grab	6/30/2015 9:00	6/30/2015 9:00							980															
Base Grab	7/30/2015 9:40	7/30/2015 9:40							461															
Base Composite	7/30/2015 9:46	7/31/2015 8:30	0.00020	3.2	53.4	0.00021	0.00110	0.039		148	0.00110	0.00092	0.05	0.03	0.06	0.032	7.4	6.1	237	1.00	0.21	9	7	0.01750
Base Grab	8/27/2015 11:15	8/27/2015 11:15	0.00020		64.8	0.00048	0.00100	0.053	411	188	0.00068	0.00100	0.05	0.03	0.20	0.042	7.2		265	2.10	0.72	32	18	0.01240
Base Grab	9/22/2015 8:45	9/22/2015 8:45	0.00020		48.6	0.00021	0.00100	0.045	201	144	0.00038	0.00055	0.05	0.03	0.08	0.034	7.6	6.8	221	0.78	0.18	6	5	0.00790
Base Grab	10/19/2015 10:30	10/19/2015 10:30							60															
Base Grab	10/20/2015 10:00	10/20/2015 10:00	0.00020	7.6	75.1	0.00023	0.00500	0.031		230	0.00083	0.00110	0.05	0.03	0.03	0.022	7.0	9.8	335	1.70	0.24	14	11	0.00680
Base Grab	11/23/2015 13:45	11/23/2015 13:45	0.00020		32.3	0.00050	0.00500	0.159		104	0.00041	0.00070	0.20	0.03	0.22	0.134	7.5		168	1.10	0.26	3	3	0.00500
Base Grab	12/21/2015 8:30	12/21/2015 8:30	0.00020		106.3	0.00042	0.00100	0.020	17	244	0.00024	0.00090	0.33	0.03	0.17	0.020	7.5	16.5	400	0.91	0.08	4	2	0.01410
		Base Average	0.00020	3.9	122.7	0.00033	0.00232	0.050	198	232	0.00051	0.00106	0.14	0.03	0.27	0.037	7.6	17.0	410	1.25	0.21	8	6	0.00912
Snow melt Grab	3/9/2015 13:50	3/9/2015 13:50	0.00020		358.0	0.00094	0.00220	0.167		492	0.00074	0.00190	0.50	0.04	0.64	0.155	7.1		1030	2.00	0.23	18	11	0.01400
Storm Grab	4/9/2015 9:05	4/9/2015 9:05							111															
Storm Composite	5/7/2015 17:46	5/8/2015 0:45	0.00020		148.3	0.00110	0.01650	0.070		292	0.00230	0.00210	0.05	0.03	0.62		7.8		470	1.60	0.18	49	15	0.02630
Storm Composite	6/4/2015 1:46	6/4/2015 9:15	0.00020		64.2	0.00024	0.00100	0.025		148	0.00037	0.00078	0.05	0.03	0.14		7.7		254	0.84	0.17	6	4	0.00780
Storm Grab	6/22/2015 8:55	6/22/2015 8:55							6300															
Storm Composite	6/22/2015 16:01	6/23/2015 7:30	0.00020		86.3	0.00054	0.00500	0.055		202	0.00051	0.00200	0.05	0.03	0.19		7.9		328	1.00	0.17	10	5	0.00740
Storm Composite	6/28/2015 16:15	6/29/2015 0:15	0.00020		71.6	0.00048	0.00500	0.075		170	0.00099	0.00130	0.05	0.03	0.29	0.047	7.8		270	1.30	0.19	11	6	0.01280
Storm Composite	7/6/2015 4:00	7/6/2015 9:00	0.00020		46.9	0.00039	0.00270	0.052		126	0.00059	0.00110	0.05	0.03	0.15	0.045	7.6		201	0.86	0.16	10	6	0.01230
Storm Grab	7/6/2015 8:42	7/6/2015 8:42							7500															
Storm Composite	7/12/2015 23:31	7/13/2015 3:46	0.00020	3.7	38.1	0.00120	0.00330	0.071		100	0.00180	0.00170	0.07	0.03	0.21	0.059	7.5	4.8	174	1.40	0.29	20	9	0.02190
Storm Composite	7/18/2015 2:15	7/18/2015 9:00	0.00020		28.1	0.00024	0.00190	0.117		80	0.00064	0.00100	0.05	0.03	0.26		7.8		144	1.10	0.23	30	23	0.01090
Storm Composite	7/28/2015 7:46	7/29/2015 8:30	0.00020		45.7	0.00037	0.00110	0.051		128	0.00069	0.00100	0.05	0.03	0.02	0.029	7.9	5.2	198	1.00	0.19	9	6	0.02050
Storm Grab	7/28/2015 8:55	7/28/2015 8:55							2420															
Storm Composite	8/7/2015 1:31	8/7/2015 9:00	0.00020		46.4	0.00097	0.00350			126	0.00150	0.00150	0.05	0.03	0.02		7.5			1.60	0.32	25	14	0.02680
Storm Composite	8/16/2015 21:30	8/17/2015 8:30	0.00020		70.4	0.00019	0.00082	0.032		184	0.00190	0.00089	0.05	0.03	0.02		7.7			1.10	0.19	8	7	0.00960
Storm Composite	8/18/2015 13:01	8/19/2015 7:15	0.00020	3.1	80.8	0.00020	0.00140	0.038		204	0.00057	0.00083	0.05	0.03	0.02	0.045	7.7	7.3	344	0.97	0.19	7	5	0.01190
Storm Grab	8/19/2015 9:05	8/19/2015 9:05							1203															
Storm Composite	8/22/2015 22:45	8/23/2015 19:15	0.00020		63.6	0.00020	0.00120	0.046		164	0.00044	0.00064	0.05	0.03	0.02		8.0		263	0.79	0.17	7	5	0.00990
Storm Composite	9/6/2015 7:31	9/7/2015 12:15	0.00020		68.0	0.00024	0.00500	0.130		180	0.00073	0.00094	0.05	0.03	0.19				286	1.20	0.28	12	8	0.01610
Storm Composite	9/7/2015 6:30	9/17/2015 19:30	0.00020		56.4	0.00038	0.00160	0.069		160	0.00068	0.00080	0.05	0.03	0.12	0.066	7.7	6.9	243	0.90	0.19	8	6	0.01660
Storm Composite	9/9/2015 21:16	9/10/2015 9:15	0.00020		64.1	0.00022	0.00100	0.087		168	0.00094	0.00081	0.05	0.03	0.02	0.053			281	1.10	0.27	12	9	0.01160
Storm Composite	10/23/2015 14:31	10/24/2015 18:30	0.00020		79.0	0.00046	0.00220	0.080		184	0.00120	0.00120	0.05	0.03	0.08		7.8		336	1.90	0.32	16	11	0.01360
Storm Composite	10/28/2015 0:31	10/29/2015 8:30	0.00020		82.4	0.00330	0.00240	0.157		224	0.00098	0.00150	0.06	0.03	0.31		7.4	10.6	343	1.70	0.29	10	7	0.01450
Storm Composite	10/31/2015 7:31	11/1/2015 4:45	0.00020		72.4	0.00047	0.00500	0.888		200	0.00096	0.00110	0.06	0.04	0.54	0.870	7.4		320	1.50	0.30	9	6	0.01430
Storm Composite	11/11/2015 17:31	11/12/2015 3:00	0.00020	3.4	61.3	0.00180	0.00500	0.118		160	0.00086	0.00079	0.10	0.03	0.36	0.111	7.5	7.5	256	1.50	0.31	14	7	0.00930
Storm Composite	11/16/2015 17:00	11/17/2015 14:15	0.00020		40.6	0.00063	0.00500	0.112		118	0.00081	0.00110	0.21	0.03	0.28	0.091	7.6		164	1.10	0.21	7	4	0.01510
Storm Grab	11/17/2015 9:35	11/17/2015 9:35							1733															
		Snow melt Average	0.00020	-	358.0	0.00094	0.00220	0.167	-	492	0.00074	0.00190	0.50	0.04	0.64	0.155	7.1	-	1030	2.00	0.23	18	11	0.01400
		Storm Average	0.00020	3.4	65.7	0.00068	0.00353	0.120	3211	166	0.00097	0.00115	0.06	0.03	0.19	0.142	7.7	7.0	271	1.22	0.23	14	8	0.01446
		Annual Average	0.00020	3.7	96.1	0.00055	0.00303	0.094	1203	201	0.00079	0.00114	0.10	0.03	0.23	0.085	7.6	12.0	351	1.26	0.22	12	7	0.01241
		Annual Maximum	0.00020	7.6	371.7	0.00330	0.01650	0.888	7500	540	0.00230	0.00210	0.50	0.04	0.79	0.870	8.1	38.9	1030	2.10	0.72	49	23	0.02680
		Annual Minimum	0.00020	1.0	28.1	0.00009	0.00030	0.020	5	80	0.00013	0.00055	0.05	0.03	0.02	0.006	7.0	4.8	144	0.77	0.08	3	2	0.00230
		Annual Median	0.00020	3.4	69.2	0.00039	0.00215	0.055	157	176	0.00069	0.00105	0.05	0.03	0.19	0.045	7.6	7.4	284	1.10	0.19	9	6	0.01235

Actual number less than value (<)
Actual number greater than value (>)
Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
Not collected

Table C-6: 2015 Phalen Creek subwatershed laboratory data.

Phalen Creek

Sample Type	Sampling Start Date/Time	Sampling End Date/Time	Cd mg/L	CBOD mg/L	Cl mg/L	Cr mg/L	Cu mg/L	Dissolved P mg/L	*E. coli* mpn/100 mL	Hardness mg/L	Pb mg/L	Ni mg/L	NO_3 mg/L	NO_2 mg/L	NH_3 mg/L	Ortho-P mg/L	pH	SO_4 mg/L	TDS mg/L	TKN mg/L	Total P mg/L	TSS mg/L	VSS mg/L	Zn mg/L
Base Grab	1/15/2015 9:50	1/15/2015 9:50	0.00020	1	210.6	0.00052	0.02500	0.048	1	476	0.00024	0.00150	1.66	0.03	0.04	0.047		64.9	718	0.35	0.21	3	1	0.00780
Base Grab	2/13/2015 11:05	2/13/2015 11:05	0.00020		187.5	0.00066	0.00062	0.026	79	472	0.00030	0.00074	1.69	0.03	0.02	0.031			649	0.32	0.04	2	1	0.00720
Base Grab	3/19/2015 11:40	3/19/2015 11:40							2															
Base Composite	3/19/2015 12:02	3/20/2015 8:46	0.00024		182.8	0.00076	0.00120	0.030		484	0.00160	0.00087	1.73	0.03	0.02	0.035			634	0.36	0.05	2	1	0.01200
Base Composite	4/14/2015 10:17	4/15/2015 9:31	0.00020	1.8	159.0	0.00081	0.00220	0.033		460	0.00270	0.00110	1.64	0.03	0.02	0.036	8.2	62.6	617	0.46	0.09	4	2	0.01720
Base Grab	4/15/2015 10:00	4/15/2015 10:00							4															
Base Composite	5/12/2015 9:32	5/13/2015 9:01	0.00020		149.6	0.00073	0.00160	0.031		452	0.00320	0.00093	1.72	0.03	0.02	0.027	8.1		613	0.32	0.06	2	2	0.01150
Base Grab	5/13/2015 10:10	5/13/2015 10:10							12															
Base Composite	6/1/2015 10:32	6/2/2015 9:16	0.00020		158.6	0.00047	0.00100	0.026		448	0.00034	0.00068	1.64	0.03	0.02	0.031	8.0		610	0.03	0.08	1	1	0.00740
Base Grab	6/2/2015 10:00	6/2/2015 10:00							15															
Base Composite	6/29/2015 11:17	6/29/2015 19:01	0.00020		152.2	0.00066	0.00500	0.053		424	0.00076	0.00095	1.44	0.03	0.11	0.030	8.2		564	0.33	0.07	5	2	0.00980
Base Grab	6/30/2015 10:40	6/30/2015 10:40							210															
Base Grab	7/30/2015 11:10	7/30/2015 11:10							1553															
Base Composite	7/30/2015 11:32	7/31/2015 9:16	0.00020	0.9	169.1	0.00066	0.00100	0.042		266	0.00063	0.00064	1.49	0.03	0.02	0.034	7.9	57.5	615	0.53	0.08	2	2	0.01430
Base Grab	8/27/2015 9:40	8/27/2015 9:40	0.00020		155.2	0.00061	0.00100	0.051	64	460	0.00031	0.00068	2.05	0.03	0.04	0.058	7.7		614	0.44	0.05	1	1	0.01210
Base Grab	9/22/2015 10:10	9/22/2015 10:10	0.00020		132.6	0.00063	0.00100	0.169	32	456	0.00040	0.00061	1.63	0.03	0.03	0.090	7.8	58.5	635	0.32	0.09	2	1	0.01320
Base Grab	10/19/2015 9:45	10/19/2015 9:45							15															
Base Composite	10/19/2015 10:02	10/20/2015 9:02	0.00020	1.1	146.7	0.00068	0.00500	0.071		496	0.00039	0.00085	1.59	0.03	0.02	0.051	8.0	60.5	647	0.31	0.11	1	1	0.00990
Base Grab	11/24/2015 10:30	11/24/2015 10:30	0.00020		148.8	0.00170	0.00500	0.032		444	0.00021	0.00073	1.22	0.03	0.02	0.030	7.4		619	0.38	0.06	1	1	0.00800
Base Grab	12/21/2015 9:45	12/21/2015 9:45	0.00020		163.5	0.00067	0.00100	0.033	411	456	0.00027	0.00061	1.74	0.03	0.02	0.035	7.4	66.1	635	0.41	0.05	2	1	0.01530
		Base Average	0.00020	1.2	162.8	0.00074	0.00389	0.050	200	446	0.00087	0.00084	1.63	0.03	0.03	0.041	7.9	61.7	628	0.35	0.08	2	1	0.01121
Snow melt Grab	3/9/2015 15:00	3/9/2015 15:00	0.00021		871.5	0.00740	0.02590	0.435		304	0.02170	0.00570	0.87	0.09	0.75	0.397	7.1		1590	3.70	0.78	92	49	0.12300
Storm Composite	3/29/2015 5:02	3/29/2015 5:32			344.8			0.067		144			0.75	0.04	0.10					8.30	2.88			
Storm Composite	4/1/2015 21:02	4/1/2015 23:01	0.00072		99.4	0.02340	0.06910	0.168		152	0.08590	0.01660	0.79	0.08		0.129				5.20	0.90	540	211	0.40500
Storm Composite	4/9/2015 8:47	4/9/2015 21:16	0.00020		43.6	0.01200	0.02390	0.127		64	0.02900	0.00610	0.05	0.03	0.16	0.094			151	2.00	0.38	215	75	0.13900
Storm Grab	4/9/2015 10:05	4/9/2015 10:05							1553															
Storm Composite	4/12/2015 22:02	4/13/2015 1:48	0.00029		33.1	0.01210	0.03420	0.057		64	0.04830	0.00860	0.40	0.04	0.22		7.2		127	2.70	0.54	335	141	0.18900
Storm Composite	5/3/2015 17:47	5/3/2015 19:31	0.00120		37.0	0.03130	0.09010	0.051		72	0.16200	0.02230	0.66	0.05	0.19	0.005			161	8.40	1.56	1920	516	0.52400
Storm Composite	5/7/2015 18:02	5/7/2015 19:16	0.00084		13.7	0.02170	0.05810	0.084		48	0.13000	0.01510	0.08	0.03	0.16		7.4		82	4.90	0.94	698	198	0.32400
Storm Composite	5/10/2015 22:32	5/11/2015 1:46	0.00020		13.6	0.00500	0.01450	0.090		56	0.02390	0.00370	0.42	0.03	0.57	0.066			76	1.90	0.33	251	82	0.07870
Storm Composite	5/14/2015 16:17	5/14/2015 21:01	0.00020		33.3	0.00720	0.01160	0.056		92	0.00840	0.00240	0.48	0.03	0.14	0.044	7.4		140	1.00	0.18	39	21	0.05960
Storm Composite	5/26/2015 14:02	5/26/2015 20:01	0.00020		24.1	0.00760	0.01240	0.045		64	0.01350	0.00280	0.32	0.03	0.02		7.4		111	1.20	0.24	75	43	0.07160
Storm Composite	5/29/2015 4:02	5/29/2015 6:17	0.00022		9.8	0.00620	0.01770	0.148		32	0.03270	0.00450	0.31	0.03	0.10	0.099	7.1		63	2.50	0.50	336	127	0.09970
Storm Composite	6/3/2015 13:17	6/3/2015 14:19	0.00053		10.2	0.01330	0.03480	0.090		34	0.07380	0.00890	0.14	0.03	0.02		6.9		67	3.60	0.69	463	166	0.19300
Storm Composite	6/7/2015 0:02	6/7/2015 1:47	0.00030		7.6	0.00790	0.02120	0.088		26	0.06120	0.00590	0.17	0.03	0.14		7.3		212	2.00	0.46	348	97	0.11300
Storm Composite	6/17/2015 14:17	6/17/2015 16:46	0.00035		9.6	0.01180	0.02430	0.073		30	0.05480	0.00620	0.40	0.03	0.22	0.054			62	1.60	0.30	236	75	0.12900
Storm Composite	6/20/2015 6:16	6/20/2015 8:20	0.00020		12.7	0.00380	0.01600	0.068		42	0.01750	0.00480	0.16	0.03	0.29		7.3		80	1.40	0.23	83	32	0.07100
Storm Composite	6/22/2015 8:03	6/22/2015 10:01	0.00020		11.7	0.00620	0.01260	0.030		40	0.01580	0.00320	0.09	0.03	0.17		7.3		75	1.40	0.25	62	24	0.06660
Storm Grab	6/22/2015 9:45	6/22/2015 9:45																						
Storm Composite	6/28/2015 16:32	6/28/2015 17:16	0.00024		6.9	0.01000	0.02230	0.058		30	0.04660	0.00550	0.13	0.03	0.02	0.016	7.0		60	1.90	0.35	153	55	0.12500
Storm Composite	7/6/2015 4:03	7/6/2015 13:01	0.00020		7.5	0.00340	0.00960	0.044		32	0.01350	0.00190	0.10	0.03	0.02	0.032	7.4		53	0.48	0.12	42	14	0.04320
Storm Grab	7/6/2015 9:55	7/6/2015 9:55							2420															
Storm Composite	7/12/2015 23:32	7/13/2015 1:43	0.00020	4.5	6.2	0.00530	0.01620	0.047		24	0.03360	0.00420	0.31	0.03	0.11	0.026	7.3	2.9	55	1.10	0.24	5010	118	0.07700
Storm Composite	7/18/2015 1:03	7/18/2015 1:25	0.00043		5.3	0.01080	0.03970	0.072		26	0.08810	0.00990	0.11	0.03	0.12		7.1		55	2.40	0.54	90	17	0.21300
Storm Composite	7/28/2015 7:02	7/28/2015 9:01	0.00057		9.1	0.00710	0.01790	0.092		34	0.02440	0.00370	0.12	0.03	0.02		7.4	3.8	60	1.30	0.31	91	33	0.10900
Storm Grab	7/28/2015 9:35	7/28/2015 9:35							9700															
Storm Composite	8/6/2015 12:47	8/7/2015 2:46	0.00031		12.1	0.00790	0.03110	0.101		42	0.04710	0.00640	0.36	0.03	0.05	0.039	6.9		48	2.40	0.53	292	101	0.18500
Storm Composite	8/16/2015 20:33	8/16/2015 22:46	0.00025		6.8	0.00630	0.01740	0.105		28	0.03740	0.00400	0.32	0.03	0.02	0.065	7.1		53	1.90	0.45	396	80	0.10100
Storm Composite	8/18/2015 12:17	8/18/2015 15:46	0.00020	3.3	7.2	0.00720	0.01470	0.057		28	0.02520	0.00380	0.16	0.03	0.02	0.045	7.5	3.1	48	0.88	0.22	109	38	0.07450
Storm Composite	8/22/2015 21:02	8/23/2015 0:16	0.00021		9.6	0.00580	0.01530	0.079		36	0.03600	0.00420	0.29	0.03	0.15		7.3		71	1.40	0.30	195	51	0.07420
Storm Composite	9/2/2015 4:17	9/2/2015 5:31	0.00020		18.8	0.00340	0.01490	0.353		66	0.01350	0.00330	0.62	0.06	0.02		7.3		134	2.00	0.63	342	76	0.08710
Storm Composite	9/17/2015 6:02	9/17/2015 7:35	0.00029		2.8	0.00800	0.02170	0.082		20	0.05760	0.00490	0.24	0.03	0.20	0.069	7.0	2.1	23	1.40	0.33	5990	442	0.11800
Storm Composite	10/8/2015 4:34	10/8/2015 5:47	0.00020		16.7	0.00420	0.02060	0.758		50	0.02060	0.00400	0.74	0.05	0.58	0.512	7.1		137	4.50	1.08	180	107	0.12300
Storm Composite	10/23/2015 13:17	10/23/2015 16:17	0.00020		18.3	0.00670	0.02020	0.637		80	0.01740	0.00380	0.05	0.03	0.02		7.1		148	2.80	0.83	149	99	0.11600
Storm Composite	10/31/2015 3:18	10/31/2015 9:02	0.00020		26.1	0.00220	0.00640	0.173		84	0.00400	0.00140	0.05	0.03	0.02	0.123	7.3		147	0.73	0.26	15	11	0.03520
Storm Composite	11/11/2015 19:20	11/12/2015 0:07	0.00020	5.7	4.8	0.00410	0.00780	0.129		24	0.01580	0.00220	0.05	0.03	0.06	0.120	7.5	2.9	49	1.10	0.26	40	17	0.04710
Storm Composite	11/17/2015 6:02	11/17/2015 16:17	0.00020		6.7	0.00460	0.00600	0.069		28	0.01310	0.00220	0.05	0.03	0.02	0.051	7.4		62	0.74	0.21	42	21	0.05220
Storm Grab	11/17/2015 10:00	11/17/2015 10:00							1553															
		Snow melt Average	0.00021	-	871.5	0.00740	0.02590	0.435	-	304	0.02170	0.00570	0.87	0.09	0.75	0.397	7.1	-	1590	3.70	0.78	92	49	0.12300
		Storm Average	0.00033	4.5	28.0	0.00888	0.02408	0.132	3807	51	0.04169	0.00588	0.29	0.03	0.13	0.088	7.2	3.0	90	2.42	0.47	276	103	0.13479
		Annual Average	0.00029	2.6	85.7	0.00644	0.01816	0.115	1102	171	0.02918	0.00439	0.69	0.03	0.12	0.079	7.4	35.0	288	1.85	0.36	187	72	0.09801
		Annual Maximum	0.00120	5.7	871.5	0.03130	0.09010	0.758	9700	496	0.16200	0.02230	2.05	0.09	0.75	0.512	8.2	66.1	1590	8.40	1.56	1920	516	0.52400
		Annual Minimum	0.00020	0.9	2.8	0.00047	0.00062	0.026	1	20	0.00021	0.00061	0.05	0.03	0.02	0.005	6.9	2.1	23	0.03	0.04	1	1	0.00720
		Annual Median	0.00020	1.8	18.8	0.00555	0.01510	0.069	72	64	0.01745	0.00370	0.40	0.03	0.04	0.046	7.4	57.5	134	1.40	0.26	87	36	0.07435

Actual number less than value (<)
Actual number greater than value (>)
Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
Outlier statistically determined to be outside the standard range of data
Not collected

Table C-7: 2015 St. Anthony Park subwatershed laboratory data.

St. Anthony Park

Sample Type	Sampling Start Date/Time	Sampling End Date/Time	Cd mg/L	CBOD mg/L	Cl mg/L	Cr mg/L	Cu mg/L	Dissolved P mg/L	*E. coli* mpn/100 mL	Hardness mg/L	Pb mg/L	Ni mg/L	NO_3 mg/L	NO_2 mg/L	NH_3 mg/L	Ortho-P mg/L	pH	SO_4 mg/L	TDS mg/L	Fe mg/L	TKN mg/L	Total P mg/L	TSS mg/L	VSS mg/L	Zn mg/L
Illicit Discharge Composite	06/29/2015 19:47	06/29/2015 20:53	0.00051		12.5	0.00980	0.02960	0.025		36	0.02990	0.01000			0.18	0.010	7.2				2.50	0.43	488	220	0.16500
Illicit Discharge Grab	06/30/2015 08:50	06/30/2015 08:50	0.00020		47.4	0.00037	0.00500	0.023		202	0.00049	0.00500			0.04	0.010	7.9				0.84	0.07	12	4	0.01040
Illicit Discharge Grab	07/14/2015 10:40	07/14/2015 10:40	0.00020		344.0	0.00089	0.00450	0.020	921	286	0.00340	0.01800	0.80	0.03	0.14	0.012	7.3	65.0	774		1.50	0.05	20	8	0.02700
Illicit Discharge Grab	07/20/2015 09:10	07/20/2015 09:10	0.00180		263.3	0.16000	0.06670	0.020		312	0.05760	0.08270	0.87	0.03	0.28	0.005	7.3	73.8	717	305.0	5.40	2.56	1390	370	1.03000
		IDDE Average	0.00068	-	166.8	0.04277	0.02645	0.022	921	209	0.02285	0.02893	0.84	0.03	0.16	0.009	7.4	69.4	746	305.0	2.56	0.78	478	151	0.30810
Base Grab	02/13/2015 08:35	02/13/2015 08:35	0.00023		308.8	0.01910	0.01610	0.020	166	508	0.00730	0.03420	0.88	0.03	0.30	0.005			921		1.30	0.20	25	3	0.05430
Base Grab	03/19/2015 08:30	03/19/2015 08:30	0.00020		229.6	0.00970	0.00790	0.024	2	560	0.00150	0.03780	0.82	0.03	0.36	0.006	7.1		811		0.81	0.06	51	8	0.03510
Base Grab	04/15/2015 08:30	04/15/2015 08:30	0.00020	2.2	42.6	0.00043	0.00060	0.020	5	208	0.00021	0.00240	0.50	0.03	0.02	0.005	8.3	24.5	275		0.71	0.08	6	3	0.00350
Base Composite	05/12/2015 09:02	05/13/2015 07:46	0.00020		338.2	0.00750	0.00700	0.020		328	0.00290	0.01010	0.87	0.03	0.06	0.005	8.1		831		1.20	0.16	50	19	0.04990
Base Grab	05/13/2015 08:10	05/13/2015 08:10							24																
Base Composite	06/01/2015 09:03	06/02/2015 08:01	0.00020		361.8	0.00071	0.00240	0.020		392	0.00094	0.01080	0.83	0.03	0.05	0.005	8.1		890		0.87	0.05	12	6	0.01950
Base Grab	06/02/2015 08:20	06/02/2015 08:20							37																
Base Grab	06/30/2015 08:50	06/30/2015 08:50							260																
Base Grab	07/30/2015 08:20	07/30/2015 08:20							105																
Base Composite	07/30/2015 09:17	07/31/2015 07:31	0.00022	1.4	269.4	0.01010	0.00480	0.020		380	0.00200	0.06760	0.79	0.03	0.14	0.005	7.4	183.0	803		1.20	0.09	74	19	0.12100
Base Grab	08/27/2015 08:20	08/27/2015 08:20	0.00020		84.9	0.00051	0.00100	0.022	102	270	0.00039	0.01890	0.67	0.03	0.08	0.005	7.6		410		0.87	0.05	18	5	0.01580
Base Grab	09/22/2015 09:00	09/22/2015 09:00	0.00020		123.5	0.00160	0.00180	0.020	98	280	0.00056	0.02550	0.62	0.03	0.11	0.005	7.5	77.8	500		0.80	0.07	29	8	0.02760
Base Grab	10/19/2015 08:30	10/19/2015 08:30							49																
Base Composite	10/19/2015 09:31	10/19/2015 15:14	0.00020	0.9	256.2	0.00610	0.00500	0.020		544	0.00150	0.06920	1.00	0.04	0.22	0.006	7.6	194.0	913		0.64	0.07	73	15	0.07970
Base Grab	11/24/2015 08:30	11/24/2015 08:30	0.00020		69.4	0.00061	0.00500	0.020		240	0.00032	0.00940	0.91	0.03	0.08	0.009	7.7		353		0.93	0.07	12	5	0.00760
Base Grab	12/21/2015 08:30	12/21/2015 08:30	0.00020		31.2	0.00031	0.00100	0.020	46	192	0.00014	0.00250	1.13	0.03	0.02	0.013	7.7	22.6	279		0.82	0.09	3	1	0.01090
		Base Average	0.00020	1.5	192.3	0.00515	0.00478	0.021	81	355	0.00161	0.02622	0.82	0.03	0.13	0.006	7.7	100.4	635 -		0.92	0.09	32	8	0.03863
Snow melt Grab	03/09/2015 13:45	03/09/2015 13:45	0.00020		525.8	0.00840	0.01210	0.020		432	0.00370	0.02700	0.78	0.04	0.44	0.017	7.1		1230		1.90	0.22	85	25	0.04740
Storm Grab	04/09/2015 08:45	04/09/2015 08:45	0.00054		66.3	0.02300	0.05220	0.037	2420	108	0.03620	0.01670	0.44	0.07	0.20	0.038	7.1		193		1.70	0.45	438	108	0.32300
Storm Composite	05/07/2015 18:02	05/07/2015 21:16	0.00051		21.3	0.01290	0.03470	0.060		48	0.03860	0.01020	0.25	0.04	0.76		7.5		90		3.30	0.51	327	129	0.19600
Storm Composite	05/10/2015 22:32	05/11/2015 02:18	0.00020		13.9	0.00250	0.00890	0.056		40	0.00580	0.00230	0.30	0.03	0.44	0.036	7.4		66		1.20	0.17	69	32	0.04580
Storm Composite	05/14/2015 18:32	05/14/2015 21:16	0.00020		52.0	0.00440	0.00900	0.022		84	0.00440	0.00270	0.38	0.05	0.25	0.015	7.4		157		0.81	0.12	24	10	0.04400
Storm Composite	05/29/2015 05:32	05/29/2015 06:03	0.00020		20.4	0.00240	0.00670	0.055		34	0.00610	0.00250	0.29	0.03	0.17	0.038	7.6				0.97	0.17	189	123	0.03670
Storm Composite	06/20/2015 08:01	06/20/2015 09:16	0.00020		20.5	0.00330	0.00830	0.050		40	0.00560	0.00480	0.47	0.05	0.30		7.0		96		0.92	0.16	56	23	0.04760
Storm Composite	06/22/2015 08:16	06/22/2015 11:46	0.00021		13.3	0.00550	0.01210	0.030		32	0.01010	0.00510	0.23	0.03	0.04		7.5		69		1.00	0.18	70	23	0.07490
Storm Grab	06/22/2015 08:45	06/22/2015 08:45							20100																
Storm Composite	07/06/2015 03:02	07/06/2015 06:34	0.00020		7.1	0.00250	0.00940	0.020		20	0.00620	0.00260	0.19	0.03	0.05	0.014	7.7		47		1.10	0.12	43	13	0.05530
Storm Grab	07/06/2015 08:20	07/06/2015 08:20							27500																
Storm Composite	07/28/2015 07:17	07/28/2015 08:23	0.00020		6.4	0.00520	0.01150	0.033		22	0.01240	0.00410	0.15	0.03	0.03		6.9	2.8	43		0.83	0.21	96	28	0.07540
Storm Grab	07/28/2015 08:30	07/28/2015 08:30							25900																
Storm Composite	08/06/2015 23:47	08/07/2015 03:16	0.00038			0.00740	0.02190			80	0.01770	0.01470				0.011	7.4	25.3		9.6	1.80	0.34	241	97	0.15000
Storm Composite	08/16/2015 19:32	08/17/2015 00:16	0.00020		22.2	0.00510	0.01350	0.040		56	0.00910	0.00710	0.44	0.03	0.03	0.019	7.2		108		1.00	0.21	81	22	0.08720
Storm Composite	08/18/2015 14:46	08/18/2015 20:01	0.00020	2.0	14.2	0.00340	0.00610	0.022		32	0.00430	0.00320	0.18	0.03	0.02	0.019	7.3	6.9	57	1.9	0.48	0.11	29	8	0.03640
Storm Composite	08/22/2015 21:03	08/23/2015 00:16	0.00026		15.7	0.00660	0.01690	0.045		44	0.01480	0.00680	0.28	0.03	0.04		6.1		82		1.40	0.31	219	69	0.10300
Storm Composite	09/06/2015 09:02	09/06/2015 13:31	0.00020		36.9	0.00250	0.00780	0.110		90	0.00410	0.00740	0.28	0.03	0.12				176		1.00	0.26	38	12	0.03960
Storm Composite	09/24/2015 05:32	09/24/2015 09:00	0.00020		32.0	0.00230	0.00720	0.099		86	0.00370	0.00800	0.35	0.04	0.06		7.7		154		0.78	0.21	35	14	0.04700
Storm Composite	10/23/2015 12:03	10/23/2015 19:31	0.00020		23.7	0.00570	0.01790	0.081		80	0.01260	0.00910	0.14	0.03	2.00		7.4		145		1.70	0.76	153	58	0.10300
Storm Composite	10/27/2015 23:17	10/28/2015 20:46	0.00020		33.7	0.00210	0.00660	0.113		80	0.00260	0.00730	0.25	0.04	0.03		7.1		162		0.67	0.16	15	10	0.03920
Storm Composite	10/31/2015 03:47	10/31/2015 12:16	0.00020		32.4	0.00180	0.00620	0.077		76	0.00380	0.00610	0.18	0.03	0.02	0.049	7.4		155		0.57	0.17	16	11	0.03840
Storm Composite	11/17/2015 07:16	11/17/2015 12:16	0.00020		11.4	0.00300	0.00500	0.032		32	0.00650	0.00360	0.14	0.03	0.03	0.008	7.3		97		0.55	0.11	33	11	0.03780
Storm Grab	11/17/2015 09:05	11/17/2015 09:05							1733																
		Snow melt Average	0.00020	-	525.8	0.00840	0.01210	0.020	-	432	0.00370	0.02700	0.78	0.04	0.44	0.017	7.1 -		1230 -		1.90	0.22	85	25	0.04740
		Storm Average	0.00025	2.0	24.6	0.00535	0.01378	0.055	15531	57	0.01077	0.00654	0.27	0.04	0.26	0.025	7.3	11.7	112	5.8	1.15	0.25	114	42	0.08317
		Annual Average	0.00028	1.6	110.4	0.00965	0.01235	0.039	4675	179	0.00907	0.01587	0.51	0.03	0.21	0.014	7.4	67.6	374	105.5	1.26	0.26	129	43	0.09386
		Annual Maximum	0.00180	2.2	525.8	0.16000	0.06670	0.113	27500	560	0.05760	0.08270	1.13	0.07	2.00	0.049	8.3	194.0	1230	305.0	5.40	2.56	1390	370	1.03000
		Annual Minimum	0.00020	0.9	6.4	0.00031	0.00060	0.020	2	20	0.00014	0.00230	0.14	0.03	0.02	0.005	6.1	2.8	43	1.9	0.48	0.05	3	1	0.00350
		Annual Median	0.00020	1.7	35.3	0.00340	0.00780	0.024	105	86	0.00430	0.00800	0.44	0.03	0.10	0.010	7.4	45.2	176	9.6	0.97	0.16	50	14	0.04700

Actual number less than value (<)
Actual number greater than value (>)
Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
Not collected

Table C-8: 2015 Trout Brook-East Branch subwatershed laboratory data.

Trout Brook East Branch

Sample Type	Sampling Start Date/Time	Sampling End Date/Time	Cd mg/L	CBOD mg/L	Cl mg/L	Cr mg/L	Cu mg/L	Dissolved P mg/L	*E. coli* mpn/100 mL	Hardness mg/L	Pb mg/L	Ni mg/L	NO_3 mg/L	NO_2 mg/L	NH_3 mg/L	Ortho-P mg/L	pH	SO_4 mg/L	TDS mg/L	TKN mg/L	Total P mg/L	TSS mg/L	VSS mg/L	Zn mg/L
Base Grab	1/15/2015 11:20	1/15/2015 11:20	0.00020	7.9	303.3	0.00230	0.00500	0.021	276	560	0.00760	0.00490	0.24	0.03	0.07	0.022		54.1	913	0.99	0.22	49	10	0.01900
Base Grab	2/13/2015 10:05	2/13/2015 10:05	0.00020		353.2	0.00240	0.00400	0.266	387	650	0.00460	0.00730	0.05	0.03	0.07	0.228			956	1.30	0.55	65	12	0.02200
Base Grab	3/19/2015 10:45	3/19/2015 10:45							8															
Base Composite	3/19/2015 11:16	3/20/2015 8:00	0.00020		366.1	0.00059	0.00190	0.205		460	0.00066	0.00750	0.05	0.03	0.02	0.157			1050	1.20	0.53	9	6	0.01630
Base Grab	4/15/2015 10:50	4/15/2015 10:50	0.00020	7.9	313.7	0.00044	0.00140	0.117	5	512	0.00069	0.00650	0.05	0.03	0.06	0.098	7.5	47.8	949	1.10	0.48	6	3	0.01050
Base Composite	5/12/2015 15:16	5/13/2015 10:15	0.00020		354.6	0.00190	0.00570	0.030		472	0.00440	0.00550	0.07	0.03	0.02	0.014	8.1		883	0.92	0.23	35	11	0.01600
Base Grab	5/13/2015 10:30	5/13/2015 10:30							62															
Base Composite	6/1/2015 13:46	6/2/2015 0:16	0.00020		300.0	0.00340	0.00690	0.020		492	0.00640	0.00790	0.05	0.03	0.02	0.005	7.7		912	1.60	0.37	93	26	0.02480
Base Grab	6/2/2015 8:50	6/2/2015 8:50							5200															
Base Grab	6/18/2015 10:40	6/18/2015 10:40							3100															
Base Composite	6/29/2015 10:31	6/29/2015 18:30	0.00020		106.1	0.00900	0.01530	0.070		200	0.01430	0.01100	0.05	0.03	0.08	0.013	7.5		380	1.40	0.42	180	38	0.04330
Base Grab	6/30/2015 9:55	6/30/2015 9:55							1414															
Base Grab	7/8/2015 10:55	7/8/2015 10:55							951															
Base Grab	7/16/2015 9:30	7/16/2015 9:30	0.00020	8.4	282.5	0.00130	0.00430	0.020		468	0.00220	0.00540	0.26	0.03	0.04	0.008	7.5	37.5	772	1.10	0.31	10	7	0.01350
Base Grab	7/30/2015 10:25	7/30/2015 10:25							291															
Base Grab	7/31/2015 8:40	7/31/2015 8:40	0.00020	26.0	329.2	0.00540	0.00980	0.020		540	0.01120	0.00760	0.22	0.03	0.04	0.006	7.1	52.3	930	1.20	0.25	63	12	0.03930
Base Composite	8/4/2015 14:46	8/5/2015 13:30	0.00020		348.1	0.00093	0.00260	0.020		540	0.00150	0.00400	0.05	0.03	0.02		7.8		943	0.91	0.09	21	7	0.01620
Base Grab	8/27/2015 10:20	8/27/2015 10:20	0.00020		321.1	0.00088	0.00120	0.022	276	524	0.00093	0.00370	0.21	0.03	0.06	0.011	7.9		909	0.69	0.05	4	2	0.00800
Base Grab	9/22/2015 9:05	9/22/2015 9:05	0.00020		315.0	0.00150	0.00150	0.027	259	460	0.00074	0.00310	0.13	0.03	0.02	0.017	7.5	56.1	769	0.78	0.18	10	6	0.01240
Base Composite	10/19/2015 8:49	10/20/2015 8:00	0.00020	11.0	290.2	0.00140	0.00500	0.020		552	0.00200	0.00380	0.05	0.03	0.02	0.007	7.9	56.1	891	0.75	0.14	28	9	0.01200
Base Grab	10/20/2015 9:00	10/20/2015 9:00							11															
Base Grab	11/24/2015 13:35	11/24/2015 13:35	0.00020		298.5	0.00280	0.00500	0.020		528	0.00250	0.00430	0.26	0.03	0.06	0.005	7.6		854	0.89	0.10	9	3	0.00970
Base Grab	12/21/2015 9:00	12/21/2015 9:00	0.00020		327.6	0.00540	0.00860	0.020	53	520	0.01100	0.00740	0.36	0.03	0.05	0.005	7.7	67.3	919	1.50	0.19	139	22	0.04000
		Base Average	0.00020	12.2	307.3	0.00264	0.00521	0.060	878	499	0.00471	0.00599	0.14	0.03	0.04	0.043	7.7	53.0	869	1.09	0.27	48	12	0.02020
Snow melt Grab	3/9/2015 14:05	3/9/2015 14:05	0.00034		753.5	0.01130	0.02620	0.391		272	0.02890	0.01090	0.30	0.10	0.77	0.326	7.1		1530	4.70	1.11	280	71	0.11100
Storm Composite	4/1/2015 21:46	4/2/2015 0:30	0.00020		319.9	0.00860	0.02220	0.105		180	0.01340	0.00900	0.44	0.08		0.073				4.00	0.58			0.09820
Storm Composite	4/9/2015 9:01	4/9/2015 10:30	0.00020		158.9	0.00700	0.01570	0.125		96	0.01180	0.00560	0.30	0.04	0.42	0.105				2.70	0.58			0.07960
Storm Grab	4/9/2015 9:20	4/9/2015 9:20							173															
Storm Composite	4/9/2015 20:15	4/10/2015 4:30			162.4								1.92	0.03						1.90	0.28	39	10	
Storm Composite	4/12/2015 22:46	4/13/2015 10:45	0.00020		108.6	0.00570	0.01330	0.064		92	0.02150	0.00520	0.24	0.05	0.16		7.0		293	1.70	0.36	159	34	0.05790
Storm Grab	6/22/2015 9:35	6/22/2015 9:35							11000															
Storm Grab	7/6/2015 9:45	7/6/2015 9:45							6300															
Storm Grab	7/28/2015 8:20	7/28/2015 8:20	0.00020	11.0	65.3	0.00900	0.01080	0.137	30500	106	0.00920	0.00510	0.37	0.04	0.17	0.129	7.5	12.0	219	1.40	0.33	67	14	0.03140
Storm Composite	8/18/2015 12:31	8/18/2015 22:00	0.00020	3.6	34.5	0.00930	0.01220	0.048		64	0.01080	0.00570	0.22	0.03	0.02	0.058	7.6	8.2	143	1.30	0.36	127	26	0.04250
Storm Composite	8/22/2015 21:00	8/23/2015 12:45	0.00020		56.6	0.00880	0.01460	0.061		96	0.01290	0.00600	0.21	0.03	0.03		7.6		191	1.40	0.38	225	44	0.04980
Storm Composite	9/2/2015 4:31	9/2/2015 7:30	0.00026		95.2	0.01440	0.02380	0.067		162	0.01850	0.01160	0.23	0.06	0.06		7.8			2.90	0.58	191	77	0.08250
Storm Composite	9/6/2015 8:00	9/7/2015 5:30	0.00020		93.9	0.00430	0.00790	0.069		170	0.00550	0.00370	0.25	0.04	0.10				342	1.20	0.29	42	19	0.03050
Storm Composite	9/9/2015 21:45	9/10/2015 8:45	0.00020		63.1	0.00510	0.01000	0.077		112	0.00840	0.00440	0.24	0.03	0.05	0.056			234	1.50	0.37	86	23	0.04040
Storm Composite	9/17/2015 6:00	9/17/2015 12:01	0.00020		12.8	0.01090	0.01660	0.071		40	0.01860	0.00830	0.35	0.03	0.15	0.064	7.3	6.1	89	1.50	0.38	188	35	0.05990
Storm Composite	9/17/2015 12:16	9/17/2015 20:00	0.00020		17.2	0.00720	0.01070	0.071		44	0.00900	0.00450	0.31	0.04	0.04	0.028	7.5	7.9	87	0.99	0.24	76	14	0.03950
Storm Composite	9/23/2015 14:16	9/25/2015 4:00	0.00020		85.8	0.00360	0.00650	0.069		162	0.00550	0.00300	0.11	0.03	0.02	0.036	7.7		315	1.30	0.27	46	18	0.02710
Storm Composite	10/8/2015 5:00	10/8/2015 9:00	0.00020		233.9	0.00350	0.00710	0.136		356	0.00420	0.00500	0.06	0.03	0.30	0.075	7.9		697	1.70	0.34	71	16	0.02530
Storm Composite	10/23/2015 8:31	10/24/2015 11:45	0.00020		53.1	0.00250	0.00670	0.171		100	0.00260	0.00260	0.05	0.03	0.02		7.4		213	1.30	0.39	36	14	0.02360
Storm Composite	10/27/2015 23:01	10/29/2015 9:00	0.00020		80.0	0.00220	0.00570	0.285		134	0.00220	0.00230	0.05	0.03	0.02		7.3	18.6	304	1.00	0.34	17	12	0.02170
Storm Composite	10/31/2015 6:31	11/1/2015 7:00	0.00020		112.2	0.00180	0.00500	0.095		216	0.00170	0.00230	0.05	0.03	0.02	0.050	7.6		415	1.10	0.25	17	11	0.01250
Storm Composite	11/11/2015 18:31	11/12/2015 9:45	0.00020	6.0	19.4	0.00700	0.00740	0.142		48	0.00760	0.00400	0.05	0.03	0.04	0.114	7.7	7.2	113	0.95	0.32	96	25	0.03190
Storm Composite	11/17/2015 1:45	11/18/2015 9:30	0.00020		34.6	0.00400	0.00500	0.047		80	0.00550	0.00340	0.05	0.03	0.02	0.033	7.4		173	0.83	0.19	54	14	0.03070
Storm Grab	11/17/2015 8:45	11/17/2015 8:45							2420															
		Snow melt Average	0.00034	-	753.5	0.01130	0.02620	0.391	-	272	0.02890	0.01090	0.30	0.10	0.77	0.326	7.1	-	1530	4.70	1.11	280	71	0.11100
		Storm Average	0.00020	6.9	95.1	0.00638	0.01118	0.102	10079	125	0.00938	0.00509	0.29	0.04	0.10	0.068	7.5	10.0	255	1.61	0.36	90	24	0.04361
		Annual Average	0.00021	10.2	204.9	0.00488	0.00899	0.092	3299	294	0.00790	0.00566	0.23	0.04	0.09	0.065	7.6	33.2	593	1.48	0.34	77	20	0.03526
		Annual Maximum	0.00034	26.0	753.5	0.01440	0.02620	0.391	30500	650	0.02890	0.01160	1.92	0.10	0.77	0.326	8.1	67.3	1530	4.70	1.11	280	77	0.11100
		Annual Minimum	0.00020	3.6	12.8	0.00044	0.00120	0.020	5	40	0.00066	0.00230	0.05	0.03	0.02	0.005	7.0	6.1	87	0.69	0.05	4	2	0.00800
		Annual Median	0.00020	8.2	162.4	0.00380	0.00700	0.069	291	208	0.00595	0.00515	0.21	0.03	0.04	0.036	7.6	37.5	697	1.30	0.33	54	14	0.02880

Actual number less than value (<)
Actual number greater than value (>)
Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
Not collected

Table C-9: 2015 Trout Brook-West Branch subwatershed laboratory data.

Trout Brook West Branch

Sample Type	Sampling Start Date/Time	Sampling End Date/Time	Cd mg/L	CBOD mg/L	Cl mg/L	Cr mg/L	Cu mg/L	Dissolved P mg/L	*E. coli* mpn/100 mL	Hardness mg/L	Pb mg/L	Ni mg/L	NO_3 mg/L	NO_2 mg/L	NH_3 mg/L	Ortho-P mg/L	pH	SO_4 mg/L	TDS mg/L	BOD mg/L	TKN mg/L	Total P mg/L	TSS mg/L	VSS mg/L	Zn mg/L
Base Grab	1/15/2015 11:30	1/15/2015 11:30	0.00020	1.2	89.8	0.00120	0.00500	0.020	1733	228	0.00280	0.00150	0.53	0.03	0.20	0.006		31.9	352		0.91	0.09	29	10	0.00970
Base Grab	2/13/2015 10:20	2/13/2015 10:20	0.00020		75.3	0.00083	0.00240	0.020	1986	240	0.00150	0.00130	0.70	0.03	0.19	0.006			335		0.86	0.07	16	5	0.00670
Base Grab	3/19/2015 10:55	3/19/2015 10:55							135																
Base Composite	3/19/2015 11:32	3/20/2015 9:46	0.00020		76.1	0.00042	0.00230	0.020		204	0.00080	0.00083	0.55	0.03	0.11	0.006			299		0.63	0.04	7	3	0.00500
Base Grab	4/15/2015 11:10	4/15/2015 11:10	0.00020	2.5	107.8	0.00049	0.00130	0.020	86	212	0.00038	0.00096	0.41	0.03	0.05	0.007	8.0	24.6	365		0.75	0.07	6	3	0.00580
Base Grab	5/13/2015 10:45	5/13/2015 10:45	0.00020		106.5	0.00026	0.00110	0.020	58	164	0.00041	0.00085	0.31	0.03	0.07	0.012	8.1		335		0.74	0.06	3	3	0.00500
Base Grab	6/2/2015 9:25	6/2/2015 9:25	0.00020		96.5	0.00033	0.00100	0.020	194	172	0.00039	0.00087	0.35	0.03	0.12	0.013	7.9		327		0.74	0.06	4	2	0.00500
Base Composite	6/29/2015 10:31	6/29/2015 19:00	0.00020		87.8	0.00029	0.00500	0.057		158	0.00071	0.00100	0.25	0.03	0.07	0.035	8.0		284		0.77	0.09	7	3	0.00680
Base Grab	6/30/2015 10:15	6/30/2015 10:15							355																
Base Grab	7/30/2015 10:30	7/30/2015 10:30							238																
Base Composite	7/30/2015 10:46	7/30/2015 11:29	0.00020	1.3	84.4	0.00033	0.00200	0.020		174	0.00200	0.00110	0.45	0.03	0.03	0.016	8.1	20.4	301		0.91	0.09	7	5	0.01500
Base Grab	8/27/2015 10:30	8/27/2015 10:30	0.00020		82.1	0.00041	0.00100	0.034	248	194	0.00091	0.00097	0.60	0.03	0.09	0.015	7.8		313		0.73	0.05	5	2	0.01070
Base Grab	9/22/2015 9:20	9/22/2015 9:20	0.00020		80.3	0.00069	0.00150	0.020	142	164	0.00240	0.00100	0.29	0.03	0.09	0.011	7.6	18.3	305		1.20	0.13	17	9	0.01190
Base Grab	10/20/2015 9:10	10/20/2015 9:10	0.00020	1.3	75.3	0.00048	0.00500	0.020	131	212	0.00064	0.00079	0.48	0.03	0.11	0.010	7.9	28.7	333		0.62	0.05	9	4	0.00240
Base Grab	11/24/2015 13:55	11/24/2015 13:55	0.00020		90.9	0.00086	0.00500	0.020		184	0.00180	0.00120	0.28	0.03	0.19	0.010	7.7		319		1.00	0.08	17	6	0.00570
Base Grab	12/21/2015 9:05	12/21/2015 9:05	0.00020		94.5	0.00043	0.00100	0.064	308	220	0.00043	0.00094	0.66	0.03	0.16	0.005	7.7	28.6	369		0.89	0.10	5	2	0.01000
		Base Average	0.00020	1.6	88.3	0.00054	0.00258	0.027	468	194	0.00117	0.00102	0.45	0.03	0.11	0.012	7.9	25.4	326	-	0.83	0.08	10	4	0.00767
Snow melt Grab	3/9/2015 14:10	3/9/2015 14:10	0.00020		263.8	0.00460	0.01160	0.115		232	0.00810	0.00380	0.76	0.05	0.37	0.097	7.3		745		3.00	0.43	120	28	0.03740
Storm Composite	4/9/2015 9:02	4/9/2015 10:31	0.00026		55.1	0.01190	0.02620	0.065		72	0.01860	0.00750	0.53	0.04	0.22	0.064			171		3.20	0.74	346	106	0.13700
Storm Grab	4/9/2015 9:25	4/9/2015 9:25							6300																
Storm Composite	4/9/2015 18:17	4/9/2015 20:31	0.00020		46.2	0.00550	0.01130	0.066		56	0.00590	0.00290	1.61	0.38	0.18	0.074			192		1.10	0.24	65	24	0.05110
Storm Composite	5/10/2015 21:16	5/11/2015 4:46	0.00020		22.3	0.00280	0.00890	0.081		64	0.01080	0.00220	0.29	0.03	0.72	0.050			92		1.30	0.23	441	78	0.04160
Storm Composite	5/14/2015 16:16	5/15/2015 8:46	0.00020		77.5	0.00210	0.00540	0.037		136	0.00170	0.00140	0.31	0.03	0.13	0.025	7.5		252		0.96	0.13	12	6	0.02140
Storm Composite	5/24/2015 15:01	5/25/2015 5:46	0.00022		53.1	0.00300	0.01120	0.071		200	0.00400	0.00230	0.14	0.03	0.05		7.5		209		1.90	0.46	67	33	0.04060
Storm Composite	5/26/2015 14:01	5/26/2015 20:02	0.00020		29.9	0.00500	0.00970	0.041		60	0.00620	0.00230	0.22	0.03	0.02		7.6		116		1.30	0.22	159	33	0.04760
Storm Composite	5/29/2015 4:17	5/29/2015 4:49	0.00038		17.7	0.00960	0.02930	0.100		42	0.03660	0.00850	0.21	0.03	0.02	0.056	7.1		86		3.90	0.74	3170	342	0.15400
Storm Composite	6/3/2015 13:31	6/3/2015 16:01	0.00025		18.5	0.00540	0.01350	0.059		44	0.01800	0.00420	0.16	0.03	0.02		7.1		93		2.70	0.47	1120	202	0.07030
Storm Composite	6/7/2015 0:32	6/7/2015 5:16	0.00020		23.3	0.00260	0.00720	0.066		50	0.00840	0.00220	0.22	0.03	0.19		7.4		100		1.80	0.25	145	46	0.03300
Storm Composite	6/20/2015 6:16	6/20/2015 8:47	0.00020		18.5	0.00320	0.01180	0.070		48	0.00850	0.00250	0.31	0.05	0.23		7.2		103		1.70	0.26	73	30	0.05340
Storm Composite	6/22/2015 8:17	6/22/2015 10:01	0.00020		20.1	0.00420	0.00840	0.033		46	0.00600	0.00220	0.21	0.03	0.07		7.3		91		1.30	0.23	58	23	0.03950
Storm Grab	6/22/2015 9:40	6/22/2015 9:40							7500																
Storm Composite	6/28/2015 0:16	6/28/2015 2:16	0.00025		22.7	0.00460	0.01500	0.074		52	0.01300	0.00400	0.27	0.05	0.16	0.044	7.2		121	15	2.50	0.36	231	82	0.07620
Storm Composite	6/28/2015 16:18	6/28/2015 19:45	0.00026		19.1	0.00370	0.01020	0.046		48	0.01170	0.00280	0.31	0.03	0.03	0.020	7.3		105		1.90	0.26	463	89	0.04720
Storm Composite	7/6/2015 1:16	7/6/2015 6:17	0.00020		19.1	0.00490	0.02280	0.039		48	0.01390	0.00450	0.17	0.03	0.02	0.014	6.8		105		2.30	0.36	513	98	0.11800
Storm Grab	7/6/2015 9:55	7/6/2015 9:55							1000																
Storm Composite	7/12/2015 23:31	7/13/2015 0:31	0.00026	6.9	7.4	0.01820	0.01950	0.023		28	0.02520	0.00530	0.18	0.03	0.02	0.013	7.3	2.5	60		1.80	0.38	6100	266	0.08470
Storm Composite	7/18/2015 1:17	7/18/2015 6:01	0.00020		19.2	0.00260	0.00880	0.071		50	0.00940	0.00220	0.28	0.03	0.26		7.4		98		1.50	0.23	56	19	0.03520
Storm Composite	7/28/2015 7:16	7/28/2015 7:47	0.00020		10.9	0.00620	0.02400	0.127		36	0.01690	0.00460	0.18	0.03	0.09		7.2	3.3	70		2.30	0.52	105	34	0.09580
Storm Grab	7/28/2015 8:35	7/28/2015 8:35							13400																
Storm Composite	8/6/2015 1:46	8/7/2015 3:01	0.00020		12.4	0.00610	0.01790	0.082		40	0.02010	0.00690	0.38	0.03	0.02	0.041	7.6				2.60	0.49	486	131	0.10000
Storm Composite	8/18/2015 12:46	8/18/2015 18:15	0.00020	4.0	11.6	0.00450	0.00970	0.043		36	0.00830	0.00270	0.19	0.03	0.02	0.042	7.4	3.7	73		0.79	0.17	28	11	0.04340
Storm Grab	8/19/2015 10:15	8/19/2015 10:15							2420																
Storm Composite	8/22/2015 21:02	8/22/2015 23:46	0.00020		18	0.00540	0.01490	0.056		52	0.01680	0.00420	0.33	0.03	0.06		7.2		87		1.80	0.37	464	89	0.07310
Storm Composite	9/2/2015 4:16	9/2/2015 5:45	0.00020		23.1	0.01100	0.01610	0.075		66	0.01130	0.00600	0.71	0.08	0.02		7.0		137		2.30	0.51	70	36	0.07130
Storm Composite	9/6/2015 7:31	9/6/2015 9:30	0.00020		17.2	0.00580	0.01440	0.084		52	0.01110	0.00520	0.44	0.06	0.14				107		1.80	0.40	103	33	0.08070
Storm Composite	9/9/2015 21:46	9/9/2015 23:30	0.00035		17.8	0.00400	0.01290	0.068		52	0.01070	0.00360	0.36	0.03	0.20	0.053			110		1.50	0.26	87	31	0.06980
Storm Composite	9/17/2015 5:31	9/17/2015 11:31	0.00020		10.7	0.00520	0.01150	0.060		42	0.01220	0.00300	0.37	0.03	0.16	0.059	7.4	4.3	75		1.60	0.28	88	26	0.05840
Storm Composite	10/27/2015 20:31	10/28/2015 1:47	0.00020		28.8	0.00210	0.00780	0.258		76	0.00290	0.00210	0.05	0.03	0.28		7.2	7.9	156		1.60	0.39	31	19	0.03010
Storm Composite	10/31/2015 2:46	10/31/2015 9:16	0.00020		33.4	0.00130	0.00500	0.106		80	0.00310	0.00140	0.05	0.03	0.10	0.073	7.5		153		1.20	0.25	26	15	0.02180
Storm Composite	11/11/2015 16:01	11/11/2015 21:47	0.00020	17.0	10.6	0.00410	0.00950	0.267		48	0.01000	0.00260	0.10	0.03	0.20	0.232	7.0	3.6	82		1.80	0.52	157	62	0.05750
Storm Composite	11/17/2015 1:01	11/17/2015 8:46	0.00020		22.7	0.00260	0.00500	0.040		64	0.00780	0.00220	0.05	0.03	0.07	0.036	7.3		113		0.94	0.16	45	18	0.03410
Storm Grab	11/17/2015 8:50	11/17/2015 8:50							6300																
		Snow melt Average	0.00020	-	263.8	0.00460	0.01160	0.115	-	232	0.00810	0.00380	0.76	0.05	0.37	0.097	7.3	-	745	-	3.00	0.43	120	28	0.03740
		Storm Average	0.00022	9.3	24.5	0.00527	0.01314	0.079	6153	60	0.01175	0.00363	0.31	0.05	0.13	0.056	7.3	4.2	117	15	1.84	0.35	319	71	0.06381
		Annual Average	0.00022	4.9	50.0	0.00379	0.00984	0.064	2363	106	0.00839	0.00282	0.36	0.04	0.13	0.038	7.5	14.8	199	15	1.55	0.27	216	49	0.04581
		Annual Maximum	0.00038	17.0	263.8	0.01820	0.02930	0.267	13400	240	0.03660	0.00850	1.61	0.38	0.72	0.232	8.1	31.9	745	15	3.90	0.74	3170	342	0.15400
		Annual Minimum	0.00020	1.2	7.4	0.00026	0.00100	0.020	58	28	0.00038	0.00079	0.05	0.03	0.02	0.005	6.8	2.5	60	15	0.62	0.04	3	2	0.00240
		Annual Median	0.00020	2.5	26.1	0.00310	0.00920	0.058	332	64	0.00795	0.00225	0.31	0.03	0.11	0.023	7.4	13.1	137	15	1.40	0.25	65	25	0.04005

Actual number less than value (<)
Actual number greater than value (>)
Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
Outlier statistically determined to be outside the standard range of data
Not collected

Table C-10: 2015 Trout Brook Outlet subwatershed laboratory data.

Trout Brook Outlet

Sample Type	Sampling Start Date/Time	Sampling End Date/Time	Cd mg/L	CBOD mg/L	Cl mg/L	Cr mg/L	Cu mg/L	Dissolved P mg/L	*E. coli* mpn/100 mL	Hardness mg/L	Pb mg/L	Ni mg/L	NO_3 mg/L	NO_2 mg/L	NH_3 mg/L	Ortho-P mg/L	pH	SO_4 mg/L	TDS mg/L	TKN mg/L	Total P mg/L	TSS mg/L	VSS mg/L	Zn mg/L
Base Grab	1/15/2015 10:45	1/15/2015 10:45	0.00020	1.3	169.7	0.00110	0.00500	0.020	921	408	0.00280	0.00200	0.720	0.030	0.18	0.006		66.6	632	0.870	0.070	20	6	0.01090
Base Grab	2/13/2015 10:45	2/13/2015 10:45	0.00020		161.3	0.00052	0.00150	0.020	488	412	0.00097	0.00180	0.810	0.030	0.11	0.008			624	0.760	0.060	6	3	0.00500
Base Grab	3/19/2015 11:15	3/19/2015 11:15							160															
Base Composite	3/20/2015 9:17	3/20/2015 9:17	0.00020		150.8	0.00017	0.00090	0.020		444	0.00016	0.00110	0.490	0.030	0.05	0.009			582	0.560	0.020	5	2	0.00500
Base Grab	4/15/2015 10:25	4/15/2015 10:25	0.00020	3.0	160.2	0.00046	0.00100	0.020	119	340	0.00033	0.00140	0.670	0.030	0.05	0.007	8.0	51.5	548	0.730	0.060	4	2	0.00400
Base Grab	5/13/2015 10:40	5/13/2015 10:40	0.00020		134.4	0.00054	0.00140	0.020	78	308	0.00075	0.00160	0.480	0.030	0.04	0.005	7.9		512	0.760	0.060	5	3	0.00500
Base Composite	6/1/2015 10:32	6/2/2015 10:16	0.00020		134.9	0.00037	0.00110	0.020		280	0.00059	0.00120	0.520	0.030	0.02	0.005	8.0		478	0.800	0.060	6	4	0.00770
Base Grab	6/2/2015 10:25	6/2/2015 10:25							225															
Base Composite	6/29/2015 11:31	6/29/2015 19:46	0.00020		116.6	0.00140	0.00500	0.046		240	0.00240	0.00220	0.380	0.030	0.03	0.006	8.0		413	0.800	0.100	24	7	0.01040
Base Grab	6/30/2015 11:00	6/30/2015 11:00							411															
Base Grab	7/30/2015 10:55	7/30/2015 10:55							135															
Base Composite	7/30/2015 11:01	7/30/2015 12:22	0.00020	1.3	149.4	0.00038	0.00100	0.020		262	0.00082	0.00140	0.570	0.030	0.05	0.005	8.1	50.6	539	1.000	0.060	4	2	0.01270
Base Grab	8/27/2015 10:00	8/27/2015 10:00	0.00020		189.4	0.00039	0.00100	0.020	201	244	0.00071	0.00140	0.720	0.030	0.11	0.009	7.9		578	0.860	0.050	6	2	0.00720
Base Grab	9/22/2015 10:20	9/22/2015 10:20	0.00020		117.9	0.00092	0.00150	0.020	138	286	0.00190	0.00140	0.520	0.030	0.06	0.005	7.8	47.0	504	0.930	0.100	10	6	0.01520
Base Grab	10/19/2015 10:00	10/19/2015 10:00							64															
Base Composite	10/19/2015 10:16	10/20/2015 9:16	0.00020	1.6	154.5	0.00035	0.00500	0.020		388	0.00057	0.00130	0.670	0.030	0.11	0.008	8.1	64.6	623	0.620	0.060	9	4	0.00580
Base Grab	11/24/2015 14:35	11/24/2015 14:35	0.00020		147.4	0.00078	0.00500	0.021		288	0.00150	0.00150	0.470	0.030	0.18	0.007	7.8		460	0.910	0.080	11	5	0.00620
Base Grab	12/21/2015 9:20	12/21/2015 9:20	0.00020		154.7	0.00064	0.00130	0.020	88	372	0.00085	0.00150	0.800	0.030	0.17	0.005	7.7	59.5	584	0.800	0.040	7	2	0.01380
		Base Average	0.00020	1.8	149.3	0.00062	0.00236	0.022	252	329	0.00110	0.00152	0.602	0.030	0.09	0.007	7.9	56.6	544	0.800	0.063	9	4	0.00838
Snow melt Grab	3/9/2015 15:20	3/9/2015 15:20	0.00020		448.5	0.00410	0.01230	0.178		312	0.01010	0.00400	0.730	0.060	0.60	0.148	6.9		954	3.500	0.530	122	38	0.04010
Storm Grab	4/9/2015 10:05	4/9/2015 10:05							2420															
Storm Composite	5/14/2015 17:01	5/14/2015 21:01	0.00020		95.0	0.00370	0.00690	0.020		204	0.00420	0.00290	0.350	0.030	0.12	0.009	7.5		315	1.100	0.180	26	13	0.02940
Storm Composite	5/26/2015 17:02	5/26/2015 20:31	0.00020		55.0	0.00580	0.01000	0.039		106	0.01000	0.00410	0.200	0.030	0.02		7.8		200	1.300	0.290	156	80	0.04710
Storm Composite	5/29/2015 4:31	5/29/2015 8:16	0.00020		43.3	0.00560	0.01350	0.095		84	0.01940	0.00540	0.260	0.030	0.05	0.069	7.2		165	2.100	0.470	269	96	0.06130
Storm Composite	6/3/2015 13:17	6/3/2015 17:31	0.00027		45.8	0.00840	0.01820	0.024		328	0.02950	0.00620	0.220	0.030	0.02		7.3		171	5.900	0.760	322	114	0.08730
Storm Composite	6/7/2015 0:17	6/7/2015 5:16	0.00020		42.3	0.00620	0.01490	0.061		84	0.02560	0.00600	0.240	0.030	0.15		7.2		167	2.000	0.380	240	78	0.06470
Storm Composite	6/17/2015 14:46	6/17/2015 19:31	0.00045		42.7	0.01300	0.02740	0.059		102	0.04500	0.01030	0.410	0.050	0.10	0.024			190	2.700	0.600	380	136	0.11500
Storm Composite	6/20/2015 6:46	6/20/2015 8:46	0.00020		41.3	0.00410	0.01180	0.108		92	0.01160	0.00400	0.320	0.040	0.21		7.6			2.400	0.450	109	49	0.06110
Storm Composite	6/22/2015 9:16	6/22/2015 10:46	0.00020		44.0	0.00500	0.01020	0.045		90	0.00670	0.00360	0.240	0.030	0.08		7.4			1.400	0.320	66	30	0.04750
Storm Grab	6/22/2015 9:55	6/22/2015 9:55							5200															
Storm Composite	6/28/2015 16:31	6/28/2015 21:31	0.00020		52.4	0.00850	0.01780	0.048		100	0.01500	0.00800	0.270	0.030	0.02	0.022	7.6		198	1.500	0.360	170	54	0.06050
Storm Composite	7/6/2015 1:16	7/6/2015 11:02	0.00021		32.4	0.00690	0.01890	0.078		72	0.02170	0.00690	0.140	0.030	0.02	0.022	7.3		138	1.400	0.370	188	42	0.06450
Storm Grab	7/6/2015 9:40	7/6/2015 9:40							6300															
Storm Composite	7/12/2015 23:31	7/13/2015 9:16	0.00022	4.5	32.4	0.00980	0.02180	0.067		68	0.03290	0.01050	0.260	0.030	0.02	0.020	7.7	8.3	144	1.600	0.500	1310	56	0.07000
Storm Composite	7/18/2015 1:16	7/18/2015 6:16	0.00020		35.4	0.00580	0.01490	0.130		78	0.02250	0.00570	0.340	0.030	0.10		7.6		153	1.400	0.340	124	24	0.05930
Storm Composite	7/28/2015 7:32	7/28/2015 10:07	0.00020		25.0	0.00560	0.01090	0.291		60	0.01010	0.00370	0.280	0.030	0.05		7.4	7.7	119	1.900	0.650	105	37	0.06540
Storm Grab	7/28/2015 9:50	7/28/2015 9:50							11000															
Storm Composite	8/7/2015 1:46	8/7/2015 3:01														0.048				2.900	0.930	351	105	
Storm Composite	8/18/2015 13:17	8/18/2015 17:16	0.00020	3.3	19.2	0.00770	0.01310	0.063		50	0.01900	0.00560	0.220	0.030	0.02	0.049	7.5	7.1	96	0.960	0.320	145	28	0.05620
Storm Composite	8/22/2015 21:01	8/22/2015 23:16	0.00027		22.0	0.01010	0.02370	0.150		64	0.04560	0.00950	0.290	0.030	0.03		7.3		123	2.800	0.750	910	118	0.09310
Storm Composite	9/6/2015 7:46	9/6/2015 9:31	0.00025		34.7	0.00860	0.02150	0.118		86	0.02570	0.00830	0.420	0.060	0.12					3.700	0.740	173	42	0.09590
Storm Composite	9/9/2015 21:46	9/9/2015 23:31	0.00020		36.4	0.00670	0.01660	0.122		86	0.02500	0.00640	0.350	0.030	0.19	0.051			164	1.900	0.490	322	72	0.08250
Storm Composite	9/17/2015 5:47	9/17/2015 11:17	0.00026		17.6	0.01250	0.02310	0.072		58	0.04460	0.01060	0.380	0.040	0.13	0.065	7.6	7.2	93	1.700	0.480	618	84	0.09090
Storm Composite	9/17/2015 11:46	9/17/2015 19:01	0.00020		30.4	0.00780	0.01460	0.044		80	0.02330	0.00610	0.350	0.030	0.08	0.053	7.4	10.5	269	1.200	0.290	117	24	0.05910
Storm Composite	10/23/2015 13:31	10/23/2015 17:16	0.00020		41.2	0.00720	0.02260	0.230		116	0.01510	0.00590	0.050	0.030	0.02		7.2		200	2.900	0.710	276	120	0.09580
Storm Composite	10/24/2015 0:01	10/24/2015 4:01	0.00020		27.3	0.00270	0.00830	0.103		144	0.00640	0.00290	0.140	0.030	0.02		7.4		140	1.300	0.310	66	25	0.03690
Storm Composite	10/28/2015 0:01	10/28/2015 22:46						0.282									7.6			1.100	0.410	27	17	
Storm Composite	10/31/2015 6:17	10/31/2015 10:01	0.00020		56.2	0.00260	0.00700	0.361		140	0.00580	0.00230	0.050	0.030	0.02	0.286	7.6			1.200	0.350			0.02830
Storm Composite	11/11/2015 16:31	11/12/2015 5:31	0.00020	6.8	22.4	0.00720	0.01380	0.139		84	0.02250	0.00560	0.050	0.030	0.06	0.109	7.4	8.3	125	1.600	0.420	205	69	0.06660
Storm Grab	11/17/2015 10:05	11/17/2015 10:05							2420															
		Snow melt Average	0.00020	-	448.5	0.00410	0.01230	0.178	-	312	0.01010	0.00400	0.730	0.060	0.60	0.148	6.9	-	954	3.500	0.530	122	38	0.04010
		Storm Average	0.00022	4.9	38.9	0.00702	0.01572	0.115	5468	103	0.02118	0.00611	0.253	0.033	0.07	0.064	7.5	8.2	167	1.998	0.475	278	63	0.06689
		Annual Average	0.00021	3.1	88.8	0.00469	0.01093	0.085	1786	188	0.01383	0.00444	0.389	0.033	0.09	0.039	7.6	32.4	339	1.637	0.339	182	42	0.04561
		Annual Maximum	0.00045	6.8	448.5	0.01300	0.02740	0.361	11000	444	0.04560	0.01060	0.810	0.060	0.60	0.286	8.1	66.6	954	5.900	0.930	1310	136	0.11500
		Annual Minimum	0.00020	1.3	17.6	0.00017	0.00090	0.020	64	50	0.00016	0.00110	0.050	0.030	0.02	0.005	6.9	7.1	93	0.560	0.020	4	2	0.00400
		Annual Median	0.00020	3.0	45.8	0.00500	0.01090	0.054	225	116	0.01010	0.00400	0.350	0.030	0.06	0.009	7.6	28.8	200	1.300	0.340	113	29	0.04750

Actual number less than value (<)
Actual number greater than value (>)
Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
Not collected

APPENDIX D:
2015 LOADING TABLES

APPENDIX D 2015 LOADING TABLES

Table D-1: Como 7 event load table, 2015.

Event Start Date	Event Start Time	Event Stop Date	Event Stop Time	Event TP Load (lb)	Event TSS Load (lb)
4/1/2015	20:30:00	4/1/2015	20:55:00	0.03	18
4/6/2015	6:15:00	4/6/2015	9:30:00	0.03	17
4/9/2015	1:30:00	4/9/2015	2:30:00	0.01	3
4/9/2015	8:15:00	4/9/2015	12:00:00	0.49	286
4/9/2015	16:45:00	4/9/2015	23:00:00	0.17	97
4/10/2015	9:30:00	4/10/2015	12:00:00	0.03	16
4/12/2015	21:30:00	4/13/2015	4:00:00	0.99	821
4/18/2015	23:30:00	4/19/2015	2:15:00	0.03	20
4/19/2015	5:15:00	4/19/2015	9:30:00	0.05	27
4/19/2015	19:30:00	4/19/2015	22:30:00	0.05	28
4/24/2015	14:00:00	4/24/2015	15:00:00	0.00	3
4/24/2015	18:45:00	4/24/2015	21:45:00	0.04	24
5/3/2015	17:30:00	5/3/2015	21:30:00	3.51	1,797
5/7/2015	13:25:00	5/7/2015	14:15:00	0.04	13
5/7/2015	17:40:00	5/7/2015	22:00:00	1.07	339
5/10/2015	20:15:00	5/11/2015	4:30:00	0.87	277
5/12/2015	0:00:00	5/12/2015	5:15:00	0.05	16
5/14/2015	14:00:00	5/15/2015	3:45:00	0.19	20
5/15/2015	4:15:00	5/15/2015	5:30:00	0.00	1
5/16/2015	21:15:00	5/17/2015	1:30:00	0.06	18
5/17/2015	10:30:00	5/17/2015	15:00:00	0.02	5
5/17/2015	21:30:00	5/17/2015	22:00:00	0.00	0
5/21/2015	11:15:00	5/21/2015	12:15:00	0.00	1
5/24/2015	1:45:00	5/24/2015	2:30:00	0.00	0
5/24/2015	10:15:00	5/25/2015	4:30:00	1.04	68
5/26/2015	13:25:00	5/27/2015	6:15:00	0.29	47
5/27/2015	8:45:00	5/27/2015	10:45:00	0.00	1
5/27/2015	12:00:00	5/27/2015	12:30:00	0.00	0
5/29/2015	3:30:00	5/30/2015	4:00:00	1.09	402
5/31/2015	8:45:00	5/31/2015	9:30:00	0.00	0
6/1/2015	14:45:00	6/1/2015	15:45:00	0.00	1
6/2/2015	14:30:00	6/2/2015	15:30:00	0.00	1
6/2/2015	16:00:00	6/2/2015	16:30:00	0.00	0
6/3/2015	9:30:00	6/3/2015	10:45:00	0.00	1
6/3/2015	12:45:00	6/4/2015	8:45:00	0.90	1,106
6/4/2015	15:45:00	6/4/2015	16:30:00	0.00	1
6/6/2015	15:45:00	6/6/2015	16:30:00	0.00	1
6/6/2015	20:15:00	6/6/2015	22:15:00	0.01	4
6/6/2015	23:45:00	6/7/2015	16:15:00	0.45	247
6/11/2015	5:30:00	6/11/2015	19:15:00	0.22	123
6/12/2015	9:15:00	6/12/2015	15:00:00	0.02	12
6/13/2015	9:15:00	6/13/2015	16:15:00	0.03	16

6/15/2015	10:15:00	6/15/2015	11:15:00	0.00	2
6/17/2015	8:20:00	6/17/2015	16:45:00	0.10	54
6/20/2015	6:00:00	6/20/2015	15:00:00	0.46	124
6/22/2015	7:30:00	6/22/2015	14:30:00	0.38	214
6/25/2015	10:30:00	6/25/2015	17:30:00	0.03	14
6/26/2015	8:30:00	6/26/2015	14:15:00	0.03	15
6/27/2015	21:30:00	6/29/2015	9:15:00	0.55	308
6/29/2015	19:25:00	6/30/2015	5:00:00	0.18	101
6/30/2015	9:00:00	6/30/2015	13:45:00	0.02	13
7/1/2015	10:15:00	7/1/2015	13:00:00	0.01	4
7/2/2015	8:30:00	7/2/2015	10:00:00	0.01	3
7/3/2015	7:25:00	7/3/2015	14:15:00	0.04	16
7/4/2015	11:30:00	7/4/2015	14:15:00	0.01	6
7/5/2015	8:45:00	7/5/2015	9:15:00	0.00	2
7/5/2015	9:30:00	7/5/2015	9:45:00	0.00	0
7/5/2015	10:30:00	7/5/2015	15:30:00	0.02	9
7/6/2015	1:00:00	7/6/2015	22:30:00	1.78	782
7/7/2015	7:10:00	7/7/2015	7:20:00	0.01	5
7/7/2015	7:30:00	7/7/2015	9:15:00	0.01	4
7/7/2015	13:45:00	7/7/2015	22:00:00	0.04	16
7/8/2015	16:00:00	7/8/2015	16:15:00	0.00	0
7/9/2015	12:15:00	7/9/2015	17:00:00	0.02	8
7/10/2015	7:45:00	7/10/2015	9:00:00	0.02	9
7/10/2015	13:30:00	7/10/2015	16:15:00	0.01	4
7/12/2015	14:45:00	7/12/2015	15:00:00	0.00	0
7/12/2015	23:15:00	7/13/2015	8:30:00	1.08	565
7/13/2015	10:25:00	7/13/2015	14:15:00	0.10	42
7/14/2015	15:30:00	7/14/2015	17:45:00	0.01	2
7/15/2015	9:30:00	7/15/2015	13:45:00	0.01	6
7/15/2015	19:45:00	7/15/2015	20:00:00	0.00	0
7/16/2015	16:45:00	7/17/2015	2:00:00	0.08	33
7/17/2015	15:30:00	7/17/2015	16:15:00	0.00	1
7/18/2015	1:00:00	7/18/2015	14:00:00	0.43	118
7/21/2015	12:30:00	7/22/2015	8:30:00	0.07	29
7/23/2015	11:15:00	7/23/2015	12:45:00	0.01	2
7/24/2015	5:30:00	7/24/2015	13:00:00	0.07	33
7/27/2015	7:15:00	7/27/2015	9:00:00	0.01	6
7/27/2015	13:15:00	7/27/2015	15:30:00	0.01	3
7/28/2015	6:45:00	7/28/2015	13:15:00	0.49	187
7/29/2015	9:00:00	7/29/2015	12:45:00	0.02	9
7/30/2015	15:00:00	7/30/2015	17:45:00	0.01	6
7/31/2015	12:45:00	7/31/2015	17:15:00	0.03	12
8/1/2015	9:15:00	8/1/2015	13:15:00	0.02	11
8/2/2015	9:15:00	8/2/2015	16:30:00	0.04	20
8/3/2015	7:40:00	8/3/2015	9:00:00	0.03	14
8/3/2015	12:00:00	8/3/2015	15:15:00	0.01	3
8/6/2015	9:45:00	8/6/2015	11:45:00	0.01	3
8/6/2015	15:30:00	8/7/2015	2:30:00	0.12	65

8/8/2015	9:30:00	8/8/2015	11:30:00	0.01	6
8/9/2015	14:15:00	8/9/2015	16:15:00	0.04	21
8/10/2015	7:15:00	8/10/2015	9:00:00	0.01	6
8/11/2015	8:55:00	8/11/2015	13:15:00	0.02	13
8/11/2015	15:30:00	8/11/2015	16:00:00	0.00	1
8/12/2015	8:30:00	8/12/2015	11:15:00	0.01	7
8/13/2015	4:15:00	8/13/2015	7:15:00	0.01	6
8/14/2015	6:55:00	8/14/2015	8:30:00	0.01	8
8/14/2015	13:15:00	8/14/2015	14:00:00	0.00	1
8/15/2015	9:15:00	8/15/2015	12:45:00	0.02	9
8/16/2015	10:00:00	8/16/2015	12:45:00	0.01	6
8/16/2015	17:45:00	8/16/2015	18:30:00	0.05	27
8/16/2015	18:35:00	8/16/2015	18:40:00	0.00	1
8/16/2015	20:00:00	8/16/2015	20:05:00	0.00	0
8/16/2015	21:00:00	8/17/2015	5:00:00	0.31	169
8/17/2015	15:45:00	8/17/2015	16:00:00	0.00	0
8/17/2015	18:00:00	8/17/2015	19:55:00	0.06	31
8/17/2015	20:00:00	8/17/2015	22:45:00	0.01	7
8/18/2015	7:45:00	8/18/2015	9:15:00	0.01	7
8/18/2015	11:30:00	8/18/2015	16:30:00	0.28	47
8/19/2015	10:10:00	8/19/2015	10:35:00	0.02	12
8/20/2015	9:45:00	8/20/2015	13:30:00	0.02	9
8/21/2015	8:45:00	8/21/2015	11:00:00	0.01	5
8/22/2015	10:00:00	8/22/2015	11:45:00	0.01	3
8/22/2015	18:30:00	8/22/2015	20:45:00	0.01	5
8/22/2015	20:50:00	8/23/2015	2:30:00	0.17	68
8/23/2015	7:30:00	8/23/2015	8:30:00	0.02	8
8/23/2015	13:30:00	8/23/2015	14:15:00	0.00	1
8/24/2015	10:00:00	8/24/2015	12:45:00	0.01	7
8/25/2015	9:15:00	8/25/2015	12:30:00	0.02	8
8/26/2015	9:45:00	8/26/2015	12:15:00	0.01	6
8/27/2015	7:30:00	8/27/2015	9:15:00	0.02	9
8/27/2015	10:30:00	8/27/2015	14:45:00	0.01	8
8/29/2015	10:00:00	8/29/2015	12:15:00	0.01	5
8/30/2015	9:00:00	8/30/2015	12:30:00	0.02	9
8/31/2015	8:15:00	8/31/2015	12:45:00	0.02	12
9/2/2015	2:45:00	9/2/2015	10:15:00	0.22	112
9/3/2015	10:45:00	9/3/2015	12:00:00	0.00	2
9/6/2015	4:45:00	9/6/2015	16:15:00	0.45	147
9/7/2015	9:00:00	9/7/2015	10:00:00	0.01	3
9/7/2015	14:45:00	9/7/2015	15:15:00	0.00	0
9/8/2015	4:45:00	9/8/2015	8:15:00	0.05	26
9/8/2015	10:00:00	9/8/2015	12:15:00	0.01	5
9/9/2015	9:15:00	9/9/2015	11:15:00	0.01	4
9/9/2015	21:15:00	9/10/2015	1:30:00	0.16	45
9/10/2015	5:15:00	9/10/2015	8:30:00	0.02	11
9/11/2015	11:15:00	9/11/2015	13:00:00	0.01	3
9/12/2015	7:00:00	9/12/2015	7:30:00	0.01	4

9/12/2015	12:30:00	9/12/2015	14:30:00	0.01	4
9/13/2015	9:30:00	9/13/2015	11:15:00	0.01	4
9/14/2015	9:30:00	9/14/2015	11:00:00	0.00	2
9/16/2015	4:00:00	9/16/2015	6:15:00	0.02	8
9/16/2015	7:30:00	9/16/2015	8:30:00	0.01	5
9/16/2015	9:00:00	9/16/2015	19:45:00	0.03	15
9/16/2015	22:40:00	9/16/2015	23:15:00	0.01	5
9/17/2015	1:30:00	9/17/2015	2:15:00	0.01	4
9/17/2015	5:00:00	9/17/2015	18:30:00	0.94	469
9/18/2015	18:30:00	9/18/2015	18:45:00	0.00	1
9/18/2015	19:40:00	9/18/2015	20:05:00	0.02	8
9/18/2015	21:55:00	9/18/2015	22:15:00	0.03	13
9/20/2015	18:15:00	9/20/2015	21:00:00	0.02	10
9/22/2015	9:15:00	9/22/2015	12:30:00	0.01	6
9/23/2015	9:00:00	9/23/2015	10:30:00	0.00	2
9/23/2015	14:00:00	9/23/2015	22:30:00	0.08	41
9/24/2015	0:30:00	9/24/2015	9:45:00	0.14	68
9/26/2015	9:00:00	9/26/2015	9:45:00	0.01	3
9/27/2015	9:30:00	9/27/2015	12:00:00	0.01	4
9/28/2015	10:00:00	9/28/2015	11:30:00	0.01	3
10/3/2015	10:45:00	10/3/2015	12:00:00	0.01	1
10/4/2015	11:30:00	10/4/2015	13:00:00	0.01	1
10/6/2015	10:45:00	10/6/2015	13:00:00	0.01	2
10/11/2015	8:45:00	10/11/2015	9:30:00	0.01	3
10/11/2015	13:30:00	10/11/2015	15:00:00	0.01	1
10/12/2015	10:45:00	10/12/2015	12:45:00	0.01	1
10/15/2015	9:00:00	10/15/2015	10:30:00	0.03	6
10/15/2015	13:30:00	10/15/2015	13:45:00	0.01	1
10/16/2015	9:10:00	10/16/2015	11:15:00	0.06	12
10/19/2015	8:00:00	10/19/2015	8:30:00	0.00	1
10/20/2015	9:45:00	10/20/2015	10:15:00	0.00	1
10/20/2015	11:15:00	10/20/2015	12:15:00	0.00	1
10/21/2015	11:45:00	10/21/2015	13:00:00	0.00	1
10/22/2015	10:45:00	10/22/2015	13:45:00	0.02	3
10/23/2015	7:45:00	10/24/2015	7:15:00	1.88	223
10/25/2015	10:45:00	10/25/2015	12:15:00	0.01	1
10/26/2015	5:15:00	10/26/2015	5:45:00	0.00	0
10/26/2015	10:45:00	10/26/2015	11:45:00	0.00	1
10/27/2015	10:00:00	10/27/2015	10:15:00	0.00	0
10/27/2015	11:15:00	10/27/2015	11:45:00	0.00	0
10/27/2015	19:30:00	10/29/2015	13:30:00	1.24	27
10/30/2015	11:45:00	10/30/2015	13:15:00	0.01	1
10/31/2015	2:00:00	10/31/2015	14:45:00	0.38	56
11/3/2015	13:00:00	11/3/2015	16:45:00	0.04	4
11/5/2015	12:45:00	11/5/2015	16:30:00	0.04	5
11/7/2015	9:25:00	11/7/2015	9:45:00	0.01	1
11/11/2015	16:15:00	11/12/2015	4:20:00	4.54	2,609
Total Annual Event Load (lbs)				**29.97**	**13,309**

Table D-2: Como 3 event load table, 2015.

Event Start Date	Event Start Time	Event Stop Date	Event Stop Time	Event TP Load (lb)	Event TSS Load (lb)
3/23/2015	2:00:00	3/23/2015	18:00:00	0.35	58
3/24/2015	15:45:00	3/24/2015	20:00:00	0.06	10
3/24/2015	22:15:00	3/25/2015	5:30:00	0.14	23
3/25/2015	11:00:00	3/25/2015	15:45:00	0.10	16
3/29/2015	4:30:00	3/29/2015	9:15:00	0.62	101
3/29/2015	12:15:00	3/29/2015	17:15:00	0.60	97
4/1/2015	20:30:00	4/2/2015	8:30:00	4.25	479
4/6/2015	3:00:00	4/6/2015	20:00:00	0.39	196
4/8/2015	8:15:00	4/8/2015	9:15:00	0.01	3
4/9/2015	1:15:00	4/10/2015	6:30:00	2.77	932
4/10/2015	9:15:00	4/10/2015	18:15:00	0.24	122
4/12/2015	21:30:00	4/13/2015	13:15:00	2.61	1,681
4/14/2015	11:00:00	4/14/2015	17:00:00	0.06	28
4/15/2015	12:30:00	4/15/2015	15:45:00	0.08	40
4/17/2015	11:00:00	4/17/2015	11:30:00	0.00	1
4/18/2015	23:15:00	4/20/2015	9:45:00	1.09	547
4/24/2015	18:30:00	4/25/2015	5:00:00	0.39	196
5/1/2015	2:00:00	5/1/2015	6:45:00	0.04	19
5/1/2015	10:45:00	5/1/2015	16:00:00	0.08	36
5/3/2015	17:30:00	5/4/2015	7:00:00	3.06	2,592
5/4/2015	13:45:00	5/5/2015	2:15:00	0.07	34
5/5/2015	11:15:00	5/5/2015	11:45:00	0.00	1
5/5/2015	13:00:00	5/5/2015	13:45:00	0.02	11
5/6/2015	12:15:00	5/6/2015	20:30:00	0.05	22
5/7/2015	13:15:00	5/8/2015	14:15:00	2.89	1,328
5/8/2015	17:00:00	5/8/2015	20:30:00	0.01	6
5/9/2015	0:00:00	5/9/2015	0:45:00	0.00	1
5/10/2015	20:15:00	5/10/2015	20:45:00	0.03	12
5/10/2015	23:55:00	5/11/2015	16:00:00	1.53	703
5/12/2015	0:00:00	5/12/2015	13:15:00	0.20	93
5/14/2015	14:30:00	5/15/2015	5:45:00	0.74	341
5/16/2015	21:15:00	5/17/2015	2:45:00	0.13	60
5/22/2015	15:15:00	5/22/2015	15:45:00	0.00	2
5/24/2015	11:15:00	5/25/2015	9:15:00	1.59	730
5/26/2015	12:00:00	5/27/2015	3:15:00	0.90	360
5/29/2015	3:30:00	5/29/2015	13:30:00	1.46	651
5/29/2015	15:30:00	5/30/2015	2:15:00	0.57	264
6/3/2015	13:00:00	6/4/2015	6:15:00	2.35	2,634
6/5/2015	11:15:00	6/5/2015	12:00:00	0.01	4
6/7/2015	0:15:00	6/7/2015	11:00:00	0.98	650
6/7/2015	19:45:00	6/7/2015	20:00:00	0.00	0
6/11/2015	6:15:00	6/11/2015	14:45:00	0.28	104
6/11/2015	15:30:00	6/11/2015	17:45:00	0.02	6
6/13/2015	11:15:00	6/13/2015	13:30:00	0.02	9
6/17/2015	14:15:00	6/17/2015	19:45:00	1.27	999

6/20/2015	6:00:00	6/20/2015	12:00:00	0.39	105
6/20/2015	13:00:00	6/20/2015	13:15:00	0.00	1
6/22/2015	7:45:00	6/22/2015	13:00:00	0.35	155
6/22/2015	16:15:00	6/22/2015	16:30:00	0.00	-
6/25/2015	10:00:00	6/25/2015	10:45:00	0.01	3
6/25/2015	14:30:00	6/25/2015	15:00:00	0.00	1
6/27/2015	23:45:00	6/28/2015	5:00:00	0.39	138
6/28/2015	16:15:00	6/28/2015	19:00:00	0.04	14
6/29/2015	11:15:00	6/29/2015	11:30:00	0.00	0
6/29/2015	19:30:00	6/29/2015	23:15:00	0.30	112
7/5/2015	22:45:00	7/5/2015	23:00:00	0.00	1
7/6/2015	1:00:00	7/6/2015	18:00:00	2.13	781
7/12/2015	23:15:00	7/13/2015	8:00:00	3.76	1,808
7/15/2015	21:30:00	7/15/2015	22:15:00	0.01	5
7/16/2015	16:45:00	7/17/2015	6:00:00	0.22	107
7/17/2015	9:45:00	7/17/2015	11:00:00	0.02	8
7/18/2015	1:00:00	7/18/2015	13:45:00	1.00	263
7/19/2015	11:45:00	7/19/2015	12:45:00	0.00	2
7/21/2015	22:15:00	7/21/2015	22:45:00	0.01	4
7/22/2015	21:45:00	7/22/2015	22:15:00	0.01	4
7/24/2015	5:30:00	7/24/2015	16:45:00	0.22	105
7/28/2015	7:00:00	7/29/2015	0:00:00	1.19	256
8/3/2015	9:00:00	8/4/2015	0:00:00	0.21	83
8/4/2015	11:00:00	8/4/2015	21:45:00	0.07	29
8/5/2015	18:15:00	8/7/2015	10:30:00	1.01	229
8/9/2015	13:15:00	8/9/2015	20:30:00	0.15	62
8/13/2015	0:00:00	8/13/2015	9:45:00	0.13	51
8/16/2015	17:45:00	8/17/2015	10:15:00	0.86	346
8/17/2015	17:15:00	8/19/2015	18:45:00	4.66	3,348
8/22/2015	19:45:00	8/23/2015	10:30:00	2.00	1,677
9/2/2015	2:45:00	9/2/2015	10:15:00	0.63	113
9/2/2015	15:40:00	9/2/2015	15:45:00	0.00	1
9/6/2015	5:45:00	9/6/2015	19:15:00	1.29	302
9/8/2015	3:00:00	9/8/2015	8:15:00	0.32	95
9/8/2015	15:10:00	9/8/2015	15:15:00	0.00	1
9/9/2015	8:00:00	9/10/2015	9:00:00	1.10	2,053
9/10/2015	15:40:00	9/10/2015	15:45:00	0.00	1
9/16/2015	3:30:00	9/17/2015	7:10:00	4.14	3,264
9/17/2015	9:10:00	9/19/2015	9:30:00	7.10	670
9/20/2015	16:45:00	9/21/2015	15:00:00	0.39	117
9/23/2015	14:00:00	9/24/2015	15:15:00	1.27	381
9/28/2015	13:15:00	9/29/2015	0:15:00	0.09	27
10/8/2015	3:15:00	10/8/2015	15:30:00	1.15	302
10/22/2015	10:45:00	10/22/2015	17:45:00	0.08	17
10/23/2015	6:00:00	10/24/2015	8:00:00	4.57	1,285
10/24/2015	8:20:00	10/24/2015	17:00:00	0.04	9
10/26/2015	5:15:00	10/26/2015	8:45:00	0.01	2
10/27/2015	14:15:00	10/27/2015	16:30:00	0.02	4

10/27/2015	19:30:00	10/29/2015	18:00:00	3.33	672
10/31/2015	2:15:00	10/31/2015	16:30:00	1.18	237
11/2/2015	15:15:00	11/2/2015	16:00:00	0.01	2
11/11/2015	16:15:00	11/12/2015	18:15:00	8.90	3,942
11/12/2015	20:00:00	11/12/2015	20:45:00	0.00	1
Total Annual Event Load (lbs)				**86.85**	**39,398**

Table D-3: East Kittsondale base load and event load tables, 2015.

Month	Base TP Load (lb)	Base TSS Load (lb)
January	2.46	148
February	1.19	102
March	3.95	316
April	2.78	239
May	3.74	257
June	2.69	221
July	2.97	235
August	2.92	291
September	6.6	417
October	3.21	278
November	2.8	185
December	3.27	223
Total Annual Base Load (lbs)	**38.58**	**2,911**

Event Start Date	Event Start Time	Event Stop Date	Event Stop Time	Event TP Load (lb)	Event TSS Load (lb)
3/23/2015	2:00:00	3/23/2015	18:00:00	0.35	58
3/24/2015	15:45:00	3/24/2015	20:00:00	0.06	10
3/24/2015	22:15:00	3/25/2015	5:30:00	0.14	23
3/25/2015	11:00:00	3/25/2015	15:45:00	0.10	16
3/29/2015	4:30:00	3/29/2015	9:15:00	0.62	101
3/29/2015	12:15:00	3/29/2015	17:15:00	0.60	97
4/1/2015	20:30:00	4/2/2015	8:30:00	4.25	479
4/6/2015	3:00:00	4/6/2015	20:00:00	0.39	196
4/8/2015	8:15:00	4/8/2015	9:15:00	0.01	3
4/9/2015	1:15:00	4/10/2015	6:30:00	2.77	932
4/10/2015	9:15:00	4/10/2015	18:15:00	0.24	122
4/12/2015	21:30:00	4/13/2015	13:15:00	2.61	1,681
4/14/2015	11:00:00	4/14/2015	17:00:00	0.06	28
4/15/2015	12:30:00	4/15/2015	15:45:00	0.08	40
4/17/2015	11:00:00	4/17/2015	11:30:00	0.00	1
4/18/2015	23:15:00	4/20/2015	9:45:00	1.09	547
4/24/2015	18:30:00	4/25/2015	5:00:00	0.39	196
5/1/2015	2:00:00	5/1/2015	6:45:00	0.04	19
5/1/2015	10:45:00	5/1/2015	16:00:00	0.08	36

5/3/2015	17:30:00	5/4/2015	7:00:00	3.06	2,592
5/4/2015	13:45:00	5/5/2015	2:15:00	0.07	34
5/5/2015	11:15:00	5/5/2015	11:45:00	0.00	1
5/5/2015	13:00:00	5/5/2015	13:45:00	0.02	11
5/6/2015	12:15:00	5/6/2015	20:30:00	0.05	22
5/7/2015	13:15:00	5/8/2015	14:15:00	2.89	1,328
5/8/2015	17:00:00	5/8/2015	20:30:00	0.01	6
5/9/2015	0:00:00	5/9/2015	0:45:00	0.00	1
5/10/2015	20:15:00	5/10/2015	20:45:00	0.03	12
5/10/2015	23:55:00	5/11/2015	16:00:00	1.53	703
5/12/2015	0:00:00	5/12/2015	13:15:00	0.20	93
5/14/2015	14:30:00	5/15/2015	5:45:00	0.74	341
5/16/2015	21:15:00	5/17/2015	2:45:00	0.13	60
5/22/2015	15:15:00	5/22/2015	15:45:00	0.00	2
5/24/2015	11:15:00	5/25/2015	9:15:00	1.59	730
5/26/2015	12:00:00	5/27/2015	3:15:00	0.90	360
5/29/2015	3:30:00	5/29/2015	13:30:00	1.46	651
5/29/2015	15:30:00	5/30/2015	2:15:00	0.57	264
6/3/2015	13:00:00	6/4/2015	6:15:00	2.35	2,634
6/5/2015	11:15:00	6/5/2015	12:00:00	0.01	4
6/7/2015	0:15:00	6/7/2015	11:00:00	0.98	650
6/7/2015	19:45:00	6/7/2015	20:00:00	0.00	0
6/11/2015	6:15:00	6/11/2015	14:45:00	0.28	104
6/11/2015	15:30:00	6/11/2015	17:45:00	0.02	6
6/13/2015	11:15:00	6/13/2015	13:30:00	0.02	9
6/17/2015	14:15:00	6/17/2015	19:45:00	1.27	999
6/20/2015	6:00:00	6/20/2015	12:00:00	0.39	105
6/20/2015	13:00:00	6/20/2015	13:15:00	0.00	1
6/22/2015	7:45:00	6/22/2015	13:00:00	0.35	155
6/22/2015	16:15:00	6/22/2015	16:30:00	0.00	-
6/25/2015	10:00:00	6/25/2015	10:45:00	0.01	3
6/25/2015	14:30:00	6/25/2015	15:00:00	0.00	1
6/27/2015	23:45:00	6/28/2015	5:00:00	0.39	138
6/28/2015	16:15:00	6/28/2015	19:00:00	0.04	14
6/29/2015	11:15:00	6/29/2015	11:30:00	0.00	0
6/29/2015	19:30:00	6/29/2015	23:15:00	0.30	112
7/5/2015	22:45:00	7/5/2015	23:00:00	0.00	1
7/6/2015	1:00:00	7/6/2015	18:00:00	2.13	781
7/12/2015	23:15:00	7/13/2015	8:00:00	3.76	1,808
7/15/2015	21:30:00	7/15/2015	22:15:00	0.01	5
7/16/2015	16:45:00	7/17/2015	6:00:00	0.22	107
7/17/2015	9:45:00	7/17/2015	11:00:00	0.02	8
7/18/2015	1:00:00	7/18/2015	13:45:00	1.00	263
7/19/2015	11:45:00	7/19/2015	12:45:00	0.00	2
7/21/2015	22:15:00	7/21/2015	22:45:00	0.01	4
7/22/2015	21:45:00	7/22/2015	22:15:00	0.01	4
7/24/2015	5:30:00	7/24/2015	16:45:00	0.22	105
7/28/2015	7:00:00	7/29/2015	0:00:00	1.19	256

8/3/2015	9:00:00	8/4/2015	0:00:00	0.21	83
8/4/2015	11:00:00	8/4/2015	21:45:00	0.07	29
8/5/2015	18:15:00	8/7/2015	10:30:00	1.01	229
8/9/2015	13:15:00	8/9/2015	20:30:00	0.15	62
8/13/2015	0:00:00	8/13/2015	9:45:00	0.13	51
8/16/2015	17:45:00	8/17/2015	10:15:00	0.86	346
8/17/2015	17:15:00	8/19/2015	18:45:00	4.66	3,348
8/22/2015	19:45:00	8/23/2015	10:30:00	2.00	1,677
9/2/2015	2:45:00	9/2/2015	10:15:00	0.63	113
9/2/2015	15:40:00	9/2/2015	15:45:00	0.00	1
9/6/2015	5:45:00	9/6/2015	19:15:00	1.29	302
9/8/2015	3:00:00	9/8/2015	8:15:00	0.32	95
9/8/2015	15:10:00	9/8/2015	15:15:00	0.00	1
9/9/2015	8:00:00	9/10/2015	9:00:00	1.10	2,053
9/10/2015	15:40:00	9/10/2015	15:45:00	0.00	1
9/16/2015	3:30:00	9/17/2015	7:10:00	4.14	3,264
9/17/2015	9:10:00	9/19/2015	9:30:00	7.10	670
9/20/2015	16:45:00	9/21/2015	15:00:00	0.39	117
9/23/2015	14:00:00	9/24/2015	15:15:00	1.27	381
9/28/2015	13:15:00	9/29/2015	0:15:00	0.09	27
10/8/2015	3:15:00	10/8/2015	15:30:00	1.15	302
10/22/2015	10:45:00	10/22/2015	17:45:00	0.08	17
10/23/2015	6:00:00	10/24/2015	8:00:00	4.57	1,285
10/24/2015	8:20:00	10/24/2015	17:00:00	0.04	9
10/26/2015	5:15:00	10/26/2015	8:45:00	0.01	2
10/27/2015	14:15:00	10/27/2015	16:30:00	0.02	4
10/27/2015	19:30:00	10/29/2015	18:00:00	3.33	672
10/31/2015	2:15:00	10/31/2015	16:30:00	1.18	237
11/2/2015	15:15:00	11/2/2015	16:00:00	0.01	2
11/11/2015	16:15:00	11/12/2015	18:15:00	8.90	3,942
11/12/2015	20:00:00	11/12/2015	20:45:00	0.00	1
Total Annual Event Load (lbs)				**86.85**	**39,398**

Table D-4: Hidden Falls base load and event load tables, 2015.

Month	Base TP Load (lb)	Base TSS Load (lb)
January	-	-
February	-	-
March	-	-
April	0.15	11
May	0.81	96
June	0.9	138
July	2.5	386
August	1.66	722
September	0.87	98
October	0.81	153
November	1.23	174
December	-	-
Total Annual Base Load (lbs)	**8.93**	**1,778**

Event Start Date	Event Start Time	Event Stop Date	Event Stop Time	Event TP Load (lb)	Event TSS Load (lb)
4/19/2015	13:15:00	4/19/2015	14:00:00	0.02	10
4/19/2015	19:15:00	4/19/2015	22:00:00	0.05	29
4/24/2015	18:00:00	4/25/2015	2:15:00	0.13	67
5/3/2015	19:00:00	5/3/2015	20:15:00	0.03	43
5/7/2015	13:00:00	5/7/2015	15:15:00	0.03	41
5/7/2015	17:15:00	5/8/2015	7:00:00	0.66	829
5/10/2015	20:30:00	5/10/2015	21:30:00	0.01	17
5/10/2015	21:45:00	5/11/2015	19:30:00	1.39	1,766
5/14/2015	15:30:00	5/15/2015	3:25:00	0.41	541
5/16/2015	20:45:00	5/17/2015	6:30:00	0.34	449
5/24/2015	13:45:00	5/24/2015	15:30:00	0.03	40
5/24/2015	15:45:00	5/25/2015	9:00:00	0.79	1,040
5/26/2015	13:30:00	5/27/2015	4:45:00	1.1	1,454
5/29/2015	3:15:00	5/30/2015	16:45:00	2.62	3,345
6/3/2015	12:30:00	6/5/2015	5:30:00	3.86	2,383
6/6/2015	23:45:00	6/8/2015	19:45:00	1.63	2,110
6/11/2015	5:45:00	6/12/2015	2:00:00	0.24	325
6/17/2015	13:45:00	6/19/2015	13:15:00	9.22	7,415
6/20/2015	5:45:00	6/20/2015	17:45:00	0.43	560
6/22/2015	7:30:00	6/23/2015	21:00:00	3.79	4,940
6/27/2015	23:30:00	6/28/2015	0:45:00	0.01	20
6/28/2015	16:00:00	6/28/2015	18:00:00	0.03	37
6/29/2015	19:30:00	6/30/2015	23:00:00	1.56	2,013
7/6/2015	1:00:00	7/11/2015	1:30:00	12.94	6,838
7/12/2015	23:30:00	7/14/2015	19:45:00	10.79	7,474
7/15/2015	7:15:00	7/15/2015	8:00:00	0.03	20
7/15/2015	10:00:00	7/15/2015	12:00:00	0.41	228
7/15/2015	13:15:00	7/15/2015	14:15:00	0.05	28

7/16/2015	16:30:00	7/16/2015	18:45:00	0.08	47
7/18/2015	0:45:00	7/18/2015	13:15:00	1.43	768
7/19/2015	23:15:00	7/20/2015	7:20:00	0.13	75
7/24/2015	5:30:00	7/24/2015	7:45:00	0.08	45
7/28/2015	6:30:00	7/29/2015	11:30:00	1.77	468
8/6/2015	11:45:00	8/6/2015	12:45:00	0.02	19
8/6/2015	21:00:00	8/7/2015	0:15:00	0.05	47
8/7/2015	1:00:00	8/7/2015	3:15:00	0.22	182
8/8/2015	10:15:00	8/8/2015	11:15:00	0.02	19
8/9/2015	14:30:00	8/9/2015	15:15:00	0.01	9
8/16/2015	19:45:00	8/21/2015	20:15:00	1.92	1,646
8/22/2015	20:30:00	8/23/2015	0:30:00	0.42	348
8/24/2015	9:30:00	8/24/2015	10:40:00	0.03	30
8/24/2015	13:00:00	8/24/2015	13:25:00	0.01	10
8/24/2015	13:45:00	8/24/2015	16:55:00	0.09	79
9/2/2015	3:30:00	9/2/2015	5:15:00	0.07	66
9/6/2015	6:30:00	9/7/2015	3:15:00	0.67	624
9/8/2015	5:00:00	9/8/2015	6:45:00	0.05	52
9/9/2015	21:15:00	9/11/2015	5:30:00	0.48	474
9/16/2015	22:00:00	9/16/2015	23:15:00	0.01	8
9/17/2015	1:00:00	9/17/2015	2:15:00	0.01	7
9/17/2015	5:15:00	9/22/2015	5:45:00	5.53	1,196
9/23/2015	13:30:00	9/23/2015	15:00:00	0.29	264
9/24/2015	2:30:00	9/24/2015	3:15:00	0.02	23
9/24/2015	6:15:00	9/24/2015	9:15:00	0.12	116
10/8/2015	4:00:00	10/8/2015	10:45:00	0.52	508
10/23/2015	7:30:00	10/23/2015	8:45:00	0.09	90
10/23/2015	11:30:00	10/23/2015	19:15:00	0.69	681
10/23/2015	22:15:00	10/24/2015	22:45:00	2.09	2,051
10/27/2015	19:00:00	11/1/2015	19:30:00	10.28	10,165
11/11/2015	14:45:00	11/16/2015	15:15:00	7.29	3,311
11/17/2015	4:15:00	11/19/2015	6:30:00	3.03	655
Total Annual Event Load (lbs)				**90.12**	**68,145**

Table D-5: Villa Park Outlet base load and event load tables, 2015.

Month	Base TP Load (lb)	Base TSS Load (lb)
January	-	-
February	-	-
March	3.93	126
April	7.48	384
May	8.58	404
June	8.02	204
July	8.19	250
August	9.37	438
September	9.92	279
October	6.5	361
November	9.65	200
December	-	-
Total Annual Base Load (lbs)	**71.64**	**2,646**

Event Start Date	Event Start Time	Event Stop Date	Event Stop Time	Event TP Load (lb)	Event TSS Load (lb)
4/1/2015	19:45:00	4/2/2015	8:45:00	0.15	41
4/9/2015	7:30:00	4/10/2015	19:30:00	1.03	191
4/12/2015	20:30:00	4/13/2015	13:45:00	0.85	155
4/22/2015	7:00:00	4/23/2015	12:15:00	0.75	148
4/24/2015	13:30:00	4/24/2015	15:30:00	0.00	2
4/28/2015	14:45:00	4/29/2015	16:00:00	0.32	66
5/1/2015	9:00:00	5/2/2015	4:00:00	0.23	22
5/3/2015	17:15:00	5/4/2015	21:30:00	0.55	48
5/7/2015	17:15:00	5/9/2015	21:30:00	6.30	1,800
5/10/2015	20:00:00	5/12/2015	22:00:00	2.67	218
5/26/2015	10:30:00	5/28/2015	10:00:00	1.85	163
5/29/2015	3:30:00	5/30/2015	19:45:00	2.63	221
6/3/2015	12:45:00	6/9/2015	10:15:00	6.35	244
6/17/2015	14:00:00	6/18/2015	22:30:00	0.36	32
6/20/2015	5:45:00	6/21/2015	13:45:00	0.66	58
6/22/2015	7:00:00	6/23/2015	8:15:00	0.51	44
6/27/2015	23:30:00	7/2/2015	17:30:00	6.83	416
7/6/2015	0:45:00	7/9/2015	5:00:00	6.59	422
7/12/2015	20:15:00	7/16/2015	3:45:00	15.85	1,140
7/17/2015	22:15:00	7/19/2015	14:15:00	4.16	640
7/28/2015	6:30:00	7/30/2015	8:45:00	2.05	101
8/6/2015	22:15:00	8/9/2015	1:30:00	1.49	148
8/16/2015	17:30:00	8/22/2015	2:45:00	4.30	159
8/22/2015	18:15:00	8/24/2015	15:00:00	0.19	1
9/2/2015	3:15:00	9/3/2015	22:00:00	0.77	38
9/6/2015	4:45:00	9/8/2015	20:15:00	2.26	105
9/9/2015	20:45:00	9/11/2015	22:00:00	2.77	134
9/17/2015	4:45:00	9/20/2015	8:15:00	7.02	316

10/8/2015	3:45:00	10/9/2015	11:30:00	1.08	30
10/21/2015	16:30:00	10/22/2015	16:30:00	0.53	13
10/23/2015	9:30:00	10/25/2015	2:30:00	4.07	198
10/27/2015	20:45:00	10/30/2015	6:30:00	2.73	76
10/31/2015	4:15:00	11/1/2015	0:30:00	0.80	10
11/11/2015	16:15:00	11/15/2015	13:15:00	15.56	740
11/16/2015	9:45:00	11/16/2015	12:30:00	0.01	1
11/17/2015	3:15:00	11/19/2015	19:00:00	12.63	565
Total Annual Event Load (lbs)				**116.91**	**8,703**

Table D-6: Phalen Creek base load and event load tables, 2015.

Month	Base TP Load (lb)	Base TSS Load (lb)
January	28.17	1,322
February	32.89	2,328
March	17.02	961
April	28.57	2,378
May	37.22	2,497
June	39.67	3,149
July	29.97	1,604
August	29.8	1,748
September	30.65	1,243
October	34.43	1,267
November	32.81	1,193
December	36.91	1,308
Total Annual Base Load (lbs)	**378.11**	**20,996**

Event Start Date	Event Start Time	Event Stop Date	Event Stop Time	Event TP Load (lb)	Event TSS Load (lb)
3/29/2015	4:15:00	3/29/2015	17:30:00	16.15	2,483
4/1/2015	20:30:00	4/2/2015	3:00:00	18.63	11,323
4/6/2015	6:00:00	4/6/2015	10:15:00	1.28	747
4/9/2015	8:15:00	4/9/2015	12:15:00	7.93	4,545
4/9/2015	16:45:00	4/10/2015	0:45:00	5.37	2,894
4/12/2015	21:30:00	4/13/2015	5:45:00	23.15	14,548
4/18/2015	23:15:00	4/19/2015	3:15:00	1.24	714
4/19/2015	5:45:00	4/19/2015	9:00:00	0.92	535
4/19/2015	13:45:00	4/19/2015	15:15:00	0.44	260
4/19/2015	19:15:00	4/19/2015	23:45:00	1.96	1,093
5/3/2015	17:30:00	5/3/2015	23:30:00	49.69	61,508
5/6/2015	0:00:00	5/6/2015	1:30:00	0.54	369
5/7/2015	13:45:00	5/7/2015	15:00:00	0.57	389
5/7/2015	17:30:00	5/7/2015	22:15:00	38.99	29,067
5/10/2015	20:15:00	5/11/2015	5:15:00	16.19	12,823

5/12/2015	1:15:00	5/12/2015	5:30:00	2.03	1,372
5/14/2015	15:00:00	5/15/2015	0:00:00	4.76	1,125
5/17/2015	14:30:00	5/17/2015	21:45:00	9.68	6,068
5/24/2015	14:00:00	5/25/2015	6:00:00	12.37	8,111
5/26/2015	13:15:00	5/26/2015	22:15:00	8.64	2,912
5/29/2015	3:45:00	5/29/2015	11:15:00	24.38	16,760
5/29/2015	15:45:00	5/29/2015	21:00:00	4.04	2,728
6/3/2015	12:45:00	6/3/2015	17:45:00	24.69	16,783
6/3/2015	19:00:00	6/3/2015	23:00:00	10.56	4,241
6/6/2015	23:45:00	6/7/2015	7:15:00	32.04	24,810
6/7/2015	23:30:00	6/8/2015	3:30:00	5.31	2,157
6/11/2015	6:15:00	6/11/2015	13:30:00	6.61	2,754
6/13/2015	11:00:00	6/13/2015	12:45:00	1.23	538
6/17/2015	14:00:00	6/17/2015	21:00:00	18.57	15,033
6/20/2015	6:00:00	6/20/2015	12:15:00	6.77	2,598
6/22/2015	7:30:00	6/22/2015	15:00:00	6.73	1,768
6/26/2015	17:00:00	6/26/2015	21:45:00	4.44	1,822
6/27/2015	23:45:00	6/28/2015	7:30:00	8.81	3,580
6/28/2015	16:00:00	6/28/2015	20:30:00	7.51	3,439
6/29/2015	19:15:00	6/30/2015	1:00:00	4.51	1,860
7/5/2015	23:45:00	7/6/2015	22:00:00	19.42	6,896
7/12/2015	23:00:00	7/13/2015	13:45:00	39.75	30,992
7/15/2015	10:00:00	7/15/2015	11:45:00	0.61	294
7/16/2015	16:30:00	7/16/2015	22:15:00	3.7	1,741
7/18/2015	0:45:00	7/18/2015	10:30:00	34.5	5,817
7/24/2015	3:45:00	7/24/2015	5:30:00	1.05	494
7/24/2015	6:00:00	7/24/2015	9:00:00	2.64	1,235
7/28/2015	6:45:00	7/28/2015	12:00:00	10.88	3,302
8/6/2015	12:30:00	8/6/2015	14:00:00	1.28	746
8/6/2015	22:45:00	8/7/2015	0:15:00	0.87	608
8/7/2015	1:15:00	8/7/2015	4:00:00	8.28	5,273
8/9/2015	14:45:00	8/9/2015	16:30:00	0.68	473
8/16/2015	20:00:00	8/17/2015	5:15:00	22.57	20,107
8/17/2015	17:30:00	8/17/2015	18:15:00	0.24	172
8/17/2015	18:45:00	8/17/2015	22:30:00	1.55	1,067
8/18/2015	11:15:00	8/18/2015	22:30:00	15.56	8,149
8/19/2015	3:30:00	8/19/2015	7:45:00	5.72	3,711
8/22/2015	18:30:00	8/23/2015	9:30:00	26.49	17,722
9/2/2015	3:15:00	9/2/2015	9:15:00	11.66	6,456
9/6/2015	6:45:00	9/6/2015	12:45:00	13.66	6,715
9/8/2015	4:45:00	9/8/2015	11:00:00	4.84	2,440
9/9/2015	21:15:00	9/10/2015	4:45:00	10.62	5,253
9/10/2015	6:00:00	9/10/2015	8:00:00	0.98	522
9/16/2015	3:30:00	9/16/2015	5:00:00	0.45	247
9/16/2015	21:45:00	9/17/2015	4:45:00	5.6	2,836
9/17/2015	5:30:00	9/17/2015	21:45:00	63.61	30,337
9/18/2015	18:15:00	9/19/2015	1:15:00	7.26	3,701
9/20/2015	18:00:00	9/20/2015	21:30:00	1.93	1,001

9/23/2015	14:00:00	9/24/2015	0:30:00	14.62	7,248
9/24/2015	2:30:00	9/24/2015	8:45:00	7.12	3,634
10/8/2015	4:00:00	10/8/2015	9:30:00	20.78	3,500
10/23/2015	7:45:00	10/24/2015	9:30:00	102.35	18,576
10/27/2015	19:45:00	10/28/2015	14:00:00	9.97	2,336
10/28/2015	14:30:00	10/28/2015	18:15:00	1.74	435
10/28/2015	19:00:00	10/29/2015	0:30:00	2.96	756
10/29/2015	9:15:00	10/29/2015	11:30:00	0.77	195
10/31/2015	2:00:00	10/31/2015	14:00:00	8.07	483
11/5/2015	14:30:00	11/5/2015	18:00:00	4.77	801
11/11/2015	16:30:00	11/12/2015	13:00:00	57.65	9,107
11/16/2015	11:15:00	11/16/2015	16:00:00	4.17	722
11/17/2015	5:15:00	11/19/2015	5:45:00	37.03	7,597
11/26/2015	10:45:00	11/26/2015	17:15:00	2.13	396
12/1/2015	3:15:00	12/1/2015	9:00:00	0.11	4
12/8/2015	14:00:00	12/8/2015	16:15:00	0.04	2
12/10/2015	12:15:00	12/10/2015	17:15:00	0.51	18
12/13/2015	4:00:00	12/13/2015	16:00:00	0.52	19
12/14/2015	5:30:00	12/14/2015	17:30:00	3.94	140
12/16/2015	2:15:00	12/16/2015	18:00:00	1.08	38
12/23/2015	6:15:00	12/24/2015	2:15:00	1.63	58
Total Annual Event Load (lbs)				**985.09**	**488,129**

Table D-7: St. Anthony Park base load and event load tables, 2015.

Month	Base TP Load (lb)	Base TSS Load (lb)
January	27.19	3,850
February	24.86	6,000
March	33.11	10,711
April	33.65	4,860
May	51.08	12,654
June	55.28	9,111
July	28.56	5,251
August	17.54	5,178
September	21.62	6,290
October	20.82	4,842
November	26.1	8,556
December	22.87	3,388
Total Annual Base Load (lbs)	**362.68**	**80,692**

Event Start Date	Event Start Time	Event Stop Date	Event Stop Time	Event TP Load (lb)	Event TSS Load (lb)
1/18/2015	15:00:00	1/18/2015	16:30:00	0.42	528
1/24/2015	15:00:00	1/24/2015	17:00:00	0.57	715
1/26/2015	15:00:00	1/26/2015	19:45:00	1.66	2,001

3/7/2015	13:00:00	3/7/2015	19:30:00	2.32	1,031
3/8/2015	12:45:00	3/8/2015	21:15:00	3.45	1,514
3/9/2015	12:45:00	3/10/2015	0:00:00	3.72	1,468
3/10/2015	14:00:00	3/10/2015	17:45:00	1.07	487
3/23/2015	10:15:00	3/23/2015	13:30:00	1.19	542
3/24/2015	13:45:00	3/24/2015	16:00:00	0.6	273
3/24/2015	22:45:00	3/25/2015	1:00:00	0.64	292
3/25/2015	10:45:00	3/25/2015	15:15:00	1.4	627
3/29/2015	4:45:00	3/29/2015	5:50:00	0.44	193
3/29/2015	12:00:00	3/29/2015	15:15:00	0.92	413
4/1/2015	12:00:00	4/1/2015	12:45:00	0.11	88
4/1/2015	21:30:00	4/1/2015	22:30:00	0.53	342
4/1/2015	23:15:00	4/2/2015	2:00:00	0.56	419
4/6/2015	4:45:00	4/6/2015	13:45:00	2.73	1,775
4/9/2015	8:30:00	4/10/2015	6:00:00	35.77	36,366
4/10/2015	10:15:00	4/10/2015	13:45:00	1.35	951
4/12/2015	20:15:00	4/13/2015	14:45:00	18.45	11,330
4/14/2015	8:00:00	4/14/2015	8:45:00	0.12	104
4/19/2015	0:15:00	4/19/2015	4:00:00	0.71	500
4/19/2015	5:15:00	4/19/2015	8:15:00	0.7	611
4/19/2015	20:30:00	4/19/2015	21:05:00	0.17	113
5/1/2015	12:00:00	5/1/2015	13:00:00	0.12	71
5/3/2015	16:45:00	5/4/2015	7:45:00	11.62	5,767
5/5/2015	13:00:00	5/5/2015	14:15:00	0.15	86
5/7/2015	14:30:00	5/7/2015	15:05:00	0.13	69
5/7/2015	17:15:00	5/8/2015	7:30:00	52.48	33,804
5/10/2015	21:45:00	5/11/2015	23:45:00	23.01	9,386
5/12/2015	1:45:00	5/12/2015	5:00:00	0.64	363
5/14/2015	15:45:00	5/15/2015	2:00:00	3.32	658
5/16/2015	22:15:00	5/16/2015	23:30:00	0.46	239
5/17/2015	9:30:00	5/17/2015	13:45:00	1.08	583
5/17/2015	20:15:00	5/17/2015	21:30:00	0.27	164
5/19/2015	10:00:00	5/19/2015	11:45:00	0.31	183
5/20/2015	5:45:00	5/20/2015	11:15:00	1.48	821
5/20/2015	13:15:00	5/20/2015	14:45:00	0.49	282
5/20/2015	18:15:00	5/20/2015	21:45:00	0.78	468
5/21/2015	14:30:00	5/21/2015	15:45:00	0.44	248
5/22/2015	9:45:00	5/22/2015	11:15:00	0.47	269
5/23/2015	8:30:00	5/23/2015	10:00:00	0.43	248
5/23/2015	13:00:00	5/23/2015	16:00:00	0.83	503
5/24/2015	9:45:00	5/24/2015	13:45:00	1.15	654
5/24/2015	17:15:00	5/25/2015	5:30:00	8.8	4,714
5/26/2015	2:30:00	5/26/2015	6:30:00	1.67	950
5/26/2015	8:45:00	5/26/2015	21:30:00	14.82	8,018
5/27/2015	19:00:00	5/27/2015	20:15:00	0.43	242
5/28/2015	16:45:00	5/28/2015	17:45:00	0.31	177
5/29/2015	5:00:00	5/30/2015	1:30:00	16	18,837
5/30/2015	6:45:00	5/30/2015	14:30:00	3.41	1,892

5/31/2015	10:45:00	6/2/2015	16:00:00	14.96	8,173
6/3/2015	13:30:00	6/3/2015	14:45:00	1.13	719
6/3/2015	15:25:00	6/3/2015	20:15:00	3.63	2,356
6/3/2015	20:50:00	6/4/2015	2:15:00	4.39	2,880
6/4/2015	14:45:00	6/4/2015	17:30:00	1.06	690
6/6/2015	10:15:00	6/6/2015	12:00:00	0.45	349
6/7/2015	0:30:00	6/7/2015	2:10:00	2.31	1,421
6/7/2015	2:40:00	6/7/2015	8:00:00	3.19	2,122
6/7/2015	18:00:00	6/7/2015	22:45:00	1.34	904
6/8/2015	2:00:00	6/8/2015	3:00:00	0.28	204
6/9/2015	19:00:00	6/9/2015	20:00:00	0.26	197
6/11/2015	6:15:00	6/11/2015	9:00:00	1.22	797
6/12/2015	14:00:00	6/12/2015	15:45:00	0.42	326
6/14/2015	13:15:00	6/14/2015	14:00:00	0.15	114
6/17/2015	15:30:00	6/17/2015	17:00:00	0.88	547
6/20/2015	7:30:00	6/20/2015	9:05:00	2.36	831
6/22/2015	7:45:00	6/22/2015	18:00:00	13.85	5,572
6/23/2015	11:15:00	6/23/2015	14:30:00	0.63	443
6/29/2015	19:30:00	6/30/2015	2:30:00	18.54	10,941
7/6/2015	2:30:00	7/7/2015	7:00:00	20.63	7,543
7/12/2015	23:15:00	7/14/2015	8:30:00	63.46	34,877
7/16/2015	18:15:00	7/16/2015	21:15:00	1.21	733
7/17/2015	12:00:00	7/18/2015	15:15:00	12.81	7,255
7/18/2015	18:15:00	7/18/2015	19:00:00	0.24	151
7/23/2015	14:00:00	7/23/2015	15:00:00	0.23	147
7/24/2015	7:00:00	7/24/2015	7:55:00	0.86	487
7/24/2015	8:00:00	7/24/2015	8:45:00	0.36	212
7/28/2015	6:15:00	7/28/2015	14:30:00	26.83	12,610
7/29/2015	12:15:00	7/29/2015	14:15:00	0.58	355
8/6/2015	17:45:00	8/6/2015	20:15:00	0.63	225
8/6/2015	21:45:00	8/7/2015	6:30:00	11.38	8,351
8/9/2015	15:45:00	8/9/2015	18:30:00	0.79	279
8/16/2015	19:00:00	8/17/2015	4:45:00	7.44	2,844
8/17/2015	18:45:00	8/17/2015	21:15:00	1.21	423
8/18/2015	12:15:00	8/18/2015	20:35:00	8.83	2,433
8/19/2015	10:15:00	8/19/2015	10:48:19	0.12	44
8/22/2015	20:30:00	8/23/2015	1:45:00	13.53	9,577
8/27/2015	12:15:00	8/27/2015	14:00:00	0.51	182
8/29/2015	13:30:00	8/29/2015	14:45:00	0.33	119
8/30/2015	13:45:00	8/30/2015	15:30:00	0.46	163
8/31/2015	12:30:00	8/31/2015	13:15:00	0.22	78
9/2/2015	4:15:00	9/2/2015	12:15:00	3	1,107
9/6/2015	5:30:00	9/6/2015	16:30:00	8.16	1,109
9/8/2015	6:30:00	9/8/2015	10:00:00	0.93	344
9/9/2015	21:15:00	9/10/2015	12:45:00	5.12	1,878
9/13/2015	12:45:00	9/13/2015	16:30:00	0.7	261
9/14/2015	11:45:00	9/14/2015	12:30:00	0.09	35
9/15/2015	8:00:00	9/15/2015	16:30:00	1.94	718

9/15/2015	20:45:00	9/16/2015	3:30:00	1.28	478
9/17/2015	5:15:00	9/17/2015	17:40:00	42.75	15,441
9/18/2015	18:30:00	9/19/2015	5:00:00	9.16	3,356
9/20/2015	20:00:00	9/21/2015	0:15:00	0.59	220
9/21/2015	14:00:00	9/21/2015	20:00:00	1.02	378
9/23/2015	15:30:00	9/23/2015	19:00:00	0.65	244
9/24/2015	5:00:00	9/24/2015	12:45:00	4.13	628
10/8/2015	4:00:00	10/8/2015	6:10:00	1.61	536
10/10/2015	9:15:00	10/10/2015	15:30:00	1.32	460
10/18/2015	18:45:00	10/18/2015	21:15:00	0.27	97
10/19/2015	9:15:00	10/19/2015	10:45:00	0.19	66
10/21/2015	11:00:00	10/21/2015	11:45:00	0.08	29
10/23/2015	11:00:00	10/23/2015	17:31:47	26.23	5,301
10/23/2015	23:15:00	10/24/2015	5:10:00	14.24	4,812
10/27/2015	9:45:00	10/27/2015	10:45:00	0.11	41
10/27/2015	22:15:00	10/29/2015	9:45:00	18.46	1,394
10/30/2015	11:45:00	10/30/2015	13:50:00	0.42	146
10/30/2015	17:45:00	10/30/2015	18:45:00	0.11	42
10/31/2015	1:30:00	10/31/2015	18:15:00	9.1	729
11/8/2015	14:15:00	11/8/2015	16:15:00	0.17	30
11/10/2015	11:00:00	11/10/2015	14:45:00	0.24	41
11/11/2015	16:30:00	11/13/2015	20:30:00	41.42	9,257
11/16/2015	1:00:00	11/16/2015	2:45:00	0.11	18
11/16/2015	7:00:00	11/17/2015	0:45:00	3.36	685
11/17/2015	6:00:00	11/19/2015	3:15:00	31.88	9,508
11/26/2015	10:30:00	11/26/2015	16:45:00	0.55	97
12/1/2015	3:30:00	12/1/2015	15:45:00	1.34	612
12/4/2015	10:45:00	12/4/2015	12:45:00	0.12	53
12/5/2015	10:00:00	12/5/2015	22:00:00	1.6	644
12/7/2015	13:15:00	12/7/2015	14:45:00	0.15	71
12/8/2015	13:00:00	12/8/2015	18:00:00	0.72	299
12/10/2015	14:15:00	12/10/2015	18:00:00	0.51	215
12/13/2015	4:00:00	12/13/2015	16:45:00	1.82	736
12/14/2015	8:30:00	12/14/2015	21:15:00	9.14	3,357
12/16/2015	2:15:00	12/16/2015	19:45:00	6.58	2,551
12/21/2015	8:45:00	12/21/2015	10:00:00	0.13	53
12/23/2015	7:00:00	12/23/2015	8:15:00	0.11	52
12/23/2015	9:00:00	12/23/2015	22:00:00	3.24	1,291
Total Annual Event Load (lbs)				**723.26**	**350,473**

Table D-8: Trout Brook-East Branch base load and event load tables, 2015.

Month	Base TP Load (lb)	Base TSS Load (lb)
January	10.14	2,955
February	6.95	2,153
March	19.71	1,078
April	5.64	534
May	8.09	1,432
June	10.14	1,027
July	12.84	1,190
August	13.47	1,594
September	10.35	1,180
October	13.47	1,439
November	12.29	1,303
December	18.45	2,245
Total Annual Base Load (lbs)	**141.54**	**18,131**

Event Start Date	Event Start Time	Event Stop Date	Event Stop Time	Event TP Load (lb)	Event TSS Load (lb)
3/6/2015	13:45:00	3/6/2015	16:45:00	0.26	58
3/7/2015	13:30:00	3/7/2015	15:30:00	0.32	72
3/8/2015	11:45:00	3/9/2015	0:30:00	2.55	499
3/9/2015	12:30:00	3/9/2015	20:45:00	4.37	1,196
3/29/2015	4:30:00	3/30/2015	0:45:00	2.86	571
4/1/2015	20:30:00	4/2/2015	5:15:00	2.91	146
4/9/2015	8:15:00	4/10/2015	17:15:00	7.90	717
4/12/2015	21:45:00	4/13/2015	21:00:00	7.49	3,383
4/18/2015	23:30:00	4/19/2015	5:15:00	0.36	46
4/19/2015	7:15:00	4/19/2015	9:30:00	0.14	18
4/19/2015	13:15:00	4/20/2015	4:15:00	1.35	170
5/3/2015	17:30:00	5/4/2015	17:15:00	4.13	1,394
5/5/2015	9:15:00	5/5/2015	11:45:00	0.16	58
5/7/2015	17:30:00	5/8/2015	12:15:00	7.55	2,530
5/10/2015	21:45:00	5/11/2015	17:45:00	8.22	2,758
5/12/2015	1:15:00	5/12/2015	5:15:00	0.42	150
5/14/2015	16:15:00	5/15/2015	1:00:00	1.59	554
5/17/2015	16:00:00	5/17/2015	22:45:00	0.98	338
5/24/2015	16:45:00	5/25/2015	7:15:00	2.03	702
5/26/2015	13:15:00	5/27/2015	18:45:00	5.71	1,926
5/29/2015	4:00:00	5/30/2015	8:30:00	8.91	2,976
6/3/2015	13:00:00	6/5/2015	18:00:00	11.38	4,591
6/7/2015	0:00:00	6/8/2015	8:45:00	11.75	4,726
6/17/2015	14:00:00	6/19/2015	0:45:00	11.32	4,501
6/20/2015	6:00:00	6/21/2015	16:45:00	4.95	2,038
6/22/2015	7:45:00	6/23/2015	9:15:00	3.75	1,575
6/26/2015	17:00:00	6/27/2015	6:45:00	1.41	602
6/27/2015	23:45:00	6/30/2015	17:30:00	14.16	5,716

7/6/2015	1:00:00	7/10/2015	9:30:00	28.87	7,356
7/12/2015	23:15:00	7/15/2015	10:20:00	28.74	7,245
7/15/2015	14:15:00	7/16/2015	0:35:00	0.96	267
7/16/2015	12:10:00	7/17/2015	21:00:00	4.43	1,235
7/18/2015	1:00:00	7/18/2015	23:30:00	10.00	2,574
7/23/2015	9:45:00	7/23/2015	11:45:00	0.11	33
7/24/2015	2:45:00	7/24/2015	3:45:00	0.06	18
7/24/2015	5:45:00	7/24/2015	10:15:00	0.46	133
7/24/2015	19:00:00	7/24/2015	20:30:00	0.09	29
7/25/2015	23:15:00	7/26/2015	2:15:00	0.18	54
7/26/2015	3:00:00	7/26/2015	5:15:00	0.14	42
7/26/2015	9:15:00	7/26/2015	10:00:00	0.04	11
7/26/2015	11:15:00	7/26/2015	12:45:00	0.08	25
7/26/2015	22:15:00	7/26/2015	23:00:00	0.04	12
7/27/2015	12:30:00	8/1/2015	23:00:00	12.81	2,769
8/7/2015	1:15:00	8/7/2015	15:15:00	3.27	1,108
8/11/2015	16:15:00	8/12/2015	6:30:00	1.01	357
8/14/2015	4:30:00	8/14/2015	5:15:00	0.03	13
8/15/2015	9:00:00	8/15/2015	9:45:00	0.04	14
8/15/2015	18:15:00	8/15/2015	19:00:00	0.03	9
8/16/2015	0:45:00	8/16/2015	1:30:00	0.04	13
8/16/2015	5:30:00	8/16/2015	6:15:00	0.04	14
8/16/2015	19:30:00	8/17/2015	3:30:00	1.11	381
8/18/2015	11:15:00	8/20/2015	2:00:00	16.43	6,070
8/20/2015	15:30:00	8/20/2015	21:45:00	0.32	118
8/22/2015	20:45:00	8/24/2015	1:50:00	9.71	5,965
9/2/2015	3:30:00	9/2/2015	13:10:00	3.71	1,269
9/6/2015	7:10:00	9/6/2015	22:55:00	4.07	588
9/8/2015	4:40:00	9/8/2015	12:35:00	1.07	342
9/9/2015	21:15:00	9/10/2015	16:00:00	5.39	1,273
9/16/2015	22:00:00	9/17/2015	1:20:00	0.31	100
9/17/2015	5:05:00	9/18/2015	3:30:00	24.08	10,372
9/18/2015	19:40:00	9/19/2015	5:25:00	1.47	471
9/20/2015	18:20:00	9/20/2015	22:10:00	0.29	95
9/23/2015	13:45:00	9/24/2015	18:40:00	5.40	943
10/6/2015	11:15:00	10/6/2015	19:30:00	0.44	62
10/8/2015	4:15:00	10/8/2015	20:00:00	2.99	659
10/23/2015	7:45:00	10/24/2015	23:45:00	11.89	1,103
10/27/2015	20:45:00	10/28/2015	10:45:00	3.12	138
10/28/2015	15:45:00	10/29/2015	5:40:00	1.81	255
10/31/2015	3:30:00	10/31/2015	15:10:00	1.68	103
11/5/2015	14:45:00	11/5/2015	20:45:00	0.37	92
11/11/2015	15:30:00	11/12/2015	17:00:00	22.67	6,961
11/16/2015	9:15:00	11/16/2015	19:50:00	1.31	311
11/17/2015	4:40:00	11/20/2015	4:55:00	24.25	5,518
11/30/2015	8:30:00	11/30/2015	11:30:00	0.20	50
11/30/2015	16:00:00	11/30/2015	18:50:00	0.27	66
12/1/2015	3:20:00	12/1/2015	3:40:00	0.00	0

12/1/2015	6:00:00	12/1/2015	12:10:00	0.11	13
12/1/2015	12:40:00	12/1/2015	13:15:00	0.00	0
12/1/2015	21:30:00	12/2/2015	0:35:00	0.04	4
12/2/2015	5:45:00	12/2/2015	9:00:00	0.03	4
12/2/2015	13:25:00	12/2/2015	15:05:00	0.01	1
12/2/2015	22:45:00	12/3/2015	0:15:00	0.01	1
12/3/2015	11:55:00	12/4/2015	10:05:00	0.45	55
12/10/2015	12:30:00	12/11/2015	1:05:00	0.27	33
12/11/2015	17:55:00	12/11/2015	18:10:00	0.00	0
12/13/2015	4:20:00	12/13/2015	4:55:00	0.00	0
12/13/2015	5:45:00	12/13/2015	6:20:00	0.00	0
12/13/2015	8:05:00	12/13/2015	8:25:00	0.00	0
12/14/2015	5:35:00	12/15/2015	5:15:00	2.96	361
12/16/2015	4:10:00	12/16/2015	18:00:00	0.47	57
12/23/2015	6:40:00	12/24/2015	14:35:00	1.02	125
12/26/2015	16:45:00	12/28/2015	10:30:00	0.57	70
Total Annual Event Load (lbs)				**370.70**	**111,371**

Table D-9: Trout Brook-West Branch base load and event load tables, 2015.

Month	Base TP Load (lb)	Base TSS Load (lb)
January	56.95	6,959
February	69.06	15,179
March	93.06	10,429
April	75.71	6,282
May	124.23	23,025
June	108.62	12,232
July	120.14	14,559
August	83.46	13,784
September	68.4	18,762
October	97.32	14,803
November	99.21	21,669
December	168.86	26,147
Total Annual Base Load (lbs)	**1,165.02**	**183,830**

Event Start Date	Event Start Time	Event Stop Date	Event Stop Time	Event TP Load (lb)	Event TSS Load (lb)
1/24/2015	14:30:00	1/24/2015	15:30:00	0.01	8
1/26/2015	14:30:00	1/26/2015	17:30:00	0.05	28
3/7/2015	12:30:00	3/7/2015	19:00:00	8.00	1,935
3/8/2015	12:15:00	3/8/2015	19:45:00	9.85	2,395
3/9/2015	12:30:00	3/9/2015	21:00:00	10.12	3,029
3/16/2015	10:07:30	3/16/2015	12:15:00	1.64	407
3/23/2015	10:45:00	3/23/2015	16:00:00	4.73	1,168
4/6/2015	6:30:00	4/6/2015	11:15:00	1.68	554

4/9/2015	8:15:00	4/9/2015	14:00:00	19.85	9,489
4/9/2015	16:45:00	4/10/2015	1:45:00	8.42	2,524
4/18/2015	7:00:00	4/18/2015	10:00:00	0.85	295
4/18/2015	23:30:00	4/19/2015	2:45:00	1.83	601
4/19/2015	6:00:00	4/19/2015	8:30:00	1.22	417
4/19/2015	19:30:00	4/19/2015	23:15:00	2.10	695
5/3/2015	17:30:00	5/4/2015	2:30:00	17.59	10,314
5/7/2015	13:15:00	5/9/2015	4:00:00	44.14	25,783
5/10/2015	20:15:00	5/14/2015	10:15:00	65.28	148,184
5/14/2015	15:30:00	5/15/2015	9:15:00	6.18	209
5/15/2015	14:30:00	5/16/2015	4:30:00	14.04	8,915
5/16/2015	21:15:00	5/16/2015	23:30:00	2.44	1,543
5/17/2015	15:45:00	5/17/2015	18:00:00	2.13	1,353
5/24/2015	14:15:00	5/24/2015	16:15:00	1.90	263
5/24/2015	16:45:00	5/24/2015	21:30:00	6.37	3,925
5/24/2015	22:00:00	5/24/2015	22:30:00	0.62	402
5/25/2015	2:45:00	5/25/2015	4:30:00	2.26	1,457
5/26/2015	13:00:00	5/28/2015	17:30:00	40.94	4,174
5/29/2015	3:45:00	5/31/2015	1:45:00	169.72	770,619
6/3/2015	13:05:00	6/6/2015	16:15:00	148.60	380,292
6/6/2015	23:45:00	6/7/2015	13:45:00	27.71	17,309
6/17/2015	14:15:00	6/17/2015	22:15:00	29.22	15,570
6/20/2015	5:45:00	6/20/2015	17:45:00	14.67	4,406
6/22/2015	7:45:00	6/22/2015	22:15:00	14.61	3,973
6/26/2015	16:30:00	6/26/2015	19:45:00	5.49	3,037
6/27/2015	23:45:00	6/28/2015	5:50:00	16.24	10,747
6/28/2015	16:00:00	7/1/2015	12:15:00	66.31	135,887
7/6/2015	1:00:00	7/11/2015	13:00:00	238.99	365,501
7/12/2015	23:00:00	7/19/2015	15:30:00	274.53	51,263
7/24/2015	6:00:00	7/24/2015	9:30:00	3.92	2,372
7/28/2015	6:45:00	7/29/2015	3:00:00	46.66	9,663
7/29/2015	5:45:00	7/29/2015	7:00:00	1.05	669
8/6/2015	12:30:00	8/6/2015	14:45:00	1.37	900
8/6/2015	22:30:00	8/7/2015	7:00:00	12.90	7,905
8/9/2015	14:45:00	8/9/2015	17:30:00	2.66	1,663
8/16/2015	19:30:00	8/16/2015	23:50:00	6.99	4,231
8/17/2015	1:00:00	8/17/2015	3:00:00	0.80	518
8/17/2015	19:00:00	8/17/2015	22:15:00	3.09	1,928
8/18/2015	11:15:00	8/21/2015	3:30:00	40.69	6,781
8/22/2015	20:30:00	8/23/2015	11:15:00	26.31	35,428
9/2/2015	3:30:00	9/2/2015	9:00:00	12.62	1,659
9/6/2015	7:00:00	9/6/2015	15:15:00	16.93	4,356
9/8/2015	4:15:00	9/8/2015	8:30:00	5.52	2,249
9/9/2015	21:15:00	9/10/2015	5:00:00	10.53	3,513
9/10/2015	6:00:00	9/10/2015	9:45:00	4.44	1,827
9/12/2015	14:45:00	9/12/2015	20:00:00	2.75	1,129
9/17/2015	5:00:00	9/21/2015	18:15:00	143.97	45,171
9/23/2015	14:00:00	9/23/2015	23:00:00	14.68	5,948

9/24/2015	2:15:00	9/25/2015	4:30:00	35.80	14,447
10/8/2015	4:15:00	10/8/2015	8:30:00	6.13	1,942
10/23/2015	8:00:00	10/23/2015	10:10:00	1.62	536
10/23/2015	11:30:00	10/23/2015	18:45:00	11.32	3,584
10/23/2015	22:30:00	10/24/2015	11:15:00	19.33	6,202
10/27/2015	19:30:00	10/30/2015	8:30:00	84.37	5,899
10/31/2015	2:15:00	11/1/2015	18:15:00	32.05	2,889
11/11/2015	15:30:00	11/18/2015	7:40:00	359.29	108,268
11/18/2015	13:00:00	11/18/2015	16:15:00	15.60	4,839
11/18/2015	17:40:00	11/18/2015	19:00:00	5.37	1,674
11/23/2015	8:00:00	11/23/2015	8:45:00	0.93	290
11/23/2015	19:00:00	11/25/2015	4:45:00	62.68	19,440
11/26/2015	10:30:00	11/26/2015	17:45:00	12.24	3,790
11/30/2015	23:15:00	12/1/2015	1:00:00	2.15	670
12/1/2015	4:30:00	12/1/2015	15:00:00	0.83	128
12/8/2015	14:00:00	12/8/2015	16:45:00	0.28	43
12/10/2015	12:30:00	12/10/2015	16:30:00	0.97	148
12/13/2015	4:15:00	12/13/2015	11:45:00	0.86	132
12/13/2015	12:00:00	12/13/2015	12:45:00	0.01	1
12/14/2015	5:30:00	12/18/2015	5:30:00	20.05	3,074
12/18/2015	10:15:00	12/18/2015	18:00:00	0.44	68
12/23/2015	7:00:00	12/24/2015	0:15:00	2.87	440
Total Annual Event Load (lbs)				**2,313.37**	**2,335,085**

Table D-10: Trout Brook Outlet base load and event load tables, 2015.

Month	Base TP Load (lb)	Base TSS Load (lb)
January	111.8	24,701
February	60.91	12,237
March	173.5	24,804
April	99.49	15,140
May	158.01	18,370
June	202.32	20,178
July	164.69	25,681
August	129.86	17,918
September	129.37	18,459
October	141.75	17,295
November	185.33	36,079
December	101.21	21,756
Total Annual Base Load (lbs)	**1,658.24**	**252,617**

Event Start Date	Event Start Time	Event Stop Date	Event Stop Time	Event TP Load (lb)	Event TSS Load (lb)
1/4/2015	10:15:00	1/4/2015	11:00:00	0.17	31
1/18/2015	13:30:00	1/18/2015	17:30:00	1.18	213

1/24/2015	13:30:00	1/24/2015	15:15:00	0.47	83
1/26/2015	14:15:00	1/26/2015	17:45:00	1.06	191
2/14/2015	11:00:00	2/14/2015	15:15:00	2.29	689
2/24/2015	13:30:00	2/24/2015	17:15:00	2.06	620
3/6/2015	13:45:00	3/6/2015	17:45:00	6.74	1,590
3/7/2015	10:45:00	3/7/2015	21:45:00	21.00	4,915
3/8/2015	12:15:00	3/8/2015	19:00:00	16.91	3,953
3/9/2015	12:15:00	3/9/2015	17:45:00	12.61	3,054
3/23/2015	10:15:00	3/23/2015	16:15:00	10.70	2,521
3/29/2015	4:15:00	3/29/2015	9:45:00	11.98	2,766
3/29/2015	12:15:00	3/29/2015	16:15:00	9.43	2,187
4/6/2015	6:00:00	4/6/2015	12:00:00	4.17	1,854
4/9/2015	8:15:00	4/9/2015	13:45:00	8.12	3,400
4/9/2015	16:45:00	4/10/2015	0:00:00	10.42	4,428
4/18/2015	23:15:00	4/19/2015	3:15:00	3.35	1,488
4/19/2015	6:00:00	4/19/2015	9:15:00	2.56	1,154
4/19/2015	13:30:00	4/19/2015	17:15:00	2.93	1,300
4/19/2015	19:30:00	4/19/2015	23:15:00	4.13	1,805
5/3/2015	16:15:00	5/4/2015	3:00:00	25.43	14,760
5/7/2015	17:45:00	5/8/2015	8:30:00	44.42	25,692
5/10/2015	20:15:00	5/12/2015	14:30:00	106.28	59,733
5/14/2015	15:45:00	5/15/2015	1:45:00	9.86	1,493
5/17/2015	15:30:00	5/17/2015	18:15:00	4.52	2,738
5/24/2015	17:00:00	5/24/2015	21:00:00	6.83	4,151
5/24/2015	22:15:00	5/25/2015	5:15:00	12.81	7,721
5/26/2015	13:15:00	5/27/2015	11:00:00	42.87	24,772
5/29/2015	3:45:00	5/30/2015	10:15:00	110.57	67,420
6/3/2015	12:45:00	6/4/2015	21:15:00	190.66	84,536
6/6/2015	22:30:00	6/8/2015	6:30:00	93.04	63,645
6/11/2015	6:00:00	6/12/2015	11:00:00	60.40	28,038
6/13/2015	10:00:00	6/13/2015	11:30:00	1.92	1,036
6/17/2015	13:30:00	6/18/2015	2:00:00	70.47	46,817
6/20/2015	6:00:00	6/20/2015	15:15:00	28.81	7,336
6/22/2015	7:45:00	6/22/2015	13:45:00	14.19	3,146
6/26/2015	17:00:00	6/26/2015	20:45:00	6.91	3,515
6/27/2015	23:45:00	7/3/2015	9:00:00	205.05	106,330
7/6/2015	0:00:00	7/12/2015	7:45:00	345.73	186,838
7/12/2015	22:00:00	7/15/2015	21:00:00	319.62	880,547
7/16/2015	16:00:00	7/16/2015	22:45:00	11.64	6,350
7/18/2015	0:45:00	7/20/2015	1:00:00	113.36	43,632
7/24/2015	5:15:00	7/24/2015	9:00:00	5.34	2,881
7/28/2015	6:45:00	7/28/2015	14:30:00	46.84	7,584
8/6/2015	12:00:00	8/6/2015	13:45:00	1.94	990
8/6/2015	22:45:00	8/6/2015	23:45:00	0.99	516
8/7/2015	1:15:00	8/7/2015	7:00:00	45.73	17,471
8/9/2015	14:15:00	8/9/2015	17:45:00	4.04	2,069
8/11/2015	16:00:00	8/11/2015	17:30:00	1.35	706
8/16/2015	20:15:00	8/17/2015	1:30:00	11.64	5,700

8/17/2015	19:00:00	8/17/2015	23:00:00	4.82	2,459
8/18/2015	12:00:00	8/19/2015	19:15:00	78.07	37,476
8/22/2015	20:45:00	8/23/2015	5:15:00	68.26	84,658
9/2/2015	3:15:00	9/2/2015	10:30:00	14.39	8,317
9/6/2015	6:30:00	9/6/2015	16:00:00	45.05	10,626
9/8/2015	4:30:00	9/8/2015	8:30:00	7.89	4,583
9/9/2015	20:15:00	9/10/2015	4:45:00	28.75	19,646
9/10/2015	6:00:00	9/10/2015	8:45:00	5.53	3,278
9/15/2015	20:30:00	9/15/2015	21:15:00	0.82	488
9/16/2015	22:00:00	9/16/2015	23:30:00	2.29	1,348
9/17/2015	5:15:00	9/19/2015	10:30:00	171.53	173,450
9/19/2015	11:10:00	9/19/2015	12:00:00	1.36	814
9/20/2015	18:30:00	9/20/2015	20:30:00	3.44	2,047
9/23/2015	13:50:00	9/23/2015	20:30:00	19.48	11,194
9/24/2015	1:45:00	9/24/2015	11:30:00	22.71	13,259
10/5/2015	21:15:00	10/5/2015	22:00:00	0.59	206
10/8/2015	3:45:00	10/8/2015	10:15:00	10.50	3,482
10/23/2015	8:00:00	10/23/2015	10:45:00	3.31	1,136
10/23/2015	12:15:00	10/23/2015	19:25:00	37.41	15,017
10/23/2015	22:30:00	10/24/2015	7:15:00	21.60	4,788
10/27/2015	20:15:00	10/29/2015	8:30:00	86.63	5,196
10/29/2015	9:15:00	10/29/2015	11:00:00	2.31	812
10/31/2015	3:00:00	10/31/2015	16:45:00	29.59	8,514
11/11/2015	15:15:00	11/15/2015	0:55:00	262.30	133,716
11/16/2015	9:30:00	11/16/2015	18:10:00	21.63	11,273
11/17/2015	3:40:00	11/20/2015	3:30:00	264.06	135,084
11/26/2015	12:00:00	11/26/2015	12:40:00	1.02	550
12/1/2015	3:45:00	12/1/2015	5:15:00	0.00	0
12/10/2015	12:30:00	12/10/2015	17:00:00	0.19	41
12/13/2015	4:55:00	12/13/2015	6:50:00	0.06	13
12/13/2015	8:45:00	12/13/2015	9:30:00	0.00	0
12/14/2015	6:15:00	12/14/2015	15:15:00	1.26	271
12/16/2015	5:00:00	12/16/2015	6:10:00	0.01	3
12/16/2015	11:30:00	12/16/2015	12:15:00	0.00	0
12/16/2015	16:45:00	12/16/2015	17:20:00	0.00	0
12/17/2015	14:45:00	12/17/2015	16:30:00	0.03	6
12/23/2015	8:00:00	12/23/2015	11:45:00	0.14	31
12/23/2015	12:15:00	12/23/2015	13:15:00	0.01	2
Total Annual Event Load (lbs)				**3,292.55**	**2,440,189**