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MISSISSIPPI WATERSHED MANAGEMENT ORGANIZATION

Annual Monitoring Report 2013



MWMO Watershed Bulletin: 2014-1

Annual Monitoring Report 2013

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Completion Date: March 2014

Acknowledgements

The Mississippi Watershed Management Organization (MWMO) thanks the following groups for their cooperation and assistance with MWMO monitoring activities: the City of Minneapolis Departments of Public Works, Regulatory Services, and Environmental Services; City of Saint Anthony Village Public Works Department; Minnesota Department of Transportation; and Saint Anthony Falls Laboratory at the University of Minnesota.

■ ■ ■

Suggested citation:

Mississippi Watershed Management Organization. 2014. *Annual Monitoring Report 2013*. MWMO Watershed Bulletin 2014-1. 76 pp.

Front Cover: MWMO Weather Station (above left), Grass and Oaks (above right), and River Monitoring for Hydraulic Mixing (below)

The MWMO Weather Station was installed in May 2013 and provides real-time weather information.
Mississippi River monitoring for hydraulic mixing continued in 2013.This photo shows the monitoring staff in between sites.

Photographs by B. Jastram (above left and right) MWMO, and S. Kennedy (below) Minneapolis

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Abstract

In 2013, 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 monitored 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. The MWMO contracted the Anoka Conservation District to carry out monitoring activities on Sullivan Lake in Columbia Heights.

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 at least twice per month from seven monitoring locations in the MWMO's 14-mile stretch of the Mississippi River. 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 2013, the MWMO continued 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 2013. 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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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 Siemens
a.k.a.	also known as
ACD	Anoka Conservation District
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, 1988
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

Automatic 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 laboratory processing of a sample (i.e. nutrients, solids, and metals)

Outfall: the end of a stormwater pipe, where the stormwater enters the receiving waterbody

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

Secchi tube: a modified transparency tube that is designed to function like the traditional Secchi disk used in lake monitoring

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. Watershed boundaries are defined by elevation

Annual Monitoring Report 2013

Executive Summary

The annual monitoring report details the monitoring activities and results of the Mississippi Watershed Management Organization's (MWMO) 2013 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 2013 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. The Anoka Conservation District (ACD) also monitored water elevation and water quality in Sullivan Lake for the MWMO.

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 at least twice per month from seven monitoring locations in the MWMO's 14-mile stretch of the Mississippi River. 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 early 2013, the MPCA released its Draft Upper Mississippi River Bacteria TMDL Study and Protection Plan (MPCA, 2013). This document designated the stretch of the Mississippi River within the MWMO as a Protection Reach and deferred it for a TMDL study.

In 2013, the MWMO continued 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. From April 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 contracted the ACD to conduct monitoring activities on Sullivan Lake in Columbia Heights to evaluate the lake's current conditions. The lake currently exhibits poor water quality, is highly eutrophic, and had severe algae blooms from May through September, the months when it was monitored.

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. 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 2013 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 2013 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. The MWMO also contracted the Anoka Conservation District to carry out monitoring activities on Sullivan Lake in Columbia Heights.

In 2013, the MWMO continued monitoring the Mississippi River at five cross-sections in three different reaches to develop methods to fill hydraulic mixing data gaps in the MWMO's 14-mile stretch of the Mississippi River. From April 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.

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 Sullivan Lake (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.

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 stretch 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.

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.

Tables 3 and 4 show 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, 10SA, Edison High School, Columbia Golf Course, 6th ST NE, and the MWMO Weather Station were collected by the MWMO. In 2013, the MWMO installed heated rain gauges with data loggers at the Edison High School (July), the Columbia Golf Course (September), and the MWMO Weather Station (May) sites to better monitor precipitation, including the water equivalent of snow. A Citizen Monitor gauge was set up in October at the 6th ST NE site, and the data are being collected and submitted to the MWMO by a volunteer. Precipitation data at the SAFL site were collected by SAFL. Precipitation at Lock and Dam 1 was measured by the USACE. Precipitation data from precipitation monitoring sites in St. Cloud, Becker, Elk River, and New Hope were downloaded from the Minnesota Climatology Working Group website and precipitation data from precipitation monitoring sites in Chanhassen and the Minneapolis St. Paul International Airport were downloaded from the Midwestern Regional Climate Center website.

Table 3. 2013 monthly precipitation (inches) at several locations in the Upper Mississippi River basin

	St. Cloud[1]	Becker[2]	Elk River[3]	New Hope[4]	SAFL[5]	Lock and Dam 1[6]	Chanhassen[7]	Minneapolis St. Paul International Airport[8]
January	0.45	0.56	0.48	0.70	0.62	0.95	0.66	0.86
February	1.33	1.23	1.09	1.29	0.33	0.59	1.05	1.33
March	2.63	2.31	1.54	2.24	1.06	0.53	1.64	2.04
April	2.90	2.99	3.80	5.46	3.29	5.93	5.60	5.22
May	4.98	2.17	2.79	4.55	4.66	4.93	6.55	6.24
June	5.76	4.39	5.43	8.49	5.45	6.33	6.28	5.17
July	1.43	2.39	4.22	3.48	2.39	0.50	4.69	3.51
August	0.85	1.05	0.47	1.65	1.37	2.01	1.74	2.07
September	1.87	2.79	2.78	1.27	0.84	1.20	1.57	1.35
October	4.34	3.64	3.10	4.53	3.31	3.63	3.53	3.00
November	0.53	0.63	0.98	0.59	0.41	0.70	0.51	0.52
December	1.77	1.45	1.01	1.66	0.30	0.00	1.26	1.46
Total	28.84	25.6	27.69	35.91	24.03	27.30	35.08	32.77

[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/coop**

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

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

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

[7] Location: Latitude 44.8514 Longitude -93.5650, Source**: http://mrcc.isws.illinois.edu/climate**

[8] Location: Latitude 44.88306 Longitude: -93.22889, Source: **http://mrcc.isws.illinois.edu/climate**

Table 4. 2013 monthly precipitation (inches) at several locations in the MWMO precipitation monitoring network

	1NE[1]	10SA[2]	Edison High School[3]	Columbia Golf Course[4]	6th ST NE[5]	MWMO Weather Station[6]
January	.66	0.60				
February	.73	0.11				
March	1.69	1.48				
April	4.38	3.58				
May	4.01	5.40				
June	6.79	4.53				6.87
July	2.44	2.46				2.06
August	0.88	1.65	1.55			1.06
September	1.06	1.08	1.29			0.93
October	3.55	3.50	4.17	4.01	3.46	3.26
November	0.55	0.51	0.60	0.66	0.23	0.65
December	0.85	0.41	0.87	0.93	1.43	0.43
Total	27.69	25.31	8.64	6.40	5.12	15.50

[1] Location: Latitude 45.02389 Longitude -93.2772, Source: MWMO data, 1NE

[2] Location: Latitude 45.01278 Longitude -93.2203, Source: MWMO data, 10SA

[3] Location: Latitude 45.012 Longitude -93.22, Source: MWMO Data, Edison High School

[4] Location: Latitude 45.027 Longitude -93.255, Source: MWMO Data, Columbia Golf Course

[5] Location: Latitude 45.053 Longitude -93.259, Source: Paul Virck 4628 6th ST NE Minneapolis MN

[6] Location: Latitude 45.013 Longitude -93.272, Source: MWMO Data, MWMO Weather Station

The MWMO acknowledges a link between precipitation and Mississippi River water quality. 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. 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

In 2013, grab samples were collected from seven locations in the Mississippi River at least two times per month. 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.

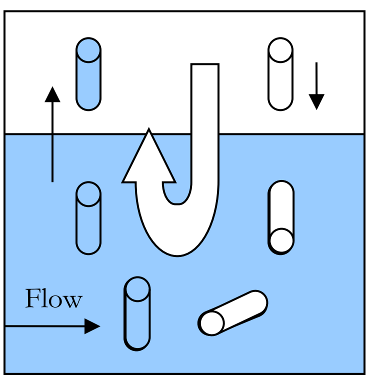

Figure 1. Diagram of sample collection method

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. Transparency was measured using a Secchi tube.

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 2013 are shown in Figures 2 and 3. All staff gauges were installed on April 2 and 3 of 2013. High water level submerged many of the gauges on April 30. Staff discovered that gauges at MR857.6 and MR858.1 were bent on May 1. New gauges were installed at these two sites on September 25. Bent gauges were surveyed before being replaced and these surveys were used to calculate the elevation of MR 857.6 and MR858.1 during the time in which the gauges were bent. 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.

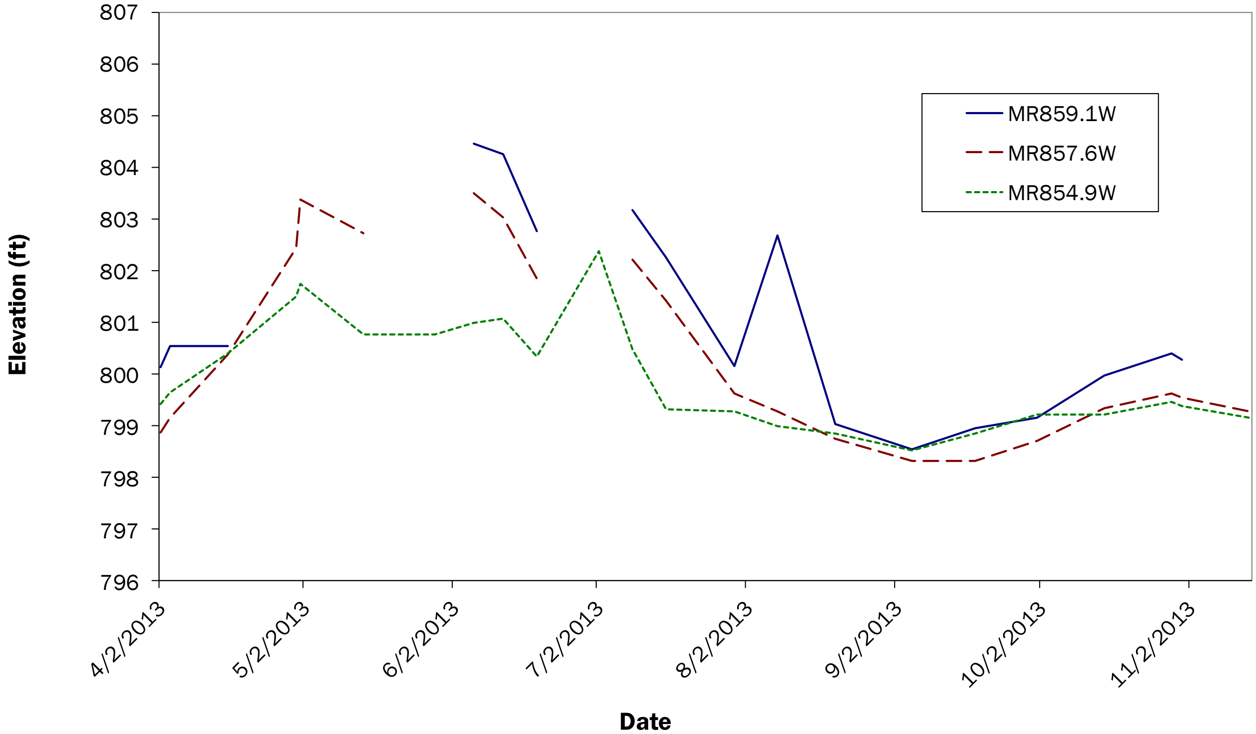

Figure 2. Mississippi River water elevations at three monitoring sites upstream of Saint Anthony Falls

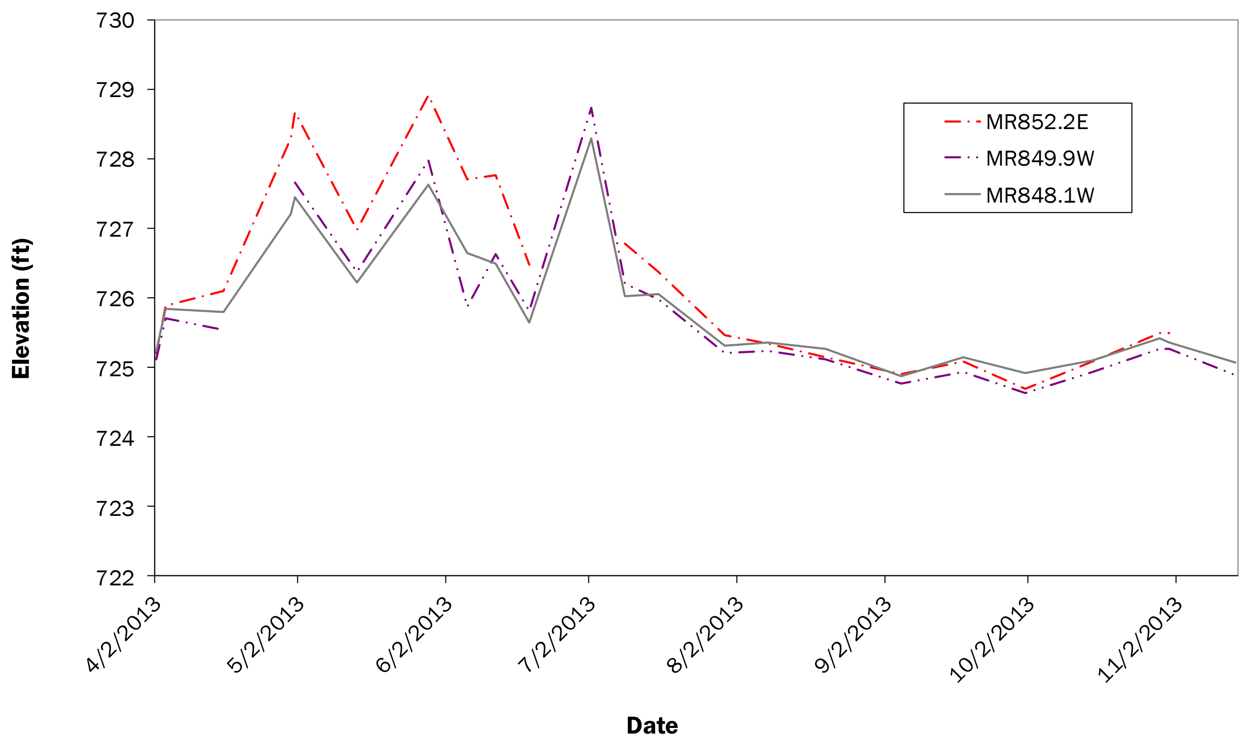

Figure 3. Mississippi River water elevations at three monitoring sites downstream of Saint Anthony Falls

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 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. Most sites exceeded this standard in one or more months of 2013. 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 5 presents a summary of all *E. coli* exceedances.

Prior to 2013, the MWMO collected *E. coli* samples at river sites at least 5 times per month to compute a monthly geomean. During this time, data were being collected to contribute to the MPCA's TMDL assessment of the Upper Mississippi River. In early 2013, the MPCA released its Draft Upper Mississippi River Bacteria TMDL Study and Protection Plan (MPCA, 2013). This document designated the stretch of the Mississippi River within the MWMO as a Protection Reach and deferred it for a TMDL study.

Although the reach is now under protection mode, the MWMO continued to sample *E. coli* at the 7 river sites at least twice per month in 2013, with the goal of maintaining a baseline of data. Refer to Table D.1 in Appendix D for the monitoring data.

Table 5. Sites that exceeded 1,260 MPN/100mL in >10% of samples for the Mississippi River in 2013

Month	Sites that exceed 1,260 MPN/100 mL in > 10% of samples
April	None
May	None
June	MR859.1, MR857.6W, MR852.2E
July	MR857.6W, MR852.2E, MR849.9W
August	None
September	None
October	MR857.6W, MR853.5E

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 4 shows boxplots of the 2013 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 rain event.

Two additional factors should be considered when evaluating these results. First, these results are based on a maximum of four 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.

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 information 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 at least two times per month throughout the 2013 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.

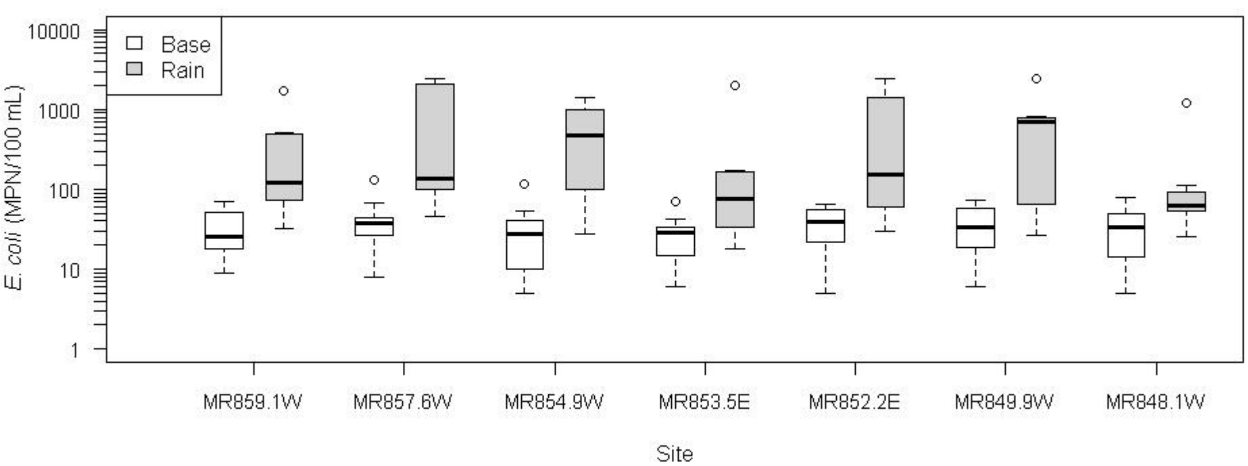

Figure 4. 2013 Mississippi River *E. coli* monitoring results, separated by baseflow and stormflow samples

Mississippi River Monitoring For Hydraulic Mixing

In 2006, the MWMO developed plans to better fulfill 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 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).

In 2013, the MWMO continued monitoring the Mississippi River at five locations (cross-sections) in three different reaches. Beginning in April, staff visited each of the cross-sections weekly until the river froze in December. 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 and ending just above the bottom of the river (Figure 5).

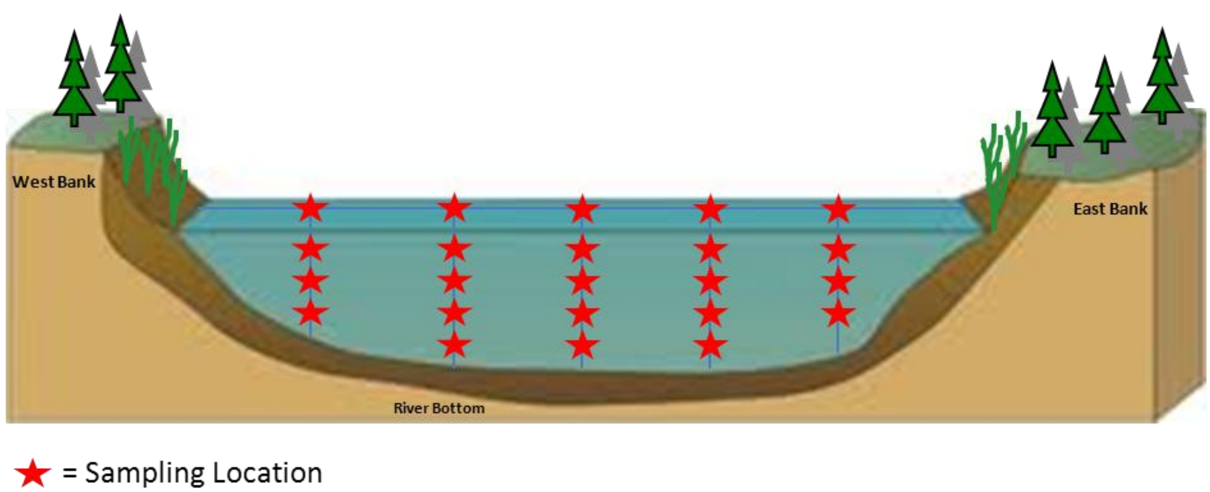

Figure 5. Diagram of a cross-section for river hydraulic mixing sampling. Each star represents a data collection point

Site Selection

Figure A.3 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 monitoring 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 monitoring 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 sand.

Methodology

Data Collection

Each cross-section was divided laterally into five equal lengths, and measurements were taken at the mid-point of each (Figure 5) 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. River sites were accessed with an

18-foot John boat, when accessible. The water depth at site MR859.1 (Camden) is lower than at other sites; therefore, this site was monitored only when accessible by boat. Examples of data collected at a cross-section during a sampling visit are presented in Table 6 and Figure 6.

Table 6. River monitoring data for cross-section MR854.8 (2NNBC) for November 8, 2013

	East Bank		Midpoint		West Bank
Lateral Position	**1**	**2**	**3**	**4**	**5**
Depth (ft)			**Temperature (C)**		
0	4.6	4.6	4.7	4.7	4.6
3	4.6	4.6	4.7	4.7	4.6
6	4.6	4.6	4.7	4.7	4.6
9	4.6	4.6	4.7	4.6	4.6
12	4.6	4.6	4.7	4.6	—
15	—	4.6	4.7	4.6	—
18	—	—	4.7	4.6	—
			Dissolved Oxygen (mg/L)		
0	13.57	13.54	13.52	13.34	13.34
3	13.50	13.54	13.37	13.27	13.18
6	13.53	13.55	13.42	13.34	13.28
9	13.47	13.56	13.39	13.41	13.16
12	13.43	13.58	13.34	13.36	—
15	—	13.49	13.38	13.32	—
18	—	—	13.35	13.35	—
			pH		
0	8.50	8.51	8.54	8.53	8.50
3	8.49	8.50	8.54	8.53	8.50
6	8.49	8.51	8.54	8.52	8.49
9	8.48	8.51	8.53	8.52	8.50
12	8.47	8.51	8.53	8.52	—
15	—	8.52	8.54	8.51	—
18	—	—	8.53	8.51	—
			Specific Conductivity (uS/cm)		
0	368.6	367.0	365.3	367.1	373.5
3	368.7	367.8	367.1	368.5	374.0
6	368.6	367.8	367.3	369.4	373.8
9	368.6	367.7	368	370.1	373.3
12	368.7	367.7	368.5	370.6	—
15	—	368.6	367.9	370.2	—
18	—	—	368.7	370.6	—
			Salinity (ppt)		
0	0.18	0.18	0.17	0.18	0.18
3	0.18	0.18	0.18	0.18	0.18
6	0.18	0.18	0.18	0.18	0.18
9	0.18	0.18	0.18	0.18	0.18
12	0.18	0.18	0.18	0.18	—
15	—	0.18	0.18	0.18	—
18	—	—	0.18	0.18	—

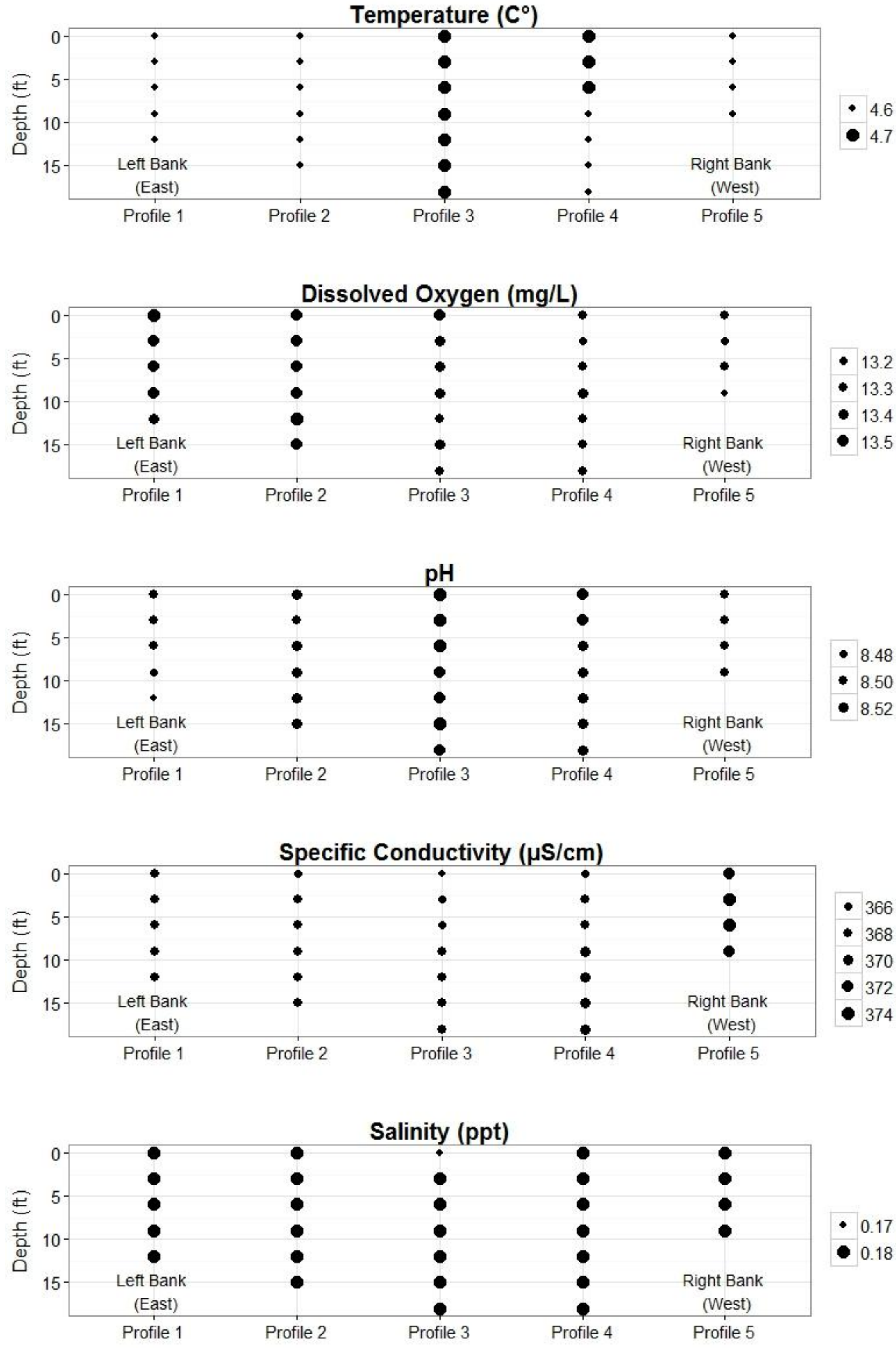

Figure 6. Mississippi River monitoring data for cross-section MR854.8 (2NNBC) for November 8, 2013

Data Collection Quality Control
The MWMO staff followed established calibration procedures for YSI data quality control. Dissolved oxygen, 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.

Lake Monitoring

The MWMO has 3 lakes within its watershed boundary. Two of the lakes, Loring Pond and Sullivan Lake, were monitored during 2013 by other organizations. Since Loring Pond has been monitored by the Minneapolis Park and Recreation Board for several years, the MWMO did not monitor it during 2013. Previously, the MWMO monitored Loring Pond for *E. coli*; however, that monitoring was discontinued because the MPCA does not assess Loring Pond for *E. coli*. Refer to previous MWMO Annual Monitoring Reports at **www.mwmo.org** for further details about MWMO historical monitoring at Loring Pond. MPRB data can be found in their Water Resources Reports found on their website (MPRB, 2013). Sullivan Lake, located in Columbia Heights, was historically monitored for water level, chlorophyll-a, and total phosphorus; however, the chemical parameters had not been monitored for several years. The MWMO contracted the Anoka Conservation District (ACD) to conduct water elevation and water quality monitoring during 2013, to gain an understanding of current lake conditions. Details of the history of Sullivan Lake monitoring, 2013 data, and historical water elevation data can be found in the Sullivan Lake Monitoring Report 2013 (MWMO, 2014).

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 RM 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 RM 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. Upstream of where it enters the City of Minneapolis stormwater drainage system, Bassett's Creek was monitored as part of the Metropolitan Council's WOMP (Watershed Outlet Monitoring Program), a collaboration between the Bassett's Creek Watershed Management Commission and Metropolitan Council Environmental Services.

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 RM 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 baseflow in this stormwater drainage system. Northern Pike (*Esox lucius*) 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 RM 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 RM 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. The tunnel eventually drains into the Mississippi River several miles away on the east bank at RM 853.2. There is generally continuous baseflow in this stormwater drainage system.

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). For the majority of analytes, 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. *E. coli* grab samples were collected in lab-sterilized 125 milliliter plastic bottles. For all samples, bottles were capped after 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 a Secchi tube.

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.

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.

Parameter 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. 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, 2013)

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 2013, as 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 23 through May 29, and June 23 through July 7 (Figure 7). Water levels at 4PP show tailwater in the pipe from April 27 through May 17, May 21 through June 14, and June 21 through July 7 (Figure 8). On June 21, during a rain event, a power surge occurred at the 4PP stormwater site and the automated sampling equipment shut off. The large event also washed the sampler's remote pump out of the tunnel and into the river. On August 29, a storm damaged the automated sampling equipment at the 4PP site. The equipment was sent in for repair and modification. Alternate equipment was installed at the site on September 19. On October 23, the new automated equipment and remote pump were installed. Water levels at 6UMN show tailwater in the pipe from April 16 through May 18, May 19 through June 15, and June 21 through July 8 (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.

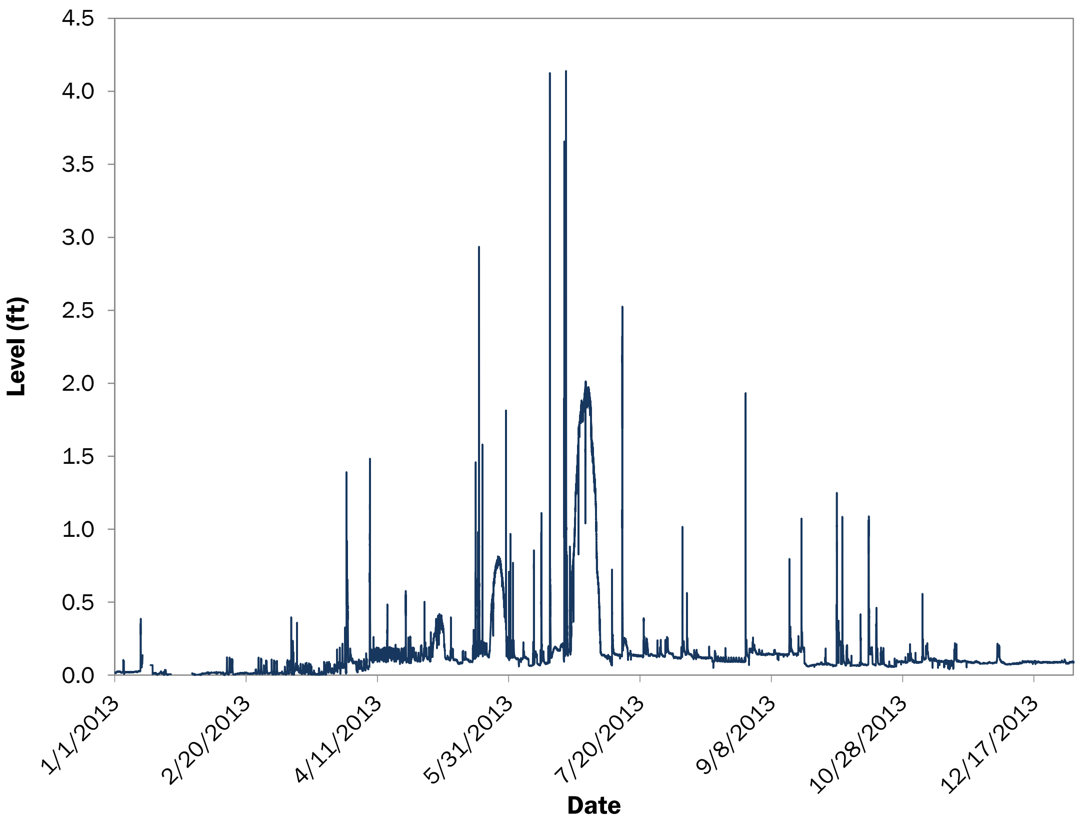

Figure 7. Water level for 1NE outfall

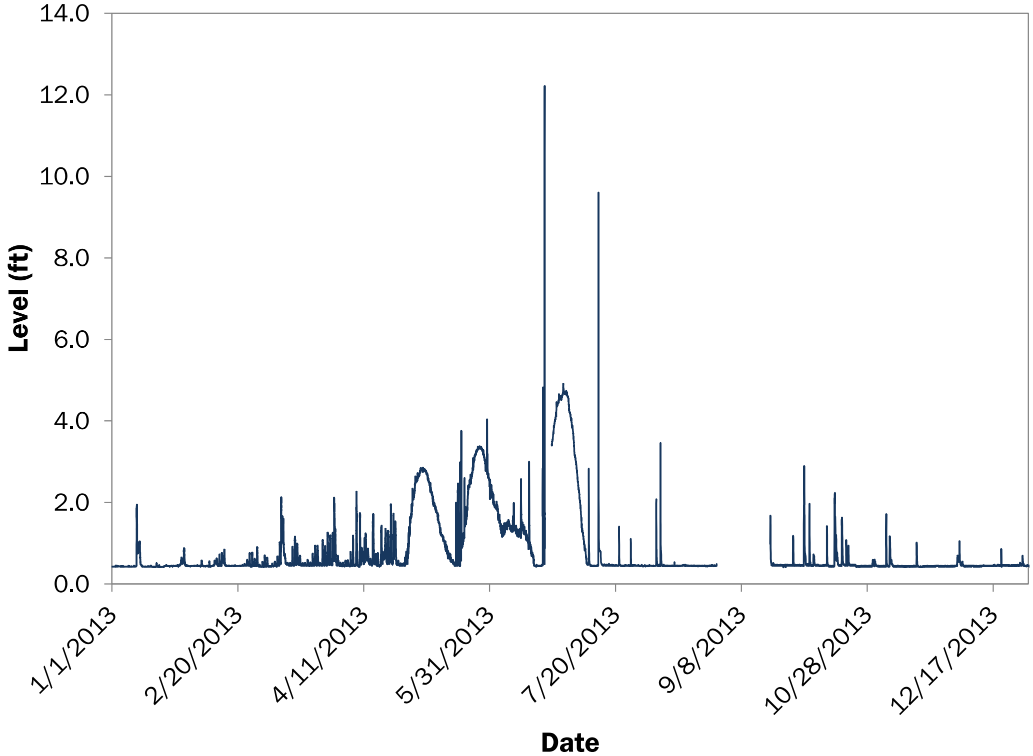

Figure 8. Water level for 4PP outfall

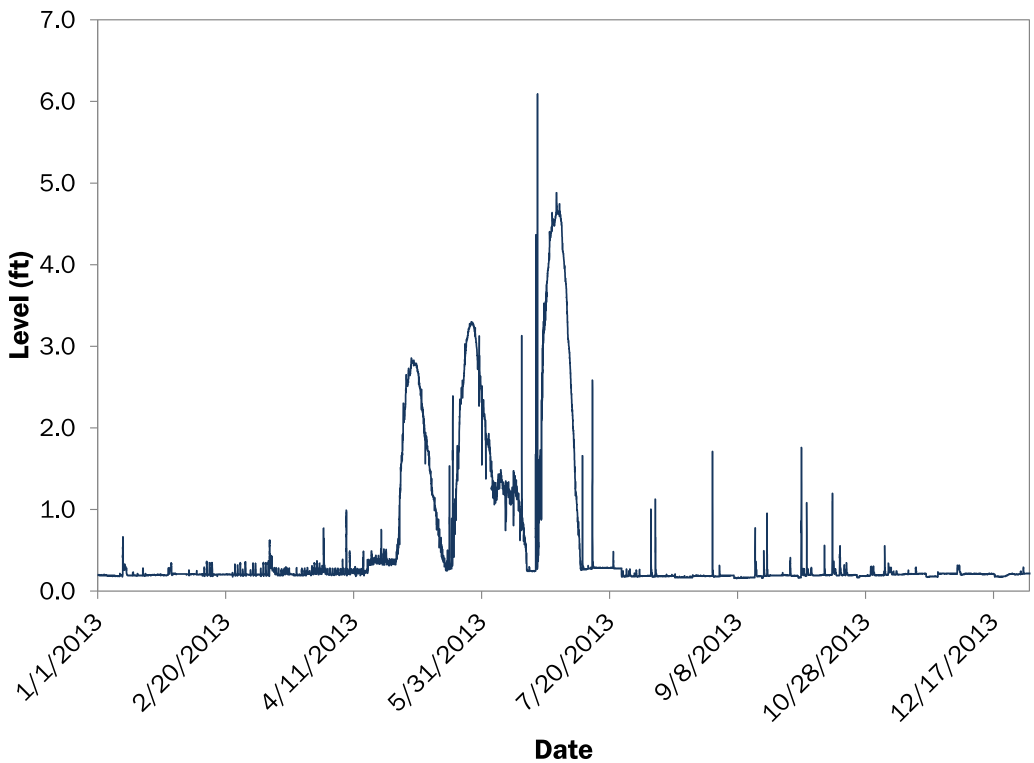

Figure 9. Water level for 6UMN outfall

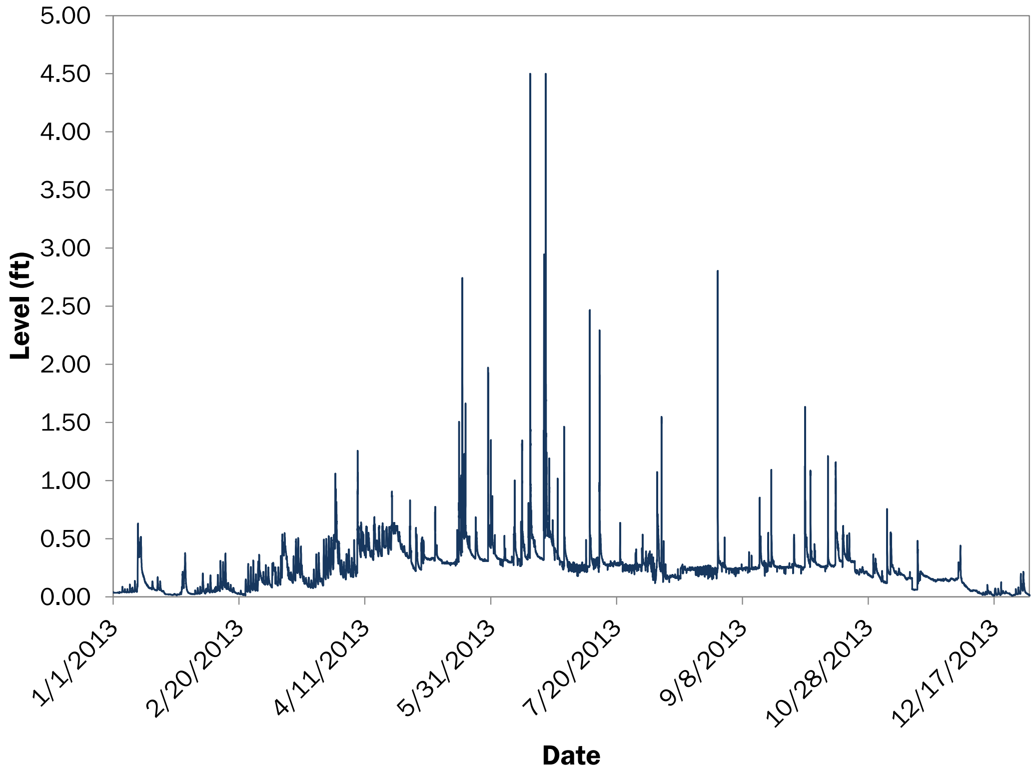

Figure 10. Water level for 10SA stormwater drainage system

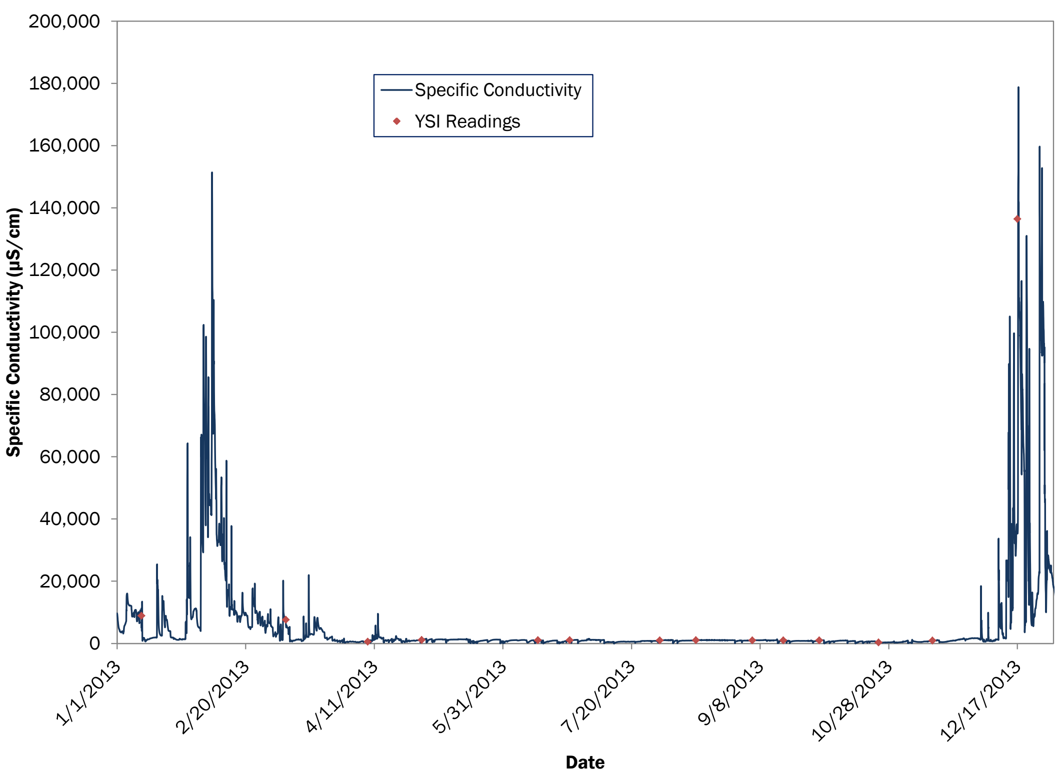

Figure 11. Continuous specific conductivity monitoring data for 10SA stormwater drainage system. Points represent YSI readings measured in the tunnel compared to conductivity sensor readings.

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 2013 stormwater data separated out into baseflow and rain event values. Rain sample *E. coli* concentrations were typically 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.

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.

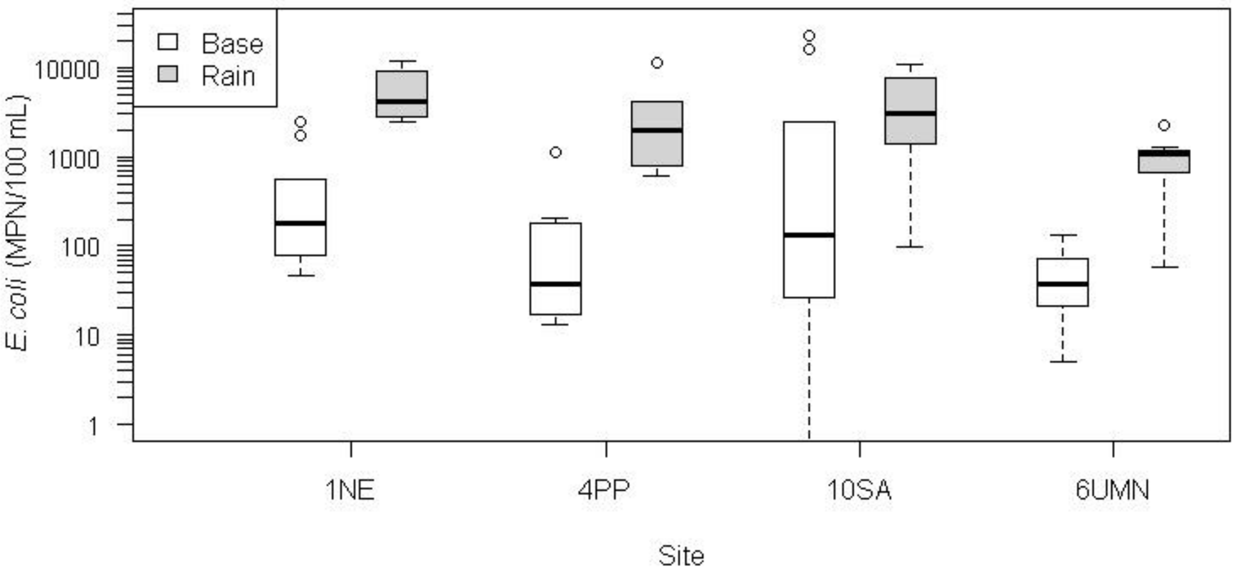

Figure 12. *E. coli* data from all stormwater sites in 2013, separated by baseflow and rain event samples

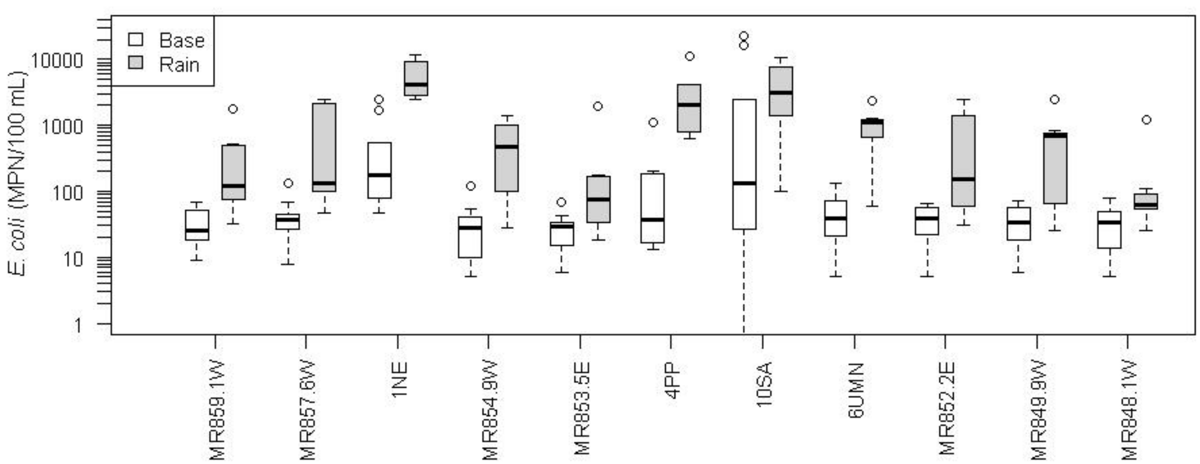

Figure 13. All Mississippi River and stormwater bacteria data from 2013, listed in order from upstream to downstream river location. Data are separated into baseflow and rain event samples

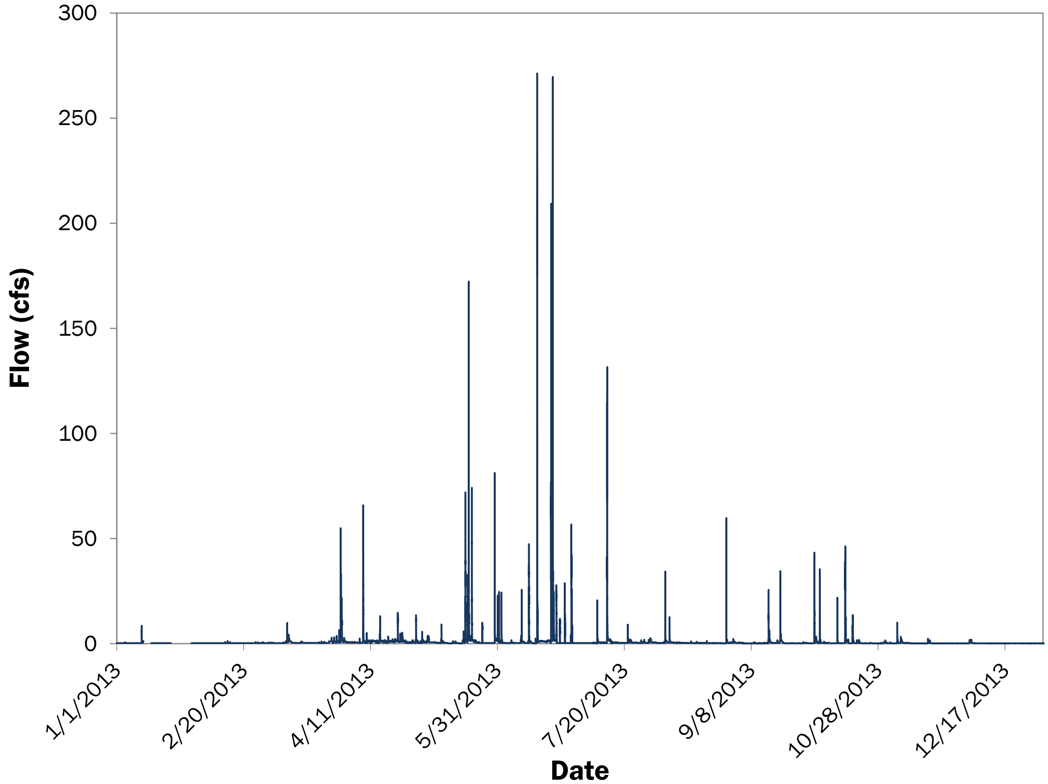

Figure 14. Discharge for 1NE outfall

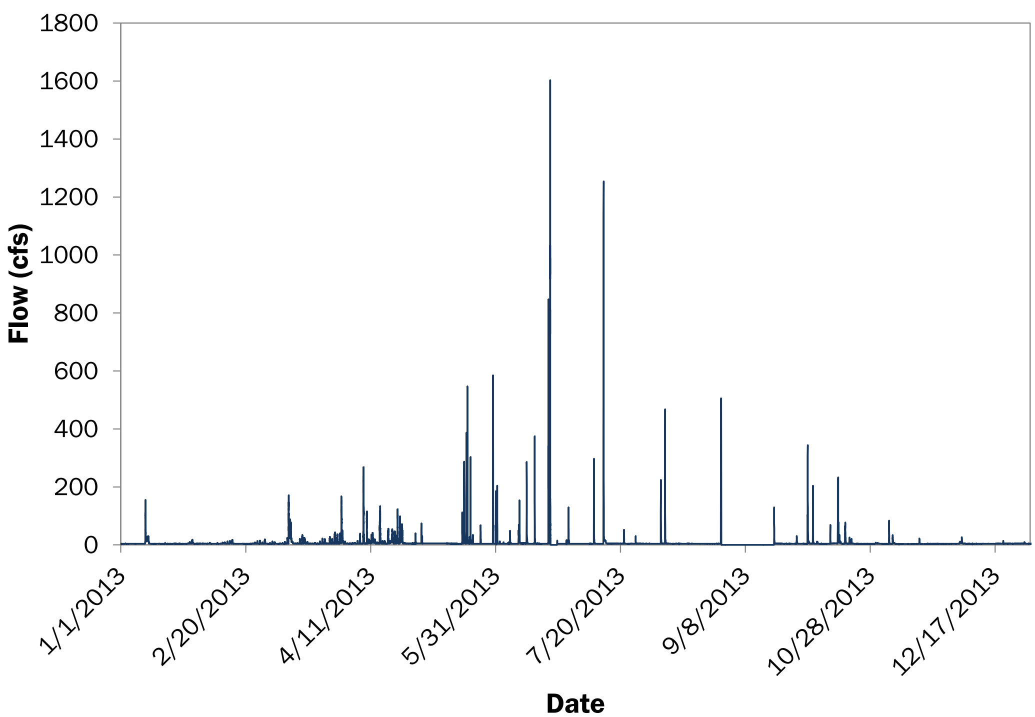

Figure 15. Discharge for 4PP outfall

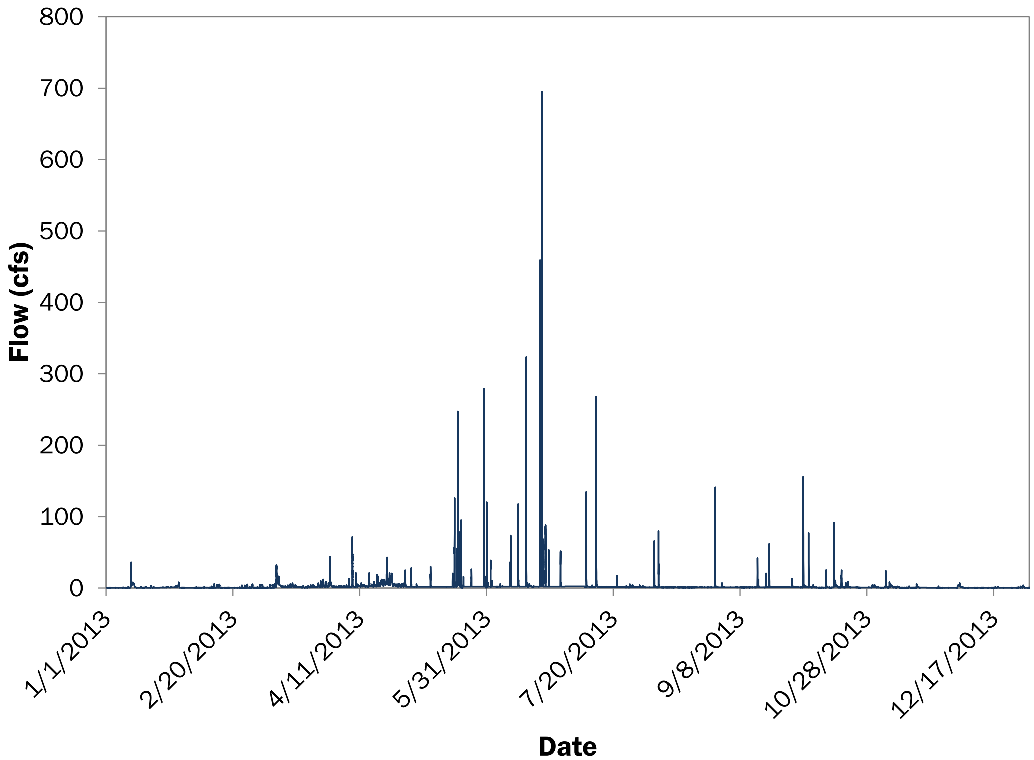

Figure 16. Discharge for 6UMN outfall

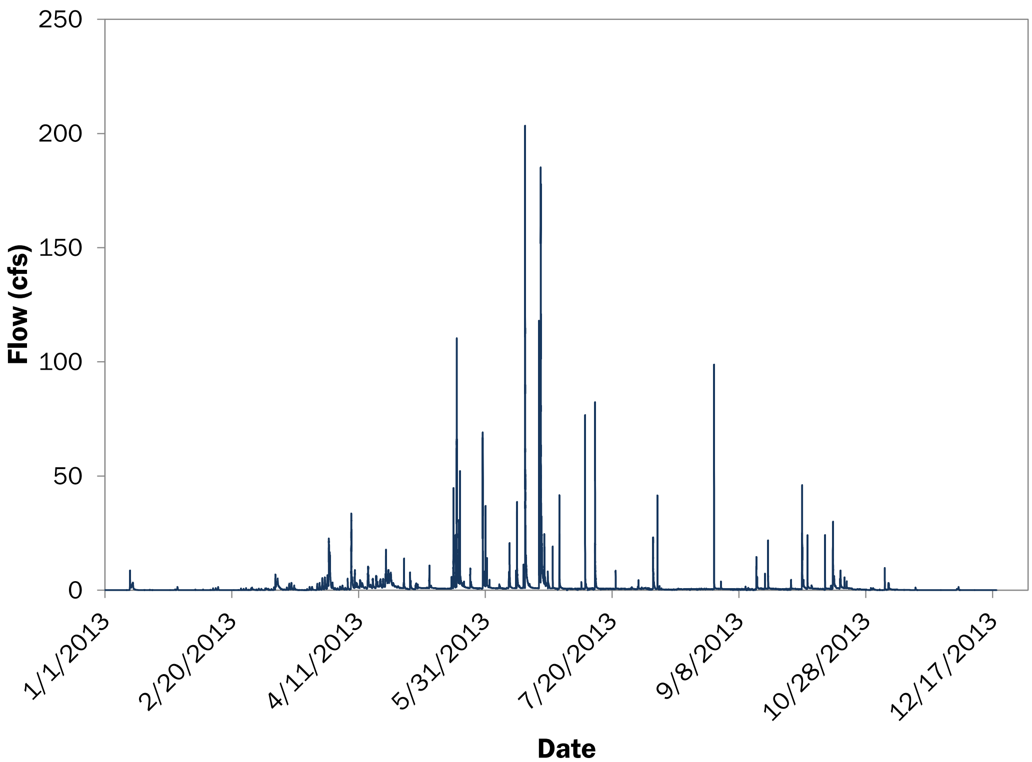

Figure 17. Discharge for 10SA stormwater drainage system

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.

Parameter 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. 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

2013 Work Plan

Following is a list of work plan accomplishments for the year 2013:

- Worked with new MWMO member cities (Fridley, Columbia Heights, and Hilltops) to assess their monitoring needs and identified a new stormwater outfall monitoring site and lake level and lake water quality monitoring for Sullivan/Sandy Lake
- Prepared and signed a professional services agreement with Anoka Conservation District to coordinate and monitor Sullivan/Sandy lake for water level monitoring and water quality monitoring
- Expanded MWMO precipitation monitoring network by installing two heated precipitation gauges and one citizen precipitation recorder
- Applied and obtained a permit from the City of Minneapolis to install a weather station at the MWMO's headquarters facility
- Purchased and installed a weather station at the MWMO's headquarters facility

- Continued to monitor four stormwater outfall sites using automated samplers. The 2NNBC site was monitored by grab sampling when there was positive flow from the tunnel to the river. The 7LSTU site was monitored by automated and/or grab sampling depending on the presence of tailwater in the outfall tunnel
- Continued monthly monitoring of the Kasota Ponds wetlands in St. Paul
- Submitted all of MWMO's Kasota Ponds data to the MPCA's EQuIS database
- Continued to monitor seven sites on the Mississippi River and six stormwater outfall sites for *E. coli* and submitted the data to the MPCA
- Continued working on developing monitoring protocols for the Mississippi River monitoring for hydraulic mixing and collected physical parameters (pH, temperature, dissolved oxygen, and conductivity) data at five cross-sections on the river from April 2013 to December 2013
- Researched and finalized the methodology to calculate pollutant loadings from stormwater outfall sites and completed the estimates of pollutant loadings for 5 years of monitoring data for the 1NE site,
- Worked with the City of Minneapolis and MPRB to collect data for the City of Minneapolis' NPDES permit
- Coordinated and worked with the City of Minneapolis to assist with their illicit discharge monitoring program
- Worked with the MPCA to assist with the Upper Mississippi River Bacteria TMDL Project and the Twin Cities Metro Area Chloride Project
- Worked with the City of Minneapolis Health Department 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 and conduct tree planting to improve stormwater quality
- Developed partnerships with Capital Region Watershed District water quality monitoring staff to collaborate on monitoring work
- Worked with other state and federal agencies to develop the long-term comprehensive monitoring plan for the Mississippi River within the reaches of the MWMO
- Shared MWMO data through the MPCA's EQuIS database, the MWMO's annual monitoring report, and data requests.

2014 Work Plan

The 2014 work plan for the MWMO's monitoring program includes:

- Continue to work with the new MWMO member cities to assess their monitoring needs and assist in developing additional monitoring plans for stormwater monitoring and lake monitoring
- Expand precipitation monitoring network using heated precipitation gauges and citizen precipitation recorders
- Obtain permit, purchase equipment and install the monitoring equipment at the new outfall monitoring site
- Install a level troll at the 2NNBC site to continuously monitor the water level from the tunnel to the Mississippi River
- 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 monthly monitoring of the Kasota Ponds wetlands in St. Paul

- Continue to monitor biweekly 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
- Complete the pollutant loading calculations for the stormwater outfall sites
- Continue to work with the City of Minneapolis and MPRB to collect data for the City of Minneapolis' NPDES permit
- Continue to 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 Project 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

References

Minneapolis Park and Recreation Board. 2013. Water Resources Reports at **http://www.minneapolisparks.org/default.asp?PageID=791** (accessed 02/2014).

Minnesota Pollution Control Agency. 2007. *Minnesota Statewide Mercury Total Maximum Daily Load.* Minnesota Pollution Control Agency, Saint Paul, MN, March 2007. 75 p. available at **www.pca.state.mn.us/publications/wq-iw4-01b.pdf** (accessed 02/2014).

Minnesota Pollution Control Agency. 2010. *Mississippi Watershed Management Organization Ambient Surface Water Monitoring Program Quality Assurance Project Plan*. 33 pp.

Minnesota Pollution Control Agency. 2012. "TMDL Project: Upper Mississippi River – Bacteria". *Minnesota's Impaired Waters and TMDLs* available at **http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/tmdl-projects/upper-mississippi-river-basin-tmdl/project-upper-mississippi-river-bacteria.html?menuid=&redirect=1** (accessed 02/2014).

Minnesota Pollution Control Agency. 2013. *DRAFT: Upper Mississippi River Bacteria TMDL Study & Protection Plan.* 274 pp.

Mississippi Watershed Management Organization. 2007. *2006 Annual Monitoring Report.* 54 pp. available at **www.mwmo.org/docs.html** (accessed 02/2014).

Mississippi Watershed Management Organization. 2008. *MWMO Big River Study Report*. 165 pp.

Mississippi Watershed Management Organization. 2009. *Annual Monitoring Report 2007*. MWMO Watershed Bulletin 2009-1. 49 pp. available at **www.mwmo.org/docs.html** (accessed 02/2014).

Mississippi Watershed Management Organization. 2013. *Standard Operating Procedure for Data Processing*. MWMO SOP: Data Processing – 2013. 3 pp.

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

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

Mississippi Watershed Management Organization. 2014. *Sullivan Lake Monitoring Report 2013*. MWMO Watershed Bulletin 2014-4. 8 pp. available at **www.mwmo.org/docs.html** (accessed 03/2014).

Appendix A – Watershed Maps

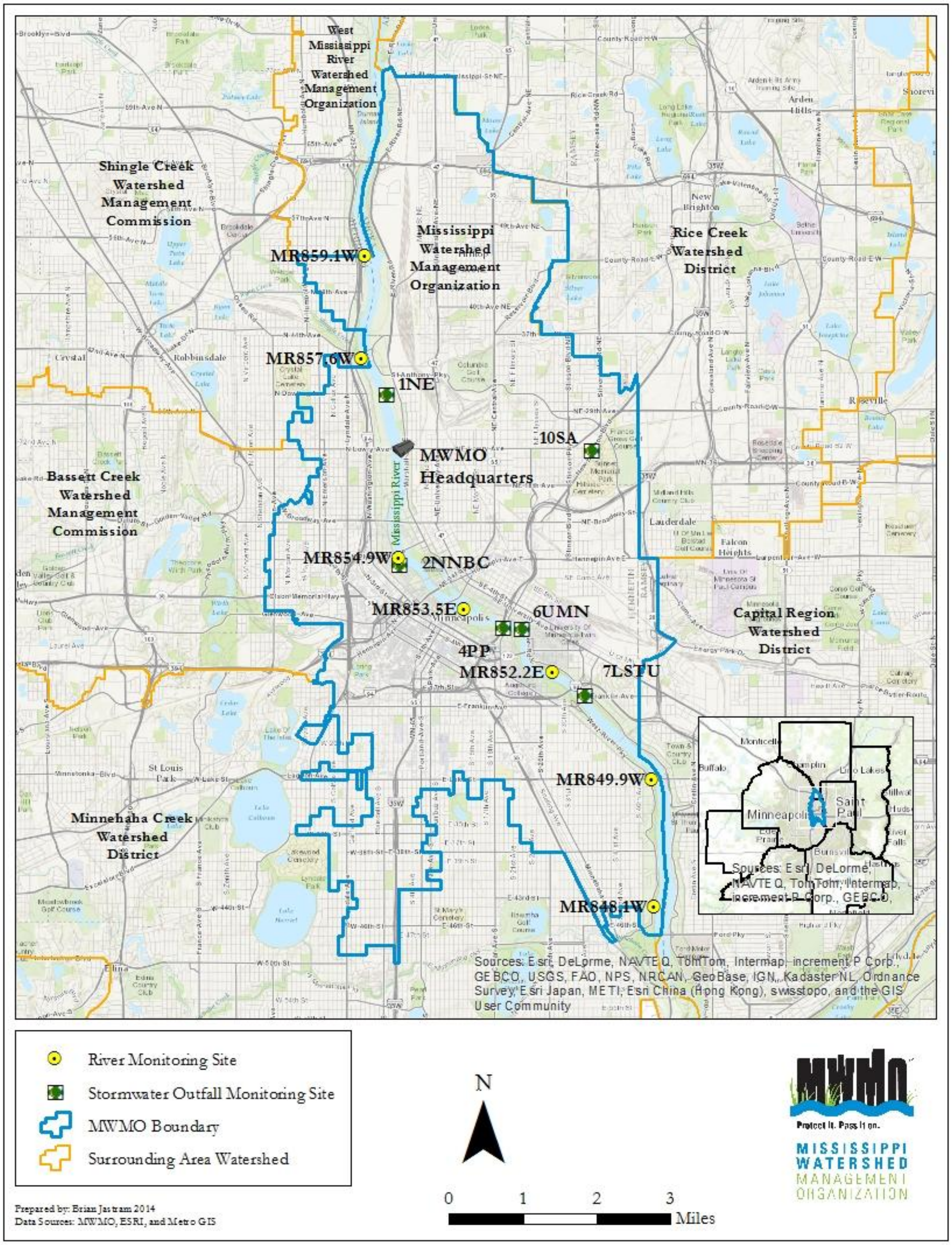

Figure A.1. MWMO watershed boundary, river monitoring sites for bacteria, and stormwater monitoring sites

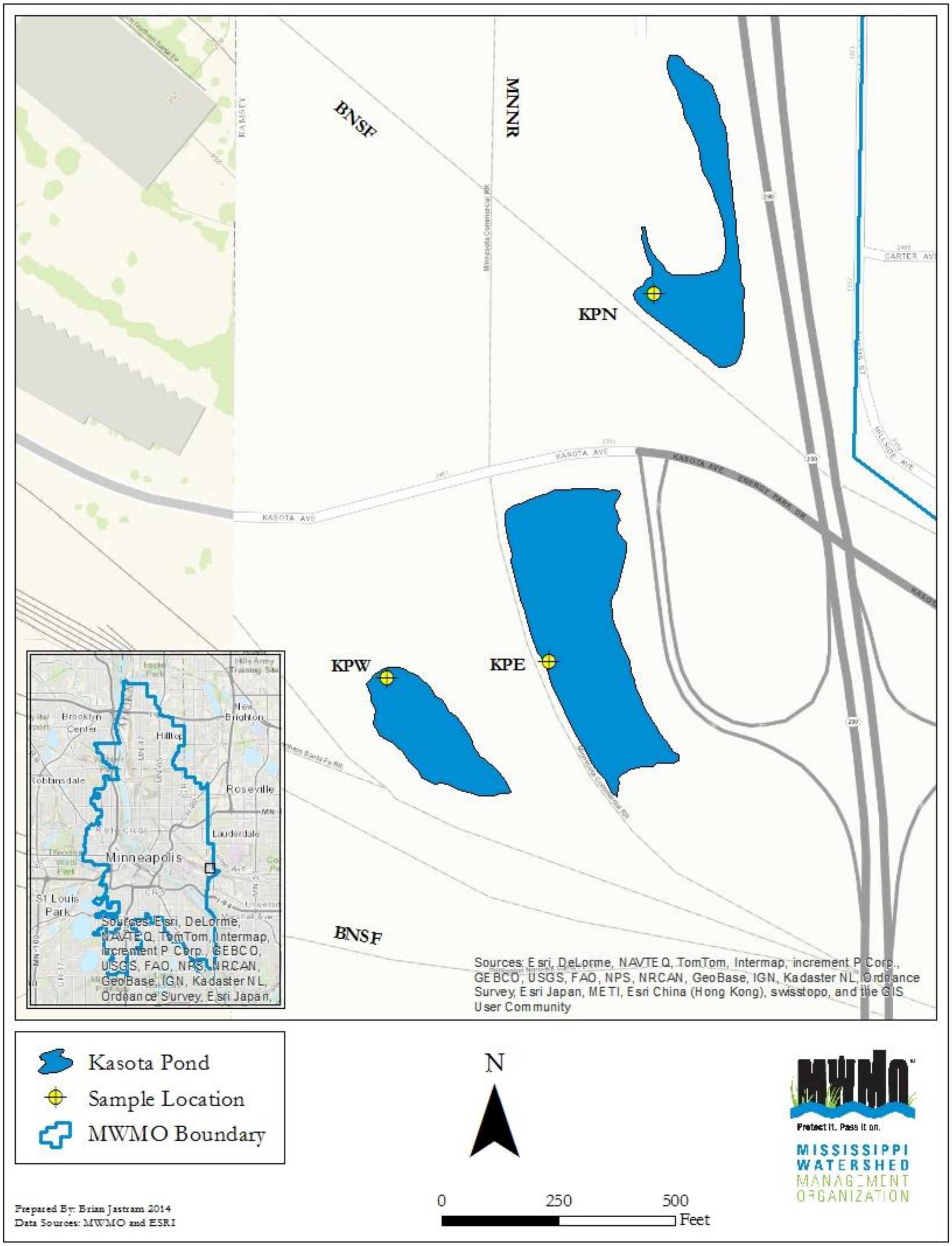

Figure A.2. MWMO wetland (Kasota Ponds) monitoring sites

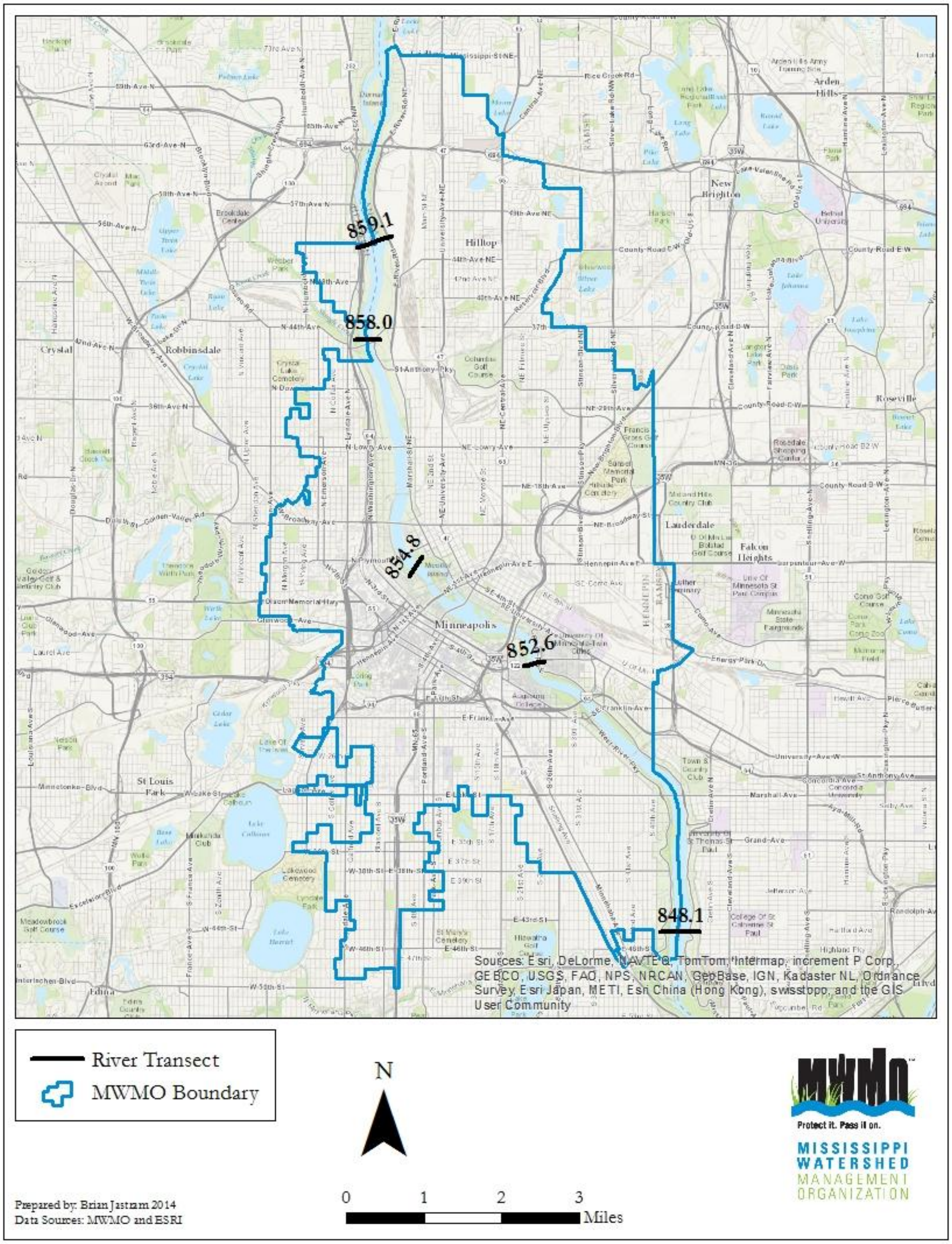

Figure A.3. Mississippi River monitoring locations for hydraulic mixing

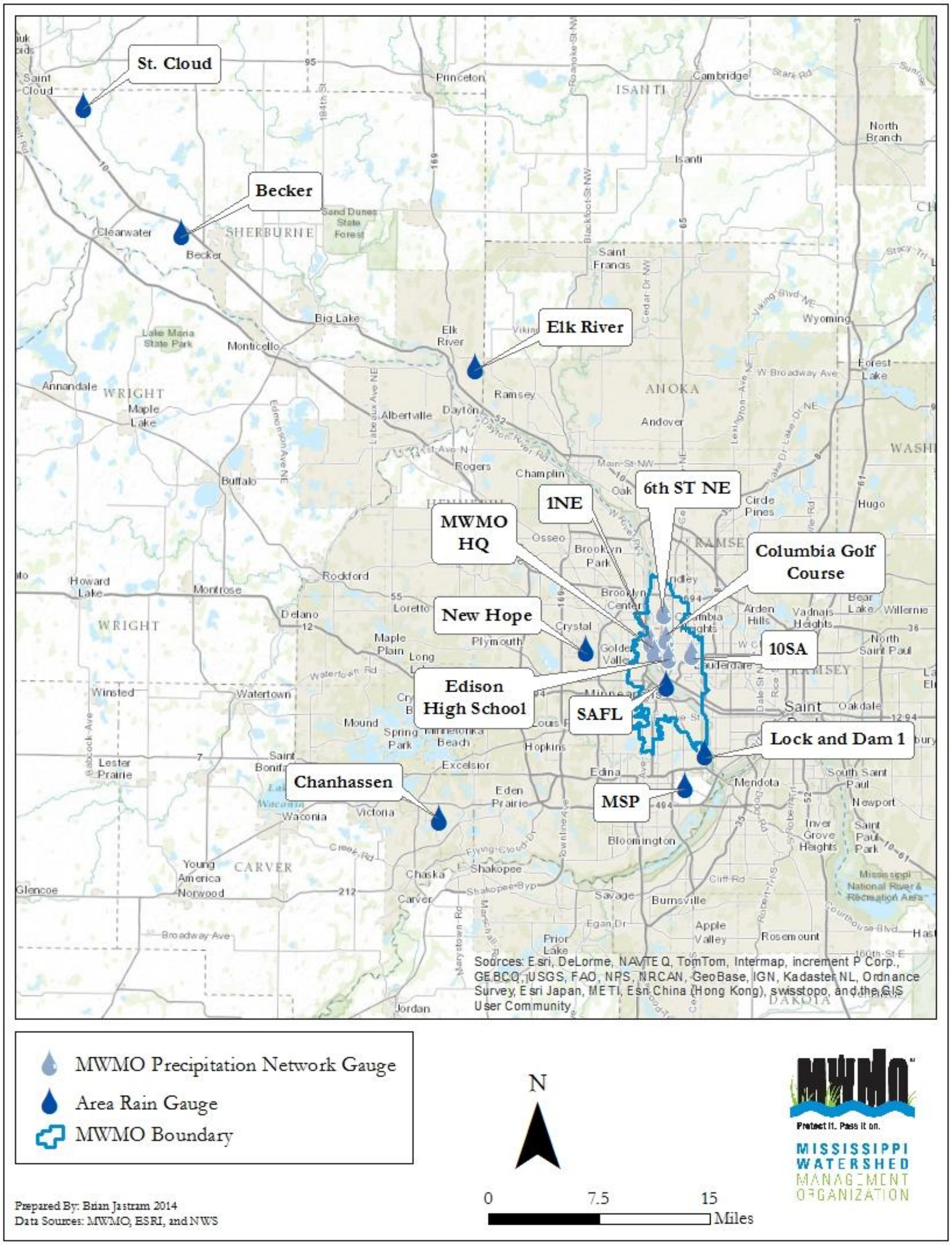

Figure A.4. Precipitation gauges in the Upper Mississippi River Basin

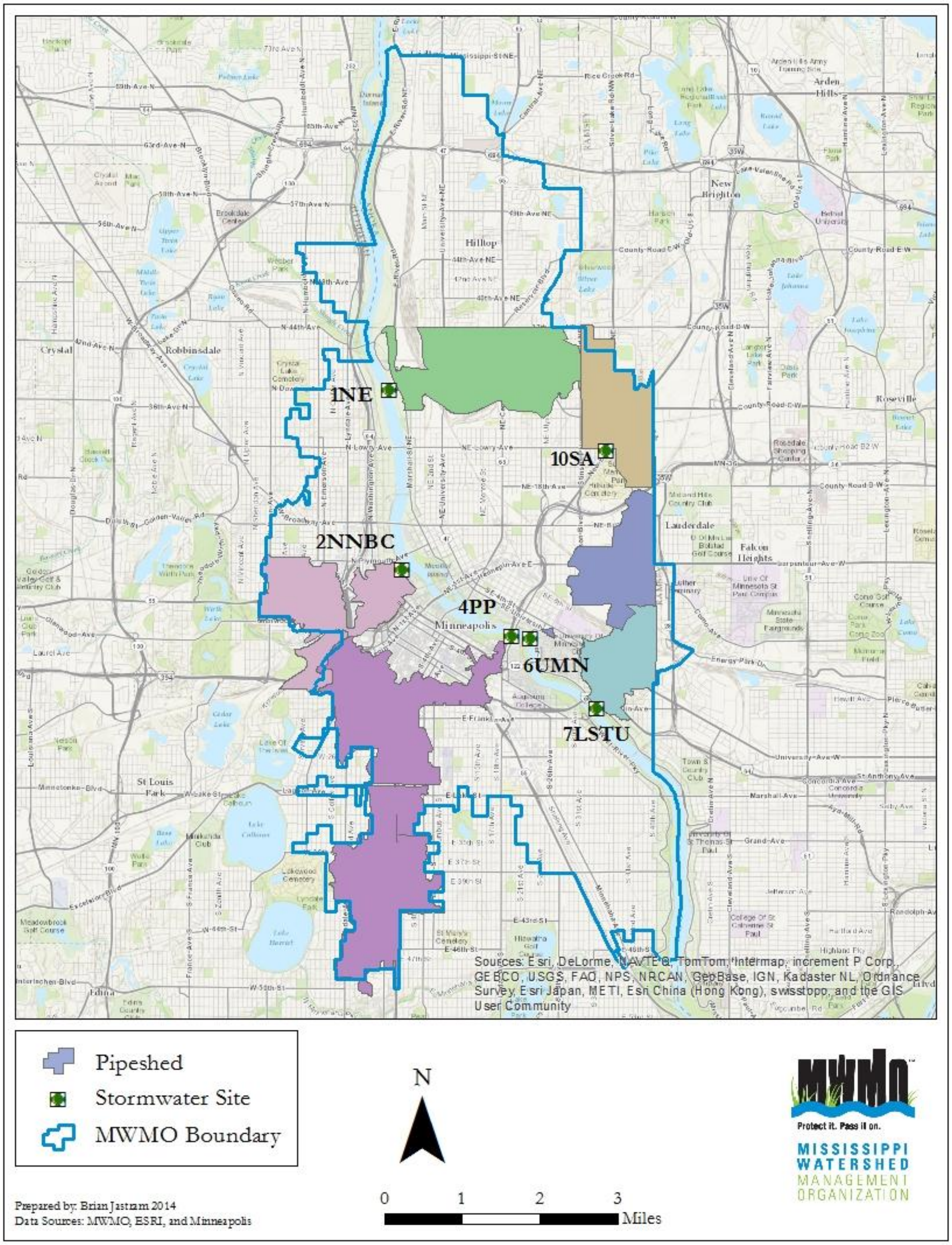

Figure A.5. Stormwater pipesheds monitored by the MWMO

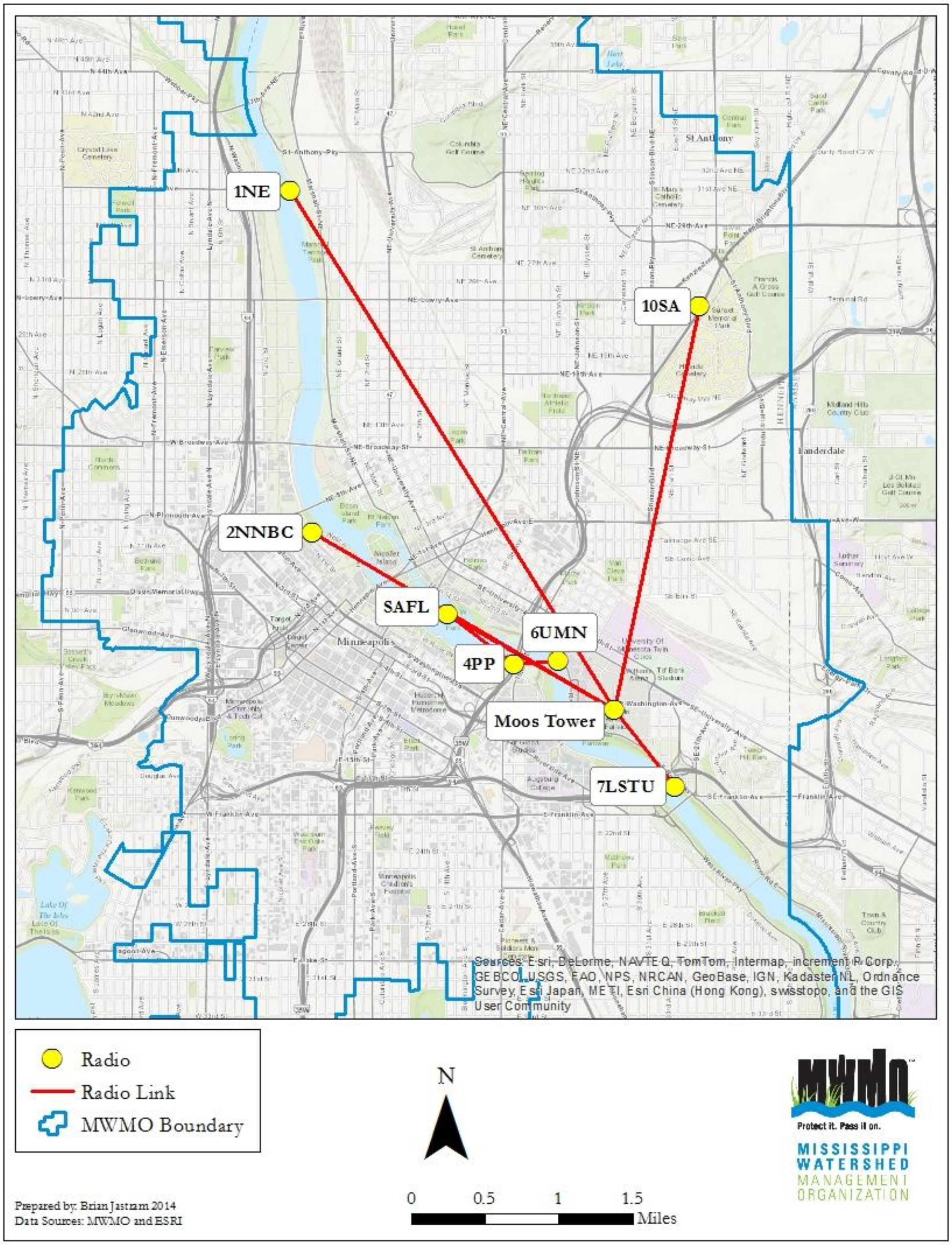

Figure A.6. Remote access real-time data monitoring network

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	1/10/2013 17:10	1/11/13 6:50	0.32	13.75	0.02	Composite	X	—	—	X	X	—
†2	1/28/2013 10:10	1/28/13 16:10	0.27	6.00	0.05	Composite	—	X(l)	—	X(l)	—	—
†3	2/13/2013 12:35	2/13/13 21:15	0.23	8.75	0.03	Composite	—	X(l)	—	X(l)	—	—
†4	2/23/2013 14:13	2/24/13 14:52	n/a	n/a	n/a	Composite	—	X(l)	—	—	—	—
†5	2/24/2013 15:38	2/25/13 19:53	n/a	n/a	n/a	Composite	—	—	—	X(l)	—	—
†6	2/25/2014 14:30	2/25/2014 17:30	n/a	n/a	n/a	Composite	—	X(l)	—	X(l)	—	—
†7	2/27/2013 12:26	2/27/2013 23:20	n/a	n/a	n/a	Composite	—	X(l)	—	X(l)	—	—
†8	2/27/2013 12:29	3/1/2013 13:31	n/a	n/a	n/a	Composite	—	—	—	X(l)	—	—
†9	3/7/2013 13:37	3/7/2013 19:39	n/a	n/a	n/a	Cmp. & Grab	—	X(l)X(l)	—	—	—	—
†10	3/8/2013 9:10	3/8/2013 9:11	n/a	n/a	n/a	Cmp. & Grab	X	X(l)	—	X	X	—
†11	3/9/2013 1:55	3/10/13 3:10	0.51	25.25	0.02	Composite	X(l)	—	—	—	—	—
†12	3/13/2013 14:39	3/15/2013 11:44	n/a	n/a	n/a	Composite	—	X(l)	—	—	—	—
†13	3/15/2013 7:35	3/15/13 14:10	0.13	6.50	0.02		—	—	—	—	—	—
†14	3/28/2013 12:33	3/28/2013 12:23	n/a	n/a	n/a	Cmp. & Grab	X	X	—	X	—	X
†15	3/29/2013 13:19	3/29/2013 14:07	n/a	n/a	n/a	Composite	—	X(l)	—	—	X(l)	—
†16	3/30/2013 4:55	3/30/13 9:15	0.32	4.25	0.08	Composite	X(l)	—	—	—	—	—
17	4/6/2013 16:00	4/6/13 18:00	0.10	2.00	0.05		—	—	—	—	—	—
18	4/7/2013 22:30	4/8/13 4:50	0.74	6.25	0.12	Composite	X	X	—	—	X	—
19	4/9/2013 8:35	4/9/13 12:30	0.20	4.00	0.05		—	—	—	—	—	—
20	4/10/2013 11:45	4/10/13 13:20	0.15	1.50	0.10		—	—	—	—	—	—
†21	4/11/2013 11:15	4/11/13 19:10	0.33	8.00	0.04	Composite	—	X	—	—	—	—
†22	4/12/2013 11:55	4/12/13 16:15	0.18	4.25	0.04	Composite	—	—	—	X	—	—
†23	4/14/2013 13:45	4/14/13 21:40	0.39	8.00	0.05	Composite	X(l)	X(l)	—	X(l)	X(l)	—
†24	4/17/2013 19:00	4/18/13 17:05	0.24	22.00	0.01	Composite	—	—	—	X(l)	—	—
†25	4/19/2013 12:00	4/19/13 19:35	0.21	7.50	0.03	Composite	—	X(l)	—	—	—	—
26	4/20/2013 10:10	4/20/13 11:05	0.10	1.00	0.10		—	—	—	—	—	—
27	4/21/2013 17:30	4/21/13 19:10	0.12	1.75	0.07	Composite	X(l)	—	—	—	—	—
†28	4/22/2013 14:30	4/22/13 18:00	0.12	3.50	0.03	Composite	X(l)	X(l)	—	X(l)	—	—
29	4/23/2013 11:55	4/23/13 13:15	0.25	1.25	0.20		—	—	—	—	—	—
30	4/28/2013 18:00	4/28/2013 20:30	0.16	2.50	0.06	Composite	X(l)	—	—	—	—	—
31	5/1/2013 5:45	5/1/13 14:15	0.21	8.50	0.02	Grab	(ec)	(ec)	(ec)	(ec)	(ec)	—
32	5/3/2013 10:50	5/4/13 7:40	0.18	20.75	0.01		—	—	—	—	—	—
33	5/8/2013 19:50	5/8/13 23:15	0.15	3.50	0.04		—	—	—	—	—	—
34	5/17/2013 14:25	5/17/13 15:55	0.17	1.50	0.11		—	—	—	—	—	—
35	5/18/2013 6:40	5/18/13 11:30	0.91	4.75	0.19	Composite	X(l)	X(l)	—	X(l)	—	—
36	5/19/2013 6:35	5/20/13 2:30	1.14	20.00	0.06	Composite	—	X(l)	—	—	—	—
37	5/20/2013 13:35	5/20/13 23:40	0.33	10.00	0.03		X(l)	—	—	—	—	—
38	5/21/2013 14:45	5/22/13 11:40	0.14	21.00	0.01	Composite	—	X(l)	—	—	—	—
39	5/24/2013 20:45	5/25/13 1:30	0.22	4.75	0.05	Composite	—	X(l)	—	—	—	—
40	5/29/2013 17:00	5/30/13 1:25	0.76	8.00	0.10	Composite	—	X(l)	—	—	—	—
41	5/31/2013 1:35	5/31/13 1:55	0.17	0.25	0.68		—	—	—	—	—	—
42	5/31/2013 15:05	5/31/13 15:20	0.20	0.25	0.80		—	—	—	—	—	—

† 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

Table B.1 continued. 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
43	6/5/2013 4:05	6/5/13 18:30	0.10	14.50	0.01	Grab	X	X	—	—	—	—
44	6/9/2013 2:30	6/9/13 15:00	0.46	12.50	0.04	Composite	X(l)	X(l)	—	—	—	—
45	6/12/2013 9:10	6/12/13 14:10	0.84	5.00	0.17	Cmp. & Grab	X(l)(ec)	X(l)(ec)	—	—	—	—
46	6/15/2013 15:10	6/15/13 16:20	0.72	1.25	0.58	Composite	—	X(l)	—	—	—	—
47	6/21/2013 2:30	6/21/13 6:10	0.94	3.75	0.25	Composite	X	X	—	X	X	—
48	6/21/2013 19:40	6/21/13 20:35	1.28	1.00	1.28	Composite	—	X(l)	—	—	X(l)	—
49	6/22/2013 2:20	6/22/13 6:25	0.33	4.00	0.08		—	—	—	—	—	—
50	6/23/2013 5:55	6/23/13 7:25	0.28	1.50	0.19		—	—	—	—	—	—
51	6/29/2013 3:35	6/29/13 5:35	0.32	2.00	0.16	Composite	—	X(l)	—	—	—	—
52	7/9/2013 8:15	7/9/13 9:10	0.43	1.00	0.43	Cmp. & Grab	(ec)	X(l)(ec)	—	(ec)	X(l)(ec)	(ec)
53	7/13/2013 3:40	7/13/13 7:45	1.75	4.00	0.44	Composite	X(l)	X(l)	—	—	X(l)	—
54	7/30/2013 2:05	7/30/13 10:50	0.03	9.00	0.00	Grab	(ec)	(ec)	—	(ec)	(ec)	—
55	8/5/2013 2:10	8/5/13 4:10	0.50	2.00	0.25	Composite	X	X	—	—	X	—
56	8/6/2013 19:30	8/6/13 21:40	0.53	2.25	0.24	Composite	—	X(l)	—	—	X(l)	—
57	8/29/2013 4:25	8/29/13 5:00	0.27	0.50	0.54	Composite	X(l)	X(l)	—	X(l)	X(l)	—
58	9/14/2013 17:55	9/15/13 11:10	0.39	17.25	0.02	Composite	X(l)	X(l)	—	—	X(l)	—
59	9/17/2013 23:00	9/18/13 6:55	0.05	8.00	0.01	Grab	(ec)	(ec)	—	(ec)	(ec)	—
60	9/19/2013 11:15	9/19/13 12:40	0.25	1.50	0.17	Cmp. & Grab	—	X(l)	X(l)	X(l)	X(l)	X(l)
61	9/28/2013 10:10	9/28/13 13:45	0.13	3.50	0.04		—	—	—	—	—	—
62	10/2/2013 19:25	10/3/13 1:20	1.03	6.00	0.17	Composite	—	X	—	—	X	—
63	10/4/2013 21:40	10/5/13 0:35	0.28	3.00	0.09	Composite	—	X(l)	—	—	—	—
64	10/5/2013 0:11	10/5/13 12:15	0.09	12.00	0.01	Composite	—	—	—	—	X(l)	—
65	10/11/2013 22:40	10/11/13 22:55	0.10	0.25	0.40		—	—	—	—	—	—
66	10/14/2013 20:55	10/16/13 2:30	1.08	29.50	0.04	Cmp. & Grab	X(l)(ec)	X(l)X(l)(ec)	X(l)(ec)	x(ec)	X(l)X(l)(ec)	X(l)(ec)
67	10/17/2013 19:20	10/18/13 4:05	0.39	8.75	0.04	Composite	—	X(l)	—	—	—	—
68	10/30/2013 21:00	10/31/13 6:00	0.12	30.00	0.00	Cmp. & Grab	—	—	—	X(l)	—	—
69	11/4/2013 10:55	11/4/13 11:55	0.12	1.00	0.12	Composite	—	—	—	X(l)	X(l)	—
70	11/5/2013 18:55	11/6/13 10:15	0.20	15.25	0.01	Composite	X(l)	X(l)	—	X(l)	X(l)	—
71	11/16/2013 12:55	11/16/13 19:05	0.10	6.25	0.02	Composite	X(l)	—	—	X(l)	—	—
72	12/2/2013 15:20	12/2/13 21:15	0.16	6.00	0.03	Composite	—	—	—	X(l)	—	—

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 20th 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

Table D.1. Monitoring data for Mississippi River sites

River Mile	Sample Date Sample 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* (MPN/ 100 mL)
MR859.1W	4/4/2013 11:24	Base Grab	43	37.6	15.86	226.9	389.5	8.07	66.5	0.19	24
MR859.1W	4/16/2013 12:30	Base Grab	38	37.6	15.86	228.9	389.5	8.07	64.0	0.19	9
MR859.1W	5/1/2013 11:57	Rain Grab	35	48.9	12.30	247.9	352.9	7.97	49.0	0.17	96
MR859.1W	5/14/2013 12:03	Base Grab	73	55.6	10.90	252.0	325.9	8.05	52.0	0.16	14
MR859.1W	5/29/2013 12:50	Base Grab	75	59.2	10.67	280.6	346.4	7.83	60.0	0.17	25
MR859.1W	6/6/2013 11:05	Base Grab	52	59.2	10.19	285.4	351.9	7.98	50.0	0.17	52
MR859.1W	6/12/2013 12:40	Rain Grab	65	62.1	10.18	270.5	321.4	7.88	40.0	0.15	1,733
MR859.1W	6/19/2013 12:22	Base Grab	81	70.5	9.83	387.3	415.7	8.12	38.0	0.20	64
MR859.1W	7/2/2013 11:20	Base Grab	76	73.4	8.17	362.2	376.8	7.79	44.0	0.18	64
MR859.1W	7/9/2013 12:47	Rain Grab	78	78.3	7.36	431.7	426.1	8.03	42.0	0.20	517
MR859.1W	7/16/2013 13:12	Base Grab	89	79.0	2.34	438.8	429.8	8.01	39.0	0.20	70
MR859.1W	7/30/2013 12:36	Rain Grab	71	70.9	—	413.5	442.5	8.24	90.0	0.21	52
MR859.1W	8/8/2013 12:50	Base Grab	71	74.7	10.42	467.4	479.1	8.67	> 100.0	0.23	40
MR859.1W	8/20/2013 12:36	Base Grab	88	77.4	9.43	421.3	419.4	8.59	89.0	0.20	13
MR859.1W	9/5/2013 12:45	Base Grab	80	73.9	9.75	416.5	430.3	8.64	95.0	0.21	19
MR859.1W	9/18/2013 13:42	Rain Grab	73	66.2	9.67	350.0	395.7	8.64	> 100.0	0.19	122
MR859.1W	10/1/2013 12:26	Base Grab	71	65.7	11.20	367.6	417.5	8.72	> 100.0	0.21	46
MR859.1W	10/15/2013 13:41	Rain Grab	52	55.6	9.82	312.7	404.9	8.35	> 100.0	0.20	461
MR859.1W	10/29/2013 13:42	Base Grab	37	43.3	14.04	252.0	391.7	8.58	> 100.0	0.19	18
MR859.1W	10/31/2013 13:20	Rain Grab	44	44.4	13.62	250.7	383.2	8.44	> 100.0	0.18	32
MR859.1W	11/14/2013 12:53	Base Grab	41	37.9	16.67	238.4	407.4	8.81	100.0	0.19	19
MR857.6W	4/4/2013 11:17	Base Grab	44	37.0	15.36	298.2	517.1	7.93	—	0.25	27
MR857.6W	4/16/2013 12:27	Base Grab	38	37.0	15.65	336.3	583.7	7.78	89.0	0.28	33
MR857.6W	5/1/2013 11:41	Rain Grab	35	49.3	12.04	287.3	406.7	7.97	55.0	0.20	96
MR857.6W	5/14/2013 11:50	Base Grab	71	55.6	10.72	274.7	355.5	7.90	58.0	0.17	8
MR857.6W	5/29/2013 12:32	Base Grab	74	59.4	10.46	309.4	381.0	7.92	68.0	0.18	27
MR857.6W	6/6/2013 10:46	Base Grab	51	59.0	9.93	322.0	398.5	8.02	60.0	0.19	57
MR857.6W	6/12/2013 12:25	Rain Grab	65	62.1	9.51	308.7	367.0	7.77	34.0	0.18	> 2,420
MR857.6W	6/19/2013 12:11	Base Grab	79	70.0	9.27	452.9	489.1	8.07	44.0	0.24	39
MR857.6W	7/2/2013 11:10	Base Grab	75	73.0	8.21	384.1	400.7	7.72	38.0	0.19	68
MR857.6W	7/9/2013 12:31	Rain Grab	78	77.9	7.13	480.5	475.9	7.98	54.0	0.23	1,986
MR857.6W	7/16/2013 12:59	Base Grab	88	78.4	.09	459.5	452.6	8.05	34.0	0.22	133
MR857.6W	7/30/2013 12:20	Rain Grab	71	71.1	8.95	413.1	441.0	8.36	75.0	0.21	135
MR857.6W	8/8/2013 12:35	Base Grab	71	73.2	8.91	420.2	438.1	8.60	> 100.0	0.21	40
MR857.6W	8/20/2013 12:24	Base Grab	88	75.9	8.95	445.0	449.7	8.56	95.0	0.22	20
MR857.6W	9/5/2013 12:25	Base Grab	80	72.7	8.77	422.7	442.9	8.65	50.0	0.21	44
MR857.6W	9/18/2013 13:30	Rain Grab	73	65.5	9.17	365.1	416.2	8.57	100.0	0.20	105
MR857.6W	10/1/2013 12:11	Base Grab	70	65.3	9.81	376.2	430.0	8.60	> 100.0	0.21	66
MR857.6W	10/15/2013 13:29	Rain Grab	54	54.3	10.08	319.0	419.7	8.33	> 100.0	0.20	2,240
MR857.6W	10/29/2013 13:10	Base Grab	37	43.2	14.01	253.9	395.7	8.51	> 100.0	0.19	19
MR857.6W	10/31/2013 13:03	Rain Grab	44	44.6	13.27	296.2	451.4	8.30	> 100.0	0.22	46
MR857.6W	11/14/2013 12:37	Base Grab	41	37.4	16.24	249.1	429.9	8.68	100.0	0.21	28

Table D.1 continued. Monitoring data for Mississippi River sites

River Mile	Sample Date Sample 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* (MPN/ 100 mL)
MR854.9W	4/4/2013 10:36	Base Grab	42	36.7	14.78	216.8	378.6	7.76	—	0.18	15
MR854.9W	4/16/2013 11:39	Base Grab	36	35.8	15.26	206.4	367.4	7.63	71.0	0.17	10
MR854.9W	5/1/2013 11:11	Rain Grab	35	49.6	12.14	237.9	335.5	7.92	45.0	0.16	28
MR854.9W	5/14/2013 11:12	Base Grab	73	55.4	10.56	230.5	298.8	7.84	60.0	0.14	10
MR854.9W	5/29/2013 12:05	Base Grab	72	59.0	10.43	262.6	324.7	7.89	60.0	0.16	32
MR854.9W	6/6/2013 9:43	Base Grab	50	59.4	10.05	274.0	337.2	8.08	54.0	0.16	40
MR854.9W	6/12/2013 11:37	Rain Grab	60	62.2	9.64	268.7	318.6	7.67	35.0	0.15	1,168
MR854.9W	6/19/2013 11:30	Base Grab	76	70.3	9.39	359.4	386.5	8.25	50.0	0.19	28
MR854.9W	7/2/2013 10:40	Base Grab	75	73.6	8.32	343.2	356.1	7.84	38.0	0.17	54
MR854.9W	7/9/2013 11:51	Rain Grab	77	78.6	7.25	403.1	396.4	8.05	55.0	0.19	816
MR854.9W	7/16/2013 12:15	Base Grab	88	78.8	5.65	410.7	403.2	8.08	41.0	0.19	118
MR854.9W	7/30/2013 12:00	Rain Grab	70	70.9	9.07	364.6	390.1	8.39	57.0	0.19	102
MR854.9W	8/8/2013 11:55	Base Grab	69	73.4	8.40	384.2	399.5	8.59	89.0	0.19	46
MR854.9W	8/20/2013 11:46	Base Grab	85	77.5	8.81	422.1	419.5	8.53	89.0	0.20	5
MR854.9W	9/5/2013 11:42	Base Grab	75	74.1	9.40	411.2	424.2	8.71	69.0	0.20	36
MR854.9W	9/18/2013 12:42	Rain Grab	71	65.7	9.33	347.4	394.0	8.61	100.0	0.19	130
MR854.9W	10/1/2013 11:23	Base Grab	68	65.8	10.07	373.5	423.8	8.61	> 100.0	0.20	40
MR854.9W	10/15/2013 12:31	Rain Grab	54	55.2	10.15	296.6	385.7	8.46	> 100.0	0.19	1,046
MR854.9W	10/29/2013 12:16	Base Grab	37	43.2	13.47	234.3	365.7	8.48	> 100.0	0.18	24
MR854.9W	10/31/2013 12:35	Rain Grab	43	43.7	13.53	238.3	368.4	8.31	> 100.0	0.18	96
MR854.9W	11/14/2013 11:51	Base Grab	40	36.1	15.46	222.1	391.9	8.50	100.0	0.19	18
MR853.5E	4/4/2013 10:21	Base Grab	42	36.0	15.20	210.3	372.6	7.99	46.0	0.18	18
MR853.5E	4/16/2013 11:20	Base Grab	36	34.7	15.54	189.9	344.4	7.80	53.5	0.16	17
MR853.5E	5/1/2013 10:56	Rain Grab	35	50.2	12.27	223.5	312.2	7.65	—	0.15	18
MR853.5E	5/14/2013 10:44	Base Grab	71	55.4	10.70	217.9	282.4	7.91	41.0	0.14	7
MR853.5E	5/29/2013 11:45	Base Grab	70	58.5	10.94	229.0	285.4	8.08	—	0.14	42
MR853.5E	6/6/2013 9:20	Base Grab	50	59.5	10.14	252.9	310.5	8.11	50.0	0.15	31
MR853.5E	6/12/2013 11:10	Rain Grab	59	62.2	9.93	257.0	304.6	7.75	—	0.15	162
MR853.5E	6/19/2013 11:10	Base Grab	76	70.0	8.90	330.6	356.9	8.27	36.0	0.17	29
MR853.5E	7/2/2013 10:10	Base Grab	73	—	—	—	—	—	—	—	43
MR853.5E	7/9/2013 11:30	Rain Grab	76	78.3	7.71	370.6	365.5	8.15	32.0	0.17	172
MR853.5E	7/16/2013 11:55	Base Grab	87	78.1	7.52	377.8	373.8	8.21	30.0	0.18	70
MR853.5E	7/30/2013 11:43	Rain Grab	69	69.4	.99	349.6	379.9	8.49	74.0	0.18	38
MR853.5E	8/8/2013 11:30	Base Grab	68	72.7	8.55	375.1	392.8	8.59	91.0	0.19	31
MR853.5E	8/20/2013 11:17	Base Grab	82	74.3	8.17	414.1	411.9	8.61	87.0	0.20	15
MR853.5E	9/5/2013 11:17	Base Grab	75	73.9	8.42	409.4	423.4	8.70	79.0	0.20	34
MR853.5E	9/18/2013 12:16	Rain Grab	71	65.5	9.22	339.3	387.0	8.65	90.0	0.19	75
MR853.5E	10/1/2013 10:59	Base Grab	67	65.5	9.46	360.3	410.4	8.71	72.0	0.20	49
MR853.5E	10/15/2013 12:04	Rain Grab	54	55.6	10.48	288.3	372.9	8.52	> 100.0	0.18	1,986
MR853.5E	10/29/2013 11:53	Base Grab	37	43.2	13.76	226.9	353.6	8.56	> 100.0	0.17	15
MR853.5E	10/31/2013 11:45	Rain Grab	43	43.5	13.41	227.5	353.4	8.39	> 100.0	0.17	28
MR853.5E	11/14/2013 11:22	Base Grab	40	36.0	15.50	214.1	379.2	8.58	100.0	0.18	20

Table D.1 continued. Monitoring data for Mississippi River sites

River Mile	Sample Date Sample 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* (MPN/ 100 mL)
MR852.2E	4/4/2013 9:20	Base Grab	38	36.5	15.86	232.1	407.4	7.28	58.0	0.19	46
MR852.2E	4/16/2013 10:21	Base Grab	35	35.4	17.03	197.9	354.2	7.24	64.0	0.17	22
MR852.2E	5/1/2013 10:00	Rain Grab	36	50.7	12.46	232.5	332.4	7.26	43.0	0.15	30
MR852.2E	5/14/2013 9:50	Base Grab	73	55.2	11.54	228.8	297.2	7.64	43.0	0.14	19
MR852.2E	5/29/2013 10:45	Base Grab	70	58.5	11.03	242.5	301.6	7.87	55.0	0.14	56
MR852.2E	6/6/2013 8:33	Base Grab	50	59.5	10.78	262.0	321.9	7.94	59.0	0.15	36
MR852.2E	6/12/2013 10:25	Rain Grab	61	62.4	10.15	223.4	264.3	7.70	33.0	0.13	> 2,420
MR852.2E	6/19/2013 9:30	Base Grab	73	70.0	9.54	345.0	372.6	7.98	37.0	0.18	43
MR852.2E	7/2/2013 9:12	Base Grab	69	73.4	9.39	307.8	319.9	7.88	31.5	0.15	55
MR852.2E	7/9/2013 9:54	Rain Grab	71	77.4	8.06	348.5	347.4	8.08	33.0	0.16	1,484
MR852.2E	7/16/2013 10:09	Base Grab	84	77.7	9.19	404.2	400.9	7.95	40.0	0.19	62
MR852.2E	7/30/2013 10:41	Rain Grab	67	69.1	—	358.1	391.1	8.03	76.0	0.19	60
MR852.2E	8/8/2013 9:48	Base Grab	68	73.8	8.45	394.3	408.1	8.66	88.0	0.20	56
MR852.2E	8/20/2013 9:34	Base Grab	72	77.4	6.47	425.1	423.8	8.56	73.0	0.20	5
MR852.2E	9/5/2013 9:41	Base Grab	70	72.0	8.70	414.3	437.4	8.51	65.0	0.21	34
MR852.2E	9/18/2013 10:12	Rain Grab	67	65.3	9.06	351.2	400.9	8.63	91.0	0.19	147
MR852.2E	10/1/2013 9:26	Base Grab	66	65.5	9.48	381.8	435.0	8.57	72.0	0.21	43
MR852.2E	10/15/2013 10:28	Rain Grab	54	56.1	10.42	307.5	394.8	8.53	> 100.0	0.19	770
MR852.2E	10/29/2013 9:41	Base Grab	36	43.2	13.96	236.4	369.3	8.43	> 100.0	0.18	19
MR852.2E	10/31/2013 11:17	Rain Grab	43	43.7	13.63	242.3	374.6	8.37	> 100.0	0.18	30
MR852.2E	11/14/2013 8:55	Base Grab	38	36.5	15.80	226.5	397.7	8.59	100.0	0.19	46
MR849.9W	4/4/2013 9:03	Base Grab	41	35.8	15.50	216.1	384.8	7.66	61.0	0.18	29
MR849.9W	4/16/2013 9:52	Base Grab	34	34.9	16.45	198.9	360.2	7.29	65.5	0.17	16
MR849.9W	5/1/2013 9:40	Rain Grab	36	50.9	12.60	239.3	331.0	7.35	36.0	0.16	66
MR849.9W	5/14/2013 9:20	Base Grab	74	55.0	11.28	227.0	295.9	7.25	49.0	0.14	6
MR849.9W	5/29/2013 9:58	Base Grab	69	58.3	11.29	249.0	310.7	7.93	60.0	0.15	33
MR849.9W	6/6/2013 8:12	Base Grab	50	59.4	10.73	265.8	327.2	7.87	54.0	0.16	53
MR849.9W	6/12/2013 10:05	Rain Grab	62	62.4	10.05	275.1	325.7	7.70	46.0	0.16	727
MR849.9W	6/19/2013 9:15	Base Grab	72	70.3	10.05	350.2	376.7	7.99	34.0	0.18	37
MR849.9W	7/2/2013 8:50	Base Grab	69	73.9	9.03	322.3	334.0	7.75	39.0	0.16	56
MR849.9W	7/9/2013 9:05	Rain Grab	70	77.7	8.02	353.2	350.7	8.15	42.0	0.17	> 2,420
MR849.9W	7/16/2013 9:47	Base Grab	83	77.7	8.82	396.9	393.7	7.87	38.0	0.19	72
MR849.9W	7/30/2013 10:20	Rain Grab	66	70.7	8.91	362.1	388.1	8.17	62.0	0.19	26
MR849.9W	8/8/2013 9:25	Base Grab	68	75.2	7.86	390.6	397.9	8.62	89.0	0.19	70
MR849.9W	8/20/2013 9:11	Base Grab	71	75.6	7.80	417.9	424.4	8.46	88.0	0.20	9
MR849.9W	9/5/2013 9:18	Base Grab	70	72.7	8.34	420.4	440.7	8.42	70.0	0.21	62
MR849.9W	9/18/2013 9:50	Rain Grab	66	64.4	8.98	346.0	399.7	8.55	100.0	0.19	687
MR849.9W	10/1/2013 9:13	Base Grab	66	64.4	9.64	372.4	429.4	8.51	78.0	0.21	70
MR849.9W	10/15/2013 9:35	Rain Grab	53	55.9	10.36	286.8	369.1	8.46	> 100.0	0.18	816
MR849.9W	10/29/2013 9:18	Base Grab	36	43.3	13.93	236.1	367.3	8.44	> 100.0	0.18	21
MR849.9W	10/31/2013 11:00	Rain Grab	43	43.7	13.62	238.3	368.8	8.38	> 100.0	0.18	63
MR849.9W	11/14/2013 8:26	Base Grab	37	36.7	15.57	222.3	388.5	8.71	—	0.19	24

Table D.1 continued. Monitoring data for Mississippi River sites

River Mile	Sample Date Sample 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* (MPN/ 100 mL)
MR848.1W	4/4/2013 8:36	Base Grab	39	37.2	14.90	221.5	383.8	7.37	81.5	0.18	24
MR848.1W	4/16/2013 9:51	Base Grab	36	35.2	16.85	199.3	358.5	7.12	63.0	0.17	11
MR848.1W	5/1/2013 9:27	Rain Grab	35	50.4	12.79	236.1	328.9	7.45	41.0	0.16	57
MR848.1W	5/14/2013 8:56	Base Grab	70	54.7	11.42	224.3	294.1	7.56	45.0	0.14	12
MR848.1W	5/29/2013 9:25	Base Grab	65	58.1	11.07	244.4	305.2	7.78	49.0	0.15	46
MR848.1W	6/6/2013 7:55	Base Grab	49	59.2	10.77	265.0	326.5	7.40	54.0	0.16	39
MR848.1W	6/12/2013 9:40	Rain Grab	61	62.4	10.40	272.5	322.6	7.68	53.0	0.15	50
MR848.1W	6/19/2013 8:55	Base Grab	71	70.3	9.59	348.8	375.2	7.80	36.0	0.18	16
MR848.1W	7/2/2013 8:30	Base Grab	67	73.9	9.11	321.9	333.0	7.51	42.0	0.16	54
MR848.1W	7/9/2013 8:53	Rain Grab	71	78.3	7.73	391.4	386.4	8.08	52.0	0.18	73
MR848.1W	7/16/2013 9:30	Base Grab	83	77.4	7.33	394.8	393.5	7.51	37.0	0.19	79
MR848.1W	7/30/2013 10:10	Rain Grab	67	70.2	8.07	362.4	390.5	7.99	76.0	0.19	25
MR848.1W	8/8/2013 9:00	Base Grab	67	74.8	7.80	389.8	398.8	8.46	91.0	0.19	53
MR848.1W	8/20/2013 8:49	Base Grab	70	75.0	7.70	418.0	427.0	8.15	85.0	0.20	7
MR848.1W	9/5/2013 9:01	Base Grab	69	73.4	8.92	420.8	437.8	8.05	65.0	0.21	35
MR848.1W	9/18/2013 9:21	Rain Grab	66	64.4	9.03	348.9	403.0	8.50	92.0	0.19	63
MR848.1W	10/1/2013 8:54	Base Grab	65	65.1	9.50	373.4	427.7	8.55	76.0	0.21	48
MR848.1W	10/15/2013 9:15	Rain Grab	52	56.1	10.21	286.4	368.3	8.42	> 100.0	0.18	1,203
MR848.1W	10/29/2013 8:56	Base Grab	36	44.1	13.90	237.2	364.6	8.49	> 100.0	0.18	16
MR848.1W	10/31/2013 10:42	Rain Grab	43	43.7	13.69	237.7	367.8	8.38	> 100.0	0.18	111
MR848.1W	11/14/2013 8:06	Base Grab	37	36.1	15.80	219.2	387.6	8.54	100.0	0.18	13

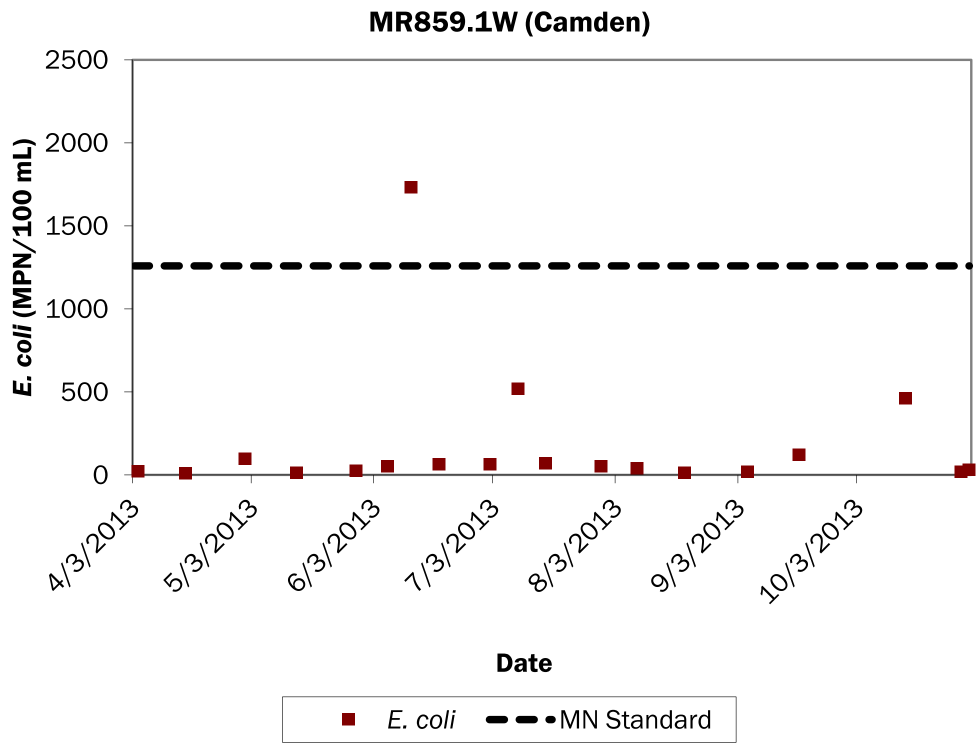

Figure D.1. *E.coli* data for MR859.1W

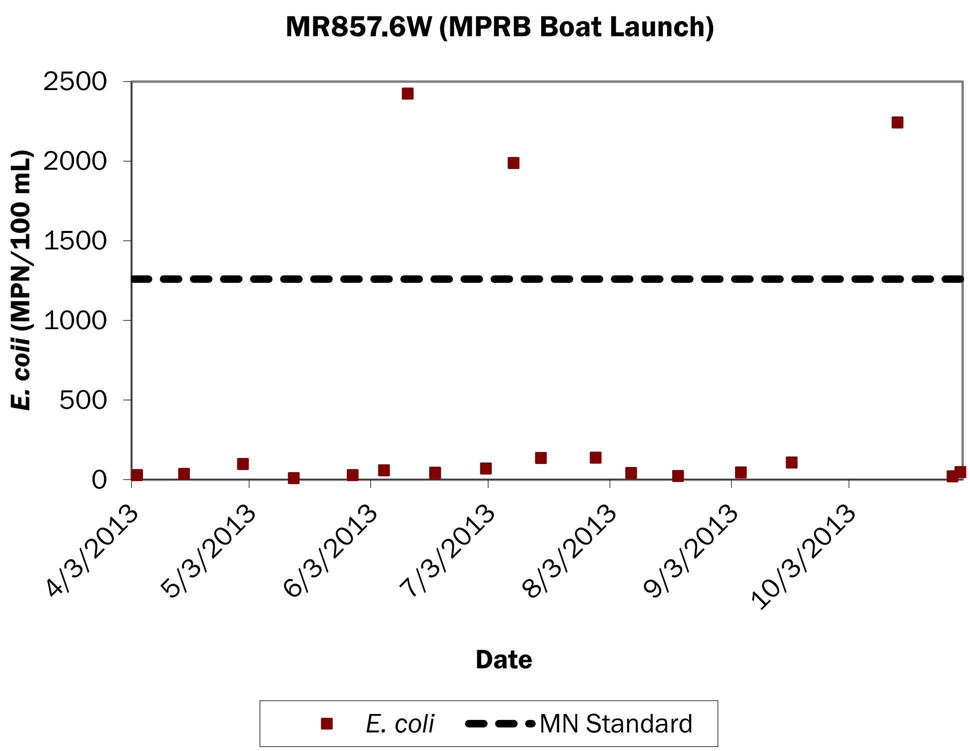

Figure D.2. *E.coli* data for MR857.6W

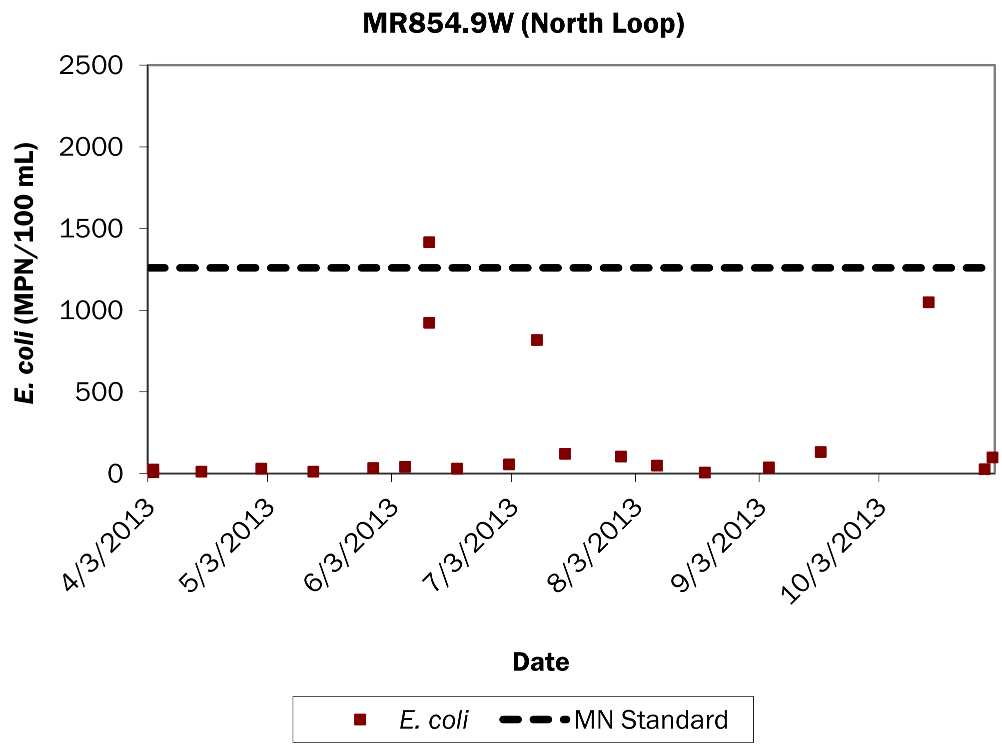

Figure D.3. *E.coli* data for MR854.9W

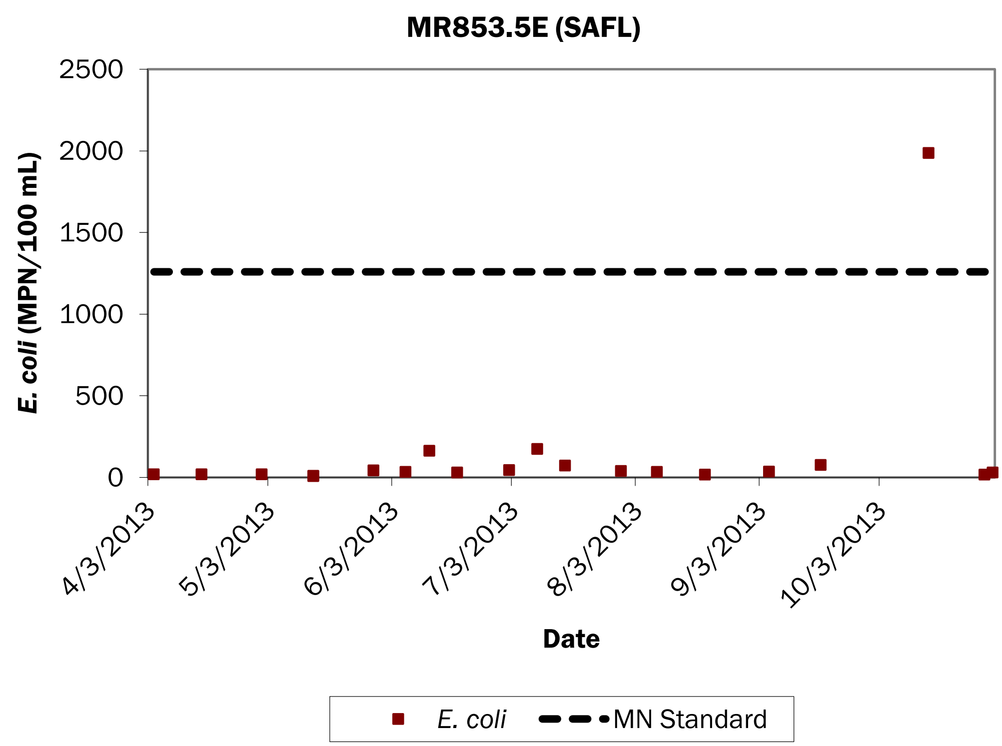

Figure D.4. *E. coli* data for MR853.5E

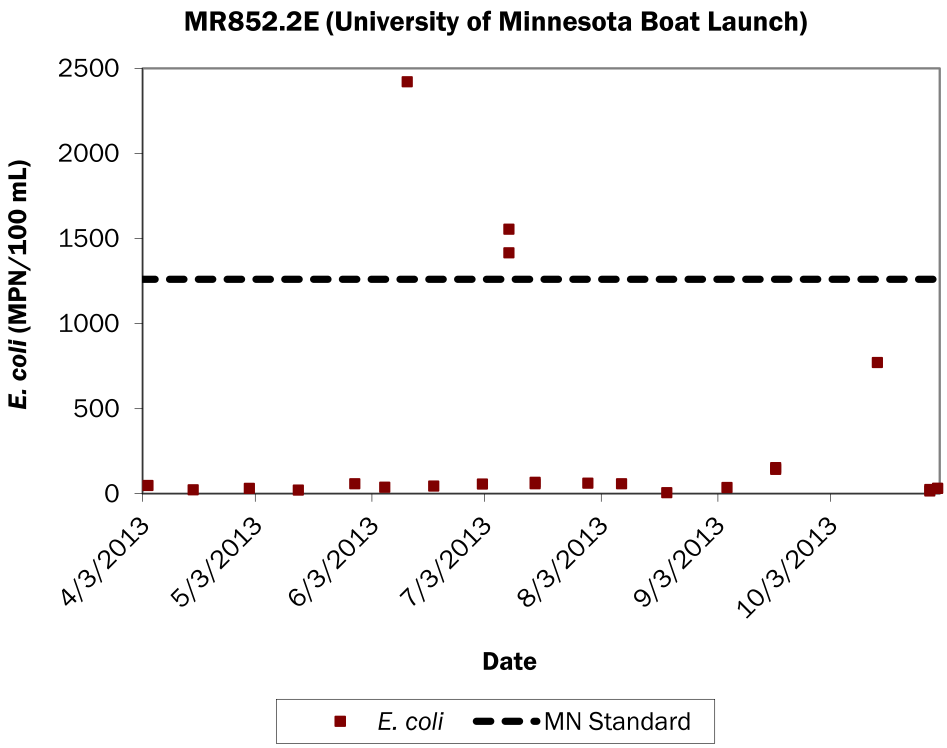

Figure D.5. *E. coli* data for MR852.2E

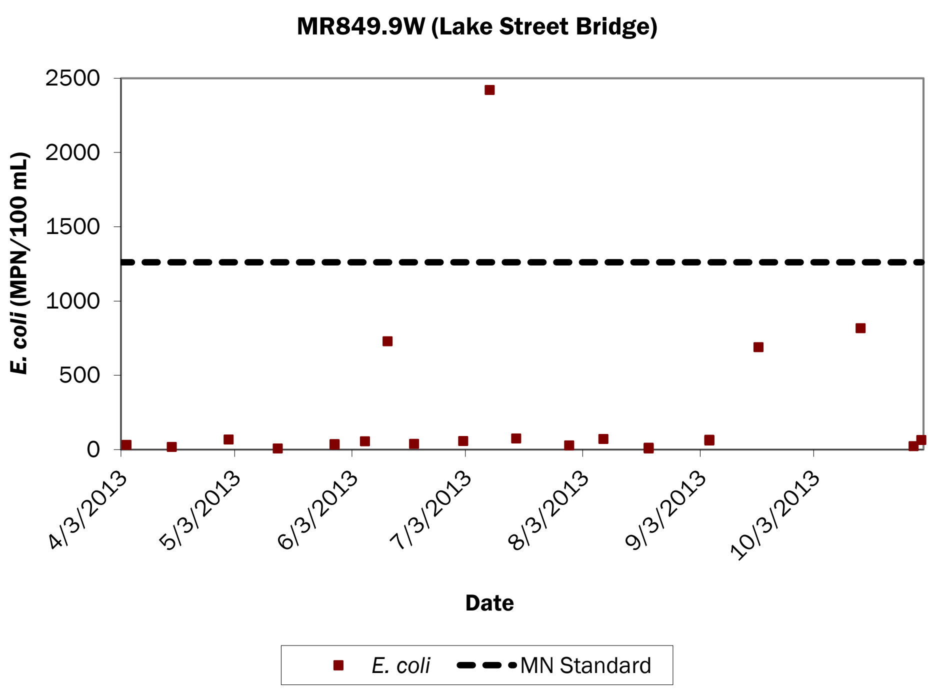

Figure D.6. *E. coli* data for MR849.9W

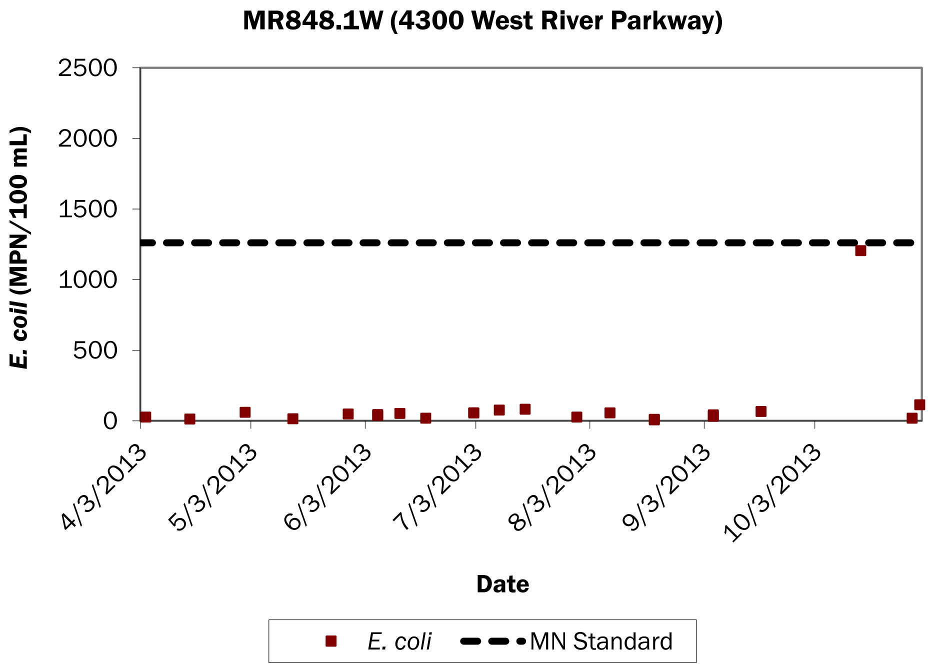

Figure D.7. *E.coli* data for MR848.1W

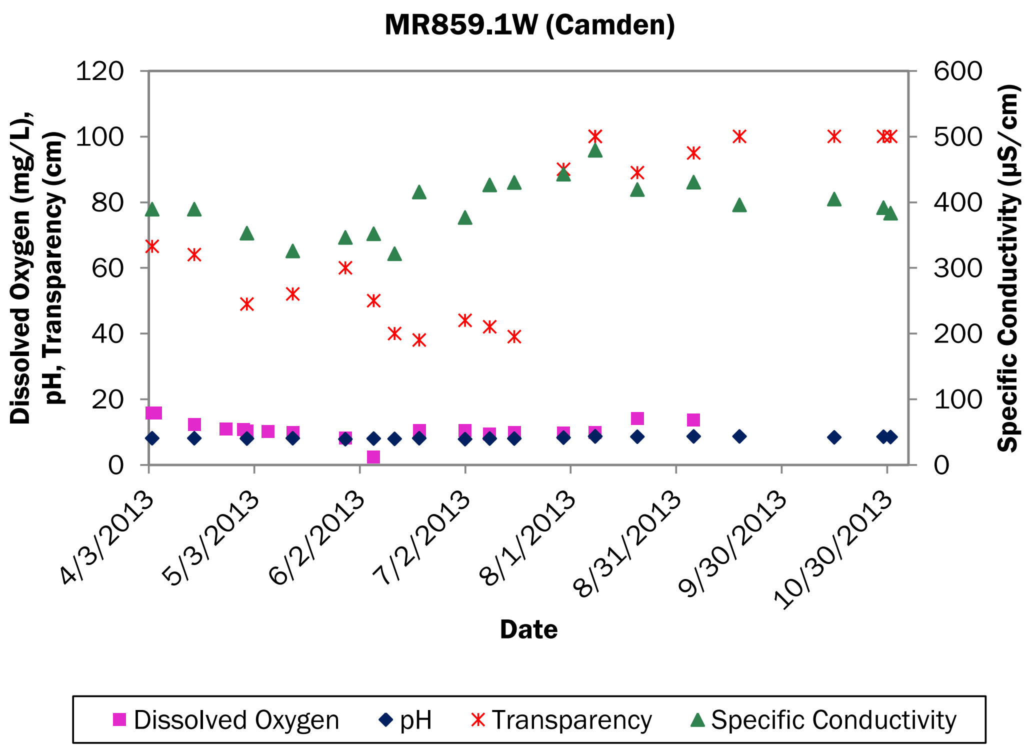

Figure D.8. Dissolved oxygen, pH, transparency, and specific conductivity for MR859.1W

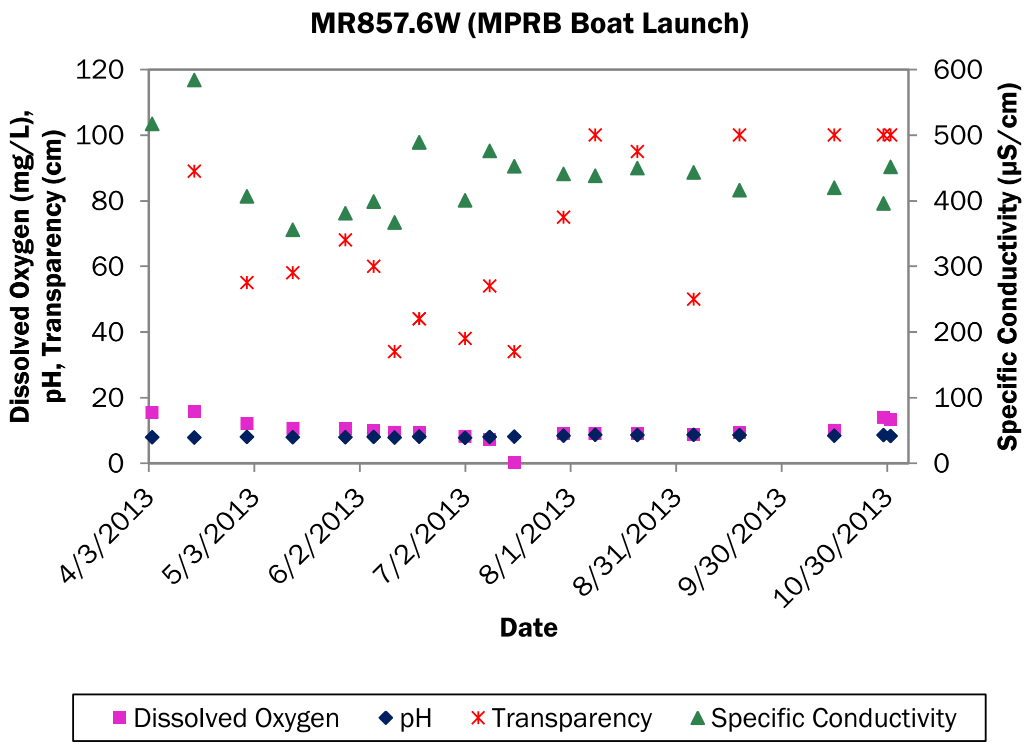

Figure D.9. Dissolved oxygen, pH, transparency, and specific conductivity for MR857.6W

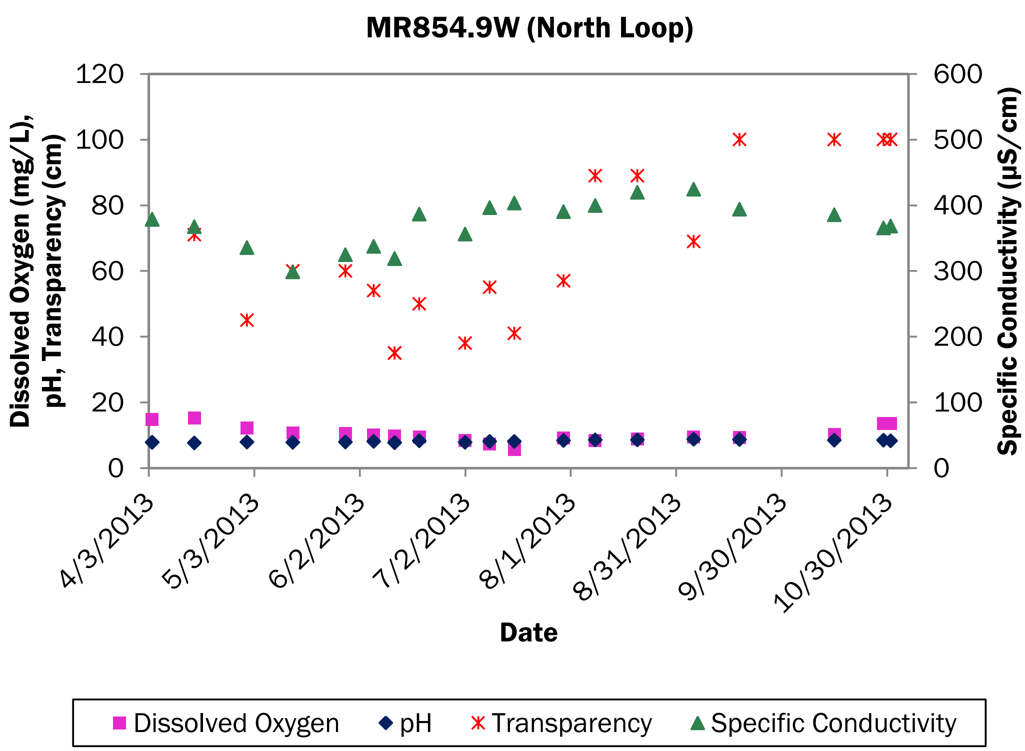

Figure D.10. Dissolved oxygen, pH, transparency, and specific conductivity for MR854.9W

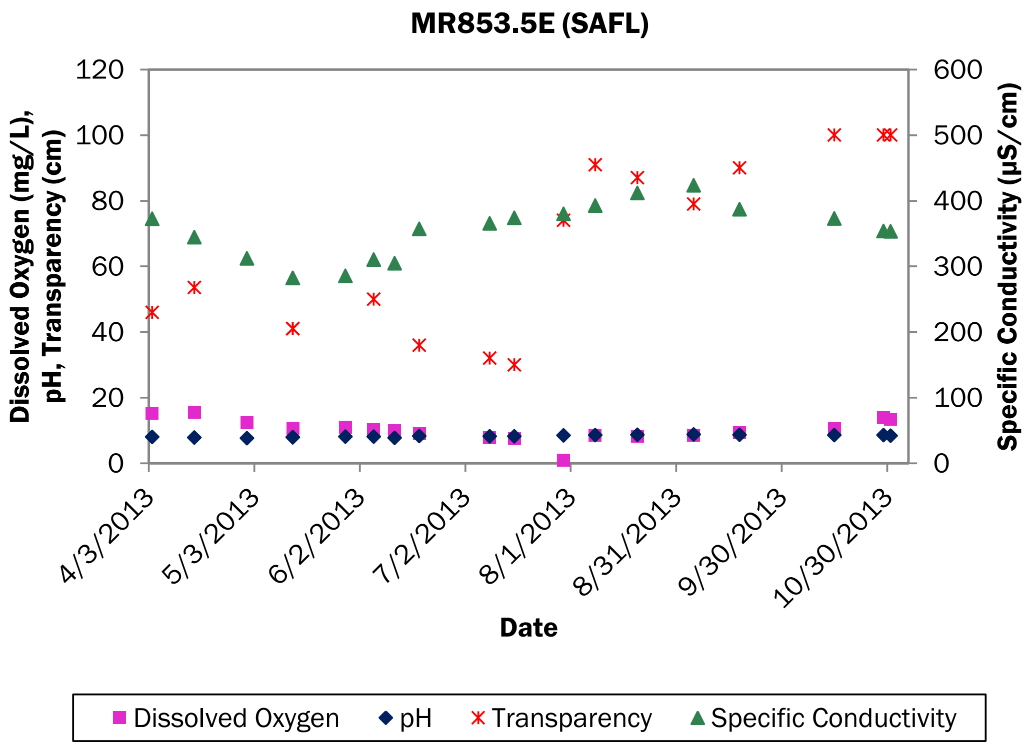

Figure D.11. Dissolved oxygen, pH, transparency, and specific conductivity for MR853.5E

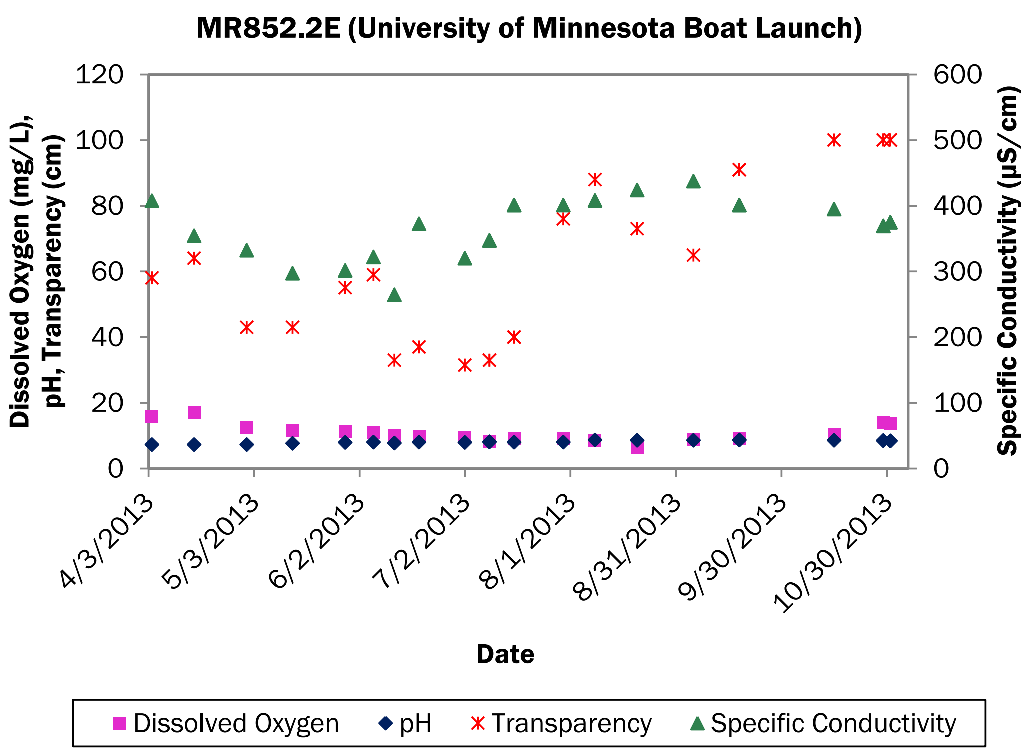

Figure D.12. Dissolved oxygen, pH, transparency, and specific conductivity for MR852.2E

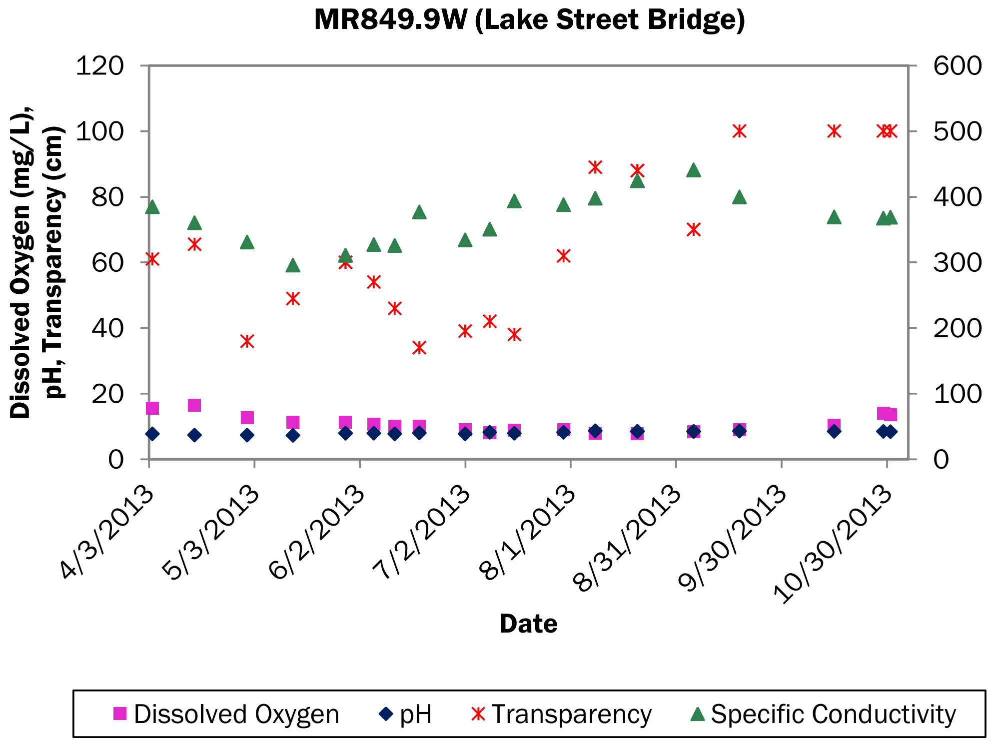

Figure D.13. Dissolved oxygen, pH, transparency, and specific conductivity for MR849.9W

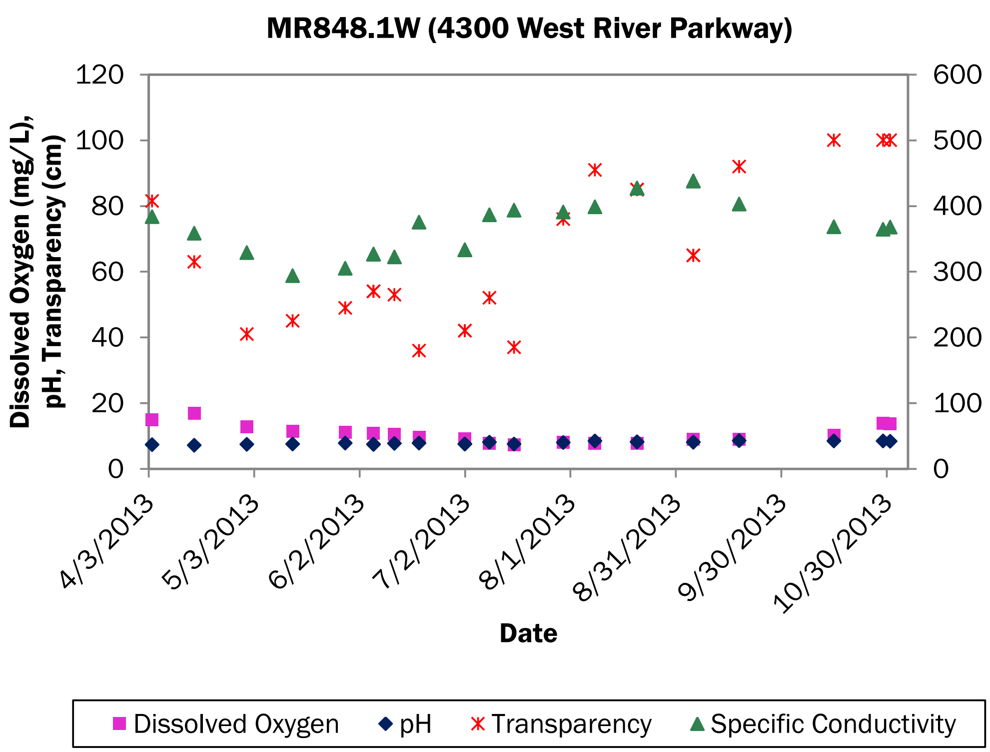

Figure D.14. Dissolved oxygen, pH, transparency, and specific conductivity for MR 848.1W

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.

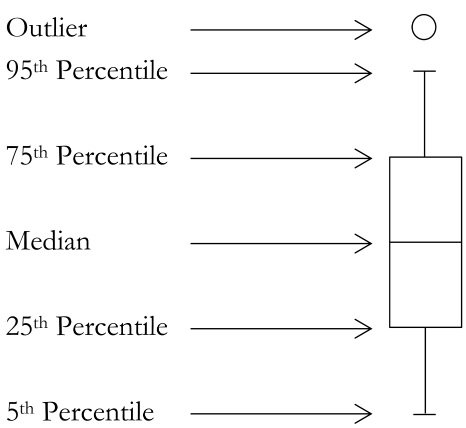

Figure E.1. An example boxplot. Each plot contains all available bacteria data for the site

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* (MPN/ 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)
1/10/2013 19:27	1/10/2013 22:12	Rain /Melt Composite	35	47.8	12.33	2,069.0	2,999.0	7.09	4.0	1.57			242	112	1,510	11.50	0.202	0.652	0.156	7.20	0.62	0.10	0.36
1/15/2013 9:44	1/15/2013 9:45	Base Grab	10	41.5	12.38	1,153.0	1,848.0	7.09	> 100.0	0.94			~ 1	~ 1	1,060			~ 0.043		0.72			
2/8/2013 9:05	2/8/2013 9:06	Base Grab	20	44.1	12.48	1,524.0	2,345.0	7.26	> 100.0	1.21			< 1	~ 1	1,320	134.00	< 0.020	< 0.020	~ 0.005	0.54	0.07	< 0.03	1.24
3/8/2013 9:10	3/8/2013 9:11	Base Grab	20	43.3	11.87	2,470.0	3,839.0	7.19	56.0	2.03	—	—	5	~ 2	2,060	90.20	0.052	~ 0.044	0.019	1.10	0.20	0.04	0.81
3/9/2013 3:39	3/10/2013 0:20	Melt Composite	25	45.9	9.84	1,513.0	2,258.0	7.04	7.0	1.16	—	—	133	43	1,120	2.09	0.317	0.688	—	6.10	1.34	0.07	0.79
3/21/2013 9:56	3/21/2013 9:57	Base Grab	10	38.7	12.72	1,585.0	2,672.0	7.25	> 100.0	1.37	—	—	~ 2	~ 1	1,460	105.00	~ 0.039	0.086	0.035	1.00	0.28	< 0.03	0.70
3/28/2013 14:16	3/28/2013 14:17	Melt Grab	40	43.9	12.59	604.0	931.0	7.19	10.0	0.47	—	—	48	~ 17	552	8.57	0.610	0.829	0.578	3.90	1.12	0.08	0.41
3/30/2013 5:22	3/30/2013 8:09	Rain /Melt Composite	20	40.1	10.24	423.5	695.3	7.19	4.5	0.34	—	—	277	137	432	5.40	0.250	0.981	—	5.50	1.04	0.06	0.53
4/2/2013 9:12	4/2/2013 9:13	Base Grab	24	35.1	12.96	299.0	538.0	7.27	33.0	0.26	—	—	19	17	335	44.80	0.950	1.190	0.910	6.80	2.74	0.56	1.76
4/4/2013 10:58	4/4/2013 10:59	Base Grab	43	42.8	11.45	557.0	879.0	7.65	57.0	0.43	> 2,420	< 0.20	—	—	—	—	—	—	—	—	—	—	—
4/8/2013 1:06	4/8/2013 5:37	Rain /Melt Composite	42	47.3	—	125.0	182.4	7.10	7.5	0.09	—	—	131	38	112	4.96	0.091	0.579	0.079	2.30	0.56	0.04	0.37
4/14/2013 17:06	4/14/2013 19:55	Rain /Melt Composite	34	50.7	11.97	—	385.3	6.90	—	0.19	—	—	65	~ 29	201	—	—	—	—	—	—	—	—
4/16/2013 12:03	4/16/2013 12:04	Base Grab	36	41.2	12.76	523.0	843.0	7.80	90.5	0.41	1,720	0.20	—	—	—	—	—	—	—	—	—	—	—
4/21/2013 18:23	4/21/2013 20:34	Rain /Melt Composite	38	52.5	11.27	345.2	465.8	6.68	—	0.23	—	—	126	~ 50	244	17.90	0.054	0.345	—	1.90	0.19	0.03	0.65
4/22/2013 18:06	4/23/2013 15:36	Rain /Melt Composite	32	48.7	11.87	543.0	775.0	6.98	7.0	0.38	—	—	77	~ 25	424	11.80	0.053	0.235	0.041	1.40	0.13	0.05	0.83
4/28/2013 22:26	4/29/2013 0:03	Rain Composite	53	64.9	7.83	536.0	614.0	6.98	—	0.30	—	—	424	148	332	14.80	0.076	1.150	0.056	6.90	0.65	0.12	1.51
4/29/2013 13:12	4/29/2013 13:13	Base Grab	68	57.2	9.55	700.0	886.0	7.30	25.0	0.44	—	—	14	7	492	49.20	0.065	0.139	0.056	1.35	0.25	0.06	1.84
5/1/2013 11:30	5/1/2013 11:31	Rain Grab	35	45.7	11.16	330.3	494.8	7.61	6.0	0.24	3,200	—	—	—	—	—	—	—	—	—	—	—	—
5/14/2013 11:32	5/14/2013 11:33	Base Grab	73	52.3	10.16	1,049.0	1,419.0	7.61	> 100.0	0.72	548	0.24	—	—	—	—	—	—	—	—	—	—	—
5/16/2013 9:35	5/16/2013 9:36	Base Grab	73	52.2	10.30	—	—	7.13	> 100.0	0.81	—	—	~ 1	~ 1	954	137.00	~ 0.022	~ 0.050	0.031	0.94	0.25	0.03	1.70
5/18/2013 7:20	5/18/2013 10:29	Rain Composite	67	66.4	4.35	—	—	7.44	8.5	0.09	—	—	234	82	101	4.16	0.139	0.970	—	4.80	~ 0.03	< 0.03	< 0.05
5/20/2013 23:14	5/21/2013 2:48	Rain Composite	58	62.6	8.31	—	—	6.97	14.5	0.09	—	—	163	52	147	6.51	0.102	0.340	0.039	2.10	0.13	0.04	0.42
5/23/2013 9:10	5/23/2013 9:12	Base Grab	47	50.9	10.65	772.0	1,068.0	6.87	> 100.0	0.53	—	—	4	~ 2	646	99.70	0.089	0.134	0.075	1.90	0.17	0.10	2.98
6/5/2013 10:06	6/5/2013 10:07	Base Grab	56	52.2	10.88	981.0	1,334.0	7.54	38.0	0.67	—	—	11	~ 5	768	110.50	~ 0.025	0.081	0.024	1.05	0.08	0.06	3.71
6/6/2013 10:10	6/6/2013 10:11	Base Grab	51	51.6	10.29	920.0	1,260.0	7.76	> 100.0	0.63	185	0.29	—	—	—	—	—	—	—	—	—	—	—
6/9/2013 13:27	6/9/2013 15:06	Rain Composite	64	63.7	7.73	162.7	188.5	6.72	21.0	0.09	—	—	72	36	87	7.81	0.075	0.291	—	1.70	0.11	0.03	0.76
6/12/2013 12:00	6/12/2013 12:01	Rain Grab	64	61.3	9.50	105.1	126.0	7.76	10.0	0.06	11,800	—	—	—	—	—	—	—	—	—	—	—	—
6/12/2013 10:49	6/12/2013 11:49	Rain Composite	70	63.7	8.10	92.1	107.1	6.88	10.0	0.05	—	—	63	24	72	2.84	0.063	0.278	—	1.40	0.19	< 0.03	0.22
6/18/2013 10:12	6/18/2013 10:13	Base Grab	69	62.1	9.03	660.0	784.0	7.63	> 100.0	0.39	—	—	~ 2	~ 1	476	82.30	0.119	0.207	0.131	1.60	0.34	0.16	2.22
6/19/2013 11:50	6/19/2013 11:51	Base Grab	78	63.1	9.01	688.0	807.0	7.90	> 100.0	0.40	81	0.00	—	—	—	—	—	—	—	—	—	—	—
6/21/2013 2:46	6/21/2013 4:21	Rain Composite	68	70.2	6.73	128.9	139.0	6.96	17.0	0.06	—	—	181	67	122	8.41	~ 0.039	0.610	0.010	3.80	~ 0.06	0.05	3.24

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* (MPN/ 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)
7/9/2013 12:10	7/9/2013 12:11	Rain Grab	78	72.1	6.96	446.4	470.6	7.84	62.0	0.23	6,500	—	—	—	—	—	—	—	—	—	—	—	—
7/13/2013 4:04	7/13/2013 5:47	Rain Composite	79	76.1	4.6	118.1	119.2	6.42	42.0	0.06	—	—	47	18	61	4.6	0.062	0.257	—	1.20	0.07	0.04	0.16
7/15/2013 9:35	7/15/2013 9:36	Base Grab	79	60.6	9.43	1,244.0	1,507.0	7.46	> 100.0	0.76	—	—	~ 1	~ 2	925	191.0	0.137	0.112	0.048	1.80	0.36	0.20	2.51
7/16/2013 12:33	7/16/2013 12:34	Base Grab	89	65.1	6.87	1,304.0	1,493.0	7.79	> 100.0	0.75	46	0.28	—	—	—	—	—	—	—	—	—	—	—
7/30/2013 12:15	7/30/2013 12:16	Rain Grab	70	63.9	—	453.0	526.6	7.82	45.0	0.26	11,600	—	—	—	—	—	—	—	—	—	—	—	—
8/5/2013 2:48	8/5/2013 5:42	Rain Composite	—	67.5	7.7	187.7	208.9	7.57	20.0	0.10	—	—	94	40	128	19.2	0.095	0.396	0.088	1.90	0.08	0.05	0.41
8/8/2013 12:15	8/8/2013 12:16	Base Grab	69	62.2	8.87	421.3	439.4	8.60	> 100.0	0.21	55	< 0.20	—	—	—	—	—	—	—	—	—	—	—
8/9/2013 8:30	8/9/2013 8:31	Base Grab	64	58.1	—	1,220.0	1,525.0	7.65	> 100.0	0.77	—	—	< 1	< 1	941	195.0	< 0.020	~ 0.025	~ 0.008	0.70	~ 0.04	0.04	2.89
8/20/2013 12:06	8/20/2013 12:07	Base Grab	85	62.2	—	1,198.0	1,421.0	8.03	> 100.0	0.72	168	< 0.20	—	—	—	—	—	—	—	—	—	—	—
8/21/2013 8:43	8/21/2013 8:44	Base Grab	78	62.6	9.08	1,323.0	1,562.0	7.68	> 100.0	0.79	—	—	~ 1	~ 1	999	203.0	~ 0.036	~ 0.037	0.024	0.65	0.11	0.05	2.35
8/29/2013 5:06	8/29/2013 6:20	Rain Composite	78	58.3	4.94	244.6	305.2	7.48	—	0.15	—	—	378	130	200	40.5	0.284	1.240	0.215	7.40	0.61	0.06	0.86
9/5/2013 12:06	9/5/2013 12:07	Base Grab	77	62.1	—	12.7	15.1	8.26	> 100.0	0.76	80	0.34	—	—	—	—	—	—	—	—	—	—	—
9/10/2013 8:31	9/10/2013 8:32	Base Grab	71	64.0	8.72	1,334.0	1,547.0	7.92	> 100.0	0.78	—	—	< 1	~ 1	964	193.0	< 0.020	~ 0.027	0.010	0.64	~ 0.04	< 0.03	1.69
9/14/2013 20:24	9/15/2013 6:14	Rain Composite	68	56.5	7.56	207.0	264.6	7.16	—	0.13	—	—	45	17	160	37.5	0.089	0.535	—	2.00	0.12	0.06	0.49
9/18/2013 13:12	9/18/2013 13:13	Rain Grab	73	64.4	8.8	261.8	302.0	7.94	99.0	0.14	> 2,420	—	—	—	—	—	—	—	—	—	—	—	—
9/24/2013 8:43	9/24/2013 8:44	Base Grab	58	58.6	9.54	1,231.0	1,529.0	8.20	> 100.0	0.77	—	—	~ 1	~ 1	969	182.0	< 0.020	~ 0.020	0.012	0.55	~ 0.03	< 0.03	1.72
10/1/2013 11:53	10/1/2013 11:54	Base Grab	69	60.6	8.8	1,214.0	1,468.0	8.18	> 100.0	0.74	921	0.22	—	—	—	—	—	—	—	—	—	—	—
10/8/2013 9:23	10/8/2013 9:24	Base Grab	53	57.9	10.24	1,171.0	1,468.0	8.12	> 100.0	0.74	—	—	< 1	~ 1	841	196.0	~ 0.041	0.074	0.042	1.20	0.35	0.12	1.36
10/15/2013 12:59	10/15/2013 13:00	Rain Grab	54	55.2	9.82	259.3	337.5	7.85	9.0	0.16	4,200	—	—	—	—	—	—	—	—	—	—	—	—
10/14/2013 23:31	10/15/2013 2:39	Rain Composite	47	49.3	9.6	59.8	84.8	7.12	40.0	0.04	—	—	20	10	41	3.6	0.113	0.256	—	0.76	< 0.02	< 0.03	1.35
10/22/2013 8:35	10/22/2013 8:36	Base Grab	30	43.0	11.82	910.0	1,422.0	8.23	65.0	0.71	—	—	4	~ 1	856	181.0	0.061	0.097	0.059	1.10	0.41	0.04	1.44
10/29/2013 12:46	10/29/2013 12:47	Base Grab	37	50.9	11.90	1,150.0	1,588.0	8.20	> 100.0	0.81	214	0.24	—	—	—	—	—	—	—	—	—	—	—
10/31/2013 10:36	10/31/2013 10:37	Rain Grab	—	—	—	—	—	—	—	—	> 2,420	—	—	—	—	—	—	—	—	—	—	—	—
11/7/2013 8:35	11/7/2013 8:36	Base Grab	26	48.2	11.0	707.0	1,019.0	7.95		0.51	—	—	~ 2	3	611	112.0	0.143	0.155	0.068	0.76	0.16	< 0.03	0.77
11/4/2013 12:58	11/6/2013 13:49	Rain Composite	26	48.6	9.1	263.9	378.2	7.51	100.0	0.18	—	—	17	10	231	24.2	0.178	0.318	—	0.98	< 0.02	< 0.03	0.23
11/14/2013 12:14	11/14/2013 12:15	Base Grab	41	51.6	10.84	1,121.0	1,532.0	8.24	100.0	0.78	365	0.20	—	—	—	—	—	—	—	—	—	—	—
11/16/2013 14:06	11/16/2013 21:04	Rain Composite	33	39.4	—	—	—	—	—	—	—	—	49	35	442	39.5	0.289	0.988	—	4.70	~ 0.03	0.04	0.29
11/19/2013 9:04	11/19/2013 9:05	Base Composite	28	48.6	11.0	1,037.0	1,487.0	8.01	> 100.0	0.75	—	—	< 1	< 1	926	—	—	0.120	—	1.80	—	—	—
12/17/2013 8:55	12/17/2013 8:56	Base Grab	23	43.5	12.32	1,021.0	1,581.0	7.94	—	0.80	548	—	< 1	~ 1	1,020	—	—	< 0.020	—	0.72	—	—	—

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)
1/10/2013 19:27	1/10/2013 22:12	Rain /Melt Composite	35	873.0	76	219	15.0	15.0	21.0	0.0067	0.0409	0.0013	0.0098	~ 0.0005	0.0311	0.0232	0.2980	< 0.0002	~0.00041	0.0040	0.0157	—
1/15/2013 9:44	1/15/2013 9:45	Base Grab	—	294.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2/8/2013 9:05	2/8/2013 9:06	Base Grab	392	409.0	500	~ 10	3.6	< 1.0	< 1.0	0.0011	0.0012	0.0041	0.0041	< 0.0001	< 0.0001	< 0.0050	< 0.0050	< 0.0002	< 0.0002	< 0.0005	< 0.0005	—
3/8/2013 9:10	3/8/2013 9:11	Base Grab	308	987.0	404	36	7.1	1.2	1.6	0.0035	0.0043	0.0041	0.0041	< 0.0001	0.0008	0.0230	0.0338	< 0.0002	< 0.0002	0.0007	0.0015	—
3/9/2013 3:39	3/10/2013 0:20	Melt Composite	30	556.0	52	157	23.9	—	12.0	—	0.0356	—	0.0087	—	0.0207	—	0.2090	—	~ 0.0004	—	0.0157	8
3/21/2013 9:56	3/21/2013 9:57	Base Grab	328	619.0	464	18	10.0	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
3/28/2013 14:16	3/28/2013 14:17	Melt Grab	51	213.0	84	90	18.4	15.0	19.0	0.0097	0.0143	0.0021	0.0038	0.0012	0.0089	0.0499	0.1090	< 0.0002	< 0.0002	0.0022	0.0044	—
3/30/2013 5:22	3/30/2013 8:09	Rain /Melt Composite	29	155.0	44	213	23.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4/2/2013 9:12	4/2/2013 9:13	Base Grab	106	48.0	168	140	49.1	> 24.0	> 24.0	—	—	—	—	—	—	—	—	—	—	—	—	—
4/8/2013 1:06	4/8/2013 5:37	Rain /Melt Composite	18	29.9	40	85	8.3	5.2	8.1	0.0040	0.0222	0.0008	0.0054	0.0006	0.0190	0.0184	0.1490	< 0.0002	~ 0.0002	0.0020	0.0073	—
4/14/2013 17:06	4/14/2013 19:55	Rain /Melt Composite	—	—	—	—	—	4.6	5.7	—	—	—	—	—	—	—	—	—	—	—	—	—
4/21/2013 18:23	4/21/2013 20:34	Rain /Melt Composite	41	86.3	60	104	8.0	—	—	0.0054	0.0207	0.0022	0.0056	< 0.0050	0.0133	0.0085	0.1330	< 0.0002	< 0.0002	0.0012	0.0084	< 6
4/22/2013 18:06	4/23/2013 15:36	Rain /Melt Composite	47	177.0	—	67	13.4	< 3.0	3.6	—	—	—	—	—	—	—	—	—	—	—	—	78
4/28/2013 22:26	4/29/2013 0:03	Rain Composite	49	131.1	80	334	22.6	14.0	15.0	—	—	—	—	—	—	—	—	—	—	—	—	—
4/29/2013 13:12	4/29/2013 13:13	Base Grab	133	133.4	236	35	11.2	1.9	2.6	—	—	—	—	—	—	—	—	—	—	—	—	—
5/16/2013 9:35	5/16/2013 9:36	Base Grab	358	206.6	530	19	4.8	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
5/18/2013 7:20	5/18/2013 10:29	Rain Composite	40	23.4	48	169	10.7	—	—	0.0105	0.0419	0.0022	0.0090	0.0005	0.0257	0.0169	0.2080	< 0.0002	~ 0.0003	0.0010	0.0134	—
5/20/2013 23:14	5/21/2013 2:48	Rain Composite	28	28.5	44	81	11.8	6.1	7.4	—	—	—	—	—	—	—	—	—	—	—	—	—
5/23/2013 9:10	5/23/2013 9:12	Base Grab	214	122.3	332	35	12.9	1.5	2.2	—	—	—	—	—	—	—	—	—	—	—	—	—
6/5/2013 10:06	6/5/2013 10:07	Base Grab	294	163.4	448	31	8.4	1.3	1.8	0.0029	0.0058	0.0035	0.0036	< 0.0001	0.0033	0.0140	0.0337	< 0.0002	< 0.0002	0.0003	0.0012	—
6/9/2013 13:27	6/9/2013 15:06	Rain Composite	33	24.2	48	54	10.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6/12/2013 10:49	6/12/2013 11:49	Rain Composite	26	9.8	52	51	9.9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6/18/2013 10:12	6/18/2013 10:13	Base Grab	167	83.6	256	48	10.8	1.3	1.6	—	—	—	—	—	—	—	—	—	—	—	—	—
6/21/2013 2:46	6/21/2013 4:21	Rain Composite	32	27.8	60	134	17.1	> 7.1	> 7.1	0.0072	0.0271	0.0013	0.0056	~ 0.0003	0.0196	0.0273	0.1260	< 0.0002	~ 0.0003	0.0007	0.0060	13
7/13/2013 4:04	7/13/2013 5:47	Rain Composite	30	10.9	44	49	6.9	—	—	0.0032	0.0100	0.0010	0.0020	~ 0.0002	0.0051	0.0147	0.0494	< 0.0002	< 0.0002	0.0005	0.0021	8
7/15/2013 9:35	7/15/2013 9:36	Base Grab	290	180.3	268	23	8.8	< 1	< 1	0.0018	0.0020	0.0034	0.0035	< 0.0001	~ 0.0002	0.0081	0.0088	< 0.0002	< 0.0002	0.0002	0.0003	—
8/5/2013 2:48	8/5/2013 5:42	Rain Composite	36	20.5	68	69	12.9	12	19	0.0040	0.0137	0.0010	0.0033	~ 0.0004	0.0078	0.0132	0.0933	< 0.0002	< 0.0002	0.0049	0.0036	—
8/9/2013 8:30	8/9/2013 8:31	Base Grab	376	162.1	512	18	5.1	1	< 1	0.0018	0.0016	0.0040	0.0039	< 0.0001	< 0.0001	0.0062	0.0062	< 0.0002	< 0.0002	0.0006	~ 0.0001	< 6
8/21/2013 8:43	8/21/2013 8:44	Base Grab	375	34.2	560	16	6.3	< 1	< 1	—	—	—	—	—	—	—	—	—	—	—	—	—
8/29/2013 5:06	8/29/2013 6:20	Rain Composite	64	25.8	128	286	54.5	> 48	> 48	—	—	—	—	—	—	—	—	—	—	—	—	—
9/10/2013 8:31	9/10/2013 8:32	Base Grab	379	170.2	528	16	7.3	< 1	< 1	0.0015	0.0015	0.0039	0.0040	< 0.0001	~ 0.0002	0.0057	0.0079	< 0.0002	< 0.0002	0.0013	0.0002	—
9/14/2013 20:24	9/15/2013 6:14	Rain Composite	60	22.2	100	69	16.4	—	—	0.0059	0.0153	0.0015	0.0029	~ 0.0002	0.0061	0.0167	0.0752	< 0.0002	< 0.0002	0.0017	0.0036	—
9/24/2013 8:43	9/24/2013 8:44	Base Grab	378	192.7	492	~ 14	4.8	< 1	< 1	—	—	—	—	—	—	—	—	—	—	—	—	—
10/8/2013 9:23	10/8/2013 9:24	Base Grab	348	155.9	584	19	6.6	< 1	< 1	—	—	—	—	—	—	—	—	—	—	—	—	—
10/14/2013 23:31	10/15/2013 2:39	Rain Composite	21	6.6	40	35	6.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10/22/2013 8:35	10/22/2013 8:36	Base Grab	358	178.9	512	18	4.7	< 1	< 1	0.0014	0.0021	0.0041	0.0044	< 0.0001	0.0014	0.0078	0.0122	< 0.0002	< 0.0002	0.0002	0.0005	—
11/7/2013 8:35	11/7/2013 8:36	Base Grab	251	116.0	328	25	7.8	—	—	0.0025	0.0025	0.0033	0.0032	< 0.0010	< 0.0010	0.0149	0.0115	< 0.0002	< 0.0002	0.0006	0.0007	—
11/4/2013 12:58	11/6/2013 13:49	Rain Composite	88	44.3	112	62	17.2	—	—	0.0068	0.0084	0.0017	0.0022	< 0.0010	0.0023	0.0267	0.0369	< 0.0002	< 0.0002	0.0017	0.0023	—
11/16/2013 14:06	11/16/2013 21:04	Rain Composite	142	88.8	220	206	59.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11/19/2013 9:04	11/19/2013 9:05	Base Grab	—	176.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12/17/2013 8:55	12/17/2013 8:56	Base Grab	—	174.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

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* (MPN/ 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)
4/16/2013 11:25	4/16/2013 11:26	Base Grab	35	42.3	10.86	461.5	730.7	7.32	24.0	0.36	148	< .20	—	—	—	—	—	—	—	—	—	—	—
9/19/2013 12:00	9/19/2013 12:01	Rain Grab	74	20.1	8.04	149.1	164.5	8.43	9.0	0.08	—	—	296	59	90	10.3	0.120	0.997	0.102	2.400	0.270	0.05	0.48
10/15/2013 12:25	10/15/2013 12:26	Rain Grab	54	55.4	7.97	263.2	341.3	7.65	32.0	0.16	7,300	—	—	—	—	—	—	—	—	—	—	—	—
10/15/2013 13:10	10/15/2013 13:11	Rain Grab	55	13.2	8.58	296.2	347.9	7.77	30.0	0.17	—	—	16	12	199	14.8	0.174	0.336	0.139	1.700	0.110	0.03	0.75

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	Total Biological Oxygen Demand 5-day	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)
9/19/2013 12:00	9/19/2013 12:01	Rain Grab	26	12	56	128	9.8	8.7	16.0	< 0.0050	0.0517	0.0007	0.0125	0.0008	0.0857	0.0074	0.2980	< 0.0002	0.0010	0.0025	0.0153	—
10/15/2013 13:10	10/15/2013 13:11	Rain Grab	70	47	—	48	9.5	6.8	7.7	—	—	—	—	—	—	—	—	—	—	—	—	—

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* (MPN/ 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)
1/10/2013 18:14	1/10/2013 21:26	Rain/Melt Composite	35	46.4	12.24	2,864.0	4,240.0	7.38	3	2.26	—	—	268	100	2,100	18.7	0.1440	0.773	0.107	7.00	0.64	0.14	0.49
1/15/2013 11:59	1/15/2013 12:00	Base Grab	10	47.5	10.75	980.0	1,429.0	7.81	> 100	0.72	—	—	~ 1	< 1	791	—	—	~ 0.031	—	0.46	—	—	—
1/28/2013 13:03	1/29/2013 19:09	Rain/Melt Composite	18	55.4	7.07	10,359.0	13,453.0	7.11	10	7.79	—	—	61	30	7,360	53.0	~ 0.0230	0.229		3.70	0.72	0.27	0.96
2/8/2013 11:02	2/8/2013 11:03	Base Grab	20	48.4	10.52	1,696.0	2,438.0	7.72	> 100	1.26	—	—	5	~ 4	1,310	64.4	< 0.0200	~ 0.039	0.017	0.84	~ 0.06	< 0.03	1.32
2/13/2013 15:03	2/14/2013 21:58	Melt Composite	10	50.4	8.34	8,915.0	12,417.0	7.07	6	7.13	—	—	114	68	6,690	49.9	~ 0.0330	0.202	—	3.70	0.67	0.15	1.03
2/24/2013 15:38	2/24/2013 19:53	Melt Composite	25	62.2	6.91	8,750.0	10,382.0	7.11	5	5.90	—	—	132	62	5,700	—	—	0.281	—	4.40	—	—	—
2/25/2013 15:41	2/25/2013 22:12	Melt Composite	33	46.2	9.69	4,126.0	6,119.0	7.15	—	3.33	—	—	96	62	3,200	—	—	0.238	—	4.30	—	—	—
2/27/2013 12:26	2/27/2013 23:20	Melt Composite	30	49.3	9.12	3,426.0	4,848.0	7.08	4	2.61	—	—	161	88	2,670	42.0	0.6860	1.220	—	9.30	1.24	0.13	0.82
3/8/2013 11:22	3/8/2013 11:23	Melt Grab	20	47.8	9.66	1,898.0	2,750.0	7.66	57	1.43	—	—	7	4	1410	72.1	~ 0.0255	~ 0.046	0.018	0.90	0.15	0.03	1.15
3/21/2013 13:13	3/21/2013 13:15	Base Grab	10	46.9	10.60	1,126.0	1,651.0	7.78	> 100	0.84	—	—	40	39	902	81.4	1.0600	0.050	0.500	0.53	~ 0.05	< 0.03	1.16
3/28/2013 15:10	3/28/2013 15:11	Melt Grab	40	43.7	11.92	488.9	757.0	7.33	11	0.37	—	—	57	~ 23	516	20.1	0.4540	0.704	0.420	3.80	1.20	0.06	0.54
4/2/2013 10:30	4/2/2013 10:31	Base Grab	26	46.9	10.88	987.0	1,451.0	7.51	> 100	0.75	—	—	< 1	< 1	805	74.3	~ 0.0290	~ 0.041	0.030	0.55	0.08	< 0.03	1.24
4/4/2013 9:50	4/4/2013 9:51	Base Grab	41	49.3	9.90	945.0	1,340.0	7.42	> 100	0.67	156.0	< .20	—	—	—	—	—	—	—	—	—	—	—
4/12/2013 11:06	4/14/2013 6:48	Melt Composite	35	52.0	10.64	1,785.0	2,430.0	6.93	31	1.26	—	—	30	~ 15	1,260	44.1	—	0.152	~ 0.007	1.10	0.10	0.03	0.89
4/14/2013 13:38	4/14/2013 21:01	Rain/Melt Composite	35	50.7	11.62	783.0	1,087.0	6.67	9	0.54	—	—	95	42	548	8.7	~ 0.0335	0.241	0.025	2.00	0.51	0.04	0.65
4/16/2013 10:49	4/16/2013 10:50	Base Grab	35	46.8	11.33	912.0	1,342.0	7.20	> 100	0.67	21.0	< .20	—	—	—	—	—	—	—	—	—	—	—
4/18/2013 12:41	4/21/2013 22:21	Rain/Melt Composite	38	53.8	9.31	1,910.0	2,537.0	7.15	—	1.32	—	—	56	~ 23	925	26.0	0.0760	0.175	—	1.70	0.06	0.04	0.57
4/22/2013 15:31	4/23/2013 23:08	Rain/Melt Composite	34	54.1	10.36	1,023.0	1,352.0	7.10	13	0.68	—	—	65	~ 24	679	36.3	< 0.0200	0.143	~ 0.009	1.50	0.07	0.03	0.44
5/1/2013 10:47	5/1/2013 10:48	Rain Grab	35	47.8	10.77	360.0	523.0	7.55	20	0.25	1,600.0		—	—	—	—	—	—	—	—	—	—	—
5/17/2013 14:37	5/19/2013 8:10	Rain Composite	69	69.1	5.41	—	—	—	10	0.09	—	—	292	68	118	8.4	0.0820	0.647	—	3.55	0.21	0.04	0.26
6/18/2013 11:20	6/18/2013 11:21	Base Grab	70	56.1	10.08	1,156.0	1,484.0	7.96	> 100	0.75	—	—	3	~ 1	891	89.9	~ 0.0280	0.064	0.033	0.90	~ 0.05	< 0.03	1.38
6/19/2013 10:45	6/19/2013 10:46	Base Grab	76	56.3	11.16	1,137.0	1,456.0	8.07	> 100	0.74	17.0	.25	—	—	—	—	—	—	—	—	—	—	—
6/21/2013 2:44	6/21/2013 7:59	Rain Composite	75	71.6	7.03	121.5	129.0	7.09	23	0.06	—	—	104	35	71	6.3	< 0.0200	0.361	< 0.005	2.20	0.09	< 0.03	0.77
7/9/2013 11:06	7/9/2013 11:07	Rain Grab	76	70.0	7.41	240.7	260.0	7.62	—	0.12	11,100.0		—	—	—	—	—	—	—	—	—	—	—
7/15/2013 12:48	7/15/2013 12:49	Base Grab	87	56.5	11.97	989.0	1,265.0	7.65	6	0.64	—	—	112	18	737	84.9	~ 0.0430	0.288	0.055	1.30	0.13	< 0.03	1.40
7/16/2013 11:17	7/16/2013 11:18	Base Grab	88	56.1	10.58	1,093.0	1,404.0	7.83	—	0.71	1,120.0	—	—	—	—	—	—	—	—	—	—	—	—
7/30/2013 11:36	7/30/2013 11:37	Rain Grab	69	56.5	9.44	1,045.0	1,335.0	7.98	—	0.67	800.0	—	—	—	—	—	—	—	—	—	—	—	—
8/8/2013 11:05	8/8/2013 11:06	Base Grab	68	57.4	9.78	1,109.0	1,401.0	8.08	—	0.71	13.0	—	—	—	—	—	—	—	—	—	—	—	—
8/9/2013 10:20	8/9/2013 10:21	Base Grab	69	58.1	—	1,214.0	1,520.0	8.11	—	0.77	—	—	~ 2	~ 1	872	90.4	~ 0.0390	0.060	0.025	0.54	0.07	< 0.03	1.88
8/20/2013 10:51	8/20/2013 10:52	Base Grab	80	60.3	10.02	1,224.0	1,488.0	8.16	> 100	0.75	54.0	< .20	—	—	—	—	—	—	—	—	—	—	—
8/21/2013 10:05	8/21/2013 10:06	Base Grab	80	62.6	9.53	1,268.0	1,497.0	8.26	> 100	0.76	—	—	~ 2	~ 1	860	93.6	~ 0.0310	~ 0.046	0.024	0.25	~ 0.04	< 0.03	1.72
8/29/2013 5:15	8/29/2013 5:17	Rain Grab	77	—	—	—	—	—	—	—	—	—	—	—	—	71.3	~ 0.0230	0.154	0.018	1.40	0.15	< 0.03	1.36

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* (MPN/ 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)
9/5/2013 10:55	9/5/2013 10:56	Base Grab	70	55.9	9.93	1,154.0	1,484.0	8.19	> 100	0.75	206.0	.24	—	—	—	—	—	—	—	—	—	—	—
9/10/2013 9:42	9/10/2013 9:43	Base Grab	73	56.5	9.90	1,142.0	1,460.0	8.27	> 100	0.74	—	—	< 1	~ 1	832	95.0	~ 0.0370	0.053	0.029	0.82	0.20	0.04	1.77
9/18/2013 11:42	9/18/2013 11:43	Rain Grab	70	59.0	8.49	693.0	856.0	7.90	52	0.42	> 2,420.0	—	—	—	—	—	—	—	—	—	—	—	—
9/19/2013 12:39	9/19/2013 12:40	Rain Grab	74	66.7	8.93	225.7	253.2	7.91	14	0.12	—	—	97	~ 37	156	10.5	0.1110	0.664	0.102	1.90	0.31	0.06	0.80
9/24/2013 9:40	9/24/2013 9:41	Base Grab	60	55.4	10.00	1,139.0	1,476.0	8.22	> 100	0.75	—	—	~ 1	~ 1	848	91.3	~ 0.0460	0.074	0.031	0.41	~ 0.06	< 0.03	1.39
10/1/2013 10:35	10/1/2013 10:36	Base Grab	67	55.9	10.35	1,151.0	1,481.0	8.71	> 100	0.75	231.0	.46	—	—	—	—	—	—	—	—	—	—	—
10/8/2013 10:56	10/8/2013 10:57	Base Grab	55	55.6	9.99	1,116.0	1,446.0	8.21	> 100	0.73	—	—	~ 2	~ 2	805	87.9	< 0.0200	~ 0.036	0.023	2.60	0.06	< 0.03	1.62
10/15/2013 11:36	10/15/2013 11:37	Rain Grab	54	54.3	9.49	437.1	575.8	7.37	—	0.28	4,200.0	—	—	—	—	—	—	—	—	—	—	—	—
10/22/2013 10:52	10/22/2013 10:53	Base Grab	35	51.3	10.33	1,079.0	1,484.0	8.29	> 100	0.75	—	—	< 1	< 1	825	89.7	~ 0.0360	~ 0.042	0.022	0.29	0.07	< 0.03	1.44
10/29/2013 11:15	10/29/2013 11:16	Base Grab	37	49.6	10.63	1,039.0	1,464.0	8.31	> 100	0.74	17.0	.16	—	—	—	—	—	—	—	—	—	—	—
10/30/2013 21:00	10/31/2013 6:00	Rain Composite	41	51.1	9.96	798.0	1,102.0	8.10	—	0.55	—	—	~ 5	~ 4	621	66.2	0.0560	0.136	0.050	1.50	0.14	0.10	1.40
10/31/2013 11:45	10/31/2013 11:46	Rain Grab	—	50.2	9.98	959.0	1,342.0	8.09	—	0.68	613.0	—	—	—	—	—	—	—	—	—	—	—	—
11/4/2013 11:30	11/5/2013 9:30	Rain Composite	44	46.9	10.77	474.8	696.4	8.08	—	0.34	—	—	93	51	400	40.0	0.1260	0.452	—	2.20	0.27	0.06	0.90
11/5/2013 20:34	11/6/2013 20:42	Rain Composite	27	39.7	11.57	666.0	1,102.0	8.02	—	0.55	—	—	17	12	573	39.4	0.1270	0.198	—	0.89	0.07	0.04	0.73
11/7/2013 11:00	11/7/2013 11:01	Base Grab	27	48.4	10.40	965.0	1,385.0	8.14	100	0.70	—	—	~ 2	~ 2	801	87.2	~ 0.0220	0.077	0.023	0.33	~ 0.05	< 0.03	1.16
11/14/2013 10:48	11/14/2013 10:49	Base Grab	40	50.5	10.45	1,072.0	1,489.0	8.34	100	0.75	35.0	.10	—	—	—	—	—	—	—	—	—	—	—
11/16/2013 13:36	11/16/2013 21:42	Rain Composite	33	52.0	7.83	1,202.0	1,635.0	7.18	< 40	0.83	—	—	87	56	932	43.3	0.1460	0.792	—	6.00	0.21	0.04	0.15
11/19/2013 9:36	11/19/2013 9:37	Base Grab	28	48.0	10.96	1,014.0	1,465.0	8.26	> 100	0.74	—	—	~ 1	~ 1	832	—	—	0.052	—	0.73	—	—	—
12/2/2013 18:00	12/3/2013 17:00	Rain/Melt Composite	31	47.8	8.52	2,150.0	3,112.0	7.46	10	1.63	—	—	73	34	1,460	45.3	~ 0.0490	0.463	—	4.20	0.09	0.13	1.40
12/17/2013 11:21	12/17/2013 11:22	Base Grab	25	49.6	10.21	3,846.0	5,420.0	8.01	—	2.94	11.5	—	7	2	2,825	—	—	~ 0.047	—	0.76	—	—	—

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	Total Biological Oxygen Demand 5-day	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)
1/10/2013 18:14	1/10/2013 21:26	Rain/Melt Composite	46	1,146.0	120	376	19.1	28.0	38.0	0.0183	0.0900	0.0023	0.0135	~ 0.0004	0.0515	0.0510	0.5830	< 0.0002	0.0007	0.0057	0.0246	31
1/15/2013 11:59	1/15/2013 12:00	Base Grab	—	207.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
1/28/2013 13:03	1/29/2013 19:09	Rain/Melt Composite	156	4,136.0	372	212	17.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 6
2/8/2013 11:02	2/8/2013 11:03	Base Grab	300	521.0	512	~ 17	5.1	< 1.0	< 1.0	0.0006	0.0013	0.0019	0.0021	< 0.0001	~ 0.0002	0.0057	0.0117	< 0.0002	< 0.0002	< 0.0005	< 0.0005	—
2/13/2013 15:03	2/14/2013 21:58	Melt Composite	169	3,777.0	356	160	12.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2/24/2013 15:38	2/24/2013 19:53	Melt Composite	—	3,373.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2/25/2013 15:41	2/25/2013 22:12	Melt Composite	—	1,686.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2/27/2013 12:26	2/27/2013 23:20	Melt Composite	133	1,464.0	300	373	48.5	—	> 95.0	0.0154	0.0439	0.0023	0.0070	~ 0.0003	0.0216	0.0258	0.2030	< 0.0002	~ 0.0003	0.0060	0.0123	—
3/8/2013 11:22	3/8/2013 11:23	Melt Grab	279	563.0	464	28	5.7	1.5	1.8	0.0019	0.0033	0.0025	0.0026	< 0.0001	0.0009	0.0101	0.0225	< 0.0002	< 0.0002	0.0006	0.0015	—
3/21/2013 13:13	3/21/2013 13:15	Base Grab	304	273.0	480	~ 7	6.7	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
3/28/2013 15:10	3/28/2013 15:11	Melt Grab	86	175.0	136	100	16.2	16.0	20.0	0.0112	0.0202	0.0016	0.0035	0.0006	0.0116	0.0227	0.0929	< 0.0002	< 0.0002	0.0017	0.0050	—
4/2/2013 10:30	4/2/2013 10:31	Base Grab	291	258.0	528	~ 8	7.4	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
4/12/2013 11:06	4/14/2013 6:48	Melt Composite	157	660.9	284	36	5.1	1.5	2.6	—	—	—	—	—	—	—	—	—	—	—	—	—
4/14/2013 13:38	4/14/2013 21:01	Rain/Melt Composite	48	243.6	78	113	8.9	6.8	9.3	—	—	—	—	—	—	—	—	—	—	—	—	—
4/18/2013 12:41	4/21/2013 22:21	Rain/Melt Composite	50	486.4	180	89	5.4	—	—	0.0057	0.0312	0.0014	0.0053	< 0.0050	0.0149	0.0141	0.1340	< 0.0002	< 0.0002	0.0075	0.0161	< 6
4/22/2013 15:31	4/23/2013 23:08	Rain/Melt Composite	72	328.7	192	67	6.1	2.7	4.4	—	—	—	—	—	—	—	—	—	—	—	—	< 6
5/17/2013 14:37	5/19/2013 8:10	Rain Composite	41	25.1	62	151	9.0			0.0084	0.0468	0.0017	0.0081	~ 0.0004	0.0480	0.0230	0.2260	< 0.0002	~ 0.0003	0.0020	0.0134	22
6/18/2013 11:20	6/18/2013 11:21	Base Grab	278	313.5	484	~ 8	3.9	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
6/21/2013 2:44	6/21/2013 7:59	Rain Composite	24	12.5	40	90	11.4	> 7.2	> 7.2	0.0080	0.0206	0.0013	0.0032	~ 0.0003	0.0185	0.0188	0.0751	< 0.0002	< 0.0002	0.0011	0.0040	< 7
7/15/2013 12:48	7/15/2013 12:49	Base Grab	277	244.0	536	39	5.3	1.1	1.5	0.0018	0.0189	0.0030	0.0103	< 0.0001	0.0204	0.0112	0.0337	< 0.0002	< 0.0002	0.0004	0.0072	—
8/9/2013 10:20	8/9/2013 10:21	Base Grab	293	258.0	500	16	4.7	< 1.0	< 1.0	< 0.0010	0.0014	0.0032	0.0032	< 0.0001	0.0005	0.0036	0.0059	< 0.0002	< 0.0002	0.0003	0.0004	< 6
8/21/2013 10:05	8/21/2013 10:06	Base Grab	298	61.2	496	~ 9	3.6	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
8/29/2013 5:15	8/29/2013 5:17	Rain Grab	200	180.6	356	83	17.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9/10/2013 9:42	9/10/2013 9:43	Base Grab	289	249.1	496	~ 9	3.5	< 1.0	< 1.0	0.0007	0.0016	0.0033	0.0032	< 0.0001	~ 0.0001	0.0031	0.0062	< 0.0002	< 0.0002	0.0011	0.0002	—
9/19/2013 12:39	9/19/2013 12:40	Rain Grab	49	31.9	92	85	9.3	12.0	14.0	0.0050	0.0237	0.0008	0.0045	0.0008	0.0286	0.0076	0.1230	< 0.0002	< 0.0002	0.0023	0.0086	—
9/24/2013 9:40	9/24/2013 9:41	Base Grab	294	264.6	504	~ 10	3.3	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
10/8/2013 10:56	10/8/2013 10:57	Base Grab	289	238.9	480	26	7.8	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
10/22/2013 10:52	10/22/2013 10:53	Base Grab	301	248.6	488	~ 10	2.9	< 1.0	< 1.0	~ 0.0004	0.0009	0.0039	0.0040	< 0.0001	~ 0.0001	0.0038	0.0057	< 0.0002	< 0.0002	~ 0.0001	0.0002	—
10/30/2013 21:00	10/31/2013 6:00	Rain Composite	222	161.0	376	52	13.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11/4/2013 11:30	11/5/2013 9:30	Rain Composite	128	94.2	216	125	18.3	—	—	0.0092	0.0266	0.0021	0.0050	< 0.0010	0.0140	0.0193	0.1130	< 0.0002	0.0012	0.0021	0.0053	—
11/5/2013 20:34	11/6/2013 20:42	Rain Composite	160	221.7	260	56	15.2	—	—	0.0076	0.0118	0.0020	0.0028	< 0.0010	0.0027	0.0298	0.0410	< 0.0002	~ 0.0002	0.0017	0.0026	—
11/7/2013 11:00	11/7/2013 11:01	Base Grab	282	257.8	480	15	3.9	—	—	0.0013	0.0016	0.0037	0.0044	< 0.0010	< 0.0010	0.0091	0.0163	< 0.0002	< 0.0002	~ 0.0001	0.0003	—
11/16/2013 13:36	11/16/2013 21:42	Rain Composite	148	479.3	288	244	60.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11/19/2013 9:36	11/19/2013 9:37	Base Grab	—	262.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12/2/2013 18:00	12/3/2013 17:00	Rain/Melt Composite	159	724.2	284	151	33.1	—	—	0.0186	0.0350	0.0038	0.0064	0.0014	0.0125	0.0602	0.1480	< 0.0002	~ 0.0003	0.0063	0.0108	—
12/17/2013 11:21	12/17/2013 11:22	Base Grab	—	1,383.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

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* (MPN/ 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)
1/10/2013 18:44	1/11/2013 7:22	Rain/Melt Composite	35	38.84	13.81	1,498.0	2,517.0	7.61	5.5	1.29	—	—	125	33	1,290	14.60	0.124	0.510	0.090	4.00	0.42	0.08	0.54
1/15/2013 11:17	1/15/2013 11:18	Base Grab	10	45.50	11.61	805.0	1,209.0	7.86	> 100.0	0.60	—	—	34	~ 4	675	—	—	~ 0.044	—	0.44	—	—	—
2/8/2013 10:24	2/8/2013 10:25	Base Grab	20	47.84	11.21	1,347.0	1,952.0	7.63	> 100.0	1.00	—	—	7	~ 2	1,070	54.20	< 0.020	< 0.020	< 0.005	0.42	< 0.02	< 0.03	1.07
3/8/2013 10:30	3/8/2013 10:35	Base Grab	20	47.30	11.09	1,840.0	2,688.0	7.78	76.5	1.40	—	—	3	~ 2	1,390	44.80	< 0.020	~ 0.033	0.012	0.35	< 0.02	< 0.03	1.08
3/21/2013 11:24	3/21/2013 11:29	Base Grab	10	44.24	11.50	860.0	1,319.0	7.82	> 100.0	0.67	—	—	3	~ 1	737	60.10	1.410	~ 0.048	0.128	0.59	< 0.02	< 0.03	1.04
3/29/2013 15:31	3/30/2013 10:10	Rain/Melt Composite	31	39.56	13.22	663.0	1,101.0	7.38	7.5	0.54	—	—	122	44	648	12.00	0.107	0.386	—	3.60	0.71	0.06	0.55
4/2/2013 10:02	4/2/2013 10:03	Base Grab	26	44.96	11.74	860.0	1,302.0	7.52	> 100.0	0.65	—	—	~ 2	< 1	734	57.10	< 0.020	~ 0.042	0.025	0.52	~ 0.02	< 0.03	1.04
4/4/2013 9:33	4/4/2013 9:34	Base Grab	41	43.88	10.84	789.0	1,216.0	7.98	> 100.0	0.61	73	< 0.20	—	—	—	—	—	—	—	—	—	—	—
4/7/2013 21:38	4/8/2013 5:31	Rain/Melt Composite	43	43.88	—	178.4	275.0	7.28	11.5	0.13	—	—	101	19	156	7.19	0.060	0.205	0.047	1.50	0.55	0.04	0.46
4/14/2013 14:09	4/14/2013 21:09	Rain/Melt Composite	35	41.72	13.55	606.0	967.0	6.51	—	0.48	—	—	61	33	468	—	—	0.182	—	1.50	0.35	< 0.03	0.54
4/16/2013 10:25	4/16/2013 10:26	Base Grab	35	44.42	12.17	711.0	1,085.0	8.09	71.5	0.54	18	< 0.22	—	—	—	—	—	—	—	—	—	—	—
5/1/2013 10:19	5/1/2013 10:20	Rain Grab	36	47.48	10.99	347.4	505.6	7.42	21.0	0.25	1,300	—	—	—	—	—	—	—	—	—	—	—	—
6/18/2013 10:45	6/18/2013 10:46	Base Grab	70	58.10	10.49	1,114.0	1,394.0	8.12	> 100.0	0.70	—	—	~ 2	< 1	826	81.50	~ 0.039	0.059	0.048	0.55	< 0.02	< 0.03	1.46
6/19/2013 9:55	6/19/2013 9:56	Base Grab	74	56.66	10.52	1,109.0	1,412.0	8.01	> 100.0	0.71	38	0.26	—	—	—	—	—	—	—	—	—	—	—
6/21/2013 2:59	6/21/2013 4:34	Rain Composite	73	68.00	8.24	98.1	108.5	7.27	12.0	0.05	—	—	140	39	63	5.34	~ 0.022	0.340	< 0.005	2.00	0.22	< 0.03	0.35
6/21/2013 20:04	6/21/2013 21:00	Rain Composite	83	72.50	7.75	68.3	71.7	7.12	12.0	0.03	—	—	240	~ 52	38	2.05	~ 0.034	0.318	—	1.50	0.07	< 0.03	0.22
7/9/2013 8:38	7/9/2013 10:06	Rain Composite	78	71.24	8.16	133.7	142.3	7.62	—	0.07	—	—	132	41	88	8.62	0.136	0.353	0.117	2.50	0.67	0.04	0.64
7/9/2013 10:12	7/9/2013 10:13	Rain Grab	72	69.26	7.81	139.4	151.7	8.21	30.0	0.07	2,300	—	—	—	—	—	—	—	—	—	—	—	—
7/13/2013 4:16	7/13/2013 6:02	Rain Composite	87	74.48	7.64	92.1	94.5	7.78	37.0	0.04	—	—	57	16	52	3.82	< 0.020	0.129	—	0.79	0.09	0.05	0.30
7/15/2013 11:40	7/15/2013 11:41	Base Grab	82	59.54	10.85	924.0	1,134.0	8.02	> 100.0	0.57	—	—	~ 1	~ 1	762	85.80	< 0.020	~ 0.041	< 0.005	0.62	< 0.02	< 0.03	1.51
7/16/2013 10:28	7/16/2013 10:29	Base Grab	86	62.60	9.57	1,170.0	1,380.0	7.87	> 100.0	0.69	21	< 0.20	—	—	—	—	—	—	—	—	—	—	—
7/30/2013 10:50	7/30/2013 10:51	Rain Grab	67	61.88	8.90	621.0	741.0	8.06	30.0	0.36	300	—	—	—	—	—	—	—	—	—	—	—	—
8/5/2013 2:53	8/5/2013 5:26	Rain Composite	69	64.94	8.91	111.8	128.1	7.90	24.0	0.06	—	—	68	~ 28	81	6.66	0.060	0.166	0.061	0.99	0.16	0.03	0.38
8/6/2013 19:57	8/6/2013 21:59	Rain Composite	63	66.02	7.49	112.8	127.9	7.45	—	0.06	—	—	175	69	110	7.55	~ 0.041	0.298	< 0.005	1.90	0.08	< 0.03	0.34
8/8/2013 10:05	8/8/2013 10:06	Base Grab	68	59.90	9.80	1,070.0	1,309.0	8.21	> 100.0	0.66	56	< 0.20	—	—	—	—	—	—	—	—	—	—	—
8/9/2013 9:50	8/9/2013 9:51	Base Grab	69	58.46	—	1,052.0	1,311.0	8.18	> 100.0	0.66	—	—	< 1	~ 1	683	81.10	< 0.020	~ 0.035	0.010	0.22	< 0.02	< 0.03	1.36
8/20/2013 9:57	8/20/2013 9:58	Base Grab	73	62.06	8.5	1,102.0	1,309.0	8.00	> 100.0	0.66	36	< 0.20	—	—	—	—	—	—	—	—	—	—	—
8/21/2013 9:41	8/21/2013 9:42	Base Grab	79	62.60	9.19	1,081.0	1,276.0	8.20	> 100.0	0.64	—	—	5	~ 2	732	77.00	~ 0.027	0.054	0.013	0.48	< 0.02	< 0.03	1.18
8/29/2013 5:15	8/29/2013 5:30	Rain Composite	78	73.76	5.11	196.4	203.5	7.39	—	0.10	—	—	316	94	137	14.30	0.319	0.885	0.258	4.70	0.46	0.04	0.85

Table F.4 continued. 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* (MPN/ 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)
9/5/2013 10:08	9/5/2013 10:09	Base Grab	70	60.80	9.14	976.0	1,180.0	8.12	> 100.0	0.59	132	0.33	—	—	—	—	—	—	—	—	—	—	—
9/10/2013 10:20	9/10/2013 10:21	Base Grab	74	59.36	9.82	1,034.0	1,241.0	8.19	> 100.0	0.62	—	—	< 1	~ 1	715	75.00	< 0.020	0.053	0.012	0.46	< 0.02	< 0.03	1.22
9/14/2013 20:18	9/15/2013 6:30	Rain Composite	75	54.86	9.57	164.4	215.0	7.68	—	0.10	—	—	40	17	138	12.90	0.121	0.334	—	1.50	0.11	0.05	0.59
9/18/2013 10:34	9/18/2013 10:35	Rain Grab	68	61.34	9.03	271.2	325.2	8.17	59.0	0.16	1,046	—	—	—	—	—	—	—	—	—	—	—	—
9/19/2013 11:34	9/19/2013 13:48	Rain Composite	59	64.04	7.74	140.3	162.7	7.54	—	0.08	—	—	180	62	91	11.80	0.080	0.377	—	2.00	0.09	0.04	0.46
9/24/2013 10:10	9/24/2013 10:11	Base Grab	61	57.56	9.64	960.0	1,210.0	8.32	> 100.0	0.61	—	—	~ 2	~ 1	734	75.60	< 0.020	~ 0.030	0.014	0.31	< 0.02	< 0.03	1.21
10/1/2013 9:48	10/1/2013 9:49	Base Grab	66	58.10	9.75	941.0	1,178.0	8.27	> 100.0	0.59	22	< 0.20	—	—	—	—	—	—	—	—	—	—	—
10/2/2013 19:49	10/2/2013 22:17	Rain Composite	58	60.08	9.19	89.2	108.9	7.81	20.0	0.05	—	—	125	42	76	6.51	0.071	0.248	0.059	1.70	0.50	0.06	0.55
10/5/2013 0:11	10/5/2013 12:15	Rain Composite	72	51.80	10.55	156.2	213.3	7.84		0.10	—	—	41	16	134	12.30	~ —	—	—	0.93	< —	< 0.03	0.36
10/8/2013 10:19	10/8/2013 10:20	Base Grab	53	56.12	9.95	1,000.0	1,284.0	8.33	> 100.0	0.65	—	—	~ 1	~ 1	728	75.00	< 0.020	< 0.020	~ 0.008	0.43	< 0.02	< 0.03	1.25
10/11/2013 23:11	10/14/2013 9:06	Rain Composite	56	—	—	—	—	—	—	—	—	—	—	—	—	43.60	< 0.020	0.328	—	2.50	< 0.02	0.05	0.75
10/14/2013 23:22	10/15/2013 7:03	Rain Composite	55	52.70	10.78	73.6	99.1	7.72	46.0	0.05	—	—	18	9	54	4.60	~ 0.049	0.097	0.040	0.48	0.07	< 0.03	0.24
10/15/2013 10:45	10/15/2013 10:46	Rain Grab	54	55.22	9.67	325.4	423.5	8.11	17.0	0.20	1,100	—	—	—	—	—	—	—	—	—	—	—	—
10/22/2013 10:10	10/22/2013 10:11	Base Grab	35	46.04	11.14	857.0	1,276.0	8.42	> 100.0	0.64	—	—	< 1	< 1	749	77.70	~ 0.028	< 0.020	0.016	0.37	~ 0.02	< 0.03	1.13
10/29/2013 10:06	10/29/2013 10:07	Base Grab	36	48.38	11.30	883.0	1,269.0	8.33	> 100.0	0.64	5	0.22	—	—	—	—	—	—	—	—	—	—	—
10/31/2013 11:15	10/31/2013 11:16	Rain Grab	—	51.26	10.46	789.0	1,085.0	8.21	—	0.54	59	—	—	—	—	—	—	—	—	—	—	—	—
11/4/2013 12:46	11/4/2013 16:08	Rain Composite	44	39.74	12.86	239.5	395.7	7.90	—	0.19	—	—	191	59	—	—	0.074	0.490	—	2.30	0.31	0.05	0.59
11/5/2013 21:01	11/6/2013 22:22	Rain Composite	27	40.28	12.23	423.7	695.2	8.15	—	0.34	—	—	29	14	—	35.20	~ 0.032	0.097	—	0.72	~ 0.03	0.03	0.62
11/7/2013 10:14	11/7/2013 10:15	Base Grab	27	45.32	12.96	779.0	1,173.0	8.29	100.0	0.59	—	—	~ 3	~ 2	635	69.55	~ 0.051	0.063	0.036	0.42	~ 0.04	< 0.03	1.27
11/14/2013 9:37	11/14/2013 9:38	Base Grab	39	46.76	11.65	852.0	1,254.0	8.41	100.0	0.63	4	0.13	—	—	—	—	—	—	—	—	—	—	—
11/19/2013 9:50	11/19/2013 9:51	Base Grab	28	44.06	12.05	837.0	1,287.0	8.33	100.0	0.64	—	—	< 1	< 1	758	—		~ 0.030	—	0.28	—	—	—
12/17/2013 10:31	12/17/2013 10:32	Base Grab	25	47.30	11.84	1,251.0	1,828.0	8.50	—	0.93	1	—	< 1	~ 1	1,050	—	—	< 0.020	—	0.48	—	—	—

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)
1/10/2013 18:44	1/11/2013 7:22	Rain/Melt Composite	57	716.0	100	145	12.3	13.0	17.0	0.00810	0.03120	0.00300	0.01020	~ 0.00025	0.02240	0.03280	0.21100	< 0.00020	~ 0.00046	0.00340	0.01200	10
1/15/2013 11:17	1/15/2013 11:18	Base Grab	—	132.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2/8/2013 10:24	2/8/2013 10:25	Base Grab	336	362.0	464	~ 6	5.5	< 1.0	1.2	0.00100	0.00150	0.00510	0.00550	< 0.00010	~ 0.00046	0.00500	0.00710	< 0.00020	< 0.00020	0.00055	< 0.00050	
3/8/2013 10:30	3/8/2013 10:35	Base Grab	339	519.0	464	21	5.0	1.0	1.2	0.00180	0.00230	0.00560	0.00540	< 0.00010	0.00062	0.00920	0.01320	< 0.00020	< 0.00020	0.00027	0.00061	—
3/21/2013 11:24	3/21/2013 11:29	Base Grab	337	137.0	460	~ 7	9.2	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
3/29/2013 15:31	3/30/2013 10:10	Rain/Melt Composite	61	238.0	100	127	22.8	—		—	—	—	—	—	—	—	—	—	—	—	—	—
4/2/2013 10:02	4/2/2013 10:03	Base Grab	345	196.0	400	~ 10	4.6	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
4/7/2013 21:38	4/8/2013 5:31	Rain/Melt Composite	41	33.6	56	72	7.3	3.8	6.0	0.00490	0.01950	0.00140	0.00560	~ 0.00045	0.01310	0.01760	0.11500	< 0.00020	~ 0.00021	0.00180	0.00590	—
4/14/2013 14:09	4/14/2013 21:09	Rain/Melt Composite	49	209.0	68	70	—	4.7	6.7	—	—	—	—	—	—	—	—	—	—	—	—	—
6/18/2013 10:45	6/18/2013 10:46	Base Grab	323	241.0	452	~ 9	4.0	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
6/21/2013 2:59	6/21/2013 4:34	Rain Composite	21	8.7	44	84	15.3	> 7.2	> 7.2	0.00870	0.02820	0.00150	0.00590	~ 0.00039	0.01610	0.01880	0.09480	< 0.00020	~ 0.00027	0.00110	0.00550	< 6
6/21/2013 20:04	6/21/2013 21:00	Rain Composite	22	3.1	40	63	5.4	—		—	—	—	—	—	—	—	—	—	—	—	—	—
7/9/2013 8:38	7/9/2013 10:06	Rain Composite	23	14.6	52	101	19.7	19.0	23.0	0.00920	0.02470	0.00250	0.00650	~ 0.00034	0.01570	0.02410	0.13800	< 0.00020	~ 0.00027	0.00280	0.00730	—
7/13/2013 4:16	7/13/2013 6:02	Rain Composite	26	6.4	48	46	5.8	—	—	0.00560	0.01290	0.00099	0.00250	< 0.00010	0.00590	0.00980	0.05070	< 0.00020	< 0.00020	0.00055	0.00240	—
7/15/2013 11:40	7/15/2013 11:41	Base Grab	93	203.0	444	~ 10	3.5	< 1.0	< 1.0	0.00140	0.00140	0.00470	0.00470	< 0.00010	< 0.00010	0.00560	0.00490	< 0.00020	< 0.00020	0.00018	0.00023	—
8/5/2013 2:53	8/5/2013 5:26	Rain Composite	34	10.1	60	62	13.6	10.0	14.0	0.00600	0.01450	0.00180	0.00420	~ 0.00024	0.00710	0.02080	0.08520	< 0.00020	< 0.00020	0.00200	0.00620	—
8/6/2013 19:57	8/6/2013 21:59	Rain Composite	34	11.6	64	81	10.1	6.8	15.0	—	—	—	—	—	—	—	—	—	—	—	—	—
8/9/2013 9:50	8/9/2013 9:51	Base Grab	305	181.3	448	16	4.9	3.6	3.9	0.00130	0.00110	0.00490	0.00480	< 0.00010	~ 0.00011	0.00380	0.00490	< 0.00020	< 0.00020	0.00064	0.00021	< 6
8/21/2013 9:41	8/21/2013 9:42	Base Grab	323	37.2	444	~ 13	5.3	2.6	2.7	—	—	—	—	—	—	—	—	—	—	—	—	—
8/29/2013 5:15	8/29/2013 5:30	Rain Composite	47	21.3	164	247	39.1	39.0	> 48.0	—	—	—	—	—	—	—	—	—	—	—	—	—
9/10/2013 10:20	9/10/2013 10:21	Base Grab	309	174.0	440	~ 11	5.2	< 1.0	1.2	0.00110	0.00130	0.00450	0.00500	< 0.00010	< 0.00010	0.00560	0.00610	< 0.00020	< 0.00020	0.00150	0.00020	—
9/14/2013 20:18	9/15/2013 6:30	Rain Composite	51	21.8	84	60	13.8	—	—	0.00670	0.01490	0.00300	0.00530	~ 0.00018	0.00530	0.01600	0.07770	< 0.00020	< 0.00020	0.00160	0.00280	—
9/19/2013 11:34	9/19/2013 13:48	Rain Composite	39	12.8	68	116	11.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9/24/2013 10:10	9/24/2013 10:11	Base Grab	327	176.6	456	~ 11	3.0	1.5	1.7	—	—	—	—	—	—	—	—	—	—	—	—	—
10/2/2013 19:49	10/2/2013 22:17	Rain Composite	28	7.9	44	71	7.5	7.3	> 8.0	0.00500	0.01680	0.00150	0.00480	~ 0.00036	0.01130	0.01830	0.10400	< 0.00020	~ 0.00020	0.00170	0.00500	—
10/5/2013 0:11	10/5/2013 12:15	Rain Composite	53	20.9	76	47	6.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10/8/2013 10:19	10/8/2013 10:20	Base Grab	317	174.5	402	~ 8	3.3	1.2	1.3	—	—	—	—	—	—	—	—	—	—	—	—	—
10/11/2013 23:11	10/14/2013 9:06	Rain Composite	179	100.6	284	84	9.3	—	13.0	—	—	—	—	—	—	—	—	—	—	—	—	—
10/14/2013 23:22	10/15/2013 7:03	Rain Composite	25	6.5	40	26	5.1	4.0	5.3	—	—	—	—	—	—	—	—	—	—	—	—	—
10/22/2013 10:10	10/22/2013 10:11	Base Grab	344	182.6	336	~ 8	2.4	< 1.0	< 1.0	0.00110	0.00100	0.00490	0.00490	< 0.00010	~ 0.00013	0.00590	0.00750	< 0.00020	< 0.00020	0.00018	0.00018	—
11/4/2013 12:46	11/4/2013 16:08	Rain Composite	94	44.8	—	117		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11/5/2013 21:01	11/6/2013 22:22	Rain Composite	163	111.5	252	32	8.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11/7/2013 10:14	11/7/2013 10:15	Base Grab	316	148.3	476	~ 9	3.1	—	—	0.00125	0.00135	0.00445	0.00485	< 0.00100	0.00270	0.00800	0.00545	< 0.00020	< 0.00020	0.00026	0.00029	—
11/19/2013 9:50	11/19/2013 9:51	Base Grab	—	211.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12/17/2013 10:31	12/17/2013 10:32	Base Grab	—	352.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

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* (MPN/ 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)
3/28/2013 15:56	3/28/2013 15:57	Melt Grab	40	6.0	12.99	596.0	936.0	7.41	4.8	0.46	—	—	271	73	592	14.4	0.449	0.917	0.472	4.300	0.660	0.06	0.36
7/9/2013 9:30	7/9/2013 9:31	Rain Grab	70	72.9	8.05	343.0	358.5	8.04	4.0	0.17	21,400	—	—	—	—	—	—	—	—	—	—	—	—
9/19/2013 12:30	9/19/2013 12:31	Rain Grab	—	—	—	—	—	—	—	—	—	—	254	~ 56	140	14.1	0.258	0.746	0.188	2.400	0.360	0.07	0.55
10/15/2013 9:58	10/15/2013 9:59	Rain Grab	54	53.6	10.56	220.3	292.9	8.09	7.0	0.14	2,600	—	—	—	—	—	—	—	—	—	—	—	—
10/15/2013 12:00	10/15/2013 12:01	Rain Grab	55	12.3	10.88	295.8	390.5	8.15	—	0.19	—	—	23	8	204	16.9	~ 0.048	0.150	0.036	0.800	0.090	0.04	0.24

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	Total Biological Oxygen Demand 5-day	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)
3/28/2013 15:56	3/28/2013 15:57	Melt Grab	77	208	112	144	17.1	14.0	20.0	0.0089	0.0245	0.0018	0.0077	0.0009	0.0326	0.0150	0.1450	< 0.0002	~ 0.0004	0.0011	0.0078	—
9/19/2013 12:30	9/19/2013 12:31	Rain Grab	46	19	68	178	15.4	13.0	19.0	0.0076	0.0358	0.0017	0.0117	0.0007	0.0435	0.0102	0.2250	< 0.0002	0.0006	0.0057	0.0172	—
10/15/2013 12:00	10/15/2013 12:01	Rain Grab	78	54	—	46	8.5	6.6	7.6	—	—	—	—	—	—	—	—	—	—	—	—	—

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* (MPN/ 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)
1/15/13 10:30	1/15/2013 10:35	Base Grab	10	38.3	12.1	1,372.0	2,329.0	7.43	25.0	1.19	—	—	9	6	1,200	—	—	0.193	—	2.00	—	—	—
1/29/13 8:46	1/29/2013 15:47	Melt Composite	18	51.4	9.62	14,118.0	19,363.0	7.05	—	11.53	—	—	82	32	10,900	6.55	< 0.020	0.294	—	7.00	1.43	0.17	0.88
2/13/13 13:53	2/14/2013 21:58	Melt Composite	10	44.4	10.5	10,814.0	16,525.0	7.08	—	9.64	—	—	188	~ 116	8,970	24.20	0.446	0.336	—	4.70	1.07	0.14	0.76
2/23/13 14:13	2/24/2013 14:52	Melt Composite	25	62.8	7.8	11,094.0	13,059.0	6.67	—	7.55	—	—	134	~ 56	7,090	—	—	0.318	—	3.60	—	—	—
2/25/13 14:30	2/25/2013 17:30	Melt Composite	33	45.1	11.5	5,558.0	8,390.0	7.02	—	4.66	—	—	82	31	4,410	—	—	0.482	—	3.60	—	—	—
2/27/13 12:29	3/1/2013 1:31	Melt Composite	25	45.7	8.92	4,599.0	6,888.0	6.85	7.0	7.38	—	—	78	~ 27	3,460	12.90	0.070	0.518	—	5.60	1.92	0.08	0.32
3/7/13 9:28	3/7/2013 9:29	Base Grab	21	37.8	13.68	4,889.0	8,379.0	7.10	22.5	4.60	—	—	9	~ 4	4,220	5.40	0.156	0.358	0.109	3.90	1.59	0.13	0.57
3/7/13 13:37	3/7/2013 19:39	Melt Composite	20	43.0	11.96	4,558.0	7,123.0	7.14	—	3.90	—	—	92	32	3,600	10.70	0.100	0.297	0.044	3.00	0.86	0.10	0.65
3/8/2013 12:39	3/10/2013 12:57	Melt Composite	25	50.5	9.64	1,318.0	1,833.0	6.94	—	0.94	—	—	46	18	908	4.23	0.325	0.476	—	4.50	1.36	0.06	0.94
3/13/2013 14:39	3/15/2013 11:44	Melt Composite	25	49.6	8.30	3,041.0	4,282.0	7.11	9.5	2.29	—	—	69	~ 25	2,280	10.60	0.289	0.459	—	3.90	0.86	0.08	0.47
3/21/2013 10:50	3/21/2013 10:55	Base Grab	10	36.5	11.50	3,502.0	6,147.0	7.29	31.0	3.30	—	—	~ 4	~ 3	3,200	10.80	0.107	0.228	0.092	3.20	1.32	0.14	0.86
3/28/2013 12:33	3/28/2013 23:47	Melt Composite	30	48.9	10.57	516.0	736.0	6.99	18.0	0.36	—	—	42	~ 11	568	6.83	0.514	0.661	0.459	3.50	1.06	0.06	0.64
3/29/2013 13:19	3/30/2013 14:07	Rain /Melt Composite	23	49.3	9.30	554.0	784.0	7.14	11.5	0.39	—	—	85	42	444	5.68	0.314	0.500	—	3.25	1.00	0.06	0.68
4/2/2013 9:33	4/2/2013 9:35	Base Grab	25	37.8	12.59	618.0	1,060.0	7.28	31.0	0.52	—	—	13	4	570	11.20	0.208	0.345	0.203	2.40	0.58	0.07	1.04
4/4/2013 9:56	4/4/2013 9:57	Base Grab	41	41.2	12.37	507.0	818.0	7.74	35.0	0.40	< 2,420	< 0.20	—	—	—	—	—	—	—	—	—	—	—
4/8/2013 0:44	4/8/2013 8:37	Rain /Melt Composite	42	49.5	11.40	247.0	348.7	7.16	13.0	0.17	—	—	102	~ 27	210	4.45	0.089	0.280	0.085	1.80	0.61	0.04	0.59
4/11/2013 11:17	4/12/2013 9:20	Rain /Melt Composite	30	45.0	12.2	2,232.0	3,382.0	6.89	9.0	1.78	—	—	80	~ 28	1,720	7.93	0.063	0.192	0.052	1.70	0.32	0.04	0.92
4/14/2013 13:03	4/15/2013 2:48	Rain /Melt Composite	34	50.5	11.96	512.0	712.0	6.94	15.5	0.35	—	—	57	~ 22	368	8.76	0.055	0.222	0.054	1.60	0.40	0.03	0.89
4/16/2013 10:51	4/16/2013 10:52	Base Grab	35	39.0	13.14	705.0	1,181.0	7.82	56.0	0.58	19,360	< 0.20	—	—	—	—	—	—	—	—	—	—	—
4/19/2013 9:17	4/22/2013 9:20	Rain /Melt Composite	38	51.8	10.73	849.0	1,160.0	6.96	17.0	0.58	—	—	39	~ 15	500	14.80	0.079	0.171	—	1.30	0.15	0.04	1.39
4/22/2013 13:47	4/24/2013 6:25	Rain /Melt Composite	33	52.3	10.92	636.0	862.0	7.20	19.5	0.43	—	—	38	~ 12	453	11.60	0.086	0.179	0.074	1.20	0.08	0.04	1.63
4/29/2013 13:41	4/29/2013 13:42	Base Grab	70	59.9	10.08	918.0	1,121.0	7.52	89.0	0.56	—	—	6	3	612	34.40	0.083	0.105	0.061	1.60	0.23	0.05	2.68
5/1/2013 10:30	5/1/2013 10:31	Rain Grab	35	46.58	11.51	451.8	666.5	7.30	27.0	0.33	4,550	—	—	—	—	—	—	—	—	—	—	—	—
5/14/2013 10:15	5/14/2013 10:16	Base Grab	72	51.4	10.83	952.0	1,306.0	7.52	> 100.0	0.66	< 1	< 0.20	—	—	—	—	—	—	—	—	—	—	—
5/16/2013 10:14	5/16/2013 10:15	Base Grab	75	53.1	10.43	—	—	7.47	> 100.0	—	—	—	< 1	~ 1	746	74.10	~ 0.023	< 0.020	0.017	0.41	< 0.02	< 0.03	2.25
5/18/2013 7:23	5/18/2013 16:05	Rain Composite	69	68.5	5.9	—	—	7.33	16.0	0.15	—	—	128	38	151	7.47	~ 0.048	0.327	—	2.10	0.23	0.04	0.38
5/19/2013 7:08	5/19/2013 17:26	Rain Composite	69	69.4	6.21	—	—	7.24	10.0	0.12	—	—	192	37	124	6.96	< 0.020	0.363	—	2.40	0.38	0.04	0.40
5/20/2013 13:14	5/21/2013 2:07	Rain Composite	57	63.9	7.96	—	—	6.99	28.0	0.16	—	—	67	~ 19	193	10.30	0.052	0.173	0.046	1.20	0.14	0.04	0.73
5/23/2013 9:47	5/23/2013 9:48	Base Grab	49	55.0	10.25	782.0	1,019.0	7.21	> 100.0	0.51	—	—	4	~ 2	559	51.20	0.049	0.084	0.044	0.82	~ 0.03	< 0.03	2.71
5/25/2013 0:51	5/25/2013 14:51	Rain Composite	56	59.9	8.70	501.0	612.0	6.95	60.0	0.30	—	—	8	4	342	22.30	~ 0.041	0.085	—	1.10	0.19	0.05	1.25
5/29/2013 11:12	5/29/2013 11:13	Base Grab	70	54.7	10.46	906.0	1,186.0	8.03	> 100.0	0.59	17	0.00	—	—	—	—	—	—	—	—	—	—	—
5/29/2013 22:39	5/30/2013 7:24	Rain Composite	72	65.7	7.88	224.5	255.3	7.00	20.0	0.12	—	—	145	36	137	7.59	0.078	0.263	0.043	1.40	0.08	0.03	0.41
6/5/2013 10:45	6/5/2013 10:46	Rain Grab	57	55.2	9.67	536.0	697.0	7.47	14.0	0.34	—	—	52	~ 28	431	32.00	0.126	0.429	0.101	2.50	0.40	0.14	2.15
6/6/2013 8:55	6/6/2013 8:56	Base Grab	50	52.5	10.23	824.0	1,113.0	7.71	> 100.0	0.56	> 2,420	0.21	—	—	—	—	—	—	—	—	—	—	—
6/9/2013 7:29	6/9/2013 16:23	Rain Composite	64	63.3	8.2	230.9	270.4	7.22	41.0	0.13	—	—	29	11	156	7.57	0.072	0.157	—	1.00	0.18	0.04	1.89
6/12/2013 10:45	6/12/2013 10:46	Rain Grab	59	61.7	9.4	76.0	90.8	7.35	11.0	0.04	10,800	—	—	—	—	—	—	—	—	—	—	—	—
6/12/2013 9:13	6/12/2013 16:11	Rain Composite	68	64.8	8.0	197.1	226.3	7.03	16.0	0.11	—	—	68	22	137	6.56	~ 0.039	0.203	—	1.40	0.30	0.04	0.43
6/15/2013 15:20	6/15/2013 16:24	Rain Composite	72	72.9	7.1	85.2	89.0	6.92	—	0.04	—	—	193	33	64	2.03	0.053	0.309	—	—	—	—	—
6/18/2013 9:20	6/18/2013 9:21	Base Grab	65	59.2	10.36	790.0	974.0	7.76	> 100.0	0.48	—	—	~ 2	< 1	568	54.10	0.088	0.104	0.082	0.47	< 0.02	0.04	2.49
6/19/2013 10:20	6/19/2013 10:21	Base Grab	76	59.2	10.07	887.0	1,095.0	8.04	> 100.0	0.55	548	0.21	—	—	—	—	—	—	—	—	—	—	—
6/21/2013 2:44	6/21/2013 7:46	Rain Composite	70	70.0	7.56	171.4	185.2	7.16	13.0	0.09	—	—	108	19	102	5.96	0.086	0.623	0.041	1.60	0.14	0.03	0.49
6/21/2013 19:57	6/21/2013 21:12	Rain Composite	82	74.8	6.55	87.8	89.8	6.30	15.0	0.04	—	—	177	~ 29	53	2.10	0.075	0.294	—	1.40	0.11	< 0.03	0.25
6/29/2013 3:29	6/29/2013 5:43	Rain Composite	76	73.8	7.1	181.6	187.9	7.74	25.0	0.09	—	—	61	16	104	6.34	0.056	0.181	—	0.78	~ 0.05	< 0.03	0.30

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* (MPN/ 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)
7/1/2013 9:53	7/1/2013 9:54	Base Grab	76	60.3	9.63	894.0	1,088.0	8.02	> 100	.54	—	—	< 1	~ 1	622	63.70	~ 0.044	~ 0.041	0.039	0.59	< 0.02	< 0.03	1.92
7/2/2013 9:37	7/2/2013 9:38	Base Grab	71	58.8	10.23	922.0	1,143.0	7.75	> 100	.57	27	0.00	—	—	—	—	—	—	—	—	—	—	—
7/9/2013 8:21	7/9/2013 9:40	Rain Composite	75	75.0	7.63	152.8	156.1	7.77	—	.07	—	—	171	39	82	6.64	0.110	0.356	0.094	2.20	0.60	0.05	0.54
7/9/2013 10:36	7/9/2013 10:37	Rain Grab	73	73.4	6.82	464.6	483.3	7.80	40	.23	10,800	—	—	—	—	—	—	—	—	—	—	—	—
7/13/2013 4:03	7/13/2013 7:30	Rain Composite	81	78.3	6.18	122.2	120.6	7.12	27	.06	—	—	56	8	54	3.45	0.054	0.143	—	0.68	0.15	0.05	0.29
7/15/2013 10:47	7/15/2013 10:48	Base Grab	81	60.8	10.23	830.0	1,002.0	7.78	> 100	.50	—	—	< 1	~ 1	558	61.75	~ 0.040	~ 0.045	0.039	0.36	< 0.02	< 0.03	1.46
7/16/2013 10:55	7/16/2013 10:56	Base Grab	86	62.8	9.65	884.0	1,029.0	7.82	> 100	.51	42	0.20	—	—	—	—	—	—	—	—	—	—	—
7/30/2013 11:08	7/30/2013 11:09	Rain Grab	69	61.2	1.03	585.0	704.4	7.71	> 100	.35	1,700	—	—	—	—	—	—	—	—	—	—	—	—
8/5/2013 2:31	8/5/2013 6:42	Rain Composite	70	70.3	8.14	235.8	253.9	7.67	—	.12	—	—	54	18	146	10.20	0.058	0.176	0.050	1.10	0.16	0.03	0.40
8/6/2013 19:41	8/6/2013 20:51	Rain Composite	61	71.1	6.39	129.1	137.7	7.42	—	.06	—	—	402	66	95	6.11	0.055	0.418	0.025	2.20	~ 0.05	< 0.03	0.32
8/8/2013 10:37	8/8/2013 10:38	Base Grab	69	66.0	8.99	1,082.0	1,226.0	8.44	69	.61	276	< 0.20	—	—	—	—	—	—	—	—	—	—	—
8/9/2013 9:07	8/9/2013 9:08	Base Grab	67	58.5	—	833.0	1,036.0	7.75	> 100	.52	—	—	< 1	< 1	596	67.55	~ 0.024	~ 0.027	0.021	0.25	< 0.02	< 0.03	1.42
8/20/2013 10:31	8/20/2013 10:32	Base Grab	80	60.8	10.59	893.0	1,080.0	8.23	> 100	.54	111	< 0.20	—	—	—	—	—	—	—	—	—	—	—
8/21/2013 9:06	8/21/2013 9:07	Base Grab	78	60.1	9.67	855.0	1,041.0	8.07	> 100	.52	—	—	< 1	~ 1	607	66.90	~ 0.022	~ 0.023	0.021	0.12	< 0.02	< 0.03	1.23
8/29/2013 4:48	8/29/2013 5:35	Rain Composite	91	79.9	6.90	152.1	147.7	7.78	11	.07	—	—	347	58	98	6.92	0.176	0.442	0.125	2.50	0.39	< 0.03	0.60
9/5/2013 10:29	9/5/2013 10:30	Base Grab	70	57.9	10.10	798.0	1,000.0	8.22	> 100	.50	20	0.00	—	—	—	—	—	—	—	—	—	—	—
9/10/2013 8:57	9/10/2013 8:58	Base Grab	73	59.4	9.80	823.0	1,014.0	8.11	> 100	.50	—	—	< 1	< 1	583	66.25	~ 0.024	~ 0.021	0.019	0.19	< 0.02	< 0.03	1.20
9/14/2013 20:01	9/15/2013 5:58	Rain Composite	72	59.2	8.29	193.7	239.1	7.50	42	.11	—	—	39	13	138	11.90	~ 0.046	0.168	—	1.10	0.12	0.04	0.48
9/18/2013 11:05	9/18/2013 11:06	Rain Grab	69	60.6	9.46	459.6	556.3	8.04	100	.27	1,553	—	—	—	—	—	—	—	—	—	—	—	—
9/19/2013 11:21	9/19/2013 15:12	Rain Composite	58	66.4	6.90	197.5	222.4	7.54	—	.11	—	—	171	58	133	10.60	0.087	0.292	—	1.50	0.10	0.03	0.38
9/24/2013 9:12	9/24/2013 9:13	Base Grab	58	55.9	10.64	778.0	1,002.0	8.18	> 100	.50	—	—	< 1	~ 1	534	62.80	~ 0.036	~ 0.026	0.025	0.17	< 0.02	< 0.03	1.21
10/1/2013 10:10	10/1/2013 10:11	Base Grab	66	57.2	10.18	799.0	1,012.0	8.18	> 100	.50	60	0.22	—	—	—	—	—	—	—	—	—	—	—
10/2/2013 19:34	10/3/2013 1:05	Rain Composite	58	61.7	9.21	92.0	110.0	7.79	19	.05	—	—	92	26	78	4.71	0.051	0.206	0.043	1.30	0.39	< 0.03	0.44
10/4/2013 23:56	10/6/2013 13:47	Rain Composite	68	55.4	10.58	427.7	613.4	8.02	—	.30	—	—	15	7	346	35.00	~ 0.040	0.124	—	0.67	< 0.02	< 0.03	0.78
10/8/2013 9:46	10/8/2013 9:47	Base Grab	53	55.6	10.29	968.0	903.0	8.16	> 100	.45	—	—	~ 2	~ 2	534	54.70	< 0.020	~ 0.046	0.013	0.33	< 0.02	< 0.03	1.10
10/11/2013 22:48	10/13/2013 19:48	Rain Composite	52	50.9	9.06	419.3	580.2	7.98	—	.28	—	—	99	30	355	33.70	< 0.020	0.190	0.021	1.50	~ 0.03	< 0.03	0.76
10/14/2013 23:07	10/17/2013 9:03	Rain Composite	50	50.2	9.92	197.0	275.1	7.73	51	.13	—	—	18	8	125	12.00	0.056	0.155	—	0.64	< 0.02	< 0.03	< 0.05
10/15/2013 11:14	10/15/2013 11:15	Rain Grab	54	53.8	10.04	242.6	321.6	7.91	—	.15	1,300	—	—	—	—	—	—	—	—	—	—	—	—
10/17/2013 23:57	10/18/2013 8:15	Rain Composite	50	49.3	11.71	161.4	228.6	7.84	> 100	.11	—	—	10	4	125	10.30	0.082	0.089	0.076	0.43	< 0.02	< 0.03	0.27
10/22/2013 9:37	10/22/2013 9:38	Base Grab	30	48.6	10.98	538.0	772.0	8.28	> 100	.38	—	—	~ 2	~ 1	448	48.20	~ 0.028	0.064	0.017	0.29	< 0.02	< 0.03	1.01
10/29/2013 10:44	10/29/2013 10:45	Base Grab	37	50.5	10.90	299.8	417.4	8.41	> 100	.20	135	0.13	—	—	—	—	—	—	—	—	—	—	—
10/31/2013 12:30	10/31/2013 12:31	Rain Grab	—	—	—	—	—	—	—	—	99	—	—	—	—	—	—	—	—	—	—	—	—
11/5/2013 20:12	11/6/2013 8:39	Rain Composite	26	47.1	9.95	216.5	316.7	7.57	—	.15	—	—	22	12	162	5.61	0.090	0.247	—	0.88	< 0.02	< 0.03	0.09
11/7/2013 9:31	11/7/2013 9:32	Base grab	26	46.6	12.45	269.7	397.9	8.02	56	.19	—	—	7	6	224	15.70	~ 0.041	0.145	0.010	0.87	< 0.02	< 0.03	0.06
11/14/2013 10:16	11/14/2013 10:17	Base Grab	39	48.7	11.07	662.0	945.0	8.48	> 100	.47	158	0.15	—	—	—	—	—	—	—	—	—	—	—
11/19/2013 9:07	11/19/2013 9:08	Base Grab	28	47.1	11.80	355.4	520.2	8.08	60	.25	—	—	5	4	299	—	—	0.181	—	0.84	—	—	—
12/17/2013 9:35	12/17/2013 9:36	Base Grab	23	38.8	6.38	81,194.0	136,395.0	7.96	—	100.98	> 2,420	—	22	7	96,500	—	—	0.292	—	2.80	—	—	—

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)	Carbonaceous Biological Oxygen Demand 5-day	Total Biological Oxygen Demand 5-day	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)
1/15/13 10:30	1/15/2013 10:35	Base Grab	—	594.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1/29/13 8:46	1/29/2013 15:47	Melt Composite	59	6,218.0	280	417	18.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2/13/13 13:53	2/14/2013 21:58	Melt Composite	58	5,063.0	196	304	13.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2/23/13 14:13	2/24/2013 14:52	Melt Composite	—	4,362.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2/25/13 14:30	2/25/2013 17:30	Melt Composite	—	2,538.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2/27/13 12:29	3/1/2013 1:31	Melt Composite	95	2,014.0	200	113	14.8	—	—	0.0045	0.0182	0.0022	0.0045	< 0.0001	0.0045	0.0158	0.0658	< 0.0002	< 0.0002	0.0017	0.0061	—
3/7/13 9:28	3/7/2013 9:29	Base Grab	114	2,321.0	228	117	12.4	4.5	6.0	0.0074	0.0120	0.0024	0.0030	~ 0.0001	0.0010	0.0112	0.0323	< 0.0002	< 0.0002	0.0021	0.0034	—
3/7/13 13:37	3/7/2013 19:39	Melt Composite	53	2,176.0	140	147	18.1	7.9	11.0	—	—	—	—	—	—	—	—	—	—	—	—	—
3/8/13 12:39	3/10/2013 12:57	Melt Composite	34	489.0	76	90	24.5	—	16.0	—	0.0188	—	0.0035	—	0.0038	—	0.0709	—	< 0.0002	—	0.0060	< 6
3/13/13 14:39	3/15/2013 11:44	Melt Composite	46	1,312.0	96	107	17.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3/21/13 10:50	3/21/2013 10:55	Base Grab	97	1,659.0	220	63	25.6	2.1	2.9	—	—	—	—	—	—	—	—	—	—	—	—	—
3/28/13 12:33	3/28/2013 23:47	Melt Composite	43	157.0	80	—	19.1	13.0	16.0	0.0104	0.0125	0.0016	0.0029	~ 0.0004	0.0029	0.0171	0.0363	< 0.0002	< 0.0002	0.0020	0.0032	9
3/29/13 13:19	3/30/2013 14:07	Rain /Melt Composite	38	174.0	52	89	23.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4/2/13 9:33	4/2/2013 9:35	Base Grab	72	268.0	148	42	27.4	5.8	7.4	—	—	—	—	—	—	—	—	—	—	—	—	—
4/8/13 0:44	4/8/2013 8:37	Rain /Melt Composite	29	71.0	64	69	8.8	3.0	4.4	0.0048	0.0225	0.0010	0.0099	~ 0.0004	0.0111	0.0100	0.1060	< 0.0002	< 0.0002	0.0018	0.0139	—
4/11/13 11:17	4/12/2013 9:20	Rain /Melt Composite	126	890.0	116	82	12.7	6.6	8.1	0.0050	0.0155	0.0013	0.0045	< 0.0001	0.0061	0.0166	0.0849	< 0.0002	< 0.0002	0.0092	0.0151	—
4/14/13 13:03	4/15/2013 2:48	Rain /Melt Composite	50	157.6	84	53	7.4	3.4	4.8	—	—	—	—	—	—	—	—	—	—	—	—	—
4/19/13 9:17	4/22/2013 9:20	Rain /Melt Composite	76	225.3	116	45	8.1	—	—	0.0069	0.0130	0.0014	0.0029	< 0.0050	< 0.0050	0.0046	0.0352	< 0.0002	< 0.0002	0.0031	0.0055	< 6
4/22/13 13:47	4/24/2013 6:25	Rain /Melt Composite	86	170.0	116	39	9.4	1.5	2.4	—	—	—	—	—	—	—	—	—	—	—	—	< 8
4/29/13 13:41	4/29/2013 13:42	Base Grab	167	207.2	252	30	11.3	2.1	2.9	—	—	—	—	—	—	—	—	—	—	—	—	—
5/16/13 10:14	5/16/2013 10:15	Base Grab	375	144.3	532	~ 12	3.1	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
5/18/13 7:23	5/18/2013 16:05	Rain Composite	44	52.1	64	80	5.6	—	—	—	0.0196	—	0.0048	—	0.0060	—	0.0721	—	< 0.0002	—	0.0067	—
5/19/13 7:08	5/19/2013 17:26	Rain Composite	46	35.0	68	96	7.2	—	—	0.0065	0.0248	0.0012	0.0071	~ 0.0001	0.0122	0.0091	0.0944	< 0.0002	~ 0.0002	0.0014	0.0094	—
5/20/13 13:14	5/21/2013 2:07	Rain Composite	71	39.5	100	41	8.1	3.2	5.0	—	—	—	—	—	—	—	—	—	—	—	—	—
5/23/13 9:47	5/23/2013 9:48	Base Grab	271	115.3	396	~ 13	6.4	1.1	1.2	—	—	—	—	—	—	—	—	—	—	—	—	—
5/25/13 0:51	5/25/2013 14:51	Rain Composite	156	76.7	208	18	6.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5/29/13 22:39	5/30/2013 7:24	Rain Composite	56	33.3	240	53	7.8	6.3	7.6	—	—	—	—	—	—	—	—	—	—	—	—	—
6/5/13 10:45	6/5/2013 10:46	Rain Grab	151	89.0	240	88	16.8	9.0	14.0	0.0077	0.0132	0.0060	0.0045	< 0.0001	0.0030	0.0145	0.0507	< 0.0002	< 0.0002	0.0013	0.0034	—
6/9/13 7:29	6/9/2013 16:23	Rain Composite	59	32.8	84	29	5.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6/12/13 9:13	6/12/2013 16:11	Rain Composite	57	28.8	32	48	8.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6/15/13 15:20	6/15/2013 16:24	Rain Composite	19	9.5	36	49	3.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6/18/13 9:20	6/18/2013 9:21	Base Grab	302	96.8	408	16	5.2	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
6/21/13 2:44	6/21/2013 7:46	Rain Composite	37	22.8	84	55	11.9	7.1	> 7.1	0.0041	0.0109	0.0010	0.0040	< 0.0001	0.0059	0.0062	0.0374	< 0.0002	< 0.0002	0.0006	0.0037	12
6/21/13 19:57	6/21/2013 21:12	Rain Composite	19	8.0	40	48	5.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6/29/13 3:29	6/29/2013 5:43	Rain Composite	43	20.9	52	40	5.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

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)	Carbonaceous Biological Oxygen Demand 5-day	Total Biological Oxygen Demand 5-day	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)
7/1/13 9:53	7/1/13 9:54	Base Grab	345	121.3	472	~ 10	3.9	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
7/9/13 8:21	7/9/13 9:40	Rain Composite	31	14.9	60	89	15.0	13.0	15.0	0.0096	0.0199	0.0015	0.0053	0.0005	0.0081	0.0137	0.0758	< 0.0002	< 0.0002	0.0028	0.0073	—
7/13/13 4:03	7/13/13 7:30	Rain Composite	25	14.4	56	28	4.4	—	—	0.0055	0.0119	0.0008	0.0028	< 0.0001	0.0031	0.0098	0.0225	< 0.0002	< 0.0002	0.0006	0.0026	—
7/15/13 10:47	7/15/13 10:48	Base Grab	343	100.2	444	~ 11	3.5	< 1.0	< 1.0	0.0077	0.0085	0.0070	0.0070	< 0.0001	< 0.0001	0.0036	0.0019	< 0.0002	< 0.0002	0.0004	0.0003	—
8/5/13 2:31	8/5/13 6:42	Rain Composite	63	24.3	88	58	14.6	9.2	12.0	0.0071	0.0135	0.0018	0.0034	~ 0.0002	0.0029	0.0104	0.0385	< 0.0002	< 0.0002	0.0036	0.0021	—
8/6/13 19:41	8/6/13 20:51	Rain Composite	42	11.1	60	91	8.1	5.9	7.6	—	—	—	—	—	—	—	—	—	—	—	—	—
8/9/13 9:07	8/9/13 9:08	Base Grab	342	96.2	464	~ 13	3.1	1.4	1.4	0.0103	0.0104	0.0082	0.0078	~ 0.0001	~ 0.0001	0.0067	0.0025	< 0.0002	< 0.0002	0.0006	0.0003	< 6
8/21/13 9:06	8/21/13 9:07	Base Grab	363	99.6	476	~ 11	4.1	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
8/29/13 4:48	8/29/13 5:35	Rain Composite	35	14.0	64	130	22.4	20.0	23.0	—	—	—	—	—	—	—	—	—	—	—	—	—
9/10/13 8:57	9/10/13 8:58	Base Grab	353	89.1	494	~ 7	2.0	< 1.0	< 1.0	0.0079	0.0082	0.0071	0.0070	~ 0.0001	~ 0.0001	< 0.0050	0.0070	< 0.0002	< 0.0002	0.0004	0.0003	—
9/14/13 20:01	9/15/13 5:58	Rain Composite	65	20.5	96	42	11.8	—	—	0.0084	0.0138	0.0014	0.0026	< 0.0001	0.0018	0.0075	0.0270	< 0.0002	< 0.0002	0.0018	0.0026	—
9/19/13 11:21	9/19/13 15:12	Rain Composite	58	19.8	84	72	7.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9/24/13 9:12	9/24/13 9:13	Base Grab	361	88.5	462	8	2.8	< 1.0	< 1.0	—	—	—	—	—	—	—	—	—	—	—	—	—
10/2/13 19:34	10/3/13 1:05	Rain Composite	22	8.4	48	53	7.2	6.0	7.3	0.0045	0.0140	0.0011	0.0037	< 0.0001	0.0069	0.0069	0.0575	< 0.0002	< 0.0002	0.0019	0.0052	—
10/4/13 23:56	10/6/13 13:47	Rain Composite	192	56.1	252	32	4.9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10/8/13 9:46	10/8/13 9:47	Base Grab	309	81.9	396	~ 8	2.7	< 1.0	1.1	—	—	—	—	—	—	—	—	—	—	—	—	—
10/11/13 22:48	10/13/13 19:48	Rain Composite	191	50.1	320	42	5.2	4.8	8.3	—	—	—	—	—	—	—	—	—	—	—	—	—
10/14/13 23:07	10/17/13 9:03	Rain Composite	79	20.2	108	30	4.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10/17/13 23:57	10/18/13 8:15	Rain Composite	67	19.0	76	29	5.4	3.4	4.1	—	—	—	—	—	—	—	—	—	—	—	—	—
10/22/13 9:37	10/22/13 9:38	Base Grab	271	68.0	372	~ 12	2.8	< 1.0	1.1	0.0029	0.0033	0.0035	0.0035	~ 0.0001	~ 0.0002	0.0040	0.0044	< 0.0002	< 0.0002	0.0004	0.0004	—
11/5/13 20:12	11/6/13 8:39	Rain Composite	50	58.4	64	48	11.6	—	—	0.0065	0.0091	0.0021	0.0032	< 0.0010	0.0016	0.0125	0.0265	< 0.0002	< 0.0002	0.0021	0.0031	—
11/7/13 9:31	11/7/13 9:32	Base Grab	100	51.0	140	30	7.2	—	—	0.0022	0.0024	0.0011	0.0012	< 0.0010	< 0.0010	0.0089	0.0047	< 0.0002	< 0.0002	0.0005	0.0006	—
11/19/13 9:07	11/19/13 9:08	Base Grab	—	55.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12/17/13 9:35	12/17/13 9:36	Base Grab	—	57,631.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

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)
1/8/2013	13:42	34	32.9	0.97	2,344	4,408	6.83	2.30	37	30	2,460	0.274	0.016	5.10	< 0.02	< 0.03	< 0.05	1,029	1,190	< 0.0050	< 0.0050	0.0026	0.0027	< 0.0001	0.0006	0.0128	0.0152	< 0.0002	< 0.0002	0.00240	0.00031
2/12/2013	9:07	26	37.6	0.27	3,649	6,947	6.11	3.71	140	~ 92	4,040	0.736	0.028	5.10	1.20	< 0.03	< 0.05	1,823	444	< 0.0003	0.0016	0.0033	0.0039	< 0.0001	0.0032	< 0.0050	0.0087	< 0.0002	< 0.0002	0.00120	0.00077
3/7/2013	10:17	27	32.4	1.26	3,363	6,386	7.06	3.40	198	78	3,560	1.515	~ 0.005	7.05	3.36	< 0.03	< 0.05	1,367	1,195	< 0.0003	0.0013	0.0018	0.0022	< 0.0001	0.0026	0.0032	0.0080	< 0.0002	< 0.0002	0.00074	0.00078
4/23/2013	9:30	30	38.3	8.46	758	1,286	6.76	0.64	4	~ 2	597	0.063	< 0.005	0.91	< 0.02	< 0.03	0.31	279	156	0.0033	0.0039	0.0009	0.0010	< 0.0050	< 0.0050	0.0124	0.0180	< 0.0002	< 0.0002	0.00077	0.00078
5/6/2013	10:00	56	51.1	12.34	—	—	6.87	0.95	~ 2	~ 1	1,010	~ 0.030	< 0.005	1.00	< 0.02	< 0.03	< 0.05	445	312	0.0016	0.0018	0.0010	0.0010	< 0.0001	< 0.0001	0.0035	0.0047	< 0.0002	< 0.0001	< 0.00050	0.00050
6/4/2013	9:30	62	62.1	5.13	1,099	1,306	6.92	0.66	7	7	704	0.127	~ 0.009	1.20	< 0.02	< 0.03	< 0.05	246	252	0.0007	0.0010	0.0009	0.0009	< 0.0001	< 0.0001	0.0056	0.0048	< 0.0002	< 0.0002	0.00036	0.00027
7/1/2013	10:50	78	69.8	0.27	951	1,029	7.18	0.51	24	16	530	0.241	0.058	2.10	0.13	< 0.03	< 0.05	180	212	0.0011	0.0017	0.0010	0.0011	< 0.0001	0.0017	0.0062	0.0085	< 0.0002	< 0.0002	0.00044	0.00079
8/2/2013	8:43	66	68.2	1.27	1,149	1,267	6.95	0.63	17	7	678	0.081	~ 0.006	1.60	0.09	< 0.03	< 0.05	244	292	< 0.0003	0.0015	0.0007	0.0010	< 0.0001	0.0026	0.0061	0.0146	< 0.0002	< 0.0002	0.00023	0.00073
9/11/2013	9:36	73	71.2	0.47	1,708	1,819	6.92	0.92	67	~ 20	986	0.214	< 0.005	3.30	0.37	< 0.03	< 0.05	421	392	< 0.0003	0.0035	0.0010	0.0021	< 0.0001	0.0080	0.0050	0.0219	< 0.0002	< 0.0002	0.00160	0.00160
10/9/2013	9:21	63	57.4	5.44	1,336	1,687	7.66	0.86	7	6	—	0.204	~ 0.009	2.40	< 0.02	< 0.03	< 0.05	433	388	~ 0.0005	~ 0.0004	0.0015	0.0013	< 0.0001	~ 0.0002	0.0038	0.0098	< 0.0002	< 0.0002	0.00021	~ 0.00015
12/18/2013	9:43	22	34.5	1.34	1,465	2,670	7.01	1.36	8	5	1,370	0.052	< 0.005	2.60	0.84	< 0.03	< 0.05	605	588	< 0.0003	< 0.0003	0.0015	0.0016	< 0.0001	~ 0.0001	0.0069	0.0083	< 0.0002	< 0.0002	0.00033	0.00032

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)
1/8/2013	14:13	34	34.2	13.02	855	1,569.0	7.30	0.78	8	8	802	0.128	< 0.005	2.90	0.10	< 0.03	< 0.05	403.0	300	< 0.0050	< 0.0050	0.0016	0.0015	< 0.0001	~ 0.0001	0.0036	0.0029	< 0.0002	< 0.0002	0.00060	~ 0.00010
2/12/2013	9:32	29	35.1	5.73	1,044	1,881.0	7.23	0.94	6	6	985	0.186	0.026	2.50	0.35	< 0.03	< 0.05	454.0	344	0.0010	0.0024	0.0017	0.0018	< 0.0001	~ 0.0003	< 0.0050	< 0.0050	< 0.0002	< 0.0002	0.00130	< 0.00050
3/7/2013	10:54	30	34.2	0.98	1,119	2,054.0	7.37	1.03	3	3	1,050	0.084	0.011	2.20	0.51	< 0.03	< 0.05	467.0	276	0.0007	0.0010	0.0017	0.0019	~ 0.0001	~ 0.0002	0.0042	0.0063	< 0.0002	< 0.0002	0.00044	~ 0.00015
4/23/2013	9:57	31	39.2	15.21	845	1,412.4	7.10	0.70	11	8	704	0.085	< 0.005	1.30	< 0.02	< 0.03	< 0.05	343.4	216	0.0015	0.0024	0.0010	0.0015	< 0.0001	< 0.0050	0.0039	0.0157	< 0.0002	< 0.0002	0.00030	0.00064
5/6/2013	10:25	58	52.7	11.49	—	—	7.18	1.01	4	3	1,050	~ 0.040	~ 0.008	0.96	< 0.02	< 0.03	< 0.05	495.3	292	0.0014	0.0015	0.0013	0.0014	< 0.0001	~ 0.0001	0.0160	0.0140	< 0.0002	< 0.0002	< 0.00050	< 0.00050
6/4/2013	9:45	62	63.9	9.69	1,500	1,745.0	7.77	0.89	7	6	990	~ 0.043	< 0.005	1.20	< 0.02	< 0.03	< 0.05	409.5	288	0.0011	0.0013	0.0013	0.0015	< 0.0001	~ 0.0001	0.0102	0.0048	< 0.0002	< 0.0002	0.00024	0.00017
7/1/2013	10:22	76	72.9	8.31	1,313	1,373.0	7.78	0.69	8	6	716	0.069	< 0.005	1.25	< 0.02	< 0.03	< 0.05	328.9	250	0.0019	0.0023	0.0015	0.0017	< 0.0001	~ 0.0005	0.0055	0.0051	< 0.0002	< 0.0002	~ 0.00015	0.00025
8/2/2013	8:59	67	71.6	11.95	1,436	1,524.0	8.33	0.77	13	10	837	0.080	< 0.005	1.20	< 0.02	< 0.03	< 0.05	386.6	276	~ 0.0005	~ 0.0006	0.0012	0.0012	< 0.0001	0.0005	0.0058	0.0024	< 0.0002	< 0.0002	0.00140	~ 0.00015
9/11/2013	10:02	74	72.7	8.60	1,461	1,529.0	8.38	0.77	21	16	820	0.272	< 0.005	2.70	< 0.02	< 0.03	< 0.05	403.5	248	< 0.0003	~ 0.0005	0.0008	0.0012	< 0.0001	~ 0.0004	< 0.0050	< 0.0050	< 0.0002	< 0.0002	0.00130	~ 0.00011
10/9/2013	9:57	64	58.3	8.12	1,214	1,514.0	7.78	0.77	19	13	812	0.125	< 0.005	2.20	< 0.02	< 0.03	< 0.05	460.7	232	0.0009	0.0014	0.0011	0.0014	~ 0.0001	0.0012	0.0048	0.0061	< 0.0002	< 0.0002	0.00022	0.00028
12/18/2013	10:17	26	32.7	9.19	930	1,757.0	7.73	0.87	12	12	903	0.105	< 0.005	2.35	~ 0.07	< 0.03	< 0.05	414.9	296	0.0007	0.0007	0.0009	0.0014	~ 0.0002	~ 0.0002	0.0051	0.0045	< 0.0002	< 0.0002	0.00036	~ 0.00012

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)
1/8/2013	14:35	35	33.8	19.90	1,628.0	3,000.0	7.12	1.53	22	21	1,620	0.195	0.012	4.40	< 0.02	< 0.03	< 0.05	709.0	670	< 0.0050	< 0.0050	0.0025	0.0026	< 0.0001	~ 0.0002	0.0066	0.0051	< 0.0002	< 0.0002	0.00120	0.00016
2/12/2013	9:47	28	33.1	0.39	1,982.0	3,715.0	6.96	1.92	22	25	1,900	0.666	0.010	4.10	0.50	< 0.03	< 0.05	819.0	850	~ 0.0003	0.0008	0.0026	0.0027	< 0.0001	~ 0.0004	< 0.0050	0.0059	< 0.0002	< 0.0002	0.00074	< 0.00050
3/7/2013	11:24	30	32.2	0.72	1,776.0	3,391.0	7.12	1.74	31	~ 18	1,830	0.478	~ 0.007	4.10	1.42	< 0.03	< 0.05	753.0	850	< 0.0003	0.0006	0.0022	0.0023	< 0.0001	0.0006	0.0045	0.0050	< 0.0002	< 0.0002	0.00110	0.00031
4/23/2013	10:14	31	38.8	12.11	1,179.0	1,983.0	7.13	1.00	25	23	966	0.150	0.006	2.05	0.03	< 0.03	< 0.05	456.4	280	0.0010	0.0014	0.0010	0.0011	< 0.0050	< 0.0050	0.0039	0.0073	< 0.0002	< 0.0002	0.00029	0.00026
5/6/2013	10:36	60	53.8	11.10	—	—	7.14	1.21	5	4	1,260	~ 0.029	0.020	0.92	~ 0.02	< 0.03	< 0.05	613.0	340	0.0012	0.0008	0.0012	0.0013	< 0.0001	< 0.0001	0.0056	0.0034	< 0.0002	< 0.0002	< 0.00050	< 0.00050
6/4/2013	9:55	62	63.9	3.27	1,515.0	1,763.0	7.32	0.90	4	3	984	0.057	0.019	0.63	0.07	< 0.03	< 0.05	416.0	304	~ 0.0005	~ 0.0006	0.0011	0.0011	< 0.0001	< 0.0001	0.0036	0.0037	< 0.0002	< 0.0002	0.00040	0.00026
7/1/2013	10:00	76	72.1	2.40	1,389.0	1,444.0	7.24	0.72	~ 2	~ 2	765	0.067	~ 0.007	1.20	< 0.02	< 0.03	< 0.05	358.1	268	~ 0.0004	~ 0.0006	0.0010	0.0009	< 0.0001	< 0.0001	0.0070	0.0025	< 0.0002	< 0.0002	0.00020	0.00032
8/2/2013	9:15	68	70.7	0.98	1,503.0	1,610.0	7.71	0.81	3	~ 2	873	0.059	~ 0.008	1.10	0.06	< 0.03	< 0.05	397.6	304	0.0009	< 0.0003	0.0053	0.0008	< 0.0001	< 0.0001	0.0113	~ 0.0013	< 0.0002	< 0.0002	0.00035	~ 0.00013
9/11/2013	10:10	74	72.3	1.42	1,827.0	1,921.0	7.68	0.98	3	~ 2	1,060	0.075	< 0.005	1.00	0.20	< 0.03	< 0.05	472.5	368	< 0.0003	< 0.0003	0.0010	0.0010	< 0.0001	< 0.0001	< 0.0050	< 0.0050	< 0.0002	< 0.0002	0.00160	~ 0.00010
10/9/2013	9:45	63	56.3	5.68	1,408.0	1,806.0	7.35	0.92	~ 1	~ 1	926	0.191	~ 0.005	1.60	0.31	< 0.03	< 0.05	388.0	328	~ 0.0004	< 0.0003	0.0011	0.0009	< 0.0001	~ 0.0002	0.0025	0.0037	< 0.0002	< 0.0002	~ 0.00016	< 0.00008
12/18/2013	10:00	24	35.4	6.61	1,280.0	2,291.0	7.43	1.16	~ 1	~ 2	1,220	~ 0.021	< 0.005	1.70	0.38	< 0.03	0.44	502.0	484	~ 0.0004	~ 0.0005	0.0014	0.0018	< 0.0001	~ 0.0001	0.0045	0.0052	< 0.0002	< 0.0002	0.00026	0.00025