Minneapolis
Park & Recreation Board

ECOLOGICAL SYSTEM PLAN

ADOPTED: SEPTEMBER 2020
UPDATED: JUNE 2024




Acknowledgments

The Ecological System Plan is the result of a co-funded project between Minneapolis Park and Recreation Board (MPRB) and the Mississippi Watershed Management Organization.

The Plan was shaped with input from MPRB, MWMO, the City of Minneapolis, as well as Minneapolis residents and visitors, and those who served on the Community Advisory Committee (CAC).

MPRB Planning staff thank all who participated in this planning effort and contributed ideas and feedback for their help.

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Community Advisory Committee (as established in 2014)

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R.T. Rybak	MPRB At-Large Commissioner John Erwin
Mark Andrew	MPRB At-Large Commissioner Meg Forney
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Sandy Colvin Roy	MPRB District 2 Commissioner Olson
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Mike Lynch	MPRB District 5 Commissioner Musich
Cristina Palmisano	MPRB District 6 Commissioner Bourn
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Jocelyn Beard	Minneapolis School Board Chair Mammen
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Michelle Stockness	Minneapolis Community Environmental Advisory Committee

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"Look forward for a century, to the time when the city has a population of a million, and think what will be their wants. They will have wealth enough to purchase all that money can buy, but all their wealth cannot purchase a lost opportunity, or restore natural features of grandeur and beauty, which would then possess priceless value, and which you can preserve for them if you will but say the word and save them from the destruction which certainly awaits them if you fail to utter it."

— H.W. Cleveland, *Suggestions for a System of Parks and Parkways for the City of Minneapolis, 1883*

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UPDATES - JUNE 2024

In implementing Strategy 50 in the plan, the plan was reviewed, and minor updates were made as needed.

CHAPTER 1

INTRODUCTION

Minneapolis Park and Recreation Board

Ecological System Plan

Introduction to the Minneapolis Park and Recreation Board

MPRB'S PARK SYSTEM DESCRIPTION

The Minneapolis Park and Recreation Board (MPRB) manages a complex and vibrant park system spanning more than 6,400 acres of land and water. This system consists of both large regional parks, which are natural resource based, and neighborhood parks, which include more man-made recreational amenities. In total, this system is composed of 160 neighborhood parks, 19 regional park and trail facilities, 49 recreation centers, 102 miles of biking and walking paths, 12 formal gardens, and 7 golf courses in the middle of a dynamic metropolitan area with one of the country's largest and most ecologically diverse river systems running through it.

MPRB'S VISION

Managing this system and balancing the often competing demands between humans and nature is an immense responsibility; thus MPRB has articulated a vision that is based on delivering:

- Vision Theme 1 Urban forests, natural areas, and waters that endure and captivate
- Vision Theme 2 Recreation that inspires personal growth, healthy lifestyles, and a sense of community
- Vision Theme 3 Dynamic parks that shape city character and meet diverse community needs
- Vision Theme 4 A safe place to play, celebrate, contemplate, and recreate

MPRB STRUCTURE

Each service delivery group within MPRB, including Planning, Environmental Stewardship, and Recreation, has a particular responsibility with regard to achieving better environmental quality in the parks.

- **Planning** works with the community to develop and implement visions for the physical assets within the parks. In doing so, this group considers the accessibility of the parks as well as achieving a balance between built and natural spaces.
- **Environmental Stewardship** manages and maintains the built and natural spaces, and provides environmental education programming, which means the majority of equipment used for the care of lands and waters is purchased by this department.
- **Recreation** oversees recreational programming in the parks, including athletics, aquatics, ice arenas, golf, youth development, and programming in recreation centers. This programming requires energy to power lights, buildings, and other facilities as well as water to service recreational needs.

MPRB PLANNING

MPRB's Strategic Planning Department produces different kinds of plans to help Minneapolis parks realize community visions. Service Area Master Plans are completed to address community priorities for neighborhood parks within the five service areas of the park system. Regional park master plans address the long term needs of the natural resource based regional parks. Activity plans take a subject matter dive into particular activities (such as skateboarding and urban agriculture) and how they can best be supported throughout the park system. Because environmental concerns are becoming increasingly more apparent throughout the system, now it is time for a new type of plan that presents a more environmentally focused lens towards managing the impacts of the city and recreational demands of its residents within park spaces: an ecological system plan.

MPRB'S Ecological System Plan

To successfully achieve the goals set forth in its vision, MPRB has recognized the need to partner with other agencies and organizations to achieve long term sustainability with its planning efforts. In partnership with the Mississippi Watershed Management Organization, MPRB has developed this Ecological System Plan to:

Figure 1. Ecological System Plan.

The first of its kind, the Ecological System Plan provides a framework for how environmental considerations can be addressed in ongoing planning efforts at MPRB as well as how and where the organization can look to partner with other local, regional, and statewide organizations to achieve shared environmental goals. As such, this plan ties in with natural areas management planning as well as park and service area master planning currently underway within MPRB, in addition to environmental planning efforts throughout the Twin Cities metropolitan area.

This plan addresses how MPRB approaches the quality, improvement, and continued protection of water, air, land and life within the Minneapolis park system by:

- Assessing existing conditions in parks
- Evaluating current site management and material selection practices
- Determining best management practices
- Identifying mitigation strategies and areas with highest mitigation potential
- Developing recommendations and policy goals for future planning/operations efforts at MPRB and with strategic partners

LENSES FOR THE ECOLOGICAL SYSTEM PLAN

In response to recurring environmental concerns frequently raised by park stakeholders, MPRB convened an Ecological System Plan Community Advisory Committee who identified the following areas of especially pressing environmental concern:

- Air quality issues
- Urban heat island effect
- Carbon sequestration
- Sustainable energy generation
- Stormwater runoff
- Biodiversity and habitat quality
- Habitat connectivity

Each of these concerns is connected in a complex web to the plan's broader themes of water, air, land, and life. These environmental impacts stem from human activities. Park operations also have an impact on the concerns identified by this plan's Community Advisory Committee. This plan strives to untangle the web and consider what can be done both on the individual park and system level to address environmental challenges that exist well beyond park boundary lines. As such, goals and strategies will be presented to address how these particular areas of concern within the park system relate back to the broader plan themes.

ECOLOGICAL SYSTEM PLAN LENSES

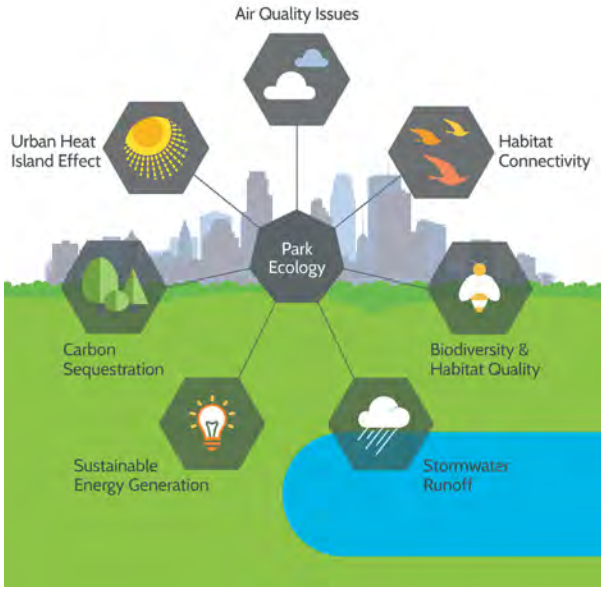


Figure 2. Ecological System Plan Lenses

ECOLOGICAL SYSTEM PLAN APPROACH

Figure 3. Ecological System Plan Approach

ECOLOGICAL SYSTEM PLAN THEMES: WATER, AIR, LAND, AND LIFE

While most MPRB plans are categorized according to their geography and management (service area, neighborhood parks, regional parks, regional trails, natural areas), this plan offers a different point of view based on ecological considerations spanning the park system. Thus, this plan has been organized according to themes that encapsulate the biodiversity, environmental sensitivity, and collaborative need for management within the parks: water, air, land, and life.

The purpose behind looking at these themes on a broad scale relates back to the MPRB vision of addressing the need to better understand dynamic and deepening environmental impacts to the park system as the city continues to grow and change around it. Water, air, land, and life are fundamentally interconnected, both in nature and in the discussion of how park spaces are managed.

GOALS, STRATEGIES, AND RECOMMENDATIONS FOR EACH THEME

The chapters that follow present environmental conditions in the parks, current mitigation measures, and finally, goals, strategies, and recommendations for each theme to help guide the work MPRB undertakes in its Planning, Environmental Stewardship, and Recreation divisions. Goals are the benchmarks MPRB can use to ask "have we achieved this?" while strategies and recommendations offer a means of progressively achieving the goals that are identified. Many of MPRB's plans are structured in this way to help advance implementation of the plan. The Ecological System Plan is no different in this respect. While it does not immediately identify exact budget numbers for implementation, it calls out the need for other plans and

operational changes, offers staffing ideas, presents possible community partnerships, and lays out more detailed recommendations based on the environmental concerns that exist, what is currently being done to address them, and what it will take both in the short and longer term to achieve the goals set forth in the plan. In order to help establish policy direction for future prioritization of projects, maps are also included to assist in current and future conditions analysis.

PLAN OUTCOMES

As global climate change continues to intensify, so do the ecological changes happening as a result. In view of these changes, the work that MPRB does through planning and implementation to protect water, air, land, and life in the parks will help to sustain park resources for generations to come. Another important outcome for MPRB's work, not only in daily operations, but in long range planning, is to adequately address the equity and environmental justice concerns that are at the forefront of the park system's conversations with all park users.

Through the Ecological System Plan, MPRB shares the methods behind its operations and maintenance practices and engages the community in a discussion about where policy, procedure, or organizational goals might be pursued differently or in partnership with other organizations and agencies in the interest of achieving better environmental results. While intended to address citywide environmental concerns, this plan has been written to reflect a strong awareness of areas within the city that have been historically disadvantaged due to unfair racial policy, environmentally compromising land use, and concentration of poverty. As a result, these areas have historically experienced inequitable investment in public amenities, elevated cases of lung and heart disease, and higher crime rates. While MPRB is not able to directly impact all of this historic cause and effect, it is important to consider what can be done on an organizational basis to act as a change agent, working for the creation of greener, healthier, and safer community spaces.

Finally, this plan serves as an invitation to the community within Minneapolis to consider how changes in personal behavior can have a significant impact in the ecological functions and environmental quality across the city, which will ultimately help to inform the quality of individual visitor experiences in the parks. The most important and impactful partnership MPRB can develop is with park users, as their visions, goals, and behaviors inform the future of the parks.

COMMUNITY ENGAGEMENT TO GUIDE PLAN OUTCOMES

Because park users help to inform park conditions, an essential component in the development of this plan has been community engagement. Each plan theme is impactful to parks in its own right, but also has the potential to be enhanced in some way by individual behavior changes. Consequently, community awareness and response to the notion of improved and increased ecological function is arguably as important as MPRB's own best management practices.

To ensure the fullest possible engagement, it was not assumed that individuals reached through this process possessed the same level of understanding regarding system ecology or the key causes and effects of environmental impacts. Therefore, the engagement process rolled out in two phases: the first focused on raising awareness that this planning effort was underway and the areas of environmental concern that had been identified by the Community Advisory Committee; the second oriented toward collecting feedback regarding environmental management strategies that could be adopted or changed within the park system. The feedback collected during this engagement process helped to drive project outcomes, clarifying which environmental topics are of the greatest concern to the community, how the community would like MPRB to address each of the topics, and where, in the parks, the community feels MPRB should deploy specific mitigation measures, environmental management strategies, and seek partnership opportunities to address critical problems whose scopes far exceed park boundaries.

PLANNING AHEAD

While the Ecological System Plan's development precedes MPRB's Comprehensive Plan update scheduled for 2020, it will set the tone both for this update as well as any service area master planning and Capital Improvement Program (CIP) projects that follow. MPRB prepares a six year Capital Improvement Program built on both park and people-based equity metrics, which is updated each year to reflect how park rankings adjust to changing community and environmental dynamics as well as annual capital expenditures.

With the goals, strategies, and recommendations articulated in this plan, MPRB will be better equipped to evaluate both its own planning process and maintenance operations with ecological considerations at top of mind. We believe that utilization of this plan will help assure a more sustainable, ecologically friendly, and environmentally aware park system for years to come.

CHAPTER 2

WATER

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.

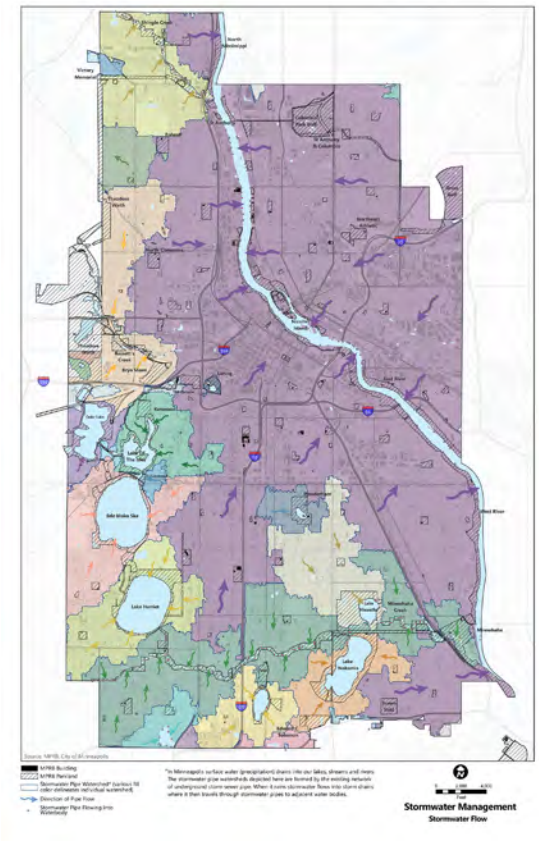


Figure 4. Stormwater flow in Minneapolis. See appendix for full size map

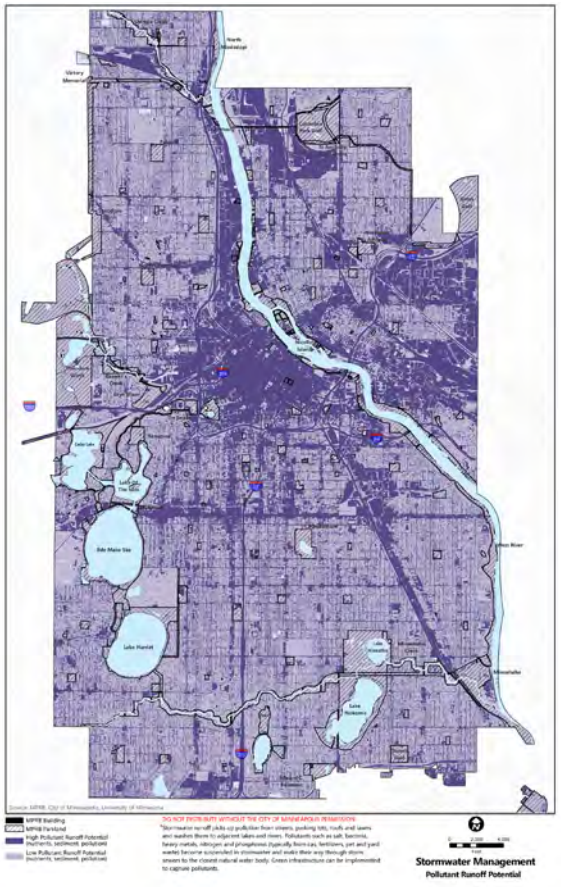


Figure 5. Pollutant loads. See appendix for full size map

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.

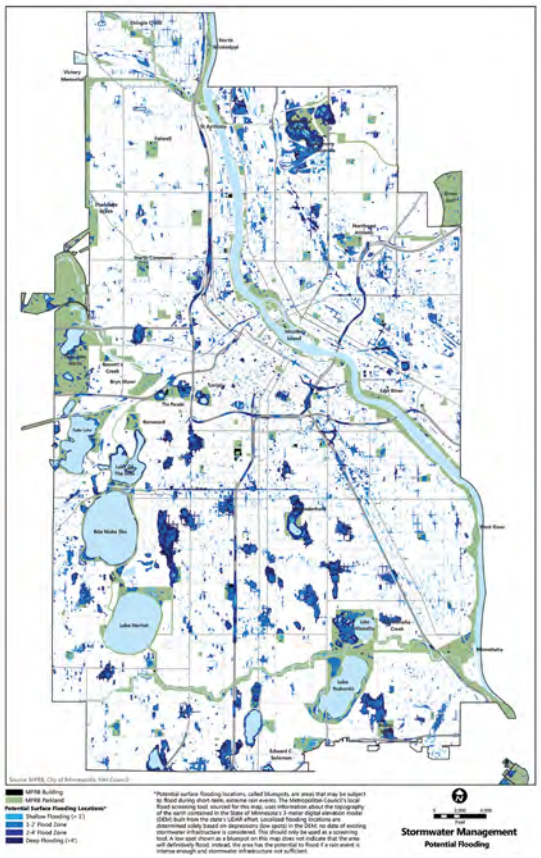


Figure 6. Potential flooding. See appendix for full size map

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.

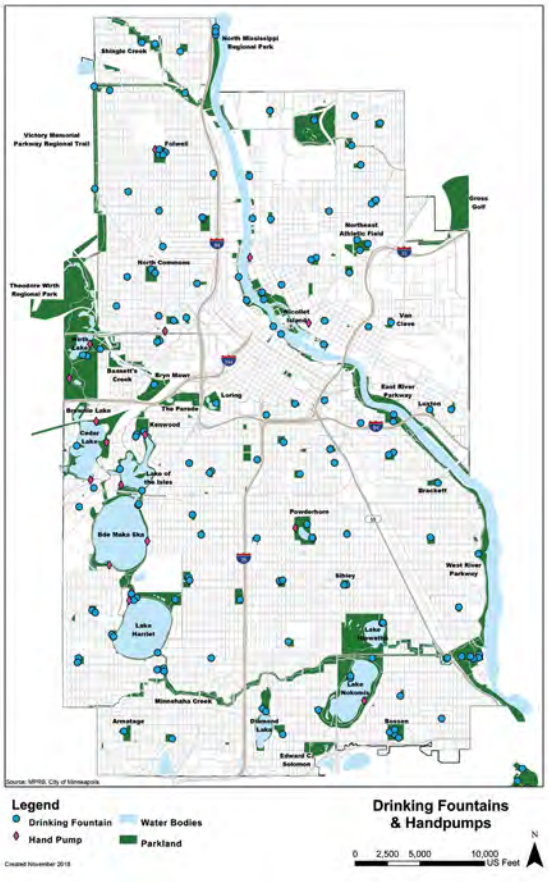


Figure 7. Map of locations of hand pumps and drinking fountains. See appendix for full size map

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.

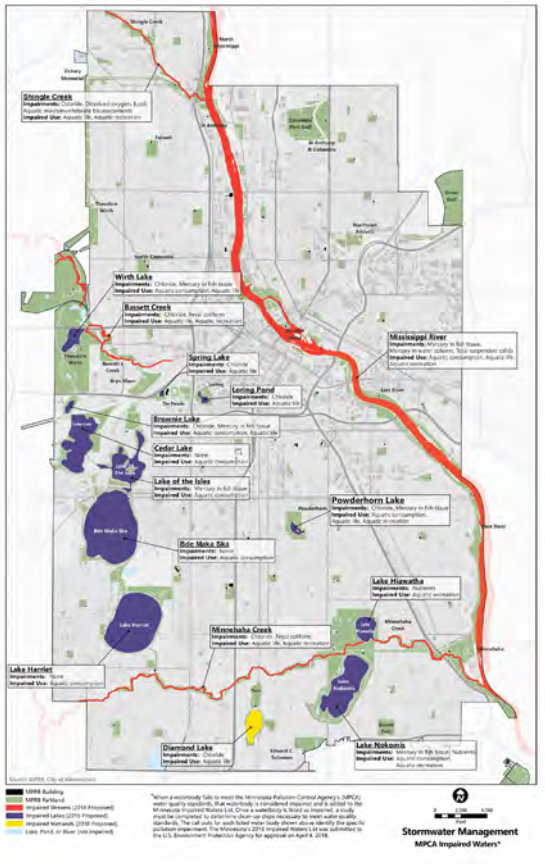


Figure 8. Map of Impaired Waters. See appendix for full size map.

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.

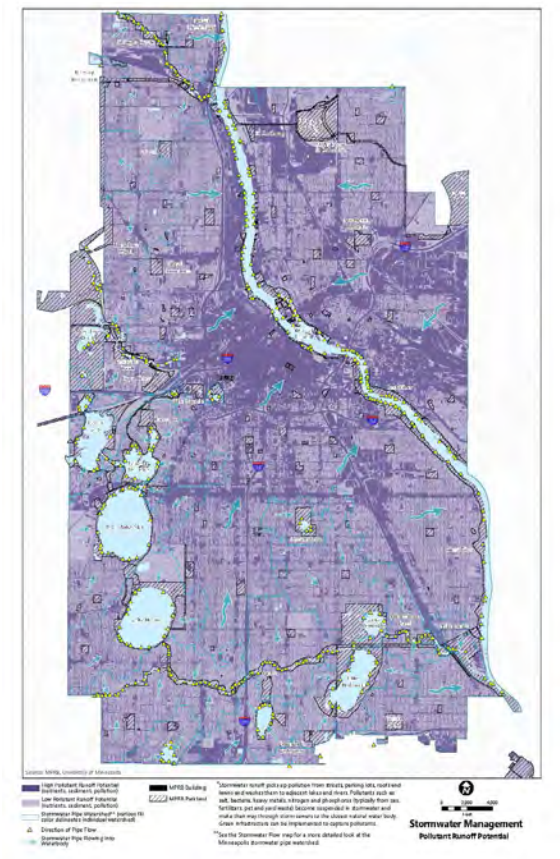


Figure 9. Map of watersheds tributary to impaired waters. See appendix for full size map.

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.*

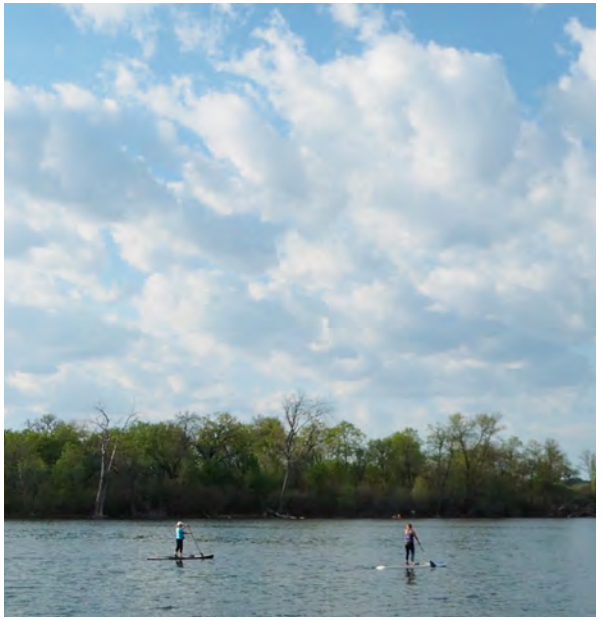
As stated earlier, aesthetics are also an important consideration in lake monitoring, as often, visual cues can be confusing and lead the public to believe water is impaired. One example in the park system where public perception of water quality is in conflict with the natural state of the water is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

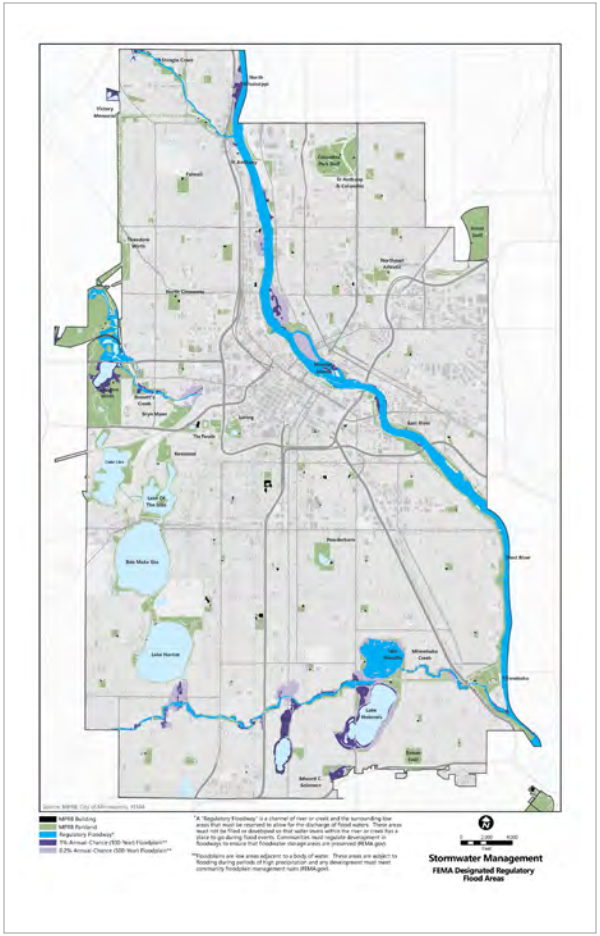


Figure 13. FEMA Designated Regulatory Flood Area map. See appendix for full size map.

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

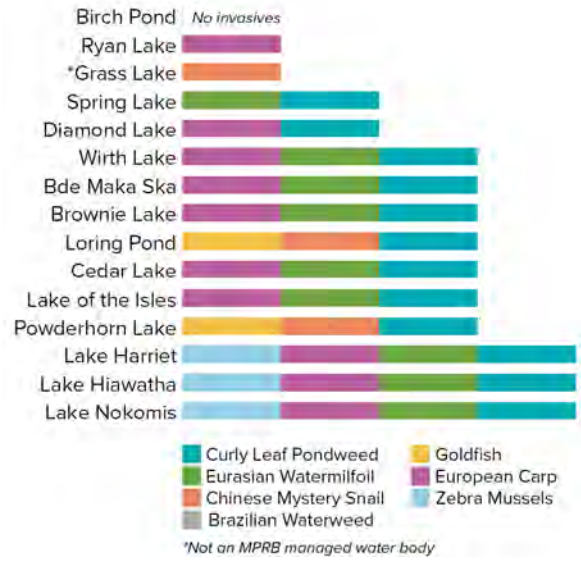


Figure 14. Aquatic invasive species.

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 best management practices for trash control at key locations 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, proper disposal, 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, increased emergent vegetation, and use of deterrents.

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 as well as properties outside service area boundaries.

5.3. Regularly conduct staff training (appropriate to work responsibilities) and public education regarding spill prevention and response

5.4. Work with City of Minneapolis and other agency and research partners to identify and address 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 and/or document 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

CHAPTER 3

AIR

AIR AND THE PARKS

"The motto of the Minneapolis Board of Park Commissioners adopted in 1883 was 'Health and Beauty.' 'Health' referred to parks providing fresh air — they would be the city's lungs. 'Beauty' signified the board's commitment to creating beautiful places in which citizens could escape from the city." (*City of Parks*, p.27)

This motto still rings true with the MPRB vision 134 years later; what can be added is how much more we've learned about the "city's lungs" in relation to the body around them. Air quality is a critical factor in how visitors experience the parks, as it impacts not only human health, but plant and animal health, and water quality, as well. Its scope is far bigger than park boundaries, having citywide and regional significance.

Poor air quality has ripple effects on water and life in the parks. As pointed out by the Minnesota Pollution Control Agency, "lakes and creeks can be harmed by air pollution that causes acid rain and fish can be affected by mercury that settles out of the air and into the water" (*The Air We Breathe*, MPCA 2017). This cycle is especially worrisome in urban areas, where air quality is poorer than in suburban and rural areas. Because of this, it is important to consider what can be done at the park level to address and mitigate pollutants in the air, especially as the Minnesota Pollution Control Agency points out that "today, most of our air pollution comes from smaller, widespread sources in our neighborhoods, [including] our vehicles, local businesses, heating and cooling, and yard and recreational equipment." (*The Air We Breathe*, MPCA 2017).

With more than 160 parks in its care, MPRB is in a unique position to work on a neighborhood park scale to implement air quality improvement strategies. This chapter assesses the types and sources of air pollution in the Minneapolis park system, the effects of this pollution, and presents strategies to mitigate these impacts with a view of how MPRB can contribute to improving air quality as well as help to mitigate climate change in the City of Minneapolis.

AIR POLLUTION IN MINNEAPOLIS

Cities are often associated with poor air quality, given the concentration of human activities that produce air pollutants. Pollutants including particulates, ozone, volatile organic compounds (VOCs), and carbon dioxide (CO2) are found in the air in Minneapolis, though the overall air quality is better than many other major cities. Minneapolis' air quality falls under Environmental Protection Agency thresholds for National Ambient Air Quality Standards (NAAQS) for all major air pollutants. This means Minneapolis is in "attainment" of the NAAQS standards. Still, it is important for MPRB to be mindful of these standards and sensitive to how they affect park spaces and park users.

The following table is a summary of information provided by the Environmental Protection Agency regarding air pollutant sources and their subsequent health effects. As the effects of bad air can be immediate and can cause serious, lasting damage to human, animal, and plant life, MPRB is committed to pursuing mitigation strategies in areas of the city that are closest to freeways and industrial uses, have the least public green space, and the most fragmented tree canopy.

POLLUTANT	SOURCE	HEALTH EFFECT
Particulates	Wood fires, construction, industrial uses, exhaust from automobiles and construction vehicles	Premature death in people with heart or lung disease, nonfatal heart attacks, irregular heartbeat, aggravated asthma, decreased lung function, increased respiratory symptoms (irritation of the airways, coughing or difficulty breathing)
Ozone	Ultraviolet light from the sun turns NOx and VOCs into ozone	Chest pain, coughing, shortness of breath, throat irritation. It may also worsen chronic respiratory diseases such as asthma as well as compromise the ability of the body to fight respiratory infections
Volatile Organic Compounds (VOCs)	Tailpipe emissions, smokestack emissions, residential heating system vapors	Eye, nose and throat irritation; headaches, loss of coordination and nausea; damage to liver, kidney and central nervous system; also one suspected cause of cancer
Carbon Dioxide (CO2)	Decomposition, respiration, burning of fossil fuels (coal, oil and natural gas)	Headaches, dizziness, restlessness, a tingling or pins or needles feeling, difficulty breathing, sweating, tiredness, increased heart rate, elevated blood pressure, coma, asphyxia, and convulsions
Nitrogen Dioxide	Burning of fossil fuels (coal, oil and natural gas)	Irritated airways, coughing, wheezing or difficulty breathing; may contribute to the development of asthma and potentially increase susceptibility to respiratory infections
Carbon Monoxide	Present whenever fuel (coal, oil, natural gas, wood, etc.) is burned	Reduced oxygen in bloodstream; concentrated amounts can lead to dizziness, confusion, unconsciousness and death
Sulfur Dioxide	Burning of fossil fuels (coal, oil and natural gas) at industrial facilities	Can harm the human respiratory system and make breathing difficult; damages foliage and decreases plant and tree growth

Figure 15. Air Pollutant Sources and Health Effects

AIR QUALITY TESTING

Air quality testing is performed by the City of Minneapolis on an ongoing basis. The most recent citywide study was completed between November 2013 and August 2013, where air samples were collected on residential, commercial, park and city properties. Approximately 900 samples were collected by 100 collection canisters throughout the city. Each canister was analyzed for 61 volatile organic compounds (VOCs) over an acceptable health benchmark set by the Minnesota Department of Health. As a result of this testing, the study found 328 locations that fell above the acceptable benchmark for the following five VOCs: benzene, formaldehyde, naphthalene, tetrachloroethylene (known as perc), and trichloroethylene (TCE).

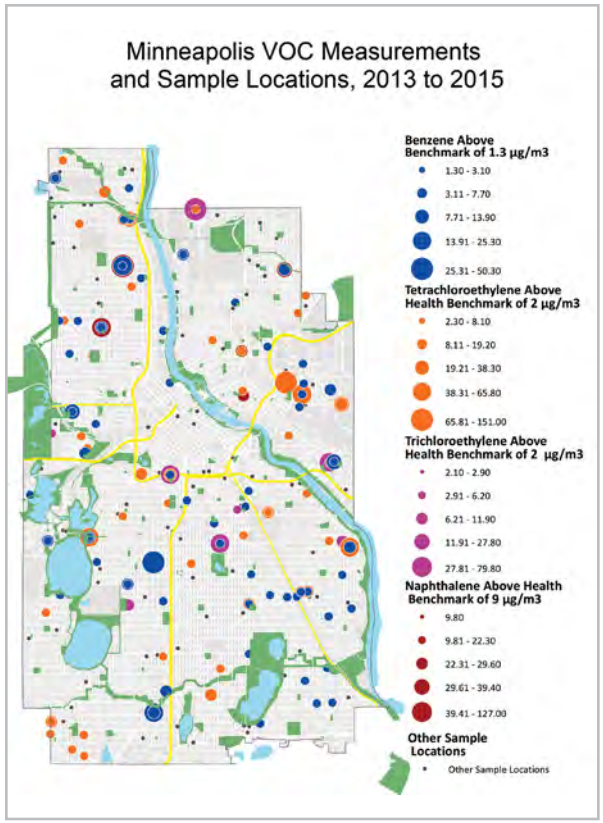


Figure 16. VOC Measurements and Sample Locations map. See appendix for full size map.

Overall, the average results of the study show that air in Minneapolis is relatively good across the entire city. Hundreds of samples came back with few or no chemicals of concern. However, there were still sample results that had chemicals over health benchmarks. “Some of these results were expected, such as benzene and formaldehyde that come from transportation sources. There were also elevated levels of chemicals like tetrachloroethylene, primarily found in dry cleaning operations, observed in samples taken across the entire city. The Health Department will continue to provide incentives through the Green Business Cost Share Program to businesses that change to cleaner practices and reduce the pollutants found in this study. To date, this approach has led to the reduction of 21.39 tons of pollution annually by working with small businesses like dry cleaners, auto body shops, and larger manufacturers” (Air Quality: A New Neighborhood Approach, City of Minneapolis, 2015).

This study, as well as others that will follow it, builds MPRB’s awareness of a key environmental factor (the presence of VOCs in the air) that impacts the quality of natural spaces in the parks, the ability of plant and animal communities to thrive, and park visitors to enjoy their visit. However, it is also important for MPRB to take an inward look at its own operations and identify and mitigate, where possible, additional sources and types of air pollution that originate in the park system.

SOURCES OF AIR POLLUTION IN THE PARKS

Daily management of the park system requires a fleet of vehicles and equipment that keep park spaces clean, green, and safe. Yet this fleet can be a source of air pollution in the parks. Park visitors also impact air quality through their chosen mode of transportation and activities they engage in while in the parks. While it may come as a surprise, the buildings found in the park system have an impact on air quality as well, given the energy source used to provide them has a direct effect on outdoor air.

FLEET

MPRB has a diverse fleet of vehicles for maintenance and Park Police to meet park care and safety requirements year round. Because vehicular use is a primary source of carbon dioxide emissions in and around the parks, it is important to consider their use in maintaining and protecting park spaces. Considering the marketplace for vehicles has extremely limited options for fuel efficient trucks and other large vehicles made to haul heavy loads (though better efficiency vehicles should be purchased to replace existing fleet vehicles when at the end of their useful life), the next best alternative is to reduce frequency of use when possible.

The opportunity for trip reduction often depends on the spatial relationship between sites where trips originate and the sites that have to be maintained in a certain timeframe. To this end, both the City of Minneapolis and MPRB have begun tracking vehicle utilization, including frequency of use, miles traveled, gas efficiency, and time spent idling, to assess fleet performance and determine whether there might be alternatives such as smaller, more efficient trucks, that can be used as larger equipment is phased out of the fleet, approximately every eight to ten years.

Where MPRB's recreational programming leads to trip generation and vehicle emissions, there is also an opportunity to think about alternative transportation types or activities that would result in lower emissions. MPRB will continue to explore hybrid, electric, and increasingly gas efficient vehicles for its fleet operations; it will also consider how to manage trips from current bases of operation to reduce miles traveled, when possible.

STREET SWEEPERS

As MPRB looks into diversifying its fleet, it would be useful to explore how incorporating different types of vehicles like street sweepers could be of benefit to water, air and land. Used to clean surface pollutants off impermeable surfaces, street sweepers can prevent further pollution of natural areas. The timing of their use is key. When street and parking lot sweeping happens right after snow melt or in advance of a big storm, it is considered a best management practice to protect water from salt and other substances on the roads. The challenge for MPRB is that because there is no vehicle currently in its fleet to achieve this work, the parks are often last in the city's scheduled service. Consequently, street sweeping often happens too late in the park system, thus missing the opportunity to protect water, air, and land from surface pollutants.

Because street sweepers are notoriously slow moving and historically inefficient regarding gas consumption, it is critical to seek out higher performing hybrid vehicles. Further, vacuum mounted street sweepers reduce the number of particulates churned into the atmosphere as the sweeper completes its work and help to maintain permeable paver surfaces much more effectively than traditional street sweepers. Thus, as MPRB explores its capacity to acquire its own street sweeping equipment, fuel efficiency and vacuum mounted equipment should be strongly considered.

GROUNDS EQUIPMENT

As with its fleet, MPRB's grounds equipment varies in size as best fits the task it has been selected to perform. Mowers, trimmers, weed whips, and blowers are all utilized to care for park. Currently, there is a need for a standardized procedure that outlines the where, when, and how often each one of these machines should be used. Thus, MPRB is in process of developing a natural areas management plan that articulates this procedure. Following its development, a comprehensive vegetation management plan should be created. Corresponding training should be offered to all park keeping staff to ensure consistency is achieved throughout the system and all vegetation is kept as best fits its growth rate and the aesthetic standard expected by the community. Additionally, this plan should address best practices for noise mitigation, given noise is another impact frequently experienced when grounds equipment is used.

VISITORS

The visits to regional parks are sampled on an annual basis in order to produce an estimate of annual visitor counts. Because visitors are counted based on their mode of access (car, bus, bike, or pedestrian) and pay-for-parking utilization is also tracked, MPRB has some baseline information on regional park user access. (This tracking is not yet done on a neighborhood level.) Despite comprehensive park access data being unavailable, access by car seems to be the leading trend in the regional parks sampled.

A 2016 Regional Parks and Trails Visitor Survey commissioned by the Metropolitan Council showed that over half of MPRB park visitors accessed regional parks and trails by car, where only 2% accessed them via transit. Completing a comprehensive park access study would enable MPRB to tell a story not only about the environmental implications of access, but also the equity implications. Those parks that are easier or more desirable to reach by

car than by any other mode present an air quality problem as well as an equity barrier to potential visitors who do not have a car. Encouraging modal shift away from the personal automobile to bike, pedestrian, and transit-based access would help to ensure continual air quality improvement within the parks and would also build a case for improved and increased regional trail infrastructure, transit service near the parks, and local infrastructure improvements (roads, sidewalks, trails, pathways, and so on) that connect neighborhoods with park access points. Achieving this shift would require increased coordination between MPRB, the City of Minneapolis Public Works, and Metro Transit, to comprehensively address park access and interjurisdictional responsibility for the infrastructure and level of service that park users need.

FIRES

It is difficult to say whether fires are a significant or consistent cause of air pollution in the park system, as they are only allowed for culinary purposes and therefore not consistently tracked. However, wood fires are a source of increased air pollution including particulates, benzene, formaldehyde, acrolein, and polycyclic aromatic hydrocarbons (PAHs), while charcoal fires produce carbon monoxide. Many park visitors are concerned about the known corresponding health implications of all of these air pollutants. The Environmental Protection Agency states, “Short-term exposures to particle pollution from wood smoke have been linked to a variety of health effects. Short-term exposures to particles (hours or days) can aggravate lung disease, causing asthma attacks and acute bronchitis, and may also increase susceptibility to respiratory infections.”

While MPRB has an ordinance prohibiting fires within park spaces except for culinary purposes (PB2-20) as well as a policy prohibiting smoking in the parks and on parkways, it issues occasional permits for fires to be held at special events. There is currently no restriction on how culinary fires are built (with wood chips versus charcoal, though there is a restriction, per a City of Minneapolis rule that any wood used for recreational fires must be untreated by paint or chemicals) or on how many permits

are issued annually for special event fires. MPRB is willing to explore the air and health impacts of different fuel sources as well as track the number of annual permits it issues to determine whether further restrictions should be put into place.

BUILDINGS — ENERGY SOURCE AND AIR QUALITY

While park buildings are not inherently air polluters, the energy required to power the buildings can be a source of air pollution depending on the type of energy required. Buildings powered by solar energy or geothermal rather than gas and electric sources burn less fossil fuel, which translates to less air pollution and better air quality in the park system. Thus, MPRB is exploring site suitability within the park system to understand which locations are best suited to solar and geothermal energy systems. This will help to direct future capital improvement projects, including the updating and potential retrofitting of facilities to include to include alternate energy sources. This goal will allow MPRB to be consistent with the City of Minneapolis pledge to achieve 100 percent renewable electricity for municipal facilities and operations by 2022 and citywide by 2030. To date, MPRB has placed eight photovoltaic solar power installations within the park system.

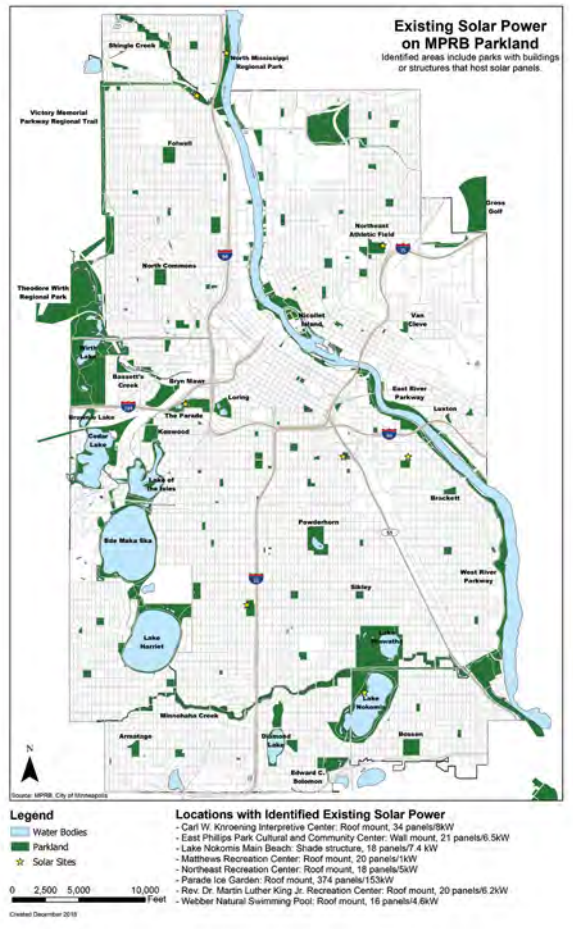


Figure 17. Map of solar power locations. See appendix for full size map.

Ongoing Mitigations for Air Quality Impacts

MPRB has a number of mitigation strategies already underway to help reduce air quality impacts that result from park operations. For instance:

VEHICLE EMISSIONS

Because vehicle emissions are the leading cause of particulates, CO2, VOCs, and CO in the City of Minneapolis, MPRB is working to identify Green Fleet Goals that are consistent with the City of Minneapolis' program that offers a discounted transit pass for staff.

PRESCRIBED PRAIRIE BURNS

MPRB prohibits burning during high MPCA air quality alert days and provides public notification of planned burns, such that hospitals, schools, care facilities, and air-sensitive populations may be better aware of and prepared for these events.

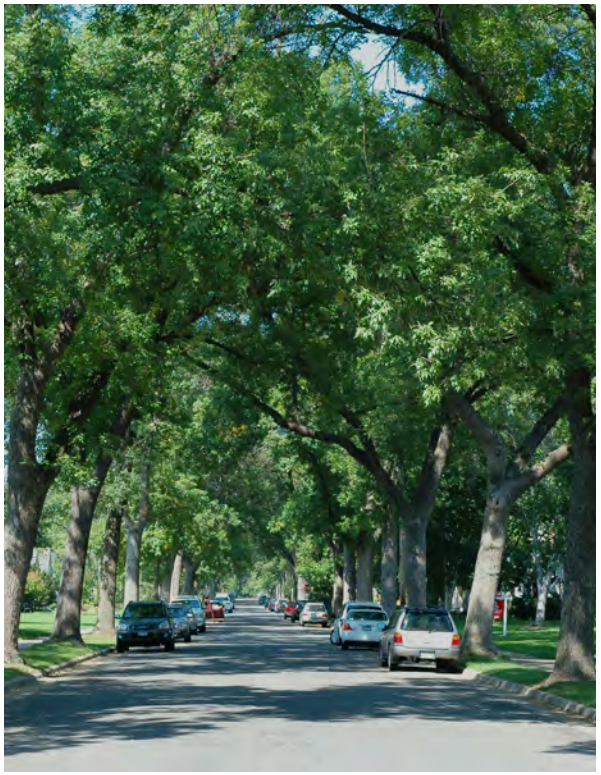
NATURAL RESOURCE/ENERGY CONSUMPTION

MPRB recognizes that natural resource consumption is an ongoing challenge at its buildings and has started to evaluate building energy consumption and cost, as well as age and efficiency of HVAC systems. In the interest of reducing its natural resource consumption, MPRB has completed a study of solar suitability at over fifty sites and has increased the use of solar energy at six parks, to help reduce the reliance on fossil fuels to power buildings, and provide solar energy education opportunities.

URBAN HEAT ISLAND EFFECT AND TREE CANOPY FRAGMENTATION

Urban heat island effect hits plant life in the parks especially hard. Since it is difficult for plant life to adapt to heat, even a few degrees can make a difference in their survival. As such, prairie restoration and tree canopy preservation projects are in effect throughout the park system to help improve the park system's ability to combat these impairments. Additionally, pervious paver projects have been piloted to determine efficacy and ease of maintenance of these materials as an alternate to impervious parking spaces, which tend to retain heat longer than pervious pavers.

With the help of a tree preservation specialist on staff, tree planting plans with a 10% genera limit have been developed to encourage species diversity and to help maintain the largest possible trees in available growing space. MPRB is also expanding public education to address protecting tree canopy throughout the city beyond park boundaries, which includes a particular emphasis on the need to water trees that line streets and boulevards in front of owned and rental housing.



Future Mitigations

MPRB is in the process of setting up a new asset management software that will enable more thorough tracking and benchmarking to take place and to get a sense of potential future air quality mitigation strategies. In the meantime, MPRB can learn about opportunities for future mitigation based on mapping of the parks current conditions (see Fig. 20 and Fig. 21).

CARBON SEQUESTRATION: PROTECT AND ENHANCE AREAS

Currently, MPRB has data reflecting tree canopy, urban heat island, air quality testing results, land cover types, and impervious surfaces. This data provides a picture of mitigation opportunities within the parks, but solutions are complex. It is not enough to say that all those areas without tree canopy should simply be filled with more trees or areas covered by impervious surfaces should be reduced. Rather, these opportunities should be examined in relation to other land covers to understand where best management practices might be put into place to affect the most change, while still maintaining the community's vision for their parks. By identifying which areas within the park system are best suited to protection, enhancement, and restoration based on existing land covers, mow frequency, and the potential need for soil improvement, MPRB will be better equipped to consider future projects. This information should be used in collaboration with other considerations within this plan related to water, habitat, and general park use to determine the best possible locations.

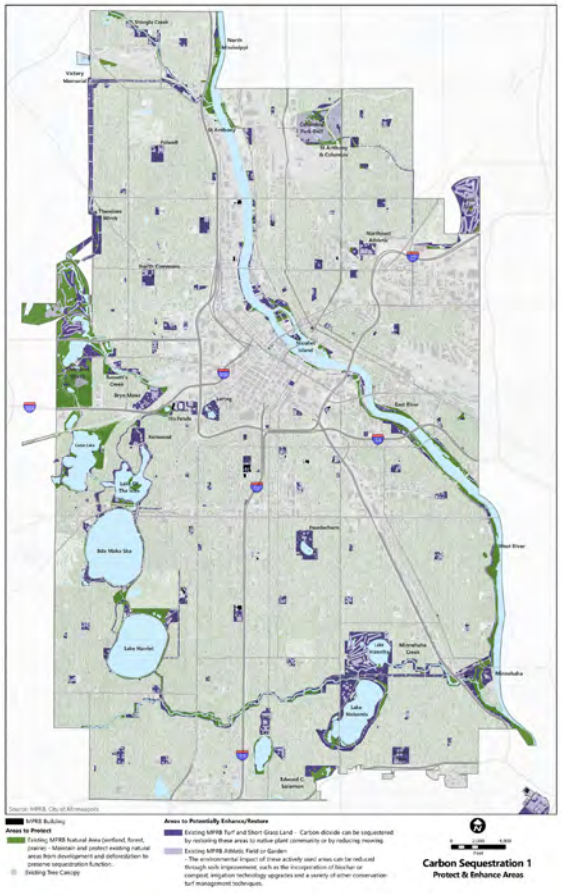


Figure 18. Carbon Sequestration Protect and Enhance Areas map. See appendix for full size map.

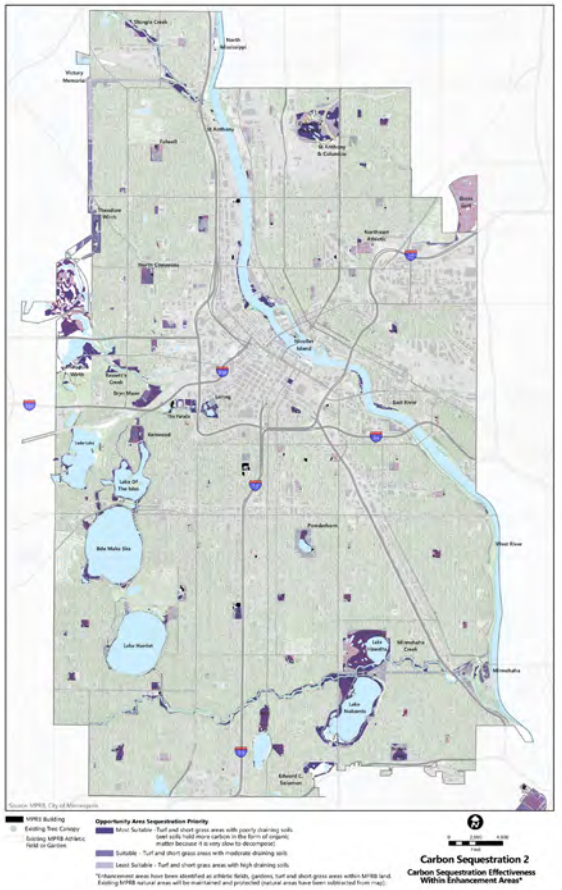


Figure 19. Carbon Sequestration Effectiveness within Enhancement Areas map. See appendix for full size map.

INCREASED ENERGY EFFICIENCY

While solar and geothermal systems are currently very expensive and typically offset a limited portion of a recreation building's total energy requirement, their use is a start at increased energy efficiency. As these systems continue to evolve and grow in offset capacity, knowing the conditions on park land that are most suited to solar and geothermal systems will help MPRB revisit the question about how and where to incorporate them in the future.

Figure 20. MPRB Buildings with Good Solar Potential. See appendix for full size map.

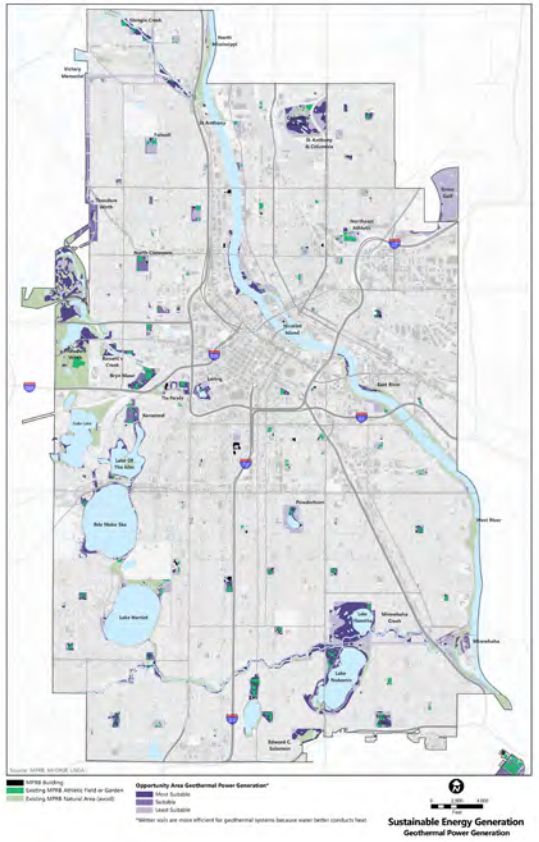


Figure 21. Sustainable Energy—Geothermal Opportunity Area map. See appendix for full size map.

Air Goals, Strategies, and Recommendations

It's important to look at both short term and long term mitigation measures for air quality concerns, as air quality is not only an environmental issue, but also an equity issue. MPCA's 2017 report, "The Air We Breathe," states "Many studies in Minnesota and around the world are trying to better understand the relationships between pollution, social conditions, and health outcomes. Some (...) indicate people of lower socio-economic status and people of color are more vulnerable to adverse health effects from exposure to air pollution. Other studies, including work by the MPCA and University of Minnesota, indicate people of color and lower-income communities are also exposed to higher levels of air pollution than those in predominantly white and higher-income areas. Historically, there have been more pollution sources, including busy roadways, located in lower-income neighborhoods and communities of color. Residents of these same neighborhoods also tend to have less access to clean and safe parks for recreation, healthy food, regular health care, and other conditions that support a healthy life."

Recommendations come in a few broad categories, including policy, procedure, partnerships, park access, and goal setting

With these findings in mind, MPRB will continue to seek out opportunities to incorporate green and natural spaces throughout Minneapolis and incorporate equity questions throughout its planning, design, and engagement processes. With current and future data in hand, MPRB will be prepared to share air quality findings with the community and work together to prioritize projects that will help achieve mitigation strategies and goals.

Existing mitigation efforts are a strong start to address air quality concerns within the City of Minneapolis, but MPRB recognizes a need to identify goals and strategies that will incorporate other best management practices beyond existing mitigation measures. The above table includes goals and strategies that will help MPRB contribute to the improvement of air quality and urban heat island in the City of Minneapolis.

As shown above, there are several impactful strategies MPRB can pursue to help meet goals related to improved air quality and climate change mitigation.

POLICY

Policy is an important vehicle for changes in air quality. For instance, the City of Minneapolis has taken a proactive step in the introduction of an ***anti-idling ordinance*** that "restricts idling of cars and other gas or diesel powered vehicles to no more than three minutes in a one hour period". While there are exceptions to this rule, based on need to idle (such as extreme weather), its intent is focused on reducing emissions, as "in general, 10 seconds of idling uses more fuel than restarting a car."

While developing policy is typically a lengthy, detailed process, it is important for MPRB to explore what it can do on the policy level to ensure consistency across the organization in meeting ecologically driven planning and operational goals. Future goals might include:

- Development of a green building policy with LEED goals for all new buildings and building retrofits
- Development of a green bidding policy that requires all contractors bidding on construction projects to present alternatives with sustainable and/or recyclable materials
- Development of a materials disposal policy that centers on reduction of waste and recycling or reuse of materials where possible
- Development of a planting policy that guides the type and concentration of plant species that may be utilized in neighborhood and regional parks

- Development of a purchasing policy that requires all equipment purchases to include the exploration of more fuel and energy efficient equipment

PROCEDURE

As policy changes correspond to subsequent changes in procedure, procedures pertaining to land management, purchasing, and construction are important to explore. Where appropriate, shifting turf landscape to natural space will have a significant impact on air quality, through eliminating mower emissions. Similarly, purchasing vehicles and equipment that meet reliability expectations while being more environmentally friendly, is a strategy MPRB intends to pursue. However, even when done, this strategy needs to be coupled with potential expansion and/or relocation of MPRB asset management and forestry facilities to result in fewer, more efficient trips. Currently, the travel between facilities and project sites within the parks often results in multiple, lengthy trips. While better fuel performance would be a positive step forward, it is also important to consider the trips that are required to complete the work. Additionally, reviewing and, if needed, changing construction specifications and requirements to be more eco-friendly, offering pre-bid contractor discussions to raise awareness about environmental performance expectations, and providing spot inspections of park-based construction projects to ensure consistency with specifications are all important changes in the planning and implementation process for current and future MPRB projects.

Another procedural strategy to improve air quality includes protecting and, where possible, increasing the number of natural elements that act as carbon sinks (places where more carbon is absorbed than carbon dioxide is produced) through planting.

- **TREES** are known for their carbon sequestering abilities, but even with 600,000 trees under its care, MPRB doesn't have nearly the number of trees that are found in private backyards throughout the city. Thus, raising awareness that maintaining healthy trees and a connected tree canopy translates to better air is an important step in preserving and improving on both the canopy found in the parks and in the surrounding neighborhoods. The key is maintenance. While MPRB will continue to prune, plant, water, remove, and replace trees where it can, residents in Minneapolis can help this effort by watering street trees in front of their homes, whether rented or owned.
- **PRAIRIES** are also known to act as carbon sinks and are faster to grow than tree stands. Additionally, prairies require less water and maintenance, act as natural erosion controls, and promote biodiversity among both plants and animals. Where natural areas are preferred to mowed turf, restored prairies are a great fit and can be installed on varying scales stemming from small pollinator patches to fields.
- **BIOCHAR**, a charcoal made from plant matter, can be planted into the ground as one very cost-effective method of sequestering carbon. Because of its ability to simultaneously hold carbon and boost soil nutrients, biochar should be explored for its potential to help the parks, especially where vegetation is most limited. Placing biochar under or around athletic fields, in gardens, and under bare dirt presents a strong opportunity to sequester carbon where trees or prairies are not present.

STRATEGIC PARTNERSHIPS

Strategic partnerships also offer the opportunity to address air quality issues that span citywide. Working with other local agencies and organizations to increase transit offerings to parks, improve and expand bike and pedestrian connections between park spaces, create green spaces and gardens in areas currently without these amenities, are all strategies consistent with MPRB seeking to fulfill its role as the "greening agency" of the city.

While air quality is not tracked on the park level, MPRB is committed to partnering with the City of Minneapolis and the Minnesota Pollution Control Agency to further their air quality testing and to better understand what mitigation efforts might be successfully deployed on the park level.

Because MPRB works with the City of Minneapolis to procure vehicles for its fleet, it is important to also work on its consistency with the city's Green Fleets Policy, which "sets guidelines to minimize greenhouse-gas (GHG) emissions of current and future fleet vehicles."

One of the strongest opportunities to do this, according to City staff, is to begin looking at transitioning the fleet to electric vehicles and expanding the availability of charging stations in the park system.

Recognizing that cars and trucks are the single largest source of air pollution in Minneapolis, MPRB will also promote alternate means of accessing and enjoying the parks. As stated in "Life and breath," a 2015 report published by the Minnesota Department of Health, in partnership with the Minnesota Pollution Control Agency, "actions such as driving less, walking and biking more, and minimizing recreational fires help reduce air pollution in Minnesota communities." As such, MPRB will continue its work with Metro Transit to determine how existing levels of service translate to park accessibility and what impact proposed routes might have on park access.

PARK ACCESS

MPRB conducts annual summer counts of regional park visits to get an estimate of visits within the regional park system. However, it does not yet have a holistic sense of how the majority of neighborhood park visitors access parks or whether the availability of transit options is an attraction (in the case of readily available options) or deterrent (in the case of limited options) to park visits. This is an important piece of the access puzzle that MPRB will need to continue researching in partnership with local transit authorities, but in the meantime, the leading observation about park access is that individual cars are the primary sources of transportation to regional parks. Park access by car will likely be a trend for some time to come, yet MPRB can certainly advocate for transit offerings that promote better park access (more frequent headways on weekends, transit stops near accessible entry points, regional transit service to parks) as well as continuing to plan for bicycle and pedestrian connections between parks, neighborhoods, regional trails, and transit services in coordination with local and regional agencies.

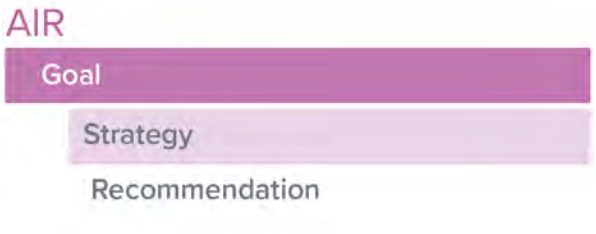
GOAL SETTING

Finally, goal setting will allow MPRB to track its operations against measurable outcomes and determine what progress is being made toward better air quality in the parks. For instance, these goals can address such things as:

- Equipment purchasing changes
- Mow frequency, height, and gas use
- Utilization of electric vehicle charging stations (MPRB already has three electric fleet vehicles and charging stations at four locations within the park system, but there is the opportunity to do much more)
- Vegetation management plan to address all park vegetation
- Use of iTree data to better understand carbon sequestration impact in parks and to help inform planting plans

As MPRB seeks to meet goals related to policy, procedure, strategic partnerships, park access, and tracking, it will be in the position to better identify opportunities for strategic shifts in planning and operations.

MPRB will also now be tasked with assessing air quality impacts from proposed maintenance, rehabilitation, restoration, planning, design and construction work in each of its future projects, per the recommendations outlined in the table below. These recommendations have been developed to chart next steps for MPRB as it works toward environmental goals shared earlier in this chapter, with the awareness of particular air impacts that are of concern within the park system and strategies and best management practices that are already in effect in park planning, operations, and maintenance.



C. AIR: CONTRIBUTE TO IMPROVING LOCAL AIR QUALITY AND REDUCING URBAN HEAT ISLAND

10. Reduce urban heat island effect and address heat equity issues

10.1. Focus tree planting in areas identified as having high heat island or low air quality

10.2. Partner in regional heat island and air quality monitoring and studies

11. Reduce vehicle and equipment emissions

11.1. Examine fleet-wide emissions and estimate emissions generated by park employees, then set reduction goals

11.2. Consider, document and communicate options for hybrid and electric vehicles for all vehicle purchases

11.3. Develop small equipment inventory that includes emissions information, then work to transition small equipment fleet to alternative options, such as electric or four-stroke

11.4. Adopt Green Fleet procedures similar to City of Minneapolis fleet procedures, including flex fuel protocols and idling standards

11.5. Complete service centers master plan with consideration of siting to achieve more efficient travel management

11.6. Develop transportation management plan and procedures for field staff that considers and optimizes travel time to and between parks and service centers, in order to reduce overall vehicle miles and emissions

11.7. Track vehicle use to determine if smaller, more efficient trucks can be used as large equipment is phased out of the fleet

12. Reduce air pollution from park supplies, materials, activities, and events

12.1. Use low-VOC or no-VOC materials (paints, glues, cleaning supplies, etc.) in buildings and in maintenance activities wherever possible

12.2. Ensure maintenance of landscapes with fire does not coincide with air quality alert days

12.3. Work with partners to monitor air quality at wood processing facility and adopt a plan to reduce emissions

D. AIR: CONTRIBUTE TO CLIMATE CHANGE MITIGATION

13. Reduce the agency-wide carbon footprint

13.1. Complete a carbon footprint analysis, including identification of areas of improvement and reduction strategies

13.2. Establish carbon footprint reduction targets and tasks and report at least annually on progress

13.3. Explore alternative energy purchasing programs, to increase percentage of MPRB energy that is generated sustainably

14. Advocate for and support carbon footprint reduction for park employees and visitors

14.1. Promote transportation mode changes for MPRB staff and park visitors, including remote work options, shared EV pool vehicles, bicycles, scooters, and transit

14.2. Improve information technology to allow for more effective remote meetings

14.3. Work with MetroTransit to evaluate and improve transit access to parks

14.4. Improve park access points for multi-modal users, including ensuring curb ramps are properly placed and designed

15. Increase building efficiency

15.1. Complete agency-wide energy audit and identify areas of improvement

15.2. Design efficiency into buildings at time of construction or major improvements

15.3. Perform energy efficiency improvements as part of general building and grounds maintenance, including door and window sealing, HVAC improvements, lighting improvements, enhanced insulation, and others

16. Explore alternative energy generation opportunities in parks

16.1. Explore geothermal and solar generation in areas determined suitable for those energy sources, when improving or constructing buildings or other site improvements

16.2. Seek grants for additional solar and/or geothermal installations

17. Sequester carbon in the park system and urban forest

17.1. Study the ability and potential of parkland and urban forest to sequester carbon, and identify areas of improvement through landscape change (in partnership with natural areas management), and other practices

17.2. Increase sequestration through management practices, including forest restoration and augmentation, restoration of grasslands and wetlands, and reduction of turf grass

17.3. Explore use of biochar under athletic fields and in soil modification projects

CHAPTER 4

LAND

Parkland Management

Ongoing Management of Impacts Related to Land

Future Mitigations

Land Goals, Strategies, and Recommendations

Parkland Management

As the Minneapolis park system has grown and changed over time, land management techniques have adapted to new technologies, community priorities, environmental concerns, and budget parameters. Because neighborhood parks tend to be smaller in size, focusing on active recreational spaces and higher maintenance turf, their care is different from the larger, more natural resource focused regional parks, where native plant communities tend to thrive, tree canopy is most complete, and water bodies are most prevalent, creating higher quality habitat for insects, birds, fish, and other animals. Thus, land management strategies for neighborhood parks tend to be focused more on maintenance and repair while those in regional parks tend to center on restoration, protection, and preservation. These strategies are tailored to the land cover, topography, ecology, as well as the recreational programs present and are mindful of long term sustainability. Additionally, these strategies are based on land management techniques and less on mitigation, as many are a reflection of daily operations already employed to manage park spaces.

This chapter assesses the varied land covers within the MPRB system, as well as corresponding operational, maintenance, and planning practices that address their care. It then identifies goals and strategies by which MPRB can be even more successful in ensuring long term sustainability of the city's treasured green spaces and makes detailed recommendations about where and how to begin this work.

LEARNING FROM THE PAST

A true visionary of his time, Horace W. S. Cleveland saw the potential in Minneapolis to create a park system that would serve the needs of generations to come. Land acquisition was a key strategy for building a park system to serve residents throughout the city. Land management evolved over time, as it became clear that human interaction with natural spaces necessitated more active management and that nature, left to its own devices, could overgrow, fall victim to invasive species, and find itself unable to sustain recreational visitor demands. As the landscape itself has changed over time — tree species and plant communities are vastly different from what they were at the birth of the park system, as is the city itself, with a dramatic increase in buildings, roadways, and other impervious surfaces—land management has had to change with it and often in partnership with other agencies, given varying regulatory authority on the land and water. Still, there is much to be learned from the stories, photos, and records of park caretaking of the past. These provide important insight into what was originally in these park spaces, what was done to care for them, and can help current staff discern what management techniques have been tried and found to be either effective or ineffective in certain spaces.

CASE STUDY SNAPSHOT: Sheepish: What's Old is New in Park Maintenance

By David C. Smith, Minneapolis Park Historian

Minneapolis has been testing goats to control invasive plants, especially buckthorn, in parks. The concept may be novel, but it's not new. Long ago in park history, attention focused on sheep rather than goats, but you say ovine, I say hircine.

The idea of sheep in Minneapolis parks was first proposed in 1906 by recently hired park superintendent Theodore Wirth. He proposed putting sheep in what was then Glenwood Park (the park was renamed for Wirth in 1938). He wrote in the annual report that year, "There is nothing prettier in landscape effect than a flock of sheep grazing on the meadow and hill-sides.

Wirth didn't get his sheep in 1906, but he kept on trying. In his 1911 Annual Report he again proposed putting sheep in Glenwood Park. Undaunted by no action, in his 1913 report Wirth pulled out all the stops for his sheep. In his grand plan for Glenwood Park he included a sheep fold on the far western edge of the park about equidistant from Glenwood (Wirth) Lake and Birch Pond. He

went even further by providing an architectural drawing for a sheep barn. The sheep, he explained, would be the "proper lawn mowers for the large open areas" of his plan.

In the long view, Wirth's plan for a sheep barn in the park was not the most notable feature he proposed for the park in 1913. More striking was the first plan for a golf course in a Minneapolis park. Wirth's plans for a golf course were implemented well before his plans for sheep in the park. The Minneapolis Park Board opened its first public golf course—nine holes at Glenwood Park—in 1916. It was an instant success and the public clamored for more. The first sheep didn't appear in the park for another five years—and it took a natural disaster to get them there.

Wirth wrote in his 1921 Annual Report that a fire that summer had destroyed several hundred young ever-

green trees that had been planted at Glenwood Park. To reduce further fire danger he had located two flocks of sheep from local farmers in the park to keep the tall weeds down so more trees wouldn't be lost to fires. In Wirth's eyes the experiment was a success and he repeated his plea for a sheepfold in the park and the acquisition of a small flock of sheep for the coming summer. To underscore his message, Wirth included in the annual report a full-page photo of a marvelously bearded shepherd watching his sheep munching weeds beside a road that we can imagine is Glenwood Parkway. Finally, the park commissioners agreed.

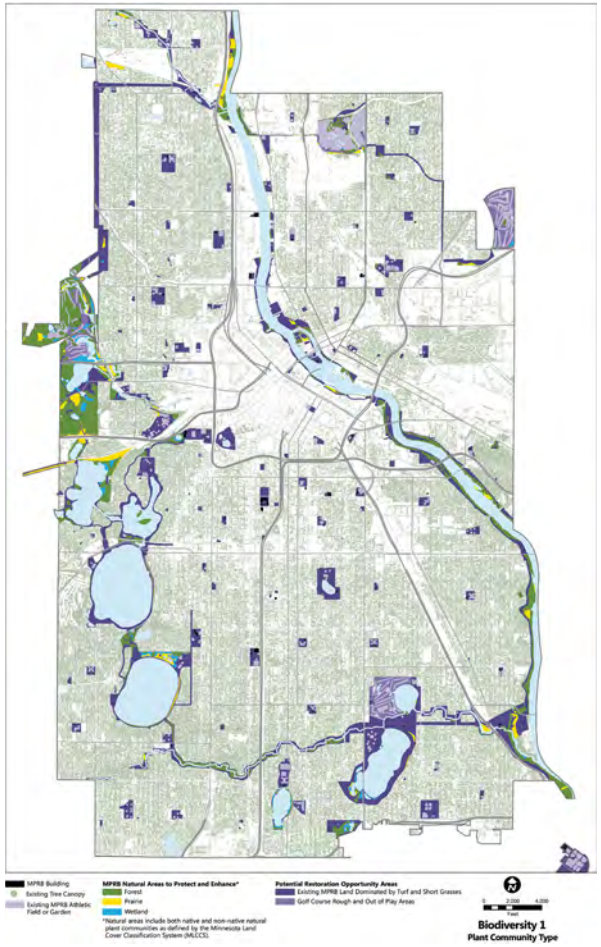


Figure 22. Biodiversity: Plant Community Types. See appendix for full size map.

The experiment lasted just one summer. The next year, in a rare annual-report admission of failure Wirth wrote, "I am forced to admit that the results obtained from sheep pasturing at Glenwood Park have but partially met our expectations." While the sheep did keep weeds down and provided a pleasing visual aspect in the park, Wirth noted that the abundance of food in the park prevented close grazing and "the pastured grounds presented an unkempt appearance." He added that it was "impossible to keep the herd out of sections which we desired to keep unmolested, in order to get the effect of native flora." His conclusion: "It appears wise to discontinue the experiment."

ASSET MANAGEMENT

Situated in Minnesota's largest and most visited city, the Minneapolis park system must adhere to a maintenance standard and level of service that meets the needs and demands of millions of community and out-of-area park visitors. Having earned the Trust for Public Land's award of "#1 Park System in the Nation" for six years running (2012-2018), MPRB is expected not only to continue its great work, but to expand on it. Thus, it is no surprise that the single largest budget item in the MPRB budget relates to management of its assets. The diversity and complexity of spaces under its care demands it. So does the need to provide equitable allocation to capital improvements throughout the park system.

One of the most challenging aspects of MPRB's asset management work is balancing the health of the land with the demands of park users. Significant use and demands for recreational spaces and opportunities result in physical wear and tear upon both built and natural spaces. While costly, damage to built facilities is often much easier to correct than damage to natural areas. Compared with built facilities, natural areas can be more sensitive to repair. Compacted or eroded soils, regrowth of vegetation, and restoration of natural asset quality takes time and, in some instances, is not possible. When it comes to the environment, loss often has much deeper impacts than what is immediately viewed by park visitors. This is why park land management, in particular, has become a careful practice blending ordinance, policy, planning, and science.

CURRENT LAND MANAGEMENT IN THE PARKS

To provide a sense of land cover that is managed within the Minneapolis park system, the chart on page 49 (figure 25) illustrates the parks as covered by tree canopy, water, impermeable surfaces, and other land covers.

TREES

Not only does MPRB tend to over 400,000 trees in its parks (including natural areas), it also cares for approximately 200,000 city owned boulevard trees, standing between curbs and sidewalks, and trees on other city properties, such as police and fire stations and stormwater treatment areas. While these trees provide a number of benefits relating to water and air, as discussed previously, there are also important benefits to the land that need to be explored. Trees contribute to soil health, provide natural erosion control, habitat, and their canopy sequesters carbon and creates much needed shade and cooling in park environments and the greater city. With all of these benefits, the tree population is one of the most valuable natural assets in the parks. Thus, the care and maintenance of trees is a critical aspect of MPRB's environmental stewardship and planting plans are in place to help with species diversification, canopy preservation, and tree resiliency. Tree removal is typically limited to instances of tree death, public safety hazards, or pest pressure. Trees within the Minneapolis park system are managed differently according to their location. Those on streets and boulevards require the most care, those in general park areas are given medium care, and those in natural woodland areas are typically given the least active management.

GRASS

General Park Turf

2,080 acres within the parks are known as general park turf. These areas can be found within neighborhood parks, active use areas in regional parks, and parkways. In them, the grass is mowed every ten days, weather permitting. Within these general turf areas, a number of acres have been identified for a "lower mow" regimen, to achieve a multi-faceted organizational and environmen-

tal benefit: reduced cost in maintenance (both staff time and equipment cost), reduced emissions from mowers, reduced spread of invasive and problem plant species, and improved habitat connection and quality.

Flowering Lawns

Also known as bee lawns, flowering lawns are made up of turf grass and low growing flowering plants such as white clover, self-heal, or creeping thyme. White clover is already common in turf areas throughout the park system. A recent research project in Minneapolis parks with the University of Minnesota Bee Lab determined that

56 species of bees forage on white clover. In addition, a survey of 537 park users from all four quadrants of the city found that 95% of park visitors (who completed the survey) moderately or strongly support flowering lawns. Phase two of the research project focuses on enhanced flowering lawns (meaning more than white clover was present) to determine the impact on bee diversity and abundance.

There are no changes to mowing practices for flowering lawns. This is a simple way the MPRB will be able support an abundance of pollinators across the park system.

Note: Additional opportunities should be explored to transition general park turf into lower mow areas or alternative land covers, to further improve on these benefits, as well as increase stormwater capture, reduce erosion risk, and add community driven programs to park spaces.

Athletic Field Turf

With active programming for baseball, softball, football, soccer, lacrosse, cricket, and other sports including broomball and hockey in the winter, athletic turf fields are very much in demand and require the most maintenance, as these areas experience the hardest and most frequent use of any turf within the park system. 430 acres of athletic field turf are groomed on a daily to weekly basis, depending on usage. This grass is mown, fertilized, and aerated to keep the grass as healthy as possible, but overuse sometimes necessitates field closure to allow the turf to recover or, where the community has requested it, to be replaced with artificial turf. Artificial turf is currently limited in terms of ecological benefit, though it does offer some intriguing stormwater infiltration possibilities, but tends to have a demonstrably longer life and lower maintenance cost than regular turf grass.

Note: When athletic fields are rested and restored with new turf, they offer an outstanding opportunity for biochar to be placed under the grass, to help improve soil health, stormwater capture, and air quality.

Golf Courses

MPRB owns and operates seven golf courses throughout the City of Minneapolis. Five are championship courses, one is executive, and one is par 3. This distinction applies to the length of the course and subsequently corresponds to the amount of time it takes to care for each course. One reason golf courses are costly features in park and recreation departments is because industry standards for the appearance and maintenance of golf courses are very high, which, in result, drives up the cost of play. This maintenance is very particular as to the frequency with which the green is mowed, grass height, application of pesticides and herbicides, and protection of rough and wetland areas. While not necessarily an intended benefit of golf courses within the Minneapolis park system, it must be recognized that they do provide an important ecological benefit with regard to stormwater capture and infiltration. When they flood, they become temporary wetlands that can absorb excess rainwater that may have otherwise flooded built infrastructure (such as trails, streets, and buildings), preventing safe use or passage.

In 2013, MPRB contracted for a Master Plan Study of its golf courses. The study included $30 million worth of recommended improvements, including extensive building improvements; addressing poor soil, turf conditions, and compaction; sand bunkers; and vegetation that encroaches on the fairways. While over half of these improvements were categorized as actions that could make MPRB courses more competitive with private courses, a number were assessed as critical improvements that should be made as soon as possible for the health and playability of the course.

Recognizing that four of the courses within the system were built, at least partially, on old lake beds and wetlands, the study noted that site drainage continues to be a critical issue on these courses and raises the question of whether the courses should be transitioned back to the land forms they used to be prior to the dredge and fill process that transformed them into golf courses. This is a highly sensitive issue, both from a public and ecological perspective. In some ways, it is impossible for the land to return to exactly what it was before, having been changed so dramatically. However, former wetlands often

return to a version of their former selves when groundwater aquifers fill, as is currently happening at the Hiawatha Golf Course. This natural process is not a welcomed, well-received, or easily accepted reality among golfers who have treasured the space and its use as they know it. Nor is it to neighbors who are concerned about what this process might mean for their properties.

NATURAL AREAS

MPRB is currently undertaking a study of its natural areas and assessing plant community types within the park system as well as identifying management strategies for each plant community. While this work is underway, the Ecological System Plan will speak generally to the types of natural areas that are being assessed.

PRAIRIES

A good example of areas rich with native vegetation, prairies are typically low in maintenance cost, once established, and high in ecological benefit. They are characterized by plains of grassland with few trees, often containing native flowers. With the ability to sequester even more carbon than trees, prairies also provide habitat for insects, birds, and ground-dwelling animals. For all of these reasons, prairies are an important part of the Minneapolis park system and present an opportunity for native plant restoration where turf grass or invasive plant species currently exist. However, it is important to note that to the casual observer, unmaintained weedy areas can often be confused with prairies and the ecological value of the two is very different. As part of MPRB's natural areas management planning, prairie areas will be mapped to help both MPRB staff and the community at large better discern which areas within the system can be classified and managed as prairies.

Note: Minneapolis is fortunate to have remnant native prairie spaces that are of great significance, both ecologically and historically, that are preserved through focused conservation efforts. Remnant prairies can be found at the 36th Street overlook along West River Parkway and Morley's prairie at the south end of Minnehaha Regional Park.

TYPES AND ACREAGE OF PLANT COMMUNITIES WITHIN THE PARKS

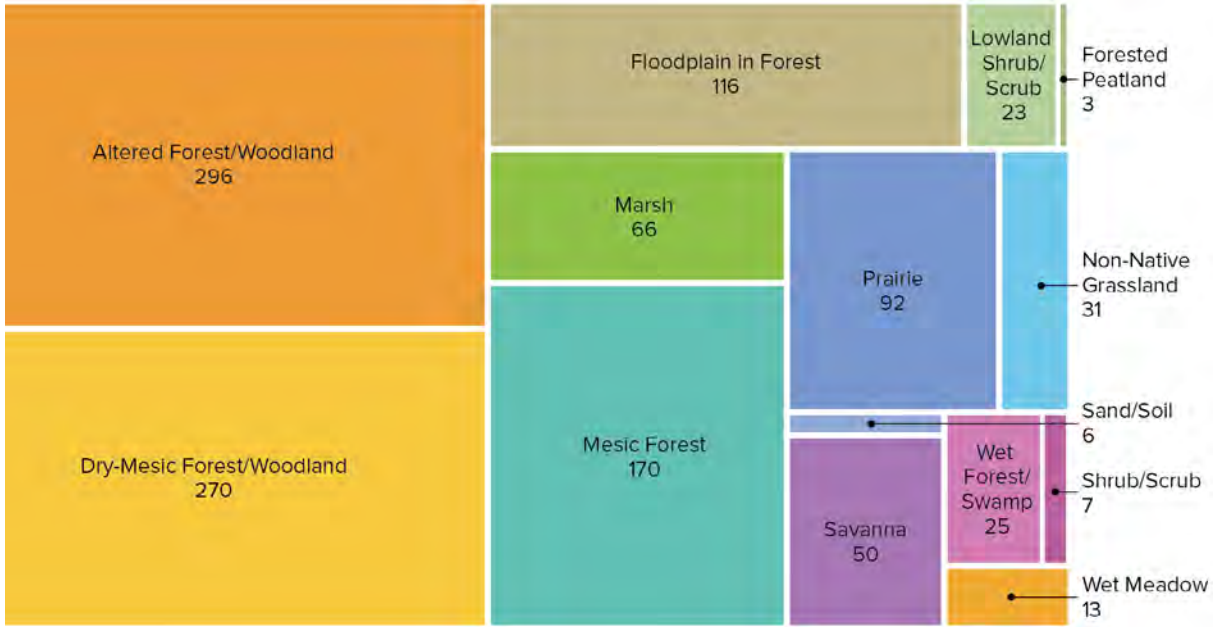


Figure 23. Types and acreage of plant communities within the parks

BEACHES AND SHORELINES

Beaches and shorelines are the physical transitions between land and water. As one is a man-made recreational amenity (beach) and the other a naturally occurring edge (shoreline), they are managed and monitored differently. Constantly changing from the effects of water, weather, erosion, loss of plant life, and pollution, these edge environments require special consideration in regards to the roles they play, both ecologically and in facilitating recreational access to water. When they deteriorate, both the land and the water suffer from it. However, restoration of beaches and shorelines is possible and a strong example is seen in the recently completed Hall's Island restoration project. Because of the work done to restore the shoreline, re-establish trees and native plants on the land, and add river rocks in the water, the island has been renewed as a natural sanctuary for birds that live in and travel through the Mississippi River flyway as well as for mussels and fish in the river.

Case study snapshot: Hall's Island—the case for re-development and re-wilding

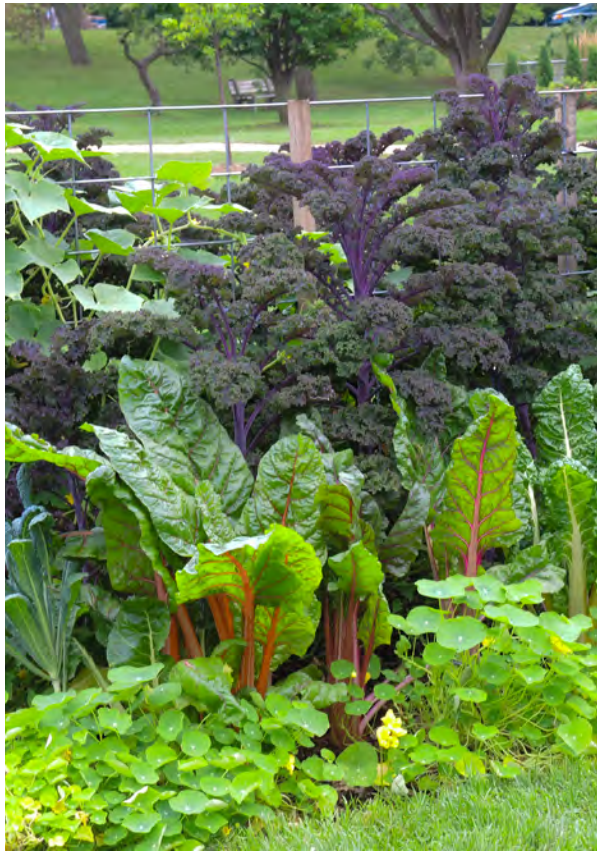
The Minneapolis Park and Recreation Board partnered with many public and non-profit organizations in a RiverFirst project to rebuild Hall's Island in the Mississippi River near the Plymouth Avenue Bridge and develop the adjacent shoreland. Hall's Island shows up in some of the earliest maps of Minneapolis. Throughout its history it was used by lumber mills to retrieve timber, Northeast Minneapolis residents as a swimming area and wildlife for natural habitat within the Mississippi River Flyway.

In 1966, Hall's Island disappeared when it was partially dredged and the channel between the island and shoreline was filled in by Scherer Bros Lumber Co., which purchased the island and land adjacent to it from Minneapolis in 1963. The reconstruction of Hall's Island restored a long-lost natural asset and stands as a landmark achievement in the long-term plan to transform Minneapolis' Upper River into an ecologically sound, publicly accessible destination.

This project has the following benefits:

Ecological Benefits

- *Nearly triples the shoreline from 1,000 linear feet of armored shoreline to nearly 3,000 linear feet of habitat-rich shoreline.*
- *Provides a safe stopover for migrating birds in the Mississippi Flyway.*
- *Creates a backwater channel designed to promote and improve mussel habitat along this stretch of river.*
- *Supports a diverse range of native plants, which will include trees, grasses, shrubs and prairie plantings.*
- *Produces a variety of nesting areas with basking logs, a sandy terrace and rock ledges to attract and protect songbirds, amphibians, reptiles and small mammals.*



Recreation Opportunities

- *Creates a softer, more accessible connection to the river with a new gravel beach that serves as a safe, smooth location to launch or land canoes and kayaks.*
- *Aids transition of north/northeast Minneapolis riverfront from predominately industrial to publicly accessible and available for recreational activities.*
- *Lays groundwork for future boardwalk, which would provide a unique experience for pedestrians to connect with the river in a controlled way that minimizes impacts to native plants and habitat.*
- *Enhances the views for commuters and recreational users of the Mississippi East Bank Trail.*

Should infrastructure on the Mississippi River be altered in the future, it is possible that additional shoreline in and along the river will be restored. Management strategies for these spaces will center on protection and preservation of the natural space and habitat in and around it.

WETLANDS

Some of the most environmentally sensitive places in the park system, wetlands are biologically rich ecosystems that have a myriad of environmental benefits including carbon sequestration, water quality improvement, shoreline erosion control, and flood mitigation. As indicated by the EPA, "Wetlands play an integral role in the ecology of a watershed. The combination of shallow water, high levels of nutrients and primary productivity is ideal for the development of organisms that form the base of the food web and feed many species of fish, amphibians, shellfish and insects. Many species of birds and mammals rely on wetlands for food, water and shelter, especially during migration and breeding" (www.epa.gov/wetlands).

In addition to natural wetlands, there are also many human-made wetlands on MPRB property that are part of the urban stormwater management system. These stormwater management structures (also known as stormwater constructed wetlands or as BMPs) appear to be wetlands, but they are man-made structures, like beaches, and their management and monitoring is necessarily different. Stormwater constructed wetlands are designed to remove particles, nutrients, and trash from stormwater prior to its discharge into waterbodies. Plantings and maintenance allow many of these structures to appear as diverse and natural as naturally occurring wetlands; however, these working landscapes require periodic dredging to ensure their functionality continues. MPRB, City of Minneapolis, and watershed management organizations often work together to site, construct, and maintain these multifunctional features in MPRB parks. With good design, stormwater wetlands can be an aesthetic park amenity and create additional habitats, like the south Bde Maka Ska constructed wetlands. (Learn more about BMPs in Chapter 2: Water.)

WATER

As the most prevalent natural landcover in the Minneapolis park system, water is a critical resource that impacts the health and maintenance of all other landcovers within the system. Its care and maintenance requires careful partnership with other local, state, and federal agencies and organizations, given shared interest in its protection and shared responsibility for impact mitigation. (For more detail, please see the "Water" chapter.)

OTHER LANDCOVERS

GARDENS

MPRB gardeners care for more than a dozen gardens from the formal spaces of Lyndale Park Gardens to the wilder acreage of the Eloise Butler Wildflower Garden and Bird Sanctuary. Each garden has unique care needs that are tailored to the flora and fauna that call it home. Gardeners follow the MPRB approved integrated pest management policy, utilize volunteer labor, abide by DNR and MDA regulations, participate in trainings, and pilot and assess new techniques. For example, in 2018, the Rose Garden was especially plagued with Japanese beetles and in addition to utilizing volunteers to remove beetles by hand, the gardener piloted a new mobile pheromone trap to fight the beetles and also tested a new product that is part of the reduced risk program under EPA registration.

Garden design must be responsive to growing conditions and shift practices to fight pests and disease more effectively. For example, good fall clean up helps to prevent

Figure 24. Designated Urban Agriculture Areas

fungus from overwintering in known locations. To fight common weeds, gardeners utilize flame torches on paver hardscapes, rely on thick layers of composted leaf mulch, and welcome the help of volunteers to remove weeds by hand. Noxious weeds, such as Canada thistle, are an ongoing challenge.

URBAN AGRICULTURE AREAS

As part of the MPRB Urban Agriculture Activity Plan implementation, designated urban agriculture areas in neighborhood parks will allow for community gardens, orchards, and other forms of urban agriculture to be built for public benefit. Because MPRB recognizes that an important success factor in this activity is soil health, it is undertaking soil screening in partnership with the University of Minnesota soils lab to assess whether contaminants are present in the soil. This screening will help MPRB to better understand whether remediation is needed as well as whether in-ground or raised bed planting is advisable for community gardens.

IMPERVIOUS SURFACES

Parking lots, roadways, paved paths, and buildings are the reason that a significant amount of the landcover in the City of Minneapolis is impervious. While each of these facilities helps to meet the transportation, housing, work, and recreational needs of the community, they often detract significantly from the ability of nature to flourish. And increasingly, they are located where the most energy consumption and pollution happen within the city. Winter maintenance of impervious surfaces can also create water or air pollution issues that can be mitigated through judicious use of sand and salt and limiting maintenance of only those areas needed. MPRB recognizes the pressure that highly developed areas place on the parks to act as escapes, respites, and healing spaces set apart from the urban bustle.

Roadways, Paved Paths, and Parking

Asphalt pavement is the most pervasive material used for roadways, paved paths, parking lots, and parking spaces within the park system. The asphalt pavement currently in place is nonporous and long lasting under heavy use, which is important in a system that sees over 23 million visits per year. However, it has little ecological benefit outside of encouraging park visitors to keep on the road or path, which can help reduce erosion and improve access to park spaces.

Sport Courts and Skate Parks

Basketball, tennis, and pickleball courts are ever more in demand within the park system, as are skate parks. While conventional materials, such as concrete, are still the primary component of these courts, MPRB will continue to explore opportunities to pursue more “green” construction methods.

Buildings

Most of the buildings within the MPRB system pre-date sustainable and accessible design concepts. Because of their age, these buildings have rather extensive structural and functional needs that must be addressed before “green” development concepts can be incorporated. However, MPRB has several projects either recently completed or currently underway that examine different facets of facility improvement needs, energy consumption, and access challenges. These reports will help the organization better identify ways in which environmentally friendly construction methods and materials might be incorporated into building repair and rehabilitation or around the building’s exterior to help reduce negative environmental impacts.

Note: As most of the infrastructure within MPRB’s system is aging and in need of repair, and funding for these repairs has been allocated through the Capital Improvement Program (CIP), MPRB has the chance to explore cost-effective green building methods and materials that might offer an alternative to those currently in place.

Ongoing Management of Impacts Related to Land

MPRB practices regular monitoring, protection, and mitigation strategies to preserve and maintain park land and pursues remediation, when needed, to bring the land to a healthier state.

CURRENT PRACTICES TO REDUCE IMPACTS TO AND FROM TREES

Historically, very little species diversity was seen in the boulevard tree population throughout Minneapolis. Publicly planted trees consisted of more than 90% elms in the early 20th century. After the devastating impact of Dutch elm disease in 1978, MPRB's Forestry department began a block by block approach to incorporate species diversity. This resulted in a dramatic increase in species diversity within neighborhoods across the city. However, this approach left individual block segments susceptible to forest pests that impact a single species or genus of tree.

MPRB's Forestry department has developed planting strategies that increase tree diversity and therefore resilience to urban forest pests across individual block segments across the city. These tree planting guidelines require at least 3-5 genera per block, a 5 individual trees per genus limit per block, and no more than 5 trees per block that might attract Asian longhorned beetles. Additionally, Forestry has been proactively removing ash trees that would otherwise fall victim to invasion by Emerald Ash Borer (EAB), a type of beetle that feeds on ash trees. In all of the replantings that occur where trees have been removed (due to EAB or for other reasons), MPRB is focusing its effort on achieving species diversity by limiting species selection that are less than 10% of any particular type or genus within each neighborhood. This increases the overall tree population's ability to withstand future forest pests and increase the overall tree canopy throughout the parks and the city. This approach will continue to evolve as the effects of climate change intensify.

TREE MIX – 2004

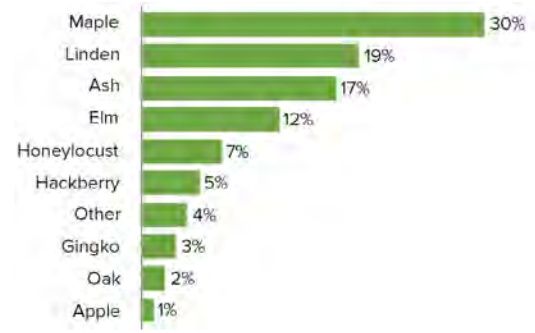


Figure 25. Tree Mix 2004

TREE MIX – 2017

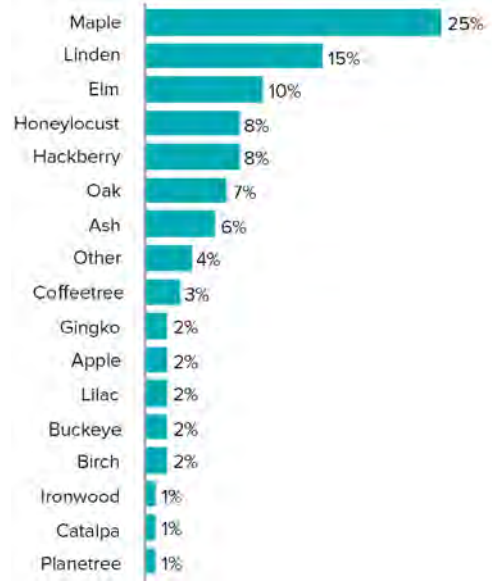


Figure 26. Tree Mix – 2017

Trees in natural woodland areas are also scouted for the potential presence of various diseases, insects, or beaver damage to determine whether tree removal is necessary. Fallen or falling trees are only removed in these areas

TREE MIX – FUTURE

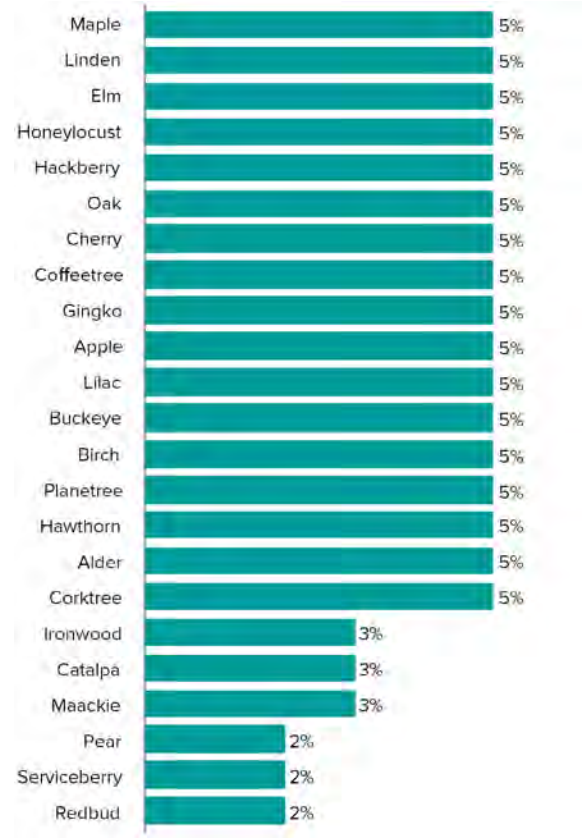


Figure 27. Tree Mix – Future

where they have blocked trails or pose a risk to pedestrian and park visitor safety.

CURRENT PRACTICES TO REDUCE IMPACTS IN TURF AREAS

Grass might seem the most common element in any park and the one element most visitors take for granted, yet there is exceptional nuance to how grass is managed. Of the 4,660 acres of grass or turf in the Minneapolis parks that is mowed, there are different mowing procedures for general grass areas, athletic turf, golf courses, and reduced mow areas. Accordingly, MPRB has mowers of various sizes to accomplish this work. There is also careful trimming that is completed around trees, shrubs, and other structures with handheld devices.

Note: For all of its turf and trimming work, MPRB selects equipment based on performance, durability, budget, and environmental considerations. Currently, the best performing large mowers factoring in all of these considerations are diesel or propane powered, though small electric push mowers have also been found to do well. As such, MPRB should explore setting a goal for transitioning to electric models as aging equipment is phased out. As this goal is met, MPRB will remain committed to trying new equipment as it reaches the marketplace to see if mower performance matches higher environmental goals.

A particularly nuanced element in managing turf as well as gardens within the park system is weed and pest control. In 2008, MPRB adopted an **Integrated Pest Management (IPM) Policy** which states the following:

> *The Minneapolis Park and Recreation Board has set a 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. Staff is required to use turf cultural practices other than herbicide applications if weeds and/or other vegetation must be controlled or removed from areas within 100 feet of wading pools or playgrounds. Insect and disease infestations are currently managed on a spot spray basis, as they are usually a rare occurrence. Further, application of any plant protectant within parks must be timed to minimize contact with park users. Posting of the park site (according to City of Minneapolis posting regulations) to be treated must occur just prior to application and if this park includes a recreation center or building, posting of a sign must occur at the entrance doors.*

The IPM goes on to specify where, how, and under what conditions pesticides and herbicides may be used in the system and MPRB is very careful of application procedures to ensure native plants and wildlife remain unharmed.

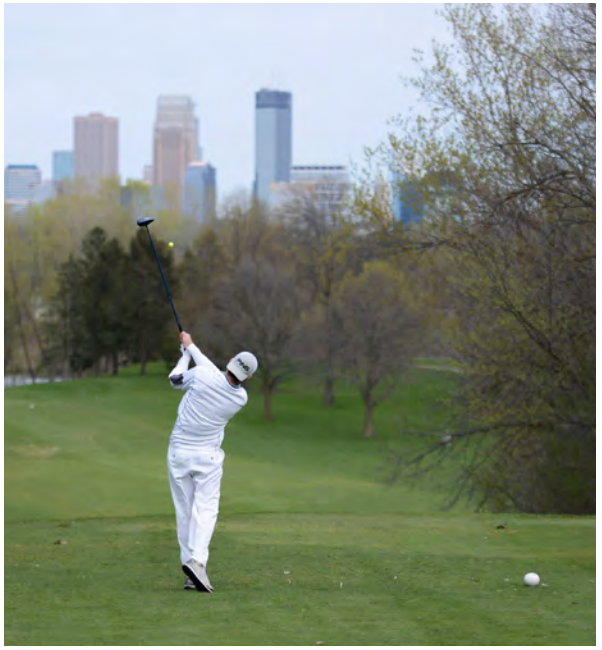
In October 2018, the Park Board of Commissioners passed a moratorium on the use of glyphosate within the entire Minneapolis park system. A committee has been formed to examine alternative pest and weed control methods that will offer a similar result, which will, among other things, need to explore the effects of various weed control methods on species to be eradicated as required by the Minnesota Department of Agriculture.

CURRENT PRACTICES TO REDUCE IMPACTS ON OR NEAR GOLF COURSES

MPRB-operated golf courses are examining opportunities to transition “roughs” into pollinator patches and completing some strategic milkweed plantings. Additionally, many of these golf courses contain Audubon protected areas and are introducing sprinkler efficiency programs to ensure better, centrally located irrigation control.

CURRENT PRACTICES TO REDUCE IMPACTS IN NATURAL AREAS

Natural areas are carefully managed by MPRB’s Environmental Management department to preserve their quality and prevent the spread of invasive plant species. MPRB works with crews of staff, volunteers, and community partners to perform strategic removal of invasives and complete restoration projects with native plant species.



The MPRB’s Environmental Management department has identified and prioritized areas for restoration and invasive species management, based on the following criteria:

- Forested areas with notable amounts of native plant species including canopy, subcanopy, shrub and herbaceous layers with good quantities of native plants.
- Prairie and savanna areas that have been identified as remnant native plant communities.
- Areas that were funded and developed as part of a larger park development or water quality improvement initiative that involve planting an area with native plants (for example turf conversion to prairie, storm water BMPs, shoreline restoration areas).

Management of native plant communities and plantings requires a multifaceted approach that is detailed to fit the specific requirements of each site. Management of these sites needs to be flexible and dynamic, as new invasive species, changes in land use and park user needs all change over time. In an urban setting the impact of park users and adjacent land use types is an important consideration as they relate to introduction of invasive species and effective establishment and management of desired vegetation.

PRAIRIES

Prescribed burns, mowing, woody plant removals, and reseeding are all used to maintain planted and native prairies in the Minneapolis park system. Prairies have been planted to replace turf grass in order to create additional habitat in the parks, provide destinations, and diversify the landscape. Many of the golf courses also present unique opportunities for plantings with native plants, especially in the "roughs."

BEACHES AND SHORELINES

Shoreline and beach erosion can happen for a number of reasons, often including a combination of trampling, wave and ice action, and shallow-rooted vegetation. Thus, restoration projects are underway to help address shoreline erosion through the establishment of native plants that will also provide habitat benefits to shorelines. Sand is also sometimes added to designated beach areas where sand has depleted over time.

WETLANDS

MPRB, in partnership with Hennepin County's Wetland Health Evaluation Project (WEHP), sponsors teams of volunteers each year to collect and analyze wetland data in order to characterize wetland health. MPRB maintains contracts with local watershed districts to manage stormwater ponds. MPRB staff also monitors wetlands on golf courses to help maintain Audubon International Cooperative Sanctuary Program certification.

CURRENT PRACTICES TO REDUCE IMPACTS ON WATER

As described in the Water chapter, there are a number of mitigation strategies underway to prevent degradation of water quality, build resiliency in the face of changing water levels, and enhance aquatic habitat. These mitigations range from partnership efforts to address specific impacts to inspections, permits, plans, and ongoing testing, management, and maintenance of water bodies.

CURRENT PRACTICES TO REDUCE IMPACTS IN PAVED AREAS

Public education and awareness campaigns, as well as staff training, are two of the biggest mitigation measures MPRB undertakes to help mitigate the impacts of paved areas (including heat island effect, contaminated stormwater runoff, limited carbon sequestration capacity, and salt and chemical use in winter). Other mitigation strategies include the use of pervious pavers, increased street sweeping, and stormwater management practices to help divert runoff to land rather than water bodies.

CURRENT PRACTICES TO REDUCE BUILDING RELATED IMPACTS

MPRB recently completed a yearlong inventory of maintenance, rehabilitation, and capital improvement needs in its neighborhood parks and many opportunities for "green" park facilities were identified in addition to needed basic repairs. This process, known as Closing the Gap, resulted in the 20 Year Neighborhood Park Plan (NPP 20), which prioritized projects based on criteria related to racial and economic equity.

A companion effort, the Americans with Disabilities Transition Plan, identified where retrofitting opportunities exist to make neighborhood recreation centers and park areas more accessible to all visitors. Thousands of action items were identified to help improve accessibility.

MPRB's Asset Management department is also taking a close look at the resource requirements of all MPRB facilities to determine how efficiently they are operating, both in terms of resource consumption and resource cost. This ongoing analysis helps MPRB to better understand where energy and water use are highest. It will be used on an ongoing basis to help MPRB identify opportunities to introduce strategies that result in better resource efficiencies.

MPRB and City of Minneapolis Public Works have partnered on a project to create site specific stormwater management plans (SWPPPs) for park maintenance facilities. To comply with the plans, monthly inspections will be completed on the sites in order to identify potential pollution issues that need to be addressed. In 2018, inspections began at the first two pilot sites in the MPRB system. Work and reporting will be directed by the new asset management system.

CURRENT PRACTICES TO REDUCE IMPACTS FROM WASTE

One particular issue with waste generated in the parks is making sure the discarded articles wind up in the correct container. If too many trash items wind up in recycling or organics containers, the entire load is considered contaminated and winds up being sent on to trash facilities. In partnership with the City of Minneapolis and Hennepin County, MPRB has added stickers to trash, recycling, and compost containers to make park visitors more aware of what belongs in which bin. At certain large events, MPRB deploys volunteer educators to ensure vendors have the correct food service materials (consistent with the City of Minneapolis' Green to Go Environmentally Acceptable Packaging Ordinance) and to provide guidance about proper disposal near trash, recycle, and organics collection bins.

Future Mitigations

Given MPRB's management and mitigation strategies often involve day to day operations, it is important to consider what can also be done in planning and programming the parks to help achieve more sustainable and Earth friendly outcomes.

For instance, as facility deficiencies are addressed in the years to come, MPRB has an outstanding opportunity to evaluate where and how to bring environmentally conscious change to its buildings and park spaces. From building and park lighting to HVAC systems to building insulation, there are numerous opportunities to introduce more environmentally friendly building materials and energy efficiencies. Examples of these opportunities include:

FACILITY/ELEMENT	EXISTING CONDITION	ENVIRONMENTAL IMPROVEMENT IDEA	POSSIBLE ACTION
Recreation Centers/ Golf Club Houses/ Maintenance Facilities	Asphalt shingles on roofs	Metal roofs or high albedo roofs, which absorb less heat and are less expensive to maintain	Build alternate bid options alongside traditional bids to compare budget/environmental benefits
	Traditional lights	LED lights	Research standards for LED lights, adopt where feasible/in budget
	Traditional outdoor lights	"Dark sky certified" lights	Explore potential policy avenue that advocates for "dark sky"lighting where feasible and appropriate to reduce light pollution
	Aging furnaces; few facilities with air conditioning	Installation of efficient AC units, replacement with more efficient HVAC units and ensuring existing units meet code	Energy audit of all buildings within MPRB control
	Poorly sealed windows and doors	Replacement with modern materials	Seal doors and windows, where possible; request budget for replacement cost
	Trash collection with separate containers for recycling and organics sees a 27% diversion rate for recycling and 2% for organics	Achieve 35% diversion rate for recycling within 5 years	Improve recycling signage; partner with Hennepin County to educate at events
	Existing bathroom fixtures may or may not be water wise	Install water wise fixtures in all new facilities and retrofits	Complete facilities assessment to determine existing fixture type

FACILITY/ELEMENT	EXISTING CONDITION	ENVIRONMENTAL IMPROVEMENT IDEA	POSSIBLE ACTION
	Open/close bay doors with no air shield to retain heat/cool at maintenance facilities	Air shields	Request budget to complete acquisition/installation of air shields
	No wash bay within system that can accommodate vehicles	Create wash bays at maintenance facilities that have proper water/ sediment capture	Request budget to complete acquisition/installation of wash bays at operations centers
Athletic Fields	Athletic turf on soil	Turf with biochar underlay	As fields are slated for rest or replacement, biochar can be laid under new grass
	Traditional field lights	LED lights	Research standards for LED lights, adopt where feasible/in budget
	Mowed turf throughout park system	Low water turf suited to MN climate	Scope how much turf in the system is low water and complete cost-benefit analysis on replacement
General turf area	General turf area	Bee/flowering lawns	Explore opportunities to transition general turf areas to bee/ flowering lawns in order to improve habitat and connect green corridors
	Pathways (formal and informal)	Formal pathways with “keep on path” signage	Promote walking, biking, and driving on established pathways to reduce compaction and erosion of turf areas
Pools, fountains, splash pads	Older, leaking infrastructure (both pipes and support systems)	Rebuild least efficient fixtures and fix leaks, where possible; install water capture systems	Complete water use audit on MPRB facilities and fixtures to determine which are least efficient
Impervious pavement	Asphalt and concrete	A combination of pervious pavers and porous concrete, where fitting, with impervious pavement	Analyze which impervious pavements are due for rehabilitation and which might be good candidates for pervious alternatives; explore different bid scenarios that include pervious materials

Figure 28. Environmental Improvement Strategies for Facilities

To make a success of these opportunities, site management and material selection practices are critically important and need to be considered at the beginning of the capital improvement process.

Land Goals, Strategies, and Recommendations

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

PLANNING

MPRB's programming and operations originate from plans and planning processes that are shaped with diverse and extensive community engagement. Accordingly, this chapter's goals and strategies focus heavily on different planning steps that can be taken to promote positive environmental outcomes. From plans that can be written to address particular land management techniques to maintenance and staffing plans to corridor and habitat planning, there are different kinds of planning techniques that can be used to improve environmental performance of turf management practices, improve habitat quality and increase habitat connectivity in the parks, maintain and improve soil health, reduce human-related impacts, and reduce construction-related impacts.

PHYSICAL DESIGN AND CONSTRUCTION

As indicated earlier in this chapter, physical design and construction of park assets and facilities (benches, lighting, athletic fields, playgrounds, buildings, etc.) can have a significant impact on the environment. Where possible, incorporating more sustainable and green building techniques and materials not only into current projects but also design guidelines and construction specifications for future projects will help MPRB to be forward thinking about impact mitigation. Further, implementing wildlife protection strategies in parkways, corridors, and in all construction projects is an essential step toward physical design that balances recreational demand with habitat considerations. To that end, identification of areas in each park or MPRB managed land where habitat might be created to establish more connective habitat corridors is another important step to improve ecological system function within the City of Minneapolis.

TRAINING

Expanded training is needed for MPRB staff to address proper equipment, pesticide, and sand and salt use; habitat and tree protection; soil compaction prevention; and construction specifications to ensure construction materials are as wildlife and environmentally friendly as they can be.

COMMUNICATION AND PUBLIC AWARENESS

In order to help reduce human-related impacts in the parks (through encroachment, trash, pet waste, off-trail exploration, and mode of park access), it is vitally important that communication and public awareness tools be utilized at strategic times and locations to raise awareness about the significance of these impacts. Improved signage, expanded outreach, public awareness campaigns, and reporting on impact mitigation are all methods that MPRB can employ to better connect with park visitors and increase their stewardship of the parks.

The following goals, strategies, and recommendations address particular impacts and offer recommendations so MPRB can achieve more environmentally friendly planning, design, operations, maintenance, and programming. Each recommendation can be evaluated on an annual basis to determine how the organization is progressing as well as to help map next steps and action items for each division within MPRB.

LAND

Goal

Strategy

Recommendation

E. LAND: MAINTAIN AND IMPROVE SOIL HEALTH

18. Conduct soil contaminant testing in parks where urban agriculture areas have been designated in park master plans

19. Utilize park development as a means of improving soil health, with mitigation partners such as Hennepin County

20. Address soil compaction during park construction, after events, or as part of park maintenance

20.1. Conduct soil compaction tests at the inception of major projects, and develop de-compaction strategies and extents

20.2. Explore use of biochar in park projects, especially athletic fields, as a means of de-compacting soils

20.3. Re-assess event fee structure to explore funding for decompaction of impacted parks

21. Minimize erosion impacts from maintenance, construction, and use

21.1. Evaluate Minnesota Erosion Control Society best management practices for inclusion in standard construction project specifications

21.2. Evaluate current erosion control construction specifications to address and avoid wildlife conflicts and concerns, and develop and implement wildlife-friendly standards

21.3. Complete slope analysis for mowing to determine best fit equipment and modify mowing plans to assign specific equipment use to different slope types

21.4. Identify erosion problem areas throughout the system and develop plans for minimizing and correcting areas that are prone to erosion

F. LAND: IMPROVE ENVIRONMENTAL PERFORMANCE OF TURF MANAGEMENT PRACTICES

22. Address environmental concerns around highly managed turf

22.1. Pursue staff training and certification, specifically the Turf Management Certificate for Water

22.2. Continue expansion of programmable, higher efficiency irrigation controls, especially at golf courses and premier sports fields

22.3. Identify opportunities to incorporate USGA Golf Course greening practices

23. Initiate mandatory pre-season mower and trimmer training to address slope, equipment suitability, compaction, grass clipping redirection, natural area protection and tree protection

24. Develop standard procedures and protocols for vehicles driving on turf, in order to limit compaction and damage

G. LAND: REDUCE NEGATIVE CONSTRUCTION-RELATED IMPACTS

25. Review and modify construction specifications and practices to increase environmental and wildlife protections

25.1. Conduct mandatory pre-construction conferences to address environment- and wildlife-friendly construction requirements, including materials selection and recycling

25.2. Install and maintain wildlife-friendly erosion control devices during construction

25.3. Save and re-use site topsoil

25.4. Require weather protection of stored materials

25.5. Require that construction permits issued to other agencies include environment- and wildlife-friendly construction specifications similar to those used on MPRB projects

26. Consider construction scheduling and project timing in the context of nesting, spawning, migration, and pollinator emergence

27. Incorporate more sustainable and green building technology and materials into design guidelines

28. Protect trees during park development and provide care during recovery

H. LAND: REDUCE HUMAN-CREATED NEGATIVE IMPACTS IN THE PARKS

29. Reduce waste generated by and in parks

29.1. Develop public awareness campaign and staff training about proper waste disposal

29.2. Track diversion rates in park waste and set system-wide diversion goals, including for MPRB-organized events

29.3. Adopt waste policies consistent with City of Minneapolis Green to Go Ordinance and Zero Waste Plan

29.4. Work with partners, vendors, and event organizers to ensure food and drink containers in parks are recyclable or compostable

29.5. Implement “deconstruction” rather than demolition during park projects to extract high value materials, require contractors to recycle materials as possible, and track construction waste diversion

29.6. Reduce single-use plastic items in parks by prohibiting them at park events, facilities, and permitted park uses

30. Reduce light pollution generated by park activities

30.1. Implement dark sky compliant lighting

30.2. Identify areas where existing lighting can be modified or eliminated to limit light spill-over, especially into natural areas, while also balancing safety

30.3. Provide staff training on dark skies and lighting impacts on people, wildlife, and ecosystems

30.4. Assess street and parkway lights for impact on parks and natural areas along with how that relates to safety considerations. Then, work with partners to redirect, shield, or remove fixtures, as needed, to balance addressing light pollution and safety.

CHAPTER 5

LIFE

LIFE IN THE PARKS

Minneapolis parks are home to a rich variety of birds, mammals, fish, and insects. While this wildlife has to adapt to a living environment transformed by the effects of human activities, it is still wild and its habitat is a critical consideration in park maintenance and management. However, there are often competing interests in wildlife protection and human recreational activities; shared spaces mean compromises happen on both sides. Thus, MPRB has been working to create programs that work to bring these interests into balance for all life within the parks while fulfilling its mission to "permanently preserve, protect, maintain, improve, and enhance its natural resources, parkland, and recreational opportunities for current and future generations." Understanding that water, air, and land conditions have the biggest impacts on the plant, animal, and insect life within the parks, this chapter considers what can be addressed in park operations that will help to mitigate these impacts, resulting in improved habitat quality and increased biodiversity.

AIR QUALITY, CLIMATE CHANGE, AND LIFE

A 2015 Minneapolis Climate Change Vulnerability Assessment prepared by graduate students at the University of Minnesota in partnership with the Sustainability and Public Health Offices at the City of Minneapolis showed that continued climate change will result in an increase in precipitation and in the number of days where extreme heat (over 90 degrees) will be experienced in Minneapolis. The same study states Minneapolis "can be considered the **urban heat island** core of our region," which will only exacerbate the effects of increased stormwater and temperature, given the greater amount of impervious surface and relatively less vegetation in the city compared with the broader metropolitan area. These effects have the potential to be devastating to the plant and animal communities that currently occupy the parks. Their ability to adapt and thrive will be severely limited if climate conditions are in a constant state of change. Climate change can also result in overpopulation of problem insect species. Mosquito populations, for instance, tend to fluctuate depending on temperature and rainfall, where tick populations tend to thrive after mild winters. Because human development and travel patterns have a significant effect on climate change, it is important to examine the steps that can be taken to reverse effects, as these effects impact park users as well as wildlife populations. Thus, MPRB must be concerned with implementing solutions that present opportunities to curtail climate change and improve air quality in order to protect and preserve natural areas and all forms of life that occupy them.

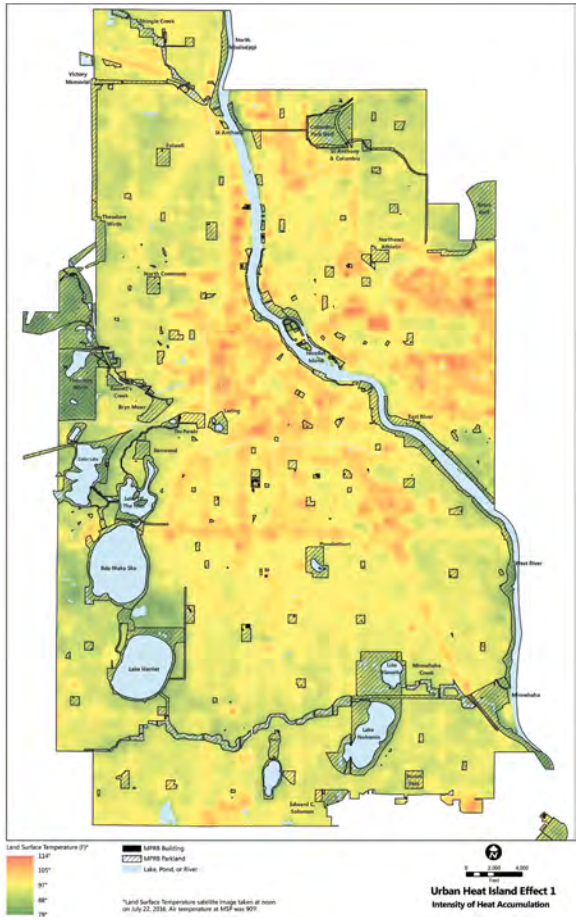


Figure 29. Urban Heat Island Effect: Intensity of Heat Accumulation. See appendix for full size map.

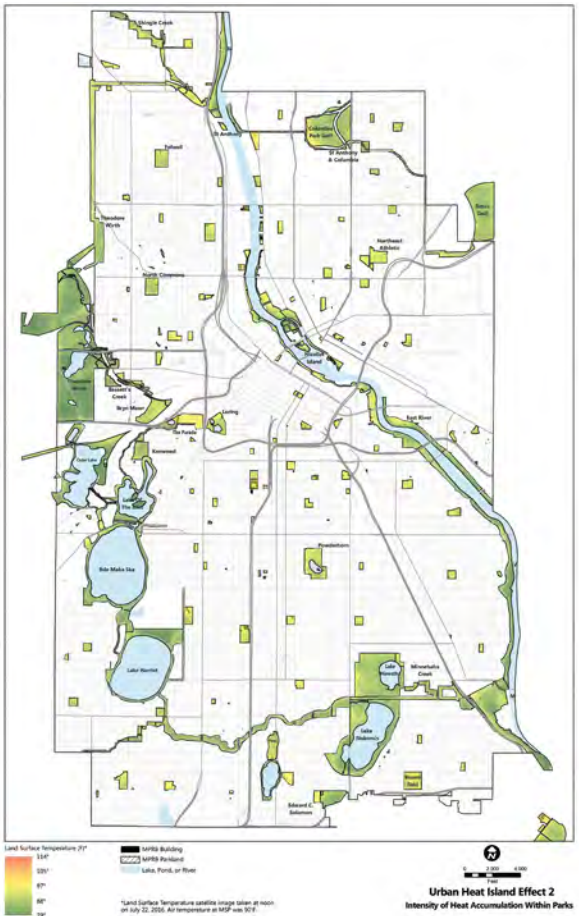


Figure 30. Urban Heat Island Effect: MPRB Intensity of Heat Accumulation. See appendix for full size map.

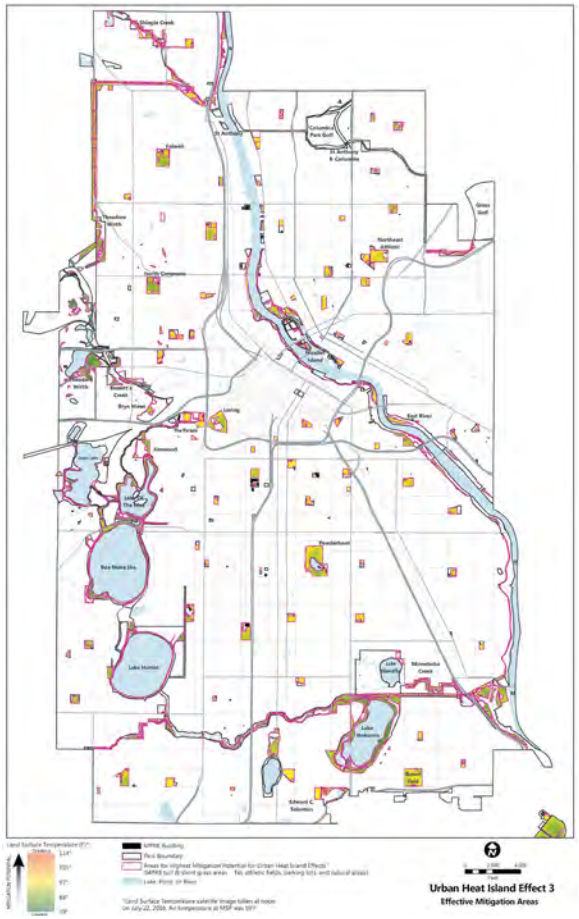


Figure 31. Urban Heat Island: Effective Mitigation Areas. See appendix for full size map.

While MPRB works diligently to explore opportunities for partnership that will result in improved conditions for plant and animal life in the parks, it is also important to note that quality of life in the parks also extends beyond plant and animal communities to the visitors who come to park properties for recreation, relaxation, and enjoyment. Because air quality in and around the parks may have an effect on the health of park users, it is critical to be mindful of what's happening near the park system when thinking about its future. "Current air pollution levels contribute to a large number of health impacts. In the seven-county Twin Cities metro area, air pollution contributed to about 2,000 deaths and hundreds of hospital admissions and emergency department visits annually for respiratory and cardiovascular conditions" (Life and Breath: How air pollution affects public health in the Twin Cities, MPCA and MDH 2015). Because of this, MPRB must continue to strategically partner with other local agencies and organizations to determine how to best individually and collectively mitigate air quality impacts that pose human health risks.

WATER AND LIFE

While there is certainly opportunity to create habitat at a certain scale in each of the neighborhood parks that MPRB manages, the highest quality habitats for wildlife in the parks are found in regional parks, as these are both larger and more naturalized than neighborhood parks. Deer, coyotes, squirrels, rabbits, turtles, fish, mussels, beaver, turkeys, geese, eagles, owls, bees, butterflies, and many other mammals, birds, insects, and water-dwelling species make themselves at home in these parks. Region-

al parks are also home to the majority of the water bodies found in the park system. As such, it is critical to consider how water quality affects habitat quality and poses potential health impacts for all forms of life throughout the park system.

"Some types of water pollution affect habitat quality or pose a threat to aquatic life. These types of pollution make it difficult for fish, macroinvertebrates like snails and insects, and native aquatic plants to thrive in and around a water body" (City Goal Results Minneapolis: Healthy lakes, Rivers, and Streams; City of Minneapolis and MPRB, 2016). However, this problem extends beyond aquatic life. Water pollution also poses a significant health risk to plant and animal species that depend on water bodies for hydration and food sources and to visitors who depend on safe beaches and water bodies for recreational activities.

While MPRB must partner to achieve improved water quality, given all of the externalities that are not under MPRB's immediate control, the organization can work toward preventing any further degradation of water quality and enhancing aquatic habitat, wherever possible. Green infrastructure, such as rain gardens, bioswales, permeable pavers, and other devices designed to catch and filter stormwater before it enters waterbodies, are essential tools in this effort. Because they also require regular maintenance, it is important to include those requirements and costs in the scope of the project when green infrastructure is proposed.

Because invasive species in water can also impact aquatic habitat, MPRB's aquatic invasive species inspections, harvesting of aquatic invasive plants, and special studies to monitor and eradicate invasive fish are all building blocks toward protecting water quality, and by extension, aquatic habitat. According to the Minnesota Department of Natural Resources website, "all surface waters in Minnesota, including lakes, rivers, streams, and wetlands, are protected for aquatic life and recreation where these uses are attainable.

Protection of **aquatic life** means:

- maintenance of healthy, diverse, and successfully reproducing populations of aquatic organisms,
- protection of the aquatic community from the direct harmful effects of toxic substances,
- protection of human and wildlife consumers of fish or other aquatic organisms.

Protection of **aquatic recreation** means:

- maintenance of conditions suitable for swimming and other forms of recreation.

CASE STUDY SNAPSHOT: Invasive carp study

As a bottom-feeding fish, carp are capable of disturbing lake beds where phosphorous has settled. This diminishes water quality by creating algal blooms. Carp also eat and uproot vegetation, which can destroy a lake's aquatic plant community. Lakes with an overgrowth of carp typically have high phosphorus concentrations, low water clarity, and little to no aquatic plant growth.

In 2000-2001, carp were removed from Lake Nokomis as part of a broader water-quality project implemented by the Blue Water Partnership. Formed in 1998 by the MPRB, the City of Minneapolis and the Minnehaha Creek Watershed District (MCWD), the Blue Water Partnership also expanded three wetlands near Lake Nokomis to create settling ponds, installed two grit chambers near the lake; and installed two generations of weirs on Minnehaha Creek to keep pollution, stormwater, and invasive species out of Lake Nokomis.

From 2010 to 2016, the MCWD conducted a biomanipulation project to remove other "rough fish" species, such as bullhead; and also to stock predator fish that could eat fish linked to increased algae and turbidity.

Based on MPRB field staff's observations of carp in possibly excessive numbers, MCWD organized an electrofishing expedition on the lake as the initial step in estimating its carp population. Based on those estimates and research conducted by Minnesota Aquatic Invasive Species Research Center at the U of M, it was determined that Lake Nokomis' carp population had indeed reached a point where water quality could be affected.

In 2016, the MPRB was awarded LCCMR funding for a project to study Lake Nokomis' carp population by applying new research to a proven approach. The goal of the project is to develop long-term management practices that improve water quality.

MPRB and MCWD partnered with scientists at two local environmental consulting firms—WSB and Blue Water Science—to implement a project with three objectives:

1. *Determine carp population structure and monitor patterns of carp movement to determine optimal times for carp removal*
2. *Remove carp from the lake during periods when the fish have aggregated (or "schooled") during winter.*
3. *Implement an Integrated Pest Management plan to lessen future impacts of carp on the lake's water quality*

The project study area is the entire Lake Nokomis subwatershed, that includes Taft Lake, Mother Lake, Legion Lake, and several wetlands where carp are most likely migrating through storm sewers, open channels, and wetlands. Carp migrate so that they can spawn in lakes and wetlands that experience winter kill (when fish die in winter due to a lack of oxygen). This eliminates competition from other fish species that feed on carp eggs and larvae.

The project is estimated to run through December 2019.

LAND AND LIFE

Land management strategies in the parks are mindful of an ever-growing, ever-changing natural world. Environmental managers, naturalists, park keepers, planners, and recreation directors work collaboratively toward long term sustainability of the parks, their programs, and native plant and animal populations that reside within them. They do this through an extensive list of standards, best management practices, and protocols, but also through goal setting and policy direction. MPRB's greatest opportunity to protect life on the land it manages is to evaluate how the land is managed and to identify what, if anything, could be improved about managerial approach. Recently, this ongoing evaluation has resulted in changes to park board policies, ordinances, and invasive plant management techniques.

INTEGRATED PEST MANAGEMENT

MPRB's **Integrated Pest Management** (IPM) procedure, adopted in 2008, "uses 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."

Effective January 1, 2019, the MPRB Board of Commissioners placed a moratorium on all use of glyphosate, a common chemical herbicide, in all parks. While in the past few years glyphosate use was limited to regional parks, mostly as spot application to eradicate noxious weeds as required by the MDA and to reduce invasive species, this change in policy is hoped to eliminate potential health risks associated with the chemical from the entire park system.

Note: MPRB still needs to assess what the alternative removal methods will be and to assess relative effectiveness, increased cost for manual labor if needed, or change in aesthetics and function of landscapes.

TERRESTRIAL INVASIVE SPECIES

In select parks and natural areas, invasive plants are addressed aggressively and subsequently, several eradication projects are underway and planned. MPRB contracts for these services, works with volunteers, and partners with local non-profits, such as Friends of the Mississippi River, to tackle invasive plant removal and restoration work.

CASE STUDY SNAPSHOT: Biological controls—knapweed and purple loostrife by Marcia Holmberg

Biological control is a process used to manage invasive plants using bioagents, the natural enemies of a plant such as insects or pathogens. Before bioagents are approved for release there is a rigorous process of testing and assessment. This work involves scientific study and collaboration with many agencies across the country such as the US Department of Agriculture and State Departments of Agriculture and Natural Resources. Testing and assessment can also involve agencies in other countries in addition to those in the United States.

Intensive research minimizes the risk that a newly imported bioagent will have a negative impact on other species including commercial agriculture crops in the United States. Additionally, the bioagents cannot harm humans and should be easy to use for a biological control program.

MPRB collaborated with the MnDNR in the 1990s to rear and introduce leaf-feeding beetles as a biocontrol for purple loosestrife in Minneapolis parks. This program has been highly successful and currently the leaf feeding beetles are well-established in Minnesota and doing a good job of controlling purple loosestrife.

MPRB worked with the Minnesota Department of Agriculture in 2003 to release insects for control of Spotted Knapweed and Leafy spurge on the Cedar Lake Regional Bike trail prairie, former railroad land.

You will still see these plants present in the park system, as the goal of a biological control program is to reduce the plants and lessen their impact on the environment.

WILDLIFE POPULATION MANAGEMENT AND PROTECTION

To meet the demands of park users as well as maintain the natural systems within the parks, wildlife management techniques are sparingly employed, when needed, to address unsustainable wildlife populations. In these instances, MPRB management techniques are consistent with US Fish and Wildlife Service (USFWS) and Minnesota Department of Natural Resources (MnDNR) requirements as well as MPRB Park Police safety standards. Additionally, MPRB has been implementing goose management since the 1980s and has a MnDNR approved Goose Management Plan.

MPRB staff recognize that more can be done to protect turtles and frogs in the parks, and as they travel to and from nesting sites. A first step is for the MRPB to assess parkways and roads that traverse park property (or roads adjacent to parks) near permanent or ephemeral waterbodies. The assessment should include items such as traffic volume and road width, shoulder materials (gravel is very attractive to snapping turtles for nesting) and grade change, noting the quality of the adjacent habitat, and identify the types of turtles found in those areas. Mitigation strategies could be seasonal or permanent and could include low wildlife fencing to prevent crossing and redirect turtles, adding better nesting sites on the 'right' side of the road, or as high traffic roadways are rebuilt, work with the City, County and MNDOT to install ecopassages (see below) to provide safe, under road crossings that will benefit more turtles, frogs, and other animals.

Within Theodore Wirth Park, turtles face mortality trying to cross Highway 55 and Glenwood Ave near Wirth Lake, and along certain sections of Wirth Parkway. Other known turtle trouble spots include Portland Ave along Diamond Lake and the west side of Hiawatha Golf Course. There are also human, dog, and turtle interactions at Powderhorn Park, at almost all beaches, especially Lake Harriet, Bde Maka Ska, and Cedar, as well as Webber Natural Swimming Pool where the MPRB is trying to keep them out of the pool area.

Note: As MPRB continues to evaluate how wildlife protection strategies might be incorporated into its daily operations, construction and development standards should be revised to require wildlife friendly materials. Erosion control netting, in particular, poses a challenge to songbirds, ducklings, small mammals, amphibians and reptiles. Erosion control netting standards should require woven or unwelded mesh. It is critical that MPRB staff monitor construction contractors to ensure they are mindful of wildlife protection as they do their work.

LIGHT POLLUTION

Light pollution negatively impacts humans, wildlife and entire ecosystems. Nocturnal wildlife, including moths, are the most affected. For example, artificial light interferes with insects' normal night-day cycle and impacts feeding and reproduction. In addition, street lights and other night lights readily attract moths which increases their exposure to predators, resulting in overall decline in moth populations. A Swiss study showed that the mortality rate of urban insects is 40 to 100-fold greater than in rural populations, due in part to the effects of light pollution.

NOISE

According to the OSHA website, "with noise, Occupational Safety and Health Administration's permissible exposure limit (PEL) is 90 dBA for all workers for an 8 hour day. The OSHA standard uses a 5 dBA exchange rate. This means that when the noise level is increased by 5 dBA, the amount of time a person can be exposed to a certain noise level to receive the same dose is cut in half." Thus, noise is something to be mindful of when thinking of the effects it can have not only on park users, but wildlife in the parks. Research shows that human activities, in general, increase background noise by 30 decibels. Special events and programming within the parks can also raise the noise levels. Additionally, maintenance of park spaces can be especially noisy, given the use blowers, mowers, and other noise producing machinery.

HABITAT AREAS

The Minneapolis park system provides homes for birds, insects, mammals, reptiles, plants, and other living beings. Whether comprised of preserved remnant prairie or mown turf under flowering trees, parks provide a wide range of habitat types and qualities. Habitat is not limited only to "nature areas," though those carefully preserved and stewarded sites provide significant advantages. In an urban area like Minneapolis, habitat may be scarce between parks, making those green spaces even more critical for habitat needs than in suburban or rural areas with their large swaths of undeveloped land. MPRB is committed to providing habitat for plants and animals in its system, and it must strategically balance the needs of habitat and the needs of recreation. The master planning of the park system in recent years has identified new and improved habitat areas in almost all parks—neighborhood and regional. MPRB also, through the urban forest, has management responsibility over perhaps the greatest opportunity for habitat: the tree canopy, where local and migratory birds like to rest and nest and where mammals and insects can find forage.

There are two main considerations with habitat: its essential presence in parks, at a variety of scales and landscape types; and how it connects across the city. This section focuses on habitat enhancement in individual parks.

NATIONAL AUDUBON SOCIETY'S IMPORTANT BIRD AREA DESIGNATION

Realizing the important role Minneapolis' parkland corridor provides for bird life, representatives from Minneapolis' Audubon Society and ACM, with approval and support of the MPRB, applied for and obtained National Audubon Society's Important Bird Area (IBA) designation for Minneapolis Chain of Lakes and Theodore Wirth Regional Parks in 2009.

The IBA program is a global initiative that seeks to "identify and conserve areas that are vital to birds and other biodiversity by working with Audubon chapters, land owners, public agencies, community groups, and other non-profits, Audubon endeavors to interest and activate a broad network of supporters to ensure that all Important Bird Areas are properly managed and conserved" (National Audubon Society, 2010).

U.S. FISH AND WILDLIFE SERVICE'S URBAN MIGRATORY BIRD TREATY

The U. S. Fish and Wildlife Service (USFWS) declared in July 2011 that the City of Minneapolis, the MPRB, the City of Saint Paul, and Audubon Minnesota were successful in their application to be part of the Urban Migratory Bird Treaty (UMBT) program. There are three major goals for the program: protect, restore, and enhance urban habitats for birds; reduce urban hazards to birds; and to educate and engage urban citizens in caring about and conserving birds and their habitats. These goals encompass everything from simple actions like keeping cats indoors to changing building codes to require new construction to follow bird safe guidelines for glass and for landscaping.

The focus area for Minneapolis and Saint Paul's UMBT is the Mississippi River corridor. Projects have focused on restoration and creation of habitat, and education through native plant gardens and interpretive signs.

ROBERTS BIRD SANCTUARY

The Thomas Sadler Roberts Bird Sanctuary is within Minneapolis Chain of Lakes Regional Park and is within the Minneapolis Chain of Lakes/Theodore Wirth Important Bird Area, designated by the National Audubon Society. The Important Bird Areas Program is an effort to identify and conserve areas that are vital to birds and other biodiversity. By working with Audubon chapters, landowners, public agencies, community groups, and other non-profits, Audubon endeavors to interest and activate a broad network of supporters to ensure that all Important Bird Areas are properly managed and con¬served. Ecologically speaking, the park system's forested natural areas would be considered fragmented: broken into small patches by road ways, paths and park lands featuring primarily turf grass and man-made amenities.

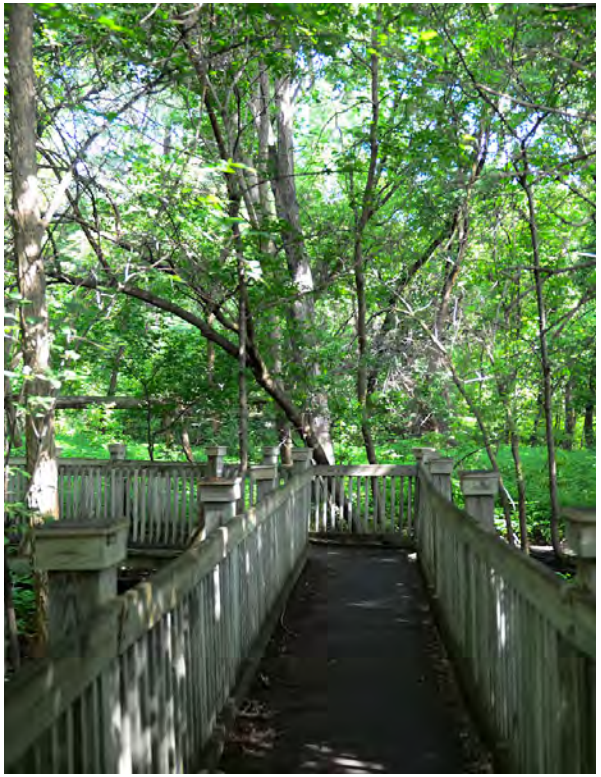
Lake Harriet, Lyndale Park and Lakewood Cemetery together total well over 300 acres of land. This acreage and the contiguous link to other parkland provides an important corridor of forest and waterways for wildlife, resident and migrating birds. White- tailed deer, turkey, fox and

Figure 32. Habitat Enhancement Zones. See appendix for full size map.

coyote have all been seen in and around the Roberts Bird Sanctuary area, as well as common urban wildlife such as raccoons and gray squirrels.

Three goals were developed for improving the condition of the Roberts Bird Sanctuary:

1. Protect, preserve, and enhance the bird habitat and native plants contained within the Sanctuary for present and future generations of people and wildlife;
2. Educate and inspire people about birds and their habitats, Minnesota native plants, and the natural world;
3. Provide a minimal infrastructure for the Sanctuary that honors the integrity of this undeveloped natural area as a bird sanctuary and a place that connects people with nature.



LEAVES

Leaves are another important consideration in tree-related habitat and land management within the parks. Leaves are essential to the survival of butterflies, moths, spiders, and dozens of arthropods. Many butterflies and moths overwinter as an egg, caterpillar, chrysalis or adult and use leaf litter for winter cover, protection from cold, and predators. For example, as cocoons and chrysalis, Luna moths and swallowtails are disguised as dried leaves, blending right in with the 'real' leaves. Mowing or shredding leaves means these cocoons and chrysalis are shredded too. The many small insects that live in leaves are an important food source for small mammals, birds, turtles, and amphibians. To support pollinators and the entire food chain within the park system, MPRB best practices should seek to follow guidelines published by the Xerxes Society and Leave the Leaves.

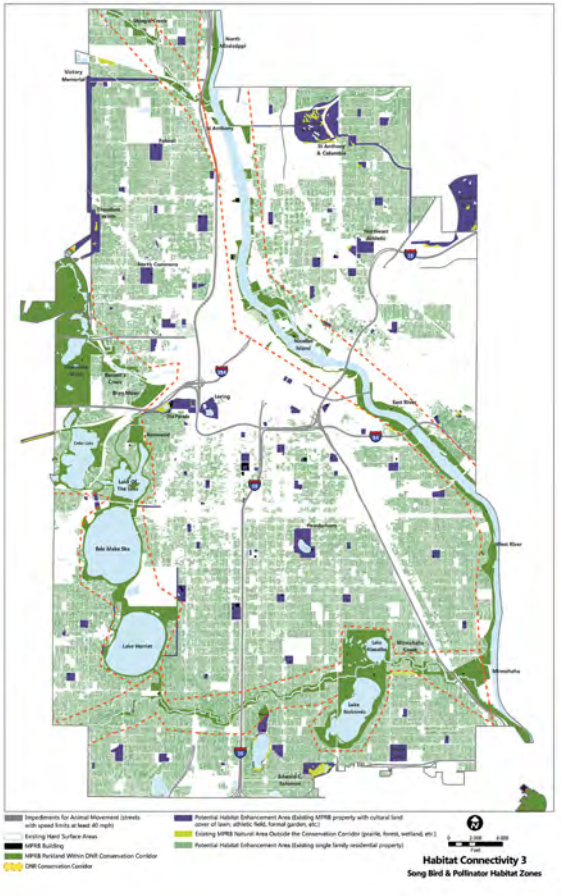


Figure 33. Song Bird & Pollinator Habitat Zones. See appendix for full size map.

POLLINATOR HABITAT

Another opportunity to improve habitat connectivity is in the creation of pollinator habitat. Given the ongoing decline of bee populations throughout the Midwest, it is critical that each city do what it can to give these essential species places to safely nest and do their work.

In 2011, the University of Minnesota Bee Lab reached out to MPRB Environmental Education staff about the possibility of placing bee "most wanted" posters at the gardens

in Lyndale Park. The Bee Lab was also working with the Xerces Society, a national non-profit dedicated to invertebrate conservation, to recruit volunteers to search for the rusty patched bumble bee (bombus affinis). This bee had rarely been seen in the previous 10 years. MPRB staff agreed to lead surveys in the park and volunteers have been helping conduct bee surveys in select parks every year since then. The rusty patched bumble bee has been found multiple times in the Minneapolis park system, including Lyndale Park. This is ecologically significant, as the rusty patched bumble bee was placed on the federal endangered species list in 2017.

From that initial connection, the Bee Lab and the MPRB Environmental Education department have worked together on many bee related projects and programs including an annual community party focused on bee and habitat education and moving people to action; a research project on flowering lawns, their impact to bee abundance and diversity as well as park visitor support for flowering lawns; incorporating bee lawn seed mixes into park projects; participating in the Minnesota Bee Atlas project for solitary nesting bees; and a new Pollinator Ambassador training program for teens.

A 2013 to 2014 survey of Eloise Butler Wildflower Garden & Bird Sanctuary's identified 104 species of bees including several uncommon or rare species, such as the rusty patched bumble bee. The study also identified plants that supported the greatest abundance of bees. These included New Jersey Tea, Queen of the Prairie, Bellflowers, Goldenrods, and native thistles.

As part of the Ecological System Plan development, MPRB partnered with Metro Blooms to map areas within Minneapolis that are most suited to the creation of pollinator habitat, including "sweet spots"-- the areas within the City of Minneapolis that would offer the greatest return on investment given the existing habitat quality and the potential to connect with other nearby habitat areas. This data has been shared with local and regional partners, including watershed districts and city and county departments to help begin a conversation about what might be tried both independently and together to expand pollinator habitat throughout the region.

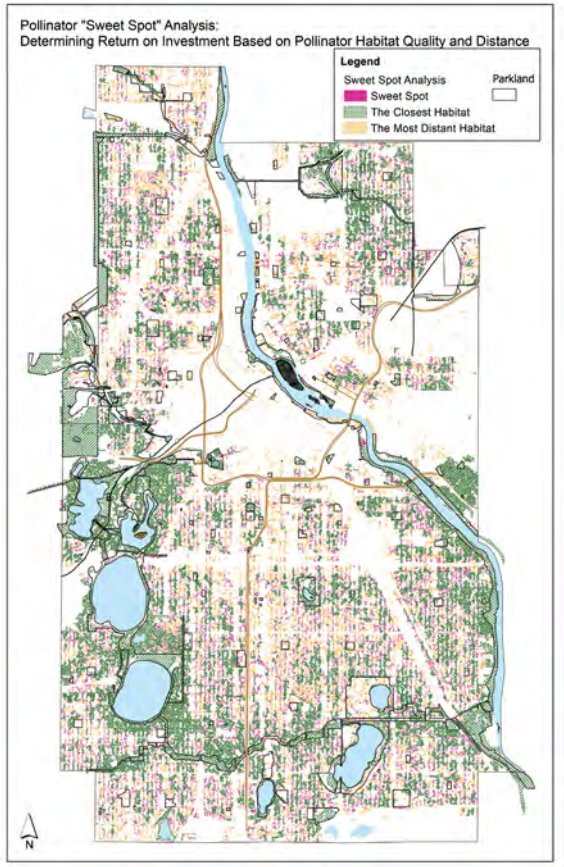


Figure 34. Pollinator "Sweet Spot" Analysis map. See appendix for full size map.

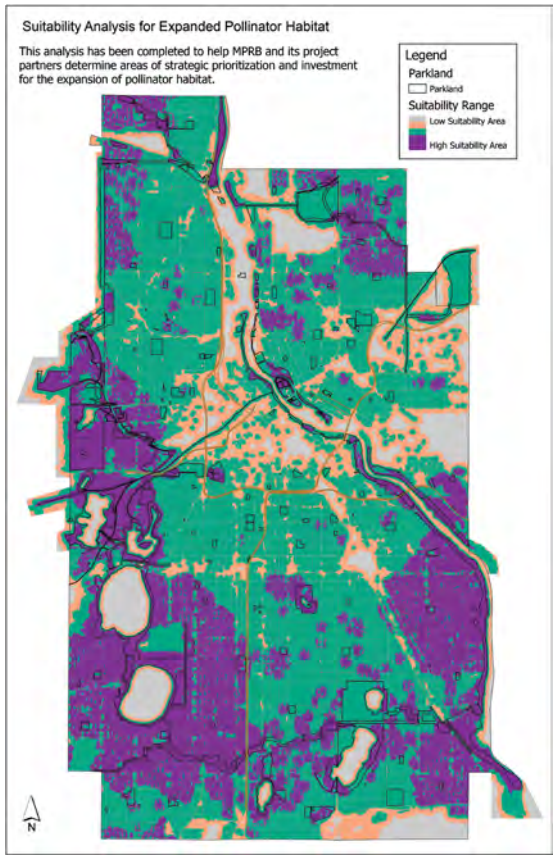
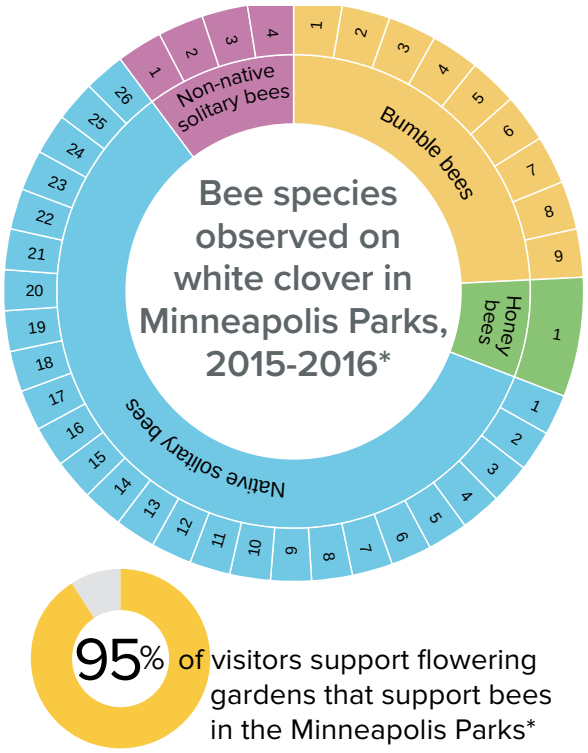


Figure 35. Suitability Analysis for Expanded Pollinator Habitat. See appendix for full size map.

Case Study Snapshot: Bee Lawn Benefits

In 2013 the University of Minnesota Bee Lab's project proposal, Enhancing Pollinator Landscapes, received funding from the Legislative-Citizen Commission on Minnesota Resources (LCCMR). The intent of the project was to develop an innovative way of helping pollinators by florally enhancing turf areas, otherwise known as Bee Lawns. This work had two parts. Part One was to run trials with native floral species to see which species could withstand mowing pressure and continue to flower when seeded into hardfescue. Part Two was to collect baseline data about bee diversity and abundance in existing typical turf areas. MPRB staff worked with student researchers to identify 11 Minneapolis park sites and one stormwater management area for monitoring to create the baseline data.

*Over the course of the 2015 growing season, this project monitored bee abundance and diversity at park sites with turf grass that had a consistent population of Dutch white clover (*Trifolium repens*). Working along a transect at each park site, approximately 1300 total specimens were captured. Findings showed that about 40% were honey bees, 29% bumblebees, and 31% other native bees.*



*MPRB and University of Minnesota Bee Lab collaboration project

Figure 36. Bees in the Minneapolis Parks

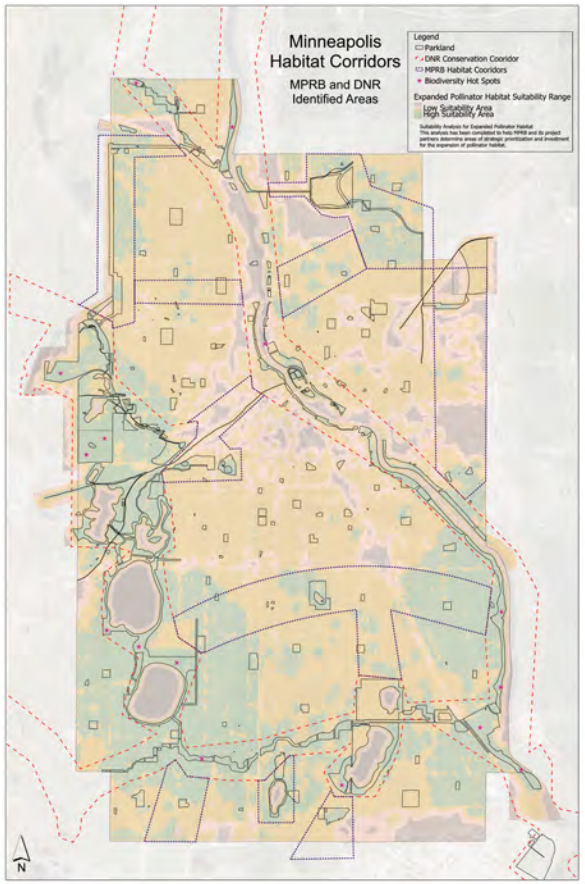


Figure 37. Habitat Corridors. See appendix for full size map.

*At the same time, the Bee Lab identified a few promising native plant species that could help enhance lawns including Calico aster (*Symphyotrichum lateriflorum*), creeping thyme (*Thymus serpyllum*), and Self-heal (*Prunella vulgaris ssp. Lanceolata*). Within the turf areas planted with Self-heal at the U of MN, researchers found zero honey bees, 38% bumblebees, and 62% other native bees.*

In Part Two of the project, four parks with clover were left as is and served as control sites, and four other clover sites were seeded or planted with plugs of creeping thyme and self-heal. Researchers then conducted bee surveys to discover if bee abundance and diversity changed as the result of a more florally diverse lawn. Findings showed that florally enhanced lawns support greater bee diversity than clover only lawns, and the bees that use Dutch white clover are different from the bees that use self-heal and creeping thyme.

Part Two of the project also included a survey of more than 500 Minneapolis park visitors to determine their attitudes towards bees, flowering lawns, and support for flowering lawns in parks. An amazing 91% of those surveyed strongly or moderately supported flowering lawns in Minneapolis parks. Researchers also held focus groups with MPRB asset management staff, and land managers from other parks, and city departments to share flowering lawn findings, as well as listen for common concerns or potential barriers to implementing flowering lawns.

It became clear through this process that incorporating enhanced flowering lawns throughout the park system is an easy, cost effective, and community supported way for MPRB to support pollinators.

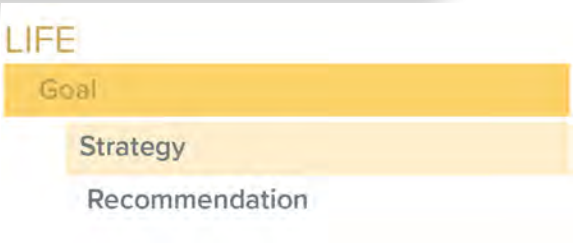
HABITAT CONNECTIVITY

To be most effective, habitat areas should connect together, creating a city-wide network of protected corridors rich with forage. The Department of Natural Resources has identified several "Conservation Corridors" in the city, mainly following established watercourses like the Mississippi River, Minnehaha Creek, and the Chain of Lakes. As part of the Ecological System Plan, MPRB examined habitat areas within its own system and also partnered with Metro Blooms to generate a "pollinator sweet spot" map. This analysis looks at the most effective return on investment in habitat enhancement, based on proximity to existing habitat. This map, coupled with habitat potential on MPRB lands (focusing specifically on birds and pollinator insects), shows how habitat connectivity could expand beyond the DNR Conservation Corridors. The result of all this analysis is a new MPRB Habitat Corridors map. It builds on the DNR's map but adds new linkages across town, essentially island-hopping between major habitat corridors.

This new habitat map can be used to prioritize habitat projects, select street tree species, and strategically target partnerships for private land improvements and community projects. Furthermore, this map shows habitat corridors that touch all parts of the city, not just those blessed with "automatic" habitat areas like lakes and rivers. Improving habitat areas and linkages on the north side, the upper south, and northeast is potentially more important in terms of overall ecological health, because these areas tend to have poorer air quality and lower human health outcomes than elsewhere. Habitat is good for plants and animals, but it is also good for people.

Life Goals, Strategies, and Recommendations

Most of the goals, strategies, and recommendations in the previous Water, Air, and Land chapters all touch on life. Overall, the goals in this plan recognize the interconnected web of ecology that exists in Minneapolis, the region, state, nation, and world. This chapter focuses on birds, mammals, insects, fish, and plants and how MPRB can improve life for them in the parks. Often, when paired together, goals can result in stacked benefits that contribute more toward the protection of life in parks than when pursued individually. It is critical that MPRB look for opportunities to achieve these stacked benefits whenever possible because, in addition to the ecological advantages they offer, they often achieve greater operational and budgetary efficiencies than independent projects. Nevertheless, the following pages include goals, strategies, and recommendations that specifically address life in all its myriad forms.



I. LIFE: PROTECT AND ENHANCE HABITAT QUALITY IN PARKS

31. Identify potential habitat areas in most parks as part of master planning efforts

32. Develop and update baseline data on wildlife in the parks, including birds, mammals, amphibians, reptiles, insects, fish, and invertebrates, using citizen science, Bio Blitzes, and other techniques

33. Reduce total acreage of turf by transitioning from turf-focused parks management to a mixture of turf and naturalized areas

33.1. Develop maintenance guidelines for natural areas

33.2. Develop staffing plans that will allow for an expansion of naturalized areas in the parks, including additional ecologist positions, park-keeper/gardener-type positions devoted to naturalized areas, and analysis of cost and staffing impact on organization

33.3. Continue to work with local partners to restore and manage natural areas, guided by park master plans and approved agreements

33.4. Expand use of fescue and drought tolerant grasses, including native plants

33.5. Complete analysis of sites most suited to pollinator-friendly habitat, including pollinator lawns, map their acreage over time, and monitor success

33.6. Reassess equipment suitability and mowing heights to protect bird, bee, and butterfly habitat.

33.7. Prepare prescriptive mowing plans that address height, frequency, timing, and landscape slope in order to protect habitat

34. Enhance management of natural and naturalized areas in parks

34.1. Complete Natural Areas Management Plan

34.2. Increase technology capability in the field to include definitions, maps, methods, and standards of maintenance

34.3. Map both formal and ad-hoc natural surface trails in the park system and identify those in need of improvement or closure to protect natural resources and to mitigate shoreline deterioration

34.4. Increase interdepartmental coordination on plantings, mowing, sight lines, and general landscape management planning

34.5. Identify areas where standing or fallen dead wood can be left to enhance habitat

35. Develop an invasive species management strategy, in keeping with IPM principles, working with state, local, and academic partners advisory groups

36. Limit use of pesticides and fertilizers

36.1. Continue to reduce pesticide and fertilizer applications, based on research-driven recommendations from partners and advisory groups

36.2. Develop and maintain Pest Management Plan for facilities, consistent with IPM program

37. Organize and activate volunteers to enhance management of natural and naturalized areas throughout the park system

37.1. Replicate and expand effective current volunteer projects and activities
37.2. Train field staff to coordinate with and support volunteer efforts
37.3. Expand MPRB volunteer coordination capability to promote volunteerism and to train, monitor, and recognize volunteers

J. LIFE: INCREASE HABITAT CONNECTIVITY THROUGHOUT THE CITY

38. Implement identified habitat corridors (see map)

38.1. Prioritize planting of bird- and pollinator-friendly vegetation, including street trees, within designated corridors, which include the Mississippi River Flyway, the Chain of Lakes, Wirth Park, Minnehaha Creek, Lakes Nokomis and Hiawatha, and several corridors newly proposed and shown on the "Minneapolis Habitat Corridors" map

38.2. Prioritize preservation of existing habitat and restoration and enhancement of new habitat within the designated corridors, with particular focus on preserving and re-storing historic ecotypes

38.3. Work with public, private, and nonprofit partners within identified corridors to implement habitat restoration and enhancement projects, including blooming boulevards, green alleys, habitat enhancement on public lands, etc.

38.4. Research, track, and report on plant life that will offer best pollinator habitat throughout the growing season, working with state, local, and academic partners

38.5. Identify and implement ways to mitigate effects on wildlife corridors during planning, construction, and programming

39. Implement wildlife protection strategies for park projects and facilities and at significant roadway crossings

39.1. Identify sites with largest number of animal-roadway conflicts, working with partner agencies, as necessary, and implement changes to reduce those conflicts

39.2. Develop and implement wildlife-friendly construction and maintenance standards, policies, and procedures (including ramps, turtle tunnels, curb cuts, signed crossings, temporary fences, seasonal signage, wildlife-friendly erosion control netting, etc.)

39.3. Reduce hazards to birds associated with built infrastructure, including buildings, through bird-safe glass, lighting modifications, and other practices

40. Increase public and staff education about wildlife and ecology

40.1. Add interpretive and educational signage in parks that speaks to the value and benefits of ecosystems and wildlife, the importance of birds and wildlife, and the variety of habitats in the MPRB system.

40.2. Continue to develop and disseminate educational resources on the above topics in the form of classes, events, printed literature, maps, videos, or other media

K. LIFE: PROTECT, MAINTAIN, AND EXPAND URBAN FOREST

41. Maintain and expand extents of the forest canopy

41.1. Set specific and realistic goals for city-wide urban forest canopy coverage, with input from the Minneapolis Tree Advisory Commission, and share publicly

41.2. Improve integration of forestry with capital projects in parks, to minimize tree removal and to capitalize on opportunities to increase urban canopy through post-project planting

41.3. Identify areas where soil compaction around trees is an issue due to general use or events, and implement remedies

41.4. Expand pruning of young trees to ensure proper shaping and health as they mature

41.5. Continue pest monitoring and management programs in partnership with federal, state, and local agencies

42. Increase urban forest diversity to make it more resilient to climate change and invasive pests

42.1. Continue to partner with University of Minnesota to research and pilot new tree species in Minneapolis within the public urban forest

42.2. Increase number of tree species and reduce overall percentage of single species as replanting takes place

42.3. Continue to partner with the City of Minneapolis and University of Minnesota to support educating the public on what trees to plant based on future climate forecasts and ways to help support the public urban forest.

L. LIFE: PROTECT AND ENHANCE AQUATIC HABITAT

43. Protect lakes, wetlands, and waterways from aquatic invasive species

43.1. Prepare an Aquatic Invasive Species Management Plan based on the Zebra Mussel Action Plan and Nokomis Carp Management Study

43.2. Continue AIS prevention and early detection programs

43.3. Update IPM to address aquatic and wetland plants

44. Develop an Aquatic Plant Management Plan that addresses fish habitat

44.1. Perform more frequent lake surveys

44.2. Plan and implement aquatic vegetation improvements that enhance habitat for fish, waterfowl, aquatic mammals, reptiles, amphibians, and invertebrates

44.3. Evaluate efficacy and need of aeration systems at the end of each system's useful life

45. Work with local, regional, and state partners to monitor and address mosquito issues

45.1. Plan and design structural BMPs so they are not breeding areas for mosquitoes, per Metropolitan Mosquito Control District (MMCD) recommendations.

45.2. Partner with MMCD on a public information campaign about biological mosquito control

M. REMAIN ACCOUNTABLE AND ADAPT WITH THE EVOLVING WORLD

46. Create interactive map layers in GIS based on the maps included in this document and make them publicly available on the MPRB website

47. Update this plan's implementation checklist and report at least annually to the MPRB Commissioners and general public

48. Review each recommendation to determine which require actionable milestones that can be tracked over time, then develop those milestones

49. Communicate and coordinate plan implementation responsibilities of all departments and divisions

50. Update and modify this plan to account for evolving and emerging technologies every three years