2023 STORMWATER QUALITY AND QUANTITY MONITORING PROGRAM

CITY OF ST. PAUL

MARCH 22, 2024

Prepared for:
City of St. Paul
15 Kellogg Blvd West
St. Paul, MN 55102

WSB PROJECT NO. 022099

TABLE OF CONTENTS

1. Introduction 1
2. Procedures and Methodology 3
   2.1. Infiltration Rate 3
      2.1.1 Data Collection 3
      2.1.2 Data Analysis 4
   2.2. Flow & Volume Reduction 4
      2.2.1 Data Collection 4
      2.2.2 Data Analysis 5
   2.3. Water Quality 5
      2.3.1 Data Collection 6
      2.3.2 Data Analysis 7
   2.4. Maintenance Inspections 8
   2.5. Pervious Surface Infiltration Rate 8
      2.5.1 Data Collection 8
3. Precipitation Summary 9
4. Beacon Bluff 12
   4.1. Water Level and Infiltration Rate Monitoring 13
   4.2. Volume Reduction Monitoring 14
   4.3. Pollutant Removal Monitoring 15
   4.4. Maintenance Inspection 16
5. St. Albans Street 18
   5.1. Water Level and Infiltration Rate Monitoring 18
   5.2. Volume Reduction Monitoring 19
   5.3. Pollutant Removal Monitoring 20
   5.4. Maintenance Inspection 20
6. Hampden Park 22
   6.1. Water Level and Infiltration Rate Monitoring 23
   6.2. Volume Reduction Monitoring 23
   6.3. Pollutant Removal Monitoring 24
   6.4. Maintenance Inspection 25
7. Victoria Street 26
   7.1. Water Level and Infiltration Rate Monitoring 26
   7.2. Volume Reduction Monitoring 27
   7.3. Pollutant Removal Monitoring 27
   7.4. Maintenance Inspection 28
8. West Shepard Pond 29
   8.1. Volume Monitoring 29
   8.2. Pollutant Monitoring 30

9. Bush-Desoto Pond 31
9.1. Water Level Monitoring 31
9.2. Volume Monitoring 31
9.3. Pollutant Monitoring 31
10. River Level Monitoring 33
11. Pervious Surface Infiltration Assessment 34
11.1. Victoria Street 34
11.2. Jackson Street 35
12. City-wide Loading Assessment 39
12.1. 2023 Pollutant Loading Calculations 39
13. 2023 Summary 46
13.1. Underground Infiltration Systems/Outfall 46
13.2. Pervious Pavement 47
13.3. 2023 Recommendations 47
14. References 48

LIST OF FIGURES

1-1 2023 Monitoring Site Locations
4-1 Beacon Bluff Infiltration BMP Drainage Areas
5-1 St. Albans Street Infiltration BMP Drainage Areas
6-1 Hampden Park Infiltration BMP Drainage Area
7-1 Victoria Street Infiltration BMP Drainage Area
8-1 Shepard Ponds Drainage Area
9-1 Bush-Desoto Pond Drainage Area
10-1 Victoria Street Pervious Pavement Test Locations
10-2 Jackson Street Pervious Pavement Test Locations
10-3 Hamline Midway Library Pervious Pavement Test Locations

APPENDICES

A. Infiltration/Water Level Charts
A.1. Beacon Bluff Water Level and Rainfall
A.2. Beacon Bluff Groundwater and Infiltration System Level
A.3. Beacon Bluff Underground System Infiltration Rate (BMP Pipe)
A.4. Beacon Bluff Underground System Infiltration Rate Trends
A.5. St. Albans Water Level and Rainfall
A.6. St. Albans Infiltration Rate
A.7. St. Albans Infiltration Rate Trends
A.8. Hampden Park Water Level and Rainfall
A.9. Hampden Park Groundwater and Infiltration System Levels
A.10. Hampden Park – Infiltration Rate
A.11. Hampden Park – Infiltration Rate Trends
A.12. Victoria Water Level and Rainfall
A.13. Victoria Underground System Infiltration Rate (BMP Pipe)
A.14. Victoria Underground System Infiltration Rate Trends

B. Flow Rate Charts
B.1. Beacon Bluff Flow Rates and Rainfall
B.2. St. Albans Flow Rates and Rainfall
B.3. Hampden Park Flow Rates and Rainfall

B.4. Victoria Flow Rates and Rainfall
B.5. West Shepard Flow Rates and Rainfall
B.6. Bush-Desoto Pond Flow Rates and Rainfall

C. Water Quality Summary and Pollutant Load Calculations
C.1. Beacon Bluff Water Quality Summary
C.2. Beacon Bluff Volume and Pollutant Reduction Summary
C.3. Saint Albans Water Quality Summary
C.4. Saint Albans Volume and Pollutant Reduction Summary
C.5. Hampden Park Water Quality Summary
C.6. Hampden Park Volume and Pollutant Reduction Summary
C.7. Victoria Water Quality Summary
C.8. Victoria Volume and Pollutant Summary
C.9. West Shepard Water Quality Summary
C.10. West Shepard Volume and Pollutant Reduction Summary
C.11. Bush-Desoto Pond Water Quality Summary
C.12. Bush-Desoto Pond Volume and Pollutant Load Summary

D. Pervious Pavement Infiltration Charts
D.1. Victoria Street Infiltration Rate Trends Chart
D.2. Jackson Street Infiltration Rate Trends Chart

E. Photolog

F. 2023 Monitoring Protocols

G. ASTM C1701 Procedures

LIST OF ABBREVIATIONS

BMP	Best Management Practices
CCB	Capital City Bikeway
CRWD	Capital Region Watershed District
Cu-ft	Cubic feet
DP	Dissolved phosphorus
EMC	Event mean concentration
FT	Feet
FWA	Flow-weighted average
HDPE	High-density polyethylene
In/hr	Inches per hour
IR	In-rock
lbs	Pounds
mg/L	Milligrams per liter
MS4	Municipal Separate Storm Sewer System
MSWM	Minnesota Stormwater Manual
MPCA	Minnesota Pollution Control Agency
MPN	Most probable number
MnDOT	Minnesota Department of Transportation
NPDES	National Pollutant Discharge Elimination System
OCS	Outlet control structure
SP	Poorly graded sand
SPCD	Saint Paul City Datum
SRP	Soluble reactive phosphorus
TP	Total phosphorus
TSS	Total suspended solids

1. Introduction

The purpose of this report is to present the findings of the City of Saint Paul's (City) 2023 Stormwater Monitoring Program. The monitoring was conducted to fulfill requirements of the City's National Pollutant Discharge Elimination System (NPDES) MS4 Phase I Permit. The data was collected and analyzed and was used to quantify stormwater volumes and loads from the Municipal Separate Storm Sewer System (MS4) and also assist in the assessment of effectiveness of the City's Stormwater Management Program.

Since 2006, the City has been required by the Minnesota Pollution Control Agency (MPCA) to construct stormwater volume reduction Best Management Practices (BMPs) concurrent with City projects that generate or reconstruct impervious surfaces. The MPCA requirements stipulate that these BMPs must provide volume reduction for the runoff from a one-inch rainfall event over the impervious surfaces of the project. In 2015, the watershed updated their standard to require that the BMP provide volume reduction for the runoff from a 1.1-inch rainfall event over the impervious surface of the project. The City has typically achieved this by constructing infiltration BMPs.

The focus of the City's stormwater monitoring program has been to monitor the effectiveness and maintenance needs of stormwater BMPs. Outfall monitoring data, collected by Capitol Region Watershed District (CRWD), is used to evaluate pollutant loading from major sub-watersheds and to estimate City-wide pollutant loading from the MS4.

Four BMPs and two drainage areas monitored via storm pipe were monitored in 2023 to quantify progress toward meeting the City's stormwater management goals and to refine current design and maintenance practices. Rainfall was also measured at four locations in the City. The 2023 monitoring sites are shown in **Figure 1-1** and listed in **Table 1-1**. This effort focused on evaluating four major parameters during the monitoring period:

- Water level/infiltration rate
- Volume reduction
- Pollutant capture
- BMP maintenance

To evaluate these parameters, electronic monitoring equipment was used to continuously measure system water levels, inflow/outflow volumes, and rainfall amounts. In addition, visual inspections and measurements of sediment accumulation were conducted periodically for each system to assess maintenance needs.

Three of the monitored BMPs are pervious pavement sites, evaluated for infiltration performance. Long-term monitoring at these sites is completed to research the benefits, feasibility, and sustainability of pervious surface parking lanes, alleyways, and bike trails in the City.

This report describes the procedures and methods used to collect water quality and quantity data, provides background information for each site monitored, and presents the results of the monitoring that was completed.

Table 1-1: 2023 City of Saint Paul Monitoring Site Summary

BMP/Site Name	BMP/Site Type	Monitored Parameters[1]
Beacon Bluff	Underground Infiltration Gallery & Rain Garden	WL, Q, WQ, GW
St. Albans Street	Underground Infiltration Gallery	WL, Q, WQ
Hampden Park	Underground Infiltration Gallery	WL, Q, WQ, GW
Victoria Street	Pervious Pavers & Underground Infiltration Gallery	WL, Q, WQ, Infiltration
West Shepard Pond	Storm Pipe/Stormwater Pond	WL, Q, WQ
Bush-Desoto Street	Storm Pipe/Stormwater Pond	Q, WQ, GW
Jackson Street Pervious Bike Path	Pervious Asphalt	Infiltration
Hamline Midway Library Pervious Alleyway	Pervious Asphalt	Infiltration
Wilder Recreation Center	Rainfall Monitoring Location	R
Fire Station 18	Rainfall Monitoring Location	R
Harriet Island Park	Rainfall Monitoring Location	R
Hampden Park Co-op	Rainfall Monitoring Location	R

1 **WL- Water Level, Q – Flow Rate, WQ – Water Quality, GW – Groundwater, R – Rainfall**

2. Procedures and Methodology

This section outlines the procedures and methods followed to perform monitoring and data analysis. For more detailed information related to equipment use monitoring protocols that were followed for this monitoring program, see the 2023 Stormwater Monitoring Protocols document located in **Appendix F**.

2.1. Infiltration Rate

The infiltration rate was measured at applicable locations by collecting water level data on a continual basis. The data was then analyzed to estimate the average infiltration rates observed during the monitoring period. The following provides a detailed description of how this was completed. The water level data collected at those sites was reviewed to determine level fluctuation over the monitoring period and to compare against normal and high-water elevations.

2.1.1 Data Collection

Water levels were monitored using electronic level loggers. The loggers were configured at each site to log data at a minimum of one reading per hour for groundwater and once every 15 minutes for BMPs.

Enclosures for the infiltration gallery level loggers were installed at Beacon Bluff, St. Albans Street, and Hampden Park. These consisted of three-inch-diameter PVC pipes with four rows of half-inch-diameter holes drilled along the pipe achieving approximately twenty holes per foot. The enclosures were then wrapped with a highly permeable geotextile fabric and secured with zip ties to protect the instrument from fine sediment accumulation. Enclosures were secured to the system floor and to the access riser wall (**Photo 2-1**). Groundwater and rain garden locations were monitored from permanent monitoring wells (**Photo 2-2**).

Photo 2-1:
Infiltration Gallery Level Monitoring Enclosure

Photo 2-2:
Beacon Bluff Rain Garden and In-Rock Wells

2.1.2 Data Analysis

The data collected at each site reflected hydrograph-type curves resulting from the rise and fall of water within the systems during and after significant rainfall events. The data was analyzed in Microsoft Excel to develop stage/infiltration rate relationships for each system. Since the infiltration rates increase exponentially at higher depths in the systems, this relationship was developed by calculating the infiltration rate at each half foot height increment. These calculations also accounted for the volume of runoff entering the system while drawdown was occurring. Infiltration of water in the horizontal direction through the vertical surfaces of the trenches was not included in this analysis, as the policies of the watershed districts only recognize infiltration through the bottom horizontal surface. The infiltration rates calculated at each increment were averaged and plotted on a graph.

The following equation was used to perform these calculations at each half foot increment:

$$\boldsymbol{Infiltration\ Rate}\left(\frac{\boldsymbol{in}}{\boldsymbol{hr}}\right) = \frac{\mathbf{0.5}\ \boldsymbol{ft} + \frac{\mathbf{V_{in}}}{\mathbf{WHSA}}}{\boldsymbol{\Delta t}}$$

where:

V_{in} = Inflow Volume (cu-ft)
WHSA = Wetted Horizontal Surface Area (sq-ft)
Δt = Time it takes for water level to drop by 0.5 ft

Monitored Infiltration rates were evaluated against design infiltration rates and infiltration rates observed during pre-construction field testing.

2.2. Flow & Volume Reduction

Stormwater runoff volume was measured at Beacon Bluff, Victoria Street, St. Albans Street, Hampden Park, Desoto Ave, and West Shepard Pond using continuous flow monitoring equipment. At BMP Sites, the data was utilized to determine the total volume of water draining to and captured by each system. Collected data was analyzed using Flowlink software and Microsoft Excel to quantify the volumes measured during each discrete rainfall event recorded during the monitoring periods. The following section provides brief descriptions of the methods and procedures used to quantify flow at each system.

2.2.1 Data Collection

Teledyne ISCO 2150 area velocity flow modules and sensors were used to monitor runoff volumes. These devices measure water level and flow velocity. Combining this information with a known conduit shape, the flow rate, and flow volume through the conduit were calculated. Each of the monitored systems received stormwater runoff from a diversion structure located along the storm sewer system. The 2150 flow sensors were positioned at the upstream and downstream pipes in these structures to measure the total volume draining to each BMP and the total volume that bypassed each BMP. **Photos 2-3** and **2-4** show the flow meters installation in West Shepard Pond and Victoria Street, respectively.

The flow modules were configured at each site to log data at one-minute intervals once the water level in the upstream pipe was greater than one-inch above the pipe invert to increase the resolution of the flow data.

Photo 2-3: Flow Monitoring Module Install Process

Photo 2-4: Flow Monitoring Equipment Install

2.2.2 Data Analysis

Flow data was regularly imported into Flowlink 5.1 for storage and analysis. Data was analyzed and validated using built-in velocity error checking parameters. The flow level and velocity data were converted to total flow volumes and exported to a Microsoft Excel spreadsheet for further analysis. Each rainfall event and associated inflow and outflow volumes were tabulated.

For the Beacon Bluff, Saint Albans Street, and Hampden Park BMPs, runoff volume was estimated for un-monitored system inlets by taking the monitored flow data and multiplying by the ratio of the respective drainage areas.

2.3. Water Quality

Water quality was monitored at the Beacon Bluff BMP, Victoria Street BMP, West Shepard, Hampden Park, Desoto Street, and St. Albans Street. The following section provides a summary of the methods and procedures used to collect and test water quality samples and analyze the data.

2.3.1 Data Collection

Photo 2-5:
Job Box Housing ISCO 6712 Sampler

Photo 2-6:
ISCO Bottle Configuration

ISCO 6712 automatic samplers were installed at all water quality locations. (**Photos 2-5** and **2-6**).

The automatic samplers were configured to collect 250 mL samples at constant volume intervals. The flow pacing intervals were initially estimated for each site to provide a minimum of six samples during a quarter-inch storm, but less than 120 samples for the three-inch storm. Flow pacing was refined during the monitoring period to achieve this objective.

Samples from sufficiently sized rainfall events were submitted to the Metropolitan Council Environmental Services (MCES) Laboratory for analysis. The samples were composited using a batch mixing technique to create one sample for the event. All water quality monitoring site composite samples were analyzed for the parameters listed in **Table 2-1** as volumes allowed, in accordance with the City's NPDES Permit. Grab samples were also collected during select storm events and analyzed for *E. Coli* and grease. The most probable number (MPN) procedure was used to determine the concentration of *E. Coli* in the stormwater runoff.

Table 2-1: Water Quality Parameters

Monitoring Parameters			
Parameters	**Method**	**Sample Type**	**Frequency**
Oil and Grease	SM 5210B	Grab	Quarterly
Chloride, Total	SM4500	Composite	10/year
Copper, Total (as Cu)	EPA 200.7	Composite	10/year
E. coli	MPN	Grab	Quarterly
Flow	NA	Measurement	NA
Hardness, Carbonate (as CaCo3)	SM 2340B	Composite	10/year
Lead, Total (as Pb)	EPA 200.7	Composite	10/year
Nitrite Plus Nitrate, Total (asN)	SM4500/NO3F	Composite	10/year
Nitrogen, Ammonia, Un-ionized (as N)	EPA 350.1	Composite	10/year
Nitrogen, Kjeldahl, Total	EPA 351.2	Composite	10/year
pH	EPA 9045D	Grab	Quarterly
Phosphate, total Dissolved or Ortho	EPA 365.1	Composite	10/year
Phosphorus, Total as P	EPA 365.1	Composite	10/year
Precipitation	NA	Measurement	1 x Day
Solids, Total Dissolved (TDS)	SM2540 C-97	Composite	10/year
Solids, Total Suspended (TSS)	ASTM D3977-97	Composite	10/year
Chemical Oxygen Demand (COD)	EPA 9056A	Composite	10/year
Organic Dissolved Carbon	EPA 9060A	Composite	10/year
Volatile Suspended Solids (VSS)	EPA 160.4	Composite	10/year
Zinc, Total (as Zn)	EPA 200.7	Composite	10/year

2.3.2 Data Analysis

The event mean concentrations (EMCs) derived from sampling events were multiplied by the corresponding volume measurements taken at each site for every rainfall event sampled. For storm events with no sampling data, a flow weighted EMC concentration from that site's entire monitoring period was used. This information was tabulated and summed to determine the total amount of pollutants generated in the contributing drainage areas and the number of pollutants captured by the BMP, at applicable sites.

2.4. Maintenance Inspections

BMP inspections were conducted at Beacon Bluff, St. Albans Street, Hampden Park, and Victoria Street sites periodically during the monitoring period. Pre-treatment structures were inspected for accumulated sediment depth and floatable debris. Underground chambers were inspected from the level monitoring location for accumulation of sediment, debris, and standing water. Inspection photos are included in the photo log (**Appendix E**).

2.5. Pervious Surface Infiltration Rate

The infiltration rate of the permeable surfaces was measured at the Victoria Street, Hamline Midway Library, and Jackson Street pervious pavement sites following the protocols outlined in ASTM method C1701 (**Appendix G**). The following section provides a summary of those methods.

2.5.1 Data Collection

Infiltration tests were conducted according to the modified ASTM C1701 methods for measuring infiltration rates (**Photo 2-7**). Five locations at Victoria Street, eighteen locations at Jackson Street, and nine locations at Hamline Midway Library were evaluated to develop an average infiltration rate measurement for each site. Tests were taken at locations that remained consistent year to year and included a combination of high and low traffic areas. At each test location, a pre-wet test was conducted, followed by two infiltration tests. The two infiltration tests were averaged to generate the infiltration rate for each location. If after 15 minutes of monitoring during a pre-wet test no infiltration was observed, the test was concluded, and no subsequent tests were completed.

Photo 2-7: Permeable Pavement Infiltration Test

3. Precipitation Summary

As part of the City's stormwater monitoring program, seasonal precipitation monitoring is conducted at the following locations: Saint Paul Fire House 18, Wilder Recreation Center, Hampden Park Co-op and a pumphouse near the center of Harriet Island Park (**Figure 1-1**). The precipitation data collected at these locations provides localized rainfall totals which are utilized for calculating rainfall intensity and runoff yield at monitored BMP sites. Each station is equipped with an automated tipping bucket that records continuously throughout the season.

Precipitation data collected by MCES, Minnesota Climatology Working Group (MCWG), and the National Weather Service (NWS) is used to supplement the City's data as needed. This includes any data gaps in seasonally monitored stations as well as parameters, such as snowfall and snowpack depth, which exceed the limitations of the City's monitoring equipment. These stations also provide a longer period of record which is valuable for analyzing rainfall trends.

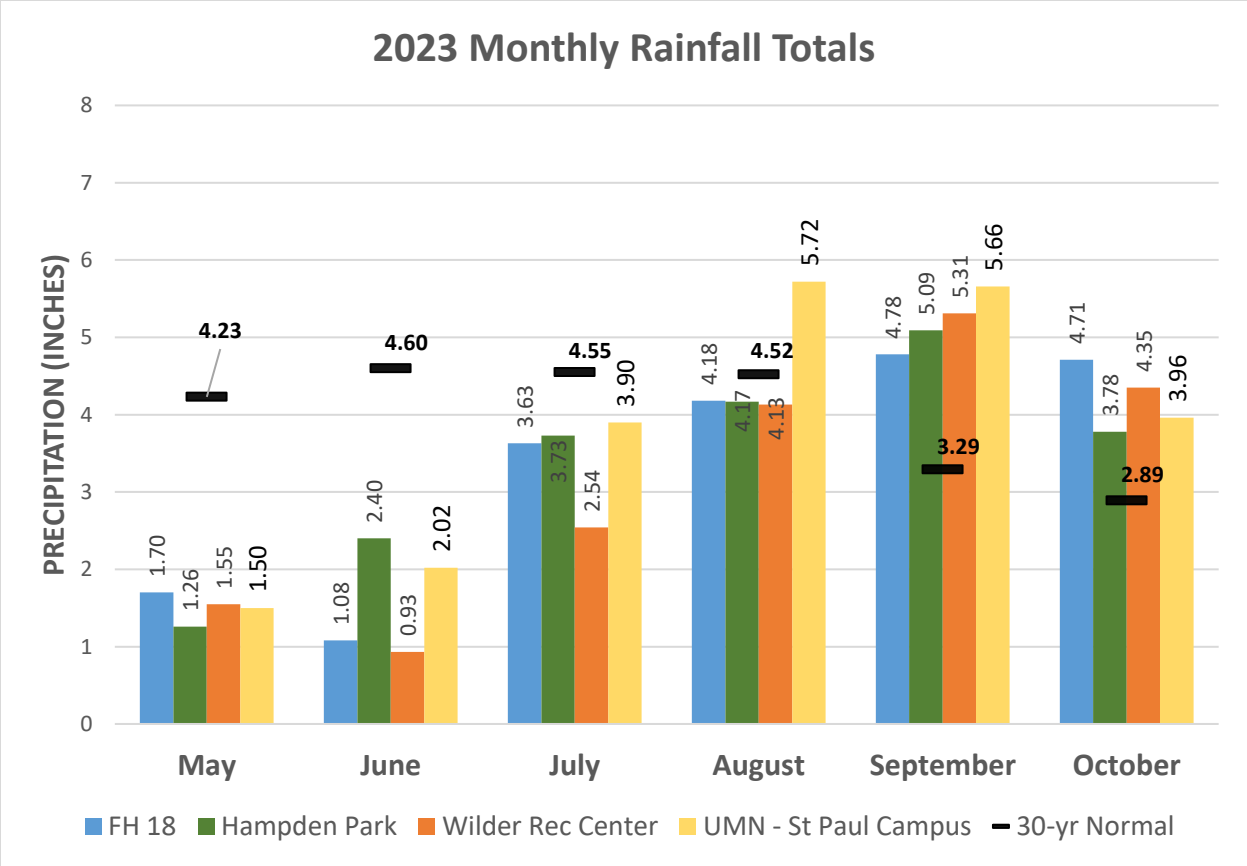
Table 3-1 and **Chart 3-1** show 2023 monthly precipitation totals for seasonally monitored sites compared to the 30-year normal. The 30-year normal reflect data collected from 1991-2020 by the U of MN St. Paul station.

May through October rainfall ranged from 18.18 inches at the Wilder Recreation Center to 20.43 inches at Hampden Park Co-op. The City-wide seasonal total average was 19.77 inches which is 4.31 inches less than the 30-year normal. The greatest variability between stations was observed during the month of July with 1.09 inches more rainfall recorded at the FH18 than the Wilder Rec Cener. The month of June saw the greatest departure from the 30-year normal (-2.99 inches).
3

Table 3-1: 2023 Seasonal Precipitation Summary

Month	FH 18	Hampden Park Co-op	Wilder Rec Center	City-Wide Average	30-yr Normal	Departure from 30-yr Normal
May	1.70	1.26	1.55	1.56	4.23	-2.67
June	1.08	2.40	0.93	1.61	4.60	-2.99
July	3.63	3.73	2.54	3.45	4.55	-1.10
August	4.18	4.17	4.13	4.55	4.52	+0.03
September	4.78	5.09	5.31	5.21	3.29	+1.92
October	4.71	3.78	4.35	4.20	2.89	+1.31
Seasonal Total	**20.08**	**20.43**	**18.81**	**19.77**	**24.08**	**-4.31**

Chart 3-1



Major rainfall events from 2023 are provided in **Table 3-2** below:

Table 3-2: 2023 Significant Rainfall Events

Date	Duration (hr)	Rainfall Total (in)[1]	Intensity (in/hr)	Event Category (precipitation frequency estimate)
6/24/23 – 6/25/23	3.88	1.27	0.33	1-year
7/26/23	6.00	1.41	0.24	1-year
8/3/23	0.68	0.80	1.17	2-year
9/23/23 – 9/24/23	10.25	1.42	0.14	1-year
10/12/23 – 10/13/23	10.53	2.34	0.22	2-year

1 - Rainfall event totals may not reflect total daily rainfall.

Table 3-3 below provides a five-year monthly precipitation summary as recorded at the University of Minnesota Saint Paul Campus. This was the first time since 2019 annual precipitation has exceeded the 30-year normal, although the months of May through June were below normal. Total precipitation in 2023 was 34.90 inches, 2.17 inches above normal. August had the greatest amount of precipitation at 5.72 inches, which was above the 30-year normal by 1.20 inches. May varied the greatest and had 1.50 inches of precipitation which was 2.73 inches below the 30-year normal.

Table 3-3: 5-year Precipitation Summary (UMN – Saint Paul Campus)

Month	2016	2017	2018	2019	2020	2021	2022	2023	30-yr Normal
January	0.28	0.93	1.07	0.36	0.81	0.62	0.54	1.78	0.68
February	0.79	0.70	1.24	2.31	0.53	0.41	0.48	2.19	0.75
March	2.15	0.58	1.38	2.09	2.76	2.94	3.19	1.84	1.61
April	3.66	3.68	2.37	3.37	1.67	2.46	3.57	3.84	3.02
May	2.05	6.54	3.52	6.44	4.43	3.36	4.89	1.50	4.23
June	3.65	3.16	4.64	2.85	4.15	1.57	0.80	2.02	4.60
July	5.97	2.45	4.07	4.75	2.20	1.57	1.37	3.90	4.55
August	9.90	8.89	2.91	6.88	3.70	6.56	4.58	5.72	4.52
September	5.19	1.25	7.19	4.88	1.05	1.82	0.29	5.66	3.29
October	3.32	4.84	3.4	4.93	2.25	2.29	0.24	3.96	2.89
November	2.70	0.42	1.41	1.67	1.37	0.97	2.04	0.09	1.53
December	2.01	0.62	1.32	2.42	0.88	1.94	1.80	2.40	1.06
Total	**41.67**	**34.06**	**34.52**	**42.95**	**25.80**	**26.51**	**23.79**	**34.90**	**32.73**
Departure from 30-yr Normal	**+8.94**	**+1.33**	**+1.79**	**+10.22**	**-6.93**	**-6.22**	**-8.94**	**+2.17**	**N/A**

4. Beacon Bluff

This system, shown in **Figure 4-1**, is owned and operated by the City. The Saint Paul Port Authority contributed financially to the project and oversaw its construction. Volume reduction credits were split between the City and the Saint Paul Port Authority based on the respective financial contribution. Performance monitoring of the system has been conducted since 2012 and rainfall monitoring for the site is conducted at Wilder Recreation Center, located 0.4 miles to the west. The BMP system details are provided in **Table 4-1**.

The system is comprised of three connected stormwater treatment structures, which include a stormwater pond west of the Duchess Street cul-de-sac (west pond), an infiltration basin east of the cul-de-sac (rain garden) (**Photo 4-1**), and an underground infiltration chamber (**Photo 4-2**) constructed directly beneath the rain garden. The underground chamber consists of three parallel, 215-foot-long, ten-foot-diameter perforated metal pipes for infiltration.

The Beacon Bluff system has a total drainage area of 143.6 acres, which consists of three subwatersheds. Stormwater from a 136.8-acre drainage area is routed to a diversion structure in the storm sewer along Duchess Street (MH7). The diverted stormwater passes through a manhole equipped with a SAFL Baffle pre-treatment system for particle settling, and then discharges to the rain garden. Two inlets on the eastern side of the rain garden discharge stormwater from a 4.7-acre drainage area immediately surrounding the BMP. Stormwater from a 2.1-acre drainage area discharges to the west pond, which outlets directly to the underground chamber.

Overflow grates within the rain garden allow stormwater to spill from the rain garden, directly into the underground chamber. When the underground chamber reaches capacity, stormwater discharges from the underground system, through an outlet control structure, back to the main storm sewer line.

Table 4-1: Beacon Bluff BMP Details

Total Drainage Area to BMP	143.6 acres
Sub-watershed to Diversion Structure (discharge to rain garden)	*136.8 acres*
Sub-watershed to Eastern Inlet Pipes (discharge to rain garden)	*4.7 acres*
Sub-watershed to West Pond (discharge from west pond to underground chamber)	*2.1 acres*
Year Constructed	2011
Total Construction Cost	$980,000
Storage Volume	159,350 cu-ft
Volume Reduction Credit Received by the City of Saint Paul	116,435 cu-ft
Volume Reduction Credit Received by Saint Paul Port Authority	42,925 cu-ft

Photo 4-1: Underground Infiltration Chamber (Facing West)

Photo 4-2: Rain Garden Located above Infiltration Chambers (Facing East)

4.1. Water Level and Infiltration Rate Monitoring

Water level was monitored by a logger placed directly in the BMP Pipe. The water level in the rain garden was not measured in 2023 due to piezometer damage following a dredge in the Spring of 2019. An additional logger was installed within the outlet control structure of the system to confirm when flow was being conveyed back to the storm sewer from the underground chamber. Groundwater elevation was also measured in two locations at the site. Water level elevations within the system and groundwater, and daily rainfall totals are presented on **Chart A.1** and **A.2** of **Appendix A**.

Photo 4-3: Water being conveyed back to the storm sewer from the underground chamber in the outlet control structure.

Overflow in the outlet control structure to the storm sewer, (**Photo 4-3**), occurred during eight treatment events. The 2023 underground chamber infiltration rate and infiltration rate trends are provided on **Charts A.3** and **A.4** of **Appendix A**, respectively. The 2023 average infiltration rate for the BMP Pipe was 0.11 inches per hour (in/hr). This is an increase from the rates observed in 2022 (0.06 in/hr) and 2021 (0.09 in/hr) (**Table 4-2**). Sediment accumulation has been observed ranging from 0.7 ft, across the basin. The 141.5-acre drainage area discharging directly to the pond conveys a significant amount of sediment and debris, which has accumulated primarily around the diversion inlet pipe. Dredge maintenance was completed on the rain garden over the Spring of 2019.

Table 4-2: Beacon Bluff Infiltration Rates

Location	Average Infiltration Rate (in/hr)											
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Beacon Bluff Rain Garden (IR-31)	2.9	0.85	0.70	0.29	0.43	0.50	0.40	NA	NA	NA	NA	NA
Beacon Bluff Underground System (IR-32)	2.55	0.57	0.64	0.30	0.15	0.11	0.12	0.12	0.12	0.09	0.06	0.11

The water level in the underground system ranged from 7.6 ft to 18.3 ft deep. Depths greater than 10 feet indicate the water is rising into the substrate above the 10-ft diameter corrugated metal infiltration pipes. The data indicates that the system did not drain to empty during the 2023 monitoring period, including over the winter months. The underground system discharged back to the storm sewer (system outflow) during 8 storm events in 2023. Discharge events occurred in 2015 (five), 2016 (nine), 2017 (ten) 2018 (fourteen), 2019 (fifteen), 2020 (seven), 2021 (nine), and 2022 (6). Groundwater elevations at the site were a minimum of 11 ft below the bottom of the underground chamber, which suggests that groundwater mounding is not the cause of standing water in the system.

The 2023 underground chamber infiltration rate trends are provided on **Chart A.4** of **Appendix A**. From 2012 to 2023, the infiltration rate has decreased from 2.55 in/hr to 0.11 in/hr, with the largest decline following the first year of monitoring in 2012. As mentioned above, standing water in the underground system has resulted in a decrease in infiltration rates.

4.2. Volume Reduction Monitoring

Stormwater flowing into the BMP was measured in the Duchess Street diversion structure and at the outlet of the west pond, which discharges directly to the underground chamber. Volume that bypassed the system was measured with a flow meter downstream of the Duchess Street diversion structure. Inflow volume from the inlets discharging into the eastern side of the rain garden was modeled using the Duchess upstream flow data and the ratio of drainage areas. Level logger data from within outlet control structure was used to identify when the underground system was at capacity, and to estimate the volume being conveyed back to the storm sewer system from the BMP. Flow rates and daily rainfall are depicted on **Chart B.1** of **Appendix B**. An event-based volume reduction summary is provided with the pollutant loading data in **Table C.2** of **Appendix C**. A summary of the 2023 Beacon Bluff Volume Reduction is included in **Table 4-3** below.

In 2023, total runoff to the Beacon Bluff system was 1,161,699 cubic feet (cu-ft). Of that volume, 475,290 cu-ft was captured by the system, resulting in a 41% volume reduction. The total flow conveyed back to the storm sewer via the rain garden's outlet control structure was 329,551 cu-ft. For the 136.8-acre drainage area to the diversion structure, the total water yield was 8,492 cu-ft/acre which is equivalent to 2.34 inches of runoff as a result of 16.37 inches of rain (14%). The greatest volume captured by the BMP was 90,105 cu-ft on October 12th, 2023. This volume represents 57% of the total storage capacity of the system.

Table 4-3: Beacon Bluff Volume Reduction

Monitoring Period	5/18/23 – 10/27/23		
Total Rainfall		16.37	in.
Diversion Structure Water Balance			
Runoff Volume:		1,094,200	cu-ft
Runoff Yield:		2.26	in/acre
Bypassed Volume:		356,858	cu-ft
Volume Diverted into BMP:		737,342	cu-ft
Beacon Bluff Rain Garden and Infiltration Gallery Inputs			
Inflow Volume from Diversion Structure:	SubWSHD A	737,342	cu-ft
Inflow Volume from West Pond:	SubWSHD B	15,233	cu-ft
Inflow Volume from Eastern Inlets:	SubWSHD C	52,266	cu-ft
System Discharge (conveyed back to storm sewer from OCS):		329,551	cu-ft
Beacon Bluff System Performance			
Total Runoff Volume:		1,161,699	cu-ft
Total Runoff Volume Captured:		475,290	cu-ft
Percent of Total Runoff Volume Captured:		41	%
Maximum Percentage of Storage: Volume Utilized [1]		57	%

[1] This is the maximum volume infiltrated by the BMP for a treatment event as a percentage of the total storage volume. The system exceeded 100% capacity on several occasions, but only a portion of the total capacity was available for infiltration due to standing water in the BMP.

4.3. Pollutant Removal Monitoring

A water quality sampler was placed in the Duchess Street diversion structure to collect samples during runoff events. The sampler was paced to collect samples at equal volume intervals to provide a representative sampling of each storm event. Samples for each event were tested as a composite to provide EMC during each event for each parameter analyzed. Grab samples were collected in the diversions structure near the automated sampler quarterly and tested for *E. Coli*. See **Charts C.1** and **C.2** of **Appendix C** for the complete water quality summary and pollutant loading calculations.

Table 4-4 below provides a load reduction summary for the loading parameters defined in NPDES Permit issued to the City in addition to ortho-phosphate. During the monitoring period, 3,029 pounds of TSS and 21.53 pounds of TP were captured by the system. Over the past 10 years of monitoring, 113,519 pounds of TSS and 507 pounds of TP have been captured at the Beacon Bluff Site.

Table 4-4: Beacon Bluff Load/Capture Summary

Monitoring Period		5/18/23 – 10/27/23		
Total Rain		16.37		
Water Quality Parameter	**Flow Weighted Average (mg/L)**	**Total Pollutant Load (lbs)**	**Load Captured (lbs)**	**Percent Reduction %**
Total Suspended Solids	102.7	7,388	3,029	41
Volatile Suspended Solids	64.5	4,712	1,932	41
Total Dissolved Solids	116.7	8554	3,507	41
Total Phosphorus	0.72	52.51	21.53	41
Ortho-phosphate	0.276	20.090	8.036	40
Chloride	6.2	450.7	184.8	41
Total Kjeldahl Nitrogen	3.48	254.88	104.5	41
Nitrate + Nitrite as N	0.42	31.0	12.4	40

4.4. Maintenance Inspection

Visual inspections of the pretreatment structure, rain garden, and underground system were completed during site visits to determine performance and maintenance needs. As shown in **Table 4-5**, sediment depths in the pretreatment device were approximately 0.4 ft to 2.2 ft throughout the 2023 season. Floatables and trash were observed in the pretreatment structure during all visits and within the rain garden.

Standing water was observed in the underground system on all visits, as discussed in **Section 4.1**. The last chamber inspection was completed in November 2014 when the system was mostly empty. At that time, roughly 0.25 ft of sediment was observed within the grooves of the corrugated pipe, along the bottom. See **Appendix E** for photos of the BMP inspections.

Table 4-5: Beacon Bluff Maintenance Inspections

Date	Sediment Depth in Pre-treatment (ft)	Sediment Depth in Infiltration Gallery (ft)[1]	Standing Water in Infiltration Gallery?	Observations
4/26/23	2.0	NM	Yes	Heavy sedimentation
5/23/23	2.2	NM	Yes	Lots of bottles
6/23/23	2.2	NM	Yes	Stagnant water in pre-treatment
7/27/23 – Pretreatment Cleaned				
8/17/23	0.4	NM	Yes	Dense vegetation in rain garden
11/7/23	0.4	NM	Yes	SAFL baffle bent

[1] Not Measured – Sediment levels could not be evaluated in the infiltration galley due to the depth of standing water and the total depth of the system.

5. St. Albans Street

This system, shown in **Figure 5-1**, was constructed in 2010 to provide volume reduction along the Central Corridor light rail transit way. Volume and flow have been monitored at the site since 2012, with water quality monitored from 2014 through 2023.

A manhole structure positioned along the main storm sewer under Aurora Avenue diverts stormwater into the underground infiltration system (**Photo 5-1**) via a 30-inch elliptical pipe. The system is also connected to the University Avenue storm sewer system. Any runoff that does not get treated by infiltration trenches and tree planters along University Avenue is directed to this system (**Photo 5-1**). When the system reaches its storage capacity, water flows west through the existing storm sewer system. The system includes a pretreatment structure comprised of a grit chamber and baffled weir to provide settling for sediment and skimming. Rainfall monitoring for the site is conducted on the roof of Fire Station 18, located across the street from the BMP. The BMP system details are provided in **Table 5-1**.

Table 5-1: St. Albans Street BMP Details

Total Drainage Area to BMP	25.2 acres
Year Constructed	2010
Total Construction Cost	$381,903
Storage Volume	31,189 cu-ft
Volume Reduction Credit Received by the City of Saint Paul	31,189 cu-ft

Photo 5-1: St. Albans 48” Perforated HDPE Installation

5.1. Water Level and Infiltration Rate Monitoring

BMP water level was monitored in the access manhole at the northwest corner of the system. The 2023 water elevations and daily rainfall is provided on **Chart A.5** of **Appendix A**. Water level monitoring indicated that the infiltration gallery reached 100% capacity two times in 2023. The infiltration gallery drew down to empty in less than a 24 hour period after the conclusion of each rain event.

Infiltration rates are presented on **Chart A.6** of **Appendix A**. In 2023, the average infiltration rate of the BMP pipe was 11.7 in/hr (**Table 5-2**), which is below the design infiltration rate of 26.0 in/hr. Infiltration rate trends for the St. Albans Street BMP pipe are depicted on **Chart A.7**.

Table 5-2: St. Albans Infiltration Rate

Location	Average Infiltration Rate (in/hr)											
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
St. Albans Street BMP Pipe	38.3	35.7	64.8	55.3	36.2	20.6	21.2	11.0	9.9	11.8	14.0	11.7

5.2. Volume Reduction Monitoring

Two flow meters were installed in the storm sewer diversion manhole located in the intersection of St. Albans Street and Aurora Avenue. One meter was installed in the elliptical pipe to capture flows into the system from the south, and the other was installed in the downstream pipe to measure flows bypassing the system to the west. The difference in volume recorded by the two meters is assumed to be diverted into, and infiltrated by, the BMP. Flow entering the system from the 30-inch pipe at the corner of St. Albans Street and University Avenue was modeled using previous years. Flow rates and daily rainfall are depicted on **Chart B.2** of **Appendix B**.

In 2023, total runoff for the St. Albans Street system was 333,162 cu-ft. Of that volume, 307,821 cu-ft was captured and infiltrated by the system, resulting in a volume reduction of 92.4% (**Table 5-3**). Only 6 storm events caused water to bypass the BMP system, and 4 of those bypass events were under 500 cf of water. The total water yield for the 25.2-acre drainage area is 13,221 cu-ft/acre which is equivalent to 3.6 inches of runoff resulting from 18.92 inches of rain (19%). The greatest volume infiltrated by the BMP was 36,172 cu-ft as a result of a 1.87 inch rain event, which represents 116% of the total storage capacity of the system. Storm-specific rainfall and volume reduction data is provided on **Chart C.4** of **Appendix C**.

Table 5-3: St. Albans Street Volume Reduction

Monitoring Period	5/5/23 – 10/26/23	
Total Rainfall	18.92	in
	System Water Balance	
Aurora Runoff Volume:	199,500	cu-ft
Aurora Bypassed Volume:	25,341	cu-ft
St. Albans and University Volume	133,661	cu-ft
	St. Albans System Performance	
Total Runoff Volume	333,162	cu-ft
Runoff Yield	3.6	in/acre
Total Runoff Volume Captured	307,821	cu-ft
Percent of Runoff Volume Captured:	92.4	%
Maximum Volume Discharge to BMP	36,172	cu-ft
Maximum Percentage of Storage Volume Utilized[1]	116	%

[1] This is the maximum volume infiltrated by the BMP for a treatment event as a percentage of the total storage volume.

5.3. Pollutant Removal Monitoring

A water quality sampler was placed in the diversion structure at the intersection of St. Albans and Aurora Ave. to collect samples during runoff events. The sampler was paced to collect samples at equal volume intervals to provide a representative sampling of each storm event. Samples for each event were tested as a composite to provide EMC during each event for each parameter analyzed. Grab samples were collected in the diversions structure near the automated sampler quarterly and tested for *E. Coli*. See **Charts C.3** and **C.4** of **Appendix C** for the complete water quality summary and pollutant loading calculations.

Table 5-4 below provides a load reduction summary for the loading parameters defined in NPDES Permit issued to the City in addition to ortho-phosphate. During the monitoring period, 2,487 pounds of TSS and 7.20 pounds of TP were captured by the system.

Table 5-4: St. Albans Load/Capture Summary

Monitoring Period		5/5/23 – 10/26/23		
Total Rain		18.92		
Water Quality Parameter	**Flow Weighted Average (mg/L)**	**Total Pollutant Load (lbs)**	**Load Captured (lbs)**	**Percent Reduction %**
Total Suspended Solids	124.5	2,487	2,213	89
Volatile Suspended Solids	119.3	1,075	935	87
Total Dissolved Solids	51.7	2,335	2,171	93
Total Phosphorus	0.35	7.20	6.70	93
Ortho-phosphate	0.045	1.002	0.992	99
Chloride	5.5	118.9	93.9	79
Total Kjeldahl Nitrogen	1.97	80.3	68.3	85
Nitrate + Nitrite as N	0.30	7.1	6.1	86

5.4. Maintenance Inspection

The pretreatment device and the underground infiltration system were inspected during site visits to evaluate maintenance needs of the BMP. As shown in **Table 5-5**, minimal sediment was observed in both the pretreatment device and the infiltration gallery. Garbage was observed in the pretreatment and infiltration gallery. Water level monitoring in the infiltration gallery confirms that the system is regularly drawing down to empty, which is consistent with no standing water observed during most BMP inspection visits. See **Appendix E** for the **Photolog**.

Table 5-5: St. Albans Maintenance Inspections

Date	Sediment Depth in Pre-treatment (ft)	Sediment Depth in Infiltration Gallery (ft)	Standing Water in Infiltration Gallery?	Observations
5/23/23	0.1	0.1	No	Trash in pre-treatment
6/15/23	0.1	0.1	No	Trash and odor in pre-treatment
6/21/23 – System Cleaned				
7/17/23	0.1	0.1	No	Some trash
8/17/23	0.1	0.1	No	Some trash
11/7/23	02	0.1	No	Some trash

6. Hampden Park

The Hampden Park infiltration gallery, shown in **Figure 6-1,** was constructed in 2014. The system consists of eight parallel perforated pipes that are 5 ft in diameter, and range in length from 40 to 100 ft. Runoff is routed to the system via a 24-inch RCP from the storm sewer line near Hampden and Raymond Avenues. Prior to entering the infiltration gallery, stormwater passes through a Vortechs pre-treatment chamber for particle settling. The infiltration gallery receives flow from a second inlet location along Hampden Avenue, farther to the north. When the system reaches full capacity, stormwater is routed back to the storm sewer via a 24-inch pipe from the southeast side of the system. Rainfall monitoring is conducted on top of the Hampden Park Co-Op across the street from the park. Monitoring has been conducted at the site since 2014. The BMP system details are provided in **Table 6-1** below.

Photo 6-1: Hampden Park BMP Construction

Table 6-1 Hampden Park BMP Details

Total Drainage Area to BMP	7.8 acres
Year Constructed	2014
Total Construction Cost	$687,132
Total Storage Volume	31,808 cu-ft
Volume Reduction Credit Received by the City of Saint Paul – Public Works	24,908 cu-ft
Volume Reduction Credit Received by the City of Saint Paul – Parks and Recreation	6,900 cu-ft

6.1. Water Level and Infiltration Rate Monitoring

Water levels were monitored within the underground infiltration system and groundwater (P2), using electronic water level loggers. Water levels and daily rainfall for 2023 are provided on **Chart A.8** and **A.9** of **Appendix A**. Water level within the BMP, ranged from 0 to 3.8 ft. The BMP water level must exceed 6.5 ft for the system to reach capacity and for water to be conveyed back to the sewer system. Based on the 2023 level data, no flow discharged back to the sewer system. In 2023, infiltration rates increased again for the first time since 2020.

The 2023 infiltration rates are presented on **Chart A.10** of **Appendix A** and are adjusted for incremental volume flow. The adjusted average infiltration rate for the BMP was 13.60 in/hr, which is above the design infiltration rate of 1.8 in/hr. Infiltration rates at the base of site during construction were calculated to be, on average, 60 in/hr using a Double Ring Infiltrometer (DRI). Infiltration rate trends are depicted on **Chart A.11**. Water level data shows that all 2023 events were infiltrated within 8 hours of a treatment event.

Table 6-2: Hampden Park Infiltration Rate

Location	Average Infiltration Rate (in/hr)							
	2016	2017	2018	2019	2020	2021	2022	2023
Hampden Park BMP	14.38	8.30	11.19	11.57	41.09	21.27	10.93	13.60

6.2. Volume Reduction Monitoring

One flow meter was installed within the 24-inch RCP diverting flow from the storm sewer to the BMP from the intersection of Hampden and Raymond Avenues. The metered drainage area consists of 6.7 acres of the total 7.8-acre drainage area to the BMP. The 2023 flow rates and daily rainfall are depicted on **Chart B.3** of **Appendix B**. No discharge was observed at the system outlet therefore that data is not plotted.

In 2023, the total monitored runoff was 255,025 cu-ft. Since monitored level within the BMP did not reach the discharge outlet, 100% of the runoff was infiltrated by the system (**Table 6-3**). The total water yield for the 7.8-acre drainage area is 32,696 cu-ft/acre which is equivalent to 9.01 inches of runoff as a result of 20.05 inches of rain (45%). The greatest volume received by the BMP was 26,012 cu-ft as a result of a 1.46-inch rain event on August 11th, 2023. This volume represents 82% of the total storage capacity of the system. Storm-specific rainfall and volume reduction data is provided on **Chart C.6** of **Appendix C**.

Table 6-3: Hampden Park Volume Reduction

Monitoring Period	5/6/23 – 10/26/23	
Total Rainfall	20.05	in
	Hampden Park Water Balance	
Raymond/Hampden Runoff Volume[1]	255,025	cu-ft
System Bypass Volume	0	cu-ft
	Hampden Park System Performance	
Total Runoff Volume	255,025	cu-ft
Runoff Yield	9.01	in/acre
Total Runoff Volume Captured	255,025	cu-ft
Percent of Runoff Volume Captured	100	%
Maximum Event Volume Captured by BMP	26,012	cu-ft
Maximum Percentage of Storage Volume Utilized[2]	82	%

[1] – The second system inlet along Hampden Avenue is not monitored, and the volume discharged to the system from that location is estimated based on monitored data at Hampden/Raymond and the ratio of the drainage areas.

[2] - This is the maximum volume infiltrated by the BMP for a treatment event as a percentage of the total storage volume.

6.3. Pollutant Removal Monitoring

A water quality sampler was placed at the intersection of Hampden and Raymond Avenues to collect samples during runoff events. The sampler was paced to collect samples at equal volume intervals to provide a representative sampling of each storm event. Samples for each event were tested as a composite to provide EMC during each event for each parameter analyzed. Grab samples were collected in the 24 in RCP near the automated sampler quarterly and tested for *E. Coli*. See **Charts C.5** and **C.6** of **Appendix C** for the complete water quality summary and pollutant loading calculations.

Table 6-4 below provides a load reduction summary for the loading parameters defined in NPDES Permit issued to the City in addition to ortho-phosphate. During the monitoring period, 3,520 pounds of TSS and 5.19 pounds of TP were captured by the system. The percentage captured for all parameters were 100% in 2023.

Table 6-4: Hampden Park/Capture Summary

Monitoring Period		5/6/23 – 10/26/23		
Total Rain (in)		20.05		
Water Quality Parameter	**Flow Weighted Average (mg/L)**	**Total Pollutant Load (lbs)**	**Load Captured (lbs)**	**Percent Reduction %**
Total Suspended Solids	278.8	3,520	3,520	100
Volatile Suspended Solids	83.5	1,019	1,019	100
Total Dissolved Solids	41.0	352	352	100
Total Phosphorus	0.33	5.19	5.19	100
Ortho-phosphate	0.039	0.63	0.63	100
Chloride	5.7	90.7	90.7	100
Total Kjeldahl Nitrogen	2.17	34.6	34.6	100
Nitrate + Nitrite as N	0.36	5.7	5.7	100

6.4. Maintenance Inspection

Sediment depths in the pretreatment structure and in the underground infiltration system were measured during site visits to determine performance and maintenance needs. As shown in **Table 6-5**, minimal sediment was observed in both the pretreatment device and infiltration gallery after maintenance was completed on May 23, 2023.

Table 6-5: Hampden Park BMP Maintenance Inspection

Date	Sediment Depth in Pre-treatment (ft)	Sediment Depth in Infiltration Gallery (ft)	Standing water in Infiltration Gallery?	Observations
5/23/23	1.0	0.3	No	Some trash
6/5/23 – System Cleaned				
6/15/23	0.3	0.3	No	Sheen on water
7/17/23	0.3	0.4	No	Strong odor and sludge in pre-treatment chamber
8/17/23	0.3	0.4	No	Sludge later in pre-treatment
11/7/23	0.6	0.4	No	Leaf mat in pre-treatment chamber

7. Victoria Street

Victoria Street monitoring site is located just East of Orchard Recreation Center and includes a permeable paver parking lane. Stormwater runoff within the 19.1 acre subwatershed is diverted from the main storm sewer to the underground system. When the system has reached its storage capacity, runoff continues to flow downstream through the storm sewer. The system includes a pretreatment structure. consisting of a grit chamber for sediment capture and a baffled weir for skimming. In addition, the runoff from Victoria Street flows to the permeable paver parking lane, passes through a layer of stone aggregate below the pavers and is collected by a drain tile pipe. The drain tile discharges the runoff into the underground infiltration system. Rainfall monitoring is conducted on top of Fire Station 18. The BMP system details are provided in **Table 7-1** below.

Table 7-1 Victoria Street BMP Details

Total Drainage Area to BMP	19.1 acres
Year Constructed	2010
Total Construction Cost	$174,000
Total Storage Volume	16,714 cu-ft
Volume Reduction Credit Received by the City of Saint Paul – Public Works	16,714 cu-ft

This system consists of one 384-foot-long, 60-inch-diameter perforated HDPE pipe located below a permeable paver parking lane. It was constructed to meet the volume reduction requirements for the Front/Victoria Residential Street Vitality Program (RSVP) project.

7.1. Water Level and Infiltration Rate Monitoring

In 2023, water levels were monitored continuously in the access manhole at the north end of the underground system along Victoria Street. Water levels were monitored within the underground infiltration using an electronic water level logger. Water levels and daily rainfall for 2023 are provided on **Chart A.12** of **Appendix A**. Water level within the BMP ranged from 0 to 5.7ft. The BMP water level must exceed 5 ft for the system to reach capacity and for water to flow to the sewer system. Based on the 2023 level data, the system reached capacity four times.

The 2023 infiltration rates are presented on **Chart A.13** of **Appendix A** and are adjusted for incremental volume flow. The adjusted average infiltration rate for the BMP was 42.34 in/hr, which is greater than the design infiltration rate of 12.8 in/hr. Infiltration rates at the base of the system during construction were calculated to be, on average, 95.9 in/hr using a Double Ring Infiltrometer (DRI). Infiltration rate trends are depicted on **Chart A.14**. Water level data shows that all 2023 events were infiltrated within 4 hours of a treatment event.

Table 7-2: Victoria Street Infiltration Rate

Location	Average Infiltration Rate (in/hr)						
	2012	2013	2019	2020	2021	2022	2023
Victoria Street BMP	46.56	48.04	21.08	48.80	25.52	45.07	42.34

7.2. Volume Reduction Monitoring

One flow meter was installed upstream of the system and one flow meter downstream of the diversion structure located near the intersection of Victoria Street and Orchard Avenue. The metered drainage area consists of 19.1 acres and drains to the BMP. The 2023 flow rates and daily rainfall are depicted on **Chart B.4** of **Appendix B**.

In 2023, the total run off to the Victoria Street system was 297,776 cu-ft. The system captured 88.4% of that volume (**Table 7-3**). The total water yield for the 19.1-acre drainage area is 15,590 cu-ft/acre which is equivalent to 4.29 inches of runoff as a result of 17.65 inches of rain (24%). The greatest volume infiltrated by the BMP was 38,954 cu-ft from a 2.38-inch rain event on October 13, 2023. This volume represents 233% of the total storage capacity of the system. Storm-specific rainfall and volume reduction data is provided on **Chart C.8** of **Appendix C**.

Table 7-3: Victoria Street Volume Reduction

Monitoring Period	4/28/23 – 10/16/23	
Total Rainfall	17.65	in
	Victoria Street Water Balance	
Runoff Volume	297,776	
System Bypass Volume	34,395	
	Victoria Street System Performance	
Total Runoff Volume	297,776	cu-ft
Runoff Yield	4.29	in/acre
Total Runoff Volume Captured	263,381	cu-ft
Percent of Runoff Volume Captured	88.4	%
Maximum Event Volume Captured by BMP	38,954	cu-ft
Maximum Percentage of Storage Volume Utilized[1]	233	%

[1] This is the maximum volume infiltrated by the BMP for a treatment event as a percentage of the total storage volume.

7.3. Pollutant Removal Monitoring

A water quality sampler was placed in the diversion structure to collect samples during runoff events. The sampler was paced to collect samples at equal volume intervals to provide a representative sampling of each storm event. Samples for each event were tested as a composite to provide EMC's for each event for each parameter analyzed. Grab samples were also collected in the diversion manhole near the automated sampler quarterly and tested for *E. Coli*. See **Charts C.7** and **C.8** of **Appendix C** for the complete water quality summary and pollutant loading calculations.

Table 7-4 below provides a load reduction summary for the loading parameters defined in NPDES Permit issued to the City in addition to ortho-phosphate. During the monitoring period, 3,903 pounds of TSS and 6.7 pounds of TP were captured by the system. The percentage captured for all parameters was above 87% in 2023.

Table 7-4: Victoria Street Load/Capture Summary

Monitoring Period		4/28/23 – 10/16/23		
Total Rainfall		17.65		
Water Quality Parameter	**Flow Weighted Average (mg/L)**	**Total Pollutant Load (lbs)**	**Load Captured (lbs)**	**Percent Reduction %**
Total Suspended Solids	189.7	3527	3,093	87
Volatile Suspended Solids	138.3	1,837	1,642	89
Total Dissolved Solids	62.3	788	710	90
Total Phosphorus	0.40	7.5	6.7	88
Ortho-phosphate	0.113	2.097	1.921	91
Chloride	5.8	107.5	95.6	88
Total Kjeldahl Nitrogen	1.99	36.99	32.73	88
Nitrate + Nitrite as N	0.322	5.98	5.33	89

7.4. Maintenance Inspection

Sediment depths in the pretreatment structure and in the underground infiltration system were measured during site visits to determine performance and maintenance needs. As shown in **Table 7-5**, minimal sediment was observed in both the pretreatment device and infiltration gallery.

Table 7-5: Victoria Street BMP Maintenance Inspection

Date	Sediment Depth in Pre-treatment (ft)	Sediment Depth in Infiltration Gallery (ft)	Standing water in Infiltration Gallery?	Observations
5/23/23	0.5	1.0	No	Mat on surface of water in pre-treatment chamber
6/26/23	0.4	1.0	No	Vegetation mat in pre-treatment chamber
7/10/23 – System Cleaned				
7/25/23	0.1	+1.0	No	Odor in pre-treatment chamber
8/17/23	0.4	+1.0	No	Raccoon in BMP pipe
11/7/23	0.5	+1.0	No	Deep sediment in BMP pipe

8. West Shepard Pond

The Shepard Road Pond monitoring location is the median of Shepard Road, just under the Smith Avenue Bridge. Monitoring here provides water quality and quantity data of water flowing from the east and west along Shepard Road. Monitoring at this site was initiated in 2023.

Photo 8-1: West Shepard Pond

8.1. Volume Monitoring

A job box housing a flow meter was placed in the median of Shepard Road near the east bound lane. A flow sensor was placed in the southwest inlet and routed underground to the job box. The 2023 flow rates and daily rainfall are depicted on **Chart B.5** of **Appendix B**.

During the 2023 monitoring period, the total volume flowing to the West Shepard Pond system was 105,164 cu-ft, of which 47,085 was infiltrated by the pond. A summary of the system can be found below (**Table 8-1.2**). The total water yield for the 8.70-acre drainage area is 12,087 cu-ft/acre. This is a water yield 3.3 inches (35%). The greatest monitored event-based volume moving through the system was 21,594 cu-ft as a result of a 0.44-inch rain event on June 10th, 2023. Due to vandalism or an animal chewing the area/velocity sensor cable, no data is available past mid-September.

Table 8-2: West Shepard Volume Summary

Monitoring Period	5/18/23 – 9/12/23	
Total Rainfall	9.25	in
West Shepard Pond Water Balance		
Runoff Volume	105,164	cu-ft
System Bypass Volume	58,079	cu-ft
West Shepard Pond System Performance		
Total Runoff Volume	105,164	cu-ft
Runoff Yield	7.63	in/acre
Total Runoff Volume Captured	47,085	cu-ft
Percent of Runoff Volume Captured	44.8	%
Maximum Event Volume Captured by BMP	11,666	cu-ft

8.2. Pollutant Monitoring

A water quality sampler was placed in the job box to collect samples during high flow/rain events. The sampler was paced to collect samples at equal volume intervals to provide a representative sampling of each storm event. Samples for each event were tested as a composite to provide EMC's for each event for each parameter analyzed. Grab samples were also collected in the stream, near the automated sampler and tested for *E. Coli*. See **Charts C.9** and **C.10** of **Appendix C** for the complete water quality summary and pollutant loading calculations.

Table 8.1-3 below provides a load summary for flow weighted averages of pollutants entering the city defined in NPDES Permit issued to the City in addition to ortho-phosphate.

Table 8-3: West Shepard Pond Pollutant Load Summary

Monitoring Period		5/18/23 – 9/12/23		
Total Rainfall		8.89		
Water Quality Parameter	**Flow Weighted Average (mg/L)**	**Total Pollutant Load (lbs)**	**Load Captured (lbs)**	**Percent Reduction %**
Total Suspended Solids	156.1	1,378	671	48.7
Volatile Suspended Solids	41.7	368	132	35.9
Total Dissolved Solids	49.3	536	171	31.9
Total Phosphorus	0.15	1.47	0.52	35.3
Ortho-phosphate	0.018	0.186	0.057	30.7
Chloride	10.1	94.4	38.7	41.0
Total Kjeldahl Nitrogen	0.85	8.32	2.88	34.6
Nitrate + Nitrite as N	0.31	3.091	0.989	32.0

9. Bush-Desoto Pond

The Bush-Desoto Pond is an infiltration basin in the southern end of the Payne-Phalen Neighborhood. The stormwater inlet is on the east side and receives water from Bush Avenue. The outlet on the west side connects excess water back to the main storm sewer line. Some channelization between the outlet and the inlet has been noted. A possible retrofit of the pond could occur as early as 2023. This would enlarge the bottom of the pond and a treatment value of 85,000 credits. The pond location is provided in **Figure 9-1**.

9.1. Water Level Monitoring

Water level was monitored by a logger placed directly in piezometer TB-2. Due to warping of the PVC pipe inside the piezometer, the water level logger was unable to be retrieved to provide any data.

9.2. Volume Monitoring

One flow meter was installed inside of the 54-inch RCP pipe upstream of the infiltration basin. The metered drainage area consists of 27.1 acres of. The 2023 flow rates and daily rainfall are depicted on **Chart B.6** of **Appendix B**.

During the 2023 monitoring period, the total event volume moving through the system was 360,890 cu-ft (**Table 9-2**). The total water yield for the 19.1-acre drainage area is 18,894 cu-ft/acre. The greatest event-based volume moving through the system was 79,178 cu-ft as a result of a 1.39-inch rain event on August 11 and 12, 2023.

Table 9-2: Bush-Desoto Pond Volume Summary

Monitoring Period	5/18/23 – 10/31/23	
Total Rainfall	10.5 in	
	Bush-Desoto Pond Water Balance	
Total Volume	360,890	cu-ft
Maximum Event Volume	79,178	cu-ft

9.3. Pollutant Monitoring

A water quality sampler was placed inside of the 54-inch RCP pipe upstream of the pond near the flow meter to collect samples during high flow/rain events. The sampler was paced to collect samples at equal volume intervals to provide a representative sampling of each storm event. Samples for each event were tested as a composite to provide EMC's for each event for each parameter analyzed. Grab samples were also collected in the stream, near the automated sampler and tested for *E. Coli*. See **Charts C.12** and **C.13** of **Appendix C** for the complete water quality summary and pollutant loading calculations.

Table 9-3 below provides a pollutant load summary for the loading parameters defined in NPDES Permit issued to the City in addition to ortho-phosphate. During the monitoring period 7,923 pounds of TSS and 13.3 pounds of TP passed through the monitored area during storm events.

Table 9-3: Bush-Desoto Pond Pollutant Load Summary

Monitoring Period		5/11/22 – 11/9/22
Total Rainfall		13.11
Water Quality Parameter	**Flow Weighted Average (mg/L)**	**Total Pollutant Load (lbs)**
Total Suspended Solids	315.7	7923
Volatile Suspended Solids	85.4	1925
Total Dissolved Solids	85.4	1924
Total Phosphorus	0.75	13.13
Ortho-phosphate	0.036	0.813
Chloride	8.7	195.3
Total Kjeldahl Nitrogen	2.71	60.96
Nitrate + Nitrite as N	0.35	7.87

10. River Level Monitoring

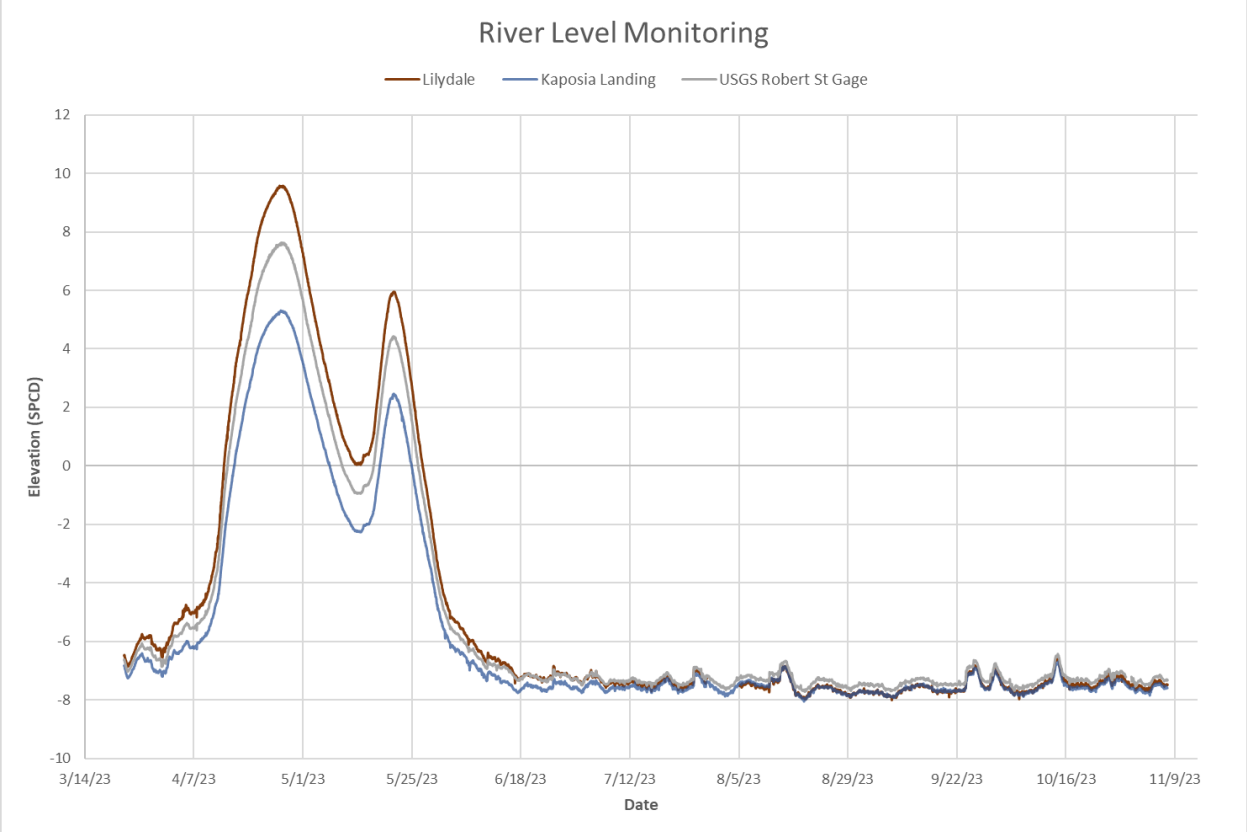
To determine elevations of the Mississippi River in relation to the United States Geological Survey (USGS) monitoring station at the Robert Street Bridge, two water level loggers were installed within the Mississippi River. One located near an outfall at Kaposia Landing and the other at the overflow of Pickerel Lake at Lilydale. A correlation between the three sites is difficult and seems to change based on the river height. The overall average river elevation at Lilydale was 0.24 feet above the USGS monitoring station and the elevation at Kaposia Landing was 0.37 feet below the USGS monitoring station. The greatest difference between sites occurred during the spring when the river level was the highest. During the summer months Lilydale and the USGS station were almost identical and could show a very flat portion of the river between the two monitoring sites.

Table 10-1 depicts the difference between river monitoring locations as well as their approximate river mile location. **Chart 10-1** shows an estimation of river level based off of the monitored water level measurements and compared to the continuous USGS monitoring station near Robert Street Bridge.

Table 10-1

	Lilydale	USGS	Kaposia Landing
Approximate River Mile	841.5	839.25	835.4
Mile Difference from USGS	Upstream 2.25 miles		Downstream 3.85 miles
Difference from USGS	0.24 ft		-0.37 ft

Chart 10-1



11. Pervious Surface Infiltration Assessment

The City has been monitoring the performance of pervious pavement BMPs constructed in the City since 2012. Pervious pavement is constructed with substantial void space to allow for infiltration or filtration of stormwater through the pavement surface as a means of stormwater management. Pervious pavement BMPs monitored in the City include porous asphalt and permeable interlocking concrete pavers. The purpose of the infiltration testing is to monitor the change in site conditions and infiltration capability of the BMPs overtime. Pavement maintenance is also monitored to study the effect of routine and rehabilitative maintenance on these BMPs.

Infiltration testing was completed at the Jackson Street Pervious Bike Path BMP and the Victoria Street pervious pavement BMP in August 2023 and November 2023. Testing was also completed at the Hamline Midway Library pervious pavement in August 2023. This section presents the results of the 2023 infiltration testing. The Infiltration testing methodologies are described in **Section 2.5.** A photolog of infiltration testing is provided in **Appendix E**.

11.1. Victoria Street

The Victoria Street pervious surface consists of a parking area completed with permeable concrete pavers designed to receive stormwater runoff from Victoria Street and the properties adjacent to it. The pavers themselves are non-permeable and they are separated with aggregate fill (**Photo 11-1** and **11-2**). The spaces between the pavers allow stormwater runoff to infiltrate into the parking surface instead of running off and being collected by the storm sewer system. The pavers were installed in 2011 and infiltration rates have been monitored annually since 2012. The site and the infiltration test locations are provided on **Figure 11-1**.

Photo 11-1: Victoria Street Pavers

Photo 11-2: Victoria Street Infiltration Testing

<u>Infiltration Test Results and Observations</u>

Five locations were tested for infiltration at the Victoria Street site. In 2015, the exact test locations from 2014 could not be located, so new locations were established in the immediate area and identified as A-E (these locations were used since 2016). Those locations are depicted on **Figure 10-1** and the results of the testing are presented in **Table 11-1** and **Chart D.1** in **Appendix D**.

A summary of the infiltration test results throughout the years are provided below.

Table 11-1: Victoria Street Infiltration Rate Summary

Infiltration Ring Location	2012 Infil Rate (in/hr)	2013 Infil Rate (in/hr)	2014 Infil Rate (in/hr)	2015 Infil Rate (in/hr)	2016 Infil Rate (in/hr)	2017 Infil Rate (in/hr)	2018 Infil Rate (in/hr)	2019 Infil Rate (in/hr)	2020 Infilt Rate (in/hr)	2021 Infilt Rate (in/hr)	2022 Infil Rate (in/hr)	2023 Infil Rate (in/hr)
IR-1	168.6	18.1	0.00	E 15.1	E 17.8	E 3.41	E 14.5	E 15.9	E 4.9	E 15.6	E 14.8	0.0
IR-2	266.6	75.7	12.9	A 0.0	A 19.4	A 3.8	A 11.5	A 4.1	A 4.7	A 8.8	A 7.0	9.7
IR-3	271.1	92.2	18.6	B 3.4	B 23.0	B 10.1	B 16.9	B 4.4	B 9.4	B 10.1	B 5.3	0.0
IR-4	69.1	24.0	9.7	C 0.0	C 6.6	C 28.9	C 6.3	C 4.0	C 3.7	C 0.0	C 9.5	5.4
IR-5	149.8	49.2	30.8	D 0.0	D 0.0	D 0.0	D 1.9	D 4.2	D 6.6	D 15.0	D 3.6	0.0
Average	**185.04**	**51.84**	**14.40**	**3.71**	**13.33**	**9.23**	**10.21**	**6.51**	**5.84**	**9.91**	**8.04**	**3.02**

- In 2023 (3.02 in/hr) compared to 2022 (8.04 in/hr) and 2021 (9.91 in/hr).
- The 2023 infiltration rates were, on average, less than 5 percent of 2012 (185.04 in/hr) infiltration rates.
- Infiltration rates have dropped to 0 in/hr at three of five locations.
- Location 2 had increased from 7.0 to 9.7 in/hr in 2023.

Photo 11-3: Location D Pre-Test

Photo 11-4: Location D Infiltration Test

11.2. Jackson Street

The Jackson Street BMP (**Photo 11-5** and **11-6**) is a designated bike path constructed of pervious asphalt. It is a section of the Capital City Bikeway (CCB), a system of off-street bicycle trails in downtown Saint Paul. The BMP is eight blocks long, stretching from Kellogg Street to 11th Street, and

consists of 2,750 square yards of pervious asphalt. Stormwater runoff filters through the asphalt and underlying media and is then conveyed to the storm sewer system via drain tile.

Monitoring locations JS-1 through JS-11 were established in November 2016 upon completion of the four-block stretch from Kellogg Boulevard to 7th Place East. Monitoring locations JS-12 through JS-18 were established in November 2017 upon completion of the four-block stretch from 7th Place East to 11th street. The monitoring locations were carefully selected to evaluate sediment loading and asphalt compaction from varying levels of pedestrian and vehicular traffic. Each site was characterized into one of three groups, identified in **Table 11-2**, based on their location and surroundings. The site and infiltration test locations are depicted on **Figure 11-2**. Site photos are provided in **Appendix E**.

Table 11-2: Monitoring Site Traffic Characterization

Site Traffic Characterization
Low: No driving and minimal foot traffic area. Adjacent to planter or minimal impervious surface.
Medium: Pedestrian cross walks or adjacent to large areas of impervious surface.
High: Driveways for parking or businesses, heavy vehicular traffic.

Photo 11-5: Capital City Bikeway (CCB) – Jackson Street/Kellogg Avenue

Photo 11-6: Jackson Street Infiltration Test

Infiltration Test Results and Observations

The site was tested for infiltration in August 2023. The infiltration test results from the 18 locations are summarized in **Chart 11-1** and **Chart D.2** in **Appendix D**, which includes all infiltration test results completed to-date. **Table 11-3** is color coded to identify the site traffic characterizations described above. The infiltration tests results are also summarized in **Table 11-3**, which presents an average infiltration rate based on the monitoring location traffic characterization. The infiltration test locations are depicted on **Figure 11-2**.

Chart 11-1: Jackson Street Infiltration Rate Summary (in/hr)

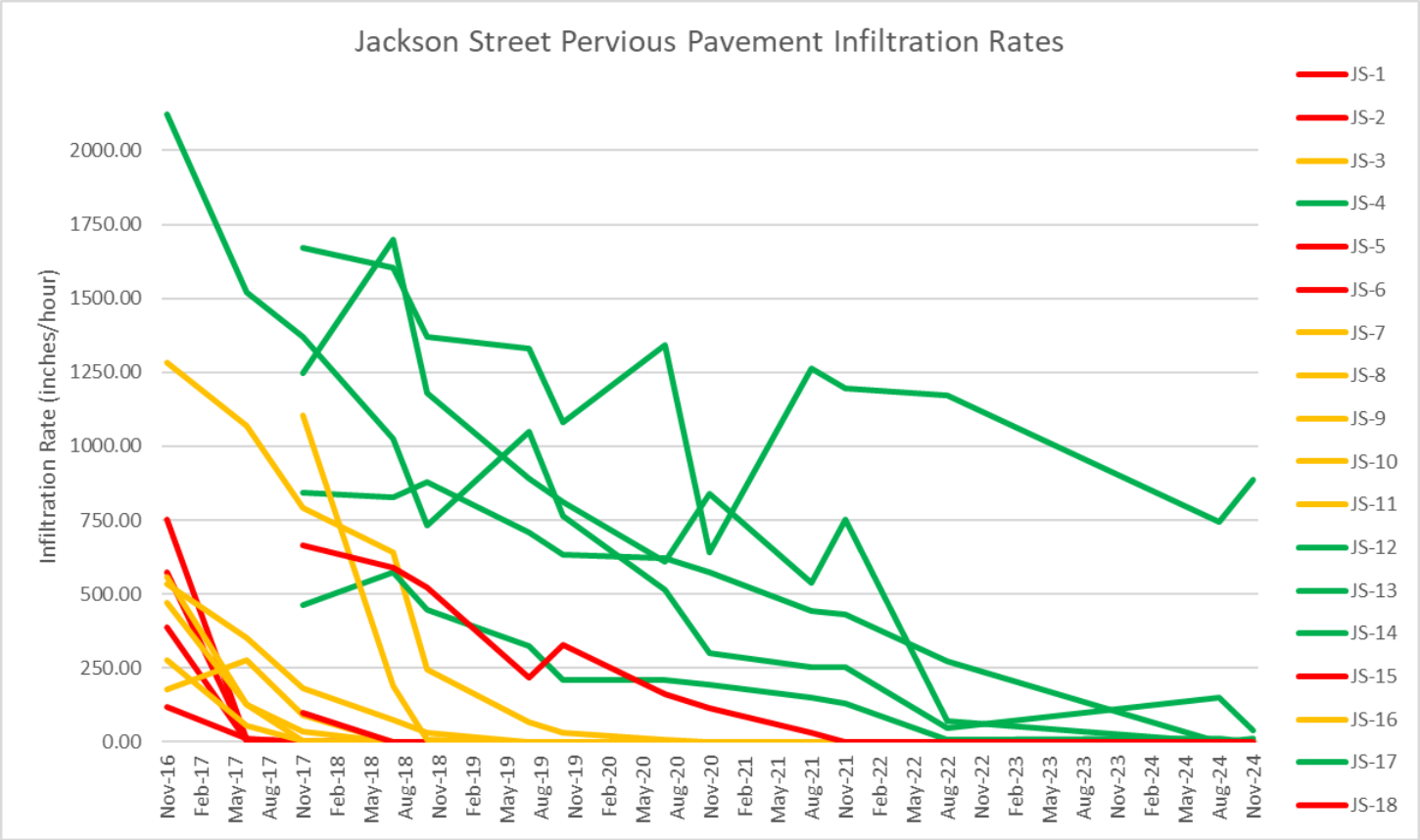


Table 11-3: Jackson Street Infiltration Summary by Site Traffic Characterization

Site Traffic Characterization	Nov 2016	Jun 2017	Nov 2017	Jul 2018	Oct 2018	Jul 2019	Oct 2019	Jul 2020	Nov 2020	Aug 2021	Nov 2021	Aug 2022	Aug 2023	Nov 2023
Low: No driving and minimal foot traffic area. Adjacent to planter or minimal impervious surface.	2122	1520	1119	1146	921	861	700	659	509	529	552	314	180.9	187.9
Medium: Pedestrian cross walks or adjacent to large areas of impervious surface.	550	334	360	187	101	35	45	21	14	4	0	0	0	0
High: Driveways for parking or businesses, heavy vehicular traffic.	457	8	21	0	0	0	0	0	0	0	0	0	0	0

A summary of the 2023 infiltration testing completed at the Jackson Street Pervious Pavement Site is provided below:

- The overall site infiltration rate was 50.3 inches per hour (in/hr) in August 2023 and 52.2 in November 2023.
  - 15 of 18 locations showed no infiltration during the August and November testing.
  - Of the remaining three locations where infiltration occurred, infiltrations rates ranged from 10.4 in/hr to 888.6 in/hr.

- Low traffic areas had an average infiltration rate of 180.9 in/hr in August 2023 and 187.9 in November 2023.
  - The average infiltration rate in August 2023 was 9% of the infiltration rate observed in November 2016 at low traffic locations.
- Medium traffic areas had an average infiltration rate of 0.0 in/hr in 2023.
  - Locations JS-7 through JS-11 are within the first constructed section of the pervious pavement near the Jackson Street and Kellogg Boulevard intersection. These locations have not shown any infiltration since October 2018.
- High traffic areas had an infiltration rate of 0.0 in/hr in 2023.
  - High traffic locations have not shown any infiltration since November 2017.

Photo 11-7: Test Locations JS-1 and JS-2 (high traffic)

12. City-wide Loading Assessment

12.1. 2023 Pollutant Loading Calculations

Monitoring of major outfalls within the City of Saint Paul was completed by the Capitol Region Watershed District (CRWD) in 2023. Annual and seasonal pollutant loads were estimated for each subwatershed within the City for the loading parameters identified in the City's MS4 permit which include chloride (Cl), total kjeldahl nitrogen (TKN), total phosphorus (TP), nitrate plus nitrite (NO3 +NO2), total suspended solids (TSS), and volatile suspended solids (VSS). The subwatersheds within the City are included in **Table 12-1** below.

Monitoring data collected by CRWD from the following subwatersheds was utilized for this assessment: East Kittsondale, St. Anthony Park, Trout Brook, and Phalen Creek. Monitoring of each subwatershed was completed at or near the outfall. The stations were configured to collect continuous flow measurements, and water quality, in accordance with the City's MS4 Permit.

Table 12-1 Watershed Inventory

Watershed	Area [acre]	Runoff Coefficient [.]	Rainfall Station
Battle Creek	1106	0.54	Wilder
Beaver Lake	192	0.33	Wilder
Belt Line	3014	0.55	Wilder
Crosby	1679	0.45	Hampden Park Co-op
Davern	1302	0.55	Hampden Park Co-op
Downtown	550	0.75	Engine House 18
East Kittsondale	1872	0.62	Engine House 18
Fish Creek	46	0.52	Wilder
Goodrich/Western	424	0.63	Engine House 18
Griffith/Pt. Douglas	460	0.61	Wilder
Hidden Falls	313	0.55	Hampden Park Co-op
Highwood	1123	0.50	Wilder
Lake Como	1294	0.47	Hampden Park Co-op
Lake Phalen	1013	0.42	Wilder
Mississippi River Blvd.	2391	0.58	Hampden Park Co-op
MRWMO	135	0.70	Hampden Park Co-op
Phalen Creek	1405	0.62	Wilder
Pigs Eye	3001	0.40	Wilder
Riverview	1017	0.57	Wilder
St. Anthony Hill	2651	0.64	Engine House 18
St. Anthony Park	2481	0.68	Hampden Park Co-op
Trout Brook	3963	0.62	Wilder
Urban	327	0.57	Wilder
West Kittsondale	1042	0.67	Hampden Park Co-op
West Seventh	451	0.60	Fire House 18

Monitored Subwatershed

Annual and seasonal city-wide flow-weighted averages were calculated for each of the loading pollutants from the monitored outfall data. TKN, TP, TSS and VSS loads were generated by CRWD in the WISKI data management program. This allowed for the extraction of baseflow and the associated load from the event load for those parameters. Cl and NO_2+NO_3 loads were calculated for the event-based volume (baseflow volume extracted), although the base flow loading for those parameters was not extracted. The following formula was used to calculate the annual/seasonal flow weighted mean concentrations (**Table 12-2**):

$$C = \frac{\sum(F_i \times C_i)}{\sum(F_i)}$$

C = annual/seasonal flow weighted mean concentration [mg/L]*
F_i = the event based flow for an individual event [cf]
C_i = the pollutant concentration for an individual event [mg/L]

*As described above, the flow-weighted mean concentration for TKN, TP, TSS, and VSS, was calculated from loads generated in the WISKI program, which extracted baseflow loading (not reflected in the formula above)

Table 12-2: City-wide Annual and Seasonal Flow-weighted Mean Concentrations

Parameter	Cl	TKN	TP	NO_2+NO_3	TSS	VSS
Units	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
Annual	348.1	2.2	0.41	0.70	210.9	50.8
Q1 (Jan-Mar)	750.6	4.2	0.63	0.91	256.1	72.5
Q2 (Apr-Jun)	273.5	2.5	0.42	0.78	225.1	119.4
Q3 (Jul-Sep)	213.9	1.9	0.37	0.58	226.7	53.7
Q4 (Oct-Dec)	375.0	1.6	0.33	0.71	160.2	30.7

Based on these calculated flow-weighted mean concentrations, the Simple Method was used to calculate each subwatershed's pollutant loading. Loads for the four monitored subwatersheds were generated using actual monitored loads. The Simple Method is show below:

$$L = 2.72\left(\frac{PP_jR_v}{12}\right)(CA)$$

L = pollutant loading for the year/season [lb]
P = rainfall depth for the year/season [in]
P_j = correction factor for storms that produce no runoff [.]
R_v = runoff coefficient [.]
C = flow-weighted mean concentration [mg/L]
A = area of the watershed [acre]

Values used in loading calculations:
R_v and A = Table 1
C = Table 2
P = Table 3
P_j = 0.85

The annual/seasonal precipitation totals for four different rainfall monitoring locations in St. Paul are provided in **Section 3** the **Table 3-1**. Each subwatershed was assigned precipitation data from the nearest precipitation monitoring site (see **Table 12-1** for assignments). The rainfall data was used as an input to the Simple Method for load calculations, as described above. Rain data outside the seasonal monitoring period was supplemented with data from the University of Minnesota – St. Paul.

The annual and seasonal pollutant loads for each of the City's subwatersheds are presented in **Tables 12-3 – 12-7**. Loads for the five monitored sites are actual totals calculated for each station. Those sites are highlighted blue.

Table 12-3. Annual Pollutant Loadings (lbs)

Subwatershed	Cl	TKN	Total P	NO2+NO3	TSS	VSS
Battle Creek	1146731	7404	1336	2308	694721	167285
Beaver Lake	121654	786	142	245	73702	17747
Belt Line	3182869	20552	3708	6405	1928267	464317
Crosby	1535821	9917	1789	3091	930441	224046
Davern	1455630	9399	1696	2929	881860	212347
Downtown	834070	5386	972	1678	505302	121674
East Kittsondale	190398	4532	863	747	308190	118153
Fish Creek	45928	297	54	92	27824	6700
Goodrich/Western	540114	3487	629	1087	327215	78792
Griffith/Pt. Douglas	538766	3479	628	1084	326399	78595
Hidden Falls	349933	2259	408	704	211999	51048
Highwood	1078109	6961	1256	2170	653147	157275
Lake Como	1236259	7982	1440	2488	748959	180346
Lake Phalen	816905	5275	952	1644	494903	119170
Mississippi River Blvd.	2818934	18202	3284	5673	1707786	411226
MRWMO	192092	1240	224	387	116374	28022
Phalen Creek	226734	4292	781	844	361245	119124
Pigs Eye	2304829	14882	2685	4638	1396327	336229
Riverview	1113034	7187	1297	2240	674306	162370
St. Anthony Hill	3430587	22151	3997	6904	2078342	500454
St. Anthony Park	311400	7306	1203	1859	558390	219637
Trout Brook	89389	4067	993	670	285181	91275
Urban	357878	2311	417	720	216812	52207
West Kittsondale	1419123	9163	1653	2856	859742	207022
West Seventh	547150	3533	637	1101	331478	79818

Table 12-4: Q1 (Jan-Mar) Pollutant Loading (lbs)

Subwatershed	Cl	TKN	Total P	NO2+NO3	TSS	VSS
Battle Creek	513049	2883	432	620	175047	49571
Beaver Lake	54428	306	46	66	18570	5259
Belt Line	1424020	8002	1200	1721	485861	137588
Crosby	649043	3647	547	784	221447	62710
Davern	615154	3457	518	743	209884	59436
Downtown	354351	1991	299	428	120901	34237
East Kittsondale	171790	1622	215	239	73959	30143
Fish Creek	20548	115	17	25	7011	1985
Goodrich/Western	229465	1289	193	277	78291	22171
Griffith/Pt. Douglas	241045	1355	203	291	82242	23290
Hidden Falls	147883	831	125	179	50456	14288
Highwood	482347	2710	406	583	164572	46604
Lake Como	522447	2936	440	631	178254	50479
Lake Phalen	365484	2054	308	442	124700	35313
Mississippi River Blvd.	1191290	6694	1004	1440	406456	115102
MRWMO	81179	456	68	98	27697	7843
Phalen Creek	184841	1157	230	292	112173	32210
Pigs Eye	1031184	5795	869	1246	351829	99633
Riverview	497973	2798	420	602	169903	48114
St. Anthony Hill	1457471	8190	1228	1762	497274	140820
St. Anthony Park	194500	1164	139	422	64688	17522
Trout Brook	21816	668	124	63	45075	12920
Urban	160115	900	135	194	54630	15470
West Kittsondale	599726	3370	505	725	204620	57945
West Seventh	232454	1306	196	281	79311	22460

Table 12-5: Q2 (Apr-Jun) Pollutant Loading (lbs)

Subwatershed	Cl	TKN	Total P	NO2+NO3	TSS	VSS
Battle Creek	198241	1838	302	565	163173	86560
Beaver Lake	21031	195	32	60	17311	9183
Belt Line	550238	5101	839	1569	452904	240255
Crosby	301344	2793	460	859	248038	131578
Davern	285610	2648	436	814	235087	124708
Downtown	147353	1366	225	420	121287	64340
East Kittsondale	10927	1772	325	277	134710	55330
Fish Creek	7940	74	12	23	6535	3467
Goodrich/Western	95420	885	146	272	78541	41664
Griffith/Pt. Douglas	93139	863	142	266	76663	40668
Hidden Falls	68660	636	105	196	56515	29980
Highwood	186378	1728	284	531	153409	81380
Lake Como	242567	2249	370	692	199658	105914
Lake Phalen	141222	1309	215	403	116241	61663
Mississippi River Blvd.	553105	5127	844	1577	455264	241507
MRWMO	37690	349	57	107	31023	16457
Phalen Creek	7719	861	150	191	62654	25113
Pigs Eye	398447	3693	608	1136	327964	173977
Riverview	192416	1784	293	549	158378	84016
St. Anthony Hill	606071	5618	924	1728	498861	264634
St. Anthony Park	42770	1996	320	462	204440	71069
Trout Brook	20711	1084	269	169	77410	25208
Urban	61868	573	94	176	50924	27014
West Kittsondale	278447	2581	425	794	229191	121581
West Seventh	96663	896	147	276	79564	42207

Table 12-6: Q3 (Jul-Sep) Pollutant Loading

Subwatershed	Cl	TKN	Total P	NO2+NO3	TSS	VSS
Battle Creek	294801	2557	512	799	312496	74093
Beaver Lake	31275	271	54	85	33152	7860
Belt Line	818250	7098	1422	2217	867364	205654
Crosby	404386	3508	703	1096	428658	101636
Davern	383271	3325	666	1039	406276	96329
Downtown	213980	1856	372	580	226824	53780
East Kittsondale	5317	980	182	188	81703	28833
Fish Creek	11807	102	21	32	12516	2968
Goodrich/Western	138566	1202	241	376	146883	34826
Griffith/Pt. Douglas	138506	1201	241	375	146819	34811
Hidden Falls	92138	799	160	250	97669	23157
Highwood	277160	2404	482	751	293796	69659
Lake Como	325510	2824	566	882	345048	81812
Lake Phalen	210009	1822	365	569	222615	52782
Mississippi River Blvd.	742233	6438	1290	2011	786784	186548
MRWMO	50578	439	88	137	53614	12712
Phalen Creek	6253	2050	346	268	176292	56646
Pigs Eye	592524	5140	1030	1606	628090	148921
Riverview	286138	2482	497	775	303313	71916
St. Anthony Hill	880114	7634	1529	2385	932941	221202
St. Anthony Park	51793	3969	704	892	278316	51793
Trout Brook	35340	2008	482	377	125182	39235
Urban	92003	798	160	249	97525	23123
West Kittsondale	373659	3241	649	1013	396087	93913
West Seventh	140371	1218	244	380	148796	35280

Table 12-7: Q4 (Oct-Dec) Pollutant Loading (lbs)

Subwatershed	Cl	TKN	Total P	NO2+NO3	TSS	VSS
Battle Creek	295608	1300	264	562	126241	24221
Beaver Lake	31360	138	28	60	13393	2570
Belt Line	820489	3607	732	1560	350395	67228
Crosby	341208	1500	304	649	145715	27957
Davern	323392	1422	288	615	138107	26497
Downtown	216986	954	194	413	92665	17779
East Kittsondale	2364	158	141	43	17818	3846
Fish Creek	11839	52	11	23	5056	970
Goodrich/Western	140512	618	125	267	60007	11513
Griffith/Pt. Douglas	138885	611	124	264	59312	11380
Hidden Falls	77743	342	69	148	33201	6370
Highwood	277918	1222	248	528	118687	22771
Lake Como	274655	1208	245	522	117294	22504
Lake Phalen	368291	1619	328	700	157281	30176
Mississippi River Blvd.	626273	2753	559	1191	267454	51314
MRWMO	42676	188	38	81	18225	3497
Phalen Creek	27921	225	55	93	10126	5155
Pigs Eye	594145	2612	530	1130	253734	48682
Riverview	286921	1261	256	546	122532	23509
St. Anthony Hill	892477	3924	796	1697	381139	73126
St. Anthony Park	22338	177	40	84	10946	22338
Trout Brook	11522	307	118	61	37514	13912
Urban	92255	406	82	175	39398	7559
West Kittsondale	315282	1386	281	600	134643	25833
West Seventh	142343	626	127	271	60788	11663

13. 2023 Summary

In 2023, six stormwater BMPs were monitored along with two locations that provide upstream stormwater data. All locations were evaluated for performance in 2023 to help the City meet its NPDES MS4 Permit monitoring requirements. The BMP systems that were monitored include underground infiltration systems, a rain garden, and pervious pavement. The systems were monitored to evaluate infiltration rates, volume reduction, and pollutant removal efficiencies. Long-term monitoring data has shown how the effectiveness of these systems change over time.

13.1. Underground Infiltration Systems/Outfall

Four underground infiltration BMPs (Beacon Bluff, St. Albans, Hampden Park, and Victoria Street) were monitored for flow to evaluate runoff and volume reduction at BMP Sites. The runoff data for each site was normalized over the individual drainage areas to evaluate drainage characteristics that contribute to each Site. A summary of the 2023 runoff and volume reduction data is presented in **Table 13-1** below.

Table 13-1: Runoff Summary

BMP Site	Drainage Area (acres)	Total Monitored Runoff (cf)	% Runoff Captured	Water Yield (in/acre)	Water Yield (cu-ft/acre)
Beacon Bluff	143.6	1,161,699	40.9	2.34	8,492
St. Albans	25.2	333,162	92.4	3.6	13,221
Hampden Park	7.8	255,025	100.0	9.1	32,696
Victoria Street	19.1	297,776	88.4	4.29	15,590

TSS and TP loads captured by the monitored BMPs are summarized in **Table 13-2**. TSS and TP loads were calculated using 2023 flow data and flow-weighted averages. Beacon Bluff had the largest runoff volume and captured the largest amount of TSS and TP. The total TSS load and TP load captured by the four systems was 11,585 pounds and 40.11 pounds, respectively.

Table 13-2: Underground Infiltration System Pollutant Capture Summary

BMP Site	TSS Captured (pounds)	TP Captured (pounds)
Beacon Bluff	3,029	21.53
St. Albans	2,213	6.70
Hampden Park	3,520	5.19
Victoria Street	3,093	6.69
Total	**11,585**	**40.11**

A summary of the 2023 infiltration rates for the underground infiltration systems is provided below.

- The infiltration rate for the Beacon Bluff underground system was 0.11 in/hr, which is 4.4% of the post-construction infiltration rate. The underground system no longer drains to empty, and groundwater mounding does not appear to be the cause of standing water, based on

groundwater elevation data. Even with standing water observed in the BMP and an increase in system discharge events, the BMP captured 37% of the total volume monitored.

- The 2023 St. Albans infiltration rate of 11.7 in/hr is greater than the MSWM infiltration rate, but less than design rate of 26.0 in/hr. The St. Albans BMP system regularly drained to empty within 24 hours of a runoff event.
- The infiltration rate for the Hampden Park BMP was 13.6 in/hr, which exceeded the design rate of 1.8 in/hr. No overflow bypass was observed and 100% of the volume received by the BMP was infiltrated, possibly due to low rain fall totals and less water moving through the pipe. The Hampden Park BMP system regularly drained to dry within 8 hours of a runoff event.
- The infiltration rate for the Victoria Street BMP was 42.3 in/hr, which is above the designed infiltration rate of 12.8 in/hr. The Victoria Street BMP regularly drained to empty within 10 hours of a runoff event.

13.2. Pervious Pavement

Infiltration testing was conducted at the Victoria Street permeable pavers and Jackson Street pervious asphalt in 2023. The Victoria Street 2023 average infiltration rate of 3.0 in/hr and is less than 2% of post-construction monitored infiltration rate.

The August 2023 infiltration rate at the Jackson Street Site was 50.3 in/hr, which is 7.6% of the infiltration rate observed during the first year of monitoring (2016). Low traffic areas were observed to have a significantly greater infiltration rates on average (180.9 in/hr) than medium traffic (0 in/hr) and high traffic (0 in/hr) areas.

13.3. 2023 Recommendations

The recommendations for the 2023 Monitoring Program include:

- Continue to perform inspections and regular maintenance on BMP pre-treatment systems and infiltration galleries.
- Continue to notify of potential illicit discharges observed at flow monitoring locations.
- Continue to complete infiltration testing at Jackson Street Pervious Bike Path to further evaluate changes in pervious surface performance with respect to pavement traffic.
- Continue river level monitoring within the Mississippi River in protected areas to capture more data during different river stages.
- According to the MPCA Minnesota Stormwater Manual, E. coli, oil and grease levels can vary greatly depending on the time of year, location, and land use. Based on sample results within the monitored watersheds, no further practices to reduce the amount of E. coli, oil and grease are recommended to be taken.
- Remove accumulated sediment at in the inlets of West Shepard Pond.

14. References

City of Saint Paul, 2018. 2017 Water Quality and Quantity Monitoring Report. Saint Paul, MN.

Erickson, Andrew J., John S. Gulliver, and Peter T. Weiss. "Capturing phosphates with iron enhanced sand filtration." *Water Research* 46.9 (2012): 3032-3042.

Erickson, Andrew J., John S. Gulliver, and Peter T. Weiss. “Monitoring an Iron-Enhanced Sand Filter Trench for the Capture of Phosphate from Stormwater Runoff.” Retrieved from the University of Minnesota Digital Conservancy, http://hdl.handle.net/11299/175078, 2015.

Erickson, Andrew J. “Removing Dissolved Pollutants from Stormwater Runoff.” St. Anthony Falls Laboratory, University of Minnesota. Presentation, October 3, 2012.

Minnesota Climatology Working Group. St. Paul Campus Climatological Observatory: precipitation data. Saint Paul, MN. Accessed 2017. http://mrcc.isws.illinois.edu.

Minnesota Pollution Control Agency 2008. Minnesota Stormwater Manual. Version 2. Accessed 2017. https://stormwater.pca.state.mn.us/index.php?title=Main_Page.

Minnesota Department of Transportation, 2015. Study: “Permeable Pavements in Cold Climates: State of the Art and Cold Climate Case Studies”. Accessed 2017. https://lrrb.org/pdf/201530.pdf.

LIST OF FIGURES

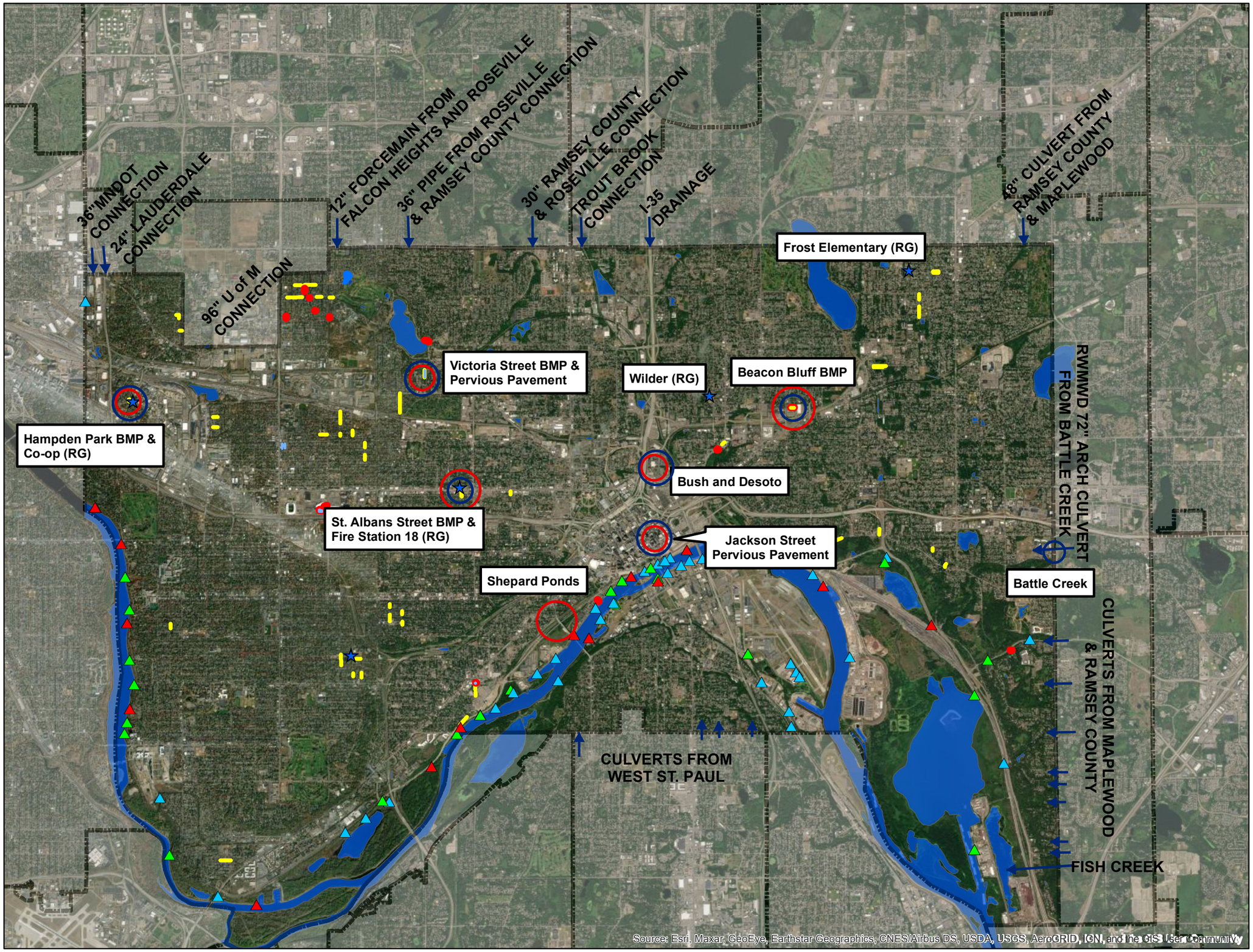
APPENDICES

City of St. Paul

2023 Water Quantity and Quality Monitoring Program

SAINT PAUL
MINNESOTA

Figure 1-1
2023 Monitoring Site Locations



N
W E
S

0 2,500 5,000 10,000
Feet

Legend

- Raingarden/Infiltration Basin
- Infiltration Trench
- Pervious Pavement
- Capitol Region Watershed District
- Lower Mississippi River WMO
- Mississippi WMO
- Ramsey/Washington/Metro WD
- 2022 Monitoring Locations
- 2023 Monitoring Locations
- Rain Gauge Locations

Outfalls

- 30" - 48"
- 50" - 72"
- > 72"

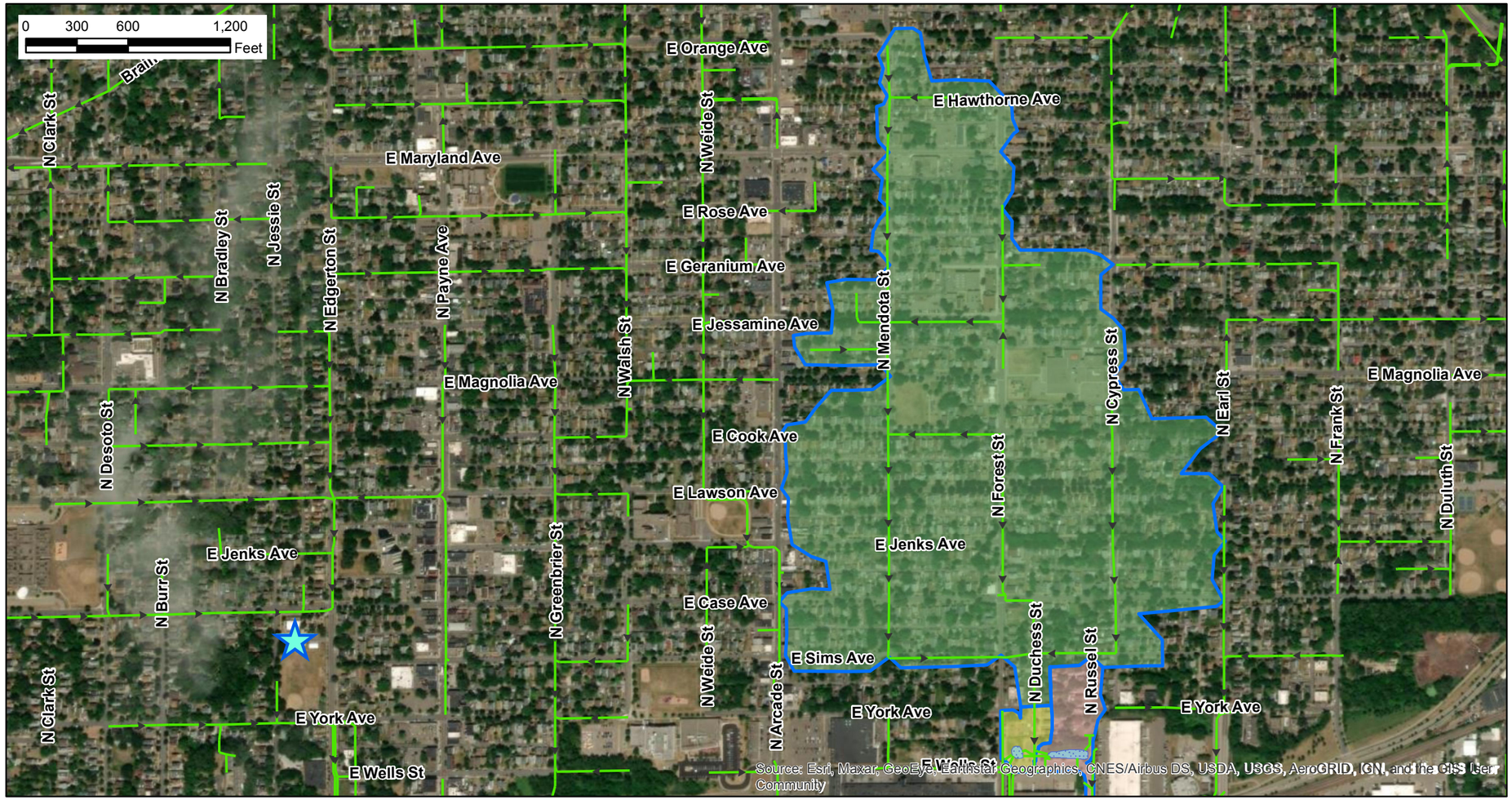
wsb

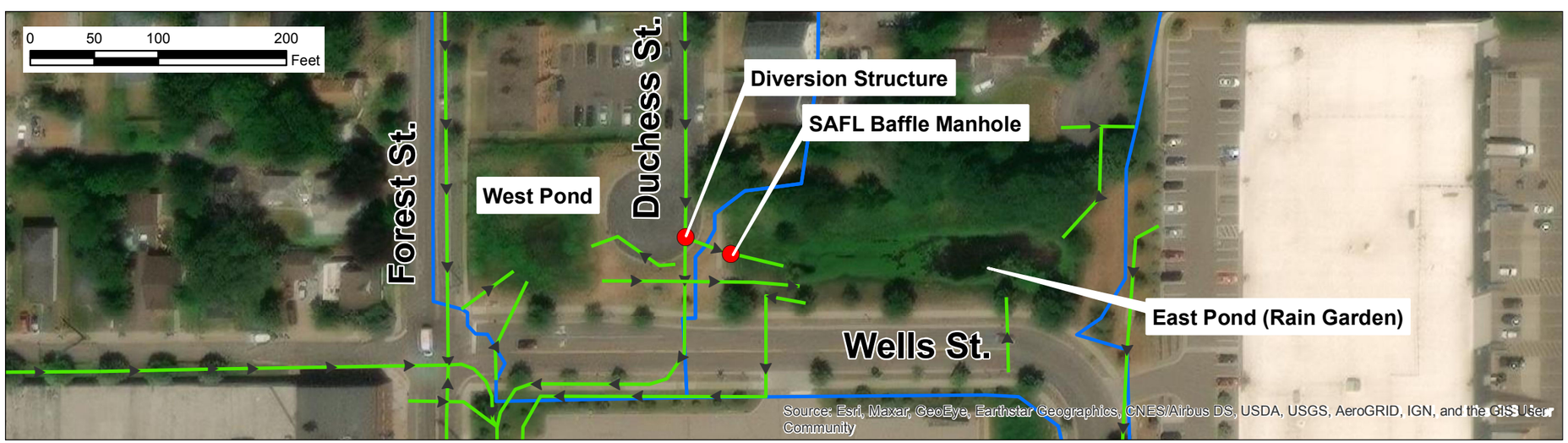
City of St. Paul

2023 Water Quantity and Quality Monitoring Program

SAINT PAUL
MINNESOTA

FIGURE 4-1
Beacon Bluff Infiltration BMP Drainage Areas





N
W E
S

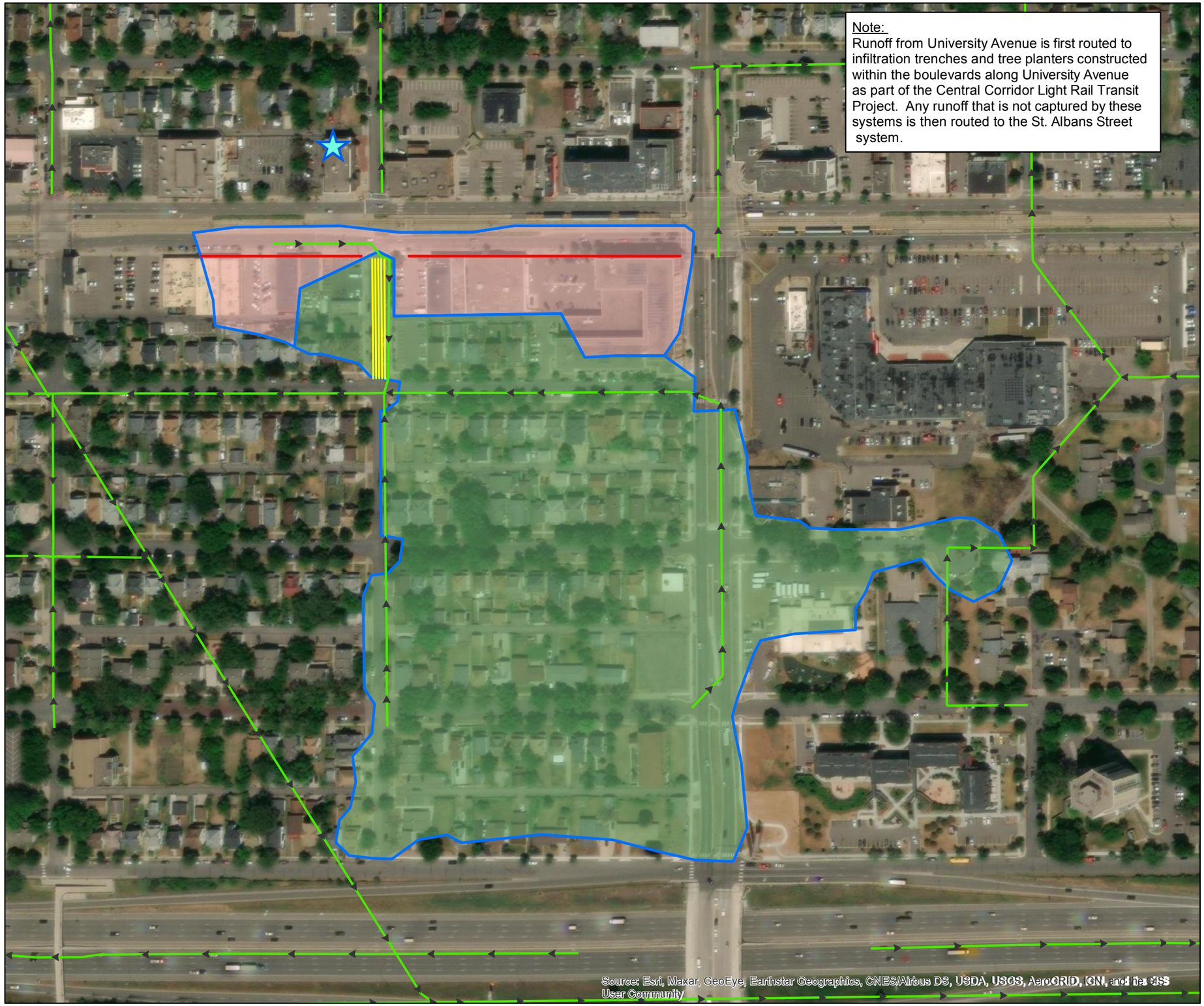
Legend

- Underground Chamber
- Storm Pipe
- Rain Gauge Location

Drainage Areas

- Subwatershed A - Diversion Structure (136.8 ac)
- Suwatershed B - East Pond (4.7 ac)
- Subwatershed C - West Pond (2.1 ac)

wsb



City of St. Paul

2023 Water Quantity and Quality Monitoring Program

SAINT PAUL
The Most Livable City in America

FIGURE 5-1

St. Albans Street Infiltration BMP Drainage Areas

N
W E
S

0 100 200 400
Feet

Legend

- Infiltration Trench
- CCLRT Infiltration Trench (Not monitored)
- Storm Pipe
- Rain Gauge Location

Drainage Areas

- St. Albans Infiltration System (20.3 ac)
- CCLRT Infiltration Trenches (4.9 acres)

wsb

K:\01610-100\GIS\Maps\Figures\2022\Figure 6-1 - Hampden Park NEW.mxd

City of St. Paul

2023 Water Quantity and Quality Monitoring Program

SAINT PAUL
MINNESOTA

FIGURE 6-1
Hampden Park Infiltration BMP Drainage Area

N
W E
S

0 50100 200 300 400
Feet

Legend

- Storm Pipe
- Rain Gauge Location
- Hampden Park BMP
- Hampden Park BMP Drainage Area

wsb

City of St. Paul

2023 Water Quantity and Quality Monitoring Program

SAINT PAUL
MINNESOTA

FIGURE 7-1
Victoria Street Infiltration BMP Drainage Areas

N
W E
S

0 75 150 300
Feet

Legend

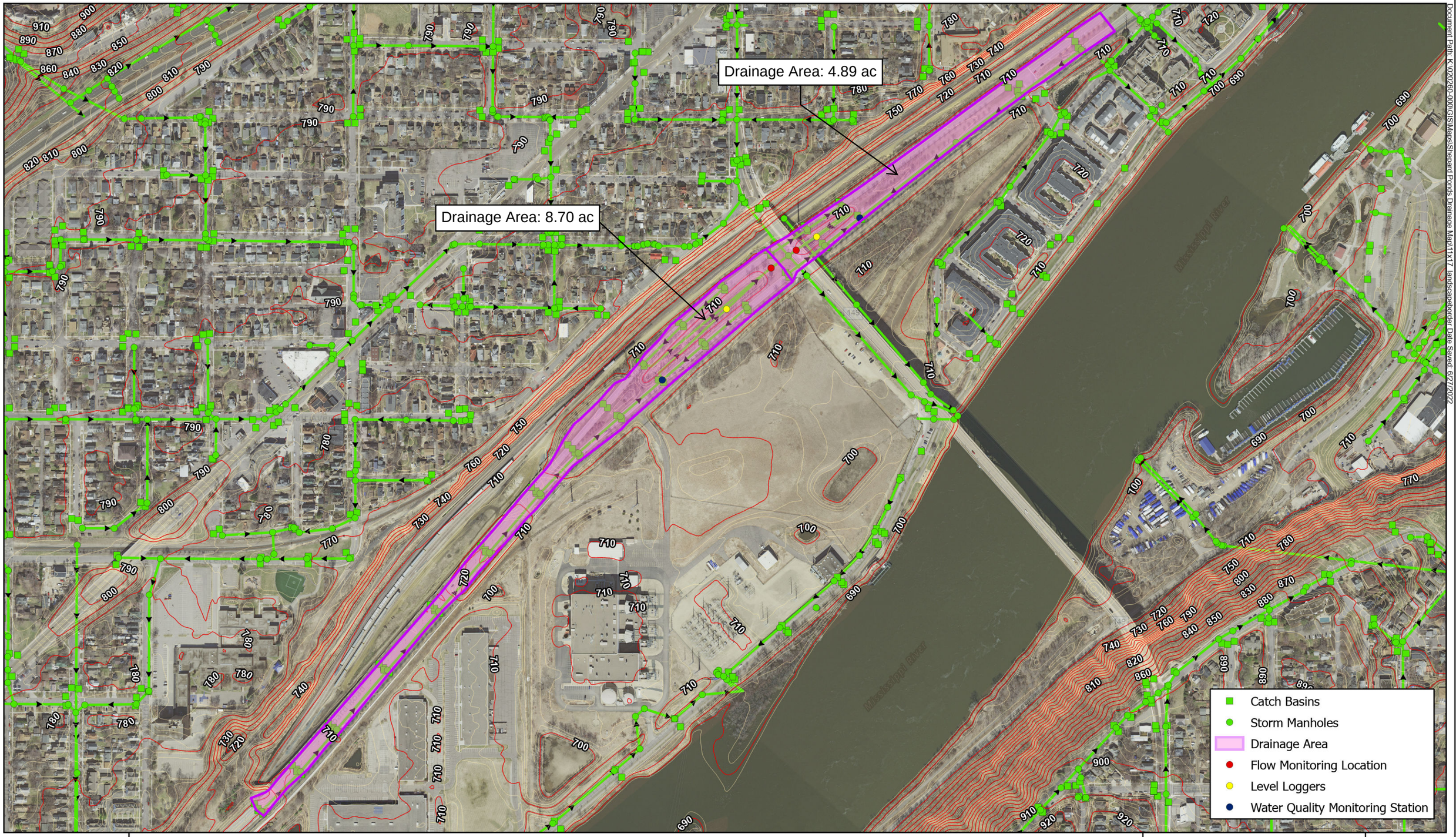
Infiltration BMPs

- Infiltration Trench
- Pervious Pavement
- Storm Pipe
- Rain Gauge Location

Drainage Areas

- Infiltration Trench (19.1 ac)
- Pervious Pavement (1.0 ac)

wsb



Document Path: K:\027\027-000\GIS\Maps\Shepard Ponds Drainage Map\11x17_landscapeborder.Date Saved: 6/27/2022

SAINT PAUL
MINNESOTA

West Shepard Pond

2023 Water Quantity and Quality Monitoring Program

Figure 8-1

N

0 400 Feet

1 inch = 400 feet

wsb

Arkwright Street
Cayuga Street
Burr Street
Phalen Boulevard
Phalen Boulevard
Bush Avenue
Edgerton Street
Reaney Avenue
Payne Avenue
Arkwright Street
Clark Street
Desoto Street
Minnehaha Avenue East
Rivoli Street
Mount Ida Street
Otsego Street
Bradley Street
Jessie Street
Bedford Street
Preble Street
Payne Avenue
Drewry Lane
Beaumont Street
Beaumont Street
Beaumont Street

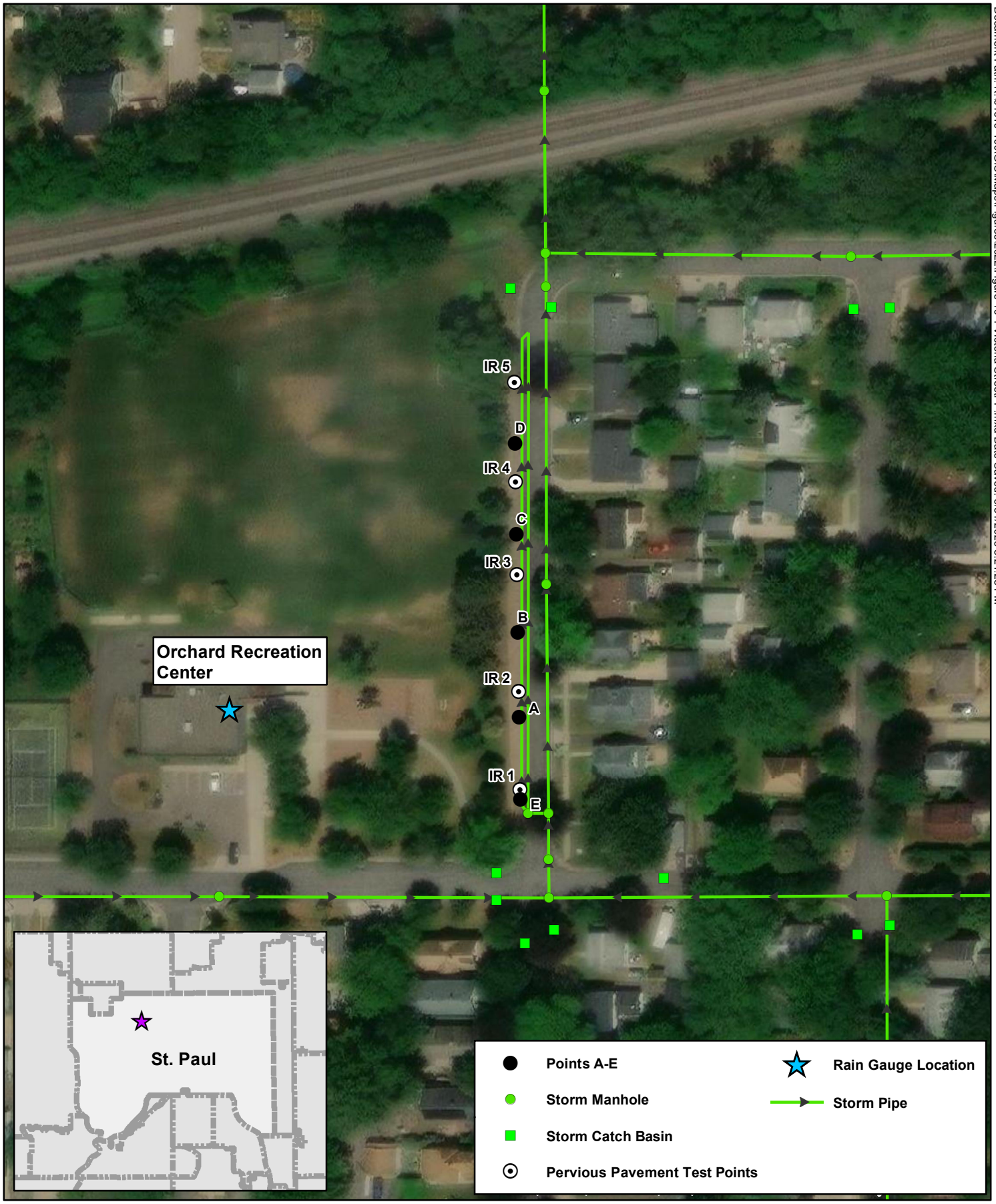
Legend
- CatchBasins
- StormSewer
- DrainageArea (27.1 ac)
- MonitoringLocation

SAINT PAUL
MINNESOTA

Bush-Desoto Pond
2023 Water Quantity and Quality
Monitoring Program
Figure 9-1

N
0 200 Feet
1 inch = 200 feet

wsb



Document Path: K:\01610-100\GIS\Maps\Figures\2022\Figure 10-1 Victoria StreetPP.mxd Date Saved: 3/31/2023 3:21:23 PM

Figure 10-1 - Victoria Street Pervious Pavement Test Locations

2023 Water Quantity and Quality Monitoring Program

N

0 30 60 120

Feet

wsb

Figure 10-2 Jackson Street (pg 1of2)
JS-1 - JS-11 Pervious Test Locations

2023 Water Quantity and Quality Monitoring Program

Pervious Pavement Testing Locations
Pervious Asphalt Bike Path

0 50 Feet
1 inch = 42 feet

wsb

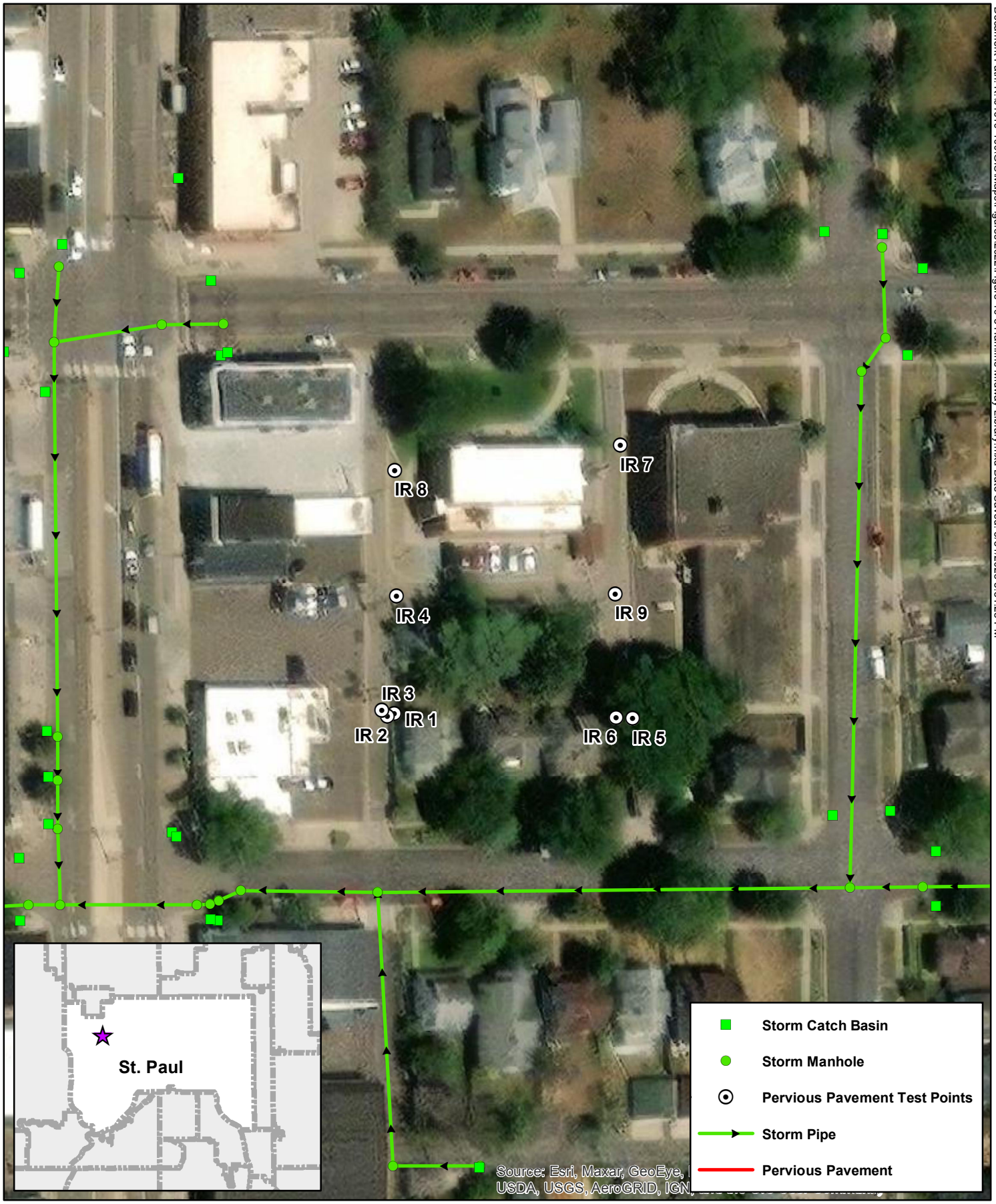
Figure 10-2 Jackson Street (pg 2of2)
JS-12 - JS-18 Pervious Test Locations

2023 Water Quantity and Quality Monitoring Program

Pervious Pavement Testing Locations
Pervious Asphalt Bike Path

0 50 Feet
1 inch = 42 feet

wsb



Document Path: K:\01610-100\GIS\Maps\Figures\2022\Figure 10-3 Hamline Midway Library.mxd Date Saved: 3/31/2023 3:31:28 PM

Figure 10-3 - Hamline Midway Library
Pervious Pavement Test Locations

2022 Water Quantity and Quality Monitoring Program
City of St Paul, MN

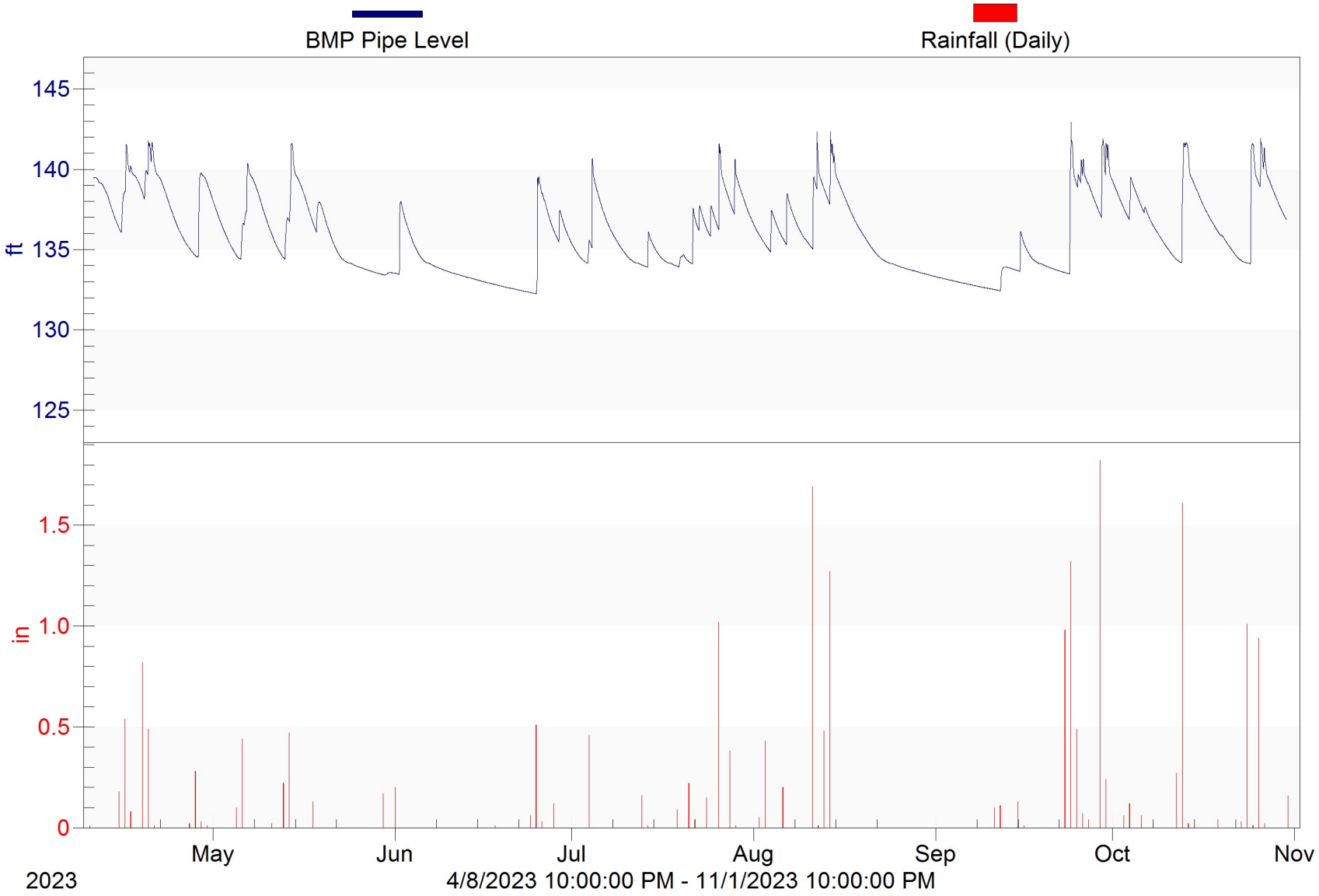
N

0 20 40 80
Feet

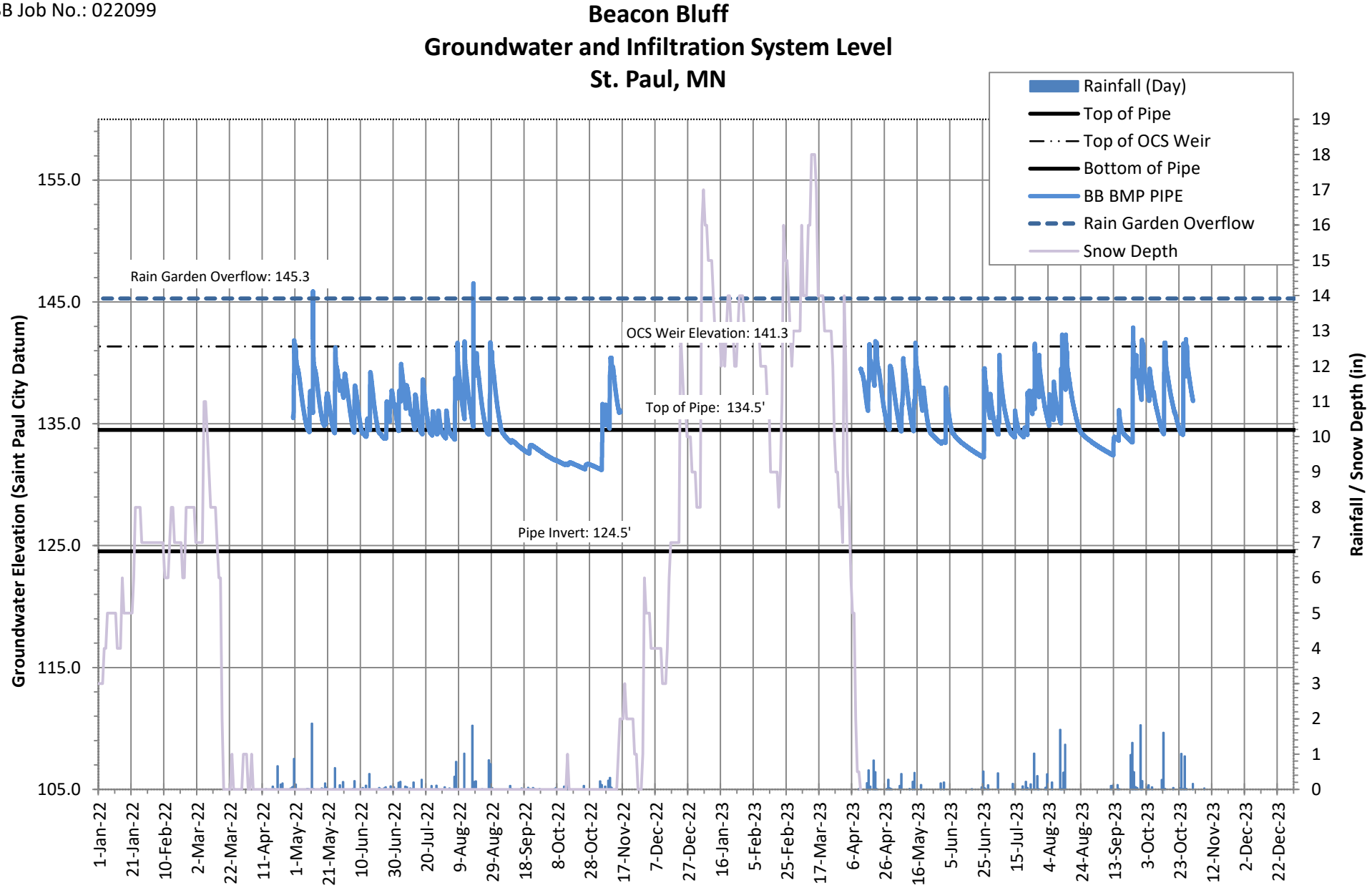
wsb

Chart A.1 Beacon Bluff

Water Level and Rainfall (SPCD)



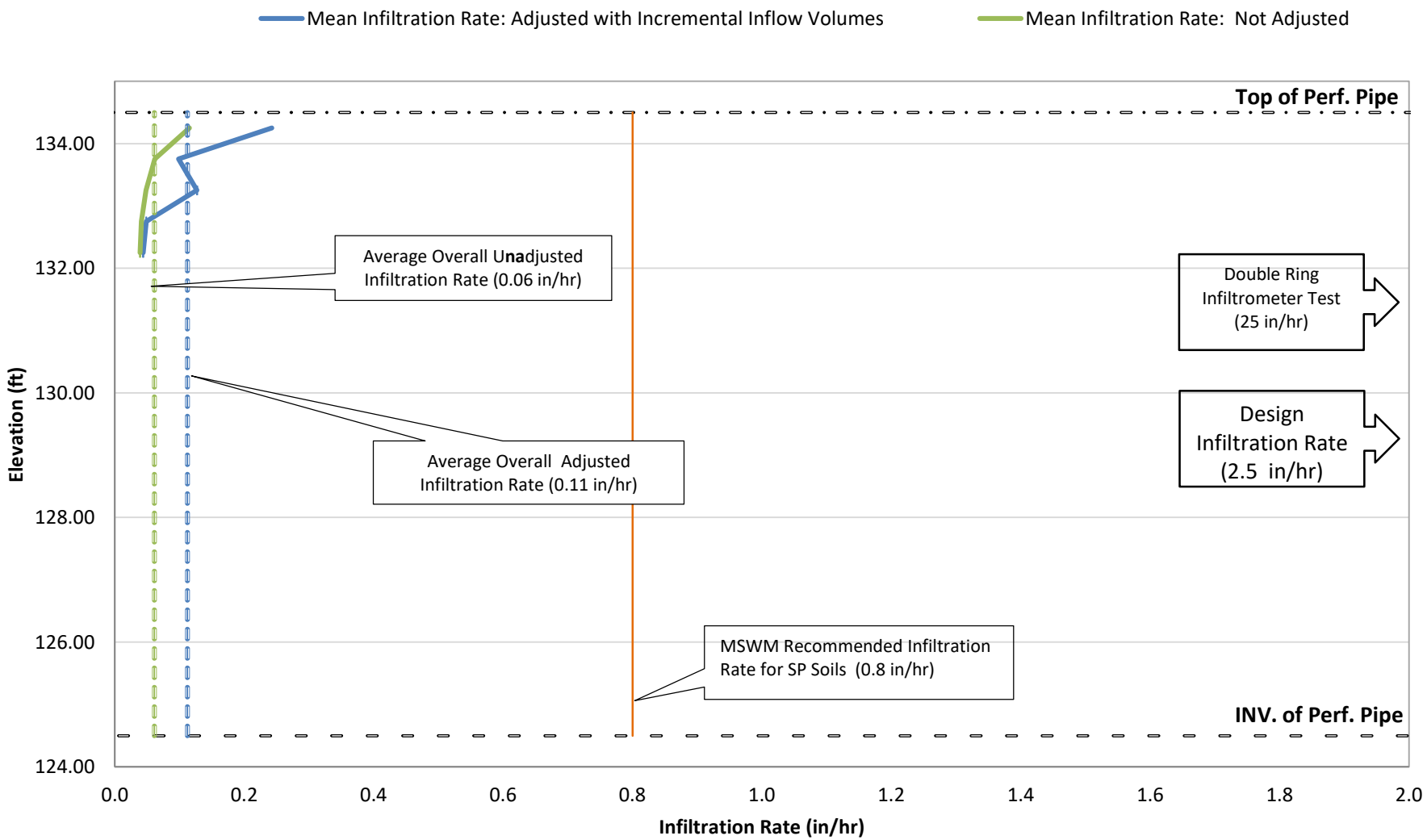
City of Saint Paul
2023 Beacon Bluff Groundwater and System Level
Chart A.2
WSB Job No.: 022099



City of Saint Paul
2023 Water Quality and Quantity Report
Chart A.3
WSB Project No.: 022099

Beacon Bluff Underground System - Infiltration Rate Graph (BMP Pipe)

(Observed at 0.5 Foot Height Intervals)



Note: Pipe Invert is 124.5'
Pipe perforated around circumference of pipe

City of Saint Paul
2023 Water Quality and Quantity Report
Chart A.4
WSB Job No.: 022099

Infiltration Rate Trends
Beacon Bluff Underground System
Adjusted with Incremental Inflow Volumes

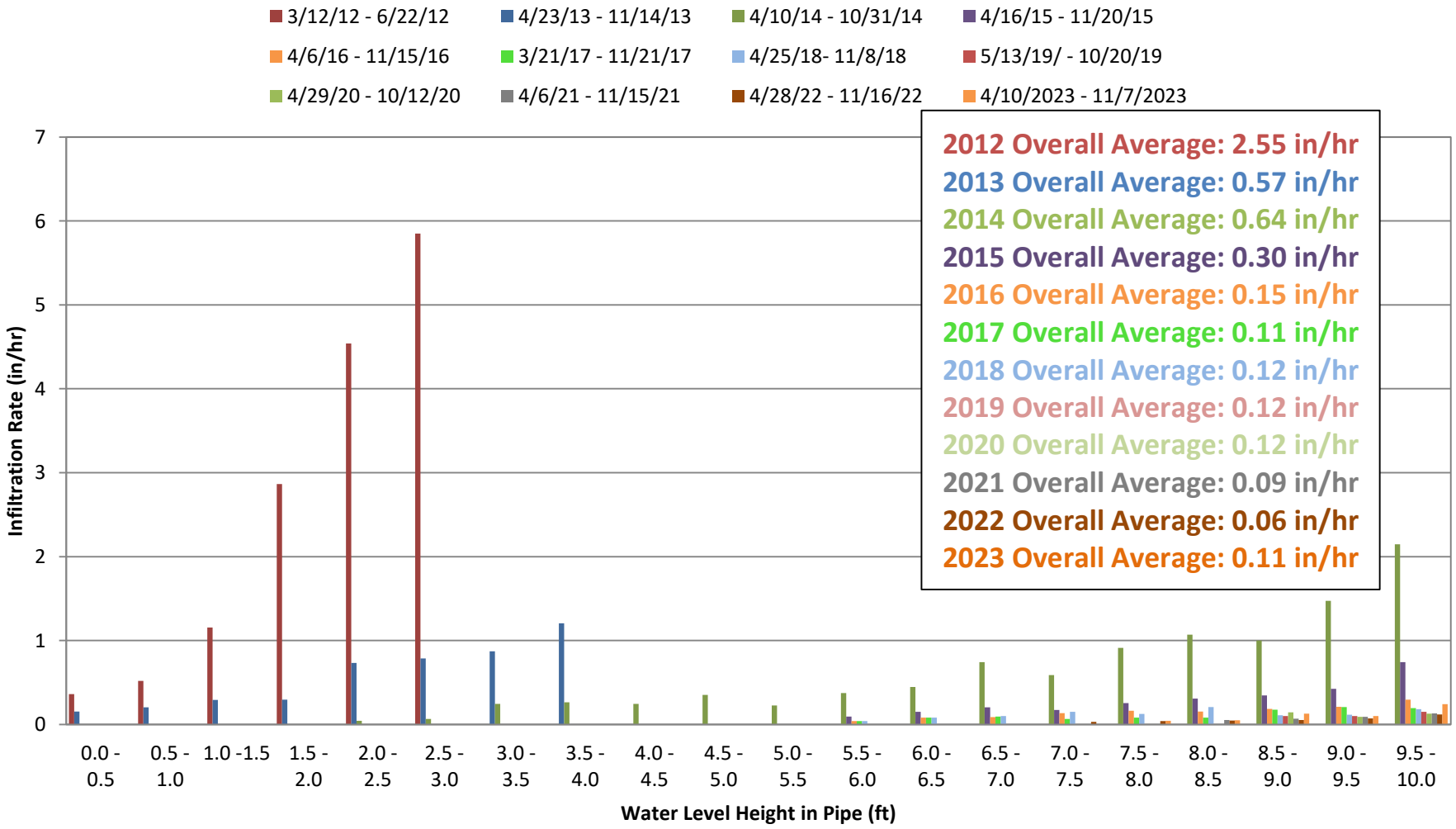
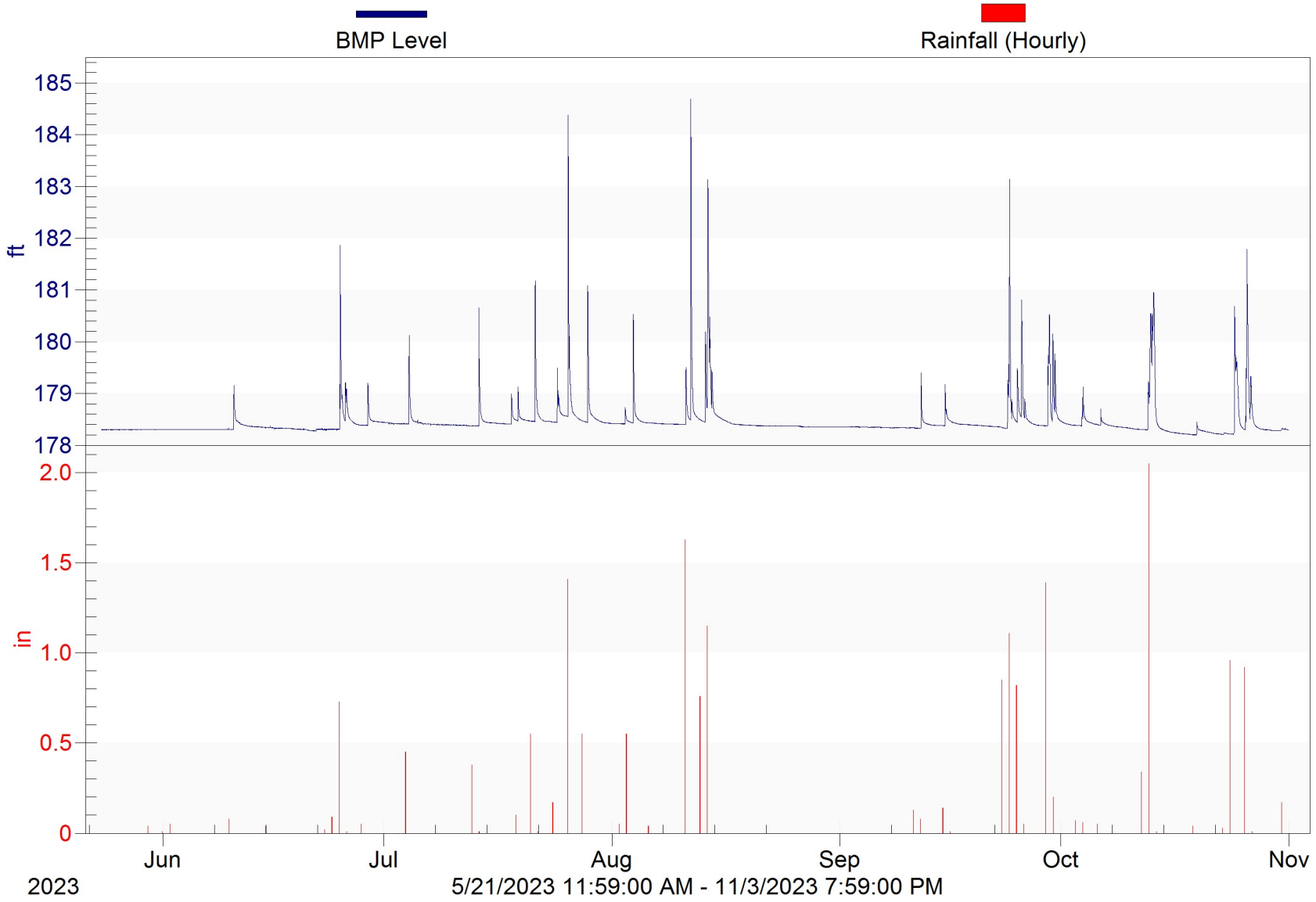


Chart A.5 St. Albans

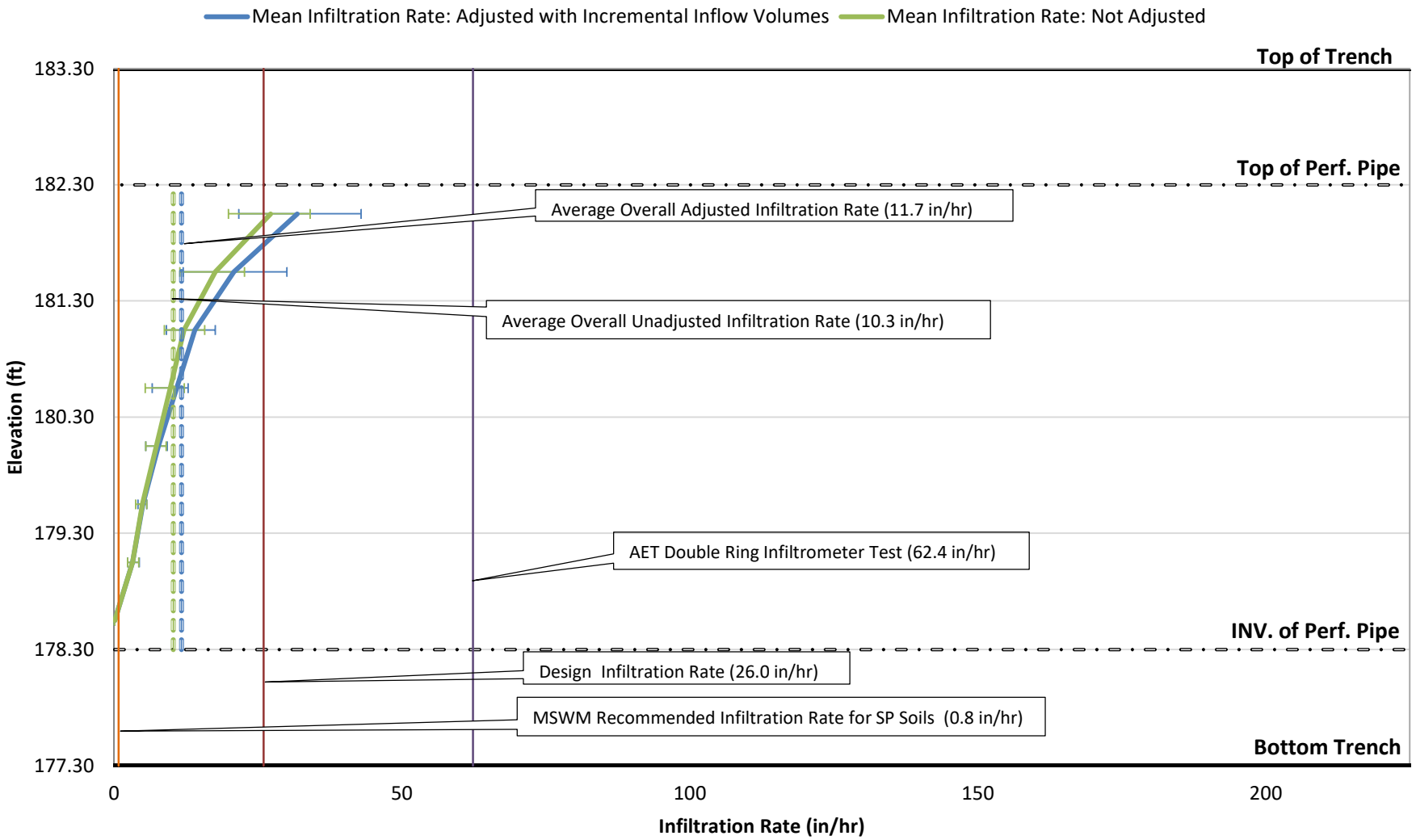
Water Level and Rainfall (SPCD)



City of Saint Paul
2023 Water Quality and Quantity Report
Chart A.6
WSB Job No.: 022099

St. Albans Street - Infiltration Rate Graph

(Observed 0.5 Foot Height Increments)



Note: Pipe Invert is 178.3'
Error Bars Represent 25th and 75th Percentiles
Pipe perforated w/ 2 rows of holes at Elev: 178.9' and 179.2'

City of Saint Paul
2023 Water Quality and Quantity Report
Chart A.7
WSB Project No.: 022099

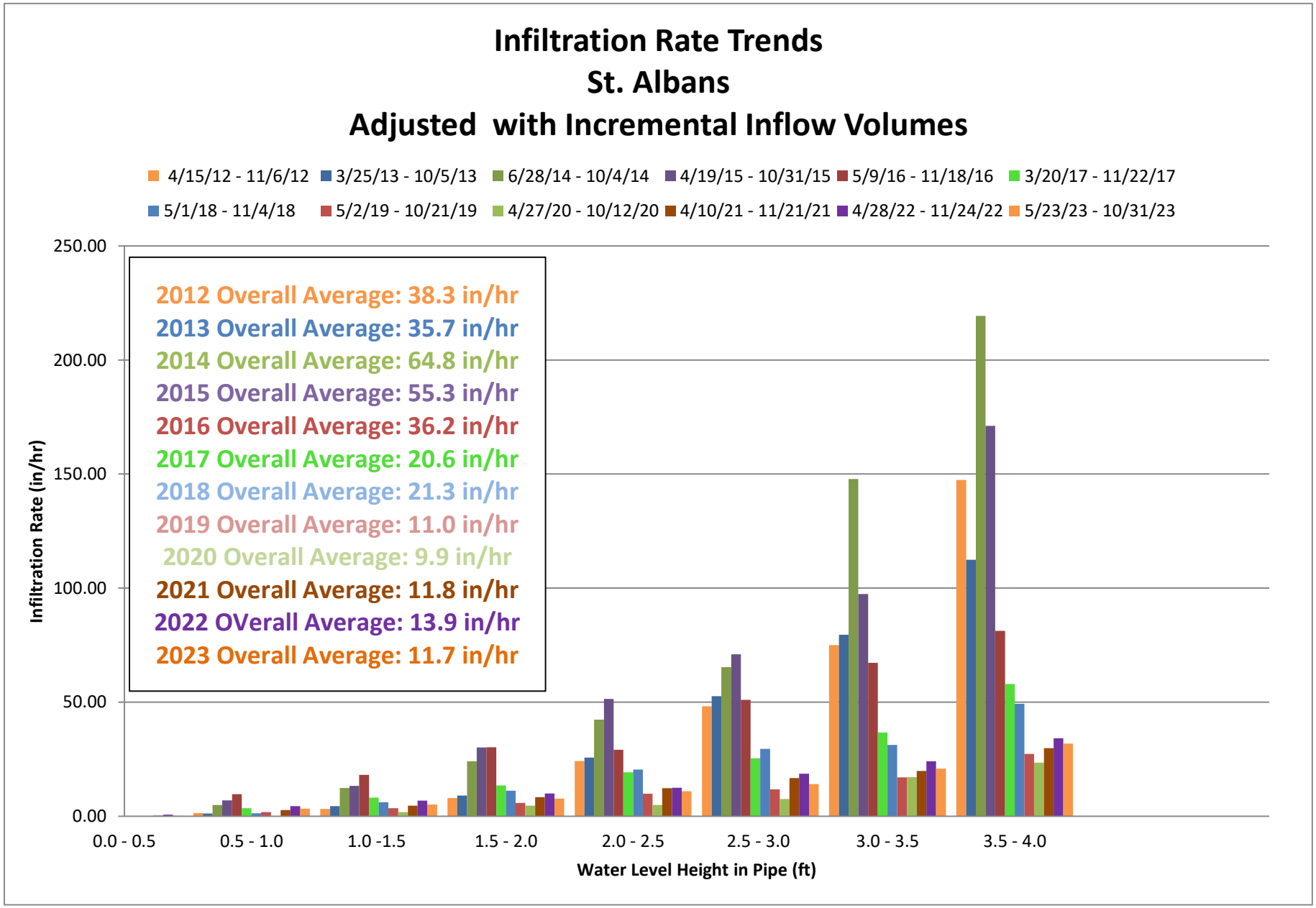
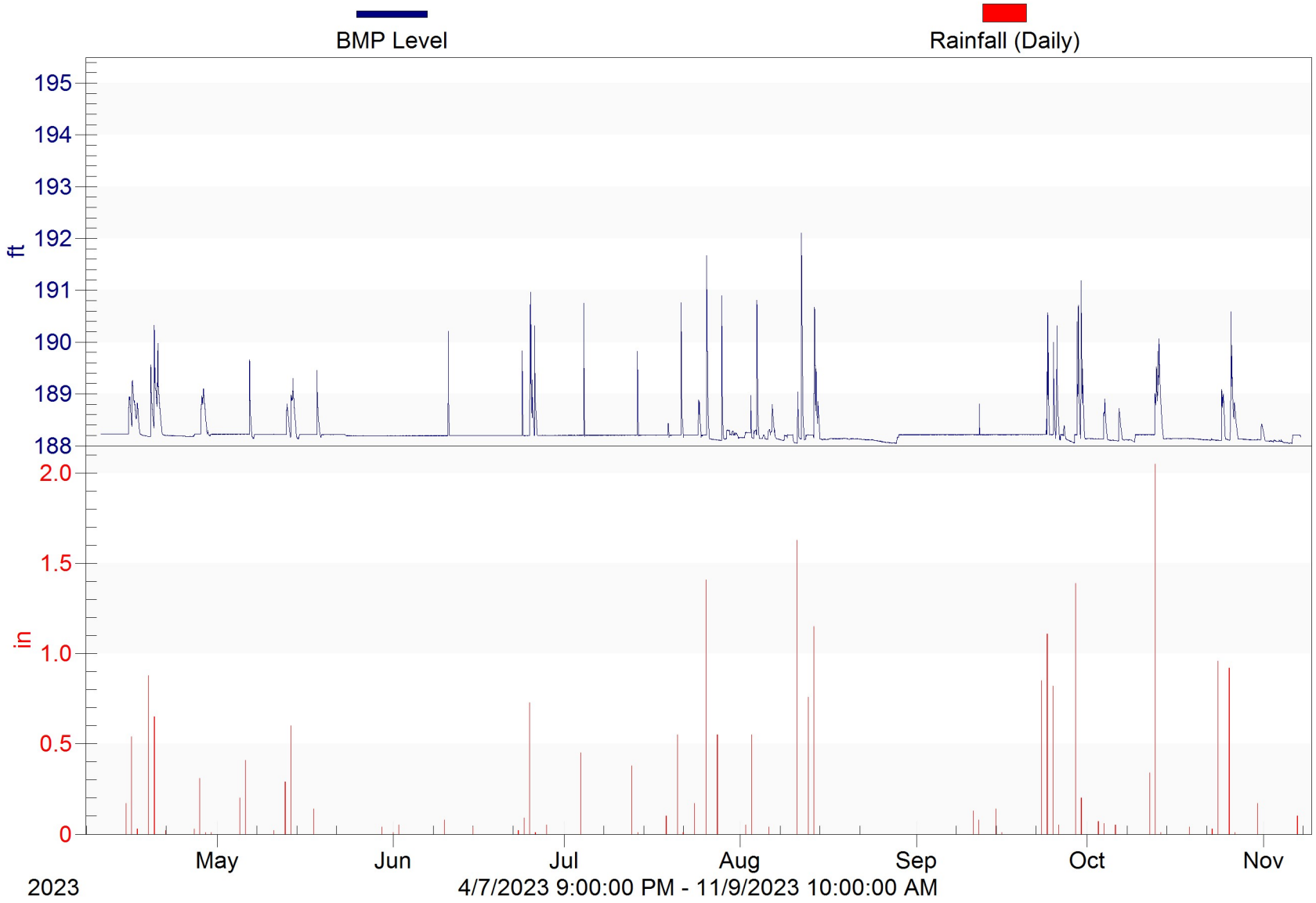
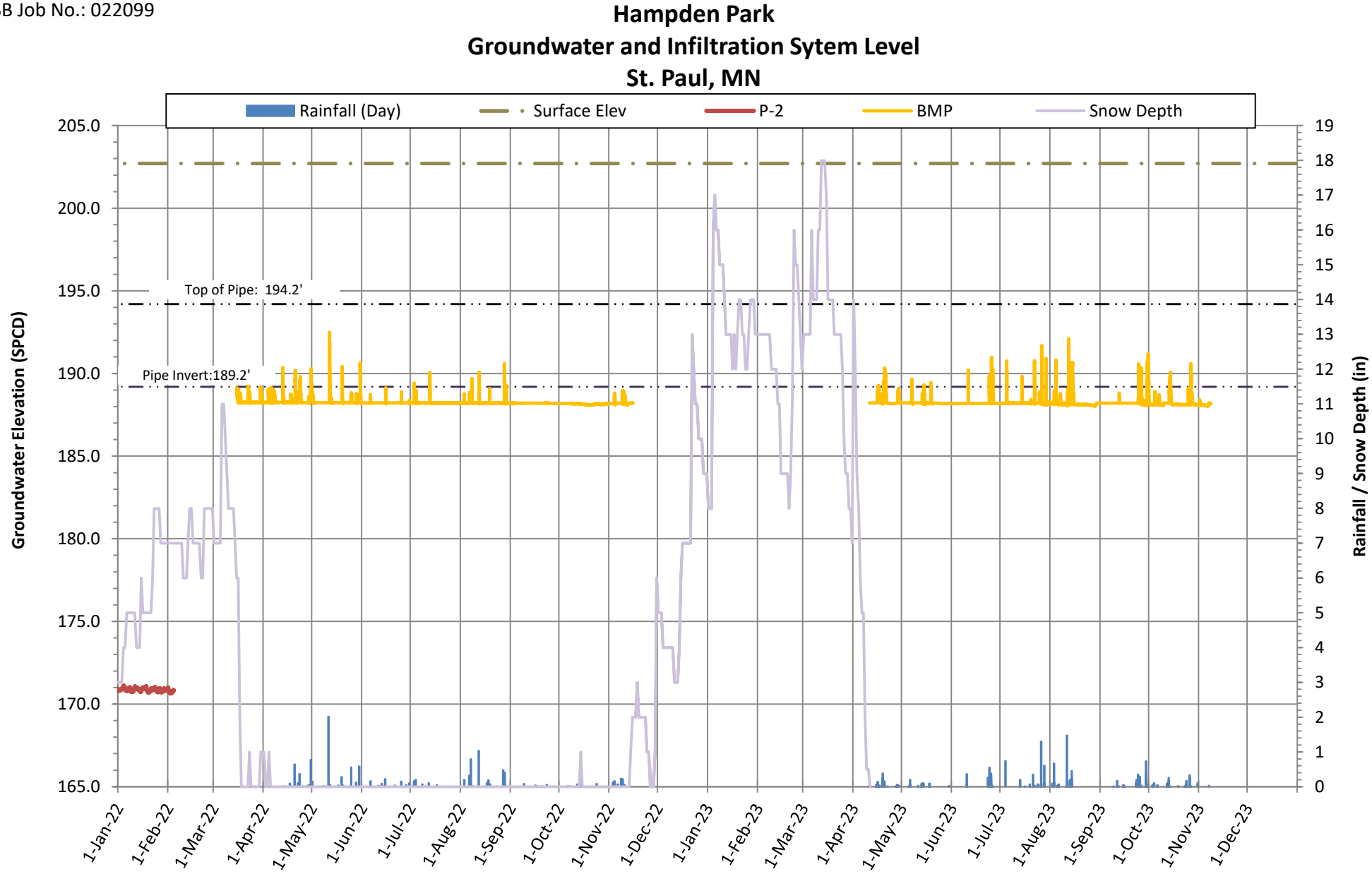


Chart A.8 Hampden Park

BMP Water Level and Rainfall



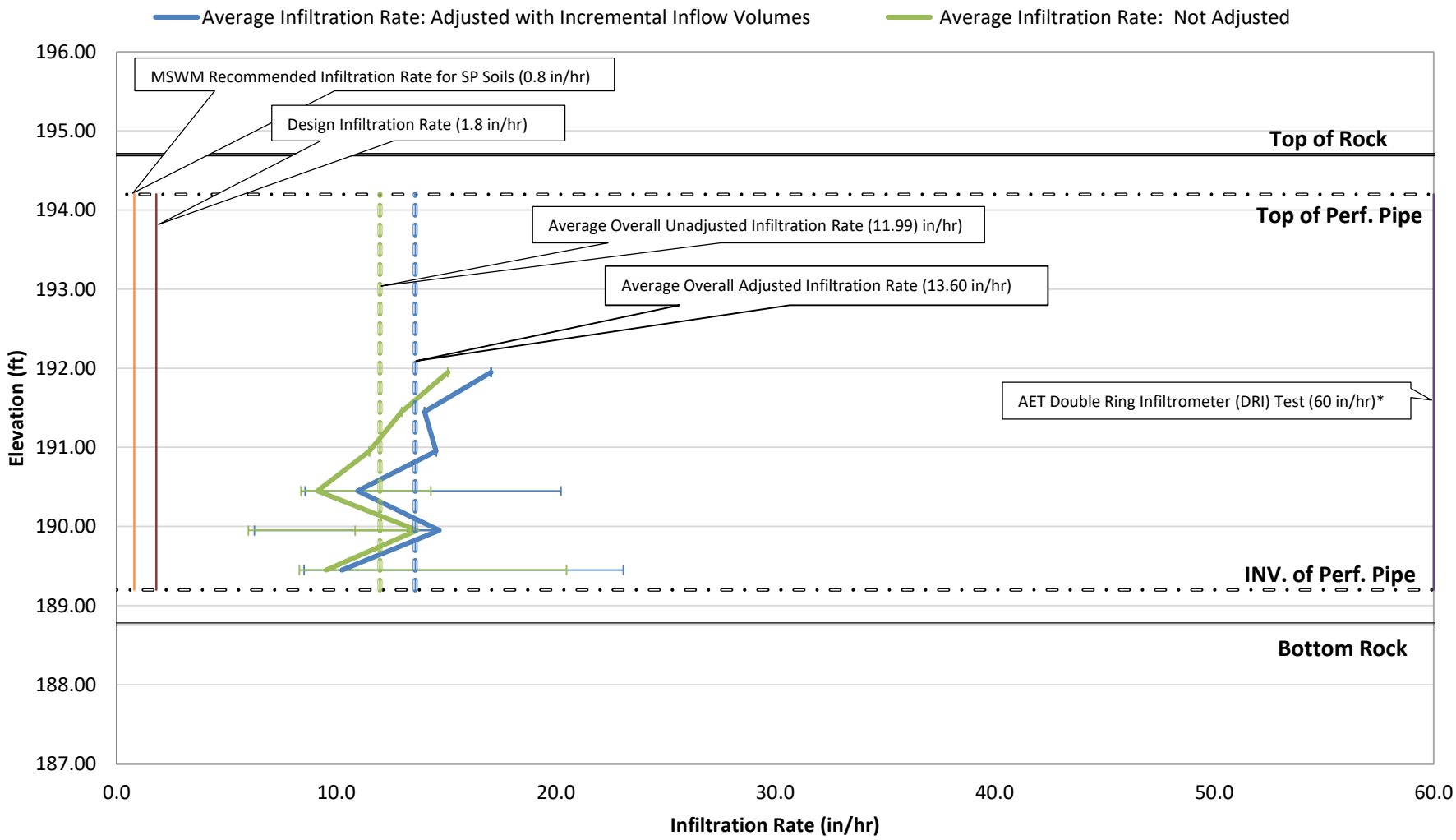
City of Saint Paul
2023 Water Quality and Quantity Report
Chart A.9
WSB Job No.: 022099



City of Saint Paul
2023 Water Quality and Quantity Monitoring
Chart A.10
WSB Job No.: 022099

Hampden Park - Infiltration Rate Graph

(Observed 0.5 Foot Height Increments)



Note: Pipe Invert is 189.2'
Error Bars Represent 25th and 75th Percentiles
* The DRI testing was completed on top of a 5 ft layer of fine filter aggregate that was constructed above the native soils, per the design.

City of Saint Paul
2023 Water Quality and Quantity Report
Chart A.11
WSB Job No.: 022099

Infiltration Rate Trends
Hampden Park
Adjusted with Incremental Inflow Volumes

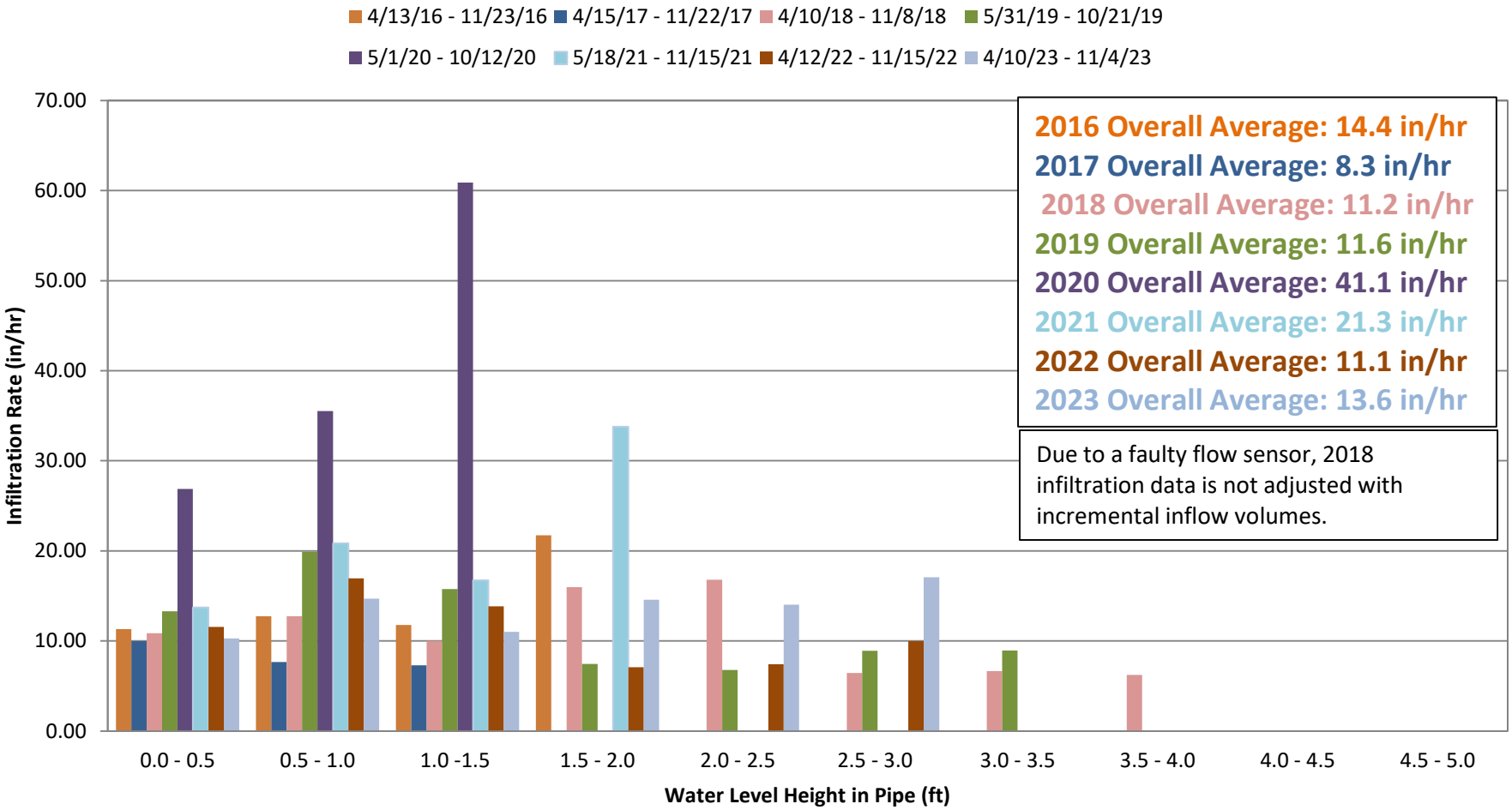
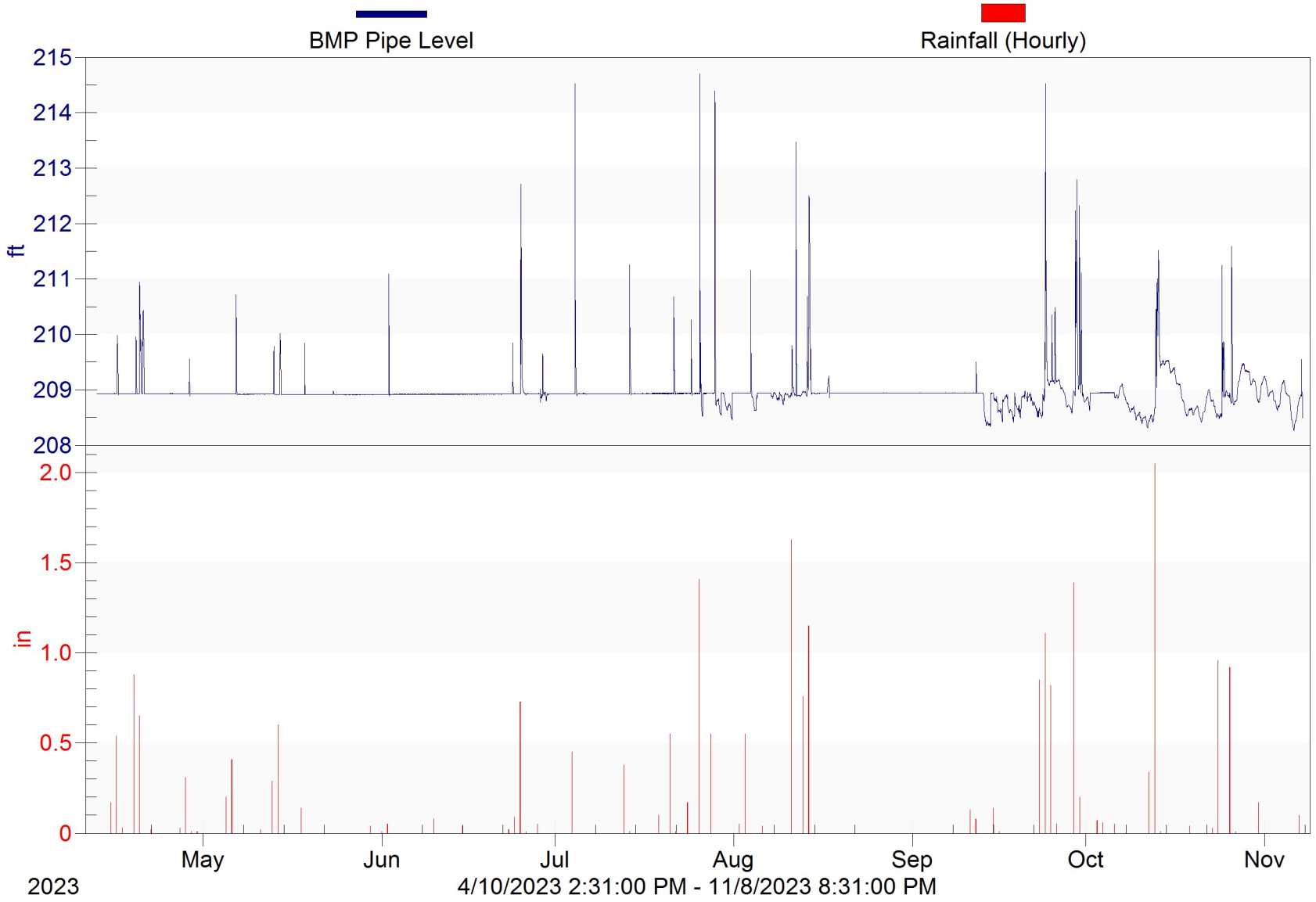


Chart A.12 Victoria

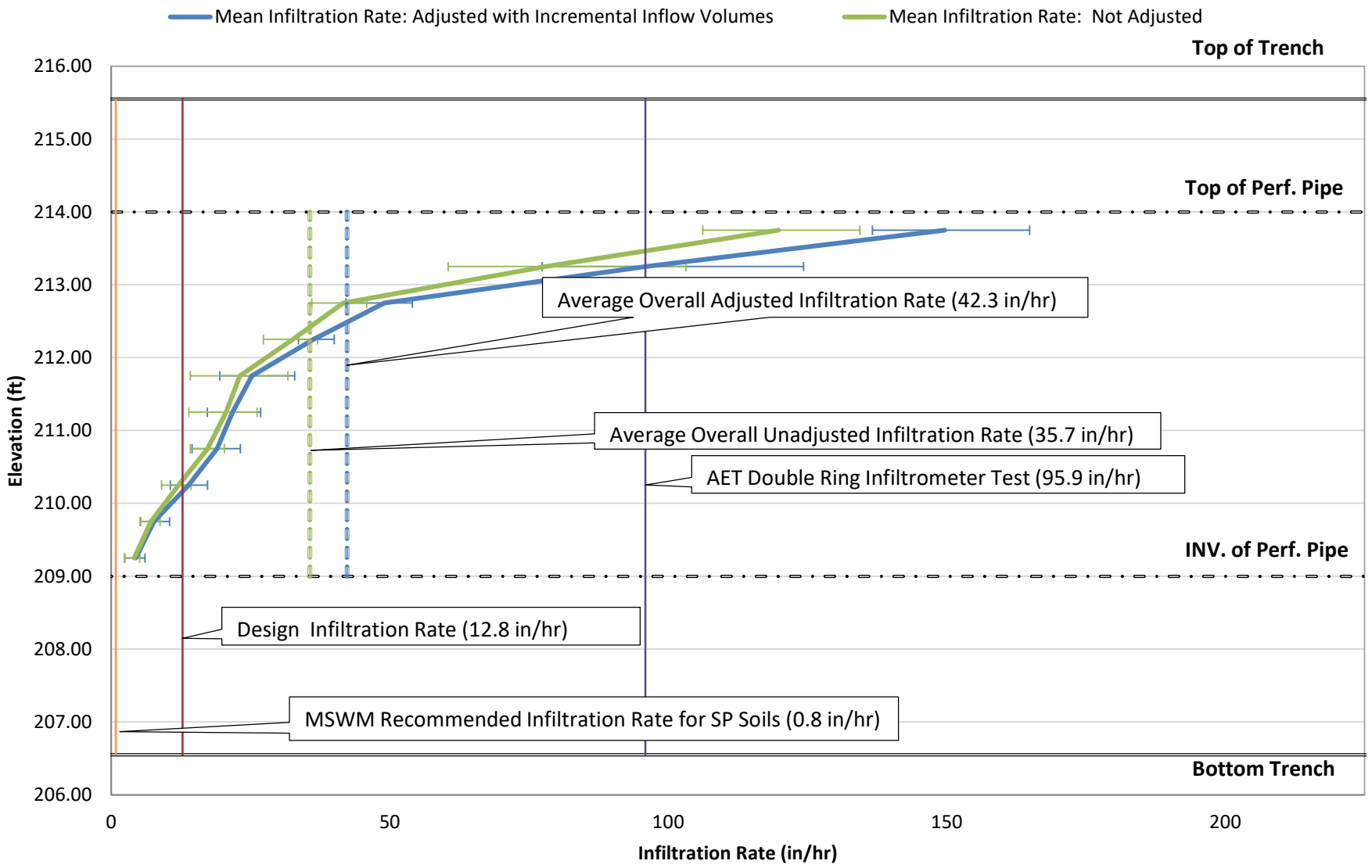
Water Level and Rainfall (SPCD)



City of Saint Paul
2023 Water Quality and Quantity Report
Chart A.13
WSB Job No.: 022099

Victoria Stage Infiltration Rate Graph

(Observed 0.5 Foot Height Increments)



Pipe Invert is 209
Error Bars Represent 25th and 75th Percentiles

City of Saint Paul
2023 Water Quality and Quantity Report
Chart A.14
WSB Job No.: 022099

Infiltration Rate
Victoria
Adjusted with Incremental Inflow Volumes

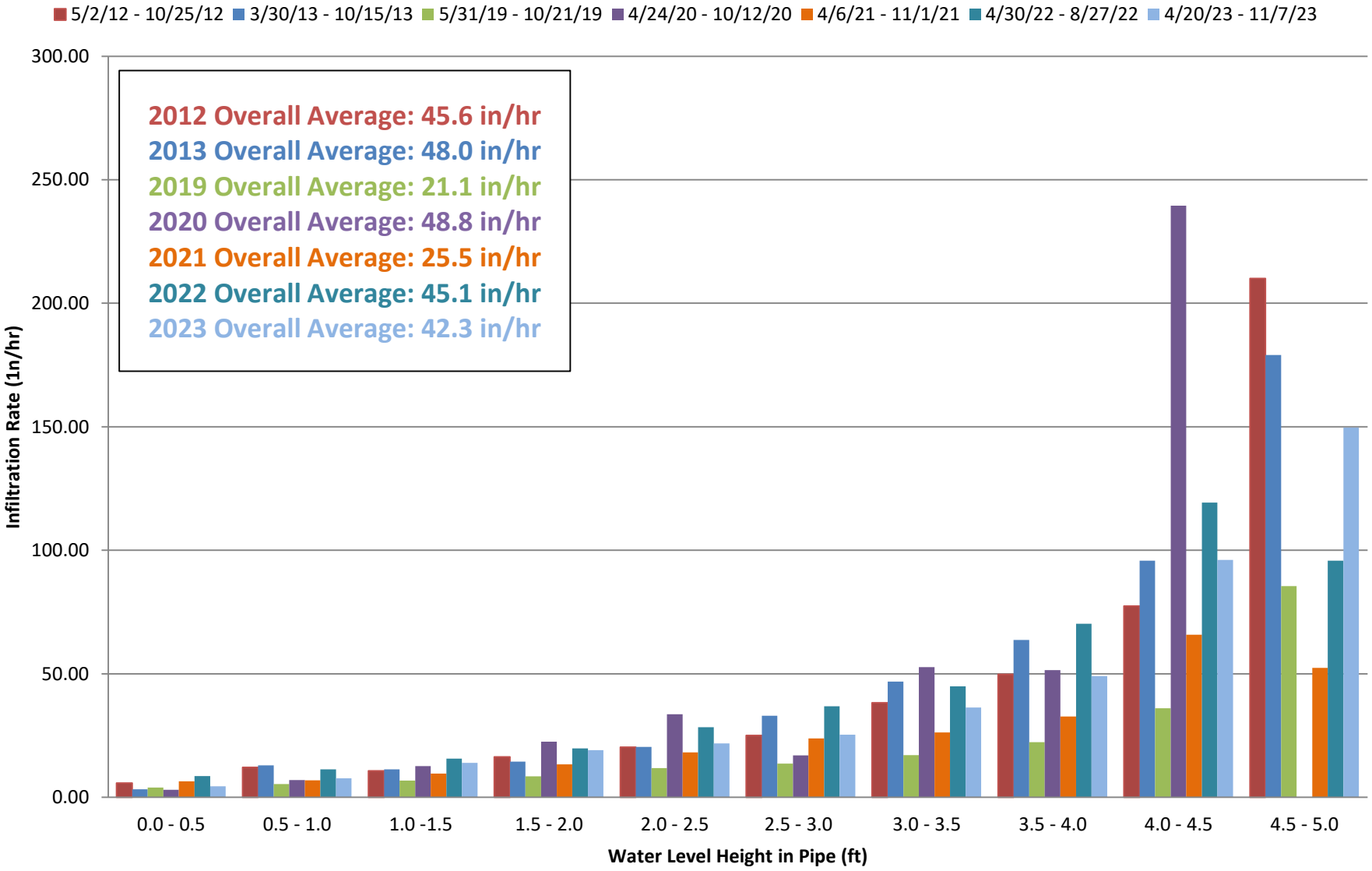


Chart B.1 Beacon Bluff

Flow Rates and Rainfall

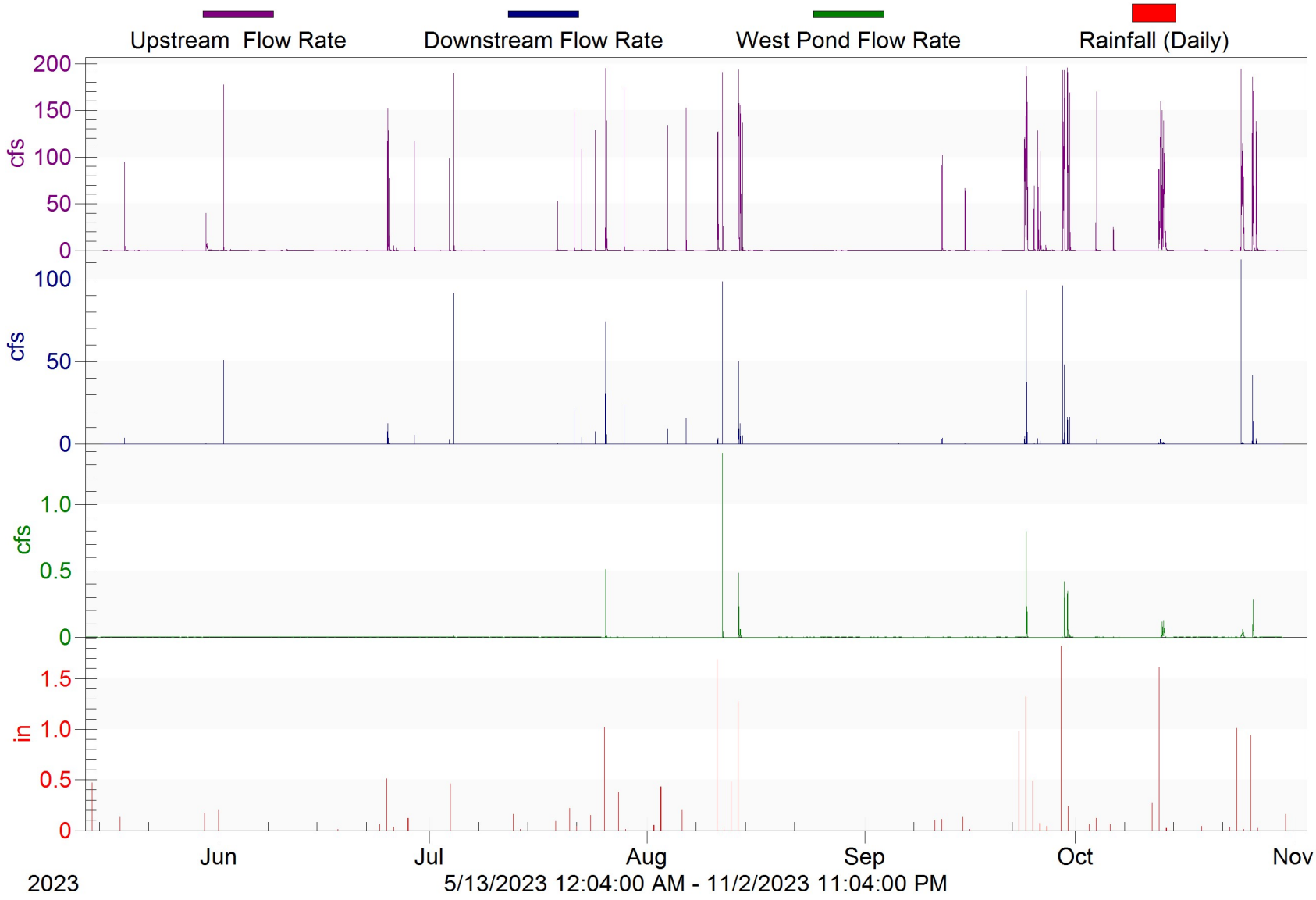


Chart B.2 St. Albans

Flow Rates and Rainfall

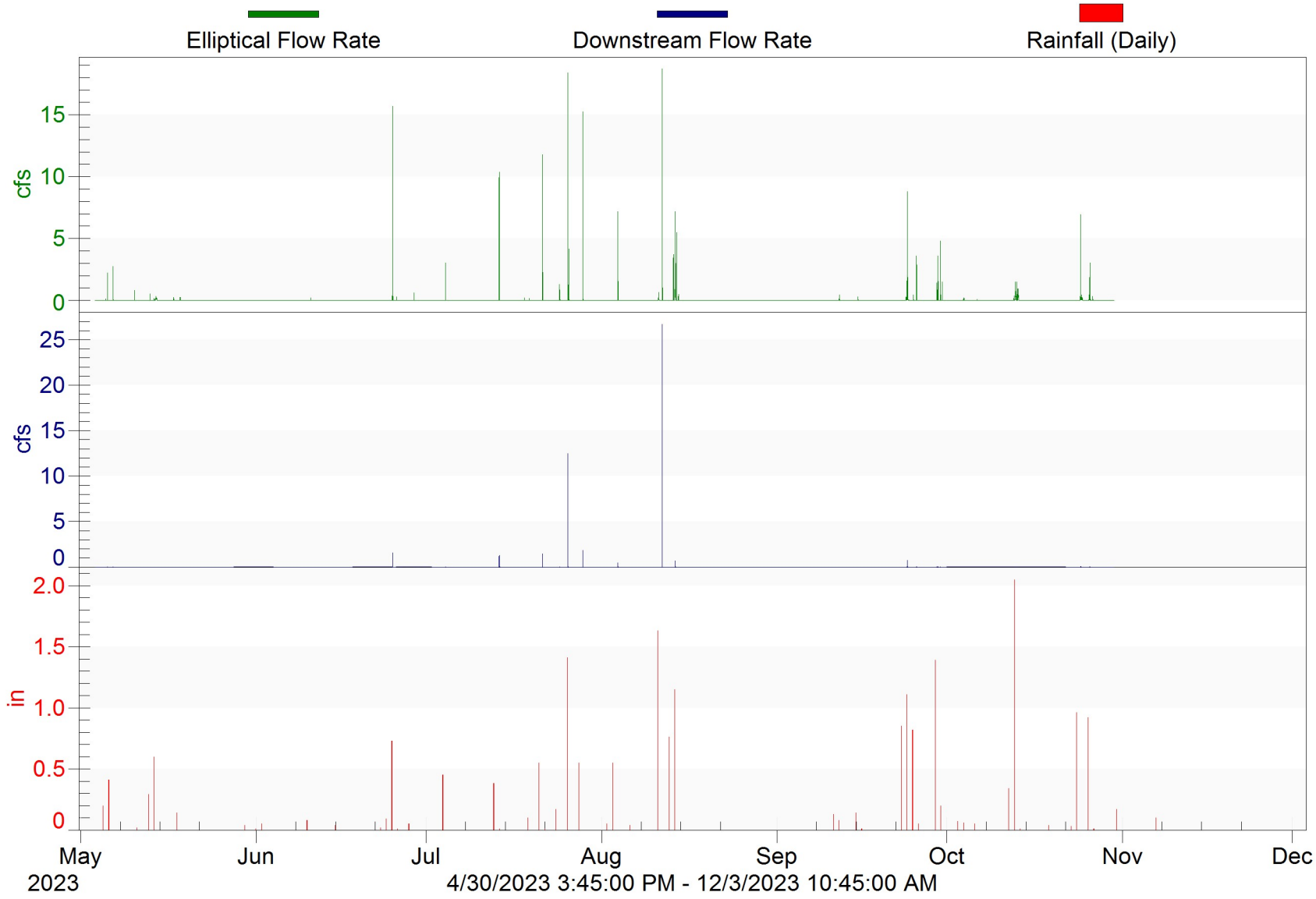


Chart B.3 Hampden Park

Flow Rates and Rainfall

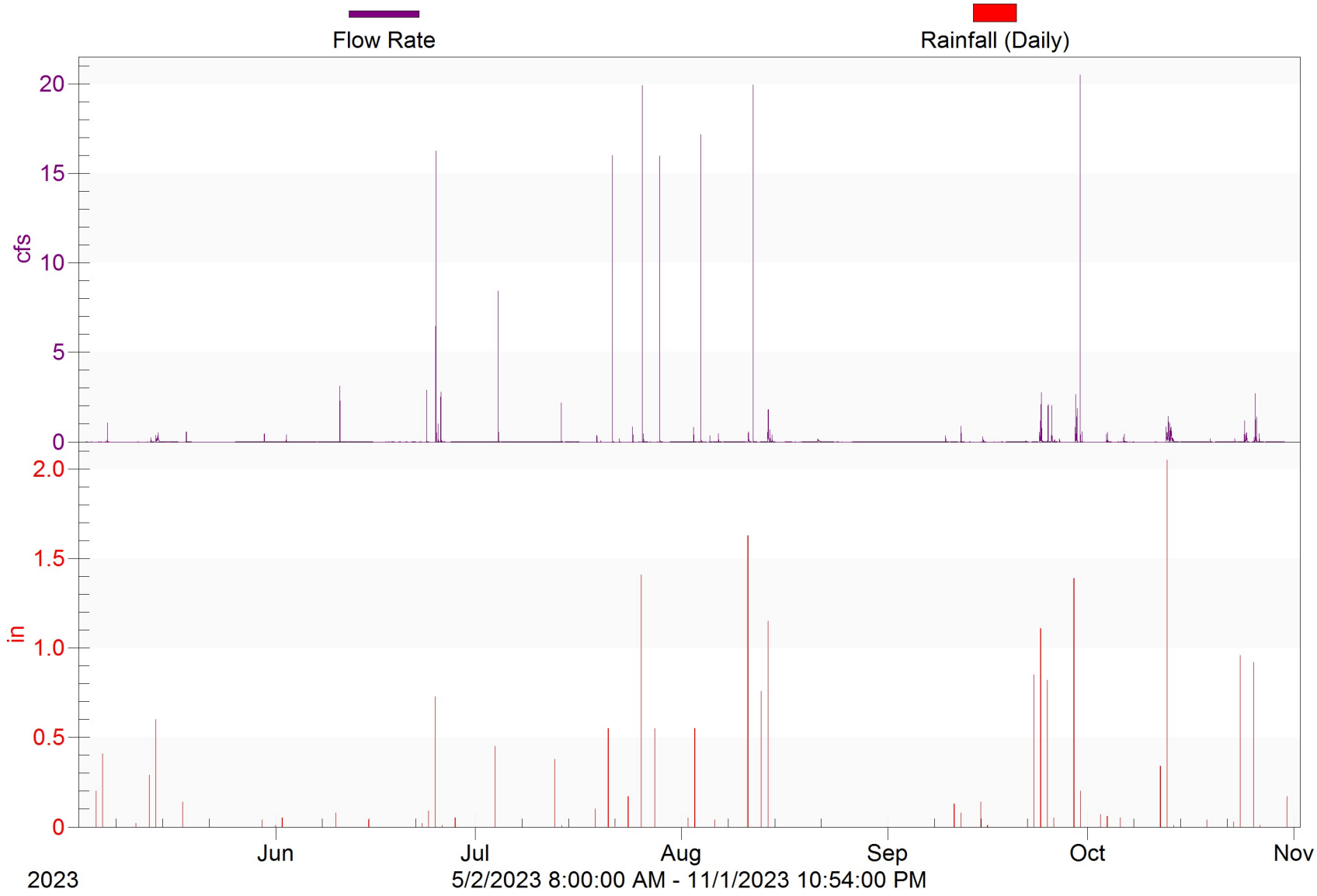


Chart B.4 Victoria

Flow Rates and Rainfall

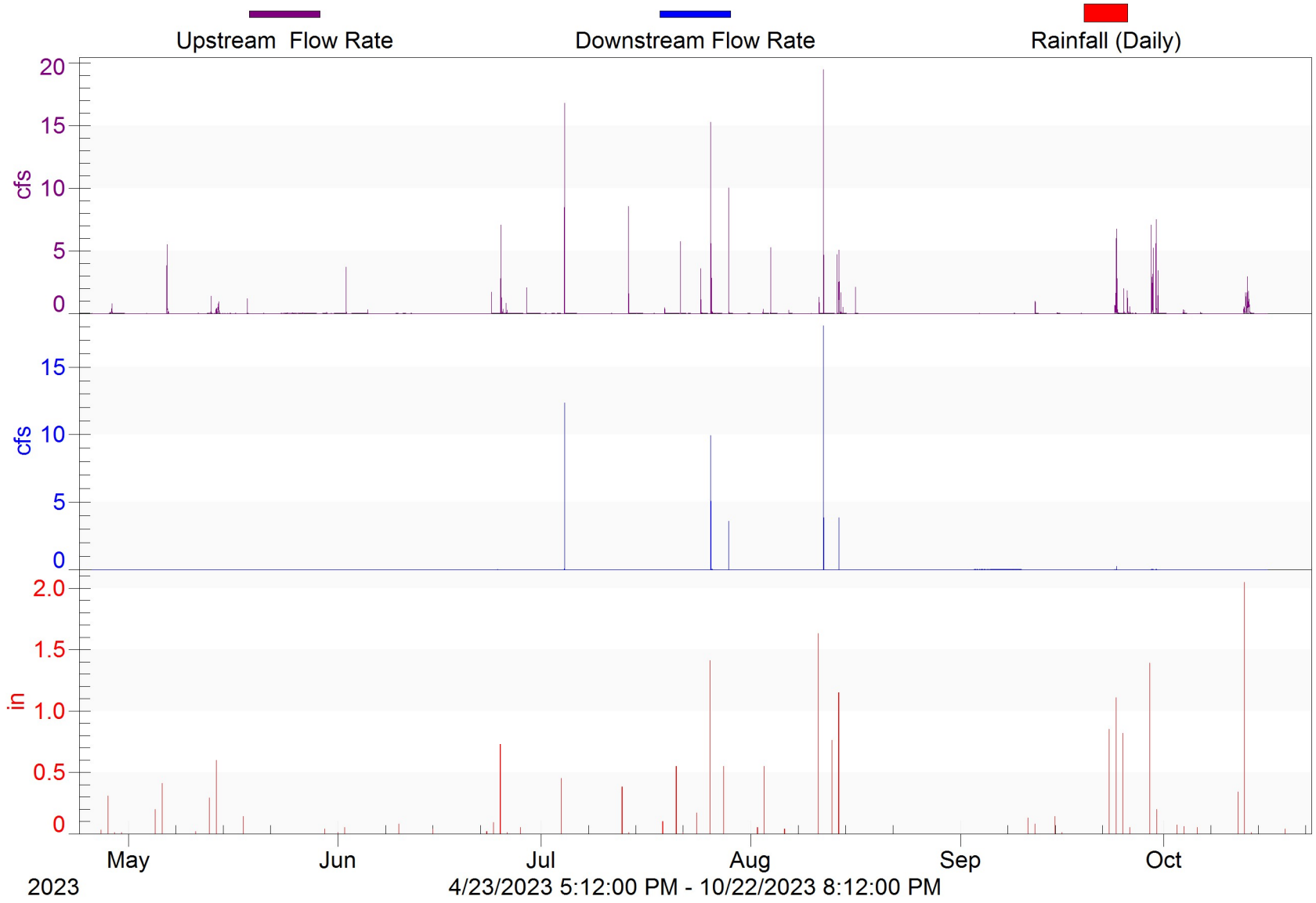


Chart B.5 West Shepard Pond

Flow Rates and Rainfall

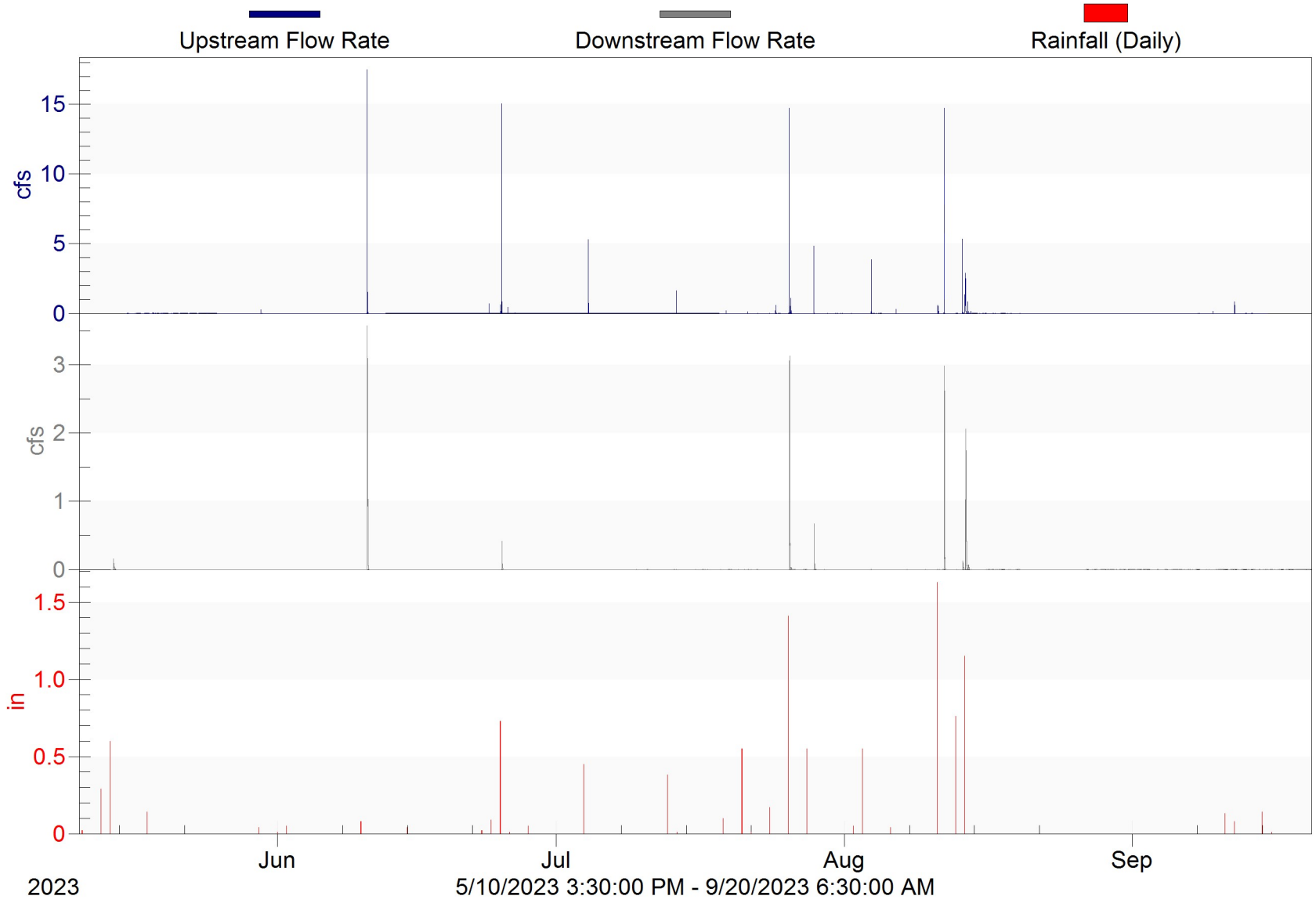
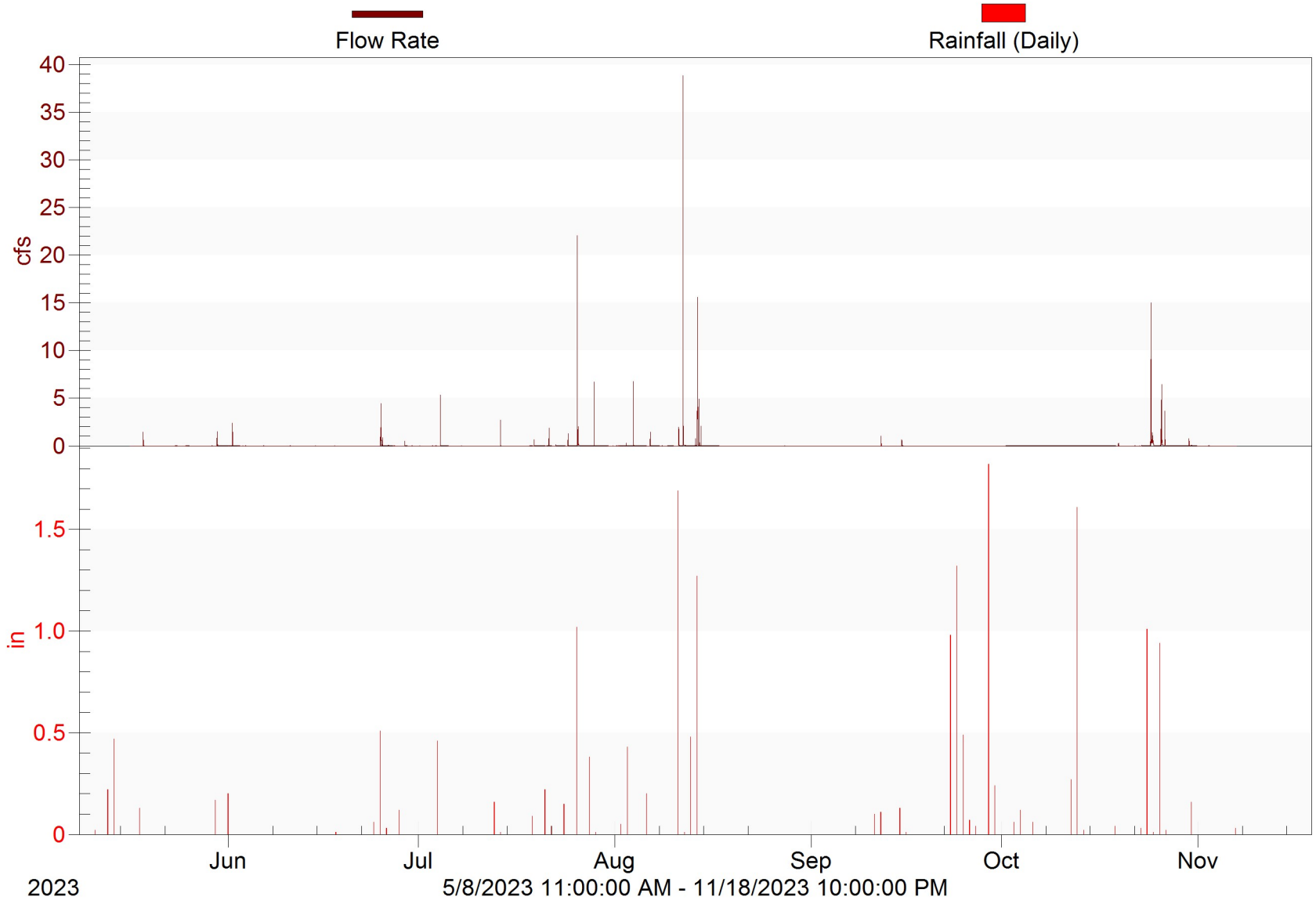


Chart B.6 Bush-Desoto

Flow Rates and Rainfall



City of Saint Paul
2023 Water Quality and Quantity Report
Table C.1
WSB Project Number: 022099

BEACON BLUFF WATER QUALITY SUMMARY

LAB ID	Date Composite Sampling Started	Date Composite Sampling Ended	TSS (mg/L)	TDS (mg/L)	VSS (mg/L)	TP (mg/L)	Ortho-P (mg/L)	Chloride (mg/L)	Ammonia as N (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate + Nitrite as N (mg/L)	Hardness as CaCO3 (mg/L)	Copper (ug/L)	Lead (ug/L)	Zinc (ug/L)	Total Organic Carbon (mg/L)	pH	COD (mg/L)	E. Coli (MPN/ 100 mL)
3137489	2/6/2023 14:05	2/6/2023 14:05	108.0	9010.0	60.0 <	0.89	0.105	6330.0	2.81	5.80	0.890	155	20.3	12.8	200.0	2.6	7.4	280.0	10900
3151264	4/3/2023 12:48	4/3/2023 12:48	44.0	96.0	22.0	0.20	0.070	32.1	0.20	1.00	0.260 <	45 <	8.2	11.7	44.1	5.1		63.0	
3168877	6/1/2023 15:46	6/1/2023 18:17	111.0	24.0 <	52.0	0.97	0.124	5.8	0.10	4.02	0.260 <	45 <	20.2	17.2	95.5	22.4		149.0	
3175771	6/25/2023 0:09	6/25/2023 8:57	130.0	200.0	85.0	1.18	0.282	7.6	0.06 <	5.87	0.260 <	45 <	18.8	9.5	109.0	86.3		372.0	
3184189	7/26/2023 1:29	7/26/2023 7:38	102.0	49.0	40.0	0.26	0.046	5.0 <	0.28	1.64	0.660 <	45 <	10.2	12.1	49.4	10.6		80.0	
3189527	8/11/2023 1:02	8/11/2023 3:57	112.0	91.0		0.41	0.112	5.0 <	0.06 <	2.32	0.700	45 <	13.0	10.3	66.8	17.4		117.0	
3190143	8/14/2023 9:23	8/14/2023 9:23															7.7		>2420 >
3202692	9/23/2023 18:01	9/24/2023 0:04	47.0	120.0		0.64	0.255	6.5	0.06 <	3.00	0.260 <	45 <	16.4	9.1	76.9	24.2		129.0	
3209422	10/12/2023 20:22	10/13/2023 4:15	26.0	40.0		0.33	0.154	5.0	0.06	1.18	0.260	45	5.7	3.7	43.9	11.7		51.0	
MINIMUM			**26.0**	**24.0**	**22.0**	**0.20**	**0.046**	**5.0**	**0.06**	**1.00**	**0.26**	**45.0**	**5.7**	**3.7**	**43.9**	**2.6**	**7.4**	**51.0**	**10900.0**
AVERAGE			**85.0**	**1203.8**	**51.8**	**0.61**	**0.144**	**799.6**	**0.45**	**3.10**	**0.44**	**58.8**	**14.1**	**10.8**	**85.7**	**22.5**	**7.6**	**155.1**	**10900.0**
MEDIAN			**105.0**	**93.5**	**52.0**	**0.53**	**0.118**	**6.2**	**0.08**	**2.66**	**0.26**	**45.0**	**14.7**	**11.0**	**71.9**	**14.6**	**7.6**	**123.0**	**10900.0**
MAXIMUM			**130.0**	**9010.0**	**85.0**	**1.18**	**0.282**	**6330.0**	**2.81**	**5.87**	**0.89**	**155.0**	**20.3**	**17.2**	**200.0**	**86.3**	**7.7**	**372.0**	**10900.0**

Laboratory analysis was completed by Metroplian Council Environmental Services

Grab Sample | Duplicate

< - Analyte not detected above the Method Detection Limit (MDL), MDL value reported

J - Result reported as estimated between the MDL and Reporting Limit (RL)

> - Analyte exceeded the maximum dection level (was not fully diluted prior to analysis)

City of Saint Paul
2023 Beacon Bluff Pollutant Loading
Table C.2
WSB Job No.: 022099

BEACON BLUFF VOLUME AND POLLUTANT REDUCTION SUMMARY

Event Time Interval		Sampling Data									Event Loading and Volume Data[1]														
		TSS	TDS	VSS	TP	Ortho-P	Chloride	Ammonia as N	Total Kjeldahl Nitrogen	Nitrate + Nitrite as N	Interval Rain	Volume Directed from Diversion Structure into Surface Basin (1)	Inflow Volume from West Pond (Subwatershed B - Discharges to Underground System) (2)	Inflow Volume from Eastern Inlet (Subwatershed C - Discharges to Surface Basin)[3] (3)	Underground System Discharged Volume (4)	Volume Captured by BMP (1+2+3)-4	% of Total Inflow to BMP from Diversion Structure	Overall Volume reduction	Captured TSS	Captured TDS	Captured VSS	Captured TP	Captured Ortho-P	Captured Chloride	Captured Ammonia as N	Captured Total Kjeldahl Nitrogen	Captured Nitrate + Nitrite as N
Start		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	In.	cf	cf	cf	cf	cf			lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
5/18/2023 13:28	5/18/2023 16:39	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.13	2440	0	210	0	2651	92.1%	57.6%	17.0	19.3	10.7	0.12	0.05	1.0	0.02	0.58	0.07
5/30/2023 4:16	5/30/2023 9:45	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.14	2934	1	140	0	3075	95.4%	100.0%	19.7	22.4	12.4	0.14	0.05	1.2	0.02	0.67	0.08
6/1/2023 15:41	6/1/2023 18:36	**111.0**	**24.0**	< **52.0**	**0.97**	**0.124**	**5.8**	**0.10**	**4.0**	**0.26**	0.20	4041	1	349	0	4391	92.0%	57.4%	30.4	6.6	14.3	0.27	0.03	1.6	0.03	1.10	0.07
6/25/2023 2:04	6/25/2023 10:03	**130.0**	**200.0**	**85.0**	**1.18**	**0.282**	**7.6**	**0.06**	< **5.9**	**0.26**	0.38	15360	2	1375	0	16737	91.8%	55.5%	135.8	209.0	88.8	1.23	0.29	7.9	0.06	6.13	0.27
6/25/2023 21:36	6/25/2023 23:15	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.02	525	1	25	0	551	95.3%	100.0%	3.5	4.0	2.2	0.02	0.01	0.2	0.00	0.12	0.01
6/26/2023 6:15	6/26/2023 7:57	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.02	243	0	12	0	255	95.3%	100.0%	1.6	1.9	1.0	0.01	0.00	0.1	0.00	0.06	0.01
7/4/2023 10:42	7/4/2023 13:57	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.45	3969	27	917	0	4913	80.7%	24.4%	31.5	35.8	19.8	0.22	0.08	1.9	0.03	1.07	0.13
7/19/2023 6:03	7/19/2023 7:20	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.06	2588	0	124	0	2711	95.4%	100.0%	17.4	19.8	10.9	0.12	0.05	1.0	0.02	0.59	0.07
7/19/2023 19:45	7/19/2023 22:03	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.03	162	1	8	0	170	95.0%	100.0%	1.1	1.2	0.7	0.01	0.00	0.1	0.00	0.04	0.00
7/21/2023 14:23	7/21/2023 16:32	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.22	3836	0	386	0	4222	90.8%	49.9%	27.1	30.8	17.0	0.19	0.07	1.6	0.03	0.92	0.11
7/22/2023 15:41	7/22/2023 17:38	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.04	3030	1	210	0	3241	93.5%	70.4%	20.8	23.6	13.1	0.15	0.06	1.3	0.02	0.70	0.09
7/24/2023 14:14	7/24/2023 17:45	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.15	3210	2	300	0	3512	91.4%	53.3%	22.5	25.6	14.1	0.16	0.06	1.4	0.02	0.76	0.09
7/26/2023 1:28	7/26/2023 4:05	**102.0**	**49.0**	**40.0**	**0.26**	**0.460**	**5.0**	< **0.28**	**1.2**	**0.66**	0.85	4028	789	969	5179	606	64.8%	2.8%	3.9	1.9	1.5	0.01	0.02	0.2	0.01	0.04	0.02
7/26/2023 4:58	7/26/2023 8:36	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.17	5778	21	421	0	6219	92.9%	67.3%	39.9	45.3	25.1	0.28	0.11	2.4	0.04	1.35	0.16
7/28/2023 16:59	7/28/2023 21:18	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.38	4123	0	525	0	4648	88.7%	40.4%	29.8	33.9	18.7	0.21	0.08	1.8	0.03	1.01	0.12
8/3/2023 21:33	8/4/2023 1:00	*103*	**116.7**	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.42	4486	0	352	0	4838	92.7%	62.6%	31.0	35.3	19.5	0.22	0.08	1.9	0.03	1.05	0.13
8/6/2023 13:22	8/6/2023 17:24	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.18	4443	0	547	0	4989	89.0%	41.6%	32.0	36.4	20.1	0.22	0.09	1.9	0.04	1.08	0.13
8/11/2023 0:30	8/11/2023 7:30	**112.0**	**91.0**	*65*	**0.41**	**0.112**	**5.0**	< **0.06**	< **2.3**	**0.70**	0.31	9533	0	695	0	10227	93.2%	67.1%	71.5	58.1	41.2	0.26	0.07	3.2	0.04	1.48	0.45
8/11/2023 17:28	8/11/2023 20:30	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	1.38	3881	2337	1171	0	7390	30.6%	26.4%	47.4	53.8	29.8	0.33	0.13	2.9	0.05	1.60	0.20
8/13/2023 21:27	8/14/2023 15:57	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	1.70	28388	2027	3891	32775	1532	81.7%	1.8%	9.8	11.2	6.2	0.07	0.03	0.6	0.01	0.33	0.04
9/11/2023 23:24	9/12/2023 3:13	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.21	12102	0	740	0	12842	94.2%	79.1%	82.3	93.6	51.7	0.57	0.22	5.0	0.09	2.79	0.34
9/15/2023 6:13	9/15/2023 9:35	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.10	7969	0	392	0	8360	95.3%	97.3%	53.6	60.9	33.7	0.37	0.14	3.2	0.06	1.82	0.22
9/23/2023 17:43	9/24/2023 6:29	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	2.21	90294	2885	8411	81744	19846	88.6%	10.6%	127.2	144.6	80.0	0.89	0.34	7.7	0.14	4.31	0.53
9/25/2023 2:10	9/25/2023 5:37	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.11	7090	0	339	0	7429	95.4%	99.9%	47.6	54.1	29.9	0.33	0.13	2.9	0.05	1.61	0.20
9/25/2023 14:38	9/25/2023 20:01	**47.0**	**120.0**	*65*	**0.64**	**0.255**	**6.5**	**0.06**	< **3.0**	**0.26**	0.29	14314	0	807	0	15121	94.7%	85.4%	44.4	113.3	60.9	0.60	0.24	6.1	0.06	2.83	0.25
9/25/2023 23:11	9/26/2023 4:18	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.10	12812	0	694	0	13506	94.9%	88.8%	86.6	98.4	54.4	0.60	0.23	5.2	0.10	2.93	0.36
9/27/2023 17:00	9/27/2023 20:42	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.04	189	0	9	0	199	95.4%	100.0%	1.3	1.4	0.8	0.01	0.00	0.1	0.00	0.04	0.01
9/29/2023 4:49	9/29/2023 13:00	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	1.36	45488	1908	4889	46820	5465	86.5%	5.0%	35.0	39.8	22.0	0.24	0.09	2.1	0.04	1.19	0.14
9/29/2023 20:55	9/30/2023 0:19	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.46	23402	1089	1868	21633	4726	88.3%	11.2%	30.3	34.4	19.0	0.21	0.08	1.8	0.03	1.03	0.13
9/30/2023 4:07	9/30/2023 8:07	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.22	9256	83	932	0	10271	90.0%	50.1%	65.8	74.8	41.4	0.46	0.18	4.0	0.07	2.23	0.27
10/3/2023 20:45	10/3/2023 23:18	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.06	2356	0	113	0	2469	95.4%	100.0%	15.8	18.0	9.9	0.11	0.04	1.0	0.02	0.54	0.07
10/4/2023 0:10	10/4/2023 1:40	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.12	8987	0	536	0	9523	94.4%	81.0%	61.0	69.4	38.4	0.43	0.16	3.7	0.07	2.07	0.25
10/6/2023 9:38	10/6/2023 11:57	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.05	1350	0	64	0	1415	95.4%	100.0%	9.1	10.3	5.7	0.06	0.02	0.5	0.01	0.31	0.04
10/12/2023 19:51	10/13/2023 7:50	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.95	85055	323	4727	0	90105	94.4%	86.6%	577.5	656.5	363.0	4.03	1.55	34.9	0.64	19.57	2.39
10/13/2023 8:12	10/13/2023 23:19	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.92	99245	1714	5067	79743	26283	93.5%	23.3%	168.5	191.5	105.9	1.18	0.45	10.2	0.19	5.71	0.70
10/19/2023 11:08	10/19/2023 13:49	**26.0**	**40.0**	*65*	**0.33**	**0.154**	**5.0**	**0.06**	< **1.2**	**0.26**	0.04	375	0	18	0	393	95.4%	100.0%	0.6	1.0	1.6	0.01	0.00	0.1	0.00	0.03	0.01
10/24/2023 11:36	10/25/2023 1:51	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.99	110519	841	5279	33546	83092	94.7%	71.2%	532.6	605.4	334.8	3.72	1.43	32.2	0.59	18.05	2.20
10/26/2023 3:24	10/26/2023 12:19	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.70	75522	1176	3607	28111	52194	94.0%	65.0%	334.5	380.3	210.3	2.34	0.90	20.2	0.37	11.34	1.38
10/26/2023 18:00	10/26/2023 22:05	*103*	*117*	*65*	*0.7*	*0.28*	*6.2*	*0.1*	*3*	*0.4*	0.21	23646	1	1130	0	24777	95.4%	100.0%	158.8	180.5	99.8	1.11	0.43	9.6	0.18	5.38	0.66
Sum											16.37	739,724	15,234	52,411	329,551	**477,818**			**3,045**	**3,525**	**1,942**	**21.64**	**8.080**	**185.8**	**3.3**	**105.1**	**12.5**
Average		88.0	87.3	59.0	0.63	0.231	5.8	0.10	2.9	0.40																	
Weighted Ave		102.7	116.7	64.5	0.72	0.276	6.2	0.11	3.48	0.42																	
STDEV		41.4	65.6	23.3	0.37	0.132	1.06	0.09	1.81	0.22																	
Median		106.5	70.0	52.0	0.53	0.205	5.40	0.06	2.66	0.26																	
Min		26.0	24.0	40.0	0.26	0.112	5.00	0.06	1.16	0.26																	
Max		130.0	200.0	85.0	1.18	0.460	7.60	0.28	5.87	0.70																	
Percent Capture of Total Runoff																**41%**			**41%**	**42%**	**41%**	**42%**	**40%**	**41%**	**39%**	**42%**	**40%**

< Sample Was not detected above the method detection limit (MDL) - MDL is reported
J Result reported as estimated between the MDL and the Reporting Limit (RL)
BOLD Sampled Event
GREY Events with no sampling data (weighted average used)
1 See Figure 2 for Locations of Subwatersheds
2 Erroneous flow data was recorded at the diversion upstream, on occasion, as a result of turbulent and high velocity flow. Runoff to the diversion was modeled for those events using a rainfall to runoff ratio developed using historical monitoring data. The events are shaded brown.
3 Volume calculated based on ratio of Subwatershed C area to Subwatershed A area - (4.66 ac)/(136.77 ac)*(Upstream Volume)

City of Saint Paul
2023 Water Quality and Quantity Report
Table C.3
WSB Project Number: 022099

SAINT ALBANS WATER QUALITY SUMMARY

LAB ID	Date Composite Sampling Started	Date Composite Sampling Ended	TSS (mg/L)	TDS (mg/L)	VSS (mg/L)	TP (mg/L)	Ortho-P (mg/L)	Chloride (mg/L)	Ammonia as N (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate + Nitrite as N (mg/L)	Hardness as CaCO3 (mg/L)	Copper (ug/L)	Lead (ug/L)	Zinc (ug/L)	Total Organic Carbon (mg/L)	pH	COD (mg/L)	E. Coli (MPN/ 100 mL)
3137487	2/6/2023 13:31	2/6/2023 13:31	376.0	13700.0	184.0	0.95	0.016	9470.0	2.79	11.00	1.430	375	69.5	36.2	863.0	9.0	7.10	1050.0	2
3151262	4/3/2023 10:18	4/3/2023 10:18	8.0	164.0	5.0	0.09	0.050	71.0	0.13	0.50	0.380 <	45 <	5.7	2.1	29.6	3.9		19.0	
3175775	6/25/2023 2:05	6/25/2023 3:16	237.0	67.0	98.0	0.85	0.148	7.6	0.06 <	4.06	0.260 <	45 <	27.5	37.7	147.0	14.8		195.0	
3178273	7/4/2023 10:33	7/4/2023 11:23	456.0	113.0	160.0	0.55	0.010 <	7.5	0.06 <	4.02	0.260 <	66	31.8	27.3	189.0	38.6		256.0	
3180774	7/13/2023 22:04	7/13/2023 22:28	435.0	97.0	151.0	0.87	0.010 <	5.0 <	0.06 <	4.81	0.260 <	46	35.7	52.9	205.0	45.7		307.0	
3200006	9/15/2023 6:13	9/15/2023 7:27	84.0		42.0	0.66	0.089	10.8	0.14	3.76		45 <	73.5	14.0	238.0			213.0	
3202686	9/23/2023 18:01	9/24/2023 1:36	58.0	58.0		0.31	0.045	5.0 <	0.06 <	1.94	0.260 <	45 <	15.3	11.9	79.0	16.2		93.0	
3202925	9/25/2023 14:28	9/25/2023 14:28																	411
3203606	9/25/2023 14:44	9/25/2023 17:18	82.0	27.0		0.26	0.022	5.0 <	0.08	1.38	0.260 <	45 <	15.9	19.5	92.2	3.5	7.60	313.0	
3204959	9/29/2023 4:43	9/29/2023 11:02	54.0	39.0		0.15	0.015	5.0 <	0.26	1.29	0.460	45 <	7.5	7.5	44.3	4.9		49.0	
3204962	9/29/2023 21:00	9/30/2023 4:51	298.0	25.0		0.23	0.025	5.0 <	0.34	1.64	0.390 <	45 <	7.6	16.0	48.9	3.9		54.0	
3205738	10/3/2023 23:53	10/4/2023 1:02	44.0		26.0														
3208796	10/13/2023 12:41	10/13/2023 12:41															7.60		131
3209418	10/13/2023 1:42	10/13/2023 10:44	29.0	24.0		0.15	0.040	5.0	0.06	0.65	0.420	45	5.2	4.4	32.3	3.2		36.0	
3209420	10/13/2023 11:56	10/13/2023 14:26	18.0	24.0		0.10	0.030	5.0	0.06	0.38	0.260	45	4.2	3.8	24.9	2.2		15.0	
MINIMUM			**8.0**	**24.0**	**5.0**	**0.1**	**0.0**	**5.0**	**0.1**	**0.4**	**0.3**	**45.0**	**4.2**	**2.1**	**24.9**	**2.2**	**7.1**	**15.0**	**2**
AVERAGE			**167.6**	**1303.5**	**95.1**	**0.4**	**0.0**	**800.2**	**0.3**	**3.0**	**0.4**	**74.3**	**25.0**	**19.4**	**166.1**	**13.3**	**7.4**	**216.7**	**181**
MEDIAN			**82.0**	**58.0**	**98.0**	**0.3**	**0.0**	**5.0**	**0.1**	**1.8**	**0.3**	**45.0**	**15.6**	**15.0**	**85.6**	**4.9**	**7.6**	**144.0**	**131**
MAXIMUM			**456.0**	**13700.0**	**184.0**	**0.9**	**0.1**	**9470.0**	**2.8**	**11.0**	**1.4**	**375.0**	**73.5**	**52.9**	**863.0**	**45.7**	**7.6**	**1050.0**	**411**

Laboratory analysis was completed by Metroplian Council Environmental Services

Grab Sample | Duplicate

< - Analyte not detected above the Method Detection Limit (MDL), MDL value reported
J - Result reported as estimated between the MDL and Reporting Limit (RL)
> - Analyte exceeded the maximum dection level (was not fully diluted prior to analysis)

City of Saint Paul
2023 St. Albans Volume Reduction Pollutant Loading
Table C.4
WSB Project No.: 022099

SAINT ALBANS INFILTRATION SYSTEM VOLUME REDUCTION AND POLLUTANT LOADING

Event Time Interval		Sampling Data									Event Loading and Volume Data												
		TSS	TDS	VSS	TP	Ortho-P	Chloride	Ammonia as N	Total Kjeldahl Nitrogen	Nitrate + Nitrite as N	Interval Rain	Eliptical Volume (1)	University 1 Volume (2)	Bypass Volume (3)	Volume Captured by BMP (1+2-3)	Captured TSS	Captured TDS	Captured VSS	Captured TP	Captured Ortho-P	Captured Chloride	Captured Ammonia as N	Captured Total Kjeldahl Nitrogen	Captured Nitrate + Nitrite as N
Start	**End**	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	In.	cu-ft	cu-ft	cu-ft	cu-ft	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
5/5/23 9:33	5/5/23 9:59	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.03	40	27	0	67	93.4	82.3	42.4	0.57	0.137	13.6	0.4	3.0	0.0
5/5/23 16:30	5/5/23 18:29	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.17	1840	1232	0	3072	23.9	9.9	22.9	0.07	0.009	1.1	1.1	1.1	0.1
5/6/23 16:08	5/6/23 17:59	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.39	4744	3178	0	7922	61.6	25.6	59.0	0.17	0.022	2.7	2.7	2.7	0.1
5/13/23 4:48	5/13/23 9:45	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.18	1096	734	0	1830	14.2	5.9	13.6	0.04	0.005	0.6	0.6	0.6	0.0
5/13/23 22:17	5/14/23 11:45	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.66	4693	3144	0	7837	60.9	25.3	58.4	0.17	0.022	2.7	2.7	2.7	0.1
5/18/23 13:18	5/18/23 16:00	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.14	669	448	0	1118	8.7	3.6	8.3	0.02	0.003	0.4	0.4	0.4	0.0
5/30/23 5:15	5/30/23 16:30	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.04	338	227	0	565	4.4	1.8	4.2	0.01	0.002	0.2	0.2	0.2	0.0
6/2/23 4:00	6/2/23 10:40	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.05	115	77	0	193	1.5	0.6	1.4	0.00	0.001	0.1	0.1	0.1	0.0
6/10/23 15:02	6/10/23 16:04	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.08	250	168	0	418	3.3	1.3	3.1	0.01	0.001	0.1	0.1	0.1	0.0
6/25/23 0:04	6/25/23 4:00	**237.0**	**67.0**	**98.0**	**0.85**	**0.148**	**7.6**	**0.06**	**<**	**4.1**	**0.26**	**<**	0.68	8884	5952	0	14836	219.5	62.1	90.8	0.79	0.137	7.0	0.1	3.8	0.2
6/25/23 19:03	6/25/23 19:31	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.05	186	125	0	311	2.4	1.0	2.3	0.01	0.001	0.1	0.1	0.1	0.0
6/28/23 20:15	6/28/23 20:45	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.05	255	171	0	426	3.3	1.4	3.2	0.01	0.001	0.1	0.1	0.1	0.0
7/4/23 10:30	7/4/23 11:45	**456.0**	**113.0**	**160.0**	**0.55**	**0.010**	**7.5**	**0.06**	**<**	**4.0**	**0.26**	**<**	0.44	3947	2644	0	6591	187.6	46.5	65.8	0.23	0.004	3.1	0.0	1.7	0.1
7/13/23 22:00	7/13/23 22:30	**435.0**	**97.0**	**151.0**	**0.87**	**0.010**	**5.0**	**0.06**	**<**	**4.8**	**0.26**	**<**	0.38	3807	2551	0	6357	172.6	38.5	59.9	0.35	0.004	2.0	0.0	1.9	0.1
7/19/23 5:54	7/19/23 6:30	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.07	162	109	0	271	2.1	0.9	2.0	0.01	0.001	0.1	0.1	0.1	0.0
7/21/23 14:00	7/21/23 14:39	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.55	6346	4252	85	10512	81.7	33.9	78.3	0.23	0.030	3.6	3.6	3.6	0.2
7/24/23 14:04	7/24/23 14:45	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.14	791	530	0	1321	10.3	4.3	9.8	0.03	0.004	0.5	0.5	0.5	0.0
7/26/23 1:23	7/26/23 3:00	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	1.2	14417	9659	8730	15346	119.3	49.5	114.3	0.33	0.043	5.2	5.2	5.2	0.3
7/26/23 4:58	7/26/23 5:34	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.16	2019	1352	0	3371	26.2	10.9	25.1	0.07	0.009	1.2	1.2	1.2	0.1
7/28/23 16:56	7/28/23 17:58	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.55	7331	4912	112	12131	94.3	39.1	90.4	0.26	0.034	4.1	4.1	4.1	0.2
8/3/23 21:36	8/3/23 22:33	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.55	4253	2850	0	7103	55.2	22.9	52.9	0.15	0.020	2.4	2.4	2.4	0.1
8/11/23 0:44	8/11/23 3:15	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.32	1760	1179	0	2940	22.9	9.5	21.9	0.06	0.008	1.0	1.0	1.0	0.1
8/11/23 17:25	8/11/23 18:43	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	1.3	24517	16427	15581	25363	197.1	81.8	189.0	0.55	0.071	8.7	8.7	8.7	0.5
8/13/23 16:36	8/13/23 17:15	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.32	3114	2086	0	5200	40.4	16.8	38.7	0.11	0.015	1.8	1.8	1.8	0.1
8/13/23 22:23	8/14/23 3:04	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	1.17	18371	12309	401	30279	235.4	97.7	225.6	0.65	0.085	10.4	10.4	10.4	0.6
8/14/23 6:20	8/14/23 7:44	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.29	2649	1775	0	4424	34.4	14.3	33.0	0.10	0.012	1.5	1.5	1.5	0.1
8/14/23 13:51	8/14/23 14:45	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.11	676	453	0	1130	8.8	3.6	8.4	0.02	0.003	0.4	0.4	0.4	0.0
9/11/23 23:28	9/12/23 3:40	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.21	1382	926	0	2308	17.9	7.4	17.2	0.05	0.006	0.8	0.8	0.8	0.0
9/15/23 6:09	9/15/23 7:31	**84.0**	*52*	**42.0**	**0.66**	**0.089**	**10.8**	**0.14**	**3.8**	**0.26**	**<**	0.11	645	432	0	1077	5.6	3.5	2.8	0.04	0.006	0.7	0.0	0.3	0.0
9/23/23 17:57	9/24/23 4:49	**58.0**	**58.0**	*119*	**0.31**	**0.045**	**5.0**	**0.06**	**<**	**1.9**	**0.26**	**<**	1.87	21919	14686	432	36172	131.0	131.0	269.5	0.70	0.102	11.3	0.1	4.4	0.6
9/25/23 1:19	9/25/23 3:32	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.2	730	489	0	1220	9.5	3.9	9.1	0.03	0.003	0.4	0.4	0.4	0.0
9/25/23 14:40	9/25/23 17:45	**82.0**	**57.0**	*119*	**0.26**	**0.022**	**5.0**	**0.08**	**1.4**	**0.26**	**<**	0.58	6988	4682	0	11669	59.7	41.5	86.9	0.19	0.016	3.6	0.1	1.0	0.2
9/29/23 4:39	9/29/23 11:30	**54.0**	**39.0**	*119*	**0.15**	**0.015**	**5.0**	**0.26**	**1.3**	**0.46**	1	7333	4913	0	12246	41.3	29.8	91.2	0.11	0.011	3.8	0.2	1.0	0.4
9/29/23 20:53	9/29/23 23:00	**298.0**	**25.0**	*119*	**0.23**	**0.025**	**5.0**	**0.34**	**1.6**	**0.39**	**<**	0.39	4328	2900	0	7228	134.5	11.3	53.9	0.10	0.011	2.3	0.2	0.7	0.2
9/30/23 4:06	9/30/23 5:45	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.19	1879	1259	0	3137	24.4	10.1	23.4	0.07	0.009	1.1	1.1	1.1	0.1
10/3/23 21:00	10/4/23 1:15	**44.0**	*52*	**26.0**	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.13	444	297	0	741	2.0	2.4	1.2	0.02	0.002	0.3	0.3	0.3	0.0
10/6/23 9:45	10/6/23 13:15	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.05	56	38	0	94	0.7	0.3	0.7	0.00	0.000	0.0	0.0	0.0	0.0
10/12/23 19:45	10/13/23 6:45	**29.0**	**24.0**	*119*	**0.15**	**0.040**	**5.0**	**0.06**	**0.7**	**0.42**	1.15	7740	5186	0	12926	23.4	19.4	96.3	0.12	0.032	4.0	0.0	0.5	0.3
10/13/23 8:15	10/13/23 19:57	**18.0**	**24.0**	*119*	**0.10**	**0.030**	**5.0**	**0.06**	**0.4**	**0.26**	1.19	10958	7342	0	18301	20.6	27.4	136.3	0.11	0.034	5.7	0.1	0.4	0.3
10/24/23 13:45	10/25/23 0:44	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.94	8476	5675	0	14151	110.0	45.7	105.4	0.30	0.040	4.8	4.8	4.8	0.3
10/26/23 3:52	10/26/23 9:00	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.78	9036	6054	0	15090	117.3	48.7	112.4	0.33	0.042	5.2	5.2	5.2	0.3
10/26/23 17:53	10/26/23 18:30	*125*	*52*	*119*	*0.3*	*0.05*	*5*	*5*	*5*	*0.3*	0.06	315	211	0	526	4.1	1.7	3.9	0.01	0.001	0.2	0.2	0.2	0.0
Sum											18.92	199500	133661	25341	**307821**	2487	1075	2335	7.20	1.002	118.9	62.9	80.3	5.8
Average		163.2	56.0	95.4	0.41	0.043	6.1	0.12	2.39	0.31														
Weighted Avg		124.5	51.7	119.3	0.35	0.045	5.5	0.10	1.97	0.30														
STDEV		165.0	32.3	61.1	0.30	0.044	2.0	0.10	1.61	0.08														
Min		18.0	24.0	26.0	0.10	0.010	5.0	0.06	0.38	0.26														
Max		456.0	113.0	160.0	0.87	0.148	10.8	0.34	4.81	0.46														
Percent Capture															**92.4%**	**89.3%**	**92.9%**	**87.4%**	**93.2%**	**99.4%**	**97.0%**	**79.0%**	**85.0%**	**85.9%**

< Sample was not detected above the method detection limit (value reported)

GREY FONT Events with no sampling data (weighted average concentration used)

BOLD Sampling evı Sampled Event

1 University Volumes after are estimated flow based on the relationship between the elipital and unvisity volumes for previous flow events

City of Saint Paul
2023 Water Quality and Quantity Report
Table C.5
WSB Project Number: 022099

HAMPDEN WATER QUALITY SUMMARY

LAB ID	Date Composite Sampling Started	Date Composite Sampling Ended	TSS (mg/L)	TDS (mg/L)	VSS (mg/L)	TP (mg/L)	Ortho-P (mg/L)	Chloride (mg/L)	Ammonia as N (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate + Nitrite as N (mg/L)	Hardness as CaCO3 (mg/L)	Copper (ug/L)	Lead (ug/L)	Zinc (ug/L)	Total Organic Carbon (mg/L)	pH	COD (mg/L)	E. Coli (MPN/ 100 mL)
3137491	2/6/2023 14:22	2/6/2023 14:22	72.0	11400.0	34.0	0.22	0.010 <	8860.0	1.25	3.50	0.710	151	18.2	7.2	205.0	3.5	7.00	222.0	2
3151266	4/3/2023 12:14	4/3/2023 12:14	26.0	53.0	10.0	0.10	0.018	15.0	0.14	0.45	0.260 <	45 <	5.4	2.3	36.3	2.6		47.0	
3171575	6/10/2023 14:50	6/10/2023 15:31	610.0	112.0	171.0	1.09	0.013	11.1	0.31	6.26	0.260 <	122	46.6	43.5	340.0	28.4		400.0	
3178269	7/4/2023 10:29	7/4/2023 11:04	794.0	58.0	104.0	0.29	0.010 <	5.0 <	0.16	1.90	0.380 <	45 <	14.1	15.7	97.8	6.1		102.0	
3184523	7/26/2023 1:20	7/26/2023 1:59	127.0	24.0 <	33.0	0.19	0.023	5.0 <	0.26	1.33	0.350 <	45 <	8.0	14.6	56.5	2.8		53.0	
3187638	8/3/2023 21:19	8/3/2023 22:30	179.0	46.0		0.21		5.0 <	0.18	1.35		45 <	9.4	13.7	77.1	5.8		75.0	
3190140	8/11/2023 17:20	8/11/2023 18:18	139.0	37.0		0.34	0.072	5.0 <	0.10	3.10	0.270	45 <	9.6	23.4	75.2	2.5		79.0	
3200008	9/15/2023 5:53	9/15/2023 9:53	69.0		26.0	0.29	0.101	10.8	0.55	1.83		45 <	14.0	8.4	87.7			121.0	
3202694	9/23/2023 17:23	9/24/2023 1:36	86.0	67.0		0.53	0.035	7.8	0.06 <	1.95	0.260 <	45 <	14.6	8.9	110.0	15.4		108.0	
3202928	9/25/2023 15:03	9/25/2023 15:03																	>2420 >
3204970	9/29/2023 4:23	9/29/2023 11:12	67.0	27.0		0.13	0.014	5.0	0.28	1.10	0.680	45	5.0	5.2	46.6	3.3		45.0	
3204972	9/29/2023 20:46	9/29/2023 20:58	438.0	24.0		0.39	0.028	5.0	0.32	2.47	0.370	45	10.5	28.5	78.3	2.8		91.0	
3208798	10/13/2023 12:21	10/13/2023 12:21															7.8		>2420 >
MINIMUM			**26.0**	**24.0**	**10.0**	**0.1**	**0.0**	**5.0**	**0.1**	**0.5**	**0.3**	**45.0**	**5.0**	**2.3**	**36.3**	**2.5**	**7.0**	**45.0**	**2.0**
AVERAGE			**237.0**	**1184.8**	**63.0**	**0.3**	**0.0**	**812.2**	**0.3**	**2.3**	**0.4**	**61.6**	**14.1**	**15.6**	**110.0**	**7.3**	**7.4**	**122.1**	**2.0**
MEDIAN			**127.0**	**49.5**	**33.5**	**0.3**	**0.0**	**5.0**	**0.3**	**1.9**	**0.4**	**45.0**	**10.5**	**13.7**	**78.3**	**3.4**	**7.4**	**91.0**	**2.0**
MAXIMUM			**794.0**	**11400.0**	**171.0**	**1.1**	**0.1**	**8860.0**	**1.3**	**6.3**	**0.7**	**151.0**	**46.6**	**43.5**	**340.0**	**28.4**	**7.8**	**400.0**	**2.0**

Laboratory analysis was completed by Metroplian Council Environmental Services
Grab Sample Duplicate
< - Analyte not detected above the Method Detection Limit (MDL), MDL value reported
J - Result reported as estimated between the MDL and Reporting Limit (RL)
> - Analyte exceeded the maximum dection level (was not fully diluted prior to analysis)

City of Saint Paul
2023 Water Quality and Quantity Report
Table C.6
WSB Project No.: 022099

HAMPDEN PARK VOLUME AND POLLUTANT REDUCTION SUMMARY

Event Time Interval		Sampling Data									Event Loading and Volume Data													
		TSS	TDS	VSS	TP	Ortho-P	Chloride	Ammonia as N	Total Kjeldahl Nitrogen	Nitrate + Nitrite as N	Interval Rain	Hampden/Raymond Inflow Volume (1)	Eastern Hampden Modeled Inflow Volume[1] (2)	Bypass Volume2 (3)	Volume Captured by BMP (1+2-3)	Percent Captured	Captured TSS	Captured TDS	Captured VSS	Captured TP	Captured Ortho-P	Captured Chloride	Captured Ammonia as N	Captured Total Kjeldahl Nitrogen	Captured Nitrate + Nitrite as N
Start	**End**	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	In.	cu-ft	cu-ft	cu-ft	cu-ft		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
5/6/23 15:57	5/6/23 18:00	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.26	1813	299	0	2112	100%	29.1	5.4	8.4	0.04	0.005	0.75	0.03	0.29	0.05
5/13/23 4:00	5/13/23 7:15	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.07	593	98	0	691	100%	9.5	1.8	2.8	0.01	0.002	0.25	0.01	0.09	0.02
5/13/23 22:10	5/14/23 11:15	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.62	6839	1128	0	7967	100%	110.0	20.4	31.8	0.16	0.020	2.83	0.10	1.08	0.18
5/18/23 11:15	5/18/23 15:00	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.21	1449	239	0	1688	100%	23.3	4.3	6.7	0.03	0.004	0.60	0.02	0.23	0.04
5/30/23 6:15	5/30/23 7:27	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.03	761	125	0	886	100%	12.2	2.3	3.5	0.02	0.002	0.32	0.01	0.12	0.02
6/10/23 14:45	6/10/23 15:51	**610.0**	**112.0**	**171.0**	**1.09**	**0.013**	**11.1**	**0.31**	**6.26**	**0.26**	0.44	3863	637	0	4501	100%	171.4	31.5	48.0	0.31	0.004	3.12	0.09	1.76	0.07
6/23/23 15:03	6/23/23 18:45	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.27	2303	380	0	2683	100%	37.0	6.9	10.7	0.05	0.007	0.95	0.03	0.36	0.06
6/24/23 23:33	6/25/23 0:18	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.54	3052	504	0	3556	100%	49.1	9.1	14.2	0.07	0.009	1.26	0.04	0.48	0.08
6/25/23 1:50	6/25/23 3:39	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.73	10351	1708	0	12059	100%	166.4	30.9	48.2	0.25	0.030	4.29	0.15	1.64	0.27
6/25/23 8:45	6/25/23 10:07	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.10	825	136	0	961	100%	13.3	2.5	3.8	0.02	0.002	0.34	0.01	0.13	0.02
6/25/23 18:59	6/26/23 7:30	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.27	2118	349	0	2467	100%	34.0	6.3	9.9	0.05	0.006	0.88	0.03	0.33	0.05
7/4/23 10:25	7/4/23 11:50	**794.0**	**58.0**	**104.0**	**0.29**	**0.010**	**< 5.0**	**< 0.16**	**1.90**	**0.38**	0.74	6538	1079	0	7616	100%	377.5	27.6	49.4	0.14	0.005	2.38	0.08	0.90	0.18
7/13/23 21:56	7/13/23 22:44	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.18	792	131	0	923	100%	12.7	2.4	3.7	0.02	0.002	0.33	0.01	0.13	0.02
7/19/23 5:38	7/19/23 8:45	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.08	583	96	0	679	100%	9.4	1.7	2.7	0.01	0.002	0.24	0.01	0.09	0.02
7/19/23 19:00	7/19/23 19:46	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.02	84	14	0	98	100%	1.4	0.3	0.4	0.00	0.000	0.03	0.00	0.01	0.00
7/21/23 13:49	7/21/23 14:35	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.35	4641	766	0	5407	100%	74.6	13.9	21.6	0.11	0.013	1.92	0.07	0.73	0.12
7/22/23 15:37	7/22/23 16:15	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.03	212	35	0	247	100%	3.4	0.6	1.0	0.01	0.001	0.09	0.00	0.03	0.01
7/24/23 14:00	7/24/23 18:15	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.16	935	154	0	1089	100%	15.0	2.8	4.4	0.02	0.003	0.39	0.01	0.15	0.02
7/26/23 1:15	7/26/23 7:08	**127.0**	**24.0 <**	**33.0**	**0.19**	**0.023**	**5.0**	**< 0.26**	**1.33**	**0.35**	1.41	20323	3353	0	23676	100%	187.7	35.5	48.8	0.28	0.034	7.39	0.38	1.97	0.52
7/28/23 16:41	7/28/23 18:00	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.71	8056	1329	0	9385	100%	129.5	24.0	37.5	0.19	0.023	3.34	0.12	1.27	0.21
8/2/23 18:42	8/2/23 21:15	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.15	1695	280	0	1974	100%	27.2	5.1	7.9	0.04	0.005	0.70	0.02	0.27	0.04
8/3/23 21:31	8/3/23 23:02	**179.0**	**46.0**	*64*	**0.21**	*0.04*	**5.0**	**< 0.18**	**1.35**	*0.4*	0.80	7843	1294	0	9137	100%	102.1	26.2	36.5	0.12	0.023	2.85	0.10	0.77	0.20
8/5/23 5:54	8/5/23 7:45	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.12	364	60	0	424	100%	5.8	1.1	1.7	0.01	0.001	0.15	0.01	0.06	0.01
8/6/23 12:22	8/6/23 17:00	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.09	1010	167	0	1177	100%	16.2	3.0	4.7	0.02	0.003	0.42	0.01	0.16	0.03
8/11/23 0:15	8/11/23 7:30	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.30	3119	515	0	3634	100%	50.1	9.3	14.5	0.07	0.009	1.29	0.04	0.49	0.08
8/11/23 17:20	8/11/23 18:45	**139.0**	**37.0**	*64*	**0.31**	*0.072*	**5.0**	**< 0.10**	**3.10**	**0.27**	1.46	22327	3684	0	26012	100%	225.7	60.1	103.9	0.50	0.117	8.12	0.16	5.03	0.44
8/13/23 22:22	8/14/23 2:52	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	1.07	8516	1405	0	9921	100%	136.9	25.4	39.6	0.20	0.024	3.53	0.12	1.35	0.22
8/14/23 6:00	8/14/23 15:45	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.25	3424	565	0	3989	100%	55.0	10.2	15.9	0.08	0.010	1.42	0.05	0.54	0.09
9/11/23 23:06	9/12/23 2:15	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.20	2212	365	0	2577	100%	35.6	6.6	10.3	0.05	0.006	0.92	0.03	0.35	0.06
9/15/23 5:56	9/15/23 11:45	**69.0**	*41*	**26.0**	**0.29**	**0.101**	**10.8**	**0.55**	**1.83**	*0.4*	0.12	1198	198	0	1396	100%	6.0	3.6	2.3	0.03	0.009	0.94	0.05	0.16	0.03
9/23/23 17:48	9/24/23 4:35	**86.0**	**67.0**	*64*	**0.53**	*0.04*	**7.8**	**0.06**	**< 1.95**	**0.26**	1.42	13111	2163	0	15275	100%	82.0	63.9	61.0	0.51	0.038	7.44	0.06	1.86	0.25
9/24/23 23:00	9/25/23 2:47	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.35	3587	592	0	4178	100%	57.7	10.7	16.7	0.09	0.010	1.49	0.05	0.57	0.09
9/25/23 12:57	9/25/23 18:00	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.50	4354	718	0	5073	100%	70.0	13.0	20.3	0.10	0.013	1.80	0.06	0.69	0.11
9/25/23 18:45	9/26/23 9:30	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.05	728	120	0	848	100%	11.7	2.2	3.4	0.02	0.002	0.30	0.01	0.12	0.02
9/26/23 18:50	9/26/23 20:15	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.05	370	61	0	431	100%	6.0	1.1	1.7	0.01	0.001	0.15	0.01	0.06	0.01
9/29/23 4:19	9/29/23 11:33	**67.0**	**27.0**	*64*	**0.13**	**0.035**	**5.0**	**0.28**	**1.10**	**0.68**	1.37	10205	1684	0	11889	100%	49.7	20.0	47.5	0.10	0.026	3.71	0.21	0.82	0.50
9/29/23 20:47	9/29/23 23:15	**438.0**	**24.0**	*64*	**0.39**	**0.028**	**5.0**	**0.32**	**2.47**	**0.37**	0.86	10841	1789	0	12630	100%	345.3	18.9	50.4	0.31	0.022	3.94	0.25	1.95	0.29
9/30/23 3:57	9/30/23 5:00	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.10	735	121	0	856	100%	11.8	2.2	3.4	0.02	0.002	0.30	0.01	0.12	0.02
10/3/23 20:30	10/4/23 4:30	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.17	1945	321	0	2265	100%	31.3	5.8	9.0	0.05	0.006	0.81	0.03	0.31	0.05
10/6/23 9:37	10/6/23 16:15	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.08	1156	191	0	1346	100%	18.6	3.4	5.4	0.03	0.003	0.48	0.02	0.18	0.03
10/12/23 19:36	10/13/23 6:21	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.78	12365	2040	0	14405	100%	198.8	36.9	57.5	0.29	0.035	5.12	0.18	1.95	0.32
10/13/23 8:08	10/14/23 3:15	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	1.03	15102	2492	0	17593	100%	242.8	45.1	70.3	0.36	0.043	6.26	0.22	2.39	0.39
10/19/23 10:45	10/19/23 11:56	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.02	206	34	0	240	100%	3.3	0.6	1.0	0.00	0.001	0.09	0.00	0.03	0.01
10/23/23 2:53	10/23/23 6:00	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.03	366	60	0	426	100%	5.9	1.1	1.7	0.01	0.001	0.15	0.01	0.06	0.01
10/24/23 13:45	10/25/23 0:56	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.62	7165	1182	0	8347	100%	115.2	21.4	33.3	0.17	0.021	2.97	0.10	1.13	0.19
10/26/23 0:44	10/26/23 11:20	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.76	7887	1301	0	9189	100%	126.8	23.5	36.7	0.19	0.023	3.27	0.11	1.25	0.20
10/26/23 19:00	10/26/23 21:06	*221*	*41*	*64*	*0.3*	*0.04*	*6*	*0.2*	*2.2*	*0.4*	0.08	944	156	0	1100	100%	15.2	2.8	4.4	0.02	0.003	0.39	0.01	0.15	0.02
Sum											20.05	218905	36119	0	**255025**	100%	3520	653	1019	5.19	0.63	90.7	3.1	34.6	5.7
Average		278.8	49.4	83.5	0.38	0.040	6.6	0.25	2.37	0.37															
Weighted Avg		221.1	41.0	64.0	0.33	0.039	5.7	0.20	2.17	0.36															
STDEV		269.0	29.9	68.1	0.29	0.034	2.6	0.15	1.59	0.15															
Min		67.0	24.0	26.0	0.13	0.010	5.0	0.06	1.10	0.26															
Max		794.0	112.0	171.0	1.09	0.101	11.1	0.55	6.26	0.68															
Percent Capture															**100%**		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

< Sample was not detected above the method detection limit (value reported)

GREY FONT Events with no sampling data (weighted average concentration used)

BOLD Sampling event

1 - Additional stormwater is conveyed to the system from the east via a pipe along Hampden Avenue. This flow is modeled using the monitored flow from the Hampden/Raymond location and the ratio of drainage areas.

2 - Water Levels in the BMP did not exceed the system outlet elevation

*Samples identified as outliers have been omitted from annual flow weighted averages

City of Saint Paul
2023 Water Quality and Quantity Report
Table C.7
WSB Project Number: 022099

VICTORIA WATER QUALITY SUMMARY

LAB ID	Date Composite Sampling Started	Date Composite Sampling Ended	TSS (mg/L)	TDS (mg/L)	VSS (mg/L)	TP (mg/L)	Ortho-P (mg/L)	Chloride (mg/L)	Ammonia as N (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate + Nitrite as N (mg/L)	Hardness as CaCO3 (mg/L)	Copper (ug/L)	Lead (ug/L)	Zinc (ug/L)	Total Organic Carbon (mg/L)	pH	COD (mg/L)	E. Coli (MPN/ 100 mL)
3139246	2/14/2023 10:21	2/14/2023 10:21	7.0	1920.0	4.0	0.32	0.256	1310.0	2.62	4.80	0.490	60	4.5	1.1	35.9	4.8	7.3	57.0	206
3151256	4/3/2023 11:19	4/3/2023 11:19	9.0	105.0	6.0	0.13	0.072	56.4	0.29	0.78	0.260 <	45 <	3.0	1.5	14.6	5.5		28.0	
3164830	5/18/2023 13:00	5/18/2023 14:01	118.0		73.0	0.83	0.206	9.2	0.29	4.60	0.420								
3180776	7/13/2023 21:54	7/14/2023 3:03	888.0	216.0	390.0	2.02	0.659	22.0	3.31	9.50	0.500 <	60	27.1	33.2	186.0	13.0		386.0	
3184521	7/26/2023 1:26	7/26/2023 5:16	232.0	24.0 <	73.0	0.35	0.010 <	5.0 <	0.06 <	2.04	0.260 <	45 <	8.2	26.2	46.8	8.5		89.0	
3187636	8/3/2023 21:26	8/3/2023 22:16	128.0	47.0		0.37		5.0 <	0.19	1.93		45 <	7.9	17.5	47.8	8.1		77.0	
3189523	8/11/2023 0:51	8/11/2023 2:16	35.0	71.0		0.38	0.143	5.7	0.06 <	1.72	0.550	45 <	5.6	5.8	25.6	18.1		89.0	
3190136	8/13/2023 16:52	8/13/2023 23:01	35.0	36.0		0.22	0.052	5.0 <	0.06	1.09	0.340 <	45 <	4.6	8.5	19.3	7.4		47.0	
3202688	9/23/2023 18:31	9/24/2023 2:36	40.0	44.0		0.34	0.114	5.0 <	0.09	1.28	0.260 <	45 <	5.6	10.6	30.2	8.7		68.0	
3202926	9/25/2023 14:44	9/25/2023 14:44																	>2420 >
3203945	9/25/2023 14:41	9/25/2023 17:51	45.0	35.0	17.0	0.23	0.070	5.0 <	0.18	1.04	0.260 <	45 <	3.4	4.4	17.0	5.7		25.0	
3204964	9/29/2023 4:36	9/29/2023 5:21	340.0	25.0		0.32	0.106	5.0 <	0.38	1.88	0.380 <	45 <	3.9	10.7	27.6	5.7		85.0	
3208797	10/13/2023 12:32	10/13/2023 12:32															7.6		>2420 >
MINIMUM			**7.0**	**24.0**	**4.0**	**0.1**	**0.0**	**5.0**	**0.1**	**0.8**	**0.3**	**45.0**	**3.0**	**1.1**	**14.6**	**4.8**	**7.3**	**25.0**	**206.0**
AVERAGE			**170.6**	**252.3**	**93.8**	**0.5**	**0.2**	**130.3**	**0.7**	**2.8**	**0.4**	**48.0**	**7.4**	**12.0**	**45.1**	**8.6**	**7.5**	**95.1**	**206.0**
MEDIAN			**45.0**	**45.5**	**45.0**	**0.3**	**0.1**	**5.0**	**0.2**	**1.9**	**0.4**	**45.0**	**5.1**	**9.6**	**28.9**	**7.8**	**7.5**	**72.5**	**206.0**
MAXIMUM			**888.0**	**1920.0**	**390.0**	**2.0**	**0.7**	**1310.0**	**3.3**	**9.5**	**0.6**	**60.0**	**27.1**	**33.2**	**186.0**	**18.1**	**7.6**	**386.0**	**206.0**

Laboratory analysis was completed by Metroplian Council Environmental Services

Grab Sample | Duplicate

< - Analyte not detected above the Method Detection Limit (MDL), MDL value reported
J - Result reported as estimated between the MDL and Reporting Limit (RL)
> - Analyte exceeded the maximum dection level (was not fully diluted prior to analysis)

City of Saint Paul
2023 Victoria Volume Reduction Pollutant Monitoring
Table C.8
WSB Project No.: 022099

VICTORIA VOLUME AND POLLUTANT REDUCTION SUMMARY

Event Time Interval		Sampling Data									Event Loading and Volume Data											
		TSS	TDS	VSS	TP	Ortho-P	Chloride	Ammonia as N	Total Kjeldahl Nitrogen	Nitrate + Nitrite as N	Interval Rain	Runoff Volume (1)	Bypassed Volume (2)	Volume Captured by BMP (1-2)	Captured TSS	Captured TDS	Captured VSS	Captured TP	Captured Ortho-P	Captured Chloride	Captured Ammonia as N	Captured Total Kjeldahl Nitrogen	Captured Nitrate + Nitrite as N
Start	**End**	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	In.	cu-ft	cu-ft	cu-ft	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
4/28/2023 2:30	4/28/2023 15:24	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.28	3776	0	3776	44.7	10.0	23.3	0.1	0.027	1.4	0.07	0.5	0.1
5/6/2023 16:12	5/6/2023 18:32	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.37	15316	0	15316	181.4	40.6	94.5	0.4	0.108	5.5	0.28	1.9	0.3
5/13/2023 4:50	5/13/2023 6:44	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.18	2941	0	2941	34.8	7.8	18.1	0.1	0.021	1.1	0.05	0.4	0.1
5/13/2023 22:25	5/14/2023 11:05	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.66	9785	0	9785	115.9	25.9	60.4	0.2	0.069	3.5	0.18	1.2	0.2
5/18/2023 13:03	5/18/2023 14:33	**118.0**	*42*	**73.0**	**0.83**	**0.206**	**9.2**	**0.29**	**4.60**	**0.420**	0.14	2580	0	2580	19.0	6.8	11.8	0.1	0.033	1.5	0.05	0.7	0.1
5/30/2023 6:30	5/30/2023 7:17	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.04	52	0	52	0.6	0.1	0.3	0.0	0.000	0.0	0.00	0.0	0.0
6/2/2023 4:00	6/2/2023 5:13	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.05	4314	0	4314	51.1	11.4	26.6	0.1	0.030	1.6	0.08	0.5	0.1
6/10/2023 15:00	6/10/2023 16:09	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.08	30	0	30	0.4	0.1	0.2	0.0	0.000	0.0	0.00	0.0	0.0
6/23/2023 15:29	6/23/2023 16:23	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.02	1264	0	1264	15.0	3.3	7.8	0.0	0.009	0.5	0.02	0.2	0.0
6/24/2023 23:44	6/25/2023 4:13	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.68	11924	0	11924	141.2	31.6	73.6	0.3	0.084	4.3	0.21	1.5	0.2
6/25/2023 6:30	6/25/2023 8:52	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.03	757	0	757	9.0	2.0	4.7	0.0	0.005	0.3	0.01	0.1	0.0
6/25/2023 15:15	6/25/2023 22:56	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.10	1266	0	1266	15.0	3.4	7.8	0.0	0.009	0.5	0.02	0.2	0.0
6/28/2023 20:17	6/28/2023 21:07	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.05	1373	0	1373	16.3	3.6	8.5	0.0	0.010	0.5	0.02	0.2	0.0
7/4/2023 10:28	7/4/2023 12:06	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.44	13620	4584	9037	107.0	24.0	55.8	0.2	0.064	3.3	0.16	1.1	0.2
7/13/2023 21:59	7/13/2023 23:01	**888.0**	**216.0**	**390.0**	**2.02**	**0.659**	**22.0**	**3.31**	**9.50**	**0.500**	0.38	3953	0	3953	219.1	53.3	96.2	0.5	0.163	5.4	0.82	2.3	0.1
7/19/2023 5:45	7/19/2023 6:51	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.07	564	0	564	6.7	1.5	3.5	0.0	0.004	0.2	0.01	0.1	0.0
7/19/2023 19:05	7/20/2023 11:45	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.03	206	0	206	2.4	0.5	1.3	0.0	0.001	0.1	0.00	0.0	0.0
7/21/2023 13:58	7/21/2023 14:59	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.55	2992	0	2992	35.4	7.9	18.5	0.1	0.021	1.1	0.05	0.4	0.1
7/24/2023 14:01	7/24/2023 14:48	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.14	2401	0	2401	28.4	6.4	14.8	0.1	0.017	0.9	0.04	0.3	0.0
7/24/2023 16:15	7/24/2023 18:22	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.03	109	0	109	1.3	0.3	0.7	0.0	0.001	0.0	0.00	0.0	0.0
7/26/2023 1:24	7/26/2023 7:49	**232.0**	**24.0**	< **73.0**	**0.35**	**0.010**	< **5.0**	< **0.06**	< **2.04**	**0.260**	1.40	18145	10312	7833	113.4	11.7	35.7	0.2	0.005	2.4	0.03	1.0	0.1
7/28/2023 16:51	7/28/2023 18:11	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.55	10248	836	9412	111.5	25.0	58.1	0.2	0.066	3.4	0.17	1.2	0.2
8/2/2023 18:38	8/2/2023 20:00	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.05	919	0	919	10.9	2.4	5.7	0.0	0.006	0.3	0.02	0.1	0.0
8/3/2023 21:29	8/3/2023 22:57	**128.0**	**47.0**	*99*	**0.37**	*0.11*	**5.0**	< **0.02**	**1.93**	**0.550**	0.55	5133	0	5133	41.0	15.1	31.7	0.1	0.036	1.6	0.01	0.6	0.2
8/6/2023 13:57	8/6/2023 18:00	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.04	317	0	317	3.8	0.8	2.0	0.0	0.002	0.1	0.01	0.0	0.0
8/11/2023 0:36	8/11/2023 3:06	**35.0**	**71.0**	*99*	**0.38**	**0.143**	**5.7**	**0.06**	< **1.72**	**0.340**	0.32	4110	0	4110	9.0	18.2	25.4	0.1	0.037	1.5	0.02	0.4	0.1
8/11/2023 17:24	8/11/2023 18:55	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	1.31	23468	16915	6554	77.6	17.4	40.4	0.2	0.046	2.4	0.12	0.8	0.1
8/13/2023 16:51	8/13/2023 17:53	**35.0**	**36.0**	*99*	**0.22**	**0.052**	**5.0**	< **0.06**	**1.09**	**0.260**	0.32	3206	0	3206	7.0	7.2	19.8	0.0	0.010	1.0	0.01	0.2	0.1
8/13/2023 19:00	8/14/2023 2:43	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	1.18	23858	1721	22137	262.2	58.7	136.6	0.6	0.156	8.0	0.40	2.8	0.4
8/14/2023 6:15	8/14/2023 9:18	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.30	2267	0	2267	26.9	6.0	14.0	0.1	0.016	0.8	0.04	0.3	0.0
8/14/2023 13:41	8/14/2023 14:55	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.11	955	0	955	11.3	2.5	5.9	0.0	0.007	0.3	0.02	0.1	0.0
9/11/2023 23:17	9/12/2023 1:33	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.21	2274	0	2274	26.9	6.0	14.0	0.1	0.016	0.8	0.04	0.3	0.0
9/15/2023 6:12	9/15/2023 11:15	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.14	279	0	279	3.3	0.7	1.7	0.0	0.002	0.1	0.01	0.0	0.0
9/23/2023 17:54	9/24/2023 4:46	**40.0**	**44.0**	*99*	**0.34**	**0.114**	**5.0**	< **0.09**	**1.28**	**0.260**	1.87	31994	27	31967	79.8	87.8	197.2	0.7	0.228	10.0	0.18	2.6	0.5
9/25/2023 1:51	9/25/2023 3:54	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.21	3218	0	3218	38.1	8.5	19.9	0.1	0.023	1.2	0.06	0.4	0.1
9/25/2023 14:24	9/26/2023 2:31	**45.0**	**35.0**	**17.0**	**0.23**	**0.070**	**5.0**	< **0.18**	**1.04**	**0.260**	0.63	7518	0	7518	21.1	16.4	8.0	0.1	0.033	2.3	0.08	0.5	0.1
9/29/2023 4:36	9/29/2023 11:48	**340.0**	**25.0**	*99*	**0.32**	**0.106**	**5.0**	< **0.38**	**1.88**	**0.380**	1.00	26519	0	26519	562.9	41.4	163.6	0.5	0.175	8.3	0.63	3.1	0.6
9/29/2023 20:54	9/29/2023 23:36	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.39	8401	0	8401	99.5	22.3	51.8	0.2	0.059	3.0	0.15	1.0	0.2
9/30/2023 1:30	9/30/2023 5:42	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.19	5478	0	5478	64.9	14.5	33.8	0.1	0.039	2.0	0.10	0.7	0.1
10/3/2023 20:51	10/4/2023 3:15	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.13	1084	0	1084	12.8	2.9	6.7	0.0	0.008	0.4	0.02	0.1	0.0
10/6/2023 9:38	10/6/2023 10:41	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	0.05	207	0	207	2.5	0.5	1.3	0.0	0.001	0.1	0.00	0.0	0.0
10/12/2023 19:49	10/13/2023 22:51	*190*	*42*	*99*	*0.4*	*0.11*	*6*	*0.3*	*2.0*	*0.32*	2.38	38954	0	38954	461.4	103.3	240.4	1.0	0.274	14.1	0.70	4.8	0.8
Sum											17.65	297,776	34,395	263,381	**3093**	**710**	**1642**	**6.69**	**1.921**	**95.6**	**4.89**	**32.73**	**5.33**
Average		206.8	62.3	138.3	0.59	0.170	7.4	0.49	2.79	0.359													
Weighted Ave*		189.7	42.5	98.8	0.40	0.113	5.8	0.29	1.99	0.322													
STDEV		276.0	63.9	169.9	0.21	0.206	1.1	1.06	2.73	0.112													
Median		118.0	40.0	73.0	0.11	0.110	0.1	0.09	1.88	0.340													
Min		35.0	24.0	17.0	0.01	0.010	0.0	0.02	1.04	0.260													
Max		888.0	216.0	390.0	0.66	0.659	3.3	3.31	9.50	0.550													
Percent Capture														**88.4%**	**87.7%**	**90.0%**	**89.4%**	**88.9%**	**91.6%**	**88.9%**	**91.2%**	**88.4%**	**89.1%**

< Sample was not detected above the method detection limit (value reported)
GREY FONT Events with no sampling data (weighted average concentration used)
BOLD Sampling ev Sampled Event

City of Saint Paul
2023 Water Quality and Quantity Report
Table C.9
WSB Project Number: 022099

WEST SHEPARD POND WATER QUALITY SUMMARY

LAB ID	Date Composite Sampling Started	Date Composite Sampling Ended	TSS (mg/L)	TDS (mg/L)	VSS (mg/L)	TP (mg/L)	Ortho-P (mg/L)	Chloride (mg/L)	Ammonia as N (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate + Nitrite as N (mg/L)	Hardness as CaCO3 (mg/L)	Copper (ug/L)	Lead (ug/L)	Zinc (ug/L)	Total Organic Carbon (mg/L)	pH	COD (mg/L)	E. Coli (MPN/ 100 mL)
3137483	2/6/2023 13:05	2/6/2023 13:05	29.0	9920.0	15.0 <	0.31	0.112	7240.0	1.46	2.80	0.770	154	28.3	3.8	130.0	2.7	7.10	134.0	1
3151258	4/3/2023 13:21	4/3/2023 13:21	10.0	1300.0	3.0	0.53	0.397	1240.0	0.18	1.80	1.640	196	13.9	5.3	31.6	4.7		45.0	
3178275	7/4/2023 10:53	7/4/2023 11:33	720.0	78.0	56.0	0.26	0.022	24.0	0.15	1.57	0.430 <	45 <	11.5	5.1	86.1	5.2		62.0	
3180778	7/13/2023 22:24	7/13/2023 22:51	186.0	142.0	77.0	0.47	0.037	36.1	0.20	2.49	0.510 <	45 <	28.1	13.8	196.0			160.0	
3184187	7/26/2023 1:43	7/26/2023 5:38	76.0	32.0	29.0	0.19	0.017	5.4	0.20	1.45	0.280 <	45 <	8.8	4.9	59.4	3.6		43.0	
3189525	8/11/2023 0:58	8/11/2023 2:24	19.0	81.0		0.12	0.011	13.1	0.06 <	0.55	0.350 <	45 <	4.2	1.4	24.7	9.8		50.0	
3190138	8/13/2023 22:54	8/14/2023 7:43	7.0	37.0		0.05 <	0.017	5.0 <	0.07	0.18	0.260 <	45 <	1.9	0.7	11.7	2.1		15.0 <	
3202690	9/23/2023 18:09	9/23/2023 23:58	23.0	74.0		0.16	0.023	11.3	0.06 <	0.66	0.260 <	45 <	6.9	2.2	34.2	11.1		44.0	
3202927	9/25/2023 14:13	9/25/2023 14:13																	>2420 >
3203608	9/25/2023 13:34	9/25/2023 17:29	17.0	35.0		0.10	0.010 <	5.0 <	0.10	0.51	0.260 <	45 <	3.0	1.1	18.6	2.8	8.40	15.0 <	
3202927	9/25/2023 14:13	9/25/2023 14:13																	>2420 >
3204966	9/29/2023 4:29	9/29/2023 11:34	21.0	44.0		0.09 0.00	0.028	5.4	0.30	0.68	0.620	45	4.0	1.6	23.5	2.3		22.0	
3204968	9/29/2023 21:14	9/29/2023 22:39	33.0	24.0		0.13	0.030	5.0	0.28	0.95	0.400	45	5.9	2.5	29.0	1.7		24.0	
3205832	10/3/2023 21:39	10/4/2023 1:34	48.0	79.0	27.0	0.27	0.025	15.7	0.06	1.54	0.620	45	9.7	3.7	111.0	21.2		98.0	
MINIMUM			**7.0**	**24.0**	**3.0**	**0.1**	**0.0**	**5.0**	**0.1**	**0.2**	**0.3**	**45.0**	**1.9**	**0.7**	**11.7**	**1.7**	**7.1**	**15.0**	**1.0**
AVERAGE			**99.1**	**987.2**	**34.5**	**0.2**	**0.1**	**717.2**	**0.3**	**1.3**	**0.5**	**66.7**	**10.5**	**3.8**	**63.0**	**6.1**	**7.8**	**59.3**	**1.0**
MEDIAN			**26.0**	**76.0**	**28.0**	**0.2**	**0.0**	**12.2**	**0.2**	**1.2**	**0.4**	**45.0**	**7.9**	**3.1**	**32.9**	**3.6**	**7.8**	**44.5**	**1.0**
MAXIMUM			**720.0**	**9920.0**	**77.0**	**0.5**	**0.4**	**7240.0**	**1.5**	**2.8**	**1.6**	**196.0**	**28.3**	**13.8**	**196.0**	**21.2**	**8.4**	**160.0**	**1.0**

Laboratory analysis was completed by Metroplian Council Environmental Services
Grab Sample | Duplicate
< - Analyte not detected above the Method Detection Limit (MDL), MDL value reported
J - Result reported as estimated between the MDL and Reporting Limit (RL)
> - Analyte exceeded the maximum dection level (was not fully diluted prior to analysis)

City of Saint Paul
2023 St. Albans Volume Reduction Pollutant Loading
Table C.10
WSB Project No.: 022099

WEST SHEPARD POND VOLUME REDUCTION AND POLLUTANT LOADING

Event Time Interval		Sampling Data									Event Loading and Volume Data												
		TSS	TDS	VSS	TP	Ortho-P	Chloride	Ammonia as N	Total Kjeldahl Nitrogen	Nitrate + Nitrite as N	Interval Rain	South Inlet Volume (1)	Noth Inlet Volume [1] Volume (2)	Bypass Volume (3)	Volume Captured (1+2-3)	Captured TSS	Captured TDS	Captured VSS	Captured TP	Captured Ortho-P	Captured Chloride	Captured Ammonia as N	Captured Total Kjeldahl Nitrogen	Captured Nitrate + Nitrite as N
Start	**End**	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	In.	cu-ft	cu-ft	cu-ft	cu-ft	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
5/18/23 13:30	5/18/23 14:04	*156*	*49*	*42*	*0.2*	*0.02*	*10*	*0.1*	*0.9*	*0.31*	0.14	107	11	0	118	1.2	0.4	0.3	0.00	0.000	0.1	0.0	0.0	0.0
5/30/23 5:08	5/30/23 7:15	*156*	*49*	*42*	*0.2*	*0.02*	*10*	*0.1*	*0.9*	*0.31*	0.04	72	7	0	80	0.8	0.2	0.2	0.00	0.000	0.1	0.0	0.0	0.0
6/10/23 15:00	6/10/23 19:51	*156*	*49*	*42*	*0.2*	*0.02*	*10*	*0.1*	*0.9*	*0.31*	0.08	19633	1963	17831	3766	36.7	11.6	9.8	0.04	0.004	2.4	0.0	0.2	0.1
6/23/23 15:30	6/23/23 17:59	*156*	*49*	*42*	*0.2*	*0.02*	*10*	*0.1*	*0.9*	*0.31*	0.02	631	63	0	694	6.8	2.1	1.8	0.01	0.001	0.4	0.0	0.0	0.0
6/25/23 0:00	6/25/23 6:15	*156*	*49*	*42*	*0.2*	*0.02*	*10*	*0.1*	*0.9*	*0.31*	0.68	11739	1174	1247	11666	113.7	35.9	30.3	0.11	0.013	7.4	0.1	0.6	0.2
6/25/23 19:00	6/25/23 19:45	*156*	*49*	*42*	*0.2*	*0.02*	*10*	*0.1*	*0.9*	*0.31*	0.06	331	33	0	364	3.5	1.1	0.9	0.00	0.000	0.2	0.0	0.0	0.0
7/4/23 10:45	7/4/23 11:33	**720.0**	**78.0**	**56.0**	**0.26**	**0.022**	**24.0**	**0.15**	**1.57**	**0.430**	0.45	6935	693	0	7628	342.9	37.1	26.7	0.12	0.010	11.4	0.1	0.7	0.2
7/13/23 22:15	7/13/23 22:30	**186.0**	**142.0**	**77.0**	**0.47**	**0.037**	**36.1**	**0.20**	**2.49**	**0.510**	0.38	1992	199	0	2191	25.4	19.4	10.5	0.06	0.005	4.9	0.0	0.3	0.1
7/19/23 6:00	7/19/23 6:27	*156*	*49*	*42*	*0.2*	*0.02*	*10*	*0.1*	*0.9*	*0.31*	0.07	197	20	0	216	2.1	0.7	0.6	0.00	0.000	0.1	0.0	0.0	0.0
7/21/23 14:15	7/21/23 14:45	*156*	*49*	*42*	*0.2*	*0.02*	*10*	*0.1*	*0.9*	*0.31*	0.55	134	13	0	148	1.4	0.5	0.4	0.00	0.000	0.1	0.0	0.0	0.0
7/24/23 14:15	7/24/23 15:02	*156*	*49*	*42*	*0.2*	*0.02*	*10*	*0.1*	*0.9*	*0.31*	0.14	1194	119	0	1313	12.8	4.0	3.4	0.01	0.002	0.8	0.0	0.1	0.0
7/26/23 1:28	7/26/23 7:45	**76.0**	**32.0**	**29.0**	**0.19**	**0.017**	**5.4**	**0.20**	**1.45**	**0.280**	1.40	13433	1343	12583	2193	10.4	4.4	4.0	0.03	0.002	0.7	0.0	0.2	0.0
7/28/23 16:59	7/28/23 19:35	*156*	*49*	*42*	*0.2*	*0.02*	*10*	*0.1*	*0.9*	*0.31*	0.55	2286	229	1572	942	9.2	2.9	2.5	0.01	0.001	0.6	0.0	0.1	0.0
8/3/23 21:45	8/3/23 22:26	*156*	*49*	*42*	*0.2*	*0.02*	*10*	*0.1*	*0.9*	*0.31*	0.55	3726	373	1	4098	39.9	12.6	10.7	0.04	0.005	2.6	0.0	0.2	0.1
8/6/23 13:51	8/6/23 14:30	*156*	*49*	*42*	*0.2*	*0.02*	*10*	*0.1*	*0.9*	*0.31*	0.03	184	18	0	202	2.0	0.6	0.5	0.00	0.000	0.1	0.0	0.0	0.0
8/11/23 0:35	8/11/23 5:30	**19.0**	**81.0**	*42*	**0.12**	**0.011**	**13.1**	**0.06** <	**0.06**	**0.350**	0.33	2028	203	0	2231	2.6	11.3	5.8	0.02	0.002	1.8	0.0	0.0	0.0
8/11/23 17:29	8/11/23 19:10	*156*	*49*	*42*	*0.2*	*0.02*	*10*	*0.1*	*0.9*	*0.31*	1.30	11422	858	8768	3512	34.2	10.8	9.1	0.03	0.004	2.2	0.0	0.2	0.1
8/13/23 16:26	8/14/23 9:45	**7.0**	**37**	*42*	**0.05** <	**0.017**	**5.0** <	**0.07**	**0.02**	**0.260**	1.80	17540	1754	16077	3217	1.4	7.4	8.4	0.01	0.003	1.0	0.0	0.0	0.1
8/14/23 14:00	8/14/23 14:31	*156*	*49*	*42*	*0.2*	*0.02*	*10*	*0.1*	*0.9*	*0.31*	0.11	212	21	0	234	2.3	0.7	0.6	0.00	0.000	0.1	0.0	0.0	0.0
9/11/23 23:30	9/12/23 3:15	*156*	*49*	*42*	*0.2*	*0.02*	*10*	*0.1*	*0.9*	*0.31*	0.21	2065	206	1	2270	22.1	7.0	5.9	0.02	0.003	1.4	0.0	0.1	0.0
Sum											8.89	95862	9302	58079	**47085**	671	171	132	0.52	0.057	38.7	0.4	2.9	1.0
Average		201.6	74.0	49.1	0.22	0.021	16.7	0.14	1.12	0.37														
Weighted Avg		156.1	49.3	41.7	0.15	0.018	10.1	0.13	0.85	0.31														
STDEV		298.3	44.2	18.3	0.16	0.010	13.3	0.07	1.06	0.10														
Min		7.0	32.0	29.0	0.05	0.011	5.0	0.06	0.02	0.26														
Max		720.0	142.0	77.0	0.47	0.037	36.1	0.20	2.49	0.51														
Percent Capture															**44.8%**	**48.7%**	**35.9%**	**31.9%**	**35.3%**	**30.7%**	**41.0%**	**29.5%**	**34.6%**	**32.0%**

< Sample was not detected above the method detection limit (value reported)
GREY FONT Events with no sampling data (weighted average concentration used)
BOLD Sampling eve Sampled Event
1 North Inlet Volumes are estimated flows based on modeling using monitored flow from the South Inlet

City of Saint Paul
2023 Water Quality and Quantity Report
Table C.11
WSB Project Number: 022099

BUSH-DESOTO POND WATER QUALITY SUMMARY

LAB ID	Date Composite Sampling Started	Date Composite Sampling Ended	TSS (mg/L)	TDS (mg/L)	VSS (mg/L)	TP (mg/L)	Ortho-P (mg/L)	Chloride (mg/L)	Ammonia as N (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate + Nitrite as N (mg/L)	Hardness as CaCO3 (mg/L)	Copper (ug/L)	Lead (ug/L)	Zinc (ug/L)	Total Organic Carbon (mg/L)	pH	COD (mg/L)	E. Coli (MPN/ 100 mL)
3137485	2/6/2023 15:11	2/6/2023 15:11	84.0	5400.0	60.0 <	0.53	0.039	3770.0	0.92	4.30	0.520	102	44.9	10.3	321.0	4.6	7.50	213.0	35
3151260	4/3/2023 13:10	4/3/2023 13:10	54.0	117.0	27.0	0.28	0.105	276.0	0.27	1.30	0.260 <	45 <	13.0	14.0	74.9	5.3		67.0	
3167993	5/30/2023 4:29	5/30/2023 7:51	3920.0	327.0	654.0	2.24	0.296	51.3	1.46	8.90	0.270	57	66.2	38.6	522.0	112.0		709.0	
3168875	6/1/2023 16:06	6/1/2023 16:31	515.0	200.0	156.0	1.05	0.010 <	39.2	0.17	6.18	0.260 <	77	46.3	32.8	329.0	37.5		460.0	
3175773	6/25/2023 0:26	6/25/2023 9:07	133.0	96.0 <	61.0	0.52	0.010 <	15.5	0.06 <	2.58	0.260 <	45 <	17.6	14.5	124.0	28.8		178.0	
3178271	7/4/2023 11:01	7/4/2023 11:44	67.0	95.0	41.0	0.42	0.010 <	11.7	0.06 <	2.30	0.260 <	45 <	13.3	14.6	87.5	17.3		110.0	
3180772	7/13/2023 22:15	7/13/2023 23:12	200.0	178.0	82.0	0.61	0.010 <	16.7	0.06 <	2.88	0.260 <	45 <	28.6	28.1	185.0	54.8		269.0	
3184185	7/26/2023 1:47	7/26/2023 2:26	112.0	37.0	46.0	0.26	0.010 <	5.0 <	0.13	1.66	0.670 <	45 <	12.5	14.8	74.3	7.2		78.0	
3189521	8/11/2023 1:52	8/11/2023 3:33	54.0	40.0		0.20	0.040	7.1	0.06 <	1.12	0.430 <	45 <	9.2	9.1	71.7	8.2		67.0	
3190134	8/11/2023 17:43	8/11/2023 18:57	388.0	51.0		0.70	0.045	5.0	0.11	2.96	0.320 <	55	37.2	82.6	241.0	3.0		156.0	
3190142	8/14/2023 9:39	8/14/2023 9:39															8.00		1203
3205830	10/4/2023 0:31	10/4/2023 1:26	142.0	82.0	56.0	0.42	0.105	8.8	0.06	2.06	0.550	45	17.9	19.6	146.0	16.4		141.0	
3209416	10/12/2023 20:17	10/13/2023 5:02	381.0	35.0		0.23	0.089	5.0	0.06	0.86	0.260	45	6.2	5.3	48.1	6.5		28.0	
MINIMUM			**54.0**	**35.0**	**27.0**	**0.2**	**0.0**	**5.0**	**0.1**	**0.9**	**0.3**	**45.0**	**6.2**	**5.3**	**48.1**	**3.0**	**7.5**	**28.0**	**35.0**
AVERAGE			**504.2**	**554.8**	**131.4**	**0.6**	**0.1**	**350.9**	**0.3**	**3.1**	**0.4**	**54.3**	**26.1**	**23.7**	**185.4**	**25.1**	**7.8**	**206.3**	**619.0**
MEDIAN			**137.5**	**95.5**	**60.0**	**0.5**	**0.0**	**13.6**	**0.1**	**2.4**	**0.3**	**45.0**	**17.8**	**14.7**	**135.0**	**12.3**	**7.8**	**148.5**	**619.0**
MAXIMUM			**3920.0**	**5400.0**	**654.0**	**2.2**	**0.3**	**3770.0**	**1.5**	**8.9**	**0.7**	**102.0**	**66.2**	**82.6**	**522.0**	**112.0**	**8.0**	**709.0**	**1203.0**

Laboratory analysis was completed by Metroplian Council Environmental Services

Grab Sample | Duplicate

< - Analyte not detected above the Method Detection Limit (MDL), MDL value reported
J - Result reported as estimated between the MDL and Reporting Limit (RL)
> - Analyte exceeded the maximum dection level (was not fully diluted prior to analysis)

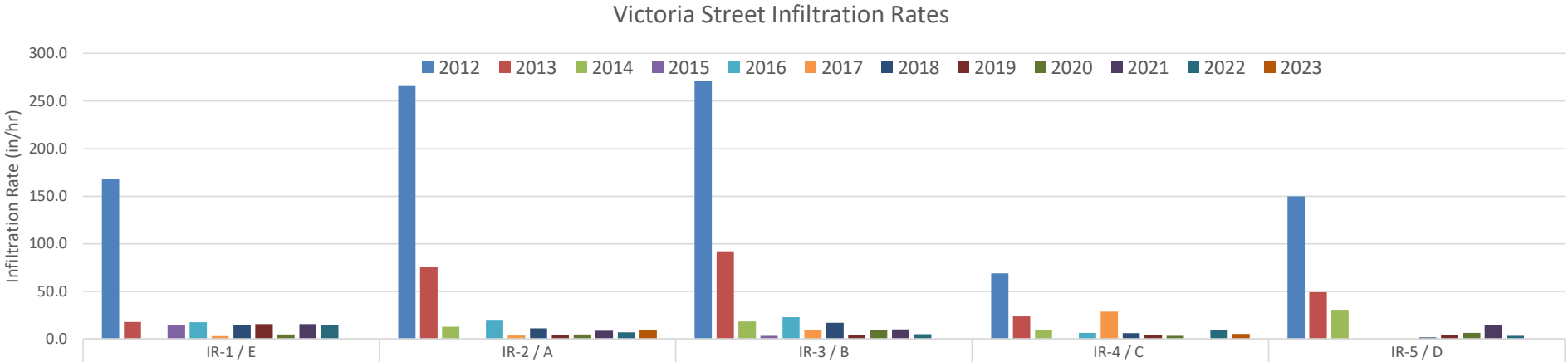
City of Saint Paul
2023 Water Quality and Quantity Report
Table C.12
WSB Project No.: 022099

BUSH-DESOTO POND VOLUME AND POLLUTANT SUMMARY

Event Time Interval		Sampling Data												Event Loading and Volume Data										
		TSS		TDS		VSS		TP		Ortho-P		Chloride		Ammonia as N		Total Kjeldahl Nitrogen		Nitrate + Nitrite as N		Interval Rain	Flow Volume	Volume	TSS	TDS	VSS	TP	Ortho-P	Chloride	Ammonia as N	Total Kjeldahl Nitrogen	Nitrate + Nitrite as N
Start	**End**	mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		In.	cu-ft	cu-ft	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
5/18/23 13:30	5/18/23 16:00	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.13	2878.7	2879	63.2	15.3	15.4	0.10	0.006	1.56	0.02	0.49	0.06
5/30/23 4:15	5/30/23 12:45	**3920.0**		**327.0**		**654.0**		**2.24**		**0.296**		**51.3**		**1.46**		**8.90**		**0.270**		0.17	4098.5	4099	1003.0	83.7	167.3	0.57	0.076	13.13	0.37	2.28	0.07
6/1/23 15:45	6/1/23 23:00	**515.0**		**200.0**		**156.0**		**1.05**		**0.010**	**<**	**39.2**		**0.17**		**6.18**		**0.260**	**<**	0.20	3354.1	3354	107.8	41.9	32.7	0.22	0.002	8.21	0.04	1.29	0.05
6/25/23 0:15	6/26/23 8:15	**133.0**		**96.0**	**<**	**61.0**		**0.52**		**0.010**	**<**	**15.5**		**0.06**	**<**	**2.58**		**0.260**	**<**	0.59	16314.2	16314	135.5	97.8	62.1	0.53	0.010	15.79	0.06	2.63	0.26
6/28/23 20:26	6/28/23 23:45	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.12	784.6	785	17.2	4.2	4.2	0.03	0.002	0.42	0.01	0.13	0.02
7/4/23 10:45	7/4/23 19:15	**67.0**		**178.0**		**10.0**		**0.42**		**0.010**	**<**	**11.7**		**0.06**		**2.30**		**0.260**	**<**	0.46	9137.9	9138	38.2	101.5	5.7	0.24	0.006	6.67	0.03	1.31	0.15
7/13/23 22:15	7/13/23 23:45	**200.0**		**37.0**		**82.0**		**0.61**		**0.010**	**<**	**16.7**		**0.06**		**2.88**		**0.260**	**<**	0.16	3012.5	3012	37.6	7.0	15.4	0.11	0.002	3.14	0.01	0.54	0.05
7/19/23 6:00	7/19/23 8:00	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.06	929.2	929	20.4	5.0	5.0	0.03	0.002	0.50	0.01	0.16	0.02
7/19/23 19:00	7/19/23 20:45	**351.7**		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.03	127.5	128	2.8	0.7	0.7	0.00	0.000	0.07	0.00	0.02	0.00
7/21/23 14:15	7/21/23 15:45	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.22	4074.5	4075	89.5	21.7	21.7	0.15	0.009	2.21	0.04	0.69	0.09
7/22/23 15:45	7/22/23 17:30	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.04	187.5	187	4.1	1.0	1.0	0.01	0.000	0.10	0.00	0.03	0.00
7/24/23 14:15	7/24/23 16:45	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.15	2274.0	2274	49.9	12.1	12.1	0.08	0.005	1.23	0.02	0.38	0.05
7/26/23 1:30	7/26/23 12:30	**112.0**		**40.0**		**46.0**		**0.26**		**0.010**	**<**	**5**	**<**	**0.13**		**1.66**		**0.670**	**<**	1.02	37251.3	37251	260.5	93.0	107.0	0.60	0.023	11.6	0.30	3.86	1.56
7/28/23 17:01	7/29/23 7:00	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.39	11553.2	11553	253.6	61.6	61.6	0.42	0.026	6.3	0.10	1.95	0.25
8/2/23 19:15	8/2/23 21:00	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.05	576.2	576	12.7	3.1	3.1	0.02	0.001	0.3	0.00	0.10	0.01
8/3/23 21:30	8/4/23 7:15	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.42	9097.8	9098	199.7	48.5	48.5	0.33	0.021	4.9	0.08	1.54	0.20
8/6/23 13:30	8/6/23 19:15	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.19	1765.2	1765	38.8	9.4	9.4	0.06	0.004	1.0	0.02	0.30	0.04
8/11/23 0:30	8/11/23 13:15	**54.0**		**51.0**		*85*		**0.20**		**0.040**		**7.1**		**0.06**	**<**	**1.16**		**0.430**	**<**	0.31	8377.3	8377	28.2	26.7	44.7	0.10	0.021	3.7	0.03	0.61	0.22
8/11/23 17:30	8/12/23 17:15	**388.0**		**82.0**		*85*		**0.70**		**0.045**		**5.0**		**0.11**		**2.96**		**0.230**	**<**	1.39	79177.9	79178	1917.8	405.3	422.3	3.46	0.222	24.7	0.54	14.63	1.14
8/13/23 16:30	8/14/23 21:45	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		1.75	74806.0	74806	1642.4	398.8	399.0	2.72	0.169	40.5	0.65	12.64	1.63
9/11/23 23:30	9/12/23 1:45	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.21	3079.2	3079	67.6	16.4	16.4	0.11	0.007	1.7	0.03	0.52	0.07
9/15/23 5:15	9/15/23 10:00	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.13	1998.6	1999	43.9	10.7	10.7	0.07	0.005	1.1	0.02	0.34	0.04
10/19/23 11:00	10/19/23 12:45	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.16	542.1	542	11.9	2.9	2.9	0.02	0.001	0.3	0.00	0.09	0.01
10/23/23 3:30	10/23/23 7:15	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.03	192.5	192	4.2	1.0	1.0	0.01	0.000	0.1	0.00	0.03	0.00
10/24/23 11:45	10/25/23 3:42	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		1.02	43661.9	43662	958.6	232.8	232.9	1.59	0.098	23.6	0.38	7.38	0.95
10/26/23 0:45	10/26/23 11:09	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.73	33488.9	33489	735.2	178.5	178.6	1.22	0.075	18.1	0.29	5.66	0.73
10/26/23 18:00	10/26/23 23:45	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.21	8057.5	8057	176.9	43.0	43.0	0.29	0.018	4.4	0.07	1.36	0.18
10/31/23 13:15	10/31/23 16:00	*352*		*85*		*85*		*0.6*		*0.04*		*9*		*0.1*		*2.7*		*0.3*		0.16	91.6	92	2.0	0.5	0.5	0.00	0.000	0.0	0.00	0.02	0.00
Sum																				10.50	360890	360890	7923	1924	1925	13.13	0.813	195.3	3.13	60.96	7.87
Average		673.6		126.4		168.2		0.75		0.054		18.9		0.26		3.58		0.33													
Weighted Avg		351.7		85.4		85.4		0.58		0.036		8.7		0.14		2.71		0.35													
STDEV		1321.8		101.7		242.9		0.66		0.099		17.1		0.49		2.62		0.15													
Min		54.0		37.0		10.0		0.20		0.010		5.0		0.06		1.16		0.23													
Max		3920.0		327.0		654.0		2.24		0.296		51.3		1.46		8.90		0.67													

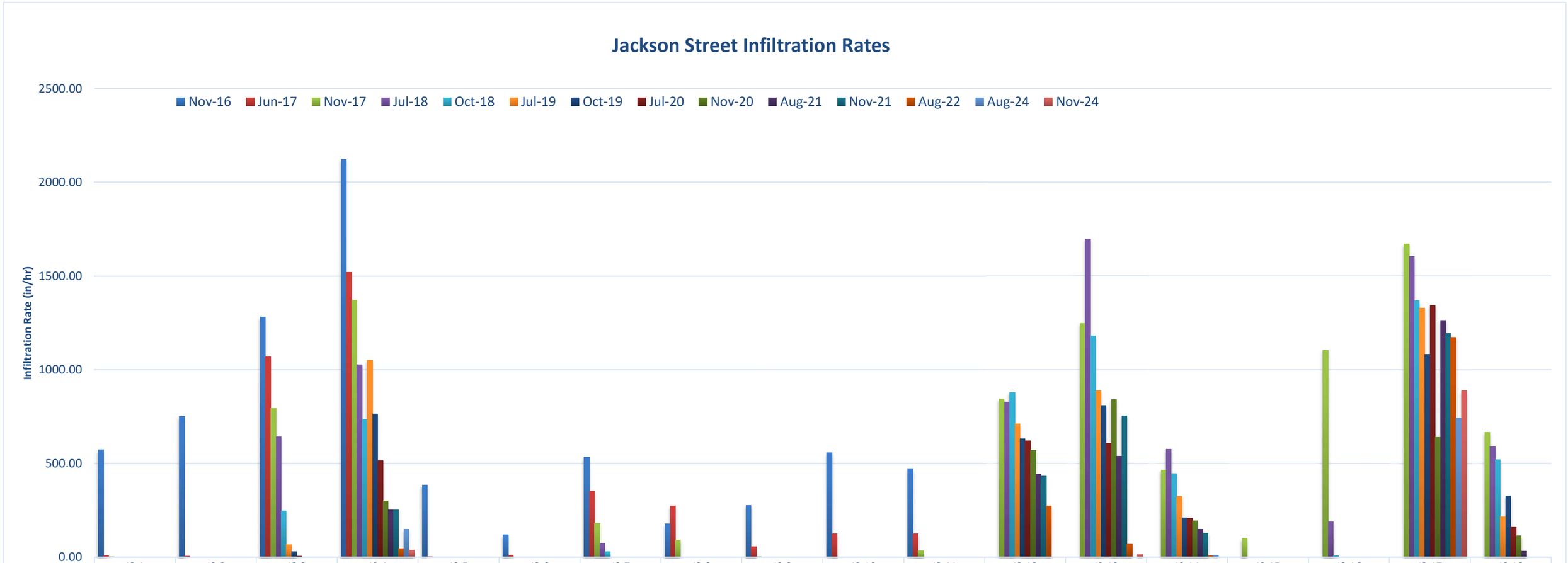
< Sample was not detected above the method detection limit (value reported)
GREY FONT Events with no sampling data (weighted average concentration used)
BOLD Sampling event

City of Saint Paul
2023 Water Quality and Quantity Report
Chart D.1
WSB Project No.: 022099



	IR-1 / E	IR-2 / A	IR-3 / B	IR-4 / C	IR-5 / D
2012	168.6	266.6	271.1	69.1	149.8
2013	18.1	75.7	92.2	24.0	49.2
2014	0.0	12.9	18.6	9.7	30.8
2015	15.1	0.0	3.4	0.0	0.0
2016	17.8	19.4	23.0	6.5	0.0
2017	3.4	3.8	10.1	28.9	0.0
2018	14.5	11.5	16.9	6.2	1.9
2019	15.9	4.1	4.4	4.0	4.2
2020	4.9	4.7	9.4	3.7	6.6
2021	15.6	8.8	10.1	0.0	15.0
2022	14.8	7.0	5.3	9.5	3.6
2023	0.0	9.7	0.0	5.4	0.0

City of Saint Paul
2023 Water Quality and Quantity Report
Chart D.2
WSB Project No.: 022099



	JS-1	JS-2	JS-3	JS-4	JS-5	JS-6	JS-7	JS-8	JS-9	JS-10	JS-11	JS-12	JS-13	JS-14	JS-15	JS-16	JS-17	JS-18
Nov-16	572.60	750.40	1282.07	2122.21	385.88	118.70	533.72	177.47	277.93	557.90	471.54							
Jun-17	9.29	6.30	1069.04	1520.13	4.49	12.12	353.94	275.34	56.12	125.46	125.40							
Nov-17	3.86	0.00	793.76	1371.96	0.00	0.00	181.73	90.77	2.38	2.07	35.49	843.29	1246.74	464.43	99.97	1104.44	1669.95	665.40
Jul-18	0.00	0.00	642.24	1026.71	0.00	0.00	73.71	0.00	0.00	0.00	0.00	827.22	1696.93	575.13	0.00	190.07	1604.98	589.63
Oct-18	0.00	0.00	247.09	733.69	0.00	0.00	29.44	0.00	0.00	0.00	0.00	877.09	1179.25	447.48	0.00	9.02	1369.65	521.52
Jul-19	0.00	0.00	67.07	1050.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	710.52	889.49	323.26	0.00	0.00	1329.45	215.70
Oct-19	0.00	0.00	30.35	764.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	633.28	809.62	211.40	0.00	0.00	1082.13	327.70
Jul-20	0.00	0.00	7.05	516.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	620.41	608.65	207.81	0.00	0.00	1343.21	160.40
Nov-20	0.00	0.00	0.00	299.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	572.01	839.81	195.40	0.00	0.00	640.06	115.47
Aug-21	0.00	0.00	0.00	254.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	442.70	537.80	148.90	0.00	0.00	1263.50	33.00
Nov-21	0.00	0.00	0.00	253.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	432.00	753.00	128.70	0.00	0.00	1194.50	0.00
Aug-22	0	0	0	46.13	0	0	0	0	0	0	0	274.28	69.76	7.885	0	0	1173.965	0
Aug-24	0	0	0	149.9	0	0	0	0	0	0	0	0	0	10.4	0	0	744.4	0
Nov-24	0	0	0	38.1	0	0	0	0	0	0	0	0	13	0	0	0	888.6	0

Lilydale Road 5/5/23

Sediment deposited after flooding near the St. Paul Yacht Club

Beacon Bluff SAFL Baffle 5/23/23

Beacon Bluff SAFLE Baffle and Rain Garden – 6/13/23

Beacon Bluff SAFL Baffle and Rain Garden – 8/17/23

Beacon Bluff SAFL Baffle and Rain Garden - 11/7/23

Bush Desoto Pond – 4/28/23

Hampden Park - 5/23/23

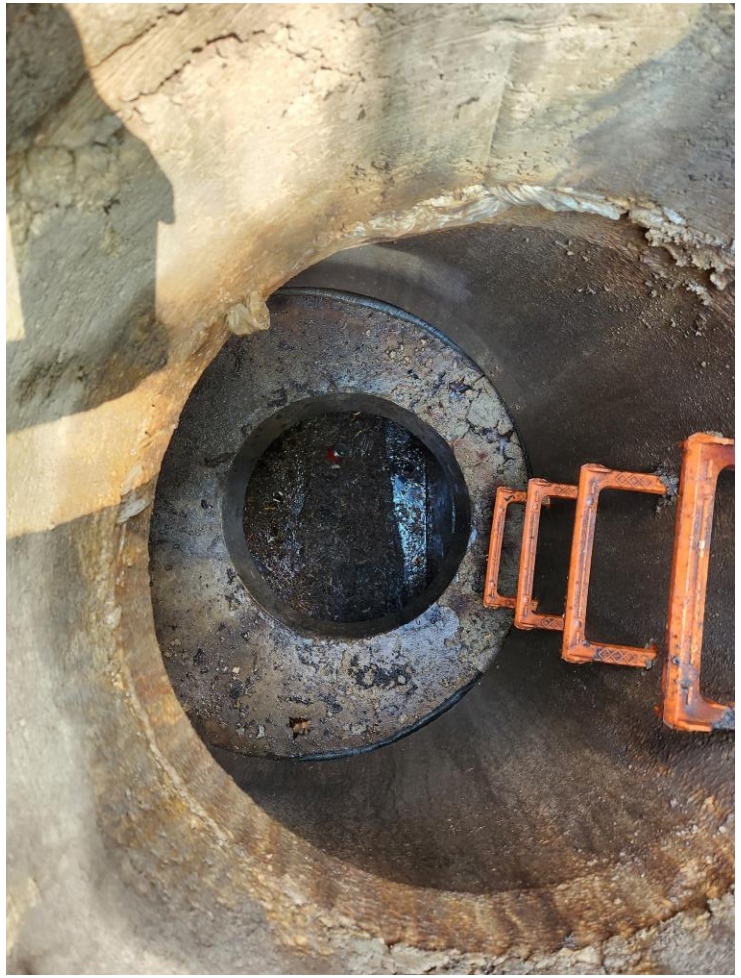
Hampden Park BMP - 6/15/23

Hampden Park BMP – 11/7/23

West Shepard Pond – 4/28/23

Victoria BMP – 5/23/23

Victoria BMP 6/26/23



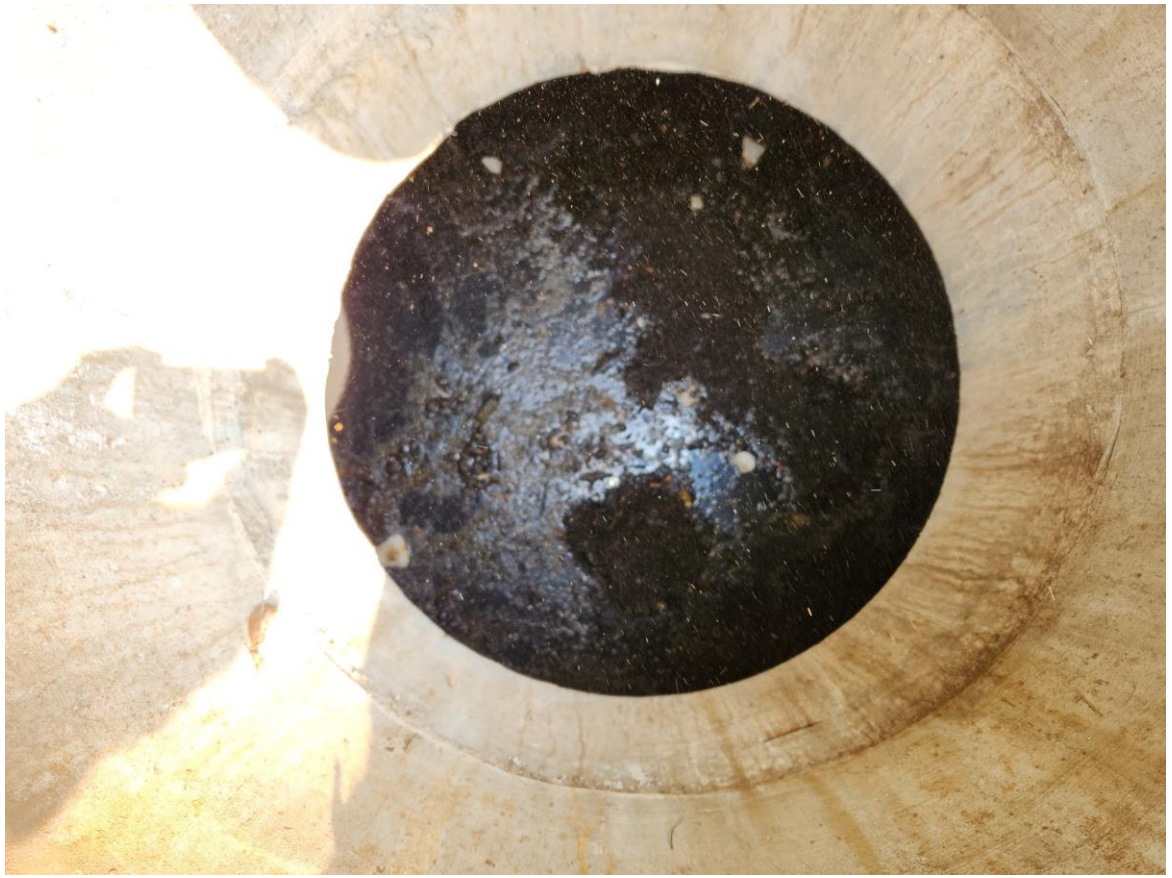
Victoria BMP – 7/25/23

Victoria BMP 8/17/23

Victoria BMP – 11/7/23

Saint Albans BMP – 11/7/23

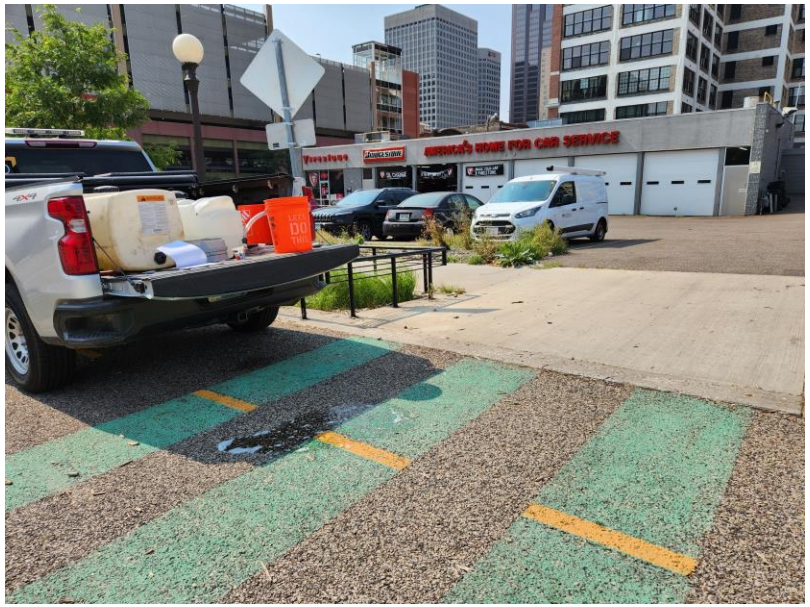
Saint Albans BMP – 6/15/23



Saint Albans BMP – 8/17/23

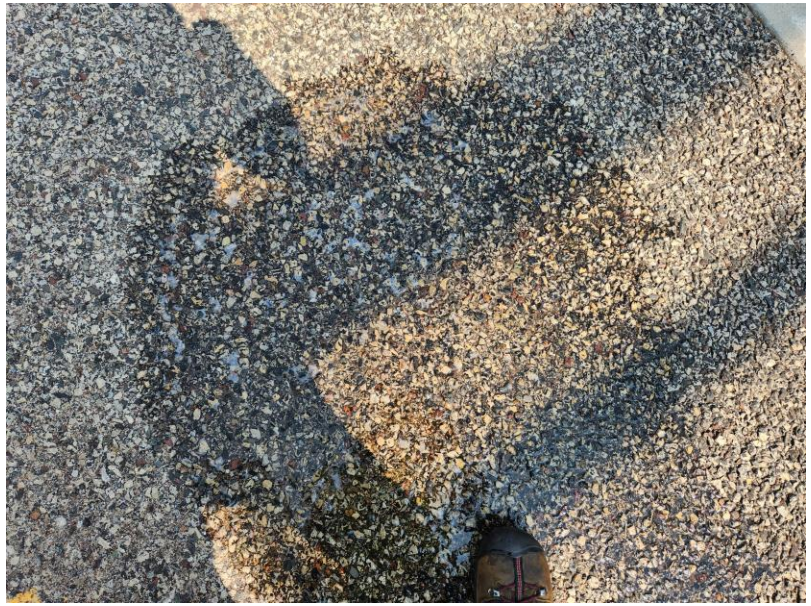
Saint Albans BMP – 11/7/23

Pervious Pavement Testing – 8/29/23



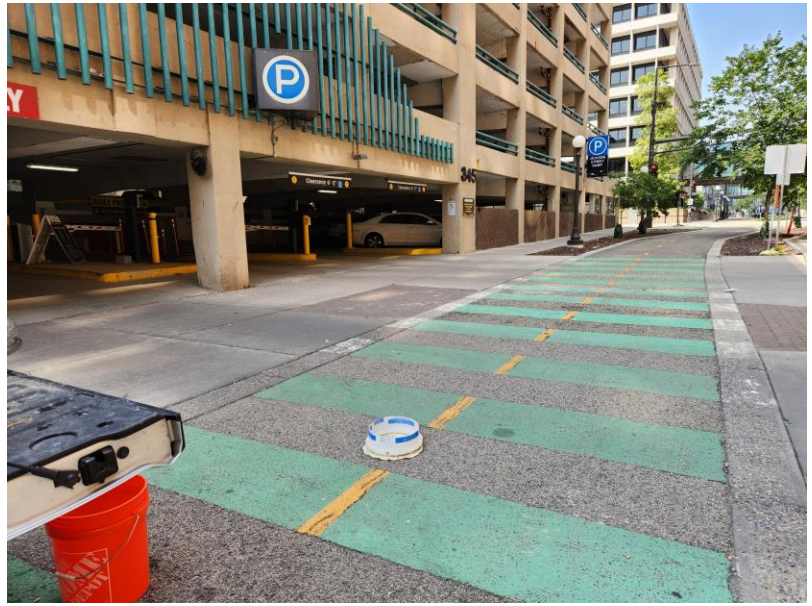

CREDIT UNION

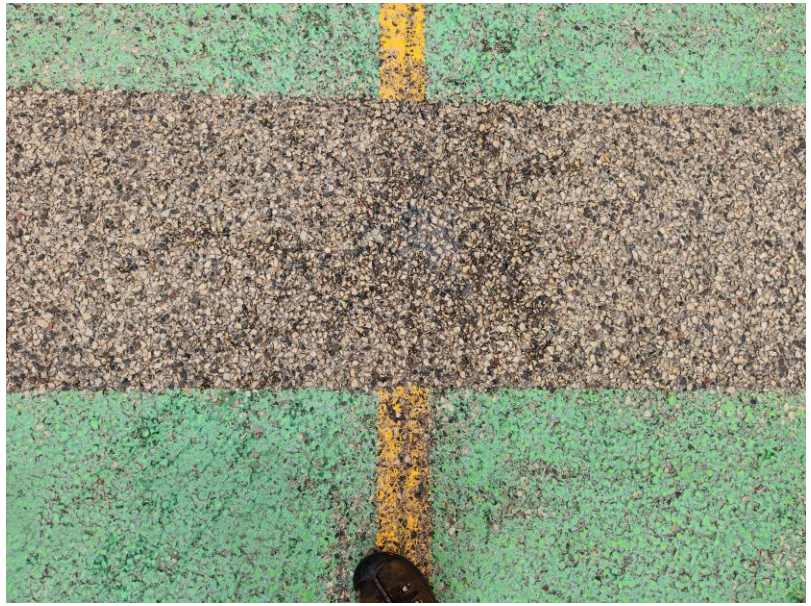

519A
FAHIYE



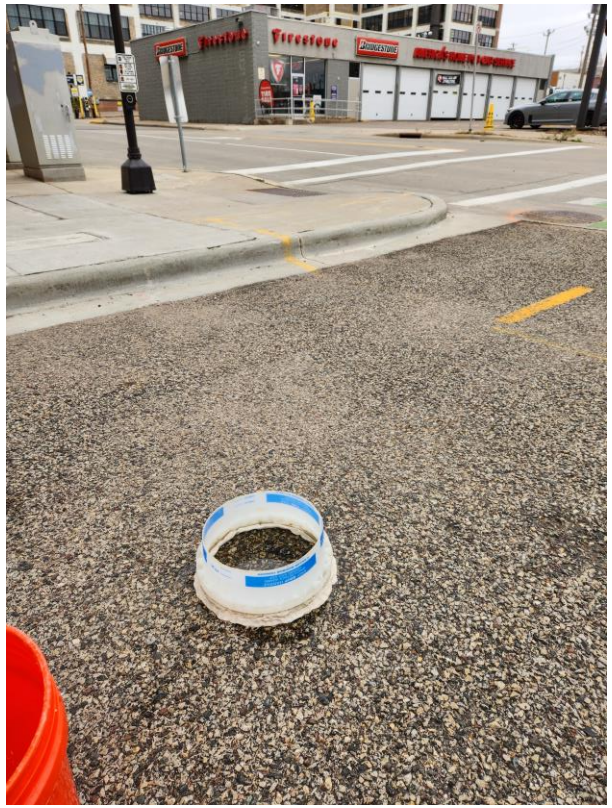

Jackson St
7th Place
LETHERT SKWIRA SCHULTZ & CO.
CERTIFIED PUBLIC ACCOUNTANTS
NO TURNS

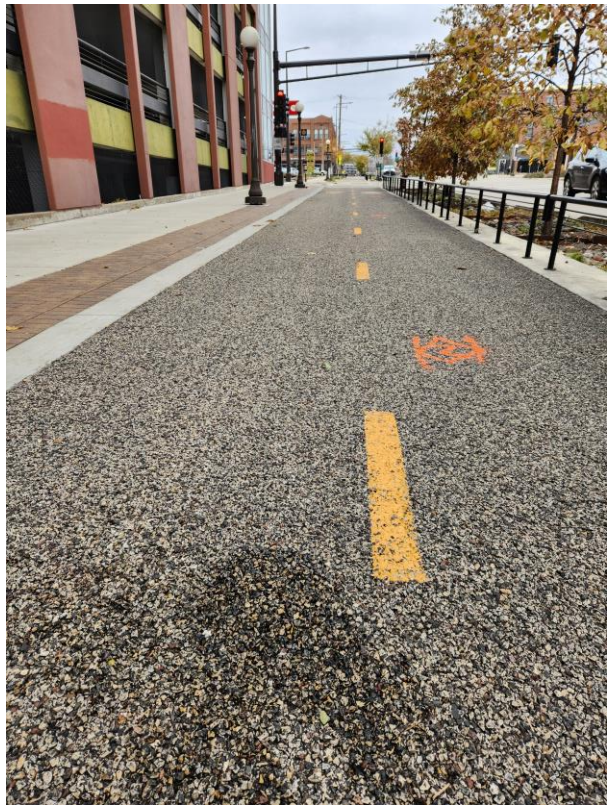

375 Jackson

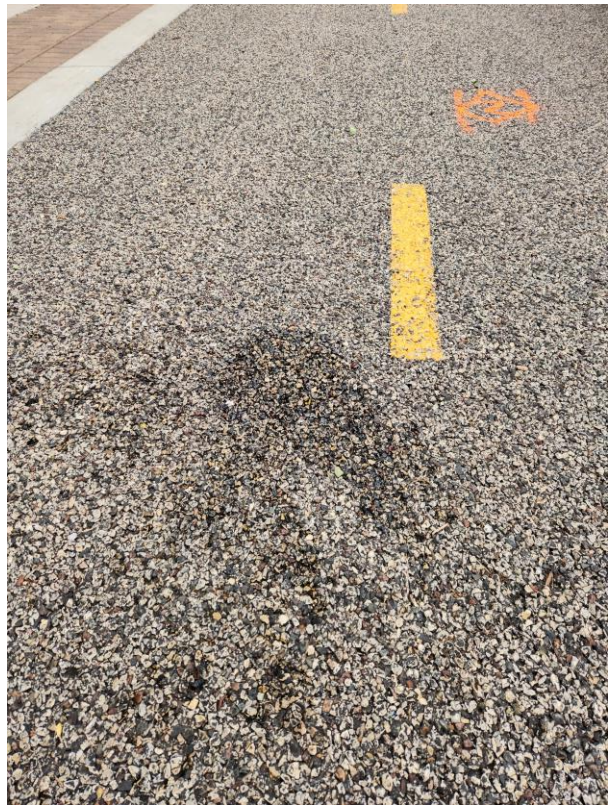


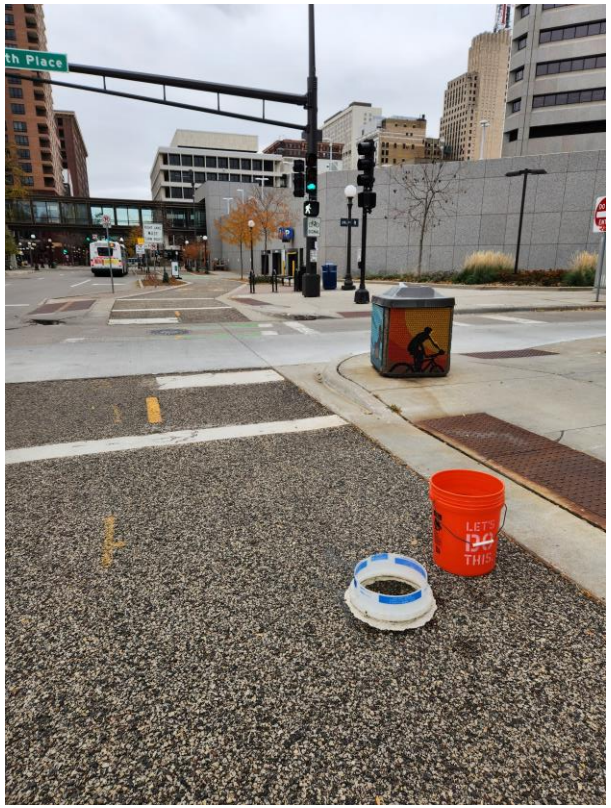


Pervious Pavement Testing – 11/10/23

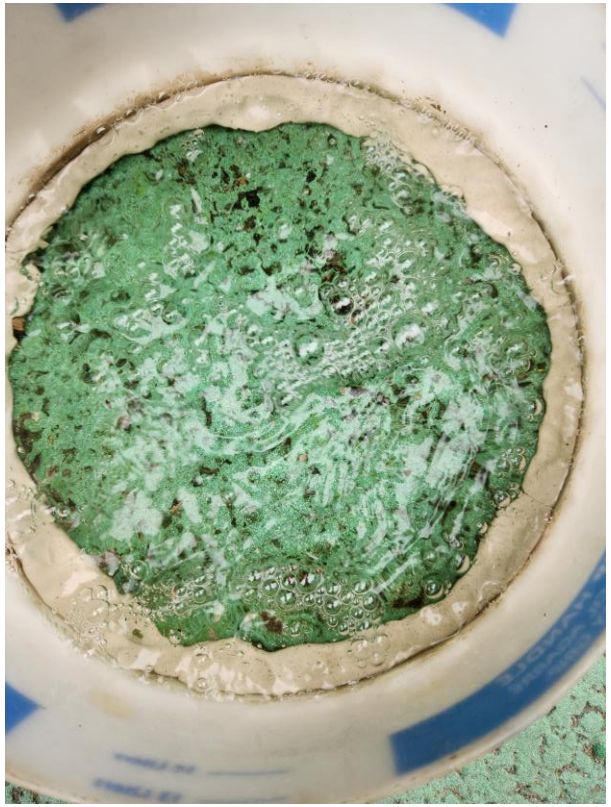

Firestone
Firestone

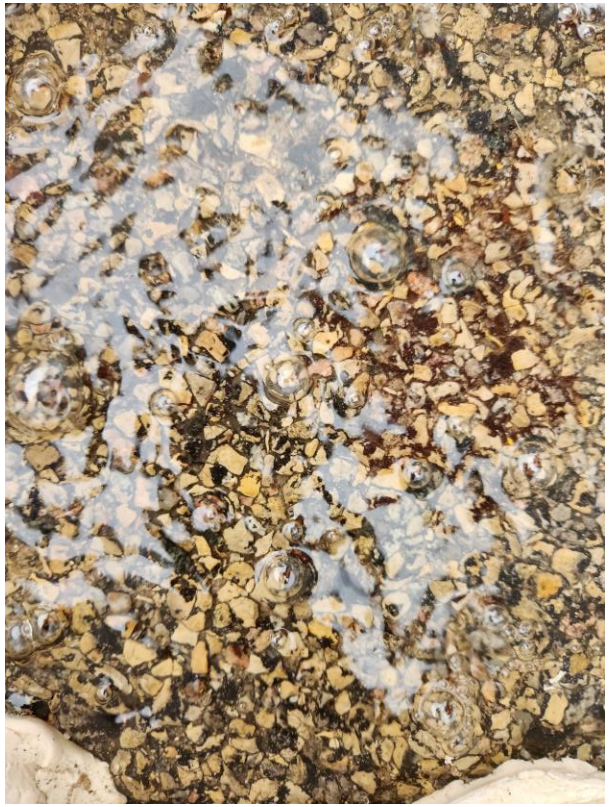


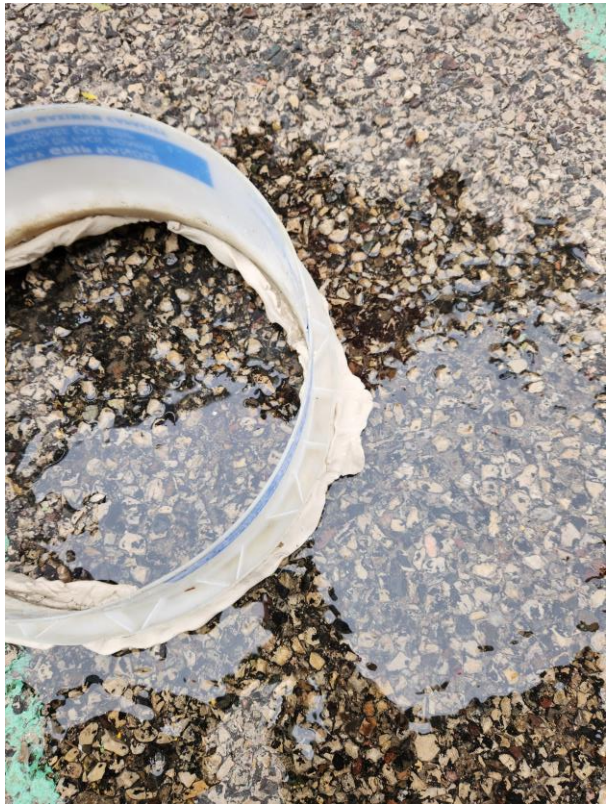


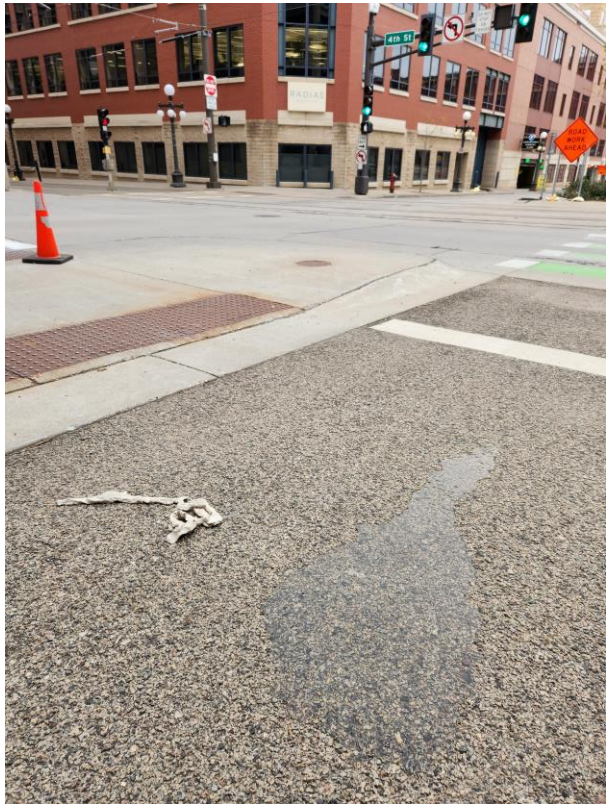

th Place


MAXIMUM CLEARANCE 12' 0"








4th St


Jackson St