CHAPTER 2

WATER

Water in the Parks

Water Resources Management in the Parks

Current Conditions Relating to Water Quality

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Current MPRB Mitigation and Prevention Strategies for Degradation of Water Quality

Water Goals, Strategies, and Recommendations

Water in the Parks

While Minnesota is famous for its abundance of water and Minneapolis is known as the City of Lakes, it is important to understand how water is being used in the parks to project future needs and anticipate potential challenges. When park visitors think of parks and water, they often think of open water, including lakes, rivers, ponds, and creeks. It's no wonder; open water is the most extensive natural land cover type within the MPRB system (totaling over 1,650 acres). Thus, the continued quality of this water is critical from recreational, ecological, and aesthetic perspectives. To this end, MPRB partners with many other local and regional organizations (cities, state agencies, watershed management organizations and districts, non-profits, and other key partners) to assess water quality and raise awareness about how it is impacted by natural factors, human behaviors, and the byproducts of urban life. However, water in the parks isn't only limited to water bodies; it also applies to municipal water used to service recreational activities. Minneapolis parks offer recreational facilities that require substantial water supply, including restrooms, drinking fountains, swimming and wading pools, splash pads, ice arenas and skating rinks, golf courses, gardens, and sport fields. For each of these facilities, water quality is important to safeguard health.

With these perspectives in mind, this chapter will analyze water in the parks through goals pertaining to water resource management, water quality, and aquatic habitat:

- **Water resource management** inventories the types of water managed and maintained by MPRB and addresses the practices that are currently in place and those that could be in place to ensure sustainable, consistent, and dependable water supply and quality.
- **Water quality** addresses the cause and effect of impairments in water bodies used for different recreational purposes.
- **Aquatic habitat** pairs the themes of water and life to assess how water quality impacts the quality of habitat for life both in and around the water. To the state of MN, poor diversity in aquatic life can be an impairment and MPRB takes this into account when planning and implementing aquatic habitat restoration work.

This analysis will be completed with the view of seeking alignment with existing MPRB, City of Minneapolis, watershed, and State of Minnesota water goals, including the Minnesota Water Sustainability Framework. Ultimately, the analysis and corresponding goals, strategies, and recommendations will help to identify future steps to ensure water quality, quantity, and aquatic habitat are sustained well into the future.

WATER RESOURCES MANAGEMENT IN MINNEAPOLIS

Before diving into how water is managed in the Minneapolis park system, it is important to build some context with water resource management in the city as a whole. Minneapolis is a water conscious city in a water conscious state. Special purpose local government units (watershed districts and watershed management organizations), are in place to address and help prevent water related issues within the boundaries of different watersheds (areas in which all the water flows to one outlet). In Minneapolis, all watersheds lead to the Mississippi River. Many organizations, including federal, state, regional, and local agencies, are focused on ensuring a healthy future for the Mississippi River as well as the watersheds leading to it, including:

- Army Corps of Engineers (ACOE)
- United States Geological Survey (USGS)
- Environmental Protection Agency (EPA)
- National Park Service- Mississippi National River and Recreation Area (MNRRA)
- Minnesota Pollution Control Agency (MPCA)
- Mississippi Watershed Management Organization (MWMO)
- Minnehaha Creek Watershed District (MCWD)
- Shingle Creek and West Mississippi Water Management Commissions
- Bassett Creek Water Management Commission (BCWMC)
- Hennepin County
- City of Minneapolis

This is not an exhaustive list, but rather, a partial one to illustrate how many different organizations undertake special planning efforts to address what can be done, within their own scope, to implement protective measures for cleaner water. For example, under the authority of the 1972 Clean Water Act, the EPA requires states to designate the beneficial use of each water body, set standards for certain pollutants, assess waterbodies as to whether standards are met, and report to EPA on waters that are not meeting standards. To meet this goal MPCA makes rules based on the standards set forth by the EPA. Each watershed management organization then writes a comprehensive plan that sets goals and policies based on local conditions. Once the MPCA approves the watershed management organizations' comprehensive plans, cities update their own local surface water management plans to detail how they will achieve the goals set forth by the MPCA.

In order to protect existing water quality in waterbodies throughout the city, MPRB and the City of Minneapolis are co-permittees on the National Pollutant Discharge and Eliminations System (NPDES) permit. This permit exists because the MPRB and City of Minneapolis operate the storm sewer system that drains stormwater from the land to waterbodies throughout the city. The NPDES permit details the responsibilities of the two organizations to reduce the discharge of pollutants in stormwater to the maximum extent practicable. MPRB's main focus on water resource management is on lakes, creeks, ponds, and wetlands within the parks, but the organization also maintains an active role in river-related discussions.

Water Resources Management in the Parks

Surface water management is an intricate and ever-changing dance between humans and nature. While some of the water in the parks is naturally present, such as surface and ground water, some, such as drinking water, is sourced from the Minneapolis Water Works. Depending on its source and use, water is managed differently to protect the land and life in and around it.

SURFACE WATER

Minneapolis enjoys surface water in many different forms, including lakes, creeks, ponds, and the Mississippi River. Surface water quantity and quality is affected by annual precipitation, proximity to groundwater, and, in many cases, to quality and quantity of stormwater inputs. Because this water is above ground, it is immediately susceptible to climate and pollution impacts. MPRB's Water Resources department takes a close look at factors affecting surface water and monitors how these changes impact water quality and inform necessary changes in water resources management in keeping with the City of Minneapolis Surface Water Management Plan and Stormwater Management Plan, watershed plans, and ultimately the National Pollutant Discharge Elimination System (NPDES) permit.

As impacts on water quality are often the result of inputs from park adjacent areas, it is essential that MPRB continue to work with community partners and agencies, including watershed districts, the City of Minneapolis Public Works Department, the Minnesota Pollution Control Agency, and neighboring cities, to name a few, to better address and manage the collective impacts of polluted stormwater runoff into lakes and creeks.

Park stormwater mitigation potential is limited as compared with effective regional stormwater management strategies, so while park properties are hailed as net capture properties by the City of Minneapolis, it's important to remember that ability has finite limits. Additionally, much of the park system was created from land that was originally wetland or prone to flooding and is therefore subject to stormwater management challenges due to water quantity. Park land that was once wetland experiences significant changes over time due to the variability of precipitation and natural changes in the levels of groundwater during wet and dry years. Park areas on wetlands that were modified in the past tend towards returning to their original state due to settling, drainage patterns, and soil type. In both cases, careful planning, site management, and construction practices must be mindfully incorporated to ensure sustainable land use. However, it's essential to first have an idea of where the challenges lie.

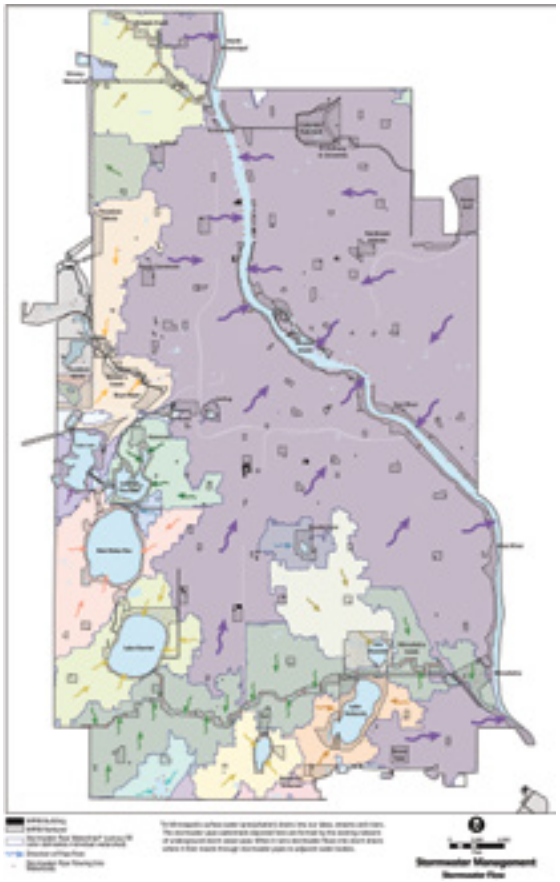


Figure 4. Stormwater flow in Minneapolis. See appendix for full size map

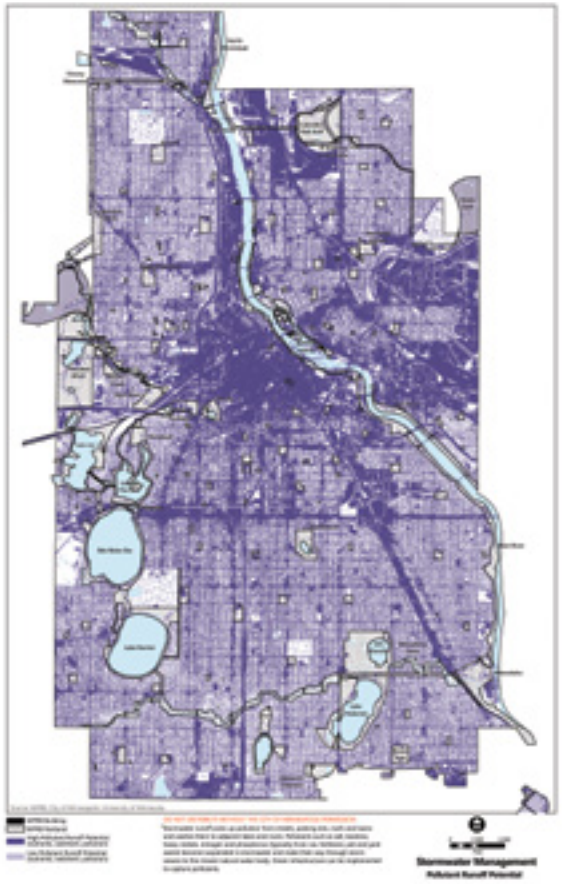


Figure 5. Pollutant loads. See appendix for full size map

Within the MPRB system, there are parks that experience localized flooding during relatively small rain events with manageable outcomes (including spring ephemeral pools, wet spots that make mowing infeasible, and slow draining areas that impede recreational programs) and there is also parkland that is located within floodplain that carries the risk of more significant flooding and potentially flood damage. Floodplain is defined in state law as land

that is adjacent to waterways like lakes and creeks that has a 1% chance of being covered by water in any given year. This land serves an important function of holding and slowing down water during flood events so that the water does not damage homes and businesses. During different levels of flooding, parkland that is in the floodplain will be impacted in various ways. For example, paths may be closed if they are covered with water. Our athletic fields may be unplayable for a period of time. The higher the chance of flooding in a particular location, the more suited the area is to passive forms of recreation. When planning parkland, its flood risk must be evaluated using the City and Watershed District's most up to date flood mapping so that sustainable use can be achieved and impacts due to flooding can be anticipated and addressed.

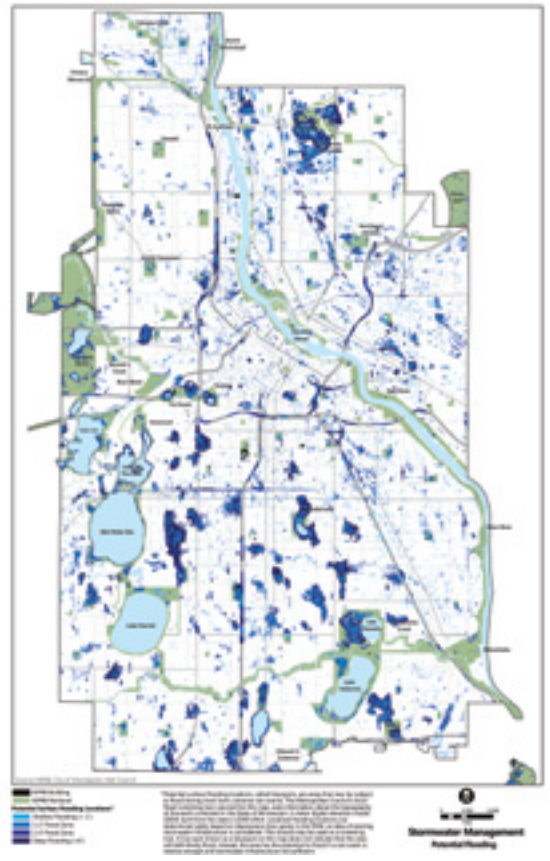


Figure 6. Potential flooding. See appendix for full size map

Note: Within park boundaries, MPRB needs to develop a policy of creating and updating management plans for surface water within the parks. This planning should include stormwater mitigation, structure inspection, and maintenance to ensure that public investments are protected. It should also define specific roles and responsibilities of different departments within MPRB, the city and watershed organizations, so that stormwater runoff is addressed and, where possible, mitigated before it reaches lakes, creeks, and wetlands. Additionally, stormwater outfalls within the parks should be closely evaluated to determine whether any pollution controls might be added to help protect surface waters from further impairment.

Figure 7. Map of locations of hand pumps and drinking fountains. See appendix for full size map

GROUND WATER

Ground water is another source of water for the parks and is piped from MPRB owned and operated wells. This water is used for irrigation, water body augmentation, and drinking water in a few locations, but in all instances, intended use corresponds with level of regulation. For instance, golf course irrigation water cannot be used as drinking water and all groundwater used for irrigation or surface water augmentation is closely tracked through compliance with DNR permits.

MPRB only uses groundwater from a well as a drinking water source in non-community systems in a few hand-pump well locations. The total amount of groundwater used for drinking is negligible and is regulated for public health purposes. The City of Minneapolis Public Health Department tests these wells per Minnesota Department of Health rules. The City of Minneapolis and MPRB partnered to do a more comprehensive study water quality in the drinking water wells recently and tested for over 100 drinking water contaminants. The positive news was that the vast majority of potential contaminants were not detected. After discussing the full set of results with the Minnesota Department of Health as well as the Minneapolis Health Department, MPRB closed several groundwater wells that either were determined to be at risk of future contamination or did not meet lead standards.

MUNICIPAL WATER

MPRB uses municipal water from the Minneapolis Water Treatment Plant (Mississippi River water that goes through the city treatment plant prior to distribution) for recreational operations, including buildings, pools, some irrigation, and drinking fountains. Because this water comes from the city through MPRB water mains, water quality testing is done at the city level and the water is tested extensively on a daily basis for hundreds of potential contaminants.

Current Conditions Relating to Water Quality

Water quality standards are defined on a spectrum involving many different measures according to the intended use of the water body. For instance, as explained in the discussion about water resource management, drinking water is often held to a different standard than water used for irrigation or recreation, because it is intended for human consumption.

Per the Clean Water Act of 1972, Minnesota is required to set its own water quality standards for all water bodies in the state. The state then assesses water bodies for potential impairments, including.

- Impairments that impact **human consumption:**
  - Mercury in fish tissue
  - Polychlorinated biphenyls (PCBs) in fish tissue, which the Environmental Protection Agency have classified as probable human carcinogens
  - Perfluorooctane sulfonate (PFOS) in fish tissue, which can cause human health effects
- Impairments that impact **aquatic life:**
  - Aquatic macroinvertebrate bioassessments
  - Chloride
  - Dissolved oxygen
  - Fishes bioassessments
- Impairments that impact **recreation:**
  - Bacteria such as e. coli
  - Excess nutrients (such as phosphorus)

These impairments stem from many different sources from local to global and range from regulatory to aesthetic. For example, mercury impairments are a global issue and regulatory changes must occur at state, federal, and global levels. The sources of many other impairments are more local, like chloride, which largely stems from use of deicing products. In the MPRB system, impairments are ongoing challenges that require strategic partnerships between local and state agencies and park stakeholders to effect change, given that the sources are often outside of MPRB control. Where MPRB has a measure of control over a pollutant source, policies can be created to lessen adverse impacts to water. In the example of chloride, MPRB closes stairways that require high levels of salt to maintain and also maintains only a single combined use (bike and pedestrian) path in winter to significantly reduce salt use.

"The process of listing impaired waters is a cycle. The State of Minnesota is required to conduct a Total Maximum Daily Load (TMDL) study for each impaired water body in order to establish goals for water quality improvement. If pollution is reduced enough so that an impaired water body meets state standards again, it can be removed from the Impaired Waters List. Over time, water bodies are removed if conditions improve and new ones are added if conditions worsen or if new standards are established for additional pollutants" (City Goal Results Minneapolis: Healthy lakes, Rivers, and Streams; City of Minneapolis and MPRB, 2016). The process of evaluation evolves over time. The Minnesota Pollution Control Agency is currently using a watershed restoration and protection strategy (WRAPS) to collect and assess data, develop strategies to protect waterbodies, and conduct restoration and protection projects within watersheds. In 2020 the assessment cycle begins for the Mississippi River (Twin Cities) subwatershed where MPRB's water resources are located and will then continue throughout the park system. This assessment is not a replacement for MPRB's annual water quality assessment program, but it will help to fill some gaps in the MPCA ten year assessment cycle.

Impaired Water Bodies in the Parks

AS OF 2018, WATER BODIES IN THE PARKS REFLECTED THE FOLLOWING IMPAIRMENTS:

BASSETT CREEK is impaired for aquatic life due to the results of a bioassessment of the fish community. It is also impaired for bacteria and chloride. Both the bacteria and chloride impairments have metro-wide TMDLs that direct practices and improvements in the watershed. Monitoring of Bassett Creek occurs through the Bassett Creek Watershed Management Commission. The creek also has a Metropolitan Council funded WOMP station (Watershed Outlet Monitoring Project) which records continuous data and has the ability to collect water samples.

BROWNIE LAKE is impaired due to mercury in fish tissue and for excess chlorides. The metro wide chloride TMDL guides improvements in chloride use in the lake's watershed; however, the unique structure of the lake makes rehabilitation extremely difficult. MPRB monitors Brownie Lake once per month every other year to assess progress and to ensure non-degradation. MN DNR assesses contaminants in the fish population.

BDE MAKA SKA (formerly Lake Calhoun) is impaired due to mercury in fish tissue and for PFOS in fish tissue. MN DNR assesses contaminants in the fish population. Enforcement action by MPCA has resulted in significant reductions in a point source of PFOS and it is not expected that a TMDL will be needed. MPRB assesses Bde Maka Ska twice per month on an annual basis to assess progress and ensure non-degradation. Because of its highly urban watershed, Bde Maka Ska is at risk of chloride impairment.

CEDAR LAKE is impaired due to mercury in fish tissue. MN DNR assesses contaminants in the fish population. MPRB assesses Cedar Lake twice monthly to ensure non-degradation.

DIAMOND LAKE is impaired for chloride. The metro wide chloride TMDL guides improvements in chloride use in the lake's watershed. MPRB assesses Diamond Lake monthly each year.

LAKE HARRIET is impaired for mercury in fish tissue and PFOS in fish tissue. Enforcement action in the Bde Maka Ska watershed should reduce PFOS in Lake Harriet. MPRB assesses Lake Harriet twice per month on an annual basis to assess progress and ensure non-degradation.

LAKE HIAWATHA is impaired for excess nutrients. MPRB assesses Lake Hiawatha twice per month on an annual basis. Data collected by MPRB was used to create a TMDL for Minnehaha Creek / Lake Hiawatha that was approved in 2014. This document guides the TMDL partners to create capital projects that will reduce both phosphorus and bacteria inputs to the lake.

LAKE NOKOMIS is impaired for mercury in fish tissue, PCB in fish tissue, and excess nutrients. Fish are assessed by the MN DNR for contaminants. MPRB collects data on Lake Nokomis twice per month on an annual basis. This data was used to create a TMDL for nutrients in this waterbody that was approved in 2011. Responsible parties in the Nokomis watershed must create capital projects that result in reduced phosphorus input to the lake.

LAKE OF THE ISLES is impaired for mercury in fish tissue and PFOS. MPRB monitors Lake of the Isles twice per month to assess progress and to ensure non-degradation. MN DNR assesses contaminants in the fish population.

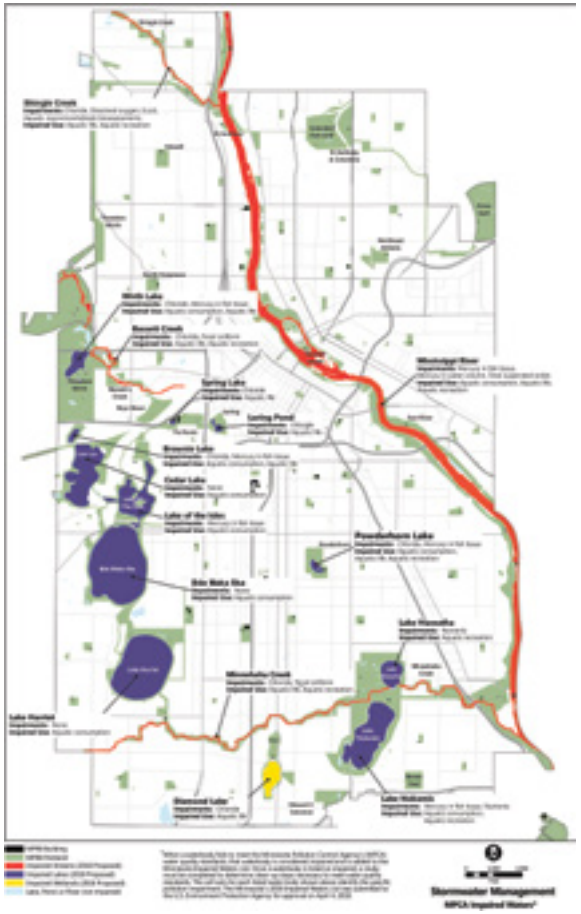


Figure 8. Map of Impaired Waters. See appendix for full size map.

LORING POND is impaired for chloride. The metro wide chloride TMDL guides improvements in chloride use in the lake's watershed. MPRB assesses this lake twice monthly on an annual basis to ensure non- degradation and assess progress.

MINNEHAHA CREEK is impaired for aquatic life due to both fish and aquatic macroinvertebrate bioassessments, chloride, bacteria, and dissolved oxygen. A permanent creek monitoring station on Minnehaha Creek is operated by the United States Geological Survey (USGS) and funded by the MCWD. MPRB and City of Minneapolis also monitor the creek periodically for project-based research. A TMDL was approved for Minnehaha Creek in 2014 for bacteria.

THE REACH OF THE MISSISSIPPI RIVER FROM UPPER SAINT ANTHONY FALLS TO THE CROW RIVER is impaired for PCB in fish tissue, bacteria, and excess nutrients. In 2014, a metrowide bacteria TMDL was approved. A TMDL study is underway for Lake Pepin that includes the watershed draining to this reach of the Mississippi. Monitoring on this stretch of the Mississippi River is undertaken by several different agencies including the MWMO, MPCA, and Met Council.

THE REACH OF THE MISSISSIPPI RIVER BETWEEN UPPER AND LOWER SAINT ANTHONY FALLS is impaired for mercury and PCB in fish tissue.

THE REACH OF THE MISSISSIPPI RIVER BETWEEN LOWER SAINT ANTHONY FALLS AND LOCK AND DAM #1 is impaired for mercury in fish tissue and for bacteria.

POWDERHORN LAKE is impaired for mercury in fish tissue and for chloride. In 2016, a metro wide chloride TMDL was approved to guide chloride use improvements in the land that drains to Powderhorn Lake. Powderhorn Lake was previously impaired for nutrients, was delisted in 2012, and relisted in 2018. This lake is monitored twice per month on an annual basis by MPRB to assess progress and non-degradation. The lake will be assessed again by MPCA in 2020.

RYAN LAKE was previously listed as impaired for excess nutrients, but was delisted in 2014 because of activities implemented under its TMDL plan. This lake is monitored via a combination of citizen monitoring and monitoring undertaken by the Shingle Creek Water Management Commission.

SHINGLE CREEK is impaired for chloride, dissolved oxygen, aquatic life (macroinvertebrates) and for bacteria. This watershed had a TMDL approved in 2007 for chloride that is now in the implementation stage. The watershed is also part of the metro wide bacteria TMDL that was approved in 2014. Shingle Creek is monitored by the Shingle Creek Water Management Commission and also has a permanent station that is operated by the USGS.

SPRING LAKE is impaired for chloride. The metro wide chloride TMDL guides improvements in chloride use in the lake's watershed; however, the unique structure of the lake makes rehabilitation extremely difficult. MPRB monitors Spring Lake monthly every other year.

SWEENEY LAKE is impaired due to mercury in fish tissue and chloride. The metro wide chloride TMDL guides improvements in chloride use in the lake's watershed. Bassett Creek WMO assesses Sweeney Lake as part of its water quality program. MN DNR assesses contaminants in fish tissue.

WIRTH LAKE is impaired for mercury in fish tissue and for chloride. MN DNR assesses contaminants in fish. In 2016, a metro wide TMDL for chloride was approved that guides chloride use improvements in land that drains to this lake. Wirth Lake was previously listed for nutrient impairment, but was delisted in 2014 due to activities carried out under the implementation plan. MPRB monitors Wirth Lake twice per month on an annual basis to ensure non degradation.

Because water body impairment is often the conclusion to a story that begins farther upstream in a watershed's drainage pattern, it is essential to also look at the bigger picture within a watershed to better understand cause and effect. The following map illustrates those watersheds that are tributary to impaired waters within Minneapolis parks. Understanding the land uses, mitigation practices, and water pollution sources within each watershed is an important part of understanding why the water in Minneapolis parks is impacted in various ways.

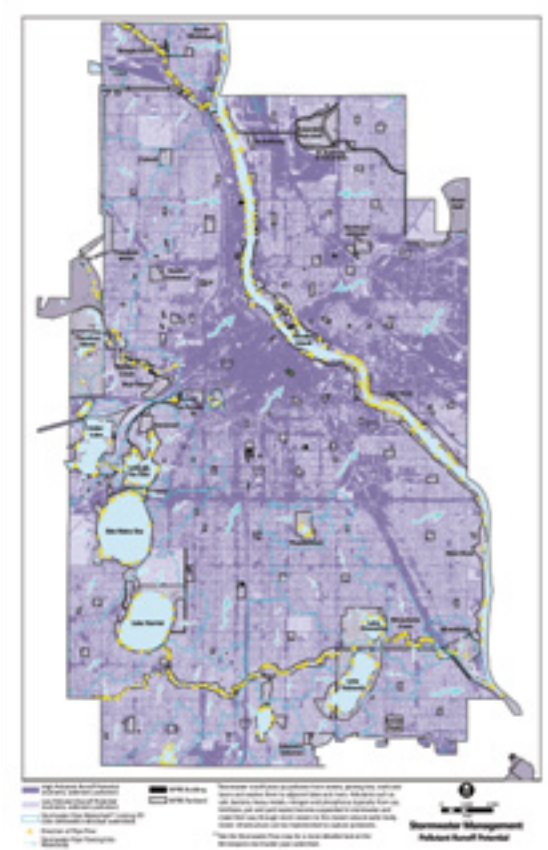


Figure 9. Map of watersheds tributary to impaired waters. See appendix for full size map.

THE OBJECTIVES OF THE MPRB LAKE MONITORING PROGRAM INCLUDE:

1. Protect public health.
2. Establish a database for tracking water quality trends.
3. Quantify and interpret both immediate and long-term changes in water quality.
4. Provide water quality information to develop realistic water quality goals.
5. Provide a basis for water quality improvement projects.
6. Evaluate the effectiveness of implemented best management practices such as ponds and grit
7. Management and early detection of Aquatic Invasive Species (AIS)

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."

Aquatic Invasive Species (AIS) are non-native plants and animals that can negatively impact lake and human health. MPRB has been monitoring for AIS since the late 1980s and completes aquatic plant surveys in lakes in the parks every two to three years. Also, since 2013, MPRB inspects watercraft at boat launches and implements an AIS prevention program. New infestations of AIS have occurred in neighboring lakes and rivers throughout the state. MPRB's program is designed to slow the spread of those species as long as possible without restricting boater access to the lakes.

CASE STUDY SNAPSHOT:
Single zebra mussel confirmed in Lake Harriet

On Friday, Sept. 8, 2017, a single zebra mussel was found by a Minneapolis Park and Recreation (MPRB) Water Quality staff member in Lake Harriet. The Minnesota Department of Natural Resources (DNR) confirmed the find and has added Lake Harriet to the Infested Waters List for zebra mussels. The listing includes the provision that Lake Harriet may be removed from the list if future surveys continue to show no zebra mussels in the lake.

The adult zebra mussel was discovered on a boat cover recovered from the bottom of Lake Harriet. Since its discovery MPRB staff has been working with the DNR, the Minnehaha Creek Watershed District (MCWD) and contractors to conduct shoreline, snorkel and diving surveys. As of 2018, no additional mussels have been found.

Being added to the DNR's Infested Waters List does not impact public use of Lake Harriet. The MPRB's Aquatic Invasive Species (AIS) inspection program, which began in 2012, will continue to inspect boats and watercraft

entering and exiting Lake Harriet, Bde Maka Ska and Lake Nokomis through the public boat launches.

According to the DNR, fewer than 250 of Minnesota's 11,842 lakes, or about 1.8 percent, are listed as infested with zebra mussels.

Whether or not a lake is listed as infested, Minnesota law requires boaters and anglers to:

- *Clean watercraft of aquatic plants and prohibited invasive species,*
- *Drain all water by removing drain plugs and keeping them out during transport, and*
- *Dispose of unwanted bait in the trash.*

Some invasive species are small and difficult to see at the access. To remove or kill them, it is recommended to take one or more of the following precautions before moving to another waterbody, especially after leaving infested waters:

- *Spray with high-pressure water.*
- *Rinse with very hot water (120 degrees F for at least two minutes or 140 degrees F for at least 10 seconds).*
- *Dry for at least five days.*

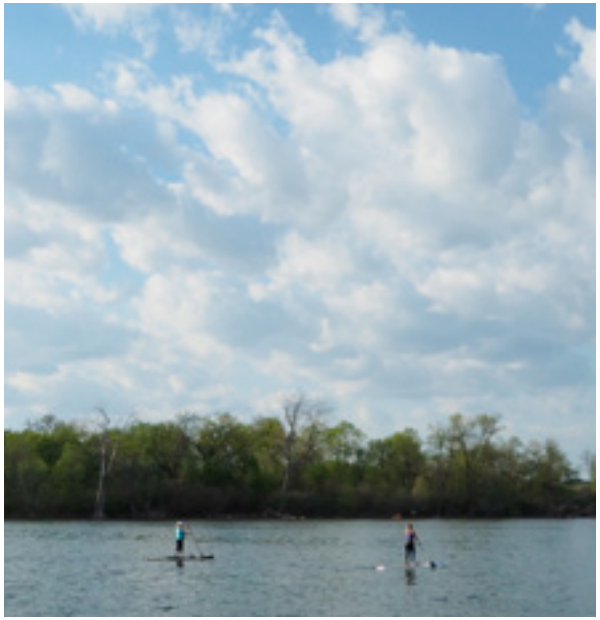
As stated earlier, aesthetics are also an important consideration in lake monitoring, as often, visual cues can be confusing and lead the public to believe water is impaired. One example in the park system where public perception of water quality is in conflict with the natural state of the water is in Loring Park, where duckweed can be seen covering the pond.

CASE STUDY SNAPSHOT: Duckweed on Loring Pond

Lee E. Frelich, Professor, University of Minnesota

The minty green covering on Loring Pond is mostly not slime (aka algae), but rather a small vascular plant known as duckweed. There are 4 genera and 12 species of duckweed listed as native to the northern U.S. One species has the smallest known flower, slightly more than 1/100th of an inch in size. Duckweed has a number of values: (1) it is a food source for waterbirds and other wildlife, (2) it reduces breeding by mosquitoes, (3) it shades the water, which keeps it cooler at mid summer, reduces the growth of algae, and provides shelter for small fish and frogs. Research is underway on the potential use of duckweed as a biofuel and as a bioremediator —- a plant that will remove nutrients and other contaminants from water if harvested.

It is normal for calm waters, such as ponds, to have a rim of duckweed during the summer; duckweed appears when temperatures are warm and sinks out of sight when the water gets cold. The very large amount of duckweed in Loring Pond results from an excessive amount of nutrients (nitrogen and phosphorous) in the water, which in turn reflects leakage of nutrients from the land that is so common in urban ecosystems. As restoration of native vegetation around the pond edge continues, it will absorb some of these nutrients before they reach the water, possibly reducing future duckweed abundance. Duckweed could also be skimmed off the pond with the positive effect of removing excess nutrients, but that would have to be balanced against duckweed's other positive impacts. For now, we should be happy that the pond has a way of responding to a broken, malfunctioning urban ecosystem, by producing that minty green layer of duckweed.



To better communicate about different conditions that affect use of public lakes, the City of Minneapolis and MPRB developed the Lake Aesthetic User and Recreation Index (LAURI). This tool, based on aesthetics rather than regulatory considerations, offers a broader view of lake water quality in the parks given a recreational user's point of view. This index incorporates the following elements:

LAKE AESTHETIC USER AND RECREATION INDEX (LAURI)

Figure 10. LAURI Index.

Updated annually, this index provides park users with a timely sense of the water they play in and around. For this index, public health is determined by the presence of Escherichia coli (E.coli) in the water, water quality is gauged by water clarity respective of lake depth, habitat quality is a measure of aquatic plant and fish diversity, recreational access is analyzed through the availability and ease of public access, and aesthetic considerations include the color and odor of the water, along with amount of garbage and debris in the water.

State water quality monitoring and LAURI tracking are extremely useful in helping MPRB to determine which water bodies are currently weaker, in terms of ecological function, and what might be done to improve them.

INDICATORS

In addition to the impairments tracked on the state level, MPRB collects data on other indicators that give it insight into how public water can best be managed and protected over time. MPRB water quality technicians complete seasonal sampling from boats at specified depths in water bodies in the parks to assess various indicators. These include:

PARAMETERS	SAMPLING FREQUENCY
Chloride, Chlorophyll-a, Conductivity, Dissolved oxygen, pH, Phytoplankton, Secchi Transparency, Temperature, Total Phosphorus, Soluble Reactive Phosphorus, Total Nitrogen, Turbidity	Once Winter Once March – April Twice per month May – September Once October – November
Silica	Once Winter Once March – April Once per month May – September Once October – November
Zooplankton	Once March – April Once per month May – September Once October – November
Alkalinity, Hardness, Sulfate, Total Kjeldahl Nitrogen, Nitrate/Nitrite	Once Winter Once March – April Once May – September Once October – November
Escherichia coli (E. coli)	Once May – September

Figure 11. MPRB lake water seasonal sampling

In addition to the chemical and physical parameters above, additional data is collected throughout the summer on the five aspects of the LAURI Index.

Pollution incidents, like spills, on MPRB property are identified, tracked, and cleaned up. A notification process through the MPCA State Duty Officer ensures that all pertinent agencies are notified when a spill occurs and that help, advice, and additional resources from outside agencies can be gathered when needed.

MPRB works with partners like the USGS and MPCA to better understand contaminants of emerging concern in MPRB waterbodies. Through the National Pollutant Discharge Elimination System (NPDES) permit in partnership with City of Minneapolis, MPRB performs stormwater monitoring in four representative watersheds in the City of Minneapolis and at structural BMP's in order to characterize the water that is reaching that park system's receiving waters.

POLLUTED STORMWATER RUNOFF

Pollutants in stormwater runoff originate from multiple different sources, including:

While this list is not exhaustive, it does illustrate how important it is for individuals, businesses, government agencies, and non-profits to consider how their activities may ultimately impact not only water, but everything else that is affected by polluted stormwater runoff.

Note: Because park users aren't necessarily aware of these pollutant sources or their cumulative impact on water bodies in the parks, it is critical to offer ongoing education and awareness events about water quality concerns.

Current MPRB Mitigation and Prevention Strategies for Degradation of Water Quality

While water is currently a plentiful resource in the park system, it is also one that is constantly under threat of degradation and in need of long term, sustainable management and protection. MPRB is aware of this need and is part of several agency and watershed district working groups, in addition to preparing its own Stormwater Pollution Prevention Plans for facilities, providing ongoing water quality awareness and education activities for the public and staff, and utilizing volunteers to help keep water bodies free of pollutants through planting projects and clean up days.

POLLUTED STORMWATER RUNOFF

Stormwater may carry polluted runoff, sand, salt, grass, leaves, and/or other natural material as it travels into waterbodies, adding nutrients and/or sediment. To address this concern, stormwater ponds, naturalized shorelines, and other "green" and gray infrastructure have been incorporated into the park system to help filter stormwater runoff before it reaches water bodies in order to help prevent algae growth and reduce TMDL. Certain structures are periodically monitored to determine efficacy of stormwater pollution prevention as well as needed maintenance to keep the infrastructure functioning properly. MPRB also manages the sweeping of parking lots, parkways, and paths within the parks and works with the City of Minneapolis to ensure street sweeping occurs on a regular basis. Additionally, MPRB trains staff to mow turf areas in a way that reduces clippings in the street and requires smart salting training to prepare for the winter season. Finally, MPRB carries out a beach bacteria monitoring program weekly during the swimming season to determine if beach closures are necessary.

STORMWATER MANAGEMENT BMPS

Physical design elements for stormwater management can be added as budget becomes available for site repair and improvement. Often, when done correctly, these elements can result in lower maintenance and environmental costs over time than traditional site design elements. The following figure depicts effective stormwater management elements as well as how they are used. The figure also includes a rough order cost, given it is a critical factor in when and where these elements may be used. "Where the City and Park Board cannot influence or control sources of water pollution, they do their best to cost-effectively manage the impacts" (*City Goal Results Minneapolis: Healthy lakes, Rivers, and Streams*; City of Minneapolis and MPRB, 2016). Examples of each of these elements exist in the MPRB System.

STORMWATER MANAGEMENT ELEMENTS	ELEMENT MANAGEMENT DESCRIPTION	INSTALLATION AND MAINTENANCE COSTS (HIGH–MEDIUM–LOW)	NOTES
Rain gardens	Intended to infiltrate first flush from small areas <1 acre.	Installation: Low to Medium Maintenance: Medium	Maintenance cost can equal construction costs every 5 years
Stormwater ponds	Permanent wet pond that removes sediment, nutrients, metals, and bacteria and may have habitat value if designed and maintained to do so.	Installation: Low to High Maintenance- Low to High	Very high life expectancy. Cost depends on land use
Bioswales	Landscaped depressions where stormwater runoff is diverted and stored. Vegetation uptakes water and runoff infiltrates into the soil below.	Installation: Medium Maintenance: Medium	Major maintenance is relatively frequent
Natural Buffers	Vegetated strips of land that treat sheet flow.	Installation: Low to Medium Maintenance: Low to Medium	Effectiveness is limited in urban settings where stormwater is piped. High habitat value
Permeable pavement	Porous pavement systems that allow stormwater to infiltrate through the surface and into the groundwater.	Installation: Medium Maintenance: Low to High	Must factor in cost of ownership of Vac truck and sweepers
Green Roofs	Vegetation placed on top of buildings and other structures, often with shallow soils and sedum-type groundcover, though some examples can include deeper planting medium, grasses, shrubs, and even trees, depending on structural capacity of the building	Installation: Medium to High Maintenance: Low	Low amount of water treated, low cost/benefit for water quality
Infiltrations basins or trenches	Infiltration systems capture a volume of runoff and infiltrate it into the ground. Pretreatment is needed to prevent blockage.	Installation: Medium to High Maintenance: Medium to High	Trenches can be difficult to maintain in urban areas
Underground storage devices, cisterns, and grit chambers	Commercially available products installed underground intended to remove solids from stormwater.	Installation: Low to High Maintenance: Low to High	Must plan for access, effectiveness is dependent on maintenance frequency
Filter devices	Commercially available products installed underground intended to treat specific pollutants in stormwater.	Installation: High Maintenance: High	High cost and level of maintenance

Figure 12. Stormwater Management BMPs.

E. COLI AND PHOSPHOROUS

Recognizing the significant impact on water quality and the potential harmful impacts on health from animal feces along shorelines and in water, MPRB conducts weekly sampling at beaches from June through August. Additionally, MPRB has developed a Canada Goose Management Plan to address its ongoing goal of limiting human and goose conflicts through an integrated management approach including habitat modification, public information, goose fencing, redistribution techniques, nesting management, trapping and removal, excrement removal and beach raking.

TRASH IN WATERBODIES

Trash often travels to water bodies by stormdrain. Because it comes from many places, it takes an ongoing effort to control. Structural controls, grit chambers, sump catch basins, and CDS units are ways to mitigate trash entering waterbodies. Most of these grey infrastructure controls are owned and managed by the City of Minneapolis. Installation of these types of structures is dictated by need and suitability of the location. MPRB staff also work with community volunteers to promote the City's adopt-a-catch-basin program to keep storm sewers clear of trash and debris. Additionally, water quality education opportunities are offered annually to the public and include information on stormwater. Finally, MPRB's trash pick up program at park buildings and sites includes recycling and composting and is connected to the City of Minneapolis trash removal service.

IMPAIRMENTS CAUSED BY CHLORIDE (SALT CONCENTRATION)

Chloride, or salt, continues to be one of the most significant causes of impairments to water bodies in the parks, and without changes in practice more waterbodies will be impaired in the future. Because salt cannot be removed from water after it pollutes it, the most important strategy to mitigate this impact is to reduce salt use throughout the parks, as well as on roads, sidewalks, and driveways near the parks. This strategy requires ongoing outreach with neighborhood residents, as well as ongoing employee "smart salting" training, to raise awareness about the significant impact salt use has on water bodies in the parks.

EMERGING CONTAMINANTS AND POLLUTION INCIDENTS (SPILLS)

MPRB works in partnership with local, state, and federal agencies to continue research and identification of issues relative to emerging contaminants. These partnerships also exist in case spills occur within the parks that require multi-agency attention. Smaller spills can be managed by MPRB crews with spill kits.

IMPAIRMENTS CAUSED BY SEDIMENT DEPOSITION AND EROSION

When erosion or sediment deposition leads to compromised access and safety, it can be extremely problematic. In addition to regular water testing, MPRB works with local partners to address contour restoration and delta removals to maintain the size and shape of surface water bodies.

Sediment in stormwater due to erosion and sand on roads reaches Minneapolis waterways through the storm sewer system. Much of this sediment does not originate from MPRB property. MPRB works with partners to address contour restoration and delta removal. Areas where stormwater is already pretreated with a device that captures sediment are prioritized. MPRB supports City ordinances and Watershed District Rules that reduce erosion and also promotes proactive street sweeping to help control impacts from erosion into the roadways.

IMPAIRMENTS CAUSED BY FLOODING

Surface water levels fluctuate according to climate, weather, and flooding events that ensue. Flooding can be seasonal, temporary, or even long term depending on the location and conditions of lake shores and creek beds. MPRB prepares for flood events by modeling flood scenarios and placing rip rap and bioengineered reinforcements on shorelines and creek banks to withstand high flows and high water levels. On a seasonal basis, pathways are temporarily closed to allow debris and sediment to be cleared and access to be restored.

Figure 13. FEMA Designated Regulatory Flood Area map. See appendix for full size map.

CONSTRUCTION AND SEASONAL CHANGES

MPRB manages winter de-watering for construction work, which involves the removal of groundwater to allow another activity to progress. Impairment is related to construction de-watering and water main breaks in proximity to lakes, as the water from de-watering travels through the storm sewer system to the lakes and erodes ice. MPRB is working with local partners and MNDNR to raise awareness about these impacts as well as construction contractors to add signage to critical areas.

GROUNDWATER PUMPING

Groundwater pumping sometimes occurs in the parks to allow recreational activity to continue in the face of rising groundwater levels that risk overtaking the land. Most recently, groundwater pumping activity has been met with controversy over whether excessive groundwater pumping should continue at Hiawatha Golf Course to allow the 18-hole golf to continue operations. It's a good example of how a water management activity that creates false conditions in a wetland area can become unsustainable and create heightened expectations of water management over time.

Case Study snapshot: Hiawatha Golf Course and Groundwater Pumping

Record rainfalls closed Hiawatha Golf Course in June 2014. In the months following the flooding, MPRB staff began the preparation of a series of concepts for the restoration and possible enhancement of Hiawatha. As concepts were about to be presented to the public, the MPRB became aware that a significant volume of groundwater was being pumped by MPRB from the golf course property into Lake Hiawatha. The final volume was determined to be 242 million gallons annually, significantly more than the MPRB's groundwater appropriations permitted volume. Once the discovery was made, work stopped on the golf course's restoration.

Since early 2016, MPRB staff has worked with the City of Minneapolis, Minnehaha Creek Watershed District, DNR and its consultant, Barr Engineering, to assess the implications, options, and parameters for pumping groundwater at the Hiawatha Golf Course property.

While the Minnesota Department of Natural Resources (MnDNR) has stated it would allow the MPRB to continue groundwater pumping at the current volume, it would do so only until the next flood occurrence, after which the property would have to reduce pumping.

An important goal of any reduced water management/ pumping scenarios has been protecting nearby homes from groundwater intrusion.

Since this discovery, the MPRB has been working diligently to address the recreational impacts and environmental concerns related to the volume of groundwater being pumped at the Hiawatha Golf Course. The MPRB held nine public meetings between January 2015 and July 2017, where MPRB and City of Minneapolis staff shared critical information and listened to community ideas and concerns. The MPRB also collected community input through an online survey. This process continues to take place.

In October 2017, the MPRB Board of Commissioners approved Resolution 2017-243, which directed MPRB staff work with the Minnesota Department of Natural Resources to obtain a Groundwater Appropriations Permit. The permit allows groundwater pumping at the current volume until a master plan for the Hiawatha Golf Course property is adopted by the MPRB Board of Commissioners and until changes to the property from the adopted master plan are implemented. It also directs staff to continue to operate Hiawatha Golf Course as an 18-hole golf course until a new master plan for the property is adopted and implementation begins that addresses issues around excessive pumping identified by the MnDNR.

While discussions continue, the MPRB continues to respond to community concerns and work collaboratively with the MnDNR, City of Minneapolis, Minnehaha Creek Watershed District and state and local officials.

AQUATIC INVASIVE SPECIES

Aquatic Invasive Species (AIS) are a great concern to the health of local water bodies. As a result, MPRB supports a robust inspection program annually at each of its boat launches as well as an early detection program. Because of the early detection program, a lone zebra mussel was found in the fall of 2017 in Lake Harriet, which added the lake to the Department of Natural Resource's Infested Waters list for the time being, but also raised awareness about the potential of zebra mussels feeding habits that starve native fish and wildlife in lakes and rivers.

AQUATIC INVASIVE SPECIES

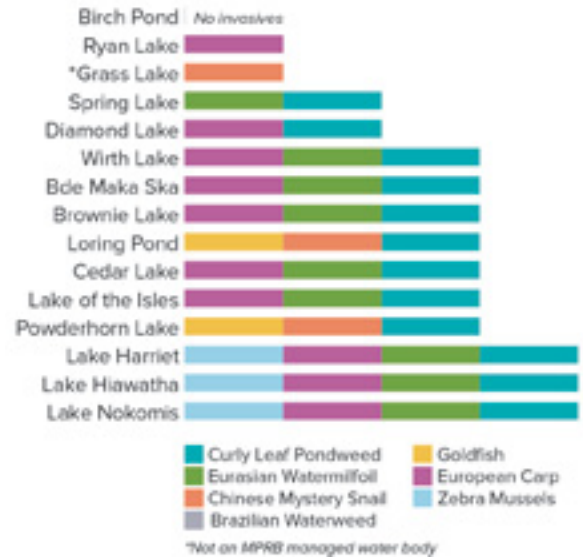


Figure 14. Aquatic invasive species.

The current mitigation strategy is to prevent new infestation for as long as possible through education efforts, boat inspections, and MPRB's prevention planning. If a new infestation occurs, MPRB uses a response plan to determine if eradication is possible or if management is needed. MPRB has a fund set aside to pay for response. To date, response planning has revolved around zebra mussel response and was tested in 2017 after the zebra mussel discovery at Lake Harriet. Responsive planning is evolving to include environmental DNA sampling (eDNA) in lake water, given the recent discovery of zebra mussels in Bde Maka Ska. In the coming years, both lakes will need more intensive monitoring to determine the extent of the infestation and if treatment or management is possible. MPRB will also evaluate Wirth Lake's susceptibility to infestation with zebra mussels due to a newly discovered infestation at Medicine Lake. Medicine Lake is connected to Bassett Creek which is separated from Wirth Lake by the Wirth Lake Outlet Structure. It is unclear if the outlet structure protects Wirth Lake from Bassett Creek in all instances.

Mitigation for Eurasian watermilfoil and curly leaf pondweed includes the use of an aquatic weed harvester in order to mow aquatic plants in areas where they conflict with recreation. For over a decade, MPRB has applied for annual permits from the MnDNR to cut aquatic plants at beaches, buoy fields, fishing docks, and selected canoe routes to improve aquatic recreation.

Note: MPRB's success story with Egeria Densa (Brazilian waterweed) in Powderhorn Lake provides strong precedent to amend IPM policy language to address aquatic weeds. In August of 2007, the aquatic invasive species Egeria densa (E. densa) was identified in Powderhorn Lake. Native to South America, this new invasive forms thick mats of vegetation and is used extensively in aquariums and water gardens. It is likely that Egeria was introduced to Powderhorn Lake through an aquarium release. Because of the risk posed to the lake, the lake itself and its connection to the Mississippi River, chemical treatment was recommended. In October of 2007, the MnDNR spot-treated stands of E. densa with Diquat, an herbicide approved for aquatic use. A total of 1.4 acres of the lake were treated in two treatment areas. One area had 28 ounces of Diquat applied and the other area had 2.54 gallons applied. Following five years of MnDNR and MPRB surveys not finding E. densa in Powderhorn, in 2014 the lake was removed from the list of waterbodies infested with this plant.

Water Goals, Strategies, and Recommendations

From playing a pivotal part in sustaining the city's ecosystem to offering unique opportunities for recreation, water nourishes, sustains, enhances, and enlivens the city and its parks. It is also a fundamental part of city, regional, and state identity as one of the most cherished natural resources. That said, water is constantly at risk because of the collective impacts that can be experienced when polluted stormwater runoff, trash, invasive species, and other substances impair it.

Recommendations come in a few broad categories, including partnerships, planning, physical design, planting, and communication.

Existing monitoring, protection, and mitigation of harmful impacts to water in the parks has been both proactive and productive, but it is critical to also have a framework for future efforts that will help move MPRB toward even stronger management and prevention. On the following pages are the primary goals to guide future planning and operations within MPRB relative to water. Following these goals are several strategies and recommendations that identify next steps for partnerships, planning, physical design and construction, planting, and public awareness that can be undertaken to help progress MPRB toward goal attainment. The paragraphs below summarize MPRB's way forward.

PARTNERSHIPS

Strong collaboration is needed to achieve each of the goals. Because water quality in the parks is dependent on conditions and dynamics outside of park boundaries, it is essential to work with partners who share in MPRB's concerns regarding regional stormwater effects and protection and preservation of public waters.

PLANNING

Future aquatic management planning should address specific areas of concern relative to protection of water quality and aquatic habitat, including: an Aquatic Invasive Species Management Plan, an Aquatic Plant Management Plan, planting and stabilization plans, and lake management plans that address aquatic vegetation and shorelines. These can be independent plans or wrapped into a larger, more comprehensive plan, based on staffing capacity and funding.

PHYSICAL DESIGN AND CONSTRUCTION

Planning to address stormwater management, fluctuating water levels, sediment, bank stability, and other factors that impact water quality informs physical design and construction in water-related projects. However, this kind of planning can be incorporated into all future projects to ensure water impacts are considered and stormwater management strategies are built into each new physical design and construction project that occurs on parkland.

PLANTING

Planting plans for trees, shrubs, and other vegetation in the parks is needed to address not only water quality concerns, but to help assure consistency with other planning efforts that are happening in the park system. Planting can also increase habitat throughout the parks. The methods of replacing like with like or freely planting where there is room to plant are easy to follow, but not the most efficient, strategic, or sustainable means of addressing ecological concerns in the parks.

COMMUNICATION AND PUBLIC AWARENESS

Environmental education efforts should continue to address water quality issues with the goal of improving public awareness of personal habits and choices that impact water in the parks, including use of salt in the winter, fertilizer on lawns and in gardens, feeding animals in the parks, pet waste and leaf removal, and proper disposal of grass clippings, to name a few.

Environmental education should also continue to address challenges in public perception of water quality including naturally occurring water-based plants that give a visual cue that there is more than just water in the lakes, creeks, and ponds within the parks. Garbage, debris, and animal feces are a much better indicator that there's something to be wary of in the water.

Based on the previously described impacts to water and goals and strategies to address those impacts, a detailed table of goals, strategies, and recommendations has been developed for future planning, operations plans, and maintenance practices at MPRB. While many of these recommendations are based on both local and regional partnerships for successful implementation, there are also those that focus on the changes that can be implemented within MPRB to improve its own water management. These recommendations are intended to provide tangible action steps to help MPRB, interagency partners, and the public better track what is being done to address water concerns in the park system and what is still left to do as work progresses.

A. WATER: IMPROVE WATER QUALITY

1. Improve management of park-generated stormwater runoff

1.1. Increase amount of stormwater infiltration, filtration, and storage, and increase disconnected hard surfaces in parks

1.2. Improve Stormwater Pollution Prevention Plans (SWPPPs) to include more comprehensive record keeping, exploration of stormwater capture and control, and surface pollutant reduction, and expand SWPPPs to all park properties, with appropriate staff training

1.3. Assess the functional and budgetary feasibility of green roofs and grey water infrastructure during all new building projects and significant retrofits

1.4. Reduce impervious surface area in parks

1.5. Protect and expand wetland and marsh areas that filter stormwater runoff

1.6. Develop a Clean Sweep Plan, which explores additional street and path sweeping technology, timing and schedule, chloride management strategies, and potential of new equipment

1.7. Improve winter maintenance plans to reduce salt use in parks, including examining which surfaces are treated, removal of excess salt around buildings, and guidance on labor practices and equipment

1.8. Set and achieve maintenance and recreation staff training goals to achieve MPCA Level II Smart Salting Certification

1.9. Expand public education regarding salt impacts on water bodies

1.10. Prioritize replacement of asphalt pavement in areas where pavement is actively eroding and drains directly into the storm sewer system

2. Contribute to management of regional stormwater in the interest of regional water quality

2.1. Continue to work with community partners and agencies, including but not limited to watershed districts, the City of Minneapolis, the Minnesota Pollution Control Agency, and neighboring cities to better address and manage the collective impacts of polluted stormwater runoff.

2.2. Implement regional stormwater facilities and BMPs in parks, in partnership with City of Minneapolis and watershed districts, only where envisioned in park master plans.

2.3. Define roles and responsibilities for MPRB, City of Minneapolis, and watershed districts for management of stormwater facilities in parks, and develop corresponding maintenance practices, budget, and repair schedule

2.4. Create, fund, and implement a stormwater BMP inspection, maintenance, and repair plan for MPRB staff, including a catalog of BMPs installed in parks

2.5. In partnership with the City of Minneapolis, evaluate stormwater outfalls within parks to determine feasibility of pollution controls

3. Reduce the amount of trash and sediment in water bodies

3.1. Complete a trash impact study that identifies estimated volumes, sources, and solutions to meet specific targets and timeframes.

3.2. Further promote the City's adopt-a-catch-basin program

3.3. Install additional maintenance control devices, such as SAFL Baffle and SAFL Snout, at key stormwater outfalls, in coordination with partners

3.4. Expand public education regarding proper waste reduction and impacts on water bodies

3.5. Work with City of Minneapolis and other agencies to remove sediment fans in water bodies

3.6. Stabilize eroding streambanks and shorelines

3.7. Create a fund to repair erosion in parks

4. Reduce water quality impacts from pets and geese

4.1. Develop a Bacteria Mitigation Strategy, which addresses beach clean-up of goose feces

4.2. Continue and expand public education about no feeding of waterfowl

4.3. Continue and expand public education about dog waste collection and environmental impacts from dog waste

4.4. Examine locations of trash cans relative to pathways and relocate, add, or remove cans where necessary

4.5. Ensure interdepartmental coordination on dog park siting, design, maintenance, and signing, to ensure impacts to water bodies are minimized

4.6. Develop a standard BMP for bacteria reduction at dog parks

4.7. Modify habitat to discourage use by geese by reducing preferred food sources, limiting preferred nesting areas, and modifying preferred sight lines and access to open water through shoreline restoration, reduction of turfgrass, and increased emergent vegetation

5. Reduce impacts of point source pollution and pollutant spills on water bodies

5.1. Expand spill kit distribution in MPRB vehicles

5.2. Expand spill response material storage to at least one location per service area

5.3. Conduct internal and external education regarding spill prevention and response

5.4. Work with City of Minneapolis and other agency and research partners to identify and address point source pollution impacting parks and water bodies and establish a coordinated plan for spills

6. Understand and respond to water quality realities

6.1. Continue water quality monitoring based on water clarity, chlorophyll-a, and phosphorous, and add other testing regimes as warranted

6.2. Conduct water quality goal-setting sessions with internal staff and external partners

6.3. Prepare lake management strategies for each MPRB-managed water body

6.4. Continue partnerships with local and state agencies to remain aware of and address emerging contaminants

B. WATER: BUILD RESILIENCY IN THE FACE OF CHANGING WATER LEVELS

7. Design, plan, and manage park facilities in light of changing water levels

7.1. Utilize projected future floodplain analysis and risks during planning efforts

7.2. Identify outfalls, walls, bridge abutments, trails, and other flood-threatened infrastructure during master planning efforts, and develop proposed solutions in light of flooding and rainfall projections

7.3. Create planting plans for trees, shrubs, and other vegetation with understanding of projected water regime

7.4. Design lakeshores and streambanks to withstand or accommodate projected future flooding and withstand a higher level of erosive energy, with a focus on bioengi-neering, naturalization, and native plants

7.5. Identify and map flood-prone recreational infrastructure, especially trails, and develop detour plans that can be implemented quickly and with clear public notification

8. Continue and strengthen partnerships to address management of citywide stormwater infrastructure

8.1. Partner with City of Minneapolis and watershed districts in the creation of park master plans, and participate in partner agency efforts, such as flood studies

8.2. Improve communication with partners and to public about water management, park impacts, and other effects of increased precipitation

9. Continue to work with partners to understand, evaluate, and help to address, as appropriate, elevated groundwater levels