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MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

Annual Monitoring Report 2012



MWMO Watershed Bulletin: 2013-1

Annual Monitoring Report 2012

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Front Cover: Stormwater Outfall Site 6UMN Monitoring Cabinet (above left), 6UMN Tunnel (above right) and River Monitoring for Hydraulic Mixing (below)
6UMN is a stormwater outfall site with a newly installed monitoring cabinet. The 6UMN tunnel has an area velocity sensor and a strainer for data and sample collection.
Mississippi River monitoring for hydraulic mixing began in 2012.This photo shows the monitoring staff during the data collection process.
Photographs by F. Rowland (above left), B. Jastram (above right) and Z. Her (below) Mississippi Watershed Management Organization

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Abstract

In 2012, the Mississippi Watershed Management Organization (MWMO) continued monitoring the Mississippi River for bacteria, monitored water quantity and water quality of the stormwater drainage systems, and monitored three wetlands (a.k.a. Kasota Ponds). Staff also began monitoring the Mississippi River at five cross-sections to develop methods to fill hydraulic mixing data gaps in the MWMO's stretch of the Mississippi River.

Under Section 303(d) of the Federal Clean Water Act, the 14-mile stretch of the Mississippi River in the MWMO is listed on the 303(d) list of impaired waters for fecal coliform. The Minnesota Pollution Control Agency (MPCA) has moved from a fecal coliform standard to an *Escherichia coliform (E. coli)* standard; therefore, all fecal coliform impairments are now evaluated with *E. coli* data. Bacteria samples were collected on a weekly basis from April to November 2012 from seven monitoring locations in the MWMO's 14-mile stretch of the Mississippi River. *E. coli* concentrations in the Mississippi River exceeded Minnesota water quality standards during the months of May through October in 2012. Long-term monitoring of the river and stormwater drainage systems is necessary to evaluate bacteria inputs from within the watershed compared to inputs from upstream sources.

In 2012, the MWMO began monitoring the Mississippi River at five locations (cross-sections) in three different reaches to develop methods to fill hydraulic mixing data gaps in the 14-mile stretch of the Mississippi River in the MWMO. Each cross-section was divided into five lateral points equally spaced throughout the width of the river. Water temperature, pH, dissolved oxygen, salinity, and specific conductivity measurements were taken at each point by using a multiparameter sonde. Measurements were taken at three-foot depth increments starting from the water surface to the bottom of the river.

The MWMO continued monitoring stormwater and wetlands in 2012. There are no water quality standards for stormwater; so, rather than comparing to standards, stormwater results are presented in the annual monitoring report. The MPCA wetlands' water quality criteria indicate that wetland water quality should maintain background conditions. Background water quality has not yet been determined for MWMO wetlands.

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Table of Contents

List of Tables

List of Figures

Acronyms and Abbreviations

1NE	stormwater outfall near the Excel Riverside Plant in northeastern Minneapolis at RM 857.2E
2NNBC	Old Bassett's Creek Tunnel outlet at RM 854.8W
4PP	stormwater outfall near the I-35W Bridge at RM 853.2W
6UMN	stormwater outfall near the University of Minnesota Coal Storage Facility at RM 853.0E
7LSTU	Bridal Veil Tunnel outlet at RM 851.6E
10SA	Saint Anthony Village stormwater drainage system sampling location, the outlet to the river is several miles away at RM 853.2E
µS	micro Siemans
a.k.a.	also known as
BMP	best management practice
C	celsius
cf	cubic foot
cfs	cubic feet per second
CFU	colony forming unit
cm	centimeter
D.O.	dissolved oxygen
DI	deionized
E. coli	*Escherichia coliform*
EQuIS	MPCA's water quality database
F	fahrenheit
ft	foot
GIS	geographic information system
GPS	global positioning system
in	inch
in/hr	inches per hour
KP	Kasota Ponds
L	liter
m	meter
MCES	Metropolitan Council Environmental Services
mg	milligram
mL	milliliter
MPCA	Minnesota Pollution Control Agency
MPN	most probable number
MPRB	Minneapolis Park and Recreation Board
MR	Mississippi River
MS4	municipal separate storm sewer system
MWMO	Mississippi Watershed Management Organization
n/a	not applicable
NAVD88	North American Vertical Datum, 1998

NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
PCBs	polychlorinated biphenyls
ppt	parts per trillion
PVC	polyvinyl chloride
RM	river mile upstream from the confluence of the Mississippi and Ohio Rivers in Cairo, IL
SAFL	Saint Anthony Falls Laboratory at the University of Minnesota
TCMA	Twin Cities Metropolitan Area
TMDL	total maximum daily load
USACE	United States Army Corps of Engineers

Glossary

Automated sampler: equipment that is programmed to collect water samples based on the parameters in the program. It allows for the collection of samples without staff being present during a precipitation or snow melt event

Baseflow: sustained flow in the stormwater drainage system that is the result of groundwater seepage or permitted discharge into the system

Best Management Practice: technique, measure, or structural control that is used to manage the quantity and improve the quality of stormwater runoff

Composite sample: a water sample that contains water collected during a precipitation or snow melt event at specific intervals throughout the event

Confined space: a space defined by the existence of all of the following conditions:

- Is large enough and so configured that an employee can bodily enter and perform assigned work
- Has limited or restricted means for entry or exit (for example, manholes)
- Is not designed for continuous employee occupancy

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

Field data: data collected at a monitoring site

Flow-paced: water samples collected with the automated sampler after a specific volume of water has passed by the area velocity sensor

Grab sample: a single water sample submitted for analysis

Illicit discharge: any discharge to the stormwater drainage system that is not composed entirely of stormwater, except for discharges allowed under a NPDES permit or water used for firefighting operations

Lab data: data that require lab processing of a sample (i.e. nutrients, solids, and metals)

Outfall: the end of a stormwater pipe, where the stormwater enters the receiving waterbody (in this case, the Mississippi River)

Pipeshed: an area of land where water from precipitation or snow melt drains into a waterbody through a man-made conveyance system of stormwater pipes (as opposed to natural systems such as streams). A pipeshed is not as elevation- and landscape-driven as a watershed

Rain duration: the number of hours of sustained precipitation. Discrete events need to be separated by eight or more hours. In rare cases, insignificant (<0.02 in) precipitation fell many hours after the main event. This was counted as a separate event

Rain event: greater than 0.01 inches of rain, eight or more hours after the last precipitation. In rare cases, insignificant (<0.02 in) precipitation that occurred less than eight hours after the last precipitation, but after many dry hours, were eliminated from the dataset

Rain intensity: calculated as the total rain event precipitation divided by the rain duration

Real-time data: data that are relayed from a monitoring site to a server and the internet where it can be viewed by MWMO staff in almost real-time. The delay time to view the data is determined by the data collection interval

Secondary parameters: parameters in a water sample that are measured at the monitoring site. These parameters are not analyzed at a laboratory (i.e. temperature, D.O., pH, conductivity, and transparency)

Stormflow: water flowing in stormwater pipes during storm (precipitation) and snow melt events. Stormflow in pipes is typically short in duration and has a high velocity

Stormwater: water that is not infiltrated during and immediately following a rain or snow melt event

Stormwater drainage system: a series of catch basins, pipes, and tunnels that carry stormwater or snow melt from the surface to a receiving waterbody

Stormwater tunnels: pipes designed to carry rain and melt event water to the nearest receiving waterbody. Note: sanitary and stormwater pipes are typically separated in Minnesota

Tailwater: a condition where the Mississippi River water level is high enough to enter outfalls and interfere with data collection

Total Maximum Daily Load: a calculation of the maximum amount of a pollutant that a waterbody can receive daily and still safely meet water quality standards

Watershed: an area of land where surface water (from rain or snow melt) runoff and groundwater drain into a waterbody, in this case, the Mississippi River. Watershed boundaries are defined by elevation

Annual Monitoring Report 2012

Executive Summary

The annual monitoring report details the monitoring activities and results of the Mississippi Watershed Management Organization's (MWMO) 2012 season. Each year, MWMO staff complete an annual monitoring report summarizing the year's monitoring activities and results and outlining the next year's work plan. Current and past reports are available on the MWMO website at **www.mwmo.org**.

The MWMO monitors water quality in the watershed's stormwater drainage system, the Mississippi River, and wetlands. Within these systems, major factors influencing water quality include the amount of precipitation, timing of precipitation events, and land use practices in the watershed. Long-term monitoring is necessary to characterize the impact of various land use practices on surface water runoff within the MWMO and, ultimately, the Mississippi River. Water quality in the Mississippi River is also influenced by precipitation and land use practices in the entire Mississippi River basin upstream of the MWMO. Long-term monitoring of the river will aid the understanding of upstream weather patterns and land use impacts on the MWMO watershed.

The 2012 monitoring season included: collection of water quality samples from seven locations in the Mississippi River and six stormwater drainage system sites for bacteria monitoring, automated collection of water quantity and water quality data from four stormwater outfall sites draining to the Mississippi River and one stormwater pipe at the jurisdictional boundary of the Cities of Saint Anthony Village and Minneapolis, and collection of water quality samples from three wetlands.

Portions of the 14-mile stretch of the Mississippi River in the MWMO are listed on the Federal Clean Water Act's Section 303(d) list of impaired waters for fecal coliform. The Minnesota Pollution Control Agency (MPCA) has moved from a fecal coliform standard to an *Escherichia coliform* (*E. coli)* standard, therefore all fecal coliform impairments are now evaluated with *E. coli* data. Bacteria samples were collected on a weekly basis from April through November 2012 from seven monitoring locations in the MWMO's 14-mile stretch of the Mississippi River. *E. coli* concentrations exceeded Minnesota water quality standards in 2012 during the months of May through October. Long-term monitoring of both the river and the stormwater drainage system is necessary to evaluate *E. coli* inputs from within the watershed compared to those inputs from upstream sources. The MPCA initiated the Upper Mississippi River Bacteria Total Maximum Daily Load (TMDL) Project in 2008 to develop daily *E. coli* load limits for the Mississippi River (MPCA, 2012).

In 2012, the MWMO began monitoring the Mississippi River at five locations (cross-sections) in three different reaches to develop methods to fill hydraulic mixing data gaps in the 14-mile stretch of the Mississippi River in the MWMO (Figure A.3). From August until the river froze in December, staff visited each of the cross-sections weekly. Each cross-section was divided into five lateral points equally spaced across the width of the river. Water temperature, pH, dissolved oxygen, salinity, and specific conductivity measurements were taken at each point by using a multiparameter sonde. Measurements were taken at three-foot depth increments starting from the water surface to the bottom of the river.

The MWMO continued monitoring water quantity and water quality of the watershed's stormwater drainage system by monitoring baseflow, snow melt events, and rain events in six stormwater tunnels draining to the Mississippi River. Samples were analyzed for nutrients, sediment, inorganics, organics, and metals analyses. Water quality standards do not exist for stormwater; therefore, data were not compared to standards but are presented in subsequent sections of the annual monitoring report. The MWMO will continue to monitor stormwater drainage systems to develop a record of baseline data to characterize stormwater quality within the watershed. The MWMO also provided stormwater data to the MPCA for TMDL projects within the watershed.

The MWMO also continued monitoring three wetlands known as Kasota Ponds. Samples were collected for nutrients, sediment, inorganics, and metals analyses. The MPCA water quality criteria indicate that wetland water quality should maintain background conditions. Background water quality has not yet been determined for MWMO wetlands.

Introduction

The annual monitoring report details the monitoring activities and results of the MWMO's 2012 monitoring season. Each year, MWMO staff complete an annual monitoring report summarizing the year's monitoring activities and results and outlining the next year's work plan. Current and past reports are available on the MWMO website at **www.mwmo.org**.

The MWMO established the monitoring program to provide a scientific basis for identifying and evaluating water quality and quantity issues, implementing solutions to improve water quality, and reestablishing natural water regimes in the watershed. The objectives of the monitoring program are to:

- Monitor biological, chemical, and physical parameters of water resources in the watershed
- Monitor water quality within the watershed
  - Develop a record of baseline data to characterize water quality and identify pollutants that exceed water quality standards
  - Assess pollutants listed on the Minnesota Impaired Waters list for the TMDL process
- Collect rate and volume data for the Mississippi River and key subwatersheds
- Monitor performance of stormwater management practices
- Collaborate with stakeholders to identify and apply a standardized data collection and assessment approach
- Develop partnerships and collaborate with other organizations and/or agencies, both inside and outside the watershed boundaries, to improve water quality in the Mississippi River
- Assess land use impact on water quality
- Participate in the technical development and update of statewide monitoring databases
- Make data accessible to the public and public entities and to MWMO staff for use as an education tool (e.g. BMP performance data)
- Develop an emergency monitoring plan in case of emergencies affecting water resources

The 2012 monitoring season included: collection of water quality samples from seven locations in the Mississippi River and six stormwater drainage system sites for bacteria monitoring, automated collection of water quantity and water quality data from four stormwater outfall sites draining to the Mississippi River and one stormwater pipe at the jurisdictional boundary of the Cities of Saint Anthony Village and Minneapolis, and collection of water quality samples from three wetlands.

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Refer to Figures A.1, A.2., and A.3. in Appendix A for the monitoring locations. Descriptions of the sampling sites are found in subsequent sections of this report.

Background

The MWMO was established in 1985 by a Joint Powers Agreement among member organizations. In 2012, the MWMO boundaries expanded to include portions of the Cities of Fridley and Columbia Heights and the City of Hilltop. The MWMO watershed boundaries are shown in Figure A.1 in Appendix A. The MWMO is a unique organization in that it includes a reach of the Mississippi River. Other local watershed districts and organizations include land and water resources up to the river's shore, but not extending into the river itself. The reach of the Mississippi River included in the MWMO extends from upstream of the Interstate-694 (I-694) bridge in Fridley downstream to Lock and Dam 1 (Ford Dam) in south Minneapolis. There are three lakes within the MWMO's boundaries: Loring Pond in Minneapolis, and Lake Sullivan (formerly known as Sandy Lake) and Highland Lake in Columbia Heights.

Minnesota regulations require that the MWMO protect water quality in the watershed. Minnesota Rules Chapter 7050 requires that all waterbodies comply with state water quality standards. Furthermore, section 303(d) of the Federal Water Pollution Control Act (commonly known as the Clean Water Act) requires states to develop TMDLs for waters with impaired uses. Impaired waters are those waters that exceed water quality standards for their classified use. Some typical classifications include drinking water, and aquatic life and recreation (swimming and fishing). According to Minnesota Rules Chapter 7050, the stretch of the Mississippi River within the MWMO watershed is divided into two reaches for classification. Table 1 highlights the most restrictive classifications.

The MWMO's stretch of the Mississippi River is listed on MPCA's 303(d) list of impaired waters for fecal coliform, mercury, and polychlorinated biphenyls (PCBs). The MPCA divided the stretch of the Mississippi River flowing through the MWMO into three reaches. Table 2 lists the impaired reaches of the river and the corresponding pollutants of concern. The MPCA has written a statewide TMDL for mercury (MPCA, 2007). Both Sullivan Lake and Highland Lake are listed on the 303(d) list of impaired water for nutrient/eutrophication and biological indicators.

Mercury and PCBs impairments are listed for aquatic consumption advisories; therefore, this report will address fecal coliform impairment only. Impairments in the lakes will be addressed in the Annual Monitoring Report 2013.

Protecting water quality in the Mississippi River is a complicated task. The reaches of the Mississippi River flowing through the MWMO are densely urbanized with commercial, industrial, residential, park lands, and downtown Minneapolis land uses contributing to the volume and quality of the water entering the river through the stormwater drainage systems. The MWMO monitors stormwater drainage systems to determine the water quantity and water quality contributions of surface runoff from the watershed to the river. However, the entire Mississippi River basin upstream of the MWMO watershed boundary contributes to water quality in the MWMO's reach of the river.

Table 1. Water use classifications for waterbodies in the MWMO

Waterbody	Water Use Classification
Mississippi River, MWMO upstream boundary to Upper Saint Anthony Falls	1C, Domestic consumption (drinking water) 2Bd Aquatic life and recreation and source of drinking water
Mississippi River, Upper Saint Anthony Falls to Lock & Dam 1 (Ford Dam)	2B Aquatic life and recreation
Loring Pond	2B Aquatic life and recreation
Sullivan (Sandy) Lake	2B Aquatic recreation
Highland (Unnamed) Lake	2B Aquatic recreation

Table 2. Pollutants in impaired waters

Impaired Waterbody	Pollutant
Mississippi River, MWMO upstream boundary to Upper Saint Anthony Falls	Fecal coliform, mercury in fish tissue, polychlorinated biphenyls (PCBs) in fish tissue
Mississippi River, Upper Saint Anthony Falls to Lower Saint Anthony Falls	Mercury in fish tissue, PCBs in fish tissue
Mississippi River, Lower Saint Anthony Falls to Lock & Dam 1 (Ford Dam)	Fecal coliform, mercury in fish tissue
Sullivan (Sandy) Lake	Nutrient/eutrophication biological indicators
Highland (Unnamed) Lake	Nutrient/eutrophication biological indicators

The upper Mississippi River is a large, dynamic river system that includes runoff from forested areas near the source at Lake Itasca, agricultural runoff from the central region of Minnesota, and the urbanized areas of Saint Cloud and the Twin Cities Metro area. Since precipitation produces surface runoff, precipitation differences throughout the upper Mississippi River basin can affect water flow and water quality in the MWMO's reaches of the Mississippi River.

Thus, if large amounts of rainfall have washed pollutants from the land upstream into the river, it is possible that flows could increase and water quality could decline, even though it has not rained in the watershed. In cooperation with other federal and state agencies as well as the watershed management organizations and districts, the MWMO plans to investigate the upstream impact on water quality to discern the effect precipitation in other portions of the state has on water quality in the MWMO's reaches of the Mississippi River.

Further complicating the investigation of water volume and quality in the river are the inputs of groundwater and the recharge to groundwater from the river. Groundwater may carry pollutants from upstream in the Mississippi River basin to the MWMO's reaches of the river. Pollutants may also leach from the river into the groundwater system. It is quite difficult to track potential groundwater inputs from an area as large as the Mississippi River basin upstream of the MWMO to the MWMO's reaches of the river. The MWMO has long-term plans to coordinate with organizations and agencies in the upper portion of the basin to improve water quality in the Mississippi River.

In 2012, the MWMO expanded its boundaries that now include two lakes in Columbia Heights. Sullivan and Highland lakes are located in densely urban areas. Descriptions of their watersheds will be provided in the Annual Monitoring Report 2013. Refer to the 2013 Work Plan section of this report for more information.

Precipitation Monitoring

Precipitation determines surface runoff and is arguably the greatest factor controlling surface water quality. As stated in the Background section of this monitoring report, water quality in the MWMO's reaches of the Mississippi River is affected by precipitation in the entire Mississippi River basin upstream of the MWMO, including tributary watersheds to the river.

Table 3 shows precipitation for several locations in the Upper Mississippi River Basin between St. Cloud and the Minneapolis St. Paul International Airport. Refer to Figure A.4 in Appendix A for the locations of the precipitation gauges. Precipitation data at sites 1NE and 10SA were collected by the MWMO. In late 2012, the MWMO installed a heated rain gauge with a data logger at site 1NE to better monitor precipitation, including the water equivalent of snow. Precipitation data at the SAFL site were collected by SAFL. Precipitation at Lock and Dam 1 was measured by the USACE. Precipitation data from all of the other precipitation monitoring sites were downloaded from the Minnesota Climatology Working Group website.

Table 3. Monthly precipitation (inches) at several locations in the Upper Mississippi River basin

	St. Cloud[1]	Becker[2]	Elk River[3]	New Hope[4]	1NE[5]	10SA[6]	SAFL[7]	Lock and Dam 1[8]	Chanhassen[9]	Minneapolis St. Paul International Airport[10]
January	0.57	0.93	0.55	0.32	0.04	0.35	0.13	0.81	0.34	0.36
February	1.24	1.06	1.44	2.21	0.58	0.62	1.14	0.77	2.42	1.71
March	1.15	1.19	1.37	1.26	1.36	1.70	1.12	1.52	1.22	1.40
April	2.60	1.78	2.05	2.72	2.08	2.53	2.06	3.37	3.20	3.04
May	8.76	11.27	11.96	9.17	7.98	7.68	6.91	9.70	11.23	9.34
June	2.36	4.32	3.52	3.62	3.05	2.74	2.54	3.92	4.73	3.59
July	3.59	4.03	4.20	4.53	3.95	4.26	3.92	5.16	3.34	4.90
August	1.22	1.24	0.90	1.64	1.43	1.31	0.69	1.26	2.30	1.38
September	0.24	0.21	0.42	0.50	0.33	0.6	0.29	0.27	0.44	0.30
October	0.73	0.68	0.10	1.52	1.32	1.29	1.27	1.42	1.16	1.30
November	1.05	0.96	0.82	0.93	0.32	0.60	0.63	0.81	0.77	0.63
December	1.52	1.58	1.35	1.79	0.36	1.22	0.66	1.91	1.65	1.64
Total	25.03	28.98	28.68	29.40	22.80	24.90	21.37	30.92	32.80	29.59

[1] Location: Latitude 45.54413 Longitude -94.07082, Source: **http://climate.umn.edu/hidradius/radius.asp**

[2] Location: Latitude 45.42064 Longitude -93.93335, Source: **http://climate.umn.edu/hidradius/radius.asp**

[3] Location: Latitude 45.52726 Longitude -93.71100, Source: **http://climate.umn.edu/hidradius/radius.asp**

[4] Location: Latitude 45.0167 Longitude -93.3667, Source: **http://climate.umn.edu/hidradius/radius.asp**

[5] Location: Latitude 45.02389 Longitude -93.2772, Source: MWMO data

[6] Location: Latitude 45.01278 Longitude -93.2203, Source: MWMO data

[7] Location: Latitude 44.98239 Longitude -93.254932, Source: Personal communication with Chris Ellis, Saint Anthony Falls Laboratory

[8] Location: Latitude 44.91497 Longitude -93.254932, Source: **http://www.mvp-wc.usace.army.mil/projects/Lock1.shtm**

[9] Location: Latitude 44.8514 Longitude -93.5650, Source**: http://climate.umn.edu/hidradius/radius.asp**

[10] Location: Latitude 44.88306 Longitude: -93.22889, Source: **http://climate.umn.edu/hidradius/radius.asp**

The MWMO acknowledges a link between precipitation and the water quality data shown in the following sections. However, the MWMO does not support quantitative analysis of this relationship because the precipitation data are not representative of the entire Mississippi River basin contributing to the MWMO watershed. Also, MWMO staff were not able to determine which sites contained heated precipitation gauges to measure water equivalent of snow fall. Table B.1 in Appendix B shows which precipitation events were sampled at each stormwater monitoring site.

Mississippi River Bacteria Monitoring

The MWMO monitors seven locations in the Mississippi River. Six sites are MWMO long-term monitoring sites and are described in the following section. The seventh site—MR853.5E, located between Upper and Lower Saint Anthony Falls—was added in 2010 to provide data for development of the Upper Mississippi River Bacteria

TMDL project that is managed by the MPCA. The monitoring sites are identified by the river mile upstream from the confluence of the Mississippi and Ohio Rivers in Cairo, Illinois, and from the nearest riverbank to the sample collection point. E refers to the east bank and W refers to the west bank. The highest river mile is the farthest upstream.

Site Descriptions

MR859.1W (Camden): The Camden site is the northernmost monitoring site in the MWMO's watershed. It is located in the North Mississippi Regional Park at the intersection of 53rd Avenue and North Lyndale in Minneapolis. The terrain surrounding the site is mostly deciduous forest with a grassland transition zone by the road. Footpaths lead from the paved trail by the road, through the forest to the monitoring site on the river. The footpaths may cause minimal erosion. There is a concrete levy wall and boulders at the sampling site and an outfall just upstream. The river is shallow (three-five feet), rocky, and swift (in places) with sandbars up and downstream. Water levels fluctuate at this site more than at any other in the watershed. Storm events can raise the water level up to three feet. Waterfowl are commonly seen in the river and on shore. Rabbits, bald eagles, a Blanding's Turtle and a beaver have also been observed.

MR857.6W (MPRB Boat Launch): This site is located adjacent to MPRB land. A paved parking lot leads to the river and boat launch. During the warmer months, a floating dock rests directly upstream from the boat launch. Flat and forested terrain surround the parking lot and boat launch area with some grassy areas and paved and unpaved trails leading up and downstream, respectively. The river bottom near shore is silty mud, gravel, and large stones. The river is deeper here than at MR859.1W and can have a swift current after rainfall. The monitoring site is upstream of the dock foundation. It is located downstream of the mouth of Shingle Creek.

MR854.9W (North Loop): The North Loop site is downstream from the Plymouth Avenue Bridge. It is adjacent to a shaded park area with picnic tables, trails, grass, and trees. The riverbank is steep and covered in brush. The shore and shallows at the sampling site are composed of loose rocks and sand. The monitoring site is at the base of a stairway that leads to the river.

MR853.5E (Saint Anthony Falls Laboratory): The Saint Anthony Falls Laboratory (SAFL) site is located between Upper and Lower Saint Anthony Falls. It is located near the bottom of the SAFL's outdoor stream laboratory. The shore is rocky.

MR852.2E (University of Minnesota Boat Launch): The University of Minnesota Boat Launch site is the first river site downstream from Lower Saint Anthony Falls. It is located in the Mississippi River Gorge, behind Coffman Union on the University of Minnesota East Bank Campus. A paved path leading from a parking lot wraps around a grassy area and the University of Minnesota rowing teams' boat house and angles west down to a boat launch. The sampling site is 100 feet upstream of the boat launch and floating dock that is used by the rowing teams. The surrounding terrain consists of deciduous forest along the river and a large grassy area behind the trees. The gently sloping bank leads to a sandy shore that continues into the river. The site is a regular entrance point to the river for approximately 100 geese that graze on the grass in the open area. Goose droppings are common here.

MR849.9W (Lake Street Bridge): This site is located beneath the Lake Street Bridge over the Mississippi River. There is parking on the street by the bridge and a foot path that leads down into the gorge to the sampling site. The elevation drops more than 70 feet from the street to the river. A small stormwater outfall and the Minneapolis Rowing Club boat facility are located just upstream of the site. There is tall grass along the river and trees on the sides of the gorge. There is a steep, three-foot riverbank leading to a rocky shore. The river bottom is sandy with limestone boulders and gravel (riprap).

MR848.1W (4300 West River Parkway): This monitoring site is the farthest downstream in the MWMO's watershed. There is a parking lot and a paved path from the parking lot into the gorge. There are foot paths leading down the bluffs to the river. The site is surrounded by hardwood forest and is just upstream from a stormwater outfall. The shore and river bottom are made up of sand and large, flat limestone rocks. The Ford Dam is less than one mile downstream from the monitoring site.

Methodology

Sample Collection, Handling, and Preservation

Grab samples were collected from seven locations in the Mississippi River on a weekly basis. Staff followed sampling procedures outlined in the MWMO's Standard Operating Procedure for Surface Water Sampling (2011). Samples were collected in lab-sterilized 125-milliliter (mL) plastic bottles. Collection occurred away from shore, in approximately three feet of water. Samples were taken in positive flow (no back eddies or stagnant water) and upstream of the monitoring specialist to prevent contamination by the disturbed river bottom. To collect samples, the monitoring specialist plunged an opened, inverted bottle one foot below the water surface, turned it upward to fill, and brought it out of the water (Figure 1). The specialist then poured some of the sample out to provide headspace for the laboratory.

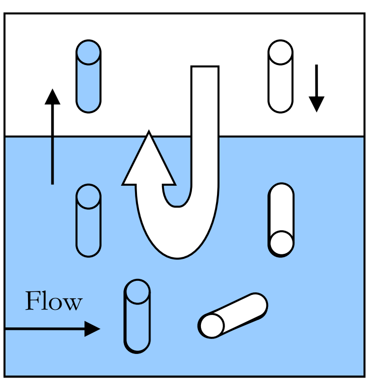

Figure 1. Diagram of sample collection method

Samples were labeled, stored on ice in a cooler, and delivered to the laboratory by the monitoring specialist after the final sample was collected. Analysis conducted on these samples did not require preservation.

Dissolved oxygen, conductivity, salinity, water temperature, and pH data for each site were collected using a YSI ProPlus sonde (YSI Inc., Yellow Springs, OH). The multiparameter probe was placed in the water approximately one foot below the surface. Data were recorded when the values stabilized.

Sampling Quality Control

The MWMO staff followed the quality control protocol outlined in the MWMO Ambient Surface Water Monitoring Quality Assurance Project Plan (MPCA, 2010). Blank samples of deionized (DI) water were submitted to laboratories once a month to verify that sample containers were clean and samples were not contaminated during travel. In addition, ten percent of all samples were collected in duplicate to verify that sampling and laboratory procedures did not jeopardize the data.

Laboratory Analyses

Bacteria samples were analyzed at the Three Rivers Park District Laboratory. The laboratory followed strict protocols for quality assurance and quality control. Information regarding laboratory protocol is available from MWMO staff.

Refer to Table C.1 in Appendix C for a list of sample parameters, the laboratories used for analysis, the analysis methods, and information regarding certification.

Water Elevation Monitoring

The MWMO has monitored Mississippi River water elevations (commonly referred to as stage) at six locations since 2005. Mississippi River water elevations rise and fall in response to precipitation events and snow melt, and are also influenced by the dams at Saint Anthony Falls and Lock and Dam 1. Since the river pools behind the dams, control activities at the dam cause changes in river elevation, even in the absence of precipitation. The MWMO data are equivalent to data collected by agencies using the North American Vertical Datum, 1988 (NAVD88).

Mississippi River water elevations for the six long-term MWMO monitoring locations in 2012 are shown in Figures 2 and 3. All staff gauges were installed on March 21, 2012. High water level submerged most of the gauges on May 28, 2012. On June 12, 2012 after the high water receded, staff discovered the gauges at sites MR859.1W, MR857.6W, and MR854.9W were bent. New gauges were installed at these three sites on July 31, 2012. Regressions between the old and new gauge readings were used to calculate accurate elevation data. The remaining time periods with missing data were the result of either high river water levels (the staff gauges were submerged underwater) or low river water levels (during which river water levels were well below the lowest elevation of the staff gauge). Water elevation data were not recorded at site MR853.5E because of the site's close proximity to Saint Anthony Falls and deep water depth. In 2012, Mississippi River water elevations varied widely from approaching flood stages in June and July to drought levels in September and October.

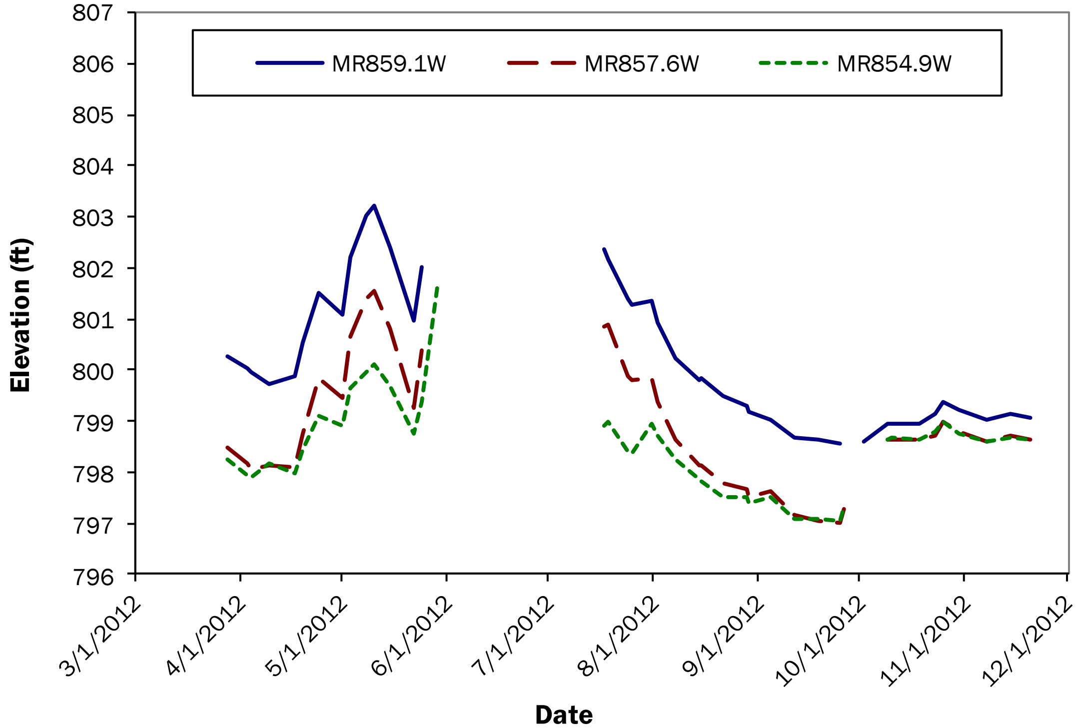

Figure 2. Mississippi River water elevations at three monitoring sites upstream of Saint Anthony Falls

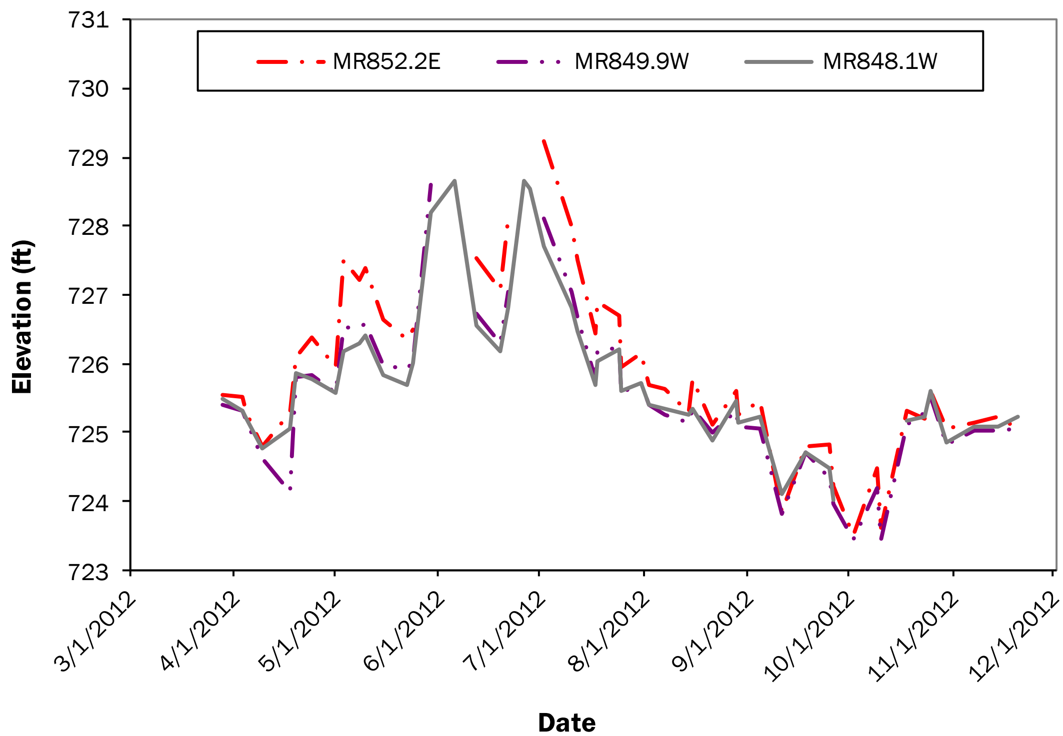

Figure 3. Mississippi River water elevations at three monitoring sites downstream of Saint Anthony Falls

Mississippi River Bacteria Monitoring Results

E. coli

Portions of the MWMO's reach of the Mississippi River are listed on the MPCA's list of impaired waters for fecal coliform pollution. In 2008, the MPCA changed the bacteria water quality standard from fecal coliform to *E. coli* for bacteria monitoring in Minnesota. The standard for *E. coli* in 2B and 2Bd waters is 126 CFU/100 mL for a monthly geomean of at least five samples. The geomean is equal to the n^{th} root of the product of the n terms:

$$Geomean_{\bar{x}} = \sqrt[n]{x_1 x_2 x_3 \ldots\ x_n}$$

Where *x* is a set of bacteria samples, *n* is the number of samples, x_1 is the value of sample one, x_2 is the value of sample two, etc.

Figure 4 shows the 2012 monthly geomeans of *E. coli* data for the Mississippi River bacteria monitoring sites. The monthly geomeans for the month of April and July did not exceed the water quality standard for any of the sites, but all sites exceeded the standard at least once. Site MR859.1W exceeded the *E. coli* standard in May, August, September, and October. Site MR857.6W exceeded the standard in May, June, September, and October. Sites MR853.5E and MR854.9W exceeded the standard once, in June and October, respectively. Site MR852.2E exceeded the standard in May and June. Sites MR849.9W and MR848.1W exceeded the standard only in June.

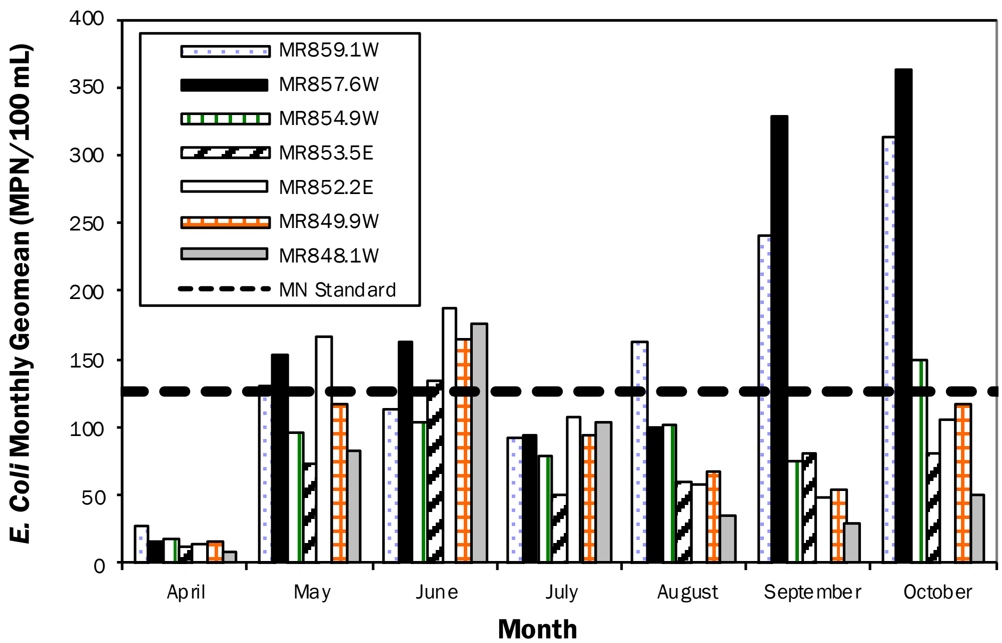

Figure 4. 2012 monthly geomeans for *E. coli* data for the Mississippi River monitoring sites

Table 4. Sites that exceed the monthly *E. coli* geomean for the Mississippi River in 2012

Month	Sites that exceed monthly geomean	Sites that exceed 1,260 MPN/100 mL in > 10% of samples	Sites that do not exceed any standards
April	None	None	All
May	MR859.1W, MR857.6W, MR852.2E	MR857.6W	MR854.9W, MR853.5E, MR849.9W, MR848.1W
June	MR857.6W, MR853.5E, MR852.2E, MR849.9W, MR848.1W	MR857.6W, MR852.2E	MR859.1W, MR 854.9W
July	None	MR857.6W, MR854.9W, MR852.2E, MR848.1W	MR859.1W, MR853.5E, MR849.9W
August	MR859.1W	MR859.1W, MR857.6W, MR854.9W, MR848.1W	MR853.5E, MR852.2E, MR849.9W
September	MR859.1W, MR857.6W	None	MR854.9W, MR853.5E, MR852.2E, MR849.9W, MR848.1W
October	MR859.1W, MR857.6W, MR854.9W	MR859.1W, MR854.9W, MR853.5E, MR849.9W, MR848.1W	MR852.2E

The MPCA *E. coli* standard also states that *E. coli* cannot exceed 1,260 CFU/100mL in more than 10% of the samples taken in one month. Every site exceeded this standard in one or more months of 2012. However, the small number of samples collected each month greatly affected these results. The *E. coli* data are presented in more detail in Figures D.1 through D.7 in Appendix D. Table 4 presents a summary of all *E. coli* exceedances.

Precipitation is an important predictor of *E. coli* concentrations. The MWMO targets sampling during baseflow conditions and local rain events to ascertain the impact of precipitation on river bacteria levels. Figure 5 shows boxplots of the 2012 river bacteria data separated out into base and rain values (Refer to Appendix E for an explanation of boxplots). Rain sample *E. coli* concentrations were typically an order of magnitude higher than baseflow values, but there were also instances of high baseflow values. Some potential causes of high baseflow *E. coli* values include water fowl congregating near the sampling site and sanitary overflow into the river. To lower the risk of exposure to high bacteria levels in the river, avoid swimming during rain and for 72 hours after a rainfall.

Two additional factors should be considered when evaluating these results. First, these results are based on a maximum of eight samples per month. Had more samples been collected, the data may have exhibited different results. Second, two unique features of the MWMO watershed are Upper and Lower Saint Anthony Falls. The Mississippi River water mixes as it flows over the falls, likely affecting water quality.

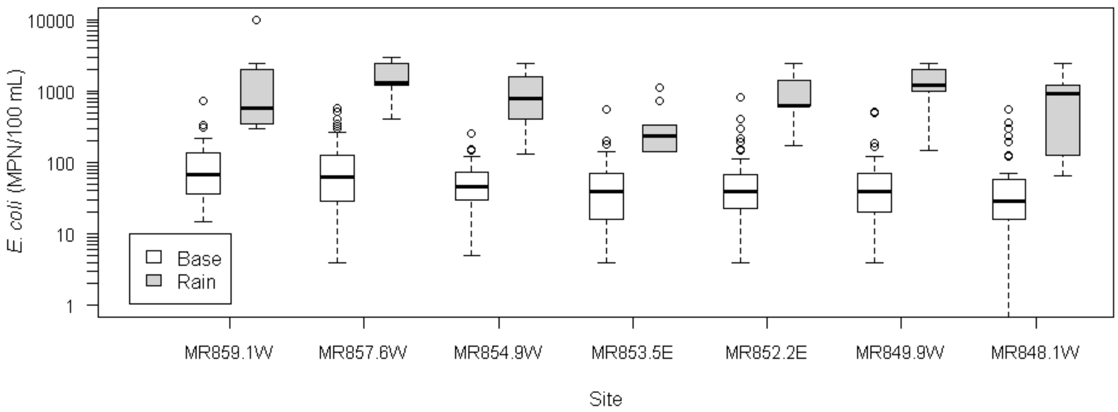

Figure 5. 2012 Mississippi River *E. coli* monitoring results, separated by baseflow and stormflow samples

As these results are highly dependent on precipitation, both in the watershed and upstream, results may differ drastically from year to year. The MWMO does not support interpretation or assumptions based solely on one year of data. The MWMO will continue to collect data on the Mississippi River to provide data for development of TMDLs in the watershed.

Water Temperature, Dissolved Oxygen, pH, Transparency, Salinity, and Specific Conductivity

The MWMO monitored dissolved oxygen, pH, water temperature, salinity, specific conductivity, and transparency on a weekly basis throughout the 2012 sampling season for the river monitoring sites. These parameters are basic measures that indicate the health of a waterbody, as they contribute to survival of fish and other aquatic organisms and plants. Refer to Figures D.8 through D.14 in Appendix D for the monitoring data.

Mississippi River Monitoring For Hydraulic Mixing

In 2006, the MWMO developed plans to better achieve its responsibility for monitoring water quality in the stormwater drainage systems and the Mississippi River (MWMO, 2006). For an accurate assessment of the water quality within the 14-mile stretch of the Mississippi River, the MWMO needed to know where, how, and when to sample the reaches of the river in the MWMO, given the patterns of hydraulic mixing as it passes through the watershed. The MWMO contracted with Emmons & Olivier Resources, Inc. in 2006, to conduct a literature review to provide necessary information for the development of big river monitoring protocols (MWMO, 2008). The study provided findings and gaps in the hydraulic and pollutant mixing literature related to large river systems. There are no site specific data or models to address mixing in the MWMO's reaches of the Mississippi River.

In 2012, the MWMO began monitoring the Mississippi River at five locations (cross-sections) in three different reaches to develop methods to fill hydraulic mixing data gaps in the 14-mile stretch of the Mississippi River in the MWMO (Figure A.3). From August until the river froze in December, staff visited each of the cross-sections weekly. Each cross-section was divided into five lateral points equally spaced across the width of the river. Water temperature, pH, D.O., salinity, and specific conductivity measurements were taken at each point by using a multiparameter sonde. Measurements were taken at three-foot depth increments starting from the water surface to the bottom of the river (Figure 6).

Site Selection

Figure A.3 in Appendix A shows the monitoring locations for hydraulic mixing. Site selection was based on the hydraulic characteristics of the four reaches in the 14-mile stretch of the Mississippi River in the MWMO (MWMO, 2008). Site MR859.1 (Camden) is just upstream of the beginning of Reach #1 (RM 859.0-RM 857.8). Site MR858.0 (2) is near the end of Reach #1 and just upstream of the Shingle Creek tributary entering the Mississippi River at river mile 857.9. Site MR854.8 (2NNBC) is near the end of Reach #2 (RM 857.8-RM 854.1) and downstream of Boom Island boat launch. Site MR852.6 (Washington Avenue Bridge) is downstream of the beginning of Reach #4 (RM 853.4-RM 847.8) at Lower Saint Anthony Falls. Site MR848.1 (6.1) is near the end of Reach #4. Data were not collected from Reach #3 (RM 854.1 – RM 853.4), located between Upper and Lower Saint Anthony Falls, due to safety concerns.

Site (Cross-Section) Descriptions

MR859.1 (Camden): This site is just upstream of the beginning of Reach #1 (RM 859.0-RM 857.8) and is the farthest upstream cross-section in the MWMO's watershed. The cross-section is 840 feet wide. The west end of the cross-section begins at site MR859.1W, near a concrete abutment and a stormwater outfall, and terminates at the opposite bank. The river bottom is rocky.

MR858.0 (2): The west end of this cross-section is 200 feet upstream from the outlet of Shingle Creek and is marked by a triple stem *Populus sp.* tree. The east end of the cross-section is a *Populus sp.* tree with no bark on the bottom 10 feet of its trunk. The cross section is 525 feet wide. The river bottom is sandy and rocky.

MR854.8 (2NNBC): The west end of this cross-section is on the shore midway between the two farthest upstream barge tie-up piers. The east end of this cross-section terminates at the concrete steps on Boom Island. The cross-section is 575 feet wide. The river bed is silty and rocky.

MR852.6 (Washington Avenue Bridge): This cross-section is just downstream from the Washington Avenue Bridge. The west end of this cross-section begins near the Bohemian Flats Park, next to the sheet pile wall in line with the park information pavilion. The east end of this transect terminates near a rectangular tunnel structure in the opposite bank. This cross-section is 525 feet wide. The river bottom is composed of sand, silt, and rocks.

MR848.1 (6.1): The west end of this cross-section begins at site MR848.1W (marked by a staff gauge) and terminates at the opposite bank near two small dead trees that are close together. This cross section is 1060 feet wide. The river bottom is mostly sandy.

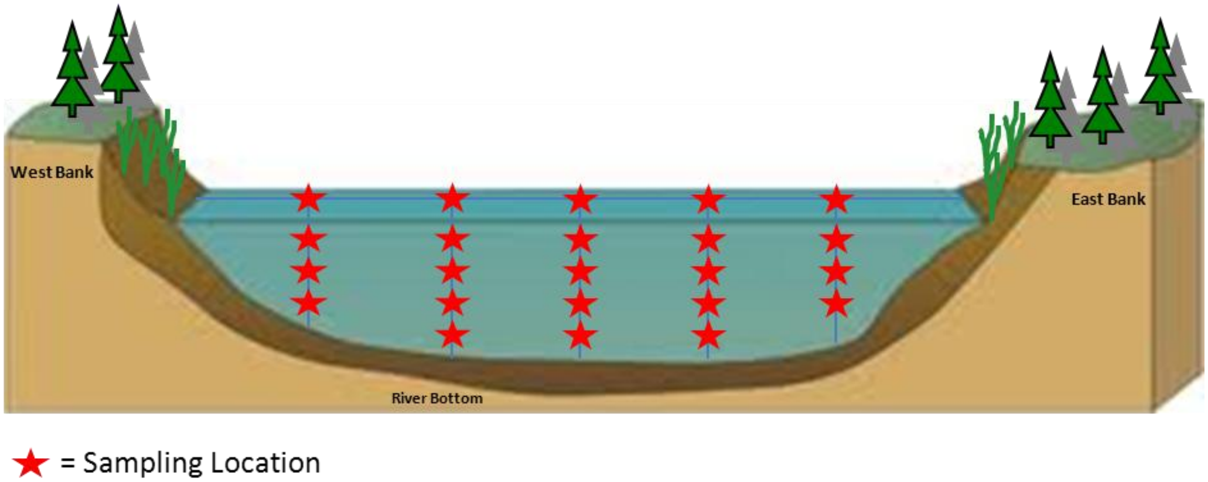

Figure 6. Diagram of a cross-section for river hydraulic mixing sampling. Each star represents a data collection point

Methodology

Data Collection

Each cross-section was divided laterally into five equal lengths, and measurements were taken at the mid-point of each (Figure 6) at three-foot depth increments from the water surface to the bottom of the river. Water temperature, pH, D.O., salinity, and specific conductivity data were collected using a multiparameter YSI ProPlus sonde mounted to a telescoping pole. Data were recorded when the values stabilized. The number of measurements made at each lateral position varied with the depth of the river. With the exception of site MR859.1 (Camden), river sites were accessed with an 18-foot John boat. At site MR859.1, staff waded across the river as far as they could safely reach. An example of data collected at a cross-section during a sampling visit is presented in Table 5.

Table 5. River monitoring data for cross-section MR856.2 (Washington Avenue Bridge) for November 8, 2012

	East Bank		Midpoint		West Bank
Lateral Position	**1**	**2**	**3**	**4**	**5**
Depth (ft)			**Temperature (C)**		
0	10.2	10.3	10.3	10.3	10.4
3	10.2	10.3	10.3	10.3	10.3
6	10.2	10.2	10.3	10.3	10.3
9	10.2	10.2	10.3	10.3	10.3
12	10.2	10.2	10.3	10.3	10.3
13	10.2	—	10.3	—	10.3
			Dissolved Oxygen (mg/L)		
0	12.07	12.22	12.46	12.69	12.59
3	11.83	12.14	12.50	12.59	12.48
6	11.73	11.97	12.43	12.45	12.31
9	11.72	11.96	12.32	12.40	12.26
12	11.73	11.91	12.42	12.38	12.22
13	11.52	—	12.29	—	12.25
			Salinity (ppt)		
0	0.22	0.22	0.22	0.22	0.22
3	0.22	0.22	0.22	0.22	0.22
6	0.22	0.22	0.22	0.22	0.22
9	0.22	0.22	0.22	0.22	0.22
12	0.22	0.22	0.22	0.22	0.22
13	0.22	—	0.22	—	0.22
			Specific Conductance (uS/cm)		
0	452.9	450.0	450.2	450.9	451.0
3	454.1	450.8	450.1	451.0	453.6
6	452.8	451.6	449.0	450.6	453.8
9	453.7	451.3	450.2	450.7	454.3
12	452.7	451.1	450.5	450.9	454.0
14	452.5	—	450.6	—	454.5
			pH		
0	8.42	8.44	8.35	8.39	8.44
3	8.42	8.41	8.39	8.41	8.39
6	8.38	8.41	8.43	8.40	8.44
9	8.45	8.42	8.42	8.43	8.42
12	8.37	8.43	8.54	8.41	8.43
13	8.41	—	8.46	—	8.39

Data Collection Quality Control

The MWMO staff followed established calibration procedures for YSI data quality control. D.O., pH, and conductivity were calibrated before every use. At the end of the day, the calibration was checked to determine if there was any drift in the YSI data measurements.

Stormwater Monitoring

The MWMO monitors five stormwater outfalls into the Mississippi River and one stormwater pipe at the jurisdictional boundary of the Cities of Saint Anthony Village and Minneapolis. The monitored locations were chosen because they are the most extensive stormwater drainage systems (pipesheds) within the watershed, and they are accessible. (Refer to Figures A.1 and A.5 in Appendix A for a map of stormwater sampling sites and pipesheds.) Site descriptions and water quantity data for each stormwater site are provided in this section.

A stormwater drainage system refers to the area that drains to one stormwater outfall. Land uses in the stormwater drainage systems affect water quality. The amount of impervious surfaces and potential pollutants differs between industrial and residential land uses. A future objective of the monitoring program is to investigate the impact of specific land uses on water quality. Refer to the Annual Monitoring Report 2007 (MWMO, 2009) for land uses in the watershed.

Site Descriptions

1NE (Excel Riverside Plant): 1NE is the northernmost outfall monitored by the MWMO. The outfall is located on the east bank of the Mississippi River on the Excel Riverside Power Plant property at river mile 857.2. The stormwater drainage system drains water from the Northeast Minneapolis Neighborhood. The outfall is a 96-inch diameter, corrugated iron pipe. The stormwater drainage system has continuous baseflow.

2NNBC (Old Bassett's Creek Tunnel Outlet): The 2NNBC outfall drains water from the Near North Minneapolis Neighborhoods and Bassett's Creek. It enters the river in a park in the North Loop Neighborhood of Minneapolis on the west bank of the Mississippi River at river mile 854.8. Bassett's Creek was buried and routed through a tunnel in 1890. In 1992, the creek was rerouted through a new tunnel that enters the Mississippi River below the surface water level, just downstream from Upper Saint Anthony Falls. There are paths leading from a parking lot to the outfall. The semi-elliptical outfall is approximately 11 feet high and 15 feet wide. Water from Bassett's Creek only flows through this original outfall during overflow periods. In 2012, Bassett's Creek was monitored by the Metropolitan Council, approximately one-quarter mile upstream of where the creek enters the City of Minneapolis stormwater drainage system.

4PP (I-35W Bridge): This outfall is located below Lower Saint Anthony Falls Lock and Dam on the west bank of the Mississippi River at river mile 853.2. It drains stormwater from the Phillips and Powderhorn Neighborhoods and the southern portion of the Central Neighborhood in Minneapolis, as well as water from the I-35W freeway. Access to the outfall is gained from the Lower Saint Anthony Falls Lock and Dam service road. The semi-elliptical tunnel is 14 feet high and 14 feet wide. There is continuous base flow in this stormwater drainage system. Northern Pike fish have been observed at the outfall during spawning season.

6UMN (University of Minnesota Coal Storage Facility): 6UMN is located on the east bank of the Mississippi River at river mile 853.0, downstream from Saint Anthony Falls, behind the University of Minnesota heating plant. The outfall drains water from the City of Minneapolis and the University of Minnesota, Minneapolis Campus. This semi-elliptical tunnel is eight feet high and eight feet wide with a rounded top and slightly U-shaped base. There is continuous baseflow in this stormwater drainage system.

7LSTU (Bridal Veil Tunnel): 7LSTU is the farthest downstream outfall monitored by the MWMO. It is located on the east bank of the Mississippi River at river mile 851.6, between the I-94 Bridge and Franklin Avenue Bridge. The outfall drains water from the City of Minneapolis and the University of Minnesota, Minneapolis Campus. The cathedral-shaped tunnel is 10.37 feet high and 6.67 feet wide. At the mouth of the outfall, five square, concrete pillars baffle (slow) water flow, and an iron stilling basin captures floatable debris.

10SA (Saint Anthony Village): 10SA differs from the other MWMO stormwater monitoring sites as it is located near the top of a stormwater drainage system rather than at the bottom near the outfall to the Mississippi River. The MWMO chose to monitor this location to investigate the quantity and quality of stormwater from the southern portion of Saint Anthony Village (594 acres) as it enters Minneapolis. The concrete stormwater pipe is 54 inches in diameter with continuous baseflow. The tunnel eventually drains into the Mississippi River several miles away on the east bank at river mile 853.2.

Methodology

Sample Collection, Handling, and Preservation

Grab and composite samples were collected from six stormwater sites in the MWMO watershed. Staff followed sampling procedures outlined in the MWMO's Standard Operating Procedure for Stormwater Sampling (2011). Samples were collected in laboratory-cleansed (non-sterile) eight-liter plastic bottles. Samples were either collected directly into the bottle as grab samples or with automatic samplers as described below. The bottle was capped after it was filled, with headspace included.

ISCO 6712 automatic samplers (Teledyne Isco, Inc., Lincoln, NE) were used at sites 1NE, 4PP, 6UMN, and 10SA. The samplers housed twenty-four one-liter plastic bottles for sample collection. Velocity, water level, and flow data were collected with an ISCO 750 Area Velocity Flow Module (Teledyne Isco, Inc., Lincoln, NE) that attached to the automatic sampler.

Samplers were programmed such that once the water level reached a certain level above baseflow, the sampler triggered to start sampling. Once triggered, the sampler rinsed the sample tubing once (4PP and 6UMN) or twice (1NE and 10SA) before drawing the sample into the containers. Samples were collected on a flow-paced basis. Once collected, the bottles were composited by pouring an equal amount of water from each sampler bottle into a two-gallon plastic bottle by a monitoring specialist. Stormwater samples were labeled and placed in a cooler for transport to the laboratory by a monitoring specialist. Samples were dropped off at the laboratory after collection of the last sample. Laboratory personnel split the sample and preserved it as needed for various analyses.

Dissolved oxygen, conductivity, salinity, temperature, and pH data were measured in the field using a YSI ProPlus sonde. The data were measured directly in the stormwater drainage system or in a separate container of stormwater. Transparency was measured using secchi tubes and water remaining from YSI measurements.

Stormwater samples were collected for a minimum of three precipitation events per month, as long as that many events occurred. If baseflow conditions were present, samples were collected twice per month from March to November, and once per month during the winter months to assess baseflow concentration of parameters.

Remote Data Access Network

The MWMO designed and deployed a remote data access network in 2008. The network was designed to collect real-time monitoring data at the stormwater sites. The network provides continuous data about stormwater level, velocity, flow, precipitation, and automated sample collection. The data are available instantaneously from any computer, allowing MWMO staff to respond more quickly to sample collection and equipment failures. The network uses radios to link five automatic water samplers to the internet, enabling the MWMO staff to view stormwater data, automated sample collection, and rainfall from the office. Radios are located at two additional locations, the SAFL roof and the Moos Tower roof on the University of Minnesota East Bank Campus, to provide line-of-sight communication between all of the monitoring sites. Refer to Figure A.6 in Appendix A for the real-time monitoring network.

MWMO staff installed a CR800 Measurement and Control Datalogger (Campbell Scientific, Inc., Logan, UT) at each stormwater monitoring location. The datalogger retrieved data from the automatic sampler. Data were then transmitted via RF450 Spread Spectrum Radios (Campbell Scientific, Inc., Logan, UT) and Yagi or omnidirectional antennas (Campbell Scientific, Inc., Logan, UT) to an NL100 Network Link Interface (Campbell Scientific, Inc., Logan, UT). The NL100 allowed communication between the dataloggers and a network-linked computer in order to store the logged data in a useable data file. Vista Data Vision software (Vista Engineering, Reykjavik, Iceland) displayed the data on webpages in graphical and tabular form so it could be viewed in real time.

Sampling Quality Control

The MWMO staff followed the quality control protocol outlined in the MWMO Ambient Surface Water Monitoring Quality Assurance Project Plan (MPCA, 2010). Blank samples of DI water were submitted to laboratories once a month to verify that sample containers were clean and samples were not contaminated during travel. In addition, ten percent of all samples were collected in duplicate to verify that sampling and laboratory procedures did not jeopardize the data.

The ISCO bottles were rinsed twice with tap water and once with DI water between storm events. Automated precipitation gauges were used at sites 1NE and 10SA sites to gather precipitation data in the watershed.

Laboratory Analyses

Fluoride samples were analyzed at Pace Analytical Services, Inc., and *E. coli* samples were analyzed at Three Rivers Park District Laboratory. All other samples were analyzed at the Metropolitan Council Environmental Services (MCES) Laboratory. Each laboratory followed strict protocols for quality assurance and quality control. Information regarding laboratory protocol is available from MWMO staff. Refer to Table C.1 in Appendix C for a list of sample parameters, the laboratories used for analysis, the analysis methods, and information regarding certification.

Parameters Information

The MWMO has conducted extensive research regarding the parameters of concern. Parameter information includes definitions, sources, impact on various organisms, and water quality standards, as well as others. Refer to the MWMO 2006 Annual Monitoring Report (MWMO, 2007) for the comprehensive list of parameters.

Data Analysis

The following data cleaning techniques were used to ensure quality data:

- Suspect data were flagged and verified with the laboratory
- Statistical regression techniques were used to interpolate automated flow data that were missing due to equipment malfunctions (MWMO, 2011)

Water Level Monitoring

Water level in a stormwater pipe is very different from water level in the Mississippi River. Stormwater pipes respond quickly to rainfall, so water levels may rise many feet within a few minutes, depending on the size and intensity of the storm event. Some stormwater pipes only contain water during precipitation events, while others have baseflow throughout the year. Stormwater monitoring sites 1NE, 4PP, 6UMN, and 10SA have baseflow throughout the year.

Water level data collected with automated equipment are presented in Figures 7-10. It should be noted that, as the Mississippi River water level rose above the base of the stormwater outfalls, river tailwater affected the water level in the stormwater pipes. This greatly impacted stormwater levels during 2012, as above-average rainfall in spring and early summer (Table 3) resulted in tailwater in several of the stormwater outfalls during June and July. Water levels at 1NE show Mississippi River tailwater in the pipe from May 28 through June 8, and June 22 through July 3 (Figure 7). Water levels at 4PP show tailwater in the pipe from May 6 through May 15, May 23 through June 16, and June 18 through July 16 (Figure 8). Site 6UMN was vandalized in October 2011, and then redesigned and equipment reinstalled successfully on March 14, 2012. Water levels at 6UMN show tailwater in the pipe from May 6 through May 15, May 25 through June 17, and June 19 through July 16 (Figure 9). Data for 7LSTU and 2NNBC are not included, as the data were not accurate due to Mississippi River tailwater in the stormwater tunnels during most of year, except for in extreme droughts.

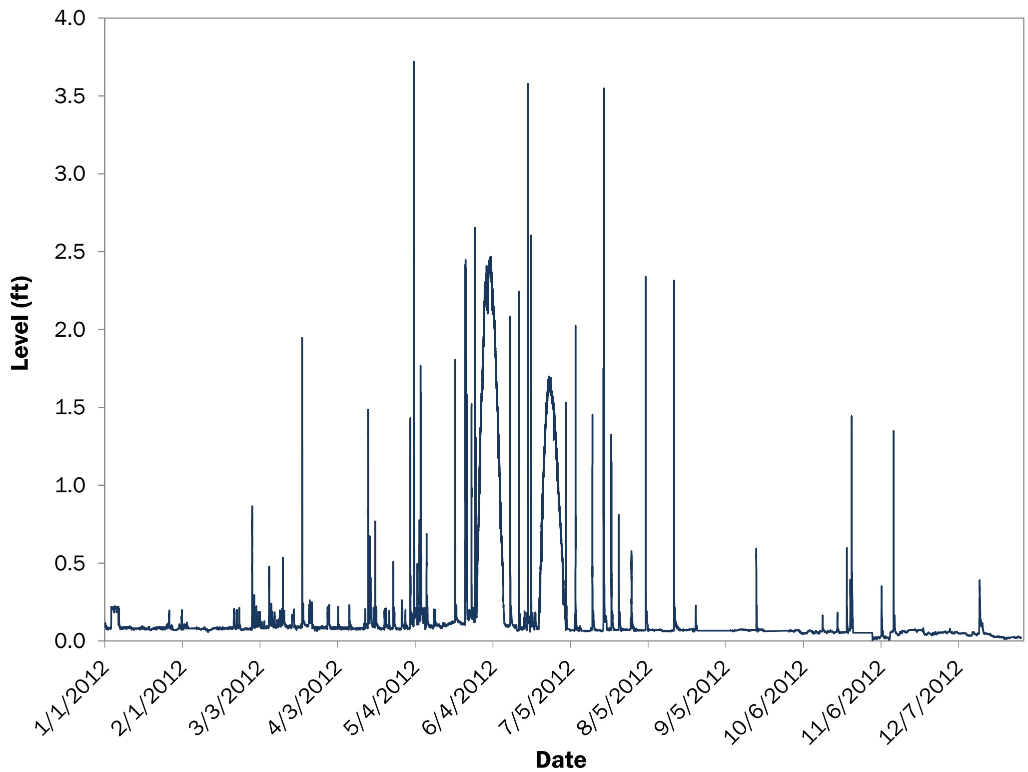

Figure 7. Water level for 1NE outfall

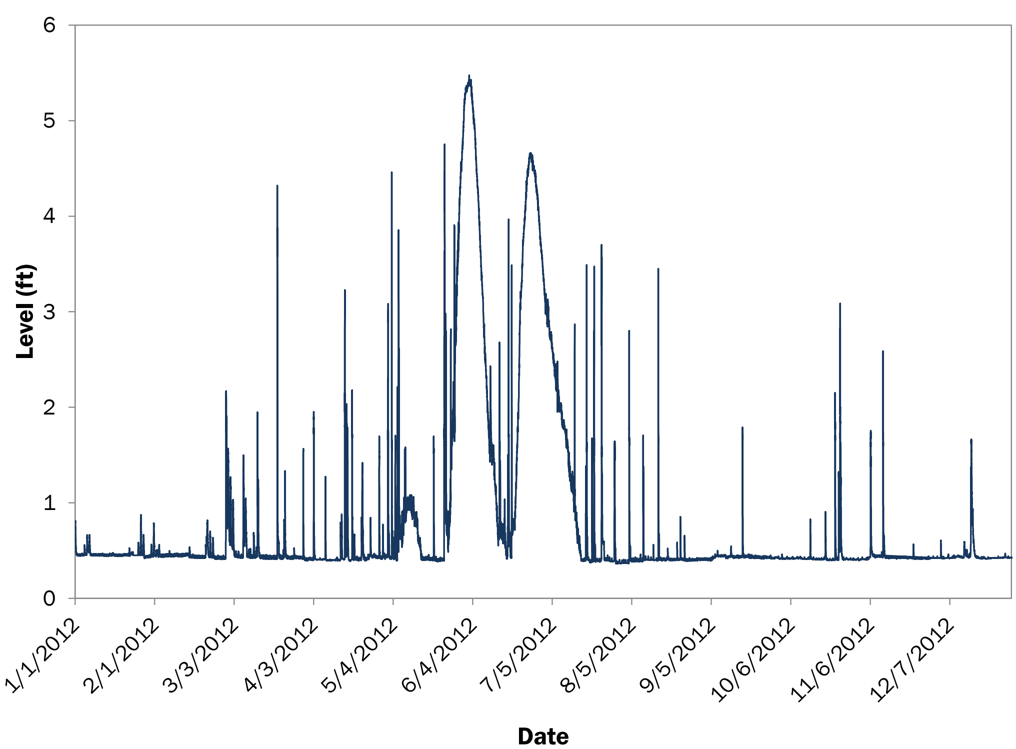

Figure 8. Water level for 4PP outfall

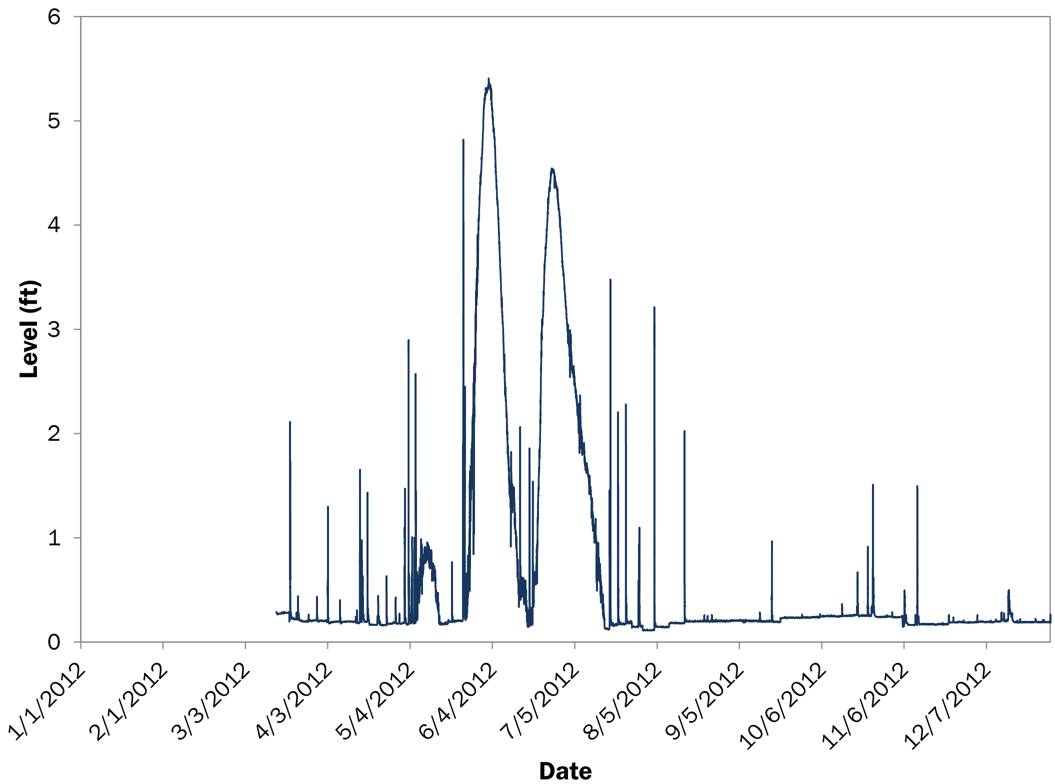

Figure 9. Water level for 6UMN outfall

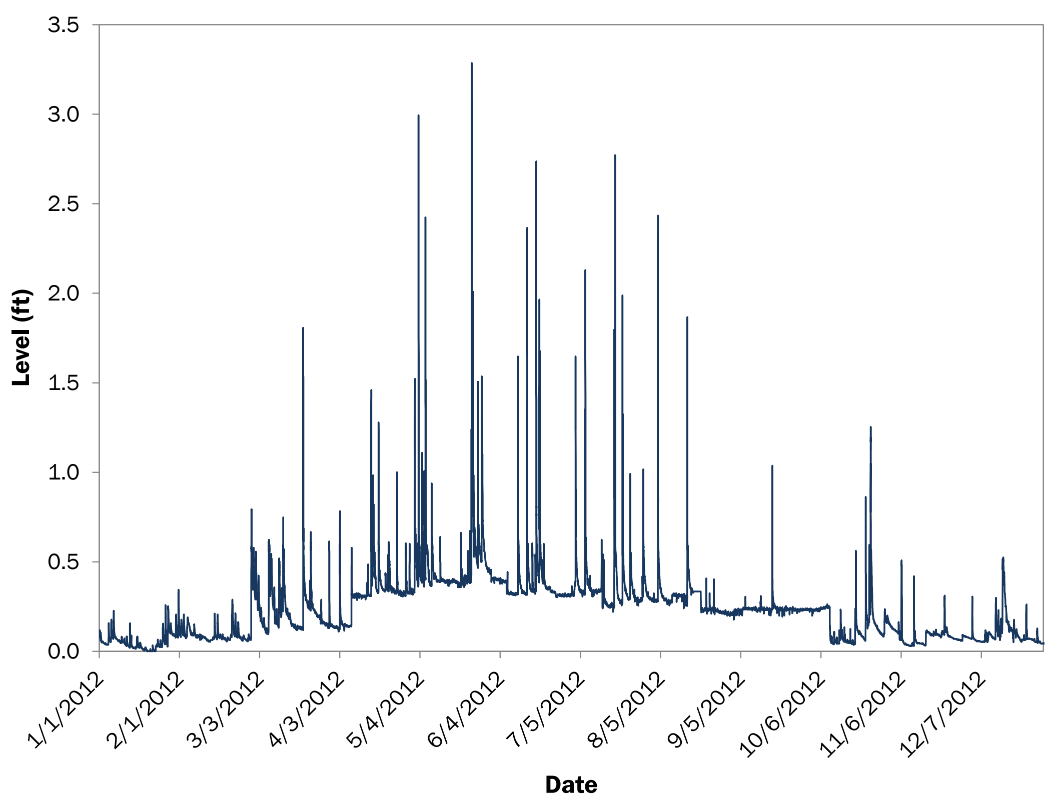

Figure 10. Water level for 10SA stormwater drainage system

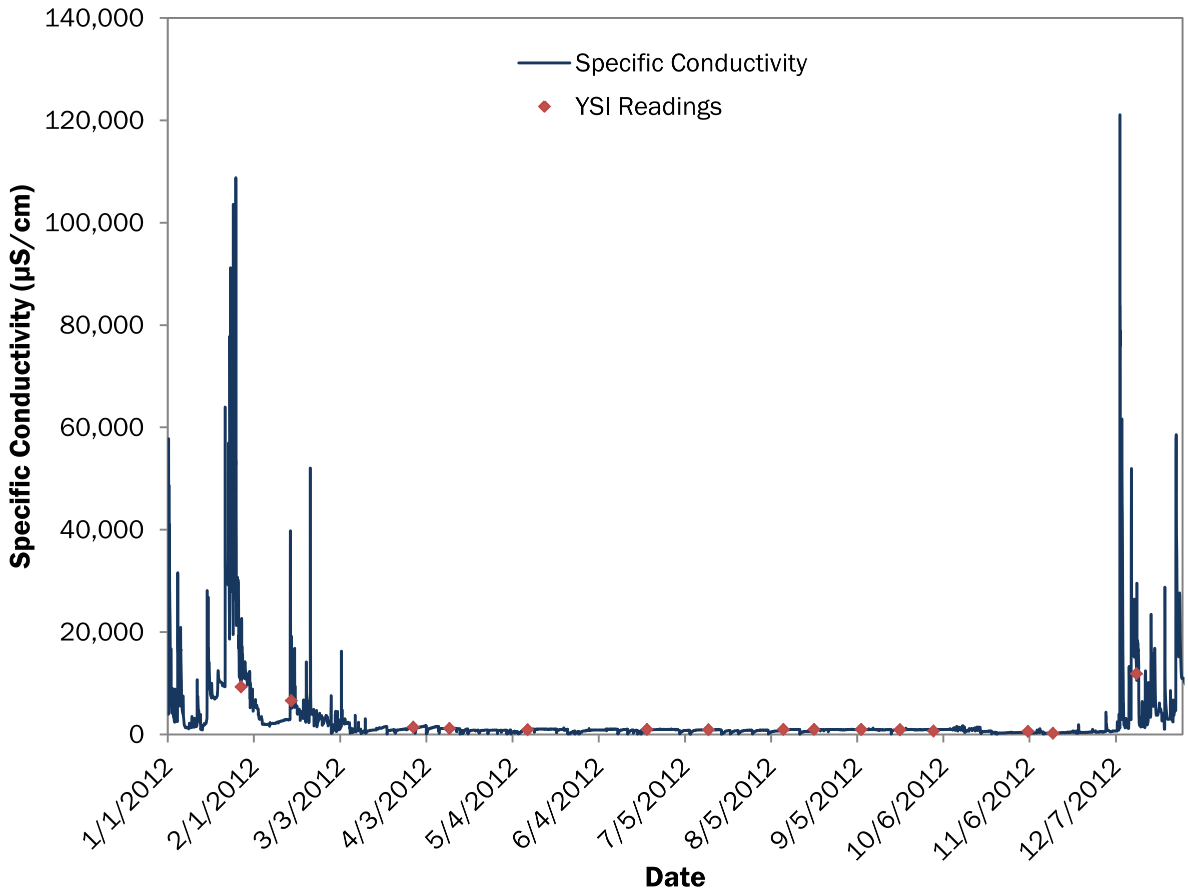

Figure 11. Continuous specific conductivity monitoring data for 10SA stormwater drainage system. Points represent YSI readings measured in the tunnel compared to conductivity sensor readings.

Stormwater Monitoring Results

The MPCA does not have water quality criteria for stormwater drainage systems; therefore, data are not compared with standards. The MWMO monitors stormwater to characterize surface runoff in the watershed and determine land contributions to water quality in the Mississippi River. Samples are collected for bacteria, nutrients, sediment, inorganics, organics, and metals analyses. The MWMO will not draw conclusions or make assumptions based on this data until 3 - 5 years of accurate flow-weighted composite data are available. The data are presented in Tables F.1 – F.6 in Appendix F. Since 2011, the MWMO has monitored specific conductivity with continuous monitoring equipment at site 10SA to provide the MPCA with detailed data for the Twin Cities Metro Area Chloride Project (Figure 11).

The MWMO monitors *E. coli* in the stormwater outfalls from April to October. Precipitation is an important predictor of *E. coli* concentrations. The MWMO targets sampling during baseflow conditions and local rain events to ascertain the impact of precipitation on stormwater bacteria levels. Figure 12 shows boxplots of the 2012 stormwater data separated out into baseflow and rain event values. Rain sample *E. coli* concentrations were an order of magnitude higher than baseflow values, but there were also instances of high baseflow values. The most likely cause of high baseflow *E. coli* values is sanitary flow into the stormwater pipes. MWMO notifies the applicable member city when there are high baseflow *E. coli* values of concern.

Figure 13 shows all of the stormwater and river *E. coli* data plotted together. The baseflow stormwater bacteria values appear to be comparable to the river bacteria, but during storms the bacteria levels from the stormwater drainage systems are much higher than the levels in the river. These data suggest that stormwater may be a large contributor of bacteria to the Mississippi River during storm events.

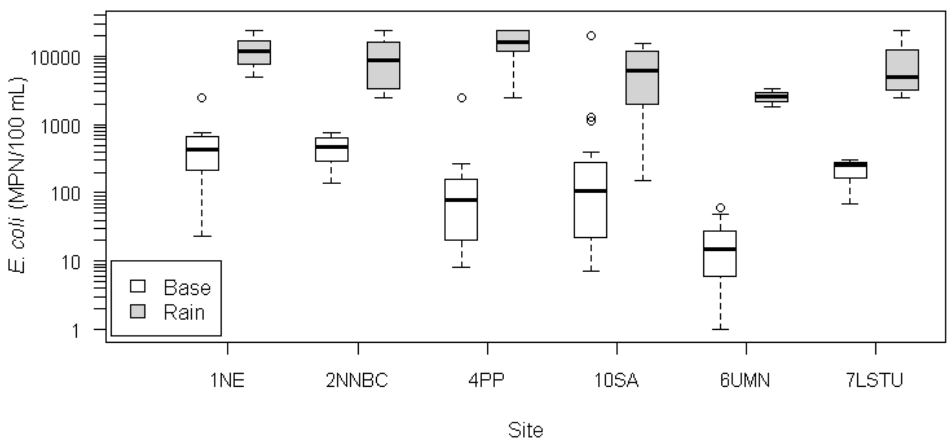

Figure 12. *E. coli* data from all stormwater sites in 2012, separated by baseflow and stormflow samples

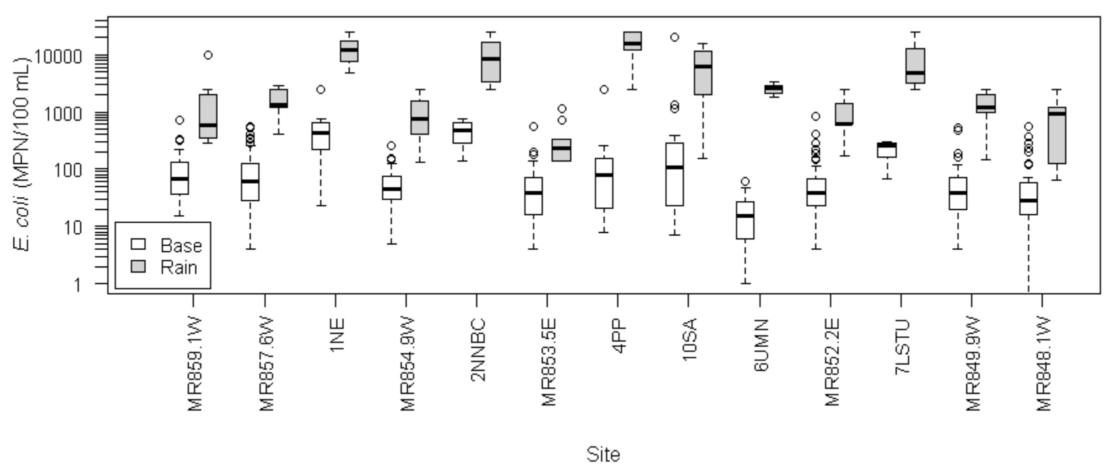

Figure 13. All Mississippi River and stormwater bacteria data from 2012, listed in order from upstream to downstream river location. Data are separated into baseflow and stormflow samples.

Discharge data collected with the automated equipment are presented in Figures 14-17. These figures show the same omissions of data described in the water level section. Discharge data for 7LSTU and 2NNBC were not available due to Mississippi River tailwater in the stormwater tunnel during almost all of the monitoring season.

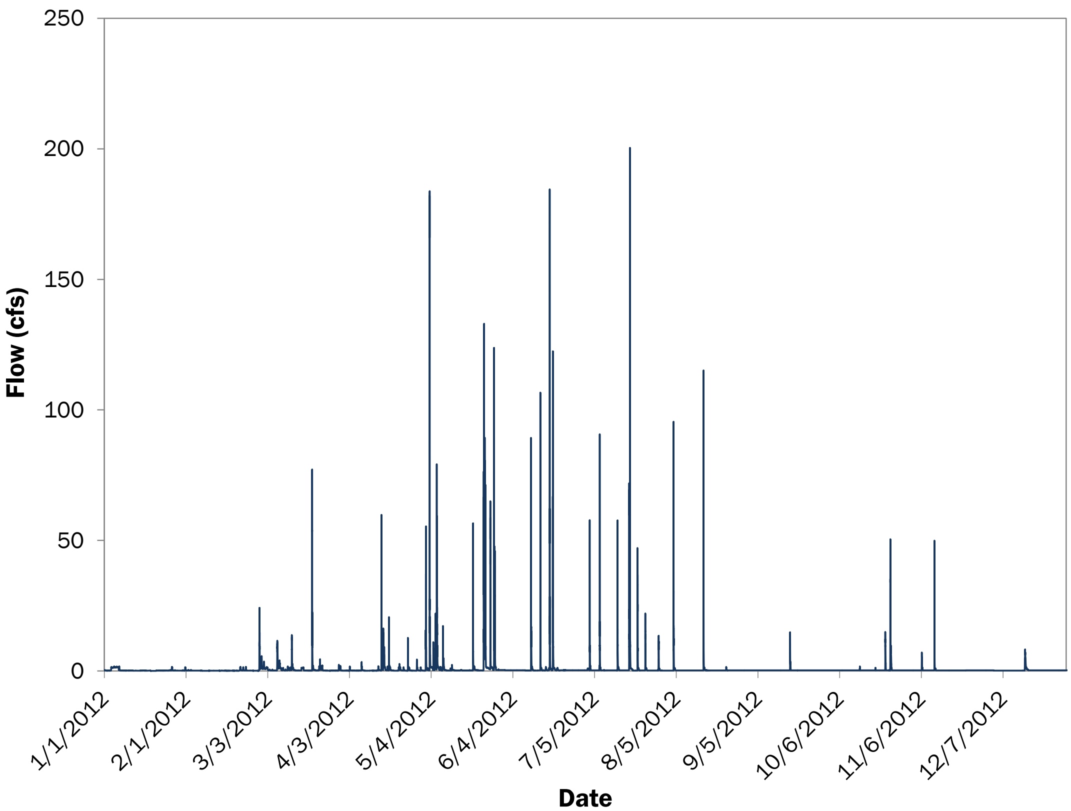

Figure 14. Discharge for 1NE outfall

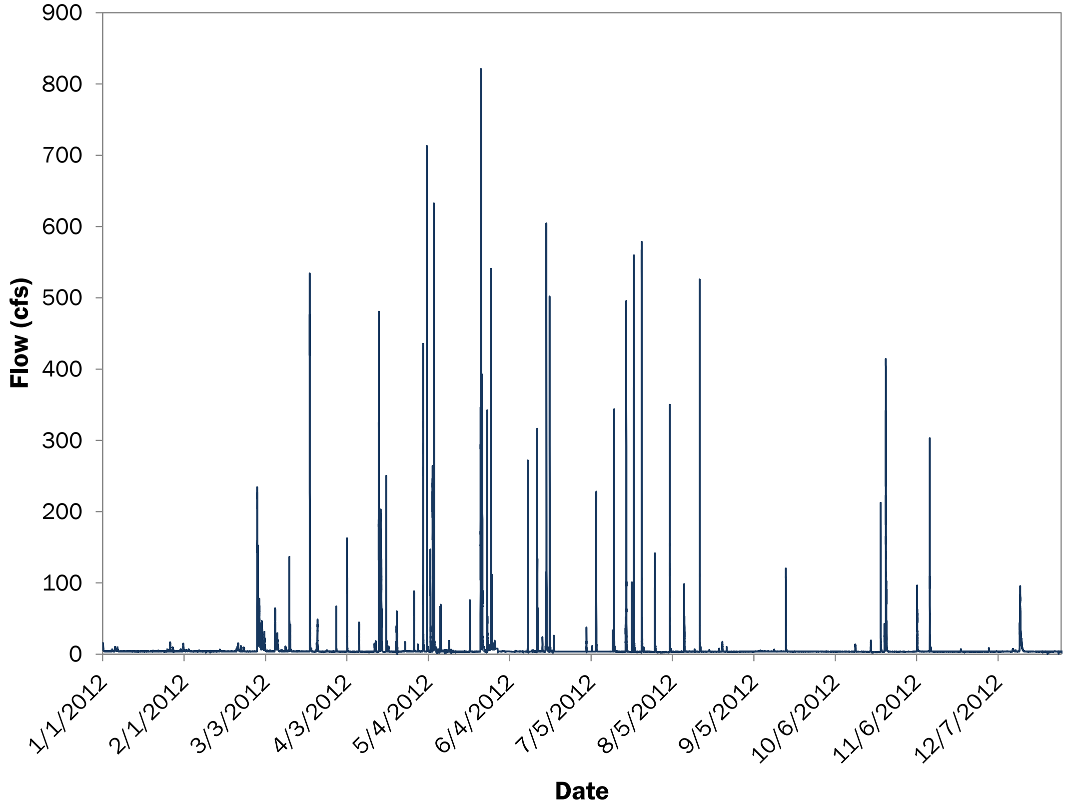

Figure 15. Discharge for 4PP outfall

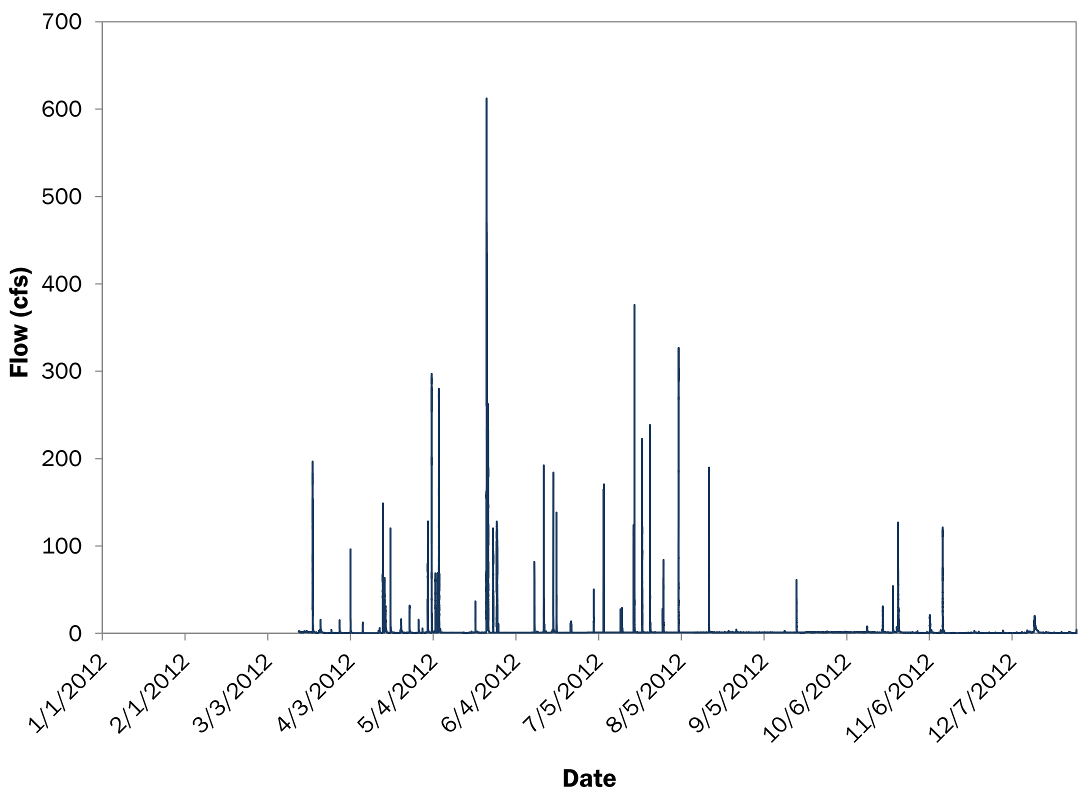

Figure 16. Discharge for 6UMN outfall

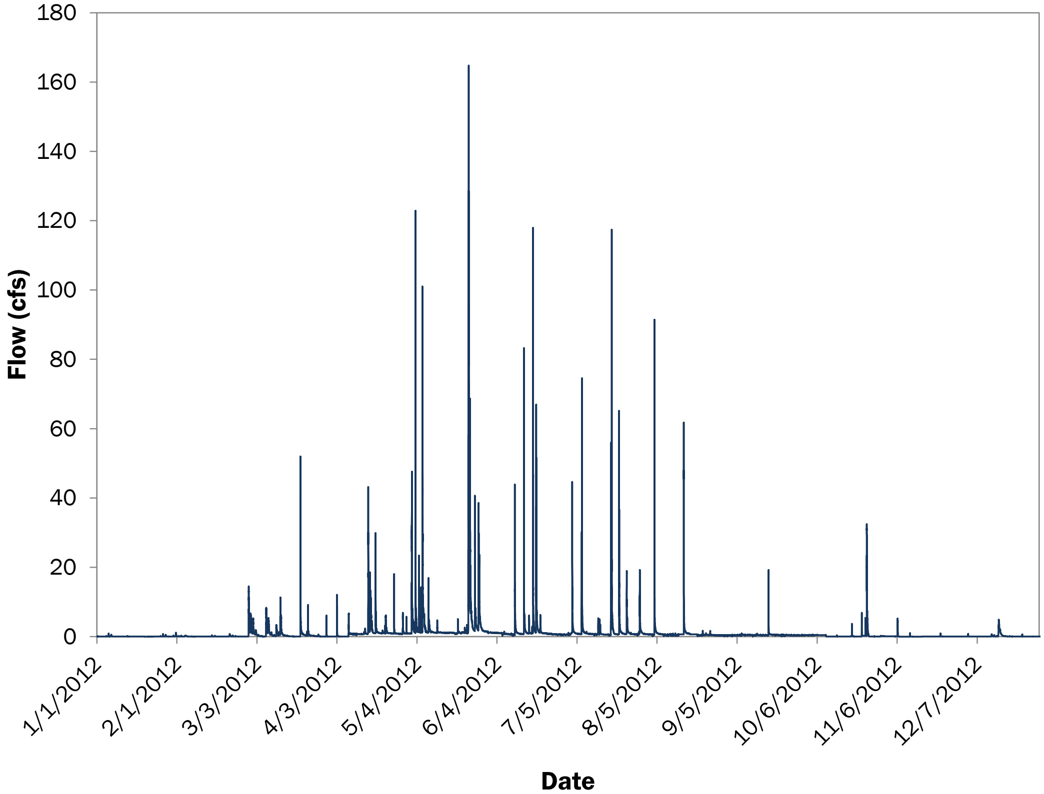

Figure 17. Discharge for 10SA stormwater drainage system

Wetland Monitoring (Kasota Ponds)

The MWMO monitored three locations in Kasota Ponds (KP). (See Figure A.2 in Appendix A for wetland sampling locations). In previous years, the MWMO monitored seven sites in Kasota Ponds. Statistical analysis of those data indicated that one site in each pond was sufficient to characterize water quality.

Site Descriptions

KPN (Kasota Pond North): KPN is the northernmost pond. It is located west of Highway 280 and south of the intersection of North Hunting Valley Road and West Doswell Avenue. The area surrounding the pond is heavily vegetated with non-native species such as buckthorn and burdock. KPN is dense with cattails and aquatic plants during the summer months. The bottom of the pond contains organic matter, silt, and clay.

KPE (Kasota Pond East): KPE is the largest of the ponds. It is also known as Mallard Marsh. It is located southwest of the intersection of Highway 280 and Kasota Avenue. There is a grassy buffer area surrounding most of the pond. Railroad tracks run alongside the west side of the pond, with approximately three feet of riprap between the tracks and the pond. Turtles and ducks are frequently observed in KPE. This wetland is dense with cattails and aquatic plants during the summer months. The bottom of the pond contains organic matter, silt, and clay.

KPW (Kasota Pond West): KPW is located just west of KPE. KPW receives runoff from a parking lot and the rail yard. Dense algal blooms are observed in KPW during the summer months, while other types of aquatic vegetation are seldom present in this pond. The pond has a sandy bottom.

Methodology

Sample Collection, Handling, and Preservation

Grab samples were collected from three locations in the KP wetlands once a month throughout the year. Collection occurred away from shore, in approximately three feet of water. Samples were collected in laboratory-cleansed (non-sterile) eight-liter plastic bottles. To collect samples, the monitoring specialist plunged an opened, inverted bottle one foot below the water surface, turned it upward to fill, and brought it out of the water. The specialist then poured some of the sample out to provide headspace for the laboratory. Dissolved oxygen, conductivity, salinity, temperature, and pH data were collected concurrently in the wetland using the methods described for the Mississippi River. When ice was present, staff conducted sampling activities by drilling a hole in the ice and using a capped, three-inch diameter PVC tube to collect the sample from the wetland.

Samples were labeled and placed in a cooler for transport to the laboratory by a monitoring specialist. Samples were dropped off at the laboratory after collection of the last sample. Laboratory personnel split the sample and preserved it as needed for various analyses.

Sampling Quality Control

The MWMO staff followed the quality control protocol outlined in the MWMO Ambient Surface Water Monitoring Quality Assurance Project Plan (MPCA, 2010). Blank samples of DI water were submitted to laboratories once a month to verify that sample containers were clean and samples were not contaminated during travel. In addition, ten percent of all samples were collected in duplicate to verify that sampling and laboratory procedures did not jeopardize the data.

Laboratory Analyses

Samples were analyzed at the MCES Laboratory. The laboratory followed strict protocols for quality assurance and quality control. Information regarding laboratory protocol is available from MWMO staff. Refer to Table C.1 in Appendix C for a list of sample parameters, the laboratories used for analysis, the analysis methods, and information regarding certification.

Parameters Information

The MWMO has conducted extensive research regarding the parameters of concern. Parameter information includes definitions, sources, impact on various organisms, and water quality standards, as well as others. Refer to the MWMO 2006 Annual Monitoring Report (2007) for the comprehensive list of parameters.

Water Quality Monitoring Results

The MWMO monitors Kasota Ponds to characterize water quality in its wetlands. Samples are collected for nutrients, sediment, inorganic, and metals analyses. The MPCA water quality criteria indicate that wetland water quality should maintain background conditions. Background water quality has not yet been determined for MWMO wetlands. The data are presented in Tables G.1 – G.3 in Appendix G.

Work Plan

Summary of 2012 Work Plan Accomplishments

It was a good year for MWMO's monitoring program. Following is a list of work plan accomplishments for the year 2012:

- Purchased a second monitoring truck and a boat to expand the MWMO's monitoring activities
- Installed a precipitation gauge with a heater at the 1NE stormwater outfall monitoring site to collect year-round precipitation data
- Reinstalled the 6UMN stormwater outfall monitoring site after the October 2011 vandalization with a new concrete pad, electricity connection, and monitoring cabinet
- Monitored four stormwater outfall sites using automated samplers
- Monitored the 2NNBC and 7LSTU stormwater outfall sites by grab sampling when there was positive flow from the outfall to the river
- Monitored three wetlands (Kasota Ponds) in St. Paul on a monthly basis
- Monitored *E. coli* throughout the monitoring season at seven sites in the Mississippi River and six stormwater sites. Data were submitted to the MPCA
- Began developing monitoring protocols for the Mississippi River hydraulic mixing monitoring and collected data at five cross-sections on the river
- Researched and started working on the methodology to calculate pollutant loads from stormwater monitoring sites to the Mississippi River
- Coordinated and worked with the City of Minneapolis staff to assist with their illicit discharge monitoring program
- Partnered with the MPCA on the Upper Mississippi River Bacteria TMDL project and the Twin Cities Metro Area Chloride Project
- Worked with the City of Minneapolis Department of Environmental Services' staff to write a contract between the MWMO and the City of Minneapolis to hire two interns to enhance their erosion and sediment control inspections program
- Worked with the City of Minneapolis and MPRB to collect data for the City of Minneapolis' National Pollutant Discharge Elimination System (NPDES) permit
- Made contacts with various state and federal agencies' staff to develop partnerships to discuss the long-term comprehensive monitoring plan for the Mississippi River within the reaches of the MWMO
- Distributed all monitoring data through MPCA's EQuIS database, MWMO's annual monitoring report, and data requests

2013 Work Plan

The 2013 work plan for the MWMO's monitoring program includes:

- Work with new MWMO member cities to assess their monitoring needs and assist in developing monitoring plans for stormwater monitoring and lake monitoring
- Expand precipitation monitoring network using heated precipitation gauges and citizen precipitation recorders
- Obtain permit, purchase, and install a weather station at the MWMO's headquarters facility
- Continue to monitor four stormwater outfall sites using automated samplers. The 2NNBC site will be monitored by grab sampling when there is positive flow from the tunnel to the river. The 7LSTU site will be monitored by automated or grab sampling depending on the presence of tailwater in the outfall.
- Continue monitoring Kasota Ponds wetlands in St. Paul
- Continue to monitor seven sites on the Mississippi River and six stormwater sites for *E. coli* and submit the data to the MPCA
- Continue working on developing monitoring protocols for the Mississippi River monitoring for hydraulic mixing and collecting data at five cross-sections on the river
- Continue to research and work on the methodology to calculate pollutant loadings from stormwater outfall sites and complete the estimates of pollutant loadings for one site
- Work with the City of Minneapolis and MPRB to collect data for the City of Minneapolis' NPDES permit
- Coordinate and work with the City of Minneapolis to assist with their illicit discharge monitoring program
- Continue to work with the MPCA to assist with the Upper Mississippi River Bacteria TMDL and the Twin Cities Metro Area Chloride Project
- Continue to work with the City of Minneapolis Environmental Services' staff to enhance their erosion and sediment control inspections program
- Continue developing partnerships with state and federal agencies to develop the long-term comprehensive monitoring plan for the Mississippi River within the reaches of the MWMO
- Share MWMO data through the MPCA's EQuIS database, the MWMO's annual monitoring report, and data requests

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programs/minnesotas-impaired-waters-and-tmdls/tmdl-projects/upper-mississippi-river-basin-tmdl/project-upper-mississippi-river-bacteria.html?menuid=&redirect=1 (accessed 02/2013).

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Mississippi Watershed Management Organization. 2011. *Standard Operating Procedure for Surface Water Sampling*. MWMO SOP: Surface Water Sampling – 2011. 5pp.

Appendix A – Watershed Maps

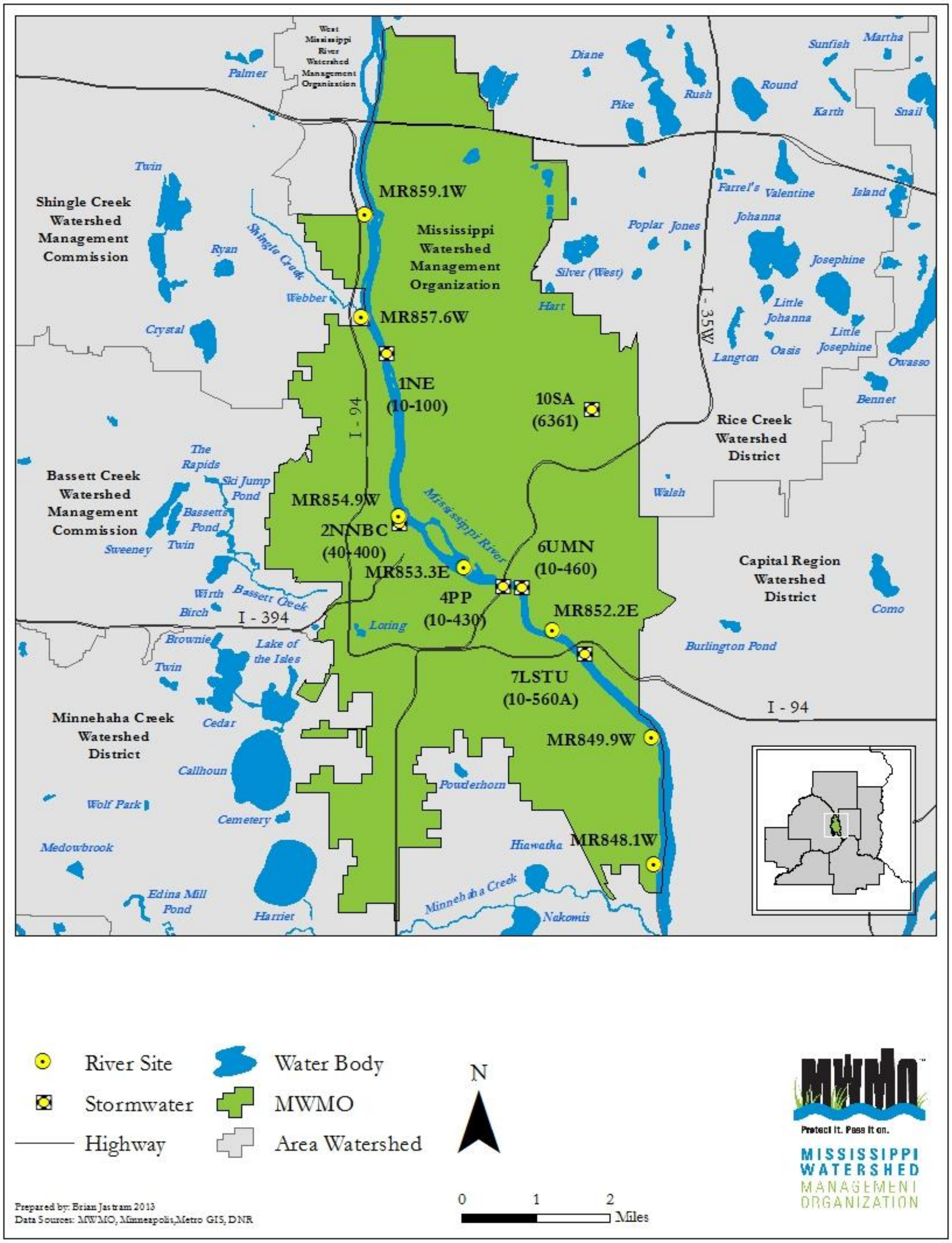

Figure A.1. MWMO watershed boundary, river monitoring sites for bacteria, and stormwater monitoring sites

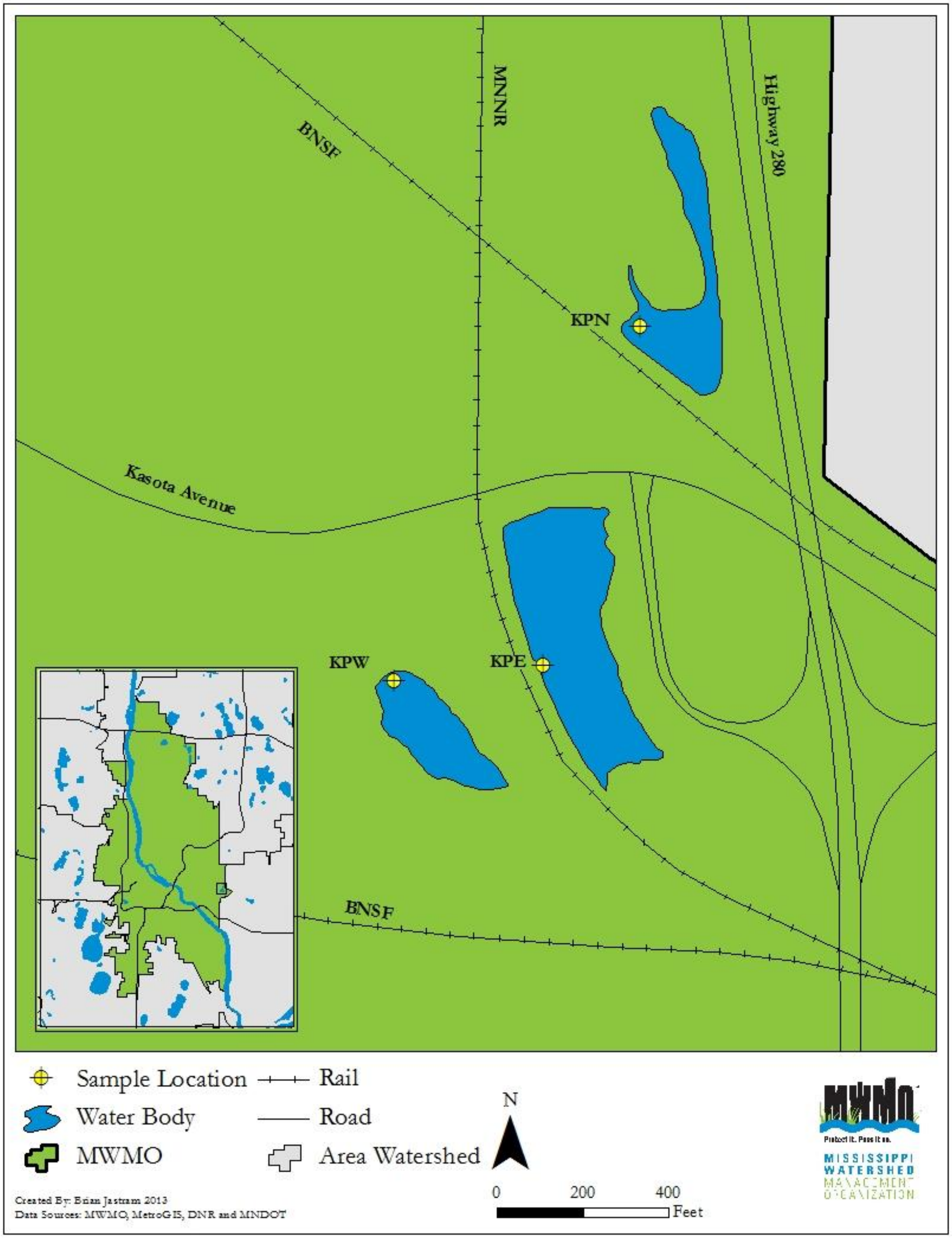

Figure A.2. MWMO wetland (Kasota Ponds) monitoring sites

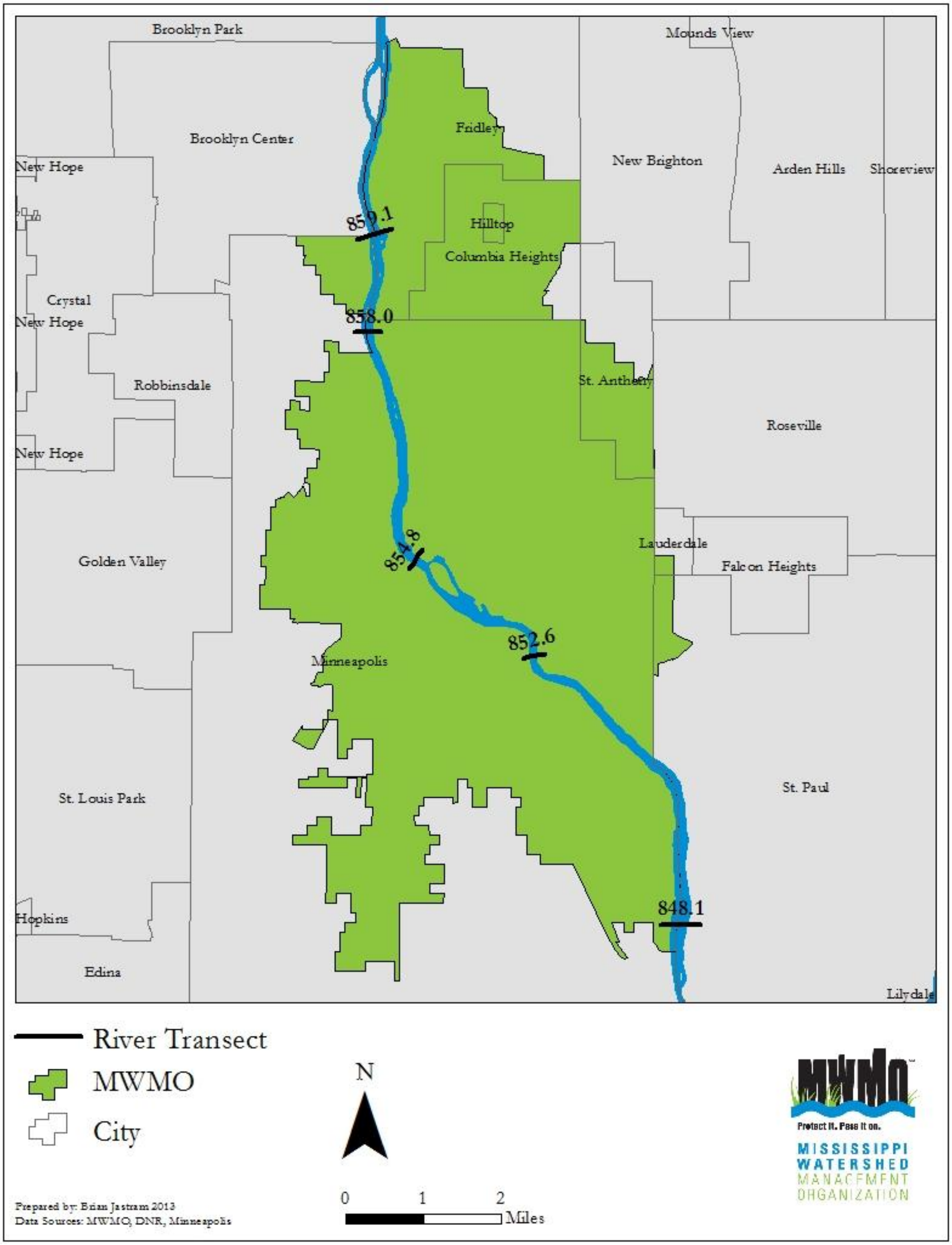

Figure A.3. Mississippi River monitoring locations for hydraulic mixing

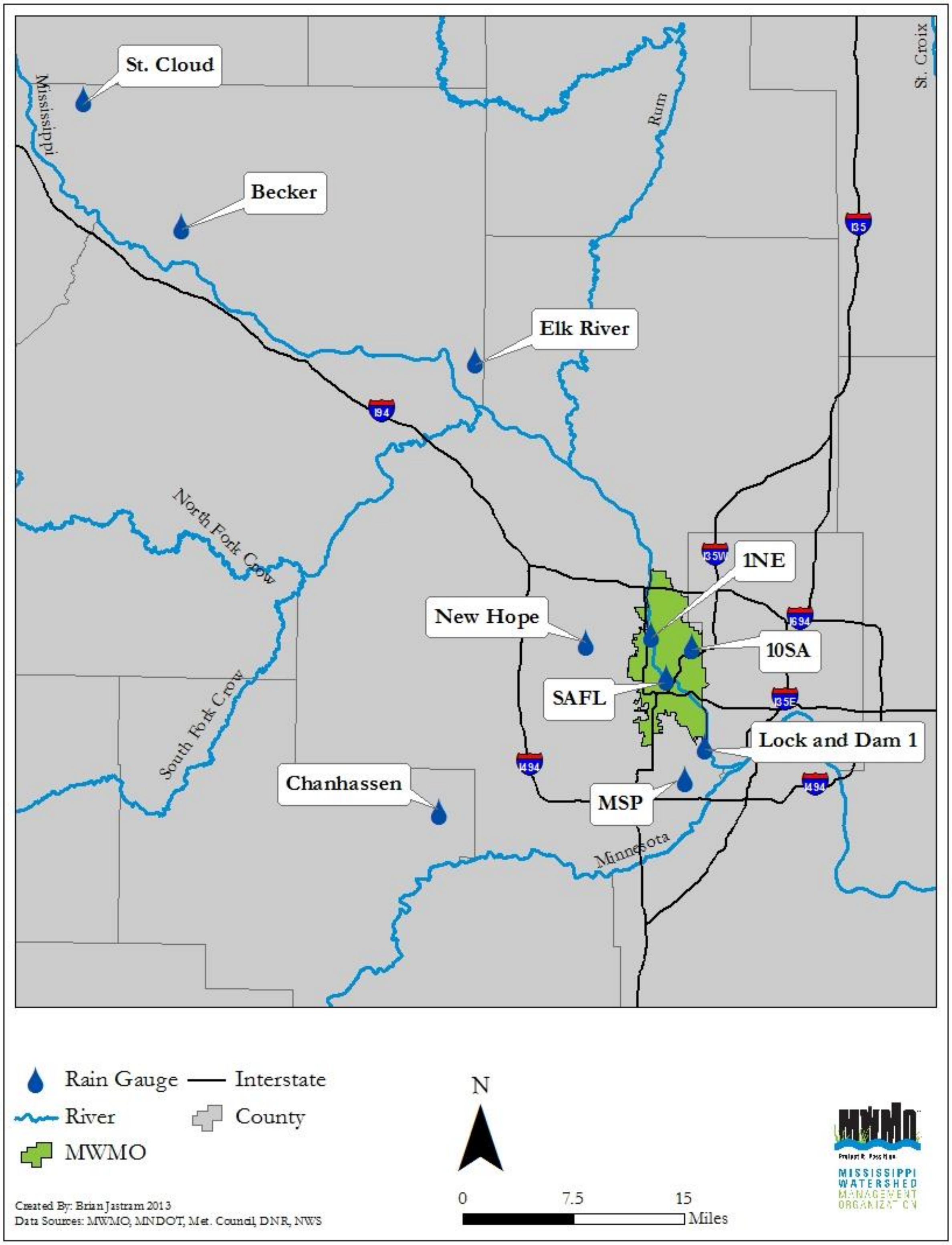

Figure A.4. Precipitation gauges in the Upper Mississippi River Basin

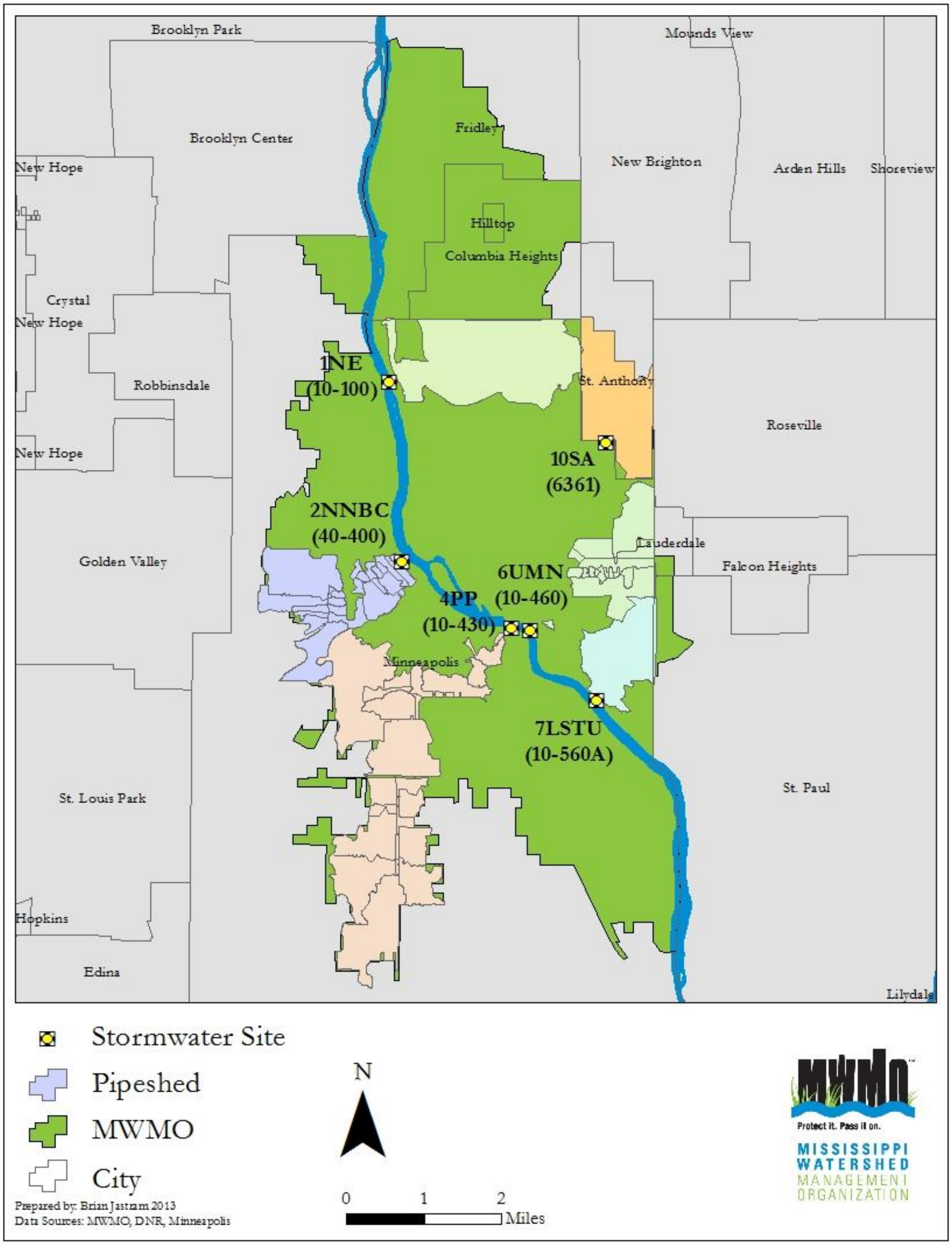

Figure A.5. Stormwater pipesheds monitored by the MWMO

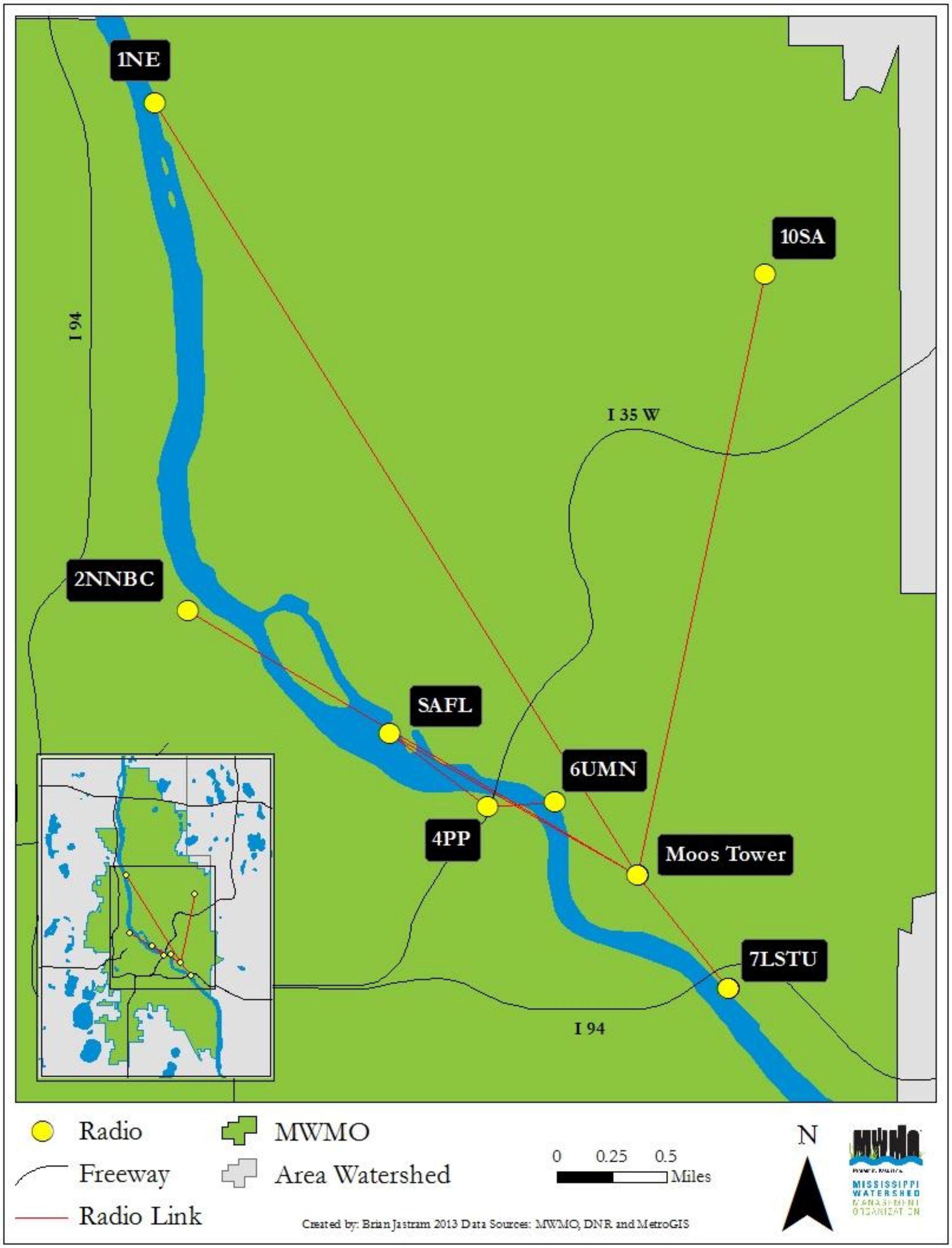

Figure A.6. Remote access real-time data monitoring network

Appendix B – Precipitation Event Sampling Data

Table B.1. Precipitation event data and samples collected. A precipitation event is defined as being greater than 0.01 inches and separated by 8 hours. The rain gauge is located at Saint Anthony Falls Laboratory.

Event #	Start Date/Time	End Date/Time	Precip. (inches)	Duration (hours)	Intensity (in/hr)	Sample Type	Site 1NE	Site 10SA	Site 2NNBC	Site 4PP	Site 6UMN	Site 7LSTU
1	1/1/2012 0:35	1/1/2012 1:45	0.1	1.25	0.08	Composite	—	—	—	X(l)	—	—
2†	1/5/2012 15:36	1/5/2012 18:22	n/a	n/a	n/a	Composite	—	—	—	X(l)	—	—
3†	1/6/2012 14:01	1/6/2012 15:28	n/a	n/a	n/a	Composite	—	X(l)	—	X(l)	—	—
4†	1/26/2012 14:10	1/26/2012 18:34	n/a	n/a	n/a	Composite	—	X(l)	—	—	—	—
5†	1/27/2012 15:31	1/27/2012 18:11	n/a	n/a	n/a	Composite	—	X(l)	—	X(l)	—	—
6†	1/31/2012 14:26	1/31/2012 20:29	n/a	n/a	n/a	Composite	—	X(l)	—	X(l)	—	—
7†	2/21/2012 5:01	2/21/2012 16:33	n/a	n/a	n/a	Composite	—	X(l)	—	X(l)	—	—
8†	2/23/2012 15:43	2/23/2012 18:33	n/a	n/a	n/a	Composite	X	—	—	—	—	—
9	2/28/2012 20:35	2/29/2012 3:00	0.53	6.5	0.08	Composite	X(l)	X(l)	—	X(l)	—	—
10	2/29/2012 12:20	2/29/2012 20:20	0.51	8	0.06	Cmp. & Grab	X(l)	—	X	—	—	X
11	3/1/2012 8:35	3/1/2012 11:25	0.11	2.75	0.04	Grab	X	—	—	—	—	—
12†	3/6/2012 12:38	3/6/2012 20:08	n/a	n/a	n/a	Cmp. & Grab	X(l)	X(l)	X	X(l)	X	X
13	3/12/2012 1:00	3/12/2012 9:40	0.26	8.75	0.03	Cmp. & Grab	X(l)	—	X(l)	X(l)	X(l)	X(l)
14	3/19/2012 19:45	3/19/2012 22:00	0.48	2.25	0.21	Composite	X(l)	X(l)	—	X(l)	—	—
15	3/22/2012 0:50	3/22/2012 19:30	.14	18.75	0.01		—	—	—	—	—	—
16	4/2/2012 23:40	4/3/2012 1:05	.20	1.5	0.13	Composite	—	X(l)	—	X(l)	—	—
17	4/15/2012 1:40	4/15/2012 4:35	.67	3	0.22	Composite	X(l)	X(l)	—	X(l)	—	—
18	4/15/2012 13:50	4/16/2012 6:55	.5	17	0.03		—	—	—	—	—	—
19	4/17/2012 23:10	4/18/2012 2:40	.2	3.5	0.06	Composite	—	X(l)	—	X(l)	—	—
20	4/21/2012 14:50	4/22/2012 3:55	.14	13	0.01	Composite	—	X(l)	—	X(l)	—	—
21	4/25/2012 2:50	4/25/2012 4:20	.18	2	0.09	Composite	X(l)	X(l)	—	—	—	—
22	4/28/2012 10:50	4/28/2012 13:45	.13	3	0.04	Composite	—	X(l)	—	X(l)	—	—
23	5/1/2012 21:30	5/2/2012 1:05	0.71	3.50	0.20	Composite	X(l)	X(l)	—	X	—	—
24	5/3/2012 9:50	5/3/2012 10:30	0.43	0.75	0.57	Cmp. & Grab	—	X(l)	—	X(l)	—	X
25	5/4/2012 18:45	5/4/2012 19:45	0.13	1.00	0.13	Composite	—	—	—	X(l)	—	—
26	5/5/2012 14:45	5/5/2012 15:55	0.30	1.25	0.24		—	—	—	—	—	—
27	5/6/2012 2:15	5/6/2012 6:25	0.93	4.25	0.22	Composite	X(l)	—	—	—	—	—
28	5/8/2012 10:55	5/8/2012 17:40	0.30	6.75	0.04	Composite	X(l)	X(l)	—	—	—	—
29	5/19/2012 18:50	5/19/2012 22:10	0.08	3.25	0.02	Composite	X(l)	X(l)		X(l)		
30	5/23/2012 20:50	5/24/2012 16:00	3.49	19.25	0.18	Cmp. & Grab	XX(l)(ec)	X(l)(ec)	X(ec)	X(l)X(l)(ec)	X(ec)	X(ec)
31	5/26/2012 10:10	5/26/2012 19:15	0.43	9.00	0.05	Composite	X(l)	—	—	—	—	—
32	5/27/2012 20:10	5/28/2012 5:05	0.67	9.00	0.07	Composite	X(l)	—	—	—	—	—
33	6/10/2012 21:00	6/11/2012 0:00	0.46	3.00	0.15	Composite	X(l)	X(l)	—	—	—	—
34	6/14/2012 9:45	6/14/2012 16:40	0.67	7.00	0.10	Cmp. & Grab	X(l)	X(l)	X	X(l)	X(l)	X
35	6/17/2012 14:10	6/18/2012 2:25	0.71	12.25	0.06	Composite	X(l)	X(l)	—	X(l)X(l)	—	—
36	6/19/2012 3:20	6/19/2012 6:00	0.48	2.75	0.17	Composite	X(l)	(ec)	—	X(l)	—	—
37	6/20/2012 15:00	6/20/2012 20:45	0.10	5.75	0.02		—	—	—	—	—	—
38	7/3/2012 3:35	7/3/2012 9:35	0.18	6.00	0.03	Composite	—	X(l)	—	—	—	—
39	7/6/2012 18:30	7/7/2012 1:50	0.64	7.25	0.09	Composite	X(l)	X(l)	—	—	—	—
40	7/13/2012 6:25	7/13/2012 18:30	0.20	12.00	0.02	Composite	X(l)	—	—	—	—	—
41	7/18/2012 2:05	7/18/2012 11:55	0.96	9.75	0.10	Cmp. & Grab	X(l)(ec)	X(l)(ec)	(ec)	X(l)(ec)	(ec)	(ec)
42	7/21/2012 6:30	7/21/2012 9:20	0.68	2.75	0.25	Composite	—	X(l)	—	X(l)	—	—
43	7/24/2012 3:55	7/24/2012 16:30	0.77	12.50	0.06	Grab	(ec)	(ec)	X(ec)	(ec)	X(l)(ec)	X(ec)
44	7/28/2012 22:50	7/29/2012 8:55	0.46	10.00	0.05	Composite	X(l)	—	—	X(l)	—	—
45	8/3/2012 23:20	8/4/2012 1:05	0.59	1.75	0.34	Composite	X(l)	X(l)	—	X(l)	X(l)	—
46	8/15/2012 7:40	8/15/2012 8:40	0.73	1.00	0.73	Cmp. & Grab	X(l)(ec)	X(l)(ec)	X(l)(ec)	X(l)(ec)	X(l)(ec)	X(l)(ec)
47	9/17/2012 3:15	9/17/2012 7:55	0.25	4.75	0.05	Composite	—	X(l)	—	X(l)	X(l)	—
48	10/19/2012 5:55	10/19/2012 12:25	0.11	6.50	0.02	Composite	—	—	—	—	X(l)	—
49	10/23/2012 6:45	10/23/2012 7:05	0.20	0.25	0.80	Composite	—	—	—	X(l)	X(l)	—
50	10/24/2012 14:50	10/25/2012 12:05	0.89	21.25	0.04	Composite	—	—	—	—	X(l)	—
51	10/25/2012 4:20	10/25/2012 12:20	0.86	8.00	0.11	Cmp. & Grab	X(l)	X(l)	—	X	—	X
52	11/6/2012 1:20	11/6/2012 16:00	0.25	14.75	0.02	Composite	—	X(l)	—	X(l)	X(l)	—
53	11/10/2012 23:10	11/11/2012 8:35	0.33	9.50	0.03	Composite	X(l)	X(l)	—	X(l)	X(l)	—
54	12/12/2012 13:30	12/12/2012 15:15	0.21	1.75	0.12		—	—	—	—	—	—
55†	12/15/2012 4:40	12/16/2012 0:25	0.43	19.75	0.02	Composite	X	X	—	X	X	—

† snowmelt event
n/a = not applicable
X = full suite of analytes
X(ec) = event sampled with *E. coli*
(ec) = event sampled with *E. coli* only
X(l) = event sampled with limited parameters generally due to holding times

Appendix C – Laboratory Methods and Certification

Table C.1. Laboratory methods and certification for each analyte

Analyte	Lab	Method	Certified
Total Metals (Copper, Nickel, Lead, Zinc, Cadmium, Chromium, Mercury)	Metropolitan Council	EPA 200.8 with ATP (Mercury) EPA 245.7	Yes
Total Soluble Metals	Metropolitan Council	EPA 200.8 with ATP (Mercury) EPA 245.7	Yes
Total Chemical Oxygen Demand	Metropolitan Council	EPA 410.4 Rev 2.0	Yes
Carbonaceous Biological Oxygen Demand (CBOD) 5-Day	Metropolitan Council	SM 5210 B-01	Yes
Total 5-day BOD	Metropolitan Council	SM 5210 B-01	No*
Total Organic Carbon	Metropolitan Council	SM 5310 A & C	n/a
Total & Volatile Suspended Solids	Metropolitan Council	SM 2540 D	Yes
Total Dissolved Solids	Metropolitan Council	SM 2540 C	No
Total Alkalinity	Metropolitan Council	EPA 310.2	Yes
Total Hardness	Metropolitan Council	SM 2340 C-97	Yes
Total Chlorides	Metropolitan Council	EPA 300.0 Rev 2.1/SM 4500-CI E-97	Yes
Total Sulfates	Metropolitan Council	EPA 300.0 Rev 2.1	Yes

*No = Indicates that the lab follows standard certification test methods but has not sought certification from the Minnesota Department of Health.

Table C.1 continued. Laboratory methods and certification for each analyte

Analyte	Lab	Method	Certified
Fluoride	Pace Analytical Services, Inc.	SM 4500-F SPADNS Method, Ref SM 20^{th} ed. P 4-82	Yes
Total Phosphorus plus Total Kjeldahl Nitrogen	Metropolitan Council	EPA 365.4 & EPA 351.2 Rev 2.0	Yes
Dissolved Phosphorus	Metropolitan Council	EPA 365.4	Yes
Orthophosphorus	Metropolitan Council	SM 4500-P E	Yes
Total Ammonia Nitrogen	Metropolitan Council	EPA 350.1 Rev 2.0	Yes
Nitrate & Nitrite Nitrogen	Metropolitan Council	4500 NO3 H-00	Yes
Total Volatile Organic Compounds	Metropolitan Council	EPA 624/625	Yes
Oil and Grease	Metropolitan Council	SM 5520 D	n/a
E. coli	Three Rivers Park District Water Resources Laboratory	SM 9223 B	Yes

Appendix D – Mississippi River Monitoring for Bacteria Data

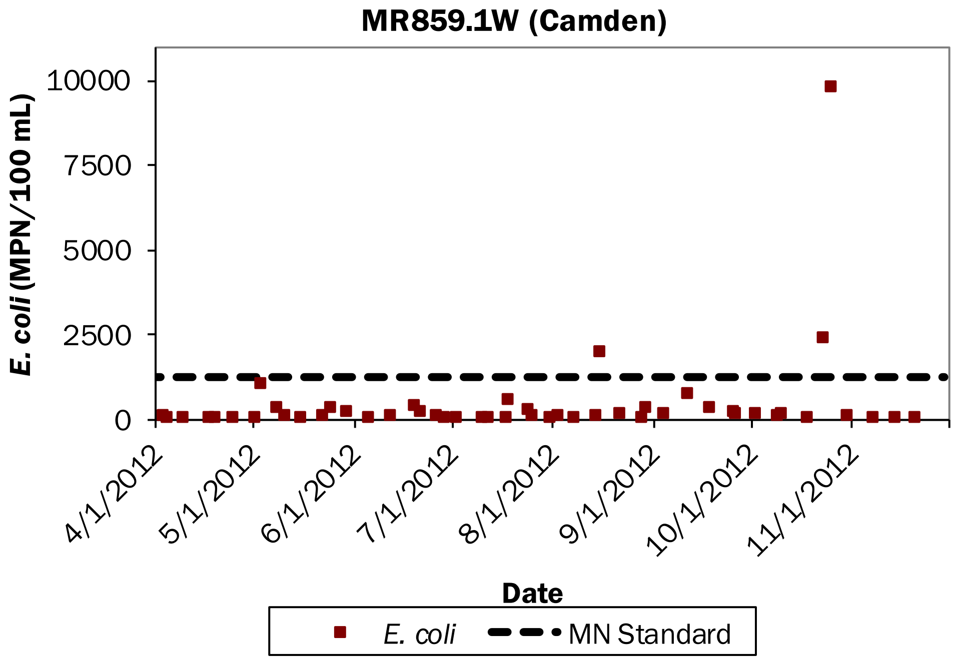

Figure D.1. *E. coli* data for MR859.1W

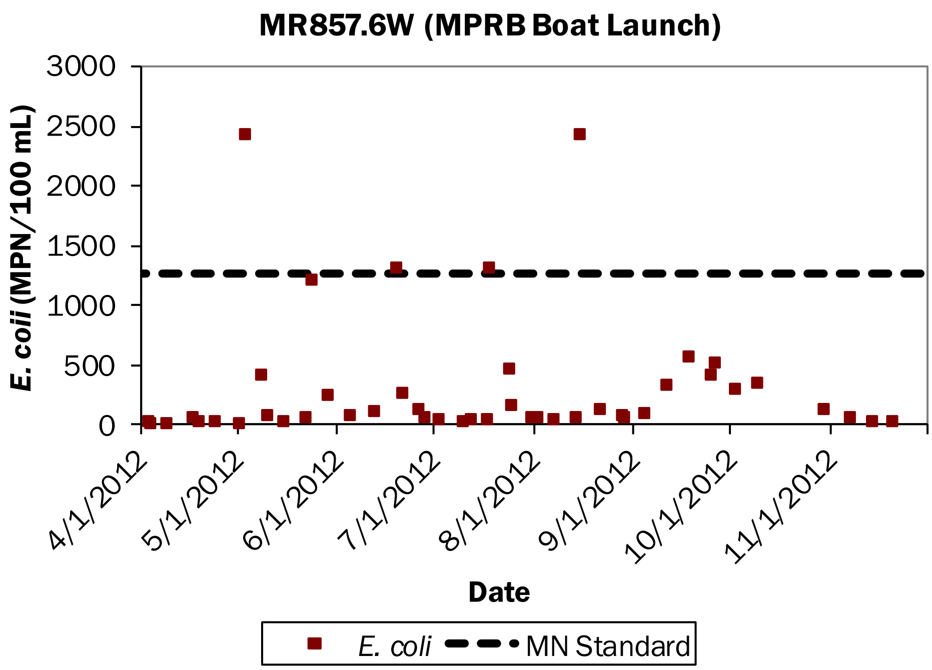

Figure D.2. *E. coli* data for MR857.6W

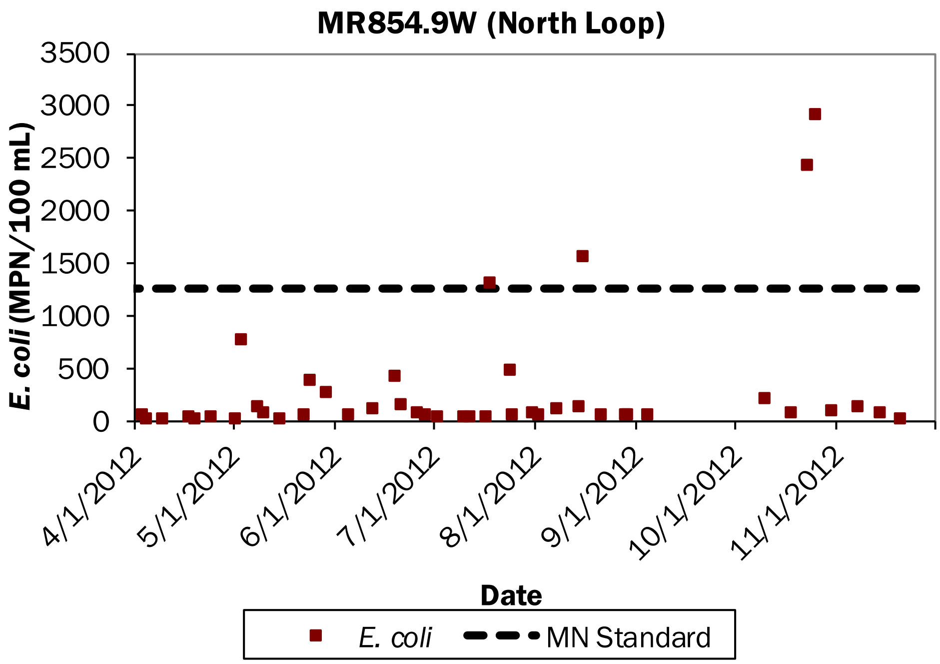

Figure D.3. *E. coli* data for MR854.9W

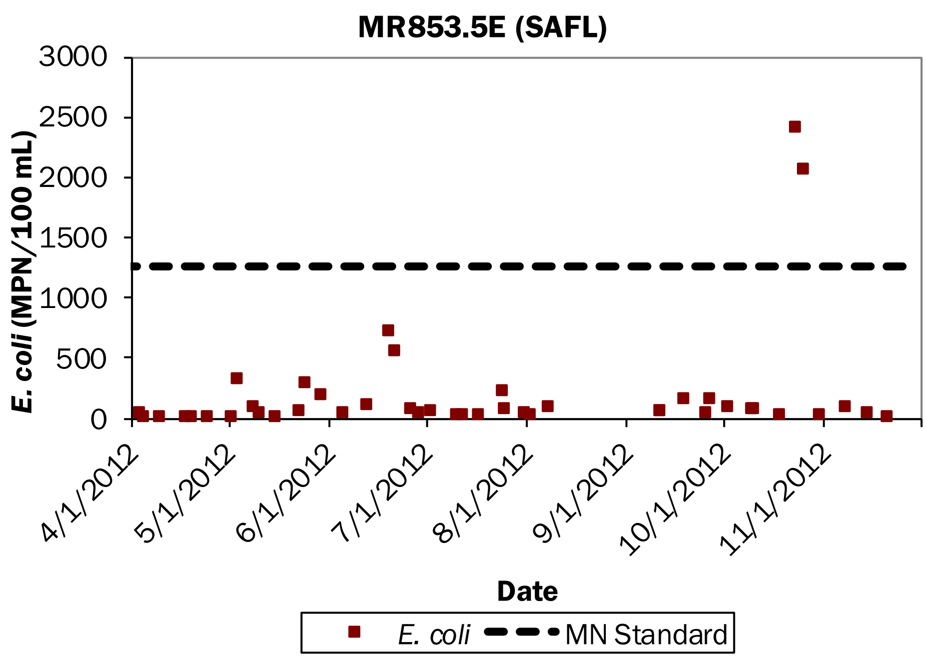

Figure D.4. *E. coli* data for MR853.5E

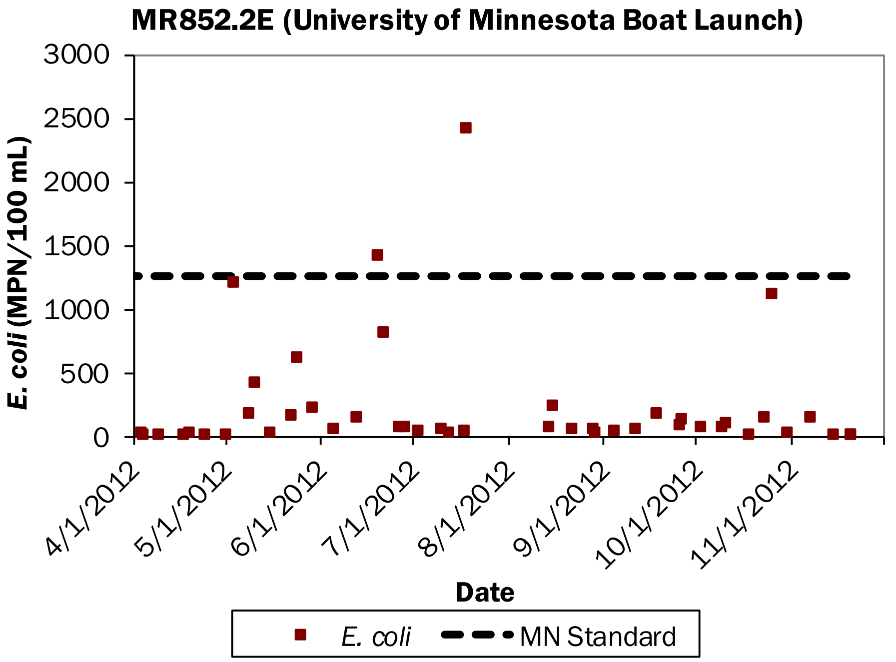

Figure D.5. *E. coli* data for MR852.2E

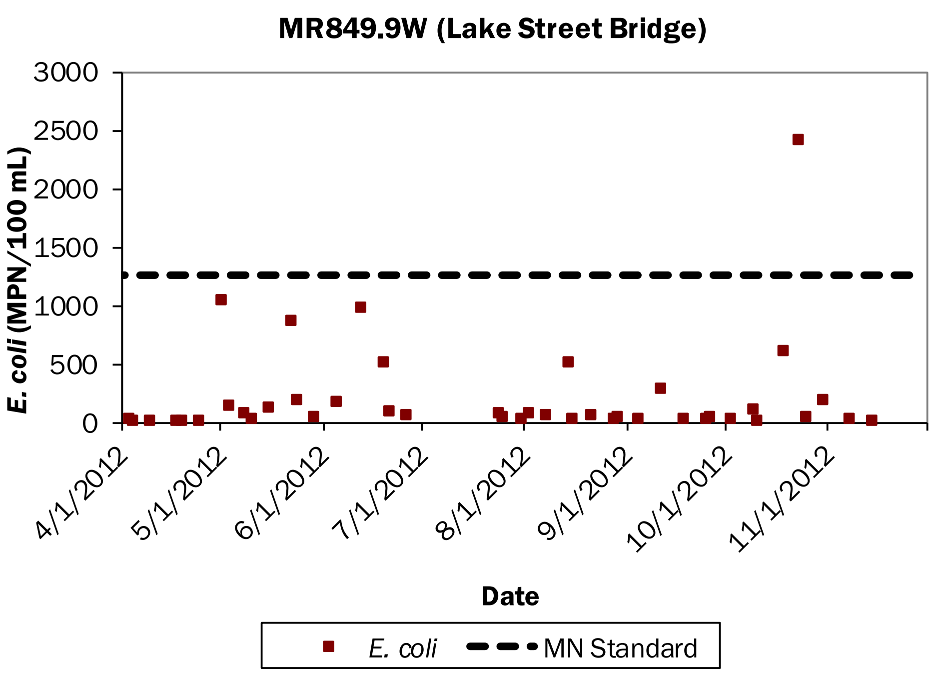

Figure D.6. *E. coli* data for MR849.9W

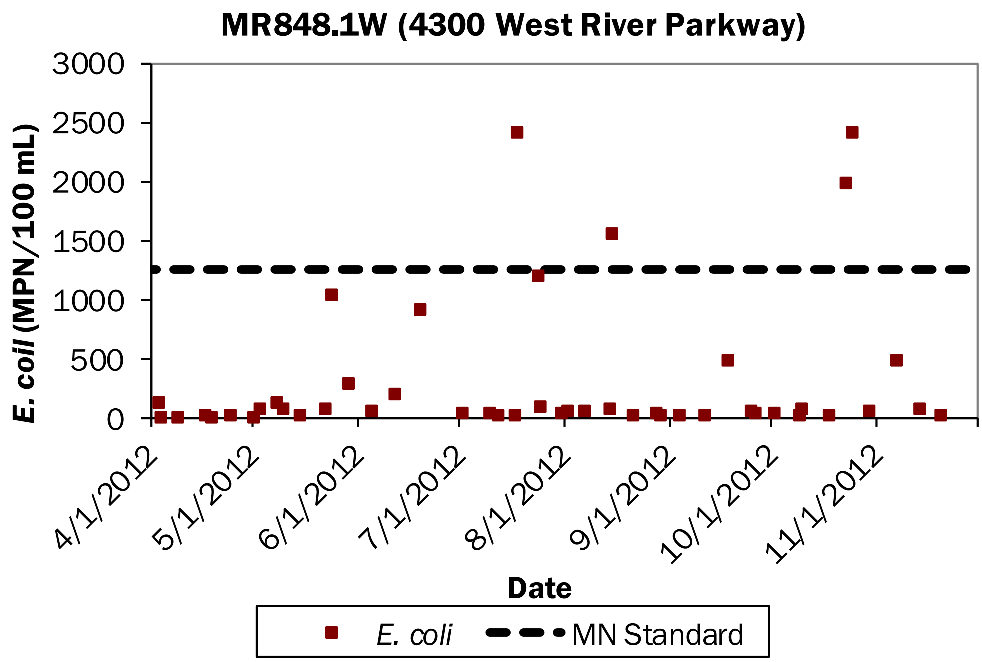

Figure D.7. *E. coli* data for MR848.1W

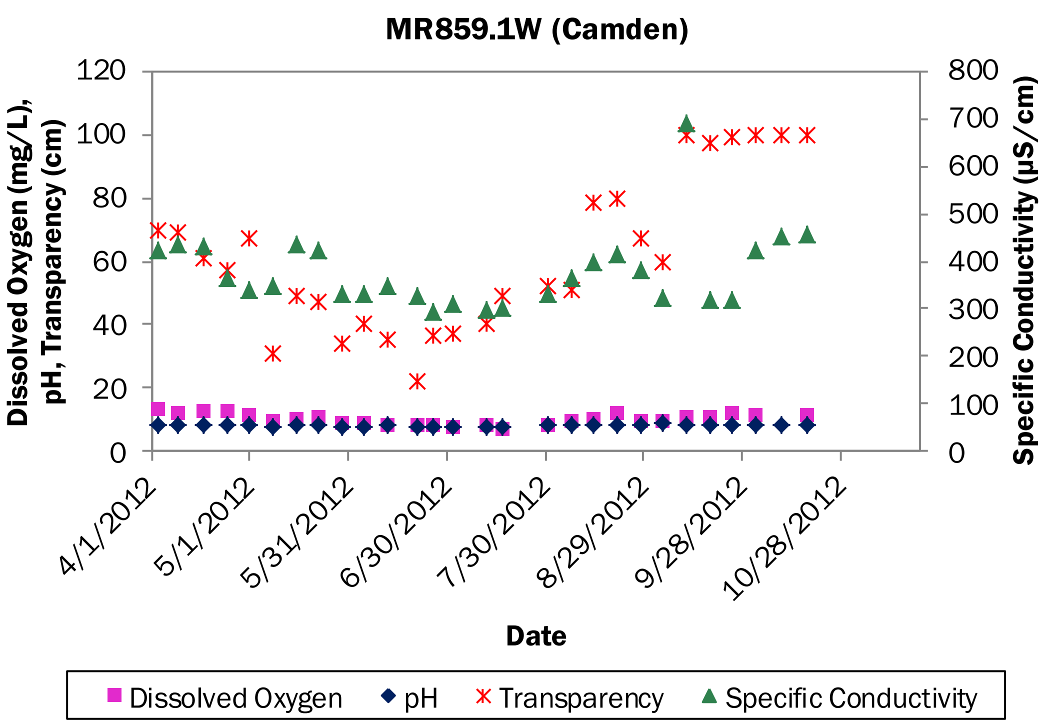

Figure D.8. Dissolved oxygen, pH, transparency, and specific conductivity for MR859.1W

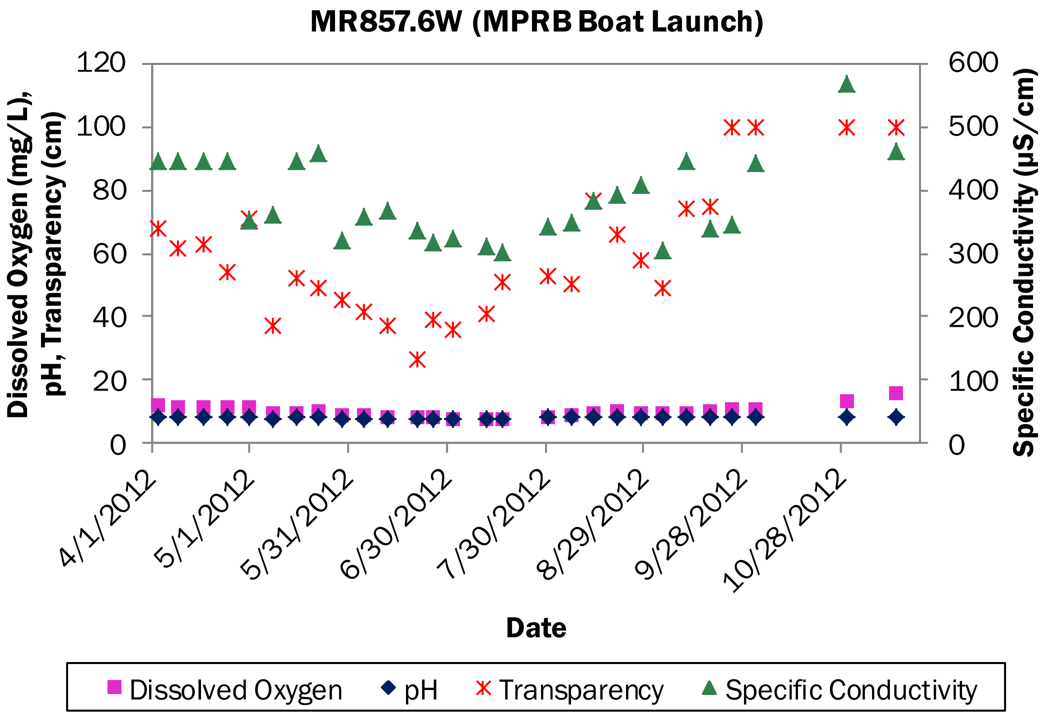

Figure D.9. Dissolved oxygen, pH, transparency, and specific conductivity for MR857.6W

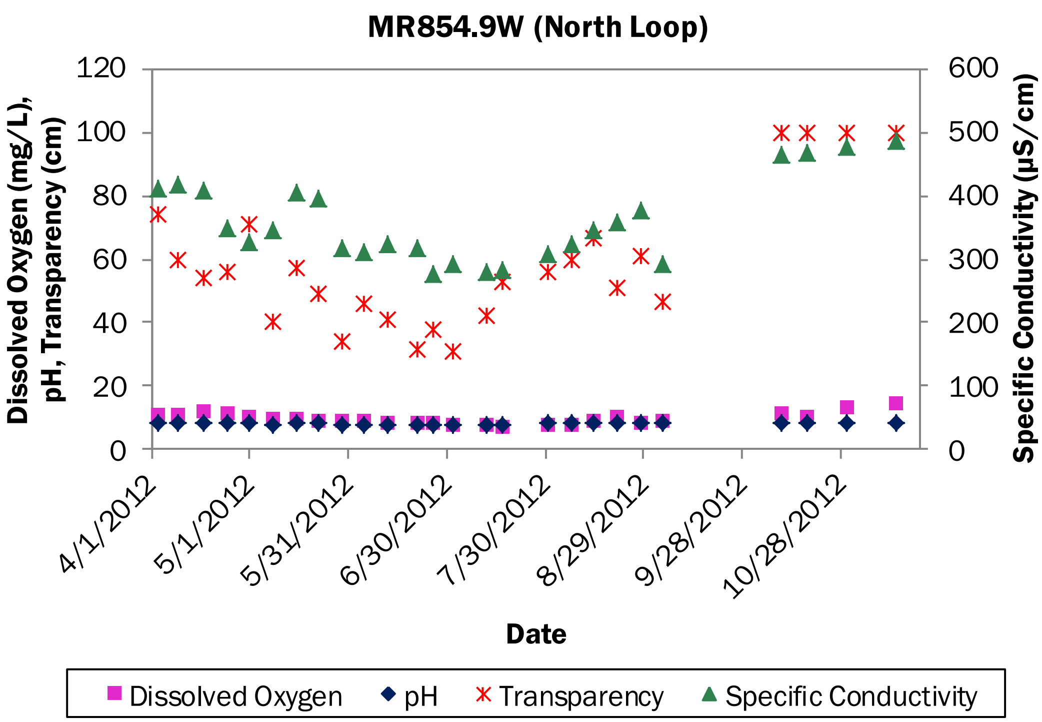

Figure D.10. Dissolved oxygen, pH, transparency, and specific conductivity for MR854.9W

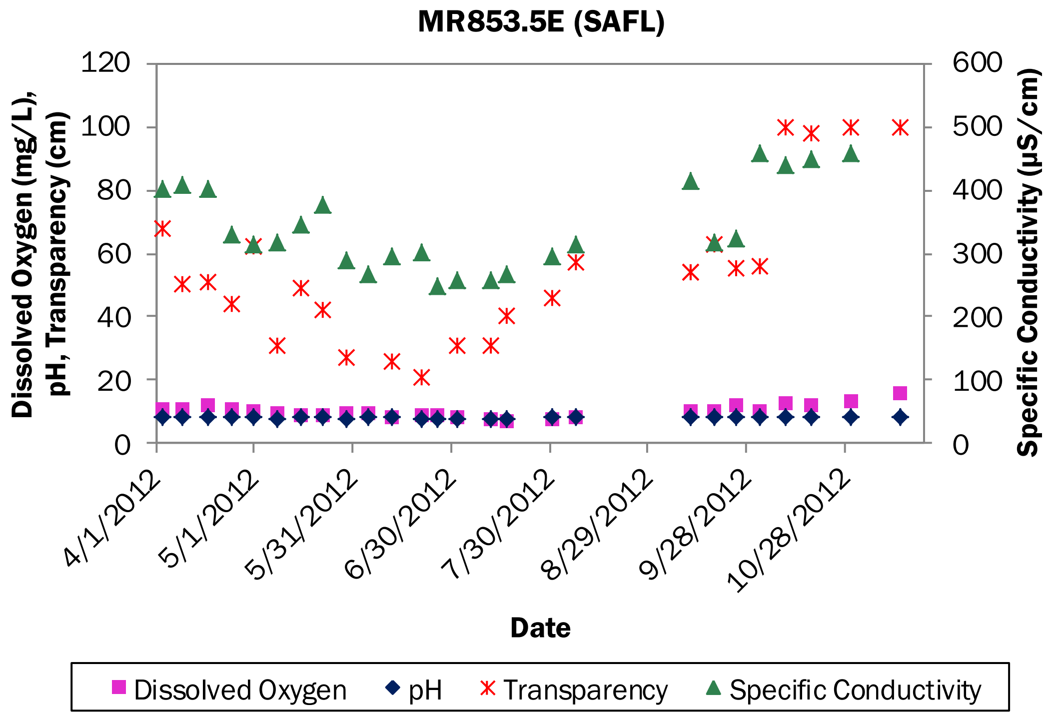

Figure D.11. Dissolved oxygen, pH, transparency, and specific conductivity for MR853.5E

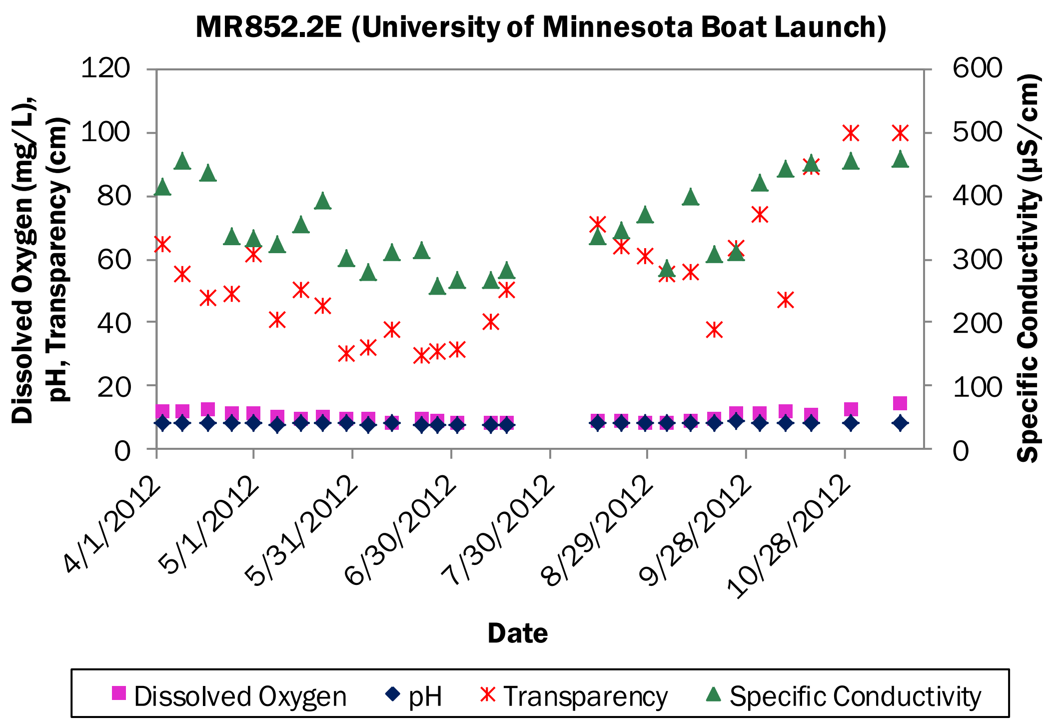

Figure D.12. Dissolved oxygen, pH, transparency, and specific conductivity for MR852.2E

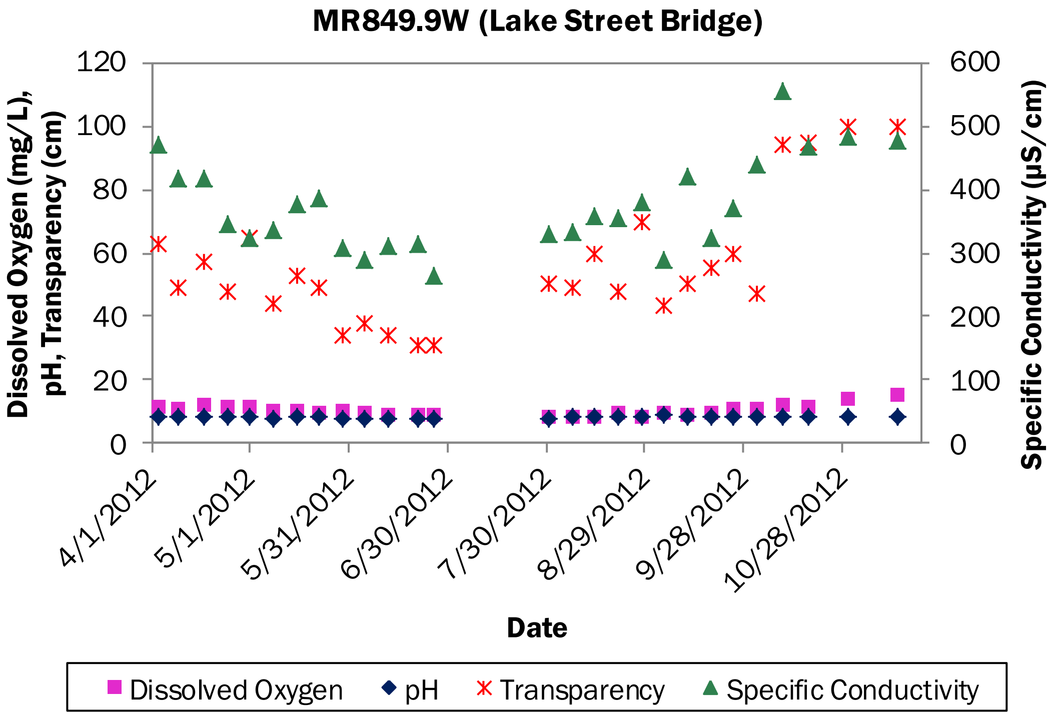

Figure D.13. Dissolved oxygen, pH, transparency, and specific conductivity for MR849.9W

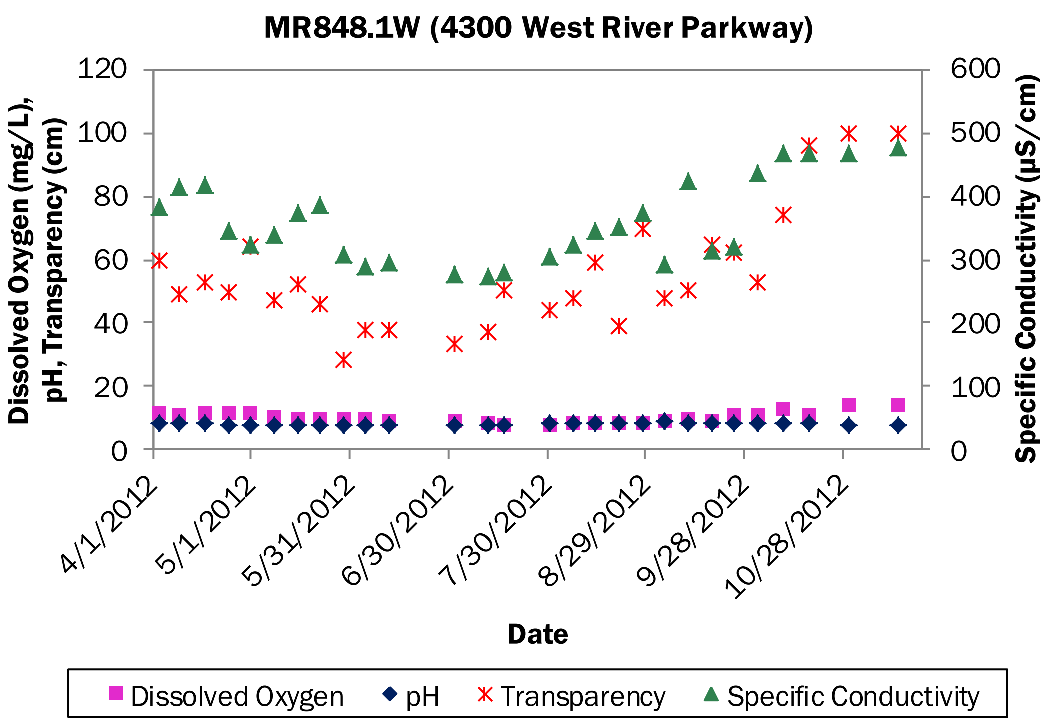

Figure D.14. Dissolved oxygen, pH, transparency, and specific conductivity for MR848.1W

Appendix E — Boxplot Explanation

Some of the bacteria data in this report are displayed using box and whisker plots (boxplots). Boxplots are a valuable way to determine trends and show variability within a year. The MWMO used boxplots in this report to show the difference in bacteria concentrations during base and rain conditions.

A boxplot uses all of the data points to compute basic summary statistics. Figure E.1 shows an example boxplot. For each plot, the box represents the middle 50 percent of the data from the 25th to the 75th percentile. The vertical lines extending off of the boxes (the 'whiskers') represent the 5th to the 25th percentile (for the lower whisker) and 75th to 95th percentile (for the upper whisker). The horizontal line that cuts across the box represents the median value, or 50th percentile. Any data point falling outside of the 5th to 95th percentile is marked by an open circle and is considered an outlier.

Generally, more compact boxes with short 'whiskers' and few outliers indicate low variability in bacteria concentrations. To better visualize the data, boxplots have been plotted on a logarithmic scale. A log scale reduces wide range data to a more manageable size in a graph.

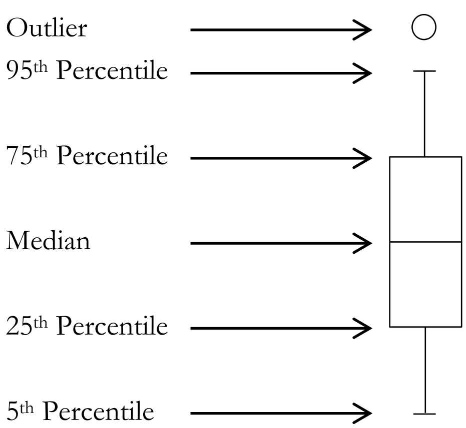

Figure E.1. An example boxplot. Each plot contains all available bacteria data for the site

Appendix F – Stormwater Monitoring Data

Table F.1. Monitoring data for 1NE outfall

Start Date Start Time	End Date End Time	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	*E. coli* (CFU/ 100 mL)	Fluoride (mg/L)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Sulfate (mg/L)	Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
1/11/2012 11:27	1/11/2012 11:28	Base Grab	40	46.4	11.38	1,271.0	1,881.0	7.73	> 60.0	0.96	–	–	~ 1	~ 1	1,875	–	–	0.048	–	0.80	–	–	–
2/15/2012 11:50	2/15/2012 11:51	Base Grab	32	44.8	11.51	1,144.0	1,737.0	8.03	> 60.0	0.88	–	–	~ 1	~ 1	1,100	175.00	~ 0.018	~ 0.037	0.016	0.78	0.15	< 0.03	1.10
2/23/2012 15:43	2/23/2012 18:33	Melt Composite	30	–	–	–	–	–	–	–	–	–	15	7	1,730	34.30	0.246	0.338	0.211	2.00	~ 0.02	0.07	1.03
2/28/2012 18:19	2/29/2012 2:51	Rain Composite	32	48.2	10.71	1,158.0	1,669.0	7.44	4.3	0.85	–	–	185	62	893	18.10	–	0.693	–	3.90	0.32	0.07	0.76
2/29/2012 14:02	2/29/2012 17:42	Rain Composite	32	45.5	11.75	2,445.0	3,676.0	7.09	5.0	1.94	–	–	76	27	1,940	10.10	0.377	0.534	0.330	3.20	0.77	0.08	0.77
3/6/2012 12:19	3/6/2012 19:14	Melt Composite	35	53.6	9.48	941.0	1,251.0	7.52	9.2	0.63	–	–	100	27	681	20.30	0.261	0.493	–	2.50	0.16	0.05	0.61
3/12/2012 1:22	3/12/2012 2:14	Rain Composite	55	–	–	–	–	–	–	–	–	–	172	59	232	7.96	0.293	0.707	0.238	3.10	0.10	0.04	0.31
3/19/2012 18:53	3/19/2012 21:53	Rain Composite	65	62.2	6.94	308.3	365.4	7.35	4.0	0.18	–	–	649	197	234	8.02	0.221	1.340	0.197	6.20	0.40	0.04	0.38
3/26/2012 13:55	3/26/2012 13:56	Base Grab	42	47.8	10.52	988.0	1,431.0	7.83	> 100.0	0.72	–	–	~ 2	~ 1	889	86.40	< 0.010	~ 0.018	0.015	0.54	0.11	< 0.03	0.99
4/4/2012 13:33	4/4/2012 13:34	Base Grab	60	50.2	–	–	–	–	–	–	613	0.28	–	–	–	–	–	–	–	–	–	–	–
4/5/2012 11:13	4/5/2012 11:14	Base Grab	60	49.5	12.09	1,017.0	1,436.0	8.01	> 100.0	0.72	–	–	~ 1	~ 1	886	86.80	< 0.010	~ 0.022	~ 0.008	0.53	0.06	< 0.03	0.91
4/15/2012 2:31	4/15/2012 5:56	Rain Composite	28	51.6	7.80	141.9	194.0		16.9	0.09	–	–	99	41	104	3.32	0.069	0.443	–	2.80	< 0.02	< 0.03	0.14
4/19/2012 8:52	4/19/2012 8:53	Base Grab	45	49.1	–	–	–	–	–	–	23	0.14	–	–	–	–	–	–	–	–	–	–	–
4/25/2012 3:52	4/25/2012 4:48	Rain Composite	55	56.8	9.60	187.4	238.4	7.55	10.0	0.11	–	–	214	101	167	7.65	0.263	0.705	0.189	4.60	1.28	0.06	0.90
4/27/2012 8:55	4/27/2012 8:56	Base Grab	42	50.4	10.42	968.0	1,349.0	7.82	> 100.0	0.68	–	–	~ 2	~ 2	873	150.50	< 0.010	0.020	~ 0.007	0.57	0.08	< 0.03	0.73
5/1/2012 21:29	5/2/2012 0:45	Rain Composite	62	62.4	7.91	140.5	166.0	7.83	11.0	0.08	–	–	221	81	109	6.80	–	0.463	0.081	2.60	0.23	0.05	0.39
5/3/2012 9:30	5/3/2012 9:31	Base Grab	65	57.2	–	–	–	–	–	–	308	0.20	–	–	–	–	–	–	–	–	–	–	–
5/6/2012 2:34	5/6/2012 8:33	Rain Composite	55	58.6	9.29	83.4	103.5	7.62	26.0	0.05	–	–	53	18	59	4.07	~ 0.049	0.158	–	0.89	0.13	< 0.03	0.26
5/8/2012 11:11	5/8/2012 17:46	Rain Composite	54	55.8	9.42	148.0	191.1	7.94	10.0	0.09	–	–	106	32	132	6.63	–	0.344	0.052	1.80	0.14	0.04	0.39
5/10/2012 9:59	5/10/2012 10:00	Base Grab	65	53.6	–	–	–	–	–	–	38	0.23	–	–	–	–	–	–	–	–	–	–	–
5/10/2012 10:09	5/10/2012 10:10	Base Grab	65	53.6	10.27	880.0	1,172.0	7.84	> 100.0	0.59	–	–	~ 1	~ 1	751	125.00	~ 0.023	0.050	0.020	0.57	0.06	0.03	0.94
5/19/2012 21:06	5/19/2012 23:06	Rain Composite	72	61.2	5.47	198.9	238.8	7.45	–	0.11	–	–	488	180	155	5.10	0.061	1.000	–	6.20	~ 0.03	< 0.03	<0.05
5/23/2012 8:29	5/23/2012 8:30	Base Grab	68	56.8	9.83	1,093.0	1,390.0	7.76	> 100.0	0.70	–	–	~ 1	~ 1	891	–	< 0.010	~ 0.027	~ 0.009	0.50	0.08	< 0.03	1.21
5/23/2012 21:19	2/24/2012 5:18	Rain Composite	65	67.5	6.97	81.7	90.9	7.79	13.2	0.04	–	–	119	32	54	–	0.055	0.284	0.053	1.90	0.16	0.04	0.29
5/24/2012 8:52	5/24/2012 8:53	Rain Grab	64	64.6	–	–	–	–	–	–	6,500	–	–	–	–	–	–	–	–	–	–	–	–
5/24/2012 13:33	5/24/2012 17:37	Rain Composite	68	61.5	8.19	93.9	112.3	8.08	16.0	0.05	–	–	41	11	64	6.86	~ 0.034	0.241	0.030	1.40	0.28	0.04	0.42
5/26/2012 10:26	5/26/2012 13:02	Rain Composite	62	65.3	7.13	102.9	117.6	7.90	33.5	0.05	–	–	51	15	65	6.41	0.061	0.181	–	1.10	0.26	0.03	0.36
5/27/2012 20:16	5/27/2012 23:25	Rain Composite	62	65.1	6.62	97.3	111.3	7.35	17.0	0.05	–	–	105	24	65	5.38	–	0.358	–	2.00	0.23	0.04	0.41
6/10/2012 21:06	6/11/2012 2:18	Rain Composite	66	72.1	4.33	141.6	149.4	6.96	14.7	0.07	–	–	174	62	86	5.61	~ 0.028	0.363	< 0.005	2.30	< 0.02	< 0.03	< 0.05
6/12/2012 9:52	6/12/2012 9:53	Base Grab	57	55.4	–	–	–	–	–	–	687	0.21	–	–	–	–	–	–	–	–	–	–	–
6/14/2012 10:06	6/14/2012 11:41	Rain Composite	69	66.4	6.15	86.7	97.8	7.44	14.0	0.05	–	–	117	32	66	2.66	< 0.010	0.299	< 0.005	1.70	~ 0.04	0.03	0.32
6/17/2012 23:22	6/18/2012 2:14	Rain Composite	71	70.0	7.50	76.2	82.3	7.93	17.0	0.04	–	–	136	35	54	2.81	~ 0.025	0.293	~ 0.009	1.90	0.19	0.04	0.30
6/19/2012 3:36	6/19/2012 7:09	Rain Composite	70	70.0	7.79	77.9	84.1	7.53	13.5	0.04	–	–	108	25	55	4.37	~ 0.043	0.313	0.044	2.00	0.49	0.04	0.46
6/19/2012 9:19	6/19/2012 9:20	Rain Grab	68	68.0	–	–	–	–	–	–	4,880	–	–	–	–	–	–	–	–	–	–	–	–
6/21/2012 10:43	6/21/2012 10:44	Base Grab	70	61.7	9.64	733.0	874.0	7.60	> 100.0	0.43	–	–	~ 1	~ 2	538	89.00	–	0.193	0.129	1.20	~ 0.06	0.07	1.49

Table F.1 continued. Monitoring data for 1NE outfall

Start Date Start Time	End Date End Time	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	*E. coli* (CFU/ 100 mL)	Fluoride (mg/L)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Sulfate (mg/L)	Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
7/6/2012 23:01	7/7/2012 1:51	Rain Composite	70	79.0	4.55	121.3	118.8	6.91	–	0.05	–	–	149	42	70	4.13	0.082	0.348	0.075	2.00	0.28	0.05	0.22
7/10/2012 10:25	7/10/2012 10:26	Base Grab	84	69.1	–	–	–	–	–	–	105	0.22	–	–	–	–	–	–	–	–	–	–	–
7/11/2012 9:12	7/11/2012 9:13	Base Grab	79	64.9	9.19	1,281.0	1,471.0	7.72	> 100.0	0.74	–	–	3	~ 1	918	172.00	~ 0.018	~ 0.022	0.012	0.65	~ 0.04	< 0.03	1.83
7/13/2012 17:21	7/13/2012 21:38	Rain Composite	93	84.6	5.27	218.8	202.5	7.01	–	0.09	–	–	79	25	128	7.97	0.078	0.295	–	1.90	0.34	0.10	0.38
7/18/2012 2:41	7/18/2012 4:38	Rain Composite	75	74.3	5.52	111.1	114.4	7.39	21.0	0.05	–	–	83	25	65	3.72	0.321	0.261	–	1.60	0.16	0.06	0.50
7/18/2012 12:54	7/18/2012 12:55	Rain Grab	73	73.9	–	–	–	–	–	–	14,140	–	–	–	–	–	–	–	–	–	–	–	–
7/23/2012 9:48	7/23/2012 9:49	Base Grab	87	61.0	9.15	1,160.0	1,398.0	7.49	> 100.0	0.70	–	–	~ 2	~ 1	872	160.00	~ 0.015	~ 0.020	0.015	0.57	~ 0.04	< 0.03	1.47
7/24/2012 11:26	7/24/2012 11:27	Rain Grab	73	74.5	–	–	–	–	–	–	8,660	–	–	–	–	–	–	–	–	–	–	–	–
7/25/2012 9:11	7/25/2012 9:12	Base Grab	83	71.2	–	–	–	–	–	–	435	0.24	–	–	–	–	–	–	–	–	–	–	–
7/29/2012 6:35	7/29/2012 10:50	Rain Composite	85	76.8	6.18	140.9	141.1	7.20	–	0.07	–	–	24	9	85	5.23	0.073	0.150	–	0.87	0.14	0.04	0.39
8/1/2012 9:25	8/1/2012 9:26	Base Grab	88	66.7	8.63	1,282.0	1,440.0	8.07	> 100.0	0.73	–	–	5	~ 1	892	94.80	~ 0.020	~ 0.023	0.017	0.53	~ 0.04	< 0.03	1.65
8/2/2012 8:49	8/2/2012 8:50	Base Grab	87	60.8	–	–	–	–	–	–	579	0.27	–	–	–	–	–	–	–	–	–	–	–
8/3/2012 23:27	8/4/2012 1:53	Rain Composite	88	69.1	4.55	120.9	132.1	7.01	16.0	0.06	–	–	114	37	86	4.11	0.137	0.506	–	2.85	0.24	0.05	0.24
8/15/2012 8:15	8/15/2012 10:30	Rain Composite	75	51.4	7.19	103.0	141.3	7.18	15.5	0.07	–	–	118	40	95	7.01	0.211	0.406	–	2.10	~ 0.02	< 0.03	0.54
8/15/2012 10:30	8/15/2012 10:31	Rain Grab	73	68.9	–	–	–	–	–	–	19,860	–	–	–	–	–	–	–	–	–	–	–	–
8/22/2012 9:44	8/22/2012 9:46	Base Grab	71	60.3	9.95	1,209.0	1,472.0	7.93	> 100.0	0.74	–	–	~ 1	~ 1	927	165.00	~ 0.016	~ 0.039	~ 0.009	0.57	~ 0.04	< 0.03	1.60
8/29/2012 12:23	8/29/2012 12:24	Base Grab	88	63.5	–	–	–	–	–	–	127	< 0.20	–	–	–	–	–	–	–	–	–	–	–
9/11/2012 11:33	9/11/2012 11:34	Base Grab	80	62.2	9.60	1,272.0	1,509.0	8.09	> 100.0	0.76	365	0.2	~ 1	< 1	888	178.00	< 0.020	~ 0.028	0.017	0.61	~ 0.05	< 0.03	1.25
9/24/2012 9:45	9/24/2012 9:46	Base Grab	55	54.5	10.52	1,116.0	1,464.0	7.72	> 100.0	0.74	–	–	~ 1	< 1	918	162.00	< 0.020	< 0.020	0.011	0.37	~ 0.05	< 0.03	1.29
9/26/2012 12:24	9/26/2012 12:25	Base Grab	56	57.2	–	–	–	–	–	–	330	0.39	–	–	–	–	–	–	–	–	–	–	–
10/9/2012 11:31	10/9/2012 11:32	Base Grab	47	52.2	9.84	1,086.0	1,474.0	7.87	98.0	0.75	770	0.41	~ 1	~ 1	912	173.00	~ 0.027	~ 0.033	0.024	0.82	0.09	0.04	1.28
10/22/2012 9:40	10/22/2012 9:41	Base Grab	50	55.8	9.69	1,140.0	1,470.0	7.58	> 100.0	0.74	–	–	~ 1	~ 1	872	174.00	~ 0.033	~ 0.040	0.022	0.84	0.10	< 0.03	0.85
10/23/2012 8:32	10/23/2012 8:33	Rain Grab	56	57.6	–	–	–	–	–	–	> 24,200	< 0.20	–	–	–	–	–	–	–	–	–	–	–
10/25/2012 11:41	10/25/2012 11:42	Rain Grab	36	48.4	–	–	–	–	–	–	12,033	–	–	–	–	–	–	–	–	–	–	–	–
10/25/2012 15:07	10/25/2012 15:08	Rain Grab	37	47.1	10.88	130.1	190.4	7.48	18.0	0.09	–	–	20	~ 10	149	9.40	0.225	0.182	0.187	0.52	< 0.02	< 0.03	< 0.05
10/30/2012 12:33	10/30/2012 12:34	Base Grab	44	52.0	–	–	–	–	–	–	727	0.27	–	–	–	–	–	–	–	–	–	–	–
11/7/2012 11:46	11/7/2012 11:47	Base Grab	43	51.8	–	–	–	–	–	–	> 2,420	0.27	–	–	–	–	–	–	–	–	–	–	–
11/10/2012 23:21	11/11/2012 1:03	Rain Composite	32	44.2	11.43	101.5	155.6	7.43	5.5	0.07	–	–	504	236	120	7.58	0.110	0.882	–	5.10	0.17	0.04	0.38
11/14/2012 9:35	11/14/2012 9:36	Base Grab	42	50.4	8.65	1,079.0	1,504.0	7.81	> 100.0	0.76	–	–	~ 2	~ 2	875	171.00	< 0.020	~ 0.026	0.011	0.50	0.10	< 0.03	0.91
11/20/2012 8:08	11/20/2012 8:09	Base Grab	35	52.9	–	–	–	–	–	–	629	0.31	–	–	–	–	–	–	–	–	–	–	–
12/15/2012 6:26	12/16/2012 7:41	Rain/Melt Composite	25	51.8	10.32	1,427.0	1,947.0	7.14	9.0	1.00	–	–	47	22	1,020	6.78	0.083	0.214	–	2.60	0.28	0.07	0.48
12/19/2012 9:50	12/19/2012 9:51	Base Grab	30	53.1	11.72	1,194.0	1,801.0	7.33	92.0	0.92	–	–	< 1	< 1	1,050	146.00	< 0.020	< 0.020	0.012	0.61	0.09	< 0.03	0.96

Table F.1 continued. Monitoring data for 1NE outfall

Start Date Start Time	End Date End Time	Sample Type	Alkalinity (mg/L CaCO3)	Chloride Ion (mg/L)	Hardness (mg/L CaCO3)	Chemical Oxygen Demand (mg/L)	Total Organic Carbon (mg/L)	Carbonaceous Biological Oxygen Demand 5-day (mg/L)	Total Biological Oxygen Demand 5-day (mg/L)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)	Oil and Grease (mg/L)
1/11/2012 11:27	1/11/2012 11:28	Base Grab	–	297	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2/15/2012 11:50	2/15/2012 11:51	Base Grab	231	263	700	24	5.4	1.1	1.4	–	–	–	–	–	–	–	–	–	–	–	–	< 6
2/23/2012 15:43	2/23/2012 18:33	Melt Composite	140	913	280	76	18.4	9.0	11.0	0.0140	0.0176	0.0021	0.0028	0.0009	0.0028	0.0299	0.0580	< 0.0002	< 0.0002	0.0037	0.0047	–
2/28/2012 18:19	2/29/2012 2:51	Rain Composite	66	481	124	200	18.8	–	18.0	0.0095	0.0443	0.0017	0.0099	0.0006	0.0311	0.0332	0.3020	< 0.0002	~ 0.0005	0.0031	0.0151	10
2/29/2012 14:02	2/29/2012 17:42	Rain Composite	37	1,201	88	131	21.8	–	14.0	–	–	–	–	–	–	–	–	–	–	–	–	–
3/6/2012 12:19	3/6/2012 19:14	Melt Composite	74	316	112	93	14.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	< 6
3/12/2012 1:22	3/12/2012 2:14	Rain Composite	46	83	50	167	14.5	11.8	15.3	–	–	–	–	–	–	–	–	–	–	–	–	–
3/19/2012 18:53	3/19/2012 21:53	Rain Composite	42	94	88	344	17.9	28.0	37.0	–	–	–	–	–	–	–	–	–	–	–	–	23
3/26/2012 13:55	3/26/2012 13:56	Base Grab	399	144	560	16	5.1	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
4/5/2012 11:13	4/5/2012 11:14	Base Grab	383	154	592	15	4.5	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
4/15/2012 2:31	4/15/2012 5:56	Rain Composite	22	40	40	89	10.4	–	–	0.0065	0.0247	0.0009	0.0044	0.0008	0.0148	0.0169	0.1340	< 0.0002	~ 0.0002	0.0017	0.0056	7
4/25/2012 3:52	4/25/2012 4:48	Rain Composite	37	38	72	174	18.8	46.0	51.0	–	–	–	–	–	–	–	–	–	–	–	–	11
4/27/2012 8:55	4/27/2012 8:56	Base Grab	356	167	528	16	6.5	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
5/1/2012 21:29	5/2/2012 0:45	Rain Composite	30	20	64	107	8.6	14.0	20.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/6/2012 2:34	5/6/2012 8:33	Rain Composite	27	10	60	37	4.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/8/2012 11:11	5/8/2012 17:46	Rain Composite	35	22	92	82	12.8	8.6	10.0	–	–	–	–	–	–	–	–	–	–	–	–	15
5/10/2012 10:09	5/10/2012 10:10	Base Grab	322	134	456	~ 14	5.9	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/19/2012 21:06	5/19/2012 23:06	Rain Composite	49	34	72	186	24.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12
5/23/2012 8:29	5/23/2012 8:30	Base Grab	397	159	–	~ 10	6.0	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/23/2012 21:19	2/24/2012 5:18	Rain Composite	26	8	–	87	9.4	7.4	12.0	0.0035	0.0124	0.0007	0.0035	~ 0.0003	0.0120	0.0081	0.0636	< 0.0002	< 0.0002	0.0041	0.0040	–
5/24/2012 13:33	5/24/2012 17:37	Rain Composite	39	7	64	52	8.3	4.9	7.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/26/2012 10:26	5/26/2012 13:02	Rain Composite	30	9	68	32	7.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/27/2012 20:16	5/27/2012 23:25	Rain Composite	29	9	60	69	9.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	< 6
6/10/2012 21:06	6/11/2012 2:18	Rain Composite	38	16	52	120	16.0	19.0	33.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
6/14/2012 10:06	6/14/2012 11:41	Rain Composite	22	8	56	69	8.1	7.6	12.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
6/17/2012 23:22	6/18/2012 2:14	Rain Composite	24	6	48	66	4.4	9.9	12.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
6/19/2012 3:36	6/19/2012 7:09	Rain Composite	22	4	60	63	8.1	6.8	9.5	–	–	–	–	–	–	–	–	–	–	–	–	< 6
6/21/2012 10:43	6/21/2012 10:44	Base Grab	227	91	332	41	12.7	< 3.0	< 3.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
7/6/2012 23:01	7/7/2012 1:51	Rain Composite	30	8	46	76	10.7	5.6	8.3	–	–	–	–	–	–	–	–	–	–	–	–	9
7/11/2012 9:12	7/11/2012 9:13	Base Grab	372	133	524	~ 9	4.7	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
7/13/2012 17:21	7/13/2012 21:38	Rain Composite	51	20	68	66	13.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	34
7/18/2012 2:41	7/18/2012 4:38	Rain Composite	24	8	44	50	8.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	< 6
7/23/2012 9:48	7/23/2012 9:49	Base Grab	396	122	516	15	4.9	< 1.0	< 1.0	0.0016	0.0015	0.0037	0.0038	< 0.0001	< 0.0001	0.0033	0.0045	< 0.0002	< 0.0002	0.0007	0.0002	< 7
7/29/2012 6:35	7/29/2012 10:50	Rain Composite	31	13	56	30	7.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8/1/2012 9:25	8/1/2012 9:26	Base Grab	378	134	560	~ 11	5.8	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
8/3/2012 23:27	8/4/2012 1:53	Rain Composite	28	9	62	86	13.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8/15/2012 8:15	8/15/2012 10:30	Rain Composite	35	10	68	78	8.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8/22/2012 9:44	8/22/2012 9:46	Base Grab	363	148	520	~ 9	4.3	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
9/11/2012 11:33	9/11/2012 11:34	Base Grab	371	144	544	~ 11	4.3	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
9/24/2012 9:45	9/24/2012 9:46	Base Grab	405	138	328	16	4.3	< 1.0	1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
10/9/2012 11:31	10/9/2012 11:32	Base Grab	364	130	588	28	9.9	3.6	4.5	–	–	–	–	–	–	–	–	–	–	–	–	–
10/22/2012 9:40	10/22/2012 9:41	Base Grab	377	140	560	~ 12	6.6	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
10/25/2012 15:07	10/25/2012 15:08	Rain Grab	49	15	60	80	24.9	> 7.9	> 7.9	–	–	–	–	–	–	–	–	–	–	–	–	–
11/10/2012 23:21	11/11/2012 1:03	Rain Composite	40	8	60	260	18.5	–	34.0	–	0.0435	–	0.0119	–	0.0440	–	0.3190	–	0.0007	–	0.0122	–
11/14/2012 9:35	11/14/2012 9:36	Base Grab	345	141	524	~ 12	5.1	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
12/15/2012 6:26	12/16/2012 7:41	Rain/Melt Composite	39	545	72	69	16.1	4.6	–	0.0069	0.0167	0.0011	0.0032	0.0006	0.0119	0.0304	0.0930	< 0.0002	~ 0.0002	0.0044	0.0065	–
12/19/2012 9:50	12/19/2012 9:51	Base Grab	367	304	504	15	6.4	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–

Table F.2. Monitoring data for 2NNBC outfall

Start Date Start Time	End Date End Time	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	*E. coli* (CFU/ 100 mL)	Fluoride (mg/L)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Sulfate (mg/L)	Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
1/9/2012 12:51	1/9/2012 12:52	Base Grab	45	51.4	5.28	2,006.0	2,752.0	7.36	35.5	1.43	—	—	9	3	1,640	—	—	0.387	—	1.80	—	—	—
2/15/2012 12:30	2/15/2012 12:31	Base Grab	32	48.0	4.77	3,529.0	5,099.0	7.19	> 60.0	2.75	—	—	6	~ 3	2,750	184.0	0.920	0.983	0.339	2.90	0.91	0.10	6.64
2/29/2012 14:55	2/29/2012 14:56	Melt Grab	34	36.1	14.44	3,068.0	5,412.0	7.01	5.6	2.88	—	—	196	76	2,890	12.0	0.189	0.505	0.170	2.90	0.66	0.09	0.63
3/6/2012 13:42	3/6/2012 13:43	Melt Grab	55	45.3	9.06	1,273.0	1,916.0	7.39	36.8	0.98	—	—	18	6	1,070	73.0	0.521	0.652	0.031	1.80	0.44	0.06	3.38
3/12/2012 10:29	3/12/2012 10:30	Rain Grab	52	46.8	10.52	398.2	586.0	7.87	9.0	0.29	—	—	48	19	319	18.2	0.186	0.395	0.168	2.30	0.32	0.08	0.85
4/4/2012 12:55	4/4/2012 12:56	Base Grab	60	53.1	—	—	—	—	—	—	517	0.20	—	—	—	—	—	—	—	—	—	—	—
4/5/2012 12:25	4/5/2012 12:26	Base Grab	60	51.6	3.37	1,104.0	1,513.0	7.42	51.5	0.77	—	—	12	6	820	64.0	~ 0.022	0.399	0.018	1.90	0.44	0.05	0.78
5/3/2012 12:45	5/3/2012 12:46	Rain Grab	67	61.7	—	—	—	—	—	—	> 2,420	—	—	—	—	—	—	—	—	—	—	—	—
5/24/2012 10:50	5/24/2012 10:51	Rain Grab	64	64.9	7.16	173.1	198.7	8.08	33.2	0.09	—	—	20	7	108	6.1	0.114	0.195	0.115	0.96	0.14	0.04	0.36
5/24/2012 11:05	5/24/2012 11:06	Rain Grab	64	65.1	—	—	—	—	—	—	3,400	—	—	—	—	—	—	—	—	—	—	—	—
6/14/2012 10:12	6/14/2012 10:13	Rain Grab	60	64.6	7.91	459.1	529.2	8.04	29.5	0.26	—	—	34	11	480	49.5	0.649	0.860	0.420	2.40	0.24	0.06	2.69
7/18/2012 11:00	7/18/2012 11:01	Rain Grab	70	72.7	—	—	—	—	—	—	> 24,200	—	—	—	—	—	—	—	—	—	—	—	—
7/24/2012 8:20	7/24/2012 8:21	Rain Grab	75	75.4	6.84	112.7	114.7	7.49	—	0.05	—	—	13	5	79	3.2	0.076	0.135	0.065	0.69	0.18	< 0.03	0.27
7/24/2012 8:20	7/24/2012 8:21	Rain Grab	72	75.4	—	—	—	—	—	—	5,170	—	—	—	—	—	—	—	—	—	—	—	—
8/15/2012 9:55	8/15/2012 9:56	Rain Grab	—	69.8	7.56	131.2	142.0	7.44	—	0.07	—	—	37	11	95	4.9	0.130	0.246	0.124	1.40	0.44	0.04	0.45
8/15/2012 10:00	8/15/2012 10:01	Rain Grab	73	69.1	—	—	—	—	—	—	12,000	—	—	—	—	—	—	—	—	—	—	—	—
8/22/2012 12:54	8/22/2012 12:55	Base Grab	82	68.4	5.80	1,200.0	1,322.0	7.53	> 100.0	0.66	—	—	4	~ 2	833	119.0	0.801	0.959	0.590	2.60	0.38	0.04	4.21
8/29/2012 12:02	8/29/2012 12:03	Base Grab	88	68.0	—	—	—	—	—	—	772	1.50	—	—	—	—	—	—	—	—	—	—	—
9/11/2012 11:05	9/11/2012 11:06	Base Grab	79	67.6	4.61	1,617.0	1,797.0	7.37	> 100.0	0.91	—	—	~ 2	~ 1	1,110	166.0	0.986	1.270	0.690	3.30	0.48	0.06	2.66
9/11/2012 11:05	9/11/2012 11:06	Base Grab	78	60.4	—	—	—	—	—	—	140	4.40	—	—	—	—	—	—	—	—	—	—	—
9/24/2012 12:24	9/24/2012 12:25	Base Grab	66	64.9	4.07	1,406.0	1,611.0	7.60	> 100.0	0.82	—	—	~ 2	~ 1	1,001	147.5	1.215	1.230	0.865	2.40	0.38	0.06	4.00
9/26/2012 11:37	9/26/2012 11:38	Base Grab	56	63.1	—	—	—	—	—	—	430	2.10	—	—	—	—	—	—	—	—	—	—	—
10/9/2012 12:20	10/9/2012 12:21	Base Grab	48	60.1	7.05	2,358.0	2,873.0	7.43	39.5	1.50	—	—	6	~ 2	1,630	155.0	~ 0.030	0.152	0.013	2.50	1.10	< 0.03	0.86
10/25/2012 9:11	10/25/2012 9:12	Rain Grab	38	50.2	—	—	—	—	—	—	16,415	—	—	—	—	—	—	—	—	—	—	—	—

Table F.2 continued. Monitoring data for 2NNBC outfall

Start Date Start Time	End Date End Time	Sample Type	Alkalinity (mg/L CaCO3)	Chloride Ion (mg/L)	Hardness (mg/L CaCO3)	Chemical Oxygen Demand (mg/L)	Total Organic Carbon (mg/L)	Carbonaceous Biological Oxygen Demand 5-day (mg/L)	Total Biological Oxygen Demand 5-day (mg/L)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)	Oil and Grease (mg/L)
1/9/2012 12:51	1/9/2012 12:52	Base Grab	—	653	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2/15/2012 12:30	2/15/2012 12:31	Base Grab	283	1,514	710	78	13.7	4.8	78.0	—	—	—	—	—	—	—	—	—	—	—	—	< 6
2/29/2012 14:55	2/29/2012 14:56	Melt Grab	36	1,824	112	148	12.6	13.0	148.0	0.0094	0.0331	0.0012	0.0055	0.0007	0.0269	0.0215	0.1890	< 0.0002	~ 0.0004	0.0146	0.0251	11
3/6/2012 13:42	3/6/2012 13:43	Melt Grab	149	467	298	46	12.5	2.5	45.5	0.0059	0.0088	0.0019	0.0025	0.0011	0.0044	0.0258	0.0477	< 0.0002	< 0.0002	0.0023	0.0026	< 6
3/12/2012 10:29	3/12/2012 10:30	Rain Grab	49	126	104	85	11.6	8.8	11.0	—	—	—	—	—	—	—	—	—	—	—	—	< 6
4/5/2012 12:25	4/5/2012 12:26	Base Grab	83	321	360	44	11.6	2.7	4.5	—	—	—	—	—	—	—	—	—	—	—	—	< 6
5/24/2012 10:50	5/24/2012 10:51	Rain Grab	60	24	64	29	10.4	3.4	5.0	0.0037	0.0056	0.0009	0.0015	~ 0.0005	0.0050	0.0108	0.0296	< 0.0002	< 0.0002	0.0036	0.0020	< 6
6/14/2012 10:12	6/14/2012 10:13	Rain Grab	148	91	260	74	24.4	4.5	6.6	0.0074	0.0135	0.0025	0.0036	0.0010	0.0088	0.0206	0.0571	< 0.0002	< 0.0002	0.0017	0.0029	< 6
7/24/2012 8:20	7/24/2012 8:21	Rain Grab	28	8	56	34	6.2	5.5	4.1	0.0024	0.0044	0.0007	0.0011	~ 0.0004	0.0031	0.0086	0.0226	< 0.0002	< 0.0002	0.0016	0.0016	< 6
8/15/2012 9:55	8/15/2012 9:56	Rain Grab	24	15	44	54	13.9	10.0	13.0	—	—	—	—	—	—	—	—	—	—	—	—	< 6
8/22/2012 12:54	8/22/2012 12:55	Base Grab	185	158	416	62	24.5	< 3.0	< 3.0	—	—	—	—	—	—	—	—	—	—	—	—	—
9/11/2012 11:05	9/11/2012 11:06	Base Grab	245	311	560	61	26.9	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
9/24/2012 12:24	9/24/2012 12:25	Base Grab	301	261	510	60	22.6	11.0	12.0	0.0053	0.0070	0.0029	0.0030	0.0008	0.0011	0.0633	0.0694	< 0.0002	~ 0.0002	0.0023	0.0022	—
10/9/2012 12:20	10/9/2012 12:21	Base Grab	333	569	830	30	6.6	< 3.0	< 3.0	—	—	—	—	—	—	—	—	—	—	—	—	—

Table F.3. Monitoring data for 4PP outfall

Start Date Start Time	End Date End Time	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	*E. coli* (CFU/ 100 mL)	Fluoride (mg/L)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Sulfate (mg/L)	Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
12/31/2011 21:00	1/1/2012 4:16	Rain Composite	20	43.9	6.40	2,814.0	4,334.0	7.59	4.4	2.31	–	–	125	60	2,330	–	–	0.455	–	3.35	–	–	–
1/5/2012 15:36	1/5/2012 18:22	Melt Composite	45	60.4	6.14	3,764.0	4,563.0	7.46	–	2.45	–	–	22	12	984	–	–	0.164	–	2.30	–	–	–
1/6/2012 14:01	1/6/2012 15:28	Melt Composite	45	60.8	6.67	2,360.0	2,850.0	7.67	–	1.49	–	–	20	10	1,540	–	–	0.146	–	2.20	–	–	–
1/9/2012 13:15	1/9/2012 13:16	Base Grab	45	49.6	10.64	973.0	1,372.0	8.02	> 60.0	0.69	–	–	~ 1	~ 1	2,550	–	–	~ 0.045	–	0.56	–	–	–
1/27/2012 15:31	1/27/2012 18:11	Melt Composite	30	48.6	6.14	6,646.0	9,511.0	7.26	5.7	5.35	–	–	120	48	5,620	–	–	0.269	–	2.80	–	–	–
1/31/2012 14:26	1/31/2012 20:29	Melt Composite	32	55.9	5.11	3,900.0	5,021.0	7.12	13.2	2.71	–	–	47	~ 29	2,840	56.90	0.130	0.415	–	5.90	1.22	0.29	0.58
2/15/2012 13:05	2/15/2012 13:06	Base Grab	32	48.0	10.30	1,145.0	1,654.0	8.01	> 60.0	0.84	–	–	< 1	~ 1	953	85.90	~ 0.025	~ 0.023	0.020	0.63	0.13	0.03	1.64
2/21/2012 5:01	2/21/2012 16:33	Melt Composite	32	54.0	4.69	5,920.0	7,837.0	7.25	5.8	4.36	–	–	109	48	4,320	48.50	< 0.020	0.279	–	3.10	0.14	0.24	0.85
2/28/2012 18:08	2/28/2012 20:15	Rain Composite	34	51.4	9.00	1,660.0	2,280.0	7.09	3.7	1.18	–	–	311	111	1,230	16.40	0.065	1.020	–	4.90	0.32	0.11	0.62
3/6/2012 12:38	3/6/2012 20:08	Melt Composite	45	60.8	8.10	636.0	769.0	7.24	16.8	0.38	–	–	60	24	422	16.00	0.483	0.520	0.273	3.20	0.38	0.06	0.49
3/12/2012 0:38	3/12/2012 5:10	Rain Composite	55	62.1	8.41	765.0	910.0	7.61	7.5	0.45	–	–	232	87	466	19.50	0.084	0.468	0.067	2.40	0.10	0.04	0.60
3/19/2012 18:52	3/19/2012 20:05	Rain Composite	65	63.5	6.42	218.1	254.6	7.35	3.9	0.12	–	–	792	212	174	5.75	0.130	1.400	0.120	6.40	0.34	0.04	0.48
3/26/2012 15:25	3/26/2012 15:26	Base Grab	42	49.1	10.15	948.0	1,348.0	7.92	> 100.0	0.68	–	–	~ 2	~ 2	764	86.30	< 0.010	~ 0.036	0.023	0.62	~ 0.06	< 0.03	1.74
4/2/2012 23:51	4/3/2012 2:51	Rain Composite	49	54.9	9.00	205.8	268.9	7.20	7.2	0.13	–	–	272	86	184	13.90	0.201	0.813	0.180	4.90	0.86	0.05	0.92
4/4/2012 11:33	4/4/2012 11:34	Base Grab	56	52.0	–	–	–	–	–	–	8	0.12	–	–	–	–	–	–	–	–	–	–	–
4/5/2012 12:57	4/5/2012 12:58	Base Grab	60	50.9	11.13	940.0	1,301.0	8.17	> 100.0	0.65	–	–	11	~ 3	705	83.95	~ 0.032	0.121	0.034	0.60	0.08	< 0.03	1.67
4/15/2012 2:07	4/15/2012 3:27	Rain Composite	28	50.5	8.52	169.2	235.5	–	15.0	0.11	–	–	117	42	120	11.40	~ 0.022	0.350	–	2.50	< 0.02	< 0.03	0.41
4/17/2012 23:23	4/18/2012 2:49	Rain Composite	58	54.3	10.48	153.9	202.7	7.77	13.7	0.10	–	–	171	57	116	11.20	0.069	0.358	0.059	2.90	0.85	0.04	0.71
4/18/2012 17:31	4/18/2012 20:41	Unknown Discharge Composite	47	56.1	9.98	408.0	524.0	7.65	–	0.26	–	–	28	8	303	31.10	0.067	0.175	–	1.10	0.28	0.04	0.81
4/19/2012 11:47	4/19/2012 11:48	Base Grab	45	50.9	–	–	–	–	–	–	27	0.12	–	–	–	–	–	–	–	–	–	–	–
4/21/2012 21:41	4/22/2012 3:42	Rain Composite	50	49.8	10.40	209.8	295.0	7.65	25.0	0.14	–	–	32	17	174	16.00	~ 0.048	0.146	–	1.10	0.32	0.04	0.67
4/27/2012 10:23	4/27/2012 10:24	Rain Grab	45	51.3	10.50	866.0	1,192.0	8.02	> 100.0	0.60	–	–	< 1	~ 1	721	79.10	~ 0.032	0.064	0.035	0.45	0.11	< 0.03	1.52
4/28/2012 12:16	4/28/2012 15:09	Rain Composite	46	54.3	7.61	236.0	311.0	7.77	15.5	0.15	–	–	58	30	197	17.20	0.060	0.320	–	1.40	~ 0.04	0.06	0.67
5/1/2012 21:44	5/2/2012 0:49	Rain Composite	60	66.4	6.14	145.9	164.3	7.19	–	0.08	–	–	155	30	105	9.19	0.054	0.301	0.031	2.10	0.30	0.08	0.47
5/3/2012 10:17	5/3/2012 11:27	Rain Composite	70	64.4	6.57	75.4	87.0	7.13	10.5	0.04	–	–	338	89	45	4.39	~ 0.038	0.634	0.010	3.60	0.35	0.03	0.32
5/3/2012 12:22	5/3/2012 12:23	Rain Grab	64	60.8	–	–	–	–	–	–	> 2,420	–	–	–	–	–	–	–	–	–	–	–	–
5/4/2012 19:04	5/4/2012 21:36	Rain Composite	55	59.5	6.96	228.9	280.8	7.35	25.0	0.13	–	–	46	18	155	15.50	0.070	0.320	–	2.40	0.40	0.10	0.67
5/19/2012 19:29	5/19/2012 22:14	Rain Composite	73	60.4	7.02	330.2	405.0	7.25	7.4	0.19	–	–	194	76	334	30.30	0.054	1.230	–	7.50	~ 0.04	< 0.03	< 0.05
5/23/2012 9:28	5/23/2012 9:29	Base Grab	68	56.1	9.97	1,015.0	1,303.0	8.17	> 100.0	0.66	–	–	~ 1	~ 2	751	83.70	~ 0.025	0.054	0.026	0.48	0.07	< 0.03	1.38
5/23/2012 20:51	5/23/2012 23:22	Rain Composite	45	68.4	4.92	164.0	180.4	7.48	11.3	0.01	–	–	88	24	37	4.87	~ 0.022	0.157	0.016	1.30	0.41	0.04	0.41
5/24/2012 11:23	5/24/2012 11:24	Rain Grab	64	64.2	–	–	–	–	–	–	9,800	–	–	–	–	–	–	–	–	–	–	–	–
5/24/2012 13:52	5/24/2012 16:16	Rain Composite	70	63.9	7.78	75.0	87.1	7.75	21.0	0.04	–	–	222	68	101	10.20	~ 0.033	0.543	0.010	3.80	0.17	0.17	0.53
6/14/2012 10:11	6/14/2012 11:18	Rain Composite	69	67.3	5.24	108.4	121.0	7.26	23.0	0.06	–	–	127	41	83	5.30	< 0.010	0.286	< 0.005	1.70	~ 0.06	< 0.03	0.54
6/17/2012 17:09	6/17/2012 17:59	Rain Composite	71	73.4	5.91	157.2	163.5	7.19	8.0	0.08	–	–	175	62	95	6.66	~ 0.013	0.357	~ 0.008	2.60	0.30	0.05	0.72
6/17/2012 23:31	6/18/2012 8:08	Rain Composite	71	71.1	7.83	54.7	58.4	7.63	9.5	0.03	–	–	255	50	50	2.41	~ 0.023	0.342	~ 0.006	2.40	0.43	0.05	0.38
6/19/2012 4:29	6/19/2012 5:58	Rain Composite	70	70.2	7.84	86.4	93.2	7.62	17.5	0.04	–	–	183	47	61	4.22	~ 0.018	0.306	0.104	2.30	0.44	0.04	0.51
6/19/2012 10:27	6/19/2012 10:28	Rain Grab	70	70.2	–	–	–	–	–	–	14,140	–	–	–	–	–	–	–	–	–	–	–	–

Table F.3 continued. Monitoring data for 4PP outfall

Start Date Start Time	End Date End Time	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	*E. coli* (CFU/ 100 mL)	Fluoride (mg/L)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Sulfate (mg/L)	Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
7/18/2012 10:14	7/18/2012 11:44	Rain Composite	75	77.0	5.42	104.1	104.2	7.30	25.0	0.05	–	–	101	28	60	4.28	~ 0.027	0.220	–	1.60	0.22	0.04	0.52
7/18/2012 12:06	7/18/2012 12:07	Rain Grab	71	72.5	–	–	–	–	–	–	24,200	–	–	–	–	–	–	–	–	–	–	–	–
7/21/2012 6:39	7/21/2012 8:52	Rain Composite	86	82.4	5.62	142.3	134.6	7.80	42.0	0.06	–	–	67	16	73	5.03	~ 0.046	0.240	–	1.50	0.54	0.05	0.52
7/23/2012 12:32	7/23/2012 12:33	Base Grab	87	62.4	9.50	1,170.0	1,383.0	7.80	> 100.0	0.70	–	–	4	~ 1	803	79.40	~ 0.038	0.072	0.035	0.54	~ 0.06	0.03	1.41
7/24/2012 10:04	7/24/2012 10:05	Rain Grab	73	70.5	–	–	–	–	–	–	14,140	–	–	–	–	–	–	–	–	–	–	–	–
7/25/2012 11:45	7/25/2012 11:46	Base Grab	91	63.7	–	–	–	–	–	–	> 2,420	< 0.20	–	–	–	–	–	–	–	–	–	–	–
7/29/2012 5:28	7/29/2012 15:23	Rain Composite	85	76.1	6.03	229.2	231.6	7.35	45.0	0.11	–	–	25	9	135	11.90	~ 0.043	0.362	–	0.99	0.08	0.05	0.60
8/1/2012 11:43	8/1/2012 11:44	Base Grab	88	63.9	9.38	1,217.0	1,414.0	8.06	> 100.0	0.71	–	–	3	~ 2	803	45.60	~ 0.029	0.051	0.029	0.46	~ 0.05	< 0.03	1.45
8/2/2012 10:09	8/2/2012 10:10	Base Grab	82	–	–	–	–	–	–	–	185	< 0.20	–	–	–	–	–	–	–	–	–	–	–
8/3/2012 23:26	8/4/2012 12:34	Rain Composite	88	72.5	5.28	178.2	187.3	7.10	27.0	0.09	–	–	84	26	121	8.88	0.082	0.252	–	1.70	0.27	0.08	0.36
8/15/2012 8:10	8/15/2012 10:45	Rain Composite	75	50.9	8.07	119.9	166.0	7.15	20.0	0.08	–	–	96	34	122	7.37	~ 0.042	0.396	–	1.90	< 0.02	< 0.03	0.48
8/15/2012 10:53	8/15/2012 10:54	Rain Grab	74	66.4	–	–	–	–	–	–	24,150	–	–	–	–	–	–	–	–	–	–	–	–
8/22/2012 11:05	8/22/2012 11:06	Base Grab	82	58.6	9.41	1,137.0	1,411.0	7.91	> 100.0	0.71	–	–	~ 1	~ 1	873	78.00	~ 0.020	~ 0.048	0.026	0.45	~ 0.04	< 0.03	1.62
8/29/2012 11:42	8/29/2012 11:43	Base Grab	85	59.7	–	–	–	–	–	–	42	< 0.20	–	–	–	–	–	–	–	–	–	–	–
9/11/2012 10:42	9/11/2012 10:43	Base Grab	76	59.4	9.62	1,199.0	1,477.0	8.11	> 100.0	0.75	–	–	~ 2	~ 1	792	88.60	~ 0.027	~ 0.045	0.039	0.74	~ 0.05	0.03	1.54
9/11/2012 10:42	9/11/2012 10:43	Base Grab	76	59.4	–	–	–	–	–	–	14	0.22	–	–	–	–	–	–	–	–	–	–	–
9/17/2012 4:22	9/17/2012 6:43	Rain Composite	60	60.3	9.04	295.7	360.0	7.72	15.5	0.17	–	–	115	45	234	17.20	0.134	0.522	–	3.10	0.45	0.08	1.10
9/24/2012 11:57	9/24/2012 11:58	Base Grab	64	55.2	10.17	754.0	979.0	8.05	> 100.0	0.49	–	–	~ 2	< 1	812	92.40	~ 0.036	~ 0.042	0.029	0.39	~ 0.04	< 0.03	1.58
9/26/2012 10:55	9/26/2012 10:56	Base Grab	55	54.7	–	–	–	–	–	–	80	0.36	–	–	–	–	–	–	–	–	–	–	–
10/9/2012 11:35	10/9/2012 11:36	Base Grab	49	54.1	–	–	–	–	–	–	130	0.38	–	–	–	–	–	–	–	–	–	–	–
10/9/2012 12:50	10/9/2012 12:51	Base Grab	48	53.4	10.14	1,029.0	1,371.0	8.00	> 100.0	0.69	–	–	~ 2	~ 1	758	87.00	~ 0.042	0.085	0.049	0.87	0.10	0.04	1.67
10/22/2012 11:17	10/22/2012 11:18	Base Grab	56	55.2	9.82	1,083.0	1,409.0	7.83	> 100.0	0.71	–	–	~ 1	~ 1	793	87.20	~ 0.043	~ 0.040	0.023	0.74	0.07	< 0.03	1.47
10/23/2012 6:57	10/23/2012 10:02	Rain Composite	40	59.9	5.22	341.2	417.1	7.00	–	0.20	–	–	198	78	273	9.61	0.172	0.356	–	1.70	~ 0.03	0.31	0.25
10/23/2012 9:38	10/23/2012 9:39	Rain Grab	56	57.2	–	–	–	–	–	–	> 24,200	< 0.20	–	–	–	–	–	–	–	–	–	–	–
10/25/2012 5:20	10/25/2012 9:37	Rain Composite	36	46.0	11.35	69.4	103.2	7.34	24.0	0.05	–	–	60	26	86	3.70	0.151	0.358	0.145	1.30	~ 0.05	0.04	0.24
10/25/2012 10:40	10/25/2012 10:41	Rain Grab	36	48.4	–	–	–	–	–	–	17,750	–	–	–	–	–	–	–	–	–	–	–	–
10/30/2012 11:19	10/30/2012 11:20	Base Grab	42	50.4	–	–	–	–	–	–	104	0.21	–	–	–	–	–	–	–	–	–	–	–
11/6/2012 2:47	11/6/2012 8:51	Rain Composite	41	44.6	10.76	219.6	334.7	7.57	–	0.16	–	–	40	20	215	16.70	0.128	0.279	0.114	2.10	0.63	0.06	1.02
11/7/2012 9:51	11/7/2012 9:52	Base Grab	40	51.8	–	–	–	–	–	–	261	< 0.20	–	–	–	–	–	–	–	–	–	–	–
11/10/2012 23:14	11/11/2012 3:15	Rain Composite	40	40.6	10.40	88.3	143.9	7.50	10.0	0.07	–	–	344	128	83	5.83	0.065	0.516	–	3.50	0.41	0.05	0.48
11/14/2012 10:53	11/14/2012 10:54	Base Grab	47	49.6	11.10	1,026.0	1,447.0	8.08	> 100.0	0.73	–	–	< 1	~ 1	778	43.40	< 0.020	~ 0.022	0.023	0.50	~ 0.06	< 0.03	1.36
11/20/2012 10:35	11/20/2012 10:36	Base Grab	41	50.7	–	–	–	–	–	–	9	0.32	–	–	–	–	–	–	–	–	–	–	–
12/15/2012 4:59	12/15/2012 10:24	Rain/Melt Composite	24	40.8	9.51	2,267.0	3,685.0	7.46	6.5	1.93	–	–	120	~ 58	1,840	16.00	~ 0.035	0.379	–	4.00	0.30	0.11	0.76
12/19/2012 11:04	12/19/2012 11:05	Base Grab	29	47.5	11.00	1,047.0	1,526.0	7.80	> 100.0	0.77	–	–	~ 1	~ 1	842	83.95	~ 0.021	~ 0.040	0.019	0.58	0.07	< 0.03	1.37

Table F.3 continued. Monitoring data for 4PP outfall

Start Date Start Time	End Date End Time	Sample Type	Alkalinity (mg/L CaCO3)	Chloride Ion (mg/L)	Hardness (mg/L CaCO3)	Chemical Oxygen Demand (mg/L)	Total Organic Carbon (mg/L)	Carbonaceous Biological Oxygen Demand 5-day (mg/L)	Total Biological Oxygen Demand 5-day (mg/L)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)	Oil and Grease (mg/L)
12/31/2011 21:00	1/1/2012 4:16	Rain Composite	–	1,477	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1/5/2012 15:36	1/5/2012 18:22	Melt Composite	–	1,405	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1/6/2012 14:01	1/6/2012 15:28	Melt Composite	–	773	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1/9/2012 13:15	1/9/2012 13:16	Base Grab	–	209	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1/27/2012 15:31	1/27/2012 18:11	Melt Composite	–	3,631	–	–	–	–	–	0.0176	0.0512	0.0032	0.0078	< 0.0001	0.0209	0.0747	0.2320	~ 0.0003	~ 0.0005	0.0038	0.0126	–
1/31/2012 14:26	1/31/2012 20:29	Melt Composite	180	1,627	340	124	–	–	–	–	0.0268	–	0.0040	–	0.0115	–	0.0760	–	~ 0.0002	–	0.0047	–
2/15/2012 13:05	2/15/2012 13:06	Base Grab	287	326	508	20	3.6	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
2/21/2012 5:01	2/21/2012 16:33	Melt Composite	180	2,557	292	192	13.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	12
2/28/2012 18:08	2/28/2012 20:15	Rain Composite	59	697	116	314	15.6	–	29.0	–	–	–	–	–	–	–	–	–	–	–	–	38
3/6/2012 12:38	3/6/2012 20:08	Melt Composite	73	171	116	96	18.6	11.0	13.0	–	–	–	–	–	–	–	–	–	–	–	–	6
3/12/2012 0:38	3/12/2012 5:10	Rain Composite	66	227	112	178	11.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	17
3/19/2012 18:52	3/19/2012 20:05	Rain Composite	45	49	180	437	13.9	25.0	32.0	–	–	–	–	–	–	–	–	–	–	–	–	31
3/26/2012 15:25	3/26/2012 15:26	Base Grab	296	202	488	17	5.7	3.8	4.2	–	–	–	–	–	–	–	–	–	–	–	–	< 6
4/2/2012 23:51	4/3/2012 2:51	Rain Composite	53	45	104	242	18.8	33.0	38.0	–	–	–	–	–	–	–	–	–	–	–	–	9
4/5/2012 12:57	4/5/2012 12:58	Base Grab	280	235	482	~ 18	3.8	< 1.0	~ 1.2	–	–	–	–	–	–	–	–	–	–	–	–	< 6
4/15/2012 2:07	4/15/2012 3:27	Rain Composite	39	33	80	108	8.9	–	–	0.0097	0.0397	0.0011	0.0051	0.0007	0.0271	0.0253	0.1820	< 0.0002	~ 0.0002	0.0031	0.0093	< 6
4/17/2012 23:23	4/18/2012 2:49	Rain Composite	40	27	84	117	7.2	–	16.0	–	–	–	–	–	–	–	–	–	–	–	–	8
4/18/2012 17:31	4/18/2012 20:41	Unknown Discharge Composite	110	85	204	26	5.1	< 3.0	3.9	0.0036	0.0083	0.0011	0.0023	~ 0.0003	0.0053	0.0109	0.0281	< 0.0002	< 0.0002	0.0014	0.0022	< 6
4/21/2012 21:41	4/22/2012 3:42	Rain Composite	59	40	108	48	8.4	5.6	7.1	–	–	–	–	–	–	–	–	–	–	–	–	27
4/27/2012 10:23	4/27/2012 10:24	Rain Grab	257	200	444	~ 11	4.6	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
4/28/2012 12:16	4/28/2012 15:09	Rain Composite	63	47	60	98	13.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
5/1/2012 21:44	5/2/2012 0:49	Rain Composite	32	21	24	111	6.6	7.2	11.0	0.0089	0.0407	0.0011	0.0048	~ 0.0004	0.0258	0.0263	0.1690	< 0.0002	~ 0.0002	0.0025	0.0105	< 6
5/3/2012 10:17	5/3/2012 11:27	Rain Composite	21	6	44	182	4.6	6.9	16.0	–	–	–	–	–	–	–	–	–	–	–	–	7
5/4/2012 19:04	5/4/2012 21:36	Rain Composite	61	40	90	81	6.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	< 7
5/19/2012 19:29	5/19/2012 22:14	Rain Composite	104	71	232	256	39.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15
5/23/2012 9:28	5/23/2012 9:29	Base Grab	308	221	512	~ 9	5.4	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/23/2012 20:51	5/23/2012 23:22	Rain Composite	25	6	60	51	8.0	5.8	8.7	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/24/2012 13:52	5/24/2012 16:16	Rain Composite	45	19	60	136	13.6	18.0	26.0	–	–	–	–	–	–	–	–	–	–	–	–	< 5

Table F.3 Continued. Monitoring data for 4PP outfall

Start Date Start Time	End Date End Time	Sample Type	Alkalinity (mg/L CaCO3)	Chloride Ion (mg/L)	Hardness (mg/L CaCO3)	Chemical Oxygen Demand (mg/L)	Total Organic Carbon (mg/L)	Carbonaceous Biological Oxygen Demand 5-day (mg/L)	Total Biological Oxygen Demand 5-day (mg/L)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)	Oil and Grease (mg/L)
6/14/2012 10:11	6/14/2012 11:18	Rain Composite	21	12	56	82	10.6	9.8	14.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
6/17/2012 17:09	6/17/2012 17:59	Rain Composite	33	17	64	110	8.2	12.0	17.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
6/17/2012 23:31	6/18/2012 8:08	Rain Composite	18	3	48	92	3.5	6.2	11.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
6/19/2012 4:29	6/19/2012 5:58	Rain Composite	29	8	56	75	7.7	7.5	10.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
7/18/2012 10:14	7/18/2012 11:44	Rain Composite	20	8	40	63	7.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	< 6
7/21/2012 6:39	7/21/2012 8:52	Rain Composite	29	12	68	54	5.7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	< 6
7/23/2012 12:32	7/23/2012 12:33	Base Grab	302	219	502	~ 16	4.5	< 3.0	~ 3.0	0.0013	0.0020	0.0019	0.0021	< 0.0001	~ 0.0005	0.0062	0.0069	< 0.0002	< 0.0002	0.0006	0.0005	< 7
7/29/2012 5:28	7/29/2012 15:23	Rain Composite	42	31	92	38	7.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8/1/2012 11:43	8/1/2012 11:44	Base Grab	300	228	520	~ 11	4.2	< 3.0	< 3.0	–	–	–	–	–	–	–	–	–	–	–	–	–
8/3/2012 23:26	8/4/2012 12:34	Rain Composite	41	20	96	62	16.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8/15/2012 8:10	8/15/2012 10:45	Rain Composite	31	22	80	102	8.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8/22/2012 11:05	8/22/2012 11:06	Base Grab	281	235	500	~ 7	2.8	1.6	1.4	–	–	–	–	–	–	–	–	–	–	–	–	–
9/11/2012 10:42	9/11/2012 10:43	Base Grab	270	206	500	19	3.5	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
9/17/2012 4:22	9/17/2012 6:43	Rain Composite	63	46	116	139	26.7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9/24/2012 11:57	9/24/2012 11:58	Base Grab	321	250	496	~ 13	2.9	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
10/9/2012 12:50	10/9/2012 12:51	Base Grab	275	186	484	23	8.5	3.6	4.3	–	–	–	–	–	–	–	–	–	–	–	–	–
10/22/2012 11:17	10/22/2012 11:18	Base Grab	317	213	498	~ 12	5.2	< 1.0	1.2	–	–	–	–	–	–	–	–	–	–	–	–	–
10/23/2012 6:57	10/23/2012 10:02	Rain Composite	80	56	136	212	52.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10/25/2012 5:20	10/25/2012 9:37	Rain Composite	21	9	68	90	22.2	> 7.9	> 7.9		0.0166		0.0025		0.0100		0.0682		< 0.0002		0.0042	–
11/6/2012 2:47	11/6/2012 8:51	Rain Composite	73	38	112	76	21.7	17.0	21.0	–	–	–	–	–	–	–	–	–	–	–	–	–
11/10/2012 23:14	11/11/2012 3:15	Rain Composite	40	11	60	200	12.5	–	23.0	–	0.0671	–	0.0087	–	0.0649	–	0.2570	–	~ 0.0004	–	0.0121	–
11/14/2012 10:53	11/14/2012 10:54	Base Grab	297	216	508	~ 6	3.6	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
12/15/2012 4:59	12/15/2012 10:24	Rain/Melt Composite	60	1,006	116	44	17.6	–	–	0.0092	0.0427	0.0018	0.0069	~ 0.0003	0.0236	0.0403	0.2340	< 0.0002	~ 0.0003	0.0036	0.0120	–
12/19/2012 11:04	12/19/2012 11:05	Base Grab	297	279	478	~ 14	5.9	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–

Table F.4. Monitoring data for 6UMN outfall

Start Date Start Time	End Date End Time	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	*E. coli* (CFU/ 100 mL)	Fluoride (mg/L)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Sulfate (mg/L)	Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
1/9/2012 14:07	1/9/2012 14:08	Base Grab	45	49.6	11.10	954.0	1,344.0	8.28	> 60.0	0.68	–	–	~ 2	~ 2	770	–	–	~ 0.033	–	0.49	–	–	–
2/15/2012 13:43	2/15/2012 13:44	Base Grab	32	47.3	11.16	939.0	1,373.0	8.18	> 60.0	0.69	–	–	~ 1	~ 1	810	73.80	~ 0.022	< 0.010	0.013	0.40	~ 0.02	< 0.03	1.56
3/1/2012 13:15	3/1/2012 13:16	Melt Grab	34	38.8	13.29	922.0	1,548.0	7.60	3.2	0.78	–	–	228	49	898	16.20	0.125	0.458	0.124	2.40	0.41	0.17	0.54
3/6/2012 14:10	3/6/2012 14:11	Melt Grab	55	46.6	11.98	356.6	527.1	7.69	6.2	0.26	–	–	192	38	315	10.70	0.120	0.403	0.140	2.30	0.30	0.07	0.33
3/12/2012 11:40	3/12/2012 11:41	Rain Grab	53	46.9	11.22	293.9	432.1	7.70	9.5	0.21	–	–	51	16	271	14.70	1.340	0.314	1.270	1.70	0.24	0.07	0.52
3/26/2012 15:55	3/26/2012 15:56	Base Grab	42	48.0	10.57	917.0	1,323.0	8.10	> 100.0	0.66	–	–	~ 3	~ 2	753	75.40	~	~ 0.014	0.010		< 0.02	< 0.03	1.51
4/4/2012 11:00	4/4/2012 11:01	Base Grab	58	51.8	–	–	–	–	–	–	7	0.22	–	–	–	–	–	–	–	–	–	–	–
4/5/2012 13:25	4/5/2012 13:26	Base Grab	60	52.7	11.35	958.0	1,292.0	8.21	> 100.0	0.65	–	–	~ 1	~ 1	734	73.80	< 0.010	~ 0.024	0.014	0.33	< 0.02	< 0.03	1.45
4/19/2012 11:10	4/19/2012 11:11	Base Grab	45	52.2	–	–	–	–	–	–	2	0.17	–	–	–	–	–	–	–	–	–	–	–
5/3/2012 11:52	5/3/2012 11:53	Rain Grab	62	60.3	–	–	–	–	–	–	> 2,420	–	–	–	–	–	–	–	–	–	–	–	–
5/23/2012 9:10	5/23/2012 9:11	Base Grab	68	56.3	9.91	1,042.0	1,336.0	8.15	> 100.0	0.67	–	–	< 1	~ 1	801	75.90	~ 0.027	0.055	0.032	0.34	~ 0.02	< 0.03	1.37
5/24/2012 10:22	5/24/2012 10:23	Rain Grab	63	63.1	8.67	197.2	231.4	8.05	8.6	0.11	–	–	106	17	85	4.94	0.074	0.233	0.081	0.94	0.17	0.04	0.30
5/24/2012 10:24	5/24/2012 10:25	Rain Grab	64	63.1	–	–	–	–	–	–	3,000	–	–	–	–	–	–	–	–	–	–	–	–
6/14/2012 12:34	6/14/2012 12:35	Rain Grab	60	61.9	9.20	115.5	137.5	8.16	10.0	0.06	–	–	81	23	116	5.52	0.070	0.225	0.064	1.40	0.50	0.05	0.53
7/18/2012 12:03	7/18/2012 12:04	Rain Grab	71	71.6	–	–	–	–	–	–	1,850	–	–	–	–	–	–	–	–	–	–	–	–
7/23/2012 11:30	7/23/2012 11:31	Base Grab	87	66.4	8.91	1,027.0	1,157.0	7.97	72.0	0.85	–	–	5	~ 1	695	65.00	0.065	0.082	0.059	0.42	~ 0.05	< 0.03	1.14
7/24/2012 9:31	7/24/2012 9:34	Rain Grab	75	70.3	7.06	122.6	132.0	7.55	–	0.06	–	–	35	7	99	5.75	0.071	0.131	0.058	0.57	0.12	0.04	0.43
7/24/2012 9:31	7/24/2012 9:32	Rain Grab	73	70.3	–	–	–	–	–	–	1,850	–	–	–	–	–	–	–	–	–	–	–	–
7/25/2012 10:57	7/25/2012 10:58	Base Grab	87	64.4	–	–	–	–	–	–	15	0.31	–	–	–	–	–	–	–	–	–	–	–
8/1/2012 11:20	8/1/2012 11:21	Base Grab	88	64.0	9.56	1,106.0	1,282.0	8.18	> 100.0	0.64	–	–	~ 1	~ 1	736	80.25	0.046	0.059	0.041	0.40	< 0.02	< 0.03	1.15
8/2/2012 10:51	8/2/2012 10:52	Base Grab	82	62.6	–	–	–	–	–	–	25	0.26	–	–	–	–	–	–	–	–	–	–	–
8/3/2012 23:30	8/4/2012 1:54	Rain Composite	88	70.7	8.51	145.9	156.2	7.84	16.0	0.07	–	–	175	40	87	5.24	0.059	0.314	–	1.90	0.32	0.05	0.47
8/15/2012 8:29	8/15/2012 9:36	Rain Composite	75	50.4	8.86	78.3	109.1	7.36	21.0	0.05	–	–	112	39	95	5.24	0.080	0.261	–	1.40	0.06	< 0.03	0.34
8/15/2012 10:19	8/15/2012 10:20	Rain Grab	73	65.7	–	–	–	–	–	–	3,400	–	–	–	–	–	–	–	–	–	–	–	–
8/22/2012 11:56	8/22/2012 11:57	Base Grab	88	61.2	9.40	1,002.0	1,206.0	8.04	> 100.0	0.60	–	–	~ 1	~ 1	777	70.30	~ 0.010	~ 0.033	0.013	0.67	< 0.02	< 0.03	1.27
8/29/2012 10:45	8/29/2012 10:46	Base Grab	82	60.1	–	–	–	–	–	–	48	< 0.20	–	–	–	–	–	–	–	–	–	–	–
9/11/2012 10:03	9/11/2012 10:04	Base Grab	74	60.4	9.34	1,096.0	1,330.0	8.01	> 100.0	0.67	21	0.25	~ 1	< 1	709	74.70	< 0.020	~ 0.023	0.018	0.66	< 0.02	< 0.03	1.24
9/17/2012 4:29	9/17/2012 6:03	Rain Composite	59	59.0	9.06	274.5	339.3	7.56		0.16	–	–	537	74	215	17.30	0.075	0.702	–	2.90	0.37	0.06	0.81
9/24/2012 11:00	9/24/2012 11:01	Base Grab	60	55.2	10.51	952.0	1,238.0	8.02	> 100.0	0.62	–	–	< 1	< 1	705	74.30	~ 0.026	~ 0.020	0.015	0.33	< 0.02	< 0.03	1.27
9/26/2012 10:37	9/26/2012 10:38	Base Grab	53	55.4	–	–	–	–	–	–	< 10	0.57	–	–	–	–	–	–	–	–	–	–	–
10/9/2012 10:15	10/9/2012 10:16	Base Grab	45	52.5	11.31	943.0	1,273.0	7.56	> 100.0	0.64	–	–	< 1	< 1	714	76.00	< 0.020	< 0.020	0.018	0.60	< 0.02	< 0.03	1.27
10/9/2012 10:15	10/9/2012 10:16	Base Grab	49	52.5	–	–	–	–	–	–	15	0.38	–	–	–	–	–	–	–	–	–	–	–
10/19/2012 10:46	10/19/2012 19:20	Rain Composite	59	56.7	5.02	454.8	580.3	7.66	–	0.28	–	–	77	35	344	31.90	0.073	0.323	–	2.20	< 0.02	0.03	0.52
10/22/2012 12:03	10/22/2012 12:04	Base Grab	59	55.4	10.41	992.0	1,288.0	8.05	> 100.0	0.65	–	–	~ 1	~ 1	700	71.50	< 0.020	< 0.020	0.015	0.19	< 0.02	< 0.03	1.21
10/23/2012 7:02	10/23/2012 11:19	Rain Composite	40	58.1	6.01	338.6	423.0	7.23	–	0.20	–	–	150	59	251	20.90	~ 0.038	0.552	–	2.40	< 0.02	< 0.03	0.51
10/23/2012 9:59	10/23/2012 10:00	Rain Grab	57	56.7	–	–	–	–	–	–	2,610	0.28	–	–	–	–	–	–	–	–	–	–	–
10/24/2012 16:58	10/25/2012 13:25	Rain Composite	37	41.9	11.42	130.8	208.7	7.36	18.0	0.10	–	–	63	~ 18	161	9.63	0.069	0.211	–	0.87	~ 0.02	< 0.03	< 0.05
10/25/2012 10:07	10/25/2012 10:08	Rain Grab	37	48.2	–	–	–	–	–	–	2,760	–	–	–	–	–	–	–	–	–	–	–	–
10/30/2012 10:33	10/30/2012 10:34	Base Grab	41	47.1	–	–	–	–	–	–	60	0.24	–	–	–	–	–	–	–	–	–	–	–
11/6/2012 3:56	11/6/2012 16:29	Rain Composite	41	42.3	12.00	221.2	350.5	7.05	–	0.20	–	–	28	11	210	17.30	0.067	0.148	0.067	1.10	0.54	0.04	0.89
11/7/2012 10:00	11/7/2012 10:01	Base Grab	41	48.6	–	–	–	–	–	–	30	0.20	–	–	–	–	–	–	–	–	–	–	–
11/10/2012 11:32	11/11/2012 1:13	Rain Composite	37	43.9	11.50	119.5	184.3	8.95	7.5	0.10	–	–	368	136	110	7.33	0.052	0.453	–	3.00	0.54	0.06	0.55
11/14/2012 11:24	11/14/2012 11:25	Base Grab	48	49.8	8.60	810.0	1,139.0	8.20	> 100.0	0.60	–	–	~ 1	~ 1	722	73.70	< 0.020	~ 0.020	0.013	0.39	~ 0.02	< 0.03	1.21
11/20/2012 9:55	11/20/2012 9:56	Base Grab	42	48.6	–	–	–	–	–	–	1	< 0.20	–	–	–	–	–	–	–	–	–	–	–
12/15/2012 5:43	12/15/2012 15:37	Rain/Melt Composite	25	37.9	13.10	984.0	1,680.0	7.80	9.0	0.80	–	–	98	~ 27	827	10.10	0.079	0.264	–	3.20	0.29	0.08	0.62

Table F.4 continued. Monitoring data for 6UMN outfall

Start Date Start Time	End Date End Time	Sample Type	Alkalinity (mg/L CaCO3)	Chloride Ion (mg/L)	Hardness (mg/L CaCO3)	Chemical Oxygen Demand (mg/L)	Total Organic Carbon (mg/L)	Carbonaceous Biological Oxygen Demand 5-day (mg/L)	Total Biological Oxygen Demand 5-day (mg/L)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)	Oil and Grease (mg/L)
1/9/2012 14:07	1/9/2012 14:08	Base Grab	–	188	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2/15/2012 13:43	2/15/2012 13:44	Base Grab	378	201	504	18	3.1	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
3/1/2012 13:15	3/1/2012 13:16	Melt Grab	65	379	144	168	16.3	7.0	7.3	0.0072	0.0327	0.0016	0.0128	0.0013	0.0394	0.0083	0.1510	< 0.0002	~ 0.00041	0.0049	0.0167	9
3/6/2012 14:10	3/6/2012 14:11	Melt Grab	51	116	92	114	12.7	8.0	11.0	0.0063	0.0232	0.0013	0.0072	0.0007	0.0254	0.0064	0.1230	< 0.0002	~ 0.00029	0.0031	0.0077	< 6
3/12/2012 11:40	3/12/2012 11:41	Rain Grab	63	88	96	74	7.50	3.5	5.1	–	–	–	–	–	–	–	–	–	–	–	–	< 6
3/26/2012 15:55	3/26/2012 15:56	Base Grab	373	173	498	~ 11	3	1.2	~ 1.1	–	–	–	–	–	–	–	–	–	–	–	–	< 6
4/5/2012 13:25	4/5/2012 13:26	Base Grab	304	175	508	~ 12	3.6	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/23/2012 9:10	5/23/2012 9:11	Base Grab	356	200	496	~ 10	4.0	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/24/2012 10:22	5/24/2012 10:23	Rain Grab	39	12	60	48	7.6	< 3.0	5.1	0.0050	0.0142	0.0011	0.0047	0.0006	0.0184	0.0043	0.0514	< 0.0002	< 0.00020	0.0049	0.0073	< 6
6/14/2012 12:34	6/14/2012 12:35	Rain Grab	27	10	64	54	9.6	6.0	7.7	–	–	–	–	–	–	–	–	–	–	–	–	< 6
7/23/2012 11:30	7/23/2012 11:31	Base Grab	314	150	472	19	4.7	< 3.0	< 3.0	0.0018	0.0021	0.0041	0.0044	< 0.0001	0.0018	0.0037	0.0059	< 0.0002	< 0.00020	0.0007	0.0006	< 6
7/24/2012 9:31	7/24/2012 9:34	Rain Grab	42	11	64	31	6.5	3.8	< 3.0	–	–	–	–	–	–	–	–	–	–	–	–	< 7
8/1/2012 11:20	8/1/2012 11:21	Base Grab	349	178	476	~ 12	4.9	< 3.0	< 3.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
8/3/2012 23:30	8/4/2012 1:54	Rain Composite	29	11	72	75	16.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8/15/2012 8:29	8/15/2012 9:36	Rain Composite	29	9	60	64	11.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8/22/2012 11:56	8/22/2012 11:57	Base Grab	294	189	432	~ 8	3.9	2.0	1.8	–	–	–	–	–	–	–	–	–	–	–	–	–
9/11/2012 10:03	9/11/2012 10:04	Base Grab	298	151	468	~ 10	3.8	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
9/17/2012 4:29	9/17/2012 6:03	Rain Composite	79	36	136	129	20.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	< 6
9/24/2012 11:00	9/24/2012 11:01	Base Grab	378	176	500	~ 11	2.8	1.2	1.2	–	–	–	–	–	–	–	–	–	–	–	–	–
10/9/2012 10:15	10/9/2012 10:16	Base Grab	326	145	500	~ 11	6.3	1.2	1.5	–	–	–	–	–	–	–	–	–	–	–	–	–
10/19/2012 10:46	10/19/2012 19:20	Rain Composite	144	64	216	106	33.2	–	–	0.0135	0.0262	0.0082	0.0159	0.0008	0.0105	0.0302	0.1010	< 0.0002	~ 0.00025	0.0030	0.0051	
10/22/2012 12:03	10/22/2012 12:04	Base Grab	375	137	504	~ 8	4.8	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
10/23/2012 7:02	10/23/2012 11:19	Rain Composite	108	43	164	154	39.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10/24/2012 16:58	10/25/2012 13:25	Rain Composite	54	17	92	62	20.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11/6/2012 3:56	11/6/2012 16:29	Rain Composite	83	31	120	42	13.7	9.0	12.0	–	–	–	–	–	–	–	–	–	–	–	–	–
11/10/2012 11:32	11/11/2012 1:13	Rain Composite	41	13	92	180	13.8	–	19.0	–	0.0436	–	0.0128	–	0.0415	–	0.2710	–	0.00055	–	0.0108	–
11/14/2012 11:24	11/14/2012 11:25	Base Grab	340	152	462	< 6	3.5	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
12/15/2012 5:43	12/15/2012 15:37	Rain/Melt Composite	51	687	116	92	15.1	–	–	0.0065	0.0208	0.0022	0.0072	~ 0.0002	0.0145	0.0210	0.1220	< 0.0002	~ 0.00030	0.0041	0.0088	–

Table F.5. Monitoring data for 7LSTU outfall

Start Date Start Time	End Date End Time	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	*E. coli* (CFU/ 100 mL)	Fluoride (mg/L)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Sulfate (mg/L)	Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
3/3/2012 13:50	3/3/2012 13:51	Melt Grab	34	36.7	14.34	1,587.0	2,778.0	7.54	2.9	1.42	–	–	159	49	1,480	13.10	0.193	0.663	0.160	3.00	0.48	0.16	0.47
3/10/2012 15:15	3/10/2012 15:16	Melt Grab	55	48.7	12.07	435.8	622.7	7.76	2.0	0.30	–	–	295	66	381	15.30	0.405	1.280	0.328	3.40	0.42	0.14	0.23
3/12/2012 11:01	3/12/2012 11:02	Rain Grab	52	46.0	11.80	439.7	654.4	7.78	7.0	0.32	–	–	60	17	378	21.30	0.106	0.248	0.097	1.50	0.19	0.04	0.49
5/3/2012 10:58	5/3/2012 10:59	Rain Grab	59	61.5	–	–	–	–	–	–	> 2,420	–	–	–	–	–	–	–	–	–	–	–	–
5/5/2012 12:15	5/5/2012 12:16	Rain Grab	75	63.0	9.70	187.4	220.0	7.81	–	0.10	–	–	145	30	126	7.36	0.121	0.365	0.105	1.10	0.29	0.04	< 0.05
5/24/2012 9:36	5/24/2012 9:37	Rain Grab	64	64.4	–	–	–	–	–	–	4,900	–	–	–	–	–	–	–	–	–	–	–	–
5/27/2012 9:36	5/27/2012 9:37	Rain Grab	63	64.4	9.50	185.4	213.9	8.07	16.5	0.10	–	–	27	6	120	7.32	0.110	0.194	0.115	0.94	0.20	0.04	0.35
6/18/2012 11:00	6/18/2012 11:01	Rain Grab	60	62.4	9.43	87.7	103.6	8.24	5.0	0.05	–	–	276	56	79	5.30	0.489	0.939	0.360	2.30	0.49	0.04	0.48
6/19/2012 9:16	6/19/2012 9:17	Rain Grab	68	68.9	–	–	–	–	–	–	3,200	–	–	–	–	–	–	–	–	–	–	–	–
7/18/2012 11:28	7/18/2012 11:29	Rain Grab	70	73.4	–	–	–	–	–	–	24,200	–	–	–	–	–	–	–	–	–	–	–	–
7/24/2012 8:55	7/24/2012 8:58	Rain Grab	75	74.3	7.56	213.3	219.5	7.52	–	0.10	–	–	21	7	128	8.08	0.136	0.217	0.112	0.88	0.17	0.05	0.35
7/24/2012 8:59	7/24/2012 9:00	Rain Grab	72	74.3	–	–	–	–	–	–	19,860	–	–	–	–	–	–	–	–	–	–	–	–
8/15/2012 9:08	8/15/2012 9:09	Rain Grab	65	68.9	8.73	103.4	113.1	8.32	5.0	0.05	–	–	312	55	102	5.83	0.234	0.793	0.203	2.10	0.33	0.04	0.44
8/15/2012 9:22	8/15/2012 9:23	Rain Grab	78	67.6	–	–	–	–	–	–	5,000	–	–	–	–	–	–	–	–	–	–	–	–
8/23/2012 13:30	8/23/2012 13:31	Base Grab	88	36.5	10.25	1,218.0	2,135.0	7.85	> 100.0	1.08	–	–	7	~ 1	1,280	145.00	~ 0.046	~ 0.034	0.017	0.79	~ 0.02	< 0.03	1.66
9/11/2012 9:10	9/11/2012 9:11	Base Grab	71	64.4	–	–	–	–	–	–	68	0.23	–	–	–	–	–	–	–	–	–	–	–
9/11/2012 9:12	9/11/2012 9:13	Base Grab	71	64.4	9.17	–	–	8.14	> 100.0	1.07	–	–	~ 1	< 1	1,195	157.50	~ 0.022	~ 0.025	0.020	0.88	~ 0.04	< 0.03	1.19
9/26/2012 9:40	9/26/2012 9:41	Base Grab	50	58.8	10.00	1,750.0	2,169.0	7.97	> 100.0	1.12	–	–	~ 2	~ 1	1,310	170.00	0.086	0.108	0.089	1.00	< 0.02	< 0.03	1.53
9/26/2012 9:40	9/26/2012 9:41	Base Grab	52	58.8	–	–	–	–	–	–	260	0.59	–	–	–	–	–	–	–	–	–	–	–
10/9/2012 10:36	10/9/2012 10:37	Base Grab	47	55.2	–	–	–	–	–	–	299	0.57	–	–	–	–	–	–	–	–	–	–	–
10/9/2012 13:15	10/9/2012 13:16	Base Grab	49	55.2	10.12	1,624.0	2,112.0	8.13	> 100.0	1.09	–	–	~ 1	< 1	1,250	153.00	0.085	0.064	0.044	1.40	0.12	0.03	1.68
10/25/2012 9:40	10/25/2012 9:41	Rain Grab	38	45.1	11.41	93.3	141.1	7.15	7.5	0.07	–	–	88	~ 23	104	6.23	0.151	0.400	0.136	1.50	0.12	< 0.03	< 0.05
10/25/2012 9:40	10/25/2012 9:41	Rain Grab	38	45.1	–	–	–	–	–	–	3,290	–	–	–	–	–	–	–	–	–	–	–	–

Table F.5 continued. Monitoring data for 7LSTU outfall

Start Date Start Time	End Date End Time	Sample Type	Alkalinity (mg/L CaCO3)	Chloride Ion (mg/L)	Hardness (mg/L CaCO3)	Chemical Oxygen Demand (mg/L)	Total Organic Carbon (mg/L)	Carbonaceous Biological Oxygen Demand 5-day (mg/L)	Total Biological Oxygen Demand 5-day (mg/L)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)	Oil and Grease (mg/L)
3/3/2012 13:50	3/3/2012 13:51	Melt Grab	62	832	152	256	13.6	10.0	14.0	0.0100	0.0440	~ 0.0018	0.0130	~ 0.0004	0.0246	0.0229	0.2600	< 0.0002	~ 0.0003	0.0105	0.0230	25
3/10/2012 15:15	3/10/2012 15:16	Melt Grab	215	111	148	210	19.9	15.0	20.0	0.0080	0.0532	0.0018	0.0176	0.0005	0.1650	0.0041	0.3270	< 0.0002	0.0011	0.0035	0.0178	9
3/12/2012 11:01	3/12/2012 11:02	Rain Grab	120	114	188	69	9.5	6.4	6.4	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/5/2012 12:15	5/5/2012 12:16	Rain Grab	37	33	84	100	11.6	13.0	18.0	0.0045	0.0276	0.0010	0.0078	0.0011	0.0366	< 0.0050	0.1340	< 0.0002	~ 0.0004	0.0018	0.0090	< 6
5/27/2012 9:36	5/27/2012 9:37	Rain Grab	38	30	76	30	8.2	3.7	5.1	0.0037	0.0078	0.0011	0.0025	0.0008	0.0080	0.0115	0.0415	< 0.0002	< 0.0002	0.0030	0.0032	< 6
6/18/2012 11:00	6/18/2012 11:01	Rain Grab	22	7	68	152	17.2	20.0	26.0	0.0048	0.0343	0.0006	0.0088	~ 0.0005	0.0473	0.0062	0.1570	< 0.0002	~ 0.0004	0.0019	0.0106	16
7/24/2012 8:55	7/24/2012 8:58	Rain Grab	43	26	68	36	9.2	9.7	8.0	0.0052	0.0071	0.0009	0.0018	~ 0.0003	0.0043	0.0077	0.0290	< 0.0002	< 0.0002	0.0027	0.0031	9
8/15/2012 9:08	8/15/2012 9:09	Rain Grab	33	8	80	147	13.9	12.0	17.0	–	–	–	–	–	–	–	–	–	–	–	–	11
8/23/12 13:30	8/23/12 13:31	Base Grab	338	384	588	33	8.6	1.2	1.0	0.0019	0.0022	0.0051	0.0047	< 0.0001	< 0.0001	0.0038	0.0089	< 0.0002	< 0.0002	0.0011	0.0002	–
9/11/2012 9:12	9/11/2012 9:13	Base Grab	337	362	582	23	7.4	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
9/26/2012 9:40	9/26/2012 9:41	Base Grab	115	417	610	26	8.7	< 3.0	3.0	–	–	–	–	–	–	–	–	–	–	–	–	–
10/9/2012 13:15	10/9/2012 13:16	Base Grab	323	332	660	51	17.7	4.6	6.5	–	–	–	–	–	–	–	–	–	–	–	–	–
10/25/2012 9:40	10/25/2012 9:41	Rain Grab	23	12	60	75	17.9	10.0	13.0	–	0.0146	–	0.0045	–	0.0160	–	0.0923	–	< 0.0002	–	0.0070	–

Table F.6. Monitoring data for 10SA stormwater drainage system

Start Date Start Time	End Date End Time	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	*E. coli* (CFU/ 100 mL)	Fluoride (mg/L)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Sulfate (mg/L)	Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
1/6/2012 12:41	1/6/2012 17:53	Melt Composite	45	–	–	–	–	–	–	–	–	–	35	15	2,760	–	–	0.264	–	2.70	–	–	–
1/9/2012 11:25	1/9/2012 11:26	Base Grab	45	45.0	11.70	967.0	1,467.0	8.06	50.9	0.74	–	–	4	3	762	–	–	0.255	–	1.00	–	–	–
1/26/2012 14:10	1/26/2012 18:34	Melt Composite	25	–	–	–	–	–	–	–	–	–	114	47	7,480	–	–	0.459	–	5.10	–	–	–
1/27/2012 14:36	1/27/2012 20:59	Melt Composite	30	–	–	–	–	–	–	–	–	–	152	68	9,920	–	–	0.339	–	3.60	–	–	–
1/31/2012 13:47	1/31/2012 15:36	Melt Composite	32	–	–	–	–	–	–	–	–	–	160	45	2,940	–	–	0.799	–	4.60	–	–	–
2/15/2012 11:10	2/15/2012 11:11	Base Grab	33	46.6	12.17	3,704.0	5,475.0	7.85	18.3	2.96	–	–	~ 8	~ 5	1,800	49.70	0.325	0.166	0.128	3.20	0.11	0.14	1.31
2/21/2012 9:16	2/21/2012 13:16	Melt Composite	32	48.4	9.52	6,825.0	9,790.0	7.27	2.7	5.52	–	–	134	59	5,485	20.55	~ 0.025	0.397	–	3.45	0.40	0.10	0.77
2/28/2012 17:56	2/28/2012 23:29	Rain Composite	33	48.2	11.15	397.1	571.2	7.67	10.4	0.28	–	–	99	36	310	5.36	0.166	0.424	–	1.90	0.27	0.05	0.38
3/6/2012 12:08	3/7/2012 12:52	Melt Composite	35	49.1	11.25	325.6	462.6	7.49	19.0	0.22	–	–	76	23	260	5.18	0.227	0.427	0.251	1.80	0.26	0.04	0.29
3/19/2012 18:52	3/19/2012 20:39	Rain Composite	65	60.8	8.01	149.9	180.9	7.71	3.5	0.09	–	–	1,010	154	150	6.17	0.126	1.100	0.115	3.50	0.34	0.04	0.28
3/26/2012 14:30	3/26/2012 14:31	Base Grab	42	46.2	11.09	833.0	1,238.0	8.09	> 100.0	0.62	–	–	3	3	656	20.20	0.109	0.173	0.103	1.00	~ 0.04	< 0.03	0.40
4/2/2012 23:56	4/3/2012 2:14	Rain Composite	49	54.7	9.63	228.2	299.0	7.82	7.5	0.01	–	–	170	56	157	8.00	0.133	0.602	0.114	4.50	0.87	0.04	0.97
4/4/2012 13:19	4/4/2012 13:20	Base Grab	60	53.1	–	–	–	–	–	–	387	0.13	–	–	–	–	–	–	–	–	–	–	–
4/5/2012 11:49	4/5/2012 11:50	Base Grab	60	48.6	11.75	899.0	1,287.0	8.28	79.0	0.65	–	–	4	3	668	18.10	0.084	0.160	0.076	1.00	< 0.02	< 0.03	0.48
4/15/2012 1:56	4/15/2012 4:44	Rain Composite	28	53.8	8.34	110.6	147.0	–	19.4	0.07	–	–	80	25	68	4.71	~ 0.029	0.258	–	1.50	~ 0.02	< 0.03	0.24
4/17/2012 22:44	4/18/2012 3:07	Rain Composite	58	54.3	10.14	204.9	269.8	7.58	–	0.13	–	–	103	33	147	11.70	0.087	0.176	0.047	1.70	0.66	< 0.03	0.71
4/19/2012 9:16	4/19/2012 9:17	Base Grab	45	51.1	–	–	–	–	–	–	10	0.13	–	–	–	–	–	–	–	–	–	–	–
4/21/2012 21:21	4/22/2012 20:36	Rain Composite	45	50.2	10.94	337.9	471.7	7.66	50.0	0.23	–	–	11	4	282	23.10	~ 0.026	0.057	–	0.59	0.20	0.03	0.91
4/25/2012 3:11	4/25/2012 5:14	Rain Composite	55	57.9	9.52	315.2	395.1	7.63	–	0.19	–	–	40	18	222	18.00	0.117	0.232	0.084	2.60	1.03	0.04	1.11
4/27/2012 9:25	4/27/2012 9:26	Rain Grab	43	51.3	10.66	718.0	989.0	7.85	> 100.0	0.49	–	–	< 1	~ 1	607	64.60	< 0.010	< 0.010	0.013	0.13	< 0.02	< 0.03	1.84
4/28/2012 11:46	4/28/2012 15:29	Rain Composite	46	52.5	9.13	312.9	422.7	7.49	–	0.20	–	–	27	12	257	20.50	~ 0.033	0.155	–	1.00	0.08	0.04	0.83
5/1/2012 21:26	5/2/2012 2:03	Rain Composite	64	63.0	8.55	126.2	148.3	7.68	11.0	0.07	–	–	82	18	91	5.41	0.050	0.184	0.044	1.10	0.20	< 0.03	0.34
5/3/2012 9:07	5/3/2012 9:08	Base Grab	65	56.3	–	–	–	–	–	–	120	0.16	–	–	–	–	–	–	–	–	–	–	–
5/3/2012 10:11	5/3/2012 11:22	Base Composite	60	66.7	7.49	100.9	90.0	7.60	–	0.05	–	–	402	61	62	2.69	~ 0.032	0.282	0.098	0.83	0.38	0.03	0.31
5/8/2012 11:19	5/9/2012 3:58	Rain Composite	56	58.3	9.68	394.9	492.8	7.83	16.0	0.24	–	–	45	12	290	25.60	~ 0.049	0.165	0.042	1.00	0.06	0.03	0.91
5/10/2012 9:14	5/10/2012 9:15	Base Grab	61	55.4	–	–	–	–	–	–	36	0.18	–	–	–	–	–	–	–	–	–	–	–
5/10/2012 9:27	5/10/2012 9:28	Base Grab	61	55.8	10.32	715.0	923.0	7.72	> 100.0	0.46	–	–	~ 2	< 1	564	60.50	0.024	0.031	0.026	0.31	< 0.02	< 0.03	1.40
5/19/2012 20:48	5/19/2012 21:34	Rain Composite	73	66.2	6.16	425.9	481.5	7.26	6.4	0.23	–	–	153	81	359	31.80	0.150	0.869	–	8.10	0.80	< 0.03	< 0.05
5/23/2012 8:51	5/23/2012 8:52	Base Grab	68	57.6	9.86	555.0	699.0	8.17	30.0	0.38	–	–	74	31	398	36.50	0.194	0.525	0.165	1.30	0.08	< 0.03	0.43
5/23/2012 20:47	5/24/2012 0:39	Rain Composite	61	66.9	7.14	103.2	115.5	7.93	31.3	0.05	–	–	134	37	56	4.54	~ 0.044	0.262	0.039	1.80	0.32	0.03	0.38
5/24/2012 9:20	5/24/2012 9:21	Rain Grab	64	64.8	–	–	–	–	–	–	9,800	–	–	–	–	–	–	–	–	–	–	–	–
5/29/2012 9:40	5/29/2012 9:41	Rain Grab	58	59.0	–	–	–	–	–	–	152	0.10	–	–	–	–	–	–	–	–	–	–	–
6/10/2012 21:03	6/11/2012 10:30	Rain Composite	66	72.1	6.28	258.4	272.3	7.46	26.2	0.13	–	–	102	24	182	14.30	~ 0.035	0.235	0.017	1.40	< 0.02	0.07	0.42
6/12/2012 10:34	6/12/2012 10:35	Base Grab	57	57.2	–	–	–	–	–	–	133	0.15	–	–	–	–	–	–	–	–	–	–	–
6/14/2012 9:56	6/14/2012 11:33	Rain Composite	69	67.5	7.82	91.0	101.2	7.50	22.5	0.05	–	–	95	22	63	3.89	~ 0.022	0.218	0.022	1.50	0.22	0.03	0.40
6/17/2012 23:26	6/17/2012 23:52	Rain Composite	71	75.6	7.83	51.2	51.9	7.80	16.0	0.02	–	–	124	32	34	1.64	~ 0.026	0.192	0.016	1.70	0.38	< 0.03	0.34
6/21/2012 11:17	6/21/2012 11:18	Base Grab	70	59.4	10.19	673.0	829.0	7.88	> 100.0	0.41	–	–	< 1	~ 1	493	48.50	~ 0.029	~ 0.028	0.033	0.25	~ 0.03	< 0.03	1.10
6/28/2012 12:07	6/28/2012 12:08	Base Grab	81	58.3	–	–	–	–	–	–	13	< 0.10	–	–	–	–	–	–	–	–	–	–	–

Table F.6 continued. Monitoring data for 10SA stormwater drainage system

Start Date Start Time	End Date End Time	Sample Type	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Transparency (cm)	Salinity (ppt)	*E. coli* (CFU/ 100 mL)	Fluoride (mg/L)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Sulfate (mg/L)	Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
7/3/2012 3:36	7/3/2012 7:39	Rain Composite	78	77.9	7.07	213.3	211.1	7.60	19.5	0.10	–	–	66	31	144	8.35	0.101	0.311	0.064	2.30	0.62	0.04	0.78
7/6/2012 23:06	7/7/2012 5:45	Rain Composite	70	84.0	5.67	224.3	208.7	7.46	45.0	0.10	–	–	42	12	115	7.77	~ 0.042	0.109	0.038	0.93	0.31	0.05	0.36
7/10/2012 11:28	7/10/2012 11:29	Base Grab	84	59.4	–	–	–	–	–	–	6	–	–	–	–	–	–	–	–	–	–	–	–
7/10/2012 11:29	7/10/2012 11:30	Base Grab	84	59.4	–	–	–	–	–	–	8	0.26	–	–	–	–	–	–	–	–	–	–	–
7/11/2012 10:22	7/11/2012 10:23	Base Grab	79	59.7	10.12	733.0	897.0	7.88	> 100.0	0.44	–	–	< 1	< 1	530	56.65	~ 0.019	~ 0.017	0.019	0.13	< 0.02	< 0.03	0.72
7/18/2012 2:16	7/18/2012 4:29	Rain Composite	80	76.6	6.65	96.9	97.3	7.53	29.0	0.04	–	–	81	21	53	3.37	~ 0.030	0.182	–	1.20	0.26	< 0.03	0.46
7/18/2012 12:12	7/18/2012 12:13	Rain Grab	71	–	–	–	–	–	–	–	6,130	–	–	–	–	–	–	–	–	–	–	–	–
7/21/2012 6:32	7/21/2012 11:15	Rain Composite	86	82.6	5.74	139.0	131.2	7.65	34.5	0.06	–	–	39	10	70	4.60	~ 0.038	0.149	–	1.40	0.56	0.07	0.56
7/23/2012 10:45	7/23/2012 10:46	Base Grab	87	61.5	9.67	685.0	819.0	7.75	> 100.0	0.40	–	–	~ 1	~ 1	472	46.90	~ 0.017	~ 0.029	0.022	0.22	< 0.02	< 0.03	0.86
7/24/2012 10:50	7/24/2012 10:51	Rain Grab	72	74.8	–	–	–	–	–	–	1,390	–	–	–	–	–	–	–	–	–	–	–	–
7/25/2012 9:37	7/25/2012 9:38	Base Grab	83	69.1	–	–	–	–	–	–	32	< 0.20	–	–	–	–	–	–	–	–	–	–	–
8/1/2012 10:20	8/1/2012 10:21	Base Grab	88	61.7	9.70	788.0	939.0	8.05	> 100.0	0.47	–	–	~ 1	~ 1	540	65.30	~ 0.017	~ 0.026	0.025	~ 0.07	< 0.02	< 0.03	1.01
8/2/2012 9:16	8/2/2012 9:17	Base Grab	86	60.3	–	–	–	–	–	–	11	< 0.20	–	–	–	–	–	–	–	–	–	–	–
8/3/2012 23:24	8/5/2012 23:25	Rain Composite	88	73.9	5.80	334.3	345.5	7.67	25.0	0.16	–	–	110	16	201	16.10	0.059	0.199	–	1.10	0.16	< 0.03	0.48
8/15/2012 8:10	8/15/2012 12:30	Rain Composite	75	52.9	8.57	127.8	171.8	7.55	27.0	0.08	–	–	46	14	104	6.34	0.060	0.224	–	1.30	0.09	< 0.03	0.33
8/15/2012 9:55	8/15/2012 9:56	Rain Grab	73	–	–	–	–	–	–	–	13,500	–	–	–	–	–	–	–	–	–	–	–	–
8/22/2012 10:33	8/22/2012 10:34	Base Grab	75	56.7	10.40	719.0	918.0	8.02	> 100.0	0.46	–	–	< 1	~ 1	555	56.30	~ 0.017	< 0.020	0.014	0.12	< 0.02	< 0.03	0.86
8/29/2012 11:17	8/29/2012 11:18	Base Grab	84	57.9	–	–	–	–	–	–	120	< 0.20	–	–	–	–	–	–	–	–	–	–	–
9/11/2012 10:24	9/11/2012 10:25	Base Grab	75	56.8	10.11	–	–	8.06	> 100.0	0.48	–	–	< 1	< 1	533	54.90	< 0.020	< 0.020	0.016	0.16	< 0.02	< 0.03	0.82
9/11/2012 10:24	9/11/2012 10:25	Base Grab	75	56.8	–	–	–	–	–	–	96	0.23	–	–	–	–	–	–	–	–	–	–	–
9/17/2012 3:49	9/17/2012 5:53	Rain Composite	59	61.7	8.64	263.6	315.1	7.30	–	0.15	–	–	113	62	216	16.30	0.088	0.322	–	2.20	0.31	< 0.03	0.71
9/24/2012 10:17	9/24/2012 10:18	Base Grab	57	54.5	10.68	700.0	920.0	7.94	> 100.0	0.46	–	–	< 1	< 1	552	62.20	< 0.020	< 0.020	0.014	0.26	< 0.02	< 0.03	1.17
9/26/2012 11:01	9/26/2012 11:02	Base Grab	56	54.1	–	–	–	–	–	–	80	0.46	–	–	–	–	–	–	–	–	–	–	–
10/9/2012 10:57	10/9/2012 10:58	Base Grab	46	54.9	9.97	900.0	1,176.0	8.02	27.0	0.59	19,860	0.59	19	~ 11	889	61.75	0.337	0.337	0.221	6.15	1.32	0.08	1.50
10/22/2012 10:22	10/22/2012 10:23	Base Grab	52	57.4	9.48	489.4	618.3	8.01	90.0	0.30	–	–	4	3	334	14.70	0.118	0.156	0.078	0.92	< 0.02	< 0.03	< 0.05
10/23/2012 8:56	10/23/2012 8:57	Rain Grab	56	57.6	–	–	–	–	–	–	15,530	0.32	–	–	–	–	–	–	–	–	–	–	–
10/25/2012 5:23	10/25/2012 14:02	Rain Composite	37	42.4	11.91	79.9	126.3	7.21	22.0	0.06	–	–	34	~ 11	98	3.18	0.090	0.202	–	0.88	< 0.02	< 0.03	0.10
10/25/2012 10:30	10/25/2012 10:31	Rain Grab	36	45.9	–	–	–	–	–	–	2,610	–	–	–	–	–	–	–	–	–	–	–	–
10/30/2012 12:11	10/30/2012 12:12	Base Grab	44	51.8	–	–	–	–	–	–	1,300	0.29	–	–	–	–	–	–	–	–	–	–	–
11/6/2012 2:14	11/6/2012 7:02	Rain Composite	41	44.6	11.41	80.4	122.6	6.89	–	0.06	–	–	24	~ 10	88	4.22	0.086	0.163	0.081	1.70	0.85	0.05	0.94
11/7/2012 8:45	11/7/2012 8:46	Base Grab	40	50.9	–	–	–	–	–	–	1,120	< 0.20	–	–	–	–	–	–	–	–	–	–	–
11/10/2012 23:13	11/11/2012 0:52	Rain Composite	34	43.0	12.16	155.1	242.6	10.50	3.0	0.12	–	–	1,640	~ 280	162	5.79	0.069	1.480	–	4.40	0.63	0.07	0.44
11/14/2012 10:16	11/14/2012 10:17	Base Grab	45	52.3	8.30	146.9	199.1	7.77	86.0	0.09	–	–	4	3	158	6.23	~ 0.028	0.091	0.024	0.88	~ 0.03	< 0.03	0.10
11/20/2012 8:25	11/20/2012 8:26	Base Grab	35	54.7	–	–	–	–	–	–	179	0.26	–	–	–	–	–	–	–	–	–	–	–
12/15/2012 8:46	12/16/2012 22:52	Rain/Melt Composite	25	54.7	10.37	1,388.0	1,820.0	7.18	21.0	0.90	–	–	23	~ 11	965	6.09	~ 0.061	0.120	–	2.20	0.19	0.05	0.44
12/19/2012 10:20	12/19/2012 10:21	Base Grab	29	45.0	10.81	2,341.0	3,542.0	7.67	> 100.0	1.90	–	–	~ 2	~ 2	1,760	6.03	~ 0.023	0.064	0.016	1.80	0.06	< 0.03	0.41

Table F.6 continued. Monitoring data for 10SA stormwater drainage system

Start Date Start Time	End Date End Time	Sample Type	Alkalinity (mg/L CaCO3)	Chloride Ion (mg/L)	Hardness (mg/L CaCO3)	Chemical Oxygen Demand (mg/L)	Total Organic Carbon (mg/L)	Biological Oxygen Demand 5-day (mg/L)	Biological Oxygen Demand 5-day (mg/L)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)	Oil and Grease (mg/L)
1/6/2012 12:41	1/6/2012 17:53	Melt Composite	–	1,668	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1/9/2012 11:25	1/9/2012 11:26	Base Grab	–	292	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1/26/2012 14:10	1/26/2012 18:34	Melt Composite	–	5,786	–	–	–	–	–	0.0154	0.0305	0.0027	0.0070	< 0.0002	0.0103	0.0449	0.1330	< 0.0004	< 0.0006	0.0041	0.0105	–
1/27/2012 14:36	1/27/2012 20:59	Melt Composite	–	8,164	–	–	–	–	–	0.0254	0.0562	0.0034	0.0103	< 0.0002	0.0145	0.0683	0.2530	< 0.0004	< 0.0004	0.0055	0.0183	–
1/31/2012 13:47	1/31/2012 15:36	Melt Composite	–	1,761	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2/15/2012 11:10	2/15/2012 11:11	Base Grab	127	1,823	268	174	55.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2/21/2012 9:16	2/21/2012 13:16	Melt Composite	~ 52	3,343	178	266	21.0	–	–	0.0201	0.0527	0.0024	0.0106	~ 0.0003	0.0152	0.0127	0.2625	< 0.0002	~ 0.0004	0.0213	0.0384	16
2/28/2012 17:56	2/28/2012 23:29	Rain Composite	22	215	48	117	14.9	–	11.0	–	–	–	–	–	–	–	–	–	–	–	–	8
3/6/2012 12:08	3/7/2012 12:52	Melt Composite	27	107	60	68	15.1	6.4	8.3	–	–	–	–	–	–	–	–	–	–	–	–	6
3/19/2012 18:52	3/19/2012 20:39	Rain Composite	37	40	348	342	14.2	16.0	27.0	–	–	–	–	–	–	–	–	–	–	–	–	18
3/26/2012 14:30	3/26/2012 14:31	Base Grab	135	261	192	38	9.2	1.9	2.7	–	–	–	–	–	–	–	–	–	–	–	–	< 6
4/2/2012 23:56	4/3/2012 2:14	Rain Composite	38	53	80	245	22.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4/5/2012 11:49	4/5/2012 11:50	Base Grab	174	285	206	34	8.7	2.2	2.8	–	–	–	–	–	–	–	–	–	–	–	–	< 6
4/15/2012 1:56	4/15/2012 4:44	Rain Composite	29	22	44	60	6.1	–	–	0.0045	0.0142	0.0007	0.0034	~ 0.0005	0.0056	0.0084	0.0638	< 0.0002	< 0.0002	0.0011	0.0039	< 6
4/17/2012 22:44	4/18/2012 3:07	Rain Composite	57	35	96	49	6.3	7.2	–	–	–	–	–	–	–	–	–	–	–	–	–	< 6
4/21/2012 21:21	4/22/2012 20:36	Rain Composite	123	59	200	26	6.9	2.4	3.4	–	–	–	–	–	–	–	–	–	–	–	–	< 6
4/25/2012 3:11	4/25/2012 5:14	Rain Composite	80	56	156	89	15.9	21.0	23.0	–	–	–	–	–	–	–	–	–	–	–	–	< 7
4/27/2012 9:25	4/27/2012 9:26	Rain Grab	350	89	492	~ 7	3.4	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
4/28/2012 11:46	4/28/2012 15:29	Rain Composite	116	46	100	47	12.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/1/2012 21:26	5/2/2012 2:03	Rain Composite	31	17	58	55	7.1	5.0	8.4	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/3/2012 10:11	5/3/2012 11:22	Base Composite	22	10	48	92	4.5	4.1	7.3	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/8/2012 11:19	5/9/2012 3:58	Rain Composite	158	54	204	38	10.0	4.3	5.9	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/10/2012 9:27	5/10/2012 9:28	Base Grab	336	86	448	~ 5	3.7	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/19/2012 20:48	5/19/2012 21:34	Rain Composite	120	55	184	318	66.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15
5/23/2012 8:51	5/23/2012 8:52	Base Grab	314	38	376	54	7.7	6.7	8.9	–	–	–	–	–	–	–	–	–	–	–	–	< 6
5/23/2012 20:47	5/24/2012 0:39	Rain Composite	38	7	56	64	10.0	6.5	11.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
6/10/2012 21:03	6/11/2012 10:30	Rain Composite	72	27	116	64	13.3	9.0	13.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
6/14/2012 9:56	6/14/2012 11:33	Rain Composite	21	7	52	48	8.7	5.8	8.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
6/17/2012 23:26	6/17/2012 23:52	Rain Composite	14	2	40	48	4.4	6.1	7.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
6/21/2012 11:17	6/21/2012 11:18	Base Grab	312	68	406	~ 10	5.1	< 3.0	< 3.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6

Table F.6 continued. Monitoring data for 10SA stormwater drainage system

Start Date Start Time	End Date End Time	Sample Type	Alkalinity (mg/L CaCO3)	Chloride Ion (mg/L)	Hardness (mg/L CaCO3)	Chemical Oxygen Demand (mg/L)	Total Organic Carbon (mg/L)	Biological Oxygen Demand 5-day (mg/L)	Biological Oxygen Demand 5-day (mg/L)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)	Oil and Grease (mg/L)
7/3/2012 3:36	7/3/2012 7:39	Rain Composite	51	17	96	96	24.9	21.0	26.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
7/6/2012 23:06	7/7/2012 5:45	Rain Composite	55	13	92	32	7.1	< 3.0	5.6	–	–	–	–	–	–	–	–	–	–	–	–	< 6
7/11/2012 10:22	7/11/2012 10:23	Base Grab	352	53	452	< 5	2.7	< 3.0	< 3.0	–	–	–	–	–	–	–	–	–	–	–	–	< 6
7/18/2012 2:16	7/18/2012 4:29	Rain Composite	24	5	60	55	9.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	< 6
7/21/2012 6:32	7/21/2012 11:15	Rain Composite	34	8	76	34	6.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	< 6
7/23/2012 10:45	7/23/2012 10:46	Base Grab	311	63	396	~ 10	3.8	1.1	1.2	0.0044	0.0050	0.0016	0.0017	< 0.0001	< 0.0001	0.0026	0.0018	< 0.0002	< 0.0002	0.0006	0.0002	< 6
8/1/2012 10:20	8/1/2012 10:21	Base Grab	363	72	496	~ 7		< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
8/3/2012 23:24	8/5/2012 23:25	Rain Composite	113	25	152	40	10.7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8/15/2012 8:10	8/15/2012 12:30	Rain Composite	47	12	92	52	8.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8/22/2012 10:33	8/22/2012 10:34	Base Grab	302	63	448	< 5	2.0	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
9/11/12 10:24	9/11/12 10:25	Base Grab	326	61	430	< 5	2.3	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
9/17/2012	9/17/12 5:53	Rain Composite	90	22	124	125	27.7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9/24/12 10:17	9/24/12 10:18	Base Grab	326	74	480	~ 10	2.1	< 1.0	< 1.0	–	–	–	–	–	–	–	–	–	–	–	–	–
10/9/12 10:57	10/9/12 10:58	Base Grab	282	160	444	373	119.3	> 48.0	> 48.0	–	–	–	–	–	–	–	–	–	–	–	–	–
10/22/12 10:22	10/22/12 10:23	Base Grab	171	79	192	40	18.2	3.6	4.4	–	–	–	–	–	–	–	–	–	–	–	–	–
10/25/12 5:23	10/25/12 14:02	Rain Composite	29	11	36	49	20.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11/6/12 2:14	11/6/12 7:02	Rain Composite	23	9	32	48	13.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11/10/12 23:13	11/11/12 0:52	Rain Composite	64	7	124	251	15.4	–	18.0	–	0.0685	–	0.0387	–	0.0398	–	0.2370	–	0.0008	–	0.0366	–
11/14/12 10:16	11/14/12 10:17	Base Grab	80	21	84	23	9.4	2.8	4.3	–	–	–	–	–	–	–	–	–	–	–	–	–
12/15/12 8:46	12/16/12 22:52	Rain/Melt Composite	49	489	88	108	13.9	–	–	0.0049	0.0097	0.0009	0.0022	~ 0.0002	0.0023	0.0120	0.0387	< 0.0002	< 0.0002	0.0035	0.0041	–
12/19/12 10:20	12/19/12 10:21	Base Grab	106	940	176	34	12.5	1.2	1.7	–	–	–	–	–	–	–	–	–	–	–	–	–

Appendix G – Kasota Ponds Monitoring Data

Table G.1. Monitoring data for Kasota Pond North

Date	Sample Time	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Salinity (ppt)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Chloride Ion (mg/L)	Hardness (mg/L CaCO3)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)
1/25/2012	11:21	27	33.1	0.41	2,558.0	4,789.0	7.15	2.51	32	~ 15	2,865	0.126	~ 0.005	2.10	~ 0.02	< 0.03	< 0.05	1,211	414	< 0.0003	0.0008	0.0028	0.0029	< 0.0001	0.0009	0.0060	0.0071	< 0.0002	< 0.0002	0.00043	0.00023
2/28/2012	10:40	28	33.8	2.77	2,360.0	4,359.0	6.99	2.28	40	23	2,340	0.224	~ 0.006	3.50	~ 0.03	< 0.03	< 0.05	979	1,360	~ 0.0006	0.0012	0.0034	0.0035	< 0.0001	0.0011	0.0237	0.0289	< 0.0002	< 0.0002	0.00290	0.00042
3/22/2012	10:05	65	55.9	8.68	1,148.0	1,477.0	7.64	0.74	33	28	779	0.214	0.014	2.80	< 0.02	< 0.03	< 0.05	332	340	0.0014	0.0018	0.0011	0.0012	< 0.0001	~ 0.0004	0.0050	0.0114	< 0.0002	< 0.0002	0.00190	0.00028
4/12/2012	10:50	57	49.6	9.26	1,433.0	2,020.0	7.81	1.04	~ 2	~ 2	1,130	~ 0.029	< 0.005	0.72	< 0.02	< 0.03	0.07	522	476	< 0.0003	~ 0.0003	0.0009	0.0009	~ 0.0003	~ 0.0004	0.0034	0.0019	< 0.0002	< 0.0002	~ 0.00012	~ 0.00011
5/17/2012	9:32	56	63.5	6.31	1,038.0	1,210.0	7.38	0.61	4	3	686	~ 0.041	~ 0.005	0.86	< 0.02	< 0.03	< 0.05	277	280	~ 0.0006	~ 0.0005	0.0007	0.0007	< 0.0001	~ 0.0001	< 0.0050	< 0.0050	< 0.0002	< 0.0002	0.00066	~ 0.00011
6/20/2012	9:01	77	74.5	2.60	854.0	879.0	6.82	0.43	3	~ 2	476	~ 0.046	~ 0.008	0.94	< 0.02	< 0.03	< 0.05	191	218	0.0007	< 0.0003	~ 0.0006	~ 0.0006	< 0.0001	~ 0.0001	~ 0.0021	~ 0.0011	< 0.0002	< 0.0002	0.00063	~ 0.00037
7/3/2012	10:02	80	79.0	2.34	1,164.0	1,140.0	7.17	0.56	10	6	605	0.137	< 0.005	1.20	< 0.02	< 0.03	< 0.05	226	260	< 0.0010	< 0.0010	0.0006	0.0007	< 0.0001	~ 0.0002	~ 0.0014	0.0019	< 0.0002	< 0.0002	0.00034	0.00017
8/13/2012	9:15	68	66.6	1.51	1,241.0	1,103.0	0.62	7.18	12	~ 11	684	0.103	< 0.005	1.10	< 0.02	< 0.03	< 0.05	268	264	< 0.0050	< 0.0050	0.0006	~ 0.0005	< 0.0001	~ 0.0001	0.0035	~ 0.0011	< 0.0002	< 0.0002	0.00043	~ 0.00009
9/13/2012	10:02	60	62.2	3.23	1,356.0	1,607.0	7.01	0.82	11	7	893	0.081	< 0.005	1.25	< 0.02	< 0.03	< 0.05	349	366	< 0.0003	< 0.0003	0.0008	0.0008	< 0.0001	~ 0.0003	~ 0.0019	0.0031	< 0.0002	< 0.0002	0.00066	< 0.00050
10/4/2012	12:40	46	57.7	7.01	1,521.0	1,911.0	7.19	0.98	14	~ 8	1,070	0.071	< 0.005	1.80	< 0.02	< 0.03	< 0.05	387	412	~ 0.0004	~ 0.0005	0.0010	0.0012	< 0.0001	0.0014	0.0027	0.0035	< 0.0002	< 0.0002	0.00024	0.00021
11/20/2012	9:42	38	42.3	11.62	1,542.0	2,440.0	7.30	1.26	68	55	1,310	~ 0.041	< 0.005	1.60	< 0.02	< 0.03	< 0.05	578	604	< 0.0003	~ 0.0005	0.0013	0.0016	< 0.0001	0.0006	~ 0.0015	0.0031	< 0.0002	< 0.0002	0.00037	~ 0.00013
12/20/2012	9:40	23	35.2	17.22	1,681.0	3,016.0	6.92	1.55	6	5	1,660	~ 0.038	< 0.005	1.10	< 0.02	< 0.03	< 0.05	930	770	0.0007	0.0008	0.0016	0.0018	< 0.0001	0.0006	0.0175	0.0081	< 0.0002	< 0.0002	0.00110	0.00028

Table G.2. Monitoring data for Kasota Pond West

Date	Sample Time	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Salinity (ppt)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Chloride Ion (mg/L)	Hardness (mg/L CaCO3)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)
1/25/2012	12:00	28	34.7	8.35	1,015.0	1,844.0	7.30	0.92	~ 1	~ 1	1,010	~ 0.016	< 0.005	1.70	0.47	< 0.03	0.28	487	408	0.0013	0.0009	0.0016	0.0016	< 0.0001	~ 0.0002	0.0208	0.0084	< 0.0002	< 0.0002	0.00031	~ 0.00010
2/28/2012	11:15	32	38.8	5.48	1,229.0	2,063.0	7.02	1.05	~ 2	~ 2	984	~ 0.019	< 0.005	1.50	0.39	< 0.03	0.20	457	344	0.0010	0.0017	0.0030	0.0032	< 0.0001	~ 0.0003	0.0189	0.0245	< 0.0002	< 0.0002	0.00110	0.00041
3/22/2012	10:30	65	59.2	9.10	1,019.0	1,258.0	7.51	0.63	5	5	632	~ 0.034	< 0.005	1.30	~ 0.03	< 0.03	< 0.05	265	240	0.0020	0.0020	0.0011	0.0011	< 0.0001	~ 0.0005	0.0045	0.0072	< 0.0002	< 0.0002	0.00043	0.00024
4/12/2012	11:06	57	52.5	8.85	1,303.0	1,759.0	7.80	0.90	~ 2	~ 2	960	~ 0.036	< 0.005	1.20	0.12	< 0.03	0.10	461	288	0.0014	0.0016	0.0014	0.0015	~ 0.0003	0.0007	0.0034	0.0040	< 0.0002	< 0.0002	0.00094	~ 0.00016
5/17/2012	9:50	56	65.3	5.77	1,340.0	1,529.0	7.50	0.77	3	~ 2	862	~ 0.017	< 0.005	1.10	0.26	< 0.03	0.10	293	284	0.0008	0.0009	0.0012	0.0012	< 0.0001	~ 0.0003	< 0.0050	< 0.0050	< 0.0002	< 0.0002	0.00023	~ 0.00013
6/20/2012	9:20	77	75.9	8.52	1,139.0	1,153.0	7.63	0.57	27	~ 9	624	0.077	< 0.005	1.30	< 0.02	< 0.03	< 0.05	294	264	0.0010	0.0024	0.0013	0.0016	< 0.0001	0.0033	0.0021	0.0102	< 0.0002	< 0.0002	0.00190	0.00061
7/3/2012	10:23	82	83.3	6.20	1,388.0	1,302.0	7.90	0.64	6	5	665	~ 0.040	< 0.005	1.10	< 0.02	< 0.03	< 0.05	307	244	< 0.0010	< 0.0010	0.0012	0.0013	< 0.0001	0.0006	0.0025	0.0035	< 0.0002	< 0.0002	0.00040	0.00018
8/13/2012	10:17	71	71.8	3.70	1,179.0	1,113.0	0.59	7.52	14	9	630	0.081	< 0.005	1.30	< 0.02	< 0.03	< 0.05	291	208	< 0.0050	< 0.0050	0.0011	0.0012	< 0.0001	0.0008	0.0054	0.0030	< 0.0002	< 0.0002	0.00043	0.00021
9/13/2012	10:54	65	65.7	3.15	1,075.0	1,222.0	7.45	0.61	10	7	648	0.091	< 0.005	1.90	< 0.02	< 0.03	< 0.05	323	224	< 0.0003	< 0.0003	0.0011	0.0011	< 0.0001	0.0005	0.0020	0.0023	< 0.0002	< 0.0002	< 0.00050	< 0.00050
10/4/2012	13:10	47	58.6	7.19	1,023.0	1,269.0	7.77	0.64	19	15	688	0.137	< 0.005	1.90	< 0.02	< 0.03	< 0.05	295	248	0.0007	0.0008	0.0011	0.0013	< 0.0001	0.0009	0.0026	0.0031	< 0.0002	< 0.0002	0.00045	~ 0.00015
11/20/2012	10:13	40	42.1	11.81	789.0	1,254.0	7.62	0.63	14	10	668	0.093	~ 0.005	1.60	< 0.02	< 0.03	< 0.05	282	256	0.0007	0.0012	0.0015	0.0016	~ 0.0003	0.0016	0.0029	0.0051	< 0.0002	< 0.0002	0.00080	0.00024
12/20/2012	10:05	23	37.2	22.48	729.0	1,261.0	8.28	0.62	19	14	658	< 0.020	~ 0.008	0.70	~ 0.02	< 0.03	< 0.05	281	224	0.0011	0.0013	0.0013	0.0015	< 0.0001	0.0008	~ 0.0015	0.0059	< 0.0002	< 0.0002	0.00098	0.00038

Table G.3. Monitoring data for Kasota Pond East

Date	Sample Time	Air Temp (F)	Water Temp (F)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductivity (µS/cm)	pH	Salinity (ppt)	Total Suspended Solids (mg/L)	Volatile Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Chloride Ion (mg/L)	Hardness (mg/L CaCO3)	Soluble Copper (mg/L)	Total Copper (mg/L)	Soluble Nickel (mg/L)	Total Nickel (mg/L)	Soluble Lead (mg/L)	Total Lead (mg/L)	Soluble Zinc (mg/L)	Total Zinc (mg/L)	Soluble Cadmium (mg/L)	Total Cadmium (mg/L)	Soluble Chromium (mg/L)	Total Chromium (mg/L)
1/25/2012	13:00	27	34.2	13.59	1,619.0	2,965.0	7.19	1.52	23	23	1,650	0.154	0.018	3.80	< 0.02	< 0.03	< 0.05	750	790	~ 0.0005	~ 0.0005	0.0016	0.0016	< 0.0001	< 0.0001	0.0016	0.0044	< 0.0002	< 0.0002	0.00026	~ 0.00015
2/28/2012	11:40	32	34.5	31.69	1,558.0	2,841.0	7.15	1.45	32	31	1,590	0.244	~ 0.005	3.40	0.23	< 0.03	< 0.05	712	1,030	0.0008	0.0012	0.0030	0.0032	< 0.0001	~ 0.0003	0.0267	0.0343	< 0.0002	~ 0.0002	0.00220	0.00120
3/22/2012	10:48	65	58.6	6.11	1,423.0	1,765.0	7.35	0.90	6	4	936	~ 0.046	0.015	1.20	~ 0.03	< 0.03	< 0.05	422	368	0.0015	0.0012	0.0014	0.0013	< 0.0001	~ 0.0003	0.0032	0.0043	< 0.0002	< 0.0002	0.00053	0.00020
4/12/2012	11:17	57	50.5	8.80	1,533.0	2,132.0	7.66	1.10	~ 2	3	1,200	~ 0.024	< 0.005	0.86	~ 0.03	< 0.03	0.08	590	432	~ 0.0005	~ 0.0004	0.0012	0.0012	~ 0.0003	~ 0.0004	0.0020	0.0017	< 0.0002	< 0.0002	0.00048	< 0.00008
5/17/2012	10:04	56	65.5	7.55	1,376.0	1,569.0	7.51	0.79	~ 1	~ 1	881	~ 0.025	~ 0.008	0.88	~ 0.02	< 0.03	< 0.05	425	268	~ 0.0004	~ 0.0004	0.0009	0.0009	~ 0.0001	< 0.0001	< 0.0050	< 0.0050	< 0.0002	< 0.0002	0.00037	~ 0.00010
6/20/2012	9:31	77	76.6	3.09	1,266.0	1,272.0	7.33	0.63	~ 2	~ 1	697	~ 0.040	~ 0.008	1.00	< 0.02	< 0.03	< 0.05	328	—	0.0006	~ 0.0004	0.0008	0.0007	< 0.0001	~ 0.0001	0.0019	0.0042	< 0.0002	< 0.0002	0.00050	~ 0.00011
7/3/2012	10:32	83	81.5	2.94	1,556.0	1,485.0	7.52	0.74	4	3	758	0.083	0.014	1.10	< 0.02	< 0.03	< 0.05	360	288	< 0.0010	< 0.0010	0.0008	0.0008	< 0.0001	< 0.0001	~ 0.0010	~ 0.0008	< 0.0002	< 0.0002	0.00032	~ 0.00009
8/13/2012	9:54	71	69.4	0.89	1,415.0	1,539.0	7.29	0.78	6	~ 3	865	0.121	~ 0.009	2.00	0.45	< 0.03	< 0.05	368	276	< 0.0050	< 0.0050	0.0009	0.0008	< 0.0001	< 0.0001	0.0047	0.0031	< 0.0002	< 0.0002	0.00043	~ 0.00011
9/13/2012	10:42	60	62.8	1.65	1,446.0	1,705.0	7.28	0.87	12	6	925	0.106	~ 0.007	1.80	0.16	< 0.03	< 0.05	461	320	< 0.0003	< 0.0003	0.0016	0.0015	< 0.0001	~ 0.0003	~ 0.0014	0.0031	< 0.0002	< 0.0002	0.00083	< 0.00050
10/4/2012	13:21	46	59.0	7.82	1,483.0	1,832.0	7.58	0.94	6	4	1,020	0.052	< 0.005	1.70	< 0.02	< 0.03	< 0.05	410	368	< 0.0003	< 0.0003	0.0012	0.0013	< 0.0001	~ 0.0003	0.0016	~ 0.0014	< 0.0002	< 0.0002	0.00050	0.00077
11/20/2012	10:30	41	42.4	9.86	1,218.0	1,920.0	7.57	0.98	15	13	984	0.069	~ 0.005	3.70	0.82	< 0.03	< 0.05	437	408	< 0.0003	~ 0.0003	0.0017	0.0018	< 0.0001	0.0008	0.0047	0.0024	< 0.0002	< 0.0002	0.00048	0.00019
12/20/2012	10:13	23	35.4	26.93	1,239.0	2,216.0	7.89	1.12	19	19	1,180	0.162	~ 0.006	3.80	~ 0.03	< 0.03	< 0.05	602	408	~ 0.0004	0.0006	0.0019	0.0019	< 0.0001	~ 0.0002	0.0033	0.0038	< 0.0002	< 0.0002	0.00065	0.00020