NPDES MS4 Phase I Permit No. MN0061018
Annual Report for 2016 Activities

Photo Courtesy of Ray Schoch

City of Minneapolis and the Minneapolis Park & Recreation Board
Co-Permittees

June 30, 2017

Minneapolis
City of Lakes

NPDES MS4 Phase I Permit
Annual Report for 2016 Activities

June 30, 2017

I hereby certify that this plan, specification, or report, was prepared by me or under my direct Supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.

Katrina Kessler

Katrina Kessler, PE

Date 6/29/17 Registration No. 45463

NPDES PERMIT NO. MN0061018
Issued December 1, 2000
Re-issued January 21, 2011

Resolution No. 2017R-278 City of Minneapolis File No. 2017-00515

Author: Reich Committee: TPW Public Hearing: 6/6/2017

Passage: 6/16/2017 Publication: 6/24/2017

RECORD OF COUNCIL VOTE				
COUNCIL MEMBER	AYE	NAY	ABSENT	ABSTAIN
REICH	✓			
GORDON	✓			
FREY	✓			
B JOHNSON	✓			
YANG	✓			
WARSAME			✓	
GOODMAN			✓	
GLIDDEN	✓			
CANO	✓			
BENDER	✓			
QUINCY	✓			
A JOHNSON	✓			
PALMISANO	✓			

Presented to Mayor Date: JUN 16 2017

Received from Mayor Date: JUN 22 2017

MAYOR ACTION

☒ APPROVED ☐ VETOED

MAYOR HODGES

JUN 21 2017
DATE

Certified an official action of the City Council

ATTEST:

CITY CLERK

Adopting the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Phase I Permit Stormwater Management Program and Annual Report for 2016 Activities.

Whereas, the City of Minneapolis is committed to improving water quality in the lakes, wetlands, streams, and Mississippi River; and

Whereas, on Jan. 21, 2011, the City of Minneapolis was issued National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit No. MN0061018 (Permit); and

Whereas, the Stormwater Management Program was prepared in accordance with the Permit, was approved by the Minnesota Pollution Control Agency (MPCA) in 2013, and was updated in 2014 and in 2015 and provided to the MPCA; and

Whereas, as required under the Permit, a public hearing was held on June 6, 2017; and

Whereas, the Annual Report for 2016 Activities will now be submitted to the Minnesota Pollution Control Agency;

Now, Therefore, Be It Resolved by The City Council of The City of Minneapolis:

That the Minneapolis City Council hereby adopts the Minneapolis Stormwater Management Program and the Annual Report on 2016 Activities.

Acknowledgements

Minneapolis Public Works - Surface Water & Sewers Division

Nico Cantarero

Paul Chellsen

Lane Christianson

Kevin Danen

Lois Eberhart

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Minneapolis Public Works - Transportation Maintenance & Repair

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Minneapolis Park & Recreation Board

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Michael Perniel

MaryLynn Pulscher

Minneapolis Regulatory Services

Steve Kennedy

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Acronyms

BCWMC	Bassett Creek Watershed Management Commission
BMP	Best Management Practice
BOD_5	Biochemical Oxygen Demand of wastewater during decomposition occurring over a 5-day period
CB	Catch Basin
CIP	Capital Improvement Program
COD	Chemical Oxygen Demand
CPED	Community Planning and Economic Development
CSO	Combined Sewer Overflow
CWA	Clean Water Act
DNR	Department of Natural Resources
EPA	Environmental Protection Agency
ESC	Erosion and Sediment Control
FWMC	Flow Weighted Mean Concentration
GIS	Geographic Information Services
I & I	Inflow and Infiltration
IPM	Integrated Pest Management
LAURI	Lake Aesthetic and User Recreation Index
LGU	Local Government Unit
LID	Low Impact Design
LSWMP	Local Surface Water Management Plan
MCES	Metropolitan Council Environmental Services
MCWD	Minnehaha Creek Watershed District
MDH	Minnesota Department of Health
MECA	Minnesota Erosion Control Association
MEP	Maximum Extent Practicable
MH	Manhole
MDA	Minnesota Department of Agriculture
MDR	Minneapolis Development Review
MIDS	Minimal Impact Design Standards
MNDOT	Minnesota Department of Transportation
MOU	Memorandum of Understanding
MPCA	Minnesota Pollution Control Agency
MPRB	Minneapolis Park and Recreation Board
MS4	Municipal Separate Storm Sewer System
MWMO	Mississippi Watershed Management Organization
NFIP	National Flood Insurance Program
NPDES	National Pollutant Discharge Elimination System

Acronyms

NRCS	National Resources Conservation Service
NURP	Nationwide Urban Runoff Program
PW-SWS	Public Works – Surface Water and Sewers
PW-TED	Public Works – Transportation, Engineering and Design
PW-TMR	Public Works – Transportation Maintenance and Repair
RDP	Rainleader Disconnect Program
SCWMC	Shingle Creek Watershed Management Commission
SMP	Stormwater Management Practice
SOP	Standard Operating Procedure
SSO	Sanitary Sewer Overflow
SW	Stormwater
SWMP	Stormwater Management Program
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSI	Trophic State Index
TSS	Total Suspended Solids
USACE	United States Army Corps of Engineers
VRS	Vehicle Related Spills
WMO	Watershed Management Organization

I. Executive Summary

Report Objective

This Report provides documentation and analysis of the Minneapolis Stormwater Management Program (SWMP) activities conducted during the previous year, 2016. The City and Minneapolis Park & Recreation Board (MPRB) departments that are responsible for the SWMP activities are jointly responsible for the completion of the required Permit submittals. Public Works provides program management and completes each Annual Report. An opportunity for public input into the SWMP and priorities is required. The permit also requires the adoption of a formal resolution each year, adopting the Annual Report and the Stormwater Management with the Annual Report. Resolution 17-00515 was passed on June 16, 2017.

This annual report is prepared in compliance with the requirements of National Pollutant Discharge Elimination System (NPDES) Permit No. MN0061018, a Municipal Separate Storm Sewer System (MS4) Phase I permit issued to City of Minneapolis (City) and the Minneapolis Park & Recreation Board (MPRB) as co-permittees. Permit No. MN0061018 was issued in December 2000 and reissued in January 2011. The Permit requires the implementation of approved stormwater management activities, referred to Stormwater Management Practices (SMPs), also known as Best Management Practices (BMPs).

The NPDES program was created in 1990 by the United States Environmental Protection Agency (EPA) to safeguard public waters through the regulation of the discharge of pollutants to surface waters including lakes, streams, wetlands, and rivers. The Minnesota Pollution Control Agency (MPCA) is the local authority responsible for administering this program. Under this program, specific permits are issued to regulate different types of municipal, industrial and construction activities and this report is related to the municipal program.

As required under the 2011 reissued permit, a new SWMP that describes the City and MPRB SMPs was submitted to the MPCA in September 2011 for review and approval. Subsequent to the MPCA's public comment period on the SWMP, revisions were submitted by the City to MPCA in May 2013, and the MPCA approved the updated SWMP in 2013. The SWMP is based on an adaptive management system, as outlined in Part V.A. of the Permit, by which the Permittees continuously monitor, analyze, and adjust the SWMP to achieve pollutant reductions. Using the adaptive management approach, revisions to the SWMP were made and submitted to the MPCA in 2014. The 2014 revisions were primarily in response to a 3-day field inspection in August 2013 by an EPA Inspection Team. The inspection, or audit, helped to identify opportunities for improvement regarding comprehensive training, written procedures and documentation, and availability of staff resources.

In July 2015, an application for permit reissuance was submitted to the MPCA, as required by the 2011 permit. The application was timely made and was accompanied by an updated version of the SWMP. As of this annual report, the version of the SWMP dated July 22, 2015 is the current version.

II. Storm Drain System Operational Management and Maintenance

Program Objective

The objective of this NPDES stormwater management program is to minimize the discharge of pollutants through the proper operational management and maintenance of the City's storm drain system. Targeted pollutants include:

Total Suspended Solids (TSS)

Nutrients

Floatable Trash

Drainage Areas and Discharges

The City of Minneapolis contributes stormwater runoff to various receiving waters within the community and outside of the city's boundaries, including Minnehaha Creek, Bassett Creek, Shingle Creek, a number of lakes, and the Mississippi River. Maps of the drainage areas that have been delineated according to topographic contours and the storm drain system are included in Appendix B. The 1990 population, size of drainage area, and land use percentages by body of receiving water are listed in Appendix A1. [Note to Liz – working with Barr on updates]

Program Overview

The City's storm drain system is operationally managed and maintained by the Operations section of the Public Works Department Surface Water & Sewers (PW-SWS) Division. Design engineering and regulatory issues are managed by the division's Capital and Regulatory sections, respectively.

In 2012, the Operations section began working on development of an Asset Management System (AMS) to help the City meet water quality targets and regulatory requirements, along with other city objectives. The city has begun to introduce Maximo™ as a software tool to compile assets, track work orders, and assist in work scheduling and purchasing. The city launched the work order functions of the Maximo™ software in spring, 2017.

Brick Egg-type Sewer

The City's goals in implementing Maximo™ include:

- Identify current state of assets and asset attributes (e.g., age, condition, etc.).
- Develop a standardized rating process for assets and asset attributes (e.g., National Association of Sewer Services Companies (NASSCO) Pipeline Assessment and Certification Program (PACP)).
- Identify risk areas.
- Identify criticality of system.
- Identify life-cycle costs.
- Improve future decision-making as a result

of data and analysis (e.g., succession planning, level of maintenance response, capital improvement project (CIP) prioritization).
- Improve documentation and recordkeeping of assets (e.g., Maximo software).
- Improve coordination and communication.
- Lower long-term operation and maintenance costs.
- Improve regulatory compliance.
- Use as a communication tool for staff and regulators for effective information transfer and knowledge retention.

An appropriate higher staffing level is a key component for achieving the City's overall goals. The current staffing level of the Operations section is approximately 113 full-time employees, up from 75 in 2013. This increase is anticipated to bring about a more proactive approach, including pollution prevention that the City is striving for. For the Operations section, there are currently 63 permanent, full-time and 6 seasonal employees working directly within the operations and maintenance area, and the remainder work within the construction area. General operations and maintenance efforts include pump station and pipeline inspections, pipeline cleaning, system repairs, rehabilitation or reconstruction, inspection and operation of control structures, operation of pump stations, cleaning of water quality structures, and operational management of stormwater detention ponds.

The table below shows the base operational functions along with the corresponding staffing:

Crews	Staff/crew	Type	Tasks
4	2	Route Truck	Daily pipe line system inspections, complaint response, and resolution to minor system operational problems
5	2	Jet Truck	"As-requested" cleaning of storm system components, routine cleaning of sanitary system pipes, and "as-requested" cleaning of pump/lift stations. Hydro jet-wash technique.
3	2	Jet-Vac Truck	Routine cleaning of sanitary system pipes. Hydro jet-wash technique. Sanitary sewer cleaning by vacuum removal of sludge and debris build-up
3	2	TV Truck	Televise and inspect storm drain and sanitary sewer system components. Log and assess condition of televised lines to determine and prioritize rehabilitation and/or repair needs to storm drain and sanitary sewer system components.
2	2	Repair Truck	Perform medium-sized repairs, requiring minimum excavation, to storm drain and sanitary sewer system pipeline components. May assist in the repair or reconstruction of larger repair/ reconstruction jobs.
2	2	Vacuum Truck	Vacuum-cleaning of water quality structures, manholes, and catch basins within the storm drain system. Assist in sanitary sewer cleaning by vacuum removal of sludge and debris build-up. Assist in repair/ construction activities using vacuum excavation process. Assist in erosion control compliance using vacuum cleanup of eroded soils and/or cleaning of erosion control structures.
1	2	Rod Truck	Remove roots and foreign objects from sanitary sewer system. Remove large debris from storm drain pipes and free ice from frozen catch basin leads.
2	1	Pond & Pump	Operate, maintain, and repair sanitary lift station and stormwater pump stations. Operate and maintain stormwater detention basins.
1	1	Shop	Perform general maintenance and repair to specialty use vehicles and emergency response equipment. Fabricate, as needed, custom metal and wood objects for sewer and storm drain operations. Provide field deliveries of materials, tools, and equipment. Maintain material inventory and fleet management data.

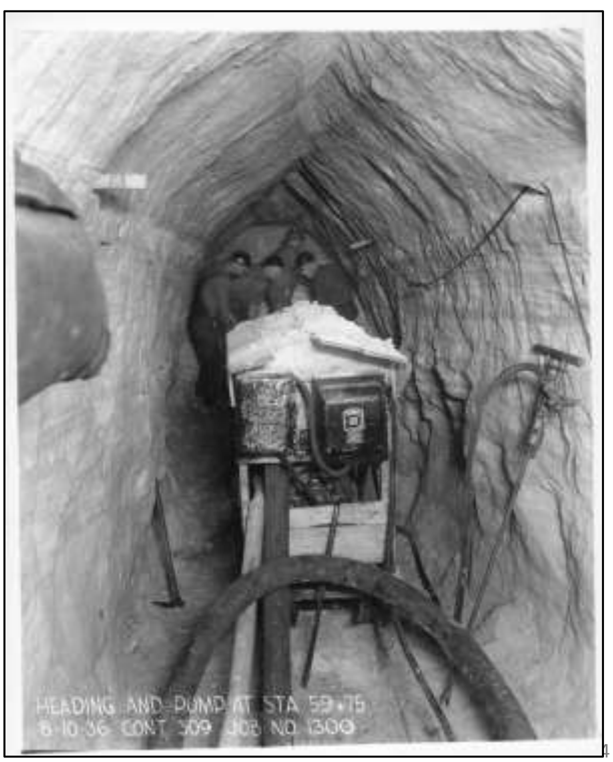
In 2016 the City also began developing Stormwater Pollution Prevention Plans for City and MPRB owned facilities to reduce the discharge of pollutants into the storm sewer system from municipal operations. Site specific plans are being developed for each facility which include site maps, operations specific Best Management Practices, and inspection and reporting requirements. An inventory of municipal operations facilities has been created which includes over 90 facilities; examples include Vehicle and Equipment Maintenance Facilities, Fleet Services, Parking Lots and Ramps, Fire Stations, Police Stations, Water Services Facilities, Stockyards, MPRB Service Centers, and MPRB Dog Parks. Plan development is being prioritized by facilities with the highest pollutant potential.

These facility plans will be used to facilitate monthly site inspections that will document all potential sources of pollution or illicit discharge to the storm sewer system from city or MPRB owned properties. Once routine monthly inspections have been well established the inspection frequency will be evaluated and increased or decreased as needed based on site specific needs such as continuing or ongoing issues, seasonal site usage, or change in property use. Ultimately the facility plans will lead the city to install additional structural BMPs where needed for long-term pollution prevention.

<u>Previous Year Activities</u>

Some of the noteworthy 2016 cleaning and repair statistics are summarized in the following list:

- Completed repairs on 318 catch basins.
- Cleaned 943.9 miles of storm drain utilizing hydro-jet washing and removed 1,681 cubic yards of sediment/material.
- Televised and condition assessed 100 miles of storm drain pipes.
- Continued repairs of 4,050 feet of storm tunnel.
- Work on the 10th Avenue SE and Central City tunnels continues, which is improving the condition of the structures and reducing erosion/transfer of the sandstone outside of the tunnel. This is decreasing transport of sand particles/solids to the Mississippi River.



III. Structural Controls Operational Management and Maintenance

Program Objective

The objective of this NPDES MS4 stormwater management program is to minimize the discharge of pollutants through the proper operational management and maintenance of structural controls within the City's storm drain system that affect system flow rates and water quality discharges.

Structural controls include:

- Retention Ponds (Wet)
- Detention Pond (Dry)
- Bio (in)filtration Basins (Rain Gardens)
- Tree Trenches, some with Silva Cells, and Pervious Pavers
- Underground Structural Sedimentation Devices (Sumps, Detention Pipes, Detention Chambers)
- Underground Structural Infiltration Devices
- Underground Structural Filtration Devices
- Hydrodynamic Separators (Proprietary Units; Stormceptor, CDS, Bay Saver, etc.)
- Outfall Structures
- Pump Stations and Level Control Weirs
- Catch Basins

Targeted pollutants include:

Total Suspended Solids (TSS)

Nutrients

Floatable Trash

Program Overview

Structural controls that are part of the City's overall storm drainage system are operationally managed and maintained by the Operations section of the Public Works Surface Water & Sewers Division. These components are routinely inspected and maintained to ensure proper operation and reliability. Frequency of inspections and assigned maintenance efforts are based on both operational experience and incurred environmental events.

By agreement with the City of Minneapolis and the MPRB, the Minnehaha Creek Watershed District monitors the design capacity of several stormwater ponds in Minneapolis and performs dredging and restoration as needed including testing for proper disposal. The MPRB also maintains small scale Park Board stormwater devices including ponds, rain gardens, and pervious pavement.

Structural controls for water quality improvement are separated into five separate categories:

Structural Controls Operational Management and Maintenance

Pretreatment Practices

Pretreatment is an integral part of BMP application. In many applications (infiltration, stormwater ponds) the practice would not function properly if pre-treatment is ignored. The purpose of pre-treatment techniques is the necessity to keep a BMP from being overloaded, primarily by sediment. Pretreatment can also be used to dampen the effects of high or rapid inflow, dissipate energy, and provide additional storage. All of these benefits help overall BMP performance. Types of pre-treatment practices include settling devices such as grit chambers, sump manholes and catch basins – sometimes enhanced with SAFL baffles, forebays, oil/water separators, and vegetated filter strips. Street sweeping is also an effective pretreatment practice.

Vegetated Swale at 25th Ave. SE

Filtration Practices

Vegetated Swale at Redeemer Church

Filtration BMPs treat urban stormwater runoff as if flows through a filtering medium, such as sand or an organic material. They are generally used on small drainage areas and are primarily designed for pollutant removal. They are effective at removing total suspended solids (TSS), particulate phosphorus, metals, and most organics. They are less effective for soluble pollutants such as dissolved phosphorus, chloride, and nitrate. Most filtration BMPs will achieve some volume reduction, depending on the BMP design and the use of vegetation to promote evapotranspiration. Filtration practices used in the City include rain gardens with underdrains, and iron enhanced sand filters.

Infiltration Practices

Infiltration BMPS treat urban stormwater runoff as it flows through a filtering medium and into underlying soil, where the water eventually percolates into groundwater, while the pollutants are removed from the runoff, either by being trapped within the practice for eventual removal after a period of accumulation, or broken down by chemical processes within the first few feet of soil ('natural attenuation'). The filtering media is typically coarse-textured and may contain organic material, as in the case of bioinfiltration BMPs. These practices are primarily designed for removal of stormwater runoff volume and pollutants in that runoff. They are effective at removing total suspended solids, (TSS), particulate phosphorus, metals, bacteria, nitrogen, and most organics. Soluble pollutants such as chloride and nitrate typically percolate through these BMPs and into underlying groundwater. These BMPs, when designed with no underdrain, include rain gardens, tree trenches (including Silva Cell systems), underground infiltration, and infiltration trenches including dry wells.

12x10 Infiltration Box Culvert Installation

Infiltration Box Culvert – inside view

In 2016 the city, in cooperation with the MWMO, completed the 24th Avenue SE Infiltration Project as part of the Combined Sewer overflow program which works to disconnect drainage from the sanitary sewer system and redirects it to the storm sewer system. The 92% impervious, 10.3 acre drainage area in an industrial area now drains to a new infiltration system within public right of way rather than discharges to the city's sanitary sewer system. Photos of the infiltration box culvert are shown.

Sedimentation Practices

Sedimentation is the process by which solids are removed from the water column by settling. Sedimentation practices include dry ponds, wet ponds, wet vaults, and other proprietary devices. Proprietary hydrodynamic devices are limited to treating small tributary areas while constructed ponds and constructed wetlands are able to be designed to treat the runoff from a much larger tributary area. These BMPs provide temporary storage of stormwater runoff and allow suspended solids to settle and be retained by the stormwater treatment practice. These BMPs are effective at removing total suspended solids (TSS) and any pollutant adsorbed to the solids but that are not effective in removing soluble pollutants or in providing any volume reduction.

Chemical Practices

Stormwater BMPs that employ chemical treatment are typically designed for treatment of a specific pollutant. Phosphorus is the most common pollutant of concern, but chemical treatment may also be employed for nitrogen, metals, and organic pollutants. The city has installed iron-enhanced sand filters and the MPRB has historically used alum as an in-lake treatment to enhance settling of suspended sediment and phosphorus by encouraging flocculation.

The city also employs structural controls to manage stormwater runoff that are not directly related to water quality. These include:

Storm Drain Outfalls

These are the structural ends of system pipelines where conveyance of stormwater runoff is discharged into receiving water bodies. Outfalls are inspected on a 5-year schedule where 20% of the outfalls are inspected each year. Site inspections evaluate the general condition of structures, determine if any significant erosion has occurred and observe any contaminant discharges. When indications of illicit or otherwise contaminated discharges are observed, they are reported to Minneapolis Environmental Services for reporting to the Minnesota Duty Officer and for further investigation and resolution. Any identified structural repair or maintenance work is prioritized and scheduled considering available personnel, budget funding, and coordination with other essential operations. Appendix A36 contains outfall maintenance information.

Pumps & Weirs
These are structural devices that mechanically affect the flow of stormwater runoff through the storm drain system. Pump stations are inspected on a regular basis for routine operational checks and are inspected annually for detailed condition assessment. Maintenance and/or repairs are performed with routine items being completed as needed and larger items being coordinated into a budgeted pump station operation program. Weirs and outlet structures are inspected and repaired as needed to facilitate their proper operational working order.


Grit Chamber Construction at Dean Pkwy

Catch Basins
These are structural devices located along the City's street system that provide entrance of stormwater runoff into the storm drainage system. Public Works crews routinely look for plugged or damaged structures. Reported damages and/ or plugs are given a priority for repair and/or cleaning. Cleaning catch basins, also known as storm drain inlets, while ensuring proper runoff conveyance from City streets, also removes accumulated sediments, trash, and debris. Augmenting this effort is the street sweeping program that targets the pick-up of street sands, leaves, and debris prior to their reaching catch basins. Repair of damaged catch basins is also a priority, given their location in city streets and ultimate impact to the traveling public.

Structural Controls Operational Management and Maintenance

Previous Year Activities

- Maintained 59 stormwater ponds and bio-infiltration facilities including underground structural filtration/infiltration devices.
- Inspected 174 grit chambers and cleaned 117 of them, removing a total of 320 cubic yards of material. The majority of the grit chambers are both maintained and owned/operated by Public Works, however some are owned and operated by others, but cleaned by Public Works under contract.
- Inspected 131 of 455 storm drain outfalls in 2016 inspection program (85 in 2015).
- Monitored and maintained 25 pump stations.
- Started storm pump stations rehabilitation project. Anticipated completion in 2019.

IV. Disposal of Removed Substances

Program Objective

A key component of the MS4 stormwater management program is collection and disposal of materials removed from the storm drain system and structural controls in a manner that will prevent pollution and that will comply with applicable regulations.

Targeted pollutants include:

Sediment

Nutrients

Floatable Trash

Additional pollutants analyzed for stormwater pond sediment dredging are Copper, Arsenic, and Polycyclic Aromatic Hydrocarbons (PAH)

Program Overview

Accumulated materials are removed from grit removal structures, catch basins, system piping, and deep drainage tunnels during the process of inspection and cleaning. Removed substances are screened for visual or olfactory indications of contamination. If contamination of the material is suspected, the City's Engineering Laboratory will select representative samples for an environmental analysis. Contaminated substances are disposed of in a landfill or another site that is approved by the Minnesota Pollution Control Agency (MPCA). Non-contaminated targeted pollutants are disposed of the same way as street sweepings, as reported in **Section VI. Roadways**. During cleaning and disposal operations, erosion control measures are applied when needed to prevent removed material from re-entering the storm drain system.

The process for accumulated materials dredged from stormwater ponds is similar. The materials to be dredged from stormwater ponds are tested in advance and disposed of properly according to MPCA guidance.

Previous Year Activities

In 2016, Minneapolis Public Works crews removed approximately 312 cubic yards of sediment and debris from grit chambers, and approximately 1,681 cubic yards from storm drains during hydro-jet washing operations. No stormwater ponds were dredged in 2016.

V. Stormwater Management Requirements for Development/Redevelopment

Program Objective

The objective of this stormwater management program is to minimize the discharge of pollutants through the regulation of construction projects. Regulation includes erosion and sediment control, and approval of stormwater management including ongoing operation and maintenance commitments. Minneapolis Code of Ordinances Title 3 Air Pollution and Environmental Protection, Chapter 52 (Erosion and Sediment Control and Drainage), and Chapter 54 (Stormwater Management) contain erosion and sediment control requirements and stormwater management instructions for developments and other land-disturbing construction activities.

Targeted pollutants include:

Phosphorus

Total Suspended Solids (TSS)

Erosion and Sediment Control

Ordinance

In 1996 the Minneapolis City Council amended Title 3 of the Minneapolis Code of Ordinances relating to Air Pollution and Environmental Protection by adding Chapter 52, entitled *Erosion and Sediment Control for Land Disturbance Activities (*now *Erosion and Sediment Control and Drainage)*.

Requirements

The city's Erosion and Sediment Control ordinance addresses development sites, demolition projects, and other land disturbing activities. Sites disturbing more than five cubic yards, or 500 square feet, are required to have an erosion control permit. Erosion & Sedimentation Control (ESC) Permits must be acquired prior to commencement of work, and must be obtained before a building permit will be issued for the site. If there will be a disturbance of greater than 5,000 square feet, an approved erosion control plan is also required for demolition and construction projects before the ESC Permit can be issued.

Enforcement

Ongoing site inspections are performed by Environmental Services inspectors. Inspectors may issue citations and fines. Failure by the permittee to comply with the ordinance will constitute a violation pursuant to Section 52.300. If there is a demonstrated failure to comply, the City reserves the right to terminate an ESC permit at any time. The City then has the option of proceeding with the necessary restoration of the site. This restoration would be done at the expense of the owner/permittee.

Previous Year Activities

A summary of the 2016 inspections is as follows:

- Permits issued: 381

- Erosion and sediment control cases inspected: 674
- Number of inspections completed: 3,071
- Enforcement actions issued for site compliance: 259
- Citations for non-compliance after enforcement action: 51

Stormwater Management for Development/Redevelopment

Ordinance

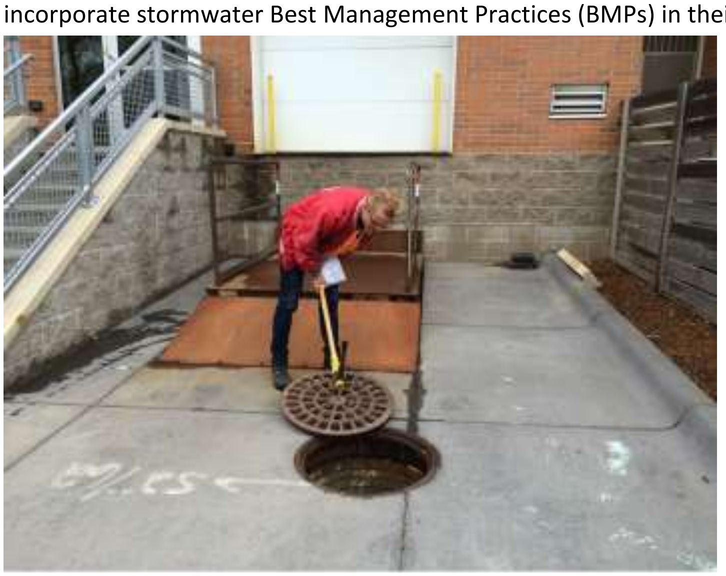
In 1999 the Minneapolis City Council amended Title 3 of the Minneapolis Code of Ordinances (relating to Air Pollution and Environmental Protection) by adding Chapter 54, which is entitled *Stormwater Management*. The ordinance establishes requirements for permanent stormwater management for development/redevelopment projects on sites that are greater than one acre.

The ordinance sets standards according to the specific receiving water body or type of water body. These standards include but are not limited to:

- Controlled rate of runoff to all receiving water bodies.
- Reductions of TSS for discharges to all receiving water bodies.
- Reductions in nutrients for stormwater that discharges to lakes and wetlands.
- Maximizing infiltration by minimizing the amount of impervious surface.
- Employing natural drainage and vegetation.

Requirements

Redevelopment of existing sites provides an opportunity to lessen the negative impacts of urbanization on the Mississippi River and other Minneapolis water resources. Stormwater management plans are required for all construction projects disturbing sites greater than 1 acre in size. Sites less than 1 acre are also encouraged to incorporate stormwater Best Management Practices (BMPs) in their design as a means of satisfying other city codes such as green space requirements. Plans are reviewed through the Minneapolis Development Review (MDR) process and approved by the Minneapolis Public Works Surface Water & Sewers Division. Operation and Maintenance Plans for BMPs are required as part of the approval process. Inspections and document checks are carried out annually or as needed, to ensure that the BMPs continue to function as approved. Once constructed and inspected for compliance with approved plans, the BMP stormwater device systems are registered with the City of Minneapolis Environmental Services, with an annual Pollution Control Annual Registration (PCAR) required for each stormwater device system registered.



Inspecting Private Stormwater BMPs

Stormwater Management Requirements for Development/Redevelopment

Previous Year Activities

During 2016, Minneapolis Public Works took part in the preliminary review of 137 projects. Of those 137 site plans, 87 projects with a total of 94 BMPs received final approval, with the appropriate permits issued. These BMPs will provide rate control and water quality for approximately 57 acres of land, including 36 acres of impervious area.

Common BMP types included:

- Rain gardens
- Pervious pavement
- Infiltration basins
- Filtration basins
- Detention ponds
- Underground infiltration chambers/pipe galleries
- Underground storage/detention chambers
- Proprietary filter chambers
- Bio-swales

VI. Roadways

Program Objective

The objective of this stormwater management program is to minimize the discharge of pollutants through the proper operation and maintenance of public streets, alleys, and municipal equipment yards.

Targeted pollutants include:

TSS

BOD_5

COD

Phosphorus

Chlorides

Program Overview

Street Sweeping

Minneapolis Public Works employs several street sweeping approaches. Some are citywide, and some vary by area or land use. Curb-to-curb sweeping operations occur citywide twice a year in the spring and fall. At those times, all city streets are swept systematically (alleys are also included in the spring), and temporary parking bans are enforced to aid with sweeping operations. Operational routines and special methods are employed to address seasonal conditions, and to optimize cleaning. Flusher trucks apply pressurized water to the streets in an effort to push sediment and debris to the gutters. Street sweepers follow behind the flusher trucks and clean the gutters. During the fall, leaves are first bunched into piles, and then the leaves are picked up before flushing and sweeping occurs. During the summer, between the spring and fall sweep events, sweepers are assigned to maintenance districts for periodic area sweeping. Downtown and other high traffic commercial areas are swept at night on a weekly basis. In addition, summer sweeping in the Chain of Lakes drainage areas has occurred since 1995 as part of the Clean Water Partnership project. Two sweepers are dedicated to cleaning drainage areas around the Chain of Lakes, and one sweeper is devoted to the Minneapolis Parkway System.

Toolcat with Covered Broom

The materials collected from street sweeping are received at two different locations, based on time of the year and nature of the material. The inorganic materials go to a construction demolition landfill site in Becker, Minnesota, to be used as daily cover. The Mulch Store, based in Chaska, MN, receives the City's organics in the fall of each year. The Mulch Store features 4 retail locations, but their main mulch operation originates in Chaska.

Special Service Districts

Special service districts are defined areas within the city where increased levels of service are provided and paid for by charges to the commercial or industrial property owners in the district. One of these special service districts, the Downtown Improvement District (DID) is a business-led non-profit organization with "a mission to make downtown Minneapolis a vibrant and attractive place for recruiting and retaining businesses, employees, residents, shoppers, students, and visitors. This is accomplished by providing services that make the 120 block district cleaner, greener, and safer." The organization is an important partner to the City, carrying out maintenance activities in the downtown public realm that minimize the discharge of pollutants through the proper maintenance of public right-of-way areas. In 2016, the trash removed from sidewalks by the DID filled 2,354 recycling bags and 20,556 trash bags. The DID also operates sweepers for gutters and sidewalks throughout the 120 block district.

Jeep with Buncher for Street Sweeping

Snow and Ice Control

The Street Maintenance section applies salt and sand to City roadways every winter for snow and ice control. Efficient application of de-icing materials is sought to appropriately balance three concerns: public safety, cost control, and environmental protection. The most obvious cost savings is realized in a reduction of the overall amount of materials used.

Reduced material amounts are also the best practice available for reducing harmful impacts on the environment. Sand harms lakes and streams by disturbing the ecosystems, and in depositing pollutants that bind to sand particles in lake bottoms and streambeds. An accumulation of sand calls for more frequent cleaning of catch basins and grit chambers. Salt is harmful to aquatic life, groundwater and to most plant and tree species. Salt causes corrosive damage to bridges, reinforcement rods in concrete streets, metal structures and pipes in the street, and vehicles.

Within Minneapolis, the following lakes and creeks do not meet standards for concentrations of chlorides set by the Minnesota Pollution Control Agency and are considered impaired:

Bassett Creek	Minnehaha Creek
Shingle Creek	Brownie Lake
Diamond Lake	Loring Lake
Powderhorn Lake	Spring Lake

Roadways

Reducing usage of salts was the focus of the Shingle Creek TMDL, which was approved by the EPA in 2007. It placed limits on chlorides (salt) discharged to Shingle Creek. Consequently, the City developed improved snow and ice control practices, and they are being implemented not only in the Shingle Creek drainage area but also citywide. Since then a Twin Cities Metro chloride study by the MPCA has also been completed. Maintenance supervisors and equipment operators are trained in appropriate winter maintenance techniques. Specific topics covered include guidelines for sand and salt application rates that are based on weather conditions, application techniques, and spreader calibration. Material spreaders are calibrated annually before the winter season. Maintenance yard housekeeping practices are designed to minimize salt/sand runoff. The materials that are used are tallied on a daily basis. Salt stockpiles are stored under cover to minimize potential groundwater contamination and runoff to surface waters.

Anti-icing used on Hiawatha Trail

Previous Year Activities

The 2016-2017 winter season began early, with numerous snow events in the early part of the season, then drier and warmer in the later season. There were 18 notable events with 27.8 inches for the season, as compared to an average of 48 inches. December and February had almost no snow fall. There were three declared snow emergencies, compared to the annual average of four, and there were 107 days of temperatures at or below freezing. There were two notable freezing rain events in 2016-2017. The quantities of salt and sand used in snow and ice control are tracked by recording amounts that are delivered by suppliers, and also by estimating the quantities that are on-hand on a daily basis. Street sweepings are scaled at the disposal site and reported to the City for record purposes only. Leaves picked up are weighed at the contractor's transfer facility in Minneapolis. The statistics for last year's program are as follows:

- Tons of salt applied to roadways: 10,135
- Tons of sand applied to roadways: 5,210
- Tons of materials reclaimed during spring and summer street sweeping operations: 15,200
- Tons of leaves collected for composting during the fall citywide sweeping: 4,442
- Staff members attended eight-hour refresher for 40-hour hazardous materials training class: 29
- Staff members attended training on the use of salt as presented by watershed organizations: 5

All division shift–staff attended the annual review of procedures. The review covers the recognition and response to hazardous materials or situations. The Division Director is a trainer for the American Public Works Association (APWA) Snow Fighters coursework.

MPRB Snow and Ice Management Training

The Minneapolis Park and Recreation Board has 27 staff that hold the MPCA's Road Salt Applicators Training Certificate. Individuals who hold this certificate have attended a voluntary training, completed and passed an associated test, and agreed to voluntarily apply best management practices to reduce chloride impacts. Attendees chose trainings that focused on the type of work they do at MPRB, either application to roads or to small sites (parking lots and sidewalks).

Performance Measures

- Amount of materials recovered as a percentage of materials applied: 128%
- Amount of salt and sand applied relative to total snowfall: 552 tons/inch

VII. Flood Mitigation

Program Objective

The primary objective of the Flood Mitigation Program is to reduce flood risks and ongoing property damages that occur due system capacity challenges of the public drainage system. There are additional benefits to this program that help reduce stormwater runoff pollutant loads. Flood mitigation projects can reduce soil/vegetation washouts and their associated sediment and nutrient loads that would be released. Flood mitigation also reduces exposure of flood flows to pollutants, debris, and organic matter lying around on parking lots, people's lawns, driveways, storage areas, and other areas, including petrochemical products, bacteria, fertilizers.

Targeted pollutants include:

All pollutants

Program Overview

Historically, areas that have experienced localized flooding due to system capacity challenges have been reported by residents or field crews. In 2014, a plan was initiated to complete detailed hydrologic / hydraulic models of the storm sewer system that will span the entire city. Models developed as a part of this work will be used to better identify, prioritize, and design the city's flood mitigation projects. Final completion of the modeling effort is expected in 2018.

Street Flooding on Garfield Ave. S – 6/25/2010

Flood mitigation projects have included strategies such as enlarging or rerouting pipes, or installing detention or retention systems. With increasing emphasis on stormwater runoff water quality, flood mitigation projects sometimes incorporate "green infrastructure" to reduce stormwater runoff volumes or reduce pollutant loads discharged to public waters through natural processes that break down pollutants using soil or vegetation.

In addition to the work done under this program, many other activities performed by the city reduce flood risks. Some of these activities include:

- Operation of backup generators for existing pump stations during power outages
- Inspection and maintenance of catch basin inlets and storm drains that are located within flood-sensitive areas
- Inclusion of various rate control or volume control Best Management Practices (BMPs) on public projects
- City stormwater regulations that require rate control and/or volume control BMPs for most private development projects
- Inspection and maintenance work on major tunnel systems that reduce system failure risks that could lead to flooding

Flood Mitigation

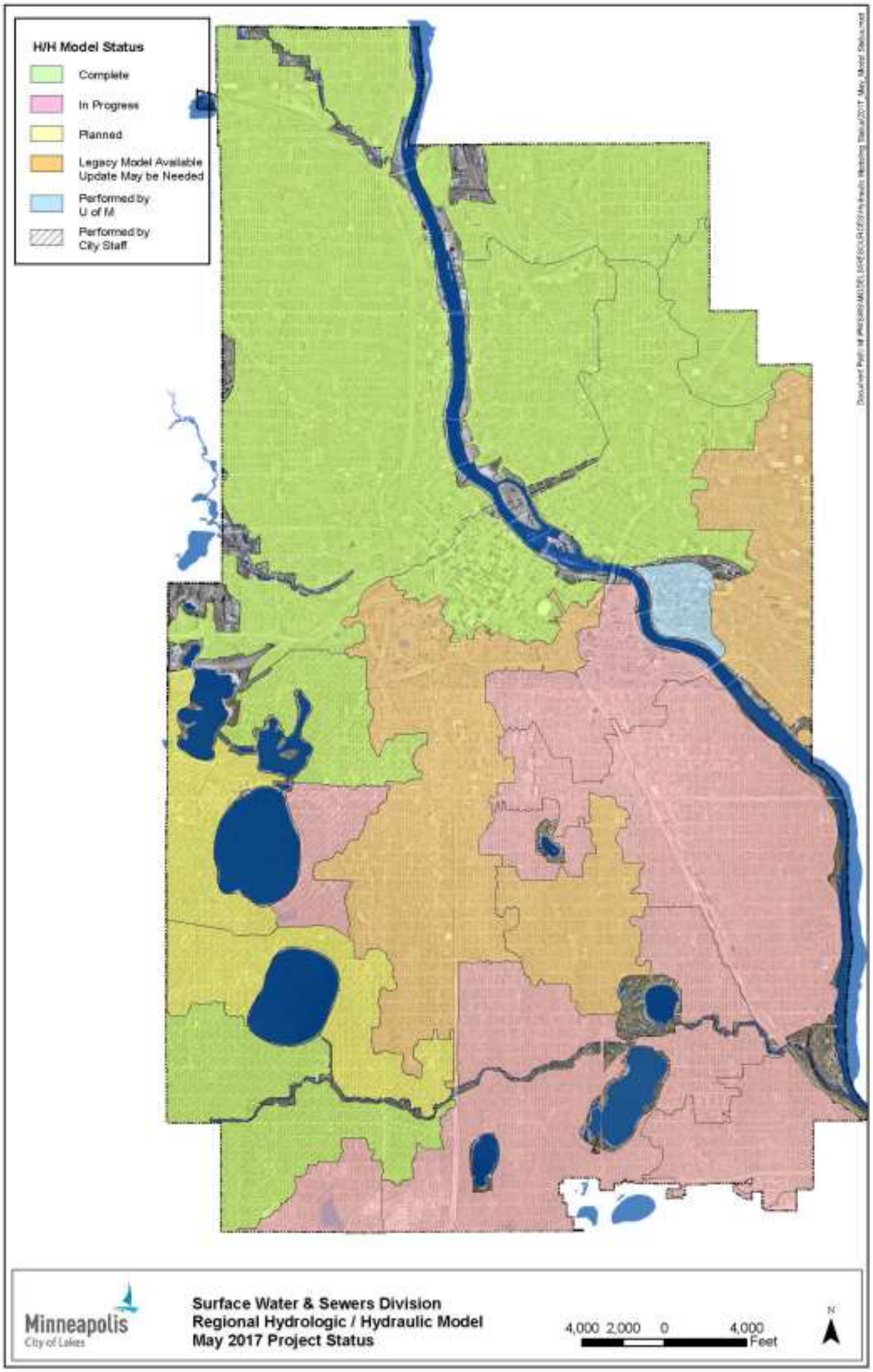
Previous Year Activities

2016 was a continuation of the effort to complete the city-wide models. Currently, 66% of the City of Minneapolis is modeled.

Performance Measures

The primary performance measures for this program are completion of the steps to identify, prioritize, design, and construct flood mitigation projects that are able to reduce the risk of flooding to habitable buildings. While most citizens will measure success by whether there is reduced neighborhood flooding, success is also achieved by reduction in runoff of sedimentation and nutrients from soil/vegetation washout, and exposure to lawn chemicals, pet waste, auto fluids, litter, and other products from water flowing over parking lots, lawns, and storage areas. Flood mitigation projects may also improve surface water quality by incorporating stormwater volume control and stormwater treatment features.

Flood Mitigation



VIII. Vegetation Management: Pesticides and Fertilizer Control

Program Objective

The objective of this stormwater management program is to minimize the discharge of pollutants by utilizing appropriate vegetation management techniques and by controlling the application of pesticides and fertilizers.

Targeted pollutants include:

Pesticides (insecticides, herbicides, fungicides etc.)

Nutrients (phosphorus, nitrogen etc.)

Program Overview – Minneapolis Park & Recreation Board Properties

Integrated Pest Management (IPM) Policy and Procedures

The Minneapolis Park and Recreation Board's (MPRB) Integrated Pest Management (IPM) policy for golf courses and general park areas is included in the MPRB's General Operating Procedures. Specific areas where IPM is intensely used is the Minneapolis Sculpture Garden and the major display gardens at Lyndale Park, Loring Park, and Minnehaha Falls Park. Gardener staff have adopted IPM techniques and use them as the appropriate course of corrective action.

The golf course foremen, along with other staff, attend the annual Minnesota Green Expo in January. There they receive updated information on the newest turf and other related research as it applies to fertilizers, pesticides, bio-controls, and other topics.

MPRB Staff Pesticide Applicator Licensing and Continuing Education

All new hires for full-time positions of park keeper, Mobile Equipment Operator (MEO), gardener, golf course park keeper, and arborist are required to obtain their Minnesota Non-Commercial Pesticide Applicator license within one year of being hired. Every two years, as mandated by the Minnesota Department of Agriculture, staff attends re-certification training, that is offered and coordinated by the University of Minnesota. This effort is in conjunction with the Minnesota Department of Agriculture.

Pesticides Use on Turf and Athletic Fields

The MPRB manages 6,400 acres of park land and water in the City of Minneapolis (approximately 18% of the City's 35,244 total land acres).

Use of pesticides to control turf weeds is not a regular practice of park maintenance for general grounds and athletic fields. Weed control pesticides may be used when a park is being renovated, or when athletic fields and surrounding areas are being sodded/seeded. It may also be used when weeds exceed 50% of the ground "turf" cover. These procedures for general grounds and athletic field maintenance are included in the MPRB's General Operating Procedures. In 2016, the MPRB banned the use of glyphosate in neighborhood parks. It may still be used in regional parks and golf courses.

Invasive Species Control

MPRB Environmental Management (Natural Resources) staff use a variety of management techniques to control invasive plants in park natural areas. These techniques include mowing, weed whipping, hand pulling, and the use of biological controls. Biological controls are a sustainable management technique that does not involve herbicides or other labor-intensive mechanical strategies. Biological control agents are insects or pathogens that are native to the invasive plant's country of origin. They are introduced after extensive research has been done by the scientific community. Biological control agents have been used in the park system for control of purple loosestrife, spotted knapweed, and leafy spurge. The MPRB has partnered with Minnesota Department of Agriculture (MDA) and Minnesota Department of Natural Resources (MnDNR), in an effort to control invasive plants with biological control agents.

Purple Loosestrife is a major invasive species problem in Minnesota wetlands. Working with the MnDNR the MPRB began a biocontrol program in the early 1990s. Leaf feeding beetles were reared and released into several sites throughout the city. At this time, these populations are self-sustaining.

Partnering with MDA, spotted knapweed and leafy spurge biological controls were released into the prairie planting along the Cedar Lake bike trail in 2003. Insects that specifically feed on these plants are successfully controlling spotted knapweed and leafy spurge in this natural area.

In its General Operating Procedures, the MPRB has established that no chemical application will be used to control aquatic weeds.

Eurasian watermilfoil, an invasive aquatic weed, is harvested mechanically on Lakes Harriet, Wirth, Cedar, Isles, and Calhoun throughout the summer months and harvested by hand at the beaches at Lake Nokomis and Wirth Lake. Eurasian watermilfoil is managed through permits through the Minnesota Department of Natural Resources, Division of Ecological and Water Resources. Coordination of control programs for Eurasian watermilfoil are determined and supervised by the Environmental Stewardship Department.

Fertilizer Use

In September 2001, the Minneapolis City Council amended Title 3 of the Minneapolis Code of Ordinances (relating to Air Pollution and Environmental Protection) by adding Chapter 55 regarding Lawn Fertilizer in January 1, 2002. The retail sale of fertilizer containing any amount of phosphorus or other compound containing phosphorus, such as phosphates, is prohibited in Minneapolis, as of January 1, 2002. The Minnesota Statute allows the use of phosphorus turf fertilizer if an approved and recent test indicates that the level of available phosphorus in the soil is insufficient or if the fertilizer is being applied to newly established turf, and only during the first growing season.

Under certain conditions specified in the Statute, fertilizer use is allowed on golf courses. Fertilization of turf on Minneapolis Park & Recreation Board Property is performed for golf courses, around athletic fields, and in areas of heavy traffic. Golf course managers and maintenance foremen do not use phosphorus fertilizers unless a current soil test has demonstrated the need for this nutrient. MPRB staff is required to complete a report for every turf fertilizer application. These records are maintained for a period of 5 years, per state law.

Recordkeeping

MPRB staff who apply pesticides and fertilizers keep records of their applications, as required by the Minnesota Department of Agriculture. Since the 1980s, golf course foremen and park maintenance staff have documented the type, amount, and locations of the chemicals that are stored at park storage facilities. These chemical inventories provide detailed information to the Fire Department as to how to deal with a possible fire at these sites. The plans identify how the fires are best extinguished and how to protect surface water in the surrounding area. The plans were put into place in the early 1980s, following a chemical company fire in north Minneapolis that resulted in the contamination of Shingle Creek.

Audubon Cooperative Sanctuary Program (ACSP) for Golf Courses

Audubon International provides comprehensive conservation and environmental education assistance to golf course superintendents and industry professionals through collaborative efforts with the United States Golf Association. The ACSP seeks to address environmental concerns while maximizing golf course opportunities thereby providing open space benefits. An important component of this program is the implementation of IPM procedures, to reduce chemical and fertilizer use to protect water quality and provide a healthier habitat for wildlife.

Participation in the program requires that golf course staff address environmental concerns related to the potential impacts of water consumption, and chemical use on local water sources, wildlife species, and native habitats. The program also provides assistance in comprehensive environmental management, enhancement and protection of existing wildlife habitats, and recognition for those who are engaged in environmentally responsible projects.

Audubon International provides information to help golf courses with:

- Environmental Planning
- Wildlife and Habitat Management
- Water Conservation
- Water Quality Management
- Outreach and Education

By completing projects in each of the above, the golf course receives national recognition as a Certified Audubon Cooperative Sanctuary. MPRB Golf Course foremen are expected to maintain the ACSP certification for courses. MPRB water quality staff conducts yearly water quality and wetland vegetation monitoring at the courses. All of the MPRB golf courses with the exception of Hiawatha have obtained Audubon Certification and the MPRB is currently in the process of obtaining certification for Hiawatha as well.

The Integrated Pest Management guidelines for Public Works Stormwater Ponds and Treatment Practices are in the Appendix A16

Previous Year Activities

Staff Pesticide Applicator Licensing and Continuing Education

Currently 162 MPRB employees hold pesticide applicator licenses, through the Minnesota Department of Agriculture (MDA).

Vegetation Management: Pesticides and Fertilizer Control

Use of Pesticides and Fertilizers on Park Lands

Pesticide Use

MPRB staff continues to reduce the use of pesticides through the use mechanical techniques and biological controls that are available for control of invasive species on park properties.

Fertilizer Use

Zero phosphorus turf fertilizers were specified for purchasing bids beginning with the 2002 fertilizer bid. This was done in response to the 2002 City and State regulation changes regarding phosphorus turf fertilizers. A wide range of zero phosphorous fertilizers are available to park maintenance and golf course foremen if fertilizer is needed due to soil test results.

Performance Measures

Currently 162 MPRB staff have a certified pesticide applicator license and 28 MPRB staff have attended classes and obtained a chloride application certificates.

Program Overview – City of Minneapolis Properties

Goals

- Public safety
- Prevent erosion
- Protect and improve water quality and ecological function
- Slow water movement, hold or convert pollutants, and enhance infiltration and evapotranspiration
- Conduct preventive maintenance for longevity of infrastructure
- Control invasive species (non-native and selected native species) growth and prevent the production and dispersal of seed
- Create wildlife habitat
- Provide a neat and attractive appearance

POLLINATOR HABITAT ENHANCEMENT

The Public Works Department is planting additional pollinator forage at its stormwater management pond properties. According to The Xerces Society for Invertebrate Conservation (excerpts, 2015):

Rain Garden at Riverside and 8th St. S

- The great majority of pollinators are insects, including bees, wasps, flies, beetles, butterflies and moths. Many bird and bat species pollinates as well.
- A pollinator community requires consistent sources of nectar, pollen, host plants and nesting material during times adults are active.
- Ideally, flowers should be available to pollinators throughout the entire growing season. Increase the abundance of pollen, nectar, and host-plant resources with use of a diverse range of plants that flower throughout the growing seasons.
- It is desirable to include a diversity of plants with different flower colors, sizes, and shapes as well as varying plant heights and growth habits to encourage the greatest number and diversity of pollinators.
- Diverse plant communities provide higher habitat value for bee pollinators. Bee diversity continues to rise with increasing flowering plant diversity.

NATIVE BIODIVERSITY – Excerpted from NATIONAL PARK SERVICE & U.S. FISH AND WILDLIFE SERVICE (Revised 2010)

Why are invasive plants a problem in natural areas?
Native plant buffers around the ponds and discharge waterways require maintenance to prevent non-native invasive species from taking over. This is critical because the native plants often require more time to become well established than the weedy species. Debris removal and weed removal will be required as small plants develop. The need for invasive plant removal will diminish as the native plants fill in.

Like an invading army, invasive plants are taking over and degrading natural ecosystems and wreaking havoc on the intricate and complex web of life involving native plants, animals and other organisms. Invasive species compete for limited natural resources including soil, water, light, nutrients and space. They displace native plants, replace wildlife food sources with exotic plants that are inedible, toxic, or otherwise harmful, draw pollinators away from native plants, hybridize with native species, push rare species closer to extinction and cause an overall reduction in native biodiversity. Some invasive species spread rapidly and unabated, changing forests, meadows, wetlands and other natural plant communities into landscapes dominated by a single species. Such "monocultures" have little ecological value. Once established over large areas, invasives require enormous amounts of time, labor and money to manage and most are difficult if not impossible to eliminate.

Herbicide use
Early control of new infestations will also reduce the likelihood of establishment and expansion. When deciding between physical and chemical methods, keep in mind that manual removal of plants can result in disturbance to the soil which can further encourage the invasive species and open the site up to new introductions. Using an herbicide leaves the plants and soil in place, thus minimizing that likelihood.

Taking action against invasive plants involves consideration of the various tools and techniques available for each plant and situation including site conditions, time of year, and resources available.
Secondary and unintended consequences of control should also be considered, for example, if plants are pulled up, soil disturbance could bring more weed seed to the surface or facilitate invasion by additional invasive plants.

The goal is to achieve effective long-term control and eventual restoration using approaches that pose the least risk of harm to people and to the environment including non-target plants and wildlife. And the bottom line is that the target species will be successfully controlled or at least reduced to a manageable level. This approach is referred to as integrated pest management (IPM).

Public Works – Surface Water & Sewers Division (PW-SWS) has adopted the Integrated Pest Management (IPM) Policy formulated by the Minneapolis Park and Recreation Board (MPRB) to guide the use of herbicides on public lands under their charge. Herbicide use shall be limited as directed in this document.

INTEGRATED PEST MANAGEMENT – Adapted from MINNEAPOLIS PARK AND RECREATION BOARD POLICY (Revised 2008)
Integrated Pest Management (IPM) is a pest management strategy that focuses on long-term prevention or suppression of pest problems with minimum impact on human health, the environment and non-target organisms. In most cases, IPM is directed at controlling pests that have an economic impact on commercial crops; however, in the instance of mosquito control, IPM is used to control nuisance and potentially dangerous mosquito populations. The guiding principles, management techniques and desired outcomes are similar in all cases.

A number of concepts are vital to the development of a specific IPM policy goal:

1. Integrated pest management is not a predetermined set of practices, but a gradual stepwise process for improving pest management.

2. Integrated pest management programs use a combination of approaches, incorporating the judicious application of ecological principles, management techniques, cultural and biological controls, and chemical methods to keep pests below levels where they cause economic damage. (Laws of MN, 1989)
3. Implementing an integrated pest management program requires a thorough understanding of pests, their life histories, their environmental requirements and natural enemies, as well as establishment of a regular, systematic program for surveying pests, their damage and/or other evidence of their presence. When treatments are necessary, the least toxic and most target-specific plant protectants are chosen.

The four basic principles of IPM used in designing a specific program are:
1. Know your key pests.
2. Plan ahead.
3. Scout regularly.
4. Implement management practices.

Selection of Management Strategies
Selection of Management Strategies pest management techniques include:
- Encouraging naturally occurring biological control.
- Adoption of cultural practices that include cultivating, pruning, fertilizing, maintenance and irrigation practices that reduce pest problems.
- Changing the habitat to make it incompatible with pest development.
- Using alternate plant species or varieties that resist pests.
- Limiting monoculture plantings where possible.
- Selecting plant protectants with a lower toxicity to humans or non-target organisms

The criteria used for selecting management options include:
- Minimization of health risk to employees and users.
- Minimization of environmental impacts (e.g. water quality, non-target organisms).
- Risk reduction (losses to pests, or nuisance/threshold level).
- Ease with which the technique can be incorporated into existing management approaches.
- Cost-effectiveness of the management technique.

Posting of Plant Protectant Applications
Comply with the City of Minneapolis ordinance regarding pesticide application (Minneapolis Code of Ordinances Title 11 [Health and Sanitation] Chapter 230 [Pesticide Control])

Recordkeeping
Produce and maintain the necessary records of all pest management activities as required by the Minnesota Department of Agriculture.

MANAGEMENT GUIDELINES

- Perpetuate the original intent of the species planted. On many sites the original intent was to establish a simplified native grassland community. Plant species were selected for their resilience, habitat value and beauty. These plants shall be managed for their proliferation.
- Manage land areas using pollinator-friendly practices. Control invasive plant species to enhance biodiversity essential to pollinators. Plant pollinator forage in appropriate locations. Do not use insecticides known to kill bees and other pollinators. Avoid spray drift at all times.

- Control [1] all species listed on the MN Noxious Weed List and comply with the MN Noxious Weed Law.
- Control invasive species in order to prevent Public Works sites from becoming sources of invasive weed seed that can disperse and establish on neighboring properties. An example is Canada thistle, which produces copious amounts of wind-blown seed that can easily become a problem on nearby public and private lands. Early detection and control will reduce the amount of herbicide needed in the long term.
- Control aggressive species that if allowed to exist on a site will quickly spread and overwhelm the site. Aggressive native species include but are not limited to Canada goldenrod, sandbar willow and cottonwood. Non-native species include but are not limited to Canada thistle, crown vetch, bird's-foot trefoil, reed canary grass, *Phragmites australis*, spotted knapweed, smooth brome, sweet clover, purple loosestrife, Siberian elm, European buckthorn, and Tartarian honeysuckle.
- Control non-native cattails (hybrid and narrow-leaf). They are common weeds in stormwater treatment facilities that may clog inlet and outlet structures, and they reduce habitat function. They are to be controlled when a threat to structures occurs, primarily by cutting the plant below the water surface. Where this is not feasible, as a last resort wick application of an aquatic-safe herbicide may be warranted, however herbicide application over water shall be avoided where practicable.
- Control fast growing, woody species such as willow, Siberian elm and box elder located where they can quickly establish and form a thicket around stormwater treatment facilities or can cause a public safety issue.
- Control species that are allelopathic [2]. These include but are not limited to spotted knapweed, garlic mustard, and leafy spurge.

Invasive Plant Management Tools
Invasive plants “spread like wildfire” at stormwater ponds. Where feasible, use mechanical means such as pulling and mowing, in order to minimize chemical usage.

- Herbaceous Plantings
  - Pulling (preferred)
  - Mowing (preferred)
    - Flail mowing
    - Spot mowing
  - Herbicide application
    - Spot spraying
    - Wick application
- Woody Plants
  - Pulling (preferred)
  - Cutting with stump application of herbicide

[1] **Control means manage or prevent the maturation and spread of propagating parts of noxious weeds from one area to another by a lawful method that does not cause unreasonable adverse effects on the environment.** *MN Noxious Weed Law 2013 MS 18.75-18.91*

[2] **Allelopathic means to produce a chemical in plant tissue that releases into the soil and prevents the growth of most other species**

Turf Areas
PW-SWS follows the Minneapolis Park and Recreation Board's General Parks and Parkways threshold of 50% for broadleaf and/or grassy weeds in turf areas. When it has been determined that this percentage has been reached or exceeded, the appropriate post emergent or pre-emergent herbicide may be applied, preferably on a spot spray basis. Selection of the appropriate herbicide of choice will be determined by trained staff after evaluating the site, the hazard rating of the product and the specific location.

Weed Control in Upland Plantings, Shrub Beds and Around Trees

Plants are selected and/or replaced in order to provide disease and insect resistant plantings, thereby reducing plant protectant applications. Weeds listed on the State of Minnesota's Noxious Weed List must be controlled as per state statute, and species will be controlled as listed in Management Guidelines above. Mechanical or manual means of weed control will be tried first when feasible. However, due to global climate change, increasing populations of tap-rooted and other perennial weeds are being transported by birds and other means. Pulling or digging of these weeds is usually not successful. Spot spraying of these tap-rooted weeds with a low toxicity herbicide will help prevent flowering, seeding and further dispersal of these pest weeds. Appropriate mulching of upland plantings, shrub beds and around trees will help decrease the number of pest weeds. If control of annual weeds in pathway or mulched areas is required, the proper pre- or post-emergent low toxicity herbicide will be applied on a spot spray basis. Posting of any plant protectant applications will be carried out according to City ordinance.

37th Avenue Greenway

Using the 37th and Columbus Flood Pond as a test site, City contractors implemented an organic weed control and site management plan. This organic no-chemical maintenance plan included breaking the site into three zones to monitor success of each of the following methods:

A. Weed control using concentrated vinegar
B. Corn gluten meal & hand pulling/ weed whipping
C. Hand pulling/ weed whipping only

We will continue this management plan in 2017 to get more data on the effectiveness.

Future Pest Control Issues

With changes in climate, the environment will be subject to many changes, including the arrival of additional pests within open space areas. Following IPM principles, the City will refer to updates in MPRB policy and practice and will work with the appropriate local, state or national agencies to determine the best control approach for these new pests.

Vegetation Management: Pesticides and Fertilizer Control

Prescribed Burns

Prescribed burns are used as a management tool to maintain the health of native plant communities. When used as a management tool, fire kills certain weeds and invasive plants, releases dormant seeds in the soil, and adds nutrients to the soil. The frequency that prairies and native grassland areas in the city are burned is dependent on the management needs and weather conditions. Weather conditions such as temperature, humidity, wind speed and direction are taken into consideration before starting a prescribed burn. In 2016 weather conditions were such that only 6 ponds were burned. In 2017 the city is planning to burn all of the pond sites that are suitable.

Camden Pond Vegitation Management- Burning

Camden Pond One month after burn

IX. Illicit Discharges and Improper Disposal to Storm Sewer System

Program Objective

The objective of this program is to minimize the discharge of pollutants to lakes, creeks, wetlands, and the Mississippi River by appropriately responding to spills and to detect, investigate and resolve illegal dumping and disposal of unpermitted, non-stormwater flows in the city's stormwater drainage system including pipes, gutters, swales and other conveyance infrastructure.

Targeted pollutants include:

All pollutants

Program Overview

Typical Hazardous Spill Response

The immediate goals of response are safety, containment of the spill, recovery of hazardous materials, and collection of data for use in assessment of site impacts. Motor vehicle collisions and electrical transformer overloads are examples of accidental releases, and results can include untreated waste and hazardous materials including heavy metals, toxics and solvents.

The life cycle of an event requires personnel from various departments and agencies to work as a team, utilizing available resources to protect people, the environment, and property. Training and response procedures are coordinated among the Regulatory Services, Public Works, and Fire Departments. The Regulatory Services Hazardous Materials Manager is responsible for coordinating recovery efforts. Events are followed by post-action debriefings to determine the causes of the events, to identify measures to improve the City's response, and to determine the means to limit future occurrences. As the assessment of the event progresses, other departments and/or outside agencies or contractors may become involved. Full procedures are documented in the City of Minneapolis Emergency Action Plan.

For small spills of petroleum products or other vehicle fluids, personnel are dispatched with appropriate equipment to apply sand or floor-dry. Once the sand or floor-dry has absorbed the spill, it is removed and then deposited in a leak-proof container. For large or extremely hazardous spills, a Hazardous Materials Response Team is also mobilized and augmented with staff from additional departments, outside agencies and/or contractors if warranted as the event progresses. For spills that reach the Mississippi River or Minneapolis lakes, boats are available for spill response and personnel are trained in boom deployment.

Spills are reported to the MPCA Public Safety Duty Officer, 911 Emergency Communications and, for qualified spills, to the National Duty Officer as required by law.

The protocol used by the Street Maintenance section for handling spills is documented in Appendix 32: Standard Operating Procedure for Vehicle Related Spills (VRS).

Emergency Response Program

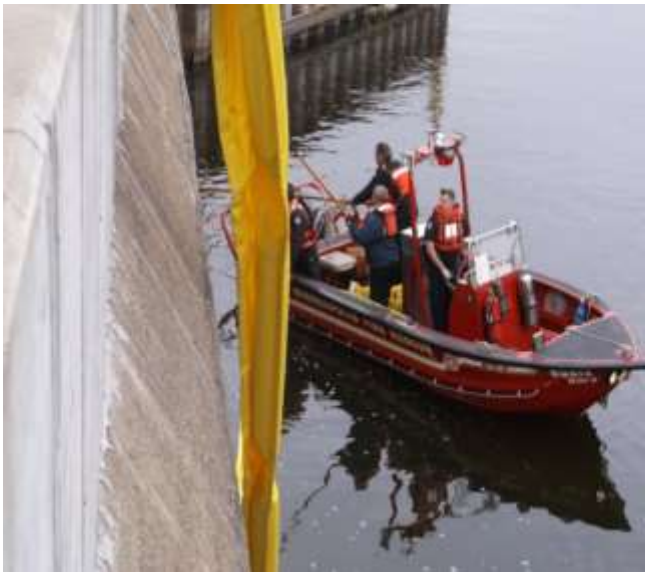
The Department of Regulatory Services operates a boat for use on the Mississippi River and other Minneapolis water bodies, to be able to respond to spills that could impact our valuable water resources. The presence of a properly equipped boat facilitates addressing these events on the Mississippi River as well as on City lakes. Regulatory Services and Public Works staff are trained in the river deployment of booms, have field experience in placement of both containment and absorbent types of booms, and have years of experience on the water. These skills, coupled with an extensive level of knowledge of the Mississippi River, City lakes, landings, and outfalls, provide a high level of protection for our precious natural resources.

Boom Deployment Drill

Additionally, Regulatory Services uses the boat for the placement of monitoring and sampling equipment used for tracking water quality, identifying points of illegal discharges, assessment of outfalls, and investigation of complaints that are inaccessible from shore. The City assists the Mississippi Watershed Management Organization in conducting a sampling program of the storm drainage system that drains to the Mississippi River. The intent of this sampling is to detect illegal discharges, and to establish a baseline of chemical, physical, and biological parameters.

Previous Year Activities

- Fire Inspection Services responded to 62 Emergency Response requests. The Minneapolis Fire Department also responds to a number of these requests. The response time varies between 5 to 20 minutes depending on Fire Department response and type of Emergency Response request.



Boom Deployment Drill

- Conducted 39 days of outfall sampling, visual inspections of outfalls and developing spill response strategies by boat. Participating agencies included Minneapolis Fire, Minneapolis Public Works, Minnesota Pollution Control Agency (MPCA) and Mississippi Watershed Management Organization (MWMO).
- Responded to 3 spill incidents on the Mississippi River where containment boom was deployed. Minneapolis Fire Inspection Services, Minneapolis Public Works (Surface Water & Sewers Division) and MPCA participated in these efforts.
- Responded to 1 spill incident on a Minneapolis lake where spill response equipment was deployed.
- Fire Inspection Services conducted 3 days of formal River Spill Response/Containment Boom Deployment training on the Mississippi River for the Minneapolis Fire Department and Minneapolis Public Works. Spill response strategies and Standard Operating Procedures were discussed; storm sewer outfall map reading was reviewed. Boats and containment booms were deployed at Minneapolis Waterworks to protect the water intakes.
- Minneapolis Fire Inspection Services coordinated and led 2 spill response overviews of the Mississippi River in Minneapolis for MPCA Emergency Response staff. Boat launches and river points of access, major outfalls, and potential pollution sources were visited. Response boat was deployed and Fire Inspection and MPCA staff reviewed spill response strategies at various outfalls.

- Fire Inspections Services participated as an instructor at WAKOTA CAER Boom School. Spill response planning, boat safety, boom deployment techniques and oil spill recovery are covered.
- Minneapolis Public Works, Minneapolis Fire, Minneapolis Regulatory Services and the Minnesota Pollution Control Agency (MPCA) conducted a Spill Response Training/Exercise on the Mississippi River on 6/22/16.
- The Training/Exercise highlighted the coordination Minneapolis has on Spill Response events with Public Works Sewer & Bridge departments, Training, Minneapolis Fire, Minneapolis Regulatory Services, and the MPCA working together. After Action Meeting identified equipment needs and future training that will be addressed.
    - Training Scenario:

    - A large (over 1,000 gallons) diesel spill occurs in the stormshed that discharges to the 28th St outfall. Diesel fuel has entered the storm system and reached the Mississippi River.
    - Public Works crews responded to the location and developed an Incident Action Plan.
  - Outline:
    - 0730: introductions, Spill Response training/Powerpoint presentation by the MPCA.
    - 0800: Exercise begins.
    - Water and sewer dye was released to a catch basin in the stormshed to simulate a diesel spill.
    - One Sewer Maintenance Crew responded to the site to evaluate and control at site, determine path of spill, and began air monitoring, called for containment boom to be deployed to the U of M Emergency boat launch.
    - One Bridge and Sewer crew deployed to the boat launch, loaded boats, responded to 28th St outfall, deployed containment boom.
    - Minneapolis Fire crews responded with boats and deployed containment boom.
    - Minneapolis Fire Inspections/MPCA deployed a boat preforming Incident Command/Safety.

Unauthorized Discharges

Environmental Services personnel carry out pollution prevention and control activities. Results are achieved through educational efforts, inspections, and coordinated community outreach events. These activities include enforcement pursuant to applicable City codes, and coordination with other regulatory agencies at the county, state and federal levels. Enforcement yields identification of the responsible party, documentation of clean-up activities, and also endeavors to reduce the flow of pollutants from illegal dumping and disposal. Response is made to reports of unauthorized discharges and illicit connections.

Complaints are received from the public, City and private contractors, City staff and other government agencies, by the following means:

- Environmental Management Complaint Form.
- Confidential calls to Minneapolis Information & Services. Within Minneapolis, the phone number is 311. Outside of Minneapolis, the phone number is 612-673-3000.
- Reports from sewer maintenance crews, plumbing inspectors, and other City personnel. These reports may be received directly by Environmental Services or submitted to Minneapolis 311.
- Reports received from the State Duty Officer.

Additionally, on occasion the Public Works-Surface Water & Sewers Division provides site investigation and mapping assistance to the MPCA related to the Minnesota Pollution Control Agency's permit enforcement and compliance programs for various types of discharges.

Previous Year Activities

- Addressed 69 calls for emergency response (containment of spills, chemical dumping, illegal disposal or handling of regulated or hazardous materials). These spills ranged from transformer leaks to spilled automotive fluids.
- Investigated 543 water and land pollution complaints (illegal dumping, improper storage of material, and chemical storage).
- Carried out brownfield maintenance, monitoring and treatment activities. Sites include:
  - Superfund sites

- Leaking petroleum sites
- Remediation systems
  - Pump, treat and discharge groundwater
  - Soil venting
- Wells
  - Monitoring wells – water samples taken to monitor the level of contamination
  - Recovery wells – contaminated groundwater is pumped from the ground. It is typically treated prior to discharge usually to the sanitary sewer.

- Approved 17 limited duration sanitary sewer and storm drain discharge permits.
- Approved 12 temporary water discharge permits.
- Approved 63 storage tank permits:
  - Above ground - 0 abandoned-in-place, 3 installed, 169 removed
  - Underground - 10 abandoned-in-place, 2 installed, 30 removed
  - Flammable waste traps – 2 removal/abandon in place.

Brownfields

At the end of 2016, there were 8 locations with 10 listings that would qualify as superfund sites. Minneapolis is also tracking 12 sites that are identified as petroleum leak sites that require additional work and monitoring before they can be closed. Over the course of 2016 there were several sites where a tank removal or an environmental site investigation identified low level petroleum contamination. These sites were reported to the state duty officer and with additional work were closed within the same calendar year, and not recorded in this number.

Activity Description	Permits
Wells	92
Temporary Monitoring wells	67
Construction Monitoring wells	6
Sealing - Residential	9
Sealing - Commercial	2
Sealing - Monitoring wells	8
Remediation	3
Temporary Impacted Soil Storage	3
Remediation System	0
Temporary Water Discharges	21
Storm	15
Sanitary	6
Tanks	63
AST	19
UST	52
Flammable Waste Traps	2

For the existing open sites along with voluntary clean-up efforts there are 16 sites with 21 operating remediation systems for cleanup of impacted soils and groundwater. Throughout the city there are 82 sites with 633 active monitoring and remedial wells. Monitoring wells are checking the performance of cleanup activities and site conditions. Samples are obtained from these wells and analyzed for contaminants of concern. Remedial wells may also have samples taken but are also used for recovery and treatment of contaminated groundwater.

Ongoing chemical storage is occurring at 795 locations with an identified quantity of 1,663 items. The chemical storage areas and the land use activities are monitored to eliminate the risks future site problems.

Permits were issued for specific tasks and projects related to brownfield sites. These tasks and projects were for the maintenance, monitoring and treatment. Overall 179 individual permits were issued.

Detection and Removal Screening Program

The field screening program to detect and investigate contaminated flows in the storm drain system is an integral part of daily operations for personnel of Public Works Surface Water & Sewer Operations, Environmental Services, and Regulatory Services. Maintenance crews routinely inspect and clean storm drain structures throughout the City. In addition, inspections of flows that generate unusual odors, stains, and deposits are included in the annual tunnel inspection, outfall inspection, and grit chamber inspection and cleaning programs. Any suspect flows are then reported to Environmental Services inspectors for further investigation. Environmental Services personnel also receive reports of alleged illicit discharges to the storm drain system from the public, other City departments, and various agencies. These combined efforts result in an annual screening of more than 20% of City drainage areas.

Facility Inspection Program

Inspectors perform site visits of facilities that store large quantities of regulated and hazardous materials. Inspections include review of handling, storage and transfer procedures as they relate to the site, spill response plans and equipment on site, employee training on spill response procedures, and identification of the required spill response contractor. The Minneapolis Fire Department participates in the majority of inspections, reviewing spill response strategies. In addition, site plan inspections also look at drainage patterns from the site to the nearest storm sewer inlet or water body and the watershed destination and outlet location.

Previous Year Activities

Conducted inspections on 53 TIER II Hazardous Materials Facilities. Inspections include review of the storage of hazardous materials, spill response plans and equipment on site, employee training on spill response procedures, identification of required spill response contractor. The Minneapolis Fire Department participates in the majority of inspections, reviewing spill response strategies.

Reviewed 358 Emergency Response plans for TIER II Hazardous Materials Facilities. Reviews include hazardous materials storage and spill response plans.

X. Storm Sewer Design for New Construction

Program Objective

There is a continuing effort to minimize the discharge of pollutants to public waters. This section describes the current focus and outlines the design measures used to control the discharge of pollutants by controlling the volume, loading or rate of stormwater discharged.

Targeted pollutants include:

Total Suspended Solids (TSS)

Phosphorus

CSO Program

Overview

In 2016, the City of Minneapolis continued its program to reduce Inflow and Infiltration (I & I) to the combined sewer system. Inflow is stormwater and other clear water sources connected directly to the sanitary sewer, and infiltration is groundwater that enters the sanitary sewer, usually through pipe and system defects. The CSO program is continuing a City focus to work toward eliminating combined sewer overflows. This effort began when the first storm drains were constructed in the 1930s. (Prior to that time, all stormwater discharge was combined with sanitary sewer discharge). The effort to eliminate combined sewer overflows was accelerated in 1960 when the City began a 40-year residential paving program. Separate storm sewers built as part of the paving program accounted for elimination of most of the City's remaining combined sewer areas. More information on the history and progress of the CSO Program can be found **online**.

Currently, the principal work is to continue to make reasonable progress of eliminating known public and private stormwater inlets or rainleaders connected to the sanitary sewer. Additionally, the City is using a targeted sanitary sewer flow metering program and smoke testing program to identify other clear water sources. The smoke testing consists of blowing a smoke-like vapor into the sanitary sewer in order to expose openings where inflow is entering the sanitary sewer. Sewer lining and repairs also contribute to I & I reduction.

The City's success with reducing I & I is transferring a problem from the sanitary sewer system to the stormwater management system, because there is limited storm sewer capacity for the inflow removed from the sanitary sewer. This has contributed to the challenges the City has to manage in the Flood Mitigation Program discussed earlier in this report.

Previous Year Activities

The storm drain project areas for 2016, and associated water quality impacts, are referenced in the following table:

Storm Sewer Design for New Construction

PROJECT AREA	PROJECT DESCRIPTION	STORMWATER RUNOFF BENEFITS
CSO Area 56 (24th Ave SE, Elm St to dead end)	Eliminated cross connection from storm to sanitary sewer	Eliminated CSO drainage area of 10.29 acres
CSO Area 159 (Queen Ave N & Plymouth Ave N)	Eliminated cross connection from storm to sanitary sewer	Eliminated CSO drainage area of 1.2 acres
CSO Area 173 (6th Ave N & 5th St N)	Eliminated cross connection from storm to sanitary sewer	Eliminated CSO drainage area of 0.22 acres
CSO Area 179 (Minnehaha Ave & 29th Ave S)	Eliminated cross connection from storm to sanitary sewer	Eliminated CSO drainage area of 0.11 acres
CSO Area 185 (E 17th St & Chicago Ave)	Eliminated cross connection from storm to sanitary sewer	Eliminated CSO drainage area of 1.42 acres

The total drainage area removed from the sanitary sewer in 2016 was 13.24 acres

In addition to separating the sanitary and storm drains, the CSO 56 project installed an underground infiltration system to reduce volume and improve water quality of the discharge from the project area.

Street Projects

For street reconstruction projects, whenever storm drain upgrades are required, installations of volume reduction systems, pollutant load-reducing facilities, and rate reduction BMPs are all considered.

Previous Year Activities

In 2016, the CSO 56 project was completed on 24th Ave SE. Planning and design were carried out for several projects that are expected to be constructed in 2017.

In 2016, the City installed cured-in-place pipe (CIPP) liners on over 7 miles of sanitary sewers and completed 68 I&I repairs.

XI. Public Education and Outreach

Program Objective

The objective of this stormwater management program is to educate the public regarding point and non-point source stormwater pollution.

Targeted pollutants include:

All pollutants

Program Overview

The City of Minneapolis and the Minneapolis Park & Recreation Board (MPRB) implement their Public Education Program to promote, publicize, and facilitate the proper management of stormwater discharges to the storm sewer system. The program's focus is to educate Minneapolis residents, business owners, employees and visitors about how *everyone's* actions affect the quality of our lakes, wetlands, streams and the Mississippi River, and how to control pollutants at the sources to reduce the discharge of pollutants to our receiving waters. The desired result is to change behavior in ways that will improve water quality. Many of the components of the program can be found at the City of Minneapolis Stormwater web site.

Some of the program activities are carried out directly by the co-permittees - the City and the MPRB. Other activities are coordinated with and carried out by watershed organizations, Hennepin County and other entities.

Previous Year Activities

City of Minneapolis Activities and Events

Mississippi River Green Team

The Mississippi River Green Team (Green Team) is a conservation-based teen crew engaged in daily hands-on environmental work throughout the summer. There are two crews of ten youth each, which work mostly in the natural areas of the Minneapolis park system, and also within the watershed of the Mississippi River. Typical work days include invasive species removal, weed wrenching, planting, watering, mulching, and citizen science work. As part of weekly education days and exposure to green career paths, this year's crews worked and learned alongside National Park Service Rangers, Minneapolis Park & Recreation Board gardeners, Minnesota Conservation Corps members, and the DNR natural resources staff. The team members also toured the City of Minneapolis water treatment plant, explore the Lock & Dam and visited the University of Minnesota Monarch Lab.

In 2016, the Green Team continued as citizen scientists for the Minnesota Dragonfly Society. Each week the teens caught and identified dragonflies at North Mississippi Regional Park. They also surveyed part of Wirth Park near JD

Rivers Children's Garden. Dragonflies are an indicator species for assessing habitat and water quality in wetlands, riparian forests, and lakeshore habitats

The Mississippi River Green Team is made possible through a partnership between the Minneapolis Park & Recreation Board and the Mississippi Watershed Management Organization, with additional funding through the City of Minneapolis STEP-UP Youth Employment Program.

In addition, the Green Team is also supported by City of Minneapolis Public Works. The team augments the work of the City's stormwater pond vegetation management contractor Wetland Habitat Restorations (WHR) The Green Team's role in 2016 focused on weed and invasive species management. Each work site offered an opportunity to work with different native plant material, identify invasive species, and learn about various stormwater best management practices. Before each event, WHR provided a tour of the site to discuss the stormwater strategies being used and identified some of the management challenges present. This produced healthy conversations about urban design, stormwater runoff, pollinator habitat, and aesthetic perception of native plantings.

WHR hosted the group at their shop and office to show the students the diversity of work that is involved in ecological design and restoration. During the visit the Green Team was introduced to the full spectrum of equipment and tools that are used in vegetation management.

The work with WHR contributes to the program's goal of exposing teens to a diversity of career paths that are possible with an interest in ecological restoration.

In 2016, the Green Team worked with WHR at the following City of Minneapolis stormwater ponds: Camden Central Pond, Central Avenue Pond at Columbia Golf Course, Columbus Ave pond at 37th Street, Heritage Park, and the Park Avenue ponds. The teens removed invasive species and weed trees, picked up trash, and mulched trees and shrub beds.

Metro Blooms Programs

Ongoing Rain Garden Workshop Program

In 2016, the City and others again sponsored a multi-part stormwater education workshop program conducted by Metro Blooms, a non-profit organization that grew out of the City's Committee on the Urban Environment (CUE). The goals of the workshop program are to reduce stormwater runoff, prevent stormwater pollution that damages our water bodies and improve the environmental and visual quality of the urban landscape. The workshops serve to inform, coach and offer consultation to Minneapolis residents protecting the upper Mississippi River watershed by installing properly designed bio-infiltration areas (rain gardens), redirecting downspouts and using native plants. One of the means of publicizing the workshops is a utility bill insert that reaches most of the approximately 100,000 households in Minneapolis. In 2016, 225 Minneapolis residents participated in workshops across the city.

Lake Nokomis Neighbors for Clean Water

In 2016, Metro Blooms continued to implement the Lake Nokomis Neighbors for Clean Water program. The City of Minneapolis was awarded a Clean Water Fund Grant by the Minnesota Board of Water & Soil Resources Competitive Grants Program for this project in 2014, in the amount of $400,000. The Minnehaha Creek Watershed District (MCWD) and Hennepin County are additional project partners, providing funding of $100,000 and $50,000, respectively. Metro Blooms is managing the three-year project, which is a major expansion of a 2013 pilot program to engage residents in an initiative to reduce pollutants in stormwater runoff entering Lake Nokomis, one of the most visited lakes in Minnesota, and determined by the State to be impaired due to excessive nutrients. Building on the success of its Powderhorn Neighborhood of Rain Gardens initiative, Metro Blooms conducted an analysis of the sub-watershed to identify priority areas for BMP installations based on drainage pattern, land uses and presence of previously constructed BMPs, and is focusing on reducing runoff and pollutants from residential backyards, rooftops and driveways. WinSLAMM modeling of potential projects demonstrates 90-92% reduction in stormwater volume, TP and TSS from drainage areas. Installations will be paired with education and outreach to property owners focused on long-term benefits of sustainable source control.

Storm Drain Stenciling

Stenciling of catch basins (also called storm drains), educates the people painting stormwater messages on the storm drains, and also shares an environmentally friendly message with area residents and other people passing by. It is a great team-building exercise that allows volunteer organizations to educate people about simple steps they can take to help improve the quality of the lakes, rivers and streams in Minneapolis.

In 2016, the City continued the program by providing self-contained stenciling kits for use by the volunteers. Each kit contains everything needed to stencil storm drains inlets: stencils, a map with storm drain inlet (catch basin) locations, stenciling paint, traffic cones, facemasks, a broom for prepping the site, latex gloves and trash bags, safety vests and glasses, and door hangers to explain the stenciling to area residents. By providing educational stormwater door hangers to distribute to residents, dialogue is encouraged between the stencilers and people who live nearby.

The stencils are specific to the type of receiving waterbody, thus referring to “Mississippi River”, “lake”, or “creek” as the case may be. The City has three versions of the “Mississippi River” stencils: in English, Spanish and Somali languages. The “lake” and “creek” stencils in were only available in English, but Spanish and Somali versions may be added.

Safety of the volunteers is very important, so we encourage groups to stencil on low traffic-volume streets, and we provide traffic cones and safety vests. If children are part of the group, we request that an adult be present at all times to supervise. The trash bags and gloves are used by the volunteers to pick up trash in the areas around the storm drain inlets, especially on the uphill side. Efforts of the organizations doing the stenciling are tracked, including maps of the target areas, the locations and numbers of the stenciled storm drains, the number of volunteers, and the number of door hangers distributed.

2016 Activities:

- Participants: 369
- Storm drains painted: 973
- Bags of trash and debris collected: 77
- Door hangers distributed 1,673

Adopt a Drain

In 2016 the city initiated an Adopt a Drain (AAD) program for city residents. This new program is aimed at helping keep waterways clean by empowering city residents to take responsibility for cleaning the catch basins/storm drains in their neighborhood. The program was rolled out in April 2016 and advertised using utility bill inserts, website and Facebook postings, and outreach to neighborhood associations and block captains.

In June 2016 the Minnehaha Creek Watershed District (MCWD) and the Standish-Ericsson Neighborhood Association (SENA) approached the city about piloting a project within the Lake Hiawatha watershed to intensively market the AAD program. Bringing in Hamline University as an additional partner, the pilot project was launched in September. Hamline trained students to door hanger all of the homes within the Standish-Ericsson neighborhoods and doorknocked and spoke to homeowners at approximately 1,500 of the 4,100 single-family properties in the area. Residents sign up to adopt a local storm drain and received a yard sign advertising their commitment to clean water. In 2016 there were 155 adopters committing to clean 276 storm drains across the city.

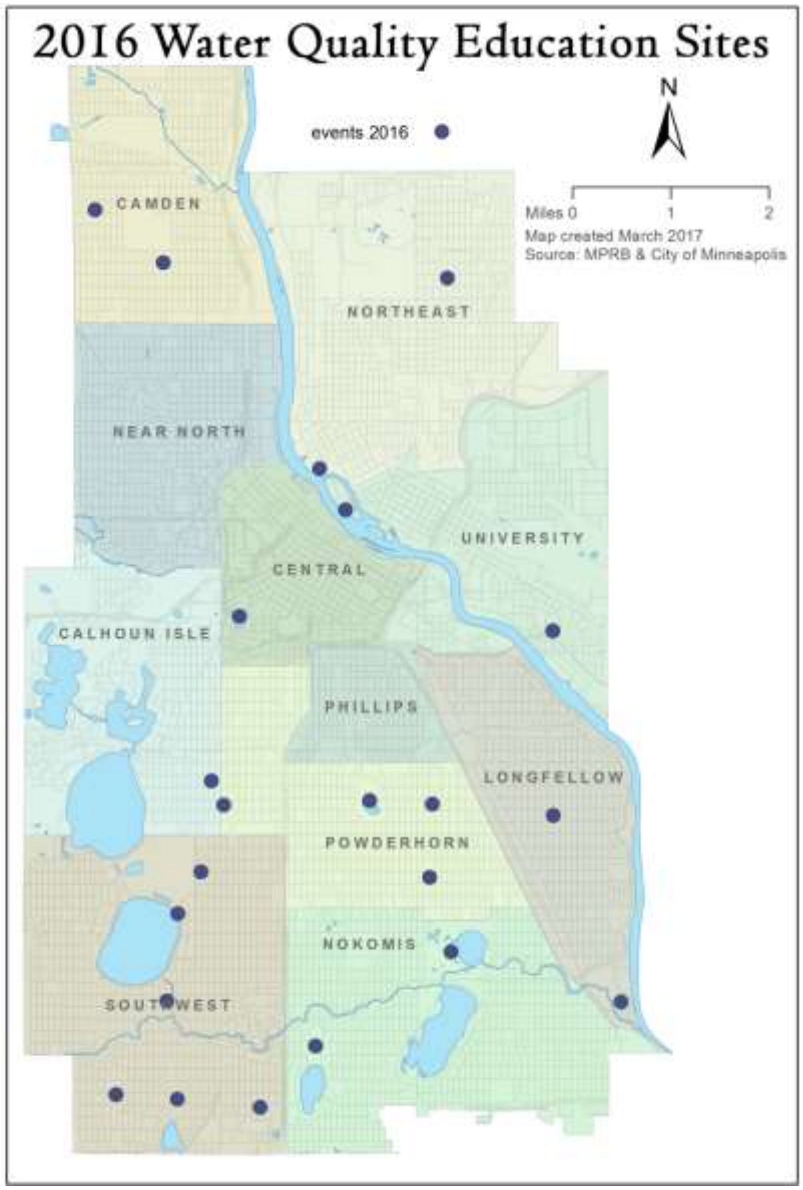
In partnership with the MCWD and Hamline University this intensive marketing of the AAD program will be expanded in 2017 to cover all the additional seven neighborhoods with 10,300 single-family homes that drain to Lake Hiawatha.

Minneapolis Park & Recreation Board Education Activities and Events

In 2016, Minneapolis Park & Recreation Board (MPRB) staff provided water quality education programs throughout the City. Environmental Management naturalist staff participated in 58 Minneapolis community festivals, neighborhood events, as well as concerts and movies (locations are listed below). Hands-on water quality educational displays focused on neighborhood watersheds and how human activities impact local water bodies. Education staff utilized portable mini-golf, an aerial photo floor graphic of the city and its watersheds, and other hands learning activities.

2016 list of parks that had water-quality education program events. Several sites hosted multiple events.

- Armatage Park
- Audobon Park
- Boom Island Park
- Bryant Square Park
- Corcoran Park
- Folwell Park
- Kenny Park
- Lake Hiawatha Park
- Longfellow Park
- Loring Park
- Luxton Park
- Lyndale Farmstead Park
- Lynnhurst Park
- Minnehaha Falls Park
- Nicollet Island Park
- Painter Park
- Pearl Park
- Powderhorn Park
- Sibley Park
- Victory Memorial Park
- Windom South Park



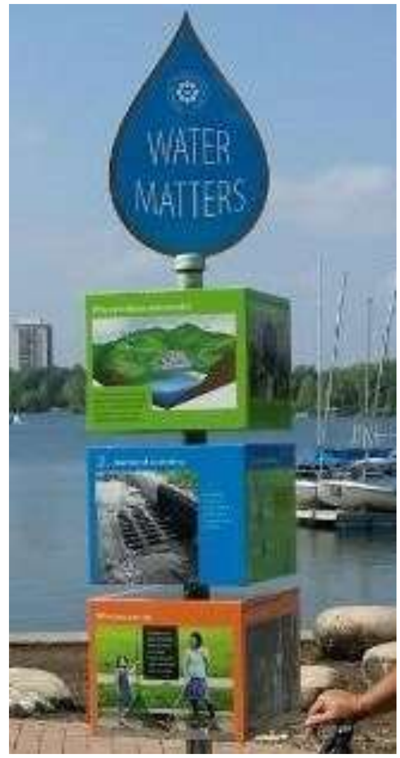
CANINES for CLEAN WATER

Canines for Clean Water

More than 100,000 dogs reside in the City of Minneapolis. They generate an estimated 41,000 pounds of solid waste each day. A water quality education program targeting dog owners was initiated in 2009 called Canines for Clean Water, and we continue to build on this work.

In 2016, the Canines for Clean Water campaign continued to focus on Public Service Announcements (PSAs) shown at the Riverview Theatre, located near the Mississippi River and Lakes Nokomis and Hiawatha. The PSAs focus on two main actions: getting pet owners to pick up after the dogs, and encouraging all property owners to stop or reduce their use of salt or chlorides. The PSAs had a simple message with images of the Mississippi River, Lake Nokomis, and Minnehaha Creek. The summer and fall message was to Protect the River, Protect the Lake, Protect the Creek: Grab a Bag and Scoop the Poop. For winter, the images featured winter scenes of the Mississippi River, Lake Nokomis, and dogs frolicking in the snow. The message here was to Protect the River, Protect the Lakes, Protect the Paws: Shovel, Don't Salt. The word *chloride* was not used in the PSA because more people understood ice melt as salt. However, detailed information about chlorides, their impacts, best practices for distribution was found on the Minneapolis Park & Recreation Board website www.minneapolisparks.org/dogs The same was true for information about the impact of dog poop on water quality.

Minnehaha Park



A moveable water quality education exhibit was deployed at Minnehaha Park near the pavilion that houses the popular restaurant, Sea Salt.

The spinning cubes (see image) provide information about watersheds, stormwater runoff, and actions people can take to positively impact water quality. This location was chosen because of the consistent captive audience of people standing in line waiting to order food. Intermittent staff observations throughout the season confirmed that many of the people waiting in line were reading the cubes.

Greening Teen Teamworks

Teen Teamworks is a summer youth employment program managed by the Minneapolis Park & Recreation Board for 30+ years. Teen Teamworks hires and trains 250 to 300 youth each summer to assist in park maintenance work for 8 to 10 weeks and attend job education sessions. The Greening Teen Teamworks program, led by two MPRB Environmental Educators, meets with all sites supervisor and youth weekly to provide education on stormwater runoff, water quality, and actions that should be taken to help keep our lakes, creeks, and river healthy. In addition, these site-based youth crews are charged with keeping the park's stormwater drains clear and curblines picked up, and at parks with waterbodies, the crews remove debris from outlets and tidy up shorelines. Crews also participate in local education outreach opportunities to demonstrate what they have learned about water quality; these projects have included speaking with park users, and coordinating interactive water quality education days at Rec Plus school-age care sites. In 2016 work sites included the following parks: Folwell, Farview, Webber, Powderhorn, North Commons, Martin Luther King Jr, Bottineau, and Pearl. All participants must complete a pre and post knowledge test. Results show that teens and supervisors increase their knowledge and understanding of water quality, watersheds, runoff, and positive actions that benefit our lakes, creeks, and river. The Greening Teen Teamworks program is funded by the Mississippi Watershed Management Organization.

At the lakes

The MPRB continued its extensive Aquatic Invasive Species (AIS) Inspection Program at the public boat launches located at Lakes Calhoun, Harriet, and Nokomis. The boat launches are staffed seven days a week from May 1 to December 1 and all boats entering and leaving the lakes are inspected for AIS. In addition to providing boat inspections, staff also serves as an information source for the park visitors. Adjacent to the AIS booths are sandwich boards with action steps people can take to be good water stewards. The sandwich board messages can be changed out daily based on weather, time of year, etc. Annually more than five million people visit the Chain of Lakes and more than one million visit Lake Nokomis.

At the park buildings

In 2015, education outreach focused on hardware stores and the potential to use floor graphics and stickers to provide reminders to users about limiting their chloride use. That research ended up informing work focusing on educating Minneapolis park staff in 2016. Stickers were prototyped in 2016:

These stickers will be placed on all chloride/de-icer/salt buckets within the park system for winter 2017. MPRB maintenance leadership has committed to purchasing new containers, spreaders, brooms and dust pans for all sites so that there will be a consistent message to all maintenance and recreation staff (the ones most likely to apply de-icer). In addition to the bucket sticker, there will be a poster or window cling with the appropriate spread pattern, and an accompanying poster directing staff to shovel first, salt only when necessary, and the sweep up any excess.

Do Not Feed the Ducks

In 2016, the MPRB piloted a new approach to persuade lake visitors to not feed the ducks, especially when eating a meal or popcorn at Bread & Pickle located at Lake Harriet. Staff observations prior to the pilot program showed a large percentage of visitors regularly fed the ducks and geese at the lake. MPRB trades staff (carpenters and painters) created table-toppers out of wood blocks, blue paint, gorilla glue, stickers and rubber ducks and then attached them to each table.

In addition, buoys with the ‘DO NOT FEED THE DUCKS’ message were placed near shore:

Bread & Pickle staff used the same graphic and stamped all of the popcorn bags so that the ‘do not feed the ducks’ was in the hands of every person who purchased popcorn.

This campaign proved effective. Staff observations of the lakeside restaurant’s patrons showed a tremendous decrease in feeding the ducks. Bread & Pickle staff also found the pilot project to be a success, noting that there was tremendous social pressure for patrons to do the right thing. One staff emailed that, “The please don't feed the ducks initiative has really worked and we are loving it.” Several park patrons sent in encouraging messages about the campaign, including this one: “Thank you for the cute signs! Bravo!”

Due to the pilot programs success, the plan for 2017 is to fabricate more permanent and professional looking table-toppers and expand to other lakeside restaurants. We will also prototype an oversized rubber ducky buoy to reinforce the ‘do not feed the ducks’ message.

The pilot program was funded by a Cynthia Krieg grant from the Minnehaha Creek Watershed District and the City of Minneapolis.

Training

Two MPRB full time staff and completed the introductory and advanced courses for Fostering Sustainable Behavior Community-Based Social Marketing (CBSM) led by Douglas McKenzie-Mohr. Six Public Works full-time staff attend the introductory course as well, and one attended the advanced course. To quote from McKenzie-Mohr’s website, “**CBSM is an approach to achieving broad sustainable behavior in our communities. It combines the knowledge from psychology and social marketing to leverage community members’ action to change behavior. CBSM is more than education; it is spurring action *by* a community and *for* a community”.** Community-based social marketing is composed of four steps: uncovering barriers to behaviors and then, based upon this information, selecting which behavior to promote; designing a program to overcome the barriers to the selected behavior; piloting the program; and then evaluating it once it is broadly implemented (McKenzie-Mohr & Smith, 1999). The MPRB’s goal is to utilize CBSM in future water quality education efforts.

In 2016 City Public Works and Regulatory Services staff conducted a joint field training exercise in sediment and erosion control. The open construction site at the Minneapolis Sculpture Garden was reviewed as a group and inspections, BMPs, ongoing BMP modifications, and record keeping were all discussed to improve inspection effectiveness and communication between the two departments.

BMP Inspection & Maintenance Training

In May 2016, 13 employees from the MPRB’s Environmental Stewardship Division completed the University of Minnesota’s two-day Erosion and Stormwater Management Certification Program. The course is designed for those who inspect, maintain or direct maintenance on stormwater control measures and practices, such as ponds and infiltration systems. Attendees learned the fundamentals of stormwater practices processes, mechanics, operations, inspections and maintenance needs, and how to create and execute a maintenance work plan. All 13 MPRB employees passed the exam to receive their certification.

Earth Day Watershed Clean-Up Event

The Earth Day Watershed Clean-up was initiated in 1995 to draw attention to the water quality improvement needs of Minneapolis' lakes, and the effects that individual actions have on urban water quality. The goals of the Earth Day Clean-Up event are to prevent trash and debris from entering Minneapolis water bodies, and to provide a volunteer experience and environmental education to Minneapolis residents and park users. This annual event occurs in Minneapolis parks and neighborhood areas that are part of the watersheds of Minneapolis water bodies, including the Chain of Lakes, Lake Nokomis, Lake Hiawatha, Powderhorn Lake, Diamond Lake, Shingle Creek, Minnehaha Creek, Bassett Creek, and the Mississippi River.

Lake Calhoun Earth Day, photo courtesy MPRB

Creekview Earth Day, photos courtesy MPRB

The annual Minneapolis Earth Day Clean-Up is held at several sites throughout the City of Minneapolis. It is a collaborative effort between the Minneapolis Park & Recreation Board (MPRB) and City of Minneapolis Solid Waste and Recycling. The 2016 event featured 36 sites across Minneapolis with more than 1,400 volunteers helping to pick up and beautify the park system. Volunteers collected an impressive 10,380 pounds of trash, recycling and metal. In addition, Earth Day participants received education in properly sorting recyclables, trash and organics as well as the opportunity to participate in naturalist led programs or to build their own bird house.

Loring Park Earth Day, photos courtesy MPRB

SITE	ADDRESS
Bassett's Creek	SE corner of Penn Ave N & 1 ½ Ave N
Beltrami Park	1111 Summer St NE
Boom Island	724 Sibley St NE
Brackett Park	2728 39th Ave S
Bryant Square Park	3101 Bryant Ave S
Cedar Lake	Cedar Lake Pkwy & W 25th St
Columbia	Columbia Pkwy & 35th Ave NE (playground parking lot)
Creekview	5001 Humboldt Ave N
Dairy Queen	4719 Lyndale Ave N
East River Pkwy	E River Pkwy & E Franklin Ave
Farview	621 29th Ave N
Father Henn Bluff	100 6th Ave SE
Gold Medal Park	2nd St S & 11th Ave S
Heritage Park	10th Ave N & Van White Memorial Parkway
Kenny/Grass Lake	1328 58th St W
Kenwood	2101 W Franklin Ave
Lake Calhoun East	W Lake St & E Calhoun Pkwy
Lake Calhoun W	W 32nd St & Calhoun Parkway
Lake Harriet	4135 Lake Harriet Parkway, Band Shell parking lot
Lake of the Isles East	W 27th St & E Lake of the Isles Pkwy
Loring Park	1382 Willow St
Lynnhurst Park	1345 W Minnehaha Pkwy
MLK Park	4055 Nicollet Ave S
Nokomis	2401 Minnehaha Pkwy E
Pearl	414 Diamond Lake Rd E
Powderhorn	3400 15th Ave S
Riverside	2700 8th St S
Sibley	1900 E 40th St
Triangle Park	10th St, between 4th & 5th Ave
Theodore Wirth	3200 Glenwood Ave (Wirth Beach Parking lot)
W River Rd N & 17th	W River Road N & 17th Ave N
W River Pkwy & 24th	W River Pkwy & E 24th St

W River Pkwy & 36th	W River Pkwy & E 36th St
W River Pkwy & 44th	W River Pkwy & E 44th St
Waite Park	1810 34th Ave NE (near playground off Garfield)
Water Works	401 1st St S (Fuji Ya parking lot)

Lake Calhoun Earth Day, photos courtesy MPRB

Web sites

STORM & SURFACE WATER MANAGEMENT – The City provides this primary web site for information about Storm and Surface Water Management:

ENVIRONMENTAL SERVICES – The City's Environmental Services section maintains their web site for additional information about its initiatives and programs.

STORMWATER MANAGEMENT PROGRAM and ANNUAL MS4 REPORT – The City and MPRB work with local watershed organizations and other partners to fulfill the requirements of the City's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit. The Stormwater Management Program and current and prior annual reports can be reviewed online to provide education to interested parties.

LOCAL SURFACE WATER MANAGEMENT PLAN – This document is a key component of the City's Comprehensive Plan. The ten-year updates for both plans are underway.

REGULATORY CONTROLS OF SURFACE WATER MANAGEMENT – The City of Minneapolis provides information regarding pesticides, fertilizers, illicit discharges, improper disposal and other water quality issues via the following City web site.

FLOOD MITIGATION INFORMATION – The City web site provides educational information regarding flood mitigation.

COMBINED SEWER OVERFLOW – (CSO) PROGRAM – The City maintains a web site to educate Minneapolis residents and property owners about the City's CSO program to eliminate Combined Sewer Overflows.

MINNEAPOLIS STORMWATER UTILITY FEE and BEST MANAGEMENT PRACTICES (BMPs) – As a component of the City's Stormwater Utility Fee, the City web site encourages the implementation of various Best Management Practices (BMPs) such as rain gardens, rain swales and pervious pavement that would reduce the overall amount of impervious surface area throughout the City. These practices would also filter and cleanse stormwater.

Minnesota Stormwater Manual: The City also maintains a link to the MPCA web site where numerous BMP suggestions are available for implementation at various scales.

PUBLIC EDUCATION & OUTREACH – Additional information about how the City and MPRB advance stormwater education activities can be found at the following web sites:

City of Minneapolis

Minneapolis Park & Recreation Board

EROSION and SEDIMENT CONTROL EDUCATION for CONTRACTORS and DEVELOPERS - During Minneapolis Development Review and the Site Plan Review processes, and during on-site inspections, Public Works and Environmental Services personnel provide Erosion and Sediment Control (ESC) guidance to contractors and developers. This guidance includes information regarding the City's ordinances, and local, state and federal regulations.

XII. Public Participation Process

Program Objective

The objective of this stormwater management program is to maximize the effectiveness of the City's NPDES program by seeking input from the public.

Targeted pollutants include:

All pollutants

Program Overview

The City of Minneapolis and the MPRB are the joint holders of the NPDES MS4 Permit, and the Annual Report is a coordinated effort by various City departments and the MPRB. The Permit requires an opportunity for public input in the development of the priorities and programs necessary for compliance. The MPCA re-issued Municipal Separate Storm Sewer System (MS4) NPDES Permit No. MN0061018 to the City of Minneapolis and the MPRB as co-permittees in January 2011.

The Permit requires the implementation of approved stormwater management activities, referred to as Best Management Practices (BMPs). A new Stormwater Management Program (SWMP), documenting the structural and non-structural Best Management Practices used by the City and the MPRB was submitted to the MPCA for public comment and approval in September, 2011 and revised and finalized in May 2013. As outlined in Part V.A. of the Permit, the Stormwater Management Program (SWMP) is based on an adaptive management system by which the Permittees continuously monitor, analyze and adjust the Program to achieve pollutant reductions. Using the adaptive management approach, revisions to the SWMP are submitted along with the Annual Report.

The 2014 revisions were primarily responsive to a 3-day field inspection in August 2013 by an EPA Inspection Team. The inspection, or audit, helped to identify opportunities for improvement regarding comprehensive training, written procedures and documentation, and availability of staff resources. Additional revisions were made in July 2015.

Each year, the City holds a public hearing at a meeting of the Transportation & Public Works Committee of the City Council, prior to submission of the Annual Report. The hearing provides an opportunity for public testimony regarding the Program and Annual Report prior to report submittal to the Minnesota Pollution Control Agency. The hearing is officially noticed in the Finance and Commerce publication, and also publicized through public service announcements on the City cable television channel. This year's public hearing date was June 6, 2017 at 9:30 AM in Council Chambers, Room 317 City Hall, 350 S 5th Street, Minneapolis, MN. The slide presentation is available at the following web site:

http://www.minneapolismn.gov/www/groups/public/@clerk/documents/webcontent/wcmsp-199819.pdf

A notice of the opportunity for public comment along with availability of the Stormwater Management Program, was sent to the 81 Minneapolis neighborhood organizations, to the governmental entities that have jurisdiction over activities relating to stormwater management, and to other interested parties announcing the web site link, and informing that written comments were being accepted until Noon on June 16, 2017. A list of the notice recipients is below.

The notice explained that emails or faxes were the preferred methods for submitting written comments, rather than conventional mail due to the additional time involved. The contact information for written comments was listed as:

City of Minneapolis
Department of Public Works
Surface Water & Sewers Division c/o Liz Stout
300 City of Lakes Building, 309 2nd Avenue S, Room 300
Minneapolis MN 55401-2268
Phone: 612-673-5284 Fax: 612-673-2048
E-mail: Elizabeth.stout@minneapolismn.gov

All testimony presented at the public hearing, and all written comments received, are recorded and given due consideration. The comments are included with the Annual Report as Appendix C. A copy of the City Council resolution adopting the Stormwater Management Program and Annual Report Activities is included each year with the submission to the Minnesota Pollution Control Agency. The Stormwater Management Program and the Annual Reports are available for viewing or downloading.

Performance Measures

Number of interested parties that were directly notified of public hearing, Stormwater Management Program (SWMP) availability, and proposed SWMP changes: 98 (includes 81 neighborhood organizations) (list follows)

Public Participation Process

ORGANIZATION	EMAIL ADDRESS	CONTACT PERSON
Bassett Creek Watershed Management Commission	Laura.jester@keystonewaters.com	Laura Jester
Citizens Environmental Advisory Committee	darrellgerber@gmail.com Kelly.muellman@minneapolismn.gov	Darrell Gerber Kelly Muellman
Clean Water Action	mzellar@cleanwater.org	Marie Zellar
Friends of the Mississippi River	wclark@fmr.org	Whitney Clark
Hennepin County Environmental Dept	Carl.michaud@co.hennepin.mn.us	Carl Michaud
Metropolitan Council Environmental Services	judy.sventek@metc.state.mn.us	Judy Sventek
(all) Minneapolis Neighborhood Organizations	Bob.Cooper@ci.minneapolis.mn.us	c/o Bob Cooper, CPED
Minnehaha Creek Watershed District	lerdahl@minnehahacreek.org	Lars Erdahl
MN Center for Environmental Advocacy	ksigford@mncenter.org	Kris Sigford
MN Dept of Agriculture, Pesticide Mgmt	ron.struss@state.mn.us	Ron Struss
MN Dept of Natural Resources, Ecological and Water Resources Division	steve.hirsch@.state.mn.us Kate.drewry@state.mn.us	Steve Hirsch Kate Drewry
MN Dept of Transportation, Water Resources	beth.neuendorf@state.mn.us	Beth Neuendorf
MN Environmental Partnership	stevemorse@mepartnership.org	Steve Morse
Mississippi River Revival	solomonsimon@hotmail.com	Sol Simon
Mississippi Water Management Organization	dsnyder@mwmo.org	Doug Snyder
St. Paul, City of	patrick.g.murphy@ci.stpaul.mn.us	Patrick Murphy
Shingle Creek Watershed Mgmt. Commission	judie@jass.biz	Judie Anderson

XIII. Coordination with Other Governmental Entities

Program Objective

The objective of this Stormwater Management Program is to maximize stormwater management efforts through coordination and partnerships with other governmental entities.

Program Overview

Coordination and partnerships of the City and the MPRB with other governmental entities include the four watershed organizations in Minneapolis: Bassett Creek Water Management Commission, Mississippi Watershed Management Organization, Minnehaha Creek Watershed District, and Shingle Creek Watershed Management Commission. Coordination activities and partnerships with other governmental entities also include MnDOT, Hennepin County, Minnesota Pollution Control Agency (MPCA), Minnesota Board of Water and Soil Resources (BWSR), Minnesota Department of Natural Resources (MDNR) neighboring cities, the Metropolitan Council, the University of Minnesota and various other entities.

The coordination and partnership activities can include the joint review of projects, joint studies, joint water quality projects, stormwater monitoring, water quality education, and investigation or enforcement activities.

Coordination with the Bassett Creek Water Management Commission (BCWMC)

In 2015, the BCWMC adopted its Third Generation Watershed Management Plan, with Minneapolis and the other eight member cities as active partners. Minneapolis provides yearly financial contributions to the BCWMC annual operations budget. The City and the MPRB are also stakeholders with other BCWMC joint power cities in development of several Total Maximum Daily Load (TMDL) studies and implementation plans.

Coordination with the Mississippi Watershed Management Organization (MWMO)

The MWMO adopted its Third Generation Watershed Management Plan in 2011. The City and MPRB participated in its planning committees. The MWMO delegates stormwater management requirements for new developments and redevelopments to its member cities and does not provide separate project review and approval. The MWMO receives revenue through direct taxation against properties within its jurisdiction. The City and the MPRB partner with the MWMO on many studies and projects.

Coordination with the Minnehaha Creek Watershed District (MCWD)

The MCWD adopted its Third Generation Plan in 2006. In 2015, the watershed began planning its next generation plan and it is intended to be adopted in 2017. Minneapolis and other district cities' staff have been active as part of the technical advisory committee (TAC). The MCWD receives revenue through direct taxation against properties within its jurisdiction. The City of Minneapolis and the MPRB are stakeholders in development of TMDL studies and implementation plans, in collaboration with the MCWD and other stakeholders.

Coordination with the Shingle Creek Watershed Management Commission (SCWMC)

The SCWMC adopted its Third Generation Watershed Management Plan in April 2013, with Minneapolis and the other member cities as active partners. Minneapolis provides yearly financial contributions to the SCWMC annual operations budget. The City of Minneapolis and the MPRB are stakeholders with other SCWMC joint power cities in development of TMDL studies and implementation plans.

Coordination with Hennepin County

In 2016 Hennepin County adopted a Natural Resources Strategic Plan. This plan is intended to guide the county and its partners, including the city, in responding to natural resource issues and developing internal and external policies, programs, and partnerships that improve, protect, and preserve natural resources. City staff and residents provided feedback on this plan through a series of meetings and survey.

Coordination with the Minnesota Pollution Control Agency (MPCA)

Minneapolis Fire Inspection Services coordinates with the MPCA on Spill Response incidents and investigations and enforcement for incidents of illegal dumping or illicit discharges to the storm drain system.

Minneapolis Public Works coordinates with the MPCA on the various work groups, including the Minnesota Stormwater Manual and surface water/groundwater interactions.

Coordination with the US Coast Guard, WAKOTA CARE, and South Metro River Response

Minneapolis Fire Inspection Services coordinates with these agencies on Spill Response issues, training, and spill response drills.

Results Minneapolis

City Goal Results Minneapolis roundtables are focused on answering the question "Are we there yet?" by reporting progress on our community indicators. These reports are analytical in nature and focused on making data-driven connections across multiple sectors. Creating City Goal Results Minneapolis reports requires input from multiple departments and external participants. The goal of this initiative is to reflect the realities experienced in Minneapolis communities. The two major objectives of the report and roundtable are 1) to have a new and different understanding of the indicators and 2) to think differently about solutions.

The City Goal Results Minneapolis report on Healthy Lakes, Rivers, and Streams was released in 2016. This report focused on water body impairments and their importance in measuring long-term water quality. The report was created in collaboration with the city Public Works-Surface Water and Sewers Division, the City Coordinator's office, and the MPRB. The roundtable conversation on Healthy Lakes, Rivers, and Streams was held on June 22, 2016. This roundtable was a unique opportunity for staff, leadership, elected officials from the City of Minneapolis and the Minneapolis Park & Recreation Board, and stakeholders from many outside agencies and organizations to engage in a robust discussion about the complex factors that influence the quality and aesthetic condition of surface waters in Minneapolis.

Previous Year Activities and Ongoing Coordination Efforts

The Minneapolis Park and Recreation Board (MPRB) and the City of Minneapolis coordinate stormwater management efforts and coordinate with the watershed management organizations, the watershed district, and other governmental agencies on a number of water quality projects. Minneapolis Public Works maintains communications with all watershed management organizations and the watershed district within the City boundaries.

Coordination with Other Governmental Entities

Interactions take several forms to facilitate communication and provide support:

- Attend selected local board and special issues meetings
- Attend selected education and public outreach committee meetings
- Take part in Technical Advisory Committee (TAC) meetings
- Inform the organizations of upcoming City capital projects in an effort to identify projects that may benefit from partnerships
- Provide developers (who submit projects for site plan review) with information and contacts to meet watershed requirements
- Share information and data regarding storm drainage system infrastructure, watershed characteristics, flooding problems, modeling data, etc.
- The MPRB and the City coordinate and partner with the watershed organizations on capital projects and water quality programs. For example:
    - A creek restoration project that is primarily funded by the Bassett Creek Watershed Management Commission and will be implemented by the City is under design and proposed for construction in 2017.
    - In 2014, the City and the MWMO began a three-year project in 2014 to develop hydrologic and hydraulic models (H&H models) for all areas in Minneapolis that are within the MWMO watershed. The MWMO is participating both technically and financially with these models.
    - A multi-year project with the Minnehaha Creek Watershed District is determining capital projects that will be jointly funded that will address localized flooding challenges, while also addressing water quality issues. One key project is to mitigate flooding at the MPRB's Hiawatha Golf Course such as occurred in 2014. The goals of this project are to reduce the risk of localized neighborhood flooding, improve water quality, and improve course conditions.
- The City's Environmental Services section coordinates with the MPCA regarding investigations and enforcement for incidents of illegal dumping or illicit discharges to the storm drain system.
- Erosion and sediment control permit inspections are coordinated with the MCWD.
- The MPRB coordinates with the watershed organizations and the Metropolitan Council on watershed outlet monitoring.
- The MPRB works with the DNR and surrounding suburbs on various capital projects and programs.
- Public Works and MPRB staff coordinates with the MPCA, the watershed organizations and other stakeholders for Total Maximum Daily Load (TMDL) studies and implementation plans.
- Public Works staff participated in the multi-year MPCA's Minimal Impact Development Standards (MIDS) Committee and several of its sub-committees. The MIDS project was essentially completed in 2013, and is a driving force behind ongoing updates to the Minnesota Stormwater Manual.
- Public Works engages with MPRB, MnDOT, Hennepin County, Metropolitan Council, and watershed organizations on those entities' capital projects and infrastructure maintenance within the City in regards to compliance with NPDES issues.

Finally, other sections of this Annual Report provide additional information about other projects or issues on which the permittees have cooperated with other governmental entities.

XIV. Stormwater Monitoring Results and Data Analysis

The purposes of monitoring and analysis under the MS4 permit are to understand and improve stormwater management program effectiveness, characterize pollutant event mean concentrations, estimate effectiveness of devices and practices, and calibrate and verify stormwater models.

In addition to stormwater monitoring, the Minneapolis Park & Recreation Board carries out an extensive lake monitoring program which is sometimes illustrative of stormwater conditions. For example, Escherichia coli (*E. coli)* monitoring following the MPCA's inland lakes standard is carried out at the MPRB's 12 official beaches located on six lakes, are important for public health and provides almost immediate indications of elevated bacteria issues (see in particular Section 19, Public Beach Monitoring, of the MPRB's Water Resources Report referenced in the next paragraph). *Escherichia coli* commonly referred to as *E. coli* is a bacterium used to indicate the potential presence of waterborne pathogens that can be harmful to human health. Elevated bacteria levels generally occur in aquatic environments after rain events, when bacteria from various sources are washed into the lakes in stormwater runoff.

2016 Water Resources Report

The Minneapolis Park & Recreation Board's annual ***2016 Water Resources Report*** is a comprehensive technical reference of water quality information for the citizens of Minneapolis. Due to the its length, only the NPDES stormwater runoff monitoring and BMP monitoring sections are included in this NPDES MS4 Annual Report, later in this Section. In prior years, they have appeared as Appendices A4 and A5 of the Annual Report. The full *2016 Water Resources Report* will be available electronically mid-2017 on the MPRB web page at www.minneapolisparks.org. The report will be found in the "Park Care – Water Resources" section of the website. Reports are also available from the Minneapolis public libraries archive department.

Minneapolis Lake Trends

In 2016, MPRB scientists monitored 12 of the city's most heavily used lakes. The data collected were used to calculate a Trophic State Index (TSI) score for each of the lakes. Lower TSI scores indicate high water clarity, low levels of algae in the water column, and/or low phosphorus concentrations. Changes in lake water quality can be tracked by looking for trends in TSI scores over time (**Table 14-1 and Figure 14-1**). A negative slope indicates improving water quality, while a positive slope indicates declining water quality. These values are especially important for monitoring long-term trends (10+ years). Historical trends in TSI scores are used by lake managers to assess improvement or degradation in water quality.

All the lakes in Minneapolis fall into either the mesotrophic or eutrophic category. Calhoun, Harriet, and Wirth Lakes are mesotrophic with moderately clear water and some algae. Brownie, Cedar, Isles, Hiawatha, Nokomis, Spring, Loring, and Powderhorn Lakes are eutrophic with higher amounts of algae. Trends in lake water quality can be seen by using the annual average TSI since the early 1990s.

Table 14-1. Water quality trends in Minneapolis lakes from 1991-2016.

Lakes with Improving Water Quality Indicators	Lakes with Stable Trends	Lakes with Declining Water Quality Indicators
Lake Calhoun	Brownie Lake	
Lake Harriet	Cedar Lake	
Lake Nokomis	Lake Hiawatha	
Wirth Lake	Lake of the Isles	
	Loring Pond	
	Powderhorn Lake	
	Spring Lake	

Lakes Calhoun, Harriet, Nokomis, and Wirth have all seen a significant improvement in water quality indicators since the early 1990s (linear regression, $p < 0.1$). Although Calhoun's water quality is improved from the early 1990s, TSI scores have stabilized in the last 10 years. The Lake Calhoun TSI score in 2016 was the lowest observed since 2005. Similarly, Lake Harriet experienced a few years with lower TSI scores following a littoral alum treatment in the mid-2000s, but has remained fairly stable the last 10 years. Low chlorophyll-*a* concentrations and clear water throughout the spring and summer of 2016 led to the lowest TSI score at Lake Harriet since 2005. Lake Nokomis experienced higher algal concentrations in 2016, especially in the fall, but has seen an improvement in water quality in the past few years following a biomanipulation project. The water quality improvement at Wirth Lake has been occurring since 1992, going from a eutrophic system dominated by algal growth to a moderately clear mesotrophic system. That trend continued in 2016.

Most of the Minneapolis lakes have no directional trend in water quality indicators since the early 1990s. The water quality in Brownie Lake has been relatively stable, with no significant trend since 1993. Brownie Lake is monitored every other year and was monitored in 2016. The water quality in Cedar Lake showed improvement following restoration efforts through the late 1990s, had a slow decline in the 2000s, and have remained fairly stable since. The 2016 Cedar Lake TSI score is still below levels in the early 1990s. The TSI scores in Lake Hiawatha have remained stable over the past 24 years. Lake Hiawatha is heavily influenced by the inflow from Minnehaha Creek and the lake has poorer water quality during drought years. The last few years has experienced above average spring and summer precipitation and led to low TSI scores, with 2016 being the second lowest recorded at Lake Hiawatha. The water quality in Lake of the Isles varies from year to year, with the last three years having low TSI scores, but there is no significant trend in any direction since 1991. Loring Pond experienced decreased water quality immediately following a dredging project in 1997; however, conditions have slowly returned to levels similar to pre-1997. Powderhorn Lake has experienced large swings in water quality, with the worst TSI scores in the late 1990s and the best scores in the late 2000s. Powderhorn has had poor water quality the past 4 years, with blue green algae blooms leading to low water clarity. The water quality in Spring Lake is variable, but there is no significant trend in any direction since 1994. Spring Lake is also monitored every other year and was not sampled in 2016, but is scheduled to be monitored again in 2017.

Diamond Lake and Grass Lake are not included in this analysis, since TSI scores are only appropriate for deeper lake systems and there are no water clarity measurements available in these lakes. There are no lakes in Minneapolis with significant decline in water quality indicators since the early 1990s (linear regression, $p <0.1$).

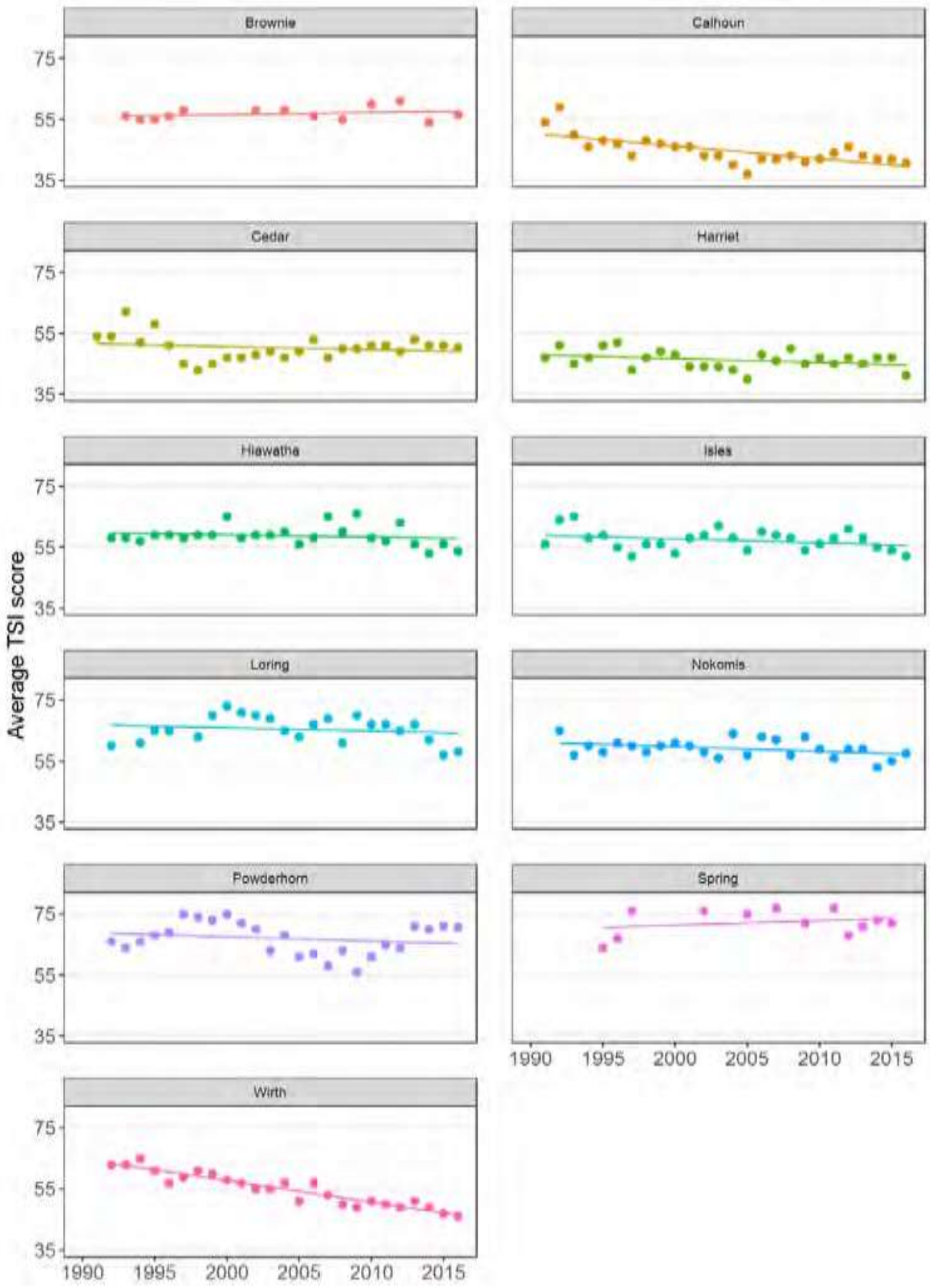


Figure 14-1. TSI scores and regression analysis for selected Minneapolis lakes 1991–2016. Lower TSI scores indicate high water clarity, low levels of algae in the water column, and/or low phosphorus concentrations. A negative slope indicates improving water quality, while a positive slope indicates declining water quality. Only Calhoun, Harriet, Nokomis, and Wirth have statistically significant trends (p <0.1).

NPDES Land Use Sites Monitoring Results (Stormwater Runoff Monitoring)

In 2016, stormwater runoff monitoring was carried out at four management sites representative of Multi-Family Residential, Recreational/Parkland, Commercial/High-Rise, and Commercial/Industrial land uses.

A. Background

The Minneapolis Park and Recreation Board (MPRB) and the City of Minneapolis are co- signatories on the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit. The MPRB has performed the NPDES MS4 stormwater monitoring since 2001. Best Management Practices (BMPs) are devices or practices used to treat and clean stormwater. The purpose of the stormwater monitoring is to characterize the quantity and quality of runoff from small areas representing various types of land use under a no BMP scenario. In reality, the results do not represent actual conditions for either runoff quantity or quality because there are numerous BMPs and other structural controls and management practices that reduce pollutants in stormwater runoff and/or temper stormwater runoff quantity in the watershed.

At the beginning of the first NPDES MS4 permit (2001-2004), the MPRB and City of Minneapolis partnered with the City of St. Paul to fulfill the NPDES monitoring requirements. Five sites in Minneapolis and St. Paul were jointly monitored between 2001–2004. In 2005, the MPRB stopped monitoring stormwater in St. Paul, and four new sites in Minneapolis were selected for monitoring. In 2006, new sites were chosen in Minneapolis to comply with the NPDES permit and to assist with modeling and load allocation efforts.
These four sites represent the major land uses in Minneapolis: residential, commercial/industrial, mixed use, and parkland.

In 2016, four Minneapolis sites: Site 6 (22nd/Aldrich), Site 7 (14th/Park), Site 8a (Pershing Park), and Site 9 (61st/Lyndale) were monitored for stormwater runoff quantity and quality. While, again, the results do not represent actual impacts of stormwater discharge to receiving waters because they do not reflect the effects of structural controls and management practices, they are nevertheless useful for comparing land uses and to create baseline conditions for water quality modeling exercises.

Methods

The summary below includes descriptions of equipment installation at each site, parameters monitored, field quality assurance sampling, computer models used, data handling, validation, and reporting.

Site Installation

The ISCO equipment installed at each site included a 2150 datalogger with low profile area velocity (AV) probe, 2105 interface module, either 2105ci or 2103ci cell phone modem, and a 3700 sampler. The 3700 sampler collected stormwater through 3/8" inner-diameter vinyl intake tubing complete with a strainer. The dataloggers flow-paced the samplers to collect flow-weighted stormwater samples over the entire storm hydrograph. Each site automatically uploaded data, via cell phone modem, to the database server from Monday through Friday. Each site could also be communicated with remotely using Flowlink Pro software in order to adjust pacing, enable or disable samplers, and to see if a site had triggered.

Equipment installation began when freezing spring temperatures were no longer a concern in order to prevent AV probe damage. Freezing conditions can damage the pressure transducer in an area velocity probe. See **Figure 14-2** for a map of site locations. Site 6 (22nd/Aldrich) was installed on 4/18/16. Site 7 (14th/Park), was installed on 4/26/16. Site 8a (Pershing Park) was installed on 4/14/16. Site 9 (61st/Lyndale) was installed on 4/26/16. All sites were uninstalled on 11/1/2016. See **Table 14-2** for site characteristics.

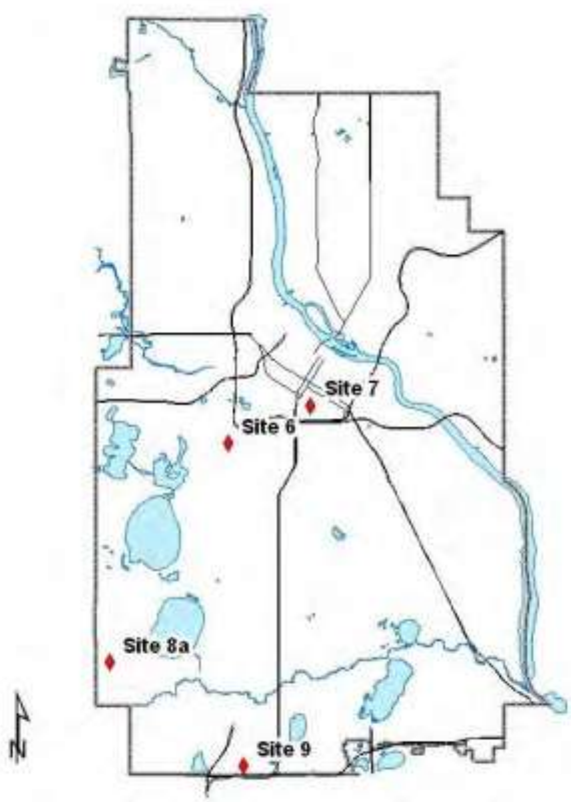


Figure 14-2. Map of the 2016 Minneapolis NPDES monitoring sites.

Table 14-2. 2016 NPDES stormwater monitoring sites in Minneapolis.

Site ID	Site 6	Site 7	Site 8a	Site 9
Location	22nd St & Aldrich Ave S	E 14th St & Park Ave S	Pershing Field east of 49 St & Chowen Ave	335 ft. east of 61st St & Harriet Ave S
Land Use	Multi–Family Residential	Commercial/Industrial/ High Rise Residential	Recreational/Parkland	Commercial/Industrial
Area (acres)	8.9	13.1	2.5	34.9
Pipe Diameter (inches)	18	42	12	36
Outfall ID#	10 – 430J	10 – 430D	57 – 100A/B	71 – 070

Sample Collection and Monitored Parameters

The MS4 permit target frequency for storm event sample collection was 15 samples per site, per year. Following two snowmelt grab samples, two to three flow-paced composite storms were collected per month per site (May-Nov). If a sample was missed during one month due to lack of precipitation events, then additional samples were taken the following month.

The total volume sampled for each site and total recorded volumes in 2016 are given in **Table 14-3** along with the seasonal aggregate percentage sampled. Detailed information on sampling events is shown in **Table 14-4**.

Table 14-3. NPDES site volume totals for the sampling period 4/27/16 – 10/31/16.

	Site 6	Site 7	Site 8a	Site 9
Total volume recorded (with Flowlink) for 2016 (cf)	200,220	707,580	66,445	1,379,230
Total volume of sampled events (cf)	121,130	395,275	33,147	642,205
% sampled ANNUAL	60%	56%	50%	47%
% sampled SPRING (May- June)	15%	30%	8%	25%
% sampled SUMMER (July- September)	68%	70%	84%	75%
% sampled FALL (October- November)	0%	0%	0%	0%

Table 14-4. 2016 precipitation event data and samples collected for NDPES sites. A precipitation event is defined as being greater than 0.10 inches and separated by 8 hours. The rain gage is located at 3800 Bryant Ave. S., Minneapolis, MN.

Event	Start Date/Time		End Date/Time		Precip (inches)	Duration (hours)	Intensity (in/hr)	Time since last Precip. (hours)	Sample Type	2016 NPDES Events Collected			
										Site 6 22nd/Aldrich	Site 7 14th/Park	Site 8a Pershing	Site 9 61st/Lyndale
+1	2/18/2016	14:45	n/a	n/a	n/a	n/a	n/a	n/a	grab	X(w/Ecoli)			X(w/Ecoli)
+2	2/19/2016	13:30	n/a	n/a	n/a	n/a	n/a	n/a	grab	X(w/Ecoli)	X(w/Ecoli)	X(w/Ecoli)	X(w/Ecoli)
+3	2/23/2016	14:00	n/a	n/a	n/a	n/a	n/a	n/a	grab		X(w/Ecoli)	X(w/Ecoli)	
4	4/20/2016	20:00	4/21/2016	18:00	0.69	22.00	0.03	23.50	grab	X(Ecoli only)	X(Ecoli only)		X(Ecoli only)
5	4/24/2016	05:45	4/25/2016	10:30	1.40	28.75	0.05	59.75	composite	X			
6	5/13/2016	07:15	5/13/2016	10:00	0.17	2.75	0.06	32.25	composite		X(lmtd)	X(lmtd)	X(lmtd)
7	5/25/2016	09:30	5/26/2016	04:15	0.34	18.75	0.02	287.50	composite		X	X(lmtd)	X
8	6/3/2016	11:30	6/3/2016	16:00	0.19	4.50	0.04	135.50	composite	X(lmtd)	X(lmtd)	X(lmtd)	X(lmtd)
9	6/9/2016	00:15	6/9/2016	07:15	0.50	7.00	0.07	128.25	composite		X(lmtd)	X	X
10	6/13/2016	00:15	6/13/2016	06:30	0.49	6.25	0.08	89.25	composite	X	X(lmtd)	X	X
11	6/14/2016	11:45	6/14/2016	23:45	1.00	12.00	0.08	29.25	comp/grab	X(w/Ecoli)	X(w/Ecoli)	X	X(w/Ecoli)
12	7/5/2016	18:00	7/5/2016	21:30	1.20	3.50	0.34	309.75	composite	X	X	X	X
13	7/10/2016	05:30	7/10/2016	07:45	0.35	2.25	0.16	104.00	composite	X	X	X	X
14	7/11/2016	23:45	7/12/2016	03:00	0.10	3.25	0.03	40.00	composite		X(lmtd)	X(lmtd)	X
15	7/14/2016	16:30	7/15/2016	03:45	0.23	11.25	0.02	61.50	composite	X(lmtd)		X(lmtd)	X(lmtd)
16	7/16/2016	22:00	7/17/2016	03:30	0.27	5.50	0.05	42.25	composite	X(lmtd)	X(lmtd)	X(lmtd)	X(lmtd)
17	7/21/2016	04:30	7/21/2016	05:30	0.16	1.00	0.16	97.00	composite	X(lmtd)	X(lmtd)		X(lmtd)
18	8/4/2016	07:15	8/4/2016	10:15	1.06	3.00	0.35	180.00	grab	X(Ecoli only)	X(Ecoli only)		X(Ecoli only)
19	8/19/2016	02:45	8/19/2016	05:30	0.42	2.75	0.15	55.50	composite	X	X	X	X
20	8/23/2016	20:45	8/24/2016	02:00	1.36	5.25	0.26	75.25	composite		X	X	X
21	8/29/2016	23:30	8/30/2016	03:15	0.89	3.75	0.24	141.50	composite	X			
22	9/15/2016	16:00	9/15/2016	20:45	0.76	4.75	0.16	152.50	composite		X		
23	9/21/2016	16:00	9/22/2016	05:30	1.89	13.50	0.14	139.25	composite	X		X	
			Totals		**13.47**					**16**	**18**	**16**	**18**

+ snowmelt event

n/a = not applicable

X = event sampled with full parameters

X(lmtd) = event sampled with limited parameters generally due to holding times e.g.BOD, Ortho P, and TDP

X(w/Ecoli) = event sampled with *E. coli*

X(Ecoli only) = only *E. coli* sampled

Table 14-5 shows the parameters tested as part of the MS4 permit for each sample collected. **Table 14-6** gives the approved methods, reporting limit, and holding time for each parameter as reported by the contract laboratory Instrumental Research, Inc. (IRI). Legend Technical Services Laboratory analyzed all metals samples. The reporting limit (RL) changed after May 1, for both Cu and Pb, where the Cu RL increased from <5µg/L to <20µg/L and Pb from <3µg/L to
<15µg/L.

Limited parameter sample designation is used when a sample is collected after some of the parameter's holding times have expired and indicates that those parameters were not analyzed (e.g. cBOD, TDP) or when sample volume is limited. In 2016, samples with limited parameters were collected 22 times. These samples were recovered more than 24 hours after collection and parameters with short holding times were not analyzed or, in some cases, there was limited composite volume.

As required by the MS4 permit, *Escherichia Coli* (*E. coli*) grab and pH samples were collected quarterly. A total of 17 *E. coli* grabs were collected in 2016. Site 6 (22nd/Aldrich), Site 7 (14th and Park), and Site 9 (61st and Lyndale) were each collected five times. Site 8a (Pershing) was collected twice. The pH was measured at the IRI laboratory.

With the exception of Site 8 (Pershing), all required *E. coli* grab and pH sampling was successfully accomplished in 2016. Site 8a was inaccessible for grab sampling after snowmelt because equipment is installed above ground at this site. Equipment cannot be hung inside of the manhole at the Pershing site because the site is prone to surcharging.

Table 14-5. The list of monitored chemical parameters for the NPDES permit. BOD is biochemical oxygen demand.

Parameter	Abbreviation	Units	Sample Type
BOD –carbonaceous, 5 Day	cBOD	mg/L	Composite
Chloride, Total	Cl	mg/L	Composite
Specific Conductivity	Sp. Cond	µmhos/cm	Composite
E. coli (*Escherichia Coli*)	*E. coli*	MPN/100mL	Grab (4X year)
Hardness	Hard	mg/L	Composite
Copper, Total	Cu	µg/L	Composite
Lead, Total	Pb	µg/L	Composite
Zinc, Total	Zn	µg/L	Composite
Nitrite+Nitrate, Total as N	NO_3NO_2	mg/L	Composite
Ammonia, Un-ionized as N	NH_3	mg/L	Composite
Kjeldahl Nitrogen, Total	TKN	mg/L	Composite
pH	pH	standard unit	Grab/Comp (4X year)
Phosphorus, Ortho-P	Ortho-P	mg/L	Composite
Phosphorus, Total Dissolved	TDP	mg/L	Composite
Phosphorus, Total	TP	mg/L	Composite
Solids, Total Dissolved	TDS	mg/L	Composite
Solids, Total Suspended	TSS	mg/L	Composite
Solids, Volatile Suspended	VSS	mg/L	Composite
Sulfate	SO_4	mg/L	Composite

Table 14-6. Analysis method, reporting limit, and holding times for parameters used by Instrumental Research, Inc.

Parameter	Method	Reporting Limit	Holding Times
cBOD, carbonaceous, 5 Day (20°C)	SM 5210 B	1.0 mg/L	24 hours
Chloride, Total	SM 4500-Cl^- B	2.0 mg/L	28 days
Specific Conductivity	SM 2510 B	10 µmhos/cm	28 days
E. coli (*Escherichia Coli*)	SM 9223B	1 MPN per 100mL	< 24hrs
Hardness	SM 2340 C	2.0 mg/L	6 months
Copper, Totalǂ	EPA 200.9	5 or 20 µg/L	6 months
Lead, Totalǂ	SM 3500-Pb B	3 or 15 µg/L	6 months
Zinc, Totalǂ	SM 3500-Zn B	2 or 20 µg/L	6 months
Nitrite+Nitrate, Total as N	SM 4500-NO_3 E	0.030 mg/L	28 days
Ammonia, Un-ionized as N	SM 4500-NH_3 F	0.500 mg/L	7 days
Kjeldahl Nitrogen, Total	SM 4500-Norg B	0.500 mg/L	7 days
pH	SM 4500 H^+ B	0.01 units	15 minutes
Phosphorus, Ortho-P	SM 4500-P A, B, G	0.010 mg/L	48 hours
Phosphorus, Total Dissolved	SM 4500-P A, B, G	0.010 mg/L	48 hours
Phosphorus, Total	SM 4500-P A, B, E	0.010 mg/L	48 hours
Solids, Total Dissolved	SM 2540 C	10.0 mg/L	7 days
Solids, Total Suspended	SM 2540 D	1.0 mg/L	7 days
Solids, Volatile Suspended	SM 2540 E	2.0 mg/L	7 days
Sulfate*	ASTM D516-90	15 mg/L	28 days

*Sulfate samples were spiked with 10 mg/L, and the spike was later subtracted in order to lower the reporting limit to 5 mg/L.

ǂMetals reporting limit (RL) changed after May 1, for Cu, Zn and Pb, where the Cu, Zn RL increased from <5µg/L to <20µg/L and Pb from <3µg/L to <15µg/L.

Field Quality Assurance Samples

A variety of quality control quality assurance measures were taken to insure defensible data. Ten percent of the samples were laboratory quality assurance samples (e.g. duplicates, spikes). A field blank was also generated for each sampling trip and was analyzed for all NPDES parameters. Field blanks consisted of deionized water which accompanied samples from the field sites to the analytical laboratory. All field blank parameters were below the minimum detection limits in 2016. As part of the overall QA/QC program, blind monthly performance samples of known concentration were made for all monitored parameters and delivered to IRI. One equipment blank was also collected in 2016.

An equipment blank (~ 2 L sample) was collected at Site 8a (Pershing) 11/08/16. This site has a standard NPDES stormwater monitoring equipment set up. To collect the equipment blank, a large bottle of deionized water was placed at the strainer end of the sampler tubing. The intake line was filled and flushed with deionized water, simulating the presample flush. After the flush was pumped to waste, a sample of deionized water was collected through the equipment. The sample taken was of sufficient volume to allow analysis of all parameters. All analytes came back from the laboratory below the minimum detection limits.

Manual transcription of data was minimized to reduce error introduction. A minimum of 10% of the final data were checked by hand against the raw data sent by the laboratory to ensure there were no errors entering, manipulating, or transferring the data. See **Quality Assurance Assessment Report** for details.

Field measurements were recorded on a Field Measurement Form in the 2016 Field Log Book. Electronic data from the laboratory were forwarded to the MPRB in preformatted spreadsheets via email. Electronic data from the laboratory were checked and passed laboratory quality assurance procedures. Protocols for data validity followed those defined in the Storm Water Monitoring Program Manual (MPRB, 2001). For data reported below the reporting limit, the reporting limit value was divided in half for use in statistical calculations.

A Chain of Custody form accompanied each set of sample bottles delivered to the lab. Each ISCO sampler tray or container was iced and labeled indicating the date and time of collection, the site location, and the field personnel initials. The collection date and time assigned to the sample was the time when the last sample of the composite was collected. The time that each composite sample was collected was recorded from the ISCO sampler onto field sheets. A complete description of methods can be found in the Storm Water Monitoring Program Manual (MPRB, 2001). All statistics were calculated using Microsoft Excel.

Computer Models used (P-8 and Flux)

The computer model P8 (v3.4) was calibrated and verified for each site, each using five different storms ranging from 0.34 inches to 1.20 inches. P8 was used to estimate daily cubic feet per second (cfs) snowmelt runoff from January through May. Daily temperature and hourly precipitation files used as P8 inputs were obtained from the National Oceanic and Atmospheric Administration (NOAA) National Data Center (NDC). Data from a heated rain gauge (for snowmelt water equivalent) was used and is located at the Minneapolis/St. Paul International Airport.

A description of P8 as described in the software's introduction:

> P8 is a model for predicting the generation and transport of stormwater runoff pollutants in small urban catchments. Simulations are driven by hourly rainfall and daily air-temperature time series.

The P8 estimated daily average cfs snowmelt data, the ISCO Flowlink measured daily average cfs runoff data, and the grab and composite water chemistry data were put into Flux32 (v3.10) to calculate flow-weighted mean concentrations.

In Flux32, all of the chemical parameters were run unstratified and, if possible, also run stratified by flow and month. A minimum of three data points are required to group the data for any stratification. Flux32 methods 2 and 6 were recorded for each parameter run (per Bruce Wilson, MPCA). The modeled concentration value with the lowest coefficient of variation was chosen and used for the final event mean concentration.

A description of Flux32 as described in the help menu (US Army Corps, 2009):

> Flux32 is interactive software designed for use in estimating the transport (load) of nutrients or other water quality constituents past a tributary sampling station over a given period of time. The basic approach of Flux32 is to use several calculation techniques to map the flow/concentration relationship developed (modeled) from the sample record onto the entire flow record. This provides an estimate of total mass transport for the whole period of study with associated error statistics. Note that this approach does NOT focus on estimating changes in loads over time (i.e. time series).
>
> An important option within Flux32 is the ability to stratify the data into groups based upon flow, date, and/or season. This is a key feature of the FLUX approach and one of its greatest strengths. In many (most) cases, stratifying the data increases the accuracy and precision of loading estimates.

Results & Discussion

Seasonal statistics (snowmelt, spring, summer, and fall) of the data for all NPDES sites were calculated and are listed in **Table 14-7**. The geometric mean was chosen for comparison purposes because it best handles data with outliers present. Seasonal patterns are evident below.

Snowmelt had the highest geometric mean concentrations for nine of the parameters (TP, TDP, Ortho-P, TKN, Cl, Hardness, TDS, Sp. Cond., and pH). It had the lowest geometric mean for three parameters (TSS, *E. coli*, and Pb). *E. coli* concentrations are temperature dependent and do not survive in cold conditions.

Spring stormwater had the highest geometric mean concentrations for eight parameters (NH_3, TSS, VSS, cBOD, Cu, Pb, and Zn). It had the lowest geometric mean concentrations for three parameters (NO_2NO_3, Ortho-P, and pH).

Summer had the highest geometric mean concentrations for one parameter (NO_2NO_3). It had the lowest geometric mean for four parameters (TP, TDP, VSS and cBOD).

Fall had the lowest geometric mean concentrations for nine parameters (TKN, NH_3, Cl, Hardness, TDS, Sulfate, Sp. Cond., Cu and Zn).

Table 14-7. 2016 statistical summary of concentrations by season from all sites (6 –9).

2016 Season	Statistical Function	TP mg/L	TDP mg/L	Ortho-P mg/L	TKN mg/L	NH_3 mg/L	NO_3NO_2 mg/L	Cl mg/L	Hardness mg/L	TSS mg/L	VSS mg/L	TDS mg/L	cBOD mg/L	Sulfate mg/L	Sp.Cond. µhmos	pH std units	*E. coli* MPN/100mL	Cu ug/L	Pb ug/L	Zn ug/L
SNOWMELT (January-March)	MEAN (geometric)	0.513	0.184	0.374	4.17	1.45	0.395	416	61	46	20	390	16	12	1033	7.6	86	20	6	86
	MEAN (arithmetic)	0.550	0.250	0.426	5.61	2.48	0.527	861	85	70	23	941	22	18	2481	7.7	354	24	10	115
	MAX	0.945	0.531	0.743	19.2	10.8	1.58	2621	230	196	35	3019	61	52	8040	9.6	1300	54	30	200
	MIN	0.330	0.044	0.156	2.06	0.745	0.065	15	14	10	6	28	7	3	73	6.4	1	10	2	10
	MEDIAN	0.484	0.238	0.421	3.33	1.06	0.432	442	52	55	25	386	12	11	1163	7.7	147	24	6	100
	STDEV	0.236	0.178	0.214	6.06	3.69	0.447	943	74	62	12	1179	20	17	3037	1.1	459	15	10	71
	NUMBER	8	8	8	7	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8
	COV	0.428	0.713	0.503	1.08	1.49	0.847	1.10	0.874	0.896	0.496	1.25	0.899	0.952	1.22	0.143	1.30	0.627	1.05	0.618
SPRING (April-May)	MEAN (geometric)	0.145	0.067	0.050	3.54	2.16	0.293	28	40	107	46	105	26	10	140	6.5	3169	33	13	155
	MEAN (arithmetic)	0.174	0.074	0.055	4.57	2.40	0.507	38	46	205	74	142	31	11	191	6.5	6494	39	20	201
	MAX	0.459	0.122	0.072	12.7	3.39	1.26	129	92	615	179	373	52	15	592	6.9	>24200	70	75	380
	MIN	0.057	0.037	0.023	1.26	1.03	0.019	11	16	21	15	46	11	5	48	5.8	461	12	7	37
	MEDIAN	0.144	0.075	0.062	2.54	2.59	0.353	21	42	85	31	69	29	9	135	6.5	4884	27	7	120
	STDEV	0.119	0.033	0.022	3.66	1.14	0.440	37	25	229	69	136	18	4	168	0.4	6978	24	25	138
	NUMBER	10	6	4	10	4	10	9	10	10	10	5	4	5	10	5	3	7	7	7
	COV	0.683	0.449	0.406	0.801	0.477	0.868	0.999	0.550	1.11	0.934	0.952	0.586	0.406	0.879	0.065	1.07	0.611	1.25	0.689
SUMMER (June-August)	MEAN (geometric)	0.141	0.055	0.059	1.23	0.364	0.420	4	30	62	20	57	4	4	87	6.7	7186	19	9	52
	MEAN (arithmetic)	0.190	0.092	0.075	1.85	0.460	0.648	18	35	94	33	72	5	7	132	6.8	9331	21	12	80
	MAX	1.58	0.759	0.273	15.7	2.37	5.65	256	84	460	158	229	17	39	1160	9.3	19863	65	61	430
	MIN	0.039	0.015	0.016	0.250	0.250	0.015	1	10	8	1	18	1	3	24	6.2	2014	5	7	10
	MEDIAN	0.133	0.052	0.058	1.24	0.250	0.518	2	28	53	19	55	4	3	87	6.6	7270	20	7	55
	STDEV	0.232	0.145	0.059	2.46	0.454	0.816	40	19	98	37	54	5	10	173	0.6	6908	11	13	87
	NUMBER	49	27	27	45	26	52	48	51	52	52	26	13	26	52	23	5	34	34	34
	COV	1.22	1.58	0.795	1.33	0.986	1.26	2.23	0.553	1.04	1.10	0.743	0.911	1.41	1.31	0.092	0.740	0.503	1.04	1.10
FALL (Sept-Nov)	MEAN (geometric)	0.249	0.087	0.073	1.08	0.250	0.361	1	19	74	26	29	8	3	58	6.9	NA	19	12	42
	MEAN (arithmetic)	0.271	0.096	0.091	1.16	0.250	0.364	1	19	85	28	29	18	3	61	6.9	NA	19	18	46
	MAX	0.349	0.130	0.163	1.57	0.250	0.420	1	26	119	38	30	45	3	88	7.2	NA	22	39	66
	MIN	0.133	0.044	0.029	0.653	0.250	0.303	1	16	33	14	26	3	3	46	6.4	NA	16	7	25
	MEDIAN	0.331	0.114	0.082	1.25	0.250	0.369	1	16	104	32	30	4	3	48	7.0	NA	18	7	46
	STDEV	0.120	0.046	0.067	0.464	0.000	0.059	0	6	46	12	3	24	0	23	0.4	NA	3	18	21
	NUMBER	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	NA	3	3	3
	COV	0.442	0.476	0.739	0.402	NA	0.161	NA	0.299	0.538	0.441	0.089	1.37	NA	0.383	0.062	NA	0.164	1.046	0.449

(blue) -highest concentration

(orange) -lowest concentration

NA=not available

STDEV= standard deviation, COV= coefficient of variation, Blue highlighted cells have the highest seasonal geometric mean, Orange cells have the lowest seasonal geometric means.

Table 14-8 shows the 2016 chemistry data for the sampled storms These data generally show peaks during snowmelt and early spring for many parameters, but at some sites there are additional peaks that occurred in late fall. Stormwater concentrations can be extremely variable because there are multiple factors affecting the concentrations like the amount or intensity of precipitation, BMP presence and maintenance.

The underlined data in **Table 14-8** are data that failed a blind laboratory monthly performance standard for that parameter. Internal QAQC procedures flag the data for an entire month for any parameter, if the blind standard fails ± 20% recovery.

Table 14-8. 2016 NDPES sampled event data by site.

Date Sampled	Time	Site Location	Sample Type	TP mg/L	TDP mg/L	OPO4 mg/L	TKN mg/L	NH3 mg/L	NO3NO2 mg/L	Cl mg/L	Hardness mg/L	TSS mg/L	VSS mg/L	TDS mg/L	cBOD mg/L	Sulfate mg/L	Sp.Cond. uhmos	pH std units	E. Coli MPN	Cu ug/L	Pb ug/L	Zn ug/L
2/18/2016	14:45	Site 6, 22nd & Aldrich	Grab	0.886	0.248	0.706	Deleted	Deleted	0.065	2621	160	64	35	3019	44	37	8040	8.0	8	54	19	190
2/19/2016	13:30	Site 6, 22nd & Aldrich	Grab	0.945	0.531	0.743	19.2	10.8	0.357	393	100	79	34	376	21	12	1118	7.9	727	30	30	200
4/21/2016	9:20	Site 6, 22nd & Aldrich	Grab																461			
5/25/2016	10:47	Site 6, 22nd & Aldrich	Comp	0.459	0.073	0.056	12.7	3.29	0.019	21	56	292	141	69	52	9	158	5.8		58	75	290
5/26/2016	4:16	Site 6, 22nd & Aldrich	Comp	0.203	0.122		2.60		0.852	17	28	21	16				73					
6/3/2016	13:59	Site 6, 22nd & Aldrich	Comp	0.162			6.18		<0.030	8	48	298	130				84					
6/9/2016	7:26	Site 6, 22nd & Aldrich	Comp	0.147	0.055	0.093	1.75	<0.500	0.497	18	20	101	35	94	7	<5	49	6.6		22	61	95
6/14/2016	13:10	Site 6, 22nd & Aldrich	Grab																12033			
6/14/2016	20:04	Site 6, 22nd & Aldrich	Comp	0.081	0.068	0.045	0.779	0.679	1.38	<2	24	60	54	19	3	<5	30			13	16	38
7/5/2016	19:56	Site 6, 22nd & Aldrich	Comp	0.173	0.166	0.052	2.17	<0.500	0.487	<2	24	87	14	36	5	5	62	6.8		20	52	87
7/10/2016	7:10	Site 6, 22nd & Aldrich	Comp	0.139	0.062	0.031	1.25	0.632	0.522	12	36	37	8	96		<5	109	6.3		27	<15	40
7/15/2016	2:10	Site 6, 22nd & Aldrich	Comp	0.052			0.913		0.639	<2	20	30	8				54					
7/17/2016	3:26	Site 6, 22nd & Aldrich	Comp	0.124			1.24		0.608	<2	24	48	18				66			28	<15	50
7/21/2016	5:08	Site 6, 22nd & Aldrich	Comp	0.307			3.56		0.064	<2	56	66	28				125					
7/23/2016	17:01	Site 6, 22nd & Aldrich	Comp	0.077			0.944		0.296	<2	12	51	17				41			23	24	44
8/4/2016	8:50	Site 6, 22nd & Aldrich	Grab																>24200			
8/19/2016	5:13	Site 6, 22nd & Aldrich	Comp	0.133	0.039	0.081	1.16	<0.500	0.317	<2	14	35	15	56		<5	36	6.2		17	22	44
8/23/2016	5:13	Site 6, 22nd & Aldrich	Comp	0.117	0.047	0.059	0.645	<0.500	0.052	<2	14	42	16	29		<5	24	6.6		18	28	33
9/21/2016	21:26	Site 6, 22nd & Aldrich	Comp	0.349	0.130	0.163	1.57	<0.500	0.369	<2	16	104	32	26	3	<5	46	7.2		16	39	46
2/19/2016	13:20	Site 7, 14th & Park	Grab	0.467	0.228	0.422	3.33	1.30	0.417	442	30	45	19	371	13	9	968	7.5	1300	<20	6.0	120
2/23/2016	14:00	Site 7, 14th & Park	Grab	0.501	0.372	0.421	2.89	1.06	0.493	442	44	33	18	396	10	14	1207	6.8	457	22	5.5	77
4/21/2016	9:35	Site 7, 14th & Park	Grab																4884			
5/13/2016	9:56	Site 7, 14th & Park	Comp	0.057			1.26		0.261	11	28	50	20				85			21	<15	111
5/16/2016	7:55	Site 7, 14th & Park	Comp	0.151			6.64		0.617	34	92	615	179				277					
5/25/2016	11:52	Site 7, 14th & Park	Comp	0.224	0.076	0.068	8.29	3.39	0.061	30	52	245	119	68	37	15	200	6.5		70	15	360
5/26/2016	4:14	Site 7, 14th & Park	Comp	0.104	0.037	0.023	2.37	1.03	1.12	21	40	51	27	156	11	9	111	6.7		27	<15	110
6/2/2016	10:11	Site 7, 14th & Park	Comp	0.026					0.061	41	88	835	244				327					
6/3/2016	15:41	Site 7, 14th & Park	Comp	0.135			5.32		0.518	18	68	460	158				169					
6/9/2016	6:33	Site 7, 14th & Park	Comp	0.089			1.93		0.791	97	60	88	34				460					
6/10/2016	15:09	Site 7, 14th & Park	Comp						0.469		56	46	33				174					
6/12/2016	3:01	Site 7, 14th & Park	Comp						0.687		64	100	55				174					
6/13/2016	5:05	Site 7, 14th & Park	Comp						2.480	23	56	80	33				123					
6/14/2016	13:00	Site 7, 14th & Park	Grab																5475			
6/14/2016	17:21	Site 7, 14th & Park	Comp	0.099	0.017	0.054			0.305	<2	32	21	7				112					
6/30/2016	12:18	Site 7, 14th & Park	Comp	0.558	0.170	0.058	4.10	<0.500	5.65	9	56	217	50	128	11	13	161	7.0		65	29	430
7/5/2016	19:00	Site 7, 14th & Park	Comp	0.408	0.112	0.075	1.46	<0.500	1.28	<2	20	31	4	36	<1.00	<5	51	6.9		17	<15	49
7/10/2016	7:53	Site 7, 14th & Park	Comp	0.105	0.046	0.024	0.902	0.504	0.817	2	20	25	10	53		6	69	6.6		19	<15	95
7/12/2016	1:56	Site 7, 14th & Park	Comp	0.066			1.67		0.847			52	24				109					
7/16/2016	13:57	Site 7, 14th & Park	Comp	0.074			0.706		0.848	4	36	24	8				90			22	<15	74
7/21/2016	5:25	Site 7, 14th & Park	Comp	0.306			2.76		0.532	<2	36	106	42				127					
7/23/2016	15:44	Site 7, 14th & Park	Comp	0.100			0.792		0.386	<2	16	55	17				52			24	<15	79
8/4/2016	8:30	Site 7, 14th & Park	Grab																7270			
8/19/2016	5:44	Site 7, 14th & Park	Comp	0.069	0.015	0.055	0.889	<0.500	0.395	<2	12	21	9	47		<5	40	6.3		16	<15	43
8/23/2016	5:44	Site 7, 14th & Park	Comp	0.070	0.023	0.029	<0.500	<0.500	0.043	<2	10	22	9	21		<5	24	6.8		12	<15	27
9/15/2016	19:37	Site 7, 14th & Park	Comp	0.133	0.044	0.029	0.653	<0.500	0.303	<2	16	33	14	30	45	<5	48	6.4		22	<15	66

Table 14-8. 2016 NDPES sampled event data by site. (Continued)

Date Sampled	Time	Site Location	Sample Type	TP mg/L	TDP mg/L	OPO4 mg/L	TKN mg/L	NH3 mg/L	NO3NO2 mg/L	Cl mg/L	Hardness mg/L	TSS mg/L	VSS mg/L	TDS mg/L	cBOD mg/L	Sulfate mg/L	Sp.Cond. uhmos	pH std units	E. Coli MPN	Cu ug/L	Pb ug/L	Zn ug/L
2/19/2016	12:40	Site 8, Pershing	Grab	0.361	0.072	0.156	4.84	0.939	0.530	199	14	10	6	28	9	<5	73	6.4	99	<20.0	8.2	79
2/23/2016	13:30	Site 8, Pershing	Grab	0.523	0.419	0.363	3.99	1.74	0.336	15	48	13	10	66	11	8	145	6.7	195	<20.0	<3	<20.0
5/13/2016	8:37	Site 8, Pershing	Comp	0.080			2.35		0.209	15	20	49	20				48					
5/26/2016	3:43	Site 8, Pershing	Comp	0.136	0.038		2.47		1.26		16	23	15	46		5	56	6.5		12	<15	37
6/3/2016	13:52	Site 8, Pershing	Comp	0.130					0.696		40	370	145				67					
6/9/2016	7:39	Site 8, Pershing	Comp	0.170	0.079	0.072	0.824	<0.500	0.543	<2	32	43	16	40	6	<5	52	6.3		24	<15	34
6/13/2016	6:47	Site 8, Pershing	Comp	0.083	0.057	0.032	0.721	<0.500	0.443	8	28	32	12	18	<1.00	<5	25	6.2		12	<15	<20.0
6/14/2016	20:23	Site 8, Pershing	Comp	0.059	0.053	0.028	0.538	0.513	0.595	<2	24	26	<2	38	<1.00	<5	24			<10.00	<15	<20.0
7/5/2016	21:29	Site 8, Pershing	Comp	0.440	0.273	0.208	2.63	<0.500	0.956	<2	40	164	133	57	5	19	100	6.9		24	<15	61
7/10/2016	7:14	Site 8, Pershing	Comp	0.138	0.112	0.074	2.47	0.620	0.574	2	16	24	11	36		<5	53	6.6		17	<15	27
7/15/2016	2:00	Site 8, Pershing	Comp	0.136			0.667		0.048	<2	20	51	19				30			12	<15	24
7/17/2016	3:30	Site 8, Pershing	Comp	0.127			<0.500		0.803	<2	24	8	3				33					
7/21/2016	5:39	Site 8, Pershing	Comp	0.216			NES		0.747	6	24	319	75				67					
7/23/2016	16:23	Site 8, Pershing	Comp	0.206			0.922		0.372	<2	18	39	7				43			14	<15	<20.0
7/24/2016	3:08	Site 8, Pershing	Comp	0.174			NES		0.660	<2	18	27	13				34			<10.00	<15	<20.0
8/19/2016	4:46	Site 8, Pershing	Comp	0.186	0.068	0.116	1.09	0.603	0.588	<2	14	11	7	39		<5	32	6.5		NES	NES	NES
8/24/2016	4:46	Site 8, Pershing	Comp	0.275	0.022	0.273	0.823	<0.500	0.133	<2	24	31	10	41		<5	61	6.8		16	<15	<20.0
9/21/2016	21:58	Site 8, Pershing	Comp	0.331	0.114	0.082	1.25	<0.500	0.420	<2	26	119	38	30	4	<5	88	7.0		18	<15	25
2/18/2016	14:25	Site 9, 61st & Lyndale	Grab	0.390	0.044	0.172	2.97	0.756	1.58	2040	230	196	34	2612	61	52	6500	9.6	1	25	<3	57
2/19/2016	13:00	Site 9, 61st & Lyndale	Grab	0.330	0.089	0.421	2.06	0.745	0.446	732	56	117	31	661	7	10	1800	8.7	44	29	4	190
4/21/2016	10:05	Site 9, 61st & Lyndale	Grab																14136			
5/13/2016	11:38	Site 9, 61st & Lyndale	Comp	0.083			1.88		0.226	62	44	118	35				309			22	<15	120
5/26/2016	5:05	Site 9, 61st & Lyndale	Comp	0.247	0.097	0.072	5.16	1.88	0.445	129	80	590	171	373	22	15	592	6.9		64	22	380
6/3/2016	16:45	Site 9, 61st & Lyndale	Comp	0.150			15.7		0.316	256	60	201	53				1160			36	<15	170
6/9/2016	8:01	Site 9, 61st & Lyndale	Comp	0.153	0.044	0.083	1.67	<0.500	0.518	60	84	251	59	229	17	39	385	9.3		31	<15	170
6/13/2016	6:42	Site 9, 61st & Lyndale	Comp	0.060	0.018	0.051	1.39	<0.500	0.195	41	40	181	58	72	3	6	139	6.6		25	<15	120
6/14/2016	12:35	Site 9, 61st & Lyndale	Grab																19863			
6/14/2016	13:11	Site 9, 61st & Lyndale	Comp	0.039	0.036	0.016	1.41	1.24	0.421	3	52	206	34	64	4	<5	95			29	<15	140
7/6/2016	0:27	Site 9, 61st & Lyndale	Comp	0.103	0.052	0.039	1.41	<0.500	1.13	24	32	97	48	104	3	6	166	7.1		33	<15	91
7/10/2016	8:04	Site 9, 61st & Lyndale	Comp	0.156	0.044	0.020	1.95	<0.500	0.452	26	28	67	13	104		7	176	6.8		19	<15	75
7/12/2016	2:08	Site 9, 61st & Lyndale	Comp	1.58	0.759	0.110	1.59	2.370	0.782	40	84	122	29	189		38	316	6.6		33	<15	320
7/15/2016	4:57	Site 9, 61st & Lyndale	Comp	0.127			<0.500		0.270	27	52	31	4				208			16	<15	34
7/17/2016	4:03	Site 9, 61st & Lyndale	Comp	0.086			<0.500		0.539	22	32	51	12				150			20	<15	60
7/21/2016	6:46	Site 9, 61st & Lyndale	Comp	0.492			2.75		0.275	34	68	69	69				266					
7/23/2016	16:16	Site 9, 61st & Lyndale	Comp	0.132			0.663		0.278	14	26	132	24				119			20	<15	78
8/4/2016	8:15	Site 9, 61st & Lyndale	Grab																2014			
8/19/2016	6:00	Site 9, 61st & Lyndale	Comp	0.179	0.015	0.174	1.29	0.551	0.336	59	34	67	22	157		7	268	6.6		23	<15	87
8/24/2016	6:00	Site 9, 61st & Lyndale	Comp	0.126	0.027	0.067	0.512	<0.500	0.087	31	20	76	19	78		<5	162	6.9		14	<15	60

Median Comparison

Table 14-9 shows a comparison of MPRB and Nationwide Urban Runoff Program (NURP) median residential, mixed use, and composite land use stormwater values. The MPRB data are split into 2016 and 2001-2015 data for comparison.

In 2016, almost all of the three MPRB land use categories saw a significant decrease or similar values in the median concentrations of all parameters when compared to the NURP data, with the exception of some TP and TKN (mixed and composite categories). It is unknown why some of the MPRB TP and TKN (mixed and composite) median data are higher than the NURP data. A possible explanation is there is more decaying vegetative material (e.g. leaf litter) in the Minneapolis watersheds than in the NURP watersheds that were studied from 1979 to 1983.

When the NURP study data were collected, lead (Pb) was widely used in gasoline (from the 1920s to 1990s). The significant lead reduction in the environment is clearly seen in the MPRB data sets since it was collected after lead in gas was banned in 1996.

It is important to note that the MPRB sites monitored in 2001-2004 are located in different watersheds and have similar but not identical land uses to those monitored in 2005-2016.

Table 14-9. Typical Median stormwater sampled concentrations.

Land Use	Residential			Mixed			Composite of all categories		
Location	MPRB[1]	MPRB[2]	NURP	MPRB[3]	MPRB[4]	NURP	MPRB[5]	MPRB[6]	NURP
Year(s)	2016	2001–2015		2016	2001–2015		2016	2001–2015	
TP (mg/L)	0.155	0.396	0.383	0.105	0.2305	0.263	0.139	0.334	0.330
TKN (mg/L)	1.57	2.50	1.9	1.80	1.55	1.29	1.57	2.04	1.5
NO_3NO_2 (mg/L)	0.369	0.358	0.736	0.518	0.423	0.558	0.461	0.423	0.68
cBOD (mg/L)	7	11	10	11	9	8	8	9	9
TSS (mg/L)	62	83	101	51	58	67	57	81	100
Cu (µg/L)	23	18	33	22	16	27	22	17	30
Pb (µg/L)	26	30	144	7	11	114	8	13	140
Zn (µg/L)	48	77	135	87	80	154	70	78	160

[1] Site 6 data.
[2] Sites 1 and 2 data, (Site 6, 2005-2015).
[3] Site 7 data.
[4] Sites 5 and 5a data, (Site 7, 2005-2015).
[5] Sites 6 – 9 data.
[6] Sites 1 – 5a data, (Site 6 – 9, 2005-2015).
NURP = median event mean concentrations as reported by the Nationwide Urban Runoff Program (USEPA, 1996).
MPRB = median values calculated by the Minneapolis Park and Recreation Board for the identified year(s).

Geometric Mean Comparison

Table 14-10 lists the statistical calculations for all measured parameters for each site. Nine of the geometric mean maximums occurred at Site 9 (61st and Lyndale) the industrial site. Thirteen of the lowest geometric mean values overwhelmingly occur at Site 8 (Pershing). This is as expected since Site 8 (Pershing) is parkland. Site 6 (22nd & Aldrich) and Site 7 (14th & Park) had two of the lowest geometric mean values each. Site 6 (22nd & Aldrich) and Site 7 (14th & Park) is a residential and mixed use watershed respectively. Site 7 (14th & Park) as a mixed use watershed has little vegetation.

Table 14-10. 2016 site concentration statistics.

Site ID	Statistical Function	TP mg/L	TDP mg/L	Ortho-P mg/L	TKN mg/L	NH_3 mg/L	NO_3NO_2 mg/L	Cl mg/L	Hardness mg/L	TSS mg/L	VSS mg/L	TDS mg/L	cBOD mg/L	Sulfate mg/L	Sp.Cond. µhmos	pH std units	E. coli MPN/100mL	Cu ug/L	Pb ug/L	Zn ug/L
6, 22nd Aldrich	MEAN (geometric)	0.190	0.101	0.104	2.09	0.627	0.225	5	30	66	26	85	10	4.66	97	6.8	952	24	28	75
6, 22nd Aldrich	MEAN (arithmetic)	0.272	0.140	0.203	3.78	1.850	0.409	194	41	88	38	382	19	7.78	632	6.8	7486	27	34	101
6, 22nd Aldrich	MAX	0.945	0.531	0.743	19.2	10.80	1.38	2621	160	298	141	3019	52	37.1	8040	8.0	24200	58	75	290
6, 22nd Aldrich	MIN	0.052	0.039	0.031	0.65	0.250	0.015	1	12	21	8	19	3	2.50	24	5.8	8	13	7	33
6, 22nd Aldrich	MEDIAN	0.155	0.073	0.070	1.57	0.250	0.363	1	24	62	23	62	7	2.50	64	6.6	727	22	28	46
6, 22nd Aldrich	STDEV	0.273	0.144	0.277	5.28	3.497	0.361	654	39	84	40	933	21	10.8	1993	0.7	10618	15	21	87
6, 22nd Aldrich	NUMBER	16	11	10	15	9	16	16	16	16	16	10	7	10	16	9	5	11	11	11
6, 22nd Aldrich	COV	1.00	1.03	1.37	1.40	1.89	0.884	3.380	0.961	0.953	1.07	2.44	1.09	1.39	3.15	0.109	1.42	0.558	0.614	0.863
7, 14th Park	MEAN (geometric)	0.134	0.062	0.064	1.78	0.546	0.486	9	36	70	27	80	12	5.81	136	6.7	2585	23	8	94
7, 14th Park	MEAN (arithmetic)	0.187	0.104	0.114	2.57	0.853	0.843	59	42	141	49	131	18	7.45	224	6.7	3877	27	9	131
7, 14th Park	MAX	0.558	0.372	0.422	8.29	3.39	5.65	442	92	835	244	396	45	14.7	1207	7.5	7270	70	29	430
7, 14th Park	MIN	0.026	0.015	0.023	0.250	0.250	0.043	1	10	21	4	21	1	2.50	24	6.3	457	10	6	27
7, 14th Park	MEDIAN	0.105	0.046	0.055	1.80	0.377	0.518	10	38	51	24	61	11	7.13	123	6.7	4884	22	7	87
7, 14th Park	STDEV	0.166	0.112	0.153	2.24	0.980	1.17	133	23	212	64	140	16	5.04	293	0.3	2890	20	7	128
7, 14th Park	NUMBER	20	11	11	18	10	23	20	22	23	23	10	7	10	23	10	5	12	12	12
7, 14th Park	COV	0.886	1.08	1.34	0.873	1.15	1.39	2.25	0.55	1.50	1.29	1.07	0.88	0.677	1.31	0.051	0.745	0.720	0.717	0.978
8, Pershing	MEAN (geometric)	0.178	0.084	0.104	1.28	0.445	0.451	3	23	39	14	38	4	3.59	51	6.6	139	12	6	20
8, Pershing	MEAN (arithmetic)	0.210	0.119	0.140	1.72	0.567	0.551	16	25	75	30	40	5	4.79	57	6.6	147	14	7	27
8, Pershing	MAX	0.523	0.419	0.363	4.84	1.740	1.26	199	48	370	145	66	11	19.2	145	7.0	195	24	8	79
8, Pershing	MIN	0.059	0.022	0.028	0.250	0.250	0.048	1	14	8	1	18	1	2.50	24	6.2	99	5	2	10
8, Pershing	MEDIAN	0.172	0.072	0.099	1.09	0.382	0.559	1	24	31	13	39	5	2.50	52	6.6	147	12	7	24
8, Pershing	STDEV	0.129	0.120	0.110	1.36	0.474	0.293	49	10	106	43	13	4	5.11	31	0.3	68	6	2	22
8, Pershing	NUMBER	18	11	10	15	10	18	16	18	18	18	11	7	11	18	10	2	13	13	13
8, Pershing	COV	0.614	1.01	0.785	0.788	0.837	0.532	3.07	0.391	1.40	1.43	0.331	0.701	1.07	0.534	0.041	0.462	0.437	0.238	0.820
9, 61st Lyndale	MEAN (geometric)	0.166	0.052	0.074	1.50	0.559	0.392	54	50	118	31	197	9	10.2	325	7.4	478	26	7	110
9, 61st Lyndale	MEAN (arithmetic)	0.261	0.111	0.111	2.52	0.799	0.488	212	60	151	42	422	17	16.8	754	7.5	7212	27	7	135
9, 61st Lyndale	MAX	1.58	0.759	0.421	15.7	2.37	1.58	2040	230	590	171	2612	61	51.5	6500	9.6	19863	64	22	380
9, 61st Lyndale	MIN	0.039	0.015	0.016	0.250	0.250	0.087	3	20	31	4	64	3	2.50	95	6.6	1	14	2	34
9, 61st Lyndale	MEDIAN	0.150	0.044	0.072	1.59	0.551	0.421	40	52	118	34	157	7	6.77	266	6.9	2014	25	7	106
9, 61st Lyndale	STDEV	0.361	0.216	0.116	3.59	0.735	0.371	502	48	130	38	748	21	17.5	1545	1.2	9198	12	4	96
9, 61st Lyndale	NUMBER	17	11	11	17	11	17	17	17	17	17	11	7	11	17	10	5	16	16	16
9, 61st Lyndale	COV	1.38	1.94	1.04	1.42	0.920	0.760	2.37	0.804	0.856	0.898	1.77	1.26	1.04	2.05	0.159	1.28	0.425	0.560	0.715
All	MEAN (geometric)	0.164	0.072	0.084	1.64	0.539	0.385	9	33	67	24	84	8	5.62	121	6.9	831	21	9	64
All	MEAN (arithmetic)	0.230	0.118	0.141	2.64	0.991	0.596	118	42	116	40	243	15	9.28	393	6.9	5480	24	13	99
All	MAX	1.58	0.759	0.743	19.2	10.8	5.65	2621	230	835	244	3019	61	51.5	8040	9.6	24200	70	75	430
All	MIN	0.026	0.015	0.016	0.250	0.250	0.015	1	10	8	1	18	1	2.50	24	5.8	1	5	2	10
All	MEDIAN	0.139	0.065	0.072	1.57	0.377	0.461	11	32	57	21	65	8	5.26	104	6.7	1300	21	7	71
All	STDEV	0.242	0.149	0.173	3.40	1.78	0.719	408	34	150	48	599	17	11.6	1202	0.8	7614	14	15	99
All	NUMBER	71	44	42	65	40	74	69	73	74	74	42	28	42	74	39	17	52	52	52
All	COV	1.05	1.26	1.23	1.29	1.79	1.21	3.46	0.819	1.29	1.20	2.47	1.14	1.25	3.06	0.115	1.39	0.607	1.11	0.995

-Highest value

-Lowest value

All = all 4 sites, STDEV = standard deviation, COV = coefficient of variation.

Site 6 (22nd & Aldrich) is an older residential watershed. It had the highest geometric means for TP, TDP, Ortho-P, TKN, NH3, *E. coli*, and Pb. The cause of the higher TP and TDP values may be either pet waste or dense leaf canopy in the watershed adding to the organic load. The higher Pb is likely the result of vehicular wear inputs (e.g. brake dust, tire weights) or legacy exterior lead paint. The geometric mean concentration of Pb has been persistently high at this site compared to the other monitored sites, and is possibly a remnant of lead based paints shedding from the older houses and into the soils. The low NO_2NO_3 and Hardness values are likely due to organic nitrogen present (leaves, grass) decomposing and possibly low mineral soils in the watershed.

Site 7 (14th & Park) is a dense mixed use watershed. It had the highest geometric mean concentrations for NO_2NO_3 and cBOD. It is unknown why these parameters were high in this watershed. Site 7 also had the lowest geometric mean for TP and Ortho-P. This is likely the result of the hard surface landscape, with minimal vegetation, in this mixed use watershed.

Site 8 (Pershing) is a Minneapolis park. It had none of the highest geometric means. Site 8 had the lowest geometric means for most parameters: TKN, Cl, TSS, VSS, TDS, cBOD, Sulfate, Sp. Cond., pH, Cu, Pb, and Zn. This is likely due to the park's less developed vegetated parkland grass covered watershed, not including *E. coli*. The *E. coli* sample was collected during snowmelt and not used for analysis since it was the only sample collected at the site.

Site 9 (61st and Lyndale) is a commercial/industrial watershed. It had the highest geometric mean for nine parameters: Cl, Hardness, TSS, VSS, TDS, Sp. Cond., pH, Cu, and Zn. Site 9 had the lowest geometric mean values for one parameter, TDP. This watershed is a light industrial site (cement factory, natural gas facility, City maintenance facility, etc.) and it is expected that many of the parameters would be higher than other watersheds due to extensive industrial activities.

Mean Comparison

Mean data were comparable to typical urban stormwater data from the Nationwide Urban Runoff Program (NURP), Center for Watershed Protection (CWP), and Bannerman *et al.* (1993) are in **Table 14-11**.

Data from MPRB Sites 1–5a (2001–2004) and 6–9 (2005–2015) were partially similar to Sites 6–9 in 2016. TP, Cl, TDS, and Pb were lower in 2016. The 2016 mean decreases in Cl and TDS are likely related to taking snowmelt samples later in the melt season. The reporting limit (RL) for metal analyses changed after May 1. The Cu RL increased from <5µg/L to <20µg/L and Pb from <3µg/L to <15µg/L. The reporting limit change for Cu does not appear to have had any effect on the mean data. The reporting limit change for Pb samples does not appear to have had the expected effect of increasing the mean concentration. The 2016 Pb mean compared to the 2001-2015 mean Pb decreased significantly. The exact cause for this Pb decrease is unknown.

Table 14-11. Typical Mean urban stormwater concentrations. " -- " = not reported.

Parameter	NURP[1]	CWP[2]	Bannerman *et al.*[3]	Mpls PW[4]	St. Paul[5]	MPRB[6] 2001–2015	MPRB[7] 2016
TP (mg/L)	0.5	0.3	0.66	0.417	0.484	0.462	0.230
TDP (mg/L)	--	--	0.27	0.251	--	0.146	0.118
TKN (mg/L)	2.3	--	--	--	2.46	2.74	2.64
NO_3NO_2 (mg/L)	0.86	--	--	--	0.362	0.582	0.596
NH_3 (mg/L)	--	--	--	0.234	--	0.582	0.596
Cl (mg/L)	--	230 (winter)	--	--	--	299	118
BOD (mg/L)	12	--	--	14.9	25	16	15
TDS (mg/L)	--	--	--	73.3	78	565	243
TSS (mg/L)	239	80	262	77.6	129	121	116
Cu (µg/L)	50	10	16	26.7	30	23.6	23.9
Pb (µg/L)	240	18	32	75.5	233	23.2	13.6
Zn (µg/L)	350	140	204	148	194	116	98

[1] USEPA (1996)
[2] Center for Watershed Protection (2000)
[3] Monroe study area of Bannerman *et al.* (1993)
[4] City of Minneapolis Public Works Department (1992) – average from a combination of land uses
[5] City of St. Paul 1994 stormwater data – average from a combination of land uses
[6] MPRB arithmetic mean data calculated from NPDES Sites 1 – 5a (2001 – 2004), 6 – 9 (2005 – 2015)
[7] MPRB arithmetic mean data calculated from NPDES Sites 6 – 9 (2016)

Flow-Weighted Mean Comparison

The flow-weighted mean concentrations presented in **Table 14-12** were calculated using FLUX32. Sample chemistry concentrations and associated daily average flows were used as inputs for these calculations. The data were run unstratified and also often run stratified by flow or season to achieve the lowest coefficient of variation, producing the most accurate and precise results. The method (2 or 6) and event mean concentration with the lowest coefficient of variation was generally chosen as the final concentration value. The “rule of sensibility” was used if the value with the lowest coefficient of variation was an extreme outlier, then the next value was chosen.

Table 14-12. 2016 flow–weighted mean concentrations and related statistics.

Site	TP (mg/L)	TDP (mg/L)	Ortho-P (mg/L)	TKN (mg/L)	NH_3 (mg/L)	NO_3NO_2 (mg/L)	Cl* (mg/L)	Hardness (mg/L)	TSS (mg/L)	VSS (mg/L)	TDS* (mg/L)	cBOD (mg/L)	Sulfate (mg/L)	Cu (µg/L)	Pb (µg/L)	Zn (µg/L)
6, 22nd Aldrich	0.179	0.086	0.069	2.50	0.613	0.341	6	30	86	39	52	8	3.0	0.021	0.035	0.070
7, 14th Park	0.168	0.051	0.050	1.37	0.344	0.285	12	23	60	24	49	8	5.0	0.003	0.006	0.065
8a, Pershing	0.225	0.109	0.092	1.00	0.326	0.208	2	24	54	27	39	4	3.0	0.003	0.004	0.014
9, 61st Lyndale	0.614	0.106	0.163	2.00	0.438	0.326	28	51	161	39	108	6	12.0	0.008	0.008	0.084
MEAN	**0.297**	**0.088**	**0.093**	**1.72**	**0.430**	**0.290**	**12**	**32**	**90**	**32**	**62**	**7**	**5.8**	**0.009**	**0.013**	**0.058**
MEDIAN	**0.202**	**0.096**	**0.080**	**1.69**	**0.391**	**0.306**	**9**	**27**	**73**	**33**	**51**	**7**	**4.0**	**0.006**	**0.007**	**0.068**
STANDEV	**0.213**	**0.027**	**0.050**	**0.665**	**0.131**	**0.060**	**11**	**13**	**49**	**8**	**31**	**2**	**4.3**	**0.009**	**0.015**	**0.031**

-Highest value

-Lowest value

* Flow–weighted mean concentrations for Cl and TDS were difficult to estimate using FLUX32 due to large outliers from the two snowmelt samples; these estimates should be used with caution. STANDEV= standard deviation.

Site 6 (22nd & Aldrich) has a multi-family residential watershed. Site 6 had the highest modeled concentrations of TKN, NH_3, NO_3NO_2, VSS, Cu, and Pb. It is hypothesized that this may be due to its location between two heavily traveled thoroughfares (Hennepin and Lyndale) where a mature dense leaf canopy may collect airborne material and deposit it following precipitation. The decaying leaf litter may be the cause of the increased nitrogen.

Site 7 (14th & Park) has a densely developed mixed-use watershed. Site 7 had the highest cBOD modeled parameter. Site 7 had the lowest modeled TP, Ortho-P, Hardness, and VSS. These are all likely due to the dense, highly developed, and low vegetation nature of the watershed.

Site 8a (Pershing) has a parkland watershed. Site 8a had the highest TDP modeled event mean concentrations. Site 8a had the lowest modeled TKN, NH_3, NO_3NO_2, Cl, TSS, TDS, cBOD, Sulfate, Cu, Pb, and Zn. This is likely due to the more natural vegetative state of the watershed and an absence of street runoff.

Site 9 (61st and Lyndale) has a commercial/industrial watershed. Site 9 had the highest modeled concentration of TP, Ortho-P, Cl, Hardness, TSS, VSS, TDS, Sulfate, and Zn. Site 9 had none of the lowest modeled event mean concentrations. Industrial activities in this watershed likely explain the higher pollutant loads. Site 9 is located adjacent to a large cement aggregate mixing facility which may explain the higher TSS values. This site sometimes had a very small baseflow. In 2008, the baseflow diminished after the cement aggregate mixing facility improved its on-site runoff via ponding.

Table 14-13 includes flow-weighted mean pollutant concentrations of data collected in the 1980s and reported by the U.S. Geological Survey (USGS) for various sites within the Twin Cities (as cited in MPCA, 2000). The Yates watershed was a stabilized residential area, the Iverson site was a residential watershed under development, and the Sandberg watershed was predominantly a light industrial land- use area, as reported by the USGS. Site 6 (22nd & Aldrich) is more closely related to the Yates residential watershed land-use characteristics and is shaded blue in the table. Site 7 (14th & Park) and Site 9 (61st and Lyndale) are more comparable to the Sandberg light industrial watershed land-use characteristics and is shaded orange in the table.

Table 14-13. 2016 Flow-weighted mean stormwater pollutant concentrations (mg/L) and ranges as reported by the USGS (as cited in MPCA, 2000).

Pollutant	Monitoring Site					
	Yates area (stabilized residential)	Site 6 (22nd Aldrich)	Iverson area (developing residential)	Sandburg area (light industrial)	Site 7 (14th Park)	Site 9 (61st Lyndale)
TSS (Mean Range)	133 (2 – 758)	86 (21 – 289)	740 (17- 26,610)	337 (7 – 4,388)	60 (21 – 396)	161 (31 – 590)
Pb (Mean Range)	0.23 (0.015 –1.8)	0.035 (0.007 -0.075)	0.02 (0.008-0.31)	0.19 (0.003 –1.5)	0.006 (0.006 – 0.029)	0.008 (0.002 – 0.035)
Zn (Mean Range)	0.198 (0.02 – 2.2)	0.070 (0.033 -0.290)	0.235 (0.028-0.53)	0.185 (0.02 –0.81)	0.065 (0.027 – 0.430)	0.086 (0.002 – 0.022)
TKN (Mean Range)	3.6 (0.6 – 28.6)	2.50 (0.65 – 19.2)	1.2 (1.0 – 29.2)	2.5 (0.4 – 16.0)	1.37 (0.250 – 8.298)	2.00 (0.250 – 15.7)
TP (Mean Range)	0.63 (0.10 –3.85)	0.179 (0.052 – 0.945)	0.62 (0.2 – 13.1)	0.63 (0.07 – 4.3)	0.168 (0.026 – 0.558)	0.614 (0.039 – 1.58)

When comparing the USGS flow-weighted mean concentrations to the MPRB sites in **Table 14-13**, Site 6 (22nd & Aldrich) was significantly lower than Yates for all parameters. The Iverson data are shown only for comparison purposes of a developing residential neighborhood.

Compared to Sandberg, Sites 7 and 9 have lower flow-weighted mean concentrations for all parameters and are well within the ranges shown in **Table 14-13**. Site 7 (14th & Park) had significantly lower values than Sandberg for all parameters. Site 9 (61st and Lyndale) had roughly half of the Sandberg values with the notable exception of TP. The Site 9 TKN values were slightly lower than Sandberg's TKN but were comparable.

The overall mean comparison of **Table 14-13** to MPRB water quality values at sites 6, 7, and 9 show that the Minneapolis sites were the same or roughly half of the values for the compared parameters. The Minneapolis mean Pb values are much lower than the Yates and Sandburg studies.

Table 14-14 shows the flow-weighted mean concentrations in 2016 compared to previous years. Flow-weighted mean concentrations for Cl and TDS were difficult to estimate using FLUX32 due to large outliers from the snowmelt samples; therefore, these estimates should be used with caution. When samples were below the RL (reporting limit), half of the RL was used for calculations.

There may be a slight increasing effect on flow-weighted means for Cu and Pb, as Legend Lab increased their reporting limits for both of these parameters. The 2016 Cu reported values increased after May 1 from <5µg/L to <20µg/L and Pb from <3µg/L to <15µg/L.

Table 14-14. MPRB flow-weighted mean concentration compared to previous years. Each year is the average flow-weighted mean concentration of all sites monitored that year.

	Flow-weighted mean concentrations															
	Sites 1-5a				Site 6-9											
Parameter	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
TP (mg/L)	0.470	0.337	0.474	0.332	0.354	0.548	0.472	0.486	0.583	0.341	0.355	0.368	0.369	0.313	0.337	0.297
TDP (mg/L)	0.112	0.095	0.114	0.121	0.123	0.135	0.108	0.139	0.249	0.063	0.126	0.123	0.157	0.121	0.089	0.088
Ortho-P (mg/L)	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	0.179	0.097	0.194	0.129	0.109	0.093
TKN (mg/L)	2.21	1.60	2.10	1.94	3.48	3.54	4.43	3.22	3.61	1.53	1.74	2.00	2.34	2.40	1.68	1.72
NH_3(mg/L)	0.494	0.722	0.346	0.918	1.74	1.64	0.970	0.966	1.64	0.666	0.922	0.719	0.747	1.00	0.262	0.430
NO_3NO_2 (mg/L)	0.398	0.423	0.496	0.382	0.448	0.638	0.496	0.582	0.755	0.414	0.498	0.397	0.402	0.937	0.396	0.290
Cl (mg/L)	37	11	587	40	18	91	412	139	803	60	213	14	72	205	229	12
Hardness (mg/L)	nc	na	nc	nc	na	nc	nc	nc	nc	na	48.0	37	41	41	30	32
TSS (mg/L)	116	83	116	70	108	156	180	148	121	107	104	101	95	123	87	90
VSS (mg/L)	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	30	31	29	34	31	32
TDS (mg/L)	306	85	725	130	252	183	737	507	3323	124	693	97	301	359	59	62
cBOD (mg/L)	12	8	16	20	9	9	17	25	53	7	11	13	13	10	8	7
Sulfate (mg/L)	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	15	18	8	7	6	6
Cd (µg/L)	0.532	0.518	2.11	2.80	2.50	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc
Cu (µg/L)	15	31	23	15	19	29	36	16	40	23	25	16	19	13	8	9
Pb (µg/L)	23	17	22	14	41	31	34	28	23	24	18	15	22	16	8	13
Zn (µg/L)	180	76	107	76	86	94	133	132	204	100	103	90	79	68	62	58

nc = data not collected. na= data not analyzed for.

Note: Cadmium (Cd) was discontinued from monitoring in 2006 because Cd concentrations had typically been below detection for the Minneapolis/St. Paul area and it was not useful information. It should also be noted the detection limit for Cd has changed over time. In 2002 it was <0.500 µg/L; in 2003 it was <2.00 µg/L and in 2004 it was <5.00 µg/L. In 2011, ortho-P (or TDP), hardness (for metals toxicity calculations), and sulfate were added. The 2016 Legend Lab Cu RL was increased in May from <5µg/L to <20µg/L and Pb RL was increased from <3µg/L to <15µg/L.

Chemical concentrations in stormwater are highly variable. Climatological factors such as precipitation amount and intensity, street sweeping type and frequency, BMP maintenance frequency, etc. can cause fluctuations in chemical concentrations. **Table 14-14** illustrates the variability of stormwater from year to year.

The variability from year to year is likely due to three causes. First, the watersheds monitored have occasionally changed. Second, the timing between street sweeping, BMP maintenance, and sampling probably affect variability within the monitoring year and between years. Third, precipitation frequency, intensity, and duration also affect results.

Surcharge Events

Surcharge events happen during high precipitation or high intensity storm events that exceed the drainage capacity of the pipes. Surcharges occur when water backs up in pipes and creates a hydrostatic pressure head, beyond the diameter of the pipe, which can result in inaccurate daily flowcalculations and must be considered when evaluating flow-weighted mean concentrations. If surcharge water inundates the ISCO sampler the samples are considered contaminated and dumped.

Table 14-15 shows the 2016 NPDES surcharge dates. With the exception of Site 8a, most of the events that caused pipes to surcharge were storms with greater than 1 inch of precipitation.

Table 14-15. Surcharge events in 2016 at the NPDES sites.

Site	Surcharge Dates
Site 6 (22nd and Aldrich) 18" pipe	8/4, 9/22
Site 7 (Park and 14th) 42" pipe	None
Site 8a (Pershing) 12" pipe	6/13, 6/14, 6/20, 6/22, 7/5, 7/10, 7/23, 7/28, 8/4, 8/10, 8/12, 8/24, 8/30, 9/5, 9/6, 9/15, 9/21, 10/5, 10/6, 10/17, 10/26
Site 9 (61st and Lyndale) 42" pipe	9/22

Site 8a (Pershing) had 21 surcharges in 2016. At this site, storms as small as 0.17 inches or as large as 2.60 inches caused pipe surcharging. At this site, two pipes and overland flow enter the manhole basin/vault and exit the outlet, a 12-inch PVC pipe. The Site 8a watershed/area of Minneapolis is lower in elevation than the surrounding areas, causing a regular back up of many storm sewers in the system. Minneapolis Public Works is aware of this problem. Surcharges at this site do not appear to have caused any flooding problems. Site 8a samples appear to not be significantly affected by surcharging because the sampler is secured in an above ground enclosure.

Best Management Practices Monitoring Results

Best management practices (BMPs) include procedures and structures designed to help reduce pollutants in stormwater runoff. The City and the MPRB carry out BMP monitoring as part of the effort to determine and improve system/BMP effectiveness through adaptive management.

In 2016, baseline monitoring was continued with multiple BMP projects. These included:

1) Iron Enhanced Sand Filters (IESF) at both a street and alley runoff site.
2) A flood relief vault and downstream pipe.
3) Webber Stormwater Pond, treating water and stormwater discharged from a Natural Swimming Pool and surrounding area.
4) Lyndale Dog Park *E. coli* bacteria sampling.

Best management practices (BMPs) include procedures and structures designed to help reduce water pollution through good housekeeping practices like street sweeping. Monitoring of BMPs in Minneapolis is done as a part of the NPDES MS4 stormwater permit activities (permit #MN0061018).

37th Avenue N Greenway, Iron Enhanced Sand Filters

BACKGROUND

The comprehensive 37th Greenway Project was a flood control project that incorporated innovative stormwater Best Management Practices (BMPs). The project, located in North Minneapolis, consisted of several blocks of 37th Street being closed off and large underground vaults buried under the former street for floodwater retention. Additionally, iron enhanced sand filters (IESF) and St. Anthony Falls Laboratory (SAFL) baffles were incorporated into the flood control project to treat stormwater runoff.

Carlos Herrera, of Herrera Environmental Consultants, in Seattle, Washington invented the first iron sand filters used for treating dissolved phosphorus in stormwater (R. Watson PE, personal communication, Feb 4, 2016). He conducted pilot scale testing using full depth filter columns in the late 1980s. The Lakemont Washington Filtration Facility was constructed in phases between 1990 and 1994 when the sand filter, enhanced with a mixture of 95% sand and 5% iron (chopped steel wool), was the first installed in the nation. They were originally called amended sand filters.

The first iron enhanced sand filter built in Minnesota was designed by Barr Engineering and the Ramsey Washington Metro Watershed District and installed in Maplewood, Minnesota. The University of Minnesota's Saint Anthony Falls Laboratory has done further research on these filters and helped to greatly expand their use.

This project consisted of auto-monitoring two IESFs, one draining a street and one draining an alley. The 37th & Morgan site was located on North Morgan Avenue and treated street runoff, while the site 37th Alley site was between North Newton Avenue and Oliver Avenue North and treated alley runoff, **Figure 14-3**. The IESFs were constructed as a 5 foot wide trench approximately 30 feet long. A drain tile, acting as an underdrain, is buried the length of the basin. The subsoil was amended with compost on the sides of the basin and it sits over a deeper native subsoil of clay. The land use in the contributing watershed is 50% impervious residential with a dense tree canopy. The drainage area of the 37th & Morgan site is 1.2 acres and the 37th Alley site is 2.3 acres. Note the large shade tree in **Figure 14-3** at the 37th and Morgan site. Vegetation maintenance was performed the first year by the general contractor and by WHR (Wetland Habitat Restoration) under City contract after that.

Figure 14-3. Map of the 37th Greenway iron enhanced sand filter monitoring sites.

When constructed, the sand filter was amended with 5% iron filings to absorb dissolved phosphorus. As stormwater passes through these filters, iron in the filter is intended to bind with dissolved phosphorus, limiting nutrients from going downstream. Typically, about 25% to 50% of the phosphorus found in stormwater is dissolved (MPRB/Mpls. NPDES event mean concentrations 2001-2015); therefore, an overall decrease in the amount of phosphorus reaching Crystal Lake downstream should be expected.

The inlet to both of the iron enhanced filters is a 12 inch flared end pipe which discharges into a small cement splash block vault **Figure 14-4**. In 2015, the outlet to the filter was a four inch PVC pipe with a threaded PVC cap with a sized restrictor hole drilled in it, which was intended to slow drainage and increase contact time with the iron filings, **Figure 14-5**. In 2016, the threaded end caps were removed at both sites in an attempt to drain the system faster and prevent anaerobic conditions. Additionally, prior to 2016 monitoring, wood chips were removed at both sites. The 37th & Morgan site also had a standpipe added to the underdrain in an attempt to dry the filter faster by venting to the atmosphere. **Figure 14-6** shows the point at which the underdrain was vented to the atmosphere.

Figure 14-4. Flared end section and splash block inlet structure to the IESF.

Figure 14-5. Photograph of the 4-inch (white) PVC outlet structure from the IESF. In 2016, the threaded end caps, present here, were removed to improve ventilation.

Figure 14-6. Photograph of where the upstream subsurface drainage system was vented to the atmosphere.

Both the inlet and outlet were auto sampled and most samples were composited. The City, MPCA, and MPRB partnered to do a detailed chemical analysis of select individual storms. Each individual bottle was analyzed separately for the more detailed analysis. Single bottle analysis was expected to allow for a better understanding of how chemistry changes in iron enhanced sand filters during the entire event hydrograph.

Methods

Site Installation

Extensive skilled labor including cement masons, plumbers, carpenters, painters, and welders were needed to fabricate and install monitoring equipment at each of the 37th IESF sites. The cement masons were critical due to the extensive concrete drilling, eye-bolt, and anchor placement needed **Figure 14-7** and **Figure 14-8**.

Figure 14-7. The cement mason drilling access holes and anchor

Figure 14-8. Mounting sub-surface anchor brackets for the sampler enclosure structures.

In order to monitor the effectiveness of the IESFs, both (37th & Morgan and 37th Alley sites) the inlets were each equipped with a ISCO 2150 datalogger, 2105 interface module, and 2103ci cell phone modem along with a low-profile AV (area velocity) level probe. In 2105, the interface module was equipped with a splitter in order to trigger both inlet and outlet samplers simultaneously. Both the inlet and outlet at each site were equipped with ISCO 3700 samplers. The 2150 datalogger used a cell phone modem to remotely upload data to MPRB's database server Monday through Friday. The datalogger could also be remotely called, checked in real time, adjusted, and programmed to change pacing or triggers.

Figure 14-9 shows the 37th Alley site with enclosures for the inlet and outlet samplers.

Figure 14-9. The 37th Alley Site. Each enclosure contains a sampler, one for the Inlet and one for the Outlet.

A tipping bucket rain gauge was installed nearby (within 1/4 mile to the east) on a secure rooftop at Folwell Recreation Center. Data was periodically collected, via laptop, throughout the summer from a Hobo datalogger attached to the tipping bucket rain gauge. Precipitation data in 2016 are entirely from the Folwell Recreation Center site. Precipitation can vary widely over short distances; therefore, having local rain data allowed for more accurate storm event precipitation totals.

Sample Collection

At both the 37th & Morgan and 37th Alley sites, the Inlet and Outlet samplers were each an ISCO 3700 auto sampler equipped with 24 one liter bottles, 3/8 inch inner diameter vinyl tubing, and an intake strainer. The Inlet low profile AV probe and intake strainer were placed just upstream from the flared end outlet with a spring ring. The Inlet strainer was installed at the pipe inlet pointing upstream and offset behind the AV probe so it would not cause interference. The Inlet sampler was triggered at ¾ inches of flow. Both sites used a splitter cable, from the datalogger, to trigger Inlet and Outlet samplers simultaneously. The datalogger was programmed so that once triggered, the Inlet sampler would sample only during the storm (flow-paced), but the Outlet sampler would be latched and continue to run (time-paced), even if the Inlet dropped below the trigger and stopped sampling. Although best available technology was used, the outlet could not be flow-paced due to the technological limitations of the AV probe. Particulate matter in the water is needed for the AV probe to measure and calculate velocity. Water in the outlet pipe had too few particles for the AV probe to perform.

The 37th & Morgan Inlet was initially programmed to flow-pace every 112 cubic feet and was changed on 6/1/16 to 250 cubic feet, taking one flow-paced sample per bottle during the storm. The Outlet sampler was programmed to be time-paced and took one sample per bottle during the storm. Initially it was programmed to trigger every 60 minutes, but was changed on 5/31/16 to every 30 minutes in consultation with Barr Engineering.

The 37th Alley Inlet was initially programmed to flow-pace every 254 cubic feet and was changed on 6/1/16 to 200 cubic feet, taking one flow-paced sample per bottle during the storm. The Outlet sampler was programmed to be time-paced, and took one sample per bottle during the storm. Initially it was programmed to trigger every 22 minutes, but was changed on 5/31/16 to trigger every 30 minutes in consultation with Barr Engineering.

RESULTS & DISCUSSION

Sample Collection

Table 14-16 shows the events collected in 2016 and the precipitation amount, duration, time since last precipitation event, and intensity of each storm. **Figure 14-10** shows a scatter plot of the 2016 precipitation events. The weather station was located on the roof of Folwell Recreation Center. The red squares are events captured and blue diamonds are events not captured.

The 37th & Morgan site collected ten paired storms in 2016, while the 37th Alley site collected 11 paired storms. Most of the storms were composited but a few of the storms had the individual bottles collected throughout the storm and analyzed separately.

In 2016, the 37th & Morgan site collected four individual bottle storms while, the 37th Alley site collected five individual bottle storms. It was believed that individual bottle analysis would allow a better understanding of what was chemically occurring (with phosphorus, solids, and iron) through time during a storm.

Table 14-16. The 2016 precipitation events captured at the 37th & Morgan and 37th Alley IESF sites. A precipitation event was defined as a storm greater than 0.10 inches, separated by eight hours or more from other precipitation. Precipitation data are from the Folwell Recreation Center roof.

Start Date/Time	End Date/Time	Folwell Precip. (inches)	Storm Duration (hours)	Intensity in/hr	Time since last Precip. (hrs)	37th & Morgan In	37th & Morgan Out	37th Alley In	37th Alley Out
5/23/2016 19:42	5/23/2016 22:17	**0.37**	**2:35**	**0.15**	**249**	Ind. Btl.	Ind. Btl.	Ind. Btl.	Ind. Btl.
5/25/2016 9:57	5/25/2016 12:24	**0.24**	**2:27**	**0.10**	**36**	Composite	Composite	Composite	Composite
6/30/2016 11:37	6/30/2016 12:04	**0.07**	**0:27**	**0.14**	**184**	Composite	Composite		
7/5/2016 16:59	7/5/2016 21:20	**2.16**	**4:21**	**0.51**	**376**	Ind. Btl.	Ind. Btl.	Ind. Btl.	Ind. Btl.
7/10/2016 5:19	7/10/2016 7:47	**0.34**	**2:27**	**0.14**	**104**	Ind. Btl.	Ind. Btl.	Ind. Btl.	Ind. Btl.
7/27/2016 13:20	7/27/2016 16:01	**0.80**	**2:41**	**0.29**	**92**	Ind. Btl.	Ind. Btl.	Ind. Btl.	Ind. Btl.
8/4/2016 6:58	8/4/2016 9:17	**2.55**	**2:18**	**1.13**	**183**			Ind. Btl.	Ind. Btl.
8/10/2016 20:11	8/11/2016 6:17	**2.86**	**10:06**	**0.29**	**155**	Composite	Composite	Composite	Composite
9/15/2016 15:57	9/15/2016 20:57	**0.70**	**5:00**	**0.14**	**153**			Composite	Composite
9/21/2016 16:09	9/22/2016 5:43	**2.62**	**13:33**	**0.19**	**139**	Composite	Composite	Composite	Composite
10/4/2016 22:12	10/5/2016 5:37	**0.93**	**7:25**	**0.12**	**230**	Composite	Composite	Composite	Composite
10/6/2016 17:35	10/7/2016 2:44	**1.00**	**9:09**	**0.11**	**36**	Composite	Composite	Composite	Composite

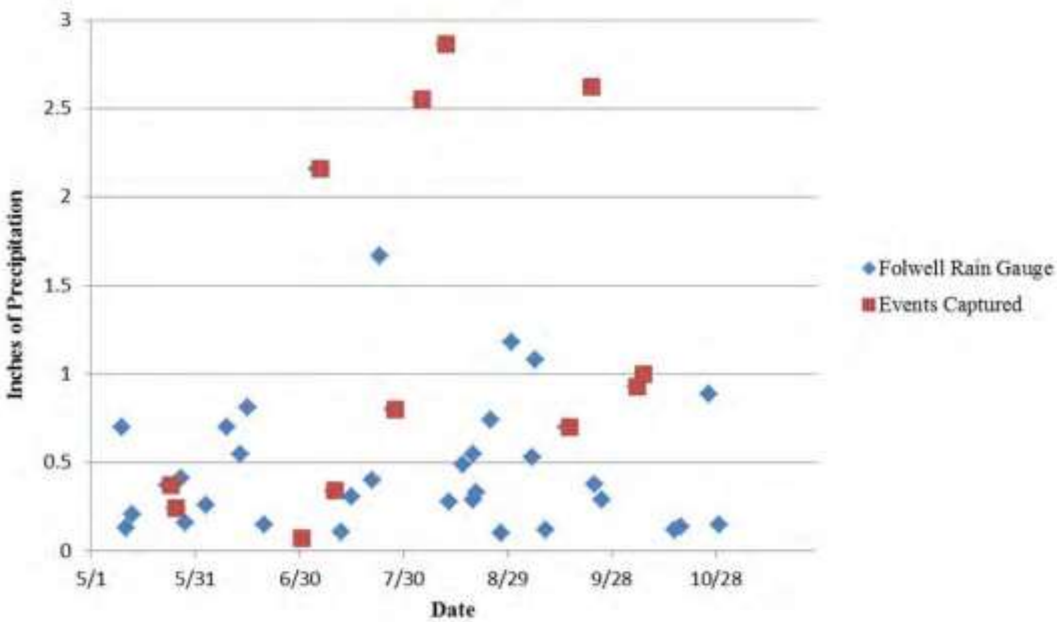


Figure 14-10. The 2016 precipitation events. The red squares are sampled events.

Event Data

Table 14-17 shows the 2016, 37th & Morgan and 37th Alley IESF chemistry data. Data that are underlined failed that parameter during the blind monthly QAQC standards from internal MPRB testing. The sample type column indicates if the sample was a composite or an individual bottle event. Individual bottle events were when each bottle was analyzed separately. In **Table 14-17,** the shaded rows separate storm events. The parameters collected were: TP, TDP, Ortho-P, TSS, and Fe.

Table 14-17. The 2016 37th & Morgan Inlet Iron Enhanced Sand Filter data.

Date Sampled	Time	Site Location	Type	TP	TDP	Ortho-P	TSS
				mg/L	mg/L	mg/L	mg/L
5/23/2016	20:12	37th & Morgan In #1	Ind. Bottle	1.19	0.904	1.01	28
5/23/2016	20:31	37th & Morgan In #2	Ind. Bottle	1.09	0.604	0.548	85
5/23/2016	20:34	37th & Morgan In #3	Ind. Bottle	0.618	0.385	0.245	214
5/23/2016	20:36	37th & Morgan In #4	Ind. Bottle	0.618	0.455	0.250	152
5/23/2016	20:38	37th & Morgan In #5	Ind. Bottle	0.566	0.518	0.251	165
5/23/2016	21:05	37th & Morgan In #6	Ind. Bottle	1.02	0.743	0.634	145
5/25/2016	13:33	37th & Morgan - In	Composite	0.954	0.931	0.604	97
6/30/2016	11:49	37th & Morgan - In	Composite	3.43	1.39	0.807	108
7/5/2016	17:49	37th & Morgan In #1	Ind. Bottle	0.843	0.403	0.396	569
7/5/2016	17:55	37th & Morgan In #2	Ind. Bottle	0.352	0.294	0.238	263
7/5/2016	18:00	37th & Morgan In #3	Ind. Bottle	0.440	0.391	0.283	611
7/5/2016	18:07	37th & Morgan In #4	Ind. Bottle	0.378	0.289	0.247	445
7/5/2016	18:15	37th & Morgan In #5	Ind. Bottle	0.364	0.253	0.250	126
7/5/2016	18:22	37th & Morgan In #6	Ind. Bottle	0.222	0.147	0.161	130
7/5/2016	18:29	37th & Morgan In #7	Ind. Bottle	0.202	0.164	0.148	101
7/5/2016	18:37	37th & Morgan In #8	Ind. Bottle	0.214	0.178	0.163	61
7/5/2016	18:44	37th & Morgan In #9	Ind. Bottle	0.220	0.179	0.159	60
7/5/2016	18:52	37th & Morgan In #10	Ind. Bottle	0.243	0.208	0.186	45
7/5/2016	19:02	37th & Morgan In #11	Ind. Bottle	0.245	0.201	0.183	34
7/5/2016	19:15	37th & Morgan In #12	Ind. Bottle	0.262	0.217	0.198	156
7/5/2016	19:31	37th & Morgan In #13	Ind. Bottle	0.167	0.128	0.123	95
7/5/2016	19:40	37th & Morgan In #14	Ind. Bottle	0.143	0.109	0.110	64
7/5/2016	20:01	37th & Morgan In #15	Ind. Bottle	0.156	0.133	0.120	48
7/5/2016	20:22	37th & Morgan In #16	Ind. Bottle	0.184	0.146	0.137	24
7/5/2016	21:03	37th & Morgan In #17	Ind. Bottle	0.152	0.106	0.101	21
7/10/2016	5:21	37th & Morgan In #1	Ind. Bottle	0.981	0.536	0.405	159
7/10/2016	5:40	37th & Morgan In #2	Ind. Bottle	0.603	0.447	0.327	41
7/10/2016	6:08	37th & Morgan In #3	Ind. Bottle	0.499	0.415	0.307	18
7/10/2016	6:28	37th & Morgan In #4	Ind. Bottle	0.380	0.286	0.241	43
7/10/2016	6:51	37th & Morgan In #5	Ind. Bottle	0.301	0.251	0.196	14
7/10/2016	7:27	37th & Morgan In #6	Ind. Bottle	0.290	0.240	0.181	6
7/27/2016	13:35	37th & Morgan In #7	Ind. Bottle	0.953	0.408	0.549	81
7/27/2016	13:38	37th & Morgan In #6	Ind. Bottle	0.852	0.486	0.505	102
7/27/2016	13:46	37th & Morgan In #5	Ind. Bottle	0.292	0.149	0.136	124
7/27/2016	13:51	37th & Morgan In #4	Ind. Bottle	0.180	0.097	0.072	48
7/27/2016	14:03	37th & Morgan In #3	Ind. Bottle	0.126	0.085	0.061	26
7/27/2016	15:03	37th & Morgan In #2	Ind. Bottle	0.206	0.096	0.074	39
7/27/2016	16:14	37th & Morgan In #1	Ind. Bottle	0.119	0.073	0.057	23
8/11/2016	4:46	37th & Morgan - In	Composite	Delete	0.057	0.053	24
9/22/2016	5:57	37th & Morgan - In	Composite	0.231	0.082	0.052	65
10/5/2016	5:43	37th & Morgan - In	Composite	0.268	0.129	0.137	18
10/7/2016	8:03	37th & Morgan - In	Composite	0.262	0.152	0.198	15

Table 14-17 (cont.). The 2016, 37th & Morgan Outlet Iron Enhanced Sand Filter data.

Date Sampled	Time	Site Location	Type	TP	TDP	Ortho-P	TSS	Fe
				mg/L	mg/L	mg/L	mg/L	ug/L
5/23/2016	20:13	37th & Morgan Out #1	Ind. Bottle	0.826	0.100	0.251	88	5100
5/23/2016	20:33	37th & Morgan Out #2	Ind. Bottle	0.530	0.362	0.333	36	880
5/23/2016	20:53	37th & Morgan Out #3	Ind. Bottle	0.462	0.274	0.378	28	870
5/23/2016	21:13	37th & Morgan Out #4	Ind. Bottle	0.254	0.108	0.133	22	1400
5/23/2016	21:33	37th & Morgan Out #5	Ind. Bottle	0.289	0.168	0.175	25	1600
5/23/2016	21:53	37th & Morgan Out #6	Ind. Bottle	NES	0.079	0.228	30	1600
5/25/2016	13:00	37th & Morgan - Out	Composite	Delete	0.334	0.283	3	2700
6/30/2016	12:19	37th & Morgan - Out	Composite	0.825	0.481	0.145	25	1300
7/5/2016	18:19	37th & Morgan Out #1	Ind. Bottle	0.506	0.442	0.443	9	490
7/5/2016	18:49	37th & Morgan Out #2	Ind. Bottle	0.488	0.412	0.424	33	440
7/5/2016	19:19	37th & Morgan Out #3	Ind. Bottle	0.467	0.410	0.409	8	350
7/5/2016	19:49	37th & Morgan Out #4	Ind. Bottle	0.472	0.417	0.423	<1	250
7/5/2016	20:19	37th & Morgan Out #5	Ind. Bottle	0.416	0.381	0.376	4	220
7/5/2016	20:49	37th & Morgan Out #6	Ind. Bottle	0.346	0.308	0.305	3	250
7/5/2016	21:19	37th & Morgan Out #7	Ind. Bottle	0.321	0.296	0.290	4	190
7/5/2016	21:49	37th & Morgan Out #8	Ind. Bottle	0.313	0.286	0.282	3	300
7/5/2016	22:19	37th & Morgan Out #9	Ind. Bottle	0.299	0.253	0.266	7	460
7/10/2016	5:51	37th & Morgan Out #1	Ind. Bottle	0.403	0.353	0.305	4	630
7/10/2016	6:21	37th & Morgan Out #2	Ind. Bottle	0.351	0.320	0.298	5	490
7/10/2016	6:51	37th & Morgan Out #3	Ind. Bottle	0.342	0.312	0.306	3	410
7/10/2016	7:21	37th & Morgan Out #4	Ind. Bottle	0.309	0.289	0.281	1	410
7/10/2016	7:51	37th & Morgan Out #5	Ind. Bottle	0.285	0.259	0.249	2	510
7/10/2016	8:21	37th & Morgan Out #6	Ind. Bottle	0.253	0.222	0.223	2	NES
7/27/2016	14:05	37th & Morgan Out #1	Ind. Bottle	0.199	0.183	0.185	1	
7/27/2016	14:35	37th & Morgan Out #2	Ind. Bottle	0.210	0.192	0.197	4	670
7/27/2016	15:05	37th & Morgan Out #3	Ind. Bottle	0.198	0.186	0.187	<1	470
7/27/2016	15:35	37th & Morgan Out #4	Ind. Bottle	0.246	0.231	0.228	1	530
7/27/2016	16:05	37th & Morgan Out #5	Ind. Bottle	0.215	0.204	0.200	2	350
7/27/2016	16:35	37th & Morgan Out #6	Ind. Bottle	0.207	0.200	0.187	2	290
7/27/2016	17:05	37th & Morgan Out #7	Ind. Bottle	0.227	0.208	0.187	6	NES
8/11/2016	7:43	37th & Morgan - Out	Composite	0.217	0.199	0.205	<1	224
9/22/2016	5:35	37th & Morgan - Out	Composite	0.191	0.171	0.170	2	350
10/7/2016	6:09	37th & Morgan - Out	Composite	0.170	0.150	0.164	1	440

Table 14-17 (cont.). The 2016 37th Alley Inlet Iron Enhanced Sand Filter data. The red cell TSS In/Out data are believed transposed and was not used in analysis.

Date Sampled	Time	Site Location	Type	TP	TDP	Ortho-P	TSS	Fe
				mg/L	mg/L	mg/L	mg/L	ug/L
5/23/2016	20:26	37th Alley In #1	Ind. Bottle	0.271	0.149	0.189	119	4600
5/25/2016	10:10	37th Alley In	Composite	0.627	0.213	0.078	309	
7/5/2016	17:54	37th Alley In #1	Ind. Bottle	0.602	0.458	0.413	898	7900
7/5/2016	17:57	37th Alley In #2	Ind. Bottle	0.484	0.385	0.358	481	5300
7/5/2016	17:59	37th Alley In #3	Ind. Bottle	0.397	0.340	0.308	586	4600
7/5/2016	18:02	37th Alley In #4	Ind. Bottle	0.398	0.322	0.289	228	2700
7/5/2016	18:04	37th Alley In #5	Ind. Bottle	0.345	0.306	0.278	275	2400
7/5/2016	18:07	37th Alley In #6	Ind. Bottle	0.326	0.293	0.264	261	2100
7/5/2016	18:11	37th Alley In #7	Ind. Bottle	0.317	0.258	0.264	260	3000
7/5/2016	18:14	37th Alley In #8	Ind. Bottle	0.291	0.256	0.241	169	2700
7/5/2016	18:18	37th Alley In #9	Ind. Bottle	0.303	0.294	0.243	307	1300
7/5/2016	18:28	37th Alley In #10	Ind. Bottle	0.368	0.283	0.272	274	720
7/5/2016	19:26	37th Alley In #11	Ind. Bottle	0.439	0.236	0.224	239	2600
7/5/2016	19:31	37th Alley In #12	Ind. Bottle	0.536	0.231	0.207	140	3600
7/5/2016	19:35	37th Alley In #13	Ind. Bottle	0.422	0.222	0.205	76	2000
7/5/2016	19:39	37th Alley In #14	Ind. Bottle	0.359	0.203	0.190	262	1600
7/5/2016	19:45	37th Alley In #15	Ind. Bottle	0.257	0.193	0.190	71	960
7/10/2016	5:27	37th Alley In #1	Ind. Bottle	0.325	0.174	0.139	43	1600
7/10/2016	6:38	37th Alley In #2	Ind. Bottle	0.300	0.249	0.188	2	610
7/27/2016	13:41	37th Alley In #1	Ind. Bottle	0.287	0.139	0.144	66	1200
7/27/2016	13:43	37th Alley In #2	Ind. Bottle	0.341	0.126	0.154	136	2200
7/27/2016	13:50	37th Alley In #3	Ind. Bottle	0.473	0.191	0.252	245	3500
7/27/2016	13:56	37th Alley In #4	Ind. Bottle	0.498	0.177	0.215	161	2300
7/27/2016	15:05	37th Alley In #5	Ind. Bottle	0.367	0.079	0.124	53	2000
8/4/2016	7:05	37th Alley In #1	Ind. Bottle	0.613	0.218	0.320	308	5100
8/4/2016	7:09	37th Alley In #2	Ind. Bottle	0.452	0.216	0.239	324	2700
8/4/2016	7:12	37th Alley In #3	Ind. Bottle	0.380	0.198	0.208	229	1900
8/4/2016	7:16	37th Alley In #4	Ind. Bottle	0.340	0.176	0.185	188	1800
8/4/2016	7:18	37th Alley In #5	Ind. Bottle	0.328	0.177	0.196	171	1500
8/4/2016	7:21	37th Alley In #6	Ind. Bottle	0.300	0.168	0.167	99	1100
8/4/2016	7:23	37th Alley In #7	Ind. Bottle	0.303	0.180	0.182	79	800
8/4/2016	7:25	37th Alley In #8	Ind. Bottle	0.303	0.172	0.169	93	1100
8/4/2016	7:39	37th Alley In #9	Ind. Bottle	0.270	0.153	0.148	69	790
8/4/2016	7:47	37th Alley In #10	Ind. Bottle	0.251	0.133	0.142	139	1100
8/4/2016	7:55	37th Alley In #11	Ind. Bottle	0.223	0.124	0.130	58	540
8/4/2016	8:10	37th Alley In #12	Ind. Bottle	0.201	0.118	0.127	56	550
8/4/2016	8:16	37th Alley In #13	Ind. Bottle	0.255	0.104	0.163	280	1900
8/4/2016	8:19	37th Alley In #14	Ind. Bottle	0.355	0.113	0.148	351	2700
8/4/2016	8:22	37th Alley In #15	Ind. Bottle	0.298	0.120	0.130	132	1200
8/4/2016	8:24	37th Alley In #16	Ind. Bottle	0.251	0.132	0.149	96	990
8/4/2016	8:27	37th Alley In #17	Ind. Bottle	0.228	0.124	0.144	92	640
8/4/2016	8:29	37th Alley In #18	Ind. Bottle	0.215	0.131	0.139	61	550
8/10/2016	20:55	37th Alley - In	Composite	0.277	0.167	0.162	68	660
9/15/2016	19:05	37th Alley - In	Composite	0.467	0.246	0.237	42	820
9/22/2016	3:32	37th Alley - In	Composite	0.346	0.144	0.120	117	1500
10/5/2016	5:06	37th Alley In	Composite	0.395	0.209	0.230	59	780
10/6/2016	23:06	37th Alley - In	Composite	0.371	0.239	0.309	35	610

Table 14-17 (cont.). The 2016, 37th Alley Outlet Iron Enhanced Sand Filter data. The red cell TSS In/Out data are believed transposed and was not used in analysis.

Date Sampled	Time	Site Location	Type	TP mg/L	TDP mg/L	Ortho-P mg/L	TSS mg/L	Fe ug/L
5/23/2016	20:45	37th Alley Out #1	Ind. Bottle	0.202	0.107	0.111	15	370
5/23/2016	21:05	37th Alley Out #2	Ind. Bottle	0.237	0.222	0.224	22	300
5/25/2016	10:09	37th Alley Out	Composite	0.264	0.261	0.244	18	130
7/5/2016	17:53	37th Alley Out #1	Ind. Bottle	0.197	0.195	0.077	44	660
7/5/2016	18:23	37th Alley Out #2	Ind. Bottle	0.207	0.164	0.163	3	280
7/5/2016	18:53	37th Alley Out #3	Ind. Bottle	0.259	0.246	0.211	8	360
7/5/2016	19:23	37th Alley Out #4	Ind. Bottle	0.314	0.294	0.268	4	460
7/5/2016	19:53	37th Alley Out #5	Ind. Bottle	0.298	0.290	0.277	4	300
7/5/2016	20:23	37th Alley Out #6	Ind. Bottle	0.377	0.375	0.348	1	450
7/5/2016	20:53	37th Alley Out #7	Ind. Bottle	0.397	0.390	0.376	15	280
7/5/2016	21:23	37th Alley Out #8	Ind. Bottle	0.394	0.389	0.365	2	240
7/10/2016	6:26	37th Alley Out #1	Ind. Bottle	0.309	0.290	0.279	1	140
7/10/2016	6:56	37th Alley Out #2	Ind. Bottle	0.356	0.350	0.338	91	120
7/27/2016	14:10	37th Alley Out #1	Ind. Bottle	0.311	0.299	0.293	NA	80
7/27/2016	14:40	37th Alley Out #2	Ind. Bottle	0.293	0.249	0.250	8	NA
7/27/2016	15:10	37th Alley Out #3	Ind. Bottle	0.266	0.251	0.239	4	100
7/27/2016	15:40	37th Alley Out #4	Ind. Bottle	0.265	0.159	0.245	4	160
7/27/2016	16:10	37th Alley Out #5	Ind. Bottle	0.196	0.180	0.160	9	230
8/4/2016	7:04	37th Alley Out #1	Ind. Bottle	0.174	0.136	0.072	22	370
8/4/2016	7:34	37th Alley Out #2	Ind. Bottle	0.187	0.165	0.157	7	180
8/4/2016	8:34	37th Alley Out #3	Ind. Bottle	0.231	0.208	0.196	4	150
8/4/2016	9:04	37th Alley Out #4	Ind. Bottle	0.259	0.238	0.236	5	170
8/4/2016	9:34	37th Alley Out #5	Ind. Bottle	0.251	0.236	0.229	5	190
8/4/2016	10:04	37th Alley Out #6	Ind. Bottle	0.370	0.343	0.327	4	260
8/4/2016	10:34	37th Alley Out #7	Ind. Bottle	0.387	0.354	0.336	4	220
8/4/2016	11:04	37th Alley Out #8	Ind. Bottle	0.355	NES	0.297	NES	NES
8/11/2016	6:48	37th Alley - Out	Composite	0.313	0.259	0.287	1	130
9/15/2016	19:34	37th Alley - Out	Composite	0.308	0.260	0.260	4	150
9/22/2016	5:11	37th Alley - Out	Composite	0.272	0.260	0.244	3	210
10/5/2016	5:59	37th Alley Out	Composite	0.250	0.223	0.224	3	120
10/7/2016	0:37	37th Alley - Out	Composite	0.270	0.240	0.254	2	140

Table 14-18 shows the storms collected in 2016 paired by their Inlet and Outlet for both the 37th & Morgan and 37th Alley sites. The phosphorus, TDP, Ortho P, TSS, and Fe results can be compared. The geometric mean and median were calculated for the storms with individual bottles collected so one value can be used for comparison with the composite samples. The geometric mean was calculated because it is one of the best statistical tools for comparison purposes of stormwater data. Single paired Inlet/Outlet samples are separated by shading of the rows. The Inlet /Outlet individual storm subtractions are presented in **Table 14-18** as Storm Difference (Geo Mean) or Storm Difference and if the storm parameter exported, the cell is highlighted yellow.

Table 14-18. The 2016 37th & Morgan paired storm comparison of composites and individual bottles during storm. Cells were colored yellow cells where the geo. mean comparison or storm comparison data appears to be exporting.

Date Sampled	Time	Site Location	Type	TP	TDP	Ortho-P	TSS	Fe
				mg/L	mg/L	mg/L	mg/L	ug/L
5/23/2016	20:12	37th & Morgan In #1	Ind. Bottle	1.19	0.904	1.01	28	3300
5/23/2016	20:31	37th & Morgan In #2	Ind. Bottle	1.09	0.604	0.548	85	4000
5/23/2016	20:34	37th & Morgan In #3	Ind. Bottle	0.618	0.385	0.245	214	1800
5/23/2016	20:36	37th & Morgan In #4	Ind. Bottle	0.618	0.455	0.250	152	1400
5/23/2016	20:38	37th & Morgan In #5	Ind. Bottle	0.566	0.518	0.251	165	1000
5/23/2016	21:05	37th & Morgan In #6	Ind. Bottle	1.02	0.743	0.634	145	1600
		37th & Morgan In GEO Mean		**0.811**	**0.577**	**0.419**	**110**	**1939**
		37th & Morgan In Median		**0.819**	**0.561**	**0.400**	**149**	**1700**
5/23/2016	20:13	37th & Morgan Out #1	Ind. Bottle	0.826	0.100	0.251	88	5100
5/23/2016	20:33	37th & Morgan Out #2	Ind. Bottle	0.530	0.362	0.333	36	880
5/23/2016	20:53	37th & Morgan Out #3	Ind. Bottle	0.462	0.274	0.378	28	870
5/23/2016	21:13	37th & Morgan Out #4	Ind. Bottle	0.254	0.108	0.133	22	1400
5/23/2016	21:33	37th & Morgan Out #5	Ind. Bottle	0.289	0.168	0.175	25	1600
5/23/2016	21:53	37th & Morgan Out #6	Ind. Bottle	NES	0.079	0.228	30	1600
		37th & Morgan Out GEO Mean		**0.431**	**0.156**	**0.235**	**34**	**1552**
		37th & Morgan Out Median		**0.462**	**0.138**	**0.240**	**29**	**1500**
		Storm Difference (Geo Mean)		**-0.380**	**-0.421**	**-0.184**	**-77**	**-387**
5/25/2016	13:33	37th & Morgan - In	Composite	0.954	0.931	0.604	97	1100
5/25/2016	13:00	37th & Morgan - Out	Composite	Delete	0.334	0.283	3	2700
		Storm Difference			**-0.597**	**-0.321**	**-94**	**1600**
6/30/2016	11:49	37th & Morgan - In	Composite	3.43	1.39	0.807	108	5300
6/30/2016	12:19	37th & Morgan - Out	Composite	0.825	0.481	0.145	25	1300
		Storm Difference		**-2.61**	**-0.913**	**-0.662**	**-84**	**-4000**
7/5/2016	17:49	37th & Morgan In #1	Ind. Bottle	0.843	0.403	0.396	569	6500
7/5/2016	17:55	37th & Morgan In #2	Ind. Bottle	0.352	0.294	0.238	263	3000
7/5/2016	18:00	37th & Morgan In #3	Ind. Bottle	0.440	0.391	0.283	611	1600
7/5/2016	18:07	37th & Morgan In #4	Ind. Bottle	0.378	0.289	0.247	445	1100
7/5/2016	18:15	37th & Morgan In #5	Ind. Bottle	0.364	0.253	0.250	126	520
7/5/2016	18:22	37th & Morgan In #6	Ind. Bottle	0.222	0.147	0.161	130	2200
7/5/2016	18:29	37th & Morgan In #7	Ind. Bottle	0.202	0.164	0.148	101	5400
7/5/2016	18:37	37th & Morgan In #8	Ind. Bottle	0.214	0.178	0.163	61	500
7/5/2016	18:44	37th & Morgan In #9	Ind. Bottle	0.220	0.179	0.159	60	260
7/5/2016	18:52	37th & Morgan In #10	Ind. Bottle	0.243	0.208	0.186	45	240
7/5/2016	19:02	37th & Morgan In #11	Ind. Bottle	0.245	0.201	0.183	34	360
7/5/2016	19:15	37th & Morgan In #12	Ind. Bottle	0.262	0.217	0.198	156	240
7/5/2016	19:31	37th & Morgan In #13	Ind. Bottle	0.167	0.128	0.123	95	610
7/5/2016	19:40	37th & Morgan In #14	Ind. Bottle	0.143	0.109	0.110	64	200
7/5/2016	20:01	37th & Morgan In #15	Ind. Bottle	0.156	0.133	0.120	48	110
7/5/2016	20:22	37th & Morgan In #16	Ind. Bottle	0.184	0.146	0.137	24	130
7/5/2016	21:03	37th & Morgan In #17	Ind. Bottle	0.152	0.106	0.101	21	200
		37th & Morgan In GEO Mean		**0.251**	**0.192**	**0.176**	**99**	**606**
		37th & Morgan In Median		**0.222**	**0.179**	**0.163**	**95**	**500**
7/5/2016	18:19	37th & Morgan Out #1	Ind. Bottle	0.506	0.442	0.443	9	490
7/5/2016	18:49	37th & Morgan Out #2	Ind. Bottle	0.488	0.412	0.424	33	440
7/5/2016	19:19	37th & Morgan Out #3	Ind. Bottle	0.467	0.410	0.409	8	350
7/5/2016	19:49	37th & Morgan Out #4	Ind. Bottle	0.472	0.417	0.423	<1	250
7/5/2016	20:19	37th & Morgan Out #5	Ind. Bottle	0.416	0.381	0.376	4	220
7/5/2016	20:49	37th & Morgan Out #6	Ind. Bottle	0.346	0.308	0.305	3	250
7/5/2016	21:19	37th & Morgan Out #7	Ind. Bottle	0.321	0.296	0.290	4	190
7/5/2016	21:49	37th & Morgan Out #8	Ind. Bottle	0.313	0.286	0.282	3	300
7/5/2016	22:19	37th & Morgan Out #9	Ind. Bottle	0.299	0.253	0.266	7	460
		37th & Morgan Out GEO Mean		**0.395**	**0.350**	**0.351**	**6**	**311**
		37th & Morgan Out Median		**0.416**	**0.381**	**0.376**	**6**	**300**
		Storm Difference (Geo Mean)		**0.144**	**0.157**	**0.175**	**-93**	**-295**

Table 14-18 (cont.). the 2016 37th & Morgan paired storm comparison of composites and individual bottles during storm. Cells were colored yellow where the geo. mean comparison or storm comparison data appears to be exporting.

Date Sampled	Time	Site Location	Type	TP	TDP	Ortho-P	TSS	Fe
				mg/L	mg/L	mg/L	mg/L	ug/L
7/10/2016	5:21	37th & Morgan In #1	Ind. Bottle	0.981	0.536	0.405	159	2800
7/10/2016	5:40	37th & Morgan In #2	Ind. Bottle	0.603	0.447	0.327	41	840
7/10/2016	6:08	37th & Morgan In #3	Ind. Bottle	0.499	0.415	0.307	18	370
7/10/2016	6:28	37th & Morgan In #4	Ind. Bottle	0.380	0.286	0.241	43	570
7/10/2016	6:51	37th & Morgan In #5	Ind. Bottle	0.301	0.251	0.196	14	280
7/10/2016	7:27	37th & Morgan In #6	Ind. Bottle	0.290	0.240	0.181	6	130
		37th & Morgan In GEO Mean		**0.463**	**0.346**	**0.265**	**27**	**512**
		37th & Morgan In Median		**0.440**	**0.351**	**0.274**	**30**	**470**
7/10/2016	5:51	37th & Morgan Out #1	Ind. Bottle	0.403	0.353	0.305	4	630
7/10/2016	6:21	37th & Morgan Out #2	Ind. Bottle	0.351	0.320	0.298	5	490
7/10/2016	6:51	37th & Morgan Out #3	Ind. Bottle	0.342	0.312	0.306	3	410
7/10/2016	7:21	37th & Morgan Out #4	Ind. Bottle	0.309	0.289	0.281	1	410
7/10/2016	7:51	37th & Morgan Out #5	Ind. Bottle	0.285	0.259	0.249	2	510
7/10/2016	8:21	37th & Morgan Out #6	Ind. Bottle	0.253	0.222	0.223	2	NES
		37th & Morgan Out GEO Mean		**0.320**	**0.289**	**0.275**	**2**	**484**
		37th & Morgan Out Median		**0.326**	**0.301**	**0.290**	**3**	**490**
		Storm Difference (Geo Mean)		**-0.142**	**-0.057**	**0.010**	**-25**	**-29**
7/27/2016	13:35	37th & Morgan In #7	Ind. Bottle	0.953	0.408	0.549	81	2500
7/27/2016	13:38	37th & Morgan In #6	Ind. Bottle	0.852	0.486	0.505	102	2000
7/27/2016	13:46	37th & Morgan In #5	Ind. Bottle	0.292	0.149	0.136	124	1200
7/27/2016	13:51	37th & Morgan In #4	Ind. Bottle	0.180	0.097	0.072	48	560
7/27/2016	14:03	37th & Morgan In #3	Ind. Bottle	0.126	0.085	0.061	26	380
7/27/2016	15:03	37th & Morgan In #2	Ind. Bottle	0.206	0.096	0.074	39	520
7/27/2016	16:14	37th & Morgan In #1	Ind. Bottle	0.119	0.073	0.057	23	410
		37th & Morgan In GEO Mean		**0.279**	**0.150**	**0.132**	**53**	**830**
		37th & Morgan In Median		**0.206**	**0.097**	**0.074**	**48**	**560**
7/27/2016	14:05	37th & Morgan Out #1	Ind. Bottle	0.199	0.183	0.185	1	
7/27/2016	14:35	37th & Morgan Out #2	Ind. Bottle	0.210	0.192	0.197	4	670
7/27/2016	15:05	37th & Morgan Out #3	Ind. Bottle	0.198	0.186	0.187	<1	470
7/27/2016	15:35	37th & Morgan Out #4	Ind. Bottle	0.246	0.231	0.228	1	530
7/27/2016	16:05	37th & Morgan Out #5	Ind. Bottle	0.215	0.204	0.200	2	350
7/27/2016	16:35	37th & Morgan Out #6	Ind. Bottle	0.207	0.200	0.187	2	290
7/27/2016	17:05	37th & Morgan Out #7	Ind. Bottle	0.227	0.208	0.187	6	NES
		37th & Morgan Out GEO Mean		**0.214**	**0.200**	**0.195**	**2**	**442**
		37th & Morgan Out Median		**0.210**	**0.200**	**0.187**	**2**	**470**
		Storm Difference (Geo Mean)		**-0.065**	**0.050**	**0.063**	**-51**	**-388**
8/11/2016	4:46	37th & Morgan - In	Composite	Delete	0.057	0.053	24	220
8/11/2016	7:43	37th & Morgan - Out	Composite	0.217	0.199	0.205	<1	224
		Storm Difference			**0.142**	**0.152**	**-23**	**4**
9/22/2016	5:57	37th & Morgan - In	Composite	0.231	0.082	0.052	65	790
9/22/2016	5:35	37th & Morgan - Out	Composite	0.191	0.171	0.170	2	350
		Storm Difference		**-0.040**	**0.089**	**0.118**	**-63**	**-440**
10/5/2016	5:43	37th & Morgan - In	Composite	0.268	0.129	0.137	18	290
10/5/2016	4:22	37th Morgan Out	Composite	0.257	0.202	0.228	3	740
		Storm Difference		**-0.011**	**0.073**	**0.091**	**-15**	**450**
10/7/2016	8:03	37th & Morgan - In	Composite	0.262	0.152	0.198	15	240
10/7/2016	6:09	37th & Morgan - Out	Composite	0.170	0.150	0.164	1	440
		Storm Difference		**-0.092**	**-0.002**	**-0.034**	**-14**	**200**

Table 14-18 (cont.). The 2016 37th Alley paired storm comparison of composites and individual bottles during storm. Cells were colored yellow where the geo. mean comparison or storm comparison data appears to be exporting. The red cells In/Out TSS data appear to be switched and the data was not used in statistics.

Date Sampled	Time	Site Location	Type	TP mg/L	TDP mg/L	Ortho-P mg/L	TSS mg/L	Fe ug/L
5/23/2016	20:26	37th Alley In #1	Ind. Bottle	0.271	0.149	0.189	119	4600
5/23/2016	20:45	37th Alley Out #1	Ind. Bottle	0.202	0.107	0.111	15	370
5/23/2016	21:05	37th Alley Out #2	Ind. Bottle	0.237	0.222	0.224	22	300
		37th Alley Out GEO Mean		**0.219**	**0.154**	**0.158**	**18**	**333**
		37th Alley Out Median		**0.220**	**0.165**	**0.168**	**18**	**335**
		Storm Difference (Geo Mean)		**-0.052**	**0.005**	**-0.031**	**-101**	**-4267**
5/25/2016	10:10	37th Alley In	Composite	0.627	0.213	0.078	309	
5/25/2016	10:09	37th Alley Out	Composite	0.264	0.261	0.244	18	130
		Storm Difference		**-0.363**	**0.048**	**0.166**	**-291**	NA
7/5/2016	17:54	37th Alley In #1	Ind. Bottle	0.602	0.458	0.413	898	7900
7/5/2016	17:57	37th Alley In #2	Ind. Bottle	0.484	0.385	0.358	481	5300
7/5/2016	17:59	37th Alley In #3	Ind. Bottle	0.397	0.340	0.308	586	4600
7/5/2016	18:02	37th Alley In #4	Ind. Bottle	0.398	0.322	0.289	228	2700
7/5/2016	18:04	37th Alley In #5	Ind. Bottle	0.345	0.306	0.278	275	2400
7/5/2016	18:07	37th Alley In #6	Ind. Bottle	0.326	0.293	0.264	261	2100
7/5/2016	18:11	37th Alley In #7	Ind. Bottle	0.317	0.258	0.264	260	3000
7/5/2016	18:14	37th Alley In #8	Ind. Bottle	0.291	0.256	0.241	169	2700
7/5/2016	18:18	37th Alley In #9	Ind. Bottle	0.303	0.294	0.243	307	1300
7/5/2016	18:28	37th Alley In #10	Ind. Bottle	0.368	0.283	0.272	274	720
7/5/2016	19:26	37th Alley In #11	Ind. Bottle	0.439	0.236	0.224	239	2600
7/5/2016	19:31	37th Alley In #12	Ind. Bottle	0.536	0.231	0.207	140	3600
7/5/2016	19:35	37th Alley In #13	Ind. Bottle	0.422	0.222	0.205	76	2000
7/5/2016	19:39	37th Alley In #14	Ind. Bottle	0.359	0.203	0.190	262	1600
7/5/2016	19:45	37th Alley In #15	Ind. Bottle	0.257	0.193	0.190	71	960
		37th Alley Out GEO Mean		**0.380**	**0.278**	**0.257**	**246**	**2420**
		37th Alley Out Median		**0.368**	**0.283**	**0.264**	**261**	**2600**
7/5/2016	17:53	37th Alley Out #1	Ind. Bottle	0.197	0.195	0.077	44	660
7/5/2016	18:23	37th Alley Out #2	Ind. Bottle	0.207	0.164	0.163	3	280
7/5/2016	18:53	37th Alley Out #3	Ind. Bottle	0.259	0.246	0.211	8	360
7/5/2016	19:23	37th Alley Out #4	Ind. Bottle	0.314	0.294	0.268	4	460
7/5/2016	19:53	37th Alley Out #5	Ind. Bottle	0.298	0.290	0.277	4	300
7/5/2016	20:23	37th Alley Out #6	Ind. Bottle	0.377	0.375	0.348	1	450
7/5/2016	20:53	37th Alley Out #7	Ind. Bottle	0.397	0.390	0.376	15	280
7/5/2016	21:23	37th Alley Out #8	Ind. Bottle	0.394	0.389	0.365	2	240
		37th Alley Out GEO Mean		**0.296**	**0.280**	**0.235**	**5**	**359**
		37th Alley Out Median		**0.306**	**0.292**	**0.273**	**4**	**330**
		Storm Difference (Geo Mean)		**-0.084**	**0.003**	**-0.022**	**-241**	**-2061**
7/10/2016	5:27	37th Alley In #1	Ind. Bottle	0.325	0.174	0.139	43	1600
7/10/2016	6:38	37th Alley In #2	Ind. Bottle	0.300	0.249	0.188	2	610
		37th Alley Out GEO Mean		**0.312**	**0.208**	**0.162**	**NA**	**988**
		37th Alley Out Median		**0.313**	**0.212**	**0.164**	**NA**	**1105**
7/10/2016	6:26	37th Alley Out #1	Ind. Bottle	0.309	0.290	0.279	1	140
7/10/2016	6:56	37th Alley Out #2	Ind. Bottle	0.356	0.350	0.338	91	120
		37th Alley Out GEO Mean		**0.332**	**0.319**	**0.307**	**NA**	**130**
		37th Alley Out Median		**0.333**	**0.320**	**0.309**	**NA**	**130**
		Storm Difference (Geo Mean)		**0.019**	**0.110**	**0.145**	**NA**	**-858**

Table 14-18 (cont.). The 2016 37th Alley paired storm comparison of composites and individual bottles during storm. Cells were colored yellow where the geo. mean comparison or storm comparison data appears to be exporting.

Date Sample d	Time	Site Location	Type	TP	TDP	Ortho-P	TSS	Fe
				mg/L	mg/L	mg/L	mg/L	ug/L
7/27/2016	13:41	37th Alley In #1	Ind. Bottle	0.287	0.139	0.144	66	1200
7/27/2016	13:43	37th Alley In #2	Ind. Bottle	0.341	0.126	0.154	136	2200
7/27/2016	13:50	37th Alley In #3	Ind. Bottle	0.473	0.191	0.252	245	3500
7/27/2016	13:56	37th Alley In #4	Ind. Bottle	0.498	0.177	0.215	161	2300
7/27/2016	15:05	37th Alley In #5	Ind. Bottle	0.367	0.079	0.124	53	2000
		37th Alley Out GEO Mean		**0.385**	**0.136**	**0.172**	**113**	**2117**
		37th Alley Out Median		**0.367**	**0.139**	**0.154**	**136**	**2200**
7/27/2016	14:10	37th Alley Out #1	Ind. Bottle	0.311	0.299	0.293	NA	80
7/27/2016	14:40	37th Alley Out #2	Ind. Bottle	0.293	0.249	0.250	8	NA
7/27/2016	15:10	37th Alley Out #3	Ind. Bottle	0.266	0.251	0.239	4	100
7/27/2016	15:40	37th Alley Out #4	Ind. Bottle	0.265	0.159	0.245	4	160
7/27/2016	16:10	37th Alley Out #5	Ind. Bottle	0.196	0.180	0.160	9	230
		37th Alley Out GEO Mean		**0.263**	**0.222**	**0.233**	**5**	**131**
		37th Alley Out Median		**0.266**	**0.249**	**0.245**	**6**	**130**
		Storm Difference (Geo Mean)		**-0.122**	**0.085**	**0.061**	**-108**	**-1986**
8/4/2016	7:05	37th Alley In #1	Ind. Bottle	0.613	0.218	0.320	308	5100
8/4/2016	7:09	37th Alley In #2	Ind. Bottle	0.452	0.216	0.239	324	2700
8/4/2016	7:12	37th Alley In #3	Ind. Bottle	0.380	0.198	0.208	229	1900
8/4/2016	7:16	37th Alley In #4	Ind. Bottle	0.340	0.176	0.185	188	1800
8/4/2016	7:18	37th Alley In #5	Ind. Bottle	0.328	0.177	0.196	171	1500
8/4/2016	7:21	37th Alley In #6	Ind. Bottle	0.300	0.168	0.167	99	1100
8/4/2016	7:23	37th Alley In #7	Ind. Bottle	0.303	0.180	0.182	79	800
8/4/2016	7:25	37th Alley In #8	Ind. Bottle	0.303	0.172	0.169	93	1100
8/4/2016	7:39	37th Alley In #9	Ind. Bottle	0.270	0.153	0.148	69	790
8/4/2016	7:47	37th Alley In #10	Ind. Bottle	0.251	0.133	0.142	139	1100
8/4/2016	7:55	37th Alley In #11	Ind. Bottle	0.223	0.124	0.130	58	540
8/4/2016	8:10	37th Alley In #12	Ind. Bottle	0.201	0.118	0.127	56	550
8/4/2016	8:16	37th Alley In #13	Ind. Bottle	0.255	0.104	0.163	280	1900
8/4/2016	8:19	37th Alley In #14	Ind. Bottle	0.355	0.113	0.148	351	2700
8/4/2016	8:22	37th Alley In #15	Ind. Bottle	0.298	0.120	0.130	132	1200
8/4/2016	8:24	37th Alley In #16	Ind. Bottle	0.251	0.132	0.149	96	990
8/4/2016	8:27	37th Alley In #17	Ind. Bottle	0.228	0.124	0.144	92	640
8/4/2016	8:29	37th Alley In #18	Ind. Bottle	0.215	0.131	0.139	61	550
		37th Alley Out GEO Mean		**0.297**	**0.149**	**0.166**	**130**	**1224**
		37th Alley Out Median		**0.299**	**0.143**	**0.156**	**116**	**1100**
8/4/2016	7:04	37th Alley Out #1	Ind. Bottle	0.174	0.136	0.072	22	370
8/4/2016	7:34	37th Alley Out #2	Ind. Bottle	0.187	0.165	0.157	7	180
8/4/2016	8:34	37th Alley Out #3	Ind. Bottle	0.231	0.208	0.196	4	150
8/4/2016	9:04	37th Alley Out #4	Ind. Bottle	0.259	0.238	0.236	5	170
8/4/2016	9:34	37th Alley Out #5	Ind. Bottle	0.251	0.236	0.229	5	190
8/4/2016	10:04	37th Alley Out #6	Ind. Bottle	0.370	0.343	0.327	4	260
8/4/2016	10:34	37th Alley Out #7	Ind. Bottle	0.387	0.354	0.336	4	220
8/4/2016	11:04	37th Alley Out #8	Ind. Bottle	0.355	NES	0.297	NES	NES
		37th Alley Out GEO Mean		**0.266**	**0.228**	**0.211**	**6**	**211**
		37th Alley Out Median		**0.255**	**0.236**	**0.233**	**5**	**190**
		Storm Difference (Geo Mean)		**-0.031**	**0.078**	**0.044**	**-124**	**-1013**
8/10/2016	20:55	37th Alley - In	Composite	0.277	0.167	0.162	68	660
8/11/2016	6:48	37th Alley - Out	Composite	0.313	0.259	0.287	1	130
		Storm Difference		**0.036**	**0.092**	**0.125**	**-67**	**-530**

Table 14-18 (cont.). The 2016 37th Alley paired storm comparison of composites and individual bottles during storm. Cells were colored yellow where the geo. mean comparison or storm comparison data appears to be exporting.

Date Sampled	Time	Site Location	Type	TP mg/L	TDP mg/L	Ortho-P mg/L	TSS mg/L	Fe ug/L
9/15/2016	19:05	37th Alley - In	Composite	0.467	0.246	0.237	42	820
9/15/2016	19:34	37th Alley - Out	Composite	0.308	0.260	0.260	4	150
		Storm Difference		**-0.159**	**0.014**	**0.023**	**-38**	**-670**
9/22/2016	3:32	37th Alley - In	Composite	0.346	0.144	0.120	117	1500
9/22/2016	5:11	37th Alley - Out	Composite	0.272	0.260	0.244	3	210
		Storm Difference		**-0.074**	**0.116**	**0.124**	**-114**	**-1290**
10/5/2016	5:06	37th Alley In	Composite	0.395	0.209	0.230	59	780
10/5/2016	5:59	37th Alley Out	Composite	0.250	0.223	0.224	3	120
		Storm Difference		**-0.145**	**0.014**	**-0.006**	**-57**	**-660**
10/6/2016	23:06	37th Alley - In	Composite	0.371	0.239	0.309	35	610
10/7/2016	0:37	37th Alley - Out	Composite	0.270	0.240	0.254	2	140
		Storm Difference		**-0.101**	**0.001**	**-0.055**	**-32**	**-470**

The 37th & Morgan site has a large tree on the southeast corner of the IESF that shades the IESF much of the day (**Figure 14-3**). Many of the IESF plantings are large and dense bushes that also provide shade. This shading may prevent the 37th & Morgan IESF from drying out completely, creating anaerobic conditions, which may contribute to the export of Fe via iron reducing or other chemotrophic bacteria.

In 2015, it was apparent the 37th & Morgan site was exporting both dissolved phosphorus and Fe. It was theorized that increased ventilation and drying may remedy the problem. The wood chips were removed at the end of 2015. Prior to monitoring in 2016, the end caps were removed from the outlet and a standpipe was added to the capped underdrain end in an attempt to improve ventilation and drying.

In 2016, the 37th & Morgan IESF followed a similar pattern to 2015 with regards to dissolved phosphorus. This site initially appeared to be removing dissolved phosphorus in early summer, but after early July 2016, when comparing the geometric means of the in/out of individual bottle storm sampling or composites, the IESF appeared to be exporting dissolved phosphorus. The venting and woodchip removal changes made appear to have had no effect on phosphorus.

Figure 14-11 shows an example from 2015 where the increasingly orange color of the 37th & Morgan Outlet sample bottles is a result of iron leaving the filter. From the top of the picture moving counterclockwise, the bottles get progressively darker as the filter exported more iron through the storm. In 2016, the iron exporting via the outlet seems to have been significantly reduced through the removal of wood chips, the addition of a vent to the underdrain, and removal of the outlet end caps. Even with these changes, the 37th & Morgan site was still exporting a small amount of iron in early spring and late fall.

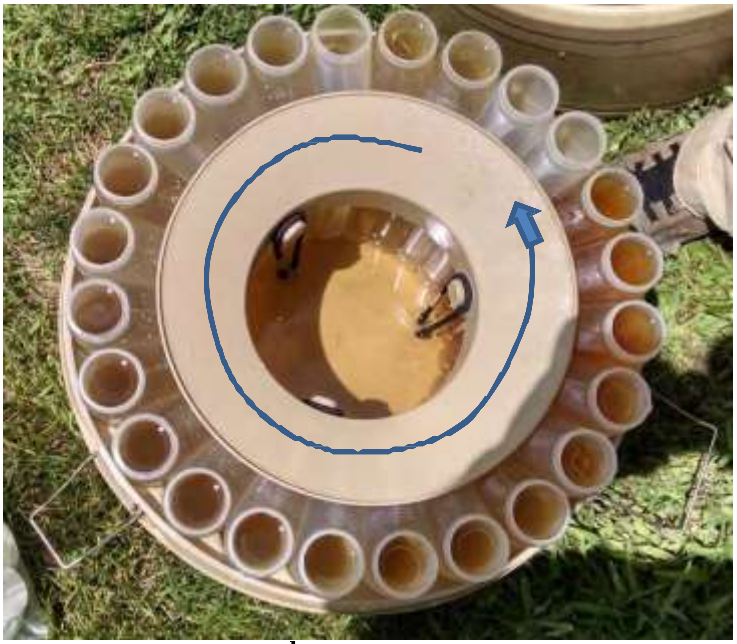


Figure 14-11. The 2015 37th & Morgan Outlet samples. Starting at 1 o'clock and moving counter clockwise samples progress through the storm.

In both 2015 and 2016, the 37th Alley IESF site appears to have removed TP, TSS, and Fe, but in early July it began exporting dissolved phosphorus. The few times in 2016 the 37th & Alley site exported TP were believed to be due to high Outlet dissolved phosphorus that inflated the Outlet TP concentration.

In 2016, the 37th Alley IESF also followed a similar pattern to 2015, with regards to dissolved phosphorus export. Unfortunately in 2016 there were only two storms collected in May and none in June, but during both May storms the IESF removed dissolved phosphorus. In 2016, the 37th Alley IESF initially appeared to remove dissolved phosphorus in early summer, but after July, when it appeared to export dissolved phosphorus regularly as shown by a comparison between the geometric means of the Inlet and Outlet.

Similar to 2015, the 37th Alley site did not export iron in 2016. The 37th Alley site is not as shaded and has full sun most of the day (**Figure 24-1**). Drier conditions that do not favor formation of anaerobic conditions or the presence of iron reducing bacteria may explain why this IESF does not export iron.

Since both IESFs exported dissolved phosphorus after mid-summer, the nutrient export phenomenon is possibly tied to temperature and/or a biological process that transforms TP into dissolved phosphorus within the IESFs. Both IESFs removed TP from stormwater. This TP could then be digested by biological soil organisms, transforming the TP into TDP and Ortho-P. The dissolved phosphorus export finding could also be due to the biological transformation of TP within the compost, placed during construction, in the iron enhanced sand filters for plant growth (**Figure 14-12)**.

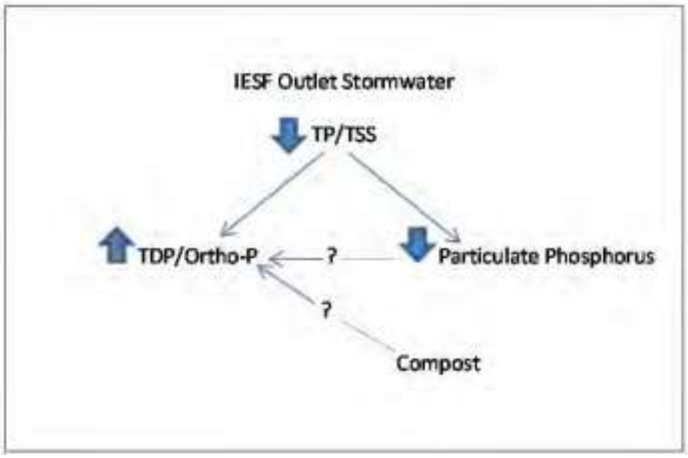


Figure 14-12. Diagram of IESF increasing and decreasing concentrations of phosphorus and possible paths. Question marks represent transformation of TP via biological activity. The blue arrows represent an increase or decrease in phosphorus.

Individual Bottle findings from the 37th & Morgan Site

Graphs and explanation of the storm events where individual bottles were tested at the 37th & Morgan site are presented below.

Figure 14-13 shows an example of the 2015 events with individual Inlet and Outlet bottles sampled throughout the storm at 37th & Morgan. The graphs show the Ortho-P In/Out and the Fe In/Out, on the same time scale. This site received street runoff which was very high in organics from its residential watershed. The figure shows very high Outlet Ortho-P values and a sharply increasing Fe concentration at the end of the storm.

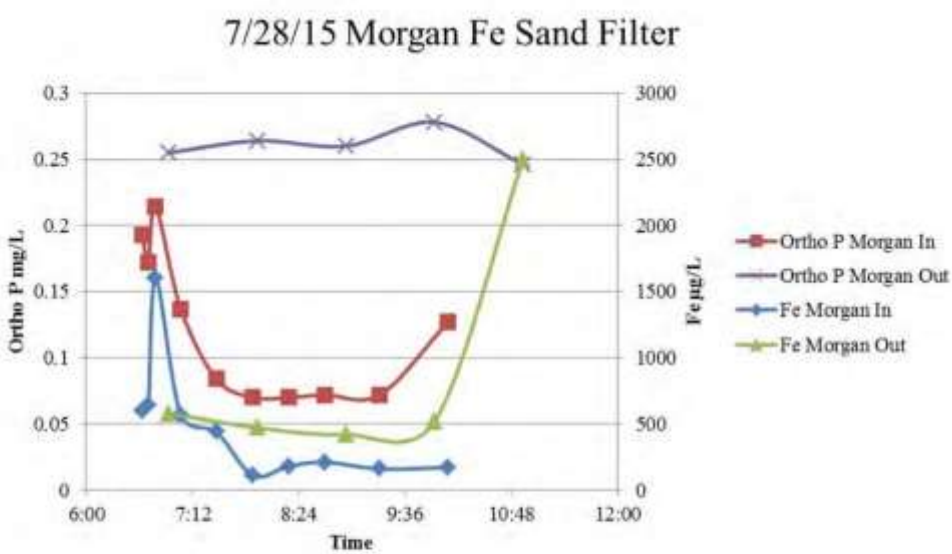


Figure 14-13. The 2015 example of the 37th & Morgan IESF In/Out concentration of individual bottles during the 7/28/15 storm of 0.21".

With the 2015 Fe export at 37th & Morgan largely remediated (**Table 14-18)**, the 2016 individual bottle figures focused largely on TP and Ortho-P. **Figures 14-14 through 14-17** show the 2016 events with individual Inlet and Outlet bottles sampled throughout the storm at 37th & Morgan. The 2016 graphs show both the TP and Ortho-P In/Out on the same time scale. This site received street runoff which was very high in organics from the residential watershed. With the 2016 changes made (standpipe venting, end cap and wood chip removal), iron export was not of significant concern and was not graphed. In the graphs below the green line (In Ortho-P) and orange line (Out Ortho-P) show a change after July and an export of dissolved phosphorus.

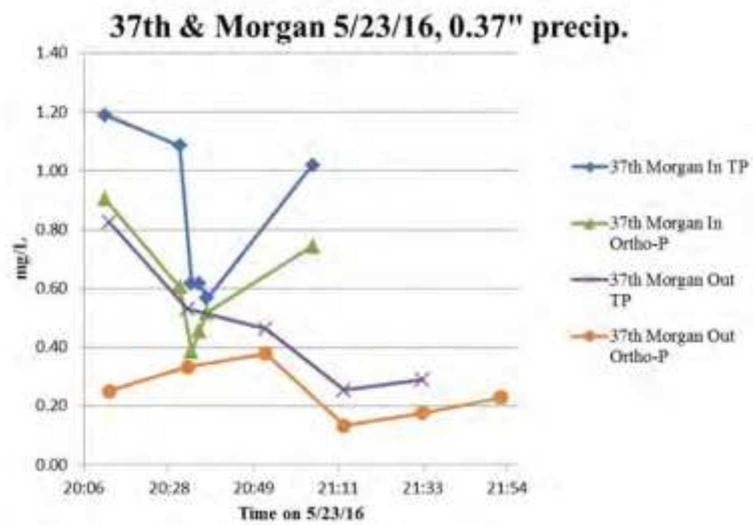


Figure 14-14. The 2016 37th & Morgan IESF In/Out concentration of individual bottles during the 5/23/16 storm of 0.37".

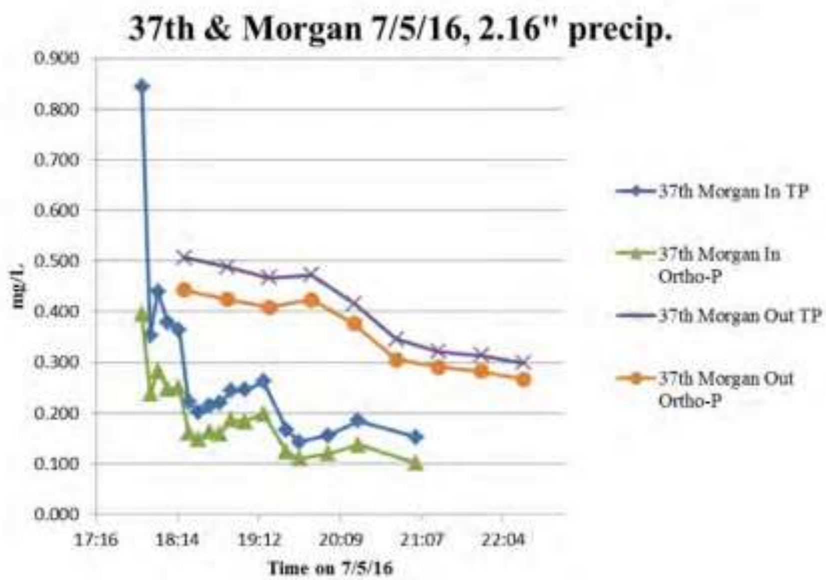


Figure 14-15. The 2016 37th & Morgan IESF In/Out concentration of individual bottles during the 7/5/16 storm of 2.16".

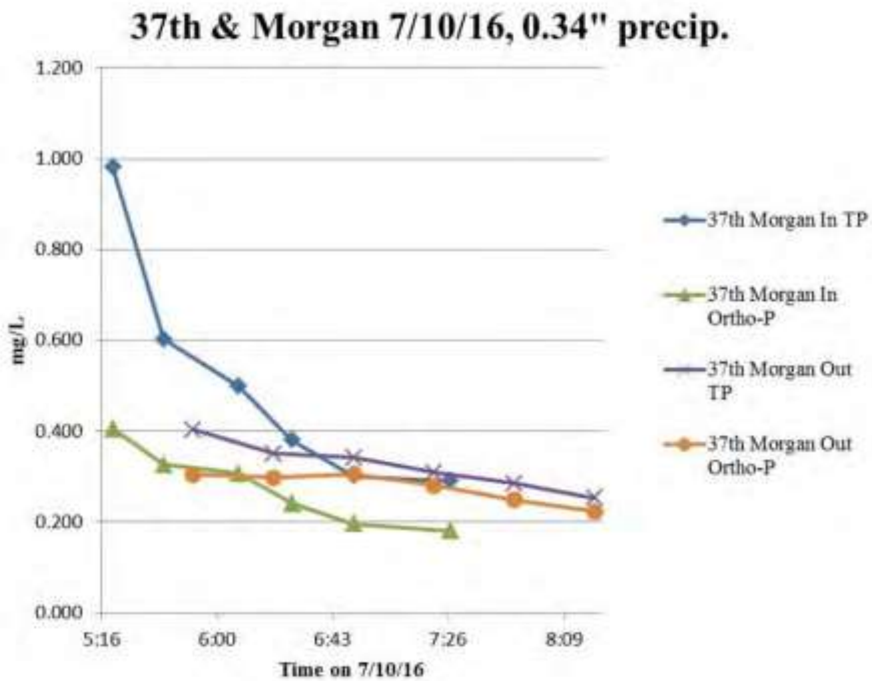


Figure 14-16. The 2016 37th & Morgan IESF In/Out concentration of individual bottles during the 7/10/16 storm of 0.34”.

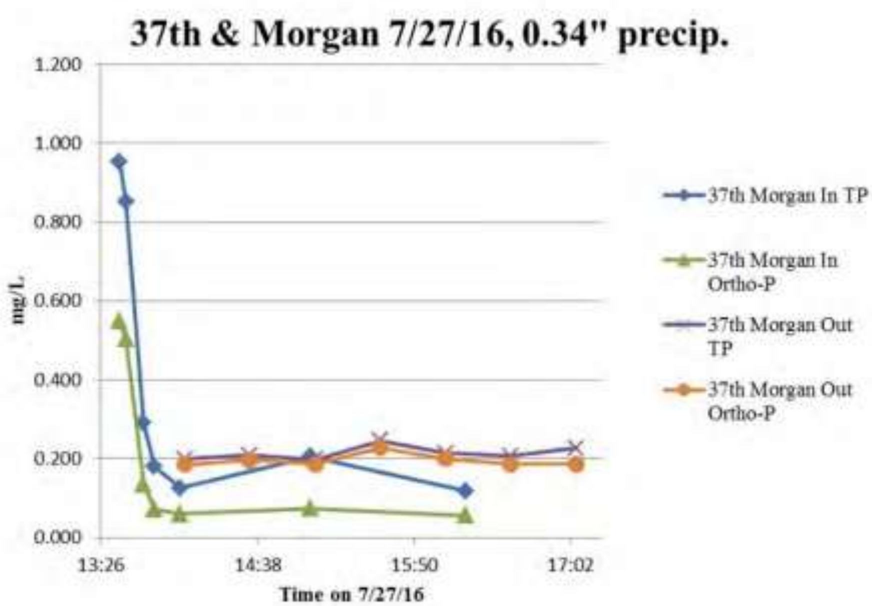


Figure 14-17. The 2016 37th & Morgan IESF In/Out concentration of individual bottles during the 7/27/2016 storm of 0.34”

In 2015, the 37th & Morgan site exported iron and dissolved phosphorus after mid July. In 2016, starting in early July, the 37th & Morgan site appears to only be exporting dissolved phosphorus, and the venting changes made appear to have largely solved the export of iron.

It should be noted that phosphorus remains iron bound only during aerobic conditions. If iron bound phosphorus becomes anaerobic, the bond releases and phosphorus becomes mobile. It is theorized dissolved phosphorus export from the filters may be resulting from multiple things. The organic solids load coming from the street may be decomposing, causing particulate total phosphorus to be digested into dissolved phosphorus. Anaerobic digestion of organic solids may also create conditions where iron bound phosphorus is released within the filter. Compost added to the filter for plant growth also may be releasing phosphorus.

Individual Bottle findings from the 37th & Alley Site

Graphs and explanation of the storm events where individual bottles were tested at the 37th Alley site are presented below.

Figure 14-18 shows an example of the 2015 37th Alley Ortho-P In/Out and the iron In/Out. This site has not exported iron and increasingly exports Ortho-P during a storm.

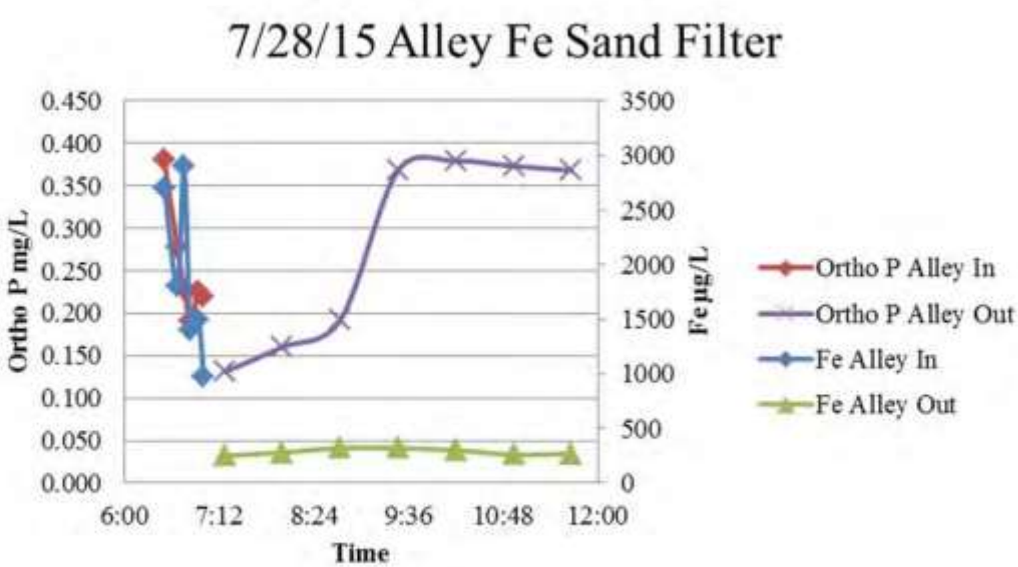


Figure 14-18. The 2015 37th Alley IESF In/Out concentration of individual bottles during the 7/28/15 storm of 0.21".

Since iron export was not a concern at the 37th Alley site, **Figures 14-19 through 14-21** show the 2016 37th Alley TP and Ortho-P In/Out individual bottle data. In the graphs below the green line (In Ortho-P) and orange line (Out Ortho-P) show an export of phosphorus through the storm. Large storms of greater than 2 inches appear to have a similar pattern. The Ortho-P at the Outlet is lower than the Inlet at the beginning of the storm and during the storm the Outlet

Ortho-P surpasses the Inlet Ortho-P concentrations, explaining the net export of dissolved phosphorus for the storm.

The dissolved phosphorus export has two possible explanations. First, particulate phosphorus contained in organic solids could be breaking down and transforming into dissolved phosphorus. Second, phosphorus export could be due to dissolved phosphorus leaching out of the IESF itself from phosphorus laden material within the BMP (i.e. compost). It is not believed that iron bound phosphorus is being released at the 37th Alley site due to anaerobic conditions, since the iron is not mobilized in the Outlet samples (as seen in the 2015, 37th & Morgan samples).

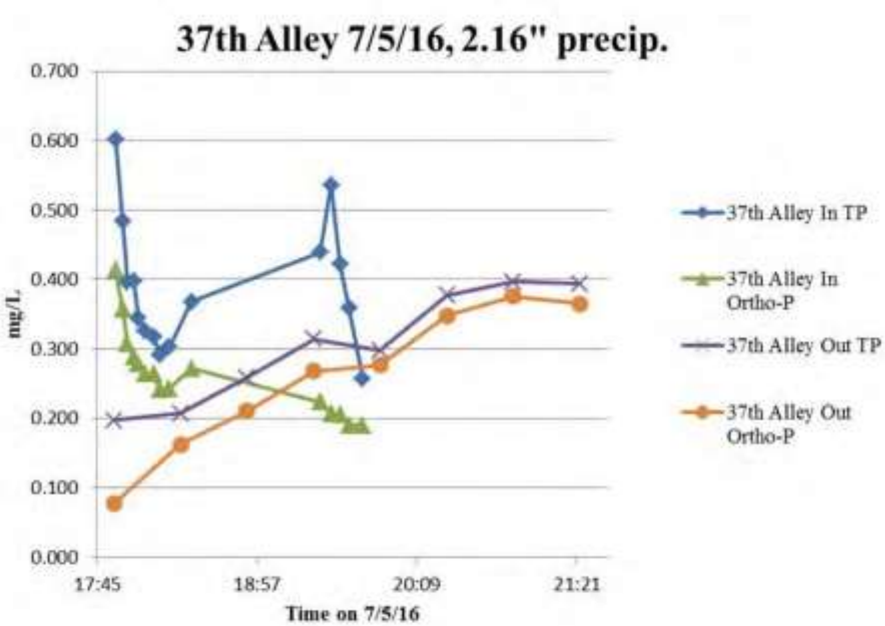


Figure 14-19. The 2016 37th Alley IESF In/Out concentration of individual bottles during the 7/5/16 storm of 2.16".

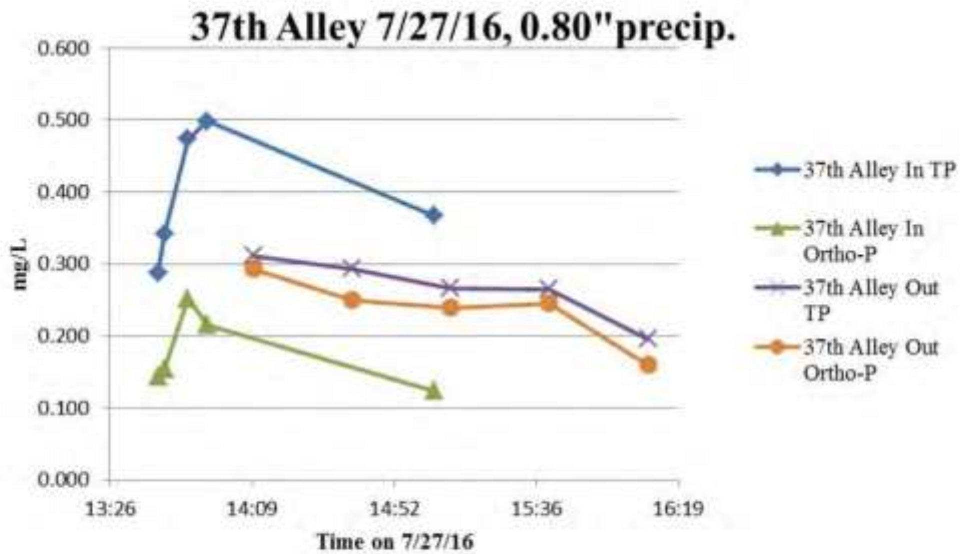


Figure 14-20. The 2016 37th Alley IESF In/Out concentration of individual bottles during the 7/27/16 storm of 0.80".

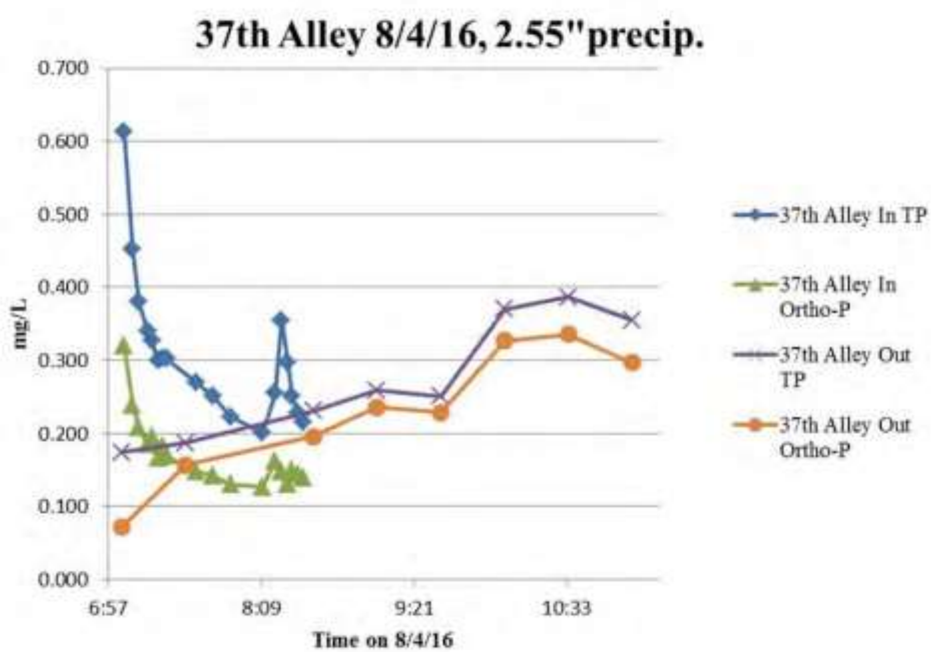


Figure 14-21. The 2016 37th Alley IESF In/Out concentration of individual bottles during the 8/4/16 storm of 2.55".

Storm Event Statistics from the 37th & Morgan Site.

The 37th & Morgan 2015 and 2016 storm summary statistics are presented below.

Table 14-19 shows the 37th & Morgan statistics for the 2015 Inlet and Outlet summary data and **Table 14-20** shows the 37th & Morgan statistics for the 2016 Inlet and Outlet summary data. The bold values are the geometric means of the storms where individual bottles were analyzed. The brown table is the 2015 data and the blue table is the 2016 data.

Table 14-19. The 2015 37th & Morgan In/Out statistics. The bold values, from the Indv Bottle Storm events, are the geometric mean of all of the bottles collected for that storm for storm events where individual bottles were analyzed.

Date Sample d/Time	Site Location	Sample Type	TP mg/L	TDP mg/L	Ortho-P mg/L	TSS mg/L	Fe ug/L
06/11/15 08:24	37th & Morgan In	Composite	0.956	0.575	0.553	13	1000
06/20/15 07:04	37th & Morgan In	Composite	0.872	0.273	0.341	130	2300
06/26/15 17:45	37th & Morgan In	Composite	0.965	0.186	0.542	119	4800
07/13/15 02:12	37th & Morgan In	Indv Btl.	**0.346**	**0.029**	**0.064**	**54**	**862**
07/18/15 04:49	37th & Morgan In	Composite	0.199	0.107	0.106	15	230
07/28/15 10:05	37th & Morgan In	Indv Btl.	**0.213**	**0.104**	**0.110**	**15**	**334**
08/07/15 01:16	37th & Morgan In	Composite	0.433	0.077	0.119	55	490
08/09/15 14:42	37th & Morgan In	Composite	0.425	0.187	0.187	17	530
08/18/15 21:34	37th & Morgan In	Composite	0.132	0.061	0.068	9	140
09/10/15 05:29	37th & Morgan In	Composite	0.120	0.098	0.070	11	200
09/17/15 07:12	37th & Morgan In	Indv Btl.	**0.234**	**0.136**	**0.125**	**39**	**239**
09/24/15 07:09	37th & Morgan In	Indv Btl.	**0.259**	**0.193**	**0.121**	**12**	**312**
10/28/15 05:30	37th & Morgan In	Indv Btl.	**1.13**	**0.962**	**0.850**	**13**	**32**
	MEAN (geometric)		**0.369**	**0.151**	**0.171**	**25**	**420**
	MEAN (artithmatic)		**0.483**	**0.230**	**0.251**	**39**	**882**
	MAX		**1.13**	**0.962**	**0.850**	**130**	**4800**
	MIN		**0.120**	**0.029**	**0.064**	**9**	**32**
	MEDIAN		**0.346**	**0.136**	**0.121**	**15**	**334**
	STDEV		**0.347**	**0.250**	**0.239**	**40**	**1267**
	NUMBER		**13**	**13**	**13**	**13**	**13**
	COV		**0.719**	**1.09**	**0.952**	**1**	**1**

Date Sample d/Time	Site Location	Sample Type	TP mg/L	TDP mg/L	Ortho-P mg/L	TSS mg/L	Fe ug/L
06/11/15 13:36	37th & Morgan Out	Composite	0.364	0.222	0.243	52	3700
06/20/15 13:27	37th & Morgan Out	Composite	0.262	0.121	0.118	8	2300
06/26/15 23:15	37th & Morgan Out	Composite	0.286	0.044	0.115	18	8300
07/13/15 06:12	37th & Morgan Out	Indv Btl.	**0.223**	**0.163**	**0.208**	**2**	**1456**
07/18/15 02:52	37th & Morgan Out	Composite	0.322	0.146	0.244	11	4600
07/28/15 10:56	37th & Morgan Out	Indv Btl.	**0.296**	**0.243**	**0.260**	**2**	**683**
08/07/15 09:21	37th & Morgan Out	Composite	0.269	0.127	0.175	9	2500
08/10/15 08:36	37th & Morgan Out	Composite	0.395	0.248	0.285	11	4900
08/19/15 04:30	37th & Morgan Out	Composite	0.203	0.147	0.169	2	980
09/10/15 08:22	37th & Morgan Out	Indv Btl.	0.209	0.140	0.189	5	2000
09/17/15 10:02	37th & Morgan Out	Indv Btl.	**0.229**	**0.154**	**0.187**	**2**	**1429**
09/24/15 08:23	37th & Morgan Out	Indv Btl.	**0.239**	**0.184**	**0.182**	**4**	**1014**
10/28/15 10:55	37th & Morgan Out	Indv Btl.	**0.903**	**0.823**	**0.797**	**6**	**890**
	MEAN (geometric)		**0.295**	**0.171**	**0.213**	**6**	**2031**
	MEAN (artithmatic)		**0.323**	**0.212**	**0.244**	**10**	**2673**
	MAX		**0.903**	**0.823**	**0.797**	**52**	**8300**
	MIN		**0.203**	**0.044**	**0.115**	**2**	**683**
	MEDIAN		**0.269**	**0.154**	**0.189**	**6**	**2000**
	STDEV		**0.177**	**0.184**	**0.167**	**13**	**2109**
	NUMBER		**13**	**13**	**13**	**13**	**13**
	COV		**0.546**	**0.865**	**0.684**	**1**	**1**

Table 14-20. The 2016 37th & Morgan In/Out statistics. The bold values marked Indv Bottle are the geometric mean of all of the bottles collected for that storm for storm events where individual bottles were analyzed.

Date Sampled	Time	Site Location	Type	TP	TDP	Ortho-P	TSS	Fe
				mg/L	mg/L	mg/L	mg/L	ug/L
5/23/2016	21:05	37th & Morgan In	Ind. Bottle	**0.811**	**0.577**	**0.419**	**110**	**1939**
5/25/2016	13:33	37th & Morgan In	Composite	0.954	0.931	0.604	97	1100
6/30/2016	11:49	37th & Morgan In	Composite	3.43	1.39	0.807	108	5300
7/5/2016	21:03	37th & Morgan In	Ind. Bottle	**0.251**	**0.192**	**0.176**	**99**	**606**
7/10/2016	7:27	37th & Morgan In	Ind. Bottle	**0.463**	**0.346**	**0.265**	**27**	**512**
7/27/2016	16:14	37th & Morgan In	Ind. Bottle	**0.279**	**0.150**	**0.132**	**53**	**830**
8/11/2016	4:46	37th & Morgan In	Composite	Delete	0.057	0.053	24	220
9/22/2016	5:57	37th & Morgan In	Composite	0.231	0.082	0.052	65	790
10/5/2016	5:43	37th & Morgan In	Composite	0.268	0.129	0.137	18	290
10/7/2016	8:03	37th & Morgan In	Composite	0.262	0.152	0.198	15	240
		MEAN (geometric)		**0.482**	**0.242**	**0.198**	**48**	**716**
		MEAN (arithmatic)		**0.772**	**0.401**	**0.284**	**62**	**1183**
		MAX		**3.43**	**1.39**	**0.807**	**110**	**5300**
		MIN		**0.231**	**0.057**	**0.052**	**15**	**220**
		MEDIAN		**0.279**	**0.172**	**0.187**	**59**	**698**
		STDEV		**1.00**	**0.443**	**0.251**	**39**	**1535**
		NUMBER		**9**	**10**	**10**	**10**	**10**
		COV		**1.30**	**1.10**	**0.881**	**0.637**	**1.30**

Date Sampled	Time	Site Location	Type	TP	TDP	Ortho-P	TSS	Fe
				mg/L	mg/L	mg/L	mg/L	ug/L
5/23/2016	21:53	37th & Morgan Out	Ind. Bottle	**0.431**	**0.156**	**0.235**	**34**	**1552**
5/25/2016	13:00	37th & Morgan Out	Composite	Delete	0.334	0.283	3	2700
6/30/2016	12:19	37th & Morgan Out	Composite	0.825	0.481	0.145	25	1300
7/5/2016	22:19	37th & Morgan Out	Ind. Bottle	**0.395**	**0.350**	**0.351**	**6**	**311**
7/10/2016	8:21	37th & Morgan Out	Ind. Bottle	**0.320**	**0.289**	**0.275**	**2**	**484**
7/27/2016	17:05	37th & Morgan Out	Ind. Bottle	**0.214**	**0.200**	**0.195**	**2**	**442**
8/11/2016	7:43	37th & Morgan Out	Composite	0.217	0.199	0.205	<1	224
9/22/2016	5:35	37th & Morgan Out	Composite	0.191	0.171	0.170	2	350
10/5/2016	4:22	37th & Morgan Out	Composite	0.257	0.202	0.228	3	740
10/7/2016	6:09	37th & Morgan Out	Composite	0.170	0.150	0.164	1	440
		MEAN (geometric)		**0.296**	**0.235**	**0.218**	**4**	**626**
		MEAN (arithmatic)		**0.336**	**0.253**	**0.225**	**9**	**854**
		MAX		**0.825**	**0.481**	**0.351**	**34**	**2700**
		MIN		**0.170**	**0.150**	**0.145**	**1**	**224**
		MEDIAN		**0.257**	**0.201**	**0.217**	**3**	**463**
		STDEV		**0.220**	**0.108**	**0.064**	**12**	**784**
		NUMBER		**9**	**10**	**10**	**9**	**10**
		COV		**0.657**	**0.425**	**0.282**	**1.33**	**0.918**

When comparing the 2015 and 2016 37th & Morgan geometric mean Inlet and Outlet concentrations of all of the storms combined, the IESF filter is capturing TP and TSS and is exporting dissolved phosphorus as shown in **Tables 14-19 and 14-20**. In 2015, the 37th & Morgan site also exported iron.

In 2015, the 37th & Morgan geometric mean TP was reduced from an Inlet concentration of 0.369 mg/L to an Outlet concentration of 0.295 mg/L. In 2016, the geometric mean TP was reduced from an Inlet concentration of 0.482 mg/L to an Outlet concentration of 0.296 mg/L. It is interesting to note that it is a statistical anomaly that the Outlet geometric mean TP concentrations in 2015 and 2016 are almost exactly the same.

In 2015, the 37th & Morgan IESF filter reduced TSS from an Inlet geometric mean of 25 mg/L to 6 mg/L at the Outlet. In 2016, the TSS Inlet geometric mean was reduced from an Inlet concentration of 48 mg/L to an Outlet concentration of 4 mg/L.

In 2015 and 2016, the 37th & Morgan IESF filter did not sequester dissolved phosphorus as it was designed. In 2015, the TDP geometric mean concentrations increased from an Inlet value of 0.151 mg/L to an Outlet value of 0.171 mg/L. The Ortho-P also increased where the geometric mean Inlet concentration of 0.171 mg/L rose to an Outlet concentration of 0.213 mg/L. In 2016, the TDP geometric mean concentration decreased from an Inlet value of 0.242 mg/L to an Outlet value of 0.235 mg/L. The Ortho-P also increased where the geometric mean Inlet concentration of 0.198 mg/L increased to an Outlet concentration of 0.218 mg/L.

In 2015, the exported iron increased from an Inlet geometric mean concentration of 0.420 mg/L to an Outlet concentration of 2.031 mg/L. In 2016, the geometric mean concentration of iron decreased from 0.716 mg/L at the Inlet to an Outlet concentration of 0.626 mg/L. There was an export of iron during a few individual storms in the early spring and late fall. The venting changes at 37th & Morgan in 2016 appear to have largely stopped the mobilization and export of iron seen in 2015.

Storm Event Statistics from the 37th Alley Site.

The 37th Alley 2015 and 2016 storm summary statistics are presented below.

Table 14-21 shows the 37th Alley statistics for the 2015 Inlet and Outlet summary data. **Table 14-22** shows the 37th Alley statistics for the 2016 Inlet and Outlet summary data. The bold values are the geometric means of the storms where individual bottles were analyzed. The brown table is the 2015 data and the blue table is the 2016 data.

Table 14-21. The 2015 37th Alley In/Out statistics. The bold values, from the Indv Btl. Storm events, are the geometric mean of all of the bottles collected for that storm.

Date	Site	Sample	TP	TDP	Ortho-P	TSS	Fe
Sample d/Time	Location	Type	mg/L	mg/L	mg/L	mg/L	ug/L
06/20/15 06:00	37th Alley In	Composite	1.40	0.500	0.536	162	3100
06/22/15 08:41	37th Alley In	Composite	0.396	0.113	0.153	45	1100
07/06/15 00:41	37th Alley In	Composite	0.387	0.139	0.226	230	430
07/13/15 00:20	37th Alley In	Indv Btl.	**0.388**	**0.105**	**0.188**	**145**	**2014**
07/28/15 07:00	37th Alley In	Indv Btl.	**0.418**	**0.186**	**0.247**	**145**	**1750**
08/06/15 15:12	37th Alley In	Composite	0.672	0.212	0.283	118	2000
08/09/15 14:21	37th Alley In	Composite	0.335	0.144	0.163	26	570
08/18/15 14:35	37th Alley In	Composite	0.203	0.113	0.127	19	370
	MEAN (geometric)		**0.447**	**0.164**	**0.218**	**82**	**1102**
	MEAN (artithmatic)		**0.524**	**0.189**	**0.240**	**111**	**1417**
	MAX		**1.40**	**0.500**	**0.536**	**230**	**3100**
	MIN		**0.203**	**0.105**	**0.127**	**19**	**370**
	MEDIAN		**0.392**	**0.142**	**0.207**	**131**	**1425**
	STDEV		**0.351**	**0.123**	**0.122**	**70**	**903**
	NUMBER		**8**	**8**	**8**	**8**	**8**
	COV		**0.670**	**0.649**	**0.507**	**0.629**	**0.638**

Date	Site	Sample	TP	TDP	Ortho-P	TSS	Fe
Sample d/Time	Location	Type	mg/L	mg/L	mg/L	mg/L	ug/L
06/20/15 07:27	37th Alley Out	Composite	0.332	0.277	0.269	2	160
06/22/15 10:01	37th Alley Out	Composite	0.341	0.309	0.278	7	98
07/06/15 09:22	37th Alley Out	Composite	0.214	0.160	0.154	10	250
07/13/15 01:11	37th Alley Out	Indv Btl.	**0.145**	**0.101**	**0.107**	**3**	**265**
07/28/15 11:40	37th Alley Out	Indv Btl.	**0.339**	**0.258**	**0.258**	**6**	**285**
08/06/15 16:12	37th Alley Out	Composite	0.388	0.278	0.272	7	190
08/09/15 15:03	37th Alley Out	Composite	0.404	0.323	0.312	6	120
08/18/15 19:51	37th Alley Out	Composite	0.340	0.293	0.283	2	140
	MEAN (geometric)		**0.299**	**0.235**	**0.229**	**5**	**177**
	MEAN (artithmatic)		**0.313**	**0.250**	**0.242**	**5**	**188**
	MAX		**0.404**	**0.323**	**0.312**	**10**	**285**
	MIN		**0.145**	**0.101**	**0.107**	**2**	**98**
	MEDIAN		**0.339**	**0.278**	**0.271**	**6**	**175**
	STDEV		**0.083**	**0.073**	**0.067**	**3**	**66**
	NUMBER		**8**	**8**	**8**	**8**	**8**
	COV		**0.264**	**0.292**	**0.276**	**0.493**	**0.351**

Table 14-22. The 2016 37th Alley In/Out statistics. The bold values, from the Indv Btl. Storm events, are the geometric mean of all of the bottles collected for that storm.

Date Sampled	Time	Site Location	Type	TP mg/L	TDP mg/L	Ortho-P mg/L	TSS mg/L	Fe ug/L
5/23/2016	20:26	37th Alley In	Ind. Bottle	**0.271**	**0.149**	**0.189**	**119**	**4600**
5/25/2016	10:10	37th Alley In	Composite	0.627	0.213	0.078	309	
7/5/2016	19:45	37th Alley In	Ind. Bottle	**0.380**	**0.278**	**0.257**	**246**	**2420**
7/10/2016	6:38	37th Alley In	Ind. Bottle	**0.312**	**0.208**	**0.162**	**9**	**988**
7/27/2016	15:05	37th Alley In	Ind. Bottle	**0.385**	**0.136**	**0.172**	**113**	**2117**
8/4/2016	8:29	37th Alley In	Ind. Bottle	**0.297**	**0.149**	**0.166**	**130**	**1224**
8/10/2016	20:55	37th Alley In	Composite	0.277	0.167	0.162	68	660
9/15/2016	19:05	37th Alley In	Composite	0.467	0.246	0.237	42	820
9/22/2016	3:32	37th Alley In	Composite	0.346	0.144	0.120	117	1500
10/5/2016	5:06	37th Alley In	Composite	0.395	0.209	0.230	59	780
10/6/2016	23:06	37th Alley In	Composite	0.371	0.239	0.309	35	610
		MEAN (geometric)		**0.365**	**0.189**	**0.178**	**80**	**1271**
		MEAN (arithmatic)		**0.375**	**0.194**	**0.189**	**113**	**1572**
		MAX		**0.627**	**0.278**	**0.309**	**309**	**4600**
		MIN		**0.271**	**0.136**	**0.078**	**9**	**610**
		MEDIAN		**0.371**	**0.208**	**0.172**	**113**	**1106**
		STDEV		**0.102**	**0.048**	**0.065**	**91**	**1229**
		NUMBER		**11**	**11**	**11**	**11**	**10**
		COV		**0.271**	**0.247**	**0.344**	**0.805**	**0.782**

Date Sampled	Time	Site Location	Type	TP mg/L	TDP mg/L	Ortho-P mg/L	TSS mg/L	Fe ug/L
5/23/2016	21:05	37th Alley Out	Ind. Bottle	**0.219**	**0.154**	**0.158**	**18**	**333**
5/25/2016	10:09	37th Alley Out	Composite	0.264	0.261	0.244	18	130
7/5/2016	21:23	37th Alley Out	Ind. Bottle	**0.296**	**0.280**	**0.235**	**5**	**359**
7/10/2016	6:56	37th Alley Out	Ind. Bottle	**0.332**	**0.319**	**0.307**	**10**	**130**
7/27/2016	16:10	37th Alley Out	Ind. Bottle	**0.263**	**0.222**	**0.233**	**5**	**131**
8/4/2016	11:04	37th Alley Out	Ind. Bottle	**0.266**	**0.228**	**0.211**	**6**	**211**
8/11/2016	6:48	37th Alley Out	Composite	0.313	0.259	0.287	1	130
9/15/2016	19:34	37th Alley Out	Composite	0.308	0.260	0.260	4	150
9/22/2016	5:11	37th Alley Out	Composite	0.272	0.260	0.244	3	210
10/5/2016	5:59	37th Alley Out	Composite	0.250	0.223	0.224	3	120
10/7/2016	0:37	37th Alley Out	Composite	0.270	0.240	0.254	2	140
		MEAN (geometric)		**0.276**	**0.242**	**0.238**	**5**	**172**
		MEAN (arithmatic)		**0.277**	**0.246**	**0.242**	**7**	**186**
		MAX		**0.332**	**0.319**	**0.307**	**18**	**359**
		MIN		**0.219**	**0.154**	**0.158**	**1**	**120**
		MEDIAN		**0.270**	**0.259**	**0.244**	**5**	**140**
		STDEV		**0.032**	**0.041**	**0.039**	**6**	**86**
		NUMBER		**11**	**11**	**11**	**11**	**11**
		COV		**0.116**	**0.168**	**0.162**	**0.876**	**0.460**

The 2015 37th Alley TP decreased from an Inlet geometric mean concentration of 0.447 mg/L to an Outlet concentration of 0.299 mg/L. The 2016 TP decreased from an Inlet geometric mean concentration of 0.365 mg/L to an Outlet concentration of 0.276 mg/L.

In 2015, the TDP and Ortho-P both increased from Inlet geometric means of 0.164 and 0.218 to outlet geometric means of 0.277 and 0.269, respectively. In 2016, TDP and Ortho-P both increased from Inlet geometric means of 0.189 and 0.178 to outlet geometric means of 0.242 and 0.238, respectively.

The 2015, TSS decreased from an Inlet geometric mean of 82 mg/L to an outlet concentration of 5 mg/L. Similarly, the 2016 TSS decreased from an Inlet geometric mean of 80 mg/L to an outlet concentration of 5 mg/L.

The 2015 site captured iron with an Inlet geometric mean of 1102 µg/L and an outlet concentration of 177 µg/L. The 2016 37th Alley site also captured iron with an Inlet geometric mean of 1271 µg/L and an outlet concentration of 172 µg/L.

Conclusions

Woodchips installed during construction were used to retain moisture for the plants in the IESF and were likely retaining moisture and further preventing IESFs from drying out. Prolonged wet conditions within the IESFs could lead to conditions favoring phosphorus and iron export, either though chemical or biological transformation.

Both 2015 and 2016 data show that generally the 37th & Morgan and the 37th Alley IESFs export more dissolved phosphorus than they receive. Particulate phosphorus may be transformed into dissolved phosphorus in the filter, or compost which was added to the IESF during construction could be an internal source of dissolved or total phosphorus. It is believed that phosphorus export is facilitated by IESF conditions remaining wet. The inability for the filters to dry is likely leading to a chemically or microbiologically facilitated release of dissolved phosphorus.

In 2015, the 37th & Morgan IESF exported iron. It is possible that shading is preventing the IESF from drying out and causing anaerobic soil conditions, leading to the mobilization of iron by iron reducing bacteria. A combination of the wood chip removal, removal of outlet end caps, and venting the sub-surface drain pipe to the atmosphere mitigated this problem to a large extent. Iron export at 37th & Morgan site was seen in only a handful of individual storms in early spring and late fall in 2016. Aerobic conditions appear to be necessary to prevent the loss of iron.

It should also be noted that although this study used best available monitoring technology, stormwater contains solids that are greater than 3/8", the size of the intake tubing. Any solids larger than this size, like leaves or cigarette butts, are not able to be pumped through the intake strainer and cannot be sampled. Undoubtedly, both IESF Inlets are receiving more solids and TP than can be measured

When siting additional IESFs it is recommended that:

- Future IESFs be constructed in sunny areas to facilitate drying and prevent anaerobic conditions.
- Construction of the underdrain pipe slope should be carefully constructed to always drain.
- Pretreatment is done to remove sediment and organic matter, as excess sediment and organic matter could lead to anaerobic conditions in the IESF.
- Careful considerations are taken to determine whether compost is needed, as it may be a phosphorus source.
- Limited vegetation is planted, as it both produces shading and retains moisture which appears to be detrimental to their functionality at removing dissolved phosphorus.

37th & Oliver Flood Relief Vault

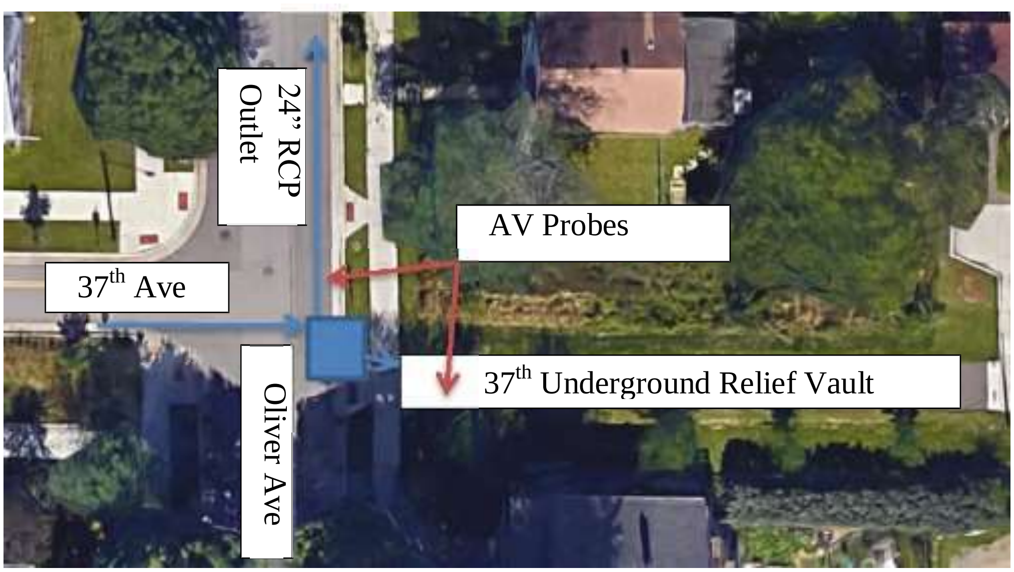
BACKGROUND

Due to historical flooding of streets and basements in this area of North Minneapolis, a series of large vaults were installed underground and work together to create flood storage. The vaults were designed to decrease surcharging and regular pipe full events in storm sewers. Data collected in this study will be used with watershed modeling to determine vault flood storage efficiency and inform improvements for future designs.

The 37th Greenway flood relief vault was built for downstream flood relief in 2011, **Figure 14-22**. The underground flood retention vault at 37th and Oliver Avenue North was monitored in 2015 and 2016 to determine if the vault provided hydraulic relief for the downstream 24" reinforced concrete pipe (RCP). This study used stage as a proxy for hydraulic pressure. The monitored vault is one of multiple flood vaults installed in the 37th Greenway.

The project drainage area is 5.5 acres, 50% impervious, and residential with a dense tree canopy.

Figure 14-22. Map of 37th Greenway Flood Relief Vault project.



Methods

Equipment Used and Installation

On 5/5/16, monitoring equipment was installed at the 37th Greenway vault and the 24" downstream pipe. The equipment consisted of a 2105ci cell phone modem, two 2150 dataloggers, two battery modules, and two area velocity (AV) probes. An AV probe was installed in the downstream 24" pipe using an extra-long cable and a spring ring. Another AV probe was installed in the vault using a standard cable. Equipment was removed on 11/4/2016.

Help from MPRB cement masons was critical to the success of the project due to the large number of eye-bolts and anchors needed to anchor equipment. **Figure 14-23** shows the level probe being anchored to the vault floor. **Figure 14-24** shows the outlet to the vault leading to the 24" downstream pipe. The 24" downstream pipe required a spring ring, because it was installed about 4 feet into the downstream pipe where it is not possible to use power tools. **Figures 14-25** and **14-26** show the 24" downstream pipe installation and final spring ring configuration. A cell phone antenna was buried in the sidewalk for better reception.

Both dataloggers at the site were programed to upload data to a network database via a cell phone modem from Monday through Friday (to conserve power).

Figure 14-23. AV Anchor plate being installed in the vault floor.

Figure 14-24. The vault entrance/exit pipe (right) and 24" downstream pipe (left).

Figure 14-25. Installation of the spring ring in the 24" downstream pipe.

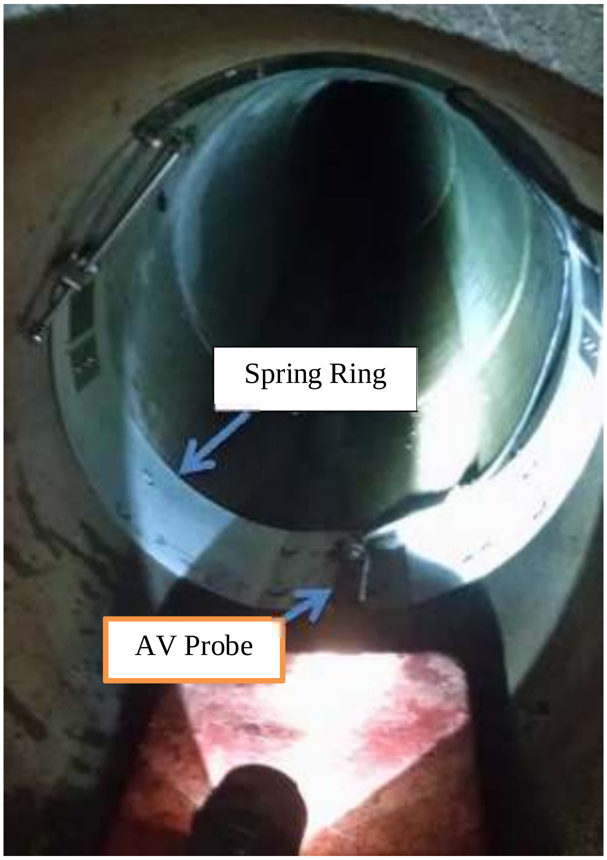


Figure 14-26. The spring ring and AV probe installed in the 24" downstream pipe.

A tipping bucket rain gauge and Hobo datalogger were installed on the roof of Folwell Park on 5/5/2016 and removed 11/7/2016. Folwell Park is approximately ¼ mile east of the 37th vault site monitored.

RESULTS & DISCUSSION

A storm is considered anything greater than 0.10" of precipitation, with 8 hours of no precipitation between events to separate storms. **Figure 14-27** shows storm events recorded at Folwell Park in 2016. The most intense large storm was on 8/4/2016 where 2.55" of precipitation fell in 2 hours and 18 minutes. Total precipitation measured from 5/5/2016 – 11/7/2016 was 29.47".

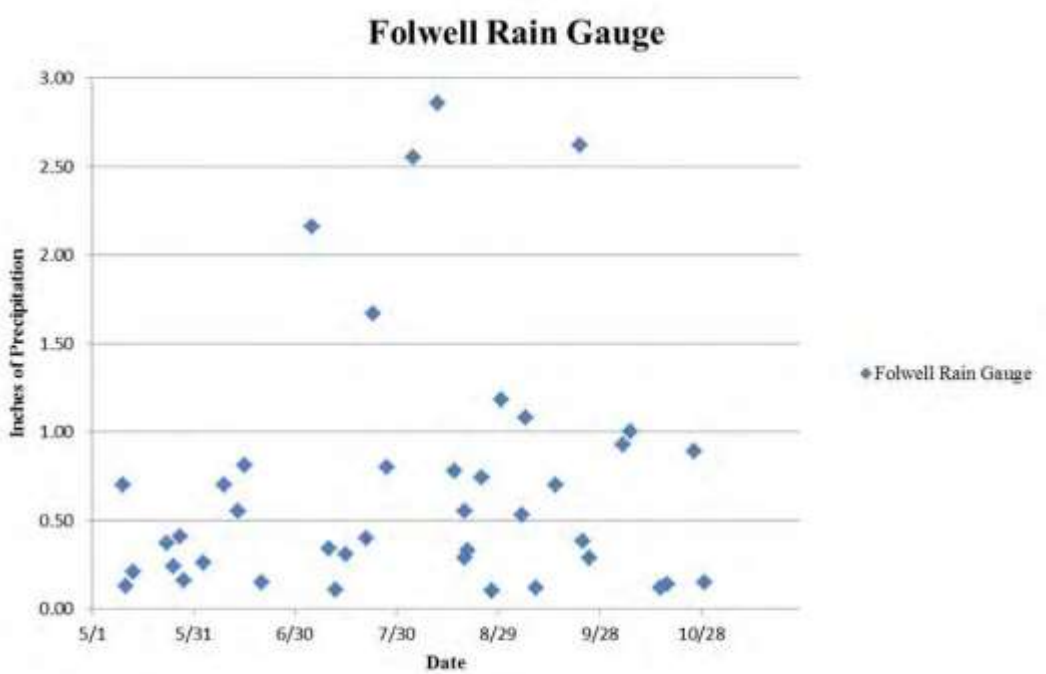


Figure 14-27. 2016 precipitation totals at Folwell Park rain gauge. Stage and Discharge Data

Figure 14-28 shows the stage and flow in the downstream pipe and stage in the vault. The vault appeared to provide a maximum amount of approximately three inches of stage reduction in the downstream pipe compared to the level in the vault during the largest and most intense storm of 2016. The flood relief in the pipe appears minimal for small storms but may have a significant effect for very large and more intense storms that were not experienced in 2016.

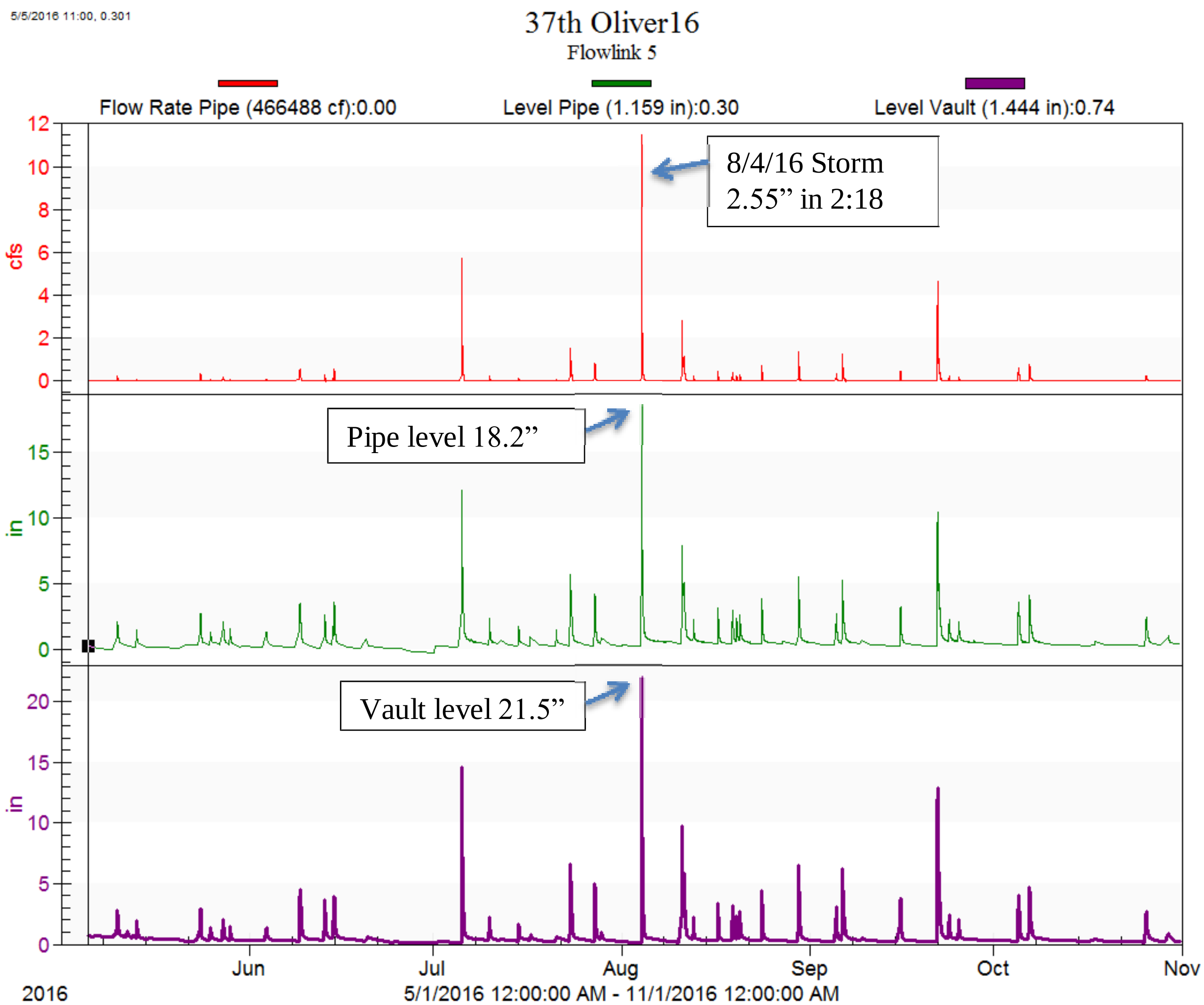


Figure 14-28. Graph of the pipe stage and discharge, and the level in the vault.

In conclusion, using stage as a proxy for hydraulic pressure, the vault appears to attenuate hydraulic pressure in the downstream 24" RCP during peak discharge. The stage in the underground vault varied when compared to the 24" downstream pipe and relieved a maximum of approximately three inches of hydraulic pressure as represented by stage in the downstream pipe, as shown in **Figure 14-28**. The stage in the pipe never exceeded 18.2 inches during the largest storm on 8/4/2016 (2.55" in 2 hours 18 min), when the vault level only measured 21.5 inches. The 24" RCP downstream pipe did not surcharge in either 2015 or 2016.

Webber Stormwater Pond (WSP)

BACKGROUND

The Webber Stormwater Pond (WSP) construction began in 2013 and finished in 2015. The purpose of this study is to determine how well the WSP treats runoff from the adjacent Webber Natural Swimming Pool (NSP), runoff from the surrounding area, and several different types of non- precipitation events. The stormwater pond is a remnant of the old Webber Pond (former public water 27111800). It has two Inlets and one Outlet, as shown in **Figure 14-29 and 14-30**. The South Inlet is a 24-inch RCP that receives drainage from the NSP wash basin and a few catch basins surrounding the NSP, **Figure 14-31**. The North Inlet is a 12-inch reinforced concrete pipe (RCP) and takes drainage from NSP overflow and the immediate pool area, **Figure 14-32**. An underdrain, located beneath the NSP, is another potential groundwater source to the pond.

The WSP Outlet is in a vault consisting of a weir with an orifice, **Figure 14-33**. The orifice is roughly a 6-inch hole about 1-foot below the top of the weir. Most of the Outlet drainage is designed to flow through the orifice into a downstream 12-inch pipe **(Figure 14-34)**, but during large storms water overtops the weir. The WSP discharges to Shingle Creek.

The joints between the weir and vault wall were sealed with expandable foam and not grout. The foam degraded and caused considerable leakage from the pond between storms.

In 2016, a large capacity washing machine was installed at the NSP in order to rinse large filters, **Figure 14-35**. This washing machine uses 25 gallons per cycle and has one wash and four rinse cycles that discharge water approximately 10 minutes apart. This washing machine discharges (**Figure 14-36**) into the downstream Webber Pond South Inlet storm sewer pipe**.** The washing machine is used twice a day. Soap is not used in the machine.

Figure 14-29. Aerial photo of Webber stormwater pond during construction.

The drainage area of the South Inlet (24" RCP) is 85,000 square feet and the North Inlet (12" RCP)drainage area is 43,000 square feet. The land use is the pool patio and grassed area around the NSP.

Figure 14-30. Photo of Webber stormwater pond following construction.

Figure 14-31. Webber South Inlet 24 inch RCP pipe. Arrow shows direction of flow. A sump is between the two pipes.

Figure 14-32. Webber Pond North Inlet 12 inch RCP pipe with AV probe and intake strainer. In 2016, a 1-inch berm was built downstream at both Inlet sites. The cement berm was built to pool water and help collect samples at low flows.

Figure 14-33. Webber Pond Outlet orifice discharging water into the 12 inch RCP Outlet. At the top of picture note the leaky orange expandable foam sealing the downstream weir side joint.

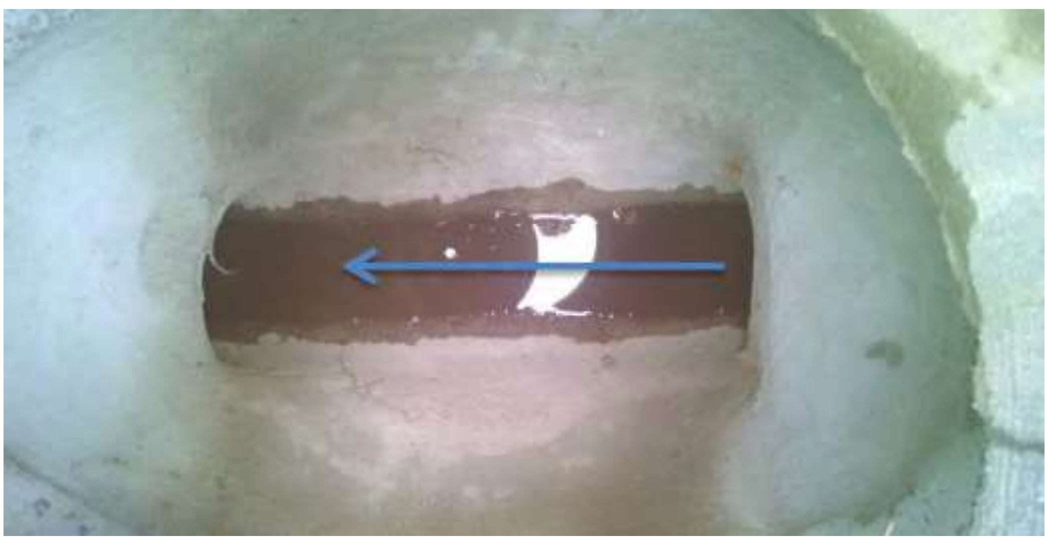


Figure 14-34. Webber Outlet 12-inch RCP pipe. Arrow shows direction of flow towards Shingle Creek.

Figure 14-35. The industrial washing machine used to rinse filters.

Figure 14-36. The washing machine discharges to the storm sewer.

Methods

Site Installation

Due to its proximity and secure location, a tipping bucket rain gauge and Hobo datalogger were installed on the roof of Folwell Recreation Center to collect precipitation data and record events. Folwell Park is three quarters of a mile south of Webber Pond. Throughout the summer of 2016, data were periodically downloaded from the Hobo datalogger via a laptop computer.

In 2016, both the North and South Inlet monitoring equipment was installed on 5/5/16, and the Outlet monitoring equipment was installed on 4/26/16. All equipment was removed on 11/1/16. In 2016, Inlet sites had ~1" high cement berms installed (5/19/16 and 5/20/16) downstream of the AV probe (**Figure 14-32)**. The berm created a pool of water which covered the AV probes and strainers, allowing low flow events to be captured.

Monitoring equipment at each of the sites included an ISCO 2150 datalogger, 2105 interface module, 2103ci cell phone modem, a low profile AV probe, and a 3700 ISCO sampler. The Inlets were too shallow to hang equipment and required above ground doghouse monitoring boxes. The Outlet equipment was hung from eye-bolts below grade at the access manhole. The datalogger used the cell phone modem to remotely upload data to a database server on Monday through Friday. The datalogger could also be remotely called up and programmed to turn samplers on or off, adjust the level, pacing, or triggers.

It should be noted that, Verizon cell phone service is very weak in this area of Minneapolis. In 2016, all of the dataloggers suffered weak signals and communication issues, as well as the North Inlet 2150 datalogger had several modem communication and internal software problems that required substantial time to solve with the manufacturer. These issues did not lead to any loss of data.

The samplers were flow-paced and equipped with 24 one-liter bottles, 3/8" ID (inner diameter) vinyl tubing, and an intake strainer. The sampler was programmed to multiplex, taking four flow-paced samples per bottle, allowing for 96 flow-paced samples per storm.

Sample Collection

In 2016, both the North and South Inlets were set to trigger at 0.75 inches of flow and paced at 50 cubic feet. Non-precipitation and low flow events produced enough flow to trigger the Inlets but not the pond Outlet. The Outlet trigger was set for 1 inch and paced at 300 cubic feet. As seen in 2015, the Outlet appeared to have an almost continuous base flow of less than 1 inch for much of the summer due to leakage at the sides of the weir.

In 2016, in order to characterize the washing machine discharge, grab samples were collected where the washing machine discharges into the South Inlet pipe. Two liter grabs were collected from each wash/rinse cycle and composited into a 5 gallon bucket. The composite bucket was agitated to homogenize the grabs and then sampled for analysis.

Results & Discussion

Sample Collection

In 2016, ten Webber North Inlet and 24 Webber South Inlet events/storms were collected. At the Webber Outlet, seven storms were collected (**Table 14-23**). Fewer Outlet samples were collected due to water leaking through the weir joints rather than flowing through the orifice. Samples could only be collected during storms where water flowed through the orifice or over the weir.

The non-precipitation events experienced at the North and South Inlets occurred due to irrigation water overspray, washing machine discharge, and pool draining events. It was a significant challenge to collect stormwater events and separate out the non-stormwater events caused by daily maintenance, washing, and irrigation discharge.

Table 14-23. The 2016 precipitation events captured at Webber Stormwater Pond and washing machine. The rain gauge was on the roof of the Folwell Recreation Center. A precipitation event was defined as a storm greater than 0.10 inches and separated by eight hours or more from other precipitation.

Start Date/Time	End Date/Time	Folwell Precip. (inches)	Storm Duration (hours)	Time since last Precip. (hrs)	Intensity in/hr	Webber Inlet North	Webber Inlet South	Webber Outlet	Wash Machine
Wash Machine Sample	5/18/2016 13:50							X	X(lmtd w/bact)
6/8/2016 23:51	6/9/2016 7:19	0.70	7:27	128	0.09		X(lmtd)		
6/12/2016 23:38	6/13/2016 7:03	0.55	7:24	88	0.07				
6/14/2016 11:55	6/15/2016 1:08	0.81	13:12	29	0.06	X(bact. only)	X(w/bact.)	X(w/bact.)	
Irrigation Event	7/12/2016 14:52						X(lmtd)		
Irrigation Event	7/13/2016 11:25						X(lmtd)		
Irrigation Event	7/13/2016 20:10						X(lmtd)		
Irrigation Event	7/14/2016 12:16						X(lmtd)		
Irrigation Event	7/15/2016 1:12						X(lmtd)		
7/14/2016 17:30	7/15/2016 5:33	0.31	12:03	0.03	63			X	
7/16/2016 21:59	7/17/2016 3:29	0.24	5:29	0.02	40	X(lmtd)	X(lmtd)	X	
Wash Event	7/18/2016 16:53						X(lmtd)		
Irrigation Event	7/19/2016 6:03						X(lmtd)		
Wash Event	7/19/2016 13:01						X(lmtd)		
Wash Event	7/20/2016 11:52						X(lmtd)		
Irrigation Event	7/21/2016 4:53						X(lmtd)		
Irrigation Event	7/21/2016 1:40					X(lmtd)			
Wash Event	7/21/2016 10:16					X(lmtd)	X(lmtd)		
Wash Machine Sample	7/22/2016 11:45								X(lmtd w/bact)
7/23/2016 10:53	7/23/2016 16:54	1.67	6:00	0.28	54	X(lmtd)	X(lmtd)		
Wash Event	7/26/2016 13:29						X(lmtd)		
Irrigation Event	7/27/2016 3:30						X(lmtd)		
7/27/2016 13:20	7/27/2016 16:01	0.80	2:41	0.29	92	X	X		
Wash Machine Sample	8/1/2016 12:50								X(lmtd w/bact)
Wash Event	8/2/2016 12:05						X(lmtd)		
Irrigation Event	8/3/2016 3:29					X(lmtd)	X(lmtd)		
8/4/2016 6:58	8/4/2016 9:17	2.55	2:18	1.13	183	X(w/bact.)	X(w/bact.)	X(w/bact.)	
8/10/2016 20:11	8/11/2016 6:17	2.86	10:06	0.29	155	X	X	X	
8/19/2016 1:00	8/19/2016 5:35	0.55	4:34	0.12	54		X		
10/6/2016 17:35	10/7/2016 2:44	1.00	9:09	0.11	36	X	X	X	

X = event sampled wit full parameters

X(lmtd) = event sampld with limited parameters generally due to holding times e.g. BOD, Ortho P, and TDP or low volume.

X(w/bact.) = event sa pled for with bacteria

X(bact. only) = only bacteria sampled

Figures 14-37 and 14-38 show the level and discharge at the two Inlets (North and South) for 2016. Diurnal swings in temperature and automatic irrigation overspray at 1am and 4am created noise and small events in the charts. The 2016 Outlet sites presented in **Figure 14-39** shows the level and discharge for the period of record. The figures show the same time period, from May 1 through Nov 1.

In 2016, the South Inlet had 127,886 cf measured, the North Inlet had 97,637 cf measured, and the Outlet had 356,035 cf measured. More discharge was measured at the Outlet than the sum of the two Inlets.

The additional Outlet volume in the mass balance was possibly caused by several contributing factors. An underdrain beneath the NSP may carry shallow groundwater to the pond that is not measured by the Inlets. Although the WSP is lined, the Outlet had a consistent base flow, which may indicate that groundwater is discharging into the WSP.

To more accurately capture inflow data and calculate a mass balance, all sites were installed at roughly the same time. More accurate inflow data was also collected because the AV probes were installed in pools. These pools were created to mitigate diurnal temperature fluctuations and provide enough flow (¾") over the AV probe to activate data and sample collection during low flow events. Even with these 2016 improvements, there was still additional unaccounted for Outlet volume.

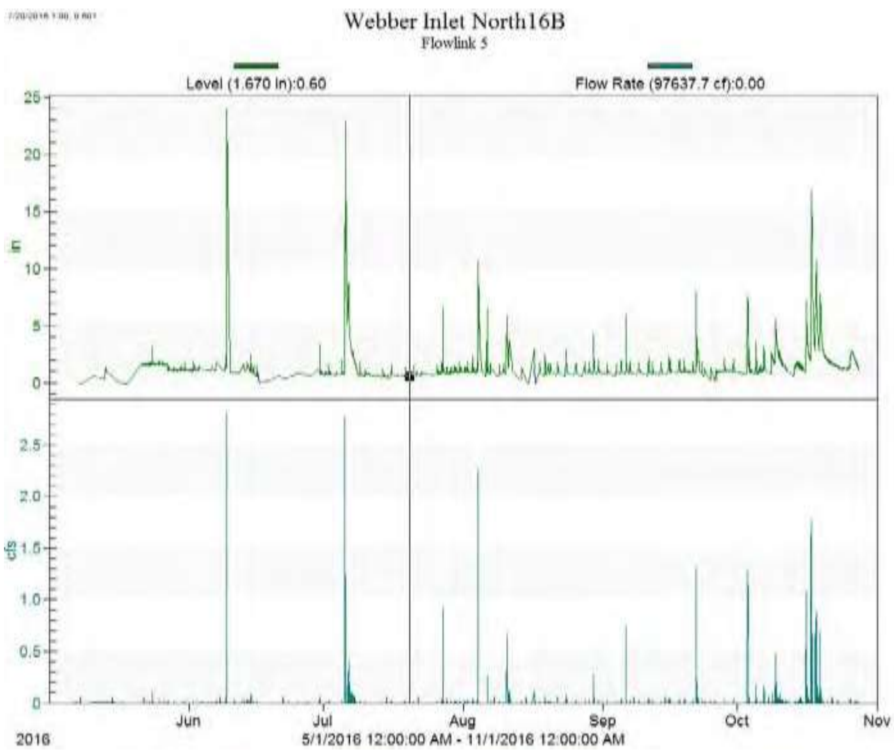


Figure 14-37. 2016 Webber Inlet North stage and discharge for the period of record.

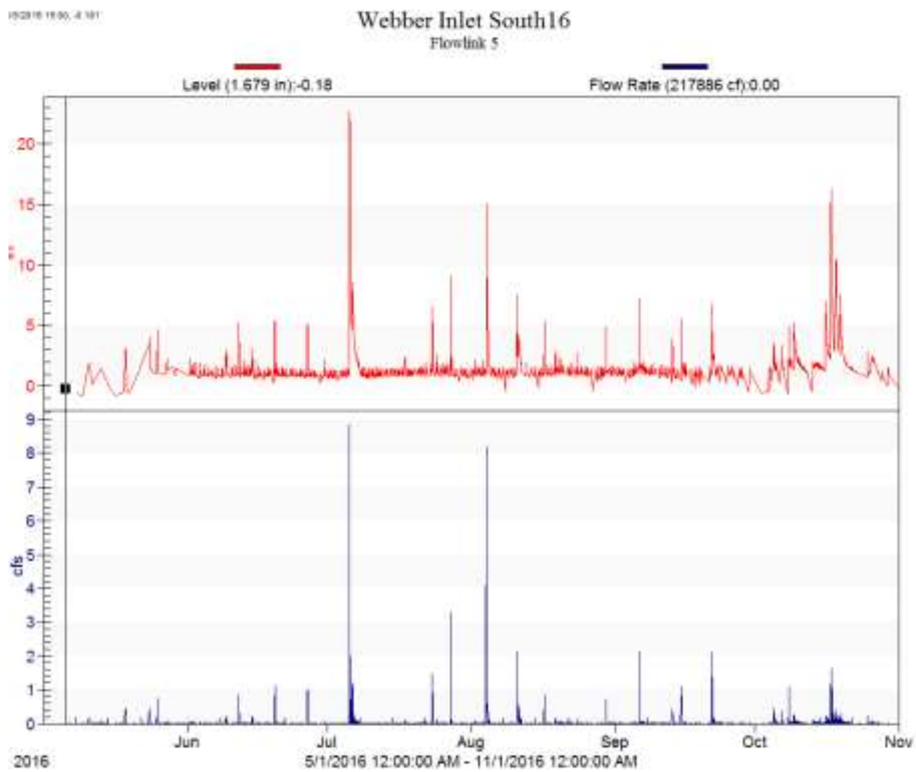


Figure 14-38. 2016 Webber Inlet South stage and discharge for the period of record.

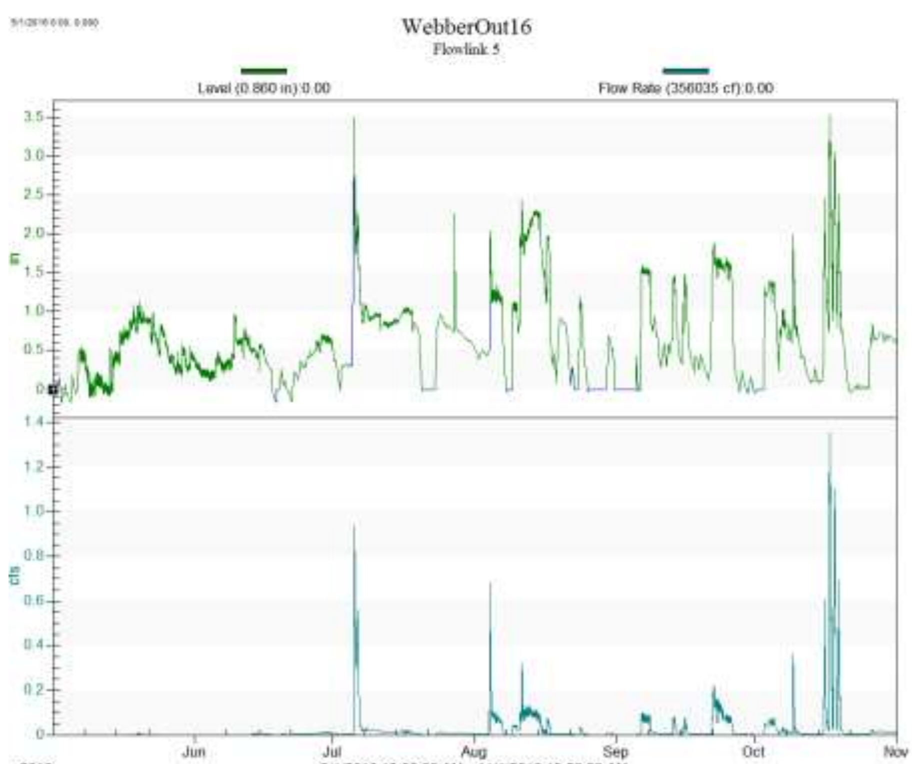


Figure 14-39. 2016 Webber Outlet stage and discharge for the period of record.

Storm Event Data and Statistics

Table 14-24 shows the 2016 Webber Stormwater Pond water chemistry data. Some of the events collected were analyzed for limited parameters because of low volume or expired holding times. The pond appears to reduce many chemical parameters. In 2016, TP, TDP, Ortho-P, TKN, NH_3, Hardness, NO_3NO_2, TSS, VSS, Sulfate, and all metals were lower at the Outlet.

Bacterial data were limited and vary highly. No conclusive determination about bacteria can be made from the limited data, but many ducks and geese were observed using Webber Stormwater Pond and may be adding additional fecal material and bacteria to the pond water.

Data that are underlined in **Table 14-24** failed MPRB's blind monthly performance standard for that month. It was deemed the data can be used with caution, noting that performance standards were outside the 80-120% recovery standards.

Table 14-24. 2016 Webber Stormwater Pond water chemistry events data. Cells with less than (<) values indicate that the concentration of that parameter was below reporting limit. NA = data not available due to expired holding time or low volume. Data that are underlined had a blind performance standard failure for that month, for that parameter. NES = not enough sample.

Date Sampled	Time	Site Location	Sample Type	TP mg/L	TDP mg/L	Ortho-P mg/L	TKN mg/L	NH3 mg/L	NO3NO2 mg/L	Cl mg/L	Hardness mg/L	TSS mg/L	VSS mg/L	TDS mg/L	cBOD mg/L	Sulfate mg/L	Sp.Cond. uhmos	pH std units	E. Coli MPN	Enterococci MPN	Pseduomonas MPN	Cu ug/L	Pb ug/L	Zn ug/L
6/8/2016	14:00	Webber In South	Sample	0.593			2.13		0.678	41	104	118	56				315							
6/9/2016	10:51	Webber In South	Sample	0.126	0.050	0.074	0.893	<0.500		41	104	39	11	205	5	22	256	7.0				21	<15	21
6/14/2016	13:35	Webber In South	Grab																225	>2420				
6/14/2016	23:39	Webber In South	Composite	0.147	0.093	0.055	1.32	0.645	0.896	3	92	56	19	147	5	19	236					24	<15.00	32
7/12/2016	14:52	Webber In South Irrigation	Composite	2.143			12.6		0.031	33	100	72	40				349							
7/13/2016	11:25	Webber In South Irrigation	Composite	0.875			19.0		0.047	29	108	109	45											
7/13/2016	20:10	Webber In South Irrigation	Composite	0.730			10.4		<0.030	40	128	75	38				411							
7/14/2016	12:16	Webber In South Irrigation	Composite	0.812			7.12		0.040	26	120	74	42				356							
7/15/2016	1:12	Webber In South Irrigation	Composite	0.425			4.66			21	108											16	<15.00	38
7/18/2016	7:34	Webber In South	Composite	0.486			7.62			21	108						344							
7/18/2016	16:53	Webber In South Wash	Composite	0.928			NES		<0.030	20	120	142	61				366							
7/19/2016	6:03	Webber In South Irrigation	Composite	0.678			7.92		<0.030	25	112	46	22				324							
7/19/2016	13:01	Webber In South Wash	Composite	2.09			23.0		<0.030	29	140	508	233				500							
7/20/2016	8:28	Webber In South Irrigation	Composite	3.37			35.9		<0.030	24	148	418	180				588							
7/20/2016	11:52	Webber In South Wash	Composite	1.20			13.7		<0.030	24	168	280	114				469							
7/21/2016	4:53	Webber In South Irrigation	Composite	5.92			65.3		<0.030	29	212	2136	812				709							
7/21/2016	10:16	Webber In South Wash	Composite	0.842			NES		<0.030	20	164	116	56				501							
7/23/2016	16:38	Webber In South	Composite	0.260			5.98		0.171	15	84	98	37				288					29	<15.00	75
7/26/2016	13:29	Webber In South Wash	Composite	0.767			7.49		5.500	23	92	45	19				303							
7/27/2016	3:30	Webber In South Irrigation	Composite	0.809			7.96		2.600	25	92	26	26				283							
7/27/2016	14:20	Webber In South	Composite	0.494	0.487	0.163	2.19	0.865	0.834	13	64	65	25	128		NES	NES	7.6				18	<15.00	34
8/2/2016	12:05	Webber In South Wash	Composite	0.378			2.18		2.090	25	104	27	14				279							
8/3/2016	3:29	Webber In South Irrigation	Composite	0.325			3.42		2.570	26	110	24	13				294					22	<15.00	22
8/4/2016	7:55	Webber In South	Composite	0.349	0.203	0.178	1.14	<0.500	0.861	12	56	43	16	91		12	158	7.7				22	<15.00	<20.0
8/4/2016	9:10	Webber In South	Grab																1050					
8/10/2016	20:58	Webber In South	Composite	0.618	0.286	0.280	4.08	0.708	0.822	10	76	94	46	115		12	192	7.8				20	<15.00	44
8/19/2016	7:07	Webber In South	Composite	0.281	0.063	0.180	2.27	0.793	0.116	15	96	55	35	169		14	247	6.7				20	<15.0	26
10/7/2016	5:21	Webber In South	Composite	0.129	0.087	0.093	<0.500	<0.500	0.070	17	72	5	2	122	<1.00	13	202	7.8				11	<15.0	<20.0
6/14/2016	13:35	Webber In North	Grab																>2420	>2420				
7/16/2016	1:32	Webber In North	Composite	0.562			3.67			3	148						361							
7/21/2016	1:40	Webber In North	Composite	0.725			NES		2.61	33	132	321	66				366							
7/21/2016	18:58	Webber In North Irrigation	Composite	0.665			NES		1.92	33	144	440	90				384							
7/23/2016	17:44	Webber In North	Composite	0.439			2.06		0.421	3	44	142	30				116					18	<15.00	37
7/27/2016	14:19	Webber In North	Composite	0.769	0.194	0.331	3.15	<0.500	0.379	<2.00	44	248	52	73		5	122	7.7				24	19	46
8/3/2016	1:57	Webber In North	Composite	0.784			14.6		4.730	25	168	241	104				431							
8/4/2016	8:15	Webber In North	Composite	0.795	0.267	0.253	2.76	0.776	1.22	4	56	193	40	88		8	138	7.8				24	17	40
8/4/2016	9:12	Webber In North	Grab																12997					
8/11/2016	8:52	Webber In North	Composite	0.185	0.217	0.118	1.03	<0.500	<0.030	<2.00	52	34	6	86		7	107	7.8				17	<15.00	<20.0
10/7/2016	1:07	Webber In North	Composite	0.195	0.128	0.142	<0.500	<0.500	0.102	8	48	11	4	75	<1.00	8	122	7.5				15	<15.0	<20.0
5/18/2016	13:50	Webber Outlet	Composite	0.036	0.016	0.014	0.641	<0.500	<0.030	27	80	9	7	126	3		212	8.6	18	8	<2	<20.00	<15.00	<20.0
6/14/2016	5:42	Webber Outlet	Composite	0.046	0.037	0.023	<0.500	0.690	<0.030	3	80	5	3	139		13	195							
6/14/2016	13:35	Webber Outlet	Grab																1	99				
7/15/2016	10:12	Webber Outlet	Composite	0.165	0.152	0.096	0.567	<0.500	0.045	15	76	32	4	127		10	201	7.5				<10.00	<15.00	<20.0
7/18/2016	5:15	Webber Outlet	Composite	0.181			0.511		0.052	158	76	6	5				231					19	<15.00	<20.0
8/4/2016	9:07	Webber Outlet	Grab																14136					
8/5/2016	9:20	Webber Outlet	Composite	0.355	0.235	0.210	1.20	<0.500	0.457	10	68	14	7	100		8	154	7.8				13	<15.00	<20.0
8/11/2016	7:40	Webber Outlet	Composite	0.235	0.192	0.172	0.947	<0.500	<0.030	9	60	4	2	105		9	153	7.8				18	<15.00	<20.0
10/7/2016	7:04	Webber Outlet	Composite	0.216	0.038	0.082	<0.500	<0.500	<0.030	NES	80	NES	NES	134	NES	NES	NES	7.5						
5/18/2016	13:20	Web Wash Machine	Grab	0.808	0.454	0.199	27.4	9.12	<0.030	41	120	614	271	251	178		421	6.5	1300	2420	>401	65	18	220
7/22/2016	11:45	Web Wash Machine	Grab	0.572			16.3		0.054	20	100	228	129				382		<100	<100	<100	36	<15.00	180
8/1/2016	12:50	Web Wash Machine	Grab	2.32			26.2		2.26	24	148	201	104				466		934	459	840	57	<15.0	200

Table 14-25 shows the 2016 statistics from the Webber Pond Inlets and Outlet. Statistics were only calculated for a chemical parameter if there were two or more measured values. When statistical analysis was performed on the data sets and less than values (<) were present, half of the less than value was used in the calculations.

When comparing the geometric means of Inlets vs Outlet, much of the same chemical removal pattern was seen in both in 2015 and 2016. It appears that the stormwater pond is removing much of the TP, TDP, Ortho-P, TKN, NH_3, NO_3NO_2, Hardness, TSS, VSS, and all metals, either by settling or degradation. The annual North Inlet cf volume was less than half of the South Inlet and the North Inlet concentrations were much lower than the South Inlet. The majority of the Inlet chemical pollutants were emanating from the South Inlet. The Outlet samples when compared to the South Inlet had higher geometric mean concentrations of Cl, TDS, and Sulfate. The increase in concentration of these chemical parameters at the Outlet may be due to soil erosion in the pond basin, perhaps contributions from waterfowl excrement, or possibly a connection with groundwater.

Table 14-26 shows load calculations for May 1 through Nov 1 of 2016. The geometric mean of all of the data for a specific parameter was used for the load concentration calculation. The Webber Stormwater Pond appears to have exported slightly more water, Chloride, and Total Dissolved Solids than it received. The concrete berms in the Inlets created a pool covering the AV probe and allowed low volume events (irrigation/washing machine) to be more accurately collected and measured. BOD was not calculated for the Webber Inlet North or the Outlet due to limited numbers of samples. As in 2015, the Pond appears to be capturing many of the same parameters: Phosphorus, Nitrogen, Hardness, Total Suspended Solids, Volatile Suspended Solids, and metals.

Table 14-25. 2016 Webber Stormwater Pond 2016 data showing statistics of the Inlets and Outlet. All less than data were transformed into half the reporting limit for statistical calculations (e.g. Pb <15 becomes 7.5).

Site ID	Statistical Function	TP mg/L	TDP mg/L	Ortho-P mg/L	TKN mg/L	NH3 mg/L	NO3NO2 mg/L	Cl mg/L	Hardness mg/L	TSS mg/L	VSS mg/L	TDS mg/L	cBOD mg/L	Sulfate mg/L	Sp.Cond. uhmos	pH std units	Cu ug/L	Pb ug/L	Zn ug/L
Webber Inlet South	MEAN (geometric)	0.626	0.133	0.128	5.18	0.519	0.132	21	106	81	37	135	3	14.9	325	7.4	20	8	26
Webber Inlet South	MEAN (arithmetic)	0.991	0.181	0.146	10.4	0.585	0.759	23	111	195	82	140	4	15.3	347	7.4	20	8	31
Webber Inlet South	MAX	5.92	0.487	0.280	65.3	0.865	5.50	41	212	2136	812	205	5	22.1	709	7.8	29	8	75
Webber Inlet South	MIN	0.126	0.050	0.055	0.250	0.250	0.015	3	56	5	2	91	1	11.5	158	6.7	11	8	10
Webber Inlet South	MEDIAN	0.648	0.093	0.163	6.55	0.677	0.070	24	106	73	37	128	5	13.9	315	7.7	21	8	29
Webber Inlet South	STDEV	1.24	0.160	0.078	14.3	0.270	1.32	9	34	431	165	38	2	4.18	132	0.473	4.79	0.00	19
Webber Inlet South	NUMBER	26	7	7	24	6	23	26	26	24	24	7	3	6	23	6	10	10	10
Webber Inlet South	COV	1.25	0.880	0.535	1.38	0.462	1.74	0.405	0.308	2.22	2.01	0.271	1	0.273	0.382	0.064	0.236	0.00	0.609
Webber Inlet North	MEAN (geometric)	0.503	0.195	0.194	2.20	0.332	0.538	6	80	130	32	80	1	7.10	202	7.7	19	11	23
Webber Inlet North	MEAN (arithmetic)	0.569	0.202	0.211	3.93	0.382	1.42	12	93	204	49	81	1	7.21	239	7.7	20	12	29
Webber Inlet North	MAX	0.795	0.267	0.331	14.6	0.776	4.73	33	168	440	104	88	1	8.40	431	7.8	24	19	46
Webber Inlet North	MIN	0.185	0.128	0.118	0.250	0.250	0.015	1	44	11	4	73	1	5.44	107	7.5	15	8	10
Webber Inlet North	MEDIAN	0.665	0.206	0.198	2.76	0.250	0.821	4	56	217	46	81	1	7.51	138	7.7	18	8	37
Webber Inlet North	STDEV	0.244	0.058	0.099	4.85	0.263	1.62	14	53	143	36	8	NA	1.44	141	0.120	4.16	5.79	17.3
Webber Inlet North	NUMBER	9	4	4	7	4	8	9	9	8	8	4	1	4	9	4	5	5	5
Webber Inlet North	COV	0.428	0.286	0.471	1.23	0.689	1.14	1.13	0.573	0.702	0.742	0.097	NA	0.200	0.591	0.016	0.212	0.495	0.604
Webber Outlet	MEAN (geometric)	0.137	0.073	0.067	0.490	0.296	0.034	16	74	9	4	121	3	10.2	189	7.8	12	8	10
Webber Outlet	MEAN (arithmetic)	0.176	0.112	0.100	0.577	0.323	0.088	37	74	12	5	122	3	10.3	191	7.8	13	8	10
Webber Outlet	MAX	0.355	0.235	0.210	1.20	0.690	0.457	158	80	32	7	139	3	13.2	231	8.6	19	8	10
Webber Outlet	MIN	0.036	0.016	0.014	0.250	0.250	0.015	3	60	4	2	100	3	8.42	153	7.5	5	8	10
Webber Outlet	MEDIAN	0.181	0.095	0.089	0.539	0.250	0.015	12	76	8	4	127	3	9.89	198	7.8	13	8	10
Webber Outlet	STDEV	0.111	0.093	0.079	0.349	0.180	0.164	60	8	11	2	16	NA	2.05	32	0.468	5.79	0.00	0.00
Webber Outlet	NUMBER	7	6	6	8	6	7	6	7	6	6	6	1	4	6	5	5	5	5
Webber Outlet	COV	0.629	0.835	0.791	0.605	0.556	1.86	1.62	0.102	0.921	0.447	0.130	NA	0.198	0.165	0.060	0.445	0.00	0.00

NA = data not available

Table 14-26. 2016 Webber Stormwater Pond Load calculations (from the geometric mean) comparing Inlets and Outlet, in pounds. The period of record is 5/1/16 through 11/1/16. Yellow highlighted areas are where the parameter is exporting. NA = not available.

LOADS	Water	TP	TDP	Ortho-P	TKN	NH3	NO3NO2	Cl	Hardness	TSS	VSS	TDS	cBOD	Sulfate	Cu	Pb	Zn
Dates 5/1/16 - 11/1/16	cubic ft	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs	Lbs
Webber Inlet South	217,886	8.51	1.80	1.74	70.5	7.06	1.79	283	1445	1096	503	1841	40	203	0.268	0.102	0.359
Webber Inlet North	97,637	3.07	1.19	1.18	13.4	2.02	3.28	36	485	795	194	489	NA	43	0.117	0.065	0.142
Webber Outlet	356,035	3.04	1.63	1.49	10.9	6.58	0.760	358	1643	195	94	2688	NA	227	0.261	0.167	0.222
Lbs Removed (Added)	(40,512)	8.54	1.36	1.42	73.0	2.50	4.31	-40	287	1695	602	-358	NA	19	0.125	0.0002	0.278
% Reduction/Added	-13%	74%	46%	49%	87%	28%	85%	-12%	15%	90%	86%	-15%	NA	8%	32%	0.1%	56%

The 2016 hydrological mass balance shows more water leaving the stormwater pond than entering, even though mitigating measures were taken to insure accurate inflow measurement. This finding is likely due to groundwater entering the pond from either the NSP underdrain, or a breach in the liner allowing groundwater into the pond. The impact of the NSP underdrain drain could be assessed in the future to see what impact it could be having on the WSP.

The Outlet does an excellent job of retaining stormwater and attenuating peak storm events. The Outlet structure causes even small storm drainage last for days. Long retention times can also be challenging when trying to cleanly separate storms when they comingle due to the long drawdown time of the pond.

In 2016, it was discovered that during construction the Outlet structure, weak joints located between the weir and vault sidewall were sealed with expandable foam and not with grout. This foam has degraded and allows slow leakage through the joints. Eddies can be seen in the downstream pool of the Outlet structure when it is not flowing through the control structure. The effect of leakage through the sides of the weir is that the pond fills and then drains down slowly between storms creating dead storage. With extra dead storage in the pond, many times no Outlet discharge occurs, and therefore discharge cannot be flow-paced or auto-sampled. This error in construction appears to be doing an excellent job of treating and slowly releasing incoming water, but reduces the number of storms that could be auto-sampled.

In 2016, the irrigation overspray draining to the 12" North Inlet pipe seems to have been mitigated. The NSP was also drained, twice, through the North 12" Inlet, which accounted for a significant amount of water discharged through this pipe.

Some of the non-precipitation events recorded at the pond Inlets were collected and analyzed, but none of these events produced enough flow to trigger the Outlet sampler.

In conclusion, the Webber Stormwater Pond reduces most pollutants from stormwater and the adjacent Natural Swimming Pool, but Cl, and TDS increased at the Outlet.

Lyndale Farmstead Dog Park

BACKGROUND

The Lyndale Farmstead Dog Park was built in 2012, **Figure 14-40**. It was a former parking lot used for equipment storage and overflow parking at the adjacent Minneapolis Park Board South Side Service Center. The Lyndale Dog Park is approximately 0.56 acres and its surface material is crushed gravel. The site is sloped to the southwest where an underdrain pipe, buried in gravel and covered with filter fabric, was constructed to carry filtered subsurface runoff to the adjacent stormwater pond. The dog park is located next to a stormwater pond that handles drainage from an adjacent residential watershed.

Following construction, fine particles washed off the gravel and plugged the filter fabric covering the subsurface drainage pipe and caused runoff to pond over the underdrain. Ponding in the dog park caused muddy and unpleasant conditions for park patrons. In 2013, above ground surface drains were retrofitted directly to the subsurface underdrain pipe. This retrofit prevented ponding, but completely circumvented any filtration through the gravel or filter fabric by directly connecting the surface drains to the subsurface pipe.

The Lyndale Dog Park drains directly to the adjacent stormwater pond where it is pumped to the Mississippi River via a lift station. The stormwater pond has historically flooded a few times a year which sometimes results in flooding half or more of the dog park, depending on the amount of precipitation and storm intensity.

The purpose of this monitoring is to collect water samples for *E. coli* analysis and characterize bacteria concentrations in runoff from the Lyndale Dog Park.

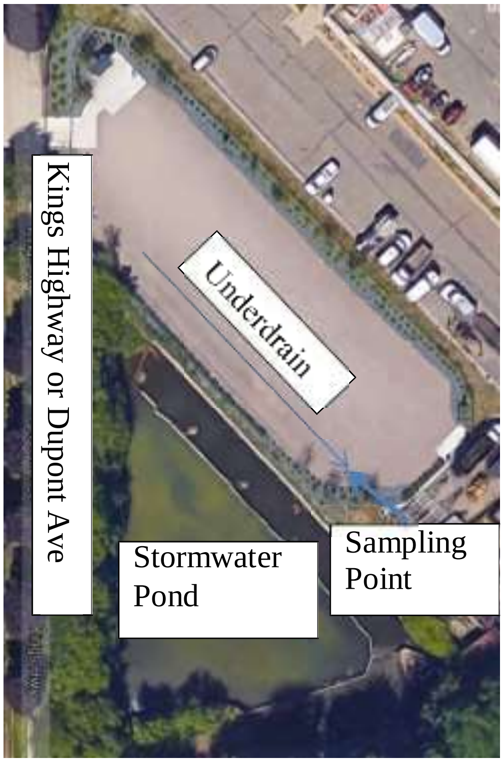


Figure 14-40. Map of Lyndale Farmstead Dog Park and adjacent stormwater pond.

Methods

Sample Collection

Bacteria grab samples were collected during precipitation events. Samples were obtained with a modified dip pole, **Figure 14-41**. The time, date, and depth of flow in the pipe was recorded when the grab sample was collected. Samples were placed on ice, delivered to the lab, and run within the *E. coli* holding time.

Figure 14-41. Collecting bacteria grab sample at Lyndale Farmstead Dog Park.

Figure 14-42 shows the 6” PVC Lyndale Dog Park subsurface underdrain pipe termination, where samples were collected.

All precipitation events were measured via a tipping bucket rain gauge at the adjacent South Side Service Center rooftop weather station, approximately 100 yards away from the sample site.

Figure 14-42. View inside the manhole of Lyndale Farmstead Dog Park. The small 6" PVC pipe at the top is the Lyndale Dog Park outlet.

RESULTS & DISCUSSION

Sample Collection

Collecting bacteria grab samples at this site proved challenging, since precipitation events infrequently occur between the hours of 8am to 2pm, Monday through Thursday. The large surface area of the gravel bed required at least ¼ inch of rain to overcome depressional storage and produce a volume of runoff that could be collected. Also, if there was more than approximately 1 ½ inches of rain and a sample was not collected immediately, the adjacent stormwater pond would surcharge the access manhole, submerging the sample point.

Tables 14-27 shows the precipitation events sampled for *E. coli* in 2016. The data were recorded at the adjacent South Side Service Center weather station.

Table 14-27. The 2016 precipitation events captured at the Lyndale Dog Park. A precipitation event was defined as being separated by eight hours or more from other precipitation.

Start Date/Time		End Date/Time		Precip (inches)	Duration (hours)	Intensity (in/hr)	Time since last Precip. (hours)	Lyndale Dog Park
4/27/2016	15:45	4/28/2016	23:15	**0.96**	**31.50**	**0.03**	**53.25**	**X(w/bact.)**
6/9/2016	00:15	6/9/2016	07:15	**0.50**	**7.00**	**0.07**	**128.25**	**X(w/bact.)**
8/4/2016	07:15	8/4/2016	10:15	**1.06**	**3.00**	**0.35**	**180.00**	**X(w/bact.)**
9/6/2016	03:45	9/6/2016	11:15	**1.05**	**7.50**	**0.14**	**17.25**	**X(w/bact.)**
10/25/2016	16:30	10/26/2016	11:00	**0.76**	**18.50**	**0.04**	**175.00**	**X(w/bact.)**
X(w/bact.) = event sampled for bacteria								

Event Data

Table 14-28 shows the bacteria data collected at the Lyndale Dog Park in 2016. In 2015, the Lyndale Dog Park *E. coli* bacteria sample concentrations ranged from 3,076 MPN to greater than 24,200 MPN. In 2016, the *E. coli* sample concentrations ranged from 2,010 MPN to 111,990 MPN.

Table 14-28. The 2016 bacteria data collected at the Lyndale Dog Park. MPN = Most Probable Number.

Date Sampled	Time	Site Location	Sample Type	*E. Coli* MPN
4/28/2016	10:25	Dog Park Underdrain	grab	1210
6/9/2016	8:10	Dog Park Underdrain	grab	6488
8/4/2016	8:00	Dog Park Underdrain	grab	12033
9/6/2016	9:35	Dog Park Underdrain	grab	61310
10/26/2016	8:00	Dog Park Underdrain	grab	111990

The 2016 fall was unusually warm and wet. The *E. coli* grab samples appear to show an increasing trend throughout the year. This phenomenon could be correlated to dog park usage, ambient temperature, or build up and wash off and corresponding *E. coli* growth and/or deposition.

Table 14-29 shows the 2016 individual land use NPDES sites *E. coli* data. In 2016, Sites 6, 7, and 9 appear to have a similar *E. coli* pattern to the Lyndale Dog Park data. The general trend of the data shows a cumulative increase in *E. coli* throughout 2016.

Table 14-29. The 2016 NPDES *E. coli* bacteria grab sample data. NPDES data are sampled quarterly at representative land use sites. MPN = most probable number.

Date Sampled	Time	Site Location	Sample Type	*E. Coli* MPN
2/18/2016	14:45	Site 6, 22nd & Aldrich	grab	8
2/19/2016	13:30	Site 6, 22nd & Aldrich	grab	727
4/21/2016	9:20	Site 6, 22nd & Aldrich	grab	461
6/14/2016	13:10	Site 6, 22nd & Aldrich	grab	12033
8/4/2016	8:50	Site 6, 22nd & Aldrich	grab	>24200
2/19/2016	13:20	Site 7, 14th & Park	grab	1300
2/23/2016	14:00	Site 7, 14th & Park	grab	457
4/21/2016	9:35	Site 7, 14th & Park	grab	4884
6/14/2016	13:00	Site 7, 14th & Park	grab	5475
8/4/2016	8:30	Site 7, 14th & Park	grab	7270
2/19/2016	12:40	Site 8, Pershing	grab	99
2/23/2016	13:30	Site 8, Pershing	grab	195
2/18/2016	14:25	Site 9, 61st & Lyndale	grab	1
2/19/2016	13:00	Site 9, 61st & Lyndale	grab	44
4/21/2016	10:05	Site 9, 61st & Lyndale	grab	14136
6/14/2016	12:35	Site 9, 61st & Lyndale	grab	19863
8/4/2016	8:15	Site 9, 61st & Lyndale	grab	2014

Table 14-30 shows the 2016 geometric mean *E. coli* comparison between NPDES sites and the Lyndale Dog Park. In 2016, the geometric mean comparison data show that the Lyndale Dog Park has much higher *E. coli* concentrations than any of the NPDES sites.

Table 14-30. The 2016 NPDES individual land use geometric mean *E. coli* comparison to the Lyndale Dog Park. Bacteria are sampled quarterly at the other NPDES representative land use sites and compared to the Lyndale Dog Park.

Site	Land Use	2016 *E. coli* Geometric Mean
22nd Aldrich	Residential	952
14th Park	Mixed Use	2,585
61st Lyndale	Industrial	478
Lyndale Dog Park	Dog Park	14,534

ESTIMATES OF ANNUAL AND SEASONAL POLLUTANT LOADS

Statistics for event mean concentrations were calculated using Microsoft Excel spreadsheets. FLUX32 (v.3.1) and P8 (v.3.4) were used to calculate flow-weighted mean concentrations and snowmelt runoffs, respectively.

All flow-weighted mean concentrations were calculated using the model FLUX32. FLUX32 calculates total mass discharge and associated error statistics based on six different calculation methods. Calculation methods 1-Direct Mean Loading and 5-Regression, Second-Order were ignored because they are inappropriate for storm sewer applications where the daily flow file contains a significant number of zero flows (Bruce Wilson, personal communication, 2001). Sample concentrations and associated daily average flows were used as input for these calculations. Data were always run as unstratified, but in order to achieve the most accurate and precise results, the data were often stratified by flow or by season. The calculation methods used were methods 2 and 6. Generally, the method and concentration value with the lowest coefficient of variation was chosen.

The model P8 was used to calculate daily flows for the snowmelt events during January through April. Daily average temperature, winter water equivalent snowpack (using a heated tipping bucket rain gauge), and hourly precipitation files obtained from the National Oceanic and Atmospheric Administration (NOAA) National Data Center (NNDC) were used as input for P8.

A description of FLUX32 as described in the help menu (US Army Corps, 2009):

The theory and the file formats described in this original manual, as well as much of the software's operation and menu structure, is still applicable to Flux.

This version of FLUX for the Win32 environment is a major revision to the original DOS/FORTRAN program authored by William W. Walker Ph.D.

Flux32 is interactive software designed for use in estimating the transport (load) of nutrients or other water quality constituents past a tributary sampling station over a given period of time.

The basic approach of Flux32 is to use several calculation techniques to map the flow/concentration relationship developed (modeled) from the sample record onto the entire flow record. This provides an estimate of total mass transport for the whole period of study with associated error statistics. Note that this approach does NOT focus on estimating changes in loads over time (i.e. time series).

An important option within Flux32 is the ability to stratify the data into groups based upon flow, date, and/or season. This is a key feature of the FLUX approach and one of its greatest strengths. In many (most) cases, stratifying the data increases the accuracy and precision of loading estimates.

A description of P8 as described in the software's introduction: "P8 is a model for predicting the generation and transport of stormwater runoff pollutants in small urban catchments. Simulations are driven by hourly rainfall and daily air-temperature time series."

The following formula was used to calculate the total annual pollutant load. Conversion factors were used to convert acres to square meters and adjust units for concentration.

L = [(P) (Pj) (Rv) (C/1000) (A*4046.9)]

where: L = seasonal pollutant load, kilograms/season

P = seasonal precipitation, inches/season (meters/season)

Pj = correction factor for storms which do not produce runoff = 0.85

Rv = runoff coefficient

C = median event mean concentration of pollutants, mg/L

A = area, acres

Conversion factors 4046.9 for acres to square meters

1000 for liters to cubic meters

The flow-weighted mean concentration (FWMC) expressed as a mean of all sites was used for the annual load estimation calculations as it most accurately reflects storm water loadings on an annual basis. The seasonal loadings were calculated from the pooled data using the median event mean concentration as there were too few data points from each watershed to use FLUX32 to determine with a reasonable degree of accuracy a seasonal FWMC for each site. The median of the data set is a better representation of the runoff data than the mean values (Bannerman et al., 1992). The annual load and a summation of the seasonal loads will not be equal due to this difference in calculation methods.

Seasonal loads were calculated on the following basis:

Season	Inclusive Dates	Precipitation for Period
Winter/snowmelt	01/01/16 – 03/31/16	3.66 inches (0.093 m)
Spring	04/01/16 – 05/31/16	5.26 inches (0.134 m)
Summer	06/01/16 – 08/31/16	17.40 inches (0.442 m)
Fall	09/01/16 – 12/31/16	14.00 inches (0.356 m)
Total	01/01/16 – 12/31/16	40.32 inches (1.024 m)

Flow-weighted mean concentrations and related statistics for NPDES parameters in 2016.

Site	TP (mg/L)	TDP (mg/L)	Ortho-P (mg/L)	TKN (mg/L)	NH_3 (mg/L)	NO_3NO_2 (mg/L)	Cl* (mg/L)	Hardness (mg/L)	TSS (mg/L)	VSS (mg/L)	TDS* (mg/L)	cBOD (mg/L)	Sulfate (mg/L)	Cu (µg/L)	Pb (µg/L)	Zn (µg/L)
6, 22nd Aldrich	0.179	0.086	0.069	2.50	0.613	0.341	6	30	86	39	52	8	3.0	0.021	0.035	0.070
7, 14th Park	0.168	0.051	0.050	1.37	0.344	0.285	12	23	60	24	49	8	5.0	0.003	0.006	0.065
8a, Pershing	0.225	0.109	0.092	1.00	0.326	0.208	2	24	54	27	39	4	3.0	0.003	0.004	0.014
9, 61st Lyndale	0.614	0.106	0.163	2.00	0.438	0.326	28	51	161	39	108	6	12.0	0.008	0.008	0.084
MEAN	**0.297**	**0.088**	**0.093**	**1.72**	**0.430**	**0.290**	**12**	**32**	**90**	**32**	**62**	**7**	**5.8**	**0.009**	**0.013**	**0.058**
MEDIAN	**0.202**	**0.096**	**0.080**	**1.69**	**0.391**	**0.306**	**9**	**27**	**73**	**33**	**51**	**7**	**4.0**	**0.006**	**0.007**	**0.068**
STANDEV	**0.213**	**0.027**	**0.050**	**0.665**	**0.131**	**0.060**	**11**	**13**	**49**	**8**	**31**	**2**	**4.3**	**0.009**	**0.015**	**0.031**

-Highest value

-Lowest value

* Flow-weighted mean concentrations for Cl and TDS were difficult to estimate using FLUX32 due to large outliers from the two snowmelt samples; these estimates should be used with caution.

STANDEV= standard deviation.

Statistical summary for event mean concentrations by season in 2016. Statistics were calculated from all sites (6-9). STDEV= standard deviation, COV= coefficient of variance.

2016 Season	Statistical FlDlction	TP	IDP	Ortbo-P	TK:\	HJ	:\O;:\O,	Cl	Hardness	TSS	\"SS	IDS	cBOD	Sulfate	SpCond.	pH	E.colt	Cu	Pb	Zn
		mg/L	rru!L	mwL	II_	mgll.	mg L	m!VL	mgL	mwL	lll!!L	mg/L	mgL	mgil.	!Jlums	std mits	:1!P:\ IOOmL	llgl1.	u L	g L
	:IIE A'i (geometric)	0.513	0.184	0.374	4.17	1.45	0.3951	416	61	46	201	390	16	12	1033	7.6	86	20	6	86
	:IIEAi (arithmetic)	0.550	0.250	0.426	5.61	2.48	0.527	861	85	70	23	941	22	18	2481	7.7	354	24	10	115
	:II.-'\X	0.945	0.531	0.743	19.2	10.8	1.58	2621	230	196	35	3019	61	52	8040	9.6	1300	54	30	200
S:\OWMELT	:II	0.330	0.044	0.156	2.06	0.745	0.065	IS	14	10	6	28	7	3	73	6.4	I	10	2	10
Qanuary-:l!arch)	:IIEDL-\:.i	0.484	0.238	0.421	333	1.06	0.432	442	52	55	25	386	12	11	1163	7.7	147	24	6	100
	SIDE\"	0.236	0178	0.214	6.06	3.69	0.447	943	74	62	12	1179	20	17	3037	1.1	459	IS	10	71
	:\DIBER	8	8	8	7	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8
	CO\"	0.428	0.713	0.503	1.08	1.49	0.847	1.10	0874	0.896	0.496	1.25	0899	0.952	1.22	0.143	1.30	0.627	1.05	0.618
	:IIL-\.:i (geometric)	0.145	0.067	0.050	3.541	2.16	0.293	28	40	107	46	105		10	140	6.5	3169	33	13	155
	:IIL-\.:i (arithmetic)	0.174	0.074	0.055	4.57	2.40	0.507	38	46	205	74	142	31	II	191	6.5	6194	39	20	201
	:IL\..'l:	0.459	0.122	0.072	12.7	3.39	1.26	129	92	615	179	373	52	15	592	6.9	>24200	70	75	380
SPRDiG	:II	0.057	0.037	0.023	126	1.03	0.019	11	16	21	15	46	11	5	48	5.8	461	12	7	37
(April- ay)	:IIEDH.:i	0.144	0.075	0.062	2.54	2.59	0.353	21	42	85	31	69	29	9	135	6.5	4884	27	7	120
	SIDE\"	0.119	0.033	0.022	3.66	1.14	0.440	37	25	229	69	136	18	4	168	0.4	6978	24	25	138
	:\DIBER	10	6	4	10	4	10	9	10	10	10	5	4	5	10	5	3	7	7	7
	CO\"	0.683	0.449	0.406	0.801	0.477	0.868	0.999	0.550	L11	0.934	0.952	0.586	0.406	0.879	0.065	1.07	0.611	1.15	0.689
	:IIL-\.:i (geometric)	0.141	0.055	0.059	123	0.364	0.420	4	30	62	20	57	4	4	87	6.7	7186	19	9	52
	:IIL-\..'i (arithmetic)	0.190	0.092	0.075	185	0.460	0.648	18	35	94	33	n	5	7	132	6.8	9331	21	12	80
	:ILU	1.58	0.759	0273	15.7	2.37	5.65	256	84	460	ISS	229	17	39	1160	9.3	19863	65	61	430
SUMI\iER	:II	0.039	0.015	0.016	0.250	0.250	0.015	I	10	8	I	18	I	3	24	6.2	2014	S	7	10
(Jwe-August)	:IIE DH..'i	0.133	0.052	0.058	124	0.250	0.518	2	28	53	19	55	4	3	87	6.6	7270	20	7	55
	SIDE\"	0.232	0145	0.059	2.46	0.454	0816	40	19	98	37	54	5	10	173	0.6	6908	II	13	87
	:\t::IIBER	49	27	27	45	26	52	48	51	52	52	26	13	26	52	23	5	34	34	34
	CO\"	1.22	1.58	0.795	133	0.986	1.26	223	0.553	1.04	1.10	0.743	0.911	1.41	1.31	0.092	0.740	0.503	1.04	1.10
	:IIL-\.:i (geometric)	0.249	0.087	0.073	1.08	0.250	0.361	I	19	74	26	29	8	3	58	6.9	:\A	19	12	42
	:IIL-\.:i (arithmetic)	0.271	0.096	0.091	1.16	0.250	0.361	I	19	85	28	29	IS	3	61	6.9	:\A	I9	IS	46
	:11.-\..\':	0.349	0.130	0.163	1.57	0.250	0.420	I	26	119	38	30	45	3	88	7.2	:\A	22	39	66
FALL	:II	0.133	0.044	0.029	0.653	0.250	0.303	I	16	33	14	26	3	3	46	6.4	:\A	16	7	25
(Sept-:'iov)	:IIEDL-\.:i	0.331	0114	0.082	125	0.250	0.369	I	16	104	32	30	4	3	48	7.0	:\A	18	7	46
	SIDE\"	0.120	0.046	0.067	0.464	0.000	0.059	0	6	46	12	3	24	0	23	0.4	:\A	3	IS	21
	:\BIBER	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	:\A	3	3	3
	CO\"	0.442	0.476	0.739	0.402	A	0161	A	0199	0.538	0.441	0.089	1.37	XA	0.383	0.062	:\A	0.lt>l	1.046	0.449

-highest concemration
-lowest concentratioo
A-rot available

Supporting Documents

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Walker, W. W., 1996. *Simplified Procedures for Eutrophication Assessment and Prediction: User Manual*. Instruction Report W-96-2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Minneapolis Park and Recreation Board (MPRB). (2015). Water Resources Report. Environmental Management. Minneapolis, MN

Appendix A

STORM DRAINAGE AREAS BY RECEIVING WATER BODY

Surface Water	Outfall	Total (acres)	Res. %	Comm. %	Ind. %	Public %	Open %	Rail %	Runoff Coeff.	Pop.
Mississippi River (Minneapolis)	10-xxx	18,077	0.53	0.16	0.16	0.04	0.07	0.04	0.46	263,400
Mississippi River (Columbia Heights)	10-100	348	0.48	0.11	0.33	0.00	0.08	0.00	0.37	2,765
Mississippi River (UofM)	15-xxx	100	0.00	0.00	0.00	1.00	0.00	0.00	0.55	0
Shingle Creek	20-xxx	1,365	0.62	0.17	0.06	0.03	0.04	0.07	0.44	11,493
Ryan Lake (Minneapolis)	21-xxx	49	1.00	0.00	0.00	0.00	0.05	0.00	0.45	388
Bassett Creek	40-xxx	2,293	0.58	0.12	0.13	0.03	0.08	0.05	0.44	26,756
New Bassett Creek Tunnel	41-xxx	219	0.22	0.26	0.26	0.04	0.10	0.11	0.45	669
Brownie Lake (Minneapolis)	51-xxx	34	0.99	0.00	0.01	0.00	0.00	0.00	0.45	193
Cedar Lake (Minneapolis)	52-xxx	224	0.79	0.01	0.00	0.00	0.17	0.03	0.38	1,674
Lake of the Isles	53-xxx	760	0.76	0.07	0.02	0.01	0.12	0.01	0.42	13,644
Lake Calhoun (Minneapolis)	54-xxx	1,249	0.69	0.11	0.03	0.10	0.07	0.00	0.46	13,640
Cemetary Lake	55-xxx	205	0.00	0.99	0.00	0.00	0.01	0.00	0.60	41
Sanctuary Pond	56-xxx	68	0.00	1.00	0.00	0.00	0.00	0.00	0.60	0
Lake Harriet	57-xxx	863	0.83	0.09	0.01	0.04	0.02	0.00	0.46	12,249
Hart Lake (Minneapolis)	61-xxx	3	0.32	0.68	0.00	0.00	0.00	0.00	0.55	0
Silver Lake (Minneapolis)	62-xxx	28	0.94	0.03	0.00	0.00	0.03	0.00	0.44	245
Crystal Lake (Minneapolis)	63-xxx	469	0.92	0.04	0.00	0.02	0.03	0.00	0.45	5,985
Legion Lake (Minneapolis)	64-xxx	49	1.00	0.00	0.00	0.00	0.00	0.00	0.45	332
Legion Lake (Richfield)	64-xxx	1,700	0.96	0.00	0.01	0.00	0.03	0.00	0.30	9,781
Richfield Lake (Minneapolis)	65-xxx	715	0.88	0.06	0.02	0.00	0.04	0.00	0.32	4,388
Richfield Lake (Richfield)	65-xxx	58	0.58	0.37	0.05	0.00	0.01	0.00	0.51	442
Wood Lake (Richfield)	66-xxx	627	0.75	0.05	0.02	0.00	0.18	0.00	0.29	7,316
Minnehaha Creek	70-xxx	3,213	0.85	0.07	0.01	0.04	0.03	0.00	0.44	38,399
Diamond Lake	71-xxx	685	0.72	0.11	0.09	0.03	0.05	0.00	0.47	6,456
Lake Nokomis	72-xxx	620	0.78	0.03	0.00	0.03	0.16	0.00	0.40	7,120
Taft Lake	73-xxx	100	0.76	0.00	0.00	0.00	0.24	0.00	0.37	675
Mother Lake (Minneapolis)	74-xxx	49	0.83	0.19	0.00	0.00	0.00	0.00	0.48	111
Mother Lake (Richfield)	74-xxx	245	0.71	0.09	0.00	0.00	0.20	0.00	0.30	2,025
Unnamed Wetland W of Mother Lake	75-xxx	41	0.91	0.00	0.00	0.00	0.00	0.09	0.41	344
Lake Hiawatha	76-xxx	1,008	0.87	0.07	0.02	0.03	0.02	0.00	0.46	14,707
Birch Pond	81-xxx	31	0.00	0.00	0.00	0.00	1.00	0.00	0.10	0
Powderhorn Lake	82-xxx	286	0.88	0.05	0.02	0.04	0.01	0.00	0.46	5,621
Grass Lake	83-xxx	386	0.90	0.04	0.00	0.05	0.02	0.00	0.46	4,128
Unnamed Wetland on Hwy 62	84-xxx	17	0.86	0.00	0.14	0.00	0.00	0.00	0.47	0
Unnamed Wetland on Ewing Ave S	85-xxx	22	0.86	0.00	0.14	0.00	0.00	0.00	0.47	0
GRAND TOTAL		**36,205**	**0.58**	**0.13**	**0.10**	**0.04**	**0.06**	**0.03**	**0.42**	**454,987**

Appendix A1 - Storm Drainage Areas by Receiving Water Body
Source: Minneapolis Public Works - Surface Water & Sewers

Appendix A-3: Sources of Pollutants in Stormwater Runoff[1]

	Coal Plants / Incinerators	Gasoline / Diesel Fuel Combustion	Metal Corrosion / Metal Protection	Road Salts	Deterioration of Brake Pads / Tires	Asphalt	Fertilizers / Pesticides / Soil Treatments	Wood Preservatives	Paints and Stains	Plastics	Soil Erosion	Sanitary Waste	Manufacturing	Animal Waste	Atmospheric Deposition	Grass Clippings, Leaves and other Plant Materials	Coal Tar Based Sealants for Parking Lots, Driveways
METALS																	
Copper [a, b]	X		X		X		X	X	X	X		X	X	X			
Lead [a]		X	X	X	X		X		X	X			X		X		
Zinc [a]			X	X	X		X		X	X			X	X			
OTHER POLLUTANTS																	
Arsenic [b]	X						X	X			X		X	X	X		
Bacteria: E. Coli [a]											X	X		X			
Cyanide		X	X	X					X	X		X					
Chloride, Total [a]	X	X		X						X		X		X			
Oil and Grease [a]		X			X	X							X				
Polycyclic Aromatic Hydrocarbons (PAH) [b]	X	X				X	X					X	X				X
Sulfate [a]	X	X				X			X	X		X		X	X		X
Volatile Organic Compounds (VOC)	X	X		X		X	X		X	X		X	X	X	X		
SEDIMENT AND OTHER SOLIDS																	
Total Dissolved Solids (TDS) [a]	X			X		X	X					X		X	X	X	
Total Suspended Solids (TSS) [a]	X		X	X	X	X	X			X	X	X	X	X	X	X	
NUTRIENTS																	
Nitrate / Nitrite [a]		X					X				X	X	X	X	X	X	
Nitrogen, Ammonia Un-Ionized [a]	X	X	X				X					X		X	X	X	
Nitrogen, Total Kjeldahl (TKN) [a]							X				X	X		X	X	X	
Phosphorus, Total [a]	X	X			X	X	X				X	X	X	X	X	X	
Phosphorus, Total Dissolved [a]	X	X					X				X	X		X	X	X	
LABORATORY ANALYSIS PARAMETERS																	
Biochemical Oxygen Demand (BOD_5) [a]							X				X	X		X	X	X	
pH [a]	X		X	X													

[a] MS4 Monitored Parameter
[b] Stormwater Pond Dredging Parameter

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[1] Sources:

Massachusetts Department of Environmental Protection, Source Water Assessment Program, DRAFT Land Use/Associated Contaminants Matrix, 1999

Mississippi Watershed Management Organization, 2006 Annual Report, Appendix C, Table 4

MPCA, Managing Dredged Materials in the State of Minnesota, Figure 2, 2009

Texas Commission on Environmental Quality (TCEQ) Source Water Assessment and Protection (SWAP) Program's List of Potential Source of Contamination Types and Subtypes Detailed Listing, Descriptions, and Applied Contaminants, 2009

CITY OF MINNEAPOLIS
STORMWATER MANAGEMENT ORDINANCE SUMMARY

Ordinance: On November 24, 1999 the Minneapolis City Council amended Title 3 of the Minneapolis Code of Ordinances, relating to Air Pollution and Environmental Protection, by adding Chapter 54, entitled "*Stormwater Management*". The Chapter 54 ordinance establishes requirements for projects with land disturbing activities on sites greater than one (1) acre, including phased or connected actions, and for existing stormwater devices.

Goals: The purpose of this ordinance is to minimize negative impacts of stormwater runoff rates, volumes and quality on Minneapolis lakes, streams, wetlands, and the Mississippi River by guiding future significant development and redevelopment activity, and by assuring long-term effectiveness of existing and future stormwater management constructed facilities. The Chapter 54 Ordinance specifies that stormwater management standards be set according to the receiving water body, and the table below lists discharge requirements by receiving water. The standards include but are not limited to:

- Reductions of suspended solids for Mississippi River discharges
- Controlled rate of runoff for discharges to streams, areas prone to flooding and areas with infrastructure limitations
- A reduction in nutrients for stormwater discharging to Minneapolis lakes and wetlands

Minneapolis Development Review: Stormwater Management Plans are required for all construction projects greater than 1 acre in size. These plans are reviewed through the "Minneapolis Development Review" process. Responsibility for ongoing operation and maintenance is one component of the Stormwater Management Plan.

Registration: Stormwater devices shall be registered with the City of Minneapolis Department of Regulatory Services, with an annual permit being required for each registered stormwater device.

Stormwater 'Buyout' for off-site management, in lieu of on-site treatment:
This option is reserved for only those sites that demonstrate that performance of on-site stormwater management is not feasible. With approval of the City Engineer, the Chapter 54 Ordinance allows developers to contribute to the construction of a regional stormwater facility in lieu of on-site treatment/management. Final plan approval is conditional on payment received.

For the complete text of the *Chapter 54 Ordinance* requirements, see the Minneapolis Storm and Surface Water Management web site:
http://www.ci.minneapolis.mn.us/stormwater/stormwater-management-for-projects/CHAPTER54Ordinance.pdf

CITY OF MINNEAPOLIS
STORMWATER MANAGEMENT ORDINANCE SUMMARY

Receiving Waters	Total Discharge Requirements
All receiving waters	70% removal of total suspended solids
Brownie Lake	10% phosphorus load reduction
Cedar Lake	40% phosphorus load reduction
Lake of the Isles	20% phosphorus load reduction
Lake Calhoun	30% phosphorus load reduction
Lake Harriet	20% phosphorus load reduction
Powderhorn Lake	30% phosphorus load reduction
Lake Hiawatha	42% phosphorus load reduction
Lake Nokomis	25% phosphorus load reduction
Loring Park Pond	0% phosphorus load increase
Webber Pond	0% phosphorus load increase
Wirth Lake[1]	30% phosphorus load reduction
Spring Lake	30% phosphorus load reduction
Crystal Lake[2]	30% phosphorus load reduction
Diamond Lake	30% phosphorus load reduction
Grass Lake	30% phosphorus load reduction
Birch Pond	0% phosphorus load increase
Ryan Lake	30% phosphorus load reduction
Other wetlands	30% phosphorus load reduction
Mississippi River	70% removal of total suspended solids
Minneapolis streams	No increase in rate of runoff from site

[1] Wirth Lake is not within the limits of the City of Minneapolis
[2] Crystal Lake in located in Robbinsdale, but receives run-off from Minneapolis

PW-SWS Stormwater Treatment Facilities

Vegetation Management Policy

Goals

- Public safety
- Prevent erosion
- Protect and improve water quality and ecological function
- Slow water movement, hold or convert pollutants, and enhance infiltration and evapotranspiration
- Conduct preventive maintenance for longevity of infrastructure
- Control invasive species (non-native and selected native species) growth and prevent the production and dispersal of seed
- Create wildlife habitat
- Provide a neat appearance

Herbicide Policy

Public Works – Surface Water & Sewers Division (PW-SWS) has adopted the Integrated Pest Management (IPM) Policy formulated by the Minneapolis Park and Recreation Board (MPRB) to guide the use of herbicides on public lands under their charge. Herbicide use shall be limited as directed in this document.

Management Guidelines

- Perpetuate the original intent of the species planted. On many sites the original intent was to establish a simplified native grassland community. Plant species were selected for their resilience, habitat value and beauty. These plants shall be managed for their proliferation.
- Control [1] all species listed on the MN Noxious Weed List and comply with the MN Noxious Weed Law.
- Control invasive species in order to prevent Public Works sites from becoming sources of invasive weed seed that can disperse and establish on neighboring properties. An example is Canada thistle, which produces copious amounts of wind-blown seed that can easily become a problem on nearby public and private lands.
- Control aggressive species that if allowed to exist on a site will quickly spread and overwhelm the site. Aggressive native species include but are not limited to Canada goldenrod, sandbar willow and cottonwood. Non-native species include but are not limited to Canada thistle,

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[1] **Control means manage or prevent the maturation and spread of propagating parts of noxious weeds from one area to another by a lawful method that does not cause unreasonable adverse effects on the environment.** *MN Noxious Weed Law 2013 MS 18.75-18.91*

crown vetch, bird's-foot trefoil, reed canary grass, *Phragmites australis*, spotted knapweed, smooth brome, sweet clover, purple loosestrife, Siberian elm, buckthorn, and Tartarian honeysuckle.

- Control non-native cattails (hybrid and narrow-leaf). They are common weeds in stormwater treatment facilities that may clog inlet and outlet structures, and they reduce habitat function. They are to be controlled when a threat to structures occurs, primarily by cutting the plant below the water surface. Where this is not feasible, as a last resort wick application of an aquatic-safe herbicide may be warranted, however herbicide application over water shall be avoided where practicable.

- Control fast growing, rank, woody species such as willow, Siberian elm and box elder that can quickly establish and form a thicket around stormwater treatment facilities or can cause a public safety issue.

- Control species that are allelopathic [2]. These include but are not limited to spotted knapweed, garlic mustard, and leafy spurge.

Invasive Plant Management Tools (where feasible, use mechanical means such as pulling and mowing, in order to minimize chemical usage)

- Herbaceous Plantings
  - Pulling (preferred)
  - Mowing (preferred)
    - Flail mowing
    - Spot mowing
  - Herbicide application
    - Spot spraying
    - Wick application
- Woody Plants
  - Pulling (preferred)
  - Cutting with stump application of herbicide

[2] **Allelopathic means to produce a chemical in plant tissue that releases into the soil and prevents the growth of most other species**

INTEGRATED PEST MANAGEMENT – ADAPTED FROM MINNEAPOLIS PARK AND RECREATION BOARD POLICY (Revised July 24, 2008)

Integrated Pest Management (IPM) is a pest management strategy that focuses on long-term prevention or suppression of pest problems with minimum impact on human health, the environment and non-target organisms. In most cases, IPM is directed at controlling pests that have an economic impact on commercial crops; however, in the instance of mosquito control, IPM is used to control nuisance and potentially dangerous mosquito populations. The guiding principles, management techniques and desired outcomes are similar in all cases.

A number of concepts are vital to the development of a specific IPM policy goal:

1. Integrated pest management is not a predetermined set of practices, but a gradual stepwise process for improving pest management.
2. Integrated pest management programs use a combination of approaches, incorporating the judicious application of ecological principles, management techniques, cultural and biological controls, and chemical methods to keep pests below levels where they cause economic damage. (Laws of MN, 1989)
3. Implementing an integrated pest management program requires a thorough understanding of pests, their life histories, their environmental requirements and natural enemies, as well as establishment of a regular, systematic program for surveying pests, their damage and/or other evidence of their presence. When treatments are necessary, the least toxic and most target-specific plant protectants are chosen.

The four basic principles of IPM used in designing a specific program are:

1. Know your key pests.
2. Plan ahead.
3. Scout regularly.
4. Implement management practices.

Selection of Management Strategies

Selection of Management Strategies pest management techniques include:

- Encouraging naturally occurring biological control.
- Adoption of cultural practices that include cultivating, pruning, fertilizing, maintenance and irrigation practices that reduce pest problems.
- Changing the habitat to make it incompatible with pest development.
- Using alternate plant species or varieties that resist pests.
- Limiting monoculture plantings where possible.
- Selecting plant protectants with a lower toxicity to humans or non-target organisms

The criteria used for selecting management options include:

- Minimization of health risk to employees and users.
- Minimization of environmental impacts (e.g. water quality, non-target organisms).
- Risk reduction (losses to pests, or nuisance/threshold level).
- Ease with which the technique can be incorporated into existing management approaches.
- Cost-effectiveness of the management technique.

Posting of Plant Protectant Applications

Comply with the City of Minneapolis ordinance regarding pesticide application (Minneapolis Code of Ordinances Title 11 [Health and Sanitation] Chapter 230 [Pesticide Control])

Recordkeeping

Produce and maintain the necessary records of all pest management activities as required by the Minnesota Department of Agriculture.

Weed Control in Upland Plantings, Shrub Beds and Around Trees

Plants are selected and/or replaced in order to provide disease and insect resistant plantings, thereby reducing plant protectant applications. Weeds listed on the State of Minnesota's Noxious Weed List must be controlled as per state statute, and species will be controlled as listed in Management Guidelines above. Mechanical or manual means of weed control will be tried first when feasible. However, due to global climate change, increasing populations of tap-rooted and other perennial weeds are being transported by birds and other means. Pulling or digging of these weeds is usually not successful. Spot spraying of these tap-rooted weeds with a low toxicity herbicide will help prevent flowering, seeding and further dispersal of these pest weeds. Appropriate mulching of upland plantings, shrub beds and around trees will help decrease the number of pest weeds. If control of annual weeds in pathway or mulched areas is required, the proper pre- or post-emergent low toxicity herbicide will be applied on a spot spray basis. Posting of any plant protectant applications will be carried out according to City ordinance.

Turf Areas

PW-SWS follows the Minneapolis Park and Recreation Board's General Parks and Parkways threshold of 50% for broadleaf and/or grassy weeds in turf areas. When it has been determined that this percentage has been reached or exceeded, the appropriate post emergent or pre-emergent herbicide may be applied, preferably on a spot spray basis. Selection of the appropriate herbicide of choice will be determined by trained staff after evaluating the site, the hazard rating of the product and the specific location.

Future Pest Control Issues

With changes in climate, the environment will be subject to many changes, including the arrival of additional pests within open space areas. Following IPM principles, the City will refer to updates in MPRB policy and practice and will work with the appropriate local, state or national agencies to determine the best control approach for these new pests.

RESOLUTION
OF THE
CITY OF MINNEAPOLIS
RESOLUTION 2015R-501

By Quincy

Designating the utility rates for water, sewer, stormwater, solid waste, and recycling service effective with water meters read on and after January 1, 2016.

Resolved by The City Council of The City of Minneapolis:

Effective with utility billings for water meters read from and after **January 1, 2016**, the meter rates for water are hereby fixed and shall be collected as follows:

Charges commence when the street valve is turned on for water service.

1. **Three dollars and forty five cents ($3.45)** per one hundred (100) cubic feet for customers not otherwise mentioned.

2. **Three dollars and sixty cents ($3.60)** per one hundred (100) cubic feet to municipalities, municipal corporations, villages and customers outside the corporate limits of the city where service is furnished through individual customer meters.

3. Rates for municipalities, municipal corporations and villages, which are established by contract, shall continue on the existing contract basis.

4. In addition to the above rates a fixed charge based on meter size will be billed each billing period or fraction thereof as follows:

Meter Size	Fixed Charge
5/8-inch	**$ 3.50**
3/4-inch	**5.25**
1-inch	**8.75**
1 1/2-inch	**17.50**
2-inch	**28.00**
3-inch	**56.00**
4-inch	**87.50**
6-inch	**175.00**
8-inch	**280.00**
10-inch	**402.50**
12-inch	**1,155.00**

5. The fixed charge for a property serviced by a combined fire/general service line shall be based on the small side register of the combined meter, provided the volume of water used on the large side register does not exceed 45,000 gallons per year. The volume of water used on the large side register in the previous year will be used to establish the fixed rate in the current year. In addition to the fixed charge, a fire line rate shall be assessed according to the size of the large side register at the annual rates established in provision (f) of this section.

The fixed charge for a property serviced by a combined fire/general service line shall be based on the large side register of the combined meter, when volume of water used on the large side register exceeds 45,000 gallons per year. The volume of water used on the large side register in the previous year will be used to establish the fixed rate in the current year.

The fixed charge for a combined fire/general service line shall remain in place for the entire year.

6. All fire standpipes, supply pipes and automatic sprinkler pipes with detector meters, direct meters or non-metered, shall be assessed according to size of connection at the following rates each per annum for the service and inspection of the fire protection pipes and meters installed, as follows:

1½ inch pipe connection ……….$ 30.00

2 inch pipe connection . . . ……..$ 30.00

3 inch pipe connection . . . …….$ 40.00

4 inch pipe connection . . . ….. $ 60.00

6 inch pipe connection . . . …..$120.00

8 inch pipe connection . . . ….. $190.00

10 inch pipe connection . . . …..$275.00

12 inch pipe connection . . . …..$790.00

When the seal of any of the valves connecting with such fire protection pipes shall be broken, it shall be forthwith resealed by a Public Works - Water Division representative. All connections for fire systems must have a post indicator valve installed at the curb if ordered by the superintendent of the waterworks. (Code 1960, As Amend., § 606.030; Ord. of 12-28-73, § 1)

7. Rates for other services and materials provided shall be fixed as follows:

Description	Materials (*before sales tax*)	Hourly Servicing Fee	Flat Rate
Install new equipment requested by customer or replace damaged or lost equipment:			
5/8" water meter	$75.00	$53.00	N/A
3/4" water meter	$100.00	$53.00	N/A
1" water meter	$145.00	$53.00	N/A
1 1/2" water meter	$360.00	$53.00	N/A
2" water meter	$460.00	$53.00	N/A
3" water meter	$1,090.00	$53.00	N/A
4" water meter	$1,476.00	$53.00	N/A
6" water meter	$2,430.00	$53.00	N/A
Encoder Receiver Transmitter (ERT)	$87.00	$53.00	N/A
Encoder 5/8" - 1"	$25.00	$53.00	N/A
Encoder 1 1/2" or greater	$80.00	$53.00	N/A

Meter couplings	$10.00	$53.00	N/A
Remove or drain a water meter	N/A	$53.00	N/A
Water meter testing	N/A	$53.00	N/A
Water meter reading, missed appointments, and posting fees	N/A	Minimum Charge $26.50	N/A
Shut Off Valve Flush Fee	N/A	$20.00	N/A
Private meter sales	Cost + 10% Overhead	$53.00	N/A
Water turn-on or shut-off - delinquent or at customer's request	N/A	$53.00	N/A
Description	**Materials (*before sales tax*)**	**Hourly Servicing Fee**	**Flat Rate**
Winter Surcharge (December 1st - April 1st)	N/A	N/A	$25.00
Water main shut down for contractor	N/A	N/A	$646.00
Penalties:			
Water meter tampering violation penalty	N/A	N/A	$200.00
Water meter bypass valve tampering penalty	N/A	N/A	$500.00
Unauthorized water service turn-on penalty	N/A	N/A	$500.00
Water system valve tampering penalty	N/A	N/A	$500.00
Violation of water emergency declaration penalty	N/A	N/A	$25.00
Water Service Tap Cutoff or Extension Permit	N/A	N/A	$50.00
Water Hydrant Usage:			
Permit	N/A	N/A	$50.00
Installation of equipment for construction, demolition, and special event usage	N/A	N/A	$200.00
Hydrant sanitation for potable water usage	N/A	N/A	$160.00

Equipment deposit for residential demolition usage	N/A	N/A	$1,200.00
Equipment deposit for commercial construction and demolition usage	N/A	N/A	$3,200.00
Water usage charged at 2016 in city rate - $3.45/ Unit (100 cubic feet)	N/A	N/A	$3.45/Unit
Water usage Fee for Residential demolition	N/A	N/A	$50.00
Temporary Water Meter for Construction Usage:			
Permit	N/A	N/A	$50.00
Temporary water meter usage fee	N/A	N/A	$200.00
Equipment and water usage deposit	N/A	N/A	$2,500.00
Water usage charged at 2016 in city rate - $3.45/ Unit (100 cubic feet). Usage will be subtracted from initial deposit until deposit is depleted.	N/A	N/A	$3.45/Unit
Large Water Main Tap by Tap Size *			
6x4"	N/A	N/A	$1,974.35
6x6"	N/A	N/A	$2,223.09
8x4"	N/A	N/A	$2,121.37
8x6"	N/A	N/A	$2,191.18
8x8"	N/A	N/A	$2,927.64
10x4"	N/A	N/A	$2,413.38
10x6"	N/A	N/A	$2,428.87
10x8"	N/A	N/A	$2,682.26
12x4"	N/A	N/A	$2,137.95
12x6"	N/A	N/A	$2,288.37
Description	**Materials (*before sales tax*)**	**Hourly Servicing Fee**	**Flat Rate**
12x8"	N/A	N/A	$3,101.02
12x12"			$5,173.88
16x4"	N/A	N/A	$2,742.34
16x6"	N/A	N/A	$2,462.04
16x8"	N/A	N/A	$3,818.13
16x12"	N/A	N/A	$5,065.03
24x4"	N/A	N/A	$2,417.34
24x6"	N/A	N/A	$3,000.42

24x8"	N/A	N/A	$4,074.35
24x12"	N/A	N/A	$5,787.74
30x4"	N/A	N/A	$3,504.50
30x6"	N/A	N/A	$3,710.99
30x8"	N/A	N/A	$5,168.75
30x12"	N/A	N/A	$8,556.31
36x4"	N/A	N/A	$3,766.39
36x6"	N/A	N/A	$3,878.74
36x8"	N/A	N/A	$4,900.95
36x12"	N/A	N/A	$7,934.67
Small Water Main Tap by Size *			
3/4x3/4"	N/A	N/A	$213.00
1x1"	N/A	N/A	$223.00
1x1¼"	N/A	N/A	$238.00
Water Main Tap Discontinue by Size *			
6x2"	N/A	N/A	$1,799.03
6x3"	N/A	N/A	$1,799.03
6x4"	N/A	N/A	$2,093.07
6x6"	N/A	N/A	$2,093.07
8x2"			$1,831.99
8x3"	N/A	N/A	$1,831.99
8x4"	N/A	N/A	$1,831.98
8x6"	N/A	N/A	$2,298.73
8x8"	N/A	N/A	$2,298.73
10x2"	N/A	N/A	$1,898.91
10x3"	N/A	N/A	$1,898.91
10x4"	N/A	N/A	$1,898.91
10x6"	N/A	N/A	$2,985.14
10x8"	N/A	N/A	$2,985.14
10x10"	N/A	N/A	$2,985.14
12x2"	N/A	N/A	$1,964.24
Description	**Materials (*before sales tax*)**	**Hourly Servicing Fee**	**Flat Rate**
12x3"	N/A	N/A	$1,964.24
12x4"	N/A	N/A	$1,964.24
12x6"	N/A	N/A	$1,964.24
12x8"	N/A	N/A	$3,052.28
12x12"	N/A	N/A	$3,052.28
16x2"	N/A	N/A	$2,491.72

16x3"	N/A	N/A	$2,491.72
16x4"	N/A	N/A	$2,491.72
16x6"	N/A	N/A	$2,491.72
16x8"	N/A	N/A	$2,491.72
16x12"	N/A	N/A	$4,187.85
24x2"	N/A	N/A	$2,898.91
24x3"	N/A	N/A	$2,898.91
24x4"	N/A	N/A	$2,898.91
24x6"	N/A	N/A	$2,898.91
24x8"	N/A	N/A	$2,898.91
24x12"	N/A	N/A	$2,898.91
Mechanical Plug Pricing*			
4" Plug	N/A	N/A	$1,799.04
6" Plug	N/A	N/A	$1,810.79
8" Plug	N/A	N/A	$1,851.88
12" Plug	N/A	N/A	$1,899.03
**When site specific circumstances preclude the use of standard methods, the fee will based on the City's estimate for time and materials. Standard fee includes installation and $50 permit fee but not excavation.*			

The sanitary sewer rates and stormwater service rate shall be applied to utility billings for water meters read from and after January 1, 2016.

Sanitary Sewer Rate

The sanitary sewer rates to be charged properties within and outside the City of Minneapolis that are served directly by the City of Minneapolis sewer system and that are all served either directly or indirectly by the sewage disposal system constructed, maintained and operated by the Metropolitan Council Environmental Services under and pursuant to Minnesota Statutes Sections 473.517, 473.519 and 473.521, Sub. 2, are hereby set as follows:

1. The sanitary sewer rate applicable inside the City of Minneapolis is **three dollars and thirty-nice cents ($3.39)** per one hundred (100) cubic feet.

2. In addition, a fixed charge based on water meter size will be billed each billing period or fraction thereof as follows:

Meter Size	Fixed Charge
5/8-inch	**$ 4.30**
3/4-inch	**6.45**
1-inch	**10.75**
1 1/2-inch	**21.50**
2-inch	**34.40**
3-inch	**68.80**
4-inch	**107.50**
6-inch	**215.00**

8-inch	**344.00**
10-inch	**494.50**
12-inch	**1,419.00**

3. The sanitary sewer rate applicable outside the City of Minneapolis for all sewage flow generated is **three dollars and thrity-nine cents ($3.39)** per one hundred (100) cubic feet when the City of Minneapolis also provides water. In addition, the fixed charge sanitary sewer rate shall be based on meter size per section (b).

4. Sanitary sewer only service outside the City of Minneapolis shall be twenty dollars ($20.00) per month.

5. The sanitary sewer charge for residential property not exceeding three (3) residential units shall be based on the volume of water used during the winter season which is defined as a four (4) month period between November 1 and March 31.

6. The sanitary sewer charge for residential property exceeding three (3) residential units and all other commercial and industrial property shall be based on measured sewage volume or the total water volume used during the billing period as is appropriate.

Stormwater Rate

The stormwater rate, subject to the provisions in Chapter 510, of the Minneapolis Code of Ordinances, is imposed on each and every Single-Family Residential Developed Property, Other Residential Developed Property, Non-Residential Developed Property, and Vacant Property, other than Exempt Property, and the owner and non-owner users, and is hereby set as follows:

1. The Equivalent Stormwater Unit (ESU) rate is **eleven dollars and ninety-four cents ($11.94).** The ESU measurement is 1,530 square feet of impervious area.

2. The stormwater rate imposed on Single-Family Residential Developed Properties shall be categorized into three tiers based on the estimated amount of impervious area as follows:

High – Single-Family Residential Developed Property – greater than one thousand five hundred and seventy-eight (1,578) square feet of estimated impervious area. The ESU shall be 1.25 and the stormwater rate set at **fourteen dollars and ninety-three cents ($14.93).**

Medium – Single-Family Residential Developed Property – equal to or greater than one thousand four hundred and eighty-five (1,485) square feet and less than or equal to one thousand five hundred and seventy-eight (1,578) square feet of estimated impervious area. The ESU shall be 1.00 and the stormwater rate set at **eleven dollars and ninety-four cents ($11.94).**

Low – Single-Family Residential Developed Property – less than one thousand four hundred and eighty-five (1,485) square feet of estimated impervious area. The ESU shall be .75 and the stormwater rate set at **eight dollars and ninety-six cents ($8.96).**

3. Stormwater charges for all other properties will be based on the following calculation:

(Gross Lot Size in sq.ft. X Runoff Coefficient) ÷ 1,530 sq. ft.= # of ESU

# of ESU X **<u>$ 11.94</u>** = Monthly Fee

The runoff coefficient assumed for each land use category is shown below.

Land Use	Coefficient Applied
Bar-Rest.-Entertainment	.75
Car Sales Lot	.95
Cemetery w/Monuments	.20
Central Business District	1.00
Common Area	.20
Garage or Misc. Res.	.55
Group Residence	.75
Ind. Warehouse-Factory	.90
Industrial railway	.85
Institution-Sch.-Church	.90
Misc. Commercial	.90
Mixed Comm.-Res-Apt	.75
Multi-Family Apartment	.75
Multi-Family Residential	.40
Office	.91
Parks & Playgrounds	.20
Public Accommodations	.91
Retail	.91
Single Family Attached	.75
Single Family Detached	ESU
Sport or Rec. Facility	.60
Utility	.90
Vacant Land Use	.20
Vehicle Related Use	.90

Solid waste and recycling variable rate charges associated with water meter read dates from and after <u>January 1, 2016</u>, the charges shall be as follows:

1. The base unit charge shall be **<u>twenty-two dollars and eighty-nine cents ($22.89)</u>** per dwelling unit per month.

2. The cart disposal charge shall be two dollars ($2.00) per month for each small cart.

3. The cart disposal charge shall be five dollars ($5.00) per month for each large cart assigned to a dwelling unit.

- **CHAPTER 510. - STORMWATER MANAGEMENT SYSTEM AND OPERATION OF A STORMWATER UTILITY**

- **510.10. - Definitions.**

In addition to the words, terms and phrases elsewhere defined in this chapter, the following words, terms and phrases as used in this chapter shall have the following meanings:

Bonds means revenue or general obligation bonds, notes, loans or other debt obligations heretofore or hereafter issued to finance the costs of improvements and/or operations and maintenance.

Building permit means a permit issued by the director of inspections that permits construction of a structure.

City means City of Minneapolis, Minnesota.

City council means governing body of the city.

Costs of capital improvements means costs incurred in providing capital improvements to the stormwater management system or any portion thereof including, without limitation, the cost of alteration, enlargement, extension, improvement, construction, reconstruction, testing and development of the stormwater management system; insurance premiums for insurance taken out and maintained during construction, professional services and studies connected thereto; principal and interest on bonds heretofore or hereafter issued, acquisition of real and personal property by purchase, lease, donation, condemnation or otherwise for the stormwater management system or for its protection; and costs associated with purchasing equipment, computers, furniture, etc., that are necessary for the operation of the system or the utility.

Debt service means an amount equal to the sum of (i) all interest payable on bonds during a fiscal year, plus (ii) any principal installments payable on the bonds during that fiscal year.

Developed property means real property, other than undisturbed property; provided that, property used for agricultural uses, upon which no dwelling unit is located, shall not constitute developed property for purposes of this chapter.

Director means the city engineer/director of the public works department for the City of Minneapolis or the director's designee.

Dwelling unit means one (1) or more rooms, designed, occupied or intended for occupancy as a separate living quarter, with a single complete kitchen facility, sleeping area and bathroom provided within the unit for the exclusive use of a single household.

Equivalent stormwater unit (ESU) means a unit of measure that is equal to the average impervious area of single-family residential developed property that falls within the medium class, with a single-family detached dwelling unit located thereon and within the city's limits, as established by city council resolution or ordinance, as provided for herein.

Equivalent stormwater unit rate or *ESU rate* means the storm sewer charge imposed on single-family residential developed property within the medium class, as established by city council resolution or ordinance, as provided herein.

Exempt property means public rights-of-way, public trails, public streets, public alleys, public sidewalks, railroad tracks that are not in railroad yards, and also means public lands and/or easements upon which the stormwater management system is constructed and/or located.

Fiscal year means a twelve-month period commencing on the first day of January of any year or such other twelve-month period adopted as the fiscal year of the city.

Impervious area means the number of square feet of hard surface areas that either prevent or retard the entry of water into the soil matrix, as it entered under natural conditions as undisturbed property, and/or cause water to run off the surface in greater quantities or at an increased rate of flow from that present under natural conditions as undisturbed property, including, but not limited to, roofs, roof extensions, driveways, pavement and athletic courts.

Other residential developed property means developed property upon which two (2) or more family and/or multi-family dwellings are located.

Non-residential developed property means developed property other than single residential developed property and other residential developed property.

Operating budget means the annual stormwater utility operating budget adopted by the city for the succeeding fiscal year.

Operations and maintenance means, without limitation, the current expenses, paid or secured, of operation, maintenance, repair and minor replacement of the system, as calculated in accordance with generally accepted accounting practice. This shall include, without limiting the generality of the foregoing, cost of studies related to the operation of the system; costs of the study performed heretofore in relation to establishing storm sewer charges for the stormwater utility and other start up costs of the stormwater utility; costs related to the national pollutant discharge elimination system permit study, application, negotiation and implementation, including public education and outreach, as mandated by federal and state laws and regulations and the costs of obtaining and complying with all other permits required by law, insurance premiums, administrative expenses, equipment costs, including professional services, labor costs and the cost of materials and supplies used for current operations.

Revenues means all rates, fees, assessments, rentals or other charges or other income received by the stormwater utility in connection with the management and operation of the system, including amounts received from the investment or deposit of monies in any fund or account, as calculated in accordance with generally accepted accounting practices.

Runoff coefficients means those numbers approved by the city council that are used to estimate the impervious area for each non-single family classified property. A list of the coefficients used for the city is found in Table 1 that is incorporated herein.

Single-family residential developed property means developed property upon which single-family detached dwellings are located.

Stormwater charge means a charge authorized by this chapter, Minnesota Statutes 2004, Section 444.075, and other applicable law, and further as set forth in resolution or ordinance heretofore or hereafter adopted or hereafter amended by the city council, which is established to pay operation and maintenance, costs of capital improvements, debt service associated with the stormwater management system and other costs included in the operating budget.

Stormwater management system, *sewer system* or *system* means storm sewers that exist at the time the ordinance codified in this chapter is adopted or that are hereafter established and all appurtenances necessary in the maintaining and operating of the same, including, but not limited to pumping stations; enclosed storm sewers; outfall sewers; surface drains; street, curb and alley improvements associated with storm or surface water improvements; natural and manmade wetlands; channels; ditches; rivers; streams; wet and dry bottom basins; pocket ponds; multiple pond systems; settling basins; infiltration trenches or basins; filter systems; bioretention areas; dry or wet swales; grass channels; roof top detention; skimming devices; grit chambers and other flood control facilities; and works for the collection, transportation, conveyance, pumping, treatment, controlling, storing, managing, and disposing storm or surface water or pollutants originating from or carried by storm or surface water.

Stormwater utility or *utility* means the utility created by this chapter to operate, maintain and improve the stormwater management system and for all other purposes set forth in this chapter.

Undisturbed property means real property that has not been altered from its natural condition in a manner that disturbed or altered the topography or soils on the property to the degree that the entrance of water into the soil matrix is prevented or retarded.

Vacant land means real property upon which there is no structure, as shown in the records of the city assessor's office, which is not designed for or regularly used for commercial residential purposes, and which is not used in connection with another piece of property. Vacant land includes undisturbed property and land with no building used as a community garden. (2004-Or-132, § 1, 11-5-04)

- **510.20. - Creation of stormwater utility.**

Pursuant to the provisions of Minnesota Statutes 2004, Section 444.075, the city's general home rule powers, its nuisance powers, police powers and all other authorized powers, the city council does establish a stormwater utility and stormwater management system and declares its intention to operate, construct, maintain, repair and replace the stormwater management system and operate the stormwater utility. (2004-Or-132, § 1, 11-5-04)

- **510.30. - Findings and determinations.**

The city finds that the elements of the stormwater management system that provides for the collection, conveyance, detention/retention, treatment and release of stormwater, the reduction of hazard to property and life resulting from stormwater runoff, improvement in general health and welfare through reduction of undesirable stormwater conditions and improvement to the water quality in the storm and surface water system and its receiving waters are of benefit and provide services to all property within the city. It is further found, determined and declared that this chapter is in furtherance of and implements the goals and strategies of the local surface water management plan, the annual Combined Sewer Overflow (CSO) report and the city's National Pollutant Discharge Elimination System (NPDES) permit. (2004-Or-132, § 1, 11-5-04)

- **510.40. - Administration.**

The stormwater utility, under the supervision of the director, shall have the power to:

(1)

Administer the acquisition, design, construction, maintenance, operation, extension and replacement of the stormwater management system, including real and personal property that is or will become a part of or protect the system.

(2)

Prepare regulations, as needed, to implement this chapter, and forward those regulations to the city council for consideration and adoption, and adopt those procedures, as are desirable, to implement adopted regulations or to carry out other responsibilities of the utility.

(3)

Administer and enforce this chapter and all regulations, guidelines and procedures adopted relating to the design, construction, maintenance, operation and alteration of the stormwater management system, including, but not limited to, the flow rate, volume, quality and/or velocity of the stormwater conveyed thereby.

a.

Advise the city council on matters relating to the stormwater management system.

b.

Develop and review plans concerning creation, design, construction, extension and replacement of the system and make recommendations to the city council related thereto.

c.

Inspect private systems, as necessary, to determine the compliance of those systems with this chapter and any regulations adopted pursuant hereto.

d.

Make recommendations to the city council concerning the adoption of ordinances, resolutions, guidelines and regulations to protect and maintain water quality within the stormwater management system in compliance with water quality standards established by state, county, regional and/or federal agencies, as now adopted or hereafter adopted or amended.

e.

Analyze the cost of services and benefits provided by the stormwater management system and the structure of fees, service charges, fines and other revenues of the stormwater utility at least once each year.

f.

Make recommendations to the city council concerning the cost of service and benefits provided by the stormwater management system and structure of fees, service charges, fines and other revenues of the stormwater utility.

g.

Analyze the appropriateness of providing credits against the stormwater charge for owners of property who employ structural or non-structural best management practices or other stormwater management practices on-site that significantly reduce the quantity or improve the quality of stormwater run-off from their property that enters the system and make recommendations to the city council regarding the provision of these credits.

h.

Administer programs established pursuant hereto or pursuant to ordinances, resolutions, regulations or guidelines hereafter adopted by the city council that provide for credits and/or incentives that reduce stormwater charges imposed against properties. (2004-Or-132, § 1, 11-5-04)

- **510.50. - Operating budget.**

The city shall, as part of its annual budget process, adopt an operating budget for the stormwater utility for the next following fiscal year. The operating budget shall be prepared in conformance with the state budget law, city policy and generally accepted accounting practices. The initial operating budget commences January 1, 2005, and ends December 31, 2005. (2004-Or-132, § 1, 11-5-04)

- **510.60. - Stormwater charge.**

(a) *Stormwater charge established*. Subject to the provisions of this chapter, there is imposed on each and every single-family residential developed property, other residential developed property and non-residential developed property, and vacant property, other than exempt property, and the owner and non-owner users thereof, a stormwater charge. In the event the owner and non-owner user of a particular developed property are not the same, the liability for the owner and non-owner user for the stormwater charge attributable to the developed property shall be joint and several liability. This stormwater charge shall be determined and set by the provisions of this chapter in accordance with the ESU and ESU rate, which is established by ordinance or resolution of the city council and which may be amended from time to time by the city council.

(1)

Stormwater charge for single-family residential developed property. Three (3) classes of single-family residential developed property are established to account for the wide range of the amount of impervious area that exists on individual single-family residential developed properties in the city. The three (3) single-family customer classes are based on statistical sampling of estimated impervious area as developed from the city assessor's single-family residential developed real estate property records which includes: foundation square footage, garage stalls, estimation of driveway square footage and foundation square footage of any outbuildings/other improvements. Classification of the single-family residential developed customer class properties into the three (3) customer classes is made based on estimated impervious area. Single-family residential developed properties will be assigned to one (1) of three (3) single-family residential customer classes. The three (3) single-family residential customer classes are as follows:

a.

Single-family residential developed property/high — greater than one thousand five hundred seventy-eight (1,578) square feet of estimated impervious area.

b.

Single-family residential developed property/medium — equal to or greater than one thousand four hundred eighty-five (1,485) square feet and less than or equal to one thousand five hundred seventy-eight (1,578) square feet of estimated impervious area.

c.

Single-family residential developed property/low — less than one thousand four hundred eighty-five (1,485) square feet of estimated impervious area.

The stormwater charge for each of these classes shall be as follows:

High	1.25 % of an ESU
Medium	1 ESU
Low	.75 % of an ESU

In the event of a newly constructed dwelling unit, the charge for the stormwater charge attributable to that dwelling unit shall commence upon the issuance of the building permit for that dwelling unit.

(2)

Stormwater charge for other residential developed property. The stormwater charge for other residential developed property shall be the ESU rate multiplied by the numerical factor obtained by multiplying the gross area of a property by the runoff coefficient for the other residential developed property, as set forth in Table 1 (the actual coefficient will be defined at the time of the annual rate adoption) and then dividing the above product by the ESU, as this ESU is established by City Council resolution or ordinance ((gross square footage X runoff coefficient)/ESU = ## ESU). In the event of a newly constructed dwelling unit, the stormwater charge attributable to that dwelling unit shall commence upon the issuance of the building permit for that dwelling unit.

(3)

Stormwater charge for non-residential developed property. The stormwater charge for non-residential developed property shall be the ESU rate multiplied by the number of ESU's for each individual non-residential developed property. The number of ESU's for each individual non-residential developed property shall be obtained by multiplying the gross area of each individual property by the runoff coefficient for the customer class that is the most similar to the use to which that individual non-residential developed property is currently being put, as set forth in Table 1 (the actual coefficient will be defined at the time of the annual rate adoption) and then dividing the above product by the ESU, as this ESU is established by city council resolution or ordinance ((gross square footage X runoff coefficient)/ESU = ## ESU)). The minimum stormwater charge for any non-residential developed property shall be in an amount equal to that of one (1) ESU. In the event of newly developed non-residential developed property, the stormwater charge attributable to that development shall commence upon the issuance of the building permit. In the event of additional development to property that is already developed property, the charge for the stormwater charge attributable to that additional development shall commence upon the issuance of the building permit.

(4)

Stormwater charge for vacant property. The stormwater charge for vacant property shall be the ESU rate multiplied by the number of ESU's for each individual vacant property. The number of ESU's for each individual vacant property shall be obtained by multiplying the gross area of each individual property by the runoff coefficient for the vacant property class, as set forth in Table 1 (the actual coefficient will be defined at the time of the annual rate adoption) and then dividing the above product by the ESU, as this ESU is established by city council resolution or ordinance ((gross square footage X runoff coefficient)/ESU = ## ESU)). There is no minimum stormwater charge for vacant property.

(b)

Stormwater charge calculation. The director shall initially, and from time to time, determine the class of residential developed property into which each individual residential developed property falls to establish the stormwater charge, based on the impervious area of the parcel as shown in the single-family records maintained by the city assessor's office. The stormwater charge for other residential developed property, for non-residential developed property, and for vacant property in the city shall be calculated as provided for subsection (a)(2), (3) & (4). The director shall make the initial calculation with respect to existing other residential developed property, non-residential developed property, and vacant property and may from time to time change this calculation from the information and data deemed pertinent by the director. With respect to property proposed to be non-residential developed property, the applicant for development approval shall submit square footage impervious area calculations, in accordance with the submission requirements for the application being submitted, as set forth in the applicable section of Title 20 of this Code.

(c)

Stormwater charge credit. A system of credits, which may reduce the stormwater charge that is imposed, as provided for above, is hereby established. A credit shall be granted for developed or undeveloped property pursuant to the rules provided for herein. The director shall, pursuant to the rules provided for herein, grant a credit to those owners or non-owner users of properties, against which stormwater charges are imposed, who employ structural or non-structural best management practices or other stormwater management practices on-site that significantly reduce the quantity or significantly improve the quality of stormwater run-off from their property that enters the system. The director shall propose rules providing guidelines for the awarding of credits. The council shall approve, or approve as modified, these rules for the awarding of credits. The rules shall be consistent with this section. A credit also shall be granted in a percentage amount set by said city council pursuant to the rules for properties with respect to which a final plan or final plat has been approved or other final development approval has been granted by the city, on or before the effective date of this ordinance, which requires the construction of an on-site structural or non-structural best management practices or other stormwater management practices that significantly reduce the quantity or improve the quality of stormwater run-off from their property that enters the system, provided that, the practices are constructed and/or operational within one (1) year from the date of the applicable final approval. The credit shall begin in the fiscal year that the practice becomes operational. The credit for the first year, however, shall be prorated to reflect the number of months of the first fiscal year that the practices are operational, where appropriate. (2004-Or-132, § 1, 11-5-04)

- **510.70. - Appeal procedure.**

(a) Owners of residential developed property, non-residential developed property or vacant property, with respect to which a stormwater charge has been imposed, that disagree:

(1) With the class into which their single-family residential developed property is placed;

(2) With the calculation of the stormwater charge;

(3) With whether their property is benefited by the stormwater utility; or

(4) With whether their property is entitled to a credit or the continuation of a credit or on the amount of a credit;

may appeal the calculation or finding to a designee of the director by giving written notice of the appeal to the director at the director's customary offices within the (10) days of notice of that determination.

The director's designee assigned to hear such appeal shall not be a person that is regularly assigned to utility billing or the stormwater utility. Appeals from the calculation or finding to the designee of the director, as delineated herein above are separate and distinct from the billing complaint procedures established by Sections 509.920 and 509.930 of this Code.

(b) The director's designee shall give written notice of the time and place for the review requested, pursuant to subsection (a) hereof, to the appealing owner or non-owner user. The review shall be held within fifteen (15) days of receipt by the director of the written appeal. In addition to any oral presentation, appellant shall state all grounds supporting the appeal in writing, attaching any exhibits, such as photographs, drawings or maps and affidavits that support the claim. In addition, the appellant shall submit a land survey prepared by a registered surveyor showing dwelling units, total property area, type of surface material and impervious area, as appropriate, and any other information that the director shall designate in writing to the appellant. The director may waive the submission of a land survey, if director determines that the survey is not necessary to make a determination on the appeal.

(c) The burden of proof shall be on the appellant to demonstrate, by clear and convincing evidence, that the determination of the director, from which the appeal is being taken, is erroneous.

(d) The filing of a notice of appeal shall not stay the imposition, calculation or duty to pay the stormwater charge. The appellant shall pay the stormwater charge, as stated in the billing.

(e) Within fifteen (15) days of the review, the director's designee shall send a written copy of the designee's decision to the appellant with a copy to the director.

(f)

If the appellant believes this decision is in error, the appellant may file a written request for a review by the city council based on the written record by filing a request with the city clerk with a copy to the director. The request for review shall be reviewed based on the written record by a committee or subcommittee of the city council, or by a person appointed by the city council, or any designated combination thereof, within thirty (30) days of the filing of the request. The report of the committee, subcommittee and/or other reviewer shall be referred to the full council and be acted upon by the full council within thirty (30) days of the review. The decision of the city council on appeal is subject to judicial review, as provided by the laws of the state.

(g)

If the director's designee's determines, upon appeal, that appellant should not pay a charge, pay a charge amount less than the amount appealed from, receive a credit or receive a greater credit than the credit appealed from or the city council, upon appeal, so determines, the city shall issue a check to the appellant in the appropriate amount within ten (10) days of the date of the applicable decision, provided the charge has, as required herein, been paid by the appellant. (2004-Or-132, § 1, 11-5-04)

- **510.80. - Stormwater charge collection.**

(a) The stormwater charge shall be billed and collected by the city. The stormwater charge shall be shown as a separate item on the billing from the sewer utility charge levied and assessed pursuant to Section 511.290. In the event the owner and non-owner of a particular developed property are not the same, the liability for the owner and non-owner user for the stormwater charge attributable to the developed property shall be joint and severable. The same administrative procedures for special assessments shall be applied to the stormwater charge, as are applied for water use under Chapter 509 of this Code.

(b)

Pursuant to Minnesota Laws 1973, Chapter 320, whenever payment remains in default for a stormwater charge, the city council may annually levy an assessment equal to the unpaid costs, including penalty and interest against each developed property that is not exempt property and upon which the stormwater charge is unpaid. (2004-Or-132, § 1, 11-5-04)

- **510.90. - Stormwater fund.**

Stormwater charges collected by the city shall be paid into a fund that is hereby created and shall be known as the "Stormwater Fund." This fund shall be used for the purpose of paying costs of capital improvements, administration of the stormwater utility, operation and maintenance and debt service of the stormwater management system and to carry out all other purposes of the utility. (2004-Or-132, § 1, 11-5-04)

- **510.100. - Equivalent stormwater unit (ESU) rate.**

The ESU and the ESU rate that is used to determine the charge for each class of residential developed property, other residential developed property, non-residential developed property, and vacant property shall be as established in an ordinance or a resolution heretofore adopted or hereafter adopted by the city council, and as thereafter amended. (2004-Or-132, § 1, 11-5-04)

- **510.110. - Severability.**

In the event that any portion or section of this chapter is determined to be invalid, illegal or unconstitutional by a court of competent jurisdiction, the decision shall in no manner affect the remaining portions or sections of this chapter, which shall remain in full force and effect.

Table 1 - Ordinance

Bar- Rest.- Entertainment	.60—.75
Car Sales Lot	.60—.95
Cemetery w/Monuments	.10—.25
Central Business District	.85—1.00
Common Area	.10—.25
Garage or Misc. Res.	.30—.55
Group Residence	.60—.75
Ind. Warehouse- Factory	.50—.90
Industrial Railway	.50—.90
Institution- Sch.- Church	.60—.95
Misc. Commercial	.60—.95
Mixed Comm.- Res - Apt.	.60—.75
Multi-Family Apartment	.60—.75
Multi-Family Residential	.35—.50
Office	.60—.95
Parks & Playgrounds	.10—.25
Public Accommodations	.60—.95
Retail	.60—.95
Single Family Attached	.60—.75
Single Family Detached	ESU
Sport or Rec. Facility	.60—.95
Utility	.50—.90
Vacant Land Use	.10—.25
Vehicle Related Use	.60—.90
LAND USE	**RANGE**

(2004-Or-132, § 1, 11-5-04; 2005-Or-102, § 1, 11-4-05)

Minneapolis Stormwater Utility Fee FAQ

What is Stormwater?

Stormwater is runoff from a rainstorm or melting snow. City landscapes - unlike forests, wetlands, and grasslands that trap water and allow it to filter slowly into the ground - contain great areas of impermeable asphalt and concrete surfaces that prevent water from seeping into the ground. Because of this, large amounts of water accumulate above the surface. This water will run off before eventually entering into our lakes, rivers and streams.

Why is it important to manage stormwater?

Minneapolis, like other communities, needs to manage stormwater to protect people's homes and properties, the environment, lakes, streams & rivers. If this is not done, stormwater will cause flooding, erosion and pollution. Heavy rains that flood streets and yards can result in property damage. Stormwater runoff also picks up pollutants and debris from streets, parking lots & yards, carrying them into our lakes, rivers and streams.

What is the stormwater utility fee on my bill?

The stormwater utility fee pays for the City's current stormwater system and annual maintenance costs. This helps to prevent and correct stormwater runoff problems in Minneapolis. All properties within City limits (with very limited exceptions) are charged a monthly stormwater utility fee. This fee had existed prior to 2005, but was included as part of the combined sanitary sewer/stormwater fee.

Because the stormwater utility fee is a user fee and not a tax, all properties regardless of ownership are required to pay for the services provided by the Minneapolis stormwater management system. This includes non-profit entities such as churches, schools and institutions, as well as properties owned by the City of Minneapolis, the State of Minnesota, and the federal government.

How is the stormwater fee calculated?

The stormwater utility fee is based on impervious area and is charged on a per unit basis. Each ESU (**E**quivalent **S**tormwater **U**nit) is 1,530 square feet of impervious area on a property. The impervious area is calculated based on the size of the property, as well as the current use. Single family properties are billed using one of the following rates:

High	1.25 ESU	$14.93
Medium	1.00 ESU	$11.94
Low	.75 ESU	$8.96

All other properties are billed as follows: Gross Lot Size in square ft. X Runoff Coefficient (based on Land Use class) divided by 1,530 square ft = # of ESU's.

What is impervious area?

Surfaces where water can not flow through freely. Examples of impervious surfaces include, but are not limited to the following:

- House footprints
- Driveways
- Parking Lots
- Sidewalks
- Patios
- Decks
- Detached garages
- Sheds
- Concrete air conditioner pads
- Brick pavers

It also includes all non-improved (vegetated or grass cover) areas that are used for parking storage or are driven upon. In an urban environment such as Minneapolis, a property's impervious area is the most significant factor affecting both stormwater quality and quantity.

Is there a way to reduce my stormwater fee?

Yes. Stormwater fees can be reduced through the City of Minneapolis Stormwater Credits Program. The credits program offers a reduction in fees to property owners who use approved methods to manage stormwater runoff on their property. Fees can also be reduced through the replacement of excess impervious area (such as unused parking lots) with landscaped green space.

How does the City's Stormwater Credits Program encourage helpful environmental practices?

The stormwater fee incorporates opportunities for property owners to reduce their stormwater bill by taking environmentally friendly steps. Stormwater utility fee reductions, also called credits, are available to those who are using or installing stormwater management tools/practices on their properties. Installing rain gardens or other materials, such as impervious pavers, allows stormwater to soak into the ground, rather than run into storm sewers.

How can I get a stormwater credit on my utility bill?

Credit guidelines and application forms can be found on the on the City of Minneapolis Stormwater Fee website . If you need additional information, please contact (612) 673-2965.

Last updated Mar 3, 2015

City of Minneapolis

Fire Inspection Services

Spill Response Protocol

1) Report to the State Duty Officer/911 Emergency Communications.

2) Assessment of the site/incident, determination of Incident Action Plan (IAP).

3) Secure appropriate City/ State/ Federal resources, as well as private contractors, for implementation of IAP.

4) Oversight of site incident remediation and recovery activities.

5) Investigation/determination of causation, potential penalties, and future prevention measures.

CITY OF MINNEAPOLIS
PUBLIC WORKS DEPARTMENT
Street Maintenance Division
Standard Operating Procedure for Vehicle Related Spills (VRS)
May, 2014

The purpose of this document is to provide detailed standard operating procedures for the Cleanup of VRS sites and the management/disposal of the impacted spill debris.

DEFINITION of TERMS

FIS: Fire Inspection Services (also historically known as Minneapolis Environmental Management or Minneapolis Pollution Control)

MPCA: Minnesota Pollution Control Agency

MSMD: Minneapolis (Public Works) Street Maintenance Division

VRM: Vehicle Related Material: Petroleum products or other vehicle fluids that are inherently related to vehicular operations. This does not include materials that are being transported by a vehicle, unless the material is clearly labeled as being one of the aforementioned products.

VT: Volumetric Threshold: Minnesota has a 5 gallon minimum quantity for reporting petroleum spills. Spill of all other chemical or material in any quantity is reportable.

Spill debris: Sand that has been placed to absorb VRM and subsequently recovered for disposal.

Scenario Number 1: MPCA informs FIS of VRS

The driver of a vehicle involved in a spill is responsible for notifying the MPCA Duty Officer, if the VT is exceeded. The Duty Officer will immediately notify the MPCA Emergency Response Unit. If the spill is of the size and nature that the Emergency Response Unit determines should be handled by FIS, the MPCA will notify FIS and provide them with the details relating to the spill incident. The FIS representative will make a determination based on the information provided by the MPCA on how to proceed, and if appropriate (typically VRM in manageable quantities), contacts MSMD.

The MSMD will dispatch personnel with appropriate equipment to apply sand to the spill site. The sand will be given a period of time in which to absorb the VRM. The sand (spill debris) will then be removed by means of a street sweeper, and deposited at the established disposal site in a designated VRM spill debris pile. If a secondary sanding is required, the procedure will remain the same. Since the volume of the spill is greater than 5 gallons, a Hazardous Material Spill Data form (see Appendix A) must be completed as soon as possible (i.e. within 24 hours or the next business day). The completed form will be sent to the FIS as soon as possible. A final report on the action(s) taken will be sent to the MPCA from FIS.

Spill Debris Pile Management

Arrangements for disposal of the spill debris pile will be a collaborative effort by the MSMD and the Engineering Laboratory. As the spill debris pile reaches a size that becomes difficult to manage within the boundaries of the disposal site, the Engineering Laboratory will be contacted. The spill debris pile will be mechanically blended and the Laboratory will select representative samples for laboratory analysis, as required by MPCA regulations. The sampling and testing will require approximately one week to complete. After receiving the laboratory analysis data, the spill debris will be disposed of in a manner pre-approved by the MPCA and the Minneapolis Procurement Division.

Scenario Number II: The MSMD discovers a VRS

MSMD personnel discover a spill or are informed of a potential VRM spill from sources other than FIS or MPCA. After arriving at the scene, they will determine whether the incident is a VRM spill, (possibly from a vehicle collision, a spill from a labeled container, etc.) and will determine if the volume of the spill is greater than the VT (5 gallons).

- Less than 5 gallons: If the spill quantity is judged to be less than 5 gallons, no contact with FIS is necessary. Sand will be applied and the procedure will continue as described in Scenario I (i.e. subsequent sanding/sweeping and stockpiling into the spill debris pile). A Hazardous Materials Spill Data form must be completed for record and documentation purposes and retained at MSMD, but is not to be sent to FIS.

- 5 gallons or more: If the MSMD representative determines that a volume of 5 gallons or more of VRM has been spilled, MSMD must contact FIS or MPCA. The same procedures for cleanup and reporting (using the Hazardous Material Spill Data form) as in Scenario I will be followed. This form must be sent to FIS.

For both cases, the disposal of the VRM spill debris pile is as detailed in Scenario I.

Potential Modification to Scenario I and II

Regulatory officials may require separate stockpiling of spill debris from specific spill incidents. Separate sampling and laboratory analysis will be required in these cases. This may also be requested to create a distinct tracking mechanism of a given spill of significant quantities and/or from a billable source. This scenario will be determined on a case-by-case basis. The process for disposal will be the same as previous scenarios.

Scenario Number III: The MSMD becomes aware of a spill of unknown material or composition

The MSMD shall contact 911 before taking any action to clean up a spill of unknown composition. FIS will manage these spills through their contracts with private entities specializing in these activities, or manage and coordinate the cleanup with the MSMD. If FIS cannot be contacted, the MPCA Duty Officer should be contacted immediately.

ADDITIONAL INFORMATION

1. Currently the disposal site for spill debris is at the Linden Yards site. The material shall be placed in two 20 cubic-yard leak-proof roll-off containers with counter-balanced lockable lids at the City Site.

2. List of Potential Contacts:

   - **Minnesota Pollution Control Agency (MPCA)**
     Duty Officer: 651-649-5451; 24 hours a day, seven days a week

   - **Fire Inspection Services (FIS)**
     Steve Kennedy: 612-685-8528 (work)
     Tom Frame: 612-673-8501 (work)
     Emergency after-hours contacts:
     Steve Kennedy 612-685-8528

   - **Engineering Laboratory**
     Paul Ogren: 612-673-2456
     Stephanie Malmberg: 612-673-3365

   - **Minneapolis Street Maintenance Division (MSMD)**
     Steve Collin: 612-673-5720 (work)
     Rick Jorgensen: 612-673-5720 (work)
     24 hours a day, 7 days a week: 612-673-5720

3. MSMD will be responsible for any billing of outside parties for services rendered for the cleanup/disposal of a spill event. The MSMD, FIS and the Engineering Laboratory will develop a system for tracking cost associated with these operations. This information will be distributed, as it becomes available.

4. This is a statement of policies and procedures, which will be revised and updated as new information becomes available.

CITY OF MINNEAPOLIS - STREET DEPARTMENT

OIL AND HAZARDOUS MATERIAL SPILL DATA

<table>
<tr><td>DATE OF REPORT</td><td>TIME OF REPORT</td><td rowspan="2">NAME & ADDRESS OF RESPONSIBLE PARTY</td></tr>
<tr><td>DATE OF INCIDENT</td><td>TIME OF INCIDENT</td></tr>
<tr><td>TYPE OF POLLUTANT</td><td>QUANTITY</td><td>CAUSE OF SPILL</td></tr>
<tr><td>PRECISE LOCATION</td><td></td><td>PERSON MAKING REPORT/PHONE NUMBER</td></tr>
<tr><td>AREAS AFFECTED</td><td></td><td>PARTY REPORTING SPILL TO STREET DEPT.</td></tr>
<tr><td>PROBABLE FLOW DIRECTION</td><td>SOIL TYPE</td><td rowspan="2">OTHERS CONTACTED:
FIS____________
MPCA____________
FIREDEPT____________
POLICE____________
OTHER</td></tr>
<tr><td colspan="2">WATERS POTENTIALLY AFFECTED</td></tr>
<tr><td colspan="2">EFFECTS OF SPILL/ IMMEDIATE DANGER TO HUMAN LIFE, PROPERTY</td><td>PROXIMITY OF WELLS, SEWER, BASEMENTS</td></tr>
<tr><td colspan="2">ACTION TAKEN TO DATE</td><td>IS THIS FIRST NOTICE REGARDING SPILL?</td></tr>
<tr><td colspan="2">CONTAINMENT OF SPILL</td><td>WHO SHOULD BE CONTACTED FOR FURTHER INFORMATION?
PHONE NO.</td></tr>
<tr><td colspan="2">CLEAN-UP TO DATE:
MATERIAL USED____________
LOADER USED____________
TRUCKS USED____________
PICK-UP TRUCK USED____________
MACHINE SWEEPER USED____________
LABOR: FOREMAN HOURS____________
MAINT CREW LEADER ____________
CONST LABORER____________
OTHER____________</td><td>COMMENTS?</td></tr>
</table>

ORIGINAL: When job completed, send immediately to Street Accounting.
COPY 1 : Send to Street Accounting with daily time when labor/eq. first used.
COPY 2 : PCA NOTIFICATION COPY - send immediately(first available interoffice mailing) to Steve Kennedy, FIS - Environmental Management, PSC, Room 401

STREET JOB#____________

LABOR COST $____________
EQUIP COST $____________
MAT'L COST $____________
TOTAL COST$____________

June, 2004

SPECIFICATION FOR DISPOSAL OF SPILL DEBRIS FROM VEHICLE RELATED SPILLS

City of Minneapolis
Department of Public Works

DEFINITIONS:

VRM: Vehicle Related Material: Petroleum products and other vehicle fluids that are inherently related to vehicular operations. This does not include materials that are being transported by a vehicle, unless the material is clearly labeled as being one of the aforementioned products.

SPILL DEBRIS: Sand that has been placed to absorb VRM and subsequently recovered for disposal.

CONTRACT PERIOD: The contract period shall be from July 1, 2004 to June 30, 2007.

SCOPE:

These specifications cover the loading, transportation and disposal of spill debris from a central site located within the City of Minneapolis. The "Contractor" for the purposes of this specification, refers to a permitted landfill facility that has been approved by the appropriate regulatory agencies.

GENERAL:

The City of Minneapolis expects to generate an estimated 500 cubic yards of spill debris during the contract period. This quantity is only an estimate of the City's requirement for said contract period, and may be increased or reduced in any amount without any adjustment in unit price. The primary source of this material is from the results of clean-up operations following vehicular collisions or accidental discharge from vehicles.

The spill debris will consist primarily of sand used to absorb VRM from City streets, as well as plastic sheeting used during the storage process. The Contractor will be required to transport and dispose of all such materials that have been stored at the City facility. The only acceptable disposal method for the spill debris shall be placement into or used as daily cover at a certified and fully permitted landfill facility.

SCOPE OF SERVICES:

The Contractor shall:

Provide two (2) 20 cubic-yard leak-proof roll-off containers with a counter-balanced lockable lid for the duration of the contract period at the City of Minneapolis Linden Yard Site, or any other designated site within the City of Minneapolis. The City of Minneapolis will provide Contractor access to this container throughout the contract period.

When a container is filled with spill debris, the City of Minneapolis will mechanically blend the material in the container and perform sampling and laboratory analysis in accordance with Minnesota Pollution Control Agency Guidance Documents. Any additional analyses required by the Contractor shall be stated in the proposal.

The City of Minneapolis will forward all pertinent analytical laboratory results to the Contractor.

The Contractor shall state in the proposal, the length of time needed, following receipt of the laboratory test results, before the full container is transported to the Contractors facility.

The City of Minneapolis will contact the Contractor, once a roll-off container is full and sampling/ analyses has begun. It shall be the responsibility of the Contractor to provide a replacement container for subsequent and interim spill debris storage. There must be, at all times, adequate space in a container available for the storage of spill debris at the City of Minneapolis facility.

The Contractor shall obtain all proper permits and manifests for the loading, transporting, and disposal of the spill debris. The contractor shall load and haul all such material to an approved disposal site. The disposal method shall be approved by the appropriate regulatory agency(s). The Contractor shall provide documentation of all required approvals to the City of Minneapolis prior to acceptance of the material. The Contractor shall also provide the City with any and all documentation required by regulatory agencies, following the disposal of the spill debris.

CONTENT OF PROPOSALS:

The following required information shall accompany each bid:

Location of landfill site.
Cost per ton of material for disposal, utilizing the aforementioned 20 cubic-yard roll-off containers.
Cost per ton of material for disposal when the material is stockpiled without the use of a roll-off container. (Minimum stockpile being 10 tons)
The cost per ton for Superfund/CERCLA indemnification (include limits).
Cost per day for two (2) 20 cubic-yard leak-proof roll-off containers with a counter-balanced lockable lid at the Minneapolis site.
Cost for the option, at the sole discretion of the city, of extending this agreement for each of two additional years.
List of subcontractors and functions.
Qualification and experience of Contractor and all subcontractors

The bid will be based on a per ton (2000 pound) basis, which will include all transportation, permitting and regulatory cost. All loads shall be weighed on scales certified by the State of Minnesota

GENERAL TERMS AND CONDITIONS:

The following are the general terms and conditions, supplemental to those contained elsewhere in these specifications, which responding Contractors must comply with in order to be consistent with the requirements for the specification. Any deviation from these or any other stated requirements must be listed as exceptions on the bid sheet.

Once the bid forms are submitted in response to these specifications, they become the property of the City of Minneapolis, whether or not the bid is accepted. The City shall have the right to use any ideas presented in any bid submitted.

Representatives of the City of Minneapolis will review all bids received. An interview may be part of the evaluation process. Factors, upon which the proposal will be judged include, but are not limited to, the following:

Residual risk to the City of Minneapolis following disposal.
Expressed understanding of the project objective.
Cost of disposal.
Project work plan, including level of detail.
Qualification of both the Contractors assigned personnel, and subcontractors.

CITY'S RIGHTS:

The City reserves the right to reject any or all proposals or parts of proposals, to accept part or all of proposal on the basis considerations other than lowest cost, and to create a project of lesser or based on the component prices submitted. The City also reserves the right to cancel the Agreement without penalty, if circumstances arise which prevent the City from completing the project. In addition, the City reserves the right to re-bid for any phase of this work.

HOLD HARMLESS:

The Contractor agrees to defend, indemnify and hold harmless the City, its officer and employees, from any liabilities, claims, damages, costs, judgments, and expenses, including attorney's fees, resulting directly or indirectly from an act or omission of the contractor, it's employees, agents or employees of subcontractors, in the performance of this contract or by reason of the failure of the contractor to fully perform, in any respect, all of its obligation under this contract.

The City agrees to defend and hold harmless insofar as the law allows the Contractor, its officers and employees, from any liabilities, claims, damages, cost, judgements, and expenses, including attorney's fees, resulting directly or indirectly from an act or omission of the City or its employees in the performance under this contract or by reason of the failure of the city to fully perform its obligations under this contract.

INTEREST OF MEMBERS OF CITY:

The Contractor represents and agrees that no member of the governing body, officer, employee or agency of the City has any interest, financial or otherwise, direct or indirect, in the Agreement.

EQUAL OPPORTUNITY STATEMENT:

Contractor agrees to comply with the provisions of all applicable federal, state and City of Minneapolis statutes, ordinances and regulations pertaining to civil rights and nondiscrimination including without limitation Minnesota Statute, Section 181.59 and Chapter 363 and Minneapolis code of Ordinances, Chapter 139, incorporated herein by reference.

AFFIRMATIVE ACTION:

Persons who are authorized to enter into contractual relationships with the City are encouraged to review the City's policies on Affirmative Action.

NON-DISCRIMINATION:

The Contractor will not discriminate against any employee or applicant for employment because of race, color, creed, religion, ancestry, sex, national origin, affectional preference, disability, age, marital status or status regard to public assistance or as a disabled veteran or veteran of the Vietnam era. Such prohibition against discrimination shall include, but no limited to, the following: employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination, rates of pay or other forms of compensation and section for training, including apprenticeship.

The Contractor shall agree to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the City, setting forth this nondiscrimination clause. In addition, the Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment with regard to race, creed, religion, ancestry, sex, national origin, affectional preference, disability, age, marital status or status wit regard to public assistance or status as a disabled veteran or veteran of the Vietnam era, and comply in all other aspects with the requirements of the Minneapolis Code, Chapter 139.

CONTRACT INCORPORATION OF PROPOSAL CONTENTS:

The contents of the proposal and any clarifications or modification to the contract thereof submitted by the successful proposer may, at the City's option, become part of the Agreement obligation and be incorporated by reference into the ensuing contract.

INSURANCE:

This agreement shall be effective only upon the approval by the City of acceptable evidence of the insurance detailed below. Such insurance secured by the Contractor shall be issued by insurance companies acceptable to the City and admitted in Minnesota. The insurance specified may be in a policy or policies of insurance, primary or excess. Such insurance shall be in force on the date of the execution of the agreement and shall remain continuously in force for the duration of the contract period.

The Contractor and its subcontractors shall secure and maintain the following insurance:

a) Worker's Compensation insurance that meets the statutory obligations with Coverage B – Employer's Liability limits of at least $100,000 each accident, $500,000 disease – policy limit and $100,000 disease each employee.

b) Commercial General Liability insurance with limits of at least $500,000 general aggregate, $500,000 products – completed operations $500,000 personal and advertising injury, $500,000 each occurrence $50,000 fire damage, and $5,000 medical expense any one person. The policy shall be on an "occurrence" basis, shall include contractual liability coverage and the City shall be named an additional insured.

c) Commercial Automobile Liability insurance covering all owned, non-owned and hired automobiles with limits of at least $500,000 per accident.

Acceptance of the insurance by the City shall not relieve, limit or decrease the liability of the Contractor. Any policy deductible or retention shall be the responsibility of the Contractor. The Contractor shall control any special unusual hazards and be responsible for any damages that result from those hazards. The City does not represent that the insurance requirements are sufficient to protect the Contractor's interest or provide adequate coverage.

Evidence of coverage is to be provided on a City provided Certificate or Insurance. A thirty- (30) day written notice is required if the policy is canceled, not renewed or materially changed.

The Contractor shall require all of its subcontractors to comply with this provision.

The Contractor shall not assign any interest in the Agreement, and shall not transfer any interest in the same (whether by assignment or novation) without the prior written approval of the City, provided, however, that claims for money due or to become due to the contractor may be assigned to a bank, trust company or other financial institution, or to a Trustee in Bankruptcy without such approval. Notice to any such assignment or transfer shall be furnished promptly to the City.

COMPLIANCE REQUIREMENTS

All Contractors hired by the City of Minneapolis are required to abide by the regulations of the Americans with Disabilities Act of 1990 (ADA) which prohibits discrimination against individuals with disabilities. The Contractor will not discriminate against any employee or applicant for employment because their disability and will take affirmative action to insure that all employment practices are free from such discrimination. Such employment practices include but are not limited to the following: Hiring, promotion, demotion, transfer, recruitment, or recruitment advertising, layoff, discharge, compensation and fringe benefits, classification referral and training. The ADA also requires contractor associated with the City of Minneapolis to provide qualified applicants and employees with disabilities with reasonable accommodations that do not impose undue hardship. Contractors also agree to post in conspicuous areas accessible to employees and applicants, notices of their policy on nondiscrimination.

In the event the Contractor's noncompliance with the nondiscrimination clauses of this agreement, this agreement may be cancelled, terminated, or suspended, in whole or part, and the Contractor may be declared ineligible by the Minneapolis City Council from any further

Grit ID	Location	Date Inspected	Floatables Y/N	Volume Of Sediment Removed	Date Cleaned
1	UPTON AVE N & 53RD AVE N	4/1/15	N	1	4/1/31
2	UPTON AVE N & 53RD AVE N	4/3/15	N	1	4/3/15
3	SHERIDAN AVE N, N OF 52ND AVE N	7/27/15	N	2	7/27/15
4	RUSSELL AVE N NORTH OF 52ND AVE N	5/26/15	N		
5	PENN AVE N & 52ND AVE N	5/11/15	N	1	5/11/15
6	PENN AVE N & 52ND AVE N	5/20/15	N	1	5/20/15
7	OLIVER AVE N & 52ND AVE N	7/4/15	N	2.5	7/24/15
8	NEWTON AVE N & SHINGLE CREEK	8/28/15	N	0.25	8/28/15
9	OLIVER AVE N & 51ST AVE N	5/11/15	N	0.5	5/11/15
10	MORGAN AVE N & 51ST AVE N	4/30/15	N	0.25	4/30/15
11	KNOX AVE N & 51ST AVE N	4/28/15 9/29/15	Y Y	0.5 2	4/30/15 9/30/15
12	KNOX AVE N & 50TH AVE N	9/16/15	Y	4	9/16/15
13	IRVING AVE N & 50TH AVE N	9/17/15	Y	2.5	9/17/15
14	JAMES AVE N, NORTH OF 49TH AVE N	5/26/15	N	0.25	5/26/15
15	21ST AVE N & 1ST ST N	10/2/15	Y	28	10/3/15
16	XERXES AVE N & 14TH AVE N	10/21/15 11/2/15	N Y	1.5 40	10/21/15 11/4/15
17	XERXES AVE N & GLENWOOD AVE	7/1/15	N	3	7/1/15
18	MORGAN AVE N & CHESNUT AVE	7/27/15	N	4.5	7/27/15
19	GIRARD AVE NO & CURRIE AVE NO				
20	BRIDAL VEIL TUNNEL OUTLET				
21	LAKE OF THE ISLES PKWY & LOGAN AVE	9/14/15	Y	18	8/15/15
22	W 22ND ST & JAMES AVE S				
23	YARD SUMPS, 26TH & HIAWATHA				
24	DREW AVE S & W LAKE ST	8/5/15	N	5.3	8/5/15
25	EXCELSIOR BLVD & MARKET PL	9/15/15	Y	12	9/16/15
26	W LAKE ST & ALDRICH AVE S	8/6/15	N	1.5	8/6/15
27	W 32ND ST & BRYANT AVE S				

27	W 32ND ST & BRYANT AVE S				
28	W 33RD ST & HOLMES AVE S	11/28/15	Y	6	11/2/15
29	W 33RD ST & GIRARD AVE S	11/3/15	N	18	11/3/15
30	YORK AVE S & W LAKE CALHOUN PARKWAY				
31	CHOWEN AVE S & W 41ST ST				
32	E 42ND ST & BLOOMINGTON AVE S	8/11/15	N	2	8/11/15
		12/4/15	Y	1	12/4/15
33	E 43RD ST & PARK AVE S				
34	W 44TH ST & LAKE HARRIET PARKWAY				
35	E 44TH ST & OAKLAND AVE S	4/24/15	N		
36	E 46TH ST & 31ST AVE S	8/13/15	N	1	8/13/15
37	46TH AVE S & GODFREY RD				
38	W 47TH ST & YORK AVE S	4/23/15	N	0.25	4/23/15
39	W 47TH ST & WASHBURN AVE S	8/6/15	N		
40	W 47TH ST & LAKE HARRIET PARKWAY				
41	W 48TH ST & YORK AVE S	4/23/15	N	1	4/23/15
42	QUEEN AVE S & LAKE HARRIET PARKWAY	11/4/15	N	32	11/6/15
43	16TH AVE S & E MINNEHAHA PKWY				
44	SHERIDAN AVE S & W 50TH ST	8/3/15	Y	2	8/3/15
45	JAMES AVE S & MINNEHAHA CREEK				
46	MORGAN AVE S & W 53RD ST	10/29/15	N	28	10/30/15
47	E 55TH ST & PORTLAND AVE S	4/21/15	N	1	4/21/15
48	E 56TH ST & PORTLAND AVE S	4/21/15	N	2	4/21/15
49	E 57TH ST & PORTLAND AVE S	4/22/15	N	0.25	4/22/15
50	E 57TH ST & PORTLAND AVE S				
51	GIRARD AVE S BETWEEN W 59TH ST & W 60TH ST	4/20/15	N	2.5	4/20/15
52	E 59TH ST & 12TH AVE S	8/10/15	N	3	8/10/15
53	GIRARD AVE S & W 60TH ST	4/21/15	N		
54	GIRARD AVE S, W 60TH ST - DUPONT AVE S	10/21/15	Y	46	10/22/15
55	GRASS LAKE TERRACE, GIRARD TO JAMES AVE S	10/22/15	N	5	10/22/15
56	GRASS LAKE SERVICE ROAD BEHIND #6035 JAMES AVE S	4/20/15	N	0.5	4/20/15
57	GRASS LAKE SERVICE ROAD BEHIND #6077 JAMES AVE S	4/20/15	N	0	
58	GRASS LAKE SERVICE ROAD BEHIND #1416 W 61ST ST	4/20/15	N	0	
59	W 61ST ST & GRASS LAKE SERVICE ROAD				
60	IRVING AVE S & W 61ST ST				
61	E RIVER RD & CECIL ST	7/20/15	N	8	7/22/15
		10/16/15	Y	3	10/16/15
62	HIAWATHA PARK REFECTORY TURN-A-ROUND	8/11/15	N	1	8/11/15

62	HIAWATHA PARK REFECTORY TURN-A-ROUND				
63	33RD AVE N & 1ST ST N/RAILROAD TRACKS	6/15/15	N	3	6/15/15
64	26TH AVE N & PACIFIC (N TRANSFER STATION)				
65	SOUTH TRANSFER STATION	8/13/15	N	2	8/13/15
66	MAPLE PLACE & EAST ISLAND AVE	7/23/15	N	1	7/23/15
67	DELASALLE DR & E ISLAND	7/23/15	N	1.5	7/23/15
68	W ISLAND - 300' S OF MAPLE PLACE	7/23/15	N	1.5	7/23/15
69	EASTMAN AVE & W ISLAND	7/23/15	N	2.5	7/23/15
70	ROYALSTON & 5TH AVE N				
71	THE MALL & E LAKE OF THE ISLES	10/14/15	Y	40	10/16/15
72	S OF 37TH AVE NE & ST ANTHONY PKWY	6/29/15	Y		
		10/1/15	Y	15	10/2/15
73	4552 KNOX AVE N (IN ALLEY BEHIND)				
74	STEVENS AVE S 300' S OF MINNEHAHA CREEK	10/26/15	N		
75	IRVING AVE N (IMPOUND LOT)				
76	MARKET PLAZA & EXCELSIOR BLVD				
77	ALLEY - 38TH TO 39TH ST & NICOLLET TO BLAISDELL AVE	4/20/15	N	0.5	4/20/15
78	SHINGLE CREEK WETLAND - W SIDE	8/4/15	Y	4	8/4/15
79	SHINGLE CREEK WETLAND - EAST SIDE	8/28/15	Y	11	8/31/15
80	WOODLAWN BLVD & E 50TH ST	8/10/15	Y	1.5	8/10/15
81	WOODLAWN BLVD & E 53RD ST				
82	12TH AVE S & POWDERHORN TERRACE	4/29/15	Y	0.25	4/29/15
83	13TH AVE S & POWDERHORN TERRACE	5/5/15	Y	0.25	5/5/15
84	3421 15TH AVE S (180' W OF CL)	4/27/15	Y	2.5	4/27/15
85	3329 14TH AVE S	4/28/15	N	0.5	4/28/15
86	13TH AVE S & E 35TH ST	4/28/15	Y	3	4/29/15
87	3318 10TH AVE S	4/30/15	Y	0.5	4/30/15
88	ACROSS THE STREET FROM 702, NO. BD. VAN WHITE BLVD.	6/16/15	Y	1	6/16/15
		8/27/15	Y	1	8/27/15
89	ACROSS THE STREET FROM 706, NO. BD. VAN WHITE BLVD.	6/16/15	Y	1	6/16/15
		8/27/15	Y	0	8/27/15
90	10TH AVE. NO. & ALDRICH AVE. NO. (S.W.C.)	7/1/15	Y	1.5	7/1/15
91	SO. BD. VAN WHITE BLVD., 200' SO. OF 8TH AVE. NO.	8/6/15	Y	0	8/6/15
92	ACROSS THE STREET FROM 701, SO. BD. VAN WHITE BLVD.	5/19/15	Y	2	5/19/15
		10/13/15	Y	1	10/13/15
93	SO. BD. VAN WHITE BLVD., 250' SO. OF 10TH AVE. NO	8/26/15	Y	3	8/26/15
94	10TH AVE. NO. & NO. BD. VAN WHITE BLVD. (S.W.C.)	12-/3	Y	1.5	12/3/15
95	WEST SIDE OF ALDRICH AVE. NO. & 9TH AVE. NO.	7/31/15	Y	2.5	7/31/15

96	8TH AVE. NO. & NO. BD. VAN WHITE BLVD. (N.E.C.)	6/16/15	Y	3	6/16/15
97	29TH AVE. & LOGAN AVE. - NO. STORM WATER DET. POND (E & W) #1	6/9/15	Y	5	6/9/15
97	29TH AVE. & LOGAN AVE. - NO. STORM WATER DET. POND (E & W) #2	6/9/15	Y	4	6/10/15
97	29TH AVE. & LOGAN AVE. - NO. STORM WATER DET. POND (E & W) #3	6/10/15	Y	4	6/10/15
		10/14/15	Y	8	10/16/15
98	MALMQUIST LN. & HUMBOLDT NO.	8/3/15	Y	3.5	8/4/15
99	SHINGLE CREEK DR. & HUMBOLDT NO.	5/11/15	N		
100	SO. OF 49TH AVE. NO. & HUMBOLDT NO.	9/29/15	Y	3.5	9/29/15
101	NO. OF 49TH AVE. NO. & HUMBOLDT NO.	7/31/15	Y		7/31/15
		9/30/15	Y	2	10/1/15
102	28TH ST. E. & HIAWATHA * MNDOT HIAWATHA				
103	E. LAKE ST. & HIAWATHA * MNDOT HIAWATHA				
104	NAWADAHA LN./SERVICE RD. & HIAWATHA * MNDOT HIAWATHA				
105	MINNEHAHA PARKWAY (NO. SIDE) S.B. LANE * MNDOT HIAWATHA				
106	E. 50TH ST. (SW COR) & HIAWATHA * MNDOT HIAWATHA				
107	E. 54TH ST. & RIVERVIEW RD. * MNDOT HIAWATHA RE-ROUTE				
108	ALLEY SUMP MH WEST OF COLUMBUS AVE S & E 37TH ST - no as-builts				
109	22ND AVE N AND W RIVER ROAD	8/5/15	Y	1	8/5/15
110	W. CALHOUND PARKWAY 100' NO. OF RICHFIELD RD.	8/14/15	Y	3	8/14/15
111	RICHFIELD RD. NEAR W. CORNER OF THE PARKING LOT	8/31/15	Y	0.25	8/31/15
112	W. 36TH ST. 30' W. OF CALHOUN PARKWAY	8/13/15	Y	4	8/13/15
113	20' EAST OF VAN WHITE MEM. BLVD (N.B.) AND 5TH AVE N (1016 - 5TH AVE N)	6/17/15	Y	2	6/17/15
114	DUPONT AVE. NO. & 4TH AVE. NO.	8/25/15	Y	2	8/25/15
115	VAN WHITE MEM. BLVD (S.B.) AND 4TH AVE N	8/26/15	Y	2	8/26/15
116	400' NORTH (60' INTO POND) VAN WHITE MEM. BLVD (S.B.) AND 4TH AVE N	6/16/15	N	0.25	6/16/15
117	300' NORTH (WEST SIDE) OF VAN WHITE MEM. BLVD (S.B.) AND 4TH AVE N	6/16/15	Y	2	6/16/15
118	200' NORTH (POND SIDE) OF VAN WHITE MEM. BLVD (S.B.) AND 10TH AVE N	8/24/15	Y	3	8/24/15
119	11TH AVE N AND VAN WHITE BLVD (N.B.)	8/24/15	Y	0.5	8/24/15
120	VAN WHITE MEM. BLVD (S.B.) (160' so. of fremont ave. no. on the e. side of the street)	8/20/15	Y	0.25	8/20/15
121	50' NORTH (EAST SIDE) OF VAN WHITE MEM. BLVD (S.B.) AND FREMONT AVE N	8/20/15	Y	0.5	8/20/15
122	MINNEHAHA PARKWAY @ 39TH AVE S N SIDE OF PKWY	9/4/15	N	3	9/4/15
123	COLUMBUS AVE S SOUTH OF E 37TH ST REROUTE - no as-builts	4/24/15	N	0.25	4/24/15
124	COLUMBUS AVE S - CHICAGO AVE S ALLEY - no as-builts	4/24/15	N	0.25	4/24/15
125	COLUMBUS AVE S ACROSS FROM #3644 - no as-builts	4/24/15	N	1	4/24/15
126	E 37TH ST AND COLUMBUS S # 3640 COLUMBUS - no as-builts	4/24/15	N	0.25	4/24/15
127	E 37TH ST AND COLUMBUS S # 3700 COLUMBUS - no as-builts	4/28/15	N	0.5	4/28/15

127	E 37TH ST AND COLUMBUS S # 3700 COLUMBUS - no as-builts				
128	W 27TH ST AND LAKE OF THE ISLES PKWY - no as-builts				
129	YARD SUMPS, 26TH AND HIAWATHA				
130	YARD SUMPS, 26TH AND HIAWATHA				
131	YARD SUMPS, 26TH AND HIAWATHA				
132	YARD SUMPS, 26TH AND HIAWATHA				
133	ALLEY DRY WELL, BETWEEN HUMBOLDT/IRVING AVE S AND W 25TH ST/26TH ST, no as-builts	4/23/15	N	1.5	4/23/15
134	W 22ND ST @ E LAKE OF THE ISLES BLVD, no as-builts				
135	CHICAGO AVE S BETWEEN WASHINGTON AVE S AND 2ND ST S - no as-builts				
136	111 22ND AVE N (ALLEY BETWEEN 1ST ST N AND 2ND ST N AT VACATED 21ST AVE N)				
137	W 44TH ST @ LAKE HARRIET PKWY EAST (Installed on existing 54" Concrete Pipe)	10/27/15	Y	5	10/27/15
138	EWING AVE S BETWEEN W. FRANKLIN AVE AND W 22ND ST - Pending as-built info	12/10/15	N	0.5	10/10/15
139	EWING AVE S @ W FRANKLIN AVE - Pending as-built info	10/20/15	N	0.25	10/20/15
140	E LAKE ST WEST OF 14TH AVE S (Hennepin County const. Lake St.)	8/12/15	N		
141	W LAKE ST EAST OF 14TH AVE S (Hennepin County const. Lake St.)	6/26/15	Y	4	6/26/15
		8/12/15	Y	0.25	8/12/15
142	18TH AVE S SOUTH OF E LAKE ST (Hennepin County const. Lake St.)	8/11/15	Y	0	8/11/15
143	LONGFELLOW AVE S SOUTH OF E LAKE ST (Hennepin County const. Lake St.)	8/11/15	Y	0	8/11/15
144	31ST AVE S NORTH OF E LAKE ST (Hennepin County const.. Lake St.)	9/2/15	Y	2	9/2/15
145	CEDAR AVE S AND E MINNEHAHA PARKWAY (20' S. of S. curb of Minnehaha & 5' W. of W. curb of Cedar)	9/1/15	N	6	9/1/15
146	E LAKE ST AND 46TH AVE S 12' W OF THE W CURB AND 9' SO OF THE N CURB ON LAKE ST (added 10/31/07) (service pending)				
147	E LAKE ST AND 47TH AVE S 6' S OF THE N CURB ON LAKE ST AND 1' W OF THE W CURB ON 47TH AVE EXTENDED (added 10/31/07) (service pending)				
148	E LAKE ST AT 42ND AVE S (8.4' W of the E curb on 42nd St and 38' N of the N curb on Lake St) (Hennepin Co. Construction) (added 11/1/07) (service pending)				
149	W 44TH ST AND ALDRICH AVE S SWC	12/10/15	Y	4	12/10/15
150	W RIVER ROAD AND 23RD AVE N				
151	DIAMOND LK RD & CLINTON AVE S				
152	3RD AVE. SO. & 2ND ST. S.				
153	PLEASANT AVE & W LAKE ST	11/8/15	Y	3.5	11/9/15
154	W LAKE ST AND DUPONT AVE S	7/27/15	Y	1	7/27/15
155	W LAKE ST AND BLAISDELL AVE S	8/3/15	Y		
156	W 43RD ST & E LAKE HARRIET PARKWAY	5/20/15	N	6	5/20/15
157	STEVENS AVE S & DIAMOND LK RD	9/29/15	N	1	9/29/15
158	E 61ST ST & COLUMBUS AVE S	9/29/15	N	4	9/29/15
159	2ND AVE N & 7TH ST N (Target Center)				
160	2ND AVE N & 6TH ST N	9/23/15	Y	0.5	9/23/15
161	3RD AVE N & WASHINGTON AVE N				

161	3RD AVE N & WASHINGTON AVE N				
162	DOWLING AVE N & OLIVER AVE N				
163	PLYMOUTH AVE N & WEST SIDE OF RIVER				
164	PLYMOUTH AVE N & EAST SIDE OF RIVER				
165	1409 Washington Ave N	10/19/15	N	2.5	10/19/15
166	Thomas Ave S & Dean Pkwy to Kenilworth Lagoon (Lake of the Isles) (Burka- plan sheet only)	10/2/15	N	4	10/2/15
167	E River Rd north of Washington Ave SE (CCLRT) no information on file per Lois E 11/15/2013				
168	Dowling Ave N Alley Drain between Morgan Ave N and Newton Ave N				
169	Dowling Ave N Alley Drain between Newton Ave N and Oliver Ave N				
170	Dowling Ave N at Oliver Ave N				
171	Newton Ave N at Dowling Ave N sump MH				
	New Van Whithe Blvd Bridge				

Body of Water	Outfall_ID	Location	Inspection Date	Structure Type	Outfall Pipe Size	Material Type
Shingle Creek	20-010	52nd Ave N and Sheridan Ave N (extended)	11-Aug-15	Concrete Apron	18	RCP
Shingle Creek	20-012	53rd Ave N and Russell Ave N (extended)	11-Aug-15	Concrete Apron	60	RCP
Shingle Creek	20-013	52nd Ave N and Russell Ave N (extended)	11-Aug-15	Concrete Apron	12	RCP
Shingle Creek	20-020	Penn Ave N and 52nd Ave N	11-Aug-15	Diffuser	0	RCP
Shingle Creek	20-030	52nd Ave N (Penn Av N)	11-Aug-15	Concrete Apron	18	RCP
Shingle Creek	20-040	52nd Ave N (Oliver Ave N)	11-Aug-15	CMP Apron	21	CMP
Shingle Creek	20-050	Newton Ave N	11-Aug-15	Concrete Apron	15	RCP
Shingle Creek	20-060	51st Ave N (Newton Av N)	11-Aug-15	Pipe	10	PVC
Shingle Creek	20-060A	51st ave n and morgan ave n	11-Aug-15	CMP Apron	12	CMP
Shingle Creek	20-070	Knox Ave N	11-Aug-15	CMP Apron	36	CMP
Shingle Creek	20-080	50th Ave N (Knox Ave N)	11-Aug-15	Concrete Apron	30	RCP
Shingle Creek	20-090	50th Ave N (James Ave N)	11-Aug-15	Pipe	21	CMP
Shingle Creek	20-100	49th Ave N (Ryan Creek)	11-Aug-15	Concrete Apron	12	RCP
Shingle Creek	20-110	49th Ave N (Ryan Creek)	11-Aug-15	Concrete Apron	36	RCP
Shingle Creek	20-120	49th Ave N (Humboldt Ave N)	12-Aug-15	Box Culvert	60	RCP
Shingle Creek	20-130A	47th Ave N (Humboldt Ave N) 200' S of 47th Ave N	12-Aug-15	Box Culvert	24	RCP
Shingle Creek	20-140	47th Ave N (Shingle Crk Pkwy)	12-Aug-15	Concrete Apron	27	RCP
Shingle Creek	20-140A	47th & Humboldt Bridge (westside)	12-Aug-15	Concrete Apron	24	RCP
Shingle Creek	20-150	47th Ave N (Girard Ave N)	12-Aug-15	CMP Apron	18	CMP
Shingle Creek	20-150A	47th Ave N (Girard Ave N) 50' North of 20-150	12-Aug-15		0	
Shingle Creek	20-160	Malmquist Lane	12-Aug-15	Concrete Apron	36	RCP
Shingle Creek	20-170	Fremont Ave N (Shingle Crk Pkwy)	12-Aug-15	Pipe	12	CMP
Shingle Creek	20-190	46th Ave N (Shingle Crk Pkwy)	12-Aug-15	CMP Apron	18	CMP
Shingle Creek	20-200A	Dupont Ave N (Shingle Crk Pkwy)	12-Aug-15	Pipe	12	CMP
Shingle Creek	20-200B	Dupont Ave N (Shingle Crk Pkwy)	12-Aug-15	Concrete Apron	60	RCP
Shingle Creek	20-210A	45th Ave N (Dupont Ave N)	12-Aug-15	Pipe	8	CMP
Shingle Creek	20-210B	44th Ave N (Soo Line RR)	12-Aug-15	Pipe	60	CMP
Shingle Creek	20-220	45th Ave N (Colfax Ave N)	12-Aug-15	Concrete Apron	24	RCP
Shingle Creek	20-230	Webber Pkwy and 43rd Ave N (goes through park to Shingle Creek)	12-Aug-15		0	
Shingle Creek	20-240	Weber Pkwy (Aldrich Ave N)	12-Aug-15	Diffuser	48	RCP
Shingle Creek	20-240B	Shingle Creek (N side of Crk @ rr bridge).	12-Aug-15	CMP Apron	24	CMP
Shingle Creek	20-250	Lyndale Ave N (S of Creek)	12-Aug-15	Pipe	12	
Shingle Creek	20-260	Lyndale Ave N (N of Creek)	12-Aug-15	Pipe	12	
Shingle Creek	20-270	I- 94 (S of Creek)	12-Aug-15	Pipe	24	
Shingle Creek	20-280	I-94 (E of I-94 at Creek)	12-Aug-15	Pipe	48	
Shingle Creek	20-290	I-94 (N of Creek)	12-Aug-15	Pipe	36	
Ryan Lake	21-010		27-Aug-15	Sluiceway	0	RCP
Bassett Creek	40-010	14th Ave N @ Xerxes Ave N	27-Aug-15	Box Culvert	72	RCP
Bassett Creek	40-015		27-Aug-15	Pipe	30	RCP

Bassett Creek	40-020	Xerxes Ave N (S of T.H. 55)		28-Aug-15	Box Culvert	20	RCP
Bassett Creek	40-030	Vincent Ave N (N of T.H. 55)		27-Aug-15	Concrete Apron	36	RCP
Bassett Creek	40-040	Upton Ave N (N of T.H. 55)		28-Aug-15	Concrete Apron	42	RCP
Bassett Creek	40-040	Upton Ave N (N of T.H. 55)		24-Aug-15	Concrete Apron	48	RCP
Bassett Creek	40-050			28-Aug-15	Pipe	24	HDPE
Bassett Creek	40-060	100' N of 5th Av N @ Thomas Av N		28-Aug-15	Pipe	18	RCP
Bassett Creek	40-070	S of Thomas Av N @ Inglewood St N		28-Aug-15	Concrete Apron	24	RCP
Basset Creek	40-080	Thomas Av N (N of Chestnut Av N)		03-Nov-15		0	
Basset Creek	40-090	Queen Av N (N of Chestnut Av N)		03-Nov-15	Pipe	48	RCP
Basset Creek	40-110	Oliver Av N - S of 2nd Av N		03-Nov-15	Pipe	24	RCP
Basset Creek	40-120	Newton Av N (S of Bassett Creek)		03-Nov-15	Pipe	0	HDPE
Basset Creek	40-120a	Newton Av N (S of Bassett Creek)		03-Nov-15	Pipe	24	RCP
Basset Creek	40-130	Morgan Av N (N of Bassett Creek)		03-Nov-15		44	RCP
Basset Creek	40-140	Morgan Av N extended (S of Bassett Creek)		03-Nov-15	Pipe	60	RCP
Basset Creek	40-150	Irving Av N		03-Nov-15	Concrete Apron	0	RCP
Basset Creek	40-160	Old Basset Creek Tunnel Entrance		04-Nov-15	Box Culvert	0	RCP
Bassett Creek	40-400	Bassett Creek outlet to Mississippi River		27-Aug-15	HDPE Apron	20	HDPE
Bassett Creek	50-025			28-Aug-15	CMP Apron	30	RCP
Brownie Lake	51-010	North edge of Brownie Lake		24-Aug-15	Box Culvert	36	RCP
Brownie Lake	51-020	Cedar Lake Road - 250' SW of Lake View		24-Aug-15	Pipe	18	PVC
Brownie lake	51-030	From St Louis Park--South edge of Brownie Lake		24-Aug-15	Pipe	60	RCP
Cedar Lake	52-010	W '21st St (extended)		24-Aug-15	CMP Apron	18	CMP
Cedar Lake	52-020	Burnham Road @ Kenilworth Lagoon		04-Nov-15	Pipe	12	CMP
Cedar Lake	52-020	Burnham Road @ Kenilworth Lagoon		24-Aug-15	Pipe	12	CMP
Cedar Lake	52-030	Park Lane - 500' North of Burnham Road		24-Aug-15		0	
Cedar Lake	52-040	Burnham Road - '100' North of Cedar Lake Pkwy		24-Aug-15		0	
Cedar Lake	52-050	Cedar Lake Pkwy @ Depot		24-Aug-15	Diffuser	12	RCP
Cedar Lake	52-070	Cedar Lake Pkwy @ Drew Ave S (extended)		24-Aug-15	Diffuser	36	RCP
Cedar Lake	52-080	Cedar Lake Pkwy @ Ewing Av S (extended		24-Aug-15		0	
Cedar Lake	52-100	Cedar Lake Pkwy @ West 24th St		24-Aug-15	Box Culvert	36	RCP
Cedar Lake	52-110	Cedar Lake Pkwy @ West 22nd St		24-Aug-15	Box Culvert	42	RCP
Cedar Lake	52-120	Cedar Lake Pkwy @ West Franklin Av		24-Aug-15	Box Culvert	0	RCP
Lake Hiawatha	76-010	27th Av S @ E44th St		16-Apr-15	CMP Apron	69	Brick
Lake Hiawatha	76-010a			16-Apr-15	Pipe	18	CMP
Lake Hiawatha	76-020a			16-Apr-15	Pipe	0	CMP
Lake Hiawatha	76-030	E 45th St @ 28th Av S		16-Apr-15		0	
Lake Hiawatha	76-040	E 45th St @ 28th Av S		15-Apr-15		0	
Lake Hiawatha	76-050	E 46th St @ 28th Av S		15-Apr-15	Pipe	12	RCP
Powderhorn Lake	82-010	Powderhorn Terrace @ 12th Av S		17-Apr-15	Concrete Apron	36	CMP
Powderhorn Lake	82-010A	100' E of 82-010		17-Apr-15	Concrete Apron	24	RCP
Powderhorn Lake	82-020	15th Av S 300' S of E 34th St		17-Apr-15	Concrete Apron	36	CMP
Powderhorn Lake	82-025	150' S of 82-020		17-Apr-15	Pipe	15	PVC
Powderhorn Lake	82-025A	West side of lake 200' s of 82-020		17-Apr-15	Pipe	12	HDPE

Powderhorn Lake	82-030	E 35th St @ 13th Av S	17-Apr-15		0	
Powderhorn Lake	82-040	10th Av S 200' S of E 33rd St	17-Apr-15	Concrete Apron	36	RCP
Powderhorn Lake	82-050		17-Apr-15	Head Wall	0	

Minneapolis TMDL Status - July 2016

Introduction:
The federal Clean Water Act requires states to adopt water quality standards to protect waters from pollution. The goal is to protect high-quality waters and improve the quality of impaired waters, so that beneficial uses (such as fishing, swimming and protection of aquatic life) are maintained and restored, where these uses are attainable. *Adapted from MPCA 12/2011 Guidance Manual for Assessing the Quality of Minnesota Surface Waters.*

The process includes the following steps: 1) Assess waters, 2) Determine whether impaired, 3) Place water on the impaired list, 4) Monitor and study the water body, 5) Complete a pollutant load allocation formula (called a "Total Maximum Daily Load", or TMDL), 6) Develop a restoration strategy, 7) Implement the strategy, 8) Monitor changes in water quality, and then 9) De-list if standards are being achieved, or 10) Determine next steps. The list of impaired water bodies, or 303(d) List, is updated every two years.

City of Minneapolis TMDL Status

Name of Surface Water (includes lakes, creeks, wetlands and Mississippi River). Alphabetical order. * indicates waterbody is not in Minneapolis.	Receives Minneapolis municipal stormwater runoff?	State ID	Next-in-line Receiving Water	Status of Impairment and TMDL Study	Designated Use that is Affected by the Impairment
BASSETT CREEK	yes (and from upstream municipalities)	07010206-538	Mississippi River	1) FISHES BIOASSESSMENTS (listed 2004) - TMDL study not started yet, may be reassessed.	Aquatic Life
				2) BACTERIA (listed 2008) - TMDL approved Nov. 2014 (metro-wide).	Aquatic Recreation
				3) CHLORIDE (listed 2010) - TMDL approved June 2016 (metro-wide).	Aquatic Life
BASSETT'S POND * (Part of Bassett Creek. Located in City of Golden Valley, in Wirth Park owned and managed by Minneapolis Park & Recreation Board)	yes	27-0036	Bassett Creek	No impairments.	
BIRCH POND	yes (portion of southbound Wirth Parkway)	27-0653	Landlocked (historic pumping to Chain of Lakes)	No impairments.	
BROWNIE LAKE	yes (and from City of Saint Louis Park)	27-0038	Cedar Lake	1) MERCURY IN FISH TISSUE (listed 1998) - Statewide TMDL approved 2008, not stormwater-related, no MS4 responsibilities, target completion 2025.	Aquatic Consumption
				2) EXCESS NUTRIENTS (listed 2004) - **DE-LISTED** 2010 (could be listed again if TP rises again).	
				3) CHLORIDE (listed 2014) - TMDL approved June 2016 (metro-wide).	Aquatic Life
CEDAR LAKE	yes (and from City of Saint Louis Park)	27-0039	Lake of the Isles	1) MERCURY IN FISH TISSUE (listed 1998) - Statewide TMDL approved 2008, not stormwater-related, no MS4 responsibilities, target completion 2025.	Aquatic Consumption
CEMETERY LAKE	no	27-0017	Lake Calhoun	No impairments.	
CRYSTAL LAKE * (Located in Robbinsdale)	yes (and from City of Robbinsdale)	27-0034	Shingle Creek	1) EXCESS NUTRIENTS (listed 2002) - TMDL Study approved 2009, in implementation stage.	Aquatic Recreation
DIAMOND LAKE	yes	27-0022	Minnehaha Creek	1) Was formerly listed for EXCESS NUTRIENTS, but removed from list in 2008 because it was determined to be a wetland (or game lake) that had been mischaracterized by DNR as a lake. There are no nutrient standards for wetlands at this time.	
				2) CHLORIDE (listed 2014) - TMDL approved June 2016 (metro-wide).	Aquatic Life
FERDINAND POND (see Legion Lake)	yes (and MnDOT Crosstown)	--	Legion Lake	No impairments. Status as a "wetland" to be determined by DNR.	
GRASS LAKE (Officially a wetland. Was previously part of Richfield Lake, which was divided by construction of Highway 62)	yes	27-0681	Landlocked/Lower Minnesota River	1) EXCESS NUTRIENTS (listed in 2006) - **DELISTED** in 2016.	Aquatic Recreation
LAKE CALHOUN	yes (and from upstream municipalities)	27-0031	Lake Harriet	1) MERCURY IN FISH TISSUE (listed 1998) - statewide TMDL completed 2008, not stormwater-related, no MS4 responsibilities, target completion 2025.	Aquatic Consumption
				2) PFOS IN FISH TISSUE (listed 2008) - regulatory action by MPCA in lieu of TMDL is underway (pollutant source in St. Louis Park), target completion 2022.	Aquatic Consumption
LAKE HARRIET	yes	27-0016	Minnehaha Creek	1) MERCURY IN FISH TISSUE (listed 1998) - statewide TMDL completed 2008, not stormwater-related, no MS4 responsibilities. Target completion 2025.	Aquatic Consumption
				2) PFOS IN FISH TISSUE (listed 2008) - regulatory action by MPCA in lieu of TMDL is underway (pollutant source in St. Louis Park), target completion 2022.	Aquatic Consumption
LAKE HIAWATHA (Part of Minnehaha Creek)	yes (and from upstream municipalities)	27-0018	Minnehaha Creek	1) EXCESS NUTRIENTS (listed 2002) - part of Minnehaha Creek *E. Coli* Bacteria/Lake Hiawatha Nutrients TMDL Study. TMDL approved 2014.	
LAKE NOKOMIS	yes (and from Richfield and a portion of MSP Airport)	27-0019	Minnehaha Creek	1) MERCURY IN FISH TISSUE (listed 1998) - Statewide TMDL approved 2008, not stormwater-related, no MS4 responsibilities, target completion 2025.	Aquatic Consumption
				2) PCB IN FISH TISSUE (listed 1998) - TMDL status unknown, target completion 2025.	Aquatic Consumption
				3) EXCESS NUTRIENTS (listed 2002) - TMDL study approved 2011, in implementation stage. (TMDL name: Minnehaha Creek Watershed Lakes)	Aquatic Recreation

Name of Surface Water (includes lakes, creeks, wetlands and Mississippi River). Alphabetical order. * indicates waterbody is not in Minneapolis.	Receives Minneapolis municipal stormwater runoff?	State ID	Next-in-line Receiving Water	Status of Impairment and TMDL Study	Designated Use that is Affected by the Impairment
LAKE OF THE ISLES	yes	27-0040	Lake Calhoun	1) MERCURY IN FISH TISSUE (listed 1998) - Statewide TMDL approved 2008, not stormwater-related, no MS4 responsibilities, target completion 2025.	Aquatic Consumption
				2) PFOS IN FISH TISSUE (listed 2008) - regulatory action underway by MPCA in lieu of TMDL (pollutant source in St. Louis Park), target completion 2022.	Aquatic Consumption
LEGION LAKE * (Located in Richfield; the former Legion Lake wetland area in Minneapolis is now Ferdinand Pond)	no (lake is in Richfield; a wetland area formerly considered part of Legion Lake is now Ferdinand Pond)	27-0024	Taft Lake	No impairments for Legion Lake, but Legion Lake is involved in the TMDL for Lake Nokomis.	
LORING LAKE (commonly called Loring Pond)	yes (little direct runoff BUT takes runoff on occasion from 35W Tunnel)	27-0655	Mississippi River	1) CHLORIDE (listed 2014) - TMDL approved June 2016 (metro-wide).	Aquatic Life
MINNEHAHA CREEK	yes (and from upstream municipalities)	07010206-539	Mississippi River	1) FISHES BIOASSESSMENTS (listed 2004) - TMDL study not started, may reassess (baseflow not constant), appears to be on hold until 2020.	Aquatic Life
				2) CHLORIDE (listed 2008) - TMDL approved June 206 (metro-wide).	Aquatic Life
				3) BACTERIA (listed 2008) - part of Minnehaha Creek *E. Coli* Bacteria/Lake Hiawatha Nutrients TMDL study. TMDL approved 2014.	Aquatic Recreation
				4) DISSOLVED OXYGEN (listed 2010) - TMDL study not started, may reassess (baseflow not constant), appears to be on hold until 2020.	Aquatic Life
				5) AQUATIC MACROINVERTEBRATE BIOASSESSMENTS (listed 2014) - TMDL study not started.	Aquatic Life
MISSISSIPPI RIVER (the specific reach upstream of Upper Saint Anthony Falls, to Coon Creek)	yes (and from upstream municipalities)	07010206-509	n/a	1) MERCURY IN FISH TISSUE (listed 1998) - Statewide TMDL approved 2008, not stormwater-related, no MS4 responsibilities, target completion 2025.	Aquatic Consumption
				2) PCB IN FISH TISSUE (listed 1998) - targeted TMDL completion date is 2025.	Aquatic Consumption
				3) BACTERIA (listed 2002) TMDL approved Nov. 2014 (metro-wide), bacteria not an issue in this river segment this round, MPCA plans to look again in 2020.	Aquatic Recreation
MISSISSIPPI RIVER (the specific reach between Upper and Lower Saint Anthony Falls)	yes (and from upstream municipalities)	07010206-513	n/a	1) MERCURY IN FISH TISSUE (listed 1998) - not stormwater-related, statewide TMDL approved 2008.	Aquatic Consumption
				2) PCB IN FISH TISSUE (listed 1998) - targeted TMDL completion date is 2025.	Aquatic Consumption
				3) BACTERIA (not listed, but part of TMDL approved Nov. 2014 (metro-wide) - bacteria not an issue in this river segment this round, MPCA plans to look again in 2020.	Aquatic Recreation
MISSISSIPPI RIVER (the specific reach downstream of Lower Saint Anthony Falls, to Lock and Dam #1)	yes (and from upstream municipalities)	07010206-503	n/a	1) MERCURY IN FISH TISSUE (listed 1998) - Statewide TMDL finalized 2008, not stormwater-related, so no MS4 responsibilities.	Aquatic Consumption
				2) BACTERIA (listed 2002) TMDL approved Nov. 2014 (metro-wide), bacteria not an issue in this river segment this round, MPCA plans to look again in 2020.	Aquatic Recreation
MISSISSIPPI RIVER * (impaired downstream of confluence with Minnesota R., to Lake Pepin)	this impairment is downstream of the Minneapolis segments	07010206-xxx	n/a	1) TOTAL SUSPENDED SOLIDS (TSS) (listed 1998) (replaced turbidity standard with site-specific TSS standard) - South Metro Ms. R. TSS TMDL study near completion. **Zero reduction required for Minneapolis MS4.**	
LAKE PEPIN * (widening of MISSISSIPPI RIVER) (as tributary to Lake Pepin nutrient/eutrophication biological indicators TMDL)	this impairment is downstream of the Minneapolis segments	25-0001	n/a	1) EXCESS NUTRIENTS (listed 2002) - Lake Pepin TMDL study in progress.	
MOTHER LAKE * (formerly in Minneapolis, now Airport)	yes	27-0023	Lake Nokomis	No excess nutrients impairment for Mother Lake, but Mother Lake is involved in the TMDL for Lake Nokomis.	
POWDERHORN LAKE	yes	27-0014	Landlocked (has been pumped to Mississippi River in the past)	1) MERCURY IN FISH TISSUE (listed 1998) - Statewide TMDL approved 2008, not stormwater-related, no MS4 responsibilities, target completion 2025.	Aquatic Consumption
				2) EXCESS NUTRIENTS (listed 2002) - **DE-LISTED** in 2012, due to improved water quality.	
				3) CHLORIDE (listed 2014) - TMDL approved June 2016 (metro-wide).	Aquatic Life
RYAN CREEK (primarily conveyed by storm drain pipe, about two blocks exposed, on industrial property)	yes (and Ryan Lake)	don't know	Shingle Creek	No impairments.	

Name of Surface Water (includes lakes, creeks, wetlands and Mississippi River). Alphabetical order. * indicates waterbody is not in Minneapolis.	Receives Minneapolis municipal stormwater runoff?	State ID	Next-in-line Receiving Water	Status of Impairment and TMDL Study	Designated Use that is Affected by the Impairment
RYAN LAKE part * (located in Minneapolis and in Cities of Robbinsdale and Brooklyn Center)	yes (and from upstream municipalities)	27-0058	Ryan Creek	1) EXCESS NUTRIENTS (listed 2002) - TMDL Study approved 2007, **DE-LISTED** 2014 because of restoration activities under TMDL Implementation Plan.	
SANCTUARY MARSH	no	27-0665	Lake Harriet	No impairments.	
SHINGLE CREEK	yes (and from upstream municipalities)	07010206-506	Mississippi River	1) CHLORIDE (listed 1998) - TMDL approved 2007, now in implementation stage.	Aquatic Life
				2) DISSOLVED OXYGEN (listed 2004) - TMDL approved 2011, now in implementation stage.	Aquatic Life
				3) AQUATIC MACROINVERTEBRATE BIOASSESSMENTS (listed 2006) - TMDL approved 2011, now in implementation stage.	Aquatic Life
				4) BACTERIA (listed 2014) - TMDL approved Nov. 2014 (metro-wide).	Aquatic Recreation
SILVER LAKE * (located in Cities of New Brighton and Columbia Heights)	yes, from a very small corner of Minneapolis (and from New Brighton, Columbia Heights and St. Anthony Village)	62-0083	Ramsey County Ditch 3, then Rice Creek	1) EXCESS NUTRIENTS (listed 2002) - TMDL approved 2010, now in implementation stage.	Aquatic Recreation
				1) MERCURY IN FISH TISSUE (listed 1998) - Statewide TMDL approved 2008, not stormwater-related, no MS4 responsibilities, target completion 2025.	Aquatic Consumption
				3) CHLORIDE (listed 2014) - TMDL approved June 2016 (metro-wide).	Aquatic Life
SPRING LAKE	yes (and from I-394)	27-0654	Landlocked? (possible occasional connection to tunnel to Mississippi River)	1) CHLORIDE (listed 2014) - TMDL approved June 2016 (metro-wide).	Aquatic Life
TAFT LAKE * (formerly in Minneapolis, now Airport)	yes (formerly part of Minneapolis, now Airport)	27-0683	Lake Nokomis	1) No excess nutrients impairment for Taft Lake, but Taft Lake is involved in the TMDL for Lake Nokomis.	
WEBBER POND	no (reconstructed 2013-2015 with no stormwater outfalls to it)	27-1118	Shingle Creek	No impairments.	
WIRTH LAKE * (located in City of Golden Valley, in Wirth Park owned and managed by Minneapolis Park & Recreation Board)	no apparent Minneapolis municipal runoff (MPRB only; parkway runoff appears to be only in Golden Valley)	27-0037	Bassett Creek	1) MERCURY IN FISH TISSUE (listed 1998) - Statewide TMDL approved 2008, not stormwater-related, no MS4 responsibilities, target completion 2025.	Aquatic Consumption
				1) CHLORIDE (listed 2016) - TMDL approved June 2016 (metro-wide).	Aquatic Life
				2) EXCESS NUTRIENTS (listed 2002) - TMDL approved 2010 (Wirth Lake Excess Nutrients TMDL Report). **DE-LISTED** 2014 because of activities carried out under TMDL Implementation Plan.	

Color Key:
Chloride.
Bacteria.
Excess nutrients.
related to Lake Nokomis Excess Nutrients TMDL.
Total Suspended Solids (TSS)
Dissolved oxygen, or bioassessments for fish or aquatic macroinvertebrates.
PFOS or PCB
Mercury - no MS4 responsibilities.

Notes:
MERCURY -- Presence of mercury is primarily airborne, not stormwater runoff. Statewide Mercury TMDL is being carried out by MPCA. No MS4 responsibilities.
PFOS -- Presence of perfluorooctane sulfonate (PFOS) is primarily related to industrial discharge. Regulatory action in lieu of TMDL is underway.
PCB -- Polychlorinated biphenyls.
* indicates waterbody is not in Minneapolis.

Message from Minnesota's Clean Water Council: We recognize that people are hungry for immediate results; however, managing water resources is an ongoing task, and some clean water outcomes may take several decades to achieve. Once a best management practice has been implemented, it often takes many years, or decades, before a positive environmental outcome is achieved in a highly degraded river, lake or groundwater source.

EROSION CONTROL

Goal: To set a consistent standard for erosion control inspections performed by City of Minneapolis Regulatory Services Inspectors that is transparent and accountable to the public.

All enforceable erosion control standards can be found in Minneapolis Code of Ordinances

- Title 3, Chapter 52 EROSION AND SEDIMENT CONTROL FOR LAND DISTURBANCE ACTIVITIES,

Best Management Practices (BMPs) used are adapted from Minnesota Department of Transportation erosion control measures.

I. Demolition and Construction >500 ft^2 and <5,000 ft^2

A. APPLICABILITY

- This section pertains to construction and demolition activities with ground disturbance greater than 500 square feet or 5 cubic yards but less than 5,000 square feet.
- Construction or Demolition permit issued by the City of Minneapolis;

B. ADMINISTRATIVE ACTIVITIES:

- On a bi-weekly basis administrative staff reviews KIVA for erosion control permits
- Upon issuance of an erosion control permit for construction or demolition administrative staff will develop a request for services (RFS) in KIVA for EMBESE.

C. INSPECTOR ACTIVITIES:

- All inspectors must attend and pass an approved erosion control course and possess a current storm water erosion control license
- Upon receiving the EMBESE RFS through KIVA the inspector conducts an initial inspection.

- If a demolition project the inspector verifies that the demolition is complete and properly graded. If there are concerns they are addressed with the Problem Properties Unit or Code Construction Services.
- If the site does not have a construction permit the inspector verifies that the contractor graded the site and removed construction debris.
- The inspector checks the contractor's erosion control best management practices to ensure that the measures are adequate to prevent erosion of soil from the site.
- Inspect sidewalk, alley, and street for soil eroding from the site or tracking from demolition activities.
- Identify and inspect storm drains in vicinity to ensure that soil eroding from the site is not entering storm drains.
- If a significant amount of soil has escaped the site and entered the storm drain which cannot be recovered a citation may be issued without prior notice.
- If demolition and site grading are complete, BMPs are in place and adequate to control erosion, and no soil is noted in public thoroughfares enter notes into KIVA noting compliance.
- Schedule site visit in 5 weeks if conditions are compliant to check erosion control status at that time or to assess the establishment of vegetation. Enter as an EMS02 for single or multi-family residential or small commercial.
- Contact the contractor directly and establish a due date to correct site issues. Follow up by writing orders in KIVA to the contractor outlining deficiencies and due date for compliance. If a contractor is notified directly their due date may be as short as 24hrs depending on severity and no longer than 7 days. The due date within this time frame is the sole discretion of the trained inspector. Any due date shorter than 24 hours or longer than 7 days requires a supervisor's or manager's approval.
- Schedule re-inspection for due date.
- If site is not in compliance upon re-inspection issue a citation to the contractor through KIVA.
- When outstanding non-compliance is resolved schedule the next round of inspections or final inspection for determining vegetative cover.
- If vegetative cover is at least 70% close RFS and permit in KIVA.

D. **RECORD KEEPING**

- Digital photographs are to be downloaded into stellant under the appropriate EMBESE folder using the correct RFS number.
- If created, paper files are to be placed into the company file in the main filing cabinet.

III. Construction >5,000 ft^2

E. APPLICABILITY

- This section pertains to construction and demolition activities with ground disturbance greater than 5000 square feet.
- Construction or demolition permit issued by the City of Minneapolis;

F. ADMINISTRATIVE ACTIVITIES:

- Administrative staff reviews KIVA for erosion control permits
- Upon issuance of an erosion control permit for construction of sites greater than 5000 square feet administrative staff develop a request for services (RFS) in KIVA for EMBESE.

G. INSPECTOR ACTIVITIES:

- All inspectors must attend and pass an approved erosion control course and possess a storm water erosion control
- Upon receiving the EMBESE RFS through KIVA on the Daily Inspection Report the inspector conducts an initial inspection.
- Upon entering the site all staff members MUST be wearing a hard hat, safety glasses and steel toed boots.
- Inspect Stormwater Pollution Prevention Plans at the job site trailer. Note inspection dates, occurrences and issues. Ensure the site was inspected on days with rains over 0.5 inches.
- If a demolition project the inspector verifies that the demolition is complete and properly graded. If there are concerns they are addressed with Code Construction Services.
- Any drainage concerns that may impact adjacent properties are noted.
- If the site does not have a construction permit the inspector verifies that the contractor graded the site and removed construction debris.
- The inspector checks the contractor's erosion control best management practices to ensure that the measures are adequate to prevent erosion of soil from the site.
- Inspect sidewalk, alley, and street for soil eroding from the site or tracking from demolition activities.
- Identify and inspect storm drains in vicinity to ensure that soil eroding from the site is not entering storm drains.
- If a significant amount of soil has escaped the site and entered the storm drain which cannot be recovered a citation may be issued without prior notice.

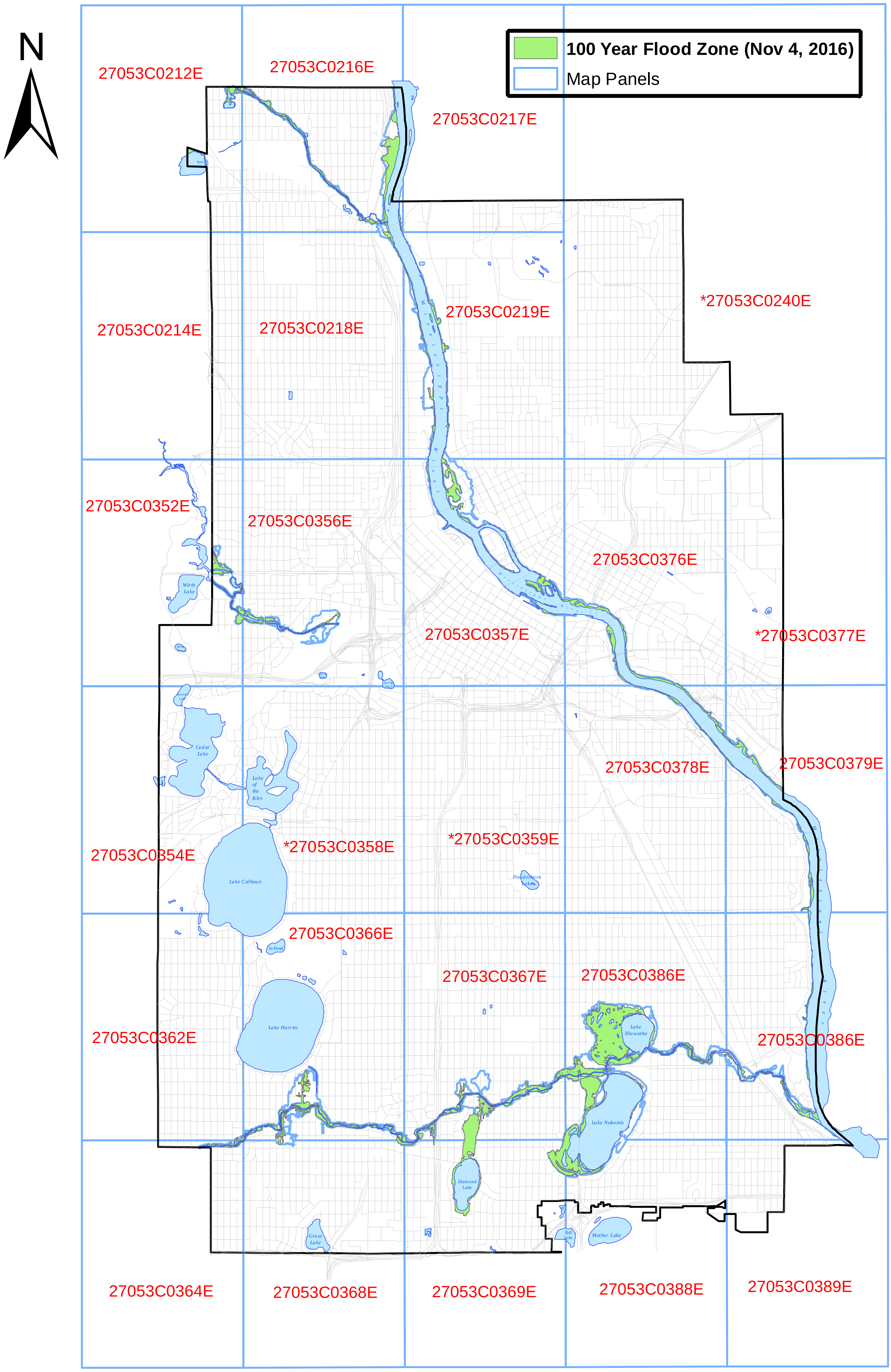
- If demolition and site grading are complete, BMPs are in place and adequate to control erosion, and no soil is noted in public thoroughfares enter notes into KIVA noting compliance.
- Schedule site visit in 7 weeks if conditions are compliant to check erosion control status at that time or to assess the establishment of vegetation.
- Following storm events greater than 0.5 inches of rain in 24hrs inspect records to ensure contractor conducted required additional inspections
- Contact the contractor directly and establish a due date to correct site issues. Follow up by writing orders in KIVA to the contractor outlining deficiencies and due date for compliance. If a contractor is notified directly their due date may be as short as 24hrs depending on severity and no longer than 7 days. The due date within this time frame is the sole discretion of the trained inspector. Any due date shorter than 24 hours or longer than 7 days requires a supervisor's or manager's approval.
- Schedule re-inspection for due date.
- If site is not in compliance upon re-inspection issue a citation to the contractor through KIVA.
- When outstanding non-compliance is resolved schedule the next round of inspections or final inspection for determining vegetative cover.
- If vegetative cover is at least 70% close RFS and permit in KIVA.

H. **RECORD KEEPING**

- Digital photographs and related documents are to be downloaded into Stellant.
- All notes of inspections must be entered in KIVA

Appendix B

F.E.M.A. DESIGNATED FLOOD ZONES



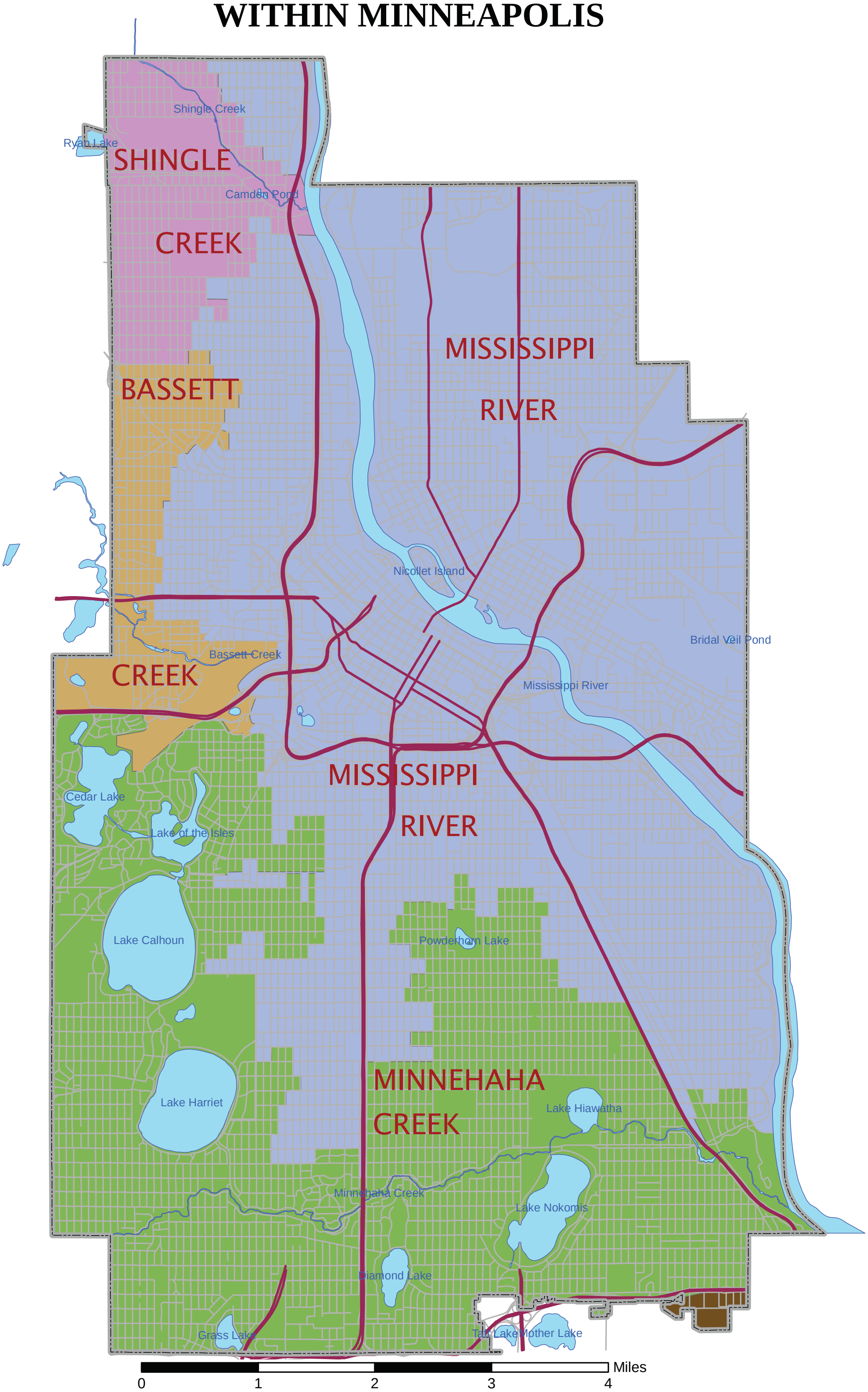
EFFECTIVE DATE FOR MAP PANELS: NOVEMBER 4, 2016

APPENDIX B-1

May 2017

Minneapolis City of Lakes

WATERSHED MANAGEMENT BOUNDARIES WITHIN MINNEAPOLIS



- Lakes & Streams
- Bassett Creek Water Management Commission
- Minneapolis/St. Paul International Airport
- Minnehaha Creek Watershed District
- Mississippi Watershed Management Organization
- Shingle Creek Watershed Management Commission

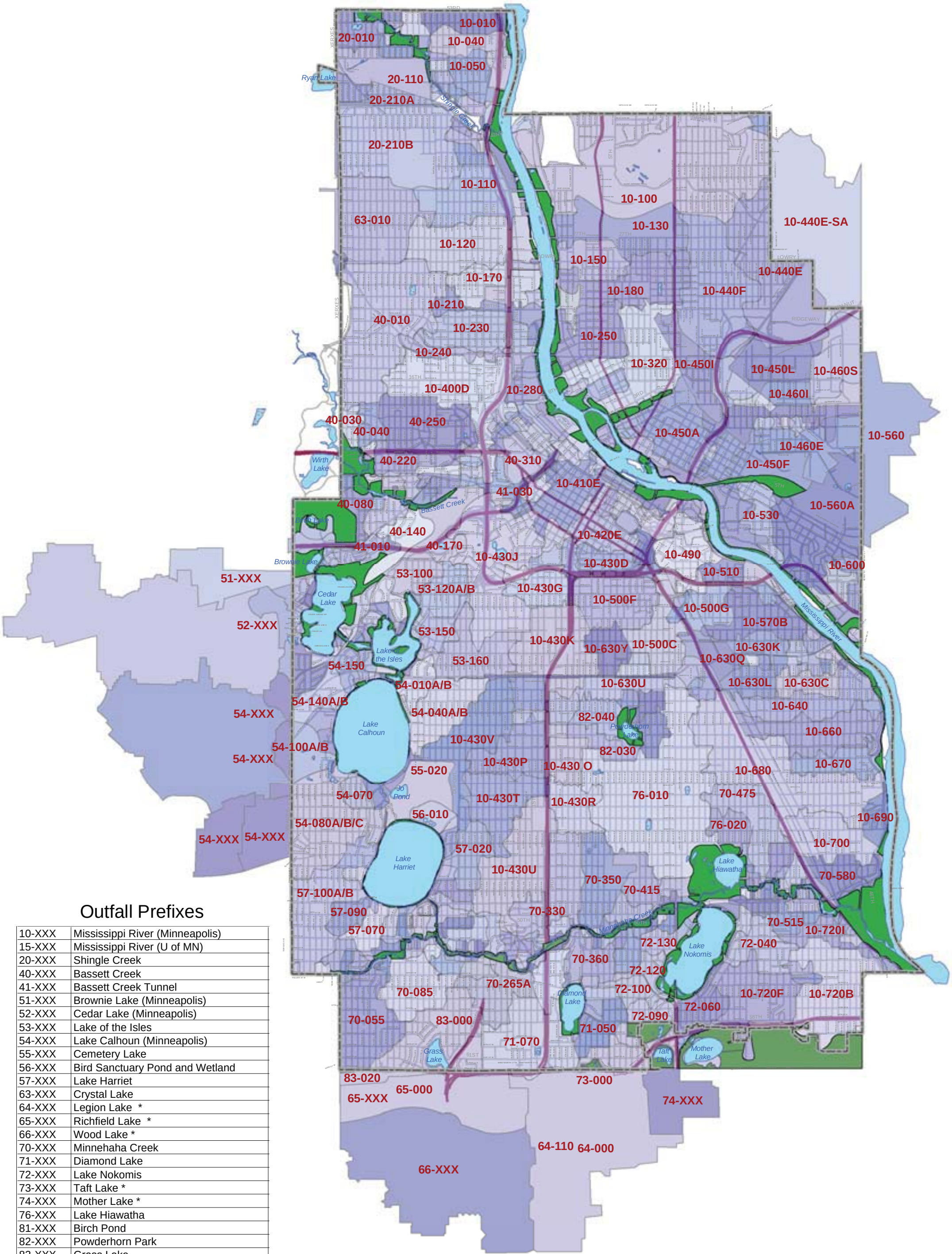
MINNEAPOLIS PUBLIC WORKS
SURFACE WATER & SEWERS DIVISION

March, 2008

APPENDIX B-2

This Map was created from the City of Minneapolis Public Work's Geographic Information System (GIS), it is a compilation of information and data from various sources. This Map is not a surveyed or legally recorded document and is intended to be used as a reference. The City of Minneapolis and its Public Works Department is not responsible for any inaccuracies contained herein or any consequences resulting from the user's use of or reliance on this GIS data.

MINNEAPOLIS STORMWATER RUNOFF DRAINAGE SUB-AREA BOUNDARIES



Outfall Prefixes

10-XXX	Mississippi River (Minneapolis)
15-XXX	Mississippi River (U of MN)
20-XXX	Shingle Creek
40-XXX	Bassett Creek
41-XXX	Bassett Creek Tunnel
51-XXX	Brownie Lake (Minneapolis)
52-XXX	Cedar Lake (Minneapolis)
53-XXX	Lake of the Isles
54-XXX	Lake Calhoun (Minneapolis)
55-XXX	Cemetery Lake
56-XXX	Bird Sanctuary Pond and Wetland
57-XXX	Lake Harriet
63-XXX	Crystal Lake
64-XXX	Legion Lake *
65-XXX	Richfield Lake *
66-XXX	Wood Lake *
70-XXX	Minnehaha Creek
71-XXX	Diamond Lake
72-XXX	Lake Nokomis
73-XXX	Taft Lake *
74-XXX	Mother Lake *
76-XXX	Lake Hiawatha
81-XXX	Birch Pond
82-XXX	Powderhorn Park
83-XXX	Grass Lake
* Drainage from Richfield	

APPENDIX B-3

Miles
0 1 2 3 4

MINNEAPOLIS PUBLIC WORKS
SURFACE WATER & SEWERS DIVISION

March, 2008

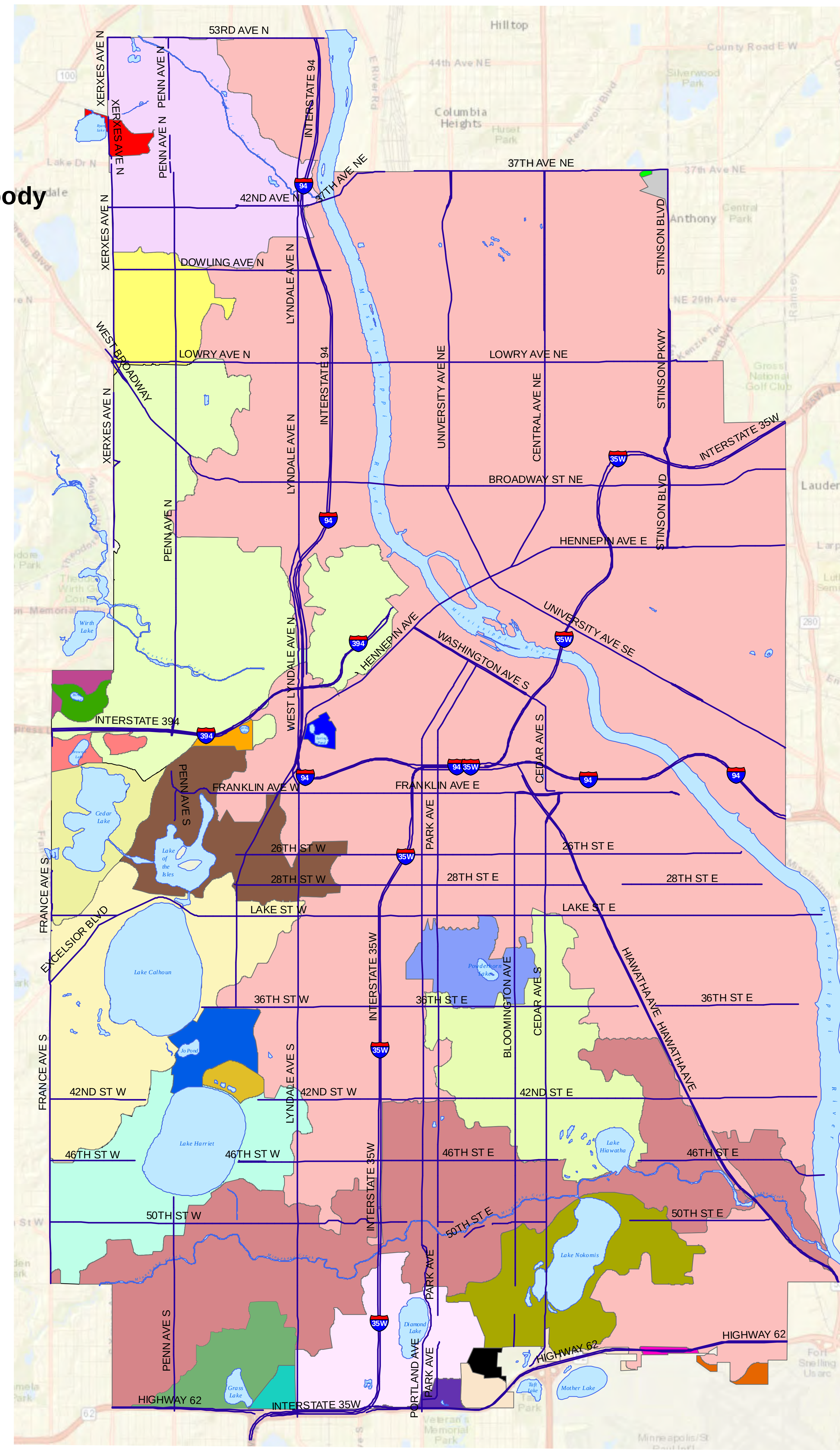
This Map was created from the City of Minneapolis Public Work's Geographic Information System (GIS), it is a compilation of information and data from various sources. This Map is not a surveyed or legally recorded document and is intended to be used as a reference. The City of Minneapolis and its Public Works Department is not responsible for any inaccuracies contained herein or any consequences resulting from the user's use of or reliance on this GIS data.

MINNEAPOLIS DRAINAGE AREAS TO RECEIVING WATER BODIES

N

Watersheds by Waterbody

- Bassett Creek
- Birch Pond
- Brownie Lake
- Cedar Lake
- Cemetery Lake
- Crystal Lake
- Diamond Lake
- Grass Lake
- Hwy 62 Wetland
- Hart Lake
- Lake Calhoun
- Lake Harriet
- Lake Hiawatha
- Lake Nokomis
- Lake of the Isles
- Legion Lake
- Loring Pond
- Minnehaha Creek
- Mississippi River
- Mother Lake
- Powderhorn Lake
- Richfield Lake
- Ryan Lake
- Sanctuary Pond
- Shingle Creek
- Silver Lake
- Solomon Park Wetland
- Spring Lake
- Taft Lake
- Wirth Lake
- reportmask
- World Street Map



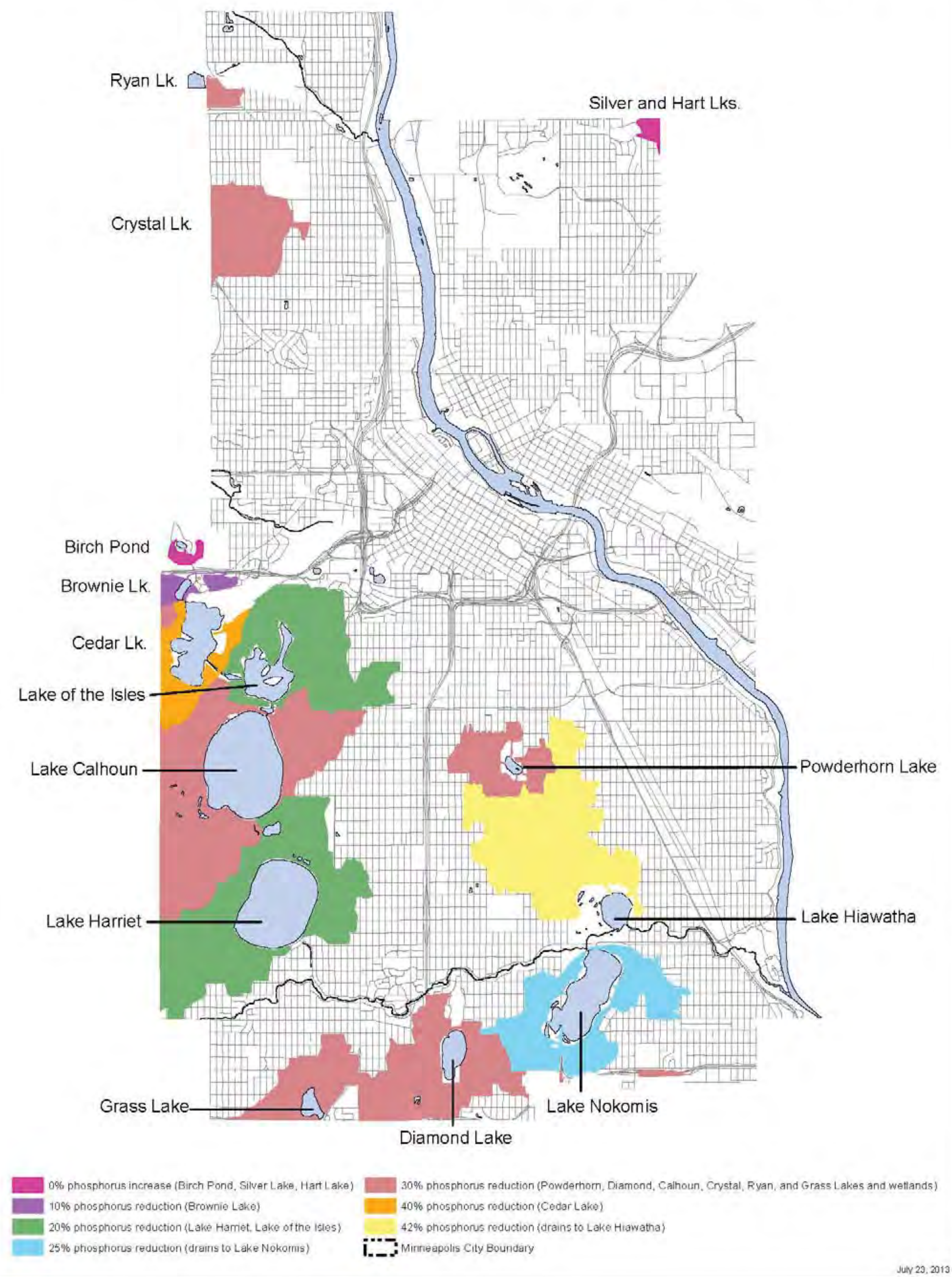
JUNE 2016

APPENDIX B-4

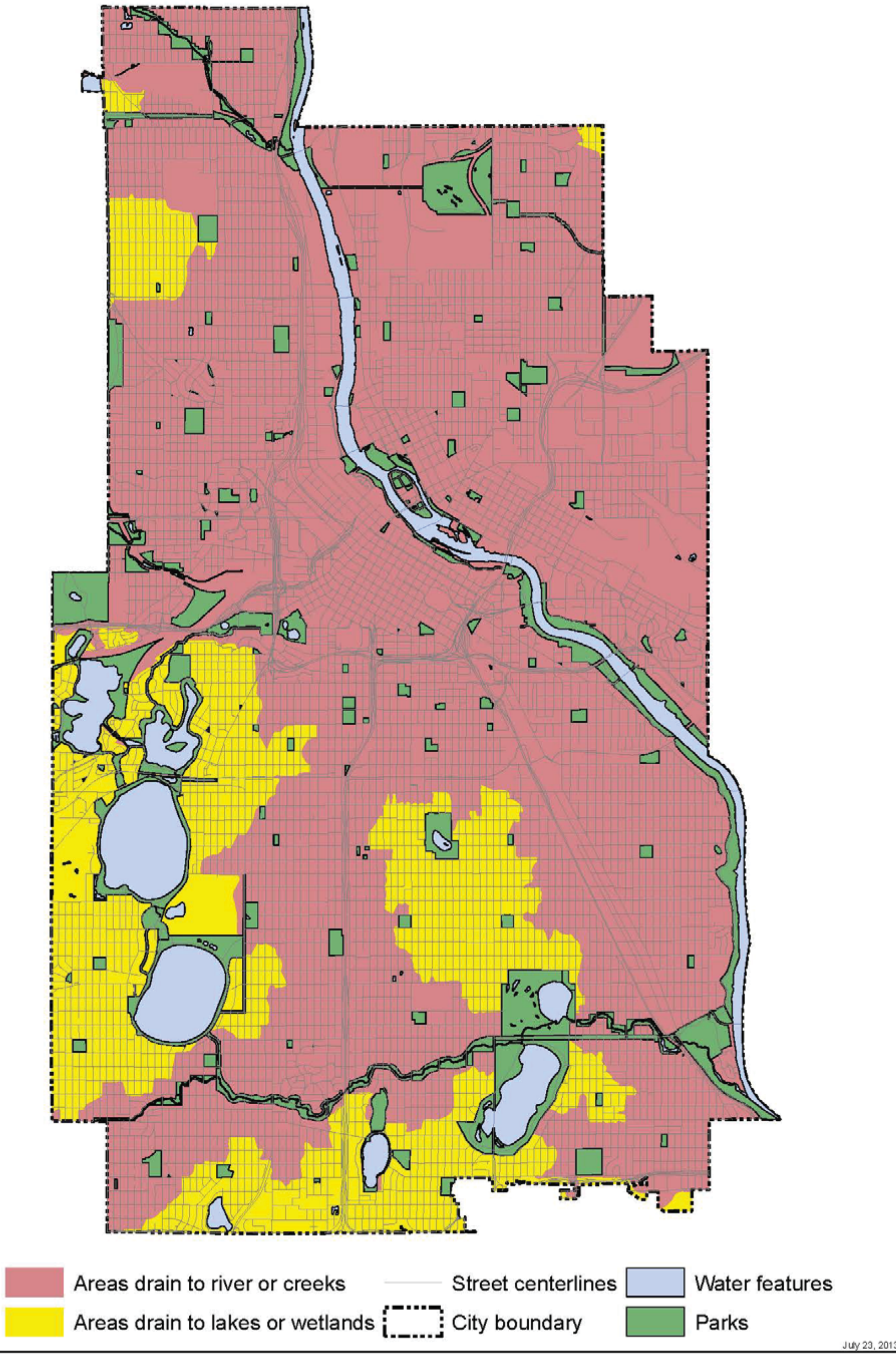
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap Community

Minneapolis City of Lakes

Appendix B5: Phosphorus Load Reductions for Lakes and Wetlands



Appendix B6: Drainage Areas By River/Creeks OR Lakes/Wetlands



Appendix C

Minneapolis
City of Lakes

June 13, 2017

City of Minneapolis, Department of Public Works
Surface Water & Sewer Division c/o Liz Stout

RE: Stormwater Management Plan Comments

Dear Liz Stout and City Staff:

Thank you for the opportunity to comment on the draft Stormwater Management Plan (SWMP) for the City of Minneapolis.

Members of the Community Environmental Advisory Commission (CEAC) would like to offer a few suggestions to enhance the strengths of the report.

1. p27, SMP 2.1, Engage a Diverse Public: Consider adding stormwater and erosion control reporting tools to the 311 mobile app to allow the public to report violations and add photos. This can help with sediment, illicit discharges, and other stormwater issues.

2. p45, SMP 3.7, Source Control Education and Outreach Program: Continue to develop and act on a Community Engagement Plan to communicate opportunities and look for partnerships.

3. p45, SMP 3.7, Source Control Education and Outreach Program: Consider active participation in the MPCA chlorine management discussions with other stakeholder groups including public works transportation staff, Freshwater Society, BOMA, MnDOT, the University of Minnesota.

4. p65, SMP 5.4, Private Development and Redevelopment Projects: Continue to prioritize green infrastructure early in project scoping and development reviews in order to get stacked benefits from infrastructure projects, especially when public works is coordinating with another lead transportation department. Consider using the ISI Envision rating system for green infrastructure when comparing project alternatives to evaluate triple bottom line benefits and life cycle analysis.

5. p75, SMP 5.9, Pilot Projects: Create a storyboard or mapping tool to communicate to residents about existing stormwater projects and pilot projects within the city.

6. p75, SMP 5.9, Pilot Projects: Consider implementing more stormwater reuse pilot projects within the city.

7. p99, SMP 6.1.11, Electronic Inventory and Mapping: Continue to work to develop this map to communicate data to residents. Consider using storyboards

and other GIS tools to make data easy for the general public to access. Also consider using this tool to communicate locations of all the stormwater BMP sites the city has implemented. People might not even be aware of a lot of these installations.

8. p103, SMP 6.3 Parking Lot and Equipment Yard management: Consider stormwater or rainwater reuse for vehicle washing.

9. p105, SMP No. 6.4: Application of Snow and Ice Control for Streets: Work with MPCA and other stakeholders on smart salt application and chloride management. (see comment 3)

10. p107, SMP 6.5, Application of Snow and Ice Control for Properties: Sweeping up of excess deicers when an excess occurs should be included in the practice.

11. p142, Appendix A-5 City goals: Work to prioritize the implementation of projects located in the two newly established Green Zones in the city, especially projects that benefit stormwater quality or reduce flooding.

12. p146, Appendix A-6, Public Education by other Entities:
    a. p147 and p152: Please update CEAC name to Community Environmental Advisory Commission. It may be worthwhile to update the contact name with the staff liaison's information as the CEAC chair typically changes every year.
    b. p148: Please update the Minnehaha Creek Watershed District contact
    c. p155: Please add the Master Water Stewards Program under Freshwater and MCWD for a potential project partner or BMP implementation.

Again, thank you for the opportunity to comment on the city's stormwater management plan. We look forward to the opportunity to work with city staff to continue to improve stormwater quality and quantity in Minneapolis.

Community Environmental Advisory Commission (CEAC)

From:	Dan Kalmon
To:	Stout, Elizabeth A.
Cc:	Pilger, Debra
Subject:	MWMO Comment: Minneapolis's Stormwater Management Program (SWMP)
Date:	Thursday, June 15, 2017 4:43:10 PM
Attachments:	image001.png image002.png image003.png image004.png image005.png

Liz,

Thank you for the opportunity to review and comment on the priorities and programs that make up Minneapolis's Stormwater Management Program (SWMP). It is not clear if Mpls has made recent changes to the (SWMP) document and is seeking a review and comment on these changes. If were made we would like some clarification on what these changes were and some time to review the changes. If no changes have been made to this document since Revisions date July 22, 2015 then the MWMO is ok with the document as it stands.

The MWMO wants to confirm this review process is not a related to Mpls's LSWMP review process requirements.

Thanks,

Daniel Kalmon
Planning Principal

(612) 746-4977 direct
(612) 465-8780 office

Mississippi Watershed Management Organization
2522 Marshall Street NE
Minneapolis, Minnesota 55418-3329
www.mwmo.org

Connect with us!

From:	Ed A. Matthiesen
To:	Stout, Elizabeth A.
Subject:	Shingle Creek minutes question regarding comments
Date:	Friday, June 16, 2017 3:43:08 PM
Attachments:	image001.png

Who is the right person to send this to?

VII. Watershed Management Plan.

Minneapolis Stormwater Plan.* The City of Minneapolis and the Minneapolis Park and Recreation Board are co-permittees holding a National Pollutant Discharge and Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Phase I Permit from the State of Minnesota. Phase I MS4s are cities over 100,000 in population, and Phase I permits have additional requirements beyond Phase II permits.

The City and MPRB are currently taking input on their Stormwater Management Program in preparation for preparing their Annual Report. The comment period extends through June 16, 2017. Comments will assist the City and MPRB with future modifications to the Program.

Staff have reviewed the Program and find that it is consistent with the standards set in the Commission's Third Generation Watershed Management Plan. They recommend the Commission submit comments on Table A-6 of the Program's Appendix. This table sets forth Public Education Activities by Other Entities, and for WMWA and Shingle Creek it contains several outdated programs and does not reflect newer initiatives. The following comments are recommended:

1. Update WMWA's website reference: westmetrowateralliance.org/
2. Eliminate the following programs which are no longer offered: Educate Policymakers, Workshop Series, and Patrick Henry High School Program
3. Add the following programs:
   a. Citizens Assisted Lake Monitoring Program (CAMP) - Shingle Creek (same description as Bassett Creek; Ryan Lake is monitored through CAMP)
   b. Watershed PREP - A fourth-grade elementary school program developed and delivered by WMWA educators to meet science standards in classroom curricula and teach kids how to help improve the quality of their local lakes and streams. (Audience is students and metrics are number of classrooms and students served.)
   c. Pledge to Plant for Pollinators and Clean Water –A campaign developed by WMWA to encourage landowners to replace turf grass and impervious surface with native vegetation. (Audience is property owners and metrics are number and size of plantings.)

Motion by G. Anderson, second by Jaeger to forward the recommended comments and WMWA's latest Annual Report to Minneapolis and MPRB. *Motion carried unanimously.* *Who is doing? I can. Are the send-to folks Liz Stout and Debra Pilger??.*

Ed Matthiesen, P.E. (MN) Principal Engineer

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7500 Olson Memorial Hwy, Suite 300 | Golden Valley, MN 55427

From:	Stout, Elizabeth A.
To:	S Y
Subject:	RE: Storm water management
Date:	Tuesday, May 30, 2017 2:59:00 PM
Attachments:	image001.png

Sharon,

Thanks for bringing this specific location to our attention.

With the increase popularity of native plantings and landscaping in the boulevard we have seen an increase in the amount of wood chips and mulch ending up in the street and in the local catch basin. We've been working with our partner, Metro Blooms, to encourage pulling out soil and depressing the boulevard area prior to planting in order to hold more water and reduce the amount of mulch/wood chips that run off. While this is a requirement for boulevard plantings put in with the assistance of Metro Blooms it isn't a requirement for commercial properties or private homeowners who undertake boulevard plantings on their own.

While the city will step in if there is a nuisance condition we are working to provide more education to property owner and developers so they can install better boulevards. If you see any other examples of boulevard plantings that are causing problems with the storm drains please don't hesitate to let me know.

Thank you for your feedback.

Liz

Elizabeth Stout, PE, CFM
Water Resources Regulatory Coordinator
Minneapolis
City of Lakes
City of Minneapolis Public Works – Surface Water & Sewers Division
City of Lakes Building, 309 South Second Avenue
Minneapolis MN 55401

Office: 612-673-5284
Elizabeth.Stout@minneapolismn.gov

From: S Y [mailto:sharon_yang88@hotmail.com]
Sent: Saturday, May 27, 2017 10:01 PM
To: Stout, Elizabeth A.
Subject: Storm water management

Dear Ms. Stout:

Don't know if this is relevant to your current storm water management discussion. Nonetheless, the city should take a look at the situation below.

I noticed a lot more landscaping on the boulevard these past two years. Especially around a business, where low maintenance landscaping is desirable. They always dump a lot of wood chips around the plants. Then these wood chips would wash off and block the storm drains. A border should be mandatory for this kind of landscaping. Example: the office buildings at 2815 S Wayzata Blvd, Minneapolis, MN 55405. Look at the planting at the corner of Wayzata Blvd and Cedar Lake Road.

Sincerely,
Sharon Yang

From: Michael Latour
To: Stout, Elizabeth A.
Subject: Flooding
Date: Monday, June 12, 2017 6:46:34 AM

Dear Elizabeth,

Forwarding this to you on stormwater flooding issue.
Also thank you for replying to my previous emails it is very professional and responsible.
Appreciate your attention to the issue.

Michael Latour

Begin forwarded message:

> **From:** Michael Latour <mugsy51z03@aol.com>
> **Date:** June 12, 2017 at 6:35:24 AM CDT
> **To:** Paul Hudalla <paul.hudalla@minneapolismn.gov>
> **Subject: Flooding**
>
> Hi Paul,
> This is Michael Latour at 2018 Fremont Ave S. Following up as requested with a couple of pictures of flooding again yesterday. Wasn't home when it first started so this had gone done some from its high mark. Would like to add that I do think a partial solution as mentioned previously. Would be a smaller scale project with setting ponds/rain garden. With the ultimate goal an area that would accommodate the high domed drainage grates. Allowing for a place for debris to collect and prevent the drains from being clogged with debris. Which is a major cause of the flooding. Two collection ponds, one on each side of street with the raised dome grates would address this problem adequately and go along way to addressing this problem. Along with partially addressing issue of toxic runoff into the lakes. It would also be much less costly and effective.
>
> Thank you,
>
> Michael Latour
>
> PS sure I will be contacting you again.