COMMUNITY ASSISTANCE
PLANNING REPORT NO. 330

A RESTORATION PLAN FOR THE OAK CREEK WATERSHED

VOLUME 2: CHAPTER 6

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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NUMBER 330

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VOLUME 2: CHAPTER 6

Prepared by the
Southeastern Wisconsin Regional Planning Commission
W239 N1812 Rockwood Drive
P.O. Box 1607
Waukesha, Wisconsin 53187-1607
www.sewrpc.org

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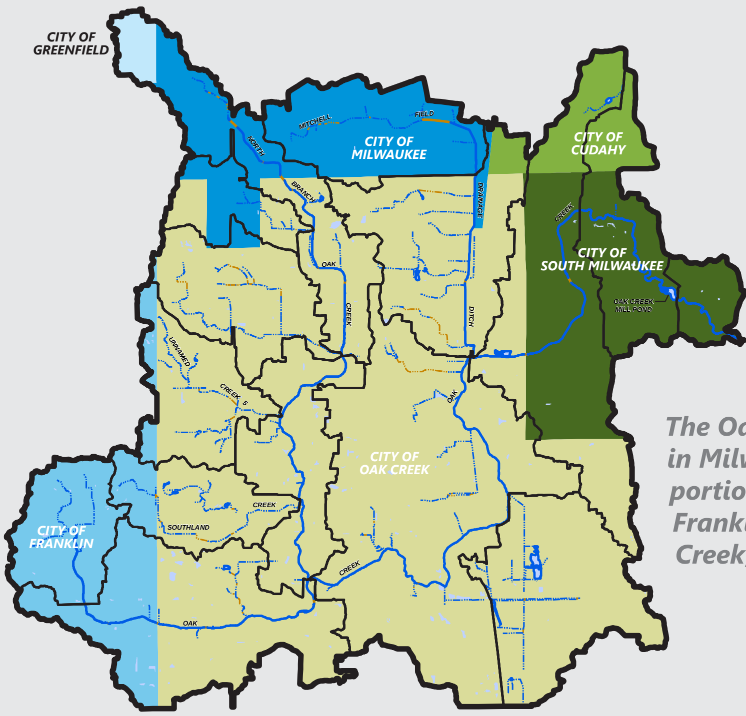
December 2021

A RESTORATION PLAN FOR THE OAK CREEK WATERSHED

EXECUTIVE SUMMARY



OAK CREEK WATERSHED FUTURE

The Oak Creek watershed is located in Milwaukee County and includes portions of the Cities of Cudahy, Franklin, Greenfield, Milwaukee, Oak Creek, and South Milwaukee.

PURPOSE

The Oak Creek Watershed Restoration Plan (Plan) is a comprehensive resource developed to provide a set of specific, targeted recommendations to improve Oak Creek, its tributaries, and the watershed as a whole. The recommendations are for focused implementation over the next thirty years, but the Plan is comprehensive in scope and it is likely that it will be implemented well beyond that timeframe.

The Plan is coordinated with other recent plans and recommendations. Notably, the 2007 SEWRPC regional water quality management plan update provides comprehensive recommendations related to land use, pollution abatement, and water quality management that are directly related to the Oak Creek watershed. This Plan includes a detailed review of the implementation status of these recommendations.

This Plan is also intended to meet the U.S. Environmental Protection Agency's Nine Key Elements for a Watershed Plan. The elements specify requirements that include identifying the sources of pollutants, describing watershed management measures and timeline for implementation, estimating costs, setting milestones and criteria for plan progress, and providing information and education.

The four focus areas for this Plan include water quality, habitat, recreational access and use, and targeted flooding. A review for these focus areas was also completed specifically for the Mill Pond and Mill Pond dam near the downstream end of the watershed in the City of South Milwaukee. This Plan was developed in consultation with an Advisory Group of experts and interested parties. Stakeholders participated through the project webpage and numerous public meetings.

The Oak Creek Watershed Restoration Plan seeks to preserve, restore, and enrich the natural environment by focusing on these four areas:

- Water Quality
- Habitat Conditions
- Recreational Access and Use
- Flooding

A RESTORATION PLAN FOR THE OAK CREEK WATERSHED

PLAN SUMMARY

The Oak Creek Watershed Restoration Plan is divided into six chapters and 21 appendices. The first three chapters provide background on how the Plan was developed, prior work that has been completed in the watershed that relates to this Plan, and a general characterization of the watershed.

The fourth Plan chapter provides a detailed inventory of the state of the watershed based on research, field surveys, and existing data. Major findings for each category are summarized below.

Stream Characteristics

Commission staff surveyed about 22 miles of Oak Creek, North Branch Oak Creek, and the Mitchell Field Drainage Ditch inventorying and geolocating stream components such as channel and water dimensions, habitat types, streambank erosion, outfalls, culverts and bridges, large debris jams, and large trash items. Historical modifications to the stream channels, the loss of wetlands, and increases in impervious surfaces due to rapid urbanization have led to many impairments to Oak Creek and its tributaries. Impairments include excessive streambed and bank erosion, disconnection of the streams from a functional floodplain, excessive sedimentation, and loss of critical instream and terrestrial habitat. In addition, impediments to aquatic organism passage between Oak Creek, its tributaries, and Lake Michigan have contributed to a relatively poor-quality aquatic organism community.

Commission staff conducted instream surveys to assess the existing conditions of the waterways. This included an assessment of habitat conditions and an inventory of the physical attributes and infrastructure associated with the stream system.

Water Quantity

Flows on Oak Creek are very flashy and adversely impact the streams of the watershed. Stream and stormwater flooding impacts are scattered throughout the watershed.

Mill Pond and Dam

The Mill Pond has significant sediment accumulation that has adversely impacted its water quality, fishery, and recreational use. The Mill Pond dam is in good condition, except that its maintenance sluice gate is inoperable.

Surface Water Quality

While instream levels of pH and concentrations of total suspended solids and some heavy metals have improved, high concentrations of fecal indicator bacteria, total phosphorus, total nitrogen, and chloride are present and constitute ongoing water quality problems. Low concentrations of dissolved oxygen are present in some tributaries and the upper reaches of Oak Creek, which is another water quality problem.

High levels of bacteria have been found in streams within the Oak Creek watershed. Potential sources of bacteria include wildlife, pet waste, or cross-connections between sanitary and storm sewers. The presence of dry-weather flow from stormwater outfalls may be an indication of illicit connections to the storm sewer system

Biological Conditions

While the quality of the biological community in some reaches of the mainstem of Oak Creek has improved, the watershed contains poor to fair quality fish and aquatic macroinvertebrate communities, reflecting the combined effects of poor water quality, habitat alteration, and habitat fragmentation.

Recreational Access and Use

Commission staff conducted various recreational use surveys to better understand the patterns of outdoor recreation throughout the watershed. The existing 1,165 acres of County Parkway, 12 miles of Oak Leaf Trail, the many acres of parks and open spaces, the Mill Pond warming house, and fishing access offer good opportunities for outdoor recreation along Oak Creek. Interested plan participants expressed a desire for additional recreational opportunities including high quality trails that support walking, hiking, and bicycling and restoration of the Mill Pond area.

The Oak Creek watershed contains many miles of recreational trails, including over 12 miles of Oak Leaf Trail and over nine miles of Forked Aster trails that support walking, hiking, biking, and other passive recreational uses.

Fishing is an important recreational activity in the Oak Creek watershed. The most popular fishing locations are located between the Creek's confluence with Lake Michigan and the Mill Pond dam. During the fall, this stretch is known for its salmon and brown trout runs.

The fifth chapter of the Plan summarizes the goals and management objectives to improve conditions in the watershed. These goals and objectives were used to develop the Plan recommendations.

PLAN RECOMMENDATIONS

The sixth and final Plan chapter summarizes the recommendations to improve conditions related to water quality, habitat, recreational access and use, flooding, and the Mill Pond and dam in the Oak Creek watershed. This includes a list of projects to be implemented over time. Recommendations include the following types of projects.

Water Quality

The Plan includes recommendations to address water pollution from point sources and urban and rural runoff. A major emphasis is placed on installing green infrastructure. The Plan also includes recommendations for implementing innovative runoff management practices to address specific pollutants such as phosphorus and pathogens. In addition, the Plan offers example stormwater management projects to retrofit current infrastructure for both water quantity and quality improvements.

Strategies to Reduce Pollution from Urban Runoff:

Grassed swales	Rain barrels	Fertilizer application controls
Bioretention facilities	Soil amendments	Pet litter and debris controls
Rain gardens	Pervious pavement	Iron enhanced sand filters
Green roofs	Stormwater treatment facilities	Riparian buffers
Native landscaping	Storm sewer systems	Regenerative stormwater conveyance
Cisterns	Leaf and lawn waste management	Nuisance waterfowl control

A RESTORATION PLAN FOR THE OAK CREEK WATERSHED

Recommended Water Quality Monitoring Includes Analyzing Indicators Related To:

Dissolved oxygen	Metals	Phosphorus	Water flow
Fecal indicator bacteria	Nitrogen compounds	Stream invertebrates	Water temperature
Fish	Organic compounds	Suspended solids	Water transparency

Habitat

Recommended actions include re-establishing natural surface water hydrology; protecting, restoring, expanding, and connecting riparian buffers; restoring and connecting wildlife habitat; restoring the quality and diversity of instream habitat; mitigating the negative impacts on aquatic and terrestrial ecosystems that are associated with climate change; and reducing trash and debris within the stream channels and riparian areas.

A well-connected floodplain can provide many beneficial functions related to water quality, aquatic and terrestrial wildlife habitat, and flood reduction. Many stream reaches within the Oak Creek watershed have been disconnected from their floodplains through channelization and erosion of the streambeds. An important recommendation in this Plan is to improve the connection of streams to a functional floodplain.

Recreational Access and Use

Recommended actions include providing a better connected trail system to both local and regional trail systems; continue to expand passive recreational opportunities throughout the watershed; pursue opportunities for voluntary acquisitions of lands adjacent to publicly owned open spaces; additional access sites for fishing; examine additional uses for the Mill Pond warming house; and continue to strive for equal access and use of recreational facilities for all interested users.

Targeted Flooding

Due to the scattered nature of flooding concerns, solutions should be evaluated on a case-by-case basis as opportunities arise. Retaining runoff onsite as much as possible and protecting areas for infiltration and flood storage is also recommended.

Mill Pond and Dam

Five alternatives and one optional spillway enhancement are summarized to improve the Mill Pond and dam area. Sediment core sampling in the Mill Pond is recommended to refine the alternatives.

The final chapter also provides details regarding Plan implementation, including public participation, measuring plan success—including water quality monitoring, a schedule and interim milestones, and potential funding sources.

The Oak Creek Watershed Restoration Plan can be accessed online at:
www.sewrpc.org/OakCreekWRP

For more information please contact
lherrick@sewrpc.org

VOLUME 1: CHAPTERS 1 – 5

VOLUME 2: CHAPTER 6

VOLUME 3: APPENDICES

CHAPTER 6

LIST OF FIGURES

LIST OF MAPS

LIST OF TABLES

Credit: SEWRPC Staff

PLAN RECOMMENDATIONS 6

6.1 INTRODUCTION

As noted in Chapter I, the purpose of the Oak Creek watershed restoration plan is to provide a set of specific, targeted recommendations that can be implemented over time to produce improvements relative to a set of focus issues related to conditions in the watershed. The recommendations address four focus areas: water quality, recreational access and use, habitat conditions, and targeted stormwater drainage and flooding issues. In addition, this plan addresses the status of the Oak Creek Mill Pond and the associated dam, considering their relationship to multiple focus issues. The improvements that would result from implementing the recommendations represent steps toward achieving the overall goal of restoring and improving the water resources and other natural resources of the Oak Creek watershed.

This watershed restoration plan was prepared in the context of the Southeastern Wisconsin Regional Planning Commission's (SEWRPC) regional water quality management plan update for the greater Milwaukee watersheds (RWQMPU),[1] which was prepared in coordination with, and largely incorporates, the Milwaukee Metropolitan Sewerage District's (MMSD) 2020 facilities plan.[2] The recommendations of the RWQMPU as they pertain to the Oak Creek watershed and the status of their implementation are summarized in Chapter 2 of this report. In addition to addressing the recommendations of the RWQMPU, this watershed restoration plan also seeks to incorporate those elements of recent and ongoing watershed management programs and initiatives that are related to the restoration plan's focus areas and are consistent with and complement the goals of the RWQMPU. These programs and initiatives are also inventoried and reviewed in Chapter 2 of this report. This plan represents a refinement of the RWQMPU and enables successful implementation of recommendations at a smaller, 28-square mile watershed scale.

This chapter presents the recommended watershed restoration plan. This plan is designed to meet the goals presented in Chapter 5 of this report. Those goals consist of management objectives or steps related to the focus issues that must be achieved to meet the long-term goals established in the RWQMPU. The plan was also prepared to meet the U.S. Environmental Protection Agency's (USEPA) nine minimum elements for a

[1] *SEWRPC Planning Report No. 50,* A Regional Water Quality Management Plan Update for the Greater Milwaukee Watersheds, *December 2007.*

[2] *Milwaukee Metropolitan Sewerage District,* MMSD 2020 Facilities Plan, *June 2007.*

watershed-based plan and to serve as a practical guide for the management of water resources within the Oak Creek watershed and for the management of the land surfaces that drain, directly and indirectly to Oak Creek and its tributaries. The plan includes both general recommendations related to the management of the watershed and a list of specific projects intended to contribute to meeting the management objectives established in Chapter 5. The general and specific types of recommendations made under this plan are described below.

Recommended Actions and Environmental Justice Populations

Improving equitable access to opportunity for all of the Region's residents is one of the important themes that guided the preparation and evaluation of recommendations throughout the VISION 2050 Recommended Regional Land Use and Transportation Plan.[3] As part of VISION 2050, Commission staff completed an equity analysis to evaluate whether the benefits and impacts of the recommended plan would be shared fairly and equitably among different populations in the Region. The equity analysis evaluated how areas with higher-than-average proportions of people of color, families in poverty, and people with disabilities (environmental justice populations) will be served by the recommendations made in the plan.[4] Each of the VISION 2050 land use recommendations was evaluated based on the degree to which the Region's environmental justice populations would receive a proportionate share of benefits or a disproportionate share of adverse impacts compared to the Region's population as a whole. The equity analysis concluded that all of the land use recommendations would have a positive impact on the Region's populations as a whole and none of the recommendations would have an adverse impact on environmental justice populations.[5]

According to Maps L.1 through L.5 in Appendix L of VISION 2050, portions of the Oak Creek watershed are home to areas with higher-than-average minority populations, families in poverty, and people with disabilities when compared to the Region as a whole. The land use recommendations provided in VISION 2050 were used as a foundation for developing both general and specific recommendations to address the four focus areas of this watershed restoration plan. It is through this framework that recommendations were developed with the goal of having a positive impact on the watershed's population as a whole, including environmental justice populations within the watershed. In particular, the following land use recommendations from VISON 2050 served as a foundation for developing this Oak Creek watershed restoration plan:

- Reserve land for parks and open space as residential neighborhoods are developed within urban service areas
- Preserve primary environmental corridors, secondary environmental corridors, isolated natural resource areas, natural areas, and critical species habitat sites to contribute to the health of the Region's natural resource base as well as that of the Region's residents
- Preserve areas with high groundwater recharge potential to protect the groundwater supply for those populations in the Region that depend on it for drinking water and for the Region-wide water quality and aquatic habitat benefits that groundwater provides to the baseflow of streams, rivers, and lakes
- Manage stormwater through compact development and sustainable development practices that minimize the total impervious surface coverage of new development, thus reducing future loads of pollutants delivered to the Region's streams, rivers, and lakes
- Target brownfield sites for redevelopment to revitalize underutilized or vacant properties

Many of the general and specific recommendations developed as part of this watershed restoration plan will also improve community resiliency to the impacts of climate change, improve access to outdoor recreational opportunities, and could have a positive impact on the overall health of the watershed's population as whole, including environmental justice populations.

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[3] *SEWRPC Planning Report No. 55,* VISION 2050, Volume III: Recommended Regional Land Use and Transportation Plan for Southeastern Wisconsin*, 2nd Edition, June 2020.*

[4] *Higher-than average proportions were determined relative to the Region as a whole.*

[5] *See Appendix L of SEWRPC 2050,* op. cit.

General Recommendations

Unless otherwise indicated, general recommendations are intended to be applicable over the entire watershed. These recommendations provide guidance for the management of natural resources within the watershed with respect to a variety of general and specific factors and issues that contribute to the problems related to each of the focus areas. These problems are identified in Chapters 4 and 5. While general recommendations are presented for each focus area, it should be kept in mind that implementation of many of these recommendations will also have beneficial effects on other focus areas. For example, implementing some urban stormwater management measures intended to address the water quality focus area by reducing the contributions of sediment to surface waters may also act to address the habitat focus area by reducing deposition of sediment in stream channels. It should be recognized that placing a recommendation within a focus area or within a category under a focus area is partially a matter of presentation.

In many instances, the general recommendations made for the Oak Creek watershed reflect recommendations that were made under the RWQMPU. Several of the general recommendations presented in this chapter consist of refinements of RWQMPU recommendations. These refinements reflect a number of factors, including specific conditions and circumstances in the Oak Creek watershed and additional data and knowledge that have become available since the release of the RWQMPU in 2007.

Specific Project Recommendations

This watershed restoration plan also presents recommendations for implementing specific projects. These projects represent specific actions that could be taken to partially implement the general recommendations discussed above. These project locations are shown on Maps 6.1 through 6.13 and listed and summarized in Table 6.1.

The list of specific projects recommended in Table 6.1 was assembled from several sources. Many were suggested by members of the public at an August 30, 2016, meeting of stakeholders that was held to solicit such suggestions. Other projects were suggested in plans or engineering surveys and reports that were developed for local units of government that are located within the watershed. Additional projects were suggested during discussions with staff from State agencies, County and municipal departments, MMSD, and interested nongovernmental organizations. Many recommended projects were suggested by the findings of a field survey of stream physical conditions and instream habitat conducted by Commission staff along Oak Creek, the North Branch of Oak Creek, and a portion of the Mitchell Field Drainage Ditch.[6]

Table 6.1 summarizes several aspects of each recommended project. The summarized aspects include:

- Identification of the focus area or areas that the project addresses. It should be noted that many projects address more than one focus area. For example, while projects addressing streambank erosion directly address the habitat focus area, they also address the water quality focus area because eroding streambanks act as a source of sediment and total suspended solids (TSS) to streams.

- Description of the project site. This description includes a written description of the location, the municipality or municipalities in which the project site is located, and the owner of the site. Project locations are also shown on Maps 6.1 through 6.13.

- A brief description of the recommended management action.

- Estimates of annual pollutant load reductions that would result from implementing the project. These are given where they were either developed in modeling results presented in engineering reports or where enough information regarding the project was available to allow for the development of an estimate.

- Identification of potential partners for implementing the recommended project.

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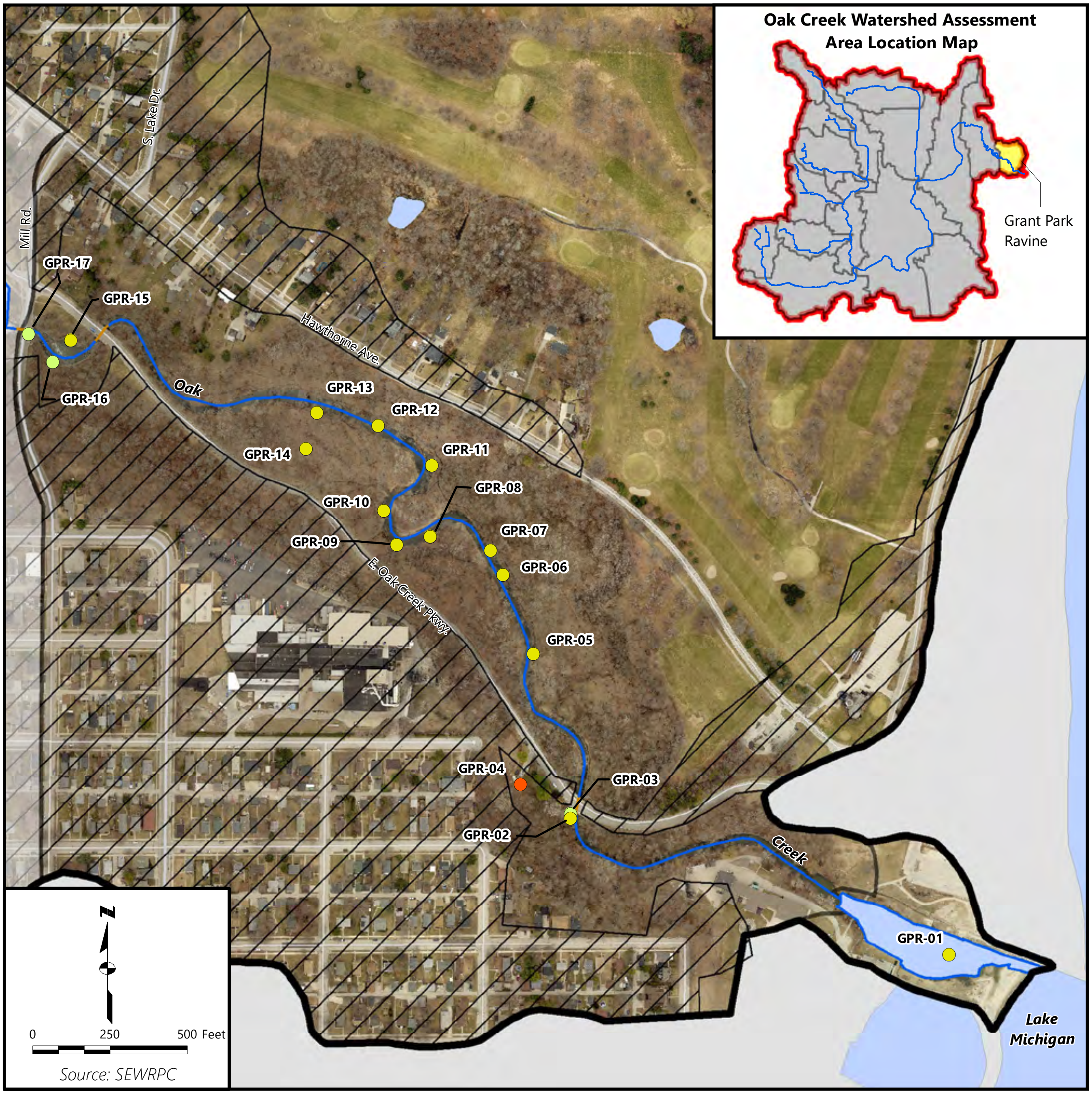
[6] *The results of these surveys are presented in Chapter 4 of this report.*

Map 6.1
Recommended Projects Within the Grant Park Ravine Assessment Area



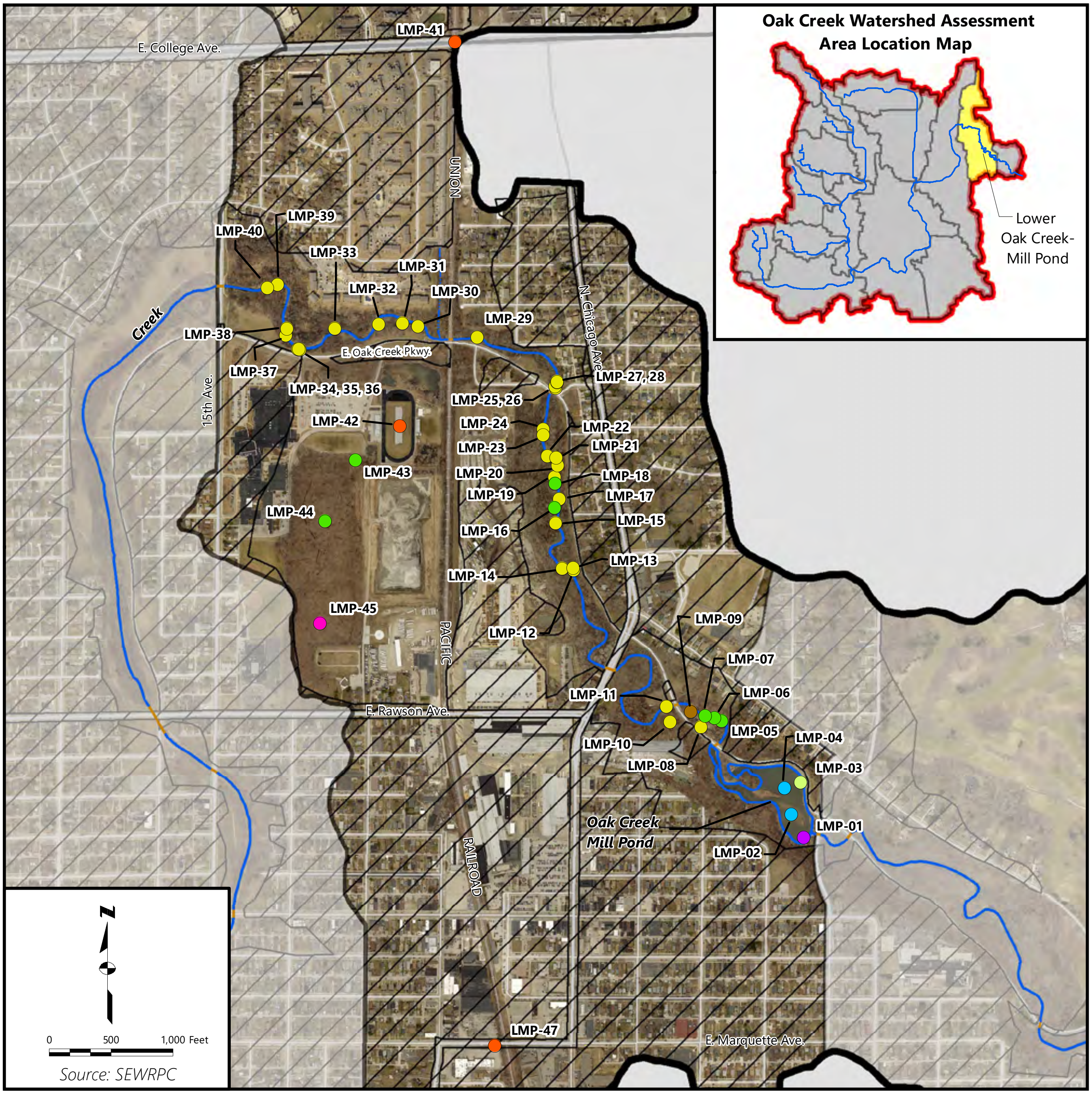
- HABITAT AND WATER QUALITY PROJECT
- WATER QUALITY AND RECREATIONAL USE AND ACCESS PROJECT
- STORMWATER DRAINAGE/FLOODING PROJECT

GPR-17 PROJECT ID IN TABLE 6.1

- AREA SERVED BY MS4
- OAK CREEK WATERSHED BOUNDARY
- ASSESSMENT AREA BOUNDARIES
- PERENNIAL STREAM
- PERENNIAL STREAM (ENCLOSED)
- INTERMITTENT STREAM
- INTERMITTENT STREAM (ENCLOSED)
- SURFACE WATER

NOTE: Points on this map indicate general area of the project. Some projects include larger reaches of stream or portions of land. See Table 6.1 for project details. No specific projects are proposed for areas of this assessment area that are not shown.

Map 6.2
Recommended Projects Within the Lower Oak Creek Mill Pond Assessment Area

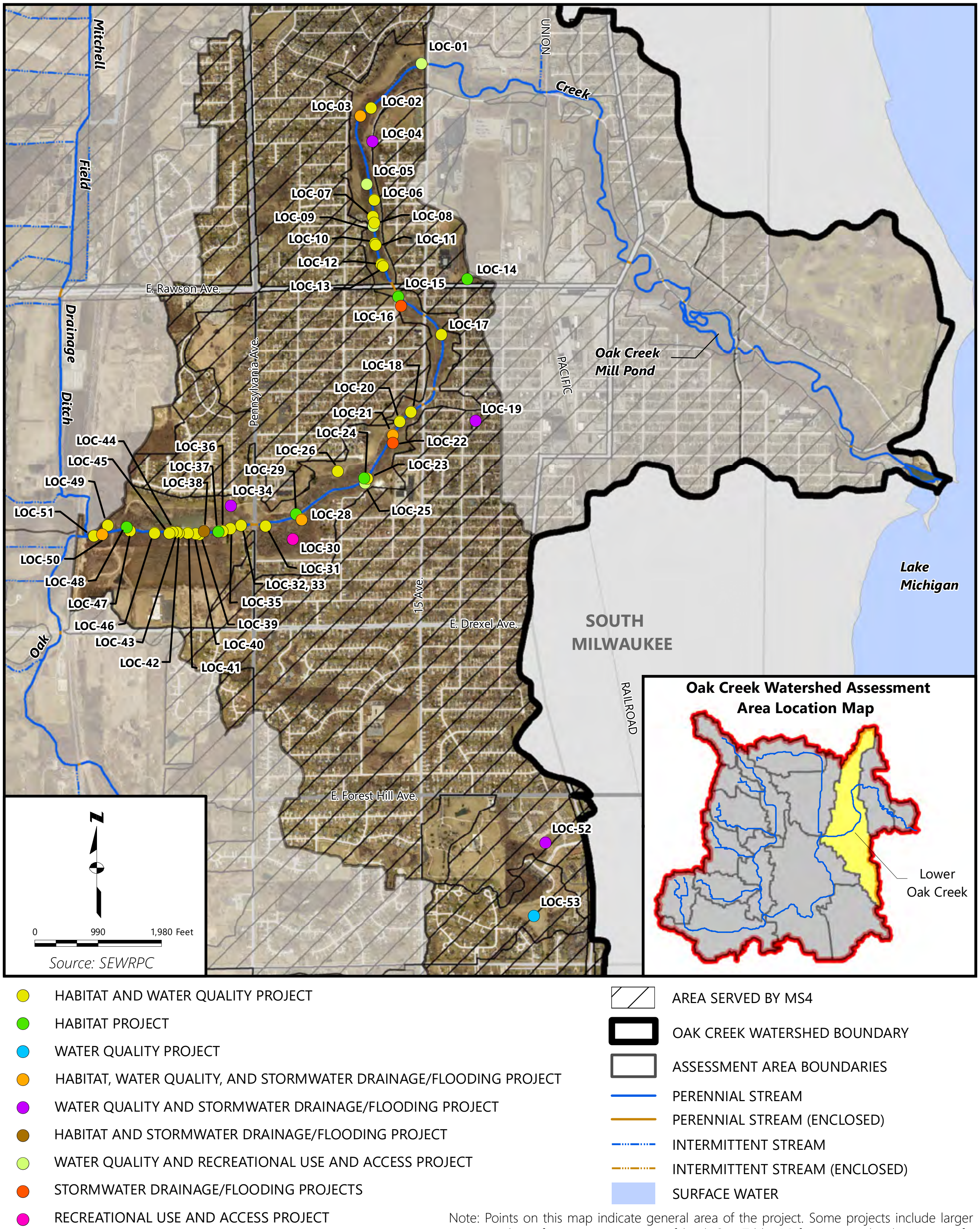


HABITAT AND WATER QUALITY PROJECT
HABITAT PROJECT
WATER QUALITY PROJECT
WATER QUALITY AND STORMWATER DRAINAGE/FLOODING PROJECT
HABITAT AND STORMWATER DRAINAGE/FLOODING PROJECT
WATER QUALITY AND RECREATIONAL USE AND ACCESS PROJECT
STORMWATER DRAINAGE/FLOODING PROJECTS
RECREATIONAL USE AND ACCESS PROJECT
LMP-47 PROJECT ID IN TABLE 6.1

AREA SERVED BY MS4
OAK CREEK WATERSHED BOUNDARY
ASSESSMENT AREA BOUNDARIES
PERENNIAL STREAM
PERENNIAL STREAM (ENCLOSED)
INTERMITTENT STREAM
INTERMITTENT STREAM (ENCLOSED)
SURFACE WATER

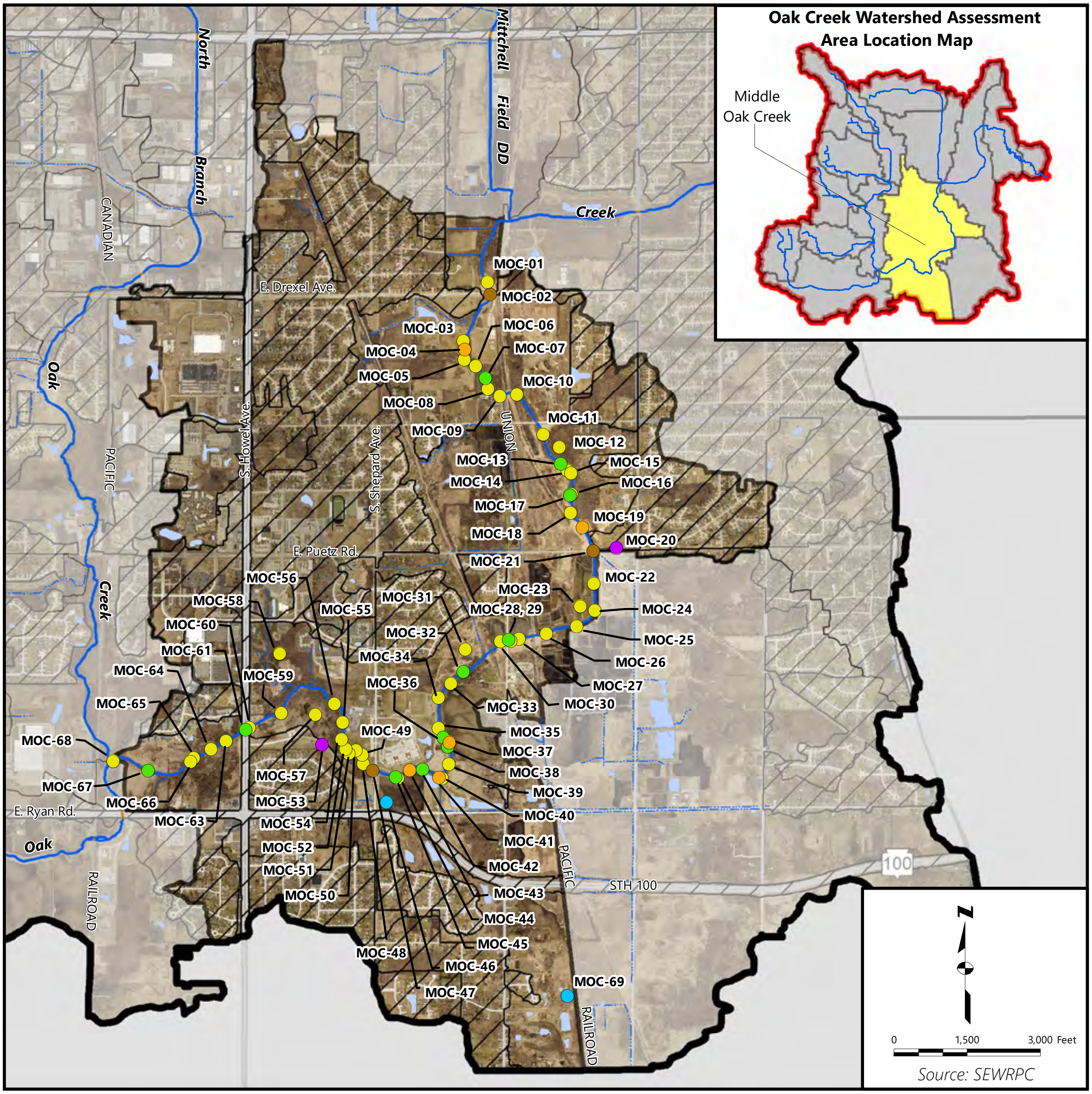
Note: Points on this map indicate general area of the project. Some projects include larger reaches of stream or portions of land. See Table 6.1 for project details. No specific projects are proposed for areas of this assessment area that are not shown.

Map 6.3
Recommended Projects Within the Lower Oak Creek Assessment Area



Note: Points on this map indicate general area of the project. Some projects include larger reaches of stream or portions of land. See Table 6.1 for project details. No specific projects are proposed for areas of this assessment area that are not shown.

Map 6.4
Recommended Projects Within the Middle Oak Creek Assessment Area

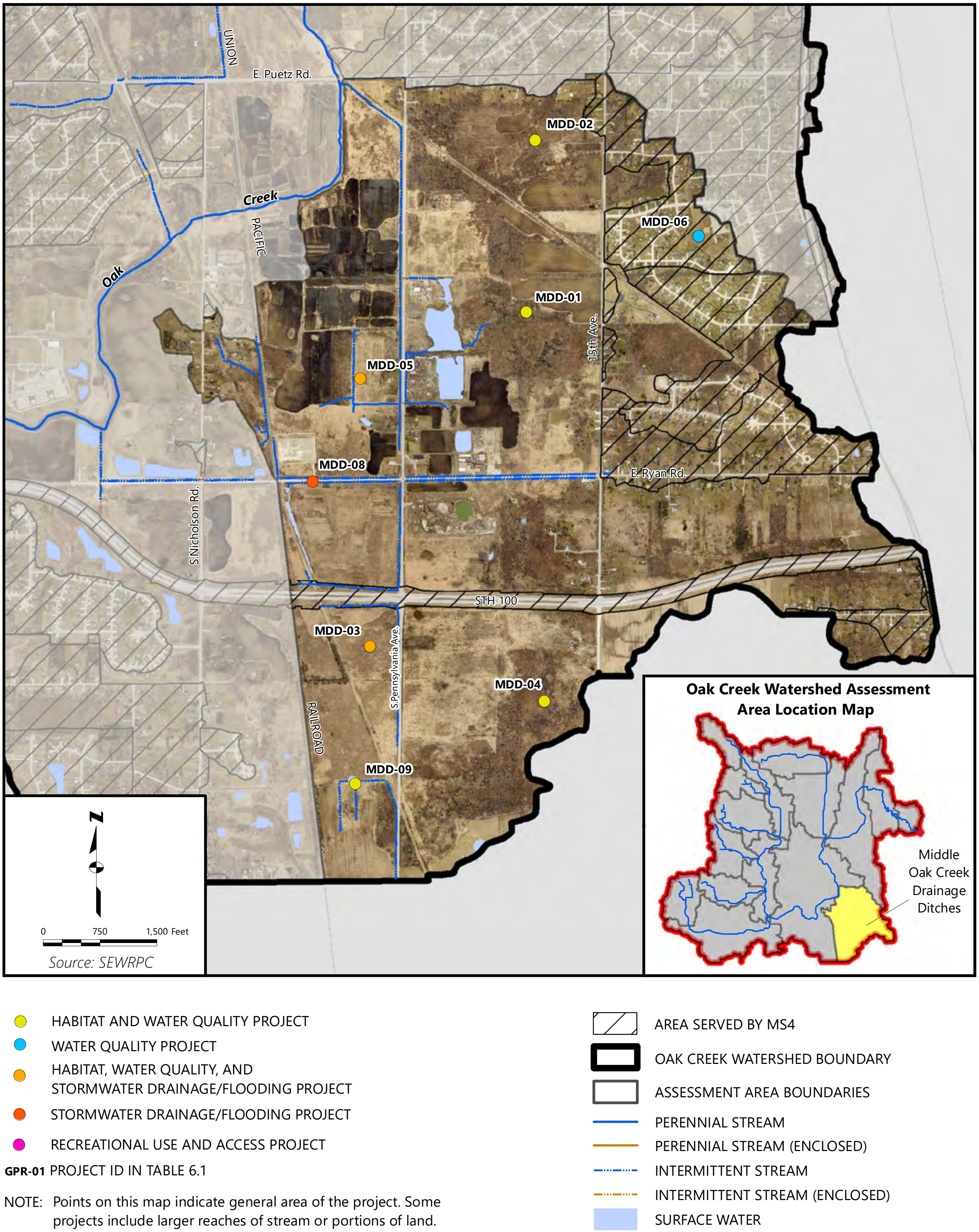


HABITAT AND WATER QUALITY PROJECT
HABITAT PROJECT
WATER QUALITY PROJECT
HABITAT, WATER QUALITY, AND STORMWATER DRAINAGE/FLOODING PROJECT
WATER QUALITY AND STORMWATER DRAINAGE/FLOODING PROJECT
HABITAT AND STORMWATER DRAINAGE/FLOODING PROJECT
MOC-69 PROJECT ID IN TABLE 6.1

Note: Points on this map indicate general area of the project. Some projects include larger reaches of stream or portions of land. See Table 6.1 for project details.

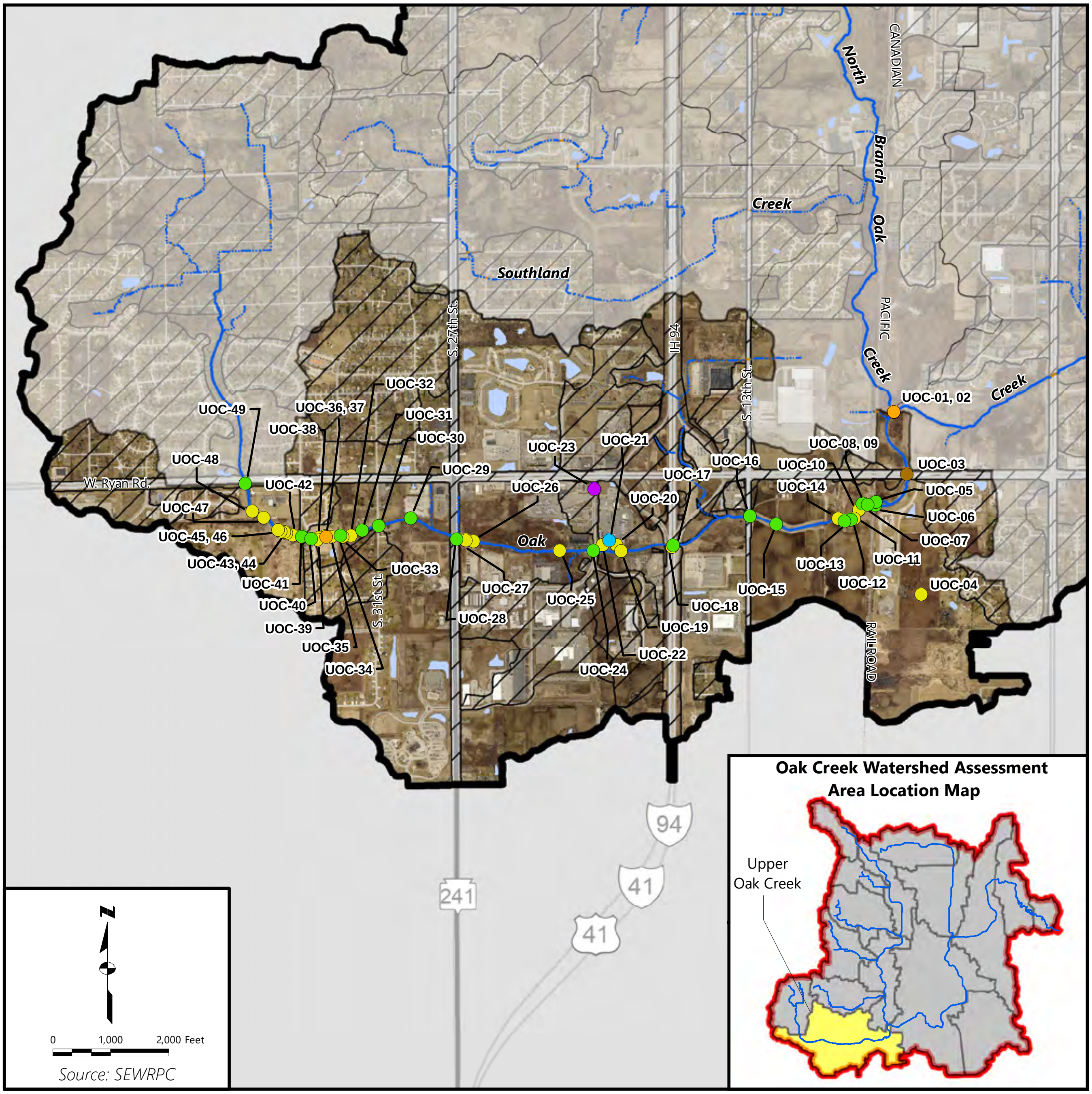
AREA SERVED BY MS4
OAK CREEK WATERSHED BOUNDARY
ASSESSMENT AREA BOUNDARIES
PERENNIAL STREAM
PERENNIAL STREAM (ENCLOSED)
INTERMITTENT STREAM
INTERMITTENT STREAM (ENCLOSED)
SURFACE WATER

Map 6.5
Recommended Projects Within the Middle Oak Creek-Drainage Ditches Assessment Area



NOTE: Points on this map indicate general area of the project. Some projects include larger reaches of stream or portions of land. See Table 6.1 for project details.

Map 6.6
Recommended Projects Within the Upper Oak Creek Assessment Area



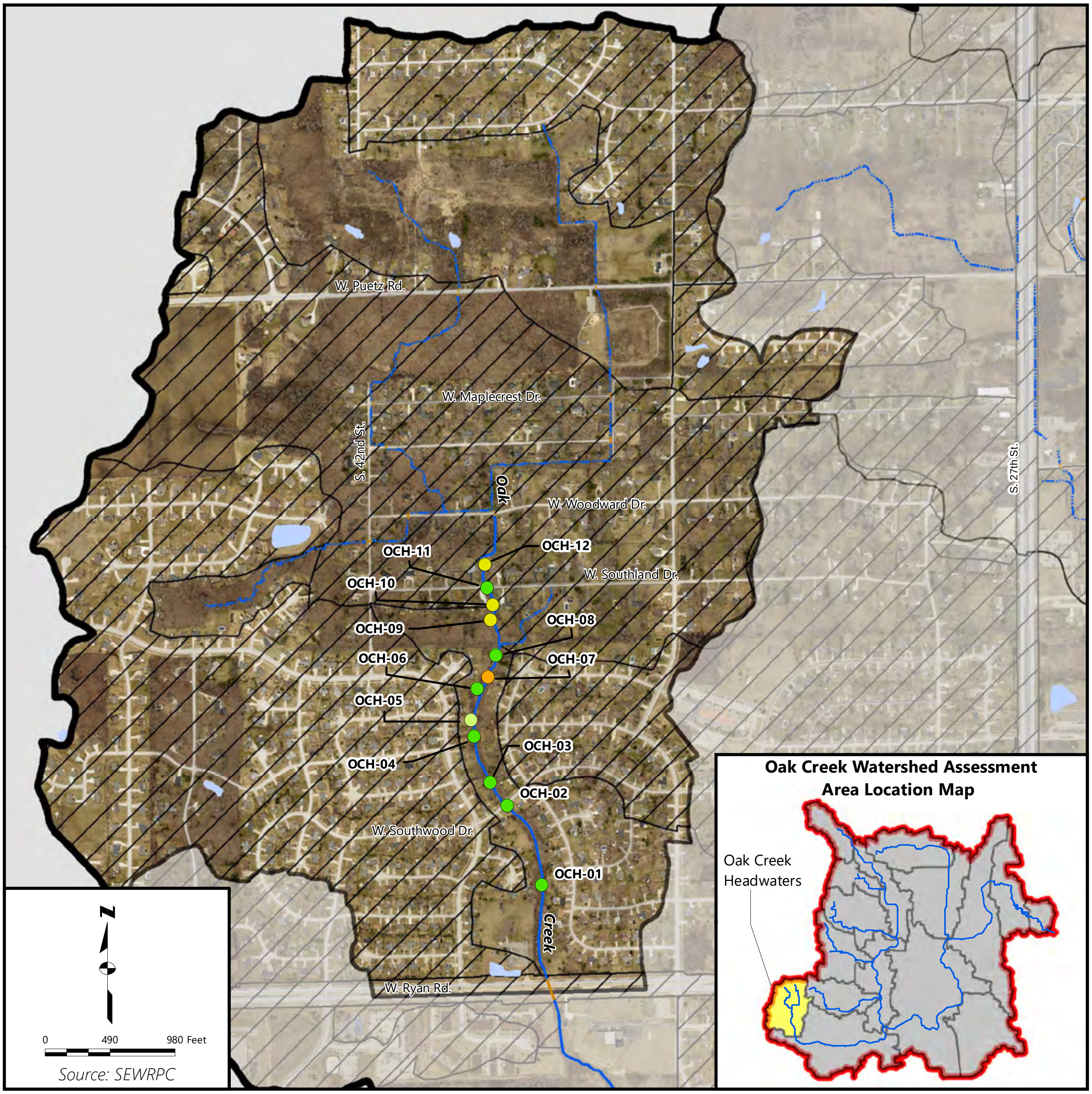
- HABITAT AND WATER QUALITY PROJECT
- HABITAT PROJECT
- WATER QUALITY PROJECT
- HABITAT, WATER QUALITY, AND STORMWATER DRAINAGE/FLOODING PROJECT
- WATER QUALITY AND STORMWATER DRAINAGE/FLOODING PROJECT
- HABITAT AND STORMWATER DRAINAGE/FLOODING PROJECT

UOC-49 PROJECT ID IN TABLE 6.1

Note: Points on this map indicate general area of the project. Some projects include larger reaches of stream or portions of land. See Table 6.1 for project details. No specific projects are proposed for areas of this assessment area that are not shown.

- AREA SERVED BY MS4
- OAK CREEK WATERSHED BOUNDARY
- ASSESSMENT AREA BOUNDARIES
- PERENNIAL STREAM
- PERENNIAL STREAM (ENCLOSED)
- INTERMITTENT STREAM
- INTERMITTENT STREAM (ENCLOSED)
- SURFACE WATER

Map 6.7
Recommended Projects Within the Oak Creek Headwaters Assessment Area

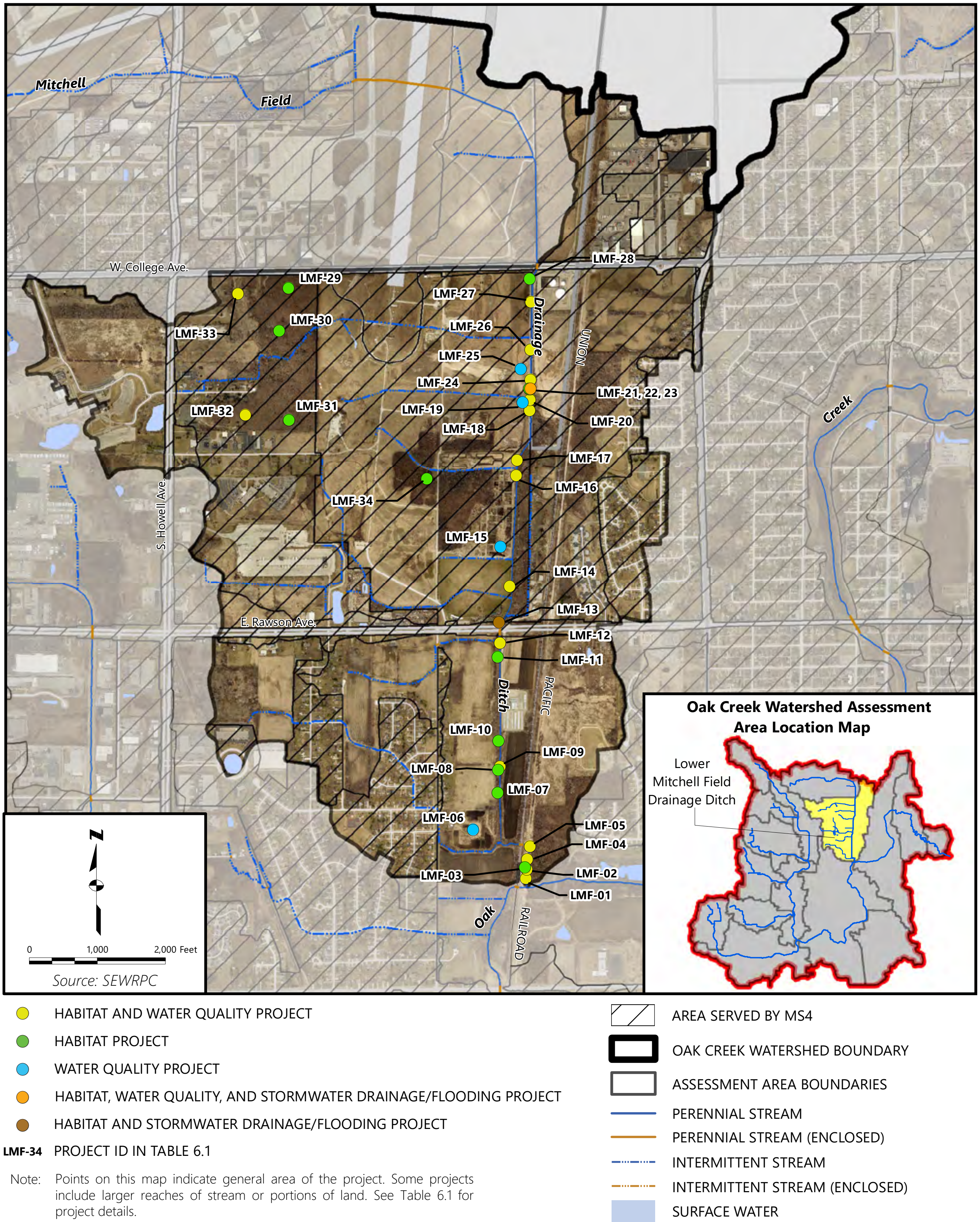


- HABITAT AND WATER QUALITY PROJECT
- HABITAT PROJECT
- HABITAT, WATER QUALITY, AND STORMWATER DRAINAGE/FLOODING PROJECT
- WATER QUALITY AND RECREATIONAL USE AND ACCESS PROJECT
- **OCH-12** PROJECT ID IN TABLE 6.1

Note: Points on this map indicate general area of the project. Some projects include larger reaches of stream or portions of land. See Table 6.1 for project details.

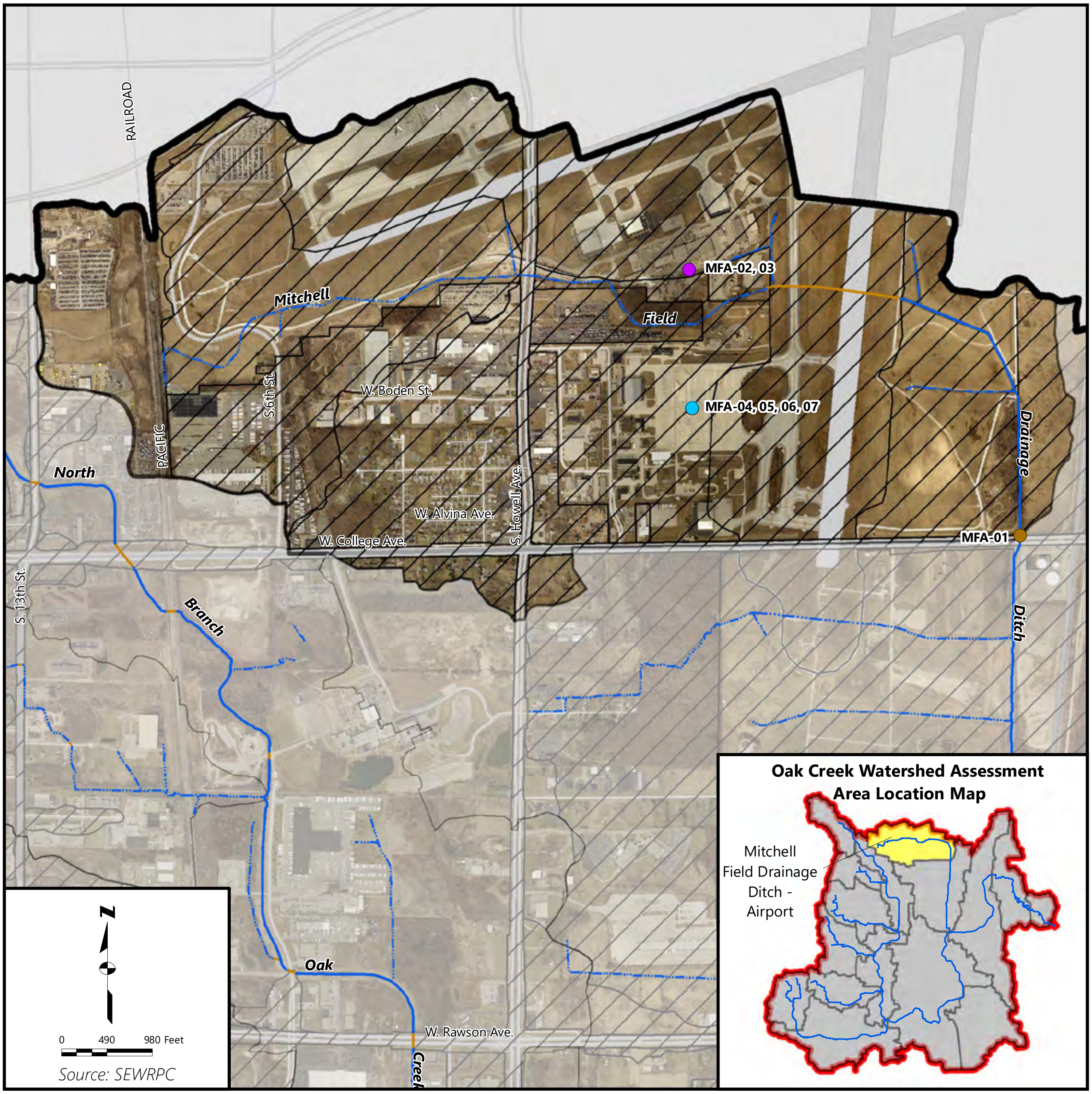
- AREA SERVED BY MS4
- OAK CREEK WATERSHED BOUNDARY
- ASSESSMENT AREA BOUNDARIES
- PERENNIAL STREAM
- PERENNIAL STREAM (ENCLOSED)
- INTERMITTENT STREAM
- INTERMITTENT STREAM (ENCLOSED)
- SURFACE WATER

Map 6.8
Recommended Projects Within the Lower Mitchell Field Drainage Ditch Assessment Area



Note: Points on this map indicate general area of the project. Some projects include larger reaches of stream or portions of land. See Table 6.1 for project details.

Map 6.9
Recommended Projects Within the Mitchell Field Drainage Ditch-Airport Assessment Area

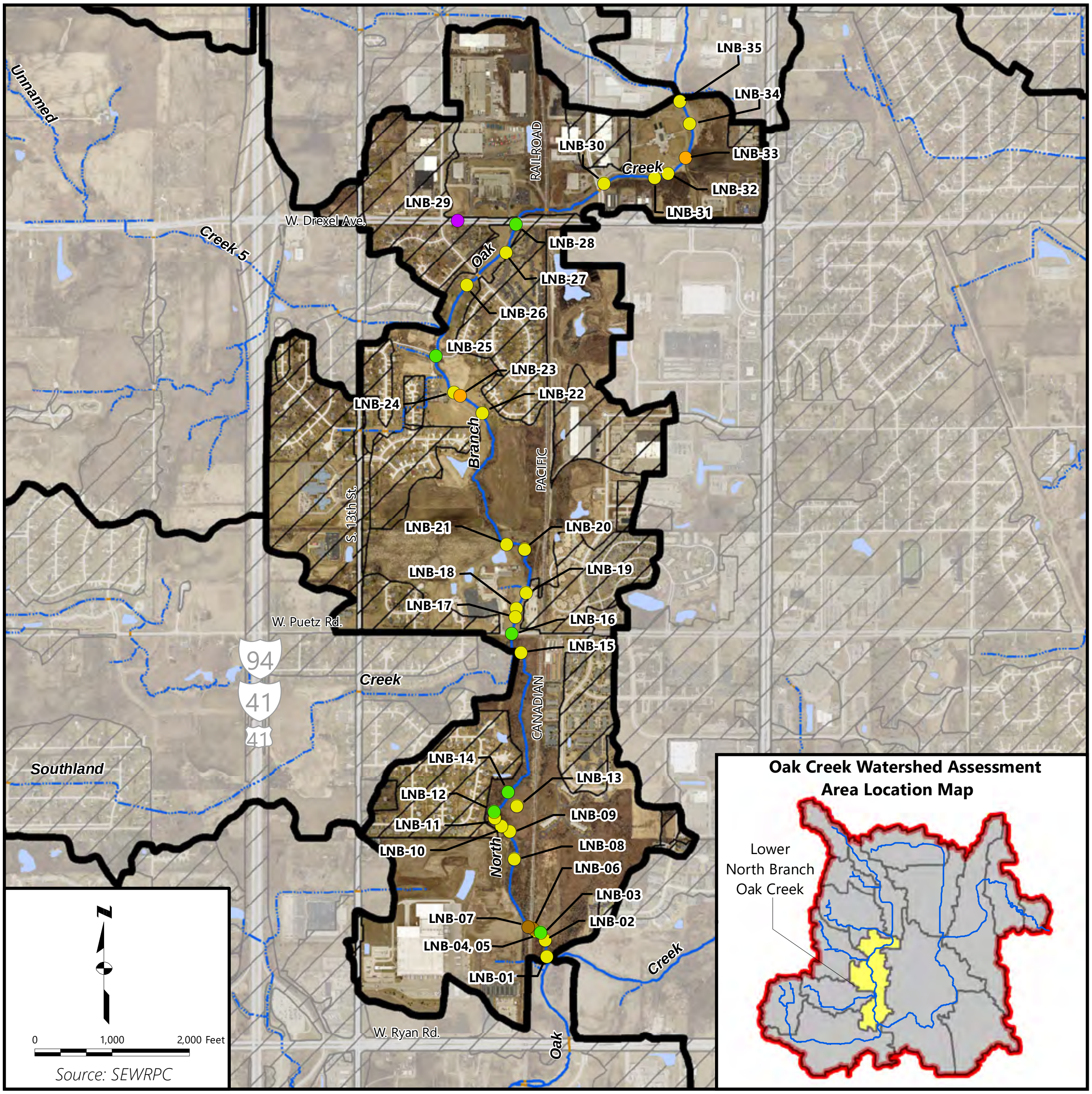


- WATER QUALITY PROJECT
- WATER QUALITY AND STORMWATER DRAINAGE/FLOODING PROJECT
- HABITAT AND STORMWATER DRAINAGE/FLOODING PROJECT
- **MFA-07** PROJECT ID IN TABLE 6.1

Note: Points on this map indicate general area of the project. Some projects include larger reaches of stream or portions of land. See Table 6.1 for project details.

- AREA SERVED BY MS4
- OAK CREEK WATERSHED BOUNDARY
- ASSESSMENT AREA BOUNDARIES
- PERENNIAL STREAM
- PERENNIAL STREAM (ENCLOSED)
- INTERMITTENT STREAM
- INTERMITTENT STREAM (ENCLOSED)
- SURFACE WATER

Map 6.10
Recommended Projects Within the Lower North Branch Oak Creek Assessment Area



HABITAT AND WATER QUALITY PROJECT

HABITAT PROJECT

HABITAT, WATER QUALITY, AND STORMWATER DRAINAGE/FLOODING PROJECT

HABITAT AND STORMWATER DRAINAGE/FLOODING PROJECT

WATER QUALIITY AND STORMWATER DRAINAGE/FLOODING PROJECT

LNB-35 PROJECT ID IN TABLE 6.1

Note: Points on this map indicate general area of the project. Some projects include larger reaches of stream or portions of land. See Table 6.1 for project details.

AREA SERVED BY MS4

OAK CREEK WATERSHED BOUNDARY

ASSESSMENT AREA BOUNDARIES

PERENNIAL STREAM

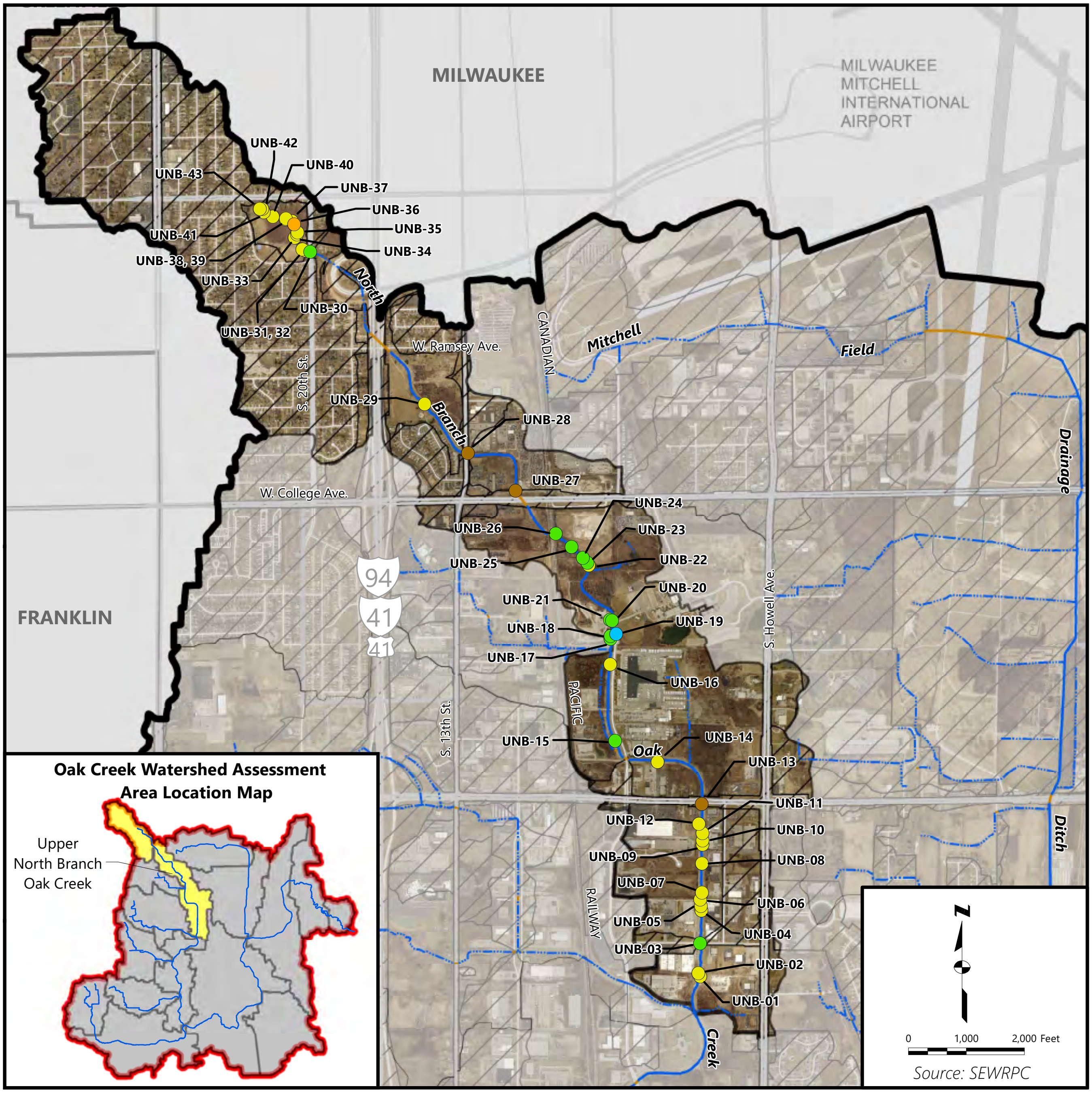
PERENNIAL STREAM (ENCLOSED)

INTERMITTENT STREAM

INTERMITTENT STREAM (ENCLOSED)

SURFACE WATER

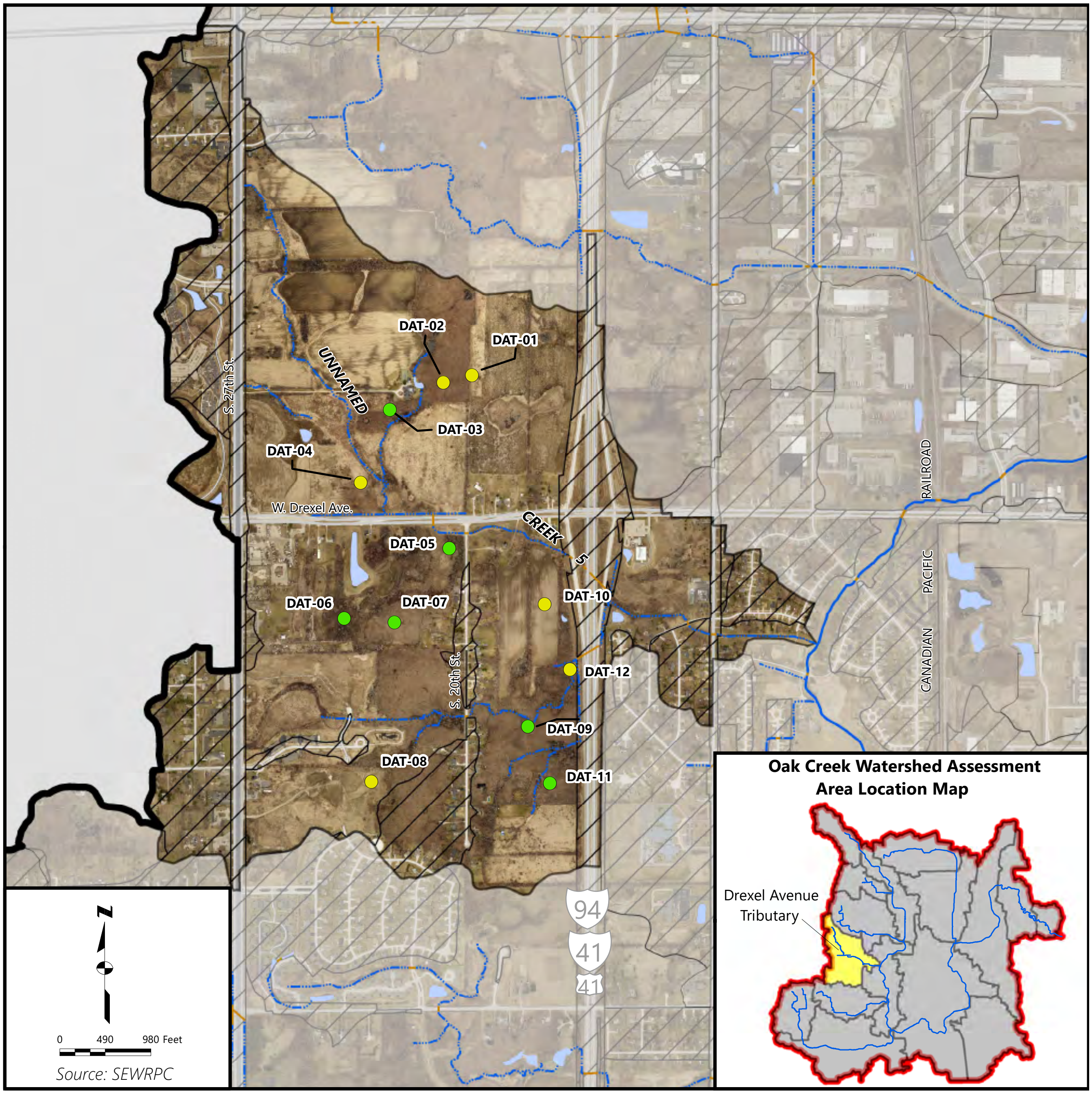
Map 6.11
Recommended Projects Within the Upper North Branch Oak Creek Assessment Area



- HABITAT AND WATER QUALITY PROJECT
- HABITAT PROJECT
- WATER QUALITY PROJECT
- HABITAT, WATER QUALITY, AND STORMWATER DRAINAGE/FLOODING PROJECT
- HABITAT AND STORMWATER DRAINAGE/FLOODING PROJECT
- **UNB-43** PROJECT ID IN TABLE 6.1
- AREA SERVED BY MS4
- OAK CREEK WATERSHED BOUNDARY
- ASSESSMENT AREA BOUNDARIES
- PERENNIAL STREAM
- PERENNIAL STREAM (ENCLOSED)
- INTERMITTENT STREAM
- INTERMITTENT STREAM (ENCLOSED)
- SURFACE WATER

Note: Points on this map indicate general area of the project. Some projects include larger reaches of stream or portions of land. See Table 6.1 for project details.

Map 6.12
Recommended Projects Within the Drexel Avenue Tributary Assessment Area



HABITAT AND WATER QUALITY PROJECT

HABITAT PROJECT

DAT-12 PROJECT ID IN TABLE 6.1

Note: Points on this map indicate general area of the project. Some projects include larger reaches of stream or portions of land. See Table 6.1 for project details.

AREA SERVED BY MS4

OAK CREEK WATERSHED BOUNDARY

ASSESSMENT AREA BOUNDARIES

PERENNIAL STREAM

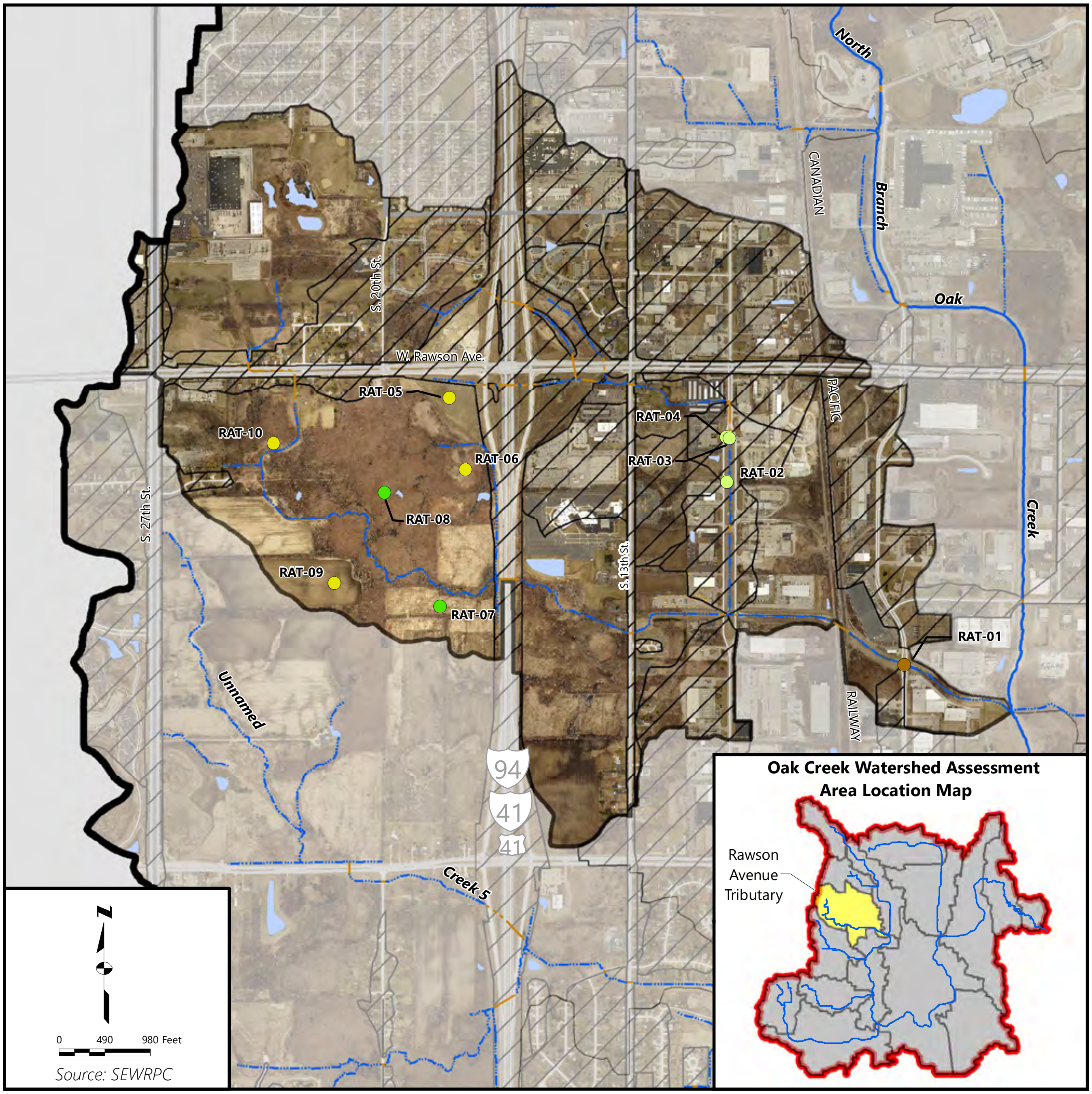
PERENNIAL STREAM (ENCLOSED)

INTERMITTENT STREAM

INTERMITTENT STREAM (ENCLOSED)

SURFACE WATER

Map 6.13
Recommended Projects Within the Rawson Avenue Tributary Assessment Area



HABITAT AND WATER QUALITY PROJECT

HABITAT PROJECT

HABITAT AND STORMWATER DRAINAGE/FLOODING PROJECT

WATER QUALITY AND RECREATIONAL USE AND ACCESS PROJECT

RAT-10 PROJECT ID IN TABLE 6.1

Note: Points on this map indicate general area of the project. Some projects include larger reaches of stream or portions of land. See Table 6.1 for project details.

AREA SERVED BY MS4

OAK CREEK WATERSHED BOUNDARY

ASSESSMENT AREA BOUNDARIES

PERENNIAL STREAM

PERENNIAL STREAM (ENCLOSED)

INTERMITTENT STREAM

INTERMITTENT STREAM (ENCLOSED)

SURFACE WATER

Table 6.1
Site-Specific Management Measures for the Oak Creek Watershed

		Site Information						Annual Pollutant Reductions						Costs (dollars)[c]			
ID Number (see Maps 6.1 – 6.13)[a]	**Focus Areas Addressed[b]**	Location	Latitude	Longitude	Municipality	Owner	**Management Action**	TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	**Key Project Partners**	Capital	Annual O&M	**Potential Funding Sources[d]**	**Priority[e]**
Oak Creek Watershed-Wide Projects (OCW)																	
OCW-01	WQ	Watershed-wide	n/a	n/a	City of South Milwaukee	n/a	Review and audit municipal code and ordinances to assess barriers to implementing green infrastructure	--	--	--	--	--	City of South Milwaukee	10,500	--	2, 10, 27, 47, 52, 57, 65, 67	Medium
OCW-02	WQ	Watershed-wide	n/a	n/a	Municipalities, Milwaukee County	Municipalities, Milwaukee County	Develop and implement written dry-weather screening procedures for MS4 outfalls	--	--	--	--	--	Municipalities, Milwaukee County	--	--	57, 65, 66, 67	High
OCW-03	WQ	Watershed-wide	n/a	n/a	Municipalities, Milwaukee County	Municipalities, Milwaukee County	Develop and implement written procedures for investigating and responding to suspected or known illicit discharges into MS4s	--	--	--	--	--	Municipalities, Milwaukee County	--	--	57, 65, 66, 67	High
OCW-04	WQ	Watershed-wide	n/a	n/a	Municipalities, Milwaukee County	Municipalities, Milwaukee County	Develop and implement a system for tracking and completing long-term inspections, maintenance, and enforcement of all public and private post-construction stormwater BMPs	--	--	--	--	--	Municipalities, Milwaukee County	--	--	50, 57, 67	High
OCW-05	WQ	Watershed-wide	n/a	n/a	Municipalities, Milwaukee County	Municipalities, Milwaukee County	Develop and implement a written salt application or salt reduction strategy	--	--	--	--	--	Municipalities, Milwaukee County	--	--	27, 52, 57, 65, 67	High
OCW-06	WQ	Watershed-wide	n/a	n/a	Municipalities, Milwaukee County, MMIA	Municipalities, Milwaukee County, MMIA	Annually calibrate deicing and anti-icing equipment	--	--	--	--	--	Municipalities, Milwaukee County, MMIA	--	--	--	High
OCW-07	WQ	Watershed-wide	n/a	n/a	Municipalities, Milwaukee County	Municipalities, Milwaukee County	Develop action benchmarks for bacteria for IDDE screening	--	--	--	--	--	Municipalities, Milwaukee County	--	--	10, 22, 52, 57, 65, 67	High
OCW-08	WQ	Watershed-wide	n/a	n/a	Municipalities, Milwaukee County	Municipalities, Milwaukee County	Develop an inventory and map of potential sources of fecal indicator bacteria for MS4	--	--	--	--	--	Municipalities, Milwaukee County	--	--	10, 22, 52, 57, 65, 67	High
OCW-09	WQ	Watershed-wide	n/a	n/a	Municipalities, Milwaukee County	Municipalities, Milwaukee County	Develop a fecal indicator bacteria elimination plan for MS4	--	--	--	--	--	Municipalities, Milwaukee County	--	--	10, 22, 52, 57, 65, 67	High
OCW-10	WQ, SWF	Watershed-wide	n/a	n/a	Municipalities, Milwaukee County	Milwaukee County	Develop and execute a pilot project that evaluates an innovate BMP design or contracting mechanism for stormwater-related services	--	--	--	--	--	Milwaukee County	--	--	13, 14, 25, 31, 44, 45, 57, 67	Medium
Grant Park Ravine Assessment Area (GPR)																	
GPR-01	H, WQ	Oak Creek estuary area adjacent to Grant Park Beach parking lot	42.90657	-87.84223	City of South Milwaukee	Milwaukee County and City of South Milwaukee	Consider restoration of estuary area to improve habitat and aesthetics with native plan installations and potentially converting backwater areas to wetland estuary habitat	--	--	--	--	--	Milwaukee County and City of South Milwaukee	--	--	3, 4, 5, 6, 7, 8, 9, 10, 11, 15, 16, 20, 21, 22, 23, 24, 25, 26, 45, 49, 52, 60, 61, 67, 69	Medium
GPR-02	WQ, H	Oak Creek mainstem, left bank WPA wall downstream of first Oak Creek Parkway crossing	42.90788	-87.84675	City of South Milwaukee	City of South Milwaukee	Repair or replace falling portion of 18-inch RCP outfall (sequence number 10 in Appendix E)	--	--	--	--	--	City of South Milwaukee	2,900	--	7, 57, 67	Medium
GPR-03	WQ, R	Mainstem of Oak Creek by Oak Creek Parkway north of Marquette Avenue (extended)	42.90792	-87.84675	City of South Milwaukee	City of South Milwaukee	Investigate and remedy source of human fecal contamination to outfall (sequence number 10 in Appendix E)	--	--	--	--	--	City of South Milwaukee	--	--	10, 22, 52, 57, 65, 67	High
GPR-04	SWF	Sanitary lift station near downstream-most crossing of the Oak Creek Parkway	42.90819	-87.84734	City of South Milwaukee	City of South Milwaukee	Complete construction of designed lift station	--	--	--	--	--	City of South Milwaukee	4,800,000	--	12, 30, 46, 50, 67	High

Table continued on next page.

Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Grant Park Ravine Assessment Area (GPR) (continued)																	
GPR-05	WQ, H	Right bank of Oak Creek within Oak Creek Parkway downstream of the Mill Pond dam[f]	42.90935	-87.84714	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 75 feet of Oak Creek with slight lateral recession rate	600	0.2	--	0.4	0.9	Milwaukee County, municipalities, and other watershed partners	26,300	1,580	8, 9, 21, 22, 25, 49, 52, 58, 67	Low
GPR-06	WQ, H	Right bank of Oak Creek within Oak Creek Parkway downstream of the Mill Pond dam[f]	42.91005	-87.84749	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 284 feet of Oak Creek with severe lateral recession rate	46,400	12.1	--	31.5	63.0	Milwaukee County, municipalities, and other watershed partners	81,900	4,910	8, 9, 21, 22, 25, 49, 52, 58, 67	High
GPR-07	WQ, H	Right bank of Oak Creek upstream from the first Oak Creek Parkway Crossing[f]	42.91027	-87.84763	City of South Milwaukee	Unknown	Repair or replace filing portion of 24-Inch RCP outfall (sequence number 14 in Appendix E)	--	--	--	--	--	Unknown	4,000	--	7, 57, 67	Medium
GPR-08	WQ, H	Left bank of Oak Creek within Oak Creek Parkway downstream of Mill Pond Dam[f]	42.91041	-87.84835	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 154 feet of Oak Creek with a moderate recession rate	8,200	2.1	--	5.5	11.0	Milwaukee County, municipalities, and other watershed partners	53,900	3,230	8, 9, 21, 22, 25, 49, 52, 58, 67	Medium
GPR-09	WQ, H	Left bank of Oak Creek within Oak Creek Parkway downstream of Mill Pond Dam[f]	42.91034	-87.84876	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 170 feet of Oak Creek with a very severe recession rate	172,000	45.1	--	117.0	234.1	Milwaukee County, municipalities, and other watershed partners	59,500	3,570	8, 9, 21, 22, 25, 29, 49, 52, 58, 67	High
GPR-10	WQ, H	Left bank of Oak Creek within Oak Creek Parkway downstream of Mill Pond Dam[f]	42.91065	-87.84891	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 34 feet of Oak Creek with a severe recession rate	13,800	3.6	--	9.4	18.7	Milwaukee County, municipalities, and other watershed partners	11,900	710	8, 9, 21, 22, 25, 49, 52, 58, 67	Medium
GPR-11	WQ, H	Right bank of Oak Creek within Oak Creek Parkway downstream of Mill Pond Dam[f]	42.91104	-87.84831	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 275 feet of Oak Creek with a moderate recession rate	22,600	5.9	--	15.3	30.6	Milwaukee County, municipalities, and other watershed partners	96,300	5,780	8, 9, 21, 22, 25, 49, 52, 58, 67	Medium
GPR-12	WQ, H	Right bank of Oak Creek within Oak Creek Parkway downstream of Mill Pond Dam[f]	42.91140	-87.84895	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 51 feet of Oak Creek with a severe recession rate	14,400	3.8	--	9.8	19.7	Milwaukee County, municipalities, and other watershed partners	17,900	1,070	8, 9, 21, 22, 25, 49, 58 52, 67	Medium
GPR-13	WQ, H	Left bank of Oak Creek within Oak Creek Parkway downstream of Mill Pond Dam[f]	42.91153	-87.84968	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 317 feet of Oak Creek with a moderate recession rate	14,800	4.6	--	11.9	2.37	Milwaukee County, municipalities, and other watershed partners	111,000	6,660	8, 9, 21, 22, 25, 49, 52, 58, 67	Medium
GPR-14	H, WQ	Milwaukee County Parks Oak Creek Parkway Management Section 1	42.911213	-87.84982	City of South Milwaukee	Milwaukee County	Forest stand improvement including supplemental canopy gap and understory planting; rapid response invasive species management, wildlife inventory applied to 29.9 acres	--	--	--	--	--	Milwaukee County	175,500	--	4, 5, 7, 11, 16, 20, 25, 26, 35, 49, 52	Medium

Table continued on next page.

Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information					Management Action	Annual Pollutant Reductions					Key Project Partners	Costs (dollars)[c]		Potential Funding Sources[d]	Priority[e]
		Location	Latitude	Longitude	Municipality	Owner		TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)		Capital	Annual O&M		
Grant Park Ravine Assessment Area (GPR) (continued)																	
GPR-15	WQ, H	Right bank of Oak Creek within Oak Creek Parkway downstream of Mill Pond Dam[f]	42.91223	-87.85262	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 93 feet of Oak Creek with a moderate recession rate	3,600	1.1	--	2.9	5.8	Milwaukee County, municipalities, and other watershed partners	32,600	1,950	8, 9, 21, 22, 25, 49, 52, 58, 67	Medium
GPR-16	WQ, R	Mainstem of Oak Creek downstream of 6th Avenue	42.91223	-87.85280	City of South Milwaukee	City of South Milwaukee	Investigate and remedy source of canine fecal contamination to outfall (sequence number 21 in Appendix E)	--	--	--	--	--	City of South Milwaukee	--	--	10, 22, 52, 57, 65, 67	High
GRP-17	WQ, R	Mainstem of Oak Creek downstream of Mill Road	42.91229	-87.85313	City of South Milwaukee	City of South Milwaukee	Investigate and remedy source of human fecal contamination to outfall (sequence number 22 in Appendix E)	--	--	--	--	--	City of South Milwaukee	--	--	10, 22, 52, 57, 65, 67	High
Lower Oak Creek-Mill Pond Assessment Area (LMP)																	
LMP-01	SWF, WQ	Oak Creek Mill Pond	42.91227	-87.85361	City of South Milwaukee	Milwaukee County	Repair Oak Creek Mill Pond sluice gate if it is determined not to pursue dam removal[g]	--	--	--	--	--	Milwaukee County	343,000	--	31, 62, 63	High
LMP-02	WQ	Oak Creek Mill Pond and vicinity	42.912780	-87.85397	City of South Milwaukee	Milwaukee County	Complete sediment transport analysis for Mill Pond area[h]	--	--	--	--	--	Milwaukee County	10,000 to 75,000	--	59, 62, 65	Medium
LMP-03	WQ, R	Oak Creek Mill Pond off Oak Creek Parkway	42.91350	-87.85366	City of South Milwaukee	City of South Milwaukee	Investigate and remedy source of human fecal contamination to outfall (sequence number 27 in Appendix E)	--	--	--	--	--	City of South Milwaukee	--	--	10, 22, 52, 57, 65, 67	High
LMP-04	WQ	Oak Creek Mill Pond and vicinity	42.91338	-87.85416	City of South Milwaukee	Milwaukee County	Conduct sediment core sampling and chemical analysis in the Mill Pond Project area[i]	--	--	--	--	--	Milwaukee County	49,000	--	59, 62	High
LMP-05	H	Oak Creek in Oak Creek Parkway upstream of Mill Pond	42.91491	-87.85600	City of South Milwaukee	Milwaukee County	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
LMP-06	H	Oak Creek in Oak Creek Parkway upstream of Mill Pond	42.91498	-87.85621	City of South Milwaukee	Milwaukee County	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
LMP-07	H	Oak Creek in Oak Creek Parkway upstream of Mill Pond	42.91503	-87.85649	City of South Milwaukee	Milwaukee County	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
LMP-08	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of the Mill Pond[f]	42.91477	-87.85663	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 66 feet of Oak Creek with a moderate lateral recession rate	3,000	1.0	--	2.5	4.9	Milwaukee County, municipalities, and other watershed partners	23,100	1,390	8, 9, 22, 25, 29, 49, 52, 58, 67	Medium
LMP-09	SWF, H	Oak Creek upstream of the Mill Pond between the third and fourth Parkway crossing	42.91512	-87.85693	City of South Milwaukee	Milwaukee County	Remove debris jams and substrate accumulation ridge that transects the main channel of Oak Creek and elevate channel invert of newly formed channel that is in close proximity to the Parkway road[j]	--	--	--	--	--	Milwaukee County	--	--	28, 30, 39	High
LMP-10	H, WQ	Milwaukee County Parks Oak Creek Parkway Management Section 2	42.91491	-87.85756	City of South Milwaukee	Milwaukee County	Reforestation of 0.75 acres; rapid response invasive species management of 22.9 acres; forest stand improvement including supplemental canopy gap and understory planting of 20 acres; floristic survey of 22.9 acres; and survey and posting of property lines	16	0.3	--	--	--	Milwaukee County	148,700	--	4, 5, 7, 11, 16, 20, 25, 26, 35, 49, 52	Low
LMP-11	WQ, H	Right bank of Oak Creek within Oak Creek Parkway upstream of the Mill Pond[f]	42.91526	-87.85766	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 26 feet of Oak Creek with a slight lateral recession rate	600	0.2	--	0.5	1.0	Milwaukee County, municipalities, and other watershed partners	9,100	550	8, 9, 22, 25, 49, 52, 58, 67	Low

Table continued on next page.

Table 6.1 (Continued)

		Site Information						Annual Pollutant Reductions						Costs (dollars)[c]			
ID Number (see Maps 6.1 – 6.13)[a]	**Focus Areas Addressed[b]**	Location	Latitude	Longitude	Municipality	Owner	**Management Action**	TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	**Key Project Partners**	Capital	Annual O&M	**Potential Funding Sources[d]**	**Priority[e]**
Lower Oak Creek-Mill Pond Assessment Area (LMP) (continued)																	
LMP-12	WQ, H	Right bank of Oak Creek within Oak Creek Parkway upstream of N. Chicago Avenue[f]	42.91832	-87.86035	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 107 feet of Oak Creek with a severe lateral recession rate	10,200	3.8	--	8.2	16.4	Milwaukee County, municipalities, and other watershed partners	37,500	2,250	8, 9, 22, 25, 29, 49, 52, 58, 67	High
LMP-13	WQ, H	Right bank of Oak Creek upstream of N. Chicago Avenue[f]	42.91837	-87.86036	City of South Milwaukee	Milwaukee County	Repair or replace failing portion of 18-inch RCP outfall (sequence number 37 in Appendix E)	--	--	--	--	--	Milwaukee County	2,900	--	7, 57, 67	High
LMP-14	WQ, H	Left bank of Oak Creek upstream of N. Chicago Avenue[f]	42.91836	-87.86068	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 74 feet of Oak Creek with a severe lateral recession rate	12,400	3.8	--	9.9	19.9	Milwaukee County, municipalities, and other watershed partners	25,900	1,550	8, 9, 22, 25, 49, 52, 58, 67	Medium
LMP-15	WQ, H	Left bank of Oak Creek upstream of N. Chicago Avenue[f]	42.91937	-87.86086	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 105 feet of Oak Creek with a moderate lateral recession rate	5,800	1.8	--	4.6	9.2	Milwaukee County, municipalities, and other watershed partners	36,800	2,210	8, 9, 22, 25, 49, 52, 58, 67	Medium
LMP-16	H	Oak Creek in Oak Creek Parkway north of Cherry Street (extended)	42.91972	-87.86088	City of South Milwaukee	Milwaukee County	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	Milwaukee County and City of South Milwaukee	--	--	9, 21, 22, 25, 32, 48, 49	High
LMP-17	WQ, H	Right bank of Oak Creek between Cherry Street (extended) and Walnut Street (extended)	42.91991	-87.86072	City of South Milwaukee	Milwaukee County	Repair or replace failing portion of 18-inch RCP outfall (sequence number 38 in Appendix E)	--	--	--	--	--	Milwaukee County	2,900	--	7, 57, 67	Medium
LMP-18	H	Oak Creek channel in Oak Creek Parkway upstream of Chicago Avenue and south of Walnut Street (extended)	42.92025	-87.86084	City of South Milwaukee	Milwaukee County	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	Milwaukee County and City of South Milwaukee	--	--	9, 21, 22, 25, 32, 48, 49	High
LMP-19	WQ, H	Left bank of Oak Creek upstream of N. Chicago Avenue[f]	42.92039	-87.86085	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 53 feet of Oak Creek with a slight lateral recession rate	600	0.2	--	0.4	0.9	Milwaukee County, municipalities, and other watershed partners	18,600	1,110	8, 9, 22, 25, 49, 52, 58, 67	Low
LMP-20	WQ, H	Right bank of Oak Creek upstream of N. Chicago Avenue[f]	42.92066	-87.86074	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 221 feet of Oak Creek with a moderate lateral recession rate	10,400	3.2	--	8.3	16.5	Milwaukee County, municipalities, and other watershed partners	77,400	4,640	8, 9, 22, 25, 49, 52, 58, 67	High
LMP-21	WQ, H	Right bank of Oak Creek between Walnut Street (extended) and Aspen Street (extended)[f]	42.92083	-87.86079	City of South Milwaukee	Milwaukee County	Repair or replace failing portion of 18-inch RCP outfall (sequence number 39 in Appendix E)	--	--	--	--	--	Milwaukee County	2.900	--	7, 57, 67	Medium
LMP-22	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of N. Chicago Avenue[f]	42.92087	-87.86105	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 70 feet of Oak Creek with a moderate lateral recession rate	3,000	0.9	--	2.4	4.8	Milwaukee County, municipalities, and other watershed partners	24,500	4,470	8, 9, 22, 25, 49, 52, 58, 67	Medium
LMP-23	WQ, H	Right bank of Oak Creek at Aspen Street (extended)[f]	42.92133	-87.86116	City of South Milwaukee	City of South Milwaukee	Repair or replace failing portion of 27-inch RCP outfall (sequence number 40 in Appendix E)	--	--	--	--	--	City of South Milwaukee	4,200	--	7, 57, 67	Medium

Table continued on next page.

Table 6.1 (Continued)

		Site Information						Annual Pollutant Reductions						Costs (dollars)[c]			
ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Location	Latitude	Longitude	Municipality	Owner	Management Action	TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Lower Oak Creek-Mill Pond Assessment Area (LMP) (continued)																	
LMP-24	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of N. Chicago Avenue[f]	42.92146	-87.86115	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 80 feet of Oak Creek with a slight lateral recession rate	600	0.2	--	0.4	0.9	Milwaukee County, municipalities, and other watershed partners	28,000	4,680	8, 9, 22, 25, 49, 52, 58, 67	Low
LMP-25	WQ, H	Right bank of Oak Creek upstream of Oak Creek Parkway and Oak Street (extended)[f]	42.92237	-87.86075	City of South Milwaukee	Unknown	Repair or replace failing portion of 12-inch CMP outfall (sequence number 43 in Appendix E)	--	--	--	--	--	Unknown	2,100	--	7, 57, 67	Low
LMP-26	WQ, H	Right bank of Oak Creek upstream of Oak Creek Parkway and Oak Street (extended)[f]	42.92240	-87.86077	City of South Milwaukee	City of South Milwaukee	Repair or replace failing portion of 27-inch RCP outfall (sequence number 44 in Appendix E)	--	--	--	--	--	City of South Milwaukee	4,200	--	7, 57, 67	Medium
LMP-27	WQ, H	Right bank of Oak Creek upstream of Oak Creek Parkway and Oak Street (extended)[f]	42.92249	-87.86070	City of South Milwaukee	Unknown	Repair or replace failing portion of 18-inch RCP outfall (sequence number 45 in Appendix E)	--	--	--	--	--	Unknown	2,900	--	7, 57, 67	Medium
LMP-28	WQ, H	Right bank of Oak Creek upstream of Oak Creek Parkway and Oak Street (extended)[f]	42.92251	-87.86070	City of South Milwaukee	Unknown	Repair or replace failing portion of 12-inch clay outfall (sequence number 46 in Appendix E)	--	--	--	--	--	Unknown	2,500	--	7, 57, 67	Low
LMP-29	WQ, H	Right bank of Oak Creek upstream of Oak Creek Parkway and Oak Street (extended)[f]	42.92353	-87.86308	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 90 feet of Oak Creek with a slight lateral recession rate	800	0.2	--	0.6	1.3	Milwaukee County, municipalities, and other watershed partners	31,500	1,890	8, 9, 22, 25, 49, 52, 58, 67	Low
LMP-30	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of Union Pacific Railroad crossing[f]	42.92381	-87.86485	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 177 feet of Oak Creek with a slight lateral recession rate	1,200	0.3	--	0.9	1.8	Milwaukee County, municipalities, and other watershed partners	62,000	3,720	8, 9, 22, 25, 49, 52, 58, 67	Low
LMP-31	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of Union Pacific Railroad crossing[f]	42.92389	-87.86532	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 59 feet of Oak Creek with a slight lateral recession rate	400	0.1	--	0.4	0.8	Milwaukee County, municipalities, and other watershed partners	20,700	1,240	8, 9, 22, 25, 49, 52, 58, 67	Low
LMP-32	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of Union Pacific Railroad crossing across from South Milwaukee High School parking lot[f]	42.92388	-87.86603	City of South Milwaukee	Milwaukee County	Repair or replace failing portion of 12-inch CMP outfall (sequence number 58 in Appendix E)	--	--	--	--	--	Milwaukee County	2,100	--	7, 57, 67	Low
LMP-33	H, WQ	Milwaukee County Parks Oak Creek Parkway Management Sections 3 and 4	42.92381	-87.86736	City of South Milwaukee	Milwaukee County	Forest stand improvement including canopy gap and understory planting of 55.7 acres; reforestation of 5.7 acres; rapid response invasive species management of 55.7 acres; floristic survey and wildlife inventory of 61.4 acres; and survey and posting of property lines	124	2.2	--	--	--	Milwaukee County	318,200	--	4, 5, 7, 11, 16, 20, 25, 26, 35, 49, 52	Low
LMP-34	WQ, H	Left bank of Oak Creek downstream of 15th Avenue and across from South Milwaukee High School[f]	42.92336	-87.86843	City of South Milwaukee	City of South Milwaukee	Repair or replace failing portion of 12-inch CMP outfall (sequence number 59 in Appendix E)	--	--	--	--	--	City of South Milwaukee	2,100	--	7, 57, 67	Low

Table continued on next page.

Table 6.1 (Continued)

		Site Information						Annual Pollutant Reductions						Costs (dollars)[c]			
ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Location	Latitude	Longitude	Municipality	Owner	Management Action	TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Lower Oak Creek-Mill Pond Assessment Area (LMP) (continued)																	
LMP-35	WQ, H	Left bank of Oak Creek downstream of 15th Avenue and across from South Milwaukee High School[f]	42.92337	-87.86847	City of South Milwaukee	Unknown	Repair or replace failing portion of 27-inch CMP outfall (sequence number 60 in Appendix E)	--	--	--	--	--	Unknown	4,000	--	7, 57, 67	High
LMP-36	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of Union Pacific Railroad crossing[f]	42.92337	-87.86849	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 22 feet of Oak Creek with a slight lateral recession rate	200	0.1	--	0.1	0.3	Milwaukee County, municipalities, and other watershed partners	7,700	460	8, 9, 22, 25, 49, 52, 58, 67	Low
LMP-37	WQ, H	Left bank of Oak Creek downstream of 15th Avenue and across from South Milwaukee High School[f]	42.92369	-87.86884	City of South Milwaukee	Milwaukee County	Repair or replace failing portion of 12-inch CMP outfall (sequence number 61 in Appendix E)	--	--	--	--	--	Milwaukee County	1,200	--	7, 57, 67	Low
LMP-38	WQ, H	Right bank of Oak Creek downstream of 15th Avenue and across from South Milwaukee High School[f]	42.92384	-87.86881	City of South Milwaukee	Unknown	Repair or replace failing portion of 24-inch CMP outfall (sequence number 62 in Appendix E)	--	--	--	--	--	Unknown	3,700	--	7, 57, 67	High
LMP-39	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of Union Pacific Railroad crossing[f]	42.92481	-87.86905	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 130 feet of Oak Creek with a slight lateral recession rate	1,000	0.6	--	0.7	1.5	Milwaukee County, municipalities, and other watershed partners	45,500	2,730	8, 9, 22, 25, 49, 52, 58, 67	Medium
LMP-40	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of Union Pacific Railroad crossing[f]	42.92475	-87.86937	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 61 feet of Oak Creek with a moderate lateral recession rate	2,000	0.6	--	1.6	3.3	Milwaukee County, municipalities, and other watershed partners	21,400	1,280	8, 9, 22, 25, 49, 52, 58, 67	Low
LMP-41	SWF	College Avenue – Union Pacific Railroad underpass	42.93009	-87.86352	Cities of Cudahy and South Milwaukee	Milwaukee County	Addition of 10 large capacity stormwater inlets to improve stormwater drainage	--	--	--	--	--	City of Cudahy	115,000	--	31, 42, 46, 57, 63, 67	High
LMP-42	SWF	South Milwaukee High School and sports complex	42.92161	-87.86791	City of South Milwaukee	South Milwaukee School District	Flood mitigation study for South Milwaukee High School and sports fields to review current conditions and refine options to reduce flooding impacts to the property from both Oak Creek and stormwater runoff	--	--	--	--	--	South Milwaukee School District and City of South Milwaukee	50,000	--	48, 57 63, 65, 67	Medium
LMP-43	H	Milwaukee County Parks Rawson Woods Management Unit 3	42.92088	-87.86684	City of South Milwaukee	Milwaukee County	Vegetation survey; invasive species control; invasive species monitoring and select control on 2.8 acres; wildlife monitoring	--	--	--	--	--	Milwaukee County Parks	11,100	--	11, 16, 19, 26, 45, 51, 53	Medium
LMP-44	H	Milwaukee County Parks Rawson Woods Management Unit 2	42.9144	-87.86791	City of South Milwaukee	Milwaukee County	Vegetation survey; invasive species control; invasive species monitoring and select control; reforestation and inter-seeding of native plants on 20.2 acres; wildlife monitoring	--	--	--	--	--	Milwaukee County Parks	67,600	--	11, 16, 19, 26, 35, 45, 51, 53	High
LMP-45	R	Rawson Woods Natural Area	42.91848	-87.86785	City of South Milwaukee	Milwaukee County	Develop a dedicated off-street nature trail loop with educational signage	--	--	--	--	--	Milwaukee County Parks	--	--	3, 11, 17, 64,	Low
LMP-47	SWF	Marquette Avenue underpass of Union Pacific Railroad crossing	42.9078	-87.86309	City of South Milwaukee	City of South Milwaukee	Flood mitigation study to review previous hydrologic and hydraulic work and develop a preferred alternative to eliminate surface flooding at this location	--	--	--	--	--	City of South Milwaukee	20,000		46, 57, 63, 65, 67	Medium
Lower Oak Creek Assessment Area (LOC)																	
LOC-01	WQ, R	Oak Creek upstream of 15th Avenue	42.92487	-87.87110	City of South Milwaukee	City of South Milwaukee	Investigate and remedy source of human fecal contamination to outfall (sequence number 72 in Appendix E)	--	--	--	--	--	City of South Milwaukee	--	--	10, 22, 52, 57, 65, 67	High

Table continued on next page.

Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Lower Oak Creek Assessment Area (LOC) (continued)																	
LOC-02	WQ, H	Left bank of Oak Creek between Elm Avenue (extended) and Oak Street (extended)	42.92302	-87.87411	City of South Milwaukee	Milwaukee County	Repair or replace failing portion of 12-inch CMP outfall (sequence number 76 in Appendix E)	--	--	--	--	--	Milwaukee County	2,100	--	7, 57, 67	Low
LOC-03	H, WQ, SWF	Oak Creek from 1,200 feet downstream of 15th Avenue (northernmost crossing) to Rawson Avenue	42.92269	-87.87474	City of South Milwaukee	Milwaukee County	Stream channel and riparian restoration of about 5,400 feet of channel[k]	--	--	--	--	--	Milwaukee County and other watershed partners	--[l]	--	7, 9, 10, 21, 22, 25, 28, 30, 39, 49, 52, 58, 60	Medium
LOC-04	WQ, SWF	Oak Creek Parkway from the entrance to Grant Park Beach to E. Rawson Avenue in the City of South Milwaukee	42.92158	-87.87408	City of South Milwaukee	City of South Milwaukee	Example Project – Install 2-foot pervious pavement strips in the parking lanes adjacent to curbs on both sides of the road along the parkway to treat runoff originating on the road	8,113	23.9	--	--	--	City of South Milwaukee	860,000	6,500	8, 25, 52, 57, 63, 66, 67	High
LOC-05	WQ, R	Oak Creek at Cherry Street (extended)	42.91975	-87.87446	City of South Milwaukee	Milwaukee County	Investigate and remedy source of canine fecal contamination to outfall (sequence number 81 in Appendix E)	--	--	--	--	--	Milwaukee County	--	--	10, 22, 52, 57, 65, 67	High
LOC-06	WQ, H	Left bank of Oak Creek within Oak Creek Parkway downstream of E. Rawson Avenue[f]	42.91906	-87.87406	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 78 feet of Oak Creek with a severe lateral recession rate	8,600	2.7	--	6.9	13.8	Milwaukee County, municipalities, and other watershed partners	27,300	1,640	8, 9, 22, 25, 49, 52, 58, 67	Medium
LOC-07	WQ, H	Right bank of Oak Creek within Oak Creek Parkway downstream of E. Rawson Avenue[f]	42.91836	-87.87416	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 46 feet of Oak Creek with a moderate lateral recession rate	1,400	0.4	--	1.1	2.3	Milwaukee County, municipalities, and other watershed partners	16,100	970	8, 9, 22, 25, 49, 52, 58, 67	Low
LOC-08	WQ, H	Left bank of Oak Creek at Chestnut Street (extended)[f]	42.91809	-87.87410	City of South Milwaukee	Milwaukee County	Repair or replace failing portion of 12-inch CMP outfall (sequence number 85 in Appendix E)	--	--	--	--	--	Milwaukee County	2,100	--	7, 57, 67	Low
LOC-09	WQ, R	Oak Creek at Chestnut Street (extended)	42.91796	-87.87415	City of South Milwaukee	City of South Milwaukee	Investigate and remedy source of canine fecal contamination to outfall (sequence number 86 in Appendix E)	--	--	--	--	--	City of South Milwaukee	--	--	10, 22, 52, 57, 65, 67	High
LOC-10	WQ, H	Right bank of Oak Creek at Cedar Street (extended)[f]	42.91721	-87.87409	City of South Milwaukee	City of South Milwaukee	Repair or replace failing portion of 18-inch RCP outfall (sequence number 89 in Appendix E)	--	--	--	--	--	City of South Milwaukee	2,900	--	7, 57, 67	Medium
LOC-11	WQ, H	Right bank of Oak Creek at Cedar Street (extended)[f]	42.91714	-87.87403	City of South Milwaukee	City of South Milwaukee	Repair or replace failing portion of 12-inch CMP outfall (sequence number 90 in Appendix E)	--	--	--	--	--	City of South Milwaukee	2,100	--	7, 57, 67	Low
LOC-12	WQ, H	Right bank of Oak Creek at Maple Street (extended)[f]	42.91630	-87.87375	City of South Milwaukee	City of South Milwaukee	Repair or replace failing portion of 18-inch CMP outfall (sequence number 91 in Appendix E)	--	--	--	--	--	City of South Milwaukee	2,100	--	7, 57, 67	Low
LOC-13	WQ, H	Left bank of Oak Creek at Maple Street (extended)[f]	42.91623	-87.87365	City of South Milwaukee	Milwaukee County	Repair or replace failing portion of 15-inch CMP outfall (sequence number 92 in Appendix E)	--	--	--	--	--	Milwaukee County	2,200	--	7, 57, 67	High
LOC-14	H	Milwaukee County Parks Rawson Woods Management Unit 1	42.91558	-87.86876	City of South Milwaukee	Milwaukee County	Invasive species monitoring and select control and reforestation with native tree and shrub species on 1.9 acres	--	--	--	--	--	Milwaukee County Parks	1,700	--	11, 16, 19, 26, 35, 45, 49, 51, 53	High
LOC-15	H	Oak Creek at E. Rawson Avenue and 16th Avenue crossing culvert	42.91490	-87.87279	City of South Milwaukee	City of South Milwaukee	Improve fish passage through triple cell culvert[m]	--	--	--	--	--	City of South Milwaukee	--	--	9, 11, 21, 25, 45, 48, 49	High
LOC-16	SWF	Sanitary lift station near 16th Avenue and Missouri Avenue (extended)	42.91451	-87.87264	City of South Milwaukee	City of South Milwaukee	Sanitary lift station study to review current configuration and evaluate component elevations relative to Oak Creek floodplain	--	--	--	--	--	City of South Milwaukee	10,000	--	31, 42, 46	Medium

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Lower Oak Creek Assessment Area (LOC) (continued)																	
LOC-17	WQ, H	Left bank of Oak Creek between Manitoba Avenue (extended) and Minnesota Avenue (extended)[f]	42.91323	-87.87036	City of South Milwaukee	Unknown	Repair or replace failing portion of 6-inch metal outfall (sequence number 99 in Appendix E)	--	--	--	--	--	Unknown	2,000	--	7, 57, 67	Low
LOC-18	WQ,H	Right bank of Oak Creek at Madison Avenue (extended)[f]	42.90996	-87.87223	City of South Milwaukee	City of South Milwaukee	Repair or replace failing portion of 18-inch CMP outfall (sequence number 107 in Appendix E)	--	--	--	--	--	City of South Milwaukee	2,300	--	7, 57, 67	Medium
LOC-19	WQ, SWF	Alleyway between 15th Avenue on the west, 13th Avenue on the east, Madison Avenue on the north, and Michigan Avenue on the south	42.90950	-87.86847	City of South Milwaukee	City of South Milwaukee	Example project – Installation of a 2-foot strip of pervious pavement along the center of the alley to treat runoff originating in the alley	186	0.5	--	--	--	City of South Milwaukee	34,000	200	25, 52, 57, 63, 66, 67	High
LOC-20	WQ, H	Right bank of Oak Creek between Madison Avenue (extended) and Michigan Avenue (extended)[f]	42.90955	-87.87289	City of South Milwaukee	City of South Milwaukee	Repair or replace failing portion of 18-inch CMP outfall (sequence number 108 in Appendix E)	--	--	--	--	--	City of South Milwaukee	2,300	--	7, 57, 67	Medium
LOC-21	H, WQ, SWF	Mainstem of Oak Creek and Parkway from the southmost crossing of 15th Avenue to 1,000 feet downstream of Pennsylvania Avenue	42.90897	-87.87332	City of South Milwaukee	Milwaukee County	Stream channel and riparian restoration of about 3,900 feet of channel[k,n]	--	--	--	--	--	Milwaukee County and other watershed partners	--[l]	--	7, 9, 10, 21, 22, 25, 28, 28, 30, 39, 49, 52, 58	Medium
LOC-22	SWF	Emergency Sanitary Relief Station near Oak Creek between Michigan Avenue (extended) and Marquette Avenue (extended)	42.90865	-87.87333	City of South Milwaukee	City of South Milwaukee	Emergency sanitary relief station study to review current configuration and evaluate component elevations relative to Oak Creek floodplain	--	--	--	--	--	City of South Milwaukee	10,000	--	31, 42, 46	Medium
LOC-23	WQ, H	Left bank of Oak Creek behind South Milwaukee City Hall	42.90714	-87.87487	City of South Milwaukee	Unknown	Repair or replace failing portion of 11-inch CMP outfall (sequence number 114 in Appendix E)	--	--	--	--	--	Unknown	2,100	--	7, 57, 67	Medium
LOC-24	H	Oak Creek behind/northwest of South Milwaukee City Hall	42.90716	-87.87506	City of South Milwaukee	Milwaukee County	Concrete removal and channel renaturalization of about 150 feet of stream channel	--	--	--	--	--	Milwaukee County	--	--	7, 9, 10, 21, 22, 25, 30, 28, 39, 49, 52, 58	Low
LOC-25	WQ, R	Oak Creek between 16th Avenue (extended) and 17th Avenue (extended)	42.90698	-87.87503	City of South Milwaukee	City of South Milwaukee	Investigate and remedy source of canine fecal contamination to outfall (sequence number 115 in Appendix E)	--	--	--	--	--	City of South Milwaukee	--	--	10, 22, 25, 52, 57, 65, 67	High
LOC-26	H, WQ	Milwaukee County Parks Oak Creek Parkway Management Section 5	42.90749	-87.87658	City of South Milwaukee	Milwaukee County	Forest stand improvement including canopy gap and understory planting of 21.3 acres; reforestation of 7.3 acres, rapid response invasive species management of 14 acres; floristic survey and wildlife inventory of 21.3 acres; survey and posting of property line	198	3.4	--	--	--	Milwaukee County	134,200	--	4, 5, 7, 11, 16, 20, 25, 26, 35, 49, 52	Low
LOC-28	H, WQ, SWF	Oak Creek from the S. Pennsylvania Avenue crossing to about 1,000 feet downstream of S. Pennsylvania Avenue	42.90545	-87.87876	City of South Milwaukee	Milwaukee County	Stream channel and riparian restoration of about 1,000 feet of channel and 20 acres of adjacent County parkland[o]	--	--	--	--	--	Milwaukee County and other watershed partners	--[l]	--	7, 9, 10, 21, 22, 25, 28, 30, 39, 49, 52, 58	Medium
LOC-29	H	Oak Creek about 630 feet downstream of S. Pennsylvania Avenue	42.90571	-87.87907	City of South Milwaukee	South Milwaukee School District	Remove or modify large woody debris jam to allow for better aquatic organism passage.	--	--	--	--	--	Milwaukee County and City of South Milwaukee	--	--	9, 21, 22, 25, 32, 48, 49	High
LOC-30	R	South bank of Oak Creek west of S. Pennsylvania Avenue	42.90464	-87.87931	City of South Milwaukee	Milwaukee County	Develop off-street nature trail through wooded area along Oak Creek	--	--	--	--	--	Milwaukee County	--	--	3, 11, 17, 60, 64	Low

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Lower Oak Creek Assessment Area (LOC) (continued)																	
LOC-31	WQ, H	Left bank of Oak Creek within Oak Creek Parkway downstream of S. Pennsylvania Avenue[f]	42.90522	-87.88088	City of South Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 54 feet of Oak Creek with a slight lateral recession rate	400	0.1	--	0.3	0.6	Milwaukee County, municipalities, and other watershed partners	18,900	1,130	8, 9, 22, 25, 49, 52, 58, 67	Low
LOC-32	WQ, H	Right bank of Oak Creek within Oak Creek Parkway upstream of S Pennsylvania Avenue[f]	42.90527	-87.88230	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 75 feet of Oak Creek with a moderate lateral recession rate	3,000	0.9	--	2.3	4.7	Milwaukee County, municipalities, and other watershed partners	26,300	1,580	8, 9, 22, 25, 49, 52, 58, 67	Medium
LOC-33	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of S Pennsylvania Avenue[f]	42.90527	-87.88230	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 75 feet of Oak Creek with a moderate lateral recession rate	3,000	0.9	--	2.3	4.7	Milwaukee County, municipalities, and other watershed partners	26,300	1,580	8, 9, 22, 25, 49, 52, 58, 67	Medium
LOC-34	WQ, SWF	Subdivision developments north of Oak Creek and east of S. Pennsylvania Avenue	42.90613	-87.88287	City of Oak Creek	City of Oak Creek and Milwaukee County	Example Project – Installation of wet retention pond with a pool size of 2.7 acres treating a 57.3-acre drainage area	5,038	15.0	6.32	--	--	City of Oak Creek and Milwaukee County	1,190,000	27,100	8, 12, 25, 31, 52, 57, 63, 67	Medium
LOC-35	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of S Pennsylvania Avenue[f]	42.90515	-87.88292	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 242 feet of Oak Creek with a moderate lateral recession rate	6,600	2.0	--	5.3	10.6	Milwaukee County, municipalities, and other watershed partners	84,700	5,080	8, 9, 22, 25, 49, 52, 58, 67	Medium
LOC-36	WQ, H	Right bank of Oak Creek within Oak Creek Parkway upstream of S Pennsylvania Avenue[f]	42.90504	-87.88340	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 32 feet of Oak Creek with a moderate lateral recession rate	400	0.2	--	0.4	0.8	Milwaukee County, municipalities, and other watershed partners	11,200	670	8, 9, 22, 25, 49, 52, 58, 67	Low
LOC-37	H	Oak Creek about 520 feet upstream from S. Pennsylvania Avenue	42.90503	-87.88365	City of Oak Creek	Milwaukee County and Private Landowner	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	Milwaukee County, City of Oak Creek, MMSD[p]	--	--	9, 21, 22, 25, 32, 48, 49	High
LOC-38	SWF, H	Oak Creek about 800 feet upstream from S. Pennsylvania Avenue	42.90507	-87.88447	City of Oak Creek	Milwaukee County	Assessment of stability of embankment and/or pond control structure between the small former quarry pond and adjacent creek, including any potential threat of failure and impacts related to downstream flooding and habitat degradation.	--	--	--	--	--	Milwaukee County	--	--	46, 50, 63, 67	Low
LOC-39	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of S Pennsylvania Avenue[f]	42.90499	-87.89090	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 67 feet of Oak Creek with a slight lateral recession rate	200	0.1	--	0.3	0.6	Milwaukee County, municipalities, and other watershed partners	23,500	1,410	8, 9, 22, 25, 49, 52, 58, 67	Low
LOC-40	WQ, H	Right bank of Oak Creek within Oak Creek Parkway upstream of S Pennsylvania Avenue[f]	42.90499	-87.88496	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 67 feet of Oak Creek with a slight lateral recession rate	200	0.1	--	0.2	0.3	Milwaukee County, municipalities, and other watershed partners	31,500	1,890	8, 9, 22, 25, 49, 52, 58, 67	Medium

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Lower Oak Creek Assessment Area (LOC) (continued)																	
LOC-41	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of S Pennsylvania Avenue[f]	42.90500	-87.88541	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 34 feet of Oak Creek with a moderate lateral recession rate	2,200	0.7	--	1.7	3.4	Milwaukee County, municipalities, and other watershed partners	11,900	710	8, 9, 22, 25, 49, 52, 58, 67	Low
LOC-42	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of S Pennsylvania Avenue[f]	42.90502	-87.88596	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 32 feet of Oak Creek with a severe lateral recession rate	4,600	1.4	--	3.7	7.4	Milwaukee County, municipalities, and other watershed partners	11,200	670	8, 9, 22, 25, 49, 52, 58, 67	Medium
LOC-43	WQ, H	Right bank of Oak Creek within Oak Creek Parkway upstream of S Pennsylvania Avenue[f]	42.90507	-87.88607	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 14 feet of Oak Creek with a moderate lateral recession rate	1,600	0.5	--	1.3	2.6	Milwaukee County, municipalities, and other watershed partners	4,900	290	8, 9, 22, 25, 49, 52, 58, 67	Low
LOC-44	WQ, H	Right bank of Oak Creek within Oak Creek Parkway upstream of S Pennsylvania Avenue[f]	42.90506	-87.88630	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 68 feet of Oak Creek with a moderate lateral recession rate	2,600	0.8	--	2.1	4.2	Milwaukee County, municipalities, and other watershed partners	23,800	1,430	8, 9, 22, 25, 49, 52, 58, 67	Medium
LOC-45	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of S Pennsylvania Avenue[f]	42.90503	-87.88650	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 42 feet of Oak Creek with a moderate lateral recession rate	400	0.2	--	0.4	0.9	Milwaukee County, municipalities, and other watershed partners	14,700	880	8, 9, 22, 25, 49, 52, 58, 67	Low
LOC-46	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of S Pennsylvania Avenue[f]	42.90505	-87.88736	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 327 feet of Oak Creek with a moderate lateral recession rate	3,800	1.8	--	4.6	9.3	Milwaukee County, municipalities, and other watershed partners	114,500	6,870	8, 9, 22, 25, 49, 52, 58, 67	Medium
LOC-47	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of S Pennsylvania Avenue[f]	42.90517	-87.88879	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 156 feet of Oak Creek with a severe lateral recession rate	7,200	3.3	--	8.6	17.3	Milwaukee County, municipalities, and other watershed partners	54,600	3,280	8, 9, 22, 25, 49, 52, 58, 67	Medium
LOC-48	H	Oak Creek about 650 feet downstream of the confluence with the Mitchell Field Drainage Ditch	42.90532	-87.88897	City of Oak Creek	Milwaukee County	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	Milwaukee County, City of Oak Creek, MMSD[p]	--	--	9, 21, 22, 25, 27, 32, 48, 49	High
LOC-49	H, WQ	Milwaukee County Parks Oak Creek Parkway Management Section 6	42.90542	-87.89006	City of Oak Creek	Milwaukee County	Grassland management of 4.6 acres; reforestation of 10.2 acres; rapid response invasive species management of 71.6 acres; forest stand improvement including supplemental gap canopy and understory planting of 64.3 acres; floristic survey and wildlife inventory of 75.8 acres	0	2.7	--	--	--	Milwaukee County	399,400	--	4, 5, 7, 11, 16, 20, 25, 26, 35, 49, 52	Low
LOC-50	H, WQ, SWF	About 3,800 feet of Oak Creek from S. Pennsylvania Avenue to 500 feet downstream of E. Drexel Avenue	42.90503	-87.89041	Cities of South Milwaukee and Oak Creek	Milwaukee County	Stream channel and riparian restoration of about 3,800 feet of channel[q]	--	--	--	--	--	Milwaukee County and other watershed partners	--[l]	--	7, 9, 10, 21, 22, 25, 28, 30, 39, 49, 52, 58	Medium

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Lower Oak Creek Assessment Area (LOC) (continued)																	
LOC-51	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of S Pennsylvania Avenue[f]	42.90499	-87.89090	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 214 feet of Oak Creek with a severe lateral recession rate	12,800	5.9	--	15.3	30.5	Milwaukee County, municipalities, and other watershed partners	74,900	4,490	8, 9, 22, 25, 49, 52, 58, 67	Medium
LOC-52	WQ, SWF	Southwest of the intersection of STH 32 and E. Forest Hill Avenue	42.89136	-87.86505	City of South Milwaukee	City of Oak Creek	Example Project – Installation of wet retention pond with a pool size of 0.74 acres, treating a drainage area of 8.1 acres	460	1.7	0.90	--	--	City of Oak Creek	320,000	6,900	8, 12, 25, 31, 52, 57, 63, 67	Medium
LOC-53	WQ	Pond near S. Ashbury Lane and E. Oakshire Drive	42.88824	-87.86582	City of Oak Creek	City of Oak Creek	Retrofit 1.85-acre wet retention pond WQ-19 into existing pond	53,062	--	--	--	--	City of Oak Creek	345,900	13,820	31, 46, 57, 63, 67	Medium
Middle Oak Creek Assessment Area (MOC)																	
MOC-01	WQ, H	Oak Creek north of E. Drexel Avenue	42.90128	-87.89317	City of Oak Creek	Milwaukee County	Establish riparian buffer along about 500 feet of Oak Creek on about 2.0 acres and manage invasive species	--	0.7	--	--	--	Milwaukee County	8,400	--	4, 7,10, 11, 15, 20, 22, 24, 25, 26, 45, 49, 52, 57, 58, 67	Low
MOC-02	H, SWF	Culvert at E. Drexel Avenue crossing of Oak Creek	42.90087	-87.89298	City of Oak Creek	City of Oak Creek	Monitor and remove accumulations of debris	--	--	--	--	--	City of Oak Creek	--	--	21, 22, 39, 49, 51	Low
MOC-03	WQ, H	Right bank of Oak Creek in Abendschein Park[f]	42.89832	-87.89514	City of Oak Creek	City of Oak Creek	Bank stabilization to address bank erosion along 49 feet of Oak Creek with a severe lateral recession rate	3,200	1.5	--	3.9	7.8	City of Oak Creek	17,200	1,030	8, 22, 25, 49, 52, 58, 67	Medium
MOC-04	H, WQ, SWF	Oak Creek through Abendschein Park from E. Drexel Avenue to the Union Pacific Railroad crossing downstream of E. Forest Hill Avenue	42.89780	-87.89503	City of Oak Creek	City of Oak Creek	Stream channel and riparian restoration of about 3,800 feet of channel[r]	--	--	--	--	--	City of Oak Creek and other watershed partners	--[l]	--	7, 9, 10, 21, 22, 25, 28, 28, 30, 39, 49, 52, 58	High
MOC-05	WQ, H	Right bank of Oak Creek in Abendschein Park[f]	42.89725	-87.89508	City of Oak Creek	City of Oak Creek	Bank stabilization to address bank erosion along 75 feet of Oak Creek with a moderate lateral recession rate	1,000	0.5	--	1.3	2.5	City of Oak Creek	26,300	1,580	8, 9, 22, 25, 49, 52, 58, 67	Low
MOC-06	WQ, H	Left bank of Oak Creek in Abendschein Park[f]	42.89688	-87.89422	City of Oak Creek	City of Oak Creek	Bank stabilization to address bank erosion along 83 feet of Oak Creek with a slight lateral recession rate	400	0.2	--	0.4	0.8	City of Oak Creek	29,100	1,740	8, 9, 22, 25, 49, 52, 58, 67	Low
MOC-07	H	Oak Creek about 580 feet downstream of Union Pacific Railroad crossing	42.89618	-87.89348	City of Oak Creek	MMSD	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Oak Creek, Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
MOC-08	WQ, H	Right bank of Oak Creek downstream of Union Pacific Railroad crossing[f]	42.89557	-87.89333	City of Oak Creek	MMSD	Bank stabilization to address bank erosion along 17 feet of Oak Creek with a moderate lateral recession rate	600	0.2	--	0.5	1.1	MMSD	6.000	360	8, 9, 22, 25, 49, 52, 58, 67	Low
MOC-09	WQ, H	Right bank of Oak Creek downstream of Union Pacific Railroad crossing[f]	42.89516	-87.89243	City of Oak Creek	MMSD	Bank stabilization to address bank erosion along 51 feet of Oak Creek with a slight lateral recession rate	600	0.2	--	0.4	0.9	MMSD	17,900	1,070	8, 9, 22, 25, 49, 52, 58, 67	Low
MOC-10	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of Union Pacific Railroad crossing[f]	42.89520	-87.89111	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 44 feet of Oak Creek with a slight lateral recession rate	200	0.1	--	0.2	0.4	Milwaukee County, municipalities, and other watershed partners	15,400	920	8, 9, 22, 25, 49, 52, 58, 67	Low
MOC-11	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of E. Forest Hill Avenue[f]	42.89297	-87.88920	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 54 feet of Oak Creek with a slight lateral recession rate	400	0.1	--	0.3	0.5	Milwaukee County, municipalities, and other watershed partners	18,900	1,130	8, 9, 22, 25, 49, 52, 58, 67	Low

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Table 6.1 (Continued)

		Site Information						Annual Pollutant Reductions						Costs (dollars)[c]			
ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Location	Latitude	Longitude	Municipality	Owner	Management Action	TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Middle Oak Creek Assessment Area (MOC) (continued)																	
MOC-12	H, WQ	Milwaukee County Parks Oak Creek Parkway Management Section 7	42.89221	-87.88800	City of Oak Creek	Milwaukee County	Grassland management of 24.2 acres; reforestation of 4.6 acres; grassland restoration of 12 acres; rapid response invasive species of 75.7 acres, forest stand improvement including supplemental canopy gap and understory planting of 26.1 acres; floristic survey and wildlife inventory of 75.7 acres; surveying and posting of property lines	8,139	0	--	--	--	Milwaukee County	349,300	--	4, 5, 7, 11, 16, 20, 25, 26, 35, 49, 52	Low
MOC-13	H	Oak Creek about 980 feet upstream of E. Forest Hill Avenue	42.89128	-87.88791	City of Oak Creek	Milwaukee County	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Oak Creek, Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
MOC-14	WQ, H	Right bank of Oak Creek within Oak Creek Parkway upstream of E. Forest Hill Avenue[f]	42.89090	-87.88740	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 109 feet of Oak Creek with a slight lateral recession rate	800	0.2	--	0.6	1.2	Milwaukee County, municipalities, and other watershed partners	38,200	2,290	8, 9, 22, 25, 49, 52, 58, 67	Low
MOC-15	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of E. Forest Hill Avenue[f]	42.89074	-87.88713	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 7 feet of Oak Creek with a slight lateral recession rate	0	0.0	--	0.0	0.1	Milwaukee County, municipalities, and other watershed partners	2,500	150	8, 9, 22, 25, 49, 52, 58, 67	Low
MOC-16	WQ, H	Right bank of Oak Creek within Oak Creek Parkway upstream of E. Forest Hill Avenue[f]	42.88956	-87.88713	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 151 feet of Oak Creek with a slight lateral recession rate	1,200	0.4	--	1.0	2.0	Milwaukee County, municipalities, and other watershed partners	52,900	3,170	8, 9, 22, 25, 49, 52, 58, 67	Low
MOC-17	H	Oak Creek about 1,300 feet downstream of E. Puetz Road	42.88949	-87.88726	City of Oak Creek	Milwaukee County	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Oak Creek, Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
MOC-18	WQ, H	Right bank of Oak Creek within Oak Creek Parkway upstream of E. Forest Hill Avenue[f]	42.88851	-87.88726	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 192 feet of Oak Creek with a moderate lateral recession rate	8,600	2.7	--	6.9	13.9	Milwaukee County, municipalities, and other watershed partners	67,200	4,030	8, 9, 22, 25, 49, 52, 58, 67	Medium
MOC-19	H, WQ, SWF	Oak Creek from the Union Pacific Railroad crossing downstream of E. Forest Hill Avenue to about 2,800 feet downstream of S. Shepard Avenue	42.88953	-87.88728	City of Oak Creek	Milwaukee County	Stream channel and riparian restoration of about 9,500 feet of channel and about 320 acres of adjacent publicly owned land[s]	--	--	--	--	--	Milwaukee County and other watershed partners	--[j]	--	7, 9, 10, 21, 22, 25, 28, 28, 30, 39, 49, 52, 58	High
MOC-20	WQ, SWF	City of Oak Creek storm sewer running parallel to E. Puetz Road from the west side of S. Pennsylvania Avenue to its outlet near the Oak Creek	42.88648	-87.88384	City of Oak Creek	City of Oak Creek	Example project – Daylighting about 720 feet of storm sewer treating a drainage area of 35.3 acres	929	3.9	0.38	--	--	City of Oak Creek	220,000	7,400	8, 10, 12, 14, 31, 46, 50, 52, 57, 63, 67	Medium
MOC-21	H, SWF	E. Puetz Road crossing of Oak Creek	42.88633	-87.88560	City of Oak Creek	City of Oak Creek	Monitor beaver activity and remove debris as needed	--	--	--	--	--	City of Oak Creek	--	--	--	Low

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Middle Oak Creek Assessment Area (MOC) (continued)																	
MOC-22	WQ, H	Right bank of Oak Creek within Oak Creek Parkway upstream of E. Puetz Road[f]	42.88453	-87.88564	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 48 feet of Oak Creek with a moderate lateral recession rate	2,000	0.6	--	1.6	3.3	Milwaukee County, municipalities, and other watershed partners	16,800	1,010	8, 22, 25, 49, 52, 58, 67	Low
MOC-23	H, WQ	Milwaukee County Parks Oak Creek Parkway Management Section 8	42.88325	-87.88667	City of Oak Creek	Milwaukee County	Shallow wetland design and installation of 5 acres; reforestation of 65.9 acres; rapid response invasive species management of 42.5 acres; floristic survey and wildlife inventory of 70.9 acres; survey and posting of property line	107,400	40.1	--	--	--	Milwaukee County	478,500	--	4, 5, 7, 11, 25, 26, 35, 37, 38, 49, 52, 69	High
MOC-24	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of E. Puetz Road[f]	42.88300	-87.88562	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 67 feet of Oak Creek with a slight lateral recession rate	600	0.2	--	0.4	0.9	Milwaukee County, municipalities, and other watershed partners	23,500	1,410	8, 9, 22, 25, 49, 52, 58, 67	Low
MOC-25	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of E. Puetz Road[f]	42.88214	-88.88702	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 186 feet of Oak Creek with a moderate lateral recession rate	8,800	2.7	--	7.0	13.9	Milwaukee County, municipalities, and other watershed partners	65,100	3,910	8, 9, 22, 25, 49, 52, 58, 67	Medium
MOC-26	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of E. Puetz Road[f]	42.88178	-87.88933	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 59 feet of Oak Creek with a moderate lateral recession rate	2,800	0.9	--	2.2	4.4	Milwaukee County, municipalities, and other watershed partners	20,700	1,240	8, 9, 22, 25, 49, 52, 58, 67	Medium
MOC-27	WQ, H	Left bank of Oak Creek within Oak Creek Parkway between S. Nicholson Road and the Union Pacific Railroad crossing[f]	42.88151	-87.89146	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 47 feet of Oak Creek with a slight lateral recession rate	400	0.2	--	0.4	0.8	Milwaukee County, municipalities, and other watershed partners	16,500	990	8, 9, 22, 25, 49, 52, 58, 67	Low
MOC-28	WQ, H	Left bank of Oak Creek within Oak Creek Parkway between S. Nicholson Road and the Union Pacific Railroad crossing[f]	42.88143	-87.89209	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 40 feet of Oak Creek with a moderate lateral recession rate	400	0.2	--	0.4	0.8	Milwaukee County, municipalities, and other watershed partners	14,000	840	8, 9, 22, 25, 49, 52, 58, 67	Low
MOC-29	H	Oak Creek immediately downstream of S. Nicholson Road bridge	42.88147	-87.89223	City of Oak Creek	Milwaukee County	Existing placement of rock across channel may obstruct passage for some fish species. Rearrange excess rubble to allow for better passage	--	--	--	--	--	Milwaukee County	--	--	3, 6, 11, 15, 16, 18, 21, 22, 49	High
MOC-30	WQ, H	Right bank of Oak Creek within Oak Creek Parkway upstream of S. Nicholson Road[f]	42.88139	-87.89287	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 5 feet of Oak Creek with a moderate lateral recession rate	200	0.1	--	0.2	0.3	Milwaukee County, municipalities, and other watershed partners	1,800	110	8, 9, 22, 25, 49, 52, 58, 67	Low
MOC-31	H, WQ	Milwaukee County Parks Oak Creek Parkway Management Section 10	42.88099	-87.89555	City of Oak Creek	Milwaukee County	Rapid response invasive species management of 68.2 acres; forest stand improvement including supplemental canopy and understory planting of 7.3 acres; grassland management of 14 acres; grassland restoration of 19.7 acres; floristic survey and wildlife inventory of 65.3 acres	40,180	7.3				Milwaukee County	331,700	--	4, 5, 7, 11, 16, 25, 26, 35, 49, 52	High

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Middle Oak Creek Assessment Area (MOC) (continued)																	
MOC-32	H	Oak Creek about 1,100 feet downstream of S. Nicholson Road	42.87975	-87.89577	City of Oak Creek	Milwaukee County	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Oak Creek, Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
MOC-33	WQ, H	Left bank of Oak Creek partially within Oak Creek Parkway and on private parcel 873-1034-0000[f]	42.87909	-87.89671	City of Oak Creek	Milwaukee County and private landowner	Bank stabilization to address bank erosion along 79 feet of Oak Creek with a slight lateral recession rate	400	0.2	--	0.4	0.8	Milwaukee County, municipalities, and other watershed partners	27,700	1,660	8, 21, 22, 25, 49, 52, 67	Low
MOC-34	WQ, H	Right bank of Oak Creek within Oak Creek Parkway upstream of S. Nicholson Road[f]	42.87833	-87.89770	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 108 feet of Oak Creek with a moderate lateral recession rate	5,000	1.6	--	4.0	8.1	Milwaukee County, municipalities, and other watershed partners	37,800	2,270	8, 9,22, 25, 49, 52, 58, 67	Medium
MOC-35	WQ, H	Right bank of Oak Creek at Oak Creek East Middle School[f]	42.87663	-87.89777	City of Oak Creek	Oak Creek School District	Bank stabilization to address bank erosion along 132 feet of Oak Creek with a moderate lateral recession rate	6,200	1.9	--	4.9	9.9	Oak Creek School District	46,200	2,770	8, 21, 22, 25, 49, 52, 67	Medium
MOC-36	H	Oak Creek about 2,380 feet downstream of S. Shepard Avenue	42.87611	-87.89740	City of Oak Creek	Unknown	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Oak Creek, Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
MOC-37	H, WQ, SWF	About 1,800 feet of Oak Creek east of Oak Creek East Middle School	42.87580	-87.87695	City of Oak Creek	Oak Creek School District and Others	Stream channel and riparian restoration of about 1,800 feet of channel[t]	--	--	--	--	--	Oak Creek School District and other watershed partners	--[l]	--	7, 9, 10, 21, 22, 25, 28, 30, 39, 49, 52, 58	High
MOC-38	H	Oak Creek about 2,200 feet downstream from S. Shepard Avenue	42.87557	-87.89707	City of Oak Creek	Unknown	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Oak Creek, Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
MOC-39	WQ, H	Left bank of Oak Creek east of Oak Creek East Middle School on parcel 873-1034-000[f]	42.87460	-87.89705	City of Oak Creek	Unknown	Bank stabilization to address bank erosion along 59 feet of Oak Creek with a moderate lateral recession rate	3,000	0.9	--	2.4	4.8	Unknown	20,700	1,240	8, 22, 25, 27, 49, 52, 58, 67	Medium
MOC-40	WQ, H	Left bank of Oak Creek southeast of Oak Creek East Middle School on parcel 873-1034-000[f]	42.87380	-87.89759	City of Oak Creek	Unknown	Bank stabilization to address bank erosion along 93 feet of Oak Creek with a moderate lateral recession rate	4,200	1.3	--	3.4	6.7	Unknown	32,600	1,950	8, 22, 25, 27, 49, 52, 58, 67	Medium
MOC-41	SWF, WQ, H	Culvert carrying drainage ditch at confluence with Oak Creek southeast of Oak Creek East Middle School	42.87385	-87.89782	City of Oak Creek	Unknown	Remove and replace failing culvert which causes backup of drainage ditches. If the culvert is no longer necessary, remove it and stabilize the drainage ditch channel and banks with riprap at the location where it flows into Oak Creek	--	--	--	--	--	Unknown	--	--	8,11, 12, 27, 31, 39, 49, 52, 57, 67	Medium
MOC-42	H	Oak Creek about 1,050 feet downstream of S Shepard Avenue	42.87434	-87.89904	City of Oak Creek	Milwaukee County and Oak Creek School District	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Oak Creek, Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
MOC-43	H, WQ, SWF	Oak Creek south of Oak Creek East Middle School	42.87428	-87.90000	City of Oak Creek	Milwaukee County and Oak Creek School District	Stream channel and riparian restoration of about 1,000 feet of channel and 20 acres of adjacent Milwaukee County parkland and leased agricultural fields[u]	--	--	--	--	--	Milwaukee County and other watershed partners	--[l]	--	7, 9, 10, 21, 22, 25, 28, 28, 30, 39, 49, 52, 58, 60	Medium

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Middle Oak Creek Assessment Area (MOC) (continued)																	
MOC-44	WQ, H	Left bank of Oak Creek downstream of S. Shepard Avenue and south of Oak Creek East Middle School[f]	42.87389	-87.90096	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 39 feet of Oak Creek with a severe lateral recession rate	8,400	2.6	--	6.7	13.5	Milwaukee County, municipalities, and other watershed partners	13,700	820	8, 9, 22, 25, 49, 52, 58, 67	Medium
MOC-45	WQ, H	Oak Creek about 400 feet downstream of S. Shepard Avenue	42.87394	-87.90113	City of Oak Creek	Milwaukee County and Oak Creek School District	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Oak Creek, Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
MOC-46	WQ	S. Shepard Avenue and E. Ryan Road (subbasin O10-5)	42.87253	-87.90189	City of Oak Creek	City of Oak Creek	Install 0.83-acre wet retention pond (WQ-39)	27,279	--	--	--	--	City of Oak Creek	167,400	6,690	31, 57, 67	Medium
MOC-47	H, SWF	Culvert at S. Shepard Avenue crossing of Oak Creek	42.87433	-87.90286	City of Oak Creek	City of Oak Creek and Milwaukee County	Monitor beaver activity and remove debris as needed	--	--	--	--	--	City of Oak Creek and Milwaukee County	--	--	--	Low
MOC-48	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of S. Shepard Avenue[f]	42.87475	-87.90356	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 33 feet of Oak Creek with a severe lateral recession rate	4,600	1.4	--	3.7	7.3	Milwaukee County, municipalities, and other watershed partners	11,600	690	8, 9, 22, 25, 49, 52, 58, 67	Medium
MOC-49	WQ, H	Right bank of Oak Creek within Oak Creek Parkway upstream of S. Shepard Avenue[f]	42.87522	-87.90365	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 86 feet of Oak Creek with a severe lateral recession rate	20,600	6.4	--	16.5	33.0	Milwaukee County, municipalities, and other watershed partners	30,100	1,810	8, 9, 22, 25, 49, 52, 58, 67	Medium
MOC-50	WQ, H	Right bank of Oak Creek within Oak Creek Parkway upstream of S. Shepard Avenue[f]	42.87549	-87.90411	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 34 feet of Oak Creek with a moderate lateral recession rate	1,800	0.5	--	1.4	2.8	Milwaukee County, municipalities, and other watershed partners	11,900	710	8, 9, 22, 25, 49, 52, 58, 67	Low
MOC-51	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of S. Shepard Avenue[f]	42.87535	-87.90463	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 67 feet of Oak Creek with a moderate lateral recession rate	4,200	1.3	--	3.3	6.7	Milwaukee County, municipalities, and other watershed partners	23,500	1,410	8, 9, 22, 25, 49, 52, 58, 67	Medium
MOC-52	WQ, H	Left bank of Oak Creek within Oak Creek Parkway and American Legion Park upstream of S. Shepard Avenue[f]	42.87556	-87.90489	City of Oak Creek	Milwaukee County and American Legion	Bank stabilization to address bank erosion along 91 feet of Oak Creek with a moderate lateral recession rate	5,000	1.5	--	4.0	7.9	Milwaukee County, American Legion, municipalities, and other watershed partners	31,900	1,910	7, 8, 11, 22, 25, 27, 49, 52, 58, 67	Medium
MOC-53	WQ, SWF	Subdivision development to the northeast of S. Howell Avenue and E. Ryan Road	42.87587	-87.90667	City of Oak Creek	City of Oak Creek and Milwaukee County	Example Project – Installation of wet retention pond with a pool size of 3.3 acres treating a drainage area of 26.4 acres	3,200	9.5	1.63	--	--	City of Oak Creek and Milwaukee County	1,020,000	20,200	8, 12 ,25, 31, 52, 57, 63, 67	Medium
MOC-54	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of S. Shepard Avenue[f]	42.87613	-87.90516	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 107 feet of Oak Creek with a severe lateral recession rate	20,600	6.3	--	16.4	32.9	Milwaukee County, municipalities, and other watershed partners	37,500	2,250	8, 9, 22, 25, 49, 52, 58, 67	High

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Middle Oak Creek Assessment Area (MOC) (continued)																	
MOC-55	WQ, H	Left bank of Oak Creek within Oak Creek Parkway and American Legion Park upstream of S. Shepard Avenue[f]	42.87707	-87.90508	City of Oak Creek	Milwaukee County and American Legion	Bank stabilization to address bank erosion along 166 feet of Oak Creek with a severe lateral recession rate	24,000	7.4	--	19.1	38.2	Milwaukee County, American Legion, municipalities, and other watershed partners	58,100	3,490	7, 8, 11, 22, 25, 27, 49, 52, 58, 67	High
MOC-56	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of S. Shepard Avenue[f]	42.87812	-87.90566	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 139 feet of Oak Creek with a moderate lateral recession rate	6,200	1.9	--	4.9	9.9	Milwaukee County, municipalities, and other watershed partners	48,700	2,920	8, 9, 22, 25, 49, 52, 58, 67	Medium
MOC-57	H, WQ	Milwaukee County Parks Oak Creek Parkway Management Section 11	42.87755	-87.90714	City of Oak Creek	Milwaukee County	Rapid response invasive species management of 53.8 acres; forest stand improvement including supplemental canopy and understory planting of 19.3 acres; reforestation of 2.6 acres; shrubland management of 25.4 acres; floristic surveys and wildlife inventory of 53.8 acres	58	1.0	--	--	--	Milwaukee County	271,700	--	4, 5, 7, 11, 16, 25, 26, 35, 49, 52	Low
MOC-58	H, WQ	Privately-owned natural areas to the north of Milwaukee County Parks Oak Creek Parkway Management Section 11	42.88103	-87.90974	City of Oak Creek	Private landowners	Voluntary acquisition of wooded/natural portions of private parcels adjacent to the north of Management Section 11 to protect wildlife dispersal corridor, buffers to Parks natural areas, and wetlands that are hydrologically connected to parkland	--	--	--	--	--	Milwaukee County and other watershed partners	--	--	19, 20, 35, 38, 46, 49, 58, 60, 61, 65, 69	Low
MOC-59	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of S. Shepard Avenue[f]	42.87768	-87.90974	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 100 feet of Oak Creek with a moderate lateral recession rate	5,000	1.7	--	4.5	9.0	Milwaukee County, municipalities, and other watershed partners	35,000	2,1000	8, 9, 22, 25, 49, 52, 58, 67	Medium
MOC-60	WQ, H	Right bank of Oak Creek within Oak Creek Parkway downstream of S. Howell Avenue[f]	42.87692	-87.91219	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 15 feet of Oak Creek with a slight lateral recession rate	0	0.0	--	0.1	0.1	Milwaukee County, municipalities, and other watershed partners	5,300	320	8, 9, 22, 25, 49, 52, 58, 67	Low
MOC-61	H	S. Howell Avenue bridge crossing of Oak Creek	42.87681	-87.91248	City of Oak Creek	Milwaukee County	Explore opportunities to improve fish passage under the bridge by improving water depths[v]	--	--	--	--	--	Milwaukee County	--	--	9, 11, 21, 22, 25, 42, 45, 48, 49	High
MOC-63	WQ, H	Left bank of Oak Creek within Oak Creek Parkway downstream of S. Howell Avenue[f]	42.87619	-87.91400	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 15 feet of Oak Creek with a slight lateral recession rate	200	0.1	--	0.2	0.3	Milwaukee County, municipalities, and other watershed partners	14,000	840	8, 9, 22, 25, 49, 52, 58, 67	Low
MOC-64	WQ, H	Right bank of Oak Creek within Oak Creek Parkway downstream of S. Howell Avenue[f]	42.87577	-87.91515	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 62 feet of Oak Creek with a slight lateral recession rate	400	0.1	--	0.3	0.6	Milwaukee County, municipalities, and other watershed partners	21,700	1,300	8, 9, 22, 25, 49, 52, 58, 67	Low

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information					Management Action	Annual Pollutant Reductions					Key Project Partners	Costs (dollars)[c]		Potential Funding Sources[d]	Priority[e]
		Location	Latitude	Longitude	Municipality	Owner		TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)		Capital	Annual O&M		
Middle Oak Creek Assessment Area (MOC) (continued)																	
MOC-65	WQ, H	Right bank of Oak Creek within Oak Creek Parkway downstream of S. Howell Avenue[f]	42.87530	-87.91650	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 114 feet of Oak Creek with a severe lateral recession rate	26,000	8.0	--	20.8	41.6	Milwaukee County, municipalities, and other watershed partners	39,900	2,390	8, 9, 22, 25, 49, 52, 58, 67	High
MOC-66	WQ, H	Left bank of Oak Creek within Oak Creek Parkway downstream of S. Howell Avenue[f]	42.87510	-87.91674	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 21 feet of Oak Creek with a moderate lateral recession rate	600	0.2	--	0.5	1.0	Milwaukee County, municipalities, and other watershed partners	7,400	440	8, 9, 22, 25, 49, 52, 58, 67	Low
MOC-67	H	Oak Creek about 860 feet downstream of the confluence with the North Branch of Oak Creek	42.87465	-87.91999	City of Oak Creek	Milwaukee County	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Oak Creek, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
MOC-68	WQ, H	Left bank of Oak Creek within Oak Creek Parkway downstream at confluence with the North Branch of Oak Creek[f]	42.87524	-87.92264	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 145 feet of Oak Creek with a moderate lateral recession rate	10,800	3.3	--	8.6	17.2	Milwaukee County, municipalities, and other watershed partners	50,800	3,050	8, 9, 22, 25, 49, 52, 58, 67	High
MOC-69	WQ	Subbasin O15-4 east of S. Nicholson Road near S. Chelsea Lee Court	42.86143	-87.88842	City of Oak Creek	City of Oak Creek	Install 8.29 wetland treatment system WQ-40	27,371	--	--	--	--	City of Oak Creek	83,400	3,290	4, 6, 8, 12, 22, 25, 30, 45, 57, 58, 67	Medium
Middle Oak Creek Drainage Ditches Assessment Area (MDD)																	
MDD-01	H, WQ	Milwaukee County Parks Oak Creek Parkway Management Section 9	42.877701	-87.87662	City of Oak Creek	Milwaukee County	Reforestation of 35.2 acres; rapid response invasive species management of 92.4 acres; forest stand improvement including supplemental canopy and understory planting of 27.8 acres; floristic surveys and wildlife inventory of 120.6 acres; survey and posting of property lines	98,810	36.9	--	--	--	Milwaukee County	492,700	--	4, 5, 7, 11, 16, 20, 25, 26, 35, 49, 52	High
MDD-02	H, WQ	Privately owned wooded parcels to the north of Oak Creek Parkway Management Section 9	42.88391	-87.87597	City of Oak Creek	Private landowners	Voluntary acquisition of wooded private parcels adjacent to the north of Management Section 9 to protect wildlife dispersal corridor, buffers to Parks natural areas, and wetlands that are hydrologically connected to parkland	--	--	--	--	--	Milwaukee County, Private landowners, and other watershed partners	554,400	--	19, 20, 35, 38, 46, 49, 58, 60, 61, 65, 69	Low
MDD-03	WQ, H, SWD	Wetland complex occupying portions of land bounded by E. Puetz Road on the north, S. 15th Avenue on the east, E. Oakwood Road on the south, and S. Shepard Avenue on the west	42.86573	-87.88475	City of Oak Creek	Milwaukee County, MMSD, and Private landowners	Investigate the extent and locations of relict drainage tile systems. Disconnect and/or remove any systems found to assist in restoring the wetland complexes.	--	--	--	--	--	Milwaukee County, MMSD, and Private landowners	--	--	4, 6, 8, 11,12, 20, 23, 25, 27, 37, 38, 39, 46, 49, 52, 58, 66	Medium
MDD-04	H WQ	Privately-owned natural areas to the west, north, and east of Milwaukee County Parks Oak Creek Parkway Management Section 13	42.86357	-87.87623	City of Oak Creek	Private landowners	Voluntary acquisition of wooded and natural private parcels adjacent to the Management Section 3 to protect wildlife dispersal corridor, buffers to Parks natural areas, and wetlands that are hydrologically connected to parkland	--	--	--	--	--	Private landowners, Milwaukee County, and watershed partners	--	--	19, 20, 35, 38, 46, 49, 58, 60, 61, 65, 69	Low

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information					Management Action	Annual Pollutant Reductions					Key Project Partners	Costs (dollars)[c]		Potential Funding Sources[d]	Priority[e]
		Location	Latitude	Longitude	Municipality	Owner		TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)		Capital	Annual O&M		
Middle Oak Creek Drainage Ditches Assessment Area (MDD) (continued)																	
MDD-05	WQ, H, SWF	Wetland complex occupying portions of land bounded by E. Puetz Road on the north, S. 15th Avenue on the east, E. Oakwood Road on the south, and S. Shepard Avenue on the west	42.87543	-87.88489	City of Oak Creek	Private landowners	Assess interest of private landowners in pursuing wetland restoration activities. Evaluate landowner interest in voluntary acquisition of parcels.	--	--	--	--	--	Milwaukee County and watershed partners	--	--	8, 20, 22, 25, 33, 37, 40, 46, 49, 58, 60, 61, 63, 65	Low
MDD-06	WQ	Northeast of 15th Avenue and E. Carollton Drive	42.88030	-87.86802	City of Oak Creek	City of Oak Creek	Retrofit 0.26-acre wet retention pond WQ-41 into existing pond to sere subbasin O17-2	4,746	--	--	--	--	City of Oak Creek	67,800	2,470	4, 6, 8, 12, 22, 25, 30, 45, 57, 58, 67	Medium
MDD-08	SWF	E. Ryan Road between S. Pennsylvania Avenue and S. Shepard Avenue	42.87175	-87.88736	City of Oak Creek	City of Oak Creek	Raise the elevation of E. Ryan Road to prevent overtopping by stormwater	--	--	--	--	--	City of Oak Creek	1,364,400	--	31, 42, 46, 47	Medium
MDD-09	H, WQ	Milwaukee County Parks Oak Creek Parkway Management Section 13	42.86077	-87.88563	City of Oak Creek	Milwaukee County	Shallow wetland design and installation of 5 acres; rapid response invasive species management of 128.6 acres; forest stand improvement including supplemental canopy gap and understory planting of 41.6 acres; reforestation of 7.3 acres; floristic surveys and wildlife inventory of 169.3 acres; property line survey and posting	13,250	4.9	--	--	--	Milwaukee County	653,200	--	4, 5, 7, 11, 16, 20, 25, 26, 35, 49, 52	Low
Upper Oak Creek Headwaters Assessment Area (UOC)																	
UOC-01	H, WQ, SWF	Area surrounding the confluence of the North Branch of Oak Creek and the mainstem of Oak Creek	42.87521	-87.92278	City of Oak Creek	WisDOT, Milwaukee County, City of Oak Creek, Canadian Pacific Railway	Conduct a detailed survey of the mainstem of Oak Creek from S. 13th Street to 1,000 feet downstream of S. Howell Avenue and the North Branch of Oak Creek downstream from W. Puetz Road to its confluence with the mainstem.[w]	--	--	--	--	--	WisDOT, Milwaukee County, City of Oak Creek, Canadian Pacific Railway	20,000	--	45, 47, 65	High
UOC-02	H, WQ, SWF	Area surrounding the confluence of the North Branch of Oak Creek and the mainstem of Oak Creek	42.87522	-87.92278	City of Oak Creek	WisDOT, Milwaukee County, City of Oak Creek, Canadian Pacific Railway	Conduct a feasibility study to explore options to address the impairments resulting from the channel modifications related to the W. Ryan Road and S. Howell Avenue expansion projects in the early 1970s.[x]	--	--	--	--	--	WisDOT, Milwaukee County, City of Oak Creek, Canadian Pacific Railway	70,000	--	28, 32, 65	High
UOC-03	H, SWF	Oak Creek W. Ryan Road culvert upstream of the confluence with the North Branch of Oak Creek	42.87225	-87.92207	City of Oak Creek	WisDOT	Monitor sediment accumulations and depths within culvert, ensure that obstructions are expeditiously removed and excavate accumulated sediment whenever threshold conditions that may lead to overtopping of W. Ryan Road are met or exceeded; remove sediment blockage on upstream side of culvert to a height just above normal flows (maintain and reinforce substrate blockage to a height just above normal flows to direct low flow to eastern cell, but allow higher flows to access the other two cells)	--	--	--	--	--	WisDOT	--	--	28, 32, 57, 63, 65, 67	Medium
UOC-04	H, WQ	Milwaukee County Parks Oak Creek Parkway Management Section 12	42.86656	-87.92134	City of Oak Creek	Milwaukee County	Rapid response invasive species management on 179.7 acres; forest stand improvement including supplemental canopy and understory planting of 65.4 acres; grassland management of 4 acres; grassland restoration of 3 acres; reforestation of 53.8 acres; floristic surveys and wildlife inventories of 200.6 acres; survey and posting of property lines	50,970	27.4	--	--	--	Milwaukee County	899,700	--	4, 5, 7, 11, 16, 20, 25, 26, 35, 49, 52	High

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Upper Oak Creek Headwaters Assessment Area (UOC) (continued)																	
UOC-05	H	Canadian Pacific Railway culvert crossing on secondary channel of Oak Creek south of W. Ryan Road	42.87097	-87.92411	City of Oak Creek	Canadian Pacific Railway	Work with Canadian Pacific Railway to consider options for removal or replacement of old, failing culvert on secondary channel	--	--	--	--	--	Canadian Pacific Railway and other watershed partners	--	--	28, 31, 46	Medium
UOC-06	H	Canadian Pacific Railway main culvert crossing of Oak Creek south of W. Ryan Road	42.87083	-87.92412	City of Oak Creek	Canadian Pacific Railway	Install strategically placed cobble and boulder substrates along both walls of south cell to provide resting areas for passing fish.	--	--	--	--	--	Canadian Pacific Railway and other watershed partners	--	--	7, 9, 11, 21, 25, 45, 48, 49, 52	Medium
UOC-07	H	Private farm road upstream of Canadian Pacific Railway crossing	42.87087	-87.92461	City of Oak Creek	Private landowner	Outlet of culvert is completely inundated by downstream ponding and concrete surrounding culvert is failing. Assess interest of landowner to remove culverts and stabilize adjacent streambank. If the access road is still needed, replace culverts with an appropriately sized culvert of span bridge.	--	--	--	--	--	Private landowner	--	--	12, 27, 28, 30, 46, 48, 49, 52, 61, 63	High
UOC-08	WQ, H	Right bank of Oak Creek within Oak Creek Parkway upstream of Canadian Pacific Railway crossing[f]	42.87091	-87.92486	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 39 feet of Oak Creek with a moderate lateral recession rate	1,600	0.6	--	1.2	2.4	Milwaukee County, municipalities, and other watershed partners	13,700	820	8, 9, 22, 25, 49, 52, 58, 67	Low
UOC-09	H	Oak Creek about 125 feet downstream of Canadian Pacific Railway crossing	42.87092	-87.92496	City of Oak Creek	Unknown	Remove or modify large woody debris jam for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Oak Creek, Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
UOC-10	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of Canadian Pacific Railway crossing[f]	42.87063	-87.92519	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 56 feet of Oak Creek with a moderate lateral recession rate	2,600	0.8	--	2.1	4.2	Milwaukee County, municipalities, and other watershed partners	19,600	1,180	8, 9, 22, 25, 49, 52, 58, 67	Medium
UOC-11	WQ, H	Left bank of Oak Creek within Oak Creek Parkway upstream of Canadian Pacific Railway crossing[f]	42.87021	-87.92551	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 78 feet of Oak Creek with a moderate lateral recession rate	3,600	1.1	--	2.9	5.8	Milwaukee County, municipalities, and other watershed partners	27,300	1,640	8, 9, 22, 25, 49, 52, 58, 67	Medium
UOC-12	H	Oak Creek about 450 feet downstream of Canadian Pacific Railway crossing	42.87018	-87.92569	City of Oak Creek	Unknown	Remove or modify large woody debris jam for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Oak Creek, Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
UOC-13	H	Oak Creek about 575 feet downstream of Canadian Pacific Railway crossing	42.87011	-87.92616	City of Oak Creek	Unknown	Remove or modify large woody debris jam for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Oak Creek, Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
UOC-14	WQ, H	Right bank of Oak Creek at parcel 905-9998-001[f]	42.87023	-87.92655	City of Oak Creek	Private landowner	Bank stabilization to address bank erosion along 33 feet of Oak Creek with a moderate lateral recession rate	1,400	0.4	--	1.1	2.3	Private landowner	11,600	690	8, 21, 22, 25, 27, 32, 48, 49	Low
UOC-15	H	Abandoned farm road crossing Oak Creek downstream of S. 13th Street	42.87005	-87.93052	City of Oak Creek	Milwaukee County or Amazon	Remove abandoned and failing wooden and steel crossing structure and rearrange rock rubble to improve fish passage	--	--	--	--	--	Milwaukee County or Amazon	--	--	6, 11, 21, 22, 25, 45, 50, 52	High
UOC-16	H	S. 13th Street culvert crossing of Oak Creek	42.87048	-87.93219	City of Oak Creek	WisDOT or City of Oak Creek	Conduct a fish passage assessment on road crossing that was replaced as part of Amazon Distribution Center development	--	--	--	--	--	WisDOT or Milwaukee County	--	--	6, 11, 21, 22, 25, 45, 50, 52	Low

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information				Owner	Management Action	Annual Pollutant Reductions					Key Project Partners	Costs (dollars)[c]		Potential Funding Sources[d]	Priority[e]
		Location	Latitude	Longitude	Municipality			TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)		Capital	Annual O&M		
Upper Oak Creek Headwaters Assessment Area (UOC) (continued)																	
UOC-17	H	Crossings of Oak Creek at IH 94 northbound, southbound, and on-ramp bridges	42.86917	-87.93717	City of Oak Creek	WisDOT	Add strategically placed large cobble or boulder substrates throughout stream channel under bridges to create channel roughness and resting areas for passing fish	--	--	--	--	--	WisDOT	--	--	6, 11, 21, 22, 25, 45, 50, 52	Medium
UOC-18	WQ, H	Left bank of Oak Creek under the southbound lanes of IH 94[f]	42.86910	-87.93727	City of Oak Creek	Unknown	Repair or replace failing portion of 24-inch RCP outfall (sequence number 271 in Appendix E)	--	--	--	--	--	Unknown	4,000	--	7, 57, 67	High
UOC-19	H, WQ	Oak Creek upstream of S. 20th Street and about 4.5 acres of adjacent riparian land	42.86895	-87.94053	City of Oak Creek	City of Oak Creek	Establish new or expand existing riparian buffer to a minimum of 75 feet from each streambank or to the extent allowable based on existing development constraints and manage invasive species	--	--	--	--	--	City of Oak Creek	18,800	--	4, 7,10, 11, 15, 20, 22, 24, 25, 26, 45, 49, 52, 57, 58, 67	Medium
UOC-20	WQ, H	Right bank of Oak Creek downstream of S. 20th Street[f]	42.86926	-87.94082	City of Oak Creek	Unknown	Repair or replace failing portion of 18-inch corrugated plastic outfall (sequence number 275 in Appendix E) draining truck stop to the north	--	--	--	--	--	Unknown	2,300	--	7, 57, 67	Medium
UOC-21	WQ	Love's Travel Stops & Country Stores parking lot west of S. 20th Street and north of Oak Creek	42.86949	-87.94129	City of Oak Creek	Love's Travel Stops & Country Stores, Inc.	Install bioretention, bioswale, or other appropriate green infrastructure to treat runoff from truck stop parking lot that currently flows directly to Oak Creek through the outfalls cited in projects UOC-20 and UOC-22[y]	--	--	--	--	--	Love's Travel Stops & Country Stores, Inc	--	--	6, 8, 11, 12, 13, 14, 25, 27, 30, 31, 45, 52, 57, 63, 67	High
UOC-22	WQ, H	Right bank of Oak Creek downstream of S. 20th Street[f]	42.86928	-87.94173	City of Oak Creek	Unknown	Repair or replace failing portions on one 18-inch corrugated plastic outfall and one 18-inch CMP outfall draining truck stop parking lot (sequence number 277 in Appendix E)	--	--	--	--	--	Unknown	4,600	--	7, 57, 67	Medium
UOC-23	WQ, SWF	Boulevard median of S. 20th Street from W. Ryan Road to south of Ridgeview Drive	42.87192	-87.94217	City of Oak Creek	City of Oak Creek	Example Project – Installation of bioswales in about 1,140 feet of boulevard median to treat runoff from 50 percent of the boulevard (1.6 acres)[z]	1,523	2.5	0.02	--	--	City of Oak Creek	69,000	4,100	8, 12, 13, 14, 25, 31, 52, 57, 63, 66, 67	Medium
UOC-24	H	S. 20th Street culvert crossing of Oak Creek	42.86902	-87.94234	City of Oak Creek	City of Oak Creek	Approximately 8-foot-wide CMP arch culvert is likely undersized based on upstream and downstream ponding. Replace with a new appropriately sized culvert	--	--	--	--	--	City of Oak Creek	--	--	7, 57, 67	Low
UOC-25	WQ, H	Right bank of Oak Creek upstream of S. 20th Street[f]	42.86906	-87.94448	City of Oak Creek	City of Oak Creek	Bank stabilization to address bank erosion along 47 feet of Oak Creek with a slight lateral recession rate	200	0.1	--	0.2	0.4	City of Oak Creek	16,500	990	8, 9, 22, 25, 49, 52, 58, 67	Low
UOC-26	WQ, H	Right bank of Oak Creek downstream of S. 27th Street[f]	42.86959	-87.95002	City of Oak Creek	City of Oak Creek	Bank stabilization to address bank erosion along 62 feet of Oak Creek with a moderate lateral recession rate	2,400	0.7	--	1.9	3.9	City of Oak Creek	21,700	1,300	8, 9, 22, 25, 49, 52, 58, 67	Low
UOC-27	WQ, H	Right bank of Oak Creek downstream of S. 27th Street[f]	42.86964	-87.95052	City of Oak Creek	City of Oak Creek	Bank stabilization to address bank erosion along 66 feet of Oak Creek with a moderate lateral recession rate	2,400	0.7	--	1.9	3.7	City of Oak Creek	23,100	1,390	8, 9, 22, 25, 49, 52, 58, 67	Low
UOC-28	H	S. 27th Street culvert crossing of Oak Creek	42.86970	-87.95109	City of Oak Creek	City of Oak Creek and WisDOT	Reinforce existing sediment bar at inlet of north cell to continue to direct fair-weather flow to the south cell and maintain sufficient water depths for fish passage but allow flow into north cell during high flow events	--	--	--	--	--	City of Oak Creek and WisDOT	--	--	7, 9, 11, 21, 25, 45, 48, 49, 52	Medium
UOC-29	H	Oak Creek about 740 feet upstream of S. 27th Street	42.87077	-87.95401	City of Franklin	Straddling Franklin Hotel Company LLC and Halquist Brothers R/E Partnership	Remove or modify large woody debris jam for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Franklin, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Site Information: Latitude	Site Information: Longitude	Site Information: Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Annual Pollutant Reductions: Total Phosphorus (pounds)	Annual Pollutant Reductions: Fecal Coliform Bacteria (trillion cells)	Annual Pollutant Reductions: Total Nitrogen (pounds)	Annual Pollutant Reductions: BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Costs (dollars)[c]: Annual O&M	Potential Funding Sources[d]	Priority[e]
Upper Oak Creek Headwaters Assessment Area (UOC) (continued)																	
UOC-30	H	31st Street culvert crossing of Oak Creek	42.87043	-87.95607	City of Franklin	City of Franklin	One cell of the two-cell structure appears to be sufficient for the majority of flow conditions and sediment accumulation and shallow water depths may make fish passage difficult during low-flow conditions. Retrofit channel at culvert inlet to direct flow during fair-weather conditions to one cell and allow flow into the second cell when needed during high flows	--	--	--	--	--	City of Franklin	--	--	28, 32, 57, 63, 65, 67	High
UOC-31	H	Oak Creek about 250 feet downstream of S. 31st Street	42.87023	-87.95716	City of Franklin	Private landowner	Remove or modify large woody debris jam for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Franklin, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
UOC-32	WQ, H	Right bank of Oak Creek upstream of S. 31st Street[f]	42.87001	-87.95788	City of Franklin	Private landowner	Bank stabilization to address bank erosion along 90 feet of Oak Creek with a moderate lateral recession rate	3,800	1.2	--	3.1	6.2	Private landowner	31,500	1,890	7, 8, 11, 27, 49	Medium
UOC-33	WQ, H	Left bank of Oak Creek upstream of S. 31st Street[f]	42.86996	-87.95843	City of Franklin	Private landowner	Bank stabilization to address bank erosion along 40 feet of Oak Creek with a moderate lateral recession rate	1,600	0.5	--	1.2	3.5	Private landowner	14,000	840	7, 8, 11, 27, 49	Low
UOC-34	H	Oak Creek about 650 feet downstream of S. 31st Street	42.87001	-87.95856	City of Franklin	Private landowner	Remove or modify large woody debris jam for better aquatic organism passage	--	--	--	--	--	Landowner, MMSD[p], City of Franklin, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49,	Medium
UOC-35	WQ, H	Left bank of Oak Creek downstream of S. 35th Street[f]	42.86998	-87.95915	City of Franklin	Milwaukee County	Bank stabilization to address bank erosion along 86 feet of Oak Creek with a moderate lateral recession rate	3,600	1.1	--	3.0	5.9	Milwaukee County, municipalities, and other watershed partners	30,100	1,810	8, 9, 22, 25, 49, 52, 58, 67	Medium
UOC-36	H, WQ, SWF	Oak Creek mainstem downstream of S. 35th Street	42.86999	-87.95949	City of Franklin	Milwaukee County	Stream channel and riparian restoration of about 500 feet of channel and 5 acres of adjacent open space land[aa]	--	--	--	--	--	Milwaukee County and other watershed partners	--[l]	--	7, 9, 10, 21, 22, 25, 30, 39, 49, 52, 58	Medium
UOC-37	WQ, H	Right bank of Oak Creek downstream of S. 35th Street[f]	42.87000	-87.95956	City of Franklin	Milwaukee County	Bank stabilization to address bank erosion along 42 feet of Oak Creek with a moderate lateral recession rate	1,400	0.4	--	1.2	2.3	Milwaukee County, municipalities, and other watershed partners	14,700	880	8, 9, 22, 25, 49, 52, 58, 67	Low
UOC-38	WQ, H	Both banks of Oak Creek downstream of S. 35th Street	42.86995	-87.95996	City of Franklin	Milwaukee County	Bank stabilization to address bank erosion along 24 feet of Oak Creek with a moderate lateral recession rate	800	0.2	--	0.6	1.3	Milwaukee County, municipalities, and other watershed partners	8,100	480	8, 9, 22, 25, 49, 52, 58, 67	Low
UOC-39	WQ, H	Left bank of Oak Creek downstream of S. 35th Street[f]	42.86985	-87.96005	City of Franklin	Milwaukee County	Bank stabilization to address bank erosion along 154 feet of Oak Creek with a severe lateral recession rate	18,800	5.8	--	15.1	30.2	Milwaukee County, municipalities, and other watershed partners	53,900	3,230	8, 9, 22, 25, 49, 52, 58, 67	Medium

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Upper Oak Creek Headwaters Assessment Area (UOC) (continued)																	
UOC-40	H	35th Street culvert crossing of Oak Creek	42.86990	-87.96044	City of Franklin	City of Franklin	Culvert is a likely impediment to fish passage due to sediment accumulation, rock placement, and water flowing through the seams of the culvert wall. Seal culvert wall joints; add grade control downstream to provide sufficient water depths through the culvert and stability for the culvert and streambank; add strategically placed cobble and boulder substates within culvert cells along both walls to provide resting areas for passing fish; rearrange rock placement downstream of culvert	--	--	--	--	--	City of Franklin	--	--	28, 32, 57, 63, 65, 67	High
UOC-41	H	Oak Creek 120 feet downstream of S. 35th Street	42.87002	-87.96105	City of Franklin	Milwaukee County	Remove or modify large woody debris jam for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Franklin, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
UOC-42	WQ, H	Right bank of Oak Creek upstream of S.35th Street within Oakwood Park[f]	42.87010	-87.96163	City of Franklin	Milwaukee County	Bank stabilization to address bank erosion along 42 feet of Oak Creek with a moderate lateral recession rate	400	0.2	--	0.5	1.1	Milwaukee County, municipalities, and other watershed partners	14,700	880	8, 9, 22, 25, 49, 52, 58, 67	Low
UOC-43	WQ, H	Left bank of Oak Creek upstream of S.35th Street within Oakwood Park[f]	42.87020	-87.96202	City of Franklin	Milwaukee County	Bank stabilization to address bank erosion along 38 feet of Oak Creek with a moderate lateral recession rate	1,600	0.5	--	1.3	2.6	Milwaukee County, municipalities, and other watershed partners	13,300	800	8, 9, 22, 25, 49, 52, 58, 67	Low
UOC-44	WQ, H	Right bank of Oak Creek upstream of S.35th Street within Oakwood Park[f]	42.87025	-87.96216	City of Franklin	Milwaukee County	Bank stabilization to address bank erosion along 10 feet of Oak Creek with a severe lateral recession rate	2,400	0.7	--	1.9	3.8	Milwaukee County, municipalities, and other watershed partners	3,500	210	8, 9, 22, 25, 49, 52, 58, 67	Medium
UOC-45	WQ, H	Left bank of Oak Creek upstream of S.35th Street within Oakwood Park[f]	42.87029	-87.96239	City of Franklin	Milwaukee County	Bank stabilization to address bank erosion along 11 feet of Oak Creek with a severe lateral recession rate	1,200	0.4	--	1.0	1.9	Milwaukee County, municipalities, and other watershed partners	3,900	230	8, 9, 22, 25, 49, 52, 58, 67	Medium
UOC-46	WQ, H	Left bank of Oak Creek upstream of S.35th Street[f]	42.87036	-87.96254	City of Franklin	Unknown	Repair or replace failing portion of 24-inch CMP outfall (sequence number 285 in Appendix E)	--	--	--	--	--	Unknown	3,700	--	7, 57, 67	Medium
UOC-47	WQ, H	Left bank of Oak Creek downstream of W. Ryan Road upstream crossing[f]	42.87097	-87.96347	City of Franklin	Jubilee Faith Center, Inc.	Bank stabilization to address bank erosion along 16 feet of Oak Creek with a moderate lateral recession rate	600	0.2	--	0.5	1.0	Jubilee Faith Center, Inc.	5,600	340	7, 8, 11, 27, 49	Low
UOC-48	WQ, H	Left bank of Oak Creek downstream of W. Ryan Road upstream crossing[f]	42.87125	-87.96420	City of Franklin	Jubilee Faith Center, Inc. and Ryan Green Apartments, LLC	Bank stabilization to address bank erosion along 66 feet of Oak Creek with a moderate lateral recession rate	1,600	0.5	--	1.2	2.5	Jubilee Faith Center, Inc. and Ryan Green Apartments, LLC	23,100	1,390	7, 8, 11, 27, 49	Low

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Table 6.1 (Continued)

		Site Information						Annual Pollutant Reductions						Costs (dollars)[c]			
ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Location	Latitude	Longitude	Municipality	Owner	Management Action	TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Upper Oak Creek Headwaters Assessment Area (UOC) (continued)																	
UOC-49	H	W. Ryan Road upstream culvert crossing of Oak Creek	42.87260	-87.96461	City of Franklin	City of Franklin	Investigate potential for improved fish passage with addition of downstream grade control to improve water depths through the culvert during low-flow periods; add strategically placed cobble and boulder substrates along both culvert walls to provide resting areas for passing fish	--	--	--	--	--	WisDOT and City of Franklin	--	--	28, 32, 57, 63, 65, 67	Medium
Oak Creek Headwaters Assessment Area (OCH)																	
OCH-01	H	Concrete drop structure No. 1 upstream from W. Ryan Road upstream crossing	42.87484	-87.96482	City of Franklin	National Venture Corporation	Drop structure completely blocks flow during baseflow periods except for flow through cracks in the structure. Remove drop structure to improve fish passage[bb]	--	--	--	--	--	National Venture Corporation and other watershed partners	--	--	7, 9, 11, 21, 25, 27, 28 30, 45, 48, 49, 52, 57, 63, 65, 67	Medium
OCH-02	H	Southwood Drive culvert crossing of Oak Creek	42.87650	-87.96574	City of Franklin	City of Franklin	Sediment accumulation at one point in the culvert constricts flow and water depths such that depth in the culvert may be insufficient for fish passage during low flow periods. Consider downstream grade control to provide sufficient water depth and adding strategically placed cobble and boulder substrates along both culvert walls of each culvert cell to provide resting areas for passing fish	--	--	--	--	--	City of Franklin	--	--	7, 9, 11, 21, 25,45, 48, 49, 52, 60	Medium
OCH-03	H	Concrete drop structure No. 2 upstream from W. Southwood Drive	42.87699	-87.96620	City of Franklin	National Venture Corporation	Drop structure completely blocks flow during fair-weather flow conditions. Remove drop structure to improve fish passage[bb]	--	--	--	--	--	National Venture Corporation and other watershed partners	--	--	7, 9, 11, 21, 25, 27,28, 30, 45, 48, 49, 52, 63, 65, 67	Medium
OCH-04	H	Concrete drop structure No. 3 upstream from W. Southwood Drive	42.87794	-87.96662	City of Franklin	National Venture Corporation	Drop structure is perched about 18 inches above downstream water surface. Remove drop structure to improve fish passage[bb]	--	--	--	--	--	National Venture Corporation and other watershed partners	--	--	7, 9, 11, 21, 25, 27, 28, 30, 45, 48, 49, 52, 63, 65, 67	Medium
OCH-05	WQ, R	Oak Creek at Martinton Drive (extended)	42.87828	-87.96669	City of Franklin	City of Franklin	Investigate and remedy source of canine fecal contamination to outfall (sequence number 295 in Appendix E)	--	--	--	--	--	City of Franklin	--	--	10, 22, 52, 57, 65, 67	High
OCH-06	H	Oak Creek about 915 feet upstream of W. Southwood Drive	42.87893	-87.96650	City of Franklin	Natural Venture Corporation	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	Landowner, MMSD[p], City of Franklin, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Low
OCH-07	H, WQ, SWF	Oak Creek from Glenwood Drive to downstream of STH 100	42.87917	-87.96618	City of Franklin	Natural Venture Corporation and private landowners	Consider regenerative stormwater conveyance restoration using a series of shallow pools, riffle grade controls, native vegetation, and underlying woodchip or gravel beds to address streambed and bank erosion and incised channels.[cc]	--	--	--	--	--	Natural Venture Corporation and private landowners	--[dd]	--	6, 7, 9, 11, 21, 25, 27, 28, 30, 45, 48, 49, 52, 67	Medium
OCH-08	H	Concrete drop structure No. 4 upstream from W. Southwood Drive	42.87961	-87.96595	City of Franklin	Natural Venture Corporation	Drop structure blocks most stream flow during fair-weather flow conditions. Remove drop structure to improve fish passage[bb]	--	--	--	--	--	National Venture Corporation and other watershed partners	--	--	7, 9, 11, 21, 25, 27, 28, 30, 45, 48, 49, 52, 63, 65, 67	Medium

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information					Management Action	Annual Pollutant Reductions					Key Project Partners	Costs (dollars)[c]		Potential Funding Sources[d]	Priority[e]
		Location	Latitude	Longitude	Municipality	Owner		TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)		Capital	Annual O&M		
Oak Creek Headwaters Assessment Area (OCH) (continued)																	
OCH-09	WQ, H	Left bank of Oak Creek downstream from W. Woodward Drive[f]	42.88035	-87.96608	City of Franklin	Private landowner	Bank stabilization to address bank erosion along 22 feet of Oak Creek with a moderate lateral recession rate	800	0.3	--	0.7	1.4	Private landowner	7,700	460	7, 8, 11, 27, 49	Low
OCH-10	WQ, H	Both banks of Oak Creek at W. Woodward Drive	42.80866	-87.96600	City of Franklin	Private landowner	Bank stabilization to address bank erosion along 298 feet of Oak Creek with a severe lateral recession rate	57,2000	17.6	--	45.8	91.5	Private landowner	104,300	6,260	7, 8, 11, 27, 49	High
OCH-11	H	Oak Creek downstream of W. Southland Drive culvert crossing	42.88101	-87.96615	City of Franklin	City of Franklin	Culvert is passable for fish, but a large accumulation of rock downstream is a likely obstruction for some species, Re-arrange the rock downstream from the culvert to improve fish passage	--	--	--	--	--	City of Franklin	--	--	7, 9, 11, 21, 25, 45, 48, 49, 52	Medium
OCH-12	WQ, H	Both banks of Oak Creek upstream of W. Southland Drive	42.881491	-87.96619	City of Franklin	Private landowner	Bank stabilization to address bank erosion along 428 feet of Oak Creek with a severe lateral erosion rate.	87,400	26.9	--	69.8	139.7	Private landowner	149,800	8,990	7, 8, 11, 27, 49	High
Lower Mitchell Field Drainage Ditch Assessment Area (LMF)																	
LMF-01	WQ, H	Left bank of Mitchell Field Drainage Ditch just upstream of confluence with Oak Creek[f]	42.90535	-87.89140	City of Oak Creek	Wisconsin Electric Power Company	Bank stabilization to address bank erosion along 43 feet of the Mitchell Field Drainage Ditch with a severe lateral recession rate	12,400	3.8	--	9.9	19.8	Wisconsin Electric Power Company	15,100	900	7, 8, 11, 27, 49	Medium
LMF-02	WQ, H	Left bank of Mitchell Field Drainage Ditch upstream of confluence with Oak Creek[f]	42.90570	-87.89135	City of Oak Creek	Wisconsin Electric Power Company	Bank stabilization to address bank erosion along 41 feet of the Mitchell Field Drainage Ditch with a severe lateral recession rate	14,800	4.5	--	11.8	23.6	Wisconsin Electric Power Company	14,400	860	7, 8, 11, 27, 49	Medium
LMF-03	H	Michell Field Drainage Ditch about 300 feet upstream of confluence with Oak Creek	42.90579	-87.89144	City of Oak Creek	Wisconsin Electric Power Company	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	WE Energies, MMSD[p], City of Oak Creek, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
LMF-04	WQ, H	Left bank of Mitchell Field Drainage Ditch upstream of confluence with Oak Creek[f]	42.90611	-87.89130	City of Oak Creek	Wisconsin Electric Power Company	Bank stabilization to address bank erosion along 68 feet of the Mitchell Field Drainage Ditch with a moderate lateral recession rate	3,800	1.1	--	3.0	5.9	Wisconsin Electric Power Company	23,800	1,430	7, 8, 11, 27, 49	Medium
LMF-05	WQ, H	Right bank of Mitchell Field Drainage Ditch just downstream of Union Pacific Railroad crossing[f]	42.90664	-87.87114	City of Oak Creek	Wisconsin Electric Power Company	Bank stabilization to address bank erosion along 38 feet of the Mitchell Field Drainage Ditch with a moderate lateral recession rate	1,200	0.4	--	0.9	1.9	Wisconsin Electric Power Company	13,300	800	7, 8, 11, 27, 49	Low
LMF-06	WQ	Subbasin M5-7 east of the intersection of S. Clement Avenue and E. Montana Avenue	42.90735	-87.89424	City of Oak Creek	City of Oak Creek	Install 1.02-acre wet retention pond WQ-25	32,981	--	--	--	--	City of Oak Creek	200,700	8,030	4, 6, 8, 12, 22, 25, 30, 45, 57, 58, 67	High
LMF-07	H	Mitchell Field Drainage Ditch about 700 feet upstream of Union Pacific Railroad Crossing	42.90883	-87.89283	City of Oak Creek	Milwaukee County and Private landowner	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	Landowner, MMSD[p], City of Oak Creek, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
LMF-08	H	Mitchell Field Drainage Ditch about 1,030 feet upstream of Union Pacific Railroad Crossing	42.90974	-87.89277	City of Oak Creek	Milwaukee County and Private landowner	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	Landowners. MMSD[p], City of Oak Creek, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
LMF-09	WQ, H	Right bank of Mitchell Field Drainage Ditch upstream of Union Pacific Railroad crossing[f]	42.90987	-87.89267	City of Oak Creek	Private landowner	Bank stabilization to address bank erosion along 37 feet of the Mitchell Field Drainage Ditch with a slight lateral recession rate	400	0.1	--	0.3	0.5	Private landowner	13,000	780	7, 8, 11, 27, 49	Low

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Lower Mitchell Field Drainage Ditch Assessment Area (LMF) (continued)																	
LMF-10	H	Mitchell Field Drainage Ditch about 1,750 feet upstream of Union Pacific Railroad Crossing	42.91091	-87.89271	City of Oak Creek	Milwaukee County and Private landowner	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	Landowner, MMSD[p], City of Oak Creek, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
LMF-11	H	Mitchell Field Drainage Ditch about 340 feet downstream of E. Rawson Avenue	42.91430	-87.89264	City of Oak Creek	Milwaukee County and Private landowner	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	Landowner, MMSD[p], City of Oak Creek, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Medium
LMF-12	WQ, H	Right bank of Mitchell Field Drainage Ditch just downstream of E. Rawson Avenue[f]	42.91486	-87.89250	City of Oak Creek	Private landowner	Bank stabilization to address bank erosion along 28 feet of the Mitchell Field Drainage Ditch with a moderate lateral recession rate	1,000	0.3	--	0.9	1.7	Private landowner	9,800	590	7, 8, 11, 27, 49	Low
LMF-13	H, SWF	E. Rawson Avenue culvert crossing of Mitchell Field Drainage Ditch	42.91570	-87.89252	City of Oak Creek	Milwaukee County	Monitor beaver activity upstream and downstream of the culvert and remove any dams that may cause flooding of the road or nearby infrastructure as needed	--	--	--	--	--	Milwaukee County	--	--	--	Low
LMF-14	WQ, H	Left bank of Mitchell Field Drainage Ditch upstream of E. Rawson Avenue[f]	42.91715	-87.89189	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 29 feet of the Mitchell Field Drainage Ditch with a moderate lateral recession rate	1,000	0.3	--	0.7	1.4	Milwaukee County, municipalities, and other watershed partners	10,500	610	8, 22, 25, 49, 52, 58, 67	Low
LMF-15	WQ	Subbasin MF-20 north of E Rawson Avenue, adjacent to the Mitchell Field Drainage Ditch	42.91874	-87.89235	City of Oak Creek	City of Oak Creek	Install 0.4-acre wet retention pond WQ-27	16,788	--	--	--	--	City of Oak Creek	89,900	3,600	4, 6, 8, 12, 22, 25, 30, 45, 57, 58, 67	Medium
LMF-16	WQ, H	Left bank of Mitchell Field Drainage Ditch upstream of E. Rawson Avenue[f]	42.92159	-87.89138	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 278 feet of the Mitchell Field Drainage Ditch with a slight lateral recession rate	600	0.3	--	0.7	1.3	Milwaukee County, municipalities, and other watershed partners	97,300	5,840	8, 22, 25, 49, 52, 58, 67	Low
LMF-17	WQ, H	Left bank of Mitchell Field Drainage Ditch upstream of E. Rawson Avenue[f]	42.92221	-87.89132	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 97 feet of the Mitchell Field Drainage Ditch with a slight lateral recession rate	800	0.2	--	0.6	1.3	Milwaukee County, municipalities, and other watershed partners	34,000	2,040	8, 22, 25, 49, 52, 58, 67	Low
LMF-18	WQ, H	Left bank of Mitchell Field Drainage Ditch downstream of E. College Avenue[f]	4.92421	-87.89056	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 143 feet of the Mitchell Field Drainage Ditch with a moderate lateral recession rate	6,600	2.1	--	5.4	10.7	Milwaukee County, municipalities, and other watershed partners	50,100	3,000	8, 22, 25, 49, 52, 58, 67	Medium
LMF-19	WQ	Subbasin M3-2 south of E. College Avenue, adjacent to Mitchell Field Drainage Ditch	42.92455	-87.89091	City of Oak Creek	City of Oak Creek	Install 0.52-acre wet retention pond WQ-24	16,301	--	--	--	--	City of Oak Creek	113,200	4,500	4, 6, 8, 12, 22, 25, 30, 45, 57, 58, 67	Medium
LMF-20	WQ, H	Left bank of Mitchell Field Drainage Ditch downstream of E. College Avenue[f]	42.92465	-87.89051	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 50 feet of the Mitchell Field Drainage Ditch with a moderate lateral recession rate	2,000	0.6	--	1.6	3.1	Milwaukee County, municipalities, and other watershed partners	1,800	110	8, 22, 25, 49, 52, 58, 67	Medium

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Lower Mitchell Field Drainage Ditch Assessment Area (LMF) (continued)																	
LMF-21	WQ, H	Left bank of Mitchell Field Drainage Ditch downstream of E. College Avenue[f]	42.92506	-87.89052	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 52 feet of the Mitchell Field Drainage Ditch with a severe lateral recession rate	7,400	2.3	--	6.0	12.0	Milwaukee County, municipalities, and other watershed partners	18,200	1,090	8, 22, 25, 49, 52, 58, 67	Medium
LMF-22	H	Mitchell Field Drainage Ditch about 1,770 feet downstream of E. College Avenue	42.92509	-87.89055	City of Oak Creek	Milwaukee County	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Oak Creek, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Low
LMF-23	H, WQ, SWF	Mitchell Field Drainage Ditch from about 1,000 feet upstream from the confluence with Oak Creek to E. College Avenue	42.92510	-87.89047	Cities of Oak Creek and Milwaukee	Milwaukee County, City of Milwaukee, and Private landowners	Stream channel and riparian restoration of about 8,500 feet of channel[ee]	--	--	--	--	--	Milwaukee County, City of Oak Creek MMSD, Private landowners	--[l]	--	7, 8, 9, 10, 21, 22, 25, 27, 28, 30, 39, 49, 52, 58	High
LMF-24	WQ, H	Left bank of Mitchell Field Drainage Ditch downstream of E. College Avenue[f]	42.92546	-87.89047	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 140 feet of the Mitchell Field Drainage Ditch with a moderate lateral recession rate	5,400	1.7	--	4.4	8.7	Milwaukee County, municipalities, and other watershed partners	49,000	2,940	8, 9, 22, 25, 49, 52, 58, 67	Medium
LMF-25	WQ	Subbasin M2-2 south of E. College Avenue adjacent to Mitchell Field Drainage Ditch	42.92589	-87.89099	City of Oak Creek	City of Oak Creek	Install 0.47-acre wet retention pond WQ-23	20,404	--	--	--	--	City of Oak Creek	104,400	4,170	4, 6, 8, 12, 22, 25, 30, 45, 57, 58, 67	High
LMF-26	WQ, H	Left bank of Mitchell Field Drainage Ditch downstream of E. College Avenue[f]	42.92667	-87.89041	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 94 feet of the Mitchell Field Drainage Ditch with a moderate lateral recession rate	5,200	1.6	--	4.1	8.2	Milwaukee County, municipalities, and other watershed partners	32,900	1,970	8, 9, 22, 25, 49, 52, 58, 67	Medium
LMF-27	WQ, H	Left bank of Mitchell Field Drainage Ditch downstream of E. College Avenue[f]	42.92859	-87.89032	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 45 feet of the Mitchell Field Drainage Ditch with a moderate lateral recession rate	2,200	0.6	--	3.4	1.7	Milwaukee County, municipalities, and other watershed partners	15,800	950	8, 9, 22, 25, 49, 52, 58, 67	Medium
LMF-28	H	Mitchell Field Drainage Ditch about 130 feet downstream of E. College Avenue	42.92953	-87.89037	City of Oak Creek	Milwaukee County	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Oak Creek, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Low
LMF-29	H	Milwaukee County Parks Cudahy Nature Preserve Management Unit 1	42.92940	-87.90363	City of Oak Creek	Milwaukee County	Vegetation survey; invasive species control; invasive monitoring and select control on 15.5 acres; wildlife monitoring	--	--	--	--	--	Milwaukee County	9.500	--	11, 16, 19, 26, 35, 45, 51, 53	Medium
LMF-30	H	Milwaukee County Parks Cudahy Nature Preserve Management Units 2 and 3	42.92769	-87.90418	City of Oak Creek	Milwaukee County	Vegetation survey; invasive species control; invasive monitoring and select control on 9.7 acres; wildlife monitoring	--	--	--	--	--	Milwaukee County	6,300	--	11, 16, 19, 26, 35, 45, 51, 53	Medium
LMF-31	H	Milwaukee County Parks Cudahy Nature Preserve Management Unit 4	42.92406	-87.90617	City of Oak Creek	Milwaukee County	Vegetation survey; invasive species control; invasive monitoring and select control on 17.0 acres; wildlife monitoring	--	--	--	--	--	Milwaukee County	10,300	--	11, 16, 19, 26, 35, 45, 51, 53	Medium
LMF-32	H, WQ	Privately-owned woodlands adjacent to the southwest corner of Cudahy Nature Preserve	42.92432	-87.90616	City of Oak Creek	Private landowner	Voluntary acquisition of 5.2-acre woodland adjacent to Management Unit 4 of the preserve[ff]	--	--	--	--	--	Landowner, Milwaukee County, and Watershed partners	--	--	11, 20, 35, 38, 45, 49, 60, 61	Low

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Lower Mitchell Field Drainage Ditch Assessment Area (LMF) (continued)																	
LMF-33	H, WQ	Privately-owned wetland/woodland complex adjacent to the northwest corner of Cudahy Nature Preserve	42.92921	-87.90639	City of Oak Creek	Private landowner	Voluntary acquisition of 11.7-acre woodland/wetland complex adjacent to Management Unit 1 of the preserve[gg]	--	--	--	--	--	Landowner, Milwaukee County and Watershed partners	--	--	11, 20, 35, 38, 45, 49, 60, 61	Low
LMF-34	H	Cluster of woodlands adjacent to the Runway Dog Park and directly southeast of Cudahy Nature Preserve	42.92155	-87.89629	City of Oak Creek	Milwaukee County	Extend the intergovernmental agreement between MMIA and DPRC for Runway Dog Park to include this 30.1-acre cluster of woodlands, allowing DPRC staff to control invasive species in the woodlands	--	--	--	--	--	Milwaukee County	--	--	26, 61	Medium
Mitchell Field Drainage Ditch-Airport Assessment Area (MFA)																	
MFA-01	H, SWF	E. College Avenue Crossing of Mitchell Field Drainage Ditch	42.93017	-87.88993	City of Milwaukee	Milwaukee County	Remove accumulated sediment and debris from the upstream end of the culvert and monitor sediment accumulation	--	--	--	--	--	Milwaukee County	--	--	11, 22, 24, 25, 48, 51, 52, 57	Medium
MFA-02	WQ, SWF	Milwaukee Mitchell International Airport	42.93827	-87.90299	City of Milwaukee	Milwaukee County-MMIA	Install rain gardens, green roofs, infiltration features, and other stormwater management features to reduce stormwater runoff throughout the airport	--	--	--	--	--	Milwaukee County-MMIA	--	--	6, 8, 11, 12, 13, 14, 25, 45, 52, 57, 63, 67	Medium
MFA-03	WQ, SWF	Milwaukee Mitchell International Airport	42.93827	-87.90299	City of Milwaukee	Milwaukee County-MMIA	Develop green infrastructure policy and/or design and construction guidelines for green infrastructure	--	--	--	--	--	Milwaukee County-MMIA	--	--	13, 14, 57, 67	Medium
MFA-04	WQ	Milwaukee Mitchell International Airport	42.93418	-87.90300	City of Milwaukee	Milwaukee County-MMIA	Train onsite airport personnel in pollution prevention procedures and make the stormwater management plan available at construction sites for review	--	--	--	--	--	Milwaukee County-MMIA	--	--	22,43, 57, 65, 67	Medium
MFA-05	WQ	Milwaukee Mitchell International Airport	42.93418	-87.90300	City of Milwaukee	Milwaukee County-MMIA	Ensure that construction sites are inspected frequently to ensure compliance with the stormwater management plan	--	--	--	--	--	Milwaukee County-MMIA	--	--	57, 66, 65, 67	Medium
MFA-06	WQ	Milwaukee Mitchell International Airport	42.93418	-87.90300	City of Milwaukee	Milwaukee County-MMIA	Coordinate stormwater management plan elements with airport tenant plans	--	--	--	--	--	Milwaukee County-MMIA	--	--	--	Medium
MFA-07	WQ	Milwaukee Mitchell International Airport	42.93418	-87.90300	City of Milwaukee	Milwaukee County-MMIA	Continue evaluation BMPs and use of technologies to reduce unnecessary deicing	--	--	--	--	--	Milwaukee County-MMIA	--	--	57, 65, 67	Medium
Lower North Branch of Oak Creek Assessment Area (LNB)																	
LNB-01	WQ, H	Left bank of North Branch of Oak Creek upstream of confluence with Oak Creek[f]	42.87537	-87.92304	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 68 feet of North Branch of Oak Creek with a severe lateral recession rate	12,200	3.8	--	9.8	19.6	Milwaukee County, municipalities, and other watershed partners	23,800	1,430	8, 9, 22, 25, 49, 52, 58, 67	Medium
LNB-02	WQ, H	Right bank of North Branch of Oak Creek upstream of confluence with Oak Creek[f]	42.87595	-87.92309	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 279 feet of North Branch of Oak Creek with a moderate lateral recession rate	15,200	4.7	--	12.2	24.4	Milwaukee County, municipalities, and other watershed partners	97,700	5,860	8, 9, 22, 25, 49, 52, 58, 67	Medium
LNB-03	H	North Branch of Oak Creek channel downstream of Canadian Pacific Railway crossing for about 400 feet	42.87622	-87.92330	City of Oak Creek	Canadian Pacific Railway, Milwaukee County[hh]	Channel bed erosion downstream of the culvert has caused about a 4-foot drop from the culvert to the downstream water surface. Retrofit the channel bed downstream from the culvert with a rock ramp with a slope of 1.5 percent to provide adequate slope for aquatic organism passage	--	--	--	--	--	Canadian Pacific Railway, Milwaukee County, watershed partners	387,500	--	7, 9, 11, 21, 25, 27, 45, 48, 49, 52	High

Table continued on next page.

Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Lower North Branch of Oak Creek Assessment Area (LNB) (continued)																	
LNB-04	WQ, H	Right bank of North Branch of Oak Creek downstream of Canadian Pacific Railway crossing[f]	42.87628	-87.92354	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 113 feet of North Branch of Oak Creek with a severe lateral recession rate	17,600	5.4	--	14.1	28.2	Milwaukee County, municipalities, and other watershed partners	39,600	2,370	8, 9, 22, 25, 49, 52, 58, 67	High
LNB-05	WQ, H	Left bank of North Branch of Oak Creek downstream of Canadian Pacific Railway crossing[f]	42.87628	-87.92354	City of Oak Creek	Milwaukee County	Bank stabilization to address bank erosion along 113 feet of North Branch of Oak Creek with a severe lateral recession rate	16,200	5.0	--	13.0	26.0	Milwaukee County, municipalities, and other watershed partners	39,600	2,370	8, 9, 22, 25, 49, 52, 58, 67	High
LNB-06	H, SWF	North Branch of Oak Creek railroad culvert crossing 0.1 mile upstream from the confluence with Oak Creek	42.87638	-87.92368	City of Oak Creek	Canadian Pacific Railway	Conduct a detailed inspection and structural integrity analysis of the Canadian Pacific Railway culvert crossing of the North Branch of Oak Creek[ii]	--	--	--	--	--	Canadian Pacific Railway	25,000	--	28, 63	High
LNB-07	H, SWF	North Branch of Oak Creek railroad culvert crossing 0.1 mile upstream from the confluence with Oak Creek	42.87645	-87.82390	City of Oak Creek	Canadian Pacific Railway	If the inspection called for in LNB-06 shows that the structure is still serviceable, action should be taken to protect the culvert bedding and foundation from further undermining and to halt flow of water under the culvert.[jj]	--	--	--	--	--	Canadian Pacific Railway	470,400	--	28, 46, 63	High
LNB-08	WQ, H	Right bank of North Branch of Oak Creek upstream of Canadian Pacific Railway crossing[f]	42.87886	-87.92448	City of Oak Creek	Aldi, Inc.	Bank stabilization to address bank erosion along 132 feet of North Branch of Oak Creek with a severe lateral recession rate	22,200	6.8	--	17.7	35.5	Aldi, Inc. and other watershed partners	46,200	2,770	7, 8, 11, 27, 49	High
LNB-09	WQ, H	Right bank of North Branch of Oak Creek upstream of Canadian Pacific Railway crossing[f]	47.87985	-87.92467	City of Oak Creek	Riverview Estates Homeowner's Association	Bank stabilization to address bank erosion along 116 feet of North Branch of Oak Creek with a moderate lateral recession rate	2,800	0.9	--	2.3	4.6	Riverview Estates Homeowner's Association and other watershed partners	40,600	2,440	7, 8, 11, 27, 49	Medium
LNB-10	WQ, H	Left bank of North Branch of Oak Creek upstream of Canadian Pacific Railway crossing[f]	42.88002	-87.92508	City of Oak Creek	Riverview Estates Homeowner's Association	Bank stabilization to address bank erosion along 266 feet of North Branch of Oak Creek with a slight lateral recession rate	200	0.0	--	0.1	0.2	Riverview Estates Homeowner's Association and other watershed partners	9,100	550	7, 8, 11, 27, 49	Low
LNB-11	WQ, H	Left bank of North Branch of Oak Creek upstream of Canadian Pacific Railway crossing[f]	42.88033	-87.92538	City of Oak Creek	Riverview Estates Homeowner's Association	Bank stabilization to address bank erosion along 29 feet of North Branch of Oak Creek with a moderate lateral recession rate	1,000	0.3	--	0.7	1.4	Riverview Estates Homeowner's Association and other watershed partners	10,200	610	7, 8, 11, 27, 49	Low
LNB-12	H	North Branch of Oak Creek upstream of W. York Street (extended)	42.88054	-87.92539	City of Oak Creek	Riverview Estates Homeowner's Association	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	Landowner, MMSD[p], City of Oak Creek, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Low
LNB-13	H, WQ	Privately-owned natural areas northwest of Milwaukee County Parks Oak Creek Parkway Management Section 12	42.88074	-87.92431	City of Oak Creek	Private Landowners	Evaluate the interest of private landowners in voluntary acquisitions of wooded and natural portions of private property adjacent to Parkway Management Unit 12[kk]	--	--	--	--	--	Landowners, Milwaukee County, and Watershed partners	--	--	11, 20, 35, 38, 45, 49, 60, 61	Low

Table continued on next page.

Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information				Owner	Management Action	Annual Pollutant Reductions					Key Project Partners	Costs (dollars)[c]		Potential Funding Sources[d]	Priority[e]
		Location	Latitude	Longitude	Municipality			TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)		Capital	Annual O&M		
Lower North Branch of Oak Creek Assessment Area (LNB) (continued)																	
LNB-14	H	North Branch of Oak Creek downstream of W. Potomac Drive (extended)	42.88123	-87.92470	City of Oak Creek	Riverview Estates Homeowner's Association	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	MMSD[p], City of Oak Creek, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Low
LNB-15	WQ, H	Right bank of North Branch of Oak Creek downstream of W. Puetz Road within Hunter's Run Condominiums[f]	42.88616	-87.92391	City of Oak Creek	Condominium Owners	Bank stabilization to address bank erosion along 43 feet of North Branch of Oak Creek with a slight lateral recession rate	200	0.1	--	0.2	0.3	Condominium Owners and other watershed partners	15,100	900	7, 8, 11, 27, 49	Low
LNB-16	H	W. Puetz Road culvert crossing of North Branch of Oak Creek	42.88683	-87.92434	City of Oak Creek	City of Oak Creek	Culvert has been replaced since SEWRPC survey was completed. A new fish passage assessment should be conducted of the culvert	--	--	--	--	--	City of Oak Creek	--	--	48	Low
LNB-17	H, WQ	North Branch of Oak Creek upstream of W. Puetz Road	42.88742	-87.92415	City of Oak Creek	City of Oak Creek	Discontinue mowing to bank of North Branch of Oak Creek; establish a vegetated riparian buffer with a minimum 75-foot width from each stream bank or to the extent allowable based on existing development (about 2.0 acres); manage for invasive species	--	--	--	--	--	City of Oak Creek	8,400	--	11, 16, 19, 26	Medium
LNB-18	WQ, H	Left bank of Oak Creek upstream of W. Puetz Road at City of Oak Creek DPW[f]	42.90773	-87.92409	City of Oak Creek	Unknown	Repair or replace failing portion of 15-inch RCP (sequence number 185 in Appendix E)	--	--	--	--	--	Unknown	2,700	--	7, 57, 67	Medium
LNB-19	WQ, H	Right bank of Oak Creek upstream of W. Puetz Road at City of Oak Creek DPW[f]	42.88827	-87.92360	City of Oak Creek	City of Oak Creek	Bank stabilization to address bank erosion along 50 feet of North Branch of Oak Creek with a moderate lateral recession rate	2,000	0.6	--	1.6	3.1	City of Oak Creek	17,500	1,100	8, 9, 22, 25, 49, 52, 58, 67	Medium
LNB-20	WQ, H	Right bank of Oak Creek upstream of W. Puetz Road at City of Oak Creek DPW[f]	42.88982	-87.92361	City of Oak Creek	City of Oak Creek	Bank stabilization to address bank erosion along 58 feet of North Branch of Oak Creek with a moderate lateral recession rate	1,800	0.6	--	1.4	2.9	City of Oak Creek	20,300	1,220	8, 9, 22, 25, 49, 52, 58, 67	Low
LNB-21	WQ, H	Left bank of Oak Creek upstream of W. Puetz Road at City of Oak Creek DPW[f]	42.89001	-87.92449	City of Oak Creek	City of Oak Creek	Bank stabilization to address bank erosion along 130 feet of North Branch of Oak Creek with a moderate lateral recession rate	6,000	1.9	--	4.9	9.7	City of Oak Creek	45,500	2,730	8, 9, 22, 25, 49, 52, 58, 67	Medium
LNB-22	WQ, H	Right bank of North Branch of Oak Creek at Willow Heights Park[f]	42.89468	-87.82549	City of Oak Creek	Unknown	Repair or replace failing portion of 24-inch corrugated plastic pipe outfall (sequence number 188 in Appendix E)	--	--	--	--	--	Unknown	3,700	--	7, 57, 67	Medium
LNB-23	H,WQ, SWF	North Branch of Oak Creek through Willow Heights Park and to 700 feet downstream of the park	42.89531	-87.92655	City of Oak Creek	City of Oak Creek	Stream channel and riparian restoration of about 1,950 feet of channel[ll]	--	--	--	--	--	City of Oak Creek and other watershed partners	--[l]	--	7, 9, 10, 21, 22, 25, 30, 39, 49, 52, 58	Low
LNB-24	WQ, H	Left bank of North Branch of Oak Creek downstream of Weatherly Drive in Willow Heights Park[f]	42.89543	-87.92684	City of Oak Creek	City of Oak Creek	Bank stabilization to address bank erosion along 43 feet of North Branch of Oak Creek with a moderate lateral recession rate	1,600	0.5	--	1.3	2.6	City of Oak Creek	15,100	900	8, 22, 25, 49, 52, 58, 67	Low
LNB-25	H	Weatherly Drive bridge over North Branch of Oak Creek	42.89675	-87.92767	City of Oak Creek	City of Oak Creek	Newly constructed bridge is a good model for a "fish friendly" crossing design; however, excessive rock placed across the channel under the crossing likely creates a fish passage impediment. Rock should be re-arranged to allow for better passage lanes.	--	--	--	--	--	City of Oak Creek	--	--	--	Medium

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Lower North Branch of Oak Creek Assessment Area (LNB) (continued)																	
LNB-26	H, WQ	North Branch of Oak Creek from confluence with Drexel Avenue Tributary to W. Drexel Avenue crossing	42.89922	-87.92608	City of Oak Creek	City of Oak Creek	Establish new or expand existing riparian buffer to a minimum of 75 feet from each streambank or to the extent allowable based on existing development constraints (about 5.3 acres). Manage invasive species	--	--	--	--	--	City of Oak Creek	22,100	--	4, 7,10, 11, 15, 20, 22, 24, 25, 26, 45, 49, 52, 57, 58, 67	Medium
LNB-27	WQ, H	Right bank of North Branch of Oak Creek downstream of W. Drexel Avenue[f]	42.90035	-87.92417	City of Oak Creek	City of Oak Creek	Repair or replace failing portion of 36-inch RCP outfall (sequence number 192 in Appendix E)	--	--	--	--	--	City of Oak Creek	5,000	--	7, 57, 67	High
LNB-28	H	W. Drexel Avenue culvert crossing of North Branch of Oak Creek	42.90133	-87.92365	City of Oak Creek	City of Oak Creek	Monitor beaver activity and remove dams if the begin to affect structure	--	--	--	--	--	City of Oak Creek	--	--	--	Low
LNB-29	WQ, SWF	Boulevard median of W. Drexel Avenue from S. 10th Street east to the crossing of North Branch of Oak Creek	42.90152	-87.92646	City of Oak Creek	City of Oak Creek	Example Project – Installation of bioswales in about 630 feet of W. Drexel Avenue to treat 50 percent of the boulevard (1.0 acre)[z]	432	0.8	0.02	--	--	City of Oak Creek	38,000	2,200	8, 12, 13, 14,25, 27, 31, 52, 57, 63, 67	High
LNB-30	WQ, H	Left bank of North Branch of Oak Creek upstream of S. 6th Street[f]	42.90271	-87.92936	City of Oak Creek	City of Oak Creek	Repair or replace failing portion of 21-inch CMP outfall (sequence number 193 in Appendix E)	--	--	--	--	--	City of Oak Creek	3,400	--	7, 57, 67	Medium
LNB-31	WQ, H	Right bank of North Branch of Oak Creek upstream of S. 6th Street and adjacent to Oak Creek Little League Complex[f]	42.90286	-87.91690	City of Oak Creek	City of Oak Creek	Bank stabilization to address bank erosion along 67 feet of North Branch of Oak Creek with a slight lateral recession rate	400	0.1	--	0.3	0.6	City of Oak Creek	23,500	1,410	8, 9, 22, 25, 49, 52, 58, 67	Low
LNB-32	WQ, H	Right bank of North Branch of Oak Creek upstream of S. 6th Street and adjacent to Oak Creek Little League Complex[f]	42.90299	-87.91626	City of Oak Creek	City of Oak Creek	Bank stabilization to address bank erosion along 131 feet of North Branch of Oak Creek with a moderate lateral recession rate	3,600	1.1	--	2.9	5.7	City of Oak Creek	45,900	2,750	8, 9, 22, 25, 49, 52, 58, 67	Medium
LNB-33	H, WQ, SWF	North Branch of Oak Creek from S. 6th Street upstream to confluence with Rawson Avenue Tributary	42.90355	-87.91539	City of Oak Creek	City of Oak Creek	Stream channel and riparian restoration of about 2,100 feet of channel[mm]	--	--	--	--	--	City of Oak Creek and other watershed partners	--[l]	--	7, 9, 10, 21, 22, 25, 30, 39, 49, 52, 58, 60	Medium
LNB-34	WQ, H	Left bank of North Branch of Oak Creek upstream of S. 6th Street and adjacent to Oak Creek Little League Complex[f]	42.90475	-87.91514	City of Oak Creek	City of Oak Creek	Bank stabilization to address bank erosion along 89 feet of North Branch of Oak Creek with a slight lateral recession rate	400	0.1	--	0.3	0.6	City of Oak Creek	31,200	1,870	8, 9, 22, 25, 49, 52, 58, 67	Low
LNB-35	WQ, H	Left bank of North Branch of Oak Creek upstream of S. 6th Street and adjacent to Oak Creek Little League Complex[f]	42.90554	-87.91561	City of Oak Creek	City of Oak Creek	Bank stabilization to address bank erosion along 71 feet of North Branch of Oak Creek with a slight lateral recession rate	400	0.1	--	0.3	0.7	City of Oak Creek	24,900	1,490	8, 9, 22, 25, 49, 52, 58, 67	Low
Upper North Branch of Oak Creek Assessment Area (UNB)																	
UNB-01	WQ, H	Left bank of North Branch of Oak Creek downstream of W. Marquette Avenue[f]	42.90746	-87.91526	City of Oak Creek	City of Oak Creek	Bank stabilization to address bank erosion along 62 feet of North Branch of Oak Creek with a moderate lateral recession rate	1,800	0.6	--	1.5	2.9	City of Oak Creek	21,700	1,300	8, 9, 22, 25, 49, 52, 58, 67	Low
UNB-02	WQ, H	Left bank of North Branch of Oak Creek downstream of W. Marquette Avenue[f]	42.90761	-87.91537	City of Oak Creek	Unknown	Repair or replace failing portion of 18-inch CMP outfall (sequence number 228 in Appendix E)	--	--	--	--	--	Unknown	2,300	--	7, 57, 67	Medium

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Site Information: Latitude	Site Information: Longitude	Site Information: Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Annual Pollutant Reductions: Total Phosphorus (pounds)	Annual Pollutant Reductions: Fecal Coliform Bacteria (trillion cells)	Annual Pollutant Reductions: Total Nitrogen (pounds)	Annual Pollutant Reductions: BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Costs (dollars)[c]: Annual O&M	Potential Funding Sources[d]	Priority[e]
Upper North Branch of Oak Creek Assessment Area (UNB) (continued)																	
UNB-03	H	W. Marquette Avenue bridge crossing of North Branch of Oak Creek	42.90901	-87.91522	City of Oak Creek	City of Oak Creek	Water levels may be insufficient for fish passage during low-flow conditions. Retrofitting a "low-flow channel" with a narrower channel width would promote sufficient water depths during average flow conditions while allowing overflow into a second "tiers" when higher flows occur	--	--	--	--	--	City of Oak Creek	--	--	21, 25, 28, 45, 52, 58	Low
UNB-04	H	Right bank of North Branch of Oak Creek upstream of W. Marquette Avenue[f]	42.91057	-87.91507	City of Oak Creek	Unknown	Repair or replace failing portion of 12-inch CMP outfall (sequence number 232 in Appendix E)	--	--	--	--	--	Unknown	2,100	--	7, 57, 67	Low
UNB-05	H	Left bank of North Branch of Oak Creek upstream of W. Marquette Avenue[f]	42.91078	-87.91511	City of Oak Creek	Unknown	Repair or replace failing portion of 12-inch CMP outfall (sequence number 233 in Appendix E)	--	--	--	--	--	Unknown	2,100	--	7, 57, 67	Low
UNB-06	H	Left bank of North Branch of Oak Creek upstream of W. Marquette Avenue[f]	42.91109	-87.91514	City of Oak Creek	Unknown	Repair or replace failing portion of 12-inch CMP outfall (sequence number 234 in Appendix E)	--	--	--	--	--	Unknown	2,100	--	7, 57, 67	Low
UNB-07	H	Right bank of North Branch of Oak Creek upstream of W. Marquette Avenue[f]	42.91141	-87.91501	City of Oak Creek	Unknown	Repair or replace failing portion of corrugated plastic outfall (sequence number 235 in Appendix E)	--	--	--	--	--	Unknown	2,100	--	7, 57, 67	Low
UNB-08	H, WQ	North Branch of Oak Creek from confluence with Rawson Avenue Tributary upstream to S. 6th Street	42.91279	-87.91497	City of Oak Creek	City of Oak Creek	Establish a "no-mow" zone and establish new or expand existing riparian buffer along about 5,390 feet of stream to a minimum width of 75 feet from each stream bank or to the extent allowable based on existing development constraints (about 15.0 acres). Manage invasive species	--	--	--	--	--	City of Oak Creek	62,600	--	4, 7,10, 11, 15, 20, 22, 24, 25, 26, 45, 49, 52, 57, 58, 67	Medium
UNB-09	WQ, H	Right bank of North Branch of Oak Creek downstream of W. Rawson Avenue[f]	42.91367	-87.91490	City of Oak Creek	Unknown	Repair or replace failing portion of corrugated plastic outfall (sequence number 238 in Appendix E)	--	--	--	--	--	Unknown	2,100	--	7, 57, 67	Low
UNB-10	WQ, H	Right bank of North Branch of Oak Creek downstream of W. Rawson Avenue[f]	42.91388	-87.91489	City of Oak Creek	Unknown	Repair or replace failing portion of corrugated plastic outfall (sequence number 239 in Appendix E)	--	--	--	--	--	Unknown	2,100	--	7, 57, 67	Low
UNB-11	WQ, H	Right bank of North Branch of Oak Creek downstream of W. Rawson Avenue[f]	42.91422	-87.91488	City of Oak Creek	Unknown	Repair or replace failing portion of corrugated plastic outfall (sequence number 241 in Appendix E)	--	--	--	--	--	Unknown	2,100	--	7, 57, 67	Low
UNB-12	WQ, H	Left bank of North Branch of Oak Creek downstream of S. 6th Street[f]	42.91465	-87.91511	City of Oak Creek	Unknown	Repair or replace failing portion of 12-inch CMP outfall (sequence number 243 in Appendix E)	--	--	--	--	--	Unknown	2,100	--	7, 57, 67	Low
UNB-13	H, SWF	W. Rawson Avenue culvert crossing of North Branch of Oak Creek	42.91560	-87.91488	City of Oak Creek	City of Oak Creek	Monitor sediment accumulation and excavate excessive sediment when accumulation may become a fish passage impediment or lead to flooding of the road or nearby infrastructure	--	--	--	--		City of Oak Creek	--	--	11, 22, 24, 25, 48, 51, 52, 57	Low
UNB-14	WQ, H	Left bank of North Branch of Oak Creek downstream of W. Rawson Avenue[f]	42.91764	-87.91765	City of Oak Creek	Unknown	Repair or replace failing portion of corrugated plastic outfall (sequence number 242 in Appendix E)	--	--	--	--	--	Unknown	2,100	--	7, 57, 67	Low
UNB-15	H	North Branch of Oak Creek upstream from the S. 6th Street crossing	42.91869	-87.92036	City of Oak Creek	City of Oak Creek	Stream channel and riparian restoration of about 2,000 feet of channel[nn]	--	--	--	--		City of Oak Creek and other watershed partners	--[l]	--	7, 9, 10, 21, 22, 25, 30, 39, 49, 52, 58	Low
UNB-16	WQ, H	Left bank of North Branch of Oak Creek across from United Parcel Service[f]	42.92230	-87.92055	City of Oak Creek	Unknown	Repair or replace failing portion of 12-inch CMP outfall (sequence number 248 in Appendix E)	--	--	--	--	--	Unknown	2,100	--	7, 57, 67	Low

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information				Owner	Management Action	Annual Pollutant Reductions					Key Project Partners	Costs (dollars)[c]		Potential Funding Sources[d]	Priority[e]
		Location	Latitude	Longitude	Municipality			TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)		Capital	Annual O&M		
Upper North Branch of Oak Creek Assessment Area (UNB) (continued)																	
UNB-17	H	North Branch of Oak Creek 250 feet downstream of MATC driveway crossing	42.92351	-87.92050	City of Oak Creek	MATC	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	MATC, MMSD[p], City of Oak Creek, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Low
UNB-18	H	North Branch of Oak Creek 210 feet downstream of MATC driveway crossing	42.92364	-87.92049	City of Oak Creek	MATC	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	MATC, MMSD[p], City of Oak Creek, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Low
UNB-19	WQ	Right bank of North Branch of Oak Creek on MATC grounds behind baseball complex[f]	42.92374	-87.92013	City of Oak Creek	MATC	MATC winter deicing salt storage building is located only 50 east of North Branch of Oak Creek. Relocated the salt storage away from a waterway to reduce unintended chloride pollution	--	--	--	--	--	MATC	--	--	45, 57, 65, 67	Medium
UNB-20	H	MATC driveway culvert crossing of North Branch of Oak Creek	42.92437	-87.92037	City of Oak Creek	MATC	Remove large debris blockage at upstream side of the culvert that is causing a fish passage impediment	--	--	--	--	--	MATC	--	--	9, 21, 22, 25, 27, 32, 48, 49	Low
UNB-21	H	North Branch of Oak Creek at upstream end of MATC driveway crossing	42.92441	-87.92050	City of Oak Creek	MATC	Remove or modify large woody debris jam to allow for better aquatic organism passage	--	--	--	--	--	MATC, MMSD[p], City of Oak Creek, and Milwaukee County	--	--	9, 21, 22, 25, 32, 48, 49	Low
UNB-22	WQ, H	Right bank of North Branch of Oak Creek upstream of MATC campus[f]	42.92702	-87.92177	City of Oak Creek	City of Oak Creek	Bank stabilization to address bank erosion along 88 feet of Oak Creek with a moderate lateral recession rate	2.800	0.8	--	2.2	4.4	City of Oak Creek	30,800	1,850	8, 9, 22, 25, 49, 52, 58, 67	Medium
UNB-23	H	Abandoned private crossing on North Branch of Oak Creek downstream of W. College Avenue	42.92714	-87.92185	City of Oak Creek	Private landowner	Steel structure is collapsing and collecting debris, causing a fish passage impediment. Structure is also a safety hazard. Remove the structure and stabilize streambanks to prevent erosion	--	--	--	--	--	Private landowner	--	--	12, 21, 25, 29 39, 46, 47	High
UNB-24	H	Abandoned private crossing on North Branch of Oak Creek downstream of W. College Avenue	42.92737	-87.92215	City of Oak Creek	Private landowner	Remove deteriorating steel bridge and stabilize streambanks to prevent erosion	--	--	--	--	--	Private landowner	--	--	12, 21, 25, 29 39, 46, 47	Medium
UNB-25	H	Abandoned private crossing on North Branch of Oak Creek downstream of W. College Avenue	42.92791	-87.92286	City of Oak Creek	Private landowner	Remove deteriorating steel bridge and stabilize streambanks to prevent erosion	--	--	--	--	--	Private landowner	--	--	12, 21, 25, 29 39, 46, 47	Medium
UNB-26	H	Abandoned private crossing on North Branch of Oak Creek downstream of W. College Avenue	42.92855	-87.92385	City of Oak Creek	Private landowner	Remove deteriorating steel bridge and stabilize streambanks to prevent erosion	--	--	--	--	--	Private landowner	--	--	12, 21, 25, 29 39, 46, 47	Medium
UNB-27	H, SWF	W. College Avenue culvert crossing of North Branch of Oak Creek	42.93073	-87.92636	City of Milwaukee	City of Milwaukee or WisDOT	There is heavy sediment accumulation just upstream of the culvert with water surface only 1.5 feet below the top of the culver cell. Condition of the interior of the culvert is unknown. Culvert should be monitored for sediment accumulation and capacity to pass stream flow	--	--	--	--	--	City of Milwaukee or WisDOT	--	--	--	Low
UNB-28	H, SWF	S. 13th Street culvert crossing of North Branch of Oak Creek	42.93246	-87.92938	City of Milwaukee	City of Milwaukee	Condition of interior of three-cell corrugated metal culvert is unknown. Consider replacing with span bridge when time for replacement	--	--	--	--	--	City of Milwaukee	--	--	31, 39, 46, 47	Low

Table continued on next page.

Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information					Management Action	Annual Pollutant Reductions					Key Project Partners	Costs (dollars)[c]		Potential Funding Sources[d]	Priority[e]
		Location	Latitude	Longitude	Municipality	Owner		TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)		Capital	Annual O&M		
Upper North Branch of Oak Creek Assessment Area (UNB) (continued)																	
UNB-29	H, WQ	North Branch of Oak Creek through Maitland Park	42.93484	-87.93208	City of Milwaukee	Milwaukee County	At a minimum, establish new or expand existing riparian buffers to or beyond 75 feet from each streambank and manage invasive species[oo]	--	--	--	--	--	Milwaukee County	20,900	--	15, 20, 22, 24, 25, 26, 45, 49, 52, 57, 58, 67	Medium
UNB-30	H	S. 20th Street culvert crossing of North Branch of Oak Creek	42.94217	-87.93921	City of Milwaukee	City of Milwaukee or Milwaukee County	Debris accumulation within the pipe culverts at the upstream end are causing a fish passage impediment. Clear debris from culvert pipes	--	--	--	--	--	City of Milwaukee or Milwaukee County	--	--	11, 48, 49, 57	High
UNB-31	WQ, H	Left bank of North Branch of Oak Creek upstream of S. 20th Street in Copernicus Park[f]	42.94224	-87.93951	City of Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 10 feet of North Branch of Oak Creek with a moderate lateral recession rate	400	0.1	--	0.3	0.6	Milwaukee County, municipalities, and other watershed partners	3,500	210	8, 9, 22, 25, 49, 52, 58, 67	Low
UNB-32	WQ, H	Left bank of North Branch of Oak Creek upstream of S. 20th Street in Copernicus Park[f]	42.94230	-87.93970	City of Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 25 feet of North Branch of Oak Creek with a severe lateral recession rate	4,800	1.5	--	3.8	7.7	Milwaukee County, municipalities, and other watershed partners	8,800	530	8, 22, 25, 27, 49, 52, 58, 60, 67	Medium
UNB-33	WQ, H	Left bank of North Branch of Oak Creek downstream of footbridge in Copernicus Park[f]	42.94287	-87.94017	City of Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 51 feet of North Branch of Oak Creek with a moderate lateral recession rate	2,400	0.7	--	1.9	3.8	Milwaukee County, municipalities, and other watershed partners	17,900	7,070	8, 9, 22, 25, 49, 52, 58, 67	Medium
UNB-34	WQ, H	Right bank of North Branch of Oak Creek downstream of footbridge in Copernicus Park[f]	42.94301	-87.94003	City of Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 41 feet of North Branch of Oak Creek with a moderate lateral recession rate	2,000	0.6	--	1.5	3.1	Milwaukee County, municipalities, and other watershed partners	14,400	860	8, 9, 22, 25, 49, 52, 58, 67	Low
UNB-35	WQ, H	Right bank of North Branch of Oak Creek downstream of footbridge in Copernicus Park[f]	42.94311	-87.93998	City of Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 41 feet of North Branch of Oak Creek with a moderate lateral recession rate	2,600	0.8	--	2.0	4.1	Milwaukee County, municipalities, and other watershed partners	14,400	860	8, 9, 22, 25, 49, 52, 58, 67	Medium
UNB-36	WQ, H	North Branch of Oak creek throughout Copernicus Park from S. 20th Street upstream to the point the Creek daylights just south of W. Grange Avenue	42.94348	-87.94019	City of Milwaukee	Milwaukee County and City of Milwaukee	Consider regenerative stormwater conveyance restoration using a series of shallow pools, riffle grade controls, native vegetation, and underlying woodchip or gravel beds to address streambed and bank erosion and incised channels.	--	--	--	--	--	Milwaukee County and City of Milwaukee	--[dd]	--	6, 7, 9, 11, 21, 25, 28, 30, 45, 48, 49, 52, 67	Medium
UNB-37	WQ, H	Right bank of North Branch of Oak Creek upstream of footbridge in Copernicus Park[f]	42.94365	-87.94034	City of Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 36 feet of North Branch of Oak Creek with a moderate lateral recession rate	1,800	0.6	--	2.9	1.5	Milwaukee County, municipalities, and other watershed partners	12,600	760	8, 9, 22, 25, 49, 52, 58, 67	Low
UNB-38	WQ, H	Right bank of North Branch of Oak Creek upstream of footbridge in Copernicus Park[f]	42.94378	-87.94071	City of Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 138 feet of North Branch of Oak Creek with a moderate lateral recession rate	6,400	2.0	--	10.3	5.2	Milwaukee County, municipalities, and other watershed partners	48,300	2,900	8, 9, 22, 25, 49, 52, 58, 67	Medium

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Table 6.1 (Continued)

		Site Information						Annual Pollutant Reductions						Costs (dollars)[c]			
ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Location	Latitude	Longitude	Municipality	Owner	Management Action	TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
							Upper North Branch of Oak Creek Assessment Area (UNB) (continued)										
UNB-39	WQ, H	Left bank of North Branch of Oak Creek upstream of footbridge in Copernicus Park[f]	42.94374	-87.94074	City of Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 141 feet of North Branch of Oak Creek with a moderate lateral recession rate	6,400	2.0	--	10.6	5.3	Milwaukee County, municipalities, and other watershed partners	49,400	2,960	8, 9, 22, 25, 49, 52, 58, 67	Medium
UNB-40	WQ, H	Left bank of North Branch of Oak Creek downstream of where the North Branch of Oak Creek daylights in Copernicus Park[f]	42.94388	-87.94155	City of Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 196 feet of North Branch of Oak Creek with a moderate lateral recession rate	13,800	4.2	--	22.0	11.0	Milwaukee County, municipalities, and other watershed partners	68,600	4,110	8, 9, 22, 25, 49, 52, 58, 67	Medium
UNB-41	WQ, H	Left bank of North Branch of Oak Creek downstream of where the North Branch of Oak Creek daylights in Copernicus Park[f]	42.94409	-87.94212	City of Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 145 feet of North Branch of Oak Creek with a severe lateral recession rate	31,400	9.6	--	50.1	25.1	Milwaukee County, municipalities, and other watershed partners	50,800	3,050	8, 9, 22, 25, 49, 52, 58, 67	High
UNB-42	WQ, H	Right bank of North Branch of Oak Creek downstream of where the North Branch of Oak Creek daylights in Copernicus Park[f]	42.94425	-87.94223	City of Milwaukee	Milwaukee County	Bank stabilization to address bank erosion along 45 feet of North Branch of Oak Creek with a severe lateral recession rate	8,600	2.7	--	13.8	6.9	Milwaukee County, municipalities, and other watershed partners	15,800	950	8, 9, 22, 25, 49, 52, 58, 67	High
UNB-43	WQ, H	Downstream of W. Grange Avenue where North Branch of Oak Creek daylights in Copernicus Park	42.94426	-87.94238	City of Milwaukee	City of Milwaukee	Repair or replace failing portion of outfall where North Branch of Oak Creek daylights	--	--	--	--	--	City of Milwaukee	--	--	7, 57, 67	High
							Drexel Avenue Tributary Assessment Area (DAT)										
DAT-01	H, WQ	Milwaukee County Parks Falk Park Management Unit Number 8	42.90586	-87.94077	City of Oak Creek	Milwaukee County	Vegetation survey; invasive species control; invasive species monitoring and select control on 9.5 acres; reforestation of 1.3 acres; maintain wildlife exclusion barrier	--	--	--	--	--	Milwaukee County	9,300	--	11, 16, 19, 26, 35, 45, 51, 53	Low
DAT-02	H, WQ	Woodland component of private residential property directly south of Milwaukee County Parks Falk Park Management Unit Number 4	42.90567	-87.94193	City of Oak Creek	Private landowner	Voluntary acquisition of 4.2-acre wooded component of residential partial directly south of Unit 4[pp]	--	--	--	--	--	Landowner, Milwaukee County and Watershed partners	163,400	--	11, 20, 35, 38, 45, 49, 60, 61, 68	Low
DAT-03	H	Milwaukee County Parks Falk Park Management Unit Number 6	42.90490	-87.94411	City of Oak Creek	Milwaukee County	Vegetation survey; invasive species control; invasive species monitoring and select control on 3.7 acres; wildlife monitoring	--	--	--	--	--	Milwaukee County	4,300	--	11, 16, 19, 26, 35, 45, 51, 53	Medium
DAT-04	H, WQ	Milwaukee County Parks Falk Park Management Unit Number 7	42.90278	-87.74535	City of Oak Creek	Milwaukee County	Vegetation survey; invasive species control; invasive species monitoring and select control on 16.8 acres; reforestation of 8.4 acres; wildlife monitoring	--	--	--	--	--	Milwaukee County	19,900	--	11, 16, 19, 26, 35, 45, 51, 53	High
DAT-05	H	Milwaukee County Parks Barloga Woods Management Unit Number 1	42.90077	-87.94186	City of Oak Creek	Milwaukee County	Vegetation survey; invasive species control; invasive species monitoring and select control on 8.8 acres	--	--	--	--	--	Milwaukee County	17,300	--	11, 16, 19, 26, 35, 45, 51, 53	Medium
DAT-06	H	Milwaukee County Parks Barloga Woods Management Unit Number 2	42.89877	-87.94615	City of Oak Creek	Milwaukee County	Vegetation survey; invasive species control; invasive species monitoring and select control; forest stand improvement on 5.1 acres	--	--	--	--	--	Milwaukee County	21,600	--	11, 16, 19, 26, 35, 45, 51, 53	Medium

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information					Management Action	Annual Pollutant Reductions					Key Project Partners	Costs (dollars)[c]		Potential Funding Sources[d]	Priority[e]
		Location	Latitude	Longitude	Municipality	Owner		TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)		Capital	Annual O&M		
Drexel Avenue Tributary Assessment Area (DAT) (continued)																	
DAT-07	H	Milwaukee County Parks Barloga Woods Management Unit Number 3	42.89862	-87.94413	City of Oak Creek	Milwaukee County	Vegetation survey; invasive species control; invasive species monitoring and select control on 33.8 acres; inter-seeding native plants on 10 acres; reforestation on 1 acre; wildlife monitoring	--	--	--	--	--	Milwaukee County	120,000	--	11, 16, 19, 26, 35, 45, 51, 53	High
DAT-08	H, WQ	Milwaukee County Parks Barloga Woods Management Unit Number 4	42.89393	-87.94522	City of Oak Creek	Milwaukee County	Vegetation survey; invasive species control; invasive species monitoring and select control on 2.3 acres; shrub planting on 2.6 acres; wildlife monitoring	100	1.7	--	--	--	Milwaukee County	12.600	--	11, 16, 19, 26, 35, 45, 51, 53	Low
DAT-09	H	Milwaukee County Parks Barloga Woods Management Unit Number 5	42.89545	-87.93887	City of Oak Creek	Milwaukee County	Vegetation survey; invasive species control; invasive species monitoring and select control; forest stand improvement on 23.4 acres; inter-seeding native plants on 10 acres; reforestation on 1 acre; wild live monitoring	--	--	--	--	--	Milwaukee County	88,500	--	11, 16, 19, 26, 35, 45, 51, 53	High
DAT-10	H, WQ	Milwaukee County Parks Barloga Woods Management Unit Number 6	42.89904	-87.93808	City of Oak Creek	Milwaukee County	Invasive species control; invasive species monitoring and select control; reforestation of 18.0 acres; wildlife monitoring	32,040	12.0				Milwaukee County	61,700	--	11, 16, 19, 26, 35, 45, 51, 53	High
DAT-11	H	Milwaukee County Parks Barloga Woods Management Unit Number 6	42.89376	-87.93805	City of Oak Creek	Milwaukee County	Vegetation survey; invasive species control; invasive species monitoring and select control; forest stand improvement on 6.9 acres; wildlife monitoring	--	--	--	--	--	Milwaukee County	27,100	--	11, 16, 19, 26, 35, 45, 51, 53	Medium
DAT-12	H, WQ	WisDOT property adjacent to the east of Barloga Woods Management Unit Number 5	42.89710	-87.93713	City of Oak Creek	WisDOT	Voluntary acquisition of 11.3-acre parcel containing the eastern section of ephemeral pond #4783[qq]	--	--	--	--	--	Landowner, Milwaukee County and Watershed partners	--	--	8, 12, 25, 27, 49, 50, 52, 60, 57, 63, 65, 67	Low
Rawson Avenue Tributary Assessment Area (RAT)																	
RAT-01	H, SWF	Bridge crossing of Rawson Avenue Tributary at 7600 S. 6th Street	42.90722	-87.92000	City of Oak Creek	City of Oak Creek	As part of bridge replacement, consider removing concrete from adjacent stream channel	--	--	--	--	--	City of Oak Creek	400,000	--	21, 25, 28, 46, 57	High
RAT-02	WQ, R	Outfall discharging into tributary to Rawson Avenue Tributary south of W. Rawson Avenue	42.91274	-87.92693	City of Oak Creek	City of Oak Creek	Investigate and remedy source of human fecal contamination to outfall (sequence number 218 in Appendix E)	--	--	--	--	--	City of Oak Creek	--	--	7, 57, 67	High
RAT-03	WQ, R	Outfall discharging into tributary to Rawson Avenue Tributary south of W. Rawson Avenue	42.91403	-87.92677	City of Oak Creek	Unknown	Investigate and remedy source of human fecal contamination to outfall (sequence number 223 in Appendix E)	--	--	--	--	--	Unknown	--	--	7, 57, 67	High
RAT-04	WQ, R	Outfall discharging into tributary to Rawson Avenue Tributary south of W. Rawson Avenue	42.91407	-87.92689	City of Oak Creek	Unknown	Investigate and remedy source of human fecal contamination to outfall (sequence number 224 in Appendix E)	--	--	--	--	--	Unknown	--	--	7, 57, 67	High
RAT-05	H	Milwaukee County Parks Falk Park Management Unit Number 1	42.91543	-87.93799	City of Oak Creek	Milwaukee County	Vegetation survey; invasive species control; invasive species monitoring and select control on 8.0 acres; wildlife monitoring	--	--	--	--	--	Milwaukee County	7,300	--	11, 16, 19, 26, 35, 45, 51, 53	Medium
RAT-06	H, WQ	Milwaukee County Parks Falk Park Management Unit Number 2	42.91331	-87.93741	City of Oak Creek	Milwaukee County	Vegetation survey; invasive species control; invasive species monitoring and select control; allowing succession to hardwood forest on 6.4 acres; wildlife monitoring	--	--	--	--	--	Milwaukee County	6,200	--	11, 16, 19, 26, 35, 45, 51, 53	High
RAT-07	H	Milwaukee County Parks Falk Park Management Unit Number 3	42.90928	-87.93858	City of Oak Creek	Milwaukee County	Vegetation survey; invasive species control; invasive species monitoring and select control on 14.2 acres; wildlife monitoring	--	--	--	--	--	Milwaukee County	11,700	--	11, 16, 19, 26, 35, 45, 51, 53	Medium

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Table 6.1 (Continued)

ID Number (see Maps 6.1 – 6.13)[a]	Focus Areas Addressed[b]	Site Information: Location	Latitude	Longitude	Municipality	Owner	Management Action	Annual Pollutant Reductions: TSS (pounds)	Total Phosphorus (pounds)	Fecal Coliform Bacteria (trillion cells)	Total Nitrogen (pounds)	BOD (pounds)	Key Project Partners	Costs (dollars)[c]: Capital	Annual O&M	Potential Funding Sources[d]	Priority[e]
Rawson Avenue Tributary Assessment Area (RAT) (continued)																	
RAT-08	H	Milwaukee County Parks Falk Park Management Unit Number 4	42.91268	-87.94070	City of Oak Creek	Milwaukee County	Vegetation survey; invasive species control; invasive species monitoring and select control on 83 acres; reforestation of understory of 5 acres; forest stand improvement of 8.3 acres; wildlife monitoring	--	--	--	--	--	Milwaukee County	92.900	--	11, 16, 19, 26, 35, 45, 51, 53	High
RAT-09	H, WQ	Milwaukee County Parks Falk Park Management Unit Number 5	42.91005	-87.94280	City of Oak Creek	Milwaukee County	Convert leased agricultural land to hardwood forest and upland shrub habitat; vegetation survey; invasive species control; invasive species monitoring and select control; reforestation of 9.2 acres; wildlife monitoring, future wildlife exclusion barrier when development to the west occurs	16,830	6.3	--	--	--	Milwaukee County	26,100	--	61	Low
RAT-10	H, WQ	Private woodland adjacent to northwest lobe of Milwaukee County Parks Falk Park Management Unit Number 4	42.91423	-87.94510	City of Oak Creek	Private landowner	Voluntary acquisition of 13.7-acre private woodlands adjacent to the northwest lobe of Unit 4[rr]	--	--	--	--	--	Landowner, Milwaukee County and Watershed partners	158,300	--	11, 20, 35, 38, 45, 49, 60, 61, 68	Low

[a] *Prefixes indicate the assessment area that the project is mapped in. The project areas of some projects extend into more than one assessment area.*

[b] *Abbreviations for focus areas:*

WQ = Water quality
H = Habitat
SWF = Stormwater drainage/flooding
R = Recreational access and use

[c] *Costs reflect 2019 conditions, based on an* Engineering News-Record *Construction Cost Index of 14,744.*

[d] *Potential funding source numbers correspond to the reference numbers given in Table 6.42.*

[e] *It is anticipated that at least 50 percent of high-priority projects will be implemented during the first 10 years of plan implementation, at least 75 percent of high-priority projects will be implemented during the first 20 years of plan implementation, and all high-priority projects will be implemented within a 30-year implementation period. It is envisioned that at least 15 percent of medium-and low-priority projects will be implemented during the first 10 years of implementation, with least 40 percent being implemented within 20 years, 65 percent being implemented within 30 years, and the balance being implemented after 30 years. It is recognized that some priority rankings may change during refinement and preliminary engineering of projects.*

[f] *Left bank and right bank are based on orientation when looking upstream.*

[g] *If the dam is not removed, repairs to the sluice gate could be completed prior to selecting a preferred alternative for the dam and pond as they would be necessary for any modification that does not fully remove the dam.*

[h] *This should be completed as part of refining alternatives for the Mill Pond area. Such an analysis would provide a better estimate of the amount of sediment being delivered to the area by Oak Creek, which would clarify the frequency of maintenance dredging that would be required for Alternatives 1 through 4. The complexity of the recommended analysis could range from a simple land use-based model to detailed sediment measurements. A basic modeling effort would include a literature review of the amount of bedload and sediment delivered by similar current land uses and streams, and subsequent completion of a model such as a unit area load model for the Oak Creek watershed. Field measurement efforts could include mapping the sediment accumulation in the Mill Pond over several years or sampling of sediment in the Creek upstream of the pond for at least a year. See the section on alternatives and recommended actions for the Mill Pond and Mill Pond dam in this chapter.*

[i] *This work will determine the level of sediment contamination and potential dredged material disposal options, both of which would impact the cost and feasibility of the alternatives for the Mill Pond and dam that are presented in this plan.*

[j] *The goal of this project would be to re-direct the main flow volume to the original channel and prevent streambank erosion from undermining infrastructure along the Oak Creek Parkway.*

[k] *Restoration could include two-stage channel design retrofit; bank regrading/shaping; breaking or removal of spoil berms to provide hydrologic connection to a floodplain terrace; improvement of habitat quality by installing natural channel design elements such as naturalized meanders, grade control, and constructed riffles; invasive species management; and riparian buffer restoration. This could be done as a single project or multiple projects.*

[l] *Depending on features incorporated, estimated capital costs range between $500 and $1,360 per linear foot.*

[m] *Potential improvements include retrofitting upstream channel to direct flow into two of the cells during lower flows, installing strategically placed cobble and bolder substrates within the culvert to provide channel roughness and resting areas for fish, and installation of grade control downstream of culvert to increase water depths inside culvert cells.*

[n] *Restoration could also include reforestation, rapid response invasive species removal, and forest stand improvements as indicated in Milwaukee County Park's ecological restoration and management plan for the Oak Creek Parkway. These are not included in the estimates of cost per linear foot.*

[o] *Restoration could include restoration of existing adjacent wetlands and lands considered to be potentially restorable wetlands by the WDNR; stabilizing eroding streambanks; reestablishing hydrologic connections between the stream channel and adjacent wetlands; installing natural channel design elements such as naturalized meanders, grade control, and/or constructed riffles; invasive species management; and forest stand improvement. This could be done as a single project or multiple projects. Depending on the restoration options selected, this project could incorporate projects LOC-26 and LOC-31.*

[p] *MMSD's involvement in projects to remove or modify large woody debris jams will be consistent with their Watercourse Flood Risk Reduction Policy that is focused on flood risk reduction from the regional flood (1-percent-annual-probability (100-year recurrence interval) flood). Specifically, MMSD will only remove debris if it is determined the debris will raise the water surface elevation during the regional flood to a level that either adds a structure to the regional floodplain or that increases the regional flood elevation by one tenth of a foot or more at a structure already within the regional floodplain.*

Table continued on next page.

Table 6.1 (Continued)

[q] Restoration could include two-stage channel design retrofit, bank regrading/shaping, and/or breaking or removal of spoil berms to provide hydrological connection to a floodplain terrace; improvement of instream habitat by installing natural channel design elements such as naturalized meanders, grade control, and/or constructed riffles; invasive species management and riparian buffer restoration. This project could be done as a single project or multiple projects. Depending on the restoration options selected, this project could incorporate project LOC-49 and address bank erosion addressed by projects LOC-32, LOC-35, LOC-36, LOC-39 through LOC-49, and LOC-51.

[r] Restoration could include two-stage channel design retrofit, bank regrading/shaping, and/or breaking or removal of spoil berms to provide hydrological connection to a floodplain terrace; improvement of instream habitat by installing natural channel design elements such as naturalized meanders, grade control, and/or constructed riffles; invasive species management and riparian buffer restoration. This project could be done as a single project or multiple projects. Depending on the restoration options selected, this project could incorporate projects MOC-03, MOC-05, MOC-06, MOC-08, and MOC-09.

[s] Restoration could include restoration of existing adjacent wetlands and those lands considered to be potentially restorable wetlands by WDNR; stabilization of eroding streambanks; reestablishing hydrological connections between stream channel and adjacent wetlands; instream habitat improvement by installing natural channel design features such as naturalized meanders, grade control, and/or constructed riffles; riparian buffer restoration including invasive species management, reforestation, grassland restoration, grassland management, and forest stand improvements. This project could be done as a single project or multiple projects. Depending on the restoration options selected, this project could incorporate projects MOC-12, MOC-23, and MOC-31 and bank erosion addressed by projects MOC-10, MOC-11, MOC-14 through MOC-16, MOC-18, MOC-22, MOC-24 through MOC-28, MOC-30, MOC-33, and MOC-34..

[t] Restoration could include two-stage channel design retrofit, bank regrading/shaping, and/or breaking or removal of spoil berms to provide hydrologic connection to a floodplain terrace; installation of natural channel design elements such as naturalized meanders, grade control, and/or constructed riffles; invasive species management; and riparian buffer restoration. This project could be done as a single project or multiple projects. Depending on the restoration options selected, this project could address bank erosion described in projects MOC-35, MOC-39, and MOC-40.

[u] Restoration could include restoring adjacent wetlands and lands considered to be potentially restorable wetlands by the WDNR; stabilizing eroding streambanks; reestablishing hydrologic connection between the stream channel and adjacent wetlands; improving stream habitat quality by installing natural channel design elements such as naturalized meanders, grade control, and/or constructed riffle habitats; invasive species management; and riparian buffer restoration to included Milwaukee County Parks' recommended grassland restoration of a currently-leased agricultural field in management Section 10 f the Oak Creek Parkway. Depending on the restoration options selected, this project could address bank erosion addressed by project MOC-44.

[v] Potential improvements could include retrofitting channel under the bridge to direct flow to a "low-flow channel" to promote sufficient water during low flow conditions while allowing overflow onto second "tier" when higher flows occur. The main "low-flow channel" should have widths similar to the channel upstream of the crossing.

[w] The survey should include channel invert elevations, detailed cross section surveys including sediment depths, detailed survey of all stream crossings including upstream and downstream structure elevations, and surveyed elevations of Milwaukee County-owned farmland that occupies a potential reconnection route to the historical channel location of Oak Creek.

[x] Further description of the proposed feasibility study is provided in the section "Recommended Actions to Maintain and Re-establish Natural Surface Water Hydrology" in this chapter.

[y] Project could be combined with repair of stormwater outfalls called for in projects UOC-20 and UOC-22.

[z] An alternative project for this location would be to install bioretention facilities at this site. See the section on stormwater management example projects in this chapter.

[aa] Restoration could include restoring adjacent wetlands and lands considered to by potentially restorable wetlands by WDNR; reestablishing hydrologic connections between the stream channel and adjacent wetlands; stabilizing eroding streambanks; improving stream habitat quality by installing natural channel design elements such as naturalized meanders, grade control, and/or constructed riffle habitats; invasive species management; and riparian buffer restoration. Depending on the restoration options selected, this project could address bank erosion described in projects UOC-35 and UOC-37 through UOC-39.

[bb] Drop structure was likely installed to control head-cutting of the channel bed. If the structure is removed, replacement grade control would be necessary. One option to consider is to stabilize the structure and utilize it as grade control in a regenerative stormwater conveyance design for this reach as recommended in project OCH-07.

[cc] The design should investigate the potential to incorporate the four existing concrete drop structures described in projects OCH-01, OCH-03, OCH-04, and OCH-08.

[dd] Capital costs estimated at $950 per linear foot. It should be noted that there was considerable variation in the costs per linear foot among the regenerative stormwater conveyance projects for which data were available and based upon whether the practice was installed in a ditch, gulley, or stream; the width and depth of channel created/restored, and specific details of construction. A higher estimate was used to account for the relatively wide channels in the Oak Creek watershed sites and the potential that such projects might require diverting the stream during construction.

[ee] Restoration could include restoring existing adjacent wetlands and those lands considered to be potentially restorable wetlands by the WDNR; stabilizing eroding streambanks; reestablishing hydrologic connections between the stream channel and adjacent wetlands; improving stream habitat quality by installing natural channel design features such as naturalized meanders, grade control, and/or constructed riffle habitats; invasive species management; and riparian buffer restoration. Depending on the restoration options selected, this project could address bank erosion described in projects LMF-01, LMF-02, LMF, 04, LMF-05, LMF-09, LMF-12, LMF-14, LMF-16 through LMF-18, LMF-20, LMF-21, LMF-24, LMF-26, and LMF-27.

[ff] Protection and management of this woodland is essential to the long-term ecological stability of the larger Cudahy Nature Preserve. This would also preserve an area considered to be vulnerable riparian buffer land.

[gg] Protection and management of this woodland/wetland complex is essential to the long-term ecological stability of the larger Cudahy Nature Preserve. This would also preserve and restore areas considered to be vulnerable riparian buffer land.

[hh] Canadian Pacific Railway owns the culvert; riparian areas are railway right-of-way; adjacent parcel is owned by Milwaukee County.

[ii] Commission staff observed significant deterioration of culvert structure including foundation cracks and crumbling. Water was observed actively flowing under the concrete box culvert structure, suggesting that the culvert's structural integrity may be compromised.

[jj] Potential actions to protect the culvert bedding and foundation include installing sheet piling, injecting grout, and installing tailwater energy dissipating armor. If the recommended inspection finds that the culvert is no longer serviceable, the structure should be replaced. Any new structure must account for current hydrology and stream morphology to prevent further channel head-cutting from undermining the stability of the new structure and/or continuing upstream—It must not simply replicate the existing structure. Replacement of the culvert with a new railroad crossing is estimated to cost about $519,000.

[kk] Acquisition would protect wildlife dispersal corridors, buffers adjacent to County Parks natural areas, wetlands that are hydrologically connected to parkland, and areas considered to be vulnerable riparian buffers. In addition, acquisition may assist in implementation of projects recommended for the area of the confluence of the North Branch of Oak Creek and the mainstem of Oak Creek.

[ll] Restoration could include two-stage channel design retrofit, bank grading/reshaping, and/or breaking or removal of spoil berms to provide hydrologic connection to a floodplain terrace; improving instream habitat by installing natural channel design elements such as naturalized meanders, grade control, and/or constructed riffle habitats; invasive species management; and riparian buffer restoration. Depending on the restoration options selected, this project could address bank erosion described in project LNB-24.

[mm] Restoration could include two-stage channel design retrofit, bank grading/reshaping, and/or breaking or removal of spoil berms to provide hydrologic connection to a floodplain terrace; improving instream habitat by installing natural channel design elements such as naturalized meanders, grade control, and/or constructed riffle habitats; invasive species management; and riparian buffer restoration. Depending on the restoration options selected, this project could address bank erosion addressed by projects LNB-31, LNB-32, LNB-34, and LNB-35.

[nn] The initial 75 feet upstream of the S. 6th Street crossing has a steep cascade with excessive amounts of rock creating a fish passage impediment. The entire reach is channelized with a dike on the west bank preventing a connection to a large floodplain wetland area. At a minimum, excessive rock should be removed to promote fish passage. A more extensive project would be to remove the dike on the west bank and restore a sinuous channel with a connection to adjacent wetlands.

[oo] Currently established riparian buffer through the park is about 25 feet on each side of the Creek and consists mostly of cattails. There is parkland available to establish larger buffers beyond the 75-foot minimum. A more extensive project could add sinuosity and vertical complexity to the channel.

[pp] Protection and management of this area is essential to the long-term ecological stability of Falk Park. This would also preserve area considered to be vulnerable riparian buffer.

[qq] Protection and management of this area is essential to the long-term ecological stability of Barloga Woods.

[rr] Protection and management of this area is essential to the long-term ecological stability of Falk Park. This would also preserve area considered to be vulnerable riparian buffer.

Source: 1000 Friends of Wisconsin; City of Cudahy; City of Oak Creek; City of Racine Public Health Department; City of South Milwaukee; Inter-Fluve, Inc.; Milwaukee County; Milwaukee County Department of Parks, Recreations and Culture; Milwaukee Metropolitan Sewerage District; Milwaukee Mitchell International Airport; Minnesota Department of Agriculture; Root-Pike WIN; Wisconsin Department of Natural Resources; Wisconsin Department of Transportation; and SEWRPC

- Estimates of capital and annual operation and maintenance (O&M) costs. These are given where they were available or where sufficient information about the project is available to develop an estimate. All costs are given in 2019 dollars.

- Potential sources of funding and technical assistance that could be sought in order to facilitate implementation of the recommended project. Potential funding sources are indicated by the identification numbers used in the inventory tables given in this chapter.

- An indication of the priority that should be given to each project for implementation.

An important early step in developing and implementing the projects recommended in Table 6.1 and similar projects, will be to evaluate them for concerns that could affect implementation. Examples of considerations related to projects that should be evaluated include:

- Screening the project area for potential archeological sites in or near the project site

- Evaluating projects involving construction or excavation for conflicts with existing utilities

- Evaluating access to the project site for workers and equipment

- Evaluating the potential impact of the project on adjacent landscapes, channel conditions, and/or landowners

- Determining the best time of year for implementing the project

- Evaluating opportunities to combine multiple recommended projects into a single effort

Conducting such evaluations could reveal potential cost savings and allow implementing organizations to reduce potential undesirable impacts of construction, installation, or other implementation efforts.

Example Stormwater Management Projects

As part of the development of specific projects, preliminary screening was conducted to identify potential opportunities for implementing several selected types of stormwater management practices. Sites were identified at which a variety of practices could potentially be installed. These practices include:

- Installing wet retention ponds.

- Daylighting storm sewers in which existing storm sewers are removed and replaced with vegetated drainage swales.

- Installing bioswales or bioretention basins in boulevard medians. In the first, grassed swales were installed in the medians. In the second, bioretention cells consisting of vegetated filters with engineered media and an underdrain were installed in the medians.

- Installing pervious pavement in parking lots, parking lanes of parkway roads, and residential alleys.

Preliminary designs for each type of practice were developed for a few selected locations in the watershed to demonstrate the feasibility of these practices. These designs represent examples of stormwater management projects that could also be implemented at other locations within the watershed. As part of the preliminary design process, planning-level estimates of costs and pollutant load reductions were developed for these projects. In some instances, multiple designs were done for the same example project type. It should be noted that implementing any of these projects would require detailed site design and optimization.

This example stormwater management project analysis provides several benefits. It demonstrates the feasibility of addressing issues related to stormwater in the Oak Creek watershed through the use of these practices. This analysis provides a screening of potential locations to consider for installing these practices. This screening analysis also provides information that may be useful for developing specific projects of these types in other locations throughout the watershed. This information includes estimates of the costs of installing and magnitudes of pollutant load reductions that might be achieved by implementing these practices. Since the evaluation of some practices include examination of different sizes and alternative design configurations, these estimates may provide insight into how costs and performance may vary for different designs.

While the discussion in the following subsections focuses on the water quality benefits of implementing these practices, it should be kept in mind that the practices evaluated may also provide water quantity benefits. Such benefits may include reductions of peak runoff volume and the 1-percent-annual-probability peak discharge. Reductions in peak runoff volume may also lead to improved quality of instream and riparian habitat.

Several of the example stormwater management projects discussed below are also included among the specific projects in Table 6.1. Several also serve as examples of types of projects recommended in later sections of this chapter related to water quality and water quantity.

<u>Identifying Potential Project Locations</u>

Potential locations for installing selected stormwater management practices are shown on Map 6.14. Locations where selected stormwater management practices could potentially be installed were identified using 2015 orthophotographs and 2010 topographic contours for Milwaukee County, subbasin maps from each municipality in the watershed, and available maps of storm sewer networks in each municipality. Opportunities for installing wet retention ponds were identified in existing residential subbasins that are not currently served by such ponds, where available open areas for installing a pond are present, and where stormwater currently drains directly into a nearby storm sewer system, drainage ditch, or waterbody. Opportunities for storm sewer daylighting projects were identified in locations where existing storm sewers lie under undeveloped land. Opportunities for installing bioswales or bioretention basins were identified for roadways that had medians. Opportunities for installing pervious pavement were identified in privately-owned parking lots covering at least one acre, parking lots of any size at churches and publicly owned facilities, parkway parking lanes, and residential alleys. It should be noted that detailed site investigations will be needed prior to development of stormwater management practices at any of these sites.

<u>Example Stormwater Management Project Design</u>

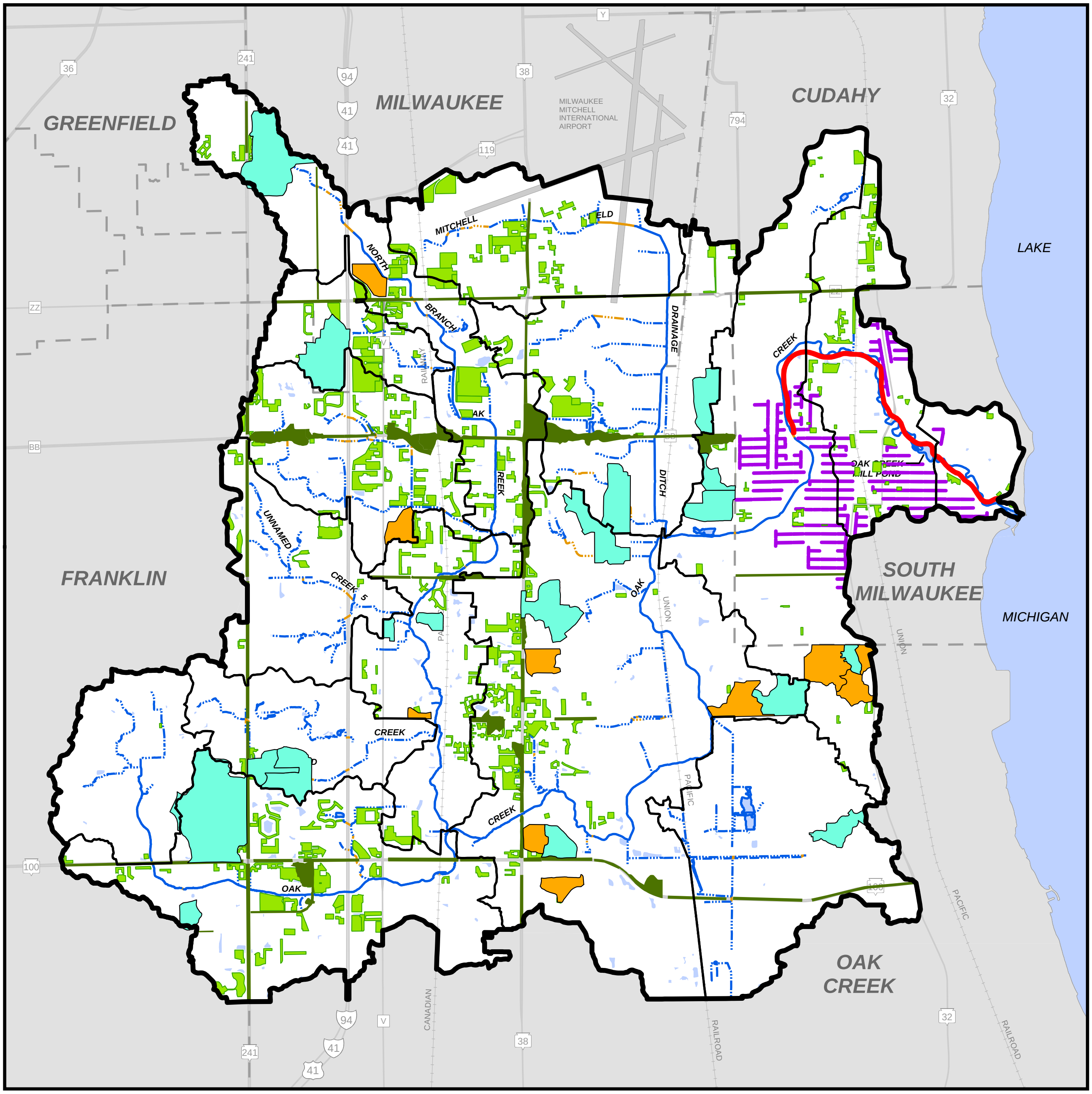
Planning level designs were developed for example projects of each type. Wet retention ponds were developed for three locations in the watershed. Storm sewer daylighting projects were designed for two locations. Bioswale projects were designed for two boulevard median locations. Bioretention projects were designed for the same two locations. Pervious pavement projects were designed for two park and ride parking lots adjacent to IH 94, an alleyway in the City of South Milwaukee, and the Oak Creek Parkway in the City of South Milwaukee. Designs for the examples of pervious pavement projects also examined alternative designs in which different amounts of existing pavement were replaced with pervious pavement for scenarios where the pavement was directly and indirectly connected to storm sewers. The locations of the example projects are shown on Map 6.15.

The development the example stormwater management projects included estimating average annual pollutant load reductions for TSS and total phosphorus that would result from project implementation. This was done using the Source Loading and Management Model for Windows (WinSLAMM). Land use and drainage area data from local community municipal separate storm sewer system (MS4) WinSLAMM model submissions were used to build the example project subbasin models where available. WinSLAMM is further described in the section on quantification of load reductions below.

Example stormwater management project pollutant load reductions for fecal coliform bacteria were estimated using the modeled average annual per acre nonpoint source load for the subwatershed in which the example project was located[7] and a median value for the reduction of fecal coliform bacteria for the

[7] *SEWRPC Technical Report No. 39,* Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds, *November 2007.*

Map 6.14
Preliminary Candidate Locations for Installation of Selected Stormwater Management Practices in the Oak Creek Watershed



ALLEYS IN WHICH TO INSTALL PERVIOUS PAVEMENT

AREAS TO BE SERVED BY BOULEVARD MEDIAN BIORETENTION OR BIOSWALE

OAK CREEK PARKWAY LOCATIONS IN WHICH TO INSTALL PERVIOUS PAVEMENT

PARKING LOTS IN WHICH TO INSTALL PERVIOUS PAVEMENT

SUBBASIN TO BE SERVED BY STORM SEWER DAYLIGHTING AND DRAINAGE SWALE

SUBBASIN TO BE SERVED BY WET RETENTION POND

OAK CREEK WATERSHED BOUNDARY

ASSESSMENT AREA BOUNDARIES

PERENNIAL STREAM

PERENNIAL STREAM (ENCLOSED)

INTERMITTENT STREAM

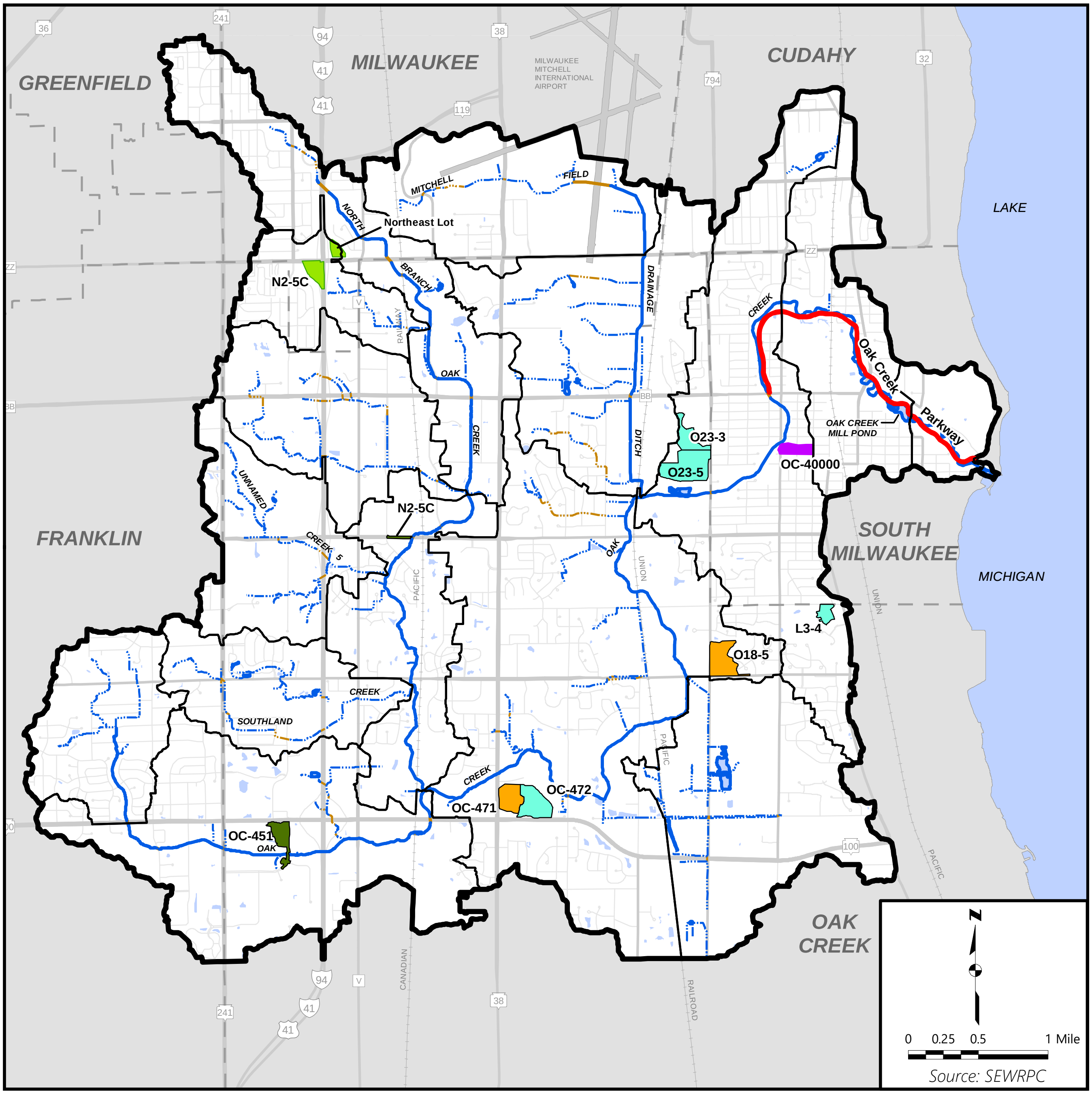
INTERMITTENT STREAM (ENCLOSED)

SURFACE WATER

0 0.25 0.5 1 Mile

Source: SEWRPC

Map 6.15
Locations of Stormwater Management Practice Example Projects Evaluated in the Oak Creek Watershed



ALLEY PERVIOUS PAVEMENT EXAMPLE PROJECTS

PARKWAY PERVIOUS PAVEMENT EXAMPLE PROJECTS

PARKING LOT PERVIOUS PAVEMENT EXAMPLE PROJECTS

BIORETENTION OR BIOSWALE EXAMPLE PROJECTS

STORM SEWER DAYLIGHTING AND DRAINAGE SWALE EXAMPLE PROJECTS

WET RETENTION POND EXAMPLE PROJECTS

OAK CREEK WATERSHED BOUNDARY

ASSESSMENT AREA BOUNDARIES

PERENNIAL STREAM

PERENNIAL STREAM (ENCLOSED)

INTERMITTENT STREAM

INTERMITTENT STREAM (ENCLOSED)

SURFACE WATER

stormwater management practice as provided in the International Stormwater BMP Database.[8] It should be noted that performance data were not available for all of the stormwater management practices for which example projects were designed.

Planning level construction cost estimates were developed for each example project. Data for developing these estimates came from several sources, including the 2009 RSMeans Construction cost data, and recent project costs from the Wisconsin and Minnesota Departments of Transportation, MMSD, and the Cities of Cudahy, Milwaukee, Oak Creek, and Wauwatosa. The cost estimates for each project include an additional 40 percent contingency for engineering and permitting costs. All cost estimates were adjusted to 2019 dollars using the Engineering News-Record Construction Cost Index, averaging values from Chicago and Minneapolis.

Wet Retention Pond Example Projects

Three examples of wet retention pond projects were designed for locations in the Oak Creek watershed. The ponds varied in size, with permanent pool areas ranging between 0.74 and 3.30 acres (see Table 6.2). The subbasins draining to these projects are shown on Map 6.15. These subbasins were selected to represent a range of contributing areas. Land use in project subbasin L3-4 consists predominantly of multifamily residential, while land use in subbasins OC-472, O23-3, and O23-5 consists predominantly of medium density single-family residential. Each of the selected subbasins have existing storm sewer networks that connect stormwater runoff directly to a nearby stream or drainage ditch. For each example project, the proposed wet retention pond was located near the outlet of the existing storm sewer system, just outside of the 1-percent-annual-probability floodplain (see Maps 6.16, 6.17, and 6.18).

Planning level costs and estimates of pollutant load reductions for the three examples of wet retention pond projects and the additional alternative are shown in Table 6.2. The proposed ponds serving subbasins L3-4, O23-3 and O23-5, and OC-471 were each estimated to reduce TSS loads by about 80 to 84 percent and total phosphorus loads by about 54 to 60 percent.

Water quantity benefits were also estimated for these wet retention pond projects. Based on the average for the example projects evaluated, wet retention ponds cost about $9,000 per cubic foot per second (cfs) reduction of runoff peak discharge or about $33,000 per acre of contributing drainage area to reduce current condition 1-percent-annual-probabilty peak discharge to 0.4 cfs per acre. The 0.4 cfs per acre discharge meets the City of Oak Creek's development and redevelopment stormwater requirements.

In addition to the retention pond projects discussed above, an alternative was evaluated in which runoff from subbasin OC-471 was routed to the pond proposed to serve subbasin OC-472. The size of the pond was not increased in this alternative because it was found that a larger pond was not feasible at the proposed project location. Load reductions for this alternative were estimated to be about 73 percent for TSS and 50 percent for total phosphorus. Preliminary analysis of this alternative suggested that the capacity of existing storm sewers might be inadequate to convey flows from large storm events to the pond, and that during such events runoff from this subbasin might flow over land or through ditches into the Creek. Resolving this would require further detailed study. For the purposes of this plan, it was decided to address runoff from this subbasin through implementation of a different practice. (see the section on storm sewer daylighting example projects below).

Storm Sewer Daylighting Example Projects

Two examples of storm sewer daylighting projects were designed for locations in the Oak Creek watershed. These projects involve excavating and removing a section of storm sewer and replacing it with a grassed drainage swale. The subbasins served by these projects are shown on Map 6.15. Land use in both subbasins consists predominantly of medium density residential development. The locations were selected to represent different-sized contributing areas and different drainage situations (see Table 6.3). A section of storm sewer in subbasin O18-5 runs parallel to E. Puetz Road and the public right-of-way could accommodate a grassed drainage swale (see Map 6.19). The situation in subbasin OC-471 is more complicated. The storm sewer network in this subbasin wraps around a subdivision and runs over 2,000 feet to the east to discharge to Oak Creek (see Map 6.20). Preliminary analysis indicated that this section of sewer was located too far

[8] *J. Clary, J. Jones, M. Leisenring, P. Hobson, and E. Strecker,* International Stormwater BMP Database: 2016 Summary Statistics, *Water Environment & Reuse Foundation, 2017.*

Table 6.2
Wet Retention Pond Example Projects Designed and Analyzed for the Oak Creek Watershed

Subbasin Served[a]	Pool Size (acres)	Area Treated (acres)	Average Annual Pollutant Load Reductions			Capital Costs (dollars)[d]	Annual Operations and Maintenance Cost (dollars)[d]
			Total Suspended Solids (pounds)[b]	Total Phosphorus (pounds)[b]	Fecal Coliform Bacteria (trillion cells)[c]		
L3-4	0.74	8.1	460	1.67	0.895	320,000	6,900
OC-472[c]	3.30	26.4	3,200	9.51	1.630	1,020,000	20,200
O23-2 & O23.5	2.70	57.3	5,038	14.96	6.323	1,190,000	27,100
OC-472 & OC-471[c]	3.30	45.7	11,000	30.90	2.822	1,020,000	20,200

[a] *See Maps 6.15 through 6.18.*

[b] *Pollutant load reductions were estimated using WinSLAMM.*

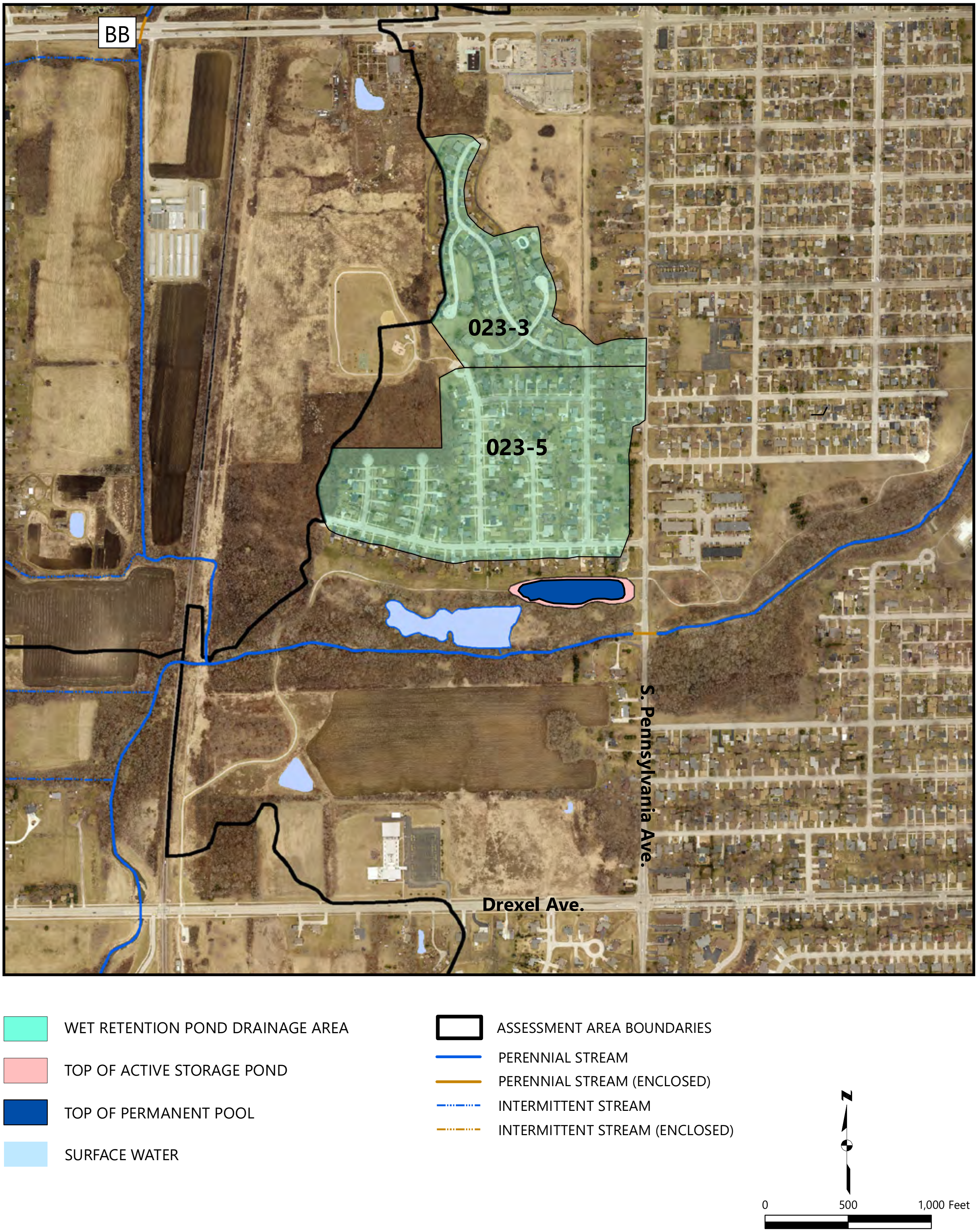
[c] *Pollutant load reductions were estimated using unit area loads from HSPF and median values of bioretention performance from the International Stormwater BMP Database.*

[d] *Costs given in 2019 dollars.*

[e] *OC-472 and OC-472 & OC-471 represent the same wet detention pond example project design serving different drainage areas.*

Source: SEWRPC

Map 6.16
Wet Retention Pond Example Project near E. Montana Avenue and S. Pennsylvania Avenue



Source: SEWRPC

Map 6.17
Wet Retention Pond Example Project North of E. Parkway Estates Drive

STORM SEWER DAYLIGHTING DRAINAGE AREA

WET RETENTION POND DRAINAGE AREA

TOP OF ACTIVE STORAGE POND

TOP OF PERMANENT POOL

SURFACE WATER

OAK CREEK WATERSHED BOUNDARY

ASSESSMENT AREA BOUNDARIES

PERENNIAL STREAM

PERENNIAL STREAM (ENCLOSED)

INTERMITTENT STREAM

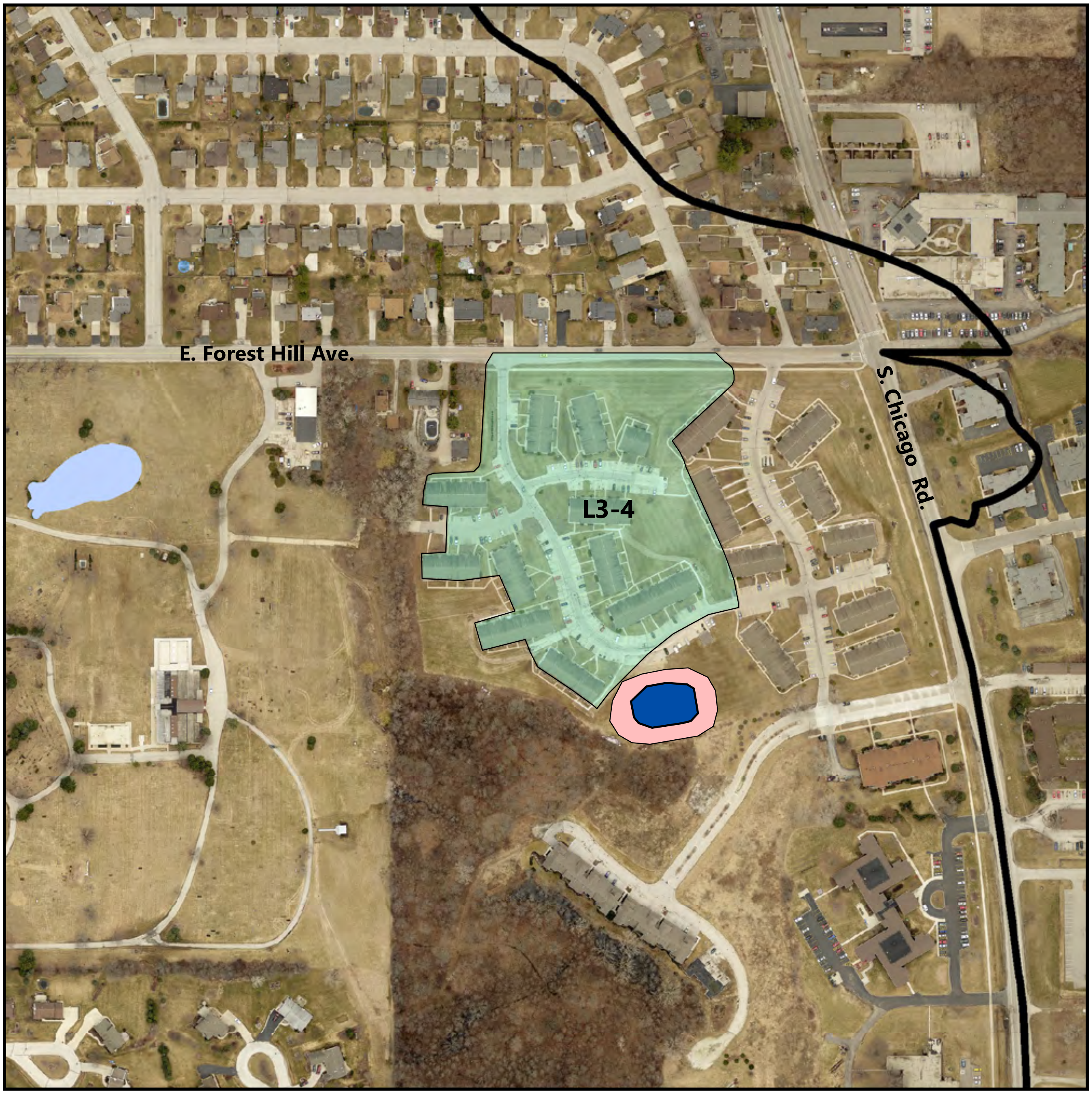
INTERMITTENT STREAM (ENCLOSED)

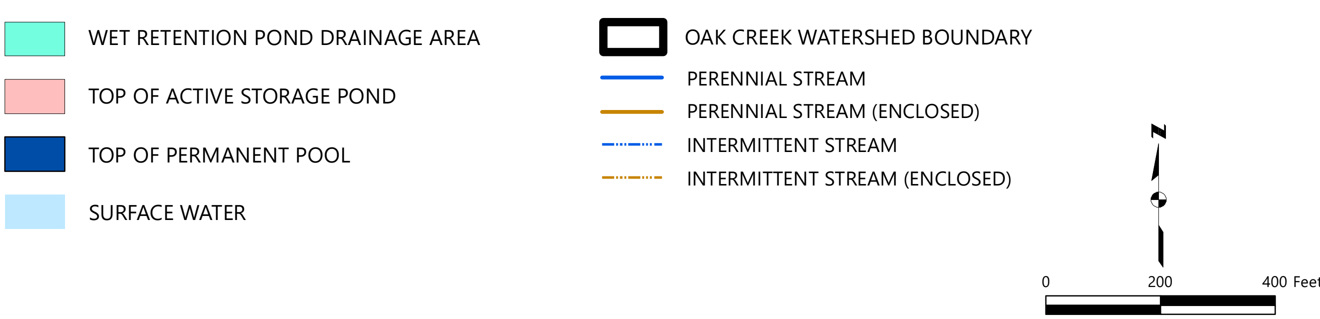
N

0 500 1,000 Feet

Source: SEWRPC

Map 6.18
Wet Retention Pond Example Project near E. Forest Hills Avenue and Newbury Drive





Source: SEWRPC

Table 6.3
Storm Sewer Daylighting Example Projects Designed and Analyzed for the Oak Creek Watershed

			Average Annual Pollutant Load Reductions				
Subbasin Served[a]	**Bioswale Length (acres)**	**Area Treated (acres)**	Total Suspended Solids (pounds)[b]	Total Phosphorus (pounds)[b]	Fecal Coliform Bacteria (trillion cells)[c]	**Capital Costs (dollars)[d]**	**Annual Operations and Maintenance Cost (dollars)[d]**
OC-471	500	19.2	811	2.78	0.206	260,000	8,000
O18-5	720	35.3	929	3.85	0.378	220,000	7,400

[a] *See Maps 6.15, 6.19, and 6.20.*

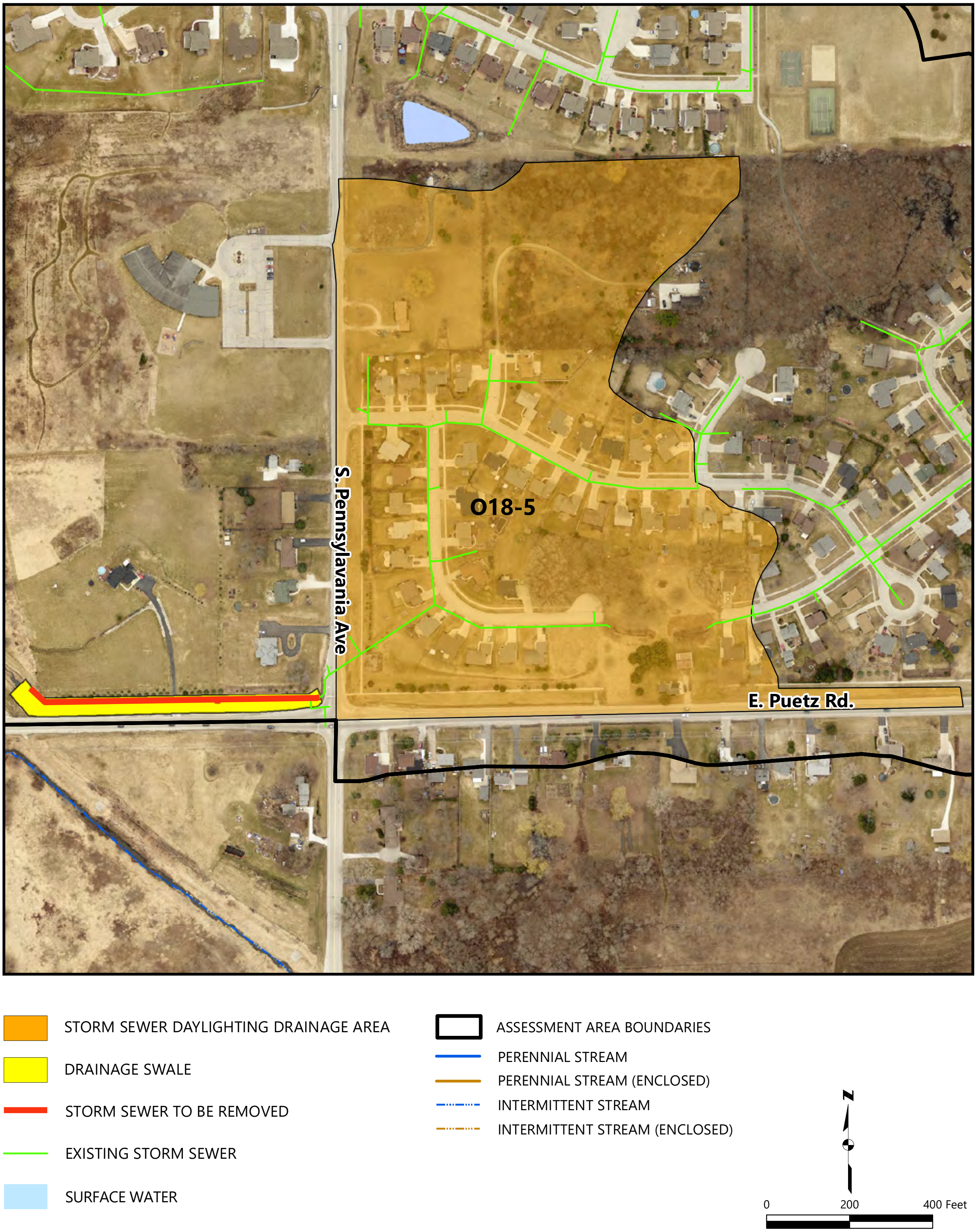
[b] *Pollutant load reductions were estimated using WinSLAMM.*

[c] *Pollutant load reductions were estimated using unit area loads from HSPF and median values of bioretention performance from the International Stormwater BMP Database.*

[d] *Costs given in 2019 dollars.*

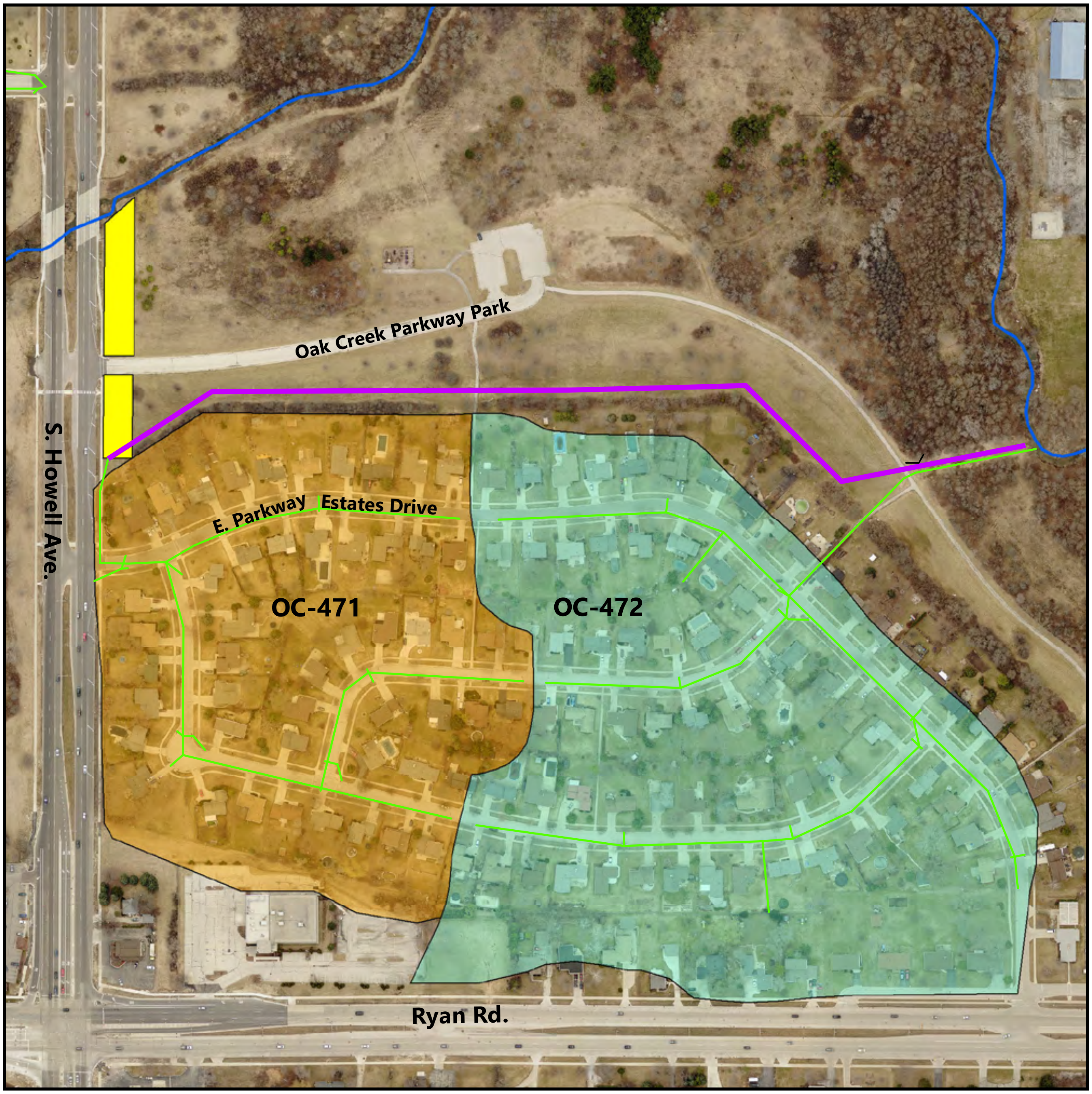
Source: SEWRPC

Map 6.19
Storm Sewer Daylighting Example Project near E. Puetz Road and S. Pennsylvania Avenue



Source: SEWRPC

Map 6.20
Storm Sewer Daylighting Example Project near E. Parkway Estates Drive and S. Howell Avenue



STORM SEWER DAYLIGHTING DRAINAGE AREA

WET RETENTION POND DRAINAGE AREA

DRAINAGE SWALE

STORM SEWER TO BE ABANDONED

EXISTING STORM SEWER

ASSESSMENT AREA BOUNDARIES

PERENNIAL STREAM

PERENNIAL STREAM (ENCLOSED)

INTERMITTENT STREAM

INTERMITTENT STREAM (ENCLOSED)

N

0 200 400 Feet

Source: SEWRPC

underground for daylighting to be feasible. Because of this, an alternative approach was designed in which the current storm sewer would be truncated at the location where it turns to run eastward. A grassed drainage swale running north to Oak Creek would be constructed at the truncated location.

Planning level costs and estimates of pollutant load reductions for the examples of storm sewer daylighting projects are shown in Table 6.3. The proposed projects were estimated to reduce TSS loads by about 24 to 28 percent and total phosphorus loads by about 18 to 22 percent, with the project serving subbasin OC-471 achieving higher reduction percentages for both pollutants.

Bioswale Example Projects

Two examples of bioswale projects were designed for locations in the Oak Creek watershed. These were both located in medians of boulevards. The bioswales differed in size, with the smaller one being sited along W. Drexel Avenue to serve subbasin NB-42B (see Map 6.21) and the larger being sited along S. 20th Street to serve subbasin OC-451 (see Map 6.22). These sites and subbasins were selected to represent different contributing areas (see Table 6.4). The subbasins served by these projects are shown on Map 6.15. Both bioswales were designed to allow runoff to flow along the grassed swales and discharge into existing storm sewers located under the median.

For each bioswale, two alternative scenarios were examined. In the first, it was assumed that the bioswale treated runoff from the entire subbasin in which it would be located. In the second, it was assumed that the bioswale treated half of the runoff solely from the boulevard and not from the remaining areas of the subbasin. The second assumption is more conservative and may give a better representation of the likely performance of a bioswale located in a boulevard median.

Planning level costs and estimates of pollutant load reductions for the two examples of bioswale projects under both scenarios are shown in Table 6.4. Under the assumption that they would treat runoff from the entire subbasin, the bioswales were estimated to reduce TSS loads by about 24 to 41 percent and total phosphorus loads by about 21 to 33 percent. Under the assumption that they would treat runoff from half of the boulevard, the bioswales were estimated to reduce TSS loads by about 15 to 16 percent and total phosphorus loads by about 12 to 13 percent.

Bioretention Basin Example Projects

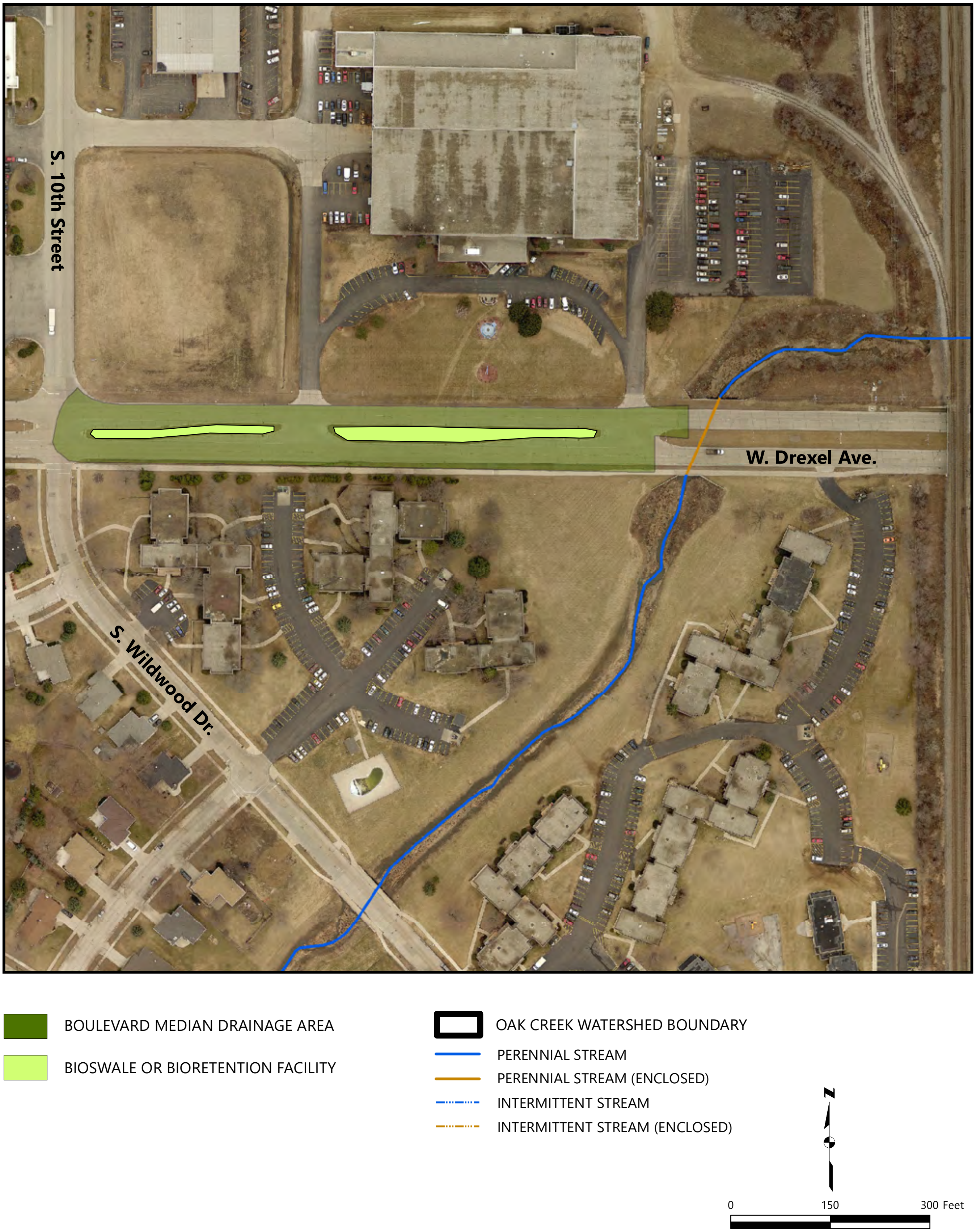
Two examples of bioretention projects were designed for locations in the Oak Creek watershed. These were both located in the same boulevard medians as the bioswale projects discussed in the previous section and serve the same subbasins (see Map 6.15).

The bioretention projects are designed to serve different sized subbasins, with subbasin NB-42B being substantially smaller than subbasin OC-451 (see Maps 6.21 and 6.22). These sites and subbasins were selected to represent different-sized contributing areas (see Table 6.5). Both bioswales were designed with engineered filter media and underdrains to drain excess water into the existing storm sewer system.

Like the bioswale projects, two alternative scenarios were examined for each bioretention project. In the first, it was assumed that the bioretention cell treated runoff from all of the subbasin in which it would be located. In the second scenario, it was assumed that the bioretention cell treated half of the runoff from the boulevard. The second assumption is more conservative and may give a better representation of the likely performance of bioretention located in a boulevard median.

Planning level costs and estimates of pollutant load reductions for the two examples of bioretention projects under both scenarios are shown in Table 6.5. Under the assumption that they would treat runoff from the entire subbasin, the bioretention cells were estimated to reduce TSS loads by about 50 to 86 percent and total phosphorus loads by about 44 to 77 percent. Under the assumption that they would treat runoff from half of the boulevard, the bioretention cells were estimated to reduce TSS loads by about 26 to 48 percent and total phosphorus loads by about 21 to 46 percent, with the project serving subbasin NB-42B achieving higher reduction percentages for both pollutants under both assumptions.

Map 6.21
Boulevard Median Bioswale or Bioretention Example Project Along W. Drexel Avenue near S. 10th Street



Source: SEWRPC

Map 6.22
Boulevard Median Bioswale or Bioretention Example Project Along S. 20th Street near W. Ryan Road

Source: SEWRPC

Table 6.4
Boulevard Bioswale Example Projects Designed and Analyzed for the Oak Creek Watershed

Subbasin Served[a]	Area Served	Bioswale Length (feet)	Area Treated (acres)	Average Annual Pollutant Load Reductions: Total Suspended Solids (pounds)[b]	Average Annual Pollutant Load Reductions: Total Phosphorus (pounds)[b]	Average Annual Pollutant Load Reductions: Fecal Coliform Bacteria (trillion cells)[c]	Capital Costs (dollars)[d]	Annual Operations and Maintenance Cost (dollars)[d]
NB-42B	100 percent of subbasin	630	2.0	1,076	2.18	0.031	38,000	2,200
NB-42B	50 percent of boulevard	630	1.0	432	0.84	0.015	38,000	2,200
OC-451	100 percent of subbasin	1,140	17.4	2,459	4.45	0.261	69,000	4,100
OC-451	50 percent of boulevard	1,140	1.6	1,523	2.46	0.024	69,000	4,100

[a] *See Maps 6.15, 6.21, and 6.22.*

[b] *Pollutant load reductions were estimated using WinSLAMM.*

[c] *Pollutant load reductions were estimated using unit area loads from HSPF and median values of bioswale performance from the International Stormwater BMP Database.*

[d] *Costs given in 2019 dollars.*

Source: SEWRPC

Table 6.5
Boulevard Bioretention Example Projects Designed and Analyzed for the Oak Creek Watershed

Subbasin Served[a]	Area Served	Bioretention cell area (square feet)	Area Treated (acres)	Average Annual Pollutant Load Reductions			Capital Costs (dollars)[d]	Annual Operations and Maintenance Cost (dollars)[d]
				Total Suspended Solids (pounds)[b]	Total Phosphorus (pounds)[b]	Fecal Coliform Bacteria (trillion cells)[c]		
NB-42B	100 percent of subbasin	10,500	2.0	2,280	50.6	--	240,000	2,600
NB-42B	50 percent of boulevard	10,500	1.0	1,271	3.01	--	240,000	2,600
OC-451	100 percent of subbasin	12,500	17.4	5,146	9.27	--	300,000	3,000
OC-451	50 percent of boulevard	12,500	1.6	2,711	4.43	--	300,000	3,000

[a] *See Map 6.15, 6.21, and 6.22.*

[b] *Pollutant load reductions were estimated using WinSLAMM.*

[c] *Pollutant load reductions were estimated using unit area loads from HSPF and median values of bioretention performance from the International Stormwater BMP Database.*

[d] *Costs given in 2019 dollars.*

Source: SEWRPC

Parking Lot Pervious Pavement Example Projects

Two examples of parking lot pervious pavement projects were designed for locations in the Oak Creek watershed. These were both located in park and ride lots adjacent to IH 94 and W. College Avenue. The parking lots differed in size, with the smaller (N2-5C) being sited southwest of the intersection and the larger (Northeast Parking) being sited northeast of the intersection (see Map 6.15). Each parking lot consists of an indirectly connected impervious area where stormwater drains to pervious areas before entering storm sewer networks. The designs for both parking lot treatments included underdrains. For the southwestern lot, the entire N2-5C subbasin was modeled. For the northeastern lot, only the parking lot was modeled.

For each parking lot pervious pavement project, several alternatives were examined (see Table 6.6). The amount of the parking lot converted to pervious pavement varied, with alternatives ranging between 0.1 and 2.0 acres. In addition, for each alternative a hypothetical situation was examined in which the parking lot was directly connected to the storm sewer network. In all scenarios examined, the pervious pavement treated only runoff generated from the parking lots.

Performance of pervious pavements in these parking lots was evaluated differently. For the parking lot in the N2-5C subbasin, the modeling examined the effects on the entire subbasin which includes the park and ride lot as well as portions of W. College Avenue, IH 94, and open land areas. The modeling for the Northeast Parking area included only the parking area (see Table 6.6).

Planning level costs and estimates of pollutant load reductions for the alternative parking lot pervious pavement projects for both the indirect connection and direct connection scenarios are shown in Table 6.6. These costs and load reductions assume that restorative cleaning such as sweeping or vacuum cleaning is done annually. Estimated reductions of TSS and total phosphorus loads were larger as the amount of pervious pavement increased. Estimated load reductions were much higher in both lots in the hypothetical situation in which the lots were directly connected to the storm sewer system. This indicates that the efficiency of pervious pavement in reducing pollutant loads from parking lots is much higher when those lots are directly connected to storm sewer systems or discharge directly into adjacent waterbodies. Thus, installation of pervious pavement should be considered for use as a stormwater best management practice (BMP) in those situations.

Alleyway Pervious Pavement Example Project

One example of an alleyway pervious pavement project was designed for the Oak Creek watershed. This proposed project is located in subbasin OC40000 in the City of South Milwaukee (see Map 6.15). The drainage area for this subbasin is about 9.9 acres. Land use in this subbasin consists of mixed use residential. The project consists of installing a strip of pervious pavement down the center of the only alley in the subbasin. The alley is about 13 feet wide total. This project is designed to treat runoff originating only in the alley.

Four alternative designs were examined. These designs differ in the width of the pervious pavement strip that would be installed, with widths varying between one foot and four feet (see Table 6.7).

Planning level costs and estimates of pollutant load reductions for the alternative alleyway pervious projects are shown in Table 6.7. These costs and load reductions assume that restorative cleaning is done annually. Depending upon the width of the pervious pavement strip, reductions of TSS represent about 5 to 7 percent of subbasin totals. Reductions of total phosphorus represent about 3 to 4 percent of subbasin totals. These reductions are relatively small because most of the subbasin was not treated by the pervious pavement.

Oak Creek Parkway Parking Lane Pervious Pavement Example Project

One example of a parkway parking lane pervious pavement project was designed for the Oak Creek watershed. This proposed project is located in the section of parkway road in the City of South Milwaukee (see Map 6.15). In the project, strips of pervious pavement would be installed along the parking lanes adjacent to the curbs. These strips would treat runoff originating on the parkway road only. The parkway road contributing area for the project is about nine acres total.

Four alternative designs were examined. These designs differ in the width of the pervious pavement strip that would be installed, and whether strips were installed on only one side or both sides of the parkway road (see Table 6.8).

Table 6.6
Parking Lot Example Projects Designed and Analyzed for the Oak Creek Watershed

Parking Lot Served[a]	Connection Scenario	Parking Lot Area (acres)	Total Drainage Area (acres)	Pervious Pavement Area (acres)	Average Annual Pollutant Load Reductions			Capital Costs (dollars)[b]	Annual Operations and Maintenance Cost (dollars)[c]
					Total Suspended Solids (pounds)[b]	Total Phosphorus (pounds)[b]	Fecal Coliform Bacteria (trillion cells)		
N2-5C	Indirectly Connected	3.5	12.3	0.10	92	0.14	--	67,000	500
N2-5C	Indirectly Connected	3.5	12.3	0.25	107	0.18	--	167,000	1,300
N2-5C	Indirectly Connected	3.5	12.3	0.50	116	0.20	--	334,000	2,500
N2-5C	Indirectly Connected	3.5	12.3	1.00	123	0.22	--	669,000	5,100
N2-5C	Indirectly Connected	3.5	12.3	2.00	127	0.23	--	1,340,000	10,100
N2-5C	Directly Connected	3.5	12.3	0.10	834	1.21	--	67,000	500
N2-5C	Directly Connected	3.5	12.3	0.25	1,095	1.62	--	167,000	1,300
N2-5C	Directly Connected	3.5	12.3	0.50	1,298	1.98	--	334,000	2,500
N2-5C	Directly Connected	3.5	12.3	1.00	1,512	2.42	--	669,000	5,100
N2-5C	Directly Connected	3.5	12.3	2.00	1,722	2.90	--	1,340,000	10,100
Northeast Parking	Indirectly Connected	6.0	6.0	0.10	160	0.24	--	67,000	500
Northeast Parking	Indirectly Connected	6.0	6.0	0.25	184	0.28	--	167,000	1,300
Northeast Parking	Indirectly Connected	6.0	6.0	0.50	199	0.31	--	334,000	2,500
Northeast Parking	Indirectly Connected	6.0	6.0	1.00	211	0.33	--	669,000	5,100
Northeast Parking	Indirectly Connected	6.0	6.0	2.00	218	0.35	--	1,340,000	10,100
Northeast Parking	Directly Connected	6.0	6.0	0.10	1,447	2.08	--	67,000	500
Northeast Parking	Directly Connected	6.0	6.0	0.25	1,902	2.76	--	167,000	1,300
Northeast Parking	Directly Connected	6.0	6.0	0.50	2,253	3.30	--	334,000	2,500
Northeast Parking	Directly Connected	6.0	6.0	1.00	2,585	3.86	--	669,000	5,100
Northeast Parking	Directly Connected	6.0	6.0	2.00	2,896	4.43	--	1,340,000	10,100

[a] *See Map 6.15.*

[b] *Pollutant load reductions were estimated using WinSLAMM.*

[c] *Costs given in 2019 dollars.*

Source: SEWRPC

Table 6.7
Alleyway Pervious Pavement Example Projects Designed and Analyzed for the Oak Creek Watershed

			Average Annual Pollutant Load Reductions				
Subbasin Served[a]	**Width of Pervious Pavement Strip (feet)**	**Area Treated (acres)**	Total Suspended Solids (pounds)[b]	Total Phosphorus (pounds)[b]	Fecal Coliform Bacteria (trillion cells)	**Capital Costs (dollars)[b]**	**Annual Operations and Maintenance Cost (dollars)[c]**
OC-40000	1	0.33	160	0.41	--	17,000	100
OC-40000	2	0.33	186	0.49	--	34,000	200
OC-40000	3	0.33	200	0.54	--	51,000	400
OC-40000	4	0.33	210	0.57	--	67,000	500

[a] *See Map 6.15.*

[b] *Pollutant load reductions were estimated using WinSLAMM.*

[c] *Costs given in 2019 dollars.*

Source: SEWRPC

Table 6.8
Parkway Pervious Pavement Example Projects Designed and Analyzed for the Oak Creek Watershed

			Average Annual Pollutant Load Reductions				
Area Treated (acres)[a]	**Width of Pervious Pavement Strip (feet)**	**Sides of Parkway Treated**	Total Suspended Solids (pounds)[b]	Total Phosphorus (pounds)[b]	Fecal Coliform Bacteria (trillion cells)	**Capital Costs (dollars)[c]**	**Annual Operations and Maintenance Cost (dollars)[c]**
9	1	1	3,151	9.14	--	210,000	1,600
9	2	1	4,056	11.99	--	430,000	3,200
9	1	2	6,404	18.28	--	430,000	3,200
9	2	2	8,113	23.99	--	860,000	6,500

[a] *See Map 6.15.*

[b] *Pollutant load reductions were estimated using WinSLAMM.*

[c] *Costs given in 2019 dollars.*

Source :SEWRPC

Planning level costs and estimates of pollutant load reductions for the alternative parking lane pervious projects are shown in Table 6.8. These costs and load reductions assume that restorative cleaning is done annually. Depending upon the number of pervious pavement strips installed and their widths, the strips were estimated to reduce TSS loads by about 34 to 89 percent and total phosphorus loads by about 33 to 86 percent. It should be noted that installing one-foot wide strips on both sides of the road resulted in greater pollutant load reductions than installing a two-foot wide strip on one side of the road.

Quantification of Load Reductions Under the Recommended Watershed Restoration Plan

This watershed restoration plan has multiple objectives that are reflected in the four focus areas related to water quality, habitat, recreation, and flooding. Thus, consistent with the Federal Clean Water Act (CWA), the plan is designed to address the physical, chemical, and biological health of the watershed and its water resources. The plan is intended to provide a guide to improving water quality in the watershed over a ten-year period; however, because of 1) the long time scales needed for reductions in pollutant loads to be measurable in a complex natural system, and 2) limitations on the financial resources available for plan implementation, the plan will realistically be implemented over a time period longer than ten years. The plan recommendations include 1) specifically identified measures to advance the achievement of overall plan objectives in the near term and 2) somewhat more broadly targeted measures that would be implemented as opportunities arise over a longer time frame. For these reasons, the effects of various plan recommendations on reducing pollutant loads to the waterbodies in the watershed are addressed in several ways:

- For specific priority water quality improvement projects, the total phosphorus, total suspended solids, fecal coliform bacteria, and total nitrogen load reductions are estimated where feasible, enabling those reductions to be compared to the RWQMPU/watershed restoration plan target reductions set forth in Tables 5.2, 5.4, 5.6, and 5.9 in Chapter 5 of this report.

- Certain plan recommendations to improve water quality may be applicable to targeted stream reaches or areas of the watershed but are not specific enough for their load reduction potential to be practically quantified individually. However, those recommendations represent refinements of the recommendations from the RWQMPU, and their effects on reducing pollutant loads and instream concentrations are specifically represented within the USEPA HSPF water quality model developed under the RWQMPU. Thus, the potential water quality improvement effects of implementing those actions have been quantified at a more-detailed level than by simply estimating load reductions. This is because the loads have been combined with streamflows and routed through the watershed stream network, producing pollutant concentrations at multiple locations, which can readily be compared with regulatory water quality criteria.

- Other plan recommendations, particularly some of those targeted to habitat improvement, may be primarily directed to improving physical and biological conditions in the watershed consistent with the CWA. While in many cases these recommendations may produce ancillary water quality benefits, such benefits may not be directly quantifiable in terms of a pollutant load reduction.

To better refine estimates of pollutant load reductions for the Oak Creek watershed, the USEPA Spreadsheet Tool for Estimating Pollutant Load (STEPL) model was applied to some specific project recommendations under this study.[9] STEPL employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various BMPs. STEPL provides a user-friendly Visual Basic interface to create a customized spreadsheet-based model in Microsoft Excel. It computes watershed surface runoff; nutrient loads, including total nitrogen, phosphorus, and 5-day biochemical oxygen demand (BOD_5); and sediment delivery based on various land uses and management practices. For each of the areas examined in the watershed using STEPL, the annual nutrient loading was calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The annual sediment load (sheet and rill erosion only) is calculated based on the Universal Soil Loss Equation and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using generalized BMP efficiencies. STEPL model results for pollutant loading and load reductions are shown in Table 6.1.

[9] *Tetra Tech, Inc.,* User's Guide: Spreadsheet Tool for the Estimation of Pollutant Load, Version 4.4, *March 2018; more information on the STEPL model can be found at it.tetratech-ffx.com/steplweb/models$docs.htm.*

WinSLAMM was applied to other specific project recommendations to estimate pollutant load reductions in areas served by MS4s.[10] WinSLAMM is a proprietary model that evaluates nonpoint source pollutant loadings in urban areas using small storm hydrology. It determines the annual runoff from a series of normal rainfall events and calculates the pollutant loading created by these events. The model is also able to evaluate the effects of stormwater BMPs such as infiltration, biofiltration, street sweeping, wet retention ponds, grass swales, porous pavement, or catch basins to estimate how effectively these devices remove pollutants. It can compute surface runoff volume; and concentrations and loads of solids; nutrients such as total phosphorus, nitrate, and total Kjeldahl nitrogen; some metals such as cadmium, copper, lead, and zinc; and the polycyclic aromatic hydrocarbon (PAH) pyrene based on various land uses and management practices. The U.S. Geological Survey (USGS) has developed stormwater flow and pollutant concentration data for calibrating WinSLAMM for use in Wisconsin.[11] Nationally, WinSLAMM has been used for TMDL development, urban stormwater BMP and MS4 system design, and evaluating MS4 compliance with permit conditions. It is accepted for use by the WDNR for showing permit compliance from individual MS4s.

Load reductions for fecal coliform bacteria were estimated using the modeled average annual per acre nonpoint source load for the subwatershed in which the project was located[12] and a median value for the reduction of fecal coliform bacteria for the stormwater management practice from the International Stormwater BMP Database.[13] It should be noted that performance data were not available for all stormwater management practices.

6.2 RECOMMENDED ACTIONS TO IMPROVE WATER QUALITY

Development of Recommendations to Improve Water Quality

As noted previously in this report, the Oak Creek watershed restoration plan was developed in the context of and refines and details the recommendations of the RWQMPU.[14] Chapter 2 of this watershed restoration plan summarizes 1) the recommendations of the RWQMPU as they relate to the Oak Creek watershed and 2) the implementation status of those recommendations within the watershed. The water quality recommendations of the RWQMPU were developed and evaluated using a comprehensive, watershed-based calibrated and validated continuous water quality simulation model. This model work is described in Appendix M. The results of this model can be applied to estimate water quality improvements that would be expected from implementation of the recommended watershed restoration plan set forth in this chapter.

Recommended Actions to Reduce Stormwater Runoff Pollution

Recommended Urban Runoff Pollution Control Measures

The recommendations of the SEWRPC RWQMPU as they relate to urban runoff pollution in the Oak Creek watershed were reviewed (see Chapter 2 of this report) and reevaluated under this watershed restoration planning effort. Based on that review and reevaluation, which included consideration of the additional water quality monitoring data collected since the RWQMPU was issued and recommendations that have already been implemented, the current applicability of the recommendations of the RWQMPU was confirmed. Thus, the following RWQMPU recommendations are reiterated with some refinements under this plan:

1. **It is recommended that urban runoff controls be implemented that are consistent with, or more rigorous than the standards set forth in NR 151.** It should be noted that all the municipalities in the watershed are required to meet the NR 151 standards to the maximum extent practicable under the conditions of their Wisconsin Pollutant Discharge Elimination System (WPDES) municipal stormwater discharge permits issued pursuant to Chapter NR 216 of the *Wisconsin Administrative Code*. By implementing controls to meet the standards of NR 151, municipalities will address construction site erosion; stormwater pollution from areas of existing and planned urban development, redevelopment,

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10 *PV & Associates,* WinSLAMM v. 10.2 User's Guide, *2014*.

11 *U.S. Geological Survey,* WinSLAMM (Source Loading and Management Model: Parameter and Standard Land-Use Files for Wisconsin), *April 6, 2016, www.usgs.gov/software/winslamm*.

12 *SEWRPC Technical Report No. 39,* op. cit.

13 *J. Clary, J. Jones, M. Leisenring, P. Hobson, and E. Strecker, 2017,* op. cit.

14 *SEWRPC Planning Report No. 50,* op. cit.

and infill; and infiltration of stormwater runoff from areas of new development. Urban best management practices to be installed under this recommendation could include 1) runoff infiltration/evapotranspiration and/or pollutant filtration devices such as grassed swales, infiltration basins, bioretention facilities, rain gardens, green roofs, and porous pavement; 2) stormwater treatment facilities, such as wet retention basins, constructed wetlands, and sedimentation/flotation devices; and 3) maintenance practices such as vacuum sweeping of roads and parking lots. The benefits of full implementation of the urban performance standards set forth in NR 151 in the reduction of fecal coliform bacteria, total suspended solids, total phosphorus, and total nitrogen loads delivered to the streams of the watershed were explicitly represented in the water quality modeling analyses conducted for the RWQMPU. These results and the impact of the recent changes in the enforcement of the urban performance standards in NR 151 are reflected in the pollutant loadings and water quality results presented in Chapter 5 of this report.

2. The RWQMPU recommended the implementation of coordinated programs to detect and eliminate illicit discharges to storm sewer systems and to control urban-sourced pathogens that are harmful to human health. As a refinement of this recommendation, **it is recommended that those municipalities in the watershed with municipal separate storm sewer systems (MS4s) regulated under the WPDES program modify their illicit discharge detection and elimination (IDDE) programs. Under this modification, some of the effort currently expended to monitor major outfalls that show no evidence of illicit discharges would be transferred to monitoring outfalls of any size that are considered likely to be conveying water contaminated with sanitary wastewater.** Because this recommendation targets the control of waterborne pathogens and the fecal indicator bacteria used to test for their likely presence, this recommendation is discussed later in this chapter in the subsection on "Coordinated Programs to Detect and Eliminate Illicit Discharges to Storm Sewer Systems." It should be noted that while this recommendation primarily targets pathogens and fecal indicator bacteria, implementation of it would also reduce inputs of nutrients to surface waters through MS4s.

3. **It is recommended that Milwaukee County and the municipalities in the watershed continue to evaluate their practices regarding the application of chlorides for ice and snow control and strive to obtain optimal application rates to ensure public safety without applying more chlorides than necessary for that purpose. It is also recommended that the County and municipalities consider alternatives to current ice and snow control programs. It is further recommended that educational programs be implemented to provide information about 1) alternative ice and snow control measures on public and private properties and 2) optimal application rates in such areas. Educational programs should target both County and municipal staff, private applicators, and the general public.**

4. **It is recommended that information and education programs required under municipal WPDES stormwater discharge permits promote voluntary practices that optimize urban fertilizer application consistent with the requirements of WDNR Technical Standard No 1100, "Interim Turf Nutrient Management."** As a refinement of this recommendation from the RWQMPU, **it is recommended that these programs also promote voluntary compliance with the existing restrictions under Wisconsin Law on the sale, use, and display of fertilizers containing phosphorus.**[15]

5. **It is recommended that all municipalities in the watershed have pet litter control ordinance requirements and that those requirements be enforced. Further measures to address pet litter should be considered on a site-specific basis in response to identified water quality problems resulting from pets.**

6. **It is recommended that existing litter and debris control programs along the urban streams of the watershed be continued and that opportunities to expand such efforts be explored.**

7. **It is recommended that installed stormwater BMPs be inspected at least annually to ensure that they are functioning as designed or are not deteriorating.**

[15] *These restrictions are set forth in Section 94.643 of the* Wisconsin Statutes.

Local units of government with MS4 permits are required to maintain maps of their MS4 system. These maps are required to identify several components of the MS4 system including but not limited to, all known MS4 outfalls, the stormwater drainage basin boundaries for each outfall, the stormwater conveyance system, municipally owned or operated structural stormwater controls, and privately-owned structural stormwater controls for which the permittee is taking credit for pollutant removal. These maps should indicate those areas within the local unit of government's jurisdiction that are served by the MS4 and those that are not. **It is recommended that Milwaukee County, MMIA and the municipalities within the watershed continue to update and refine their MS4 systems maps.** Updated maps should be submitted to the WDNR as part of their applications to renew their MS4 discharge permits every five years. Such updating will help these permittees better understand and improve the operation of their MS4 systems.[16]

Additional explanation regarding some of the approaches laid out in these recommendations is given in the subsections below. Specific projects recommended to address urban runoff pollution are included in Table 6.1. The stormwater management example projects previously discussed in the section on specific projects also illustrate some of the approaches that can be taken to address urban runoff pollution.

<u>Urban Leaf Management Programs</u>

Organic detritus is a major source of nutrients such as phosphorus to urban stormwater. This is especially the case in areas with high overhead tree canopy.[17] Studies have shown positive correlations between tree canopy and phosphorus loads on streets that vary seasonally, with highest loads occurring during the fall when trees shed their leaves.[18] While urban trees can provide multiple benefits to a community, leaf litter accumulating in roads and on other impervious surfaces can be a major source of organic detritus and thus a substantial source of phosphorus pollution to urban stormwater and urban stormwater management systems. It may be difficult to treat this nutrient pollution once it enters the storm sewer system, since during leaf senescence in the fall, most of the phosphorus contributed to urban runoff is in the form of dissolved phosphorus.[19]

Effectively managing leaves on residential streets during the fall can significantly reduce phosphorus loading from urban areas. **It is recommended that all municipalities in the watershed implement or continue to implement leaf management programs during the fall and look for improvements or optimization of these programs.** Such programs could incorporate several approaches. For example, public educations programs could emphasize mulching during lawn mowing, proper composting of leaves onsite, or mulching leaves into lawns.

A second approach would be for municipalities to conduct or continue to conduct leaf collection programs in residential areas coupled with enhanced street cleaning during the fall. To provide higher reductions of nutrient loadings, such collection programs should incorporate several elements. Leaves awaiting collection should be stored on the grassed terraces adjacent to streets or municipally owned rights-of-way between streets and sidewalks rather than in streets or gutters. This will reduce fragmentation of the leaves by traffic, which can promote leaching of phosphorus. In addition, water percolating through leaf piles on the terrace will infiltrate into terrace soils, limiting the amount of runoff that reaches streets. Removal of these leaves from terraces is still desirable because at some point during precipitation, these piles will

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[16] *As part of the instream survey of physical conditions that was conducted in 2016 and 2017, Commission staff identified and mapped outfalls that discharge into the mainstem of Oak Creek, the North Branch of Oak Creek, and the Mitchell Field Drainage Ditch. Staff noted many outfalls whose ownership they were unable to ascertain. These outfalls are listed in Appendix E of this report. Review of this appendix could serve as a first step for updating MS4 system maps.*

[17] *R.J. Waschbusch, W.R. Selbig, and R.T Bannerman,* Sources of Phosphorus in Stormwater and Street-Dirt from Two Urban Residential Basins in Madison Wisconsin, 1994-95, *U.S. Geological Survey Water-Resources Investigations Report 99-4021, 1999.*

[18] *B.D. Janke, J.C. Finlay, and S.E. Hobbie, "Trees and Streets as Drives of Urban Stormwater Nutrient Pollution,"* Environmental Science & Technology, *volume 51, pages 9,569-9,579. 2017; P. Kalinosky, L.A. Baker, S. Hobbie, R. Bintner, and C. Buyarski,* User Support Manual: Estimating Nutrient Removal by Enhance Street Sweeping, *Report to the Minnesota Pollution Control Agency, 2014.*

[19] *W.R. Selbig, N.H. Buer, R.T. Bannerman, and P. Gaebler,* Reducing Leaf Litter Contributions of Phosphorus and Nitrogen to Urban Stormwater through Municipal Leaf Collection and Street Cleaning Practices, *U.S. Geological Survey Scientific Investigations Report No 2020-5109, 2020.*

begin to contribute to runoff. To promote keeping leaves out of streets and gutters, **it is recommended that those municipalities implementing leaf collection programs enact and enforce ordinances prohibiting placement of leaves in streets and policies allowing residents to place leaves on terraces for collection.**[20] Leaf collection should be coupled with enhanced street cleaning. Recent research has found that the method and frequency of street cleaning has a greater influence on phosphorus load reductions than the method of leaf collection.[21] Greater load reductions were associated with more frequent street cleaning and regenerative-air cleaning than with less frequent and mechanical cleaning.

A third approach would involve changes in urban forestry practices. In some instances, it may be desirable to reduce leaf litter contributed to streets through strategic placement of trees away from roadways and other impervious surfaces contributing to the storm sewer system. As the phosphorus content of leaves varies among species of trees,[22] phosphorus loads could potentially be reduced by replacing trees from species with leaves containing high concentrations of phosphorus with trees from species containing lower concentrations during urban forestry tree removal and replanting activities.

Post-Construction Monitoring and Maintenance of Stormwater Best Management Practices

Over this plan's implementation schedule, it will be important to monitor the functionality of stormwater BMPs implemented in the watershed periodically after their installation. Over time, BMPs can become less efficient at achieving designed pollutant reductions due to several factors. According to the USEPA, natural variability, lack of proper maintenance and unforeseen consequences are primary causes of BMP depreciation.[23] Considering how erratic and unpredictable weather patterns are increasingly becoming, checking BMPs in the watershed will be critical for assessing their performance. BMP performance data will be used to evaluate plan implementation, modeled load reduction estimates, and to help determine if substantial progress is or is not being made toward attaining water quality standards.

To ensure that stormwater BMPs continue to function as anticipated **it is recommended that Milwaukee County and the municipalities in the Oak Creek watershed develop systems for tracking and completing long-term maintenance of post-construction BMPs**. Such systems should include:

- An inventory of all municipally owned or operated BMPs. This inventory should include:
  - Each BMP's name, location, type, and year of construction
  - A record drawing of each BMP
  - An operation and maintenance plan for each BMP which includes procedures and a schedule for inspection
- Written documentation of the municipality's ability to use privately-owned BMPs to meet the water quality requirements of their MS4 permit. Such documentation should include how the municipality is ensuring that these BMPs are being inspected and maintained.
- Municipalities requiring the submission of as-built drawings for all stormwater management BMPs installed as a part of development or redevelopment.

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[20] *For MS4 communities to claim credit toward TMDL pollutant load reductions for leaf collection programs in medium density residential areas, they are required to have such an ordinance and policy. See Wisconsin Department of Natural Resources,* Interim Municipal Phosphorus Reduction Credit for Leaf Management Programs, *EGAD No. 3800-2018-01, March 8, 2018.*

[21] Ibid.

[22] *J.R. Dorney, "Leachable and Total Phosphorus in Urban Street Tree Leaves,"* Water, Air, and Soil Pollution, *volume 28, pages 439-443, 1986.*

[23] *D.W. Meals and S.A. Dressing,* Technical Memorandum No. 1: Adjusting for Depreciation of Land Treatment When Planning Watershed Projects, *Developed for the U.S. Environmental Protection Agency by Tetra Tech, Inc., October 2015, Available at www.epa.gov/sites/production/files/2015-10/documents/tech_memo_1_oct15.pdf.*

- Written procedures used to track and enforce maintenance of stormwater management facilities that have been implemented to meet post-construction performance standards.
- Performance of long-term maintenance inspections at least once during each permit term.
- Documentation of inspections.
- A description of inspection and enforcement response procedures for addressing compliance issues with post-construction stormwater management performance standards.

Green Infrastructure

The Oak Creek watershed restoration plan encourages the use of green infrastructure to help manage stormwater. The USEPA defines green infrastructure as "an approach to wet weather management that is cost-effective, sustainable, and environmentally friendly. Green infrastructure management approaches and technologies capture, infiltrate, evapotranspire, and reuse stormwater to maintain or restore natural hydrologies."[24] This is an approach that helps store, convey, and use rainwater in more natural ways. Green infrastructure complements the gray infrastructure, such as sewer pipes, storage tunnels, and water reclamation facilities that have been, and will continue to be, the backbone for meeting water quality goals. While green infrastructure cannot entirely replace the capacity of gray infrastructure in urban areas, it can add supplemental capacity and pollutant removal.

A variety of green infrastructure practices have been developed over time. Descriptions, illustrations, and technical information regarding these practices are available in a number of recent references.[25] It should be noted that there is considerable diversity in the literature regarding the terminology used to refer to specific green infrastructure practices. For the purpose of this report, it is important to distinguish between several practices that are often referred to interchangeably. For this plan, the terms bioswale and bioretention cell refer to different practices. The former refers to a vegetated swale that water flows through, while the later refers to a vegetated cell with engineered media and an underdrain that water can filter through. Similarly, pervious pavement consists of concrete, asphalt, or pavers through which water can infiltrate, while permeable pavement consists of concrete or brick pavers separated by open joints through which water is able to infiltrate.

Municipal codes and ordinances have a broad impact on the use of green infrastructure. Depending on the code and ordinance specifics, they can provide incentives for, or present barriers to, implementing green infrastructure by the private and public sectors. Modifications to local codes, ordinances, and review processes can encourage municipalities, builders, and developers as well as property owners to implement green infrastructure practices. It would be beneficial for the municipalities in the Oak Creek watershed to review their codes to identify barriers to implementing green infrastructure practices within their jurisdictions. The results of such an audit could be used by municipalities when considering revisions to their codes and ordinances that would remove barriers to implemening green infrastructure strategies.

New MS4 permits being issued by the WDNR include conditions requiring permitted communities to remove barriers to implementation of green infrastructure. **It is recommended that municipal and County staff review their permit requirements and that the MS4s act to remove such barriers.** As an example, the City of Milwaukee updated its codes and ordinances, first in the early 2000s and again during 2016-2018. The City also updated its landscaping standards to include green infrastructure and remove barriers to installing green infrastructure. The City's actions could serve as a model for other municipalities in the watershed.

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[24] *U.S. Environmental Protection Agency,* Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices, *EPA 841-F-07-006, December 2007.*

[25] *See, for example, Milwaukee Metropolitan Sewerage District,* Fresh Coast Green Solutions: Weaving Milwaukee's Green & Grey Infrastructure into a Sustainable Future, *no date; Milwaukee Metropolitan Sewerage District,* Regional Green Infrastructure Plan, *June 2013; Milwaukee Metropolitan Sewerage District,* Green Infrastructure Standard Specifications and Plan Template Report, *October 2016; and Stormwater Solutions Engineering, LLC,* Green Infrastructure Operations & Maintenance Standards Guide, *Report to the Milwaukee Metropolitan Sewerage District, February 2020.*

A systematic review and audit of municipal codes and ordinances for barriers to green infrastructure implementation has recently been conducted for the Menomonee River watershed by MMSD, the Milwaukee County Environmental Services Division, the Southeastern Wisconsin Watersheds Trust (Sweet Water), 1,000 Friends of Wisconsin, Birchline Planning, and eight municipalities in the watershed. The Cities of Greenfield and Milwaukee, which are partially located in the Oak Creek watershed, are among the municipalities included in this review and audit of municipal codes. Similar reviews and audits were subsequently conducted for the Cities of Cudahy, Franklin, and Oak Creek with the involvement of MMSD, Birchline Planning, and Clean Wisconsin. **It is recommended that such an audit of municipal codes and ordinances for barriers to green infrastructure implementation be conducted for the City of South Milwaukee.** This audit should include examination of zoning ordinances on the minimum number of parking spaces required. Based on the costs of the audits completed for the communities in the Menomonee River watershed, the total estimated cost of this audit is $10,500.

A consideration in implementing green infrastructure in urban areas is the presence of brownfields. Brownfields are abandoned, idle, or underused commercial or industrial properties. In some instances, the redevelopment and reuse of these properties is hindered by the presence of contamination related to previous activities. The presence of contaminated soils or other contamination on these sites can limit the use of some green infrastructure strategies. Specifically, the use of strategies that rely on infiltration of stormwater is generally not appropriate on brownfield sites, as they may facilitate the transportation of contaminants into groundwater. Green roofs, cisterns, and rain barrels would be the most appropriate strategies to use on these sites, although in some cases limited infiltration may be accomplished if uncontaminated fill is placed on a site, or runoff is directed to areas of uncontaminated soil. Because of their use in phytoremediation of metals and organic compounds, stormwater trees may also be appropriate for installation in or near brownfields in some instances.[26] Remediation of a brownfield site may allow for the use of a wider array of green infrastructure strategies that rely on infiltration and should be pursued where possible. Information on brownfield areas in the watershed can be obtained from the WDNR.[27] A guidance document is available from the USEPA to assist communities, developers, and other stakeholders in determining the appropriateness of implementing stormwater management practices that promote infiltration at vacant parcels and brownfield sites.[28]

The stormwater management example projects previously discussed in the section on specific projects also provide additional information on some green infrastructure approaches that can be implemented in the Oak Creek watershed.

Green Infrastructure in the MMSD Planning Area

The MMSD has developed a green infrastructure plan for its planning area.[29] As shown on Map 6.23, this planning area includes all of the Oak Creek watershed except for the portions located in the City of South Milwaukee. In developing this GI plan, MMSD undertook a detailed data analysis of the opportunities and constraints for implementing green infrastructure strategies. Extensive data collection and mapping were conducted as part of this planning effort. These analyses include quantification of the numbers of roads, buildings, and parking lots in the planning area that can be treated with green infrastructure.

The objectives of the MMSD green infrastructure plan include:

- Capturing the first 0.5 inch of rainfall from impervious surfaces through green infrastructure

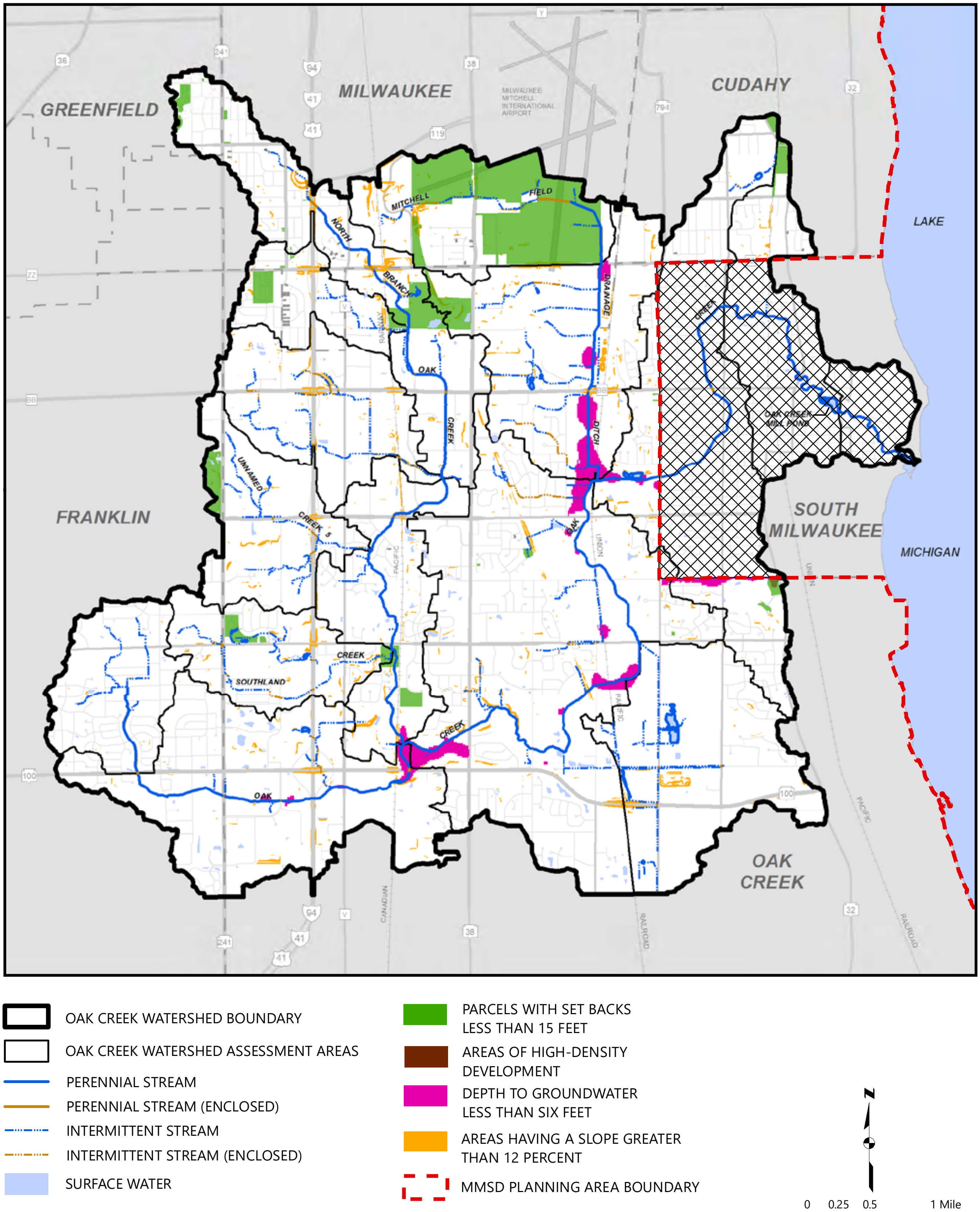
[26] *For example see: E.W. Aitchison, S.L. Kelley, P.J.J. Alvarez, and J.L. Schnoor, "Phytoremediation of 1,4-Dioxane by Hybrid Poplar Trees,"* Water Environment Research, *volume 73, pages 313-321, 2000; S.L. Doty, J.L. Freeman, C.M. Cohu, J.G. Burken, A. Firrincieli, A. Simon, Z. Kahn, J.G. Isebrands, J. Lukas, and M.J. Blaylock, "Enhanced Degradation of TCE on a Superfund Site Using Endophyte-Assisted Poplar Tree Phytoremediation,"* Environmental Science & Technology, *volume 51, pages 10,050-10,058, 2017.*

[27] *Available on the WNDR website at: dnr.wi.gov/topic/Brownfields/WRRD.html.*

[28] *U.S. Environmental Protection Agency,* Implementing Stormwater Infiltration Practices at Vacant Parcels and Brownfield Sites, *EPA 905-F-13-001, July 2013.*

[29] *Milwaukee Metropolitan Sewerage District, 2013* op. cit.

Map 6.23
Potential Constraints to the Use of Green Infrastructure Strategies Within the Portion of the Oak Creek Watershed Located in the Milwaukee Metropolitan Sewerage District Planning Area



Source: SEWRPC

- Striving toward a rainwater harvest goal of capturing the first 0.25 gallon of rainwater per square foot of impervious area for reuse

- Complementing MMSD's Private Property Infiltration and Inflow Program and Integrated Regional Stormwater Management Program

- Helping municipalities and other entities prioritize green infrastructure actions

- Helping to meet receiving water quality standards by acknowledging watershed restoration plan recommendations

- Meeting MMSD's WPDES discharge permit requirements for green infrastructure volume capture

As part of its approach to meeting these objectives, the plan developed watershed-specific recommendations for installing green infrastructure over the plan implementation period of 2014 through 2035. These recommendations were based on individual characteristics of each watershed. Specific recommendations for the Oak Creek watershed are shown in Table 6.9.

When fully implemented, recommended green infrastructure strategies would result in average annual loading reductions of about 854,100 pounds TSS and 2,970 pounds total phosphorus.[30] The capital costs of full implementation in the Oak Creek watershed are estimated as being $170 million.[31] The stormwater capture volumes, stormwater storage, and costs associated with full implementation of the recommendations for the watershed are broken down by green infrastructure strategy in Table 6.9.

The MMSD green infrastructure plan envisions that implementing its recommendations will begin slowly with higher levels of implementation occurring later in its implementation period. The MMSD plan's timeline for achieving an equivalent 0.5-inch rainwater volume capture indicates that the plan envisions that about 12 percent of the green infrastructure strategies it recommends will be installed by the end of 2020 and about 77 percent of the green infrastructure strategies it recommends will be installed by the end of 2031. Table 6.10 shows the implementation benchmarks for the MMSD green infrastructure plan. Based on available information, green infrastructure practices to capture about 5.3 percent of the recommended capture volume were installed as of the end of 2018.[32]

It should be noted that MMSD does not expect to implement the recommended levels of green infrastructure on its own. It is expected that implementation will occur through collaboration with municipalities and private property owners.

As part of the Oak Creek watershed restoration plan, it is recommended that green infrastructure strategies be implemented within the portions of the Oak Creek watershed that are located within the MMSD planning area in accordance with and on the schedule given in the MMSD green infrastructure plan. This would require implementing about 72 percent of the green infrastructure strategies recommended in the MMSD green infrastructure plan by the end of 2031 to achieve the level of implementation envisioned in that plan. The capital costs associated with this recommendation through 2031 are estimated to be about $131 million. Implementation of green infrastructure through 2031 would result in the average annual capture of about 8.1 billion gallons of stormwater and average annual loading reductions of about 616,000 pounds TSS and 2,140 pounds total phosphorus. Full implementation of the MMSD green infrastructure plan in the Oak Creek watershed would result in average annual capture of

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[30] *It is estimated that full implementation of the MMSD green infrastructure plan would result in average annual TSS load reductions of 15,109,000 pounds and average total phosphorus load reduction of 54,450 pounds in the entire MMSD planning area. To estimate the portion of these reductions that would occur in the Oak Creek watershed, the load reductions attributable to reduced combined sewer overflow volumes that would result from implementation of green infrastructure strategies was subtracted from the total load. The resulting amount was multiplied by the percentage of the impervious area in the MMSD planning area that is represented by impervious areas in the portion of the Oak Creek watershed in the MMSD planning area.*

[31] *All costs given in this section have been adjusted to 2019 dollars.*

[32] *Milwaukee Metropolitan Sewerage District,* 2050 Facilities Plan, Appendix 5D*, March 2021.*

Table 6.9
Green Infrastructure Strategies Recommended for Implementation by 2035 in the Portion of the Oak Creek Watershed Located in the MMSD Planning Area

Green Infrastructure Strategy	Units	Number of Units	Cost (dollars)[b]
Porous Pavement	Average city blocks[c]	730	131,612,000
Bioretention/Rain Gardens	150-square foot rain gardens	12,000	5,473,000
Stormwater trees	Trees[d]	27,820	1,956,000
Green Roofs	Buildings with 5,000-square-foot green roofs	100	27,147,000
Cisterns	Large buildings with 1,000-gallon cisterns[e]	150	282,000
Native Landscaping	Average city blocks[c]	100	2,096,000
Rain Barrels	House with rain barrel	7,100	282,000
Soil Amendments	Average city blocks[c]	100	1,393,000
		Total	170,241,000

[a] *The MMSD planning area encompasses all of the Oak Creek watershed except for the City of South Milwaukee.*

[b] *Costs were adjusted from 2013 dollars to 2019 dollars using the Engineering Record Construction Cost Index (CCI), CCI_{2013} = 12,217.705, CCI_{2019} =14,743.85 (multiplier of 1.206).*

[c] *The area of an average city block is estimated as being five acres.*

[d] *The MMSD Green Infrastructure Plan recommends the planting of nine new trees per average city block. The area of the portion of the Oak Creek watershed that is located in the MMSD planning area is about 3,090 average city blocks.*

[e] *The plan defines large buildings as those with roof areas greater than 6,500 square feet.*

Source: Milwaukee Metropolitan Sewerage District and SEWRPC

about 11.3 billion gallons of stormwater and average annual loading reductions of about 856,000 pounds of TSS and about 2,970 pounds of total phosphorus.

The MMSD green infrastructure plan notes that some areas within the Oak Creek watershed have characteristics that may limit the use of some green infrastructure strategies. These characteristics include areas having land slopes greater than 12 percent, areas where the depth to bedrock is less than six feet, areas where the depth to groundwater is less than six feet, small parcels in areas of high-density urban development, and areas where parcels have setbacks from the street right-of-way of less than 15 feet. The areas in the Oak Creek watershed that have these limitations are shown on Map 6.23. The plan specifically notes the presence of high groundwater at scattered locations adjacent to the mainstem of Oak Creek and the Mitchell Field Drainage Ditch within the City of Oak Creek. The MMSD plan indicates that the design of green infrastructure projects in these areas should include measures to protect groundwater quality. The plan also notes the presence of areas containing parcels with setbacks of less than 15 feet, mostly in the northern portion of the watershed in the Cities of Milwaukee and Oak Creek. It recommends the use of green infrastructure strategies that do not rely solely, or at all, on infiltration, such as green roofs, rain barrels, and cisterns, within these areas.[33]

The MMSD green infrastructure plan includes a prioritization of areas within the Oak Creek watershed for installation of green infrastructure. This prioritization identified subbasins of the surface water drainage system that presented the greatest opportunities for installation of green infrastructure and the greatest potential benefits from installing green infrastructure. This prioritization was conducted for the entire MMSD service area and was based on 11 factors, six of which were related to opportunities for installation of green infrastructure and five of which were related to potential benefits from installing green infrastructure. The factors used for prioritization in the Oak Creek watershed include:

- Opportunities for green infrastructure implementation:
  - The presence and amount of vacant land in the subbasin

[33] *While rainwater collected in rain barrels and cisterns would ultimately be used to water vegetation, it is likely that much of the water applied would be transpired by plants.*

- The presence and amount of potential redevelopment areas in the subbasin
- The presence and amount of existing areas of green infrastructure in the subbasin
- The presence and amount of parks in the subbasin
- The presence and number of potential stream corridor restoration locations in the watershed

- Areas with multiple potential benefits from green infrastructure implementation:
  - Subbasins containing areas of basement backups
  - Subbasins containing areas with potential drainage problems
  - Subbasins containing areas with potentially high inflow and infiltration into sanitary sewers
  - Subbasins located within high pollutant loading areas[34]

Table 6.10
Timeline for Achieving an Equivalent 0.5-Inch Rainwater Capture Volume Envisioned in the MMSD Green Infrastructure Plan

Year	Level of Implementation (percent)
2013	0.0
2014	0.2
2015	0.4
2016	0.7
2017	0.9
2018	1.1
2019	7.0
2020	12.0
2021	18.6
2022	25.7
2023	30.7
2024	35.7
2025	41.4
2026	47.8
2027	53.6
2028	59.3
2029	65.0
2030	70.7
2031	77.1
2032	82.9
2033	87.9
2034	95.0
2035	100.0

Source: Milwaukee Metropolitan Sewerage District and SEWRPC

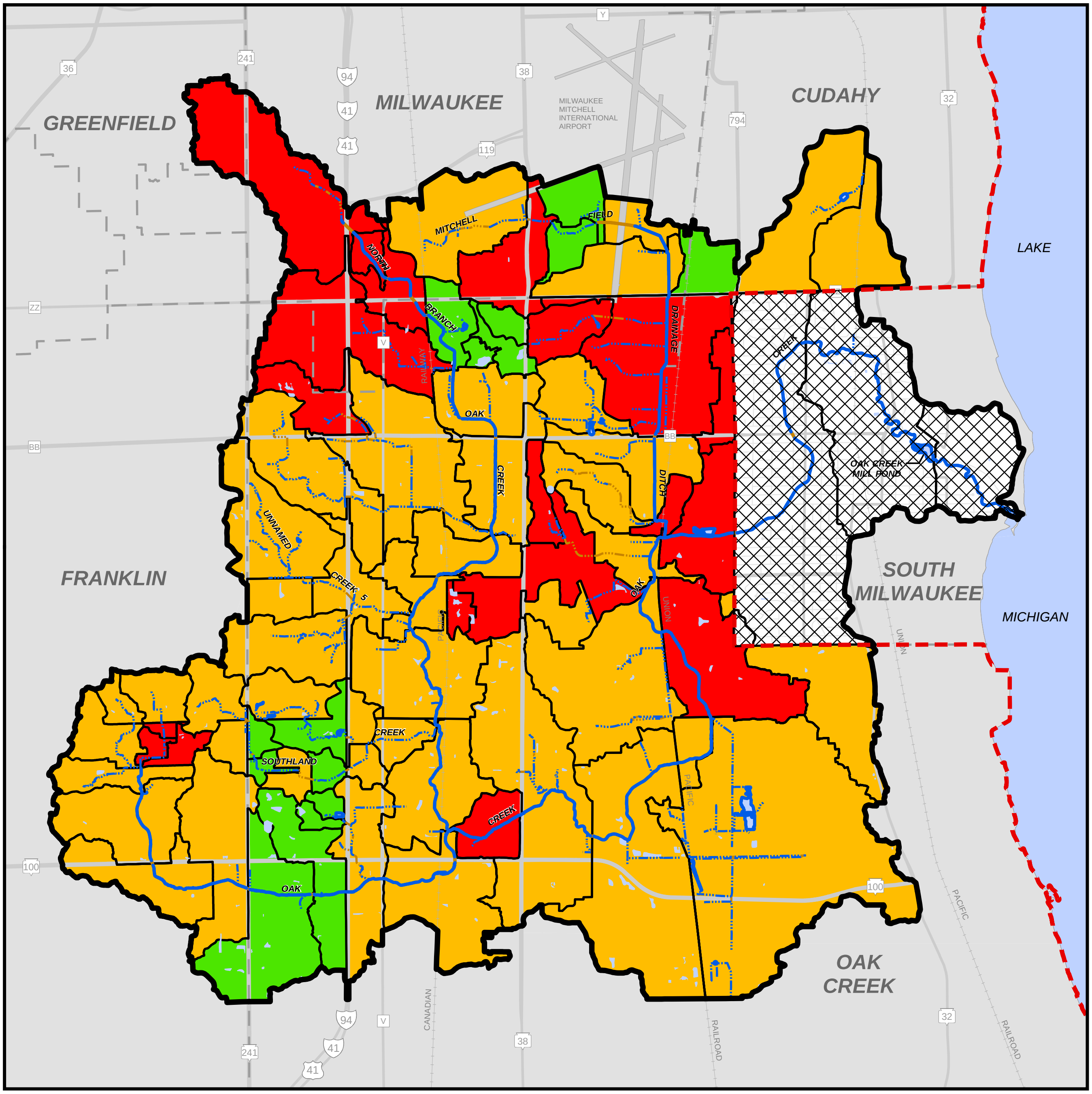
The analysis classified subbasins as having high, medium, or low priority for implementing green infrastructure strategies. This classification is shown on Map 6.24 for the Oak Creek watershed. It identifies 22 subbasins as being high-priority areas, 36 subbasins as being medium-priority areas, and 15 subbasins as being low-priority areas for implementing green infrastructure strategies. The MMSD green infrastructure plan also uses these results to identify the 10 subbasins in the watershed with the highest priority for installation of green infrastructure strategies. These subbasins are shown on Map 6.25. **For the 2022-2031 implementation period of the Oak Creek watershed plan, it is recommended that efforts to implement green infrastructure in the portions of the Oak Creek watershed located in the MMSD planning area give highest priority to installing green infrastructure projects in the 10 subbasins identified as high priority on Map 6.25.**

Green infrastructure is a relatively new technology. As communities, developers, and landowners continue to install and operate green infrastructure practices, the understanding of their performance, costs, construction and maintenance requirements, and life span is rapidly improving. Because of this improving knowledge base, it may be that some of the assumptions used to develop the MMSD green infrastructure plan should be revised. **It is recommended that MMSD update and revise its green infrastructure plan.** In light of improving knowledge, it is likely that updating the GI plan may change the recommended amounts and mixtures of green infrastructure practices recommended for the Oak Creek watershed, the schedule for implementation, the prioritization of subbasins for implementation, and the associated estimates of costs. Because of this, **it is also recommended that the recommendations of any updated MMSD green infrastructure plan pertaining to the Oak Creek watershed be incorporated into updates of the Oak Creek watershed restoration plan as a revision to the green infrastructure element.**

[34] *High pollutant loading areas were identified from the results of the calibrated water quality model that are presented in SEWPRC Planning Report No. 50,* op. cit.

Map 6.24

Combined Benefit and Opportunity Ranks for the Use of Green Infrastructure Strategies Within the Portion of the Oak Creek Watershed Located in the Milwaukee Metropolitan Sewerage District Planning Area



OAK CREEK WATERSHED BOUNDARY

MMSD SUBBASIN BOUNDARIES

PERENNIAL STREAM

PERENNIAL STREAM (ENCLOSED)

INTERMITTENT STREAM

INTERMITTENT STREAM (ENCLOSED)

SURFACE WATER

HIGH-PRIORITY SUBBASINS

MEDIUM-PRIORITY SUBBASINS

LOW-PRIORITY SUBBASINS

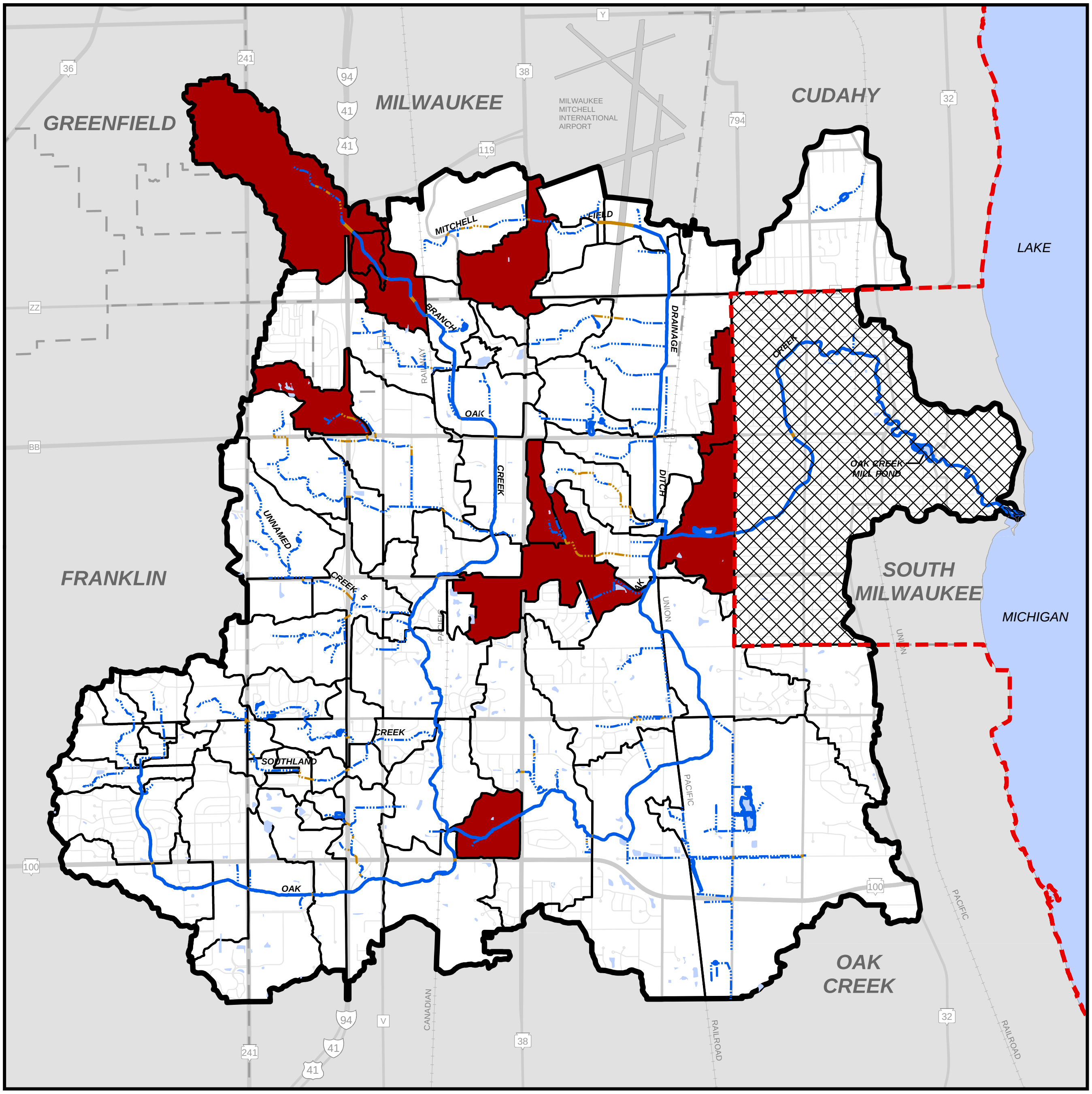
MMSD PLANNING AREA BOUNDARY

OUTSIDE MMSD PLANNING AREA

0 0.25 0.5 1 Mile

Source: SEWRPC

Map 6.25
High Priority Subbasins for the Implementation of Green Infrastructure Stategies Within the Portion of the Oak Creek Watershed Located in the Milwaukee Metropolitan Sewerage District Planning Area



OAK CREEK WATERSHED BOUNDARY
MMSD SUBBASIN BOUNDARIES
PERENNIAL STREAM
PERENNIAL STREAM (ENCLOSED)
INTERMITTENT STREAM
INTERMITTENT STREAM (ENCLOSED)
SURFACE WATER
HIGH-PRIORITY SUBBASINS FOR GREEN INFRASTRUCTURE STRATEGIES
MMSD PLANNING AREA BOUNDARY
OUTSIDE MMSD PLANNING AREA

NOTE: Some high-priority areas identified on Map 6.24 were not characterized as high priority for implementation.

0 0.25 0.5 1 Mile

Source: SEWRPC

Green Infrastructure in the City of South Milwaukee

While the City of South Milwaukee has not developed a green infrastructure plan, it has been conducting some green infrastructure installation activities. In 2013, the City developed an urban forestry plan that addresses the management of trees in street rights-of-way, city parks, and on other municipal properties.[35] This plan included an inventory of trees, tree stumps, and vacant planting sites. This inventory found 4,491 trees, 97 tree stumps, and 1,473 vacant planting sites in the areas examined.[36] The inventory also found that 745 of the trees counted were from species that are susceptible to emerald ash borer. It noted that this could increase the number of vacant planting sites to 2,218 if these trees are not chemically treated to prevent ash bore infestation. The plan recommended the City conduct some initial removals of ash and other trees in 2014 and 2015. It recommended that the City conduct routine removals of 40 trees per year and plant 125 trees per year in subsequent years. The estimated cost of this would be $91,700 per year, or $917,000 over the ten-year implementation period of this watershed restoration plan.

The presence of trees in urban areas can decrease the amount of stormwater runoff and pollutants that reach surface waters.[37] The roots and leaf litter from trees create soil conditions that promote the infiltration of rainwater into soil. Through their roots, trees take up water and nutrients reducing runoff. **It is recommended that the City of South Milwaukee continue to routinely remove and replace damaged trees and plant additional trees in accordance with the schedule recommended in the City's urban forestry plan.**

Full implementation of this recommendation over this watershed restoration plan's ten-year implementation period would reduce the number of vacant planting sites in the City to 623, not counting any sites vacated due to removal of ash trees. It should be noted that this total accounts for replacing of trees removed through routine removal.

The inventory conducted as part of the South Milwaukee urban forestry plan also found that over 48 percent and 16 percent of the trees counted were members of the maple and ash species, respectively. In order to make the forest less susceptible to insect pests and plant diseases, the urban forestry plan recommended that no more than 10 percent of the forest should consist of members of any single genus and no more than five percent should consist of members of any single species. Because of this, **it is recommended that no ash trees be planted. In addition, it is recommended that no more maple trees be planted until these goals are met.** It should be noted that continuing to implement an urban tree-planting program would provide several benefits to the City. In addition to increasing infiltration and evapotranspiration of stormwater, additional trees would help to increase shade, lessen the impacts of urban heat island effects, provide habitat for many species of animals, filter fine particulates and other pollutants from air, mitigate climate change by sequestering carbon, and reduce the impact of climate change by providing shade and evaporative cooling.

Additional opportunities for implementing green infrastructure practices in the City of South Milwaukee were identified in the section above on stormwater management example projects. That section identified parking lots, alleyways, and sections of the Oak Creek parkway located in the City in which pervious pavement could potentially be installed. Some of the example projects analyzed in that section are included in the specific projects recommended in Table 6.1.

Maintenance of Green Infrastructure Practices

All stormwater management systems require maintenance. Proper operation and maintenance activities are essential to ensure that green infrastructure will continue to function properly; yield expected volume reduction, water quality, and environmental benefits; protect public safety; meet legal standards; and protect a community's financial investment.

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[35] *Bluestem Forestry Consulting, Inc.,* City of South Milwaukee Urban Forestry Plan and Tree Inventory, *December 11, 2013.*

[36] *It should be noted that the trees in wooded areas owned by Milwaukee County were not included in the inventory.*

[37] *Center for Watershed Protection,* Making Urban Trees Count: A Project to Demonstrate the Role of Urban Trees in Achieving Regulatory Compliance for Clean Water, *December 2017.*

A recent assessment of green infrastructure maintenance in MMSD's service area documented a need for additional training and reference material on maintenance of green infrastructure practices.[38] In a survey conducted as part of this study, 14 out of the 20 respondents from local municipal staffs indicated that they would be interested in both a green infrastructure maintenance training workshop or course, and a training manual. The results of interviews conducted following the surveys suggested that the responses may have underestimated the need for training. Respondents indicated a desire for numerous resources, including technical specifications, performance standards, levels of service, and assistance with or guidance for contract documents, bidding, and inspection. The study concluded that the populations that would benefit from training opportunities and reference material extend beyond municipal staff and include property owners, landscape maintenance contractors and staff, consultants, and homeowner associations.

Some reference material has recently been completed that will assist in addressing these training needs. MMSD recently issued a report providing guidance on operations and maintenance of 11 types of green infrastructure practices, including bioretention facilities, green roofs, native landscaping, constructed wetlands, rain gardens, and various types of permeable and pervious paving materials.[39] The document presents inspection and maintenance standards, provides detailed descriptions of maintenance tasks, and provides an expected maintenance schedule for each type of practice. MMSD also issued a report examining costs of green infrastructure practices.[40] This report also makes several recommendations related to compiling and sharing information regarding the costs of green infrastructure, expanding training of construction and maintenance contractors, and providing active guidance and examples for construction and operation and maintenance bid specifications.

The assessment also noted that some of the communities surveyed expressed interest in opportunities for sharing resources for conducting green infrastructure inspection and maintenance. Areas of maintenance that could potentially be shared among municipalities include joint training activities, purchasing specialized equipment to maintain practices, hiring of seasonal staff or trained interns to inspect and maintain practices, and developing contracts to complete work on green infrastructure in multiple communities. The report pointed out that such cooperation could be organized through a number of structures including expansion of existing informal agreements among communities to include green infrastructure maintenance or as part of group MS4 permits. The structure and details of how to coordinate and manage such cooperative activities would need to be developed between participating organizations.

It is recommended that municipalities within the Oak Creek watershed track the locations, types, and frequencies of maintenance of green infrastructure within their jurisdictions. Municipalities and design staff should also design practices with maintenance in mind to ensure that they are accessible for inspection and maintenance and are also relatively easy to maintain.

It is recommended that MMSD provide additional education and training opportunities for green infrastructure maintenance. Such opportunities should be directed to a variety of audiences including private property owners, contractors, consultants, landscape and maintenance staff, and municipal designers and reviewers. Such opportunities should also promote existing resources such as MMSD's Green Vendor List, Planting Selection Tool, and Standard Green Infrastructure Plans and Specifications.

<u>Best Management Practice Pilot Projects to Reduce Concentrations of Dissolved Phosphorus Using Iron Enhancements</u>

As discussed in Chapter 4, total phosphorus is comprised of two different forms of phosphorus: particulate phosphorus and dissolved phosphorus. BMPs that rely on physical processes, such as settling or filtering of material suspended in the water, will act to remove particulate phosphorus but have no effect on dissolved phosphorus. This is a problem because, on average, about 44 percent of total phosphorus in stormwater

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[38] *Stormwater Solutions Engineering, LLC and Ruekert & Mielke, Inc.,* Green Infrastructure Maintenance: Analysis & Lessons Learned for Municipalities, *Report to the Milwaukee Metropolitan Sewerage District, March 2020.*

[39] *Stormwater Solutions Engineering, LLC, 2020* op. cit.

[40] *Birchline Planning LLC,* Green Infrastructure Costs and Incentive in Metropolitan Milwaukee, *Report to the Milwaukee Metropolitan Sewerage District, October 2019.*

consists of dissolved phosphorus.[41] In addition, the percentage of total phosphorus consisting of dissolved phosphorus has increased over time in surface waters of the Oak Creek watershed (see Chapter 4 of this report). Given the high concentrations of total phosphorus present in Oak Creek and its tributaries, complying with the State's water quality criterion for total phosphorus will require using treatment approaches that remove dissolved phosphorus from stormwater or prevent it from entering waterways. This will require using processes that convert dissolved phosphorus to solid-phase forms that can be treated by conventional stormwater BMPs.

Potential methods for removing dissolved phosphorus from solution include precipitation of the phosphorus with calcium and adsorption of phosphorus to oxides or hydroxides of iron or aluminum. The phosphorus removal potentials of several materials containing one or more of these substances have been investigated for possible use as enhancements to BMPs to improve the removal of dissolved phosphorus from stormwater. These materials include drinking water treatment residuals such as alum sludge; slag from iron refining and steel making; bauxite tailings (*i.e.* red mud); zirconium; coal fly ash; crab shells; lithium, magnesium, or manganese-layered double hydroxides; aluminum hydroxide; calcareous sand; blast furnace dust; high calcium marble; clay; diatomaceous earth; and vermiculite. Many of these materials have been found to have limitations associated with them that reduce their potential for use as BMP enhancements. These limitations include changing the pH of treated water to unacceptable levels, consisting of or containing fine-grained material that will clog filters, consisting of materials that will dissolve and pass through filters, or leaching undesirable materials into treated water. Zero-valent or metallic iron, in forms such as steel wool, iron filings, and iron shavings, has been found to be effective at capturing dissolved phosphorus. It also meets several other practical requirements for use as a BMP enhancement. It is relatively inexpensive, safe to handle, and easy to place. In addition, it has a long potential life and may not clog filters as readily as some other materials. Iron-enhanced sand filters (IESFs) were developed and tested in Minnesota and are currently accepted by the Minnesota Pollution Control Agency as a BMP for treating dissolved phosphorus in stormwater runoff.[42]

The main mechanism through which iron acts to remove dissolved phosphorus from water is the adsorption of phosphorus to the surfaces of iron oxides and hydroxides that form as iron corrodes, especially oxides and hydroxides in the form of the minerals hematite (Fe_2O_3) and goethite ($FeO(OH)$).[43] The iron in these compounds is in the ferric (Fe^{3+}) form. The surfaces on the iron oxides and hydroxides can fill up; however, new oxides and hydroxides will form as long as metallic iron is present and geochemical conditions within the filter are favorable for the formation of iron (III) oxides and hydroxides. The main conditions that affect formation of these compounds are oxidation-reduction potential and pH. Formation of iron (III) oxides and hydroxides requires that oxidizing conditions be present in the media. This means that it is important that air be able to reach the media and that the media be able to quickly dry out and achieve aerobic conditions between runoff events. This is accomplished by separating the filter from the surrounding soil with an impermeable liner to prevent intrusion of groundwater and including an underdrain in the filter that is placed above the elevation of downstream water levels.[44] In addition, it is recommended that IESFs be sized and constructed to drain and dry out within one to two days following a runoff event. Extended or constant inundation of the media results in anaerobic and reducing conditions. This drives the reduction of ferric iron to ferrous iron (Fe^{2+}), which is more soluble in water and does not adsorb phosphorus as well as ferric iron. This can result in release of adsorbed phosphorus from the media and into water.[45]

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[41] *R. Pitt, A. Maestre, R. Morquecho, T. Brown, T. Schueler, K. Cappiella, and P. Sturm,* Evaluation of NPDES Phase 1 Municipal Stormwater Monitoring Data, *University of Alabama and Center for Water Protection, 2005.*

[42] *Minnesota Pollution Control Agency, "Overview for Iron Enhanced Sand Filter," In:* Minnesota Pollution Control Manual, *stormwater.pca.state.mn.us/index.php/Overview_for_iron_enhanced_sand_filter, updated August 13, 2019.*

[43] *B.A. Fisher and J.M. Feinberg,* Formation Pathway for Iron Oxide Minerals and Geochemical Conditions for Phosphate Retention in Iron Enhanced Sand Filters, *Report to the Minnesota Stormwater Research Council, University of Minnesota Water Resources Center, November 25, 2019.*

[44] *A.J. Erickson and J.S. Gulliver,* Performance Assessment of an Iron-Enhanced Sand Filtration Trench for Capturing Dissolved Phosphorus, *Project Report No. 549, University of Minnesota St. Anthony Falls Laboratory, November 10, 2010.*

[45] *S.E. Rosenquist, W.C. Hession, M.J. Eick, and D.H. Vaughn, "Field Application of a Renewable Constructed Wetland Substrate for Phosphorus Removal,"* Journal of the American Water Resources Association, *volume 47, pages 800-812, 2011.*

Adsorption of phosphorus to iron oxides and hydroxides is also affected by pH.[46] In general, the amount of adsorption decreases as pH increases, with best adsorption occurring at moderately low pH.[47] Sufficient adsorption occurs in the pH ranges normally found in stormwater such that this should not reduce performance of an IESF; however, prior to installation of an IESF, it would be helpful to monitor the pH of the water to be treated to ensure that it does not have unusually high pH. In addition, the water to be treated should be checked to determine whether it contains high concentrations of sulfides and sulfates. The presence of high concentrations of these ions can result in the formation of iron sulfide compounds in the media.[48] This can reduce the binding of phosphorus to iron and consequently reduce the performance of the IESF.

Several different configurations have been suggested for applying IESF technology in BMPs to treat stormwater.[49] These include stand-alone IESFs, IESF trenches installed along the perimeter of wet retention ponds, and IESFs installed in ditch check dams in roadside ditches and swales. Design considerations for IESFs are given in Appendix N.

IESFs can be constructed as stand-alone filters. A diagram of the basic design is shown in Figure 6.1. In this configuration, runoff enters through the top of the filter and is treated by filtration through the filter media and adsorption of dissolved phosphorus to iron oxides and hydroxides in the filter media. The treated water leaves through an underdrain in the bottom of the filter. An example of this was used to treat water from about 18 acres of farmland that drains toward a shallow wetland and into an agricultural tile drainage system in Wright County, Minnesota.[50] The extent and quality of the drain tile system was unknown. The performance of the IESF was monitored during rainfall-induced drainage events over two years.[51] Over 20 drainage events, the IESF reduced the mass load of total phosphorus by an average of 66 percent. Load reductions for individual events varied between 42 and 95 percent. Over 31 drainage events, the IESF reduced the mass load of dissolved phosphorus by an average of 64 percent. Load reductions for individual events varied between 9 and 87 percent.

Another type of iron-enhanced BMP for treating stormwater consists of an iron-enhanced sand filter trench installed along the perimeter of a wet retention pond, either as part of the pond's initial design or as a retrofit.[52] A diagram of this design is shown in Figure 6.2. The surface of this filter is higher than the normal water level of the pond but below the level of the pond's overflow weir. This creates a filter volume that the trench can treat. As the pond fills during a storm or other runoff event, stormwater flows over the surface of the trench and into the filter media. It flows through a mixture of sand and iron and into an underdrain that leads to the outlet structure of the pond. During small runoff events consisting of less than the filter volume, all of the stormwater passes through the filter. During larger runoff events, some of the water in the basin overflows the weir and bypasses the trench. When the water level in the pond drops below the weir, the remaining stormwater passes through the filter. In order to work properly, the filter media needs to be under aerobic conditions when not filtering stormwater. To ensure this, the filter media is separated from the surrounding soil by an impermeable layer and the underdrain is placed above the downstream water level. This allows the media to be in contact with air and dry between runoff events.

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[46] *S.E. Rosenquist, W.C. Hession, M.J. Eick, and D.H. Vaughn, "Variability in Adsorptive Phosphorus Removal by Structural Stormwater Best Management Practices,"* Ecological Engineering, *volume 36, pages 664-671, 2010.*

[47] *Z.D. Wallin,* Orthophosphate Removal from Simulated Agricultural Runoff Using Zerovalent Iron Enhance Soil Media, *Master's Thesis, University of New Hampshire, Durham, New Hampshire, May 2018.*

[48] *N.F. Caraco, J.J. Cole, and G.E. Likens, "Sulfate Control of Phosphorus Availability in Lakes: A Test and Re-Evaluation of Hasler and Einsele's Model,"* Hydrobiologia, *volume 253, pages 275-280, 1993.*

[49] *A.J. Erickson, J.S. Gulliver, and P.T. Weiss, "Capturing Phosphates with Iron Enhanced Sand Filtration,"* Water Research, *volume 46, page 3,032-3,042, 2012.*

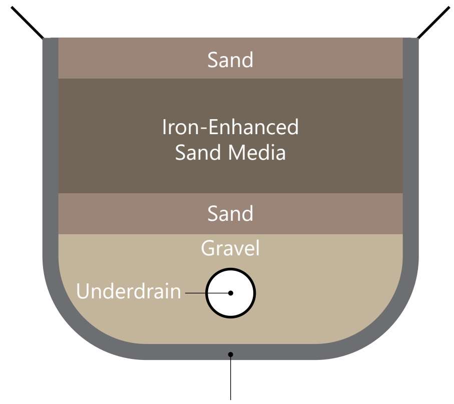
[50] *A.J. Erickson, J.S. Gulliver, and P.T. Weiss,* Monitoring an Iron-Enhanced Sand Filter for Phosphorus Capture from Agricultural Tile Drainage, *Project Report No. 581, University of Minnesota St. Anthony Falls Laboratory, June 2017.*

[51] *A.J. Erickson, J.S. Gulliver, and P.T. Weiss, "Phosphate Removal from Agricultural Tile Drainage with Iron Enhanced Sand,"* Water, *volume 9, article 672, doi: 10.3390/w9090672, 2017.*

[52] *Erickson and Gulliver 2010,* op. cit.

The performance of an IESF trench installed adjacent to a wet pond in the City of Prior Lake, Minnesota was monitored and assessed.[53] Over 28 monitored rainfall and runoff events that occurred during the years 2013 through 2015, this IESF removed 26 percent of the mass load of dissolved phosphorus. After non-routine maintenance was conducted in August 2014 to remove decomposing plant material that had accumulated on the surface of the filter, performance improved to removal of 45 percent of the dissolved phosphorus mass load. Most of the phosphate load reduction occurred during larger runoff events that had relatively high influent dissolved phosphorus concentrations and mass loads. Another IESF installation installed at a different location was monitored and found to capture and retain 71 percent of the phosphorus mass load.[54]

Figure 6.1
General Design of Iron-Enhanced Sand Filters



Note: drawing is not to scale.

Source: University of Minnesota Saint Anthony Falls Laboratory and SEWRPC

IESFs have also been installed as components of ditch check dams in roadside ditches and swales.[55] A diagram of this design is shown in Figure 6.3. These check dams intercept and detain stormwater runoff as it flows through roadside ditches. This allows particles to settle behind the check dam. The runoff then filters through the dam which contains an insert consisting of a geotextile filter sock filled with a media consisting of sand containing about 5 percent iron filings by weight. Corrosion of the iron filings produces iron oxides and hydroxides which strongly adsorb dissolved phosphorus.

Performance of a ditch check dam containing an IESF insert in Stillwater, Minnesota was monitored during 17 rainfall events in 2015[56] and 40 rainfall events in 2016 through 2018.[57] The reductions in the mass of dissolved phosphorus in stormwater treated by this BMP varied between 15 and 54 percent. By comparison, a similar ditch check dam without an IESF insert removed little to no dissolved phosphorus. Cumulative dissolved phosphorus mass retention in the filter insert decreased from 42 percent in 2015 to 23 percent in 2018. Upon examination and testing, it was found that the bottom four inches of the filter insert had provided most of the treatment of stormwater. Treatment of most of the dissolved phosphorus load by this section of the filter diminished its sorption capacity and was likely the reason for the reduction in performance.[58] This suggests that periodically remixing the filter media as a part of maintenance could maintain performance and extend the useful life of the media in the filter insert.

Other potential configurations for IESFs and iron enhancements to treat dissolved phosphorus have been suggested, including permeable weir walls,[59] iron-enhanced bioretention facilities,[60] and introduction of metallic iron into lake sediments;[61] however, no field performance data are available for these potential applications.

[53] *A.J. Erickson, P.T. Weiss, and J.S. Gulliver,* Monitoring and Iron-Enhanced Sand Filter Trench of the Capture of Phosphate from Stormwater Runoff, *Project Report No, 575, University of Minnesota St. Anthony Falls Laboratory, September 2015.*

[54] *Erickson and Gulliver 2010,* op. cit.

[55] *P. Natarajan and J.S. Gulliver,* Assessing Iron-Enhanced Swales for Pollution Prevention, *Project Report No. 576, University of Minnesota St. Anthony Falls Laboratory, September 2015.*

[56] Ibid.

[57] *P. Natarajan, J.S. Gulliver, and P.T. Weiss,* Iron-Enhanced Swale Ditch Checks for Phosphorus Retention: Final Report, *Minnesota Department of Transportation, July 2019.*

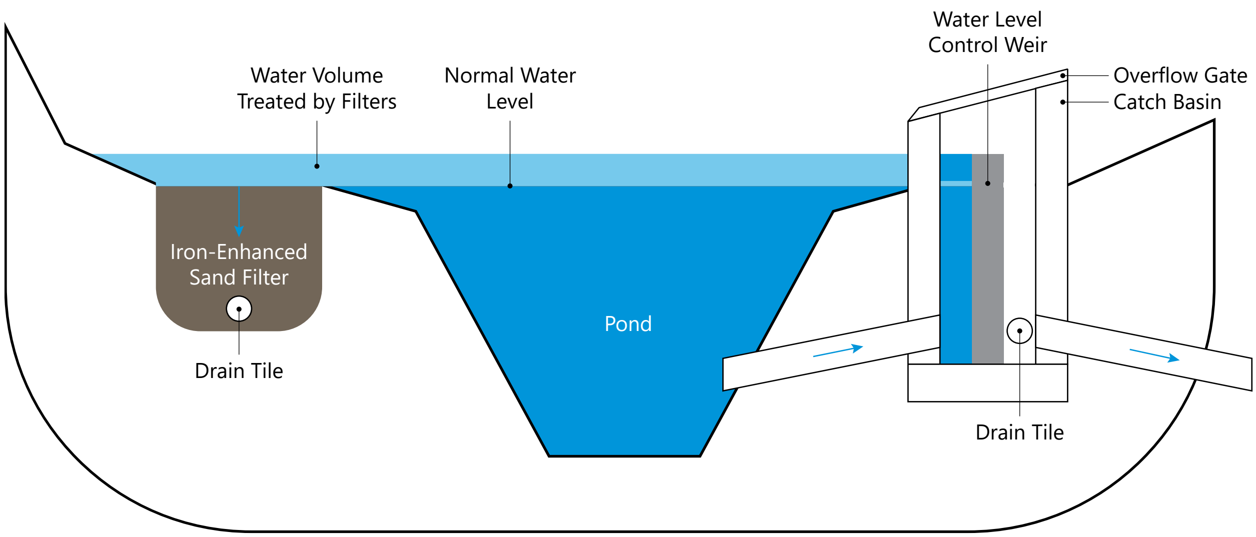
[58] Ibid.

[59] *A.J. Erickson, J.S. Gulliver, and P.T. Weiss, "Capturing Phosphates with Iron Enhanced Sand Filters,"* Water Research, *volume 46, pages 3,032-3042, 2012.*

[60] Ibid.

[61] *P. Natarajan, J.S. Gulliver, and W.A. Arnold,* Internal Phosphorus Load Reductions with Iron Filings, *Project Report No. 582, University of Minnesota St. Anthony Falls Laboratory, September 2017.*

Figure 6.2
General Design of Iron-Enhanced Sand Filter Stormwater Trenches

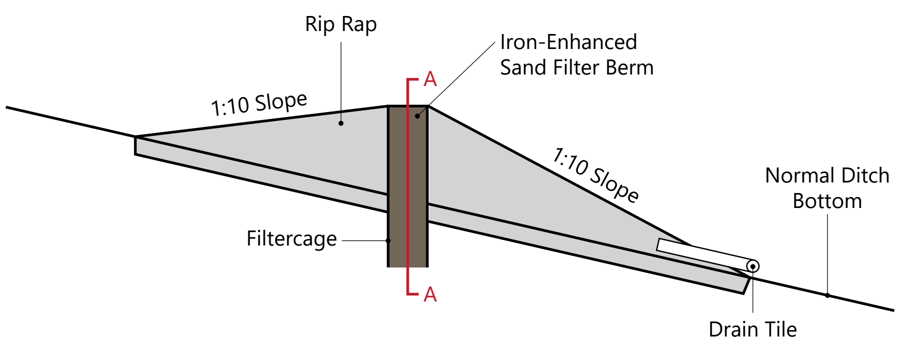


Note: drawing is not to scale.

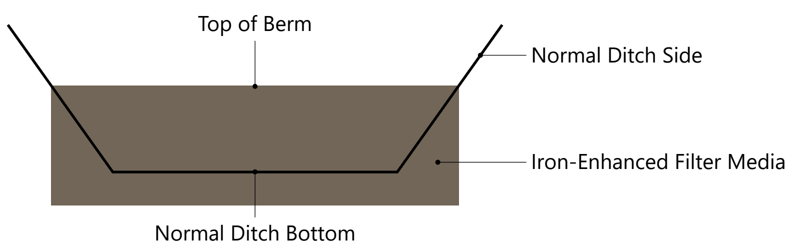
Source: University of Minnesota Saint Anthony Falls Laboratory and SEWRPC

Figure 6.3
General Design of Iron-Enhanced Sand Filter Ditch Check Dams

A. Profile



B. Cross-Section (A-A)



Note: drawing is not to scale.

Source: University of Minnesota Saint Anthony Falls Laboratory and SEWRPC

The costs of installing an IESF will depend on the design and size of the IESF and whether it is installed as a retrofit. The cost in 2010 for installing pond perimeter IESF trenches adjacent to existing stormwater ponds ranged between $3,500 and $5,000.[62] These costs did not include the costs of modifications to the ponds such as additional pipes, modifications to outlet structures, or connection to outlet structures.

IESFs require regular maintenance in order to maintain performance. Routine maintenance includes removing trash and debris from the filter, removing vegetation from the surface of the filter, raking the filter to break up the surface, and removing obstructions to underdrains and outlet structures. Non-routine maintenance may include removing accumulated solids, organics, and/or iron ocher[63] that have accumulated on or near the top of the filter; breaking up clumps of iron shaving conglomerates that have formed in the filter; mixing filter media; or replacing filter media when its phosphorus sorption capacity is exhausted. Maintenance considerations for IESFs are given in Appendix N.

The operational life of a properly sized, constructed, operated, and maintained IESF has been estimated to be about 30 to 35 years.[64] This has not been verified in the field. Media in IESF inserts for ditch check dams will probably need to be replaced more often. Once the iron in the filter media has been consumed, the media will need to be removed, disposed of, and replaced. It should be noted that the magnetic susceptibility of the iron in an IESF decreases with each inundation of the filter media. This occurs as metallic iron in the media is converted to iron oxides and hydroxides. Magnetic susceptibility is easily measured in the field. Thus, if an initial measurement of magnetic susceptibility is taken upon installation of an IESF, subsequent measurements could be used to indicate the remaining capacity of the media and determine when the media may need to be replaced.[65]

There is evidence that IESFs may also reduce concentrations of some emerging contaminants as well. One study examined concentrations of 384 emerging contaminants at paired IESF inlets and outlets during four seasonal runoff events.[66] This study found that the IESFs examined reduced the concentrations of 17 emerging contaminants with removal efficiencies ranging between 26 percent and 100 percent. These contaminants included some lifestyle and nonprescription pharmaceuticals, some polycyclic aromatic hydrocarbons (PAHs), and some compounds associated with commercial and consumer products. The IESFs showed removal efficiencies greater than 89 percent for acetaminophen, cholesterol, nicotine, triphenyl phosphate and some PAH-related compounds, around 72 percent for menthol and caffeine, and between 26 percent and 36 percent for DEET and tributyl phosphate. The data suggested that another 18 compounds might have been removed; however, the number of samples taken was not sufficient for the statistical methods used in the study to confirm.

It is recommended that pilot projects be conducted to evaluate the performance of using iron-enhanced sand filters under field conditions in the Oak Creek watershed in order to determine whether this approach would be useful in reducing contributions of phosphorus from stormwater runoff and other sources in the watershed. Such pilot projects could involve stand-alone filters or pond-perimeter IESF trenches. It should be investigated whether there are suitable sites within the watershed where stand-alone IESFs could be used to treat discharge from stormwater outfalls.

It is also recommended that these pilot projects incorporate monitoring and studies to evaluate the filters' performance. It is important that studies evaluating the field performance of this approach be conducted as part of pilot projects. Most of the field studies on the use of this technology were conducted in Minnesota which has similar climatic conditions to Wisconsin; however, because of differences in geology and development it is not clear how applicable the results of the Minnesota research may be to conditions

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[62] *Erickson and Gulliver 2010,* op. cit.

[63] *Iron ochre is a red or tan gelatinous substance formed by bacteria oxidizing ferrous iron (Fe^{2+}) to ferric iron (Fe^{3+}). When iron ochre is formed on a sand filter, it can cause clogging, reducing infiltration.*

[64] *Erickson, Gulliver, and Weiss 2012* op. cit.; *Minnesota Pollution Control Agency 2019,* op. cit.

[65] *Fisher and Feinberg 2019,* op. cit.

[66] *D.J. Fairbairn, S.M. Elliott, R.L. Kiesling, H.L. Schoenfuss, M.L. Ferry, and B.M. Westerhoff, "Contaminants of Emerging Concern in Urban Stormwater: Spatiotemporal Patterns and Removal by Iron-Enhanced Sand Filters (IESPs),"* Water Research, *volume 145, pages 332-345, 2018.*

in the Oak Creek watershed. These studies should incorporate appropriate controls to ensure that the phosphorus removal results can be attributed to the iron enhancements and not the effects of the BMP without the enhancements.

There are several questions that evaluation of the performance iron enhanced BMPs should address. These include:

- How much does the addition of iron enhancement to a BMP reduce concentrations and loads of dissolved phosphorus and total phosphorus over BMPs without iron enhancement?

- Over what range of concentrations of dissolved phosphorus and total phosphorus in influent water is this effective? Are there lower and upper thresholds beyond which performance falls off?

- Are iron-enhanced BMPs capable of removing dissolved phosphorus and total phosphorus during high flow events? How much contact time between stormwater and the iron-sand media is needed for this enhancement to be effective?

- Will iron-enhanced BMPs discharge treated water with low concentrations of dissolved phosphorus and total phosphorus?

- How long will the iron-sand media remain active?

- What maintenance regimen is required to preserve performance?

- Does the use of iron-enhancements to remove dissolved phosphorus cause other changes in water chemistry in the effluent?

<u>Best Management Practice Pilot Projects Using Other Methods to Reduce Concentrations of Pollutants</u>

As discussed in the previous section, several other materials have been investigated for potential use as enhancements to BMPs to improve the removal of dissolved phosphorus from stormwater. In addition, innovative approaches are being developed to address other pollutants. For those approaches that show promise based on laboratory and mesocosm studies, it would be desirable that pilot projects be conducted to determine whether they would be useful for reducing concentrations of pollutants from stormwater runoff and other sources under field conditions. Following proof of concept but prior to field testing, the following issues should be evaluated:

- Under what chemical conditions does the enhancement act to remove the pollutants of concern? Are there chemical conditions under which captured pollutant will be released? How do these conditions compare to those found in stormwater and stormwater BMPs?

- Does treatment using this enhancement produce changes in the concentrations or levels of other water quality constituents? Examples of such changes could include increasing pH or reducing concentrations of dissolved oxygen.

- Does the enhancement consist of fine-grained material that will pass through or clog filters?

- Does the enhancement consist of or produce materials that will dissolve and pass through filters?

- Will the enhancement result in undesirable materials being leached into treated waters?

- Will treatment using the enhancement produce toxic effects on aquatic organisms? Conducting whole effluent toxicity testing prior to field tests could address this question.[67]

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[67] *Information on whole effluent toxicity testing is available on the WDNR website at dnr.wisconsin.gov/Topic/Wastewater/WET.html; see also Wisconsin Department of Natural Resources,* Whole Effluent Toxicity (WET) Program Guidance Document, *Guidance Document No. 3400-2019-03, October 29, 2019, revised February 17, 2021.*

These questions and considerations can be generalized to address other techniques meant to treat stormwater for dissolved phosphorus or for enhancements or techniques meant to treat other pollutants.

It is recommended that any pilot projects involving other BMP enhancements incorporate monitoring and studies to evaluate the enhancements' performance. These studies should incorporate appropriate controls to ensure that the pollutant results can be attributed to the enhancements being evaluated and not the effects of the BMP without the enhancements.

There are several questions that evaluation of the performance of BMPs incorporating new approaches should address. These include:

- How much does addition of the enhancement to the BMP reduce concentrations and loads of the pollutants of concern over similar BMPs without the enhancement?

- Over what range of concentrations of the pollutants of concern in influent water is the enhancement effective? Are there lower and upper thresholds beyond which performance falls off?

- Will BMPs with the enhancement discharge or infiltrate treated water with low concentrations of the pollutants of concern?

- Are BMPs with the enhancement capable of removing the pollutants of concern during high flow events? How much contact time between stormwater and the enhanced media is needed for this enhancement to be effective?

- Will the enhancement work over the entire seasonal cycle? How will seasonal temperature differences, droughts, and freezing affect performance?

- How long will the enhancement remain active?

- What maintenance regime will be required to preserve performance?

- How are the enhancements disposed of after their functional life has passed? Does such disposal cause additional problems?

Recommended Rural Nonpoint Source Pollution Control Measures

As discussed in Chapter 3 of this report, a relatively small portion of the Oak Creek watershed is devoted to agricultural land uses. In 2015, 1,664 acres or about 9.2 percent of the land in the watershed was in agricultural land uses. This amount is expected to decrease over time. Under planned land use conditions, 1,013 acres of agricultural land would be converted to urban development. In addition, Milwaukee County owns 125 acres of land that it leases to agricultural operators. The County is in the process of converting these parcels to woodland and grassland conditions. Under planned conditions 526 acres or about 3 percent of the watershed would remain in agricultural land uses.

The recommendations of the 2007 SEWRPC RWQMPU as they relate to rural nonpoint source pollution in the Oak Creek watershed were reviewed (see Chapter 2 of this report) and reevaluated under this watershed restoration planning effort. Based on that review and reevaluation—which included consideration of the additional water quality monitoring data collected since the RWQMPU was issued and of recommendations that have already been implemented—the current applicability of the recommendations of the RWQMPU was confirmed. Thus, the following RWQMPU recommendations are reiterated under this plan:

1. **Expand the application of practices to reduce soil loss from cropland to attain erosion rates less than "T", the tolerable soil loss rate.**[68] This could be accomplished through a combination of practices, including, but not limited to, expanded conservation tillage, grassed waterways, use

[68] *"T-value" is the tolerable soil loss rate—the maximum level of soil erosion that will permit a high level of crop productivity to be sustained economically and indefinitely, as determined by the U.S. Natural Resources Conservation Service. "Excessive" cropland erosion refers to erosion in excess of the tolerable rate, or T-value.*

of cover crops, and riparian buffers. The applicable measures should be determined by developing farm management plans that are consistent with the county land and water resource management plans. It should be noted that the benefits of expansion of these practices in reducing sediments and nutrients delivered to the streams of the watershed were explicitly represented in the water quality modeling analyses conducted for the RWQMPU and are reflected in the water quality modeling results presented in Chapter 5 and Appendix M of this report.

2. **It is recommended that nutrient management plans be prepared for all agricultural operations in the watershed that do not currently have them and that application of manure and other nutrients to fields occur only in accordance with nutrient management plans.**

3. **It is recommended that marginal cropland and pastureland be converted into wetlands and prairies.** The RWQMPU recommended that a total of 10 percent of existing farmland and pasture be converted to either wetland or prairie conditions and that the focus of this effort should be on marginally productive lands, which are defined as agricultural lands other than those highly productive lands designated as Class I and Class II lands by the U.S. Natural Resources Conservation Service. The RWQMPU identified candidate areas to be given first consideration when identifying marginally productive lands to be converted to wetlands and prairies. Approximately 189 acres of candidate areas were identified in the Oak Creek watershed. These candidate areas are shown on Map 2.1 in Chapter 2 of this report. It should be noted that the benefits of expanding the conversion to wetlands and prairies in reducing fecal coliform bacteria, total suspended solids, total phosphorus, and total nitrogen loads delivered to the streams of the watershed were explicitly represented in the water quality modeling analyses conducted for the RWQMPU and are reflected in the water quality modeling results presented in Chapter 5 and Appendix M of this report. These conversions can be used to create new, and augment existing, riparian buffers.

The RWQMPU made two additional recommendations related to rural nonpoint source pollution control measures that are refined herein for the Oak Creek watershed under this watershed restoration plan. First, the RWQMPU recommended that, at a minimum, implementing county-enforced inspection and maintenance programs for all new or replacement private onsite wastewater treatment systems (POWTS) constructed after the date on which the counties adopted private sewage system programs, that voluntary county programs be instituted to inventory and inspect POWTS that were constructed prior to the dates on which the counties adopted private sewage system programs, and that the WDNR and the counties work together to strengthen oversight and enforcement of regulations for disposal of septage and to increase funding to adequately staff and implement such programs. As described in Chapter 2 of this report, regulations regarding POWTS set forth by the Wisconsin Department of Safety and Professional Services in Section SPS 383.255 of the *Wisconsin Administrative Code* mandate an expansion of county and municipal POWTS programs. Under the current rules, units of government are required to complete inventories of POWTS in their jurisdictions by October 1, 2017, and have the other elements of the program in place by October 1, 2019. **It is recommended that municipalities in the watershed where onsite wastewater treatment systems are still present implement expanded POWTS programs in accordance with the deadlines given in SPS 383.255**.

Second, the RWQMPU makes several recommendations relative to riparian buffers, including:

- Where existing riparian buffers adjacent to crop and pasture lands are less than 75 feet in width, expanding the buffer to a minimum width of 75 feet

- Pursuing opportunities to expand riparian buffers beyond the recommended minimum 75-foot width along high-quality stream systems, including those that can support and sustain the life cycles of economically important species such as salmon

- Limiting the number of stream crossings and configuring them to minimize the fragmentation of streambank habitat

Recent research has revealed much about the beneficial role of riparian buffers in protecting water quality, groundwater quality and recharge, fisheries, wildlife, and ecological resilience to invasive species.[69] In view of the results of this research, the general recommendations of the Oak Creek watershed restoration plan include the following refinements of the general buffer recommendations in the RWQMPU:

1. **It is recommended to protect and expand riparian buffer regions to the greatest extent possible with a minimum 75-foot width and an optimum 1,000-foot width goal.** The literature has revealed that a 75-foot setback width can provide highly productive instream habitat and significant pollution reduction. It also shows that the protection of a 400-foot minimum and 900-foot optimum riparian buffer width has significant benefits to wildlife populations. Given this information it has been decided that the protection and expansion of riparian buffers to 1,000 feet from the ordinary high-water mark, or within the boundaries defined by floodplains or wetlands, whichever is greater, should be a priority for this watershed.

2. **It is recommended that the continuity and connectivity of riparian buffers be protected and increased.** Fragmentation of riparian buffers by roads, railways, and utilities, combined with encroachment by development, impacts the structure and function of riparian corridors and reduces their ability to adequately protect waterways and wildlife habitat. Stream crossings also tend to have a cumulative impact on the stream and associated lands, as well as an impact on the water quality and the fishery. Therefore, it is important to reduce the linear fragmentation of the existing riparian buffers by either removing crossings where possible or by not increasing the number of crossings where practical. It is recognized that police, fire protection, and emergency medical service access is an overriding consideration for determining whether the objective of removing a crossing is feasible. This recommendation is only meant to apply to situations where more road crossings are present than are necessary to ensure adequate access for emergency services.

More detailed recommendations related to riparian buffers are given in the section on recommendations for habitat later in this chapter. Specific projects recommended to address rural nonpoint source pollution are included in Table 6.1.

Recommended Actions to Reduce Instream Concentrations of Fecal Indicator Bacteria and Pathogens

Concentrations of bacteria indicative of fecal contamination, such as the bacterium *Escherichia coli* (*E. coli*) and fecal coliform bacteria, are generally used to assess the suitability of waters for human contact. The description of surface water quality given in Chapter 4 indicates that high concentrations of these indicator bacteria are often present in surface waters of the Oak Creek watershed. This indicates that these waters may not be safe for human contact because of the possible presence of waterborne disease agents. This reduces the recreational potential of the surface waters of the watershed. Targets for reductions of fecal coliform bacteria, as developed in the RWQMPU, are presented in Chapter 5 of this report.[70]

This subsection presents several recommended measures for the reduction of inputs of fecal indicator bacteria—and the pathogenic organisms for which they serve as surrogates—to surface waters of the Oak Creek watershed. These recommendations are intended to produce the reductions needed to meet the targets set in Chapter 5. It should be kept in mind that these targets were established for the watershed restoration plan based upon the water quality model used in the RWQMPU. As discussed in Chapter 5, meeting these targets will result in improvements in the bacterial water quality of surface waters in the Oak Creek watershed; however, even with full implementation, surface waters of the watershed will not achieve full compliance with the applicable water quality criteria for recreational use.

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[69] *For example, see the review in SEWRPC, Riparian Buffer Management Guide No. 1,* Managing the Water's Edge: Making Natural Connections, *2010, which is included in Appendix G of this report.*

[70] *Targets for reduction of fecal indicator bacteria are expressed in terms of fecal coliform bacteria both because the modeling for the RWQMPU simulated fecal coliform bacteria concentrations and because until recently, the State of Wisconsin's recreational use water quality criteria were based upon concentrations of fecal coliform bacteria. It should be noted that* E. coli *is one of several species of fecal coliform bacteria.*

Coordinated Programs to Detect and Eliminate Illicit Discharges to Storm Sewer Systems

It is recommended that those municipalities in the watershed with MS4s regulated under the WPDES system modify their illicit discharge detection and elimination (IDDE) programs to transfer some of the effort currently expended to monitor major outfalls that show no evidence of illicit discharges to outfalls of any size that are considered likely to be conveying water contaminated with sanitary wastewater.

The MS4 discharge permits under which most of the permitted municipalities in the Oak Creek watershed operate their MS4s require that annual dry-weather field screening be conducted at major outfalls, including field analysis of any dry-weather flows from those outfalls.[71] Under this recommendation, **the permitted communities would develop an analysis procedure to identify those stormwater outfalls of all sizes that are most likely to be conveying water contaminated with sanitary wastewater**. This analysis procedure should consider what is known about the age and condition of the associated stormwater and sanitary wastewater conveyance systems, water quality conditions within receiving waters, and other available relevant information. The Menomonee River Watershed MS4 Permittees, which include the Cities of Greenfield and Milwaukee in the Oak Creek watershed, have developed an analysis procedure of this type. This procedure is described in Appendix O of this report. It should also be noted that the WDNR has issued guidance recommending that municipalities adopt a more targeted approach to illicit discharge detection and elimination in which outfalls are prioritized based upon their potential for conveying illicit discharges rather than solely on the size of the pipe or contributing drainage area.[72]

The analysis procedure developed by the communities would be used to target outfalls for field screening. Outfalls would be screened on the following schedule:

- Those major outfalls that had shown no evidence of illicit discharges during the term of the community's previous MS4 permit would be required to be screened at least once during the five-year permit term, with at least one-fifth of all major outfalls being screened each year on a rolling basis

- Those major outfalls for which the last two samplings conducted showed evidence of illicit discharge would be required to be screened a minimum of once per year

- All other outfalls identified for screening under the analysis procedure developed by the communities would be required to be screened annually

- Outfalls identified for annual screening would be screened each year until no evidence of illicit discharge is found for two consecutive years

- Outfalls with indeterminate sources and nonstormwater discharge would be screened annually

Upon detecting an illicit discharge, the municipality would continue to be required to immediately begin investigating the sewershed in order to find and eliminate the source(s) of the illicit discharge.

This change in procedure is intended to target sources that are likely to be contaminated with human-sourced wastewater. Given this, it would be useful for field screening to explicitly test for fecal contamination. Therefore, **it is recommended that when dry-weather flow is detected in storm sewers during field screening, the field work include sampling for fecal indicator bacteria such as *Escherichia coli*.** Adding this indicator to the suite of indicators used in field screening will give additional data for determining whether dry-weather flows represent discharges contaminated with human wastes. Should additional data be required, the municipalities should consider utilizing microbial source tracking techniques, such as screening for human sourced *Bacteroides* and *Lachnospiraceae*.

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[71] *Major outfalls are defined as those outfalls having the equivalent of an inside diameter equal to or larger than 36 inches which are associated with a drainage area of more than 50 acres, those outfalls that receive stormwater runoff from lands zoned for industrial activity with a drainage area of more than two acres, or from other lands with more than two acres of industrial activity.*

[72] *Wisconsin Department of Natural Resources, "Illicit Discharge Detection and Elimination," Program Guidance Memorandum No. 3800-2012-01, March 15, 2012.*

For most of the municipalities in the Oak Creek watershed, implementation of this recommendation will require that the WDNR authorize a change in their MS4 discharge permits. This would be best accomplished during the regular reissuance of their permit at the end of a five-year permit cycle. The City of Cudahy is covered under its own permit. This permit expired on June 11, 2018. As of June 2021, the City was operating under an extension of the permit while the WDNR was processing an application for reissuing the permit. The City of Franklin is covered under the Root River Group permit. This permit expired on September 9, 2018. As of June 2021, the City was operating under an extension of the permit while the WDNR was processing an application for reissuing the permit. The Cities of Greenfield and Milwaukee and Milwaukee County are currently covered under the Menomonee River Watershed-Based Permit and have implemented this IDDE program modification recommendation. This permit was reissued on April 1, 2020 and will expire on March 31, 2025. The City of Oak Creek is covered under its own permit, which expired on June 11, 2018. As of June 2021, the City was operating under an extension of the permit while the WDNR was processing an application for reissuing the permit. The City of South Milwaukee is covered under its own permit. This permit expired on June 11, 2018. As of June 2021, the City was operating under an extension of the permit while the WDNR was processing an application for reissuing the permit.

Design Considerations Related to Fecal Indicator Bacteria and Pathogens for Urban Stormwater BMPs

It would be expected that some urban stormwater management practices previously recommended would also act to reduce contributions of fecal indicator bacteria and the pathogens for which they are a surrogate to surface waterbodies. Tables 6.11 and 6.12 summarize data on the performance of several urban stormwater management practices with respect to two commonly used types of fecal indicator bacteria: *E. coli, and* fecal coliform bacteria.[73] There are considerable differences among BMPs in the reductions of fecal indicator bacteria concentration resulting from treatment by the BMP. The data also show differences in how particular types of BMPs perform when assessed using different types of fecal indicator bacteria. These differences may give some indication of how the performance of particular types of BMPs may differ among different bacterial pathogens.

Several things should be kept in mind when interpreting the performance values given in Tables 6.11 and 6.12. First, for any given BMP the assessment given in the table is based upon a small number of studies. Second, review of the literature shows that the performance of BMPs with respect to fecal indicator bacteria is highly variable. This variability shows up in at least three different ways. The tables suggest that the performance may differ depending upon which type of fecal indicator bacteria is used. In addition, there can be large differences in performance among individual examples of the same practice. For example, the values for the percentage of fecal indicator bacteria removed by retention ponds reported in the literature ranges between 5 percent and 99 percent.[74] At different times or under different conditions, an individual example of a practice can exhibit very different levels of performance. For example, a detention basin in Houston, Texas showed performance levels that ranged between 72 percent reductions and 1,858 percent increases in *E. coli* concentrations during different storm events.[75] Third, it is important to keep in mind that fecal indicator bacteria are not themselves pollutants of concern. Instead, they act as surrogate measures

[73] *These two indicators are monitored in the Oak Creek watershed. While a third indicator, enterococcus, is not currently monitored in the watershed; it is also recommended for use as an indicator in freshwater by the U.S. Environmental Protection Agency.*

[74] *Thomas R. Schueler and Heather K. Holland, " Microbes and Urban Watersheds: Ways to Kill 'Em," Article 67,* The Practice of Watershed Protection, *Center for Watershed Protection, Volume 3, Pages 566-574, 2000; Stephen R. Pennington, Michael D. Kaplowitz, and Scott G. Witter, "Reexamining Best Management Practices for Improving Water Quality in Urban Watersheds,"* Journal of the American Water Resources Association, *Volume 39, Pages 1,027-1,041, 2003; Lisa Tilman, Andrea Plevan, and Pat Conrad,* Effectiveness of Best Management Practices for Bacterial Removal: Developed for the Upper Mississippi River Bacteria TMDL, *Report to the Minnesota Pollution Control Agency, June 2011; Wright Water Engineers and Geosyntec Consultants,* International Stormwater Best Management Practice (BMP) Database Pollutant Category Summary: Bacteria, *Report to the Water Environment Research Foundation, Federal Highway Administration, and American Society of Civil Engineers, 2010; Geosyntec Consultants, and Wright Water Engineers,* Int-ernational Stormwater Best Management Practices (BMP) Database Pollutant Category Statistical Summary Report: Solids, Bacteria, Nutrients, and Metals, *Report to the Water Environment Research Foundation, Federal Highway Administration, and American Society of Civil Engineers, December 2014.*

[75] *Hanadi Rifai,* Study on the Effectiveness of BMPs to Control Bacteria Loads, *Final Report to the Texas Commission on Environmental Quality, August 2006.*

Table 6.11
Median Influent and Effluent Concentrations for *E. coli* Reported for Stormwater Best Management Practices

BMP Category	BMPs Analyzed		Storms Analyzed		Median Concentration (cells per 100 ml)	
	In-Flow	Out-Flow	In-Flow	Out-Flow	In-Flow	Out-Flow
Bioretention	7	7	97	96	1,200	240
Grass Swale	5	6	39	46	3,500	4,400
Retention (Wet) Pond	4	4	69	65	2,000	80
Wetland Basin	6	6	77	76	2,800	1,000
Wetland Basin/Retention Pond	10	10	146	141	2,300	450

Source: International Stormwater Best Management Database

Table 6.12
Median Influent and Effluent Concentrations for Fecal Coliform Bacteria Reported for Stormwater Best Management Practices

BMP Category	BMPs Analyzed		Storms Analyzed		Median Concentration (cells per 100 ml)	
	In-Flow	Out-Flow	In-Flow	Out-Flow	In-Flow	Out-Flow
Composite/Treatment Train	4	4	64	56	15,000	12,000
Detention (Dry) Basin	15	15	170	194	1,800	640
Grass Swale	12	11	91	82	4,900	4,400
Media Filter	15	15	184	169	900	400
Retention (Wet) Pond	10	12	121	161	3,400	1,400
Wetland Basin	5	5	42	39	12,000	900
Wetland Basin/Retention Pond	15	17	163	200	5,000	1,200
Wetland Channel	3	3	21	20	6,000	4,000

Source: International Stormwater Best Management Database

indicating the likelihood that surface waters are contaminated with fecal wastes and may contain disease-causing agents. The performance of stormwater BMPs with respect to fecal indicator bacteria may not be representative of their performance with respect to disease-causing agents. In general, it is reasonable to expect that the performance data in Tables 6.11 and 6.12 likely give a better representation of BMP performance with respect to pathogenic bacteria than they give of performance with respect to pathogenic viruses, protozoa and protozoan cysts, or helminth eggs. Unfortunately, relatively few data are available regarding the performance of stormwater BMPs with respect to disease agents.

Several factors appear to be important to the fate and transport of fecal indicator bacteria and the pathogens for which they serve as surrogates in aquatic environments.[76] These factors include natural dieoff, exposure to sunlight and its ultraviolet component, temperature, the presence of predatory microorganisms, availability of nutrients, sorption to particles, turbidity, and flow rates. Sorption to particles and sedimentation may have complex effects. Sorption to particles tends to increase the rates at which indicator bacteria and pathogens settle out of the water column. While indicator bacteria and pathogens can be removed from the water through sorption and sedimentation, there is evidence that at least some of these species are able to survive in sediment. Because of this, resuspension of sediment may act as a source of indicator bacteria and pathogens to the water. Therefore, removal of indicator bacteria and pathogens through sedimentation may not constitute permanent removal.

[76] *Reviewed in J.D. Brookes, J. Antenucci, M. Hipsey, M.D. Burch, N.J. Ashbolt, and C. Ferguson, "Fate and Transport of Pathogens in Lakes and Reservoirs,"* Environment International, *Volume 30, Pages 741-759, 2004; C. Ferguson, A.M. de Roda Husman, N. Altavilla, D. Deere, and N. Ashbolt, "Fate and Transport of Surface Water Pathogens in Watersheds,* Critical Reviews in Environmental Science and Technology, *Volume 33, Pages 299-361, 2003; W.A.M. Hijnen, E.F. Beerendonk, and G.J. Medema, "Inactivation Credit of UV Radiation for Viruses, Bacteria and Protozoan (Oo)cysts in Water: A Review,"* Water Research, *Volume 40, Pages 3-22, 2006.*

The factors above suggest several elements that should be considered in the design of stormwater BMPs in order to reduce concentrations of indicator bacteria and pathogens in water:

- BMPs should be designed in such a way as to maximize exposure to sunlight to promote inactivation of indicator bacteria and pathogens by sunlight and ultraviolet light
- BMPs should be designed in such a way as to provide habitat for microorganisms and very small animals that prey upon bacteria, protozoa, protozoan cysts, and helminth eggs
- BMPs should be designed in such a way as to promote sorption of indicator bacteria and pathogens to particles and sedimentation of these particles
- When sorption of bacteria and pathogens is a treatment process, the BMP should be designed to reduce resuspension of settled material
- BMPs with open water should be designed in such a way as to discourage their use by nuisance waterfowl that will be discussed more in the following subsections

It should be noted that practices that infiltrate stormwater will reduce bacteria loading by reducing the volume component of the load. Practices that infiltrate stormwater also typically provide treatment processes enabling sorption and filtration. Where infiltration is used, it is important to recognize that groundwater pollution can also occur, if adequate sorption and filtration do not occur prior to the infiltrated water reaching groundwater.

Reducing Impacts of Nuisance Waterfowl

Nuisance animals, such as waterfowl, can be a significant source of fecal indicator bacteria to surface waters. Studies have found high concentrations of indicator bacteria in the feces of waterfowl. For example, estimates of the concentration of fecal coliform bacteria in the feces of ring-billed gulls range from about 58 million to 1,500 million cells per gram feces, with much of the variation occurring on a seasonal basis.[77] Concentrations of *E. coli* in feces from ring-billed gulls at two Lake Michigan beaches in Chicago and Traverse City, Michigan were 14 million and 490 million cells per gram feces, respectively.[78] Concentrations of fecal coliform bacteria in the feces of Canada geese were found to be about 15,000 cells per gram feces.[79] In addition to fecal indicator bacteria, feces from nuisance animals can contain pathogenic organisms. For instance, ring-billed gull feces has been found to contain species and strains of bacteria known to be pathogenic to humans, including bacteria in the genera *Aeromonas, Campylobacter, Listeria,* and *Salmonella*.

Programs could be implemented to discourage unacceptably high numbers of waterfowl from congregating near waterbodies. Measures that could be used in these programs include expanded use of informational signs regarding the negative aspects of feeding waterfowl, ordinances prohibiting the feeding of waterfowl, covering trash receptacles near water features, landscaping that reduces the attractiveness of areas to waterfowl use, and other innovative measures such as trained dogs. It is important to note that many of these species are legally protected, so any measures that would depredate these organisms would require a permit from the U.S. Fish and Wildlife Service.

It is recommended that programs to control nuisance animals be conducted on an "as needed" basis in response to identified water quality problems resulting from nuisance animals. Measures to discourage the use of stormwater BMPs by nuisance animals should be incorporated into the design of urban stormwater BMPs.

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[77] *K.A. Alderisio, and N. DeLuca, "Seasonal Enumeration of Fecal Coliform Bacteria from the Feces of Ring-Billed Gulls (*Larus delawarensis*) and Canada Geese (*Branta canadensis*),"* Applied and Environmental Microbiology, *volume 65, pages 5,628-5,630, 1999.*

[78] *L.R. Fogarty, S.K. Haack, M.J. Wolcott, and R.L. Whitman, "Abundance and Characteristics of the Recreational Water Quality Indicator Bacteria* Escherichia coli *and Enterococci in Gull Faeces,"* Journal of Applied Microbiology, *volume 94, pages 865-878, 2003.*

[79] *Alderisio, and DeLuca, 1999,* op. cit.

Several techniques can be used to discourage nuisance waterfowl from congregating in areas adjacent to waterbodies or stormwater BMPs. They tend to work best in combination with one another.

Availability of food is a major reason why geese and gulls are attracted to certain areas and remain there for long periods of time. Methods of reducing food availability, such as enclosing trash containers and enacting and enforcing "no feeding" policies, can make these areas less attractive to geese, gulls, and other unwanted birds and animals.

Geese, in particular, prefer nicely groomed lawns adjacent to water and normally like to walk out of the water on bare, flat, or gently sloping banks. Measures that reduce the amount of these habitat features in riparian areas and adjacent to stormwater BMPs that include permanent pools will make these areas less attractive to geese. These measures include installing vegetative buffer strips, placing rock barriers consisting of boulders at least two feet in diameter along the shoreline,[80] or installing fence barriers that physically prevent geese from walking out of the water into feeding areas.

Reducing the availability of breeding and resting areas will also discourage nuisance waterfowl. Islands and peninsulas are ideal nesting sites for waterfowl. These areas are surrounded by water and offer protection and security from predators. When creating new ponds or retention basins, any islands or peninsulas should be constructed in such a way as to discourage use by waterfowl.

While there are more aggressive measures that can be taken regarding nuisance waterfowl, it is important to note that they are Federally protected under the Migratory Bird Treaty Act of 1918. This act places restrictions on some of the methods that can be used and, in particular, requires a permit from the U.S. Fish and Wildlife Service in order to use methods that would depredate these animals. Prior to using more aggressive measures, it is important to consult with the U.S. Department of Agriculture Wildlife Services.

Reducing Impacts of Pet Waste

The transport of bacteria and other contaminants found in pet waste into surface waterbodies is accelerated in an urban environment with significant areas of impervious surface and engineered stormwater drainage systems. Management of pet wastes may reduce the amounts of these wastes that enter surface waterbodies. The regional water quality management plan update recommends that all municipalities have pet litter control ordinance requirements and that those requirements be enforced.

As described in Chapter 2 of this report, Milwaukee County and four of the six municipalities that are wholly or partially located within the Oak Creek watershed have enacted ordinances regarding control of pet litter. The applicability and requirements of these ordinances vary among the jurisdictions. The County ordinance applies only to County parks and trails. While some municipal ordinances apply only to public property or parks and trails, others apply to any public property or private property other than that belonging to the owner, caretaker, or person in control of the animal. There are also differences among jurisdictions in which animals are regulated under the ordinances. While the County and two municipalities have ordinances that apply to animals, three municipalities have ordinances that specifically apply to dogs and one municipality has an ordinance that specifically applies to dogs and cats.

It is recommended that all municipalities in the watershed have pet litter control ordinance requirements and that those requirements be enforced. Further measures to address pet litter should be considered on a site-specific basis in response to identified water quality problems resulting from pets.

Measures that could be taken to address pet waste in response to an identified water quality problem include:

- Revising existing pet litter control ordinances to apply to any public property or private property other than that belonging to the owner, caretaker, or person in control of the animal

- Stricter enforcement of existing ordinances

[80] *It should be noted that riprap and smaller rock around a pond will not deter geese.*

- Installing pet waste stations in parks and along trails that are either near waterbodies or near inputs to stormwater management systems that discharge to waterbodies

- Locating any new dog parks away from waterbodies or inputs to stormwater management systems that discharge to waterbodies

- Public outreach and educational programs regarding pet waste management.

Best Management Practice (BMP) Pilot Projects to Reduce Fecal Indicator Bacteria and Pathogens

It is recommended that pilot projects be conducted to evaluate the performance of several best management practices (BMPs) under field conditions in the Oak Creek watershed in order to determine whether these practices would be useful in reducing contributions of fecal indicator bacteria and pathogens from stormwater runoff and other sources in the watershed.

At least two approaches to modifying stormwater BMPs could be used to address the contributions of fecal indicator bacteria to surface waters; however, the performance of practices using these approaches in the field and under the types of conditions present within the Oak Creek watershed are not well understood. Because of this, it would be desirable to conduct pilot projects in the watershed in which these practices could be installed, tested, and their performance evaluated. The results of such pilot projects could be evaluated to determine their usefulness. If found to be useful in the field, such results could also be applied to devising strategies for modifying existing types of BMPs to improve their efficacy at reducing contamination of surface waters by fecal indicator bacteria and pathogens. Two approaches that could be evaluated— mycoremediation, and woodchip bioreactors—are discussed below.

<u>Mycoremediation</u>

Mycoremediation is a form of bioremediation in which fungal species are used to either inactivate environmental contaminants or remove them from the environment. Fungi produce non-specific enzymes that are capable of degrading many substances. In addition, fungi take up other substances and accumulate them in their fruiting bodies. As a result of these two characteristics, mycoremediation has been used or proposed for use to address several types of environmental contamination by several types of chemicals including pesticides, heavy metals, pharmaceuticals, and persistent organic compounds. Evidence from several studies suggests that adding fungal enhancements to some common stormwater treatment practices such as bioretention facilities might improve the practices' performance in removing or inactivating fecal indicator bacteria and some pathogens. Adding such enhancements may be a relatively inexpensive way to address fecal contamination in stormwater.

Laboratory studies showed that mycelia of several fungal species grew toward, killed, degraded, and ingested microcolonies of bacteria.[81] These fungi used organic material from the digested bacteria as a source of nutrients for their own growth. It has been hypothesized that the bacterial cells act as a source of nitrogen for the fungi. One study tested 100 species from several fungal groups and found that all of the species that did this were members of the Basidiomycetes (mushrooms) group. Species that were found to be especially active in degrading bacteria include the common mushroom (*Agaricus bisporus*), the scaly inky cap mushroom (*Coprinus quadrifidus*), the wood blewit mushroom (*Lepista nuda*), *and* the pearl oyster mushroom (*Pleurotus ostreatus*) (Figure 6.4). Other studies showed that extracts from several fungal species inhibited the growth of some bacteria species.[82] Bacteria that were sensitive to inhibition by fungal extracts included *E.coli* and three non-waterborne pathogenic species. The results were dependent on the particular combination of bacterium and fungus tested, with some bacteria species being highly sensitive to

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[81] *G. Barron, "Microcolonies of Bacteria as a Nutrient Source for Lignicolous and Other Fungi,"* Canadian Journal of Botany, *volume 66, pages 2,505-2,510, 1988; T.R. Femor and D. Wood, "Degradation of Bacteria by* Agaricus bisporus *and Other Fungi,"* Journal of General Microbiology, *volume 126, pages 377-387, 1981.*

[82] *B.A. Iwalokun, U.A. Usen, A.A. Otunba, D.K. Olykoya, "Comparative Phytochemical Evaluation, Antimicrobial and Antioxidant Properties of* Pleurotus ostreatus," African Journal of Biotechnology, *volume 6, pages 1,732-1,739, 2007; M. Akyuz, A.N. Onganer, P. Erecevit, and S. Kirbag, "Antimicrobial Activity of Some Edible Mushrooms in the Eastern and Southeast Anatolia Region of Turkey,"* Gazi University Journal of Science, *Volume 26, pages 125-130, 2010; F. Kalyoncu, M. Oskay, H. Saglam, T.F. Ergodan, and A.U. Tamer, "Antimicrobial and Antioxidant Activities of Mycelia of 10 Wild Mushroom Species,"* Journal of Medicinal Food, *volume 13, pages 415-429, 2010.*

Figure 6.4
Examples of Fungal Species Found to Kill, Digest, or Inhibit Fecal Indicator Bacteria

BURGANDY MUSHROOM
Stropharia rugosos-annulata

BUTTON MUSHROOM
Agaricus bisporus

PEARL OYSTER MUSHROOM
Pleurotus ostreatus

SCALY INK CAP MUSHROOM
Coprinus quadrifidus

WHITE ELM OYSTER MUSHROOM
Pleurotus ulmarius

WOOD BLUET MUSHROOM
Lepista nuda

Source: Individual cited photographers and SEWRPC extracts from certain fungal species and less sensitive to extracts from others. The levels of inhibition varied. In some cases, the degree of inhibition was greater than that produced by four conventional antibiotics. In other cases, it was less. A review of the literature on activity of extracts found that *E. coli* and *Klebsiella pneumoniae* were the most sensitive bacteria species examined to inhibition by fungal extracts.[83] These are both gram negative bacteria and members of the fecal coliform group. Despite this, the review found that gram positive bacteria were generally more sensitive to inhibition than gram negative bacteria.

The differences in the effectiveness of extracts from different fungi against different bacteria species and the sensitivity of *E. coli* and *Klebsiella pneumoniae* have important implications for evaluating the effectiveness of mycoremediation as an approach to addressing fecal contamination of stormwater. In particular, these factors suggest that approaches to evaluating performance that rely on monitoring only *E. coli* or fecal coliform bacteria could overestimate the benefits of mycoremediation with respect to bacterial pathogens.

Laboratory bench-scale and mesocosm-scale studies have shown that treatment of simulated stormwater by exposure to mycelia of fungi such as *P. ostreatus* or *Stropharia* sp. can reduce concentrations and loads of fecal indicator bacteria such as *E. coli* and fecal coliform bacteria (see Figure 6.5).[84] These studies also show that the medium used to grow and support the fungal mycelium may have major effects on performance or cause unintended adverse impacts of fungal treatment. One study found that using straw as a medium to support fungal growth increased concentrations of *E. coli* in simulated stormwater passing through a mesocosm-scale mycofiltration system.[85] While the effects of medium on the growth of pathogenic bacteria has not been studied, the results for indicator bacteria like *E. coli* suggest that the medium used to grow and support the fungal mycelium might have similar effects on pathogenic bacteria. Another study found that passage of simulated stormwater through biocell reactors using spent mushroom compost to support fungal growth increased the pH of water being treated.[86] In addition, numerous substances, including nutrients such as phosphorus and nitrate, and metals such as aluminum, chromium, copper, iron, manganese, and zinc leached out of the compost.

Review of the available literature found only one strong field test of a BMP incorporating mycoremdiation that included performance data.[87] In this study, two bioretention cells were constructed adjacent to one another. These cells had similar designs and layouts and were planted with similar vegetation. The design of both cells included a surface layer mulch composed of alder chips. The mulch in one cell had been inoculated with the fungi *Pleurotus ostreatus, Pleurotus ulmarius, and Stropharia rugoso-annulata* and incubated to develop fungal mycelia prior to placement in the cell (see Figure 6.4). The mulch in the other cell was not inoculated or incubated. Both cells received runoff from the same horse pasture. In one analysis, concentrations of fecal coliform bacteria were monitored in runoff flowing into each cell and water flowing out of the cells through under drains. Under normal inflow conditions, the fungal-enhanced cell reduced concentrations of fecal coliform bacteria by 90 percent while the control cell reduced concentrations by 67 percent; however, during this test inflow concentrations of fecal coliform bacteria were very low, generally about 30 colony forming units per 100 milliliters (cfu per 100 ml). In a second experiment, water flowing into the cells was spiked with fecal coliform bacteria. A spike of about 13,000 cfu per 100 ml was added to the inflow every 15 minutes over a four-hour period. Concentrations of fecal coliform bacteria in outflow

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[83] *M.J. Alves, I.C.F.R. Ferreira, H.J. Froufe, R. Abreu, A. Martins, and M. Pintado, "Antimicrobial Activity of Phenolic Compounds Identified in Wild Mushrooms, SAR Analysis, and Docking Studies,"* Journal of Applied Microbiology, *volume 115, 346-357, 2013.*

[84] *See, for example, J.P. Harris,* Degradation of Harmful Bacterial in Simulated Wastewater and Stormwater Runoff by the White Rot Fungus *Pleurotus ostreatus, Undergraduate Thesis, University of Delaware, Newark Delaware, Spring 2012; T. Rogers,* Experimental Evaluation of Mycoremediation of *Escherichia coli* Bacteria in Solution Using *Pleurotus ostreatus, Master's Thesis, Evergreen State College, Olympia, Washington, June 2012; L. Stamets,* Best Mycoremediation Practices for Habitat Restoration of Small Parcels, *Master's Thesis, Evergreen State College, Olympia, Washington, June 2012; A.A. Flatt,* Removal of *Escherichia coli from Stormwater Using Mycofiltration,* Master's Thesis, Washington State University, Pullman, Washington, May 2013.

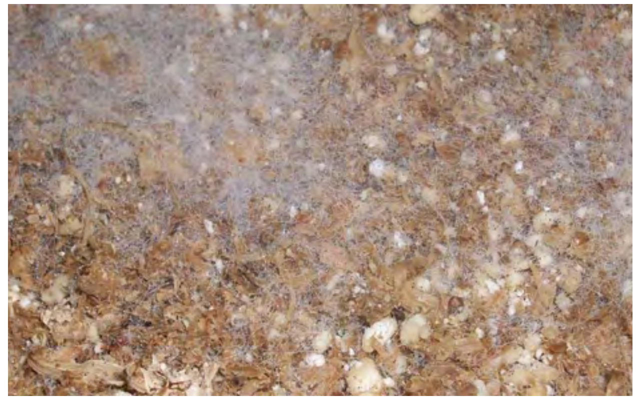
[85] *Flatt, 2013* op. cit.

[86] *Harris, 2012* op. cit.

[87] *S.A. Thomas, L.M. Aston, D.L. Woodruff, and V.I. Cullinan,* Field Demonstration of Mycoremediation for Removal of Fecal Coliform Bacteria and Nutrients in the Dungeness Watershed, Washington, *Report to the Jamestown S'Klallam Tribe, March 2009.*

from the fungal-enhanced cell averaged about 5 cfu per 100 ml and never exceeded 10 cfu per 100 ml. Concentrations of fecal coliform bacteria in outflow from the control cell increased from 0 cfu to 376 cfu per 100 ml. Following this, concentrations in outflow from the control cell decreased but remained higher than those in outflow from the fungal-enhanced cell for about 28 hours. Overall, the fungal-enhanced cell removed about 97 percent of the added bacteria while the control cell removed about 92 percent. While this test shows that adding fungal enhancements to bioretention facilities can improve performance in reducing fecal indicator bacteria at low influent concentrations, it does not address how it would perform at higher concentrations and whether there is an upper threshold concentration at which performance drops off.

Figure 6.5
Mycelium of the Pearl Oyster Mushroom (*Pleurotus ostreatus*) Growing in Wood Chip Media



Source: Wikimedia Commons User Rick Proser and SEWRPC

A second field study examined the use of a mycofiltration garden consisting of burlap sacks filled with wood chips inoculated with fungal mycelium placed in the pathway of surface runoff from a cattle feedlot.[88] Runoff entering and leaving the mycofiltration garden were sampled for concentrations of fecal coliform bacteria. In about half of the paired samples, concentrations of fecal coliform bacteria in water leaving the mycofiltration garden were lower than those entering; however, this study lacked controls examining whether burlap sacks filled with uninoculated wood chips would have an effect on bacteria concentrations, so it is not clear whether the presence of the fungal mycelium was responsible for the reduction or whether the reduction resulted from other processes occurring within the bioswale.

Using mycoremediation to enhance stormwater BMPs may be relatively inexpensive. It was estimated that enhancement of eight large bioswales at South Shore Beach in Milwaukee added about $3,000 to project costs of almost $3,000,000.[89]

It is recommended that pilot projects be conducted to evaluate the performance of using fungal enhancements to BMPs under field conditions in the Oak Creek watershed in order to determine whether this approach would be useful in reducing contributions of fecal indicator bacteria and pathogens from stormwater runoff and other sources in the watershed. Such pilot projects could involve the addition of woodchip mulch inoculated and incubated with fungi to bioretention facilities and bioswales.

It is also recommended that these pilot projects incorporate monitoring and studies to evaluate their performance. It is important that studies evaluating the field performance of this approach be conducted as part of the pilot projects. As previously discussed, almost all of the studies examining the potential of mycoremdiation to address fecal indicator bacteria and pathogens in stormwater have been conducted in laboratory settings. The few field data available were collected in the Pacific Northwest and examined bacteria concentrations that are much lower than those often found in stormwater.[90] Given the differences in climate between the Pacific Northwest and southeastern Wisconsin, it is not clear how applicable the results of this study may be to conditions in the Oak Creek watershed. These studies should incorporate appropriate controls to ensure that the results can be attributed to mycoremediation and not the effects of the BMP without the fungal enhancements.

[88] *F. Perez,* Noncompetitive Tribal Projects for the Restoration and Protection of Puget Sound: Installation of Mycofiltration Gardens to Treat Polluted Land-Based Runoff, *Report by the Stillaguamish Tribe Department of Natural Resources to the Puget Sound Partnership, December 2015.*

[89] *C. Bristoll-Groll, Stormwater Solutions Engineering, LLC., quoted in: S. Bence, "Can Green Infrastructure Alone Transform Bay View's South Shore into a Swimmable Beach?" WUWM radio, September 4, 2017 www.wuwm.com/post/can-green-infrastructure-alone-transform-bay-views-south-shore-swimmable-beach#stream/0.*

[90] *S.A. Thomas and others, 2009* op. cit.

There are several questions that evaluation of the performance fungal-enhanced BMPs should address. These include:

- How much does the addition of fungal enhancement to a BMP reduce fecal indicator bacteria and pathogen concentrations and loads over controls?

- Over what range of concentrations of fecal indicator bacteria and pathogens in influent water is this effective? Are there lower and upper thresholds beyond which performance falls off?

- Are fungal enhanced BMPs capable of removing fecal indicator bacteria and pathogens during high flow events? How much contact time between stormwater and the fungal mycelium is needed for this enhancement to be effective?

- Will fungal enhanced BMPs discharge treated water with low concentrations of fecal indicator bacteria and pathogens?

- Does the performance of fungal enhanced BMPs against pathogenic bacteria and other pathogens differ from the performance against fecal indicator bacteria? (This is important to address because if fecal indicator bacteria are more sensitive to treatment than waterborne pathogenic bacteria, treatment through mycoremediation might result in receiving waters achieving technical compliance with the recreational use criteria without improving the safety of the waters for human contact).

- Will fungal enhanced BMPs kill bacteria through the entire seasonal cycle? How will desiccation during droughts and freezing during winter affect performance?

- How long will the fungal mycelium remain active?

- What maintenance regimen is required to sustain performance? For example, will periodically adding untreated wood chip mulch be sufficient to maintain existing mycelia or will adding mulch that has been inoculated with fungi and incubated prior to addition be necessary to maintain performance? How often will maintenance need to be performed?

- Do the mushroom species used accumulate heavy metals in their fruiting bodies at concentrations that pose a risk to people who might gather and consume them? This is of concern because the fruiting bodies of several of the species examined in laboratory and field studies are edible. Some fungi have been shown to absorb and retain high concentrations of heavy metals.[91] *Pleurotus* species in particular have been reported to accumulate high levels of heavy metals.[92]

A bibliography of references related to mycoremediation is given in Appendix P.

<u>Woodchip Bioreactors</u>

Woodchip bioreactors are constructed by routing water from drainage tiles through an underground trench filled with wood chips. The design includes inflow and outflow control structures which regulate the amount of water entering the bioreactor and ensure that water remains in the bioreactor long enough for treatment to occur. They have generally been used to reduce nutrient concentrations in drainage water, mostly for nitrogen but in some instances for phosphorus. Fewer data are available regarding the performance of woodchip bioreactors with respect to fecal indicator bacteria. One study found that woodchip bioreactors produced reductions in loads of fecal indicator bacteria ranging between 60 and 69 percent.[93] A second study

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[91] *D. Michelot, E. Siobud, J. Dore, C. Viel, and F. Poirier, "Update on Metal Content Profiles in Mushrooms: Toxicological Implications and Tentative Approach to the Mechanisms of Bioaccumulation,"* Toxicon, *volume 36, pages 1,997-2,012, 1998.*

[92] *M. Kahahi and S. Sachdeva, "Mycoremediation Potential of* Pleurotus *Species for Heavy Metals: A Review,"* Bioresources and Bioengineering, *volume 4, article 32, doi: 10.1186/s40643-017-01628, 2017.*

[93] *A. Ranaivoson, J. Moncrief, R. Venteraea, M. Dittrich, Y. Chandler, and P. Rice, "Bioreactor Performance in Minnesota," Presentation at the 11th Annual Drainage Research Forum, Owatonna, Minnesota, November 23, 2010.*

showed reductions of both fecal indicator bacterial and a bacterial virus in municipal wastewater.[94] Because of this, **it is recommended that a small number of woodchip bioreactors pilot projects be conducted in areas of the Oak Creek watershed that are drained by drain tiles in order to evaluate the practicality and utility of this practice for reducing bacterial and pathogen contributions to surface waters.**

Recommended Actions to Reduce Concentrations of Chloride

The recommendations of the RWQMPU as they relate to nonpoint source pollution from chlorides in the Oak Creek watershed were reviewed (see Chapter 2 of this report) and reevaluated under this watershed restoration planning effort. Based on that review and reevaluation, which included consideration of the additional water quality monitoring data collected since the RWQMPU was issued and recommendations that have already been implemented, the current applicability of the recommendations of the RWQMPU was confirmed. Thus, the following RWQMPU recommendations are reiterated with some refinements under this plan:

- **Municipalities in the watershed and Milwaukee County should continue to evaluate their practices regarding the application of chlorides for ice and snow control and strive to obtain optimal application rates to ensure public safety without applying more chlorides than necessary for that purpose.**

- **Municipalities and the County should consider alternatives to current ice and snow control programs.** Such alternatives might include identifying areas where sand would not be a potential detriment to receiving waters or where BMPs will capture sand before it can enter receiving waters and applying sand or a sand-salt mixture to roads in these areas.

- **Education programs should be implemented to provide information about alternative ice and snow control measures on public and private properties and optimal application rates for such areas.**

- **Education programs should be implemented to provide information about alternative water softening media and the use of more efficient water softeners which are regenerated based upon the amount of water used and the quality of the water.**

The RWQMPU recommended that communities also consider implementing measures such as calibration of deicer application equipment, prewetting of solid deicers, and the use of alternative snow and ice control materials.

The MS4 permits that Milwaukee County and the municipalities in the Oak Creek watershed operate under for discharging stormwater include requirements pertaining to the application of deicing chemicals. These permits require that no more road salt or other deicers be applied than the amount necessary to maintain public safety. For most of the communities in the watershed, the permits also require the development and implementation of either a winter road management plan, salt application strategy, or salt reduction strategy to minimize the over-application of deicers. While there are differences among the permits regarding the specific information that should be included in such a plan or strategy, typical elements include:

- Identification of staff responsible for implementing winter road maintenance

- Identification of truck routes with attention to waterway crossings and road areas within 100 feet of a waterbody

- Description of deicing equipment

- Annual calibration of deicing equipment and a description of calibration methods

- Descriptions of deicing and anti-icing products and their effective temperature ranges

[94] *F. Rambags, C.C. Tanner, R. Stott, and L.A. Schipper, "Bacteria and Virus Removal in Denitrifying Bioreactors: Effects of Media Type and Age,"* Ecological Engineering, *volume 138, pages 46-53, 2019.*

- Application rates for deicing and anti-icing products
- Identification of disposal locations for mass snow removal
- Periodic training of winter road maintenance staff

It is recommended that Milwaukee County and the municipalities of the watershed develop and periodically update winter road management plans, salt application strategies, or salt reduction strategies. Such plans could also incorporate a variety of best management practices related to storage and application of deicers. These practices are described in Appendix Q. Communities should consider incorporating these practices into their winter road management plans, salt application strategies, or salt reduction strategies.

Discharge of brine used to recharge water softeners also releases chloride to the environment. While sanitary sewerage systems receive most of the brine from water softener recharge in the Oak Creek watershed, some is discharged into the remaining onsite sewage treatment systems that are present in the watershed. Appendix Q describes best management practices for reducing chloride contributions from water softening.

Recommended Actions to Reduce Point Source Pollution

The recommendations of the RWQMPU as they relate to point source pollution in the Oak Creek watershed were reviewed (see Chapter 2 of this report) and reevaluated under this watershed restoration planning effort. Based on that review and reevaluation, which included consideration of the additional water quality monitoring data collected since the RWQMPU was issued and recommendations that have already been implemented, the current applicability of the recommendations of the RWQMPU was confirmed. Thus, the following RWQMPU recommendations are reiterated under this plan:

1. **That the MMSD and the City of South Milwaukee maintain and operate wastewater treatment plants.**

2. **That municipalities in the watershed construct and maintain local sanitary sewer systems.** This recommendation applies to all of the municipalities that are wholly or partially located in the watershed.

3. **That municipalities operating local sewerage systems evaluate the need to reduce clearwater infiltration and inflow into sewers and implement Capacity, Management, Operations, and Maintenance (CMOM) programs.**[95]

4. **That discharges from all points of sewerage flow relief be eliminated.**

5. **That wastewater treatment plant and industrial discharges to surface waters continue to be regulated through the WPDES program, with effluent concentrations of pollutants being controlled to acceptable levels on a case-by-case basis through the operation of the WPDES.**

The RWQMPU also recommended that the City of South Milwaukee make several improvement and upgrades to its wastewater treatment plant. These improvements and upgrades were completed in 2015.

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[95] *CMOM is a program initiated by USEPA that provides a framework for municipalities to identify and incorporate widely accepted wastewater industry practices in order to better manage, operate, and maintain collection systems; investigate capacity constrained areas of the collection system; and respond to sanitary sewer overflow events. MMSD rules require that communities within its service area implement CMOM programs. Section NR 210.23, "Capacity, Management, Operation and Maintenance Programs," of the* Wisconsin Administrative Code *requires that units of government that have WPDES permits for operation of sewerage systems and/or wastewater treatment plants have implemented CMOM programs as of August 1, 2016.*

Recommended Actions to Address Toxic Substances and Emerging Pollutants

Household Hazardous Waste Collection

Improper disposal of household hazardous wastes can introduce pollutants into the environment, leading to contamination of surface waters and groundwater. Within Milwaukee County, MMSD conducts a household hazardous waste collection program. MMSD collects household hazardous waste at the three permanent sites located in the Cities of Franklin and Milwaukee and the Village of Menomonee Falls. This program is open to all Milwaukee County residents, including resident of the City of South Milwaukee. In addition, MMSD periodically provides waste collection at temporary collection sites**. It is recommended that MMSD's collection programs for household hazardous wastes be continued and supported.**

Pharmaceuticals and Personal Care Products

Contaminants of emerging concern include pharmaceuticals and personal care products. Recent research shows that these contaminants are entering lakes, rivers, and streams and may be producing adverse effects on fish and other aquatic organisms. These compounds can enter surface waters in a number of ways. These include disposal of medicines or products through flushing down the toilet; disposal of medicines or products by pouring down the drain; and excretion of medications by humans, pets, or farm animals. The extent of the threat posed to human health and to the integrity of surface waters by the presence of these compounds is not currently known.

It is recommended that assessments and evaluations be made of the significance for human health and for aquatic and terrestrial wildlife of the presence of pharmaceuticals and personal care products in surface waters. Ongoing research regarding the presence, effects, and fates of these compounds in the environment should continue to be monitored. As a part of the MMSD Corridor Study conducted by MMSD and USGS, sampling has been conducted for the presence of pharmaceuticals and personal care products in the water column, bed sediment, sediment pore water, and biota. It is recommended that this project be supported.

Given the uncertainty regarding the threat posed by these substances, it would be protective of human health and the integrity of surface waters to reduce inputs of these materials into the environment. Because of this, **it is recommended that collections of expired and unused medications continue to be conducted.** The WDNR has issued guidance on regulatory aspects of collecting unwanted household pharmaceuticals.[96] Several programs are currently active. Drop boxes are available at police departments in all of the municipalities that are wholly or partially located within the Oak Creek watershed.[97] Drop boxes are also available at several pharmacies in or near the Oak Creek watershed.[98] There is also an active mail-back program for disposal of pharmaceuticals. Through this program, free postage-paid drug-disposal envelopes are available at some CVS Pharmacies in the Cities of Cudahy and Milwaukee for the disposal of unwanted or expired prescriptions. With the participation of local law enforcement agencies and others, the Wisconsin Department of Justice sponsors an annual drug take back day.[99] Wisconsin also allows some unused cancer and chronic disease drugs and supplies to be donated to participating pharmacies or medical facilities for use by other patients. Rules governing this are set forth in Chapter HFS 148 of the *Wisconsin Administrative Code*.[100]

It is important to note that household pharmaceutical waste is excluded from regulation as a hazardous waste as set forth in Chapter NR 661, "Hazardous Waste Identification and Listing," of the *Wisconsin Administrative Code*. In general, if a household waste is managed separately by a non-household member, the exemption no longer applies. One exception to this is people collecting strictly household pharmaceuticals. The DNR

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[96] *Wisconsin Department of Natural Resources,* Collecting Unwanted Household Pharmaceuticals: Regulatory Guidance for Organizers of Household Pharmaceutical Collection Events, *Pub. WA-1025-2006, August 9, 2006; note that as of June 11, 2021 this guidance document was being revised.*

[97] *As of October 1, 2020, the drop box at the City of Greenfield Police Department was unavailable due to the COVID-19 pandemic.*

[98] *A mapping utility showing the locations of sites in Milwaukee County with drop boxes can be accessed at: www.takebackmymeds.com.*

[99] *More information on this can be found at doseofrealitywi.gov/drug-takeback.*

[100] *More information on this can be found at www.dhs.wisconsin.gov/guide/cancer-drugrepo.htm.*

has issued an enforcement discretion memorandum to allow for the hazardous waste exclusion to apply in this situation. As of October 1, 2020, the WDNR was updating its guidance to reflect the changes rules from the Federal Drug Enforcement Agency, Wisconsin's drug disposal law, and other recent developments.

Coal-Tar-Based Sealants

As noted in Chapter 4 of this report, the use of coal-tar-based pavement sealants to seal asphalt is a major source of PAHs to surface waters and sediment.[101] As of October 1, 2020, Milwaukee County and four municipalities in the Oak Creek watershed, the Cities of Franklin, Greenfield, Milwaukee, and Oak Creek, have enacted ordinances prohibiting the use of coal-tar-based sealants within their jurisdictions. **It is recommended that the Cities of Cudahy and South Milwaukee enact and enforce ordinances banning the use of coal-tar-based sealants.**

Molybdenum Contamination of Groundwater

As discussed in Chapter 4 of this report, contamination of private wells with molybdenum has been reported within and in the vicinity of the Oak Creek watershed. **It is recommended that municipal water utilities in the affected municipalities consider extending municipal service to locations affected by such contamination.** It should be noted that this recommendation is consistent with the 2035 water supply service areas recommended in the regional water supply plan.[102]

Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)

As discussed in Chapter 4 of this report, PFAS contamination has been detected in soil and groundwater at locations at Milwaukee Mitchell International Airport (MMIA) in the Oak Creek watershed. As of October 2020, MMIA and Milwaukee County continue to investigate the amount and extent of contamination on the airport grounds. **It is recommended that MMIA and Milwaukee County continue to document the amount and extent of PFAS contamination at the airport. In addition, consideration should be given to investigating whether surface water and sediment within the Mitchell Field Drainage Ditch have been affected by this contamination.**

Polychlorinated Biphenyls (PCBs)

As discussed in Chapter 4 of this report, high concentrations of PCBs were recently detected in surface sediment samples collected near the mouth of Oak Creek. Subsequent sampling of surficial sediments found elevated concentrations of PCBs at sites in the mainstem of Oak Creek downstream from the Mill Pond dam. The findings from sediment sampling indicate that further evaluation of sediment quality is warranted in the lower reaches of Oak Creek, especially downstream of the Mill Pond. **Such evaluation is recommended and should include collection and examination of sediment cores to characterize the extent, types, and amounts of contaminants within the sediment through its entire depth.**

The WDNR has issued consumption advisories for Lake Michigan fish due to PCB contamination of fish tissue (see Table 4.27 in Chapter 4 of this report). **It is recommended that general notice signs, based upon these fish consumption advisories, be placed at fishing access points for the reaches of Oak Creek that are downstream of the Mill Pond dam.**

6.3 RECOMMENDED ACTIONS TO IMPROVE HABITAT

Recommended Actions to Maintain and Re-Establish Natural Surface Water Hydrology

Both urbanization and agricultural development have brought significant changes to the landscape and have produced profound effects on the hydrology within the Oak Creek watershed. These landscape changes historically have included modification of drainage patterns, hardening of surfaces, alteration of groundwater infiltration within urban areas, straightening and ditching of streams, disconnection of streams from their

[101] *B.J. Mahler, P.C. Van Metre, T.J. Bashara, J.T. Wilson, and D.A. Johns, "Parking Lot Sealcoat: An Unrecognized Source of Urban Polycyclic Aromatic Hydrocarbons,"* Environmental Science and Technology, *Volume 39, pages 5,560-5,566, 2005; A.K. Baldwin, S.R. Corsi, M.A Lutz, C.G. Ingersoll, R. Dorman, C. Magruder, and M. Magruder, "Primary Sources and Toxicity of PAHs in Milwaukee-area Streambed Sediment,"* Environmental Toxicology and Chemistry, *Volume 36, pages 1,622-1,635, 2017.*

[102] *SEWRPC Planning Report,* A Regional Water Supply Plan for Southeastern Wisconsin, *December 2010.*

functional floodplain,[103] and installation of drainage tile systems in previous and current agricultural areas. These changes to the landscape generally act to increase the volume and rate of runoff from precipitation events leading to increased flashiness in stream flow, reducing the recharge of groundwater that supplies baseflow for streams and wetlands, and increasing the export of water out of the Oak Creek watershed and into Lake Michigan. The increased flashiness in stream flow reduces streambank and streambed stability, increases pollutant loading, and changes the sediment dynamics within the stream system. These changes ultimately reduce the availability of habitat and degrade its quality.

The recommendations set forth below are intended to promote restoration of the hydrologic functions of streams, wetlands, and other waterbodies in the watershed so that stream discharges more closely resemble those that are thought to have occurred prior to agricultural or urban development, to the extent possible. Specifically, decreases in high-flow magnitude, frequency, and/or duration are sought to provide potential improvements in the biological communities within the Oak Creek watershed. Some of the recommendations necessary to meet the goal of restoring the hydrology of the watershed are described in detail in other sections of this chapter that focus on other management objectives. For implementation purposes, it is important to note that those recommendations will serve multiple objectives.

Recommended Actions to Reduce Runoff Volume and Velocity and Increase Infiltration

Urban Surface Water Hydrology

Urban development often involves manipulation of the landscape in ways that increase volume and speed of runoff and decrease groundwater infiltration. When the amount of urban development in a watershed increases, the amount of impervious surface area also increases. This has been true in the Oak Creek watershed, where the amount of impervious surface has been increasing since the first Commission land use inventory was conducted in 1963. Historically, the approach to managing increases in rates and volumes of runoff caused by impervious surfaces has involved constructing stormwater infrastructure designed to convey stormwater as quickly as possible to streams and ultimately to Lake Michigan. This has led to increases in the volume of water reaching streams during wet weather and decreases in baseflow to waterbodies and wetlands during dry weather. Such changes are generally detrimental to waterbody health.

Natural features such as wetlands, floodplains, and closed depressions are vital in detaining water, facilitating the occurrence of physical and biological processes that reduce pollutant and sediment loads. Therefore, management actions should be taken to preserve and enhance the ability of the watershed to detain and more slowly release runoff, reduce peak flows, and better approximate natural runoff patterns.

1. **It is recommended to protect, restore, and enhance natural landscape elements that "slow down water" and reduce the magnitude of flashiness in stream flow and its negative effects on aquatic habitat quality.** Specific measures that can be taken to accomplish this recommendation include:

   - Protecting and restoring existing wetlands and expanding them where feasible

   - Implementing the recommendations described in the next section to protect, expand, and establish new riparian buffers to allow rainfall to be captured and infiltrated and floodwaters to be dissipated when necessary (riparian buffer recommendations are described in detail in the "Recommended Actions to Protect, Restore, Expand, and Connect Riparian Buffers" section below)

   - Implementing recommendations detailed below that emphasize the siting of urban development away from high groundwater recharge areas and installing infiltration practices in those areas where development is necessary or already exists

In such a highly urbanized watershed like Oak Creek, the capacity of the remaining natural features may be insufficient to achieve the desired goals of detaining and slowing down stormwater runoff. Periodic flooding, water quality impairment, environmental degradation, and the impacts of climate change have

[103] *It should be noted that "functional floodplain," as referred to in the recommendations to improve habitat in this section, is defined as a relatively flat valley floor or bench that can carry and/or retain some volume of flood water that has overtopped the banks of a stream. The use of the term in this section is not necessarily referencing the regulatory 1-percent-annual-probability (100-year recurrence interval) floodplain.*

demonstrated the need for an alternative and/or supplemental approach to urban stormwater management. Purpose-built artificial structures that seek to manage runoff using a variety of measures to better mimic the precipitation runoff pattern on an undisturbed landscape are recommended to supplement the natural features in the watershed.

2. **It is recommended that measures be implemented to promote stormwater reuse, storage, and infiltration in existing and planned urban areas.**[104] Artificial detention features should be installed to serve new developments or retrofitted to infrastructure in developed areas. With sound planning, it can sometimes be feasible to build features as part of new development that also serve existing development. Implementing this recommendation could involve:

   - **Enhancing the ability of rainfall and snowmelt to be detained in, filtered through, evapotranspired through, and/or infiltrated into soils.** This could be achieved by installing modern stormwater best management practices (BMPs) and green infrastructure associated with low-impact development. Such BMPs include rain gardens, bioswales, porous pavement, stormwater detention basins, and other stormwater infrastructure specifically designed and carefully located to slow runoff, improve water quality, and promote infiltration. Examples of simple infiltration measures include voluntarily directing stormwater to areas of permeable soil and favorable topography or minimizing impervious surfaces. An example of redirecting stormwater would be homeowners disconnecting roof downspouts from storm sewers or away from impervious surfaces. Such initiatives can be promoted by active educational outreach, providing instructions and supplies to property owners, and/or through subsidies. Some practices and projects, especially on public property, may qualify for partial funding through the WDNR Healthy Lakes & Rivers program.

     Schoolyard spaces within the watershed may provide opportunities for improved stormwater management while also providing environmental education, health, and social benefits. The MMSD green infrastructure for schools guidebook provides information on commonly installed types of green infrastructure that can be implemented on school grounds.[105] Green infrastructure projects and/or programs at schools may provide the additional opportunity to fulfill public information and education requirements that MS4 communities have as part of their municipal stormwater discharge permits. Given the relatively low cost, ease of implementation, and potential educational benefits, **it is recommended that all schools within the Oak Creek watershed consider establishing at least one rain garden and at least one rain barrel.**

     MMSD has recently undertaken more extensive projects at schoolyards in the City of Milwaukee. These projects remove asphalt and concrete pavements located in school playgrounds and replace them with native landscaping, trees, bioswales, cisterns, permeable synthetic turf, and porous pavement. MMSD has funded a large portion of the projects at six schools, with the remaining funds coming from the City of Milwaukee, various State and Federal agencies, and the Fund for Lake Michigan. Along with improved stormwater infiltration, the new schoolyards provide upgraded play spaces and outdoor environmental education classroom opportunities for the students. **It is recommended that funding for similar schoolyard green infrastructure projects be pursued by school districts within the Oak Creek watershed.**

   - **Municipalities should ensure that their ordinances are compatible with green infrastructure practices** (see *Green Infrastructure* section above for details).

   - **Retrofitting existing stormwater management systems with features that enhance water quality and/or moderate runoff rates.** Elements such as stormwater retention/infiltration basins, bioswales in parking lots and roadway medians, green alleys and other permeable conveyance, increasing the distance between stormwater outfalls and streambanks to allow for filtration through riparian buffers rather than direct discharge, and other infrastructure

[104] *Measures should meet or exceed minimum requirements set forth in community stormwater ordinances and requirements in place for development or redevelopment within the Milwaukee Metropolitan Sewerage District's planning area under Chapter 13.11 of the Surface Water and Stormwater Rules.*

[105] *Milwaukee Metropolitan Sewerage District, Green Infrastructure for Schools Guidebook, 2017.*

elements can help reduce the impact of urban development on the quantity of runoff and its effect on surface water quality.[106] In certain instances, stormwater infrastructure built for new development can be located and sized to also manage stormwater runoff from existing development. Such projects that can be easily integrated into stormwater system upgrades should be considered whenever practical.

- **Integrating advanced stormwater management practices into local permitting processes.** An ordinance requiring onsite stormwater management practices such as permeable conveyance, porous pavement, and limits to impervious surface as a condition of issuance of a building permit for single building developments and the additional requirement of stormwater detention for larger developments may be a step toward a more comprehensive approach that benefits urban developments, surface and groundwater quality, and a more natural watershed hydrology. Such ordinances should be actively enforced when they exist or should be considered for inclusion into existing ordinances.

Specific Area of Concern to Re-Establish Natural Surface Water Hydrology:
Confluence of Oak Creek and North Branch Oak Creek

A location of particular concern in the watershed is the area surrounding the confluence of Oak Creek and North Branch Oak Creek. The stream channels in this area were highly modified in the early 1970s as part of roadway expansion projects involving W. Ryan Road (STH 100) and S. Howell Avenue (STH 38). This work included relocating about a mile of the Oak Creek channel downstream of the W. Ryan Road crossing. This relocation of Oak Creek shortened the length of North Branch Oak Creek and moved the confluence of the two streams about 1,000 feet to the north of its original location (see Figure 4.6 in Chapter 4 of this report). Channel modifications related to the roadway work extend from upstream of W. Ryan Road to nearly 1,000 feet downstream of S. Howell Avenue.

Commission staff obtained plans from the 1972 reconstruction project of W. Ryan Road specifically related to the roadway and culvert work. The plans indicate the elevations of W. Ryan Road, as well as channel bed elevations of Oak Creek, were lowered significantly to allow for re-routing of W. Ryan Road under the Canadian Pacific Railway crossing to the west. Originally the railroad passed under W. Ryan Road at this location. The project included installation of a new three-barrel culvert at W. Ryan Road to convey Oak Creek under the newly expanded and lowered roadway. The 1972 plans further indicate that the new box culvert was installed several feet below the pre-project Oak Creek channel bed elevation, creating a nearly flat stream bed profile in the reach downstream of W. Ryan Road. While review of aerial photos and field observations make it clear that channel relocations occurred in the area downstream of Ryan Road, Commission staff was unable to locate any project design plans or specifications for the new channel construction between W. Ryan Road and S. Howell Avenue.

These channel modifications have caused several water resource management challenges in and potentially beyond the immediate area. These challenges include conditions that compromise the integrity and/or performance of stream crossings, have the potential to affect public safety, reduce the ability of floodplains to manage floodwater and mitigate Oak Creek's sediment and pollutant loads, hinder or prevent aquatic organism passage, and significantly compromise the overall ecological integrity of the stream and stream corridor in this area. Examples of these problems include:

- Re-routed, lowered, ditched, and over-widened stream segments have disconnected Oak Creek from its functional floodplain and have produced channel slopes that are not sufficient to transport the amount of sediment entering the stream. This has led to large accumulations of unconsolidated sediments in the reconstructed reach downstream of W. Ryan Road, has contributed to sedimentation within the road culvert and immediately upstream of the structure, and has greatly reduced instream habitat quality.

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[106] *For descriptions, applications, and photographs of common green infrastructure practices see, Milwaukee Metropolitan Sewerage District,* Fresh Coast Green Solutions: Weaving Milwaukee's Green & Grey Infrastructure into a Sustainable Future, *no date; Milwaukee Metropolitan Sewerage District,* Regional Green Infrastructure Plan, *June 2013; Milwaukee Metropolitan Sewerage District,* Green Infrastructure Standard Specifications and Plan Template Report, *October 2016; and Stormwater Solutions Engineering, LLC,* Green Infrastructure Operations & Maintenance Standards Guide, *Report to the Milwaukee Metropolitan Sewerage District, February 2020.*

- Current sediment accumulations within the Ryan Road culvert have restricted the flow capacity to such an extent that Oak Creek may overtop the road during extreme high flow events, including during a 1-percent-annual-probability (100-year recurrence interval) flood.

- Stream bed erosion on North Branch Oak Creek has exposed the downstream foundation of the Canadian Pacific Railway crossing located about 0.1 miles upstream of the current confluence with the mainstem of Oak Creek. The structure foundation has cracked and crumbled in multiple locations and some of the underlying material has been washed out from beneath the structure. Water has been observed actively flowing under the concrete box culvert structure, a situation that suggests that its structural integrity may be compromised. In addition, the downstream invert of the culvert is perched about 4 feet above the downstream water surface, creating a passage barrier for aquatic organisms.

In order to consider how to best address some of the challenges described above, more detailed information is necessary. Therefore, **it is recommended that a detailed survey be conducted on the mainstem of Oak Creek from S. 13th Street to 1,000 feet downstream of S. Howell Avenue; and on North Branch Oak Creek downstream of W. Puetz Road to its confluence with the mainstem of Oak Creek.** The survey should include the following (see Map 6.26):

- Survey of channel invert elevations to characterize the stream bed profiles of the existing streams

- Detailed cross-section surveys, including sediment depth measurements, to characterize the geometry of the existing stream channels

- Detailed surveys of all stream crossings in the area to include upstream and downstream structure elevations as well as elevations (and/or depths) of current sediment accumulations within the structures

- Survey of elevations of Milwaukee County-owned farmland to the northeast of the Ryan Road culvert, occupying a potential re-connection route to the historical Oak Creek channel location

After a detailed survey of the area has been completed, **it is recommended that a feasibility study be conducted to explore options to address the impairments resulting from the channel modifications described above**. The feasibility study should document the detailed survey information, include detailed hydrologic and hydraulic modeling in order to characterize the existing hydraulics through this area, and evaluate various alternative projects to improve conditions. Potential projects could range from targeted structure maintenance at stream crossings[107] to a comprehensive infrastructure protection and stream naturalization and restoration project that addresses a wide range of issues along the entire reach, including potentially re-routing Oak Creek to reconnect to the remnant historical channel. Depending on resource availability, high-priority issues in this area may be addressed individually as funding and importance dictate. The study should address the feasibility of alternative projects that would have the following objectives, in no particular order:

- Improve the stability, safety, and lifespan of road and railway culverts in the area

- Improve the ability of Oak Creek to sufficiently transport sediment through this reach

- Improve connections of Oak Creek and North Branch Oak Creek to their functional floodplains and increase the amount of flow that can be detained in floodplain areas

- Improve water quality, instream fish and aquatic organism passage, and overall instream habitat

- Reduce the potential for roadway overtopping

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[107] *A targeted individual project intended to protect the Canadian Pacific Railway culvert foundation from further undermining and to halt flow of water under the culvert is described in Table 6.1. A related project to retrofit the channel downstream of this culvert with a rock ramp in order to provide aquatic organism passage is also provided in Table 6.1.*

Map 6.26
Recommended Areas for Detailed Survey near the Oak Creek and North Branch Oak Creek Confluence

ESTIMATED AREAS FOR DETAILED CHANNEL SURVEYS

POTENTIAL RE-CONNECTION ROUTE TO HISTORICAL CHANNEL

STREAM CROSSING FOR DETAILED SURVEY (CROSSING OF PARTICULAR CONCERN)

STREAM CROSSING FOR DETAILED SURVEY

N

0 250 500 1,000 Feet

Source: SEWRPC

- Repair current and reduce future streambank erosion

- Incorporate the objectives from Milwaukee County Park's ecological restoration and management plan[108] that has been completed for the County-owned parcels in this area that include rapid response invasive species removal, grassland management, and reforestation of the leased farmland

A successful project would restore the area to a more natural surface water hydrology, while also providing the co-benefits of addressing public safety concerns, reducing maintenance needs, reducing downstream flooding, improving instream and terrestrial habitat, improving water quality, and providing valuable ecological functions.

Rural Surface Water Hydrology

Extensive networks of drainage tile are thought to have been installed within current and former agricultural lands of the watershed to drain wetlands and clear fields of rainwater as rapidly as possible and keep them productive. Some stream channels in the watershed were originally deepened and straightened to facilitate the flow of water from agricultural subsurface drainage tile outlets, to maximize conveyance of agricultural drain water, to maximize the amount of land available for cultivation, and to make the land easier to cultivate. The following recommendations are intended to mitigate the impacts of channelization and installation of drain tile on the surface water hydrology:

1. **It is recommended to restore natural surface hydrology by reducing, to the extent practicable, unnecessary drainage tile systems and retrofitting needed systems.** Specific measures that can be taken to accomplish this recommendation include:

    - Investigate drainage patterns and drainage tile system maps (when available) to determine whether there are operational drainage systems that are no longer necessary and remove or disconnect any unneeded tile systems. This could include areas that were formerly in agricultural uses but have since been developed in urban uses.[109] This recommendation is especially appropriate for lands owned by Milwaukee County that are currently leased for agricultural uses but are planned to be restored to wetland or forest and could be implemented as part of restoration efforts. Disconnection or breaking up of unneeded tile drainage systems could aid in the restoration of former wetlands.

    - Work with landowners that intend to continue farming to integrate water control structures within drainage tile systems to reduce tile flow during periods when a higher water table would not present a problem for crop production. It is recommended that pilot projects be considered to evaluate the effectiveness of this practice in reducing flashiness in these streams. The effectiveness of this practice in reducing contributions of pollutants, especially nutrients from agricultural fields could also be evaluated as part of the pilot projects.

2. **It is recommended to restore natural landscape elements that "slow down water" and reduce the magnitude of flashiness and its negative effects on aquatic habitat quality.** Specific measures that can be taken to accomplish this recommendation include:

    - Pursue opportunities and funding to restore leased agricultural fields owned by Milwaukee County to wetland, forest, and prairie habitats as described in the ecological restoration and management plan prepared by Milwaukee County Parks for the Oak Creek parkway.[110] Parcels for potential conversion are shown on Map 6.27. Additional stream restoration objectives such as reconnecting streams to their functional floodplain, streambank stabilization, establishment of riparian buffer areas, and removal of fish passage barriers should be considered as part of restorations of County-owned agricultural land.

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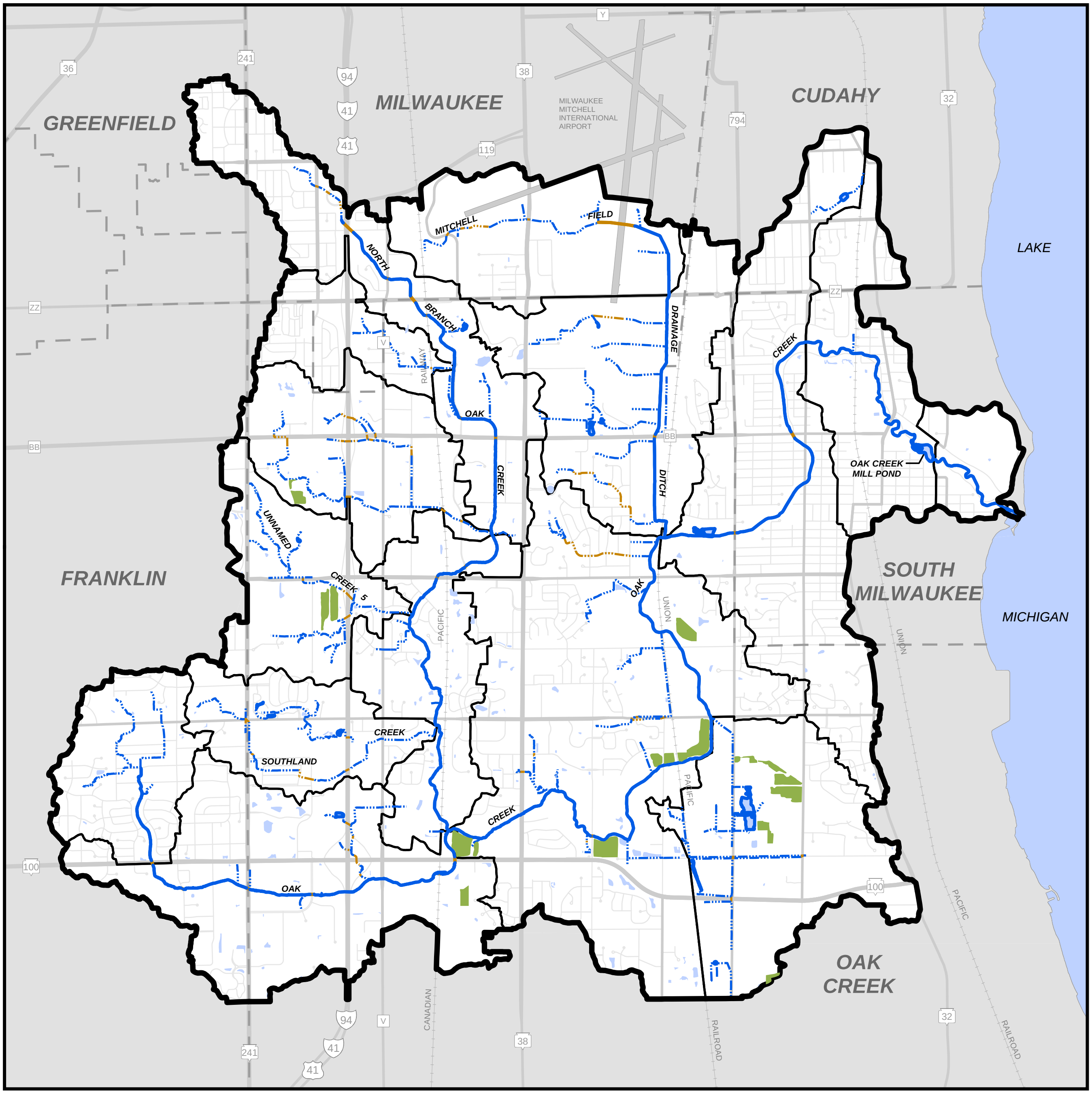
[108] *Milwaukee County Parks,* Oak Creek Parkway Ecological Restoration & Management Plan, *2019.*

[109] *This recommendation is subject to determinations that altering such tile drainage systems would not cause flooding or unintended drainage problems for current urban development.*

[110] *Milwaukee County Parks,* Oak Creek Parkway Ecological Restoration & Management Plan, *2019.*

Map 6.27
Milwaukee County Owned Agricultural Fields to be Restored to Wetland, Forest, or Prairie



OAK CREEK WATERSHED BOUNDARY

OAK CREEK WATERSHED ASSESSMENT AREAS

PERENNIAL STREAM

PERENNIAL STREAM (ENCLOSED)

INTERMITTENT STREAM

INTERMITTENT STREAM (ENCLOSED)

SURFACE WATER

MILWAUKEE COUNTY OWNED AND LEASED AGRICULTURAL FIELDS PLANNED TO BE REFORESTED OR RESTORED TO WETLAND OR GRASSLAND HABITATS

Note: See Map 6.31 for specific restoration details.

0 0.25 0.5 1 Mile

Source: SEWRPC

- Implement the recommendations described in detail below in Riparian Buffer Recommendations 2 and 3, related to the protection, purchase, and acquisition of vulnerable existing riparian buffer lands and potential buffer areas as well as establishment of new riparian buffer areas with a minimum goal of 75-foot widths and an optimum goal of 1,000-foot widths.

- Work with property owners to consider discontinuing the cultivation of existing farmed wetlands[111] and areas considered by WDNR to be potentially restorable wetlands and restore these areas to their natural wetland conditions (see Map 6.28). Incentives may be available to property owners who pursue this recommendation. This recommendation may be particularly vital if or when these lands are converted from agriculture to urban uses.

- In areas that are planned to remain in agricultural uses and that are drained by drainage tile systems, consider installation of saturated buffers. Saturated buffers redirect flows from main drainage tile lines through a lateral distribution line into a riparian buffer allowing the water to percolate into the soil and get taken up by vegetation.

3. **It is recommended to re-connect the trapezoidal ditches and channelized streams found in the agricultural or previously agricultural portions of the watershed with a functional floodplain.** It is acknowledged that potential restoration of functional floodplains among stream reaches will likely vary in its extent and characteristics based on available land area for restoration and landscape features. However, a functional floodplain should be designed to allow stream flow to overtop the banks of a main channel and spread out over a bench or a natural floodplain to reduce peak flow velocities. This recommendation will be further described in the "Recommended Actions to Maintain and Restore the Quality and Diversity of Instream Habitat" section below.

4. **It is recommended that marginal cropland and pastureland be converted to wetlands and prairies.** This is a recommendation from the RWQMPU and is described in further detail in the "Recommended Rural Nonpoint Source Pollution Control Measures" section earlier in this chapter.

Specific Area of Concern to Re-Establish Natural Surface Water Hydrology: Oak Creek Drainage Ditches Wetland Restoration and Drainage Tile Disconnection

A location with particular potential to be restored and expanded to an extensive wetland complex is located mainly in the Oak Creek Drainage Ditches assessment area, with some potential project area also within the Middle Oak Creek assessment area (see Map 6.29). The potential project area is bounded roughly by E. Puetz Road on the north, E. Oakwood Road (also the southern watershed boundary) on the south, S. 15th Avenue on the east, and S. Shepard Avenue on the west. The soils of almost the entire proposed project area consist of hydric soils (see Map 3.16 in Chapter 3 of this report). Review of historical aerial photographs indicates that much of the area had been in agricultural uses as recently as the early 1980's. The prevalence of hydric soils, the historical agricultural land use, and the extensive drainage ditch system that still parallels many of the roads, implies that this area was, and likely still remains, extensively tiled in order to drain the high water table occurring in this portion of the watershed.

As indicated on Map 3.7 in Chapter 3 of this report large portions of the potential project area are no longer used for agriculture and much of the land has reverted back to wetland conditions. These areas consist of predominantly low-diversity wetlands, mostly large monocultures of reed canary grass and various species of cattails. Despite this, Milwaukee County Natural Areas staff surveys revealed that one southern mesic forest remnant still persists with a complex series of ephemeral wetlands that contain rare semi-aquatic species. [112] The area also contains a fair amount of shrub-carr habitat type. Furthermore, there is a fair amount of land in the potential project area that is considered by WDNR to be potentially restorable wetland. It is likely that remnant drainage tile systems in the area are preventing these wetlands (and the potentially restorable wetland areas) from providing optimal hydrologic and ecological services. Therefore, **it is recommended that a survey be conducted to investigate the extent and location of relict drainage tile systems in this area. If drainage tile systems are found, it is recommended that**

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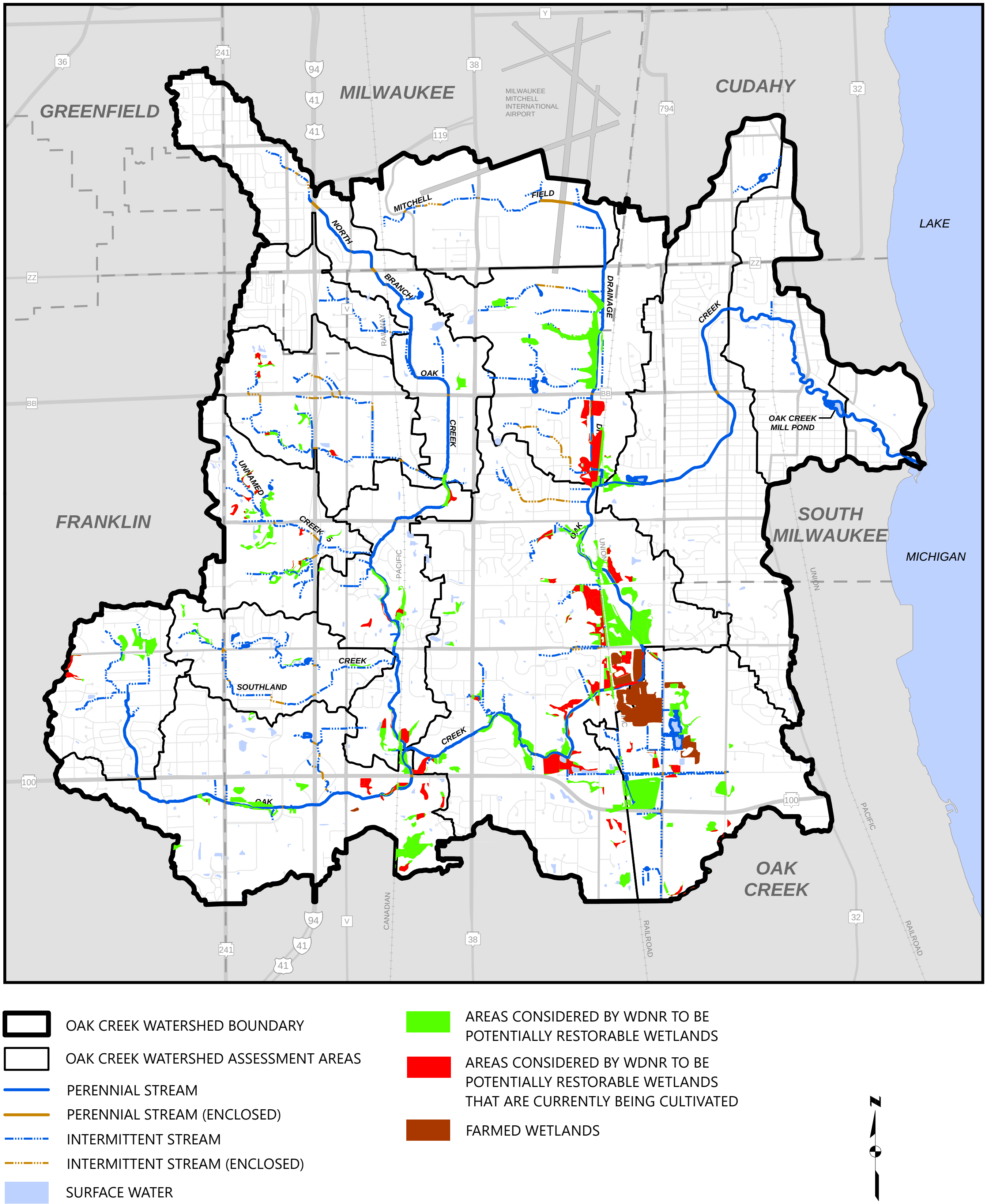
[111] *Farmed wetlands designations are included as part of the Southeastern Wisconsin Regional Planning Commission's 2015 land use inventory.*

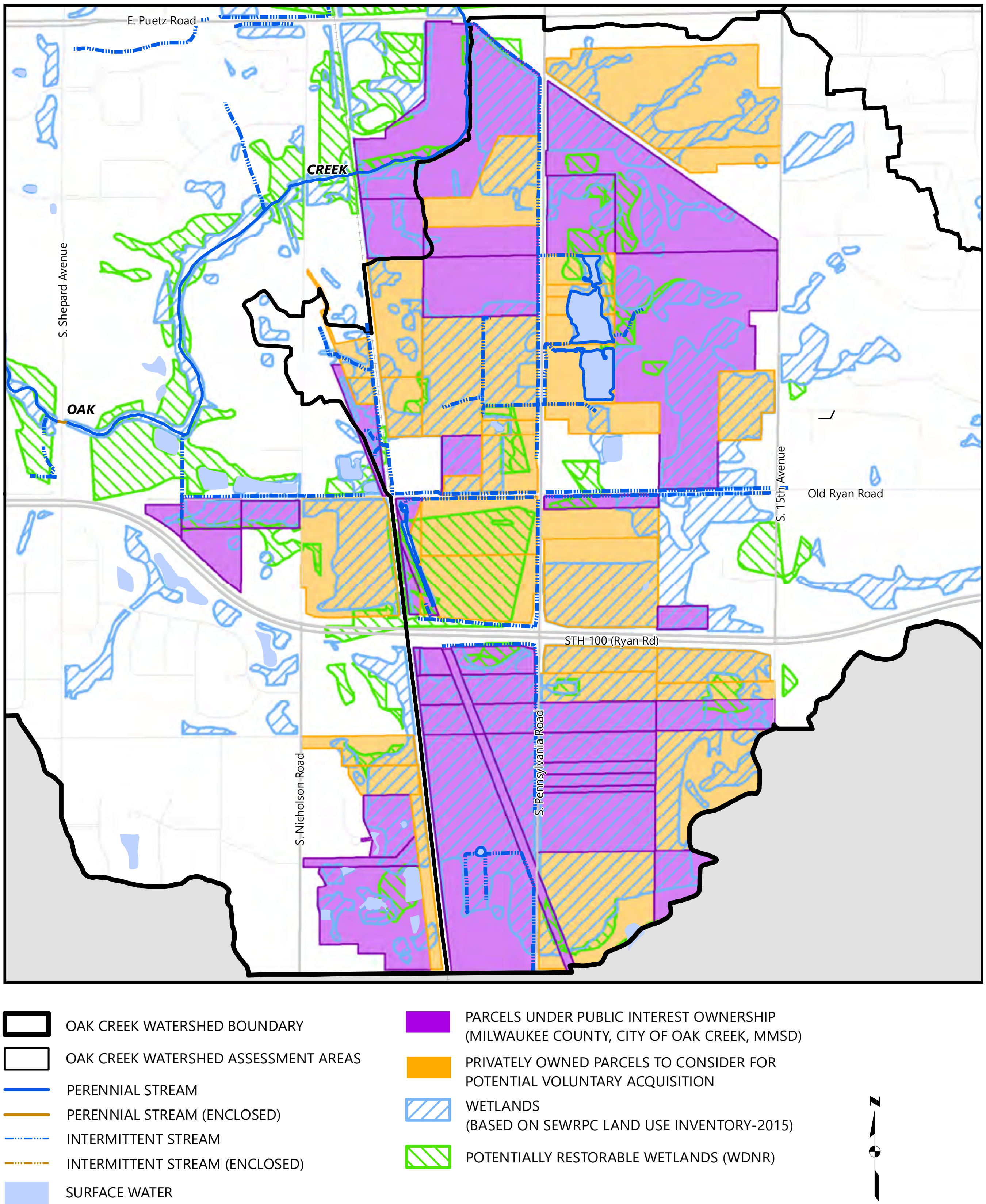
[112] Ibid.

Map 6.28
Areas to be Considered for Wetland Restoration in the Oak Creek Watershed



Source: SEWRPC

Map 6.29
Potential Areas to be Considered for Drainage Tile System Disconnection and Wetland Restoration



Source: SEWRPC

disconnection and/or removal of drainage tile systems be pursued to assist in restoring this large wetland complex.[113]

A large amount of the potential project area is currently under public interest ownership, with Milwaukee County, the City of Oak Creek, and the Milwaukee Metropolitan Sewerage District (MMSD) each holding ownership to multiple parcels in the potential project area (see Map 6.29). An ecological restoration and management plan has been completed for the parcels in this area that are owned by Milwaukee County. Recommendations from that plan include specific areas for rapid response invasive species removal, forest stand improvement, reforestation, grassland restoration and management, shallow water wildlife area restoration, formal property line surveys, potential land acquisitions, and flora and fauna surveys to fully assess the potential impacts of ecological restoration activities. **This watershed restoration plan recommends that Milwaukee County and other watershed partners pursue funding to continue the implementation of the ecological management and restoration plans completed for portions of this project area.**

The potential project area also includes privately owned parcels that contain agricultural, industrial, and single-family residential land uses. To be able to pursue restoration actions that would result in a connected wetland complex that would provide optimal hydrological functions, wildlife habitat, and ecological services, private landowner participation would be ideal. Therefore, **it is recommended that engagement with private landowners begins to assess interest in pursuing wetland restoration activities on these parcels. Further, it is recommended that watershed partners evaluate interest in potential voluntary acquisitions of privately owned parcels in the project area** (see Map 6.29). Any restoration activities on private land or property acquisitions would be voluntary and done at the complete discretion of the property owner.

Recommended Actions to Protect Areas of High Groundwater Recharge Potential

Groundwater recharge within the Oak Creek watershed supplies water to the deep and shallow aquifers that, in turn, provide baseflow to the Creek, its tributaries, and wetlands and may also provide baseflow to waterbodies outside of the watershed. Baseflow is vital to maintaining the natural hydrology, habitat quality, and the overall health of the stream system, particularly during droughts and low-flow conditions that may occur more frequently due to climate change.

Directly connected impervious surface areas discharge straight to a stormwater drainage system and ultimately to a stream with no potential for stormwater infiltration. Traditional urban development increases the area of connected impervious surfaces that, in the absence of sound land use planning, preservation of green space, installations of green infrastructure, or other land development measures to promote infiltration of runoff, will reduce infiltration volumes into the shallow aquifer. This reduction in infiltration reduces the baseflows provided by the shallow groundwater system. The loss of baseflow can lead to substantial loss in stream water depth and volume, increased water temperatures, loss of critical fish and other aquatic organism habitat, increased potential for summer fish kills caused by low dissolved oxygen concentrations, and loss or degradation of the coolwater and warmwater fishery.

The estimated percent of connected impervious surface within the Oak Creek watershed is expected to increase from a mean of about 18 percent in 2015 to almost 25 percent of the watershed under planned land use conditions. However, the proportions of impervious surfaces differs within the watershed and some assessment areas are already at or exceed 25 percent connected imperviousness (see Table 6.13). These differences will affect the available options and level of interventions needed for groundwater recharge protection. For instance, for areas that already have large amounts of impervious surface, a sound approach would be to focus on green infrastructure retrofits to treat runoff from these areas and allow for infiltration. For those areas that currently have lower amounts of impervious surface, a sound approach would be to preserve those areas, with special urgency focused on preserving areas that are also considered to have high and very high groundwater recharge potential. The planned land use conditions presented in Chapter 3 show that some current open space land uses that are planned for urban development are located within areas that are currently identified as having high and very high groundwater recharge potential. These areas of planned urban development are shown together with areas of high groundwater recharge potential on Map 6.30.

[113] *This recommendation is subject to determinations that altering such tile drainage systems would not cause flooding or unintended drainage problems for roads or other infrastructure in the area.*

Table 6.13

Estimated Percent of Current and Planned Connected Impervious Surface, Percent of Area that has High or Very High Groundwater Recharge Potential, and Percent of High and Very High Groundwater Recharge Potential Within Areas Planned to be Developed in Urban Uses

Assessment Area[a]	Communities	Percent Connected Impervious (2015)	Percent Connected Impervious Planned Conditions	Percent of Assessment Area that has High and Very High Groundwater Recharge Potential[b]	Percent of High and Very High Groundwater Recharge Potential that is Within Areas Planned to be Developed in Urban Uses[c]
Mainstem					
Grant Park Ravine	South Milwaukee	11	11	60	0
Lower Oak Creek – Mill Pond	South Milwaukee, Cudahy	29	31	15	3
Lower Oak Creek	South Milwaukee, Oak Creek, Cudahy	19	21	12	25
Middle Oak Creek Drainage Ditches	Oak Creek	7	12	3	55
Middle Oak Creek	Oak Creek	15	19	14	10
Upper Oak Creek	Oak Creek, Franklin	21	34	18	27
Oak Creek Headwaters	Franklin	12	13	3	10
Mitchell Field Drainage Ditch					
Lower Mitchell Field Drainage Ditch	Oak Creek, Milwaukee, Cudahy	15	31	24	32
Mitchell Field Drainage Ditch – Airport	Oak Creek, Milwaukee	31	34	3	14
North Branch Oak Creek					
Lower North Branch Oak Creek	Oak Creek	20	26	32	15
Upper North Branch Oak Creek	Oak Creek Milwaukee, Greenfield	25	34	32	30
Southland Creek	Oak Creek, Franklin	11	19	26	23
Drexel Avenue Tributary	Oak Creek	11	21	11	39
Rawson Avenue Tributary	Oak Creek, Franklin	24	34	14	18
College Avenue Tributary	Oak Creek, Franklin, Milwaukee	25	31	8	30
	Total Watershed	18	25	16	21

Note: Background colors indicate the level concern or potential need for intervention to mitigate negative impacts based upon the current and planned land use relative to the amounts of imperviousness and groundwater recharge potential within each assessment area:

Very High Level of Concern (red): Priority for mitigation –green infrastructure and protection

High Level of Concern (orange): Priority for mitigation – green infrastructure and protection

Moderate Level of Concern (yellow): Priority for protection

Low Level of Impact (green): Priority for protection

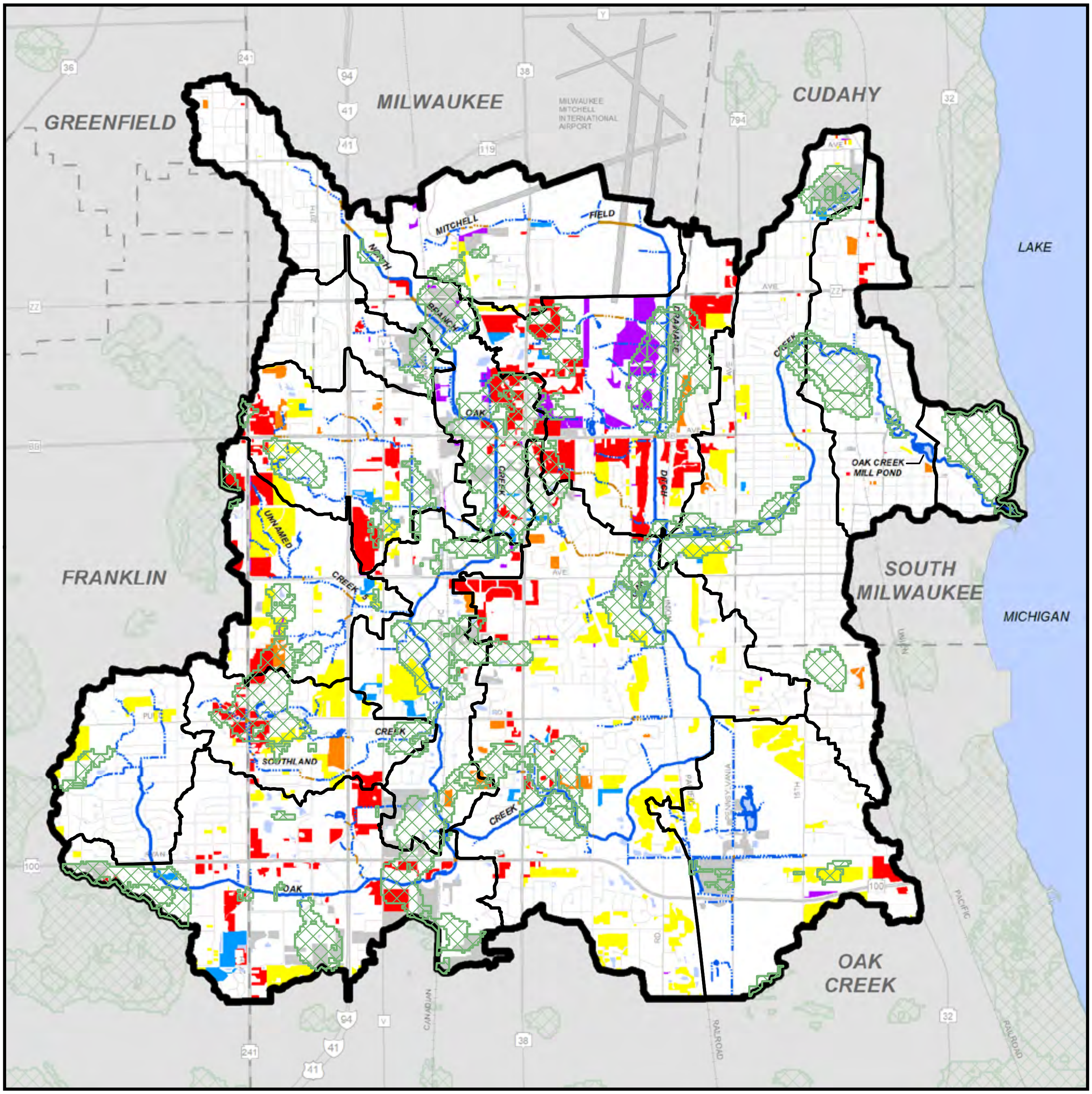
[a] *Assessment areas are shown on Map 3.2 and their total areas in acres are presented in Table 3.1.*

[b] *This column implies the level of opportunities remaining in each assessment area for protecting vital groundwater recharge areas. It should be noted that one of the inputs used in developing the model to indicate areas with high and very high groundwater recharge potential was SEWRPC's year 2000 land use inventory. Considering the age of that land use inventory, it is reasonable to assume that some of the areas defined by the model as having high or very high groundwater recharge potential may have since been developed into urban uses including the addition of impervious surfaces which may lessen the potential for groundwater recharge. For details on the model used to indicate groundwater recharge potential for areas throughout the Region, see SEWRPC Technical Report No. 47,* Groundwater Recharge in Southeastern Wisconsin Estimated by a GIS-Based Water-Balance Model, *July 2008.*

[c] *This column indicates assessment areas with higher levels of urgency for protection of groundwater recharge areas before they are potentially lost based on future planned urban development.*

Source: SEWRPC

Map 6.30
Areas of High Groundwater Recharge Potential and Areas Where Existing Year 2015 Agricultural Lands, Open Lands, and Woodlands are Projected to be Converted to Urban Uses Under Planned Conditions



AREAS OF HIGH AND VERY HIGH GROUNDWATER RECHARGE POTENTIAL

PLANNED LAND USE CATEGORY (2015 LAND USE WAS AGRICULTURE, OPEN LAND, OR WOODLAND)

SINGLE-FAMILY RESIDENTIAL
MULTIFAMILY RESIDENTIAL
COMMERCIAL
INDUSTRIAL
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES
GOVERNMENT AND INSTITUTIONAL

OAK CREEK WATERSHED BOUNDARY
ASSESSMENT AREA BOUNDARIES
PERENNIAL STREAM
PERENNIAL STREAM (ENCLOSED)
INTERMITTENT STREAM
INTERMITTENT STREAM (ENCLOSED)
SURFACE WATER

N

0 0.25 0.5 1 Mile

Source: SEWRPC

The preservation and improvement of groundwater recharge is a crucial part of any plan to maintain or improve water quality and habitat conditions by protecting sustainable ecological flows within the Oak Creek watershed.[114] Table 6.13 is intended to help communities assess the level of opportunities that currently remain for groundwater recharge protection and highlight those assessment areas (and the communities that make up the assessment areas) that are projected to potentially lose large proportions of the best remaining areas for groundwater recharge in the absence of mitigation and sound land use planning. For instance, Table 6.13 indicates that the Lower Mitchell Field Drainage Ditch, Upper North Branch Oak Creek, and Drexel Avenue Tributary assessment areas have moderate amounts of land considered to have high or very high groundwater recharge potential. However, large proportions of those areas of high and very high groundwater recharge potential are projected to be developed in urban uses under planned land use conditions. Through innovative land use planning prior to urban development, communities should make these areas a high priority to preserve in natural land cover, restrict the installation of impervious surface, and thus retain the land's ability to infiltrate groundwater. It may be prudent for communities to highlight these areas on planned land use maps to indicate the urgency to preserve their groundwater recharge functions as a part of any future development plans. This would likely be the last chance to protect such critical areas before urban structures and roadway networks are constructed. For those assessment areas currently with high amounts of impervious surfaces and very little remaining areas of high and very high groundwater recharge potential, such as the Mitchell Field Drainage Ditch—Airport and College Avenue Tributary assessment areas, the focus should be on retrofitting areas of impervious surface with green infrastructure and other stormwater infiltration practices to supplement the lost natural groundwater recharge.

Specifically, land managers and policy makers should focus on the following recommended management measures related to groundwater recharge:

1. **It is recommended that communities carefully control new development in the watershed's best remaining groundwater recharge potential areas.** This will help assure local and regional groundwater aquifers are protected. Control can include excluding certain types of development, maintaining recharge potential through thoughtful design, and minimizing impervious surface area, particularly connected impervious surfaces. Specific measures that can be taken to accomplish this recommendation include:

   - Local governments should examine the latest maps and models that identify areas of high groundwater recharge potential prior to the approval of new development proposals and/or plans. These areas should be avoided when locating new buildings or impervious surface. Local governments could consider groundwater recharge potential when designating areas for future preservation.

   - Protect and preserve areas classified as high and very high groundwater recharge potential through conservation easements, land purchases, or voluntary incentive-based measures. Such protection should also incorporate preservation of environmental corridors, isolated natural resource areas, prime agricultural areas, riparian buffers, and open lands that are associated with conservation developments that facilitate groundwater recharge (see Map 6.30 for locations of high and very high groundwater recharge areas as well as the areas planned to be developed from open space uses to urban under community planned land use conditions).

   - Installation of sewers, water lines, and other buried utilities that could intercept groundwater flow should be avoided in areas of high and very high groundwater recharge potential.

In instances where it will not be possible to avoid siting urban development on or near areas of high or very high groundwater recharge, it is even more crucial to take measures to maintain both groundwater levels and groundwater quality.

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[114] *Leroy N. Poff, and others, "The ecological limits of hydrologic alteration (ELOHA): a new framework for developing regional environmental flow standards"*, Freshwater Biology, *Volume 55, pages 147–170, 2010.*

2. **It is recommended that mitigation measures be implemented to reduce the impacts of any future urban development on groundwater recharge quantity and quality.** Specific measures that can be taken to accomplish this recommendation include:

   - Encourage local governments to consider groundwater recharge as an integral part of new development and infrastructure replacement proposals. Some Southeastern Wisconsin communities have promulgated ordinances that require integrated analysis of groundwater and surface water impacts in the process through which developers obtain permission to build new buildings and subdivisions.[115]

   - Review and update as necessary, local land use regulations to promote, where appropriate, conservation development practices that provide for the clustering of new development within the watershed to minimize potential reductions in groundwater recharge.

   - Require developers to actively incorporate infiltration in new stormwater infrastructure. Such infrastructure is best located on areas of high and very high recharge potential (see Map 3.22 in Chapter 3 of this report). Infiltration and recharge rates should be maintained as close to pre-development rates as possible by incorporating runoff management recommendations for enhancing infiltration using low-impact design standards in accordance with the regional water supply plan.[116, 117] Some examples of infiltration techniques and low-impact design include: bioretention cells, curb and gutter elimination (when practicable), bioswale road medians, grassed swales, green alleys, green parking design, permeable pavement, infiltration trenches, sand and organic filters, soil amendments, vegetated filter strips, and rain gardens. Infiltrating water must be of good quality. Therefore, existing and proposed site conditions should be taken into account when designing infiltration facilities.

Under 2015 land use conditions, the extent of urban development within the Oak Creek watershed is already enough to negatively affect groundwater quantity and quality in the shallow aquifers, and in turn water quantity and water quality within Oak Creek and its tributaries. Implementing projects that seek to restore the natural flow patterns have the potential to mitigate these effects.

3. **It is recommended that measures be taken to reduce the impact of existing urban development on groundwater recharge quantity and quality.** Specific measures that can be taken to accomplish this recommendation include:

   - Increase the infiltration of urban runoff at those sites where it can be achieved without degrading groundwater quality.

   - Retrofit current urban development to improve infiltration of rainfall and snowmelt using innovative BMPs that are associated with low-impact development. These practices could include rain gardens, installation of porous pavement in parking lots, installation of green alleys at scheduled replacement timetables, converting roadway medians to bioswales, disconnection of downspouts from sewer systems, and other green infrastructure practices as discussed above.

   - Apply the stormwater management technical standards developed by the WDNR in the design of stormwater management facilities.[118] In particular, the potential for pollutants to enter the groundwater through infiltration should be considered in the design of infiltration facilities. This consideration is especially important in areas with shallow depths to groundwater.

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[115] *The Village of Richfield in Washington County is such an example. More information may be found at the Village's website: www.richfieldwi.gov/index.aspx?NID=300.*

[116] *SEWRPC Planning Report No. 52,* A Regional Water Supply Plan for Southeastern Wisconsin, *December 2010.*

[117] *SEWRPC Technical Report No. 48,* Shallow Groundwater Quantity Sustainability Analysis Demonstration for Southeastern Wisconsin Region, *November 2009.*

[118] *WDNR approved stormwater construction technical standards are documents that specify the minimum requirements needed to plan, design, and maintain a wide array of conservation practices aimed at preserving the land and water resources of Wisconsin. Technical standards for various stormwater management practices can be found at dnr.wisconsin.gov/topic/Stormwater/standards/postconst_standards.html.*

Although infiltration into soils provides some level of pollution reduction, shallow aquifers can be vulnerable to pollution. Within the Oak Creek watershed there are specific areas associated with land uses that could potentially contribute pollutants to groundwater. These areas include golf courses and agricultural fields in high groundwater recharge areas that could also act as sources of pollution due to over-fertilization and pesticide use. These areas also include urban and residential areas, that could act as sources of a variety of urban runoff pollutants, including chloride from deicing salts, gasoline, heavy metals, fertilizers, and pesticides. Pollutants contributed by these areas can infiltrate into groundwater during rain and snow melt events. This pollution needs to be prevented to the greatest extent possible to avoid contaminating the groundwater and the baseflow of Oak Creek, its tributaries, and wetlands throughout the watershed.

4. **It is recommended that pollution reduction measures be implemented on agricultural lands and other areas, such as golf courses, with high groundwater recharge potential.** Specific measures that can be taken to accomplish this recommendation include:

   - Evaluate agricultural operations located in areas of high groundwater recharge for compliance with State standards for application of integrated nutrient and pest management practices and undertake corrective measures on those operations that are not in compliance.

   - Reduce or eliminate the application of fertilizers and pesticides to the extent practicable on other land uses prone to nutrient and chemical pollution that are located in areas of high groundwater recharge. It is particularly important that nutrient and chemical applications not occur during periods when groundwater levels are known to be high.

   - Municipal and private snow removal operations should be diligent in maintaining best management practices when applying chlorides for de-icing in areas of high groundwater recharge. Alternatives to chloride-based deicers should be considered in those areas. Recommendations to reduce chloride pollution are described in detail in the "Recommended Actions to Improve Water Quality" section earlier in this Chapter.

Recommended Actions to Protect, Restore, Expand, and Connect Riparian Buffers

The protection, restoration, expansion, and connection of riparian buffer areas represent opportunities to achieve the objective proposed by a Federal initiative to conserve and restore the lands, waters, and wildlife habitat with a national goal of conserving 30 percent of U.S. lands and waters by the year 2030. The initiative was launched as a result of a report that was submitted to the National Climate Task Force by the U.S. Department of the Interior, the U.S. Department of Agriculture, the U.S. Department of Commerce, and the Council of Environmental Quality.[119] The preliminary report recommends a ten-year, locally led campaign to conserve and restore vital land and water and aligns well with measures recommended within this watershed restoration plan. As discussed in Chapter 4, riparian buffers provide a wide array of benefits and are vital to a healthy aquatic and terrestrial ecosystem in the Oak Creek watershed. All riparian buffers provide some level of protection that is greater than if there was no buffer at all. However, wider buffers provide a greater number of functions than do narrower buffers. Therefore, **it is recommended that all efforts are made to protect and restore existing riparian buffers and establish new riparian buffer areas to the maximum extent practicable—up to, and beyond the 1,000-foot optimum buffer width**.

The riparian buffer network within the Oak Creek watershed, as assessed under 2015 conditions, is shown on Maps G.1 through G.22 in Appendix G. These maps highlight existing riparian buffers as well as areas where buffers could potentially be established to 75-foot, 400-foot, and 1,000-foot widths. These potential riparian buffer expansions would be targeted for lands that were not developed in urban uses (as of the most recent SEWRPC land use inventory in 2015), and that could be preserved in open space uses in the future, or at the very least be developed in a way to maximize preservation of riparian buffer areas. In addition, these maps identify the existing riparian buffer network of lands protecting waterbodies in this watershed and potential buffer areas, up to the 1,000-foot optimum core habitat width, that are designated as "vulnerable" to future urban development. Areas are designated as "vulnerable" when they are 1) located outside the 1-percent-

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[119] *U.S. Department of the Interior, U.S. Department of Agriculture, U.S. Department of Commerce, and the Council of Environmental Quality,* Conserving and Restoring America the Beautiful, *2021*.

annual-probability regulatory floodway[120], 2) not designated as ADID wetlands, and 3) not under protected ownership such as public ownership, nonprofit ownership, or conservation organization ownership. To guide the implementation of the riparian buffer recommendations set forth below, Figure G.1 in Appendix G identifies examples of areas that should be targeted on each of the Appendix G maps.

These maps are intended to provide individuals, organizations, and municipalities implementing this plan with guidance on areas that should be prioritized for protection. They also provide guidance as to where new riparian buffer areas could potentially be established throughout the Oak Creek watershed. Additionally, the maps indicate the areas within the watershed where large buffers may not be feasible due to existing urban development, thereby indicating where smaller buffers and other green infrastructure measures should potentially be implemented.

The maps in Appendix G provide the information necessary to begin planning riparian buffer protection and expansion projects. Specifically, land managers and policy makers should focus on the following recommendations regarding riparian buffers:

1. **It is recommended that existing riparian buffers be managed and restored** (see Examples A and B in Figure G.1, that illustrates areas that should be identified on Maps G.1 through G.22 in Appendix G in order to implement this recommendation). Specific measures that can be taken to accomplish this recommendation include:

    - Actively manage invasive species and promote establishment of native plant species. Partnerships between Milwaukee County Parks, municipal governments, schools, volunteer groups, service organizations, and concerned citizens through participation in programs offered by WDNR are critical in managing an ecologically healthy riparian buffer system in the watershed.

    - Pursue funding and partnerships to implement Milwaukee County Parks Department ecological restoration and management plans that have been developed for the County-owned parks and open space lands within the Oak Creek watershed. These County-owned lands include large expanses of riparian buffers. The management plans aim to maintain and increase native plant and wildlife diversity and reduce the impact of invasive species and represent a blueprint for creating healthier riparian buffer areas throughout the watershed. Milwaukee County Parks Department's ecological restoration plans will be discussed throughout the recommended actions to improve habitat in the watershed.

    - Riparian areas that have been heavily impacted by emerald ash borer should be a priority target for forest stand improvements (see Map 4.13 in Chapter 4 of this report). The rapid decline of floodplain and riparian forest canopy due to ash tree mortality has significantly altered the forest floor habitat, allowing invasive species, particularly common buckthorn and reed canary grass, to rapidly spread into areas where the forest canopy has been newly opened due to ash tree loss. Forest stand improvement should be a priority in these areas. Forest stand improvement could include selectively thinning aggressive native tree species such as ash, basswood, boxelder, removing all woody invasive plant species around desired vegetation, and planting native trees and shrubs in areas of existing canopy gaps. The Milwaukee County Parks Department provides detailed forest stand improvement recommendations for their Oak Creek Parkway properties including proper species to use for reforestation, number of trees to plant per acre, and restoration timelines.[121] For areas that have not had detailed restoration plans developed, the following general guidelines represent a sound approach to smaller scale reforestation efforts of riparian areas that have been heavily impacted by ash tree die-offs:

        - Avoid planting ash trees.

        - Appropriate maple tree species for floodplains and hardwood swamps include silver, freeman, and red maple.

[120] *As summarized in the floodplain zoning section in Chapter 3, all municipalities within the watershed have adopted floodplain ordinances, however this does not preclude development within the regulatory floodplains of the Oak Creek watershed.*

[121] *Milwaukee County Parks Natural Areas Staff,* Oak Creek Parkway Ecological Restoration & Management Plan, *2019*.

- No more than 20 percent of planted tree species should be members of the same genus.
- No more than six individuals of any given genus should be planted adjacent to one another.
- No more than 10 percent of planted tree species should be the same species.
- No more than three individuals of any given species should be planted adjacent to one another.
- In addition to hardwood tree species, native shrubs and small trees including willow, buttonbush, cherry, dogwood, hazelnut, winterberry, and viburnum should be included in reforestation projects. These shrubs and small tree species will compete with invasive non-native species while the comparatively slow growing tree species establish.
- An appropriate herbaceous floodplain seed mix should be applied to the project area following site preparation, especially in areas disturbed during planting of trees and shrubs.
- Invasive and non-native species should be controlled as early as possible, particularly buckthorn. Removal becomes more difficult and costly once invasive species are established.
- Consider enhancing the plantings described above by including aggressive native herbaceous species characteristic of floodplain forests and hardwood swamps. Appropriate matrix species may include many native grasses, sedges, and bulrushes. These species spread aggressively by rhizomes, making them a good choice for areas prone to disturbance and flooding.

- Promote low-impact public use and recreational access to publicly owned riparian buffer areas where possible.
- Promote awareness and education regarding management of these areas to prevent damage from introduction of new invasive species or re-introduction of eradicated invasive infestations.

2. **It is recommended that existing riparian buffers be protected** (see Examples A and B in Figure G.1, which illustrate areas that should be identified on Maps G.1 through G.22 in Appendix G in order to implement this recommendation). All existing riparian buffers that are not under public interest ownership should be considered under this recommendation; however, areas considered vulnerable to urban development should be a higher priority. Vulnerable lands are indicated in black hatching in Figure G.1 and Maps G.1 through G.22. Specific measures that can be pursued to accomplish this recommendation include:

- Acquisition of land by public interest ownership via donation or purchase and establishment of public or private conservation easements on critical lands.
- Consistent implementation and enforcement of local zoning regulations to prohibit any filling or development within the regulatory floodway and ADID wetlands.
- Communities should implement local zoning regulations to prohibit any filling and development within the flood fringe areas of the regulatory floodplain.
- Encourage establishment and management of riparian buffers within the 1-percent-annual-probability floodplain, particularly when zoning of land changes from agricultural to urban uses.
- Consistent and effective application and updating of the regulatory framework including local zoning ordinances, shoreland zoning requirements, State wetland regulations, and U.S. Army Corps of Engineers permit program for wetlands.
- Continued application of limits on development within SEWRPC-delineated primary environmental corridor (PEC) and connection of "vulnerable" existing riparian buffer lands to PEC, secondary environmental corridor (SEC), and isolated natural resource areas (INRA). Additional riparian buffer lands may be added to delineated PEC if they meet the criteria for inclusion in the corridor, thus extending the restrictions on development that are inherent to PEC designated lands.

3. **It is recommended that new riparian buffers be established to the greatest extent possible throughout the watershed with a minimum target of a 75-foot width from water's edge (150-foot total buffer width) and an optimal goal of a 1,000-foot width (or greater) from water's edge** (see Examples C, D, and E in Figure G.1, which illustrate areas that should be identified on Maps G.1 through G.22 in Appendix G to implement this recommendation). Specific measures that can be taken to accomplish this recommendation include:

    - Establish undisturbed vegetation along perennial, intermittent, and ephemeral waterways in both urban and rural areas to the extent practicable, but to a minimum of 75-feet from water's edge. The use of native species should be prioritized.
    - Areas that are projected to be converted from open space land use categories to urban uses under planned conditions and are also considered to be potential riparian buffer, as indicated on Map 4.7 in Chapter 4 of this report, are high priority areas for establishment of riparian buffers.
    - Implement reforestation and grassland restoration projects recommended as part of Milwaukee County Parks Ecological Restoration and Management plans. These projects are described in more detail in the recommendations to protect, preserve, and restore environmentally sensitive areas below.
    - Areas that are both identified by WDNR as potentially restorable wetlands and considered to be potential riparian buffer areas, as indicated on Map 4.11 in Chapter 4 of this report, are high priority areas for establishment of riparian buffers.
    - Potential riparian buffer areas that are within the 0.2-percent-annual-probability (500-year recurrence interval) floodplain but that are beyond the 1-percent-annual-probability (100-year recurrence interval) regulatory floodplain are high priority areas for establishing buffers to provide resiliency against flooding caused by more frequent intense rainfall events that are projected to occur in the Region.
    - In agricultural areas, consider installing harvestable riparian buffers where practicable and where no buffer currently exists.
    - Provide informational materials to shoreland property owners on the environmental, social, and economic benefits of establishing riparian buffers and best management practices, including instructions on how to proceed with implementation.
    - Promote available incentive programs and provide technical assistance to private landowners to establish riparian buffers on their lands.

4. **It is recommended that connections and corridors between riparian buffer areas be established to ensure connectivity and continuity of a variety of habitat types.** Specific measures that can be taken to accomplish this recommendation include:

    - Remove abandoned or nonessential roads and stream crossings where appropriate.
    - Develop and implement incentive-based programs to encourage existing landowners and businesses within the 1,000-foot zone to consider landscaping that would enhance wildlife habitat by providing connections or lanes through the lots to larger riparian buffer areas. It would also be helpful to provide educational materials and technical assistance to interested landowners. These programs should encourage the use of native plants that provide cover and food for wildlife.
    - When feasible, limit creation of new road crossings of the streams within the Oak Creek watershed.
    - Preserve, restore, and/or expand small wetlands, woodlands, and prairies that are not identified as part of an environmental corridor or an isolated natural resource area and link such features by providing corridors connected to larger riparian buffer areas.

Riparian Buffer Protection and Expansion Prioritization Strategies

The framework described above can be achieved through a combination of strategies that include land acquisition, regulation and other opportunities, and implementing best management practices. These three strategies are described in further detail below.

Land Acquisition

Not all of the environmental corridors and associated natural areas in the Oak Creek watershed, which make up large portions of the existing and potential riparian buffer areas, are protected from being cleared and developed for urban uses. It is therefore important that a prioritization for acquisition of these lands be based on the following order of importance (from highest to lowest priority):

1. Protect what currently exists on the landscape. Vulnerable existing riparian buffer areas as indicated in black hatch on Maps G.1 through G.22 in Appendix G should have highest priority for acquisition.

2. Provide a minimum width of buffer for water quality protection. Vulnerable potential riparian buffer lands up to 75-feet wide as indicated in red with black hatch on Maps G.1 through G.22 in Appendix G should have the next highest priority for acquisition.

3. Provide a minimum width of buffer for wildlife protection. Vulnerable potential riparian buffer lands up to 400-feet wide as indicated in orange with black hatch on Maps G.1 through G.22 in Appendix G should have the next highest priority for acquisition.

4. Provide an optimum width of buffer for wildlife protection. Vulnerable potential riparian buffer lands up to 1,000-feet wide as indicated in yellow with black hatch on Maps G.1 through G.22 in Appendix G should have the next highest priority for acquisition.

In addition, special consideration should be given to acquiring vulnerable existing and potential riparian buffers in locations designated as having high to very high groundwater recharge potential as shown on Map 3.22 in Chapter 3 of this report. Establishing connections and expanding critical linkages among habitat complexes to protect wildlife abundance and diversity should also be a priority. Connecting the many SECs and INRAs throughout the watershed to larger PEC areas (see Map 3.18 in Chapter 3 of this report), as well as building and expanding upon the existing protected lands, including lands in public interest ownership, the regulatory floodway, and ADID wetlands, represents a sound approach to enhancing the corridor system and wildlife areas within the watershed.

Regulatory and Other Opportunities

Opportunities Related to Existing Regulatory Protections

Existing regulations and other mechanisms restrict some activities adjacent to streams, rivers, and lakes. Chapter NR 115, "Wisconsin's Shoreland Protection Program," of the *Wisconsin Administrative Code* establishes a minimum 75-foot development setback running parallel to the ordinary high-water mark of navigable lakes, streams, and rivers.[122] Section NR 151.03 of the *Wisconsin Administrative Code* requires a minimum tillage setback standard of five feet from the top of the channel of surface waters in agricultural lands. In addition, Milwaukee County, which owns and leases a significant amount of the remaining agricultural land in the watershed, requires in its lease agreements that no annual crops be planted within 75 feet of any river or stream or within 30 feet of any field ditch. Instream field observations in the watershed and orthophotograph interpretation indicate that the small amount of remaining agricultural lands adjacent to Oak Creek and its main tributaries meet the five-foot tillage setback. It should be noted that while the five-foot tillage setback and the 75-foot development setback are important requirements to reduce disturbance along the water's edge, neither regulation requires natural vegetative buffers be maintained in these areas adjacent to the waterways and therefore they are not adequate to achieve the water quality and wildlife habitat goals for this watershed. As summarized in Chapter 4 and Appendix G, not having adequate buffer vegetation between a waterway and an agricultural field and/or urban development can contribute to significant sediment and phosphorus loading to the waterway and can significantly limit wildlife habitat.

[122] *Where an existing development pattern exists, the shoreland setback for a proposed principal structure may be reduced to the average shoreland setback of the principal structure on each adjacent lot, but the shoreland setback may not be reduced to less than 35 feet from the ordinary high-water mark of any navigable water.*

Priority areas for establishing or expanding riparian buffer include cropland where the minimum recommended buffer width of 75 feet is not being met, cropland located within the 1-percent-annual-probability (100-year recurrence interval) floodplain, and cropland containing potentially restorable wetlands within 1,000 feet of a waterway. If an agricultural area in the watershed that is not owned by Milwaukee County is being considered for conversion to urban development, it may be possible to design portions of the development to accommodate expansion of the riparian buffers to the 400- and 1,000-foot widths. This would likely be the last chance to establish such critical protective boundaries around waterways before urban structures and roadway networks are constructed.

Protection and Expansion Opportunities Related to Environmental Corridor Status

Protecting existing riparian buffers within or adjacent to environmental corridors and/or establishing new riparian buffers within environmental corridor areas that do not currently have natural land cover characteristics (i.e., Oak Creek Parkway land currently being mowed) would help preserve and increase the ecological services provided by these crucial areas. Furthermore, because the 100-year recurrence interval floodplain boundaries are a significant element of defining PEC lands, restoring these areas to riparian buffer land cover would preserve and/or improve the ability of floodplains to protect communities from future flooding events. Increased community resiliency to flooding events is even more critical as climate change impacts are likely to increase the frequency of intense rainfall events.

PEC's receive a greater level of land use protections than SEC's, INRA's, or SEWRPC designated natural areas outside of PEC.[123] Increasing the extent of land designated as PEC within the Oak Creek watershed represents a potential strategy for extending current regulatory protections provided by PEC designation to vulnerable existing and potential riparian buffers as areas within the watershed are restored. Opportunities are present in the Oak Creek watershed to expand PEC lands and to connect SEC lands to adjacent SEC and INRA land to form a contiguous corridor large enough to potentially qualify as a PEC. However, this can only be accomplished if there are sufficient natural resource features to meet the criterion for designation as a corridor and if the minimum area (400 acres), minimum length (two miles), and minimum width (200 feet) requirements for designation as PEC are met.[124]

As discussed earlier in this report, Milwaukee County Parks intends to restore all County-owned and leased agricultural land to either forest, wetland, or native grassland conditions as funding opportunities become available. In addition, MMSD's conservation plan[125] and SEWRPC's greenway connection plan[126] have identified lands within MMSD's service area that should be targeted for voluntary acquisitions and preserved in order to retain floodwater retention benefits as well as to improve water quality and wildlife habitat conditions. MMSD's Greenseams program aims to make voluntary purchases of the undeveloped, privately owned properties that were identified in the plans described above. Properties that have been acquired as part of the Greenseams program are shown on Map 4.46 in Chapter 4 of this report. It is recommended that MMSD continue to pursue voluntary acquisitions of the remaining properties identified in their conservation plan and the greenway connection plan that remain undeveloped. Both the Milwaukee County Parks and MMSD programs represent opportunities to expand riparian buffers and potentially expand planned PEC lands within the watershed, and thus the protections that a PEC designation provides. Therefore, it is recommended that any future reforestation or grassland restoration of County-owned agricultural fields and land purchased and preserved by MMSD Greenseams program be considered for designation of planned PEC, SEC, or INRA, where appropriate.

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[123] *Implementation of environmental corridor protection recommendations is envisioned to come about primarily through enactment of appropriate zoning regulations at the county and local levels of government. In addition, the WDNR and the Wisconsin Department of Safety and Professional Services seek to bring about the specific recommendations related to protection of the PECs through their public and private sanitary sewer extension approvals. Essentially, the operational rules of those departments require that the PEC protection and development density recommendations, as set forth in the SEWRPC regional land use plan, be met before State approval of sewer extensions. This State policy can have the effect of imposing more stringent development limitations than set forth in local zoning regulations.*

[124] *Procedures utilized by SEWRPC to delineate environmental corridors are documented in "Refining the Delineation of Environmental Corridors,"* SEWRPC Technical Record *Vol. 4, No. 2, March 1981.*

[125] *The Conservation Fund, et al.,* Conservation Plan for the Milwaukee Metropolitan Sewerage District, *October 2001.*

[126] *SEWRPC Memorandum Report No. 152,* A Greenway Connection Plan for the Milwaukee Metropolitan Sewerage District, *December 2002.*

Opportunities Related to ADID Wetlands
Wetlands located within PEC lands that have been designated as Advanced Delineation and Identification (ADID) wetlands under Section 404(b)(1) of the Federal Clean Water Act are deemed generally unsuitable for discharge of dredge and fill material.[127] In addition, nonagricultural performance standards set forth in Section NR 151.125 of the *Wisconsin Administrative Code* require establishment of a 75-foot protective area restricting impervious surfaces adjacent to these higher-quality ADID wetlands. This designated protective area boundary is measured horizontally from the delineated wetland boundary to the closest impervious surface.[128] Accordingly, these wetlands would have additional protections from being filled, from being encroached upon by future development, and would retain their riparian buffer functions.

<u>Best Management Practices</u>
A large portion of the vulnerable existing and potential riparian buffers in the Oak Creek watershed are located within privately owned urban and agricultural areas. It is the choice of the private landowners as to whether a riparian buffer is established on their land. Although riparian buffers can be effective in mitigating the negative effects attributed to urbanization and agricultural management practices, they cannot on their own address all the problems associated with pollutants generated by these land uses. Because of this, riparian buffers should be combined with other management practices, such as infiltration facilities, wet retention basins, porous pavements, green roofs, bioswales, and rain gardens to mitigate the effects of urban stormwater runoff. Similarly, riparian buffers should be combined with other management practices, such as reduced tillage, grassed waterways, and filter strips to mitigate the effects of agricultural runoff.

Recommended Actions to Preserve, Restore, Expand, and Connect Wildlife Habitat
The presence of healthy wildlife communities, including healthy populations of animals such as deer, fish, amphibians, reptiles, birds, and small mammals is a significant indication of a healthy watershed. This is largely because wildlife populations require large, well-connected natural areas that are associated with good water quality and good aquatic and terrestrial habitat. The presence of healthy wildlife populations also provides recreational opportunities, such as bird watching, fishing, and nature hiking.

The development patterns and infrastructure that humans create on the landscape lead to a number of obstructions that can limit both the availability of wildlife habitat and the ability for organisms to travel between multiple habitat types. These obstructions are primarily a result of roadways, railways, and buildings that fragment the natural landscape. Therefore, an effective management strategy to protect wildlife abundance and diversity in the Oak Creek watershed would be to maximize critical linkages between habitat areas in the watershed, ensuring the ability of species to access these areas. **It is recommended that the following critical linkages between habitat areas be maximized**:

- Water's edge (lake, pond, stream, wetland) to terrestrial landscapes
- Water's edge to water's edge (e.g., river to ephemeral pond, lake to ephemeral pond, permanent pond to ephemeral pond)
- Habitat complexes or embedded habitat (e.g., wetland to upland or grassland to woodland)

Recommended Actions to Protect, Preserve, and Restore Environmentally Sensitive Areas
The environmental corridors and isolated natural resource areas (see Map 3.18 in Chapter 3 of this report), as well as SEWRPC designated natural areas (NAs) and critical species habitat sites (see Map 3.19 in Chapter 3 of this report) contain some of the highest quality remaining habitat in the watershed.[129] These areas are

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[127] *Under Federal Law, Federal and State regulatory agencies are empowered to identify, in advance, those wetland areas that they collectively determine to be inappropriate for the disposal of fill and dredged materials. These determinations are made jointly in Southeastern Wisconsin by the U.S. Department of the Army, Corps of Engineers (USACE), the U.S. Environmental Protection Agency (USEPA), and the WDNR. SEWRPC provides technical assistance to these agencies in preparing maps of these areas.*

[128] *Runoff from impervious surfaces located within the protective area must be adequately treated with stormwater best management practices.*

[129] *Many of these areas are also encompassed by Milwaukee County-owned park and open space lands.*

crucial to wildlife maintenance and enhancement due to their continuity, size, and in many cases, proximity to Oak Creek and its tributaries. As discussed in the riparian buffer recommendations above, connecting the multiple INRAs and NAs throughout the Oak Creek watershed to the larger PEC and SEC areas and building and expanding upon the existing protected lands, represents a sound approach to enhance the wildlife corridor system and wildlife areas in the watershed.

The Milwaukee County Department of Parks, Recreation, & Culture's (DPRC) Natural Areas staff has been conducting invasive species surveys and developing and implementing site-specific ecological restoration and management plans for many of the County parks and County-owned open space lands located within the Oak Creek watershed. These plans are a blueprint to creating healthier and more ecologically stable open space lands throughout the watershed. Within the Oak Creek watershed, plans have been completed for Barloga Woods, Cudahy Nature Preserve, Falk Park, Oak Creek Parkway, and Rawson Woods.[130] Each plan contains invasive species survey results, identification of potential ecological threats, and restoration objectives specific to each area. These plans share common goals that include a combination of the following:

- Protecting existing high-quality natural areas within the site
- Maintaining and increasing native plant and wildlife diversity
- Reducing negative impacts of invasive species
- Providing passive recreational opportunities for the public
- Enhancing and maintaining the environmental corridor
- Engaging the public as part of the restoration management process
- Addressing encroachment activities

To maintain and improve wildlife habitat in the Oak Creek watershed, the following recommendations have been developed:

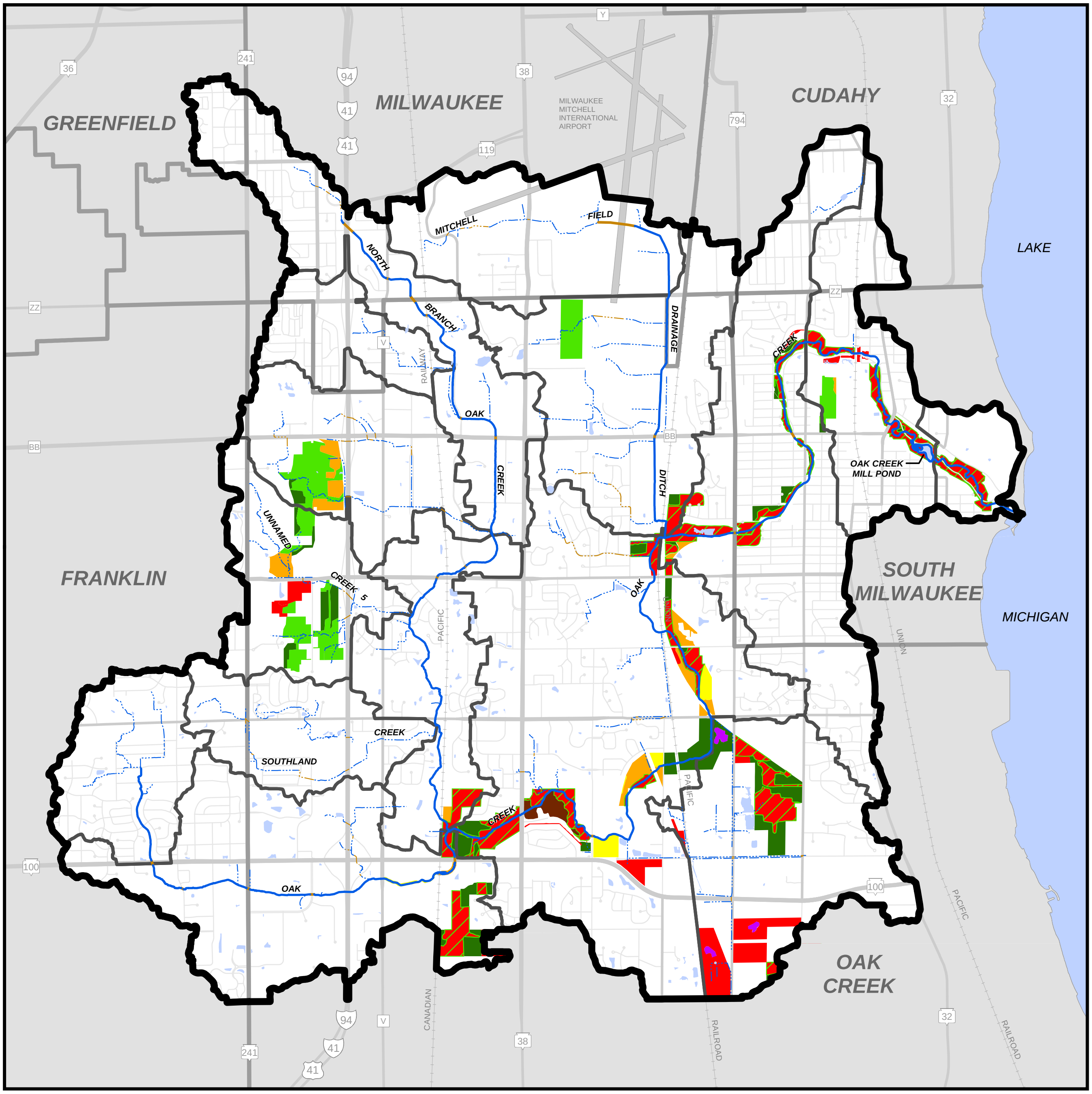
1. **It is recommended that Milwaukee County and watershed partners pursue funding to continue the implementation of the Milwaukee County DPRC's ecological restoration and management plans.** Specific management or restoration actions include rapid response invasive plant species removal, reforestation, forest stand improvement, grassland management, grassland restoration, shrub management, and creation of shallow-water wildlife areas (see Map 6.31 for recommended project locations). The conversion of all Milwaukee County-leased agricultural land to reforestation, wetland restoration, or native grassland restoration projects is included in these plans. For detailed recommendations see the individual Milwaukee County ecological restoration and management plans.[131]

2. **It is recommended that wildlife habitat be preserved and expanded through protection of riparian buffer areas considered to be "vulnerable" to development throughout the watershed (see Maps G.1 through G.22 in Appendix G) and through establishment of additional riparian buffer areas.** Establishment of riparian buffers should occur particularly at those sites where such establishment can be located contiguous with an environmental corridor and may result in a potential expansion of such corridor areas (see Map 4.8 and Map 4.9 in Chapter 4 of this report). Specific measures that can be taken to accomplish this recommendation include:

[130] *Milwaukee County Parks,* Barloga Woods Ecological Restoration & Management Plan 2016-2025, *2018; Milwaukee County Parks,* Cudahy Nature Preserve Ecological Restoration & Management Plan 2018-2027, *2018; Milwaukee County Parks,* Falk Park Ecological Restoration & Management Plan 2016-2025, *2017; Milwaukee County Parks,* Oak Creek Parkway Ecological Restoration & Management Plan, *2019; Milwaukee County Parks,* Rawson Woods Ecological Restoration & Management Plan 2017-2026, *2017*.

[131] Ibid.

Map 6.31
Recommended Projects from Milwaukee County Parks Ecological Restoration and Management Plans Within the Oak Creek Watershed



RAPID RESPONSE INVASIVE REMOVAL
RAPID RESPONSE INVASIVE REMOVAL AND FOREST STAND IMPROVEMENT
REFORESTATION
FOREST STAND IMPROVEMENT
GRASSLAND MANAGEMENT
GRASSLAND RESTORATION
SHRUB MANAGEMENT
SHALLOW-WATER WILDLIFE AREA

OAK CREEK WATERSHED BOUNDARY
ASSESSMENT AREA BOUNDARIES (SEE MAP 3.2 FOR ASSESSMENT AREA NAMES)
PERENNIAL STREAM
PERENNIAL STREAM (ENCLOSED)
INTERMITTENT STREAM
INTERMITTENT STREAM (ENCLOSED)
SURFACE WATER

N

0 0.25 0.5 1 Mile

Source: Milwaukee County Parks and SEWRPC

- Implement measures described under Riparian Buffer Recommendations 1 through 4, specifically focusing on expansion of buffer widths to the 400-foot minimum width for wildlife protection and the 1,000-foot optimum width for wildlife protection.

- Implement measures described under Groundwater Recharge Recommendations 1 and 2.

- Implement measures described under Urban Surface Water Hydrology Recommendation 1 and Rural Surface Water Hydrology Recommendations 1 through 4.

- Implement recommendations to acquire and protect wetland and woodland areas that have been identified in the adopted regional natural areas and critical species habitat protection and management plan.[132] Implementing these recommendations, in addition to those set forth in the draft park and open space plan for Milwaukee County,[133] and the County's ecological restoration and management plans would complement the protection and preservation of environmentally sensitive lands.

3. **It is recommended that habitat fragmentation be reduced by preserving and further enhancing connections between riparian buffer areas, open space, critical species habitat sites, and natural areas.** Specific measures that can be taken to accomplish this recommendation include:

- Implement measures described under Riparian Buffer Recommendations 2, 3 and 4.

- Establish corridors and buffers of natural habitat connecting isolated wetlands and ephemeral ponds to nearby upland wooded areas to allow reptiles and amphibians safe access to uplands necessary for certain life stages.

- Bridge crossings of streams may provide opportunities for wildlife to pass under roadways and between critical habitats. However, large riprap extending to the edge of the water surface is often placed under bridges to protect infrastructure. This can make passage by mammals and reptiles difficult and force them to cross roadways, potentially leading to dangerous encounters with traffic. It is recommended that bridge underpasses within the watershed be assessed for adequate dry land passage during baseflow periods. It is further recommended that installation of an approximately two-foot wide flat dry-land passage be considered as retrofits for those bridge crossings that do not provide adequate dry land passage. Note that any alterations to riprap or other materials must not impact the regulatory floodplain or the longevity or structural integrity of the bridge or other infrastructure.

- Maintain and/or re-establish connections between streams and overbank floodplains to protect, preserve, and enhance fish and wildlife habitat and water quality benefits. This action should make use of open space lands, riparian corridors, and park lands in flood prone areas, as appropriate. This management measure will be discussed in detail in the "Recommended Actions to Restore Degraded Stream Channels and Re-Establish Connections Between Stream Channels, Floodplains, and Adjacent Wetlands" section below.

- Municipalities, homeowner associations, and other managers of stormwater detention and retention basins should consider managing stormwater facilities as critical habitat for aquatic and terrestrial wildlife. This can be accomplished by reduced and selective mowing, planting native plant species in and around existing and new basins, reducing or eliminating fertilizers and pesticides near basin slopes, and limiting herbicide application and cutting to invasive species only. The use of native plants in these situations will improve filtration of detention waters, reduce pollutant loading, and provide additional wildlife habitat.

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[132] *SEWRPC Planning Report No. 42,* A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin, *September 1997; SEWRPC,* Amendment to the Natural Areas and Critical Species Habitat Protection and Management Plan for the Southeastern Wisconsin Region, *December 2010.*

[133] *Preliminary Draft of SEWRPC Community Assistance Planning Report No. 132 (2nd Edition),* A Park and Open Space Plan for Milwaukee County, *which was being updated as this plan was under preparation.*

- Maintain connections between streams and wetlands, wetland and upland complexes, and wetlands and ephemeral and/or perennial ponds, all of which provide redundancy in available habitat quantity and quality necessary to help ensure wildlife biodiversity.

- Implement technical assistance programs and/or incentive-based programs meant to encourage landowners, farmers, and businesses within the 1,000-foot optimal wildlife habitat zone to consider native landscaping that would enhance wildlife habitat by providing connections or lanes through their properties. These programs should encourage the use of native plants that provide cover and food for wildlife.

4. **It is recommended that best management practices aimed at maintaining and enhancing wildlife habitat be implemented. These practices should consist of voluntary, educational and technical assistance, and/or incentive-based programs.** Specific measures that can be taken to accomplish this recommendation include:

   - Encourage landowners to enroll in programs that provide financial incentives to restore wildlife habitats such as the Conservation Reserve Program, the Wetland Reserve Program, the Wildlife Habitat Incentives Program, and/or the Landowner Incentive Program.

   - Encourage homeowners, businesses, and other landowners to implement BMPs on their property. Examples of BMPs could include:

     - Reforesting areas where forest canopy gaps have been created by ash tree mortality. Dead ash trees should be felled prior to reforestation in order to protect any newly planted native trees and shrubs. A select number of dead snags (5-10 per acre) could be left for cavity roosting and/or nesting wildlife.[134]

     - Restoring natural fire frequency, intensity, and seasonality. Where feasible, the use of fire should be favored over the use of herbicides as a vegetation management tool, especially in drier upland ecosystems. It will be necessary to consult with appropriate municipal officials for guidelines and/or restrictions before planning and implementing any fire management activities.

     - Identifying and protecting embedded, adjacent, and sensitive habitat features such as seasonal wetlands, springs, and rock outcroppings.

     - Formulating forest and/or vegetation regeneration plans before removal of large stands of invasive species.[135]

     - Using native plant species from local sources if possible when landscaping. Landscaping that increases native flowering plants can attract vital pollinators, encourage a healthy insect food base for birds and amphibians, and help prevent the introduction and spread of exotic species.

     - Avoid mowing wetlands, shorelines, and ditches, especially from mid-spring through mid-fall. If mowing of large fields is necessary, raise the blade deck to a height of at least eight inches.

     - Avoiding storage of silage, manure, fertilizers, pesticides, deicing salts, and other contaminants near wetlands, waterbodies, or other sensitive habitat areas.

     - Using effective nutrient management for agricultural fields (timing, amounts, mechanisms of spreading) including consideration of crop rotation and burning to add nutrients rather than use of chemicals. Nutrient management plans should be developed for agricultural operations in the watershed that do not currently have them.

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[134] *This is a management action recommended by Natural Areas staff for Milwaukee County-owned open spaces but may be also applicable to some privately owned forested land.*

[135] *Ecological restoration and management plans completed by Milwaukee County Parks Natural Areas staff for County-owned open spaces may be a good starting point for restoration and management strategies.*

- Following label directions and using the minimum amounts necessary when using fertilizers, herbicides, and insecticides on agricultural lands, lawns, or golf courses.
- Installing rain gardens that are vegetated with appropriate native plant species.

Recommended Actions to Control and Manage Invasive and Nonnative Species

As described in Chapter 4 of this report, at least 97 known invasive plant species have been found in waterbodies, wetlands, riparian areas, and uplands of the Oak Creek watershed. In addition, invasive animal species found in the watershed include fish species, such as common carp and round goby; invasive crustacean species, such as rusty crayfish; invasive mollusks, such as the Chinese mystery snail; and invasive insects, such as the emerald ash borer. The presence of exotic invasive species in a habitat can produce alterations in physical and biological characteristics of that habitat. For example, the emerald ash borer has devastated the ash tree population in the Oak Creek watershed, dramatically altering the tree canopy in the riparian areas. This has reduced the quality of these areas as habitat for many other organisms and led to favorable conditions for the spread of other invasive plant species on the forest floors. Invasive species are often strong competitors for nutrients, space, and other resources, allowing them to out-compete and displace native species from habitats. As a result, invasive species have the potential to degrade the remaining high-quality natural areas within the watershed. The following recommendations are intended to control and manage the spread of nonnative and invasive species in the Oak Creek watershed.

1. **It is recommended that Milwaukee County and watershed partners pursue funding to continue implementing the Milwaukee County DPRC's ecological restoration and management plans that include continued inventory, monitoring, and control of invasive species populations.** As part of the management plans, County Natural Areas staff have prioritized targeted control and removal of "rapid response" species. These are invasive plant species that are not yet common within the park system or plant populations but have an inordinate negative impact on existing important wildlife areas. Rapid response invasive species removal areas are shown on Map 6.31. For detailed recommendations specific to each park or open space area see the individual Milwaukee County ecological restoration and management plans.[136] Reforestation and forest stand improvement efforts that are conducted as part of managing invasive species should follow the guidelines for reforestation previously described in the section on protecting and restoring riparian buffers.

2. **It is recommended that Milwaukee County DPRC continue to update the ecological restoration and management plans for County-owned park and open space sites within the watershed as the plans are implemented or as conditions change.**

3. It is recognized that some methods of invasive species control can be very labor intensive. Because of this, **it is recommended that State agencies, Milwaukee County, municipalities, and non-profit groups conduct invasive species workdays in parks and natural areas, utilizing community volunteers, partner organizations, and contractors in addition to governmental staff.** One example is the annual "Garlic Mustard Pull-A-Thon" sponsored by the Southeastern Wisconsin Invasive Species Consortium, Inc. (SEWISC). This event is a friendly competition, a fundraiser, and a way for the public to join together and have a positive impact on the natural areas in their community by removing the invasive plant species from parks, open spaces, and their own property.

4. **It is recommended that invasive species be removed and/or managed using accepted management methods.** Examples of accepted methods can be found in the Milwaukee County DPRC's invasive species management guide.[137] A copy of this guide is included as Appendix R. New information is constantly becoming available regarding the biology and management of invasive species. Because the most current information is valuable in more effectively managing these pests, **it is recommended that the Milwaukee County DPRC continue to periodically update its management guide as new techniques and knowledge becomes available.**

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[136] *Milwaukee County Parks, op. cit.*

[137] *Milwaukee County Department of Parks, Recreation & Culture,* Quick Reference Guide: Phenology and Control of Common Invasive Plant Species Found in Southeastern Wisconsin, *2021.*

5. **It is recommended that current monitoring for invasive species in the Oak Creek watershed be continued and expanded.** This should include routine updating of inventories of parks and natural areas as well as new surveys of other publicly owned open space and park lands. Given that it is important that observations of invasive species be compiled and collated, all new observations of invasive species in waterbodies or terrestrial habitats should be reported to the WDNR.[138]

6. **It is recommended that Milwaukee County, the University of Wisconsin-Extension, the WDNR, municipalities, and nongovernmental watershed partners continue educational activities related to nonnative and invasive species and the control thereof.** Such educational activities should include, but not be limited to, the distribution of informational materials, presentation of workshops, installation of signage, and answering of direct inquiries from landowners and residents. SEWISC is a good source for information for residents related to invasive species identification and removal. The organization also offers "Fighting Invasive Plants" aluminum signs for a small fee that residents can place on their properties to promote the stewardship practice to others.[139]

7. **It is recommended that roadway managers for communities within the Oak Creek watershed consider implementing guidelines outlined in the SEWISC Roadside Invasive Species Management Plan.**[140] New invasive species populations are often established along roadways and are easily spread to neighboring properties. The basic elements of a program to contain and control invasive plants on rights-of-way (ROW) should be sustained on a continuous basis and include:

   - Adjust and customize ROW mowing to prevent spreading seed and prevent seed set in established patches. In general, this means a full-mowing of the ROW should be implemented prior to seed set.

   - Monitor and identify newly occurring individual plants and very small new patches of invasive species in ROW and eradicate.

   - Aggressive and more costly control of well-established populations should only be conducted if it can be justified for specific locations (i.e., a roadside population poses a definite threat to an adjacent high-quality natural area). The goal is to not spread established populations.

Recommended Actions to Maintain and Restore the Quality and Diversity of Instream Habitat

Since at least the early 1900's, the Oak Creek system has been substantially altered through channelization, agricultural and urban development, road construction, placement of fill, construction of stormwater conveyance systems, and other actions related to agricultural and urban development. These changes have physically, chemically, and hydrologically degraded aquatic habitat.

Aquatic organisms, including fish, mussels, and insects, are essential to maintaining aquatic health by assuring an ecological balance and are also the sources of extensive recreation, especially related to fisheries. To improve upon the health of the aquatic organism communities in the Oak Creek watershed, it will be important to maintain and improve the physical, chemical, and hydrologic aspects of aquatic habitat. As these three aspects of the stream system are improved over time, there will be improved aquatic organism populations and overall health. The recommendations provided in this section are designed to restore the natural functions in the Oak Creek watershed to the extent possible, mitigate the negative impacts of hydrologic modifications, and provide essential habitat for fish and other aquatic organisms.

Implementing the recommendations set forth in this Chapter such as re-establishing natural surface water hydrology, protecting groundwater recharge areas, protecting and expanding riparian buffer areas, and managing invasive species will have far-reaching functions that improve many dimensions of aquatic habitat including:

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[138] *This can be done through the WDNR website at dnr.wisconsin.gov/topic/Invasives/report.html. This website also describes the specific information that should accompany such reports.*

[139] *More information can be found on the SEWISC website at www.sewisc.org.*

[140] *Southeastern Wisconsin Invasive Species Consortium, Inc.,* Roadside Invasive Plant Management Plan, *2015.*

- Filtering total suspended solids; nutrients, such as phosphorus and nitrogen; and chemicals, such as fertilizers and pesticides from water entering streams, resulting in reductions in pollutant loading
- Helping to maintain stream baseflows and stream depths and volumes
- Regulating maximum summer water temperatures
- Reducing destructive peak stream flows during heavy rainfall events
- Restoring natural flow patterns such as stream meandering and floodplain inundation, which will provide a variety of crucial instream habitats including pool and riffle structures and new fish spawning habitat
- Promoting conditions favorable to native aquatic and riparian plant species
- Increasing dissolved oxygen concentrations
- Promoting variable substrate composition necessary for various life stages of aquatic organisms
- Providing cover for organisms in the form of overhanging vegetation and coarse woody habitat
- Increasing streambank stability, thus reducing erosion and the resulting downstream sedimentation

In addition to the benefits that can be obtained from implementing recommendations from previous sections, the approaches to conserve and protect instream fish and aquatic organism habitat within the Oak Creek watershed includes four main elements that are described in detail in the following sections:

- Restore degraded stream channels and re-establish connections between streams, floodplains, and adjacent wetlands
- Improve instream connectivity by removing or modifying impediments to aquatic organism passage
- Manage coarse woody habitat
- Address excessive streambank erosion

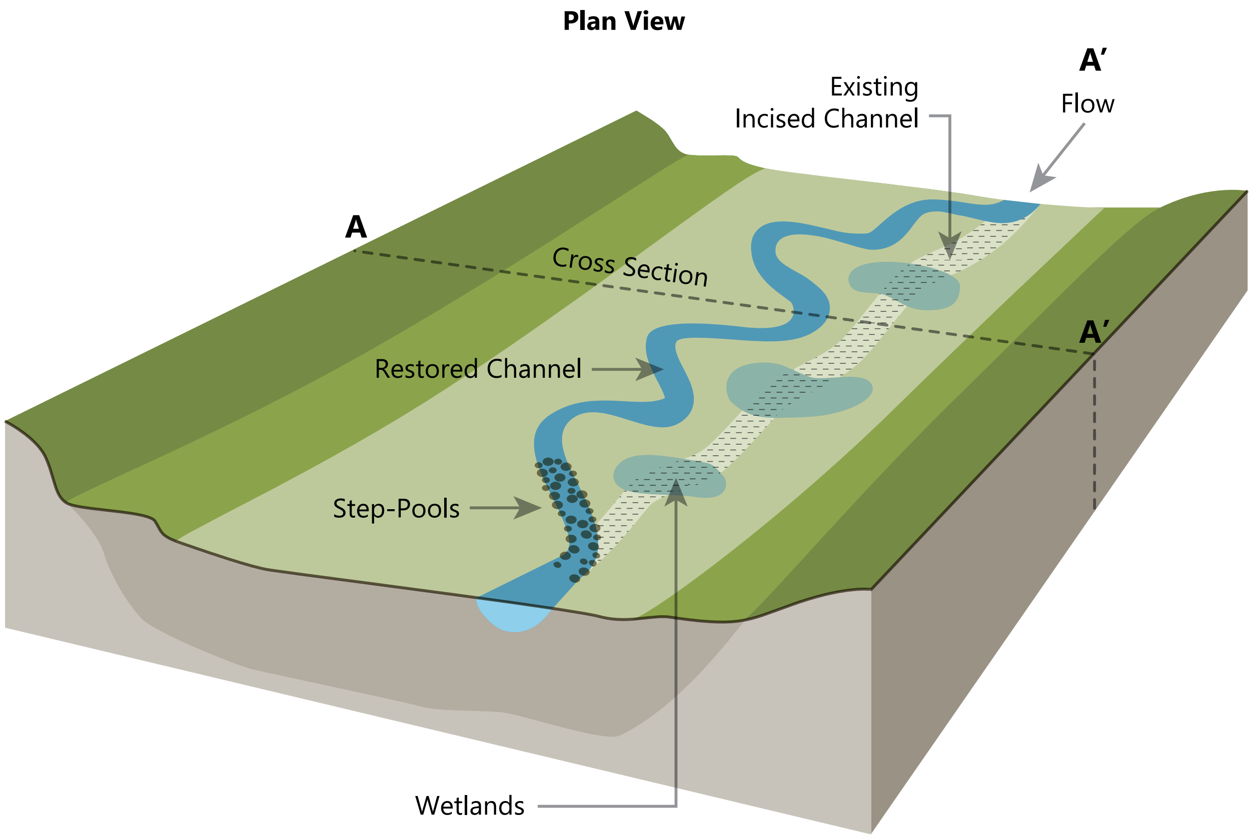
Recommended Actions to Restore Degraded Stream Channels and Re-Establish Connections Between Streams, Floodplains, and Adjacent Wetlands

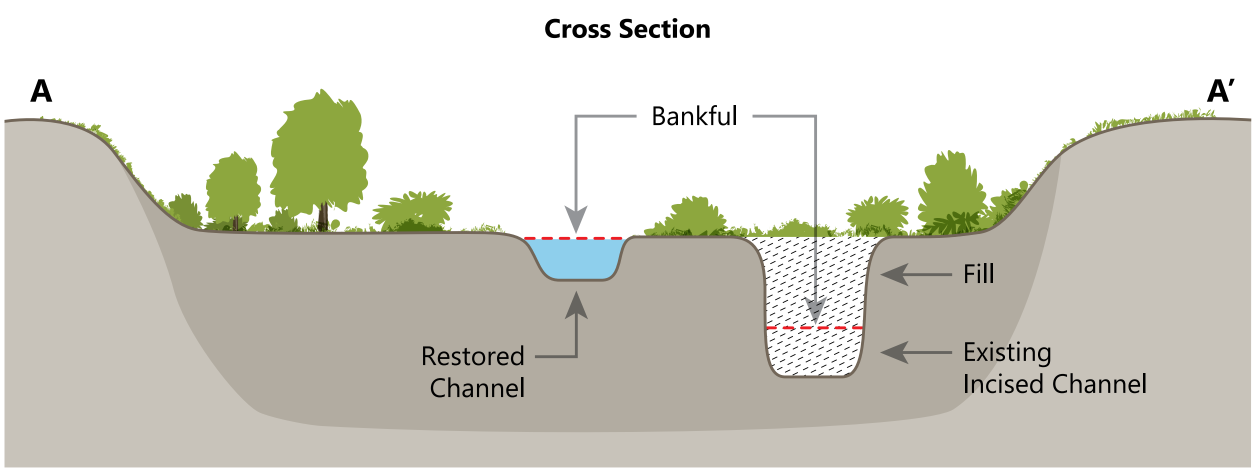
As described in Chapter 4 of this report, large stretches of the mainstem of Oak Creek, North Branch Oak Creek, and Mitchell Field Drainage Ditch have been straightened, deepened, and channelized. The quantity and distribution of pool, riffle, and run habitat units are fundamental metrics upon which overall instream habitat quality can be assessed. Generally, an equal number of pools and riffles is considered optimal for most aquatic organisms. As indicated in Table 4.7 in Chapter 4 of this report, the lack of riffle habitat units in the Lower Oak Creek, Middle Oak Creek, Lower Mitchell Field Drainage Ditch, Lower North Branch Oak Creek, and Upper North Branch Oak Creek assessment areas has led to inadequate pool/riffle ratios (i.e., lack of adequate number and quality of habitats).

1. **It is recommended that the installation of natural channel design elements such as naturalized meanders to restore pool and riffle habitats, grade control, and/or a series of constructed riffle habitats be considered for installation in the stream reaches listed above to provide valuable fish, mussel, and invertebrate habitat.** The ideal number of constructed riffle installations to be considered should create pool/riffle ratios for an assessment area closer to a 1:1 ratio. Example design elements of these potential natural channel restoration design installations are provided in Figure 6.6 and Figure 6.7. Installation of such natural channel design features could accompany potential floodplain reconnection projects described below.

Over-excavated channels, excavated spoils deposited on streambanks, and channel incision have led to the disconnection of streams from their functional floodplains throughout the Oak Creek watershed. This disconnection has reduced the natural floodplain storage capabilities to disperse flood waters and decrease

Figure 6.6
Potential Stream Restoration Design Elements to Improve Sinuosity and Stream Function

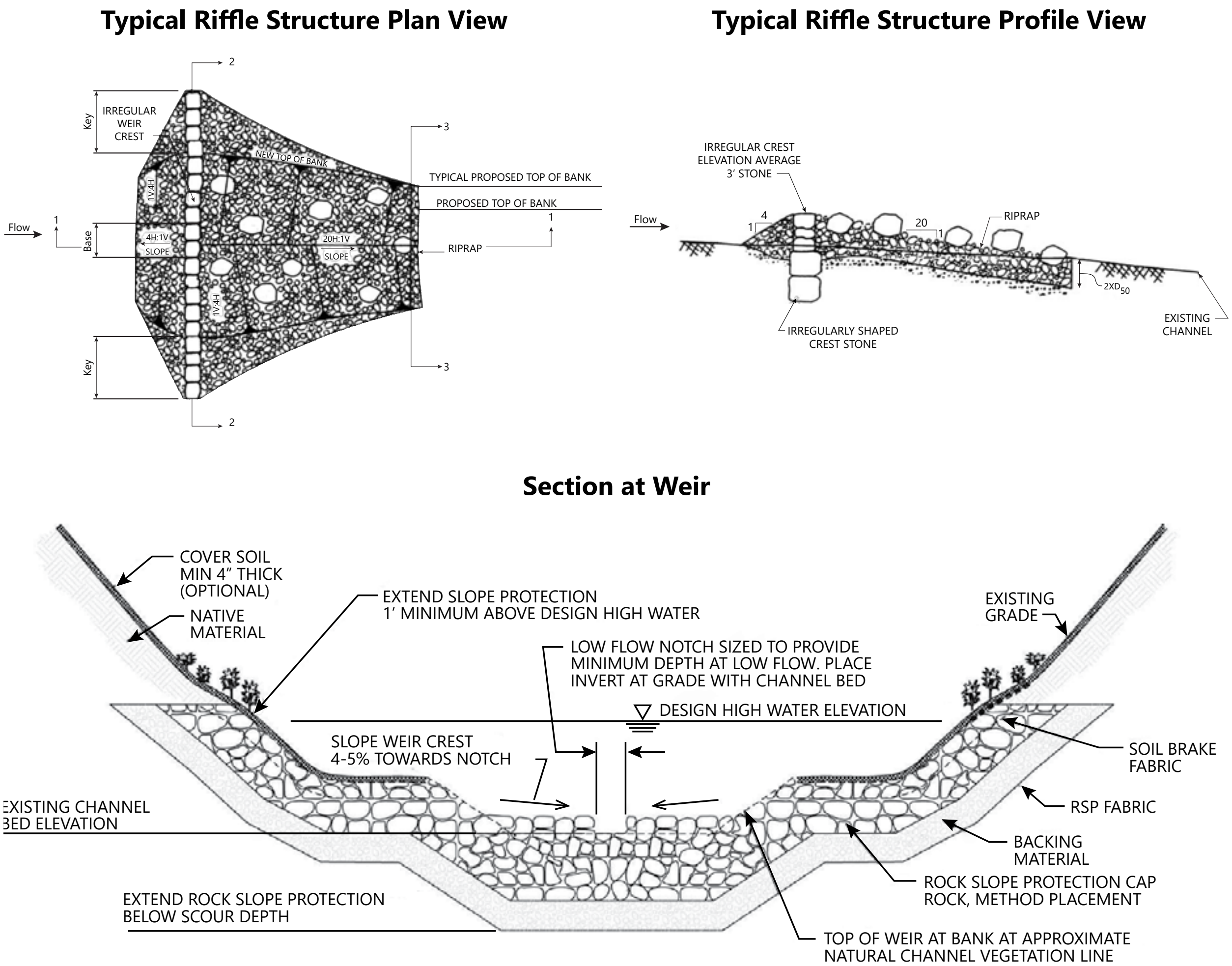




Note: The example shown in this schematic includes a raised elevation for the restored channel bed when compared to the existing channel. Any changes to channel bed elevation would need to consider upstream and downstream channel elevation profiles and elevations of road culverts and other fixed structures.

Source: Modified from W. Harman, R. Starr, M. Carter, et al., A Function-Based Framework for Stream Assessments and Restoration Projects, *US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Washington, DC, EPA 843-K-12-006, p. 36, 2012 and SEWRPC*

Figure 6.7
Example Design Elements – Naturalized Channel Grade Control Concepts



Note: Avoid excessive use of stone - avoid pavement-like or armored appearance. All installations must include choker material to bind and seal streambed. Coarse wood structure may be used to supplant stone in some applications. Grade control elements must be able to withstand high flow – key pieces must be sized to remain immobile and structures must extend beyond flood-prone width. Distribute vertical fall over several short (e.g., < 6-inch tall) riffles, and avoid channel sections with > 2 feet of vertical fall over 100 feet of channel length.

Source: Modified from D.T. Williams, David T. Williams and Associates; W. White, J. Beardsley, and S. Tomkins, Waukegan River Illinois National Nonpoint Source Monitoring Program Project, *Illinois State Water Survey, January 2011; Caltrans,* Fish Passage Design for Road Crossings: An Engineering Document Providing Fish Passage Design Guidance for Caltrans Project, *May 2007 and SEWRPC*

their destructive energy during high rainfall events, leading to streambank and streambed erosion and further channel incision. This has also disabled the stream system's ability to capture, store, and process sediment and nutrient loads. Furthermore, disconnection of streams from their functional floodplains has contributed to instream conditions that reduce the availability of quality habitat for aquatic organisms. As a result, many stream reaches in the watershed have poor quality aquatic organism communities.

It is estimated that 55, 38, and 41 percent of the total length of Oak Creek, North Branch Oak Creek, and the lower portions of the Mitchell Field Drainage Ditch, respectively, are at least partially disconnected from a functional floodplain (see Map 4.2 in Chapter 4 of this report). In many of these areas, the best way to restore the stream's hydrologic and hydraulic function and associated sediment transport capacity, streambank and stream bed stability, and overall instream habitat quality, is to physically re-establish a stream-floodplain connection, or a functional floodplain to the extent practicable.[141]

[141] *It should be noted that "floodplain," as referred to in this section, is defined as a relatively flat valley floor that can carry and hold flood waters that have overtopped the banks of a stream. The use of the term in this section is not necessarily referencing the regulatory 1-percent-annual-probability (100-year recurrence interval) floodplain boundary.*

There are four attributes that create and sustain fully functioning floodplains,[142] including:

- Connectivity—floodwaters can overtop streambanks and dissipate across land
- Variable flow—occurrence of flows at different magnitudes and at ecologically beneficial times, durations, and frequencies
- Spatial Scale—a minimum area of land accessible to inundation to allow occurrence of a full range of biotic and geomorphic processes
- Habitat and structural diversity—uniquely distributed patches of different habitats created over time by flood disturbance, sediment erosion and deposition, turn-over of vegetation, and debris recruitment

The attributes described above build upon one another, each supporting additional functions that together form a fully functional floodplain system (see Figure 6.8). Restoring functioning floodplains to affected stream reaches within the Oak Creek watershed will help regulate peak flows, provide floodwater storage during heavy rain events, reduce pollutant loads entering streams, prevent erosion, provide recreational benefits, and may contribute to groundwater recharge, all of which lead to an improvement in aquatic and terrestrial wildlife habitat. Implementing actions to improve floodplain functionality, along with vigilant protection of the regulatory floodplain, are anticipated to help decrease the vulnerability to flooding and increase resiliency of the stream network to better withstand heavy rainfall events and protect human residents and wildlife living in the watershed.

2. **Where land use, land ownership, topography and channel conditions, and soil types are conducive to periodic inundation, it is recommended that actions be taken to restore connections between streams and their functional floodplains to include re-establishing the periodic hydrologic connection of streams to adjacent existing wetlands during high flow periods, where applicable.** Restoration of and connection to adjacent areas considered by WDNR to be "potentially restorable wetlands" should also be considered where applicable. High-priority areas for such restorations are shown on Map 6.32. While the areas shown on Map 6.32 include only parcels under public interest ownership, restoration of adjacent private land could be incorporated into potential projects where the landowner is interested and willing to participate in restoration activities.

In areas where excavation spoils from channelization have been piled on banks or where incision has led to further disconnections from the floodplain, excavation and streambank re-grading will likely be necessary to restore hydrologic connectivity to the floodplain and adjacent wetlands. In reaches where the disconnection from the floodplain is not excessive, less invasive actions that do not require excavation should be explored. An example of such an action may include installing a series of channel grade control structures as described above and shown in Figure 6.7. A more natural option would be installing a series of log jams or rootwads to help initiate the process of debris recruitment that backs-up water and makes the floodplain accessible during higher flow volumes.[143] Woody debris accumulation can also increase sediment storage in a stream reach and help to aggrade streambeds making floodplains more accessible to streamflow over time.[144]

Other restoration actions that should be considered as part of restoring a functional floodplain connection include:

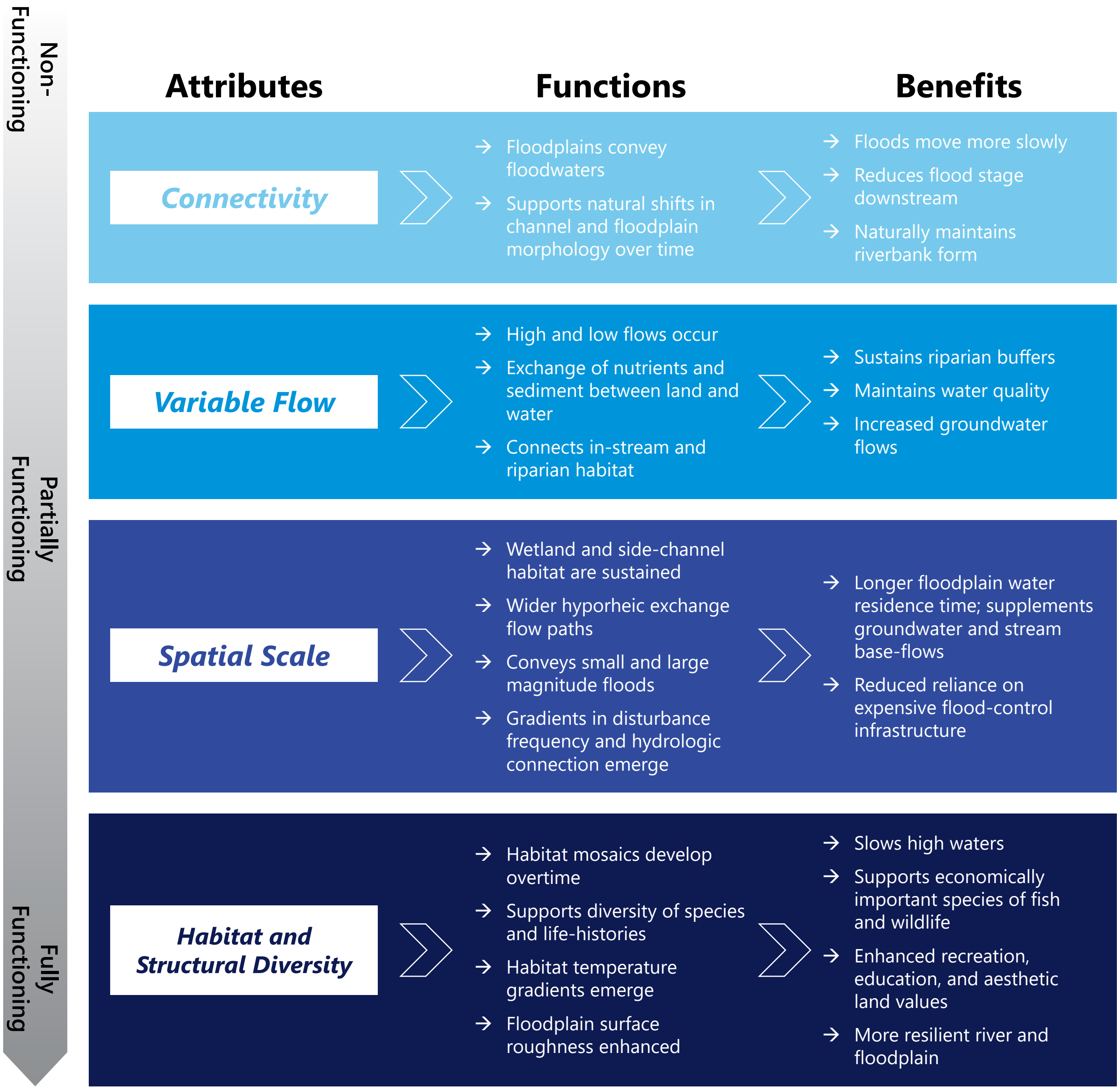
- Ensuring restored floodplain areas are managed to support natural ecosystem functions
- Restoring, maintaining, or planting native wetland and/or riparian vegetation

[142] *Johnathan Loos and Eileen Shader,* Reconnecting Rivers to Floodplains: Returning Natural Functions to Restore Rivers and Benefit Communities, *American Rivers River Restoration Program, 2016.*

[143] *Lanes for aquatic organism passage should be maintained when installing log jams.*

[144] *Any action intended to increase connectivity to the adjacent floodplain must not raise the regulatory floodplain elevation.*

Figure 6.8
Attributes, Functions, and Benefits of Ecologically Functional Floodplains



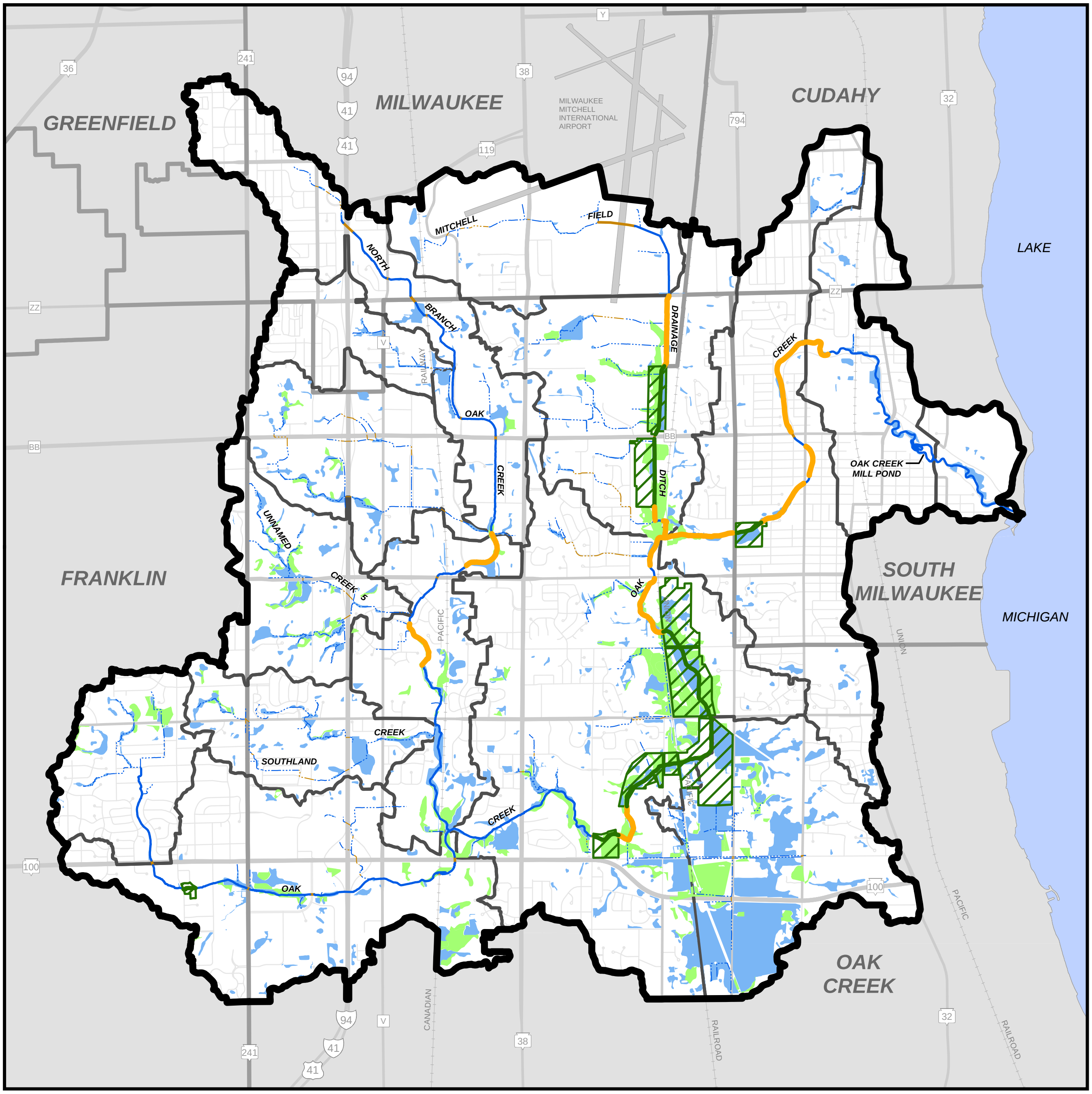
Source: Modified from Jonathon Loos and Eileen Shader, Reconnecting Rivers to Floodplains: Returning Natural Functions to Restore Rivers and Benefit Communities, *2016 and SEWRPC*

- Managing and removing invasive species[145]
- Disconnecting or dismantling drain tile systems

Some stream channels in the watershed that are disconnected from their floodplains are confined by urban development or other land features that make reconnecting to a larger fully functioning floodplain area impractical. Despite this, many of these reaches still contain opportunities to restore some degree of connection to a smaller floodplain terrace or bench to improve floodplain functionality and ecosystem services. Several methods may be used to accomplish this restoration depending on the severity of floodplain

[145] *Strategies for invasive species management from Milwaukee County Parks ecological restoration and management plans should be implemented for those areas of floodplain restoration where plans have been developed.*

Map 6.32
Potential Locations for Projects to Re-Establish a Connection Between Streams and Floodplains



AREAS TO CONSIDER PROJECTS THAT RE-ESTABLISH A FUNCTIONAL FLOODPLAIN, RESTORE WETLANDS, AND RE-ESTABLISH HYDROLOGIC CONNECTION BETWEEN STREAMS AND WETLAND COMPLEXES

STREAM REACHES TO CONSIDER PROJECTS TO IMPROVE FLOODPLAIN CONNECTION SUCH AS TWO-STAGE CHANNEL DESIGN, REMOVING OR BREAKING SPOIL PILES OR BERMS, OR REGRADING CHANNEL BANKS

EXISTING WETLANDS (2015)

POTENTIALLY RESTORABLE WETLANDS (WDNR)

OAK CREEK WATERSHED BOUNDARY

ASSESSMENT AREA BOUNDARIES
(SEE MAP 3.2 FOR ASSESSMENT AREA NAMES)

PERENNIAL STREAM

PERENNIAL STREAM (ENCLOSED)

INTERMITTENT STREAM

INTERMITTENT STREAM (ENCLOSED)

0 0.25 0.5 1 Mile

Source: WDNR and SEWRPC

disconnection and other specific characteristics of each individual stream reach.[146, 147] These methods may be used in conjunction with each other and with other stream restoration methods. Examples of these methods include:

- **Bank shaping**—regrading streambanks to an angle that can sustain vegetation growth and maintain lateral stability and connection to the floodplain or a floodplain bench.

- **Channelization spoil berm removal or breaks**—excavating and removing soils that were piled on banks during channel straightening or deepening. Often these spoil piles have disconnected the stream from a floodplain that still exists just beyond the berm. Complete removal of the berms is ideal; however, where flooding concerns may prevent complete removal, strategic breaks in the spoil berms may provide connections to floodplain areas where it is appropriate to allow for some floodplain functions.

- **Multi-stage channel design**—excavating one or more flat benches adjacent to the stream at bankfull elevation and installing associated meanders and/or other habitat features designed to accommodate a range of flows while maintaining sediment transport capacity. Multi-stage channel design includes a channel to accommodate and sustain the low flow habitat features, bankfull floodplain benches, and sometimes an inner berm below a bankfull bench. The most common form of multi-stage channel is the two-stage channel, though three- and four-stage channels are options for larger streams and areas where the necessary space is available.

3. **It is recommended that stream channels that are disconnected from their floodplains and that are confined by urban development or other land features be retrofitted with a two-stage channel design where possible. Bank shaping and breaking or removal of spoil berm piles may also be implemented where appropriate to restore and/or improve floodplain functionality.** Priority areas for this retrofitting are shown on Map 6.32. Some of the stream reaches to be considered for two-stage channel design already resemble a two-stage configuration; however, down-cutting and channel incision have severed hydrologic connections from the stream to a floodplain bench during most conditions except for extreme high flow events. In these reaches, regrading of the streambanks may be sufficient to encourage connection to the floodplain terrace at flows greater than the 1-year to 2-year recurrence interval flood event (roughly equivalent to bankfull discharge).

Two-stage channels are designed based on geomorphic principals. This design incorporates benches that function as floodplains and attempts to restore or create some natural alluvial channel processes. Figure 6.9 shows that the main channel is designed to carry flows ranging from baseflow to bankfull discharge. By limiting the width of this channel, enough flow can be maintained in the channel during low-flow periods to keep nutrient rich sediments moving and prevent sediment deposition and accumulation. The floodplain benches allow space for the stream to flow out of its banks and spread out during heavy runoff events, dissipating the energy and erosive potential of large flows. During heavy runoff events, finer sediments can settle out over the newly created floodplain bench instead of clogging the main channel. The stability of the channel banks are improved because the toe of the cut meets the floodplain bench rather than the channel bottom (see Figure 6.9).

In addition to providing improved drainage functions, two-stage channel design has the potential to create and maintain improved aquatic habitat. The main channel provides greater water depth during low-flow periods. Grasses and other native plantings on the benches can provide cover and shade for the low-flow channel resulting in moderated water temperatures. Substrates within the main channel are improved because the fine sediments can be deposited on the benches during higher flows. This results in a channel bed consisting of coarser materials such as gravel and cobble that provide more favorable spawning areas for fish and necessary habitat for macroinvertebrates. With the right conditions, two-stage channels have also been known to restore the natural meander patterns of streams over time, creating pool habitats that fish use for refuge.

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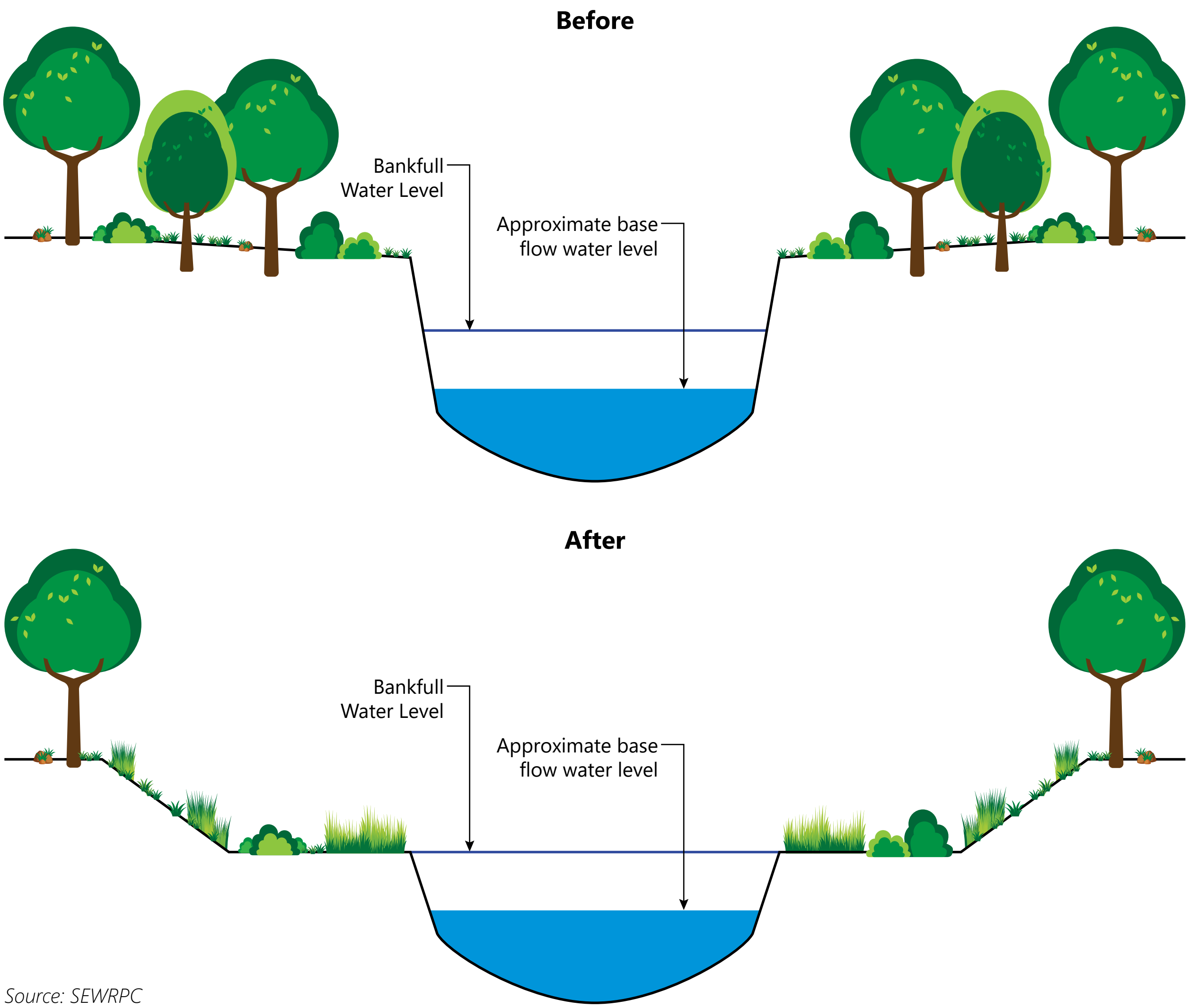
[146] *Iowa Department of Natural Resources, "Floodplain Restoration,"* River Restoration Toolbox Practice Guide 4*, April 2018.*

[147] *The recommendations in this section are general and are not meant to be a comprehensive design. Site-specific engineering and landscape design will be necessary for each stream reach chosen for restoration to determine the most appropriate and practical restoration application.*

Figure 6.9
Cross-Section Schematic of a Two-Stage Channel Design



Source: SEWRPC

Several factors should be considered when designing and constructing a two-stage channel.[148] These factors include, but are not limited to:

- Priority project areas should be selected based on need. Stream reaches with severe erosion, sedimentation issues, or drainage concerns should be addressed first.
- All utility lines including sewer and water should be identified as part of the project scope, so that such infrastructure will not be impacted or can be moved as appropriate.
- Existing streambed slopes within project areas should be less than 0.5 percent.
- Pre-project surveying and engineering should be conducted for each site to determine the optimal width and elevation of floodplain benches.
- The low-flow channel should remain undisturbed during construction. As much of the existing vegetation as possible should be left adjacent to the stream to provide stability and facilitate the process of narrowing of the stream.

[148] *National Institute of Food and Agriculture, U.S. Department of Agriculture, National Integrated Water Quality Program, "Selecting and Sizing a Two-Stage Channel System in an Agricultural Landscape," 2011.*

- All existing drain tile outlets and stormwater outfalls within the project site must be located prior to excavation and preserved to the extent possible. Both drain tiles and stormwater outfalls should be retrofitted to empty at the base of the benches, allowing drainage to be filtered through the vegetated benches. Installing a saturated buffer system in combination with a two-stage channel design may increase the effectiveness of nutrient uptake by vegetation.[149] Outfalls should be reinforced with appropriate rock protection to prevent erosion.

- The stability of the two-stage system is highly dependent on the amount and quality of vegetation on the benches. Benches and side slopes should be seeded with long-rooted native grasses as soon as possible after construction. The use of woody vegetation as the dominant vegetation type is discouraged because trees and shrubs tend to shade sunlight needed for grasses to grow and could impede the flow capacity on the second bench.

The headwaters of both Oak Creek and North Branch Oak Creek are experiencing severe channel incision and areas of excessive erosion. Because these reaches have relatively steep channel slopes and flows that are highly dependent on stormwater contributions, typical restoration options to re-establish floodplain connectivity and address severe bed and bank erosion are not optimal solutions to manage their degraded channels. Regenerative stormwater conveyance (RSC) is a relatively new restoration approach that may be more suitable for restoring the function and habitat quality of these headwater streams that are dominated by stormwater inputs. This approach provides stormwater treatment, infiltration, and conveyance within one system and can be used as an ecosystem restoration practice for eroded and degraded headwater channels in highly urbanized environments and locations where channel slopes make it difficult to implement more traditional practices.[150] A typical RSC approach utilizes a series of shallow pools, riffle grade controls, native vegetation, and underlying sand and woodchip or gravel beds to treat, detain, and convey stormwater flow. The design of an RSC system should be based upon providing safe and stable conveyance of the peak flows generated by the 1-percent-annual probability (100-year recurrence interval) storm. Figure 6.10 provides a profile view and details of two RSC configurations, including alternating pools and riffles, and three pools following a cascade. The top configuration in Figure 6.10 shows a typical profile using alternating pools and riffles. This configuration is generally used when the change in elevation along the path of the proposed RSC system does not exceed 5 percent. If the existing stream slope does exceed 5 percent, then one or more cascades can be designed into the system to provide added stability (see bottom configuration in Figure 6.10). Generally, the required number of grade control structures (riffles or cascades) and pools is equal to the change in elevation that occurs along the path of the RSC system.[151] While fish passage will likely not be possible during lower flows due to the intermittent, or near-intermittent nature of these headwater stream reaches, properly designed and constructed riffle-weirs should control the grade in a manner that allows for fish passage during higher flow volumes.

4. **It is recommended that regenerative stormwater conveyance restoration methods be considered for the Oak Creek headwater stream reach between Glenwood Drive and about 500 feet downstream of Ryan Road;**[152] **and for North Branch Oak Creek through Copernicus Park from S. 20th street to where the Creek daylights just south of W. Grange Avenue** (see Map 6.33). The RSC design for the Oak Creek headwater reach should investigate the potential to incorporate the four existing concrete drop structures identified in Appendix H as fish passage impediments (see Table H.1, Figure H.1 in Appendix H and Map 4.14 in Chapter 4 of this report) to provide the additional benefit of improved aquatic organism passage.

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[149] *Saturated buffers redirect flow from main drainage tile lines through a lateral distribution line into a riparian buffer allowing the water to percolate into the soil and get taken up by vegetation.*

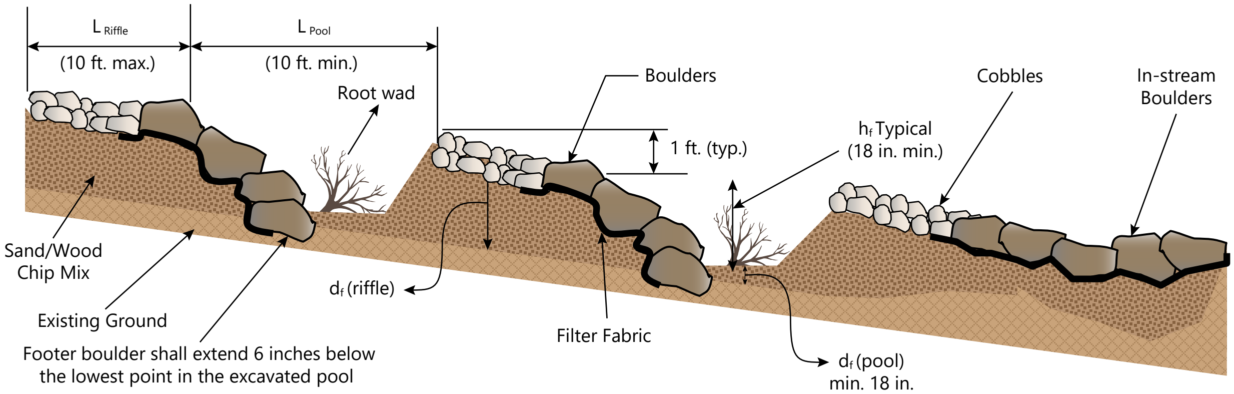
[150] *West Virginia Department of Environmental Protection, "Chapter 4.2.7 Regenerative Stormwater Conveyance System (RSC)"* West Virginia Stormwater Management & Design Guidance Manual, *November 2012.*

[151] *Hala Flores, P.E., Dennis McMonigle, and Keith Underwood,* Regenerative Step Pool Storm Conveyance (SPSC) Design Guidelines, *Anne Arundel County, Maryland, December 2012.*

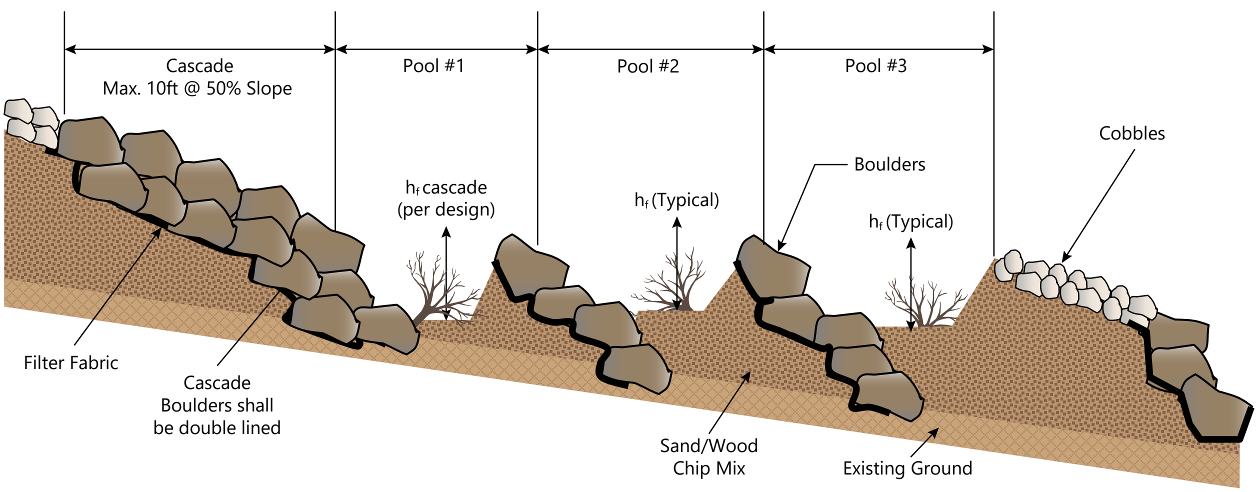
[152] *Regenerative stormwater conveyance design features may not be necessary for the full stream length described in this recommendation. The downstream extent required for an RSC project for this reach is unknown and will need to be determined during a more detailed engineering and design phase.*

Figure 6.10
Schematic Profiles of Two Typical Configurations for Regenerative Stormwater Conveyance Systems

Typical Profile – Alternating Pools and Riffles



Cascade Profile – Three Pools Following Cascade



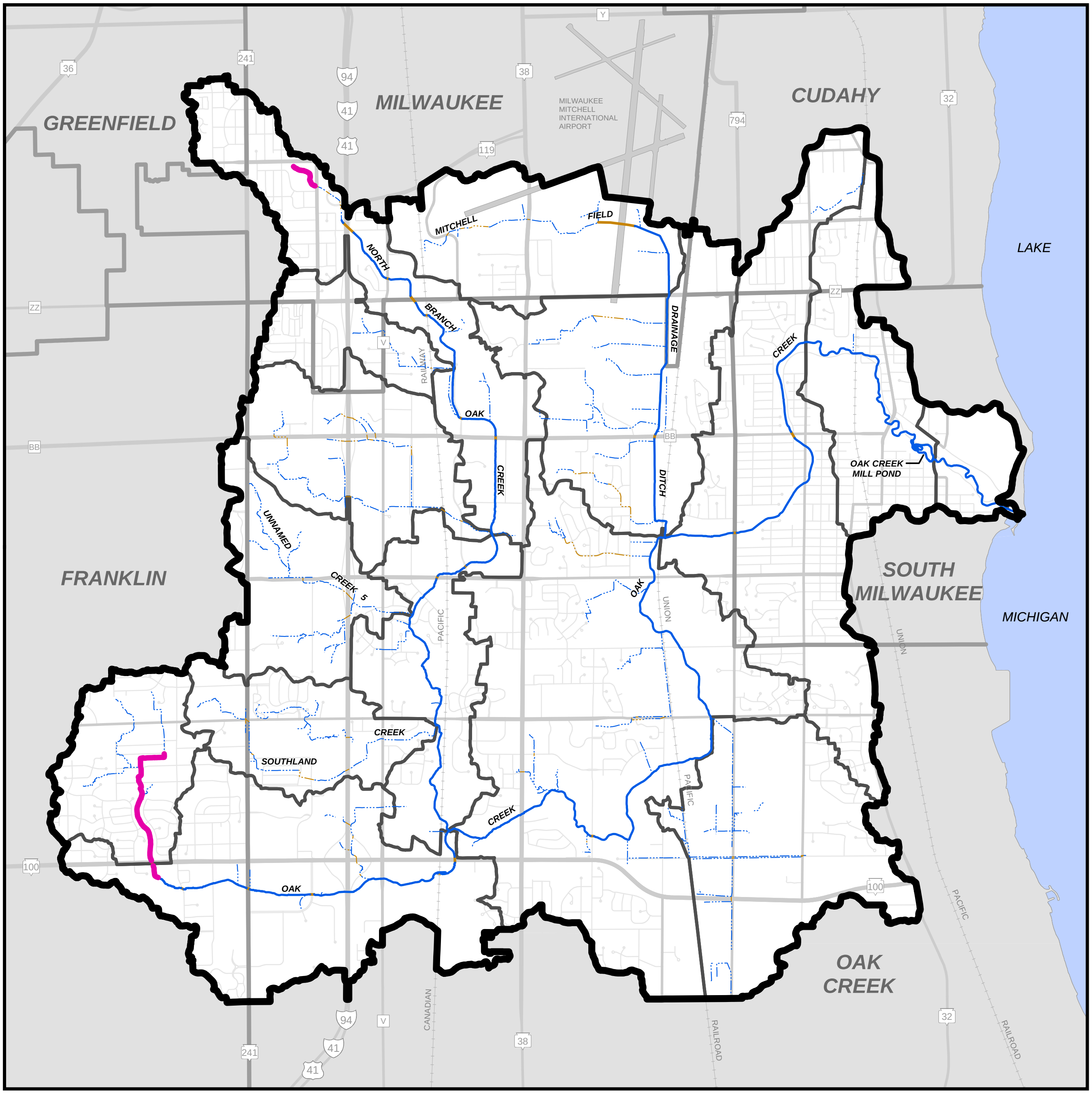
Source: Modified from Stormwater Management and Design Guidance Manual Chapter 4.2.7 Regenerative Stormwater Conveyance System, *West Virginia Department of Environmental Protection, November 2012 and SEWRPC*

Recommended Actions to Remove or Modify Impediments to Aquatic Organism Passage

Fishing, both recreational angling and commercial harvesting, is an important economic activity in Lake Michigan and the Southeastern Wisconsin Region. The maintenance and continuity of species of economic importance and the species on which they depend is largely associated with the protection, restoration, and access to appropriate habitat. To this end, efforts to remove impediments to aquatic organism migration along the mainstem and tributaries of Oak Creek and between Oak Creek and Lake Michigan are critical elements that would be necessary for the improvement of overall instream habitat and the long-term restoration of the fishery and other aquatic communities.

Commission staff conducted fish passage assessments at all accessible stream crossings along the three principal streams in the watershed, including the mainstem of Oak Creek, North Branch Oak Creek, and the Mitchell Field Drainage Ditch downstream of the MMIA property. Findings from these assessments are provided in Appendix H. Assessments along Oak Creek indicated that eight steam crossings were found to be impediments to fish passage and eight other crossings were found to be potential or partial fish passage impediments. Along North Branch Oak Creek, four stream crossings were determined to be fish passage

Map 6.33
Stream Reaches to be Considered for Regenerative Stormwater Conveyance Restoration Projects



STREAM REACHES TO BE CONSIDERED FOR REGENERATIVE STORMWATER CONVEYANCE RESTORATION PROJECTS

OAK CREEK WATERSHED BOUNDARY

ASSESSMENT AREA BOUNDARIES (SEE MAP 3.2 FOR ASSESSMENT AREA NAMES)

PERENNIAL STREAM

PERENNIAL STREAM (ENCLOSED)

INTERMITTENT STREAM

INTERMITTENT STREAM (ENCLOSED)

N

0 0.25 0.5 1 Mile

Source: SEWRPC

impediments and two other crossings were determined to be potential or partial fish passage impediments. Finally, all the stream crossings assessed along the Mitchell Field Drainage Ditch downstream of the MMIA property were determined to be passable by fish.[153] The location of fish passage impediments observed by Commission staff are shown on Maps 4.14 and 4.15, and descriptions of these impediments are provided in Table H.1 in Appendix H. The majority of fish passage obstructions were caused by significant elevation drops from the water surface upstream of a structure to the water elevation downstream of a structure, excessive culvert length, limiting water depths typically caused by oversized culverts, undersized culverts, debris or sediment accumulations, and abandoned structures in disrepair (see Figures 4.27 through 4.30 for example photographs of some impairment types).

Several issues should be kept in mind when contemplating or implementing projects to address fish passage impediments. These barriers can vary greatly in their ease of repair. Removal and/or retrofitting of these obstructions should be accompanied by the restoration or re-creation of habitat within the stream and riparian corridor that is essential for resting, rearing, feeding, and spawning of fish and other organisms. Improving access to high-quality habitats will help to restore the biotic integrity of the streams within the Oak Creek watershed. Even ephemeral streams that only flow seasonally can provide fish passage and two-way access to spawning and nursery habitat. Designs to improve fish passage through replacement or modification of hydraulic structures are provided in Appendix S. Ozaukee County's Fish Passage Program is highly developed and is also a good information resource.[154]

To maintain and restore fish and aquatic organism passage throughout the Oak Creek watershed, the following recommendations have been developed:

1. **It is recommended that plans be developed to replace, retrofit, or modify those fish passage impediments identified in Maps 4.14 and 4.15, accompanied by the restoration or re-creation of habitat within the stream and riparian corridor.** Improvements to aquatic organism passage should be implemented as opportunities such as structure failure, major blockage, or scheduled road, bridge or culvert reconstruction or replacement under municipal capital improvement programs present themselves. A brief synopsis of potential actions to improve fish passage at each assessed crossing is provided in Table H.1 of Appendix H.

2. **It is recommended that fish passage assessments be conducted at all roadway bridges, culverts, and other stream crossings throughout the watershed that were not assessed by Commission staff.** As described above, Commission staff has conducted fish passage assessments on all accessible stream crossings on the three principal streams in the watershed. For those stream crossings that have not been surveyed, it is advised that fish passage assessments be completed on an assessment area basis, with all stream crossings being evaluated within an assessment area before moving onto another assessment area. In doing so, limitations to aquatic organism passage can be evaluated on an assessment area basis indicating where work needs to be done to allow connections to high-quality habitat areas and to the mainstem of Oak Creek. It is recommended that fish passage assessments be completed first for the unassessed (and in some cases unnamed) streams immediately tributary to the mainstem of Oak Creek, followed by the unassessed streams tributary to the North Branch Oak Creek and Mitchell Field Drainage Ditch (see Map 4.14 in Chapter 4 of this report to determine locations of crossings that were not assessed by Commission staff). Periodic reassessments of the stream crossings of the Oak Creek system should be conducted to review capabilities to maintain fish passage, particularly identifying obstructions due to debris accumulation and to identify where actions need to be taken to improve passage.

Larger scale fish passage impediment removals and retrofits require hydrologic and hydraulic modeling, engineering, detailed design, and permitting. It is recommended that each stream crossing culvert considered to be a fish passage impediment be inspected by a qualified engineer to first determine if the structure is safe and remains serviceable. If inspection determines that a structure is at the end of its serviceable life, it is recommended that it be replaced with a structure that is appropriately designed to

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[153] *Due to accessibility and security issues within the Milwaukee Mitchell International Airport property, no stream crossings were assessed upstream of College Avenue.*

[154] *See website at www.co.ozaukee.wi.us/619/Fish-Passage.*

allow fish passage (see Appendix S for replacement structure design considerations). If a stream crossing is no longer needed at a particular location, removal of the fish passage barrier is recommended, along with appropriate restoration and reinforcement of the stream banks and bed in the area to prevent erosion and/or head-cutting. If inspection reveals that a structure remains serviceable, modifications or retrofits aimed at allowing aquatic organism passage should be pursued. There are many ways to retrofit passage impediments depending on the cause of the impediment and the unique characteristics of the structure and surrounding environment. Examples of specific methods and/or retrofits to remedy common types of fish passage impediments found in the Oak Creek watershed include:[155]

- For significant elevation drops:
  - Installing grade control structures such as a series of rock cross-vanes or step-pools at appropriate spacing downstream of the elevation drop to produce a backwater effect sufficient to provide a hydraulic connection from the stream to the structure.
  - Installing a rock ramp leading upstream to elevation drop. Generally, rock ramps should create an incline flatter than 1:20 (vertical : horizontal units).
- For culverts with excessive length:
  - Strategically placing appropriately sized boulders or large cobble throughout the inside of the culvert. These substrates should be placed intermittently along each culvert wall throughout the length of the culvert. Added substrates must be appropriately sized so they can withstand peak flow velocities. Note that any added substrates within the culvert must not impact the regulatory flood elevation.
  - Installing downstream grade control structures to produce a backwater effect and reduce flow velocity within the structure. Note that any installation of grade control structures must not impact the regulatory flood elevation.
- For crossings with limiting water depths (typically caused by oversized culverts):
  - Retrofitting a low-flow channel to direct flows during average flow conditions to one cell of a multi-cell culvert and promote sufficient water depths through the culvert, while allowing overflow into additional culvert cells during higher-flow events.
  - Installing downstream grade control structures to produce a backwater effect and providing sufficient depths through the culvert.
- For debris or sediment accumulations adjacent to or within culvert:
  - Regularly monitoring the structure and removing sediment or debris accumulations as they occur (e.g., beaver sometimes use these to create dams).

3. **It is recommended that the estuary area where Oak Creek flows into Lake Michigan be monitored to ensure that sediments do not accumulate to the point of potentially impeding fish migration between the Lake to Oak Creek. Additional opportunities to improve the estuary area with native plant installations and other habitat improvements should be explored.** The decision regarding management of the Mill Pond and dam may also influence the estuary area downstream of the dam. If the decision is made to remove the Mill Pond dam, it is likely that sediment that is typically trapped within the current configuration of the Mill Pond would be transported downstream. This sediment could be deposited and accumulate in the estuary area. This scenario may provide further opportunities to restore the area near Lake Michigan by converting the current

[155] *The methods and considerations provided here do not represent a complete list of options for remedy of the specific fish passage impediments. Each impediment is unique and may require a greater level of survey and professional engineering design than is provided in the scope of this watershed restoration plan.*

backwater characteristics to wetland estuary habitat. Removal of the dam would also increase the need to monitor sediment accumulations and maintain the connection with Lake Michigan.

Efforts to reduce fragmentation within the stream system should follow a three-tiered approach. As shown graphically in Figure 6.11, the components of this strategy, in order of their importance, are:

- Tier 1—Restoring connectivity and habitat quality along the entire mainstem of Oak Creek as well as between the mainstem of Oak Creek and Lake Michigan

- Tier 2—Restoring connectivity and habitat quality between the tributary streams and the mainstem of Oak Creek

- Tier 3—Restoring the connectivity of the mainstem and tributary streams to the highest-quality fish, mussel, and other aquatic organism habitat throughout the Oak Creek watershed[156]

A decision regarding the future of the Mill Pond and Mill Pond dam has not been made at the time of publication of this report.[157] Should Milwaukee County, as the owner of the dam, decide to maintain the dam in its current form, then the focus of connectivity efforts should be increasing connectivity of the mainstem upstream of the dam as well as restoring connectivity to areas described in Tier 2 and Tier 3. Alternatively, should it be decided to remove or modify the Mill Pond dam, planning and implementing the removal or modification of the dam could take considerable time. During the interim, programs to improve the free movement of aquatic organisms in the watershed should similarly focus on improving connectivity of the mainstem upstream of the dam as well as implementing Tier 2 and Tier 3 projects.

Within this three-tier framework, opportunities will arise that should be acted upon. For example, even though this strategy implies a principle that activities should generally progress from downstream to upstream, the completion of an action in a headwater area or on a tributary stream should not be passed up or ignored simply because it does not conform to this principle. Rather, all opportunities should be acted upon as they become available. Where multiple opportunities exist and limited funds are available, this strategic framework for in-stream reconnection is intended to assist decision-makers in allocating resources where they would be most appropriate and effective in achieving the goals of this restoration plan.

The Tier 1 prioritization is based upon the understanding that Lake Michigan is the most diverse resource and greatest asset available to the watershed for the maintenance of high-quality recreation as well as a sustainable fishery. Lake Michigan acts as a source of aquatic organisms to tributary streams such as Oak Creek. As described in Chapter 4, the most diverse fishery in the Oak Creek watershed is the roughly one-mile reach downstream of the Mill Pond dam. This is the only reach of the stream system in the watershed that is connected to Lake Michigan. Thus, the Mill Pond dam separates most of Oak Creek from achieving its full fisheries potential by severing its connection to Lake Michigan. This prioritization is also based upon the understanding that within stream systems the widest and deepest downstream areas are generally associated with a greater abundance and diversity of fishes than the narrower and shallower upstream areas.[158] Therefore, the highest priority, or Tier 1 approach focuses on restoring continuity of passage and habitat restoration for native fishes on the mainstem of Oak Creek from its mouth at Lake Michigan to its headwaters as shown in Figure 6.11.

The Tier 2 prioritization is based upon the understanding that, through their connection with the mainstem of Oak Creek, the tributaries are the next most diverse resources and greatest assets that have the potential to restore and maintain a sustainable fishery. Many fish species need access to a variety of habitats during their life cycles. For a fish to successfully progress from egg to adult, it must be able to get to each of these

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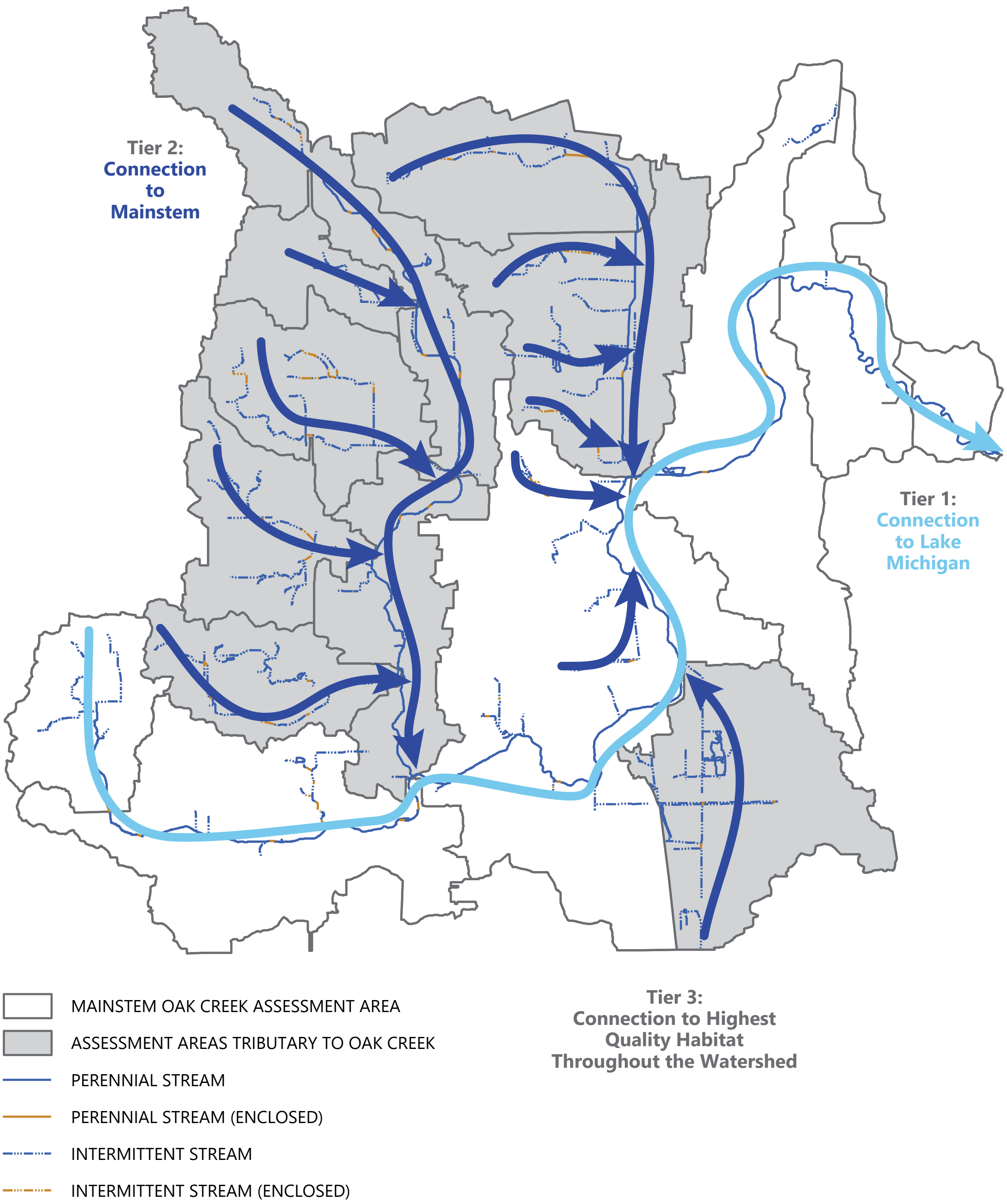
[156] *Tier-3 is a "catch all" intended to encourage flexibility for communities and stakeholders to take advantage of opportunities throughout the watershed that may arise independently of the primary strategy of restoring linkages along the mainstem and tributary streams and ultimately with Lake Michigan.*

[157] *Alternatives for the management of the Mill Pond and dam will be discussed in detail later in this Chapter.*

[158] *I.J. Schlosser, "A Conceptual Framework for Fish Communities in Small Warmwater Streams," pages 17-24 in W.J. Matthews and D.C. Heins (editors),* Community and Evolutionary Ecology of North America Stream Fishes, *University of Oklahoma Press, 1987.*

Figure 6.11
Instream Three-Tier Prioritization Strategy Within the Oak Creek Watershed



Source: SEWRPC

habitats at the appropriate life cycle stage. The connection of tributary streams to the associated mainstem provides access to feeding, spawning, and rearing sites as well as to refuges for organisms during periods of thermal stress and low-water and thus has greater potential to increase fish abundance and diversity in the stream system. Therefore, the second-tier approach focuses on addressing fish passage continuity and habitat quality from the tributary streams to the mainstem of Oak Creek. An example of a high-priority fish passage barrier that would be considered under Tier 2 prioritization is the Canadian Pacific Railway culvert on North Branch Oak Creek that is about 0.1 mile upstream of the confluence with the mainstem of Oak Creek (see structure number 65 on Map 4.14 and Figure 4.27 in Chapter 4 of this report). This obstruction completely disconnects the North Branch from the mainstem, preventing free movement of fish from between the majority of the North Branch Oak Creek and the mainstem, thus reducing fish access to a variety of habitats. The Tier 2 prioritization component is illustrated graphically in Figure 6.11.

The Tier 3 approach focuses on improving fish passage to the best habitat quality throughout the entire watershed whenever opportunities are presented. Prioritization of projects to improve the fishery quality should be based upon areas where fish passage impediments have been identified to be a problem and where improvement in ecosystem structure and function can be attained by removing these barriers. Factors to be considered in prioritizing Tier 3 projects include improving connections to one or more tributaries, increasing the length of stream between passage impediments, and improving connections to high-quality habitat areas. It is anticipated that new development or redevelopment may provide opportunities for interventions that do not conform to the first and second tier approaches. These opportunities should not be ignored; rather, where there are opportunities to enhance passage of fish and aquatic organism and/or to improve instream habitat, and where funds can be obtained, it is recommended that actions be taken to implement those opportunities.

Recommended Actions to Manage Coarse Woody Habitat

Branches, tree limbs, root wads, and entire trees that fall into, and collect along streams are commonly referred to as coarse woody habitat (CWH). CWH plays a vital role in the hydraulic, geomorphic, and biological functions of the streams and floodplains within the Oak Creek watershed. CWH helps control the shape of the channel and provides cover, shelter, resting areas, and feeding opportunities for aquatic organisms. In addition, the interaction between CWH, water, and sediment has a significant effect on channel form and process, increasing geomorphic complexity and the quality of aquatic habitat.[159] In most cases, removal of CWH can be detrimental to fish and other aquatic habitats downstream. For these reasons, **it is recommended that removal of CWH from the streams within the Oak Creek watershed should be discouraged. It is recognized that this will need to be balanced with reasonable removal efforts that are required to maintain safety, reduce the risk of property damage from flooding, and maintain aquatic organism passage.**

In some cases, excessive amounts of coarse wood can accumulate and form massive jams that span the entire width of the stream and extend completely to the bed of the channel. These debris jams can persist for decades. In these extreme instances, large woody debris jams can act as impediments to fish passage. There were 37 such large woody debris jams observed by Commission staff that had the potential to impede fish movement to some degree, as detailed in Chapter 4 (see Map 4.15 in Chapter 4 of this report). The following recommendations have been developed for the management of large woody debris jams in the Oak Creek watershed:

1. **It is recommended that assessments be conducted of all major woody debris jams within the Oak Creek watershed shown on Map 4.15 in Chapter 4 of this report to determine if they act as barriers to fish passage.** While assessments are most likely to occur during low-flow periods, it is necessary to evaluate whether the coarse woody debris would be submerged during high-flow periods, allowing for fish passage. It is also important to examine whether the jam extends completely to the channel bed. Some accumulations of coarse wood will raft upwards when sufficient stream flows are present allowing for passage of aquatic organisms under or through the jam even though the jam appears to completely block the channel when observed from above the water surface. Woody debris accumulations fitting this description should not be altered unless it is apparent that they are creating other hazards.

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[159] *C.J. Brummer, T.B. Abbe, J.R. Sampson, and D.R. Montgomery, "Influence of Vertical Channel Change Associated with Wood Accumulations on Delineating Channel Migration Zones,"* Geomorphology, *Volume 80, pages 298-309, 2006.*

2. **It is recommended that selective removal of small sections of woody debris be conducted on those large debris jams that are found to be complete fish passage barriers.** Removing only small sections of the debris jams will provide adequate fish passage without sacrificing the benefits associated with having CWH in the stream.

3. In addition to the large woody debris jams that were observed to potentially impede fish migration, Commission staff observed numerous minor accumulations of CWH. The locations of these accumulations are shown on Maps F.13 through F.35 in Appendix F. **It is recommended that periodic surveys be conducted to reassess the accumulation of CWH. While CWH accumulations can often move downstream, the locations of CWH shown on Maps F.13 through F.35 would be a good starting point for these surveys.**

Most of the bridges on the lower reaches of the mainstem of Oak Creek appear to be capable of passing wood transported downstream by the Creek. However, roadway culverts are more vulnerable to accumulations of large woody debris. Commission staff have observed several roadway culverts on the mainstem of Oak Creek and tributary streams that were occasionally blocked by large woody debris accumulations. These accumulations act to impede flow and have the potential to promote bank erosion, bed scour, and localized roadway flooding. It should be noted that the public works departments of the municipalities in the watershed appear to be responsive in clearing these blockages.

4. **It is recommended that roadway bridges and culverts continue to be periodically examined and that any large woody debris accumulations or blockages that are found at these sites be removed.**

Emerald Ash Borer infestations have caused and continue to cause substantial mortality of ash trees within the riparian corridors adjacent to Oak Creek and other streams in the watershed. As these trees continue to die, the amount of woody debris entering the streams of the Oak Creek watershed will increase. To reduce the likelihood of excessive large woody debris jams in the streams, this plan recommends the following:

5. **It is recommended that periodic thinning of deceased ash trees be carried out within riparian lands located adjacent to Oak Creek and other tributary streams in the watershed. For the purpose of this recommendation, priority should be given to those areas nearest to stream channels or floodplains that may carry fallen trees in flood waters. A selective number of dead snags should be left for cavity roosting and/or nesting wildlife; however, these should be chosen in areas that are not likely to carry flood flows. Recommended guidelines for reforestation of areas impacted by emerald ash borer can be found in the section related to restoring riparian buffers.**

Beaver activity and beaver dams were observed within the channels and corridors of Oak Creek, North Branch Oak Creek, and Mitchell Field Drainage Ditch. Beaver dams have the potential to limit fish passage and cause flooding of infrastructure. Therefore, it is important to continue to monitor beaver activity and act where appropriate. Those efforts should be focused on areas where there are nearby culverts and bridges where roadways and other structures may become threatened with flooding due to the presence of a beaver dam. Because the removal of beaver dams is a complicated and controversial issue, decisions to remove beaver dams should be addressed on a case-by-case basis.

Recommended Actions to Address Streambank and Streambed Erosion

The energy of flowing water in a stream is dissipated along the stream length by slope (meandering channels decrease slope by increasing channel length), turbulence, streambank and bed erosion, and sediment resuspension. A significant amount of the Oak Creek mainstem and tributaries have been straightened or ditched, removing the meandering channel lengths and directly increasing slope and scouring energy of the flowing water, thus leading to increased bed and bank erosion and loss of instream habitat. In addition, increases in the amount of urban development and land alterations associated with earlier agricultural land uses in the watershed may be expected to result in increases in stream flow rates and discharge volumes that result in an increased potential for streambank and streambed erosion. Excessive streambank and streambed erosion destroys aquatic habitat, spawning areas, and feeding areas; contributes to downstream water quality degradation by releasing large amounts of sediment to the water; and provides material for subsequent sedimentation downstream. This sedimentation buries valuable benthic habitats and contributes to the sediment accumulations in the Mill Pond. In addition, streambank erosion at some locations may threaten vital infrastructure.

The instream survey conducted by Commission staff identified and assessed streambank erosion sites along the Oak Creek, North Branch Oak Creek, and Mitchell Field Drainage Ditch. The findings of this survey are described in detail in Chapter 4. In order to evaluate their impact on water quality, erosion sites were modeled using the USEPA's Spreadsheet Tool for Estimating Pollutant Loads (STEPL) to estimate pollutant loads entering the streams based on measurements of length, height, and estimated lateral recession rates of each erosion site. Estimated load reductions that would result from remedying each inventoried erosion site are provided in Appendix D. It is important to note that minor streambank erosion is a normal occurrence in any stream system and should be expected.

Capital costs for individual recommended streambank stabilization projects within the Oak Creek watershed are estimated in Table 6.1 and were developed based on year 2019 unit construction costs. These estimates were based on an assumed typical stabilization approach, and include engineering, permitting, mobilization, regrading and revegetating banks, rock toe stabilization, inspection, and other contingency costs. The costs of projects may vary because there are many state-of-the-art methods that can be used to address issues related to streambank stability as alternatives to the standard approach that was assumed for cost-estimating purposes. Some of these methods are listed in Table 6.14. In addition, it is envisioned that many streambank erosion sites could be stabilized as part of recommended floodplain reconnection and/or remeandering projects. This would allow these projects to address multiple objectives. Each streambank erosion site should be evaluated on an individual basis to determine the most effective method based on specific site characteristics as well as environmental and economic factors.

Based on the results of the surveys conducted in the Oak Creek watershed, this plan makes the following recommendations regarding streambank erosion:

1. **It is recommended that the actively eroding streambanks identified in Table 6.1 and on Maps F.13 through F.35 be stabilized as opportunities arise. Priority should be given to those erosion sites listed in Table 6.15.**

    - For each streambank erosion site there are many unique factors that determine the most appropriate method to use for stabilization including the extent of erosion; stream dynamics; adjacent land use; soils; topography; and proximity to private property, structures, trees, utilities, and other infrastructure. Individual site assessments and proper pre-project engineering should be performed to determine the most appropriate approach. These assessments should take both environmental considerations and the cost effectiveness of the remediation methods into account (see Table 6.14 for examples of streambank stabilization methods). In all cases it is recommended that revegetation of the banks using bioengineering techniques be employed as part of the stabilization method, to the extent possible. State and/or municipal permits may be required prior to beginning construction activities. It may be prudent to meet with regulatory agencies prior to applying for permits to identify and avoid any potential problems in the permitting process.

2. **It is recommended that the design and implementation of the streambank stabilization projects ensure that the stream is reconnected to its floodplain whenever practicable.**

3. **It is recommended that assessments be conducted periodically following completion of streambank stabilization projects to evaluate the condition and functioning of the stabilization project. Routine maintenance at stabilization projects to sustain the functionality will also be necessary and may include:**

    - Removing dead or damaged trees

    - Repair and/or replace damaged stabilization material as needed

- Remove invasive plants and prune and selectively cut other vegetation as appropriate to reduce shade canopy to allow for plant establishment

- Treat plants if infested by insects or disease

4. **It is recommended that streambank stability surveys be conducted on streams in the watershed that have not been assessed for this plan.**

Damaged or Failed Outfalls

Commission staff inventoried the location and attributes of outfalls that were observed as part of instream surveys conducted in 2016 and 2017.[160] Data collected included the pipe size, material composition of the outfall, and an assessment of the general condition of each outfall. During the survey, Commission staff observed 136 outfalls discharging into or near surveyed portions of Oak Creek, North Branch Oak Creek, and Mitchell Field Drainage Ditch. There were 43 outfalls that were determined to be in poor or failed condition. Many of these outfalls were damaged as the result of streambank or streambed erosion. A summary of the inventory is provided in Table 4.6 in Chapter 4 of this report and the complete inventory, including mapped locations, outfall attributes, and photos are provided in Appendix E.

Table 6.14
Alternative Streambank Stabilization Practices

Instream Practices
Vanes or J-Hook Vanes
Cross Vanes
Streambank Treatment
Bank Shaping and Planting
Branch Packing
Brush Mattresses
Coconut Fiber Roll
Dormant Post Plantings
Vegetated Gabions
Joint Plantings
Live Cribwalls
Live Stakes
Live Fascines
Log, Rootwad, and Boulder Revetments
Multi-stage Channel Design/Restoration
Riprap
Stone Toe Protection
Tree Revetments
Vegetated Geogrids

Source: AECOM, City of Racine, and SEWRPC

It is recommended that outfalls assessed to be in poor or failing condition as identified in Table E.1 in Appendix E be confirmed as active and if so, replaced, repaired, or retrofitted as opportunities arise. Specific outfalls that are recommended to be remedied are also listed in Table 6.1. Methods to remedy damaged outfalls may vary significantly based on the status of the stormwater system connection to the outfall, extent of adjacent bed and bank erosion, length of damaged pipe, elevation and location of the remaining pipe sections, and site-specific conditions. Some repairs may be as simple as removing disconnected pipe and/or end sections from the site and reinforcing the remaining outfall pipe with riprap protection. Other repairs may require extensive excavation, streambank regrading, and installation of new pipe and end sections. All repaired outfalls should be reinforced with appropriate rock protection to prevent erosion. When site conditions allow, retrofit designs should be considered that allow the stormwater to filter through a vegetated buffer before entering the streams, thus providing the opportunity for pollutant removal.

In addition to the outfalls that were observed by Commission staff, all other known inventories of stormwater outfalls were analyzed and integrated into a master inventory (see Chapter 4 for more details of the inventories that were analyzed). Appendix E provides the location and attributes for 163 outfalls in addition to those that were observed by Commission staff as part of their instream surveys. These outfalls were not assessed for condition. **It is recommended that surveys of these outfalls be conducted to confirm their locations and whether they are still active. Surveys should also assess the condition of the outfalls and record the outfall dimensions and construction materials. It is further recommended that outfalls found to be in poor or failing condition be replaced, repaired, or retrofitted as opportunities arise.** Coordinates for each outfall are provided in Appendix E.

Recommended Actions to Reduce or Mitigate the Negative Physical, Chemical, and Biological Impacts on Aquatic and Terrestrial Ecosystems that are Associated with Climate Change

The changes in climate in southeast Wisconsin and the Oak Creek watershed that have occurred over the last half century and the changes that are projected to occur through the 21st century are discussed in Chapter 3 of this Report. Climate directly affects water resources and changing climatic conditions can be drivers of changes in water quantity, water quality, and aquatic and terrestrial habitat. Climate change will not be solved at the watershed scale; however, there are actions that can be implemented to mitigate the negative

[160] *Not all outfalls encountered during the instream survey could be confirmed as stormwater outfalls.*

Table 6.15
High Priority Streambank Erosion Projects for the Oak Creek Watershed[a,b]

ID Number (see Maps 6.1 – 6.13)	Location[c]	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)[d]	Key Project Partners
GPR-06	Right bank of Oak Creek within the Oak Creek Parkway downstream of the Mill Pond dam	Bank stabilization to address bank erosion along 234 feet of Oak Creek with a severe lateral recession rate	Water Quality, Habitat	Stabilization of creek bank, estimated annual pollutant load reductions of 46,400 pounds TSS, 12.1 pounds total phosphorus	81,900	Milwaukee County, municipalities, and other watershed partners
GPR-09	Left bank of Oak Creek within the Oak Creek Parkway downstream of the Mill Pond dam	Bank stabilization to address bank erosion along 170 feet of Oak Creek with a very severe lateral recession rate	Water Quality, Habitat	Stabilization of creek bank, estimated annual pollutant load reductions of 172,200 pounds TSS, 45.1 pounds total phosphorus	59,500	Milwaukee County, municipalities, and other watershed partners
LMP-12	Right bank of Oak Creek within the Oak Creek Parkway upstream of Chicago Avenue	Bank stabilization to address bank erosion along 107 feet of Oak Creek with a severe lateral recession rate	Water Quality, Habitat	Stabilization of creek bank, estimated annual pollutant load reductions of 10,200 pounds TSS, 3.2 pounds total phosphorus	37,500	Milwaukee County, municipalities, and other watershed partners
LMP-20	Right bank of Oak Creek within the Oak Creek Parkway upstream of Chicago Avenue	Bank stabilization to address bank erosion along 221 feet of Oak Creek with a severe lateral recession rate	Water Quality, Habitat	Stabilization of creek bank, estimated annual pollutant load reductions of 10,400 pounds TSS, 3.2 pounds total phosphorus	77,400	Milwaukee County, municipalities, and other watershed partners
MOC-51	Left bank of Oak Creek within Oak Creek Parkway upstream of S. Shepard Avenue	Bank stabilization to address bank erosion along 67 feet of Oak Creek with a moderate lateral recession rate	Water Quality, Habitat	Stabilization of creek bank, estimated annual pollutant load reductions of 4,200 pounds TSS, 1.3 pounds total phosphorus	23,500	Milwaukee County, municipalities, and other watershed partners
MOC-54	Left bank of Oak Creek within Oak Creek Parkway upstream of S. Shepard Avenue	Bank stabilization to address bank erosion along 107 feet of Oak Creek with a severe lateral recession rate	Water Quality, Habitat	Stabilization of creek bank, estimated annual pollutant load reductions of 20,600 pounds TSS, 6.3 pounds total phosphorus	37,500	Milwaukee County, municipalities, and other watershed partners
MOC-55	Left bank of Oak Creek within Oak Creek Parkway and American Legion Park upstream of S. Shepard Avenue	Bank stabilization to address bank erosion along 166 feet of Oak Creek with a severe lateral recession rate	Water Quality, Habitat	Stabilization of creek bank, estimated annual pollutant load reductions of 24,000 pounds TSS, 7.4 pounds total phosphorus	58,100	Milwaukee County, American Legion, municipalities, and other watershed partners
MOC-65	Right bank of Oak Creek within Oak Creek Parkway upstream of S. Howell Avenue	Bank stabilization to address bank erosion along 114 feet of Oak Creek with a severe lateral recession rate	Water Quality, Habitat	Stabilization of creek bank, estimated annual pollutant load reductions of 26,000 pounds TSS, 8.0 pounds total phosphorus	39,900	Milwaukee County, municipalities, and other watershed partners
OCH-10	Both banks of Oak Creek at W. Woodward Drive	Bank stabilization to address bank erosion along 298 feet of Oak Creek with a severe lateral recession rate	Water Quality, Habitat	Stabilization of creek bank, estimated annual pollutant load reductions of 57,200 pounds TSS, 17.6 pounds total phosphorus	104,300	Private landowner

Table continued on next page.

Table 6.15 (Continued)

ID Number (see Maps 6.1 – 6.13)	Location[c]	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)[d]	Key Project Partners
OCH-12	Both banks of Oak Creek upstream of W. Southland Drive	Bank stabilization to address bank erosion along 428 feet of Oak Creek with a severe lateral recession rate	Water Quality, Habitat	Stabilization of creek bank, estimated annual pollutant load reductions of 87,400 pounds TSS, 26.9 pounds total phosphorus	149,800	Private landowner
LNB-04	Left bank of North Branch of Oak Creek downstream of Canadian Pacific Railway crossing	Bank stabilization to address bank erosion along 113 feet of North Branch of Oak Creek with a severe lateral recession rate	Water Quality, Habitat	Stabilization of creek bank, estimated annual pollutant load reductions of 17,600 pounds TSS, 5.4 pounds total phosphorus	39,600	Milwaukee County, municipalities, and other watershed partners
LNB-05	Right bank of North Branch of Oak Creek downstream of Canadian Pacific Railway crossing	Bank stabilization to address bank erosion along 113 feet of North Branch of Oak Creek with a severe lateral recession rate	Water Quality, Habitat	Stabilization of creek bank, estimated annual pollutant load reductions of 16,200 pounds TSS, 5.0 pounds total phosphorus	39,600	Milwaukee County, municipalities, and other watershed partners
LNB-08	Right bank of North Branch of Oak Creek upstream of Canadian Pacific Railway Crossing	Bank stabilization to address bank erosion along 132 feet of North Branch of Oak Creek with a severe lateral recession rate	Water Quality, Habitat	Stabilization of creek bank, estimated annual pollutant load reductions of 22,200 pounds TSS, 6.8 pounds total phosphorus	46,200	Aldi, Inc. and other watershed partners
UNB-41	Left bank of North Branch of Oak Creek downstream of where the North Branch of Oak Creek daylights in Copernicus Park	Bank stabilization to address bank erosion along 145 feet of North Branch of Oak Creek with a severe lateral recession rate	Water Quality, Habitat	Stabilization of creek bank, estimated annual pollutant load reductions of 31,400 pounds TSS, 9.6 pounds total phosphorus	50,800	Milwaukee County, municipalities, and other watershed partners
UNB-42	Right bank of North Branch of Oak Creek downstream of where the North Branch of Oak Creek daylights in Copernicus Park	Bank stabilization to address bank erosion along 45 feet of North Branch of Oak Creek with a severe lateral recession rate	Water Quality, Habitat	Stabilization of creek bank, estimated annual pollutant load reductions of 8,600 pounds TSS, 2.7 pounds total phosphorus	15,800	Milwaukee County, municipalities, and other watershed partners

[a] *Table 6.1 provides more details on the priority projects.*

[b] *Prioritization based on total cost, length of erosional area, severity of lateral recession rate, total load reduction of total suspended solids (TSS), potential threat to infrastructure, and cost-effectiveness of load reduction of total suspended solids.*

[c] *Bank sides are when looking downstream.*

[d] *Costs are given in 2019 dollars.*

Source: SEWRPC

physical, chemical, and biological impacts that climate change can have on the Oak Creek system while at the same time improve the resiliency of the communities within the watershed to the impacts of climate change. Climate change stressors are often difficult to differentiate from, and can often intensify the impacts of, other anthropogenic stressors such as land use changes, hydrologic modifications, invasive species impacts, and loss of riparian buffers.[161] Fortunately, many actions taken to lessen other anthropogenic stressors are also likely to reduce climate change impacts and protect and sustain aquatic organisms. The following paragraphs describe adaptation strategies and restoration actions that, if implemented, would promote resistance to and build ecological resilience to the impacts of climate change in the Oak Creek watershed.

Climate models predict that there will be an increase in annual precipitation as well as an increase in the frequency of intense rainfall events. These changes are likely to have impacts on both the built and natural environments within the Oak Creek watershed. More intense storms may overwhelm under-designed stormwater infrastructure and lead to increased flooding. This indicates that there will be a need for greater investments in both gray and green stormwater infrastructure and continued assessments of the effectiveness of best management practices based on the evolving projections of climate change impacts. In addition, higher peak flows in the streams of the watershed are likely to result in more severe channel incision and streambank erosion, increased amounts of nutrients and other pollutants entering the streams, and diminished instream habitat. To mitigate these effects, **it is recommended that actions be implemented to restore or simulate natural processes that increase the capacity of the watershed to slow down, detain, and treat runoff; reduce the destructive power of peak stream flows; maintain shallow groundwater levels; and protect vital infrastructure from flooding**.

Efforts related to providing natural flood water storage by preserving and restoring floodplains and wetland areas in the watershed will be vital. Considering projections for an increased frequency of intense rainstorms in the watershed, it may be reasonable to plan for flooding impacts beyond the 1-percent-annual-probability (100-year recurrence interval) floodplain boundary that has typically been used in the past to plan for extreme flooding events. For example, protecting areas beyond the 1-percent-annual-probability (100-year recurrence interval) floodplain to the 0.2-percent-annual-probability (500-year recurrence interval) boundary or greater, where still practicable, would help to provide a greater level of protection from extreme rainfall events that are projected to increase in frequency. Communities within the watershed should consider changes to how they regulate the floodplain boundaries within their jurisdictions. This may include strengthening of floodplain ordinances and their enforcement. This could also include a reassessment and potential expansion of planned Primary Environmental Corridor areas that would provide additional leverage for communities to limit future development and provide protection in areas that may be more prone to flooding in the future. The following levels of stream flooding protections may provide a guide for communities to plan for increased resiliency considering projected climate change impacts[162]:

- *High level of protection for climate resiliency*: Regulate the 0.2-percent-annual-probability (500-year recurrence interval) floodplain boundaries with the same restrictions on development and redevelopment that are currently established for the regulatory floodway boundaries (i.e., no new development or compensatory filling allowed)

- *Moderate level of protection for climate resiliency*: Regulate the 1-percent-annual-probability (100-year recurrence interval) floodfringe areas with the same restrictions on development and redevelopment as are currently established for the regulatory floodway boundaries (i.e., no new development or compensatory filling allowed)

- *Low level of protection for climate resiliency*: Continue current floodplain regulations

[161] *Abigail J. Lynch, and others, "Climate Change Effects of North American Inland Fish Populations and Assemblages,"* Fisheries*, Volume 41(7), July 2016.*

[162] *In addition to the added resiliency of communities and the built environment, these additional protections of critical habitat areas would also alleviate the impact of projected increased drought conditions and offset the potential warming of surface waters that would likely result from projected climate change impacts.*

The Governor's Task Force on Climate Change emphasized the need to prioritize wetland and floodplain restoration to ultimately improve the capacity of watersheds across the State to handle the increased intensity and frequency of precipitation and to maintain baseflow and shallow groundwater supply during periods of drought.[163] By preventing the loss of remaining wetlands and by restoring wetlands that were previously converted to agricultural uses, the capacity for adapting to more intense rainfall events will increase. Other specific measures that can be taken to mitigate the impacts of climate change on aquatic and terrestrial systems in the watershed can be achieved by implementing recommendations related to other problems and issues facing the watershed. These can be found in the following sections:

- Recommendations to reduce stormwater runoff pollution
- Recommendations to reduce runoff velocity and increase infiltration
- Recommendations to protect areas of groundwater recharge
- Recommendations to protect, restore, expand, and connect riparian buffer areas
- Recommendations to protect, preserve, and restore environmentally sensitive areas
- Recommendations to re-establish connections between stream channels, floodplains, and adjacent wetlands
- Recommendations to address streambank and streambed erosion

While the annual number of intense rainfall events are expected to increase, models project that there will be little change in total summertime precipitation. This implies that there will be longer stretches of dry weather that could potentially lead to drought conditions. These periods of dry weather could lead to decreased summertime baseflows in the streams of the watershed, and when combined with warmer projected air temperatures, are likely to produce increased water temperatures. As discussed in detail in Chapter 4 of this Report, the USGS "FishVis" decision support tool can display modeled projections of changes in stream temperature, streamflow, and fish species occurrence throughout the 21st century. The model predicted that stream temperatures within the Oak Creek watershed will increase by up to 3.6°F, significantly reducing the extent of streams that will be suitable for cool water fish species that currently occur in the watershed. While streams in the Oak Creek watershed becoming unsuitable for cool water fish species is not an inevitable result, it is a likely scenario. This indicates that streams in the watershed are sensitive to changing air and water temperatures, precipitation patterns, and groundwater discharge and will likely require measures to reduce long-term warming in order to preserve the species currently residing in them. Therefore, **it is recommended that actions be implemented to promote stream shading, increase stormwater infiltration volumes, maintain or increase the processes that allow for direct groundwater discharge to streams, and increase and improve access to cool water habitat and refuge areas.** This can be achieved by implementing recommendations related to other problems and issues facing the watershed. These can be found in the following sections:

- Recommendations to reduce stormwater runoff pollution
- Recommendations to reduce runoff velocity and increase infiltration
- Recommendations to protect areas of groundwater recharge
- Recommendations to protect, restore, expand, and connect riparian buffer areas
- Recommendations to protect, preserve, and restore environmentally sensitive areas
- Recommendations to control and manage invasive and nonnative species

[163] *Governor's Task Force on Climate Change Report, State of Wisconsin, December 2020.*

- Recommendations to restore degraded stream channels and re-establish connections between stream channels, floodplains, and adjacent wetlands
- Recommendations to remove or modify impediments to aquatic organism passage
- Recommendations to manage coarse woody habitat

Climate change impacts are likely to alter the physical conditions of both streams and riparian areas, potentially affecting the suitability of these habitats for plant and animal species and potentially making them better suited for the establishment of invasive species. Therefore, **it is recommended that existing programs to monitor and manage invasive species and to restrict their spread be continued. In addition, response plans should be developed for addressing new areas of infestations as they occur and for addressing newly occurring invasive species when they are found in the watershed** (see the section above on recommendations to control and manage invasive and nonnative species).

Recommended Actions to Reduce Trash and Debris Within the Stream Channels and Riparian Areas

Accumulations of trash and debris in the streams and riparian corridors of the Oak Creek watershed degrade the aesthetics of the stream system. Unsightly accumulations of trash can give the public a negative impression of this natural resource and of its potential for restoration or its value as a recreational asset. Trash can also cause physical and/or chemical (toxic) damage to aquatic and terrestrial wildlife and can accumulate to such an extent that it may limit the passage of aquatic organisms. Commission staff recorded and mapped the large trash and debris items that were observed during instream surveys on Oak Creek, North Branch Oak Creek, and Mitchell Field Drainage Ditch. The findings are summarized in Table 4.1 in Chapter 4 of this report and locations are shown on Maps F.13 through F.35 in Appendix F.

Many of the watershed communities and watershed groups such as Friends of the Mill Pond and Oak Creek Watercourse, Inc. organize and/or participate in annual community cleanup events usually focused around Earth Day celebrations. **It is recommended that these community-oriented cleanup days be continued and expanded.** River cleanup days are one way of organizing and building energy for the common goal of improving the quality of the natural resources that add so much value to the community**. It is recommended that Milwaukee County, municipalities, and non-profit groups plan and organize annual or semi-annual stream cleanup days to remove trash items from streams and riparian areas of the Oak Creek watershed, utilizing community volunteers and partner organizations.** All the trash items identified on Maps F.13 through F.35 in Appendix F should be removed to improve the aesthetics, water quality, wildlife habitat, and recreational experience of the Oak Creek watershed. Coordinates and/or GIS shapefiles of locations of trash items inventoried by Commission staff are available to volunteer groups by request. In planning the Oak Creek watershed cleanup days, it may be prudent to focus cleanup efforts on areas with a particularly high concentration of trash items. Another strategy could be to focus efforts on an assessment area basis with the volunteers concentrating on a particular assessment area for each planned event. By doing so, the inventory of trash items can be updated, and progress can be more easily documented. **It is further recommended that surveys of streams for large trash and debris within the watershed that were not surveyed by Commission staff be conducted. Periodic reassessment and geolocation of large trash items along the streams of the watershed should be conducted to measure progress and to provide targeted areas for future cleanup efforts.**

In addition to removing trash items that have already been deposited in the streams and riparian areas, efforts to reduce the amount of new trash entering these areas should be increased. Considering the large amount of Milwaukee County and municipal parklands adjacent to Oak Creek and its main tributaries **this plan recommends that Milwaukee County and the watershed municipalities place and maintain additional trash receptacles along trails and parkways and in parks.** Placement of receptacles should be concentrated on the Oak Leaf Trail system near crossings of major roads, at the entrances of soft trails and paths, throughout municipal parks, and in areas where people tend to congregate such as popular fishing locations.

Unfortunately, the cost to dispose of large items such as automobile tires, furniture, mattresses, electronics, and appliances may contribute to these items being illegally dumped into steams and riparian areas of the watershed. To help discourage such illegal dumping, **it is recommended that municipalities within the watershed hold free large trash pick-up days multiple times each year**. These days should be scheduled in advance and should be well advertised on municipal websites and newsletters and distributed on trash pickup schedules. On these days, residents should be permitted to place large items on the curb or near their typical trash pickup area that are prohibited from routine trash collections. Scheduling neighborhood fall and spring cleanup days may be good times to initiate neighborhood cleanups and helpful in increasing word of mouth around the community of the large trash collection opportunities. Several watershed municipalities already hold similar large item pickup days. It is recommended that these efforts be continued, advertised, and expanded as necessary.

Electronics often contain hazardous materials such as lead and mercury that can harm human health and pollute the environment if not properly managed. For this reason, many electronic items are required by Wisconsin's electronic recycling laws to be specially recycled for disposal. **It is recommended that watershed municipalities focus efforts on publicizing electronic recycling options for their residents.** Beyond municipal electronic recycling options, "E-Cycle Wisconsin" is a State-wide manufacturer-funded program that recycles common electronics found in homes and schools. The E-Cycle Wisconsin program has a website that provides information on which electronics should be recycled; locations where electronics can be dropped off for a small fee; information for collectors; and outreach resources that local governments, retailers, recyclers, and others can use to educate their residents and customers about recycling electronics.[164]

Similarly, improper disposal of household hazardous wastes can introduce pollutants into the environment, leading to contamination of surface waters and groundwater. MMSD has collection programs for such hazardous household items. **It is recommended that MMSD's collection programs for household hazardous wastes be continued and supported.**[165] **It is further recommended that watershed municipalities continue or expand efforts to publicize hazardous waste disposal programs available to their residents.**

Improving the aesthetics along the stream corridors of the watershed, including removing and preventing trash and litter within these areas, can potentially strengthen the personal investment and connection that each person that lives or visits the Oak Creek watershed has in maintaining and restoring these valuable natural resources.

6.4 RECOMMENDED ACTIONS TO IMPROVE RECREATIONAL OPPORTUNITIES

This section presents recommendations to maintain and enhance the recreational use of and access to the surface water system and riparian areas within and surrounding the Oak Creek watershed. These include recommendations related to parks and parkways, recreational trails, fishing access to surface water, Americans with Disabilities Act (ADA) guidelines for recreational accessibility, and land acquisition for recreational use.[166]

Recommended Actions Related to Parks and Parkways

Parks and parkways encompass and protect many of the natural resources associated with the rivers and streams throughout the Region. These pockets of natural resources contain woodlands and wetlands, wildlife habitat, scenic landscapes, and provide outdoor recreation opportunities for residents within the Region. Actions to preserve, maintain, and expand parks and parkways will both preserve these natural resources and assure that residents are provided with opportunities to participate in a wide variety of outdoor recreational activities.[167] These actions also preserve the Region's cultural heritage and protect and enhance the quality of the environment. As such, the following recommendations should be considered for the Oak Creek Watershed Restoration Plan.

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[164] *More information related to the E-Cycle Wisconsin program can be found at www.dnr.wisconsin.gov/topic/Ecycle.*

[165] *More information related to MMSD's hazardous waste collection programs can be found at www.mmsd.com/what-you-can-do/home-haz-mat-collection.*

[166] *Due to insufficient water depths, most of Oak Creek and its tributaries are not suitable for recreational canoeing, kayaking, or swimming; therefore, activities related to surface waters are primarily focused on the improvement and enhancement of recreational fishing and fishing access.*

[167] *SEWRPC Community Assistance Planning Report No. 132,* A Park and Open Space Plan for Milwaukee County, *1991.*

It is recommended that Milwaukee County and municipalities within the watershed continue to maintain and improve their parks and parkway systems within the Oak Creek watershed, including their trail facilities for biking and hiking, stream access, picnic areas, and areas for passive recreation such as wildlife viewing.

Map 6.34 shows the parks and parkway sites in the watershed that are located adjacent to Oak Creek and its tributaries. Because these sites are directly associated with the major surface waters within the watershed, the protection of these areas can benefit the water quality, instream and terrestrial habitat, as well as enhance the experience of outdoor recreation along Oak Creek mainstem and its tributaries for park users. Examples of park and parkway activities that will enhance the stream and recreational use include maintaining or installing streambank stabilization measures, the installation and maintenance of riparian buffer along the Creek and its tributaries and installing educational and informational signage to enhance the public's understanding of the natural resources within the park or parkway. Cost for installing an informational plaque can vary depending on size, material, and manufacturer.

It is recommended Milwaukee County and watershed municipalities continue its efforts to manage Emerald Ash Borer infestation in its parks and natural areas. As discussed in Chapter 4, emerald ash borer has caused considerable mortality of ash trees in floodplain forests and riparian areas of the Oak Creek watershed, including many areas in the Oak Creek Parkway. Emerald ash borer prevention and management should be considered to improve and enhance trail and stream access, wildlife habitat, and maintain public safety. Such actions will prevent dead and dying trees from damaging parks and trails and injuring people. Other recommendations for addressing the impacts of emerald ash borer are discussed in the sections on recommendations to improve habitat in this chapter.

Land Acquisition Considerations for Recreational Facilities

It is the intent of this plan that all land acquisitions occur on a willing-seller, willing-buyer basis and that landowners receive fair market value for their property. Transactions funded with WDNR grants should follow the WDNR acquisition procedures, which include an appraisal by the WDNR. The recommended acquisition may also occur through land subdivision dedication as well as through donation of fee simple title or of conservation easements. Donations may yield income-tax advantages to those who donate.

Although each conservation easement is unique, some examples of land rights purchased by state or local agencies include the right to improve streams, fence livestock out of the stream corridor, permit public access and prohibit development. In addition, a conservation easement will also help protect water quality, habitat, and natural resources.[168] Where a conservation easement is utilized, the landowner retains title to the property; the easement typically prevents mowing or other disturbance of the area by the owner; provides access for site management purposes, such as the removal of woody vegetation that may shade out desired plant species; and removal of other nuisance vegetation. **It is recommended that the County or municipalities continue to pursue opportunities for acquisition of lands that would enhance the natural resources and recreational opportunities within the Oak Creek watershed.** Lands that should be considered for acquisition are identified in Milwaukee County Parks ecological restoration and management plans for areas adjacent to County parks within the watershed.[169] In addition, MMSD's conservation plan[170] and MMSD's greenway connection plan[171] have identified lands within MMSD's service area that should be targeted for voluntary acquisitions and preserved in order to retain floodwater retention benefits as well as to improve water quality and wildlife habitat conditions. Some properties identified by these plans within the Oak Creek watershed have already been purchased

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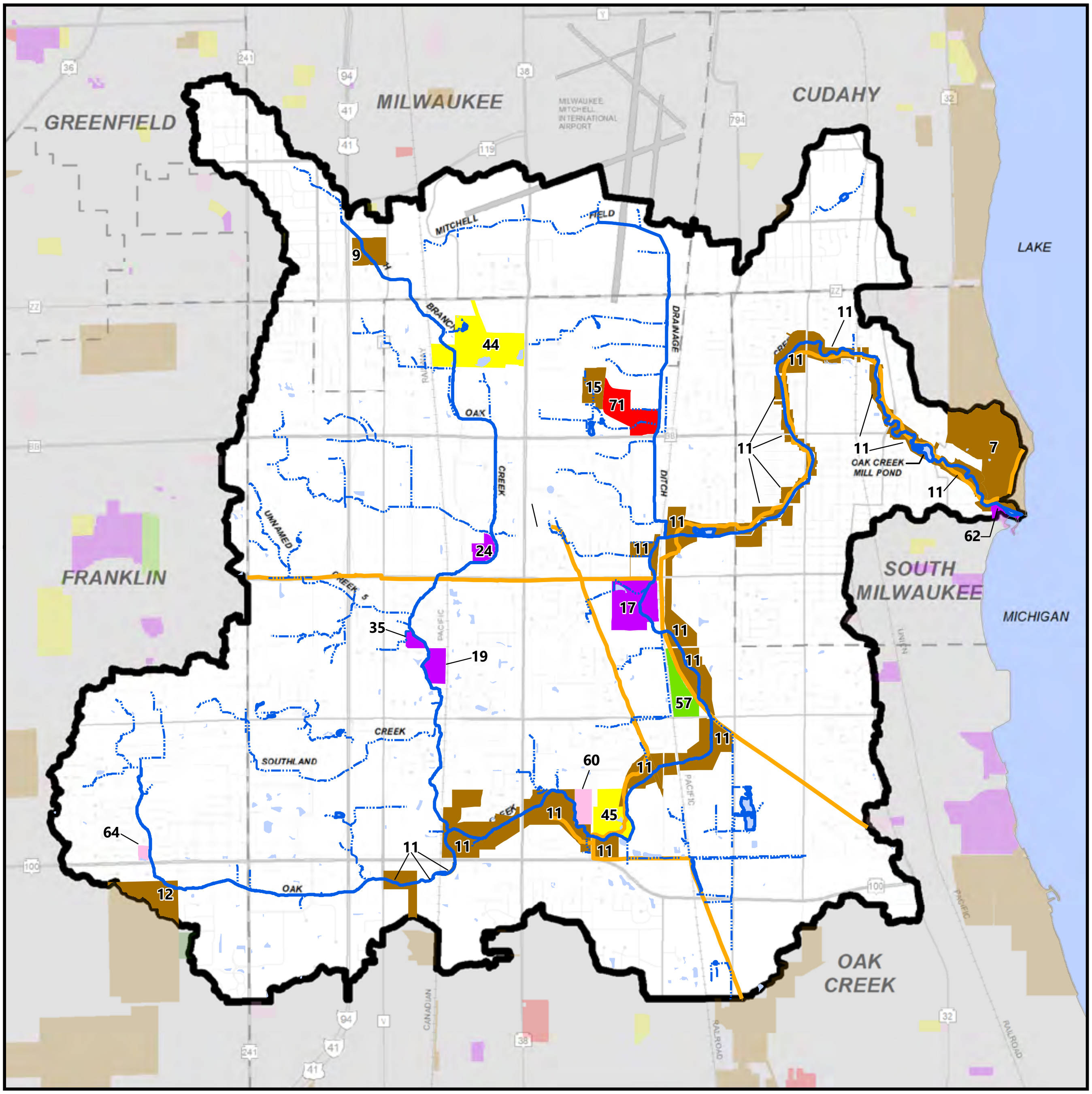
[168] *dnr.wisconsin.gov/topic/fl/RealEstate/easements.*

[169] *Milwaukee County Parks,* Barloga Woods Ecological Restoration & Management Plan 2016-2025, *2018; Milwaukee County Parks,* Cudahy Nature Preserve Ecological Restoration & Management Plan 2018-2027, *2018; Milwaukee County Parks,* Falk Park Ecological Restoration & Management Plan 2016-2025, *2017; Milwaukee County Parks,* Oak Creek Parkway Ecological Restoration & Management Plan, *2019; Milwaukee County Parks,* Rawson Woods Ecological Restoration & Management Plan 2017-2026, *2017*.

[170] *The Conservation Fund, et al.,* Conservation Plan for the Milwaukee Metropolitan Sewerage District, *October 2001.*

[171] *SEWRPC Memorandum Report No. 152,* A Greenway Connection Plan for the Milwaukee Metropolitan Sewerage District, *December 2002.*

Map 6.34
County, Municipal, and Private Organization Owned Park and Open Space Land Within the Oak Creek Watershed: 2020



COUNTY-OWNED SITE	OAK CREEK WATERSHED BOUNDARY
MUNICIPAL-OWNED SITE	PERENNIAL STREAM
SCHOOL DISTRICT-OWNED SITE	INTERMITTENT STREAM
PRIVATE ORGANIZATION-OWNED SITE	SURFACE WATER
COMMERCIAL SITE (LEASED FROM COUNTY)	
MMSD-OWNED SITE	
EXISTING RECREATIONAL TRAIL	

Note: See Table 4.42 for site names and details. Colors outside the watershed boundary are reduced in intensity to show the adjacent extent and distribution of each legend category.

N

0 0.25 0.5 1 Mile

Source: SEWRPC

through MMSD's Greenseams program (see Map 4.48 in Chapter 4 of this report). Where applicable, these properties may provide recreational opportunities for people living in the Region including hiking, bird watching, and other passive recreation.

Recommended Actions Related to Trails

As described in Chapter 5 of this report, a primary objective and goal for recreational use and access is the continued development and improvement of trails within and adjacent to the Oak Creek watershed, including an expansion of an interconnected trail system that provides connections to local, county, and regional trail systems. The Oak Leaf Trail is over 125 miles of mostly paved asphalt trail that loops around Milwaukee County with connectors along the parkway drives and municipal streets. Map 6.35 shows the extent of the existing Oak Leaf and Forked Aster trail systems in and around the watershed. All sections of the Oak Leaf Trail within the watershed are connected to one another. Furthermore, the Oak Leaf Trail within the Oak Creek watershed is connected to the Oak Leaf Trail's Root River Line to the west through the Drexel Connector and to the south through the Oak Leaf Line. It is also connected to the Oak Leaf Trial along Lake Michigan at two points through the South Shore Line. The following recommendations are intended to promote the development of a more highly interconnected trail system within the watershed and one that is better connected to trails outside of the watershed. The recommended additions to the trail system are shown on Map 6.35. The locations of proposed recreational trails shown on the map are general in nature and are subject to refinement based on detailed facility planning and negotiations with landowners to purchase land for the trails. Specifically, it should be noted that development of any new or expanded trail system should avoid areas that are determined to be ecologically sensitive.

It is recommended that Milwaukee County and municipalities within the watershed continue to maintain and improve their recreational trail systems. With the increased use of recreational trails, it is important that these systems be maintained and improved for the safety and continued use by the public. Furthermore, this recommendation can help increase the public's opportunities for exercise and outdoor recreation, leading to improvement in human health and community attention to the surface waters and natural resources within the watershed.

It is recommended that Milwaukee County expand its Oak Leaf Trail system within the Oak Creek watershed by adding 5.7 miles of additional trails. The expansions are numbered and shown on Map 6.35. **The recommended expansions include:**[172]

1. **Extending the Oak Leaf Trail along the mainstem of Oak Creek from its current terminus at E. Puetz Road to where another section begins west of S. Nicholson Road (0.65 miles)**

2. **Extending the Oak Leaf Trail to the southeast from the beginning of the section west of S. Nicholson Road to the existing Oak Leaf Trail at E. Ryan Road (0.80 miles)**

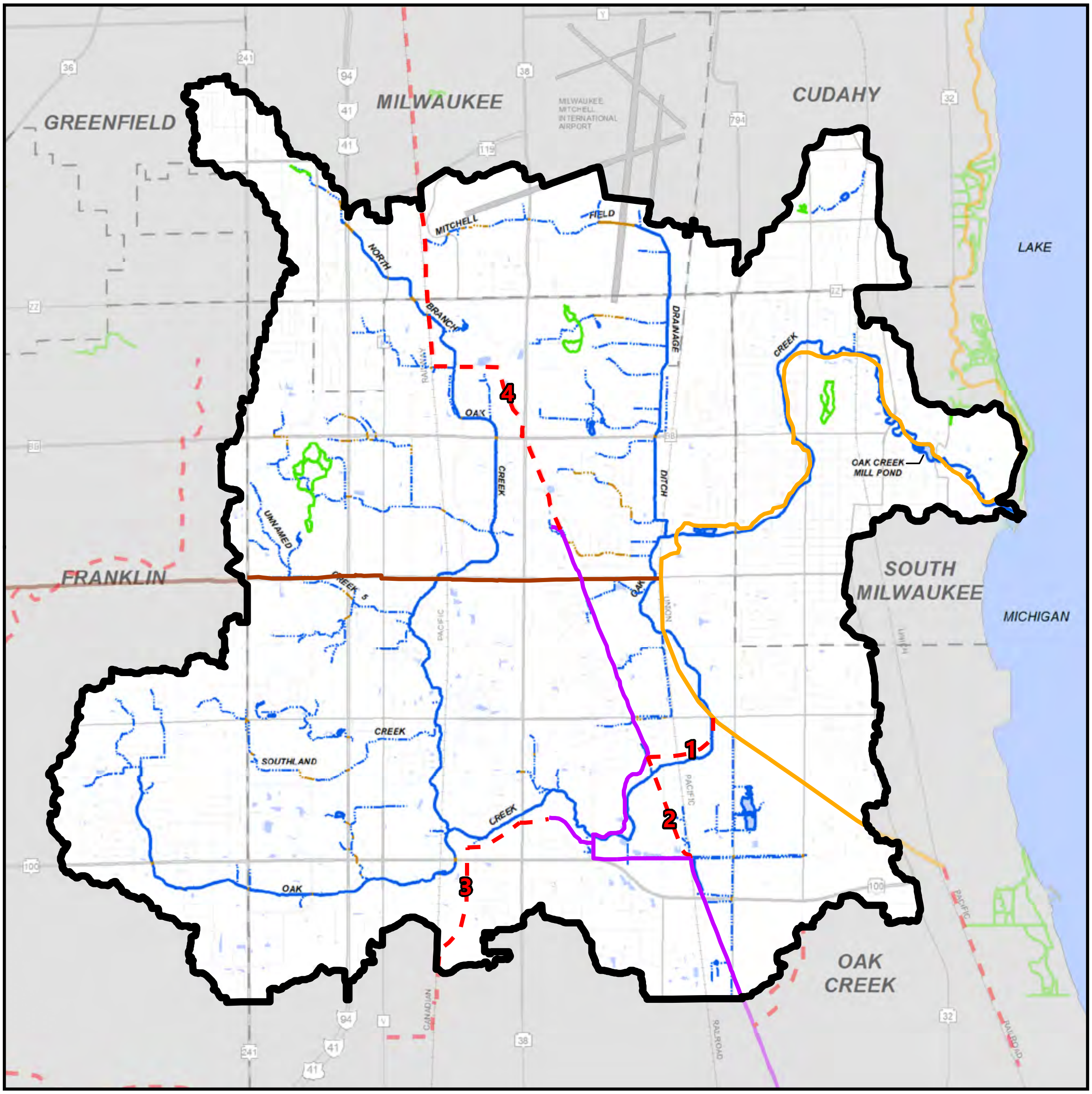
3. **Extending the Oak Leaf Trail along the mainstem of Oak Creek from its current terminus near Oak Creek Parkway Park to W. Ryan Road near the confluence with the North Branch of Oak Creek and then to the south to the watershed boundary and into the Root River watershed (1.4 miles)**

4. **Extending the Oak Leaf Trail to the northwest of the watershed toward Milwaukee Area Technical College campus north along the Canadian-Pacific railroad located directly west of Milwaukee Mitchell International Airport (2.9 miles)**

For a general cost estimate reference of a trail expansion project, Milwaukee County completed the Oak Leaf Trail South Shore Line expansion that runs along the old railroad right-of-way owned by We Energies from Drexel Avenue southeast to Bender Park. The trail extent is approximately three miles long with a soft (stone surface) trail 11 feet wide, except for a few isolated areas of a 10-foot-wide asphalt surface. The total

[172] *Milwaukee County Department of Parks, Recreation, and Culture, Milwaukee County Trails Network Plan, 2007; and SEWRPC Planning Report No. 55, VISION 2050, Recommended Regional Land Use and Transportation Plan for Southeastern Wisconsin, 2nd Edition, June 2020.*

Map 6.35
Existing and Proposed Multi-Use Trails Within the Oak Creek Watershed: 2021



FORKED ASTER HIKING TRAIL

OAK LEAF TRAIL BY NAME
(TRAIL NUMBERS 1 THROUGH 4 DISCUSSED IN TEXT):

SOUTH SHORE LINE

OAK LEAF LINE

DREXEL CONNECTOR

PROPOSED OAK LEAF TRAIL

OAK CREEK WATERSHED BOUNDARY

PERENNIAL STREAM

INTERMITTENT STREAM

SURFACE WATER

Note: Colors outside the watershed boundary are reduced in intensity to show the adjacent extent and distribution of each legend category.

N

0 0.25 0.5 1 Mile

Source: SEWRPC

estimated cost for this project was approximately $1.8 million (2020 dollars).[173] Based on the costs of the extension of the trail to Bender Park, the estimated cost for the above Oak Leaf Trail proposals would be approximately $3.2 million.

It is recommended that Milwaukee County and municipalities within the watershed consider developing other connections among trails within the watershed to connect smaller trails to the regional trail system, such as the Oak Leaf Trail. Municipal, smaller, or privately-owned recreational trails within the Oak Creek watershed should continue to expand and connect to larger trail systems including the Oak Leaf Trail within Milwaukee County and surrounding counties, such as Racine County. The County and municipalities in the northwest portion of the watershed should consider expanding trails to allow for an increased trail and commuter connection throughout the watershed. In addition, the County and municipalities should consider connecting smaller isolated trails to municipal or regional trail systems. Information on municipal and smaller recreational trails, such as biking, hiking, or multi-use trail systems that are not included on Map 6.35 can be found on municipal websites.

Improvements for passive recreational opportunities should be considered with trail expansion or maintenance projects among county, municipal, and local trail networks. **It is recommended that the governing body responsible for recreational trails consider passive recreational opportunities for the public.** Examples of passive recreation within the Oak Creek watershed include biking, bird watching, fishing, hiking, observing and photographing nature, picnicking, running, walking, and wildlife viewing. Potential projects that could increase passive recreational opportunities include installing park and trail benches; informational signage related to surrounding natural features or wildlife; bird nesting boxes to provide additional breeding habitat to help sustain or increase bird populations and improve bird viewing opportunities; and an increase of public educational and informational material available through county and local websites, social media, pamphlets, and public outreach booths on the locations and benefits of local outdoor recreational opportunities.

It is recommended Milwaukee County continue to maintain and expand its Forked Aster trail system within the Oak Creek watershed. County-owned parks with Fork Aster trails are listed in Table 4.42 and shown on Map 4.49 in Chapter 4 of this report. Trails such as these offer recreational users the benefit and experience of walking and hiking within the natural areas of the watershed.

Volunteer trails are unofficial or unsanctioned trails made over time by the public hiking or exploring natural areas or accessing waterways through woodlands or grasslands. Volunteer trails are often undesirable because they may lead to erosion and unsafe conditions, could promote encroachment on public and private property, and may lead to disturbance of sensitive areas. An example of a volunteer trail can be found on the north and south banks of Oak Creek within the Oak Creek Parkway land just downstream of the Mill Pond dam and continuing almost to the Grant Park beach parking lot. Because these volunteer trails are not sanctioned or maintained by the County, they are not monitored for stability or sustainable use. Due to the popularity of the area for hikers and anglers, especially during the annual salmon and trout runs, an officially sanctioned and maintained trail in this area should be considered. **It is recommended that as an addition to its Forked Aster trail system, the County formalizes a sustainable hiking trail along the south shore of Oak Creek from about 800 feet downstream of the Mill Pond dam and continuing on the north shore of Oak Creek to the Grant Park beach parking lot area. The formalized trail should direct hikers away from unstable streambanks and sensitive areas while providing established access points to the Creek for anglers to fish from the shore or access to wading into the Creek to fish. It is further recommended that Milwaukee County continue to address volunteer trails considered unstable or unsustainable for recreational use located within its parks and parkway system**.

It is recommended that Milwaukee County and municipalities in the watershed consider developing and maintaining informational signage throughout the trail system especially at trail head locations to provide trail users with information such as the location and name of the trail, the distance it covers, connections to other trails, and types of activities permitted on the trails. Signage could also provide information pertaining to the natural resources surrounding the trail including identifying native,

[173] *Southeastern Wisconsin Regional Planning Commission, A Transportation Improvement Program for Southeastern Wisconsin: 2021-2024, December 2020.*

endangered, threatened, or invasive flora and fauna species that may be present near the trail; describing geographic and ecological features such as the types of soils and biological communities present; and identifying adjacent waterbodies.

Recommended Actions Related to Fishing Access

The recreational use surveys discussed in Chapter 4 found that fishing is a popular water-based activity in the watershed. The following recommendations are intended to help increase recreational fishing and fishing access to the streams of Oak Creek.

It is recommended to maintain, improve, and expand fishing access from the stream banks of Oak Creek and its tributaries. Fishing access to the surface waters of Oak Creek is available from shorelines within public lands adjacent to the Creek and its tributary streams. For the most part, the Creek and its tributaries can be accessed from any public lands that the angler can legally use and where local ordinances do not prohibit fishing. Many of these lands are located within the Milwaukee County Parks and Parkway system. **It is recommended that Milwaukee County and municipalities in the watershed consider installing accessible, marked, and stable fishing locations adjacent to Oak Creek and its major tributaries along the Parkway and in parks.** As a part of this recommendation, it is suggested that signage indicating fishing access points be installed to allow for increased public fishing opportunities.

Depending on the alternative chosen by Milwaukee County to address the Mill Pond and dam (see "Alternatives and Recommended Actions for the Mill Pond and Dam" section), additional fishing access could be provided in the Mill Pond area. Specifically, elements of Alternatives 2, 3, 4, and 5 would provide additional fishing access to the Mill Pond area. **It is recommended that these elements be considered and implemented as appropriate.** In particular, an additional fishing access project associated to the Mill Pond and dam alternatives is the installation of fishing platforms. Porous pavement platforms can provide safe and accessible recreational fishing for all anglers. The two porous pavement fishing platforms presented in the Mill Pond and Dam alternatives are about 800 square feet combined (based off GIS measurements). The general cost for porous pavement is $15.35 per square-foot, therefore the cost of one platform is about $6,140.[174]

It is recommended to improve aquatic connectivity within the Oak Creek watershed to enhance the health of the Oak Creek fishery. Fish passage barriers strongly influence the distribution of species within a watershed. Removing or reducing fish passage barriers will expand aquatic connectivity and thus provide anglers with an enhanced fishing experience with improved fish populations and species richness throughout the Oak Creek mainstem and its tributaries. Specific projects that would remove or modify barriers to permit passage are included in Table 6.1.

As described in Chapter 4, the Mill Pond is managed as an urban fishing water under the State's urban fishing program. Management of the pond includes annual stocking by WDNR of about 500 catchable-size rainbow trout into the Pond. The depths and water temperatures in the pond are currently insufficient to support these fish. Because of this, **it is recommended that the WDNR reevaluate the Mill Pond's status as an urban fishing water.** In addition, the future viability of continued stocking and management of the pond as an urban fishing water depends upon the alternative chosen by Milwaukee County to address the Mill Pond and dam. Under some alternatives, the pond would be absent and under others the restored area and depth of the pond may not be sufficient to support coldwater fish such as trout. **It is recommended that the WDNR further reevaluate the Mill Pond's status as an urban fishing water following selection and implementation of an alternative for the Mill Pond and dam.**

[174] *CH2MHill, CDM Smith, and Milwaukee Metropolitan Sewerage District,* Regional Green Infrastructure Plan*, June 2013; Metropolitan Sewerage District,* Green Infrastructure Costs and Incentives in Metropolitan Milwaukee, Final Report*, October 2019; Mary Jo Lange, Director of Public Works- City of Cudahy,* "Cost for Permeable Pavement Installation," *electronic mail message to Laura K. Herrick, Chief Environmental Engineer, Southeastern Wisconsin Regional Planning Commission, November 3, 2020; Stevan Keith, Environmental Services Unit Leader- Milwaukee County,* "Green Infrastructure Cost Composite," *electronic mail message to Laura K. Herrick, Chief Environmental Engineer, Southeastern Wisconsin Regional Planning Commission, November 3, 2020; Phillip J. Beiermeister, Environmental Design Engineer- City of Oak Creek,* "Green Infrastructure Costs for Oak Creek- City of Oak Creek," *electronic mail message to Laura K. Herrick, Chief Environmental Engineer, Southeastern Wisconsin Regional Planning Commission, November 6, 2020.*

It is recommended to improve instream fish habitat in Oak Creek and its tributaries. Described previously in this report, every reach within the watershed upstream of the Mill Pond Dam has undergone significant channelization, removal of instream shelter and shading from overhanging vegetation, and alteration of the natural riffle, run, and pool structure that sustain diverse habitats for fish and their macroinvertebrate prey (see Tables 4.10 and 4.11). Implementing the recommendations discussed in the section on actions to improve habitat will increase the quality and diversity of fish species throughout Oak Creek and its tributaries. This is likely to enhance opportunities for recreational fishing. Several projects that would improve fish habitat in the watershed are included in Table 6.1.

Recommended Actions Related to Recreational Facilities

It is recommended that the County consider making the Mill Pond Warming House available to the public for the use of group gatherings for recreational or special event purposes. Depending on the County's chosen dam alternative (see "Alternatives and Recommended Actions for the Mill Pond and Dam" Section), recreational ice skating and fishing on the Mill Pond may be enhanced. As such, the County could consider using the Warming House as a facility for those interested in recreational skating or fishing.

Additionally, the Warming House could be used as a place to host special events, community meetings, or group gatherings. This recommendation should be done in a way that is consistent with existing Milwaukee County Parks policies and practices. Estimated costs associated with this recommendation are contingent on the dam alternative chosen and if the County decides to make the Warming House available to the public.

Because there are no nature centers located within the Oak Creek watershed, Milwaukee County should also consider using **the Mill Pond Warming House as an educational and informational multi-use center.** This project would likely require facility renovation and additional County staff and/or volunteers. Potential renovation upgrades might include the enhancement of Warming House amenities (i.e., heating and cooling system, restrooms, or plumbing), up-to-date ADA requirements, available parking to the public, and the provision of staff or volunteers, development of programs, and educational tools (books, maps, displays, signs, charts, and a computer). A potential public-private partnership could be explored to assist the County with the development and/or operation of an educational center. As noted in the "Alternatives and Recommended Actions for the Mill Pond and Dam" section of this report, there is a potential location for a small parking lot just south of the Mill Pond dam on a parcel owned by the City of South Milwaukee. This parcel of land is situated about 165 feet from the Mill Warming House located on top of a steep incline of land. Additionally, a stable walking path and/or stairs would have to be constructed to allow access from the potential parking site to the Warming House. Estimated total cost of this recommendation varies depending on facility upgrades, parking accommodations, and the amount of staff and staff hours needed.

Accessibility of Recreational Facilities to People with Disabilities

The Federal Americans with Disabilities Act, adopted by the U.S. Congress in 1990, requires that "reasonable accommodation" be made to provide persons with disabilities equal opportunities for access to jobs, transportation, public facilities, and services—including access to recreational facilities. All new or renovated park and recreation facilities must be designed and constructed to comply with the requirements of the Act. **It is recommended that existing public park and recreation facilities be evaluated by the unit of government concerned to determine if improvements are feasible to meet Federal accessibility requirements.** If ADA guidelines are not feasible or cannot be achieved, **it is recommended that the unit of government concerned strive to provide an equivalent experience** for those with restricted abilities in order to assist a similar outdoor experience for all those participating in outdoor recreation. Accessibility standards and guidelines are available from several agencies regarding specific types of recreational facilities.[175]

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[175] *Guidelines for boating facilities are available from the National Park Service at www.nps.gov and the U.S. Access Board at www.access-board.gov/ada. Guidelines for recreational trails can are available from the U.S. Access Board at www.access-board.gov/ada, the U.S. Forest Service at www.fs.usda.gov/managing-land/national-forests-grasslands/accessibility, and the U.S. Department of Transportation Federal Highway Administration at www.fhwa.dot.gov/accessibility. Guidelines for fishing piers and platforms are available from the U.S. Access Board at www.access-board.gov/ada/#ada-1005.*

6.5 RECOMMENDED ACTIONS TO ADDRESS TARGETED FLOODING PROBLEMS

The flooding issues in the Oak Creek watershed are scattered throughout the basin as documented in Chapter 4 of this plan. Therefore, recommended actions for flooding problems address the need for very targeted actions on a case-by-case basis. The recommended actions are divided into efforts that focus on reducing stream flooding impacts and efforts that focus on reducing stormwater flooding impacts. It should be noted that work that reduces stormwater flooding impacts may also serve to reduce stream flooding impacts. Many of the flooding recommendations overlap with recommendations in the water quality and habitat sections discussed earlier in this chapter. In addition, specific projects recommended to address targeted flooding problems are included in Table 6.1. Because of this, the discussions included in this section are brief.

It is recommended that actions to address flooding problems should also consider the potential impact of climate change. Climate change model projections predict an increased frequency of intense rainstorms in Southeastern Wisconsin that will cause larger stream and stormwater flooding as compared to past experience. Consideration of a higher standard for flood mitigation actions would increase community resiliency to potential climate change impacts (see "Recommended Actions to Reduce or Mitigate the Negative Physical, Chemical, and Biological Impacts on Aquatic and Terrestrial Ecosystems that are Associated with Climate Change" section above).

Recommended Actions to Address Targeted Stream Flooding
Stream flooding in the Oak Creek watershed was documented based on the Federal Emergency Management Agency (FEMA) regulatory flood elevations and input from stakeholders. Based on that input, the following recommendations are offered to mitigate stream flooding impacts:

1. **It is recommended to acquire and remove or floodproof (voluntarily) the remaining insurable structures that are within the regulatory floodplains of the Oak Creek watershed, as opportunities arise.**

2. **It is recommended as part of road improvement projects to evaluate opportunities to elevate or modify road crossings impacted by the regulatory flood elevations.**

3. **It is recommended to evaluate areas of stream flooding in the Oak Creek watershed on a case-by-case basis and evaluate opportunities to reduce flood impacts to public infrastructure and private property.** This may include projects that impact flood flows and flood elevations such as reconnecting the stream to its floodplain, expanding riparian buffers, channel restoration, and removing debris and excessive sediment from the stream channel. This may also include efforts to protect the impacted structure(s) by modifying, elevating, or moving the structure(s) out of the flooded area.

Recommended Actions to Address Targeted Stormwater Flooding
Stormwater flooding in the Oak Creek watershed was documented based input from stakeholders. Based on that input, the following recommendations are offered to mitigate stormwater flooding impacts:

1. **It is recommended that communities and property owners pursue stormwater management projects that retain runoff onsite as close as possible to where the rainwater falls.** This may include green infrastructure projects such as rain gardens, pervious pavement, green roofs, soil amendments, stormwater trees, and rain barrels. This may also include more traditional stormwater control features such as wetland restoration, dry detention basins, and wet retention basins.

2. **It is recommended to evaluate areas of stormwater flooding on a case-by-case basis and evaluate opportunities to reduce flood impacts to public infrastructure and private property.** This may include projects that improve stormwater conveyance or storage. This may also include efforts to protect the impacted structure(s) by modifying, elevating, or moving the structure(s) out of the flooded area.

3. **It is recommended that sufficient undeveloped land be maintained in the Oak Creek watershed for stormwater infiltration and flood storage.** The MMSD Greenseams program is a good example and is discussed in more detail in the recommended actions to protect, restore, expand, and connect riparian buffers earlier in this chapter.

6.6 ALTERNATIVES AND RECOMMENDED ACTIONS FOR THE MILL POND AND MILL POND DAM

Introduction

This section briefly reviews the previously discussed existing conditions and primary issues of concern for the Mill Pond and dam, and then describes five planning level alternatives and one optional add-on alternative that were evaluated as potential solutions to address these issues. These planning level alternatives were developed based on the management objectives for the Mill Pond and dam described in Chapter 5. A full summary of the current conditions at the Mill Pond and dam was presented in Chapter 4.

Existing Conditions

The Mill Pond dam is located on Oak Creek in the City of South Milwaukee, about a mile upstream of the Oak Creek confluence with Lake Michigan. The dam is 14 feet in height and is constructed of concrete and dolomitic masonry. As described in Chapter 4, the dam was inspected by WDNR staff and repairs are required for the dam sluice gate system. This system allows the Mill Pond to be drained for dam structure maintenance.

Sediment transported by the stream has filled the Mill Pond since dredging was last completed in 1990. As discussed in Chapter 4, as of 2015, the Mill Pond had accumulated roughly 37,700 cubic yards (CY) of sediment (in place) as compared to the original 1930s design. Sedimentation has also created islands above the pond surface. Chapter 4 discusses existing pond conditions in more detail.

In the last ten years, the warming house on the southern bank of the Mill Pond has undergone significant structural renovation and landscaping improvements. There is strong community interest in utilizing the warming house for additional recreational and educational purposes.

Hydraulic Model Development

A more detailed hydraulic model of the Mill Pond and dam area was created for this planning effort using the US Army Corps of Engineers HEC-RAS software to better understand the hydraulic conditions in the Mill Pond and dam area. In Fall 2016, Commission staff updated the current effective FEMA model of the Oak Creek watershed for a MMSD facility planning effort.[176] This model update included road structure replacements and a refinement of a divided flow area about a mile upstream of the Mill Pond that were not accounted for in the previous model. In 2020, this model was further refined by replacing the rating curve representation of the Mill Pond dam with a structural feature for the dam, and by incorporating newer 2015 bathymetry data from the City of Racine Public Health Department for the bottom of the Mill Pond.[177] This updated hydraulic model provided a means to evaluate current conditions for the Mill Pond and dam and to develop and compare the proposed planning level alternatives.

The WDNR has categorized the Mill Pond dam as a small dam, thus the dam spillway capacity requirements of Chapter NR 333 of the *Wisconsin Administrative Code* do not apply. Nevertheless, the existing spillway capacity of the Mill Pond dam was evaluated for this plan using the updated hydraulic model. Currently, the dam spillway capacity is approximately 675 cubic feet per second (cfs), which is less than the 50-percent-annual-probability (2-year recurrence interval) event. Although the requirements of NR 333 do not apply, it would be desirable to increase the spillway capacity of the Mill Pond dam to decrease the overland flow around the abutment of the dam during large storm events.

Issues of Concern

As previously discussed, the Mill Pond dam was inspected by WDNR staff and repairs are required for the dam sluice gate system. This system allows the Mill Pond to be drained for dam structure maintenance.

The Mill Pond has accumulated a substantial amount of sediment over time. Although the pond had water depths of seven to nine feet following its construction in the 1930s, the pond now has water depths of one to two feet. The accumulated sediment has caused a number of other problems for the area related to water quality as discussed in detail in Chapter 4.

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[176] *SEWRPC Staff Memorandum*, MMSD 2050 Facilities Plan – SEWRPC Floodplain Analyses, *November 29, 2017.*

[177] *L. Turner, A. Koski, and J. Kinzelman,* An Assessment of the Mill Pond Dam Impoundment – Oak Creek Watershed, *City of Racine Public Health Department Laboratory, January 2017.*

High water temperatures have been measured in the pond, especially in the northern lobe. Pond temperatures regularly exceed water temperatures recorded upstream and downstream of the pond, suggesting that the Mill Pond itself is the cause of warmer temperatures. This is a concern both for species in the Mill Pond and in downstream sections of Oak Creek, which serve as a coldwater fishery for species such as trout and salmon. Contaminants present in water and sediment samples in the Mill Pond include metals and PCBs. The entire Oak Creek watershed is also considered impaired for chloride and phosphorus. Additionally, dissolved oxygen supersaturation has been found to occur in the Mill Pond, particularly in the northern lobe. This indicates that large fluctuations in dissolved oxygen concentrations occur in the pond, a situation detrimental to fish and aquatic organisms living in the pond.

Currently, the Mill Pond dam acts as a complete barrier to native fish passage. The height of the dam and water surface elevations during flood events exceed the leaping ability of all potential migratory fish. The only species that may be able to climb the downstream face of the dam is the invasive sea lamprey. There is no record of this species being observed climbing the Mill Pond dam or in the upstream Oak Creek watershed.

The current effective FEMA floodplain mapping shows a 1-percent-annual-probability (100-year recurrence interval) water surface elevation of around 617.9 feet (ft) National Geodetic Vertical Datum of 1929 (NGVD29), which is high enough to flood the Oak Creek Parkway to the north and east of the Mill Pond (see Figure 6.12).

The current state of the Mill Pond limits its recreational functionality and value to desirable aquatic life. Historically, the Mill Pond had been used for ice skating and boating, however the pond is currently too shallow to be used for these purposes. The current Mill Pond also has limited recreational value for fishing due to its shallow depths and poor water quality.

Historical Restoration Planning Effort

In 2004, the Friends of the Mill Pond and Oak Creek Watercourse worked with Milwaukee County Parks System staff to develop a conceptual design for restoring the Mill Pond area. This effort, known as the "Mill Pond Renaissance Project," was proposed to be used by the Parks System to apply for restoration grants. The design proposed creating a meander in the creek flow that would lead to a lagoon just upstream of the dam, which could be used for ice skating (see Figure 6.13). The plan involved building a peninsula off the south bank to be used as a picnic area, which connected to Oak Creek Parkway via a pedestrian bridge. The plan recommended environmental improvements such as stabilizing eroding banks and planting native vegetation. The plan also included recreational features like a gazebo, extra lighting features, a trail loop around the pond, and a parking lot in the southeast corner of the pond area.

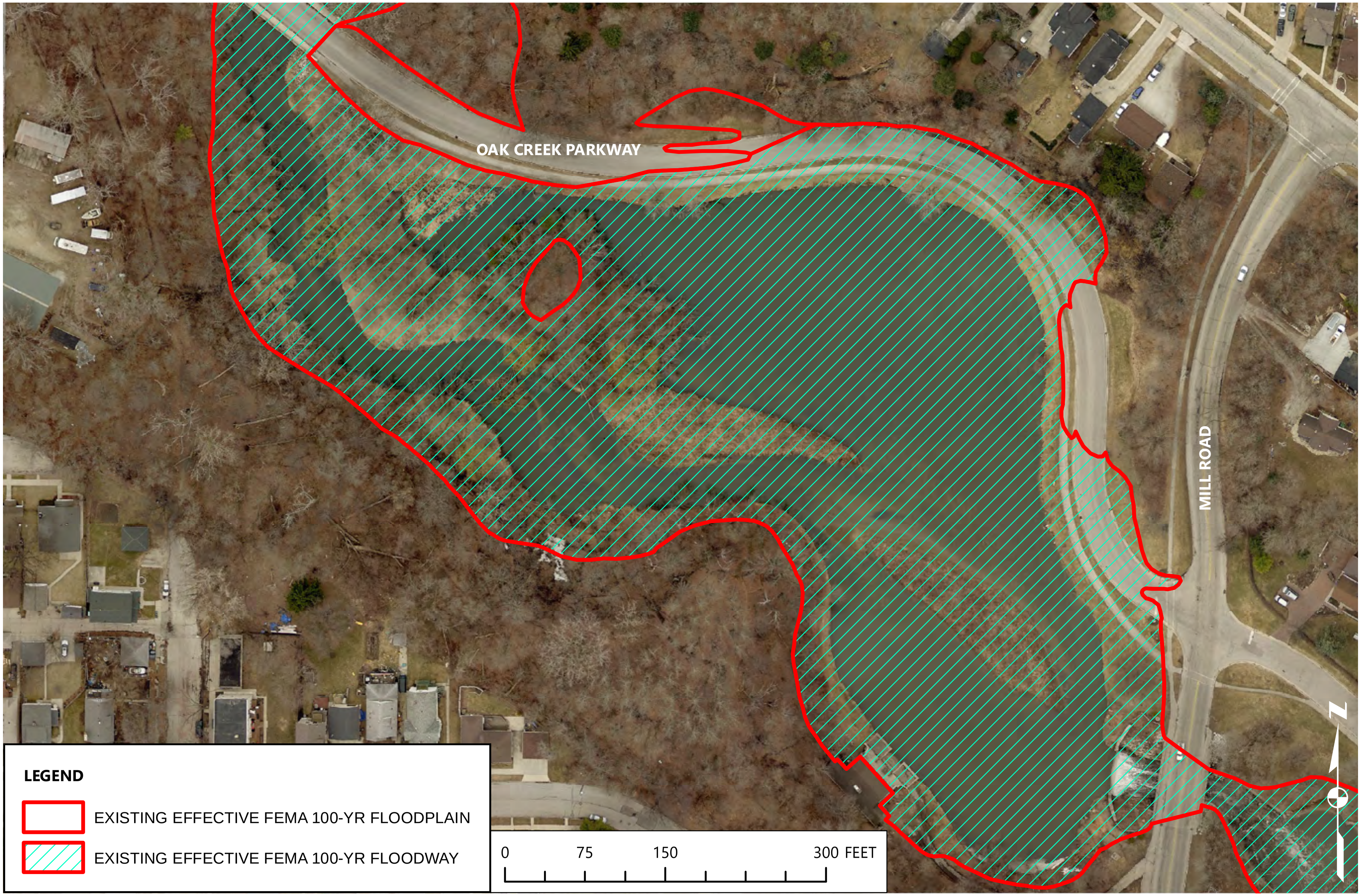
The Mill Pond Renaissance Project provided some insight into the community's priorities for the project area in the early 2000s. Unfortunately, some features included in this plan are not feasible. The main peninsula feature would not be possible due to confining the Oak Creek floodway in this area (see Figure 6.12), which would cause additional and potentially substantial flooding upstream of the Mill Pond. The proposed parking lot fill area would cover the dam sluice gate inlet and render it nonfunctional. The additional lighting would encourage night use and adversely impact nocturnal species in the Oak Creek parkway. These impacts are considered undesirable by Milwaukee County.

Planning Level Alternatives

Five planning level alternatives and one optional add-on alternative have been developed as potential solutions to address concerns and improve conditions in the Mill Pond and dam area. The first four alternatives maintain the Mill Pond dam structure, while the fifth alternative removes the dam and restores the Oak Creek channel. An optional emergency spillway and dam abutment extension design that would increase the spillway flow capacity was also evaluated for those alternatives that maintain the dam structure.

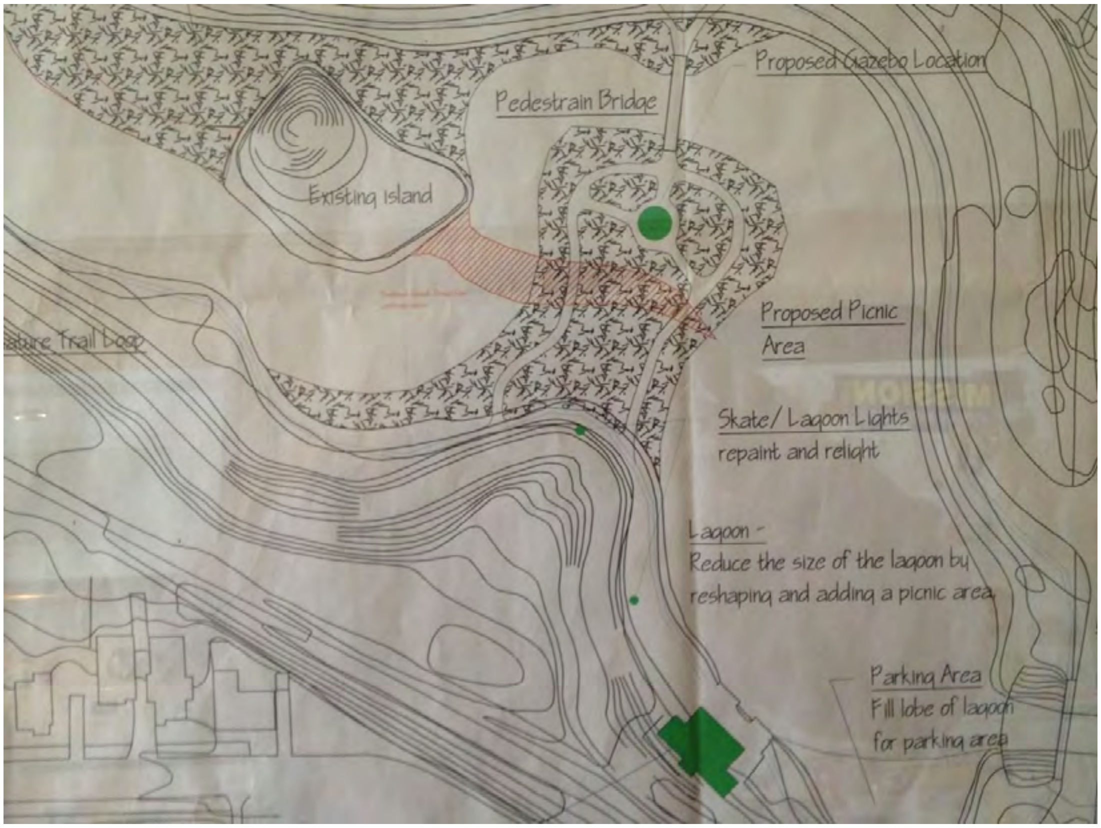
This section first discusses the design and cost assumptions used to develop the alternatives and planning levels costs. Then each alternative is described including details such as major construction components, maintenance requirements, and a planning level cost estimate.

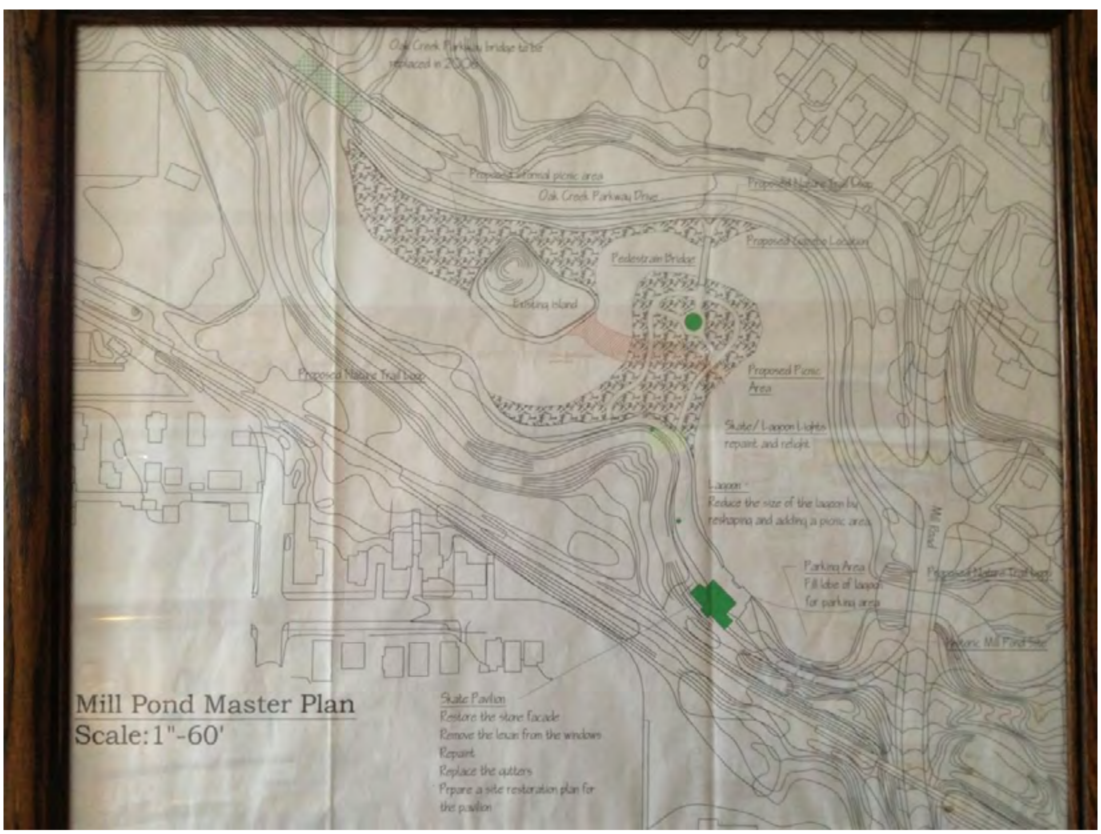
Figure 6.12
Existing Floodplain Conditions at Mill Pond



Source: SEWRPC

Figure 6.13
2006 Master Plan from Friends of the Mill Pond





Source: Friends of the Mill Pond

Design and Cost Assumptions

The Mill Pond and dam alternatives incorporate assumptions regarding sediment quality, sediment dewatering, fish passage, habitat and recreational improvements, and cost. The sections below describe the resource characteristic, design, and cost assumptions used to develop the planning level alternatives for the Mill Pond and dam area.

Sediment Quality

The planning level construction cost estimates included in this plan assume that the sediment in the Mill Pond is not severely contaminated. The presence of contaminated sediment could dramatically increase construction and maintenance costs due to the need to haul the dredged material a longer distance to a landfill site that accepts contaminated fill. To determine if the Mill Pond sediment is contaminated, all the alternative cost estimates include sediment core sampling. **Sediment core sampling is recommended at up to five locations depending on the areal extent of dredging required for each alternative.** For the planning level cost estimates, it is assumed the sediment core sampling would be done during the winter when the ice is at least a foot thick to support the soil core machinery. This method is considered the least expensive option to complete sediment core sampling. However, if less than a foot of ice is present on the pond at the time of sampling, temporary log pads or sampling from a boat would be required and this may increase sampling costs.

Sediment Dewatering

All five planning level alternatives include dewatering the Mill Pond area, allowing the accumulated sediment to dewater in place, and then either mechanically moving it within the Mill Pond area or hauling it off-site. Following sediment removal, the repaired sluice gate and/or an upstream bypass pump and pipe would be used to dewater the pond and maintain dry conditions during construction.

If dewatering the sediment in place is not feasible before hauling off-site, it may be necessary to move the dredged sediment to another location for additional dewatering. One option would be to use a nearby section of the Oak Creek Parkway to stage sediment dewatering bags. This would disrupt traffic, and therefore a potential alternative site located just south of the Mill Pond dam on a parcel owned by the City of South Milwaukee was also investigated. Using this site would require hauling sediment to the site, filling dewatering bags with the sediment, and piping the water back to Oak Creek. This method would require permission from one private landowner (Chicago & Northwestern Transportation Company) and coordination between the City and the County to lay the pipe between this dewatering site and the pond. This option was not included in the cost estimates for this plan, but **it is recommended that the City keep this parcel vacant in the event it needs to be used for future sediment dewatering.**

Fish Passage

Commission staff evaluated the potential to add a fish passage channel, or fishway, to allow fish to migrate past the dam for those alternatives where the dam remains. Ideally, the downstream end of a fishway should be just downstream of a dam, as fish swimming upstream will congregate there due to the turbulence of water over the dam. Since some fish may not swim far into dark enclosures, a fishway design should also have an open top along as much of its length as possible to allow natural lighting.

Due to the proximity of the Mill Pond dam to the Mill Road bridge and the sluice gate system, constructing an open top fishway outlet immediately downstream of the Mill Pond dam was considered infeasible. An alternative fishway design was investigated that had an outlet farther downstream of the dam in a natural pool. Based on recent fishway designs in the Region, the fishway would need to have a slope of two percent or less to accommodate the swimming abilities of regional fish species during normal flow conditions in Oak Creek. Furthermore, a sufficiently large flow volume would need to pass through this fishway to attract fish, and channel conditions downstream of the dam must be modified to help assure that migrating fish find the fishway entrance. The only feasible alignment for a potential fish passage structure with a two percent slope was on the south side of the Mill Pond, as shown in Figure 6.14. The fishway outlet is located at the pool just downstream of the dam. The fishway runs approximately 900 feet upstream and ties into the existing bottom of the pond. This alignment has a total invert elevation drop of 18 feet. For this evaluation, it was assumed that the fishway consisted of a box culvert with the top face removed, with a short, covered box culvert section for the reach passing under Mill Road.

Figure 6.14
Potential Fishway Analysis

Source: SEWRPC

The conceptual fishway design shown in Figure 6.14 would be difficult to construct and exceedingly expensive. It would not function well as a fishway given that the inlet and outlet would both be located far from the Mill Pond dam where fish are unlikely to congregate. Therefore, a fish passage design element was not included for alternatives where the dam remains.

Habitat and Recreational Improvements

Commission staff evaluated multiple terrestrial habitat and recreational features for the Mill Pond and dam alternatives. The recreational features investigated included boating, fishing piers, fishing access points, and additional walking paths. Terrestrial habitat features reviewed were vegetated terraces or benches and vegetation along the restored Mill Pond shoreline.

The only recreational features that were included in the proposed Mill Pond and dam alternatives were fishing access points and one new walking path. Boating is prohibited for ponds in the Milwaukee County Park System per Milwaukee County Code of Ordinances 47.13. Fishing piers were deemed to be infeasible as they would be difficult to access and maintain, would catch debris, and would be unsafe during flood events. There were limited opportunities for additional walking paths that would reach new terrain and be a reasonable distance from the current walking paths. With the existing configuration of Mill Pond, a walking path along the south side of the Mill Pond west of the warming house was determined to be infeasible due to the existing natural steep slopes present in that area. One additional walking path was included in this area as part of the fifth alternative in which dam removal provided sufficient space to the northwest of the warming house.

Vegetated floodplain or bench areas in the Mill Pond area were incorporated into the alternatives as appropriate. Plantings in these vegetated areas were assumed to consist of Wisconsin-native prairie and wetland plant species. It was determined that placing tall vegetation along the restored Mill Pond shoreline area would not be feasible for any of the alternatives. This was due to the desire to maintain sight lines to the Mill Pond area and warming house, as well as difficulties with establishing and maintaining this vegetation in high foot traffic areas, and the proximity of the shoreline to the existing sidewalk along the Oak Creek Parkway.

The Mill Pond and dam evaluation found evidence that natural springs may be present in the northern lobe of the pond. Where placing fill was proposed in the northern lobe as part of the Mill Pond and dam alternatives, no additional work or features were included in the planning level cost estimates to accommodate flows from the natural springs. Once an alternative is selected and construction begins, placement of French drains or a layer of clean sand may be required to facilitate flows from the natural springs.

Planning Level Costs

All items included in the planning level cost estimates for the Mill Pond and dam alternatives represent year 2019 dollars. Construction pricing was obtained chiefly from R.S. Means Heavy Construction Cost Data;[178] a 2015 AECOM cost estimate prepared for the County for the sluice gate repair;[179] and information from recent projects conducted by the Wisconsin Department of Transportation, the Minnesota Department of Transportation, and other local organizations. The planning level cost estimates also include a contingency of 35 percent to represent the costs for minor construction features, engineering design, and permitting. Permitting may include a dredging permit or a dam abandonment and removal permit from the WDNR as appropriate. A permit from the U.S. Army Corps of Engineers may also be required for construction of the selected alternative.

Dredging and hauling costs assume a volume of sediment with a 25 percent expansion factor to account for decompaction during mechanical excavation. A dredging and hauling cost of $100 per CY was used to develop the planning level cost estimates. This value was derived from the bids for the recent Estabrook dam removal and the AECOM cost estimate for the sluice gate repair. [180,181]

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[178] *R.S. Means Company, Inc.,* RSMeans Heavy Construction Cost Data, *23rd Annual Edition, 2009* and *30th Annual Edition, 2016*.

[179] *AECOM,* Milwaukee County Department of Parks, Recreation & Culture Mill Pond Dam Slide Gate Rehabilitation, Mill Road & Oak Creek Parkway, South Milwaukee, Wisconsin, *May 7, 2015. (This document is included in Appendix I of this report.)*

[180] Stacy Hron, WDNR, email correspondence dated July 29, 2020, for Estabrook dam removal bid worksheet.

[181] *AECOM 2015,* op. cit.

Sediment core sampling was assumed to occur during winter with a foot or more of ice thickness, which should be sufficient for safe core sampling. It was assumed that the core samples would extend to the anticipated depth of dredging plus two feet and that a lab sample would be taken every two feet along the core length. A recommended list of contaminants that the samples should be tested for was developed based on guidance given in Chapter NR 347 of the *Wisconsin Administrative Code* (see Table 6.16). Chemical analysis costs for sample testing were provided by the Wisconsin State Lab of Hygiene. It should be noted that WDNR reserves the authority to waive testing for contaminants of minimal concern for the project site and to add additional testing parameters based on site-specific concerns. The planning level cost per sediment core sample for all the required constituents is included in Table 6.16.

The planning level cost estimate for each alternative also includes operation and maintenance costs for the next 50 years. The planning level operation and maintenance costs for the five alternatives include future sediment dredging, vegetation maintenance, and dam inspections as appropriate. For alternatives with the dam remaining, it was assumed that re-dredging would be necessary about every 20 years based on the frequency of previous efforts by Milwaukee County. It was assumed that vegetation maintenance would be conducted during the first five years after completing construction for vegetation to become established. The alternatives where the dam remains also include a cost for dam inspections every ten years. While this is not a requirement, periodic inspection is a good practice to ensure the integrity of the dam structure and related infrastructure are maintained. Future maintenance costs were developed using an average Construction Cost Index factor and then calculated to present worth costs using an interest rate of 3.375 percent.

The five planning level alternatives and one optional add-on alternative developed for this plan are outlined below. Alternatives 1 through 4 retain the Mill Pond dam, while Alternative 5 removes the dam and restores the Oak Creek channel to a more natural configuration. The discussion below describes major construction components, maintenance requirements, and the planning level cost estimate for each alternative.

- Alternative 1 – Sluice Gate Repair
- Optional Spillway Enhancements – optional addition to Alternatives 1, 2 or 3
- Alternative 2 – Partial Pond Restoration
- Alternative 3 – Full Pond Restoration
- Alternative 4 – Bypass Channel, Dam Lowering, and Pond Restoration
- Alternative 5 – Dam Removal and Channel Restoration

Alternative 1 – Sluice Gate Repair

<u>Description and Main Features</u>

Alternative 1 represents the minimum work that must be done to bring the Mill Pond dam into compliance with the WDNR repair order. This alternative retains the Mill Pond dam and fixing the broken sluice gate as outlined in the construction plan developed by AECOM for Milwaukee County in 2015.[182] This plan includes adding a control gate structure, a new culvert between the existing gate structure and the new one, clearing the intake pipe of sediment, and dredging approximately 10 feet of sediment that currently buries the inlet pipe (see Figure 6.15). The area dredged around the inlet requires a five-foot horizontal to one-foot vertical (5:1) slope to promote sediment stability. Dredging would be completed by installing a sheet pile cofferdam, pumping water from within the cofferdam, and mechanically dredging in dry conditions. Once the sluice gate repair was completed, the cofferdam would be removed.

<u>Major Construction Components</u>

- SLUICE GATE REPAIR
  - Place cofferdam and dewater
  - Dredge and haul away approximately 1,200 CY of sediment
  - Clear existing intake pipe of sediment
  - Install new lift gate and control structure, new 2.5-ft diameter connection pipe

[182] *AECOM 2015,* op. cit.

Table 6.16
Sediment Core Tests and Associated Costs for Mill Pond Sediment

Soil Test	Cost per Sample (dollars)
Aroclors/Pesticides in Soil / Sediment (total PCBs, chlordane, dieldrin, endrin, DDT, DDE, aldrin, heptachlor, lindane, toxaphene)	700
Metals and Other Inorganic Chemicals (arsenic, barium, cadmium, chromium, copper, cyanide, iron, lead, manganese, mercury, nickel, selenium, zinc)	110
Nutrients (ammonia nitrogen, nitrate, total Kjeldahl nitrogen, total phosphorus)	210
Other Constituents (PAHs, oil and grease in solid, grain size, percent solids, total organic carbon, PFAS)	1,300
Total Cost	2,320

Sources: Section NR 347.06(6)(b)of the Wisconsin Administrative Code *and Wisconsin State Lab of Hygiene (2020 pricing)*

Maintenance Requirements

After the repairs are completed for Alternative 1, it is recommended that the sluice gate be opened, allowing water to flow through the gate at least once annually per guidance from the WDNR. For the purpose of developing planning level costs, it was assumed that dredging around the sluice gate inlet of half the volume initially dredged (600 CY) would be required once every 20 years. Half of the original dredge volume was assumed because regular operation of the sluice gate should flush some sediment from the intake area.

Planning Level Costs

The major construction components for Alternative 1 are listed above. The planning level cost estimate also includes the cost of collecting and analyzing one sediment core sample from the vicinity of the sluice gate inlet (see Figure 6.15). The total estimated present worth cost for construction and maintenance of Alternative 1 is $542,000 (2019 dollars). A summary for all the planning level costs can be found in Table 6.17. The full planning level cost estimate tabulation for Alternative 1 can be found in Appendix T.

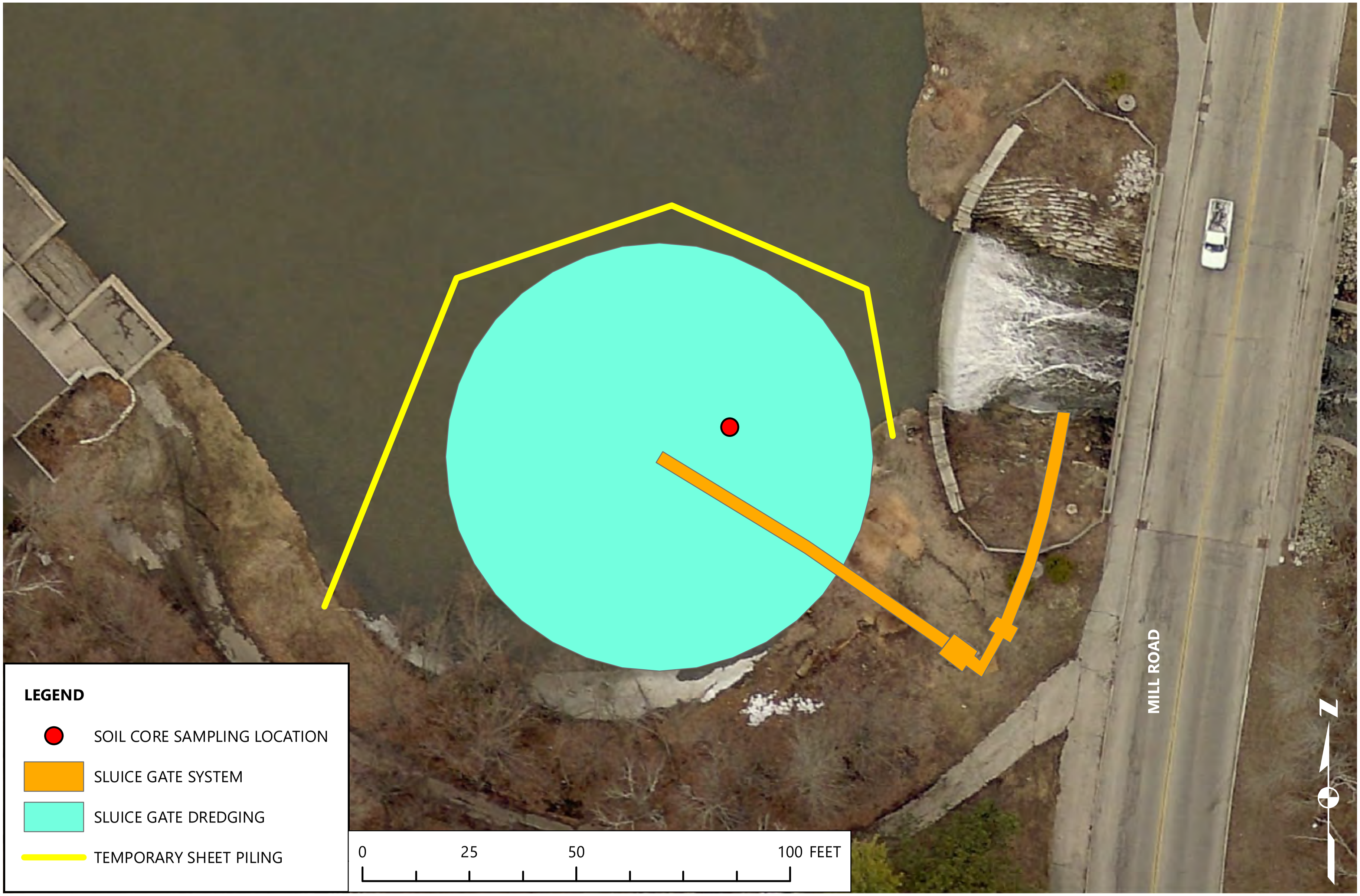
Optional Spillway Capacity Enhancements

Description and Main Features

As previously discussed, the Mill Pond dam spillway capacity is less than that needed to pass the 50-percent-annual-probability (2-year recurrence interval) flow event. When the capacity of the dam is exceeded, flood flows bypass the dam and go around the abutments of the dam structure, which could destabilize the dam. To accommodate larger storm events, two optional enhancements are described below to increase the spillway capacity of the Mill Pond dam. These enhancements could be added to Alternatives 1, 2, or 3 to improve safety at the dam and downstream on Oak Creek.

An optional emergency spillway with the configuration shown on Figure 6.16 was evaluated to increase spillway capacity. The emergency spillway design includes a concrete weir to the north of the Mill Pond dam. The top of the emergency spillway would be set to a slightly higher elevation than the top of the existing dam (611.75 ft NGVD29) allowing baseflows to continue to flow over the Mill Pond dam. Water that flows over the emergency spillway would drop approximately ten feet through a concrete structure to a large rectangular box culvert. The emergency spillway culvert would discharge through an outlet on the north bank of the Creek downstream of the dam. This outlet would include a riprap-lined channel for erosion protection due to anticipated maximum flow velocities of about 10 feet per second (fps). Additional erosion protection for the channel downstream of the dam may be necessary to maintain streambank integrity, however this was not included in the cost estimates. The combination of this emergency spillway plus the existing dam would convey flows approximately equal to the 10-percent-annual-probability (10-year recurrence interval) event (1,420 cfs) before flows would bypass the abutments of the Mill Pond dam. The emergency spillway includes a grate at the inlet weir to prevent debris from clogging the culvert and a grate at the outlet for safety. Commission staff investigated the possibility of building a new sluice gate system north of the dam to connect with the box culvert; however, this was determined to be infeasible due to the required proximity to the north dam abutment and length needed for a positive pipe slope.

Figure 6.15
Alternative 1 – Sluice Gate Repair



Source: SEWRPC

Table 6.17
Mill Pond and Dam Cost Summary

Alternative	Description	Core Sampling (Number of Sample Locations)[a]	Construction with 35 Percent Contingency[a]	Ongoing Maintenance[a,b]	Total Present Worth Cost[a]
Alternative 1	Sluice Gate Repair[c]	$14,000 (1)	$329,000	$199,000	$542,000
Alternative 2A[d]	Partial Pond Restoration[c]	$24,000 (2)	$2,202,000	$3,125,000	$5,351,000
Alternative 2B[e]	Partial Pond Restoration and Fill[c]	$24,000 (2)	$1,147,000	$3,144,000	$4,315,000
Alternative 3	Full Pond Restoration[c]	$49,000 (5)	$6,897,000	$5,464,000	$12,410,000
Alternative 4	Bypass Channel, Dam Lowering, and Pond Restoration	$49,000 (5)	$7,658,000	$2,624,000	$10,331,000
Alternative 5A[f]	Dam Removal and Channel Restoration – Large Floodplain Habitat	$49,000 (5)	$11,816,000	$61,000	$11,926,000
Alternative 5B[g]	Dam Removal and Channel Restoration – Large Floodplain Habitat	$49,000 (5)	$7,796,000	$61,000	$7,906,000
Alternative 5C[h]	Dam Removal and Channel Restoration – Small Floodplain Habitat	$49,000 (5)	$4,662,000	$61,000	$4,772,000

[a] *All costs are in 2019 dollars*

[b] *Present worth maintenance costs included dam inspections and dredging for a 50-year period for Alternatives 1, 2, 3, and 4, and vegetation maintenance for a 5-year period for Alternatives 2B, 4, and 5.*

[c] *To improve safety, dam abutment extensions and an emergency spillway would add $736,000 to the total present worth costs.*

[d] *Alternative 2A includes the full amount of dredged sediment hauled off site.*

[e] *Alternative 2B includes a portion of the dredged material used as fill in the Mill Pond northern lobe and restored with vegetative seeding, with the remaining dredged material hauled off site.*

[f] *Alternative 5A has the full amount of material hauled off site, with no fill on site. This alternative will create a large floodplain habitat.*

[g] *Alternative 5B allows a portion of the sediment to naturally erode downstream, a portion to be used as fill in the northern lobe fringe area, with the remaining amount hauled off site. This alternative will create a large floodplain habitat.*

[h] *Alternative 5C allows a portion of the sediment to naturally erode downstream, a portion to be used as fill in the northern lobe fringe area, with the remaining amount hauled off site. This alternative will create a small floodplain habitat.*

Source: SEWRPC

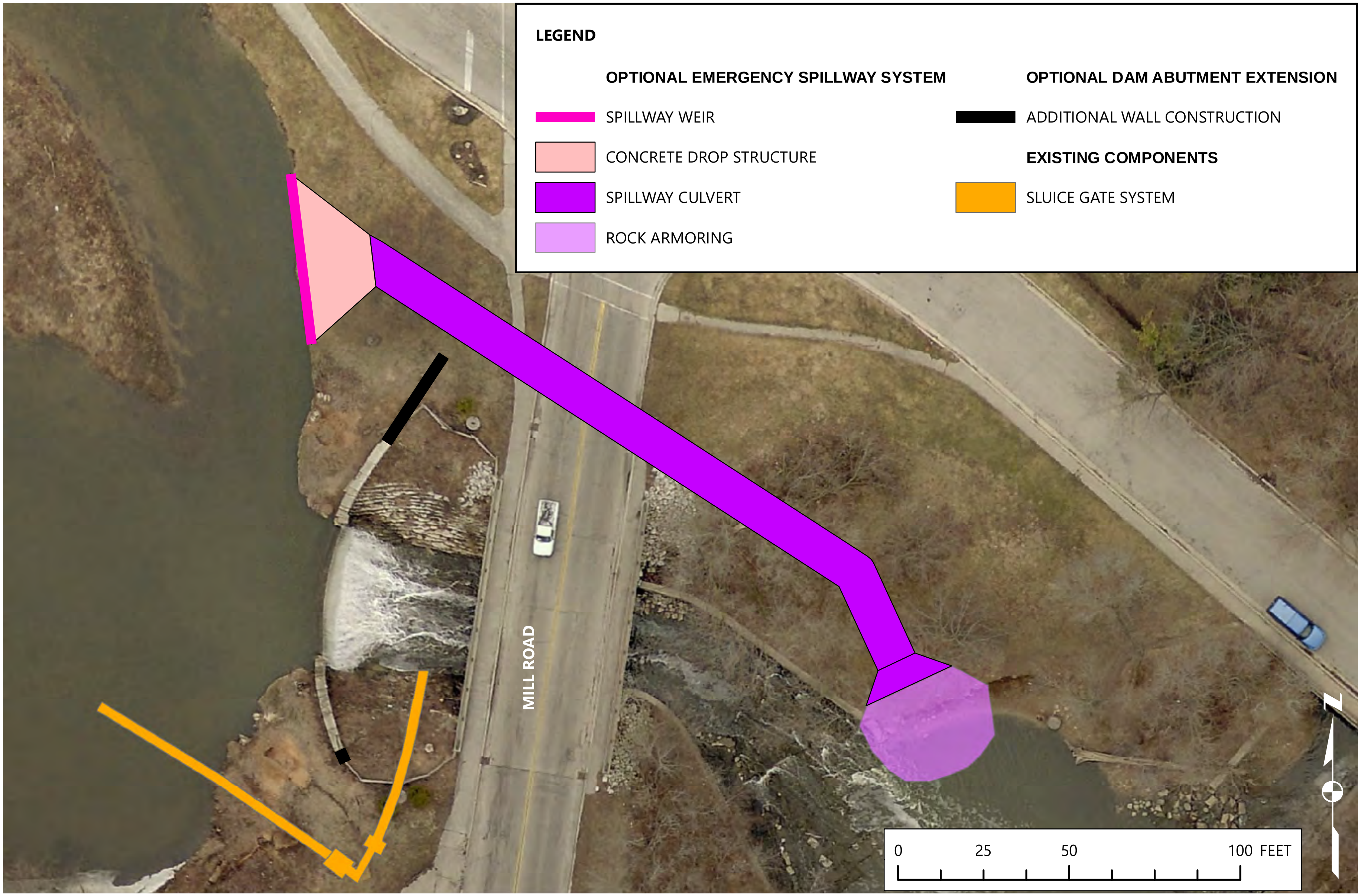
The Mill Pond dam spillway capacity could also be increased by extending the dam abutments to convey more flow over the current dam spillway (see Figure 6.16). Extending the abutments would increase the spillway capacity of the dam to about 1,050 cfs, between the 50-percent-annual-probability (2-year recurrence interval) event and the 10-percent-annual-probability (10-year recurrence interval) events. If both the emergency spillway and abutment extension designs were implemented, the dam would be able to safely convey the 2-percent-annual-probability (50-year recurrence interval) event (1,940 cfs).

<u>Major Construction Components</u>

- EMERGENCY SPILLWAY
  - Concrete weir, 50 feet long with crest elevation of 612.0 ft NGVD29
  - Concrete drop structure to 200-foot long, 8-foot by 12-foot concrete box culvert
  - Concrete end section at outlet
  - Riprap armoring at outfall area
  - Inlet and outlet grates

- ABUTMENT EXTENSIONS
  - Concrete abutment extensions for total length of 37 feet

Figure 6.16
Optional Spillway Capacity Enhancements



Source: SEWRPC

Planning Level Costs

The major construction components for the Optional Spillway Enhancements are listed above. No maintenance requirements for this alternative are included in the planning level cost estimate, although the inlet grate for the emergency spillway would require periodic inspection, maintenance, and removal of debris when necessary. The total estimated present worth cost for construction of the Optional Spillway Enhancements is $736,000. This includes $733,500 for the emergency spillway and $2,500 for the abutment extensions. Detailed planning level cost estimates for the Optional Spillway Enhancements can be found in Appendix T.

Alternative 2 – Partial Pond Restoration

Description and Main Features

Alternative 2 includes fixing the dam sluice gate and the associated dredging as described in the description of Alternative 1 and dredging the southeastern lobe of the Mill Pond to bottom elevations similar to the original Mill Pond after dam construction in the 1930s (see Figure 6.17). This alternative would retain the Mill Pond dam and its spillway capacity would remain the same as existing conditions (less than the 50-percent-annual-probability event) unless the optional spillway capacity enhancements were also incorporated. This design would create pond depths of up to seven to nine feet.

Two variations of Alternative 2 were evaluated for disposal of dredged sediment. Under the first variation, all dredged sediment would be hauled off-site (see Figure 6.17). Under the second variation, it was assumed the dredged sediment would be suitable to use to fill in the northern lobe of the Mill Pond. This area would be restored with seeded vegetation in the floodfringe area (see Figure 6.18). The fill area was designed to not impact the Oak Creek regulatory floodplain. Placing dredged material in this area may enhance the ability of wetland vegetation to survive and would reduce sediment haul volumes by as much as 10,000 CY. It may be required to place a soil cap over this fill to reduce human contact potential. The placement of a soil cap is not included in the planning level cost estimate for Alternative 2B. Under both sub-alternatives, a pervious pavement platform would be constructed along the eastern bank of the pond to the north of the dam to provide access for recreational fishing.

Should Alternative 2 be implemented, investigations will need to be conducted to determine whether a safety barrier should be placed near the dam spillway to warn ice skaters of the dam face. This investigation and such a barrier are not included in the planning level cost estimate. Alternative 2 also includes repair of the sluice gate system as described in Alternative 1. It is recommended to repair the sluice gate first, so the sluice gate can be used to dewater the Mill Pond prior to the sediment mechanical dredging for Alternative 2.

Major Construction Components

- SLUICE GATE REPAIR (see Alternative 1)

- DREDGE SOUTHERN POND LOBE
  - Dewater with sluice gate and cofferdam/piping around site
  - Dredge approximately 12,200 CY of sediment
  - Haul away 12,200 CY (Alternative 2A) or 2,200 CY (Alternative 2B) of sediment

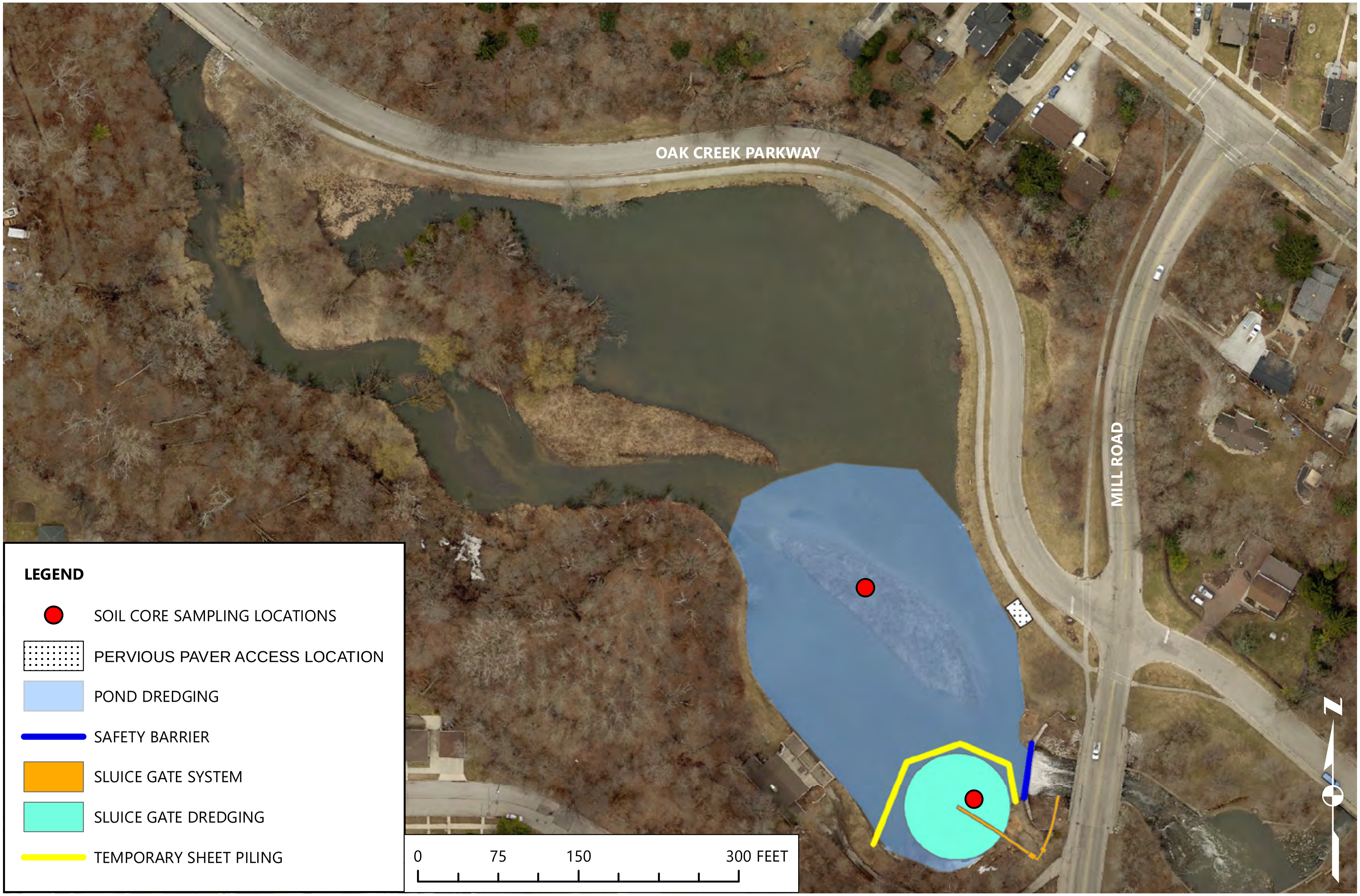
- FILL NORTHERN POND LOBE (ALTERNATIVE 2B)
  - Floodway area filled to maximum elevation of 611.7 ft NGVD29
  - Floodfringe area filled to maximum elevation of 613.7 ft NGVD29
  - Floodfringe Bank area planted with native vegetation

- RECREATIONAL ENHANCEMENTS
  - Create approximately 1.7 acres of open water or skating area
  - One pervious pavement platform for fishing

Maintenance Requirements

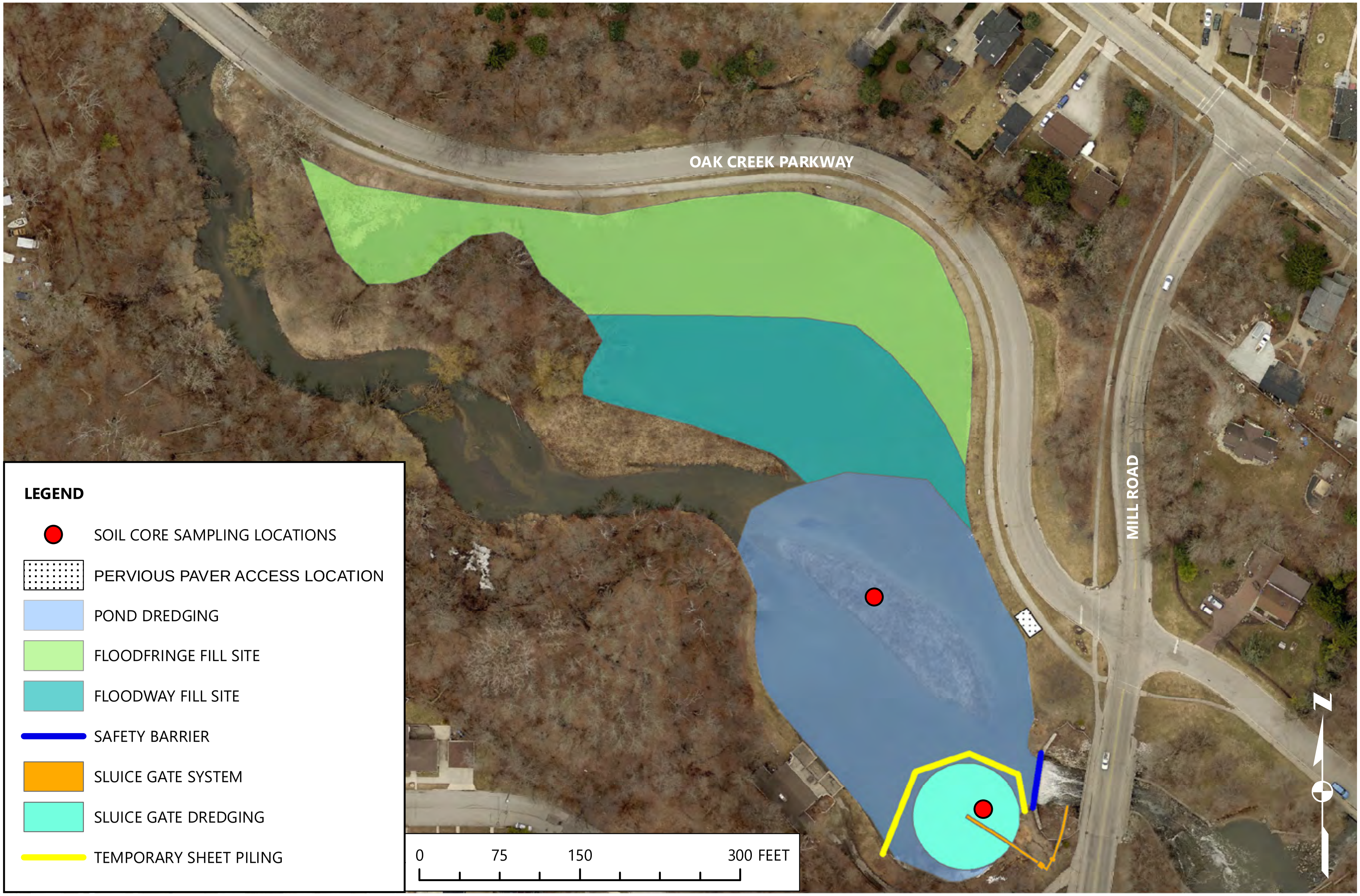
As under Alternative 1, the sluice gate should be opened at least once annually per WDNR guidance, allowing water to flow through the gate. To develop planning level costs, it was assumed that dredging the entire volume initially dredged (13,400 CY) for Alternative 2 would be required once every 20 years. The entire volume was assumed because the restored Mill Pond area is small. The vegetation that would be

Figure 6.17
Alternative 2A – Partial Pond Restoration



Source: SEWRPC

Figure 6.18
Alternative 2B – Partial Pond Restoration and Fill



Source: SEWRPC

planted in the floodfringe area for Alternative 2B would also require maintenance until desired species are firmly established. The planning level cost estimate for Alternative 2B includes vegetation maintenance for the first five years after construction.

<u>Planning Level Costs</u>

The major construction components for Alternative 2 are listed above. The planning level cost estimate also includes collection and chemical analysis of two sediment core samples (see Figure 6.17). The total estimated present worth cost for construction and maintenance of Alternative 2A is $5,351,000 (2019 dollars) and for Alternative 2B is $4,315,000 (2019 dollars). A summary of the planning level costs can be found in Table 6.17. Detailed planning level cost estimates for Alternatives 2A and 2B can be found in Appendix T.

Alternative 3 – Full Pond Restoration

<u>Description and Main Features</u>

Alternative 3 involves fixing the sluice gate of the dam and associated dredging as described in the description of Alternative 1 and dredging the accumulated sediment in the entire Mill Pond area to recreate the original 1930s condition (see Figure 6.19). This alternative retains the Mill Pond dam and its spillway capacity would remain the same as existing conditions (less than the 50-percent-annual-probability event) unless the optional spillway capacity enhancements were also incorporated. This alternative creates pond depths of up to seven to nine feet over a larger area than Alternative 2. Two pervious pavement platforms would be installed along the north and east bank of the pond to provide access for recreational fishing.

As with Alternative 2, investigations will need to be conducted to determine whether a safety barrier should be placed near the dam spillway to warn ice skaters of the dam face. This item is not included in the planning level cost estimate. In this alternative, the sluice gate system would be repaired as described in Alternative 1. It is recommended to repair the sluice gate first, so the sluice gate can be used to dewater the Mill Pond prior to the sediment mechanical dredging for Alternative 3.

<u>Major Construction Components</u>

- SLUICE GATE REPAIR (see Alternative 1)

- DREDGE POND AREA
  - Dewater with sluice gate and cofferdam/piping around site
  - Dredge and haul away approximately 46,000 CY of sediment

- RECREATIONAL ENHANCEMENTS
  - Create approximately 5.7 acres of open water or skating area
  - Two pervious pavement platforms for fishing

<u>Maintenance Requirements</u>

As with Alternative 1, the sluice gate should be opened, allowing water to flow through the gate at least once annually per guidance from the WDNR. Under Alternative 3 it was assumed that half of the volume initially dredged (23,600 CY) would be required every 20 years. For the area to be restored, this volume of dredging is reasonable as compared to the assumed volume of maintenance dredging for Alternative 2.

<u>Planning Level Costs</u>

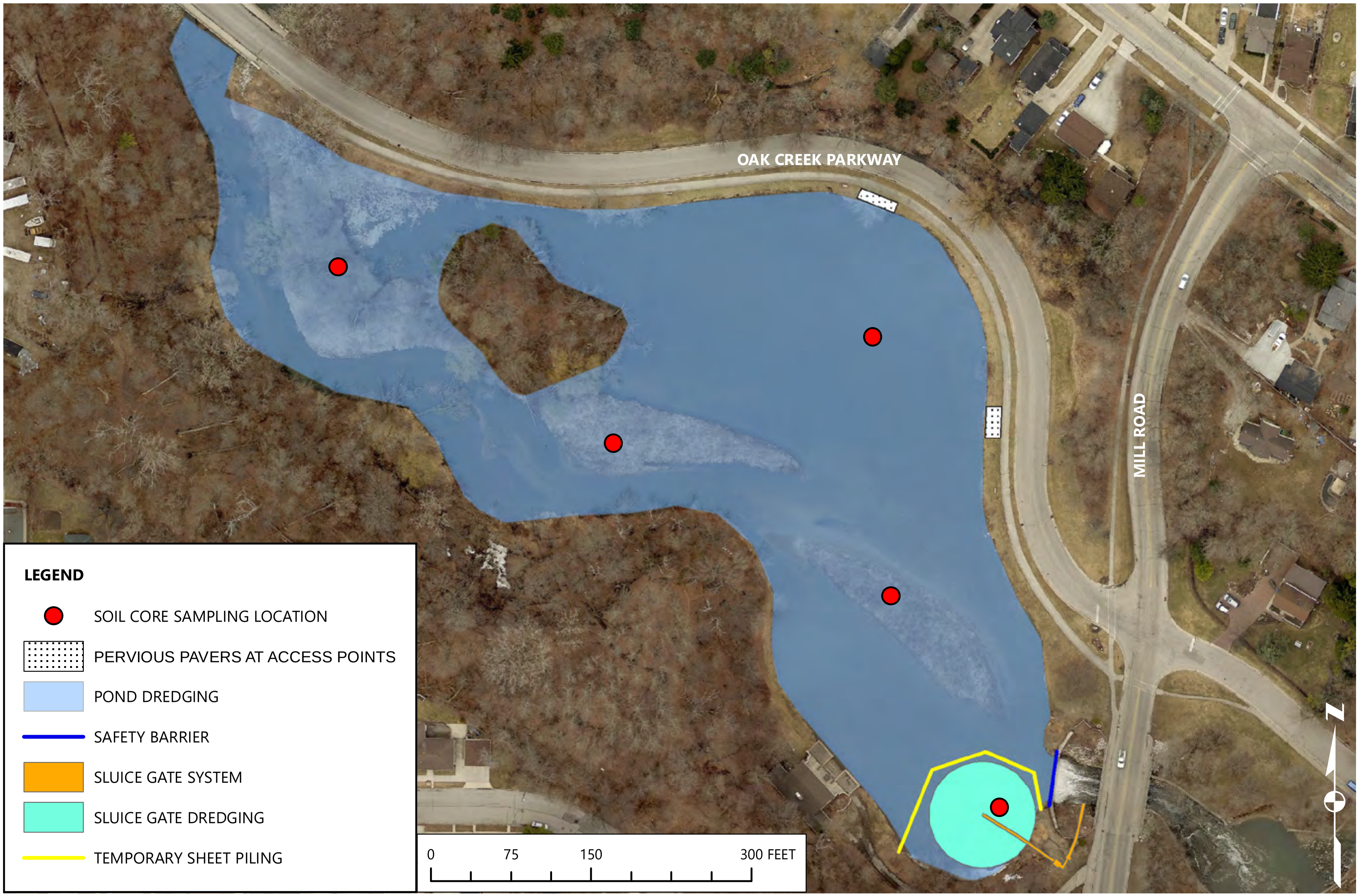
The major construction components for Alternative 3 are listed above. The planning level cost estimate also includes collection and chemical analysis of five sediment core samples (see Figure 6.19). The total estimated present worth cost for construction and maintenance of Alternative 3 is $12,410,000 (2019 dollars). A summary of the planning level costs can be found in Table 6.17. Detailed planning level cost estimates for Alternative 3 can be found in Appendix T.

Alternative 4 – Bypass Channel, Dam Lowering, and Pond Restoration

<u>Description and Main Features</u>

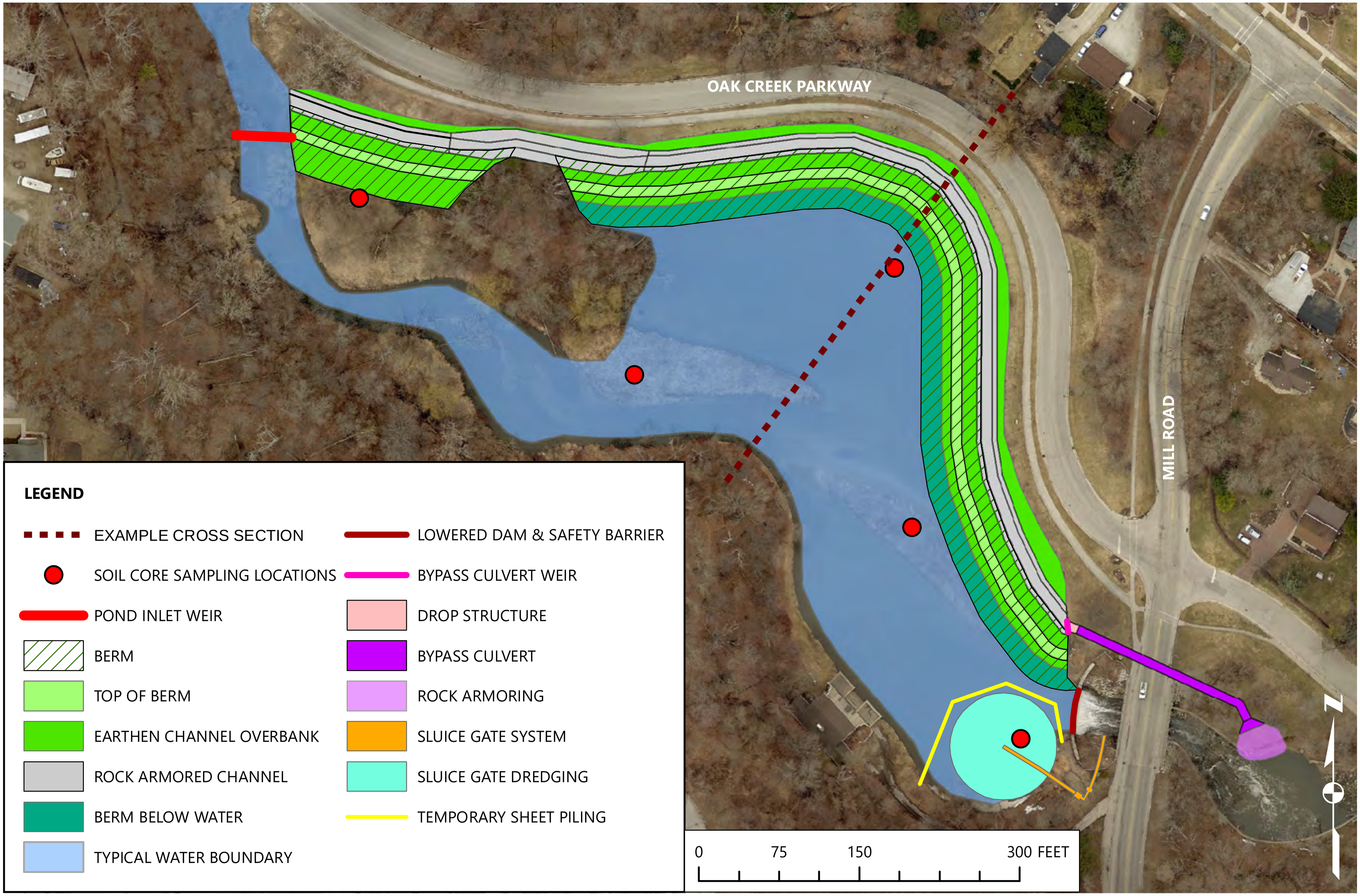
Alternative 4 includes fixing the dam sluice gate and associated dredging as described in the description of Alternative 1, diverting lower flows into a bypass channel around the Mill Pond, and restoring the remaining portion of pond (see Figure 6.20). Low flows less than the 50-percent-annual-probability (2-year recurrence

Figure 6.19
Alternative 3 – Full Pond Restoration



Source: SEWRPC

Figure 6.20
Alternative 4 – Bypass Channel, Dam Lowering, and Pond Restoration



Source: SEWRPC

interval) event convey the majority of sediment load for Oak Creek. Routing these flows around the pond would significantly reduce sediment accumulation in the restored Mill Pond. Under this alternative the remaining Mill Pond area would be dredged to a maximum depth of about six feet. The Mill Pond dam would be retained, but the dam crest would be lowered by approximately two feet.

Alternative 4 involves diverting Oak Creek low flows up to the 99-percent-annual-probability (1-year recurrence interval) event (387 cfs) through a trapezoidal rock-lined channel. This channel would run along the northern edge of the project area and connect to a culvert that bypasses the Mill Pond dam on the north side (see Figure 6.20). An inlet weir would be built at the upstream end of the Mill Pond. This weir would allow Oak Creek flows greater than approximately 80 cfs to also enter the restored pond. The section of the bypass channel near the existing island in the pond would have a smaller cross section with additional rock lining to provide enough capacity and armoring to convey the flow through this narrow area. The bypass channel would be separated from the Mill Pond by a berm that would have a clay core to prevent seepage flow between the bypass channel and the restored Mill Pond. The bypass berm may also provide additional locations for fishing access. A cross-sectional view of the proposed channel, berm, and pond geometry looking downstream is shown in Figure 6.21 at the location indicated on Figure 6.20. This cross section is oriented looking downstream, or to the southeast, and depicts the conceptual cross section for the Alternative 4 features relative to the existing Mill Pond bottom.

The downstream end of the bypass channel would discharge over a weir that would be covered by a grate with an opening at the base to allow free flow. A large concrete drop structure and culvert would be installed downstream of this weir. The culvert would convey flow under Mill Road, discharging into the Creek through an outlet located downstream of the Mill Pond dam on the north bank. Rock armoring would be placed at the outlet of the culvert for erosion protection. Additional erosion protection for the channel downstream of the dam may be necessary to maintain streambank integrity, however this was not included in the cost estimates. The configuration of this portion of Alternative 4 is shown on Figure 6.22. The bypass weir and culvert would also function as an emergency spillway for the dam. Hydraulic modeling indicated that events larger than the 2-percent-annual-probability (50-year recurrence interval) event would flow over the berm between the restored pond and the bypass channel. Alternative 4 includes lowering the Mill Pond dam crest to provide adequate hydraulic conditions at the inlet weir for the bypass channel. With the dam lowering and bypass culvert, the total spillway capacity for Alternative 4 would be between the 1-percent-annual-probability (100-year recurrence interval) and 0.2-percent-annual-probablity (500-year recurrence interval) events.

As discussed above, the planning level design for Alternative 4 includes a bypass channel for Oak Creek baseflows. This would mean that the restored pond for Alternative 4 would only see flows from Oak Creek during flow events larger than approximately 80 cfs. Review of Oak Creek flow data at the USGS gage at 15th Avenue from years 2011, 2014, and 2017, which were selected as flow data that approximated a typical year, showed that on average the pond would receive flow during 30 days per year over ten different events. An option to supplement flows to the pond would be to pump City water into the Alternative 4 restored pond during baseflow times. This pumping option is not included in the planning level cost estimate for Alternative 4.

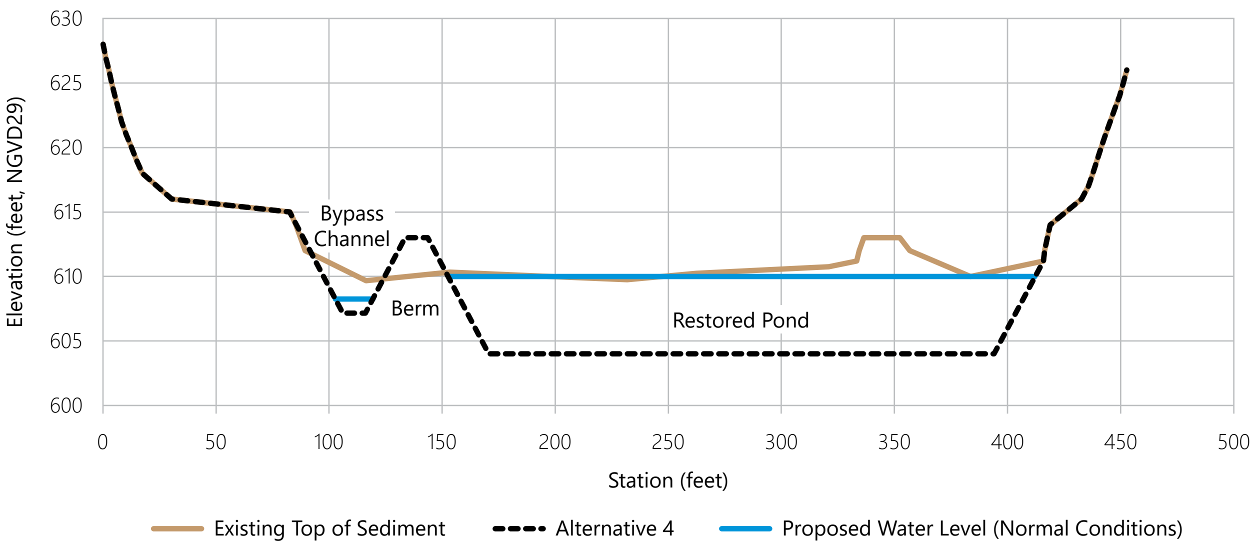
As with Alternatives 2 and 3, the need for a safety barrier at the dam spillway to warn ice skaters of the dam face should be investigated. This item is not included in the planning level cost estimate. In this alternative, the sluice gate system would be repaired as described in Alternative 1. It is recommended to repair the sluice gate first, so the sluice gate can be used to dewater the Mill Pond prior to the sediment mechanical dredging for Alternative 4. Commission staff investigated the possibility of building a new sluice gate system north of the dam to connect with the bypass culvert, however this was determined to be infeasible due to the required proximity to the north dam abutment and difficultly in establishing a positive pipe slope.

Major Construction Components

- SLUICE GATE REPAIR (see Alternative 1)

- DREDGE POND AREA
  - Dewater with sluice gate and cofferdam/piping around site
  - Dredge and haul away approximately 44,000 CY of sediment

Figure 6.21
Conceptional Cross Section for Alternative 4[a]



[a] *This figure represents the conceptual cross sections for Alternatives 4 as compared to the existing top of sediment in the Mill Pond. The figure orientation is looking downstream, or to the southeast. The location of the example cross section is shown on Figure 6.20.*

Source: SEWRPC

- LOWER DAM
  - Lower dam crest by 1.75 feet (610.0 ft NGVD)

- INLET WEIR TO POND
  - Concrete weir with top elevation of 613.4 ft NGVD29 and five-foot wide notch with invert of 610.6 ft NGVD29

- BYPASS CHANNEL AND EARTHEN BERM
  - Rock armored and grass lined trapezoidal channel
  - Channel around pond 10 feet wide at bottom with 3:1 side slopes and rock lining for lower 1.5 feet of side slope. Channel around natural island 7.4 feet wide with 2:1 side slopes and rock lining for 4.75 feet of depth.
  - Bypass berm with a top elevation of 613.0 ft NGVD29
  - Earthen berm has 3:1 side slopes and a clay core, planted with native vegetation

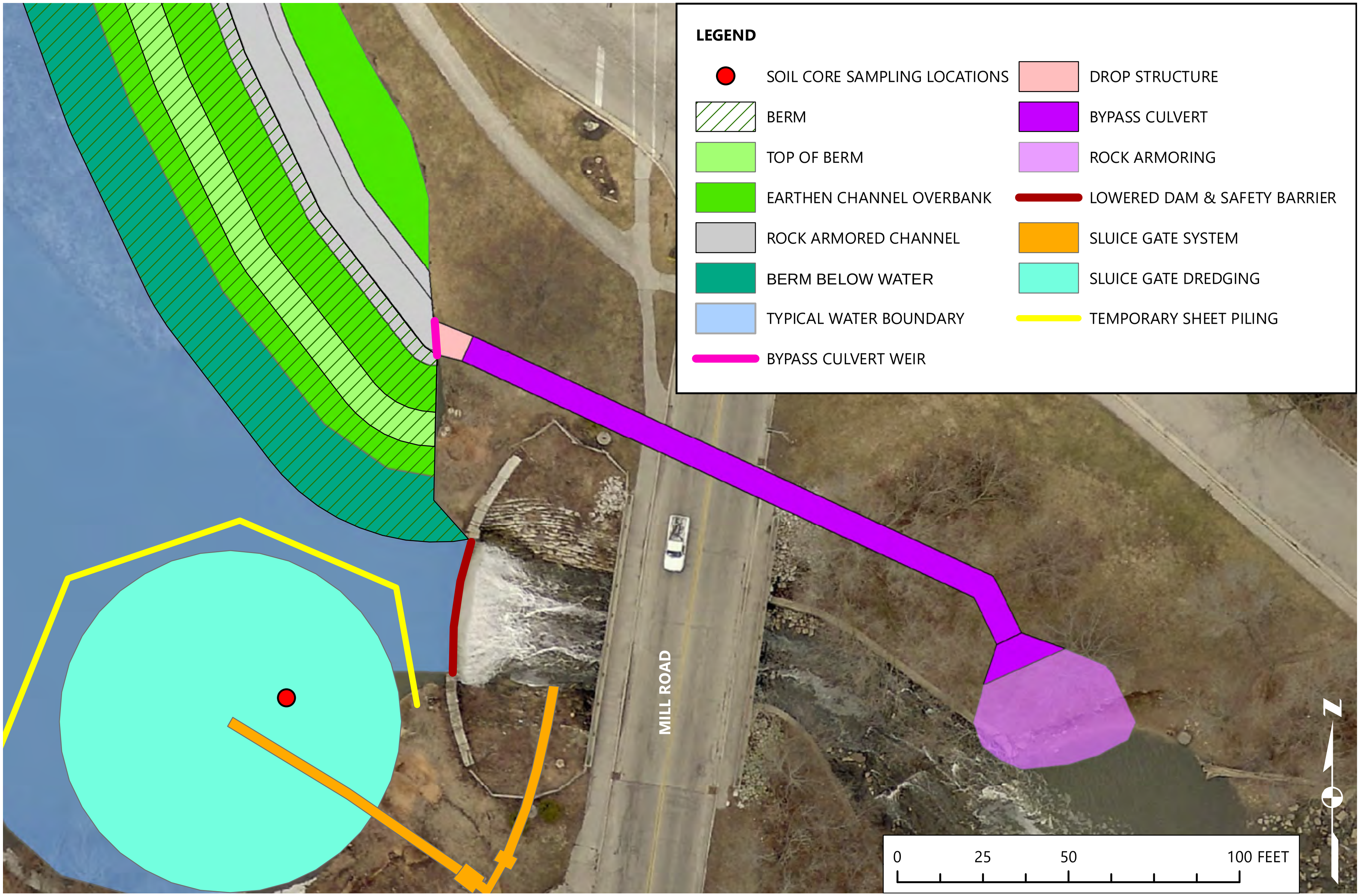
- BYPASS CULVERT SYSTEM
  - Concrete weir 10 feet wide with invert elevation of 606.25 ft NGVD29
  - Concrete drop structure to 8-ft diameter concrete culvert, 190 feet long under Mill Road
  - Rock armoring at outlet
  - Inlet and outlet grates with two-foot high opening at bottom to prevent clogging

- RECREATIONAL ENHANCEMENTS
  - Create approximately 3.5 acres of open water or skating area
  - Bypass berm for additional access to restored Mill Pond

<u>Maintenance Requirements</u>

As with Alternative 1, the sluice gate should be opened at least once annually per WDNR guidance, allowing water to flow through the gate. The inlet grate for the bypass culvert will require periodic inspection and being cleaned of debris when necessary. For the purpose of developing planning level cost estimates, it was assumed that dredging a quarter of volume initially dredged (11,000 CY) would be required every 20 years. A quarter of the entire volume was assumed as the bypass channel should divert a large portion of the sediment around the Mill Pond for Alternative 4. The vegetation planted on the earthen berm would also

Figure 6.22
Alternative 4 – Bypass Culvert Detail



Source: SEWRPC

require maintenance until desired species become established. The planning level cost estimate includes vegetation maintenance for the first five years after construction.

Planning Level Costs

The major construction components for Alternative 4 are listed above. The planning level cost estimate also includes collection and chemical analysis of five sediment core samples (see Figure 6.20). The total estimated present worth cost for construction and maintenance of Alternative 4 is $10,331,000 (2019 dollars). A summary of the planning level costs can be found in Table 6.17. Detailed planning level cost estimates for Alternative 4 can be found in Appendix T.

Alternative 5 – Dam Removal and Channel Restoration

Description and Main Features

Alternative 5 includes removing the dam and recreating a naturalized Oak Creek channel in the Mill Pond area. As was discussed in Chapter 4, a portion of the original Oak Creek channel has been permanently buried under Mill Road, thus a new channel would need to be built. The Mill Pond area would be lowered to create a new Oak Creek channel that would contain a series of meandering riffles and pools to facilitate fish passage (see Figure 6.23). Some features of the design would be similar to a channel restoration project completed by the Milwaukee Metropolitan Sewerage District on Underwood Creek in the City of Wauwatosa. The Underwood Creek project also included floodplain excavation and creation of a rock lined channel (see Figure 6.24).

Three variations of Alternative 5 were evaluated that included two different techniques to lower the Mill Pond area as well as two different shapes for the restored bank area. The sediment and soil removal techniques included combinations of dredging and hauling off-site, allowing sediment to be removed naturally by Oak Creek flows, and reworking the sediment and soil within the former pond area. The two different shapes for the restored bank area above the riffle pool complex included a large or small floodplain habitat area.

Under the Alternative 5A, all dredged sediment would be hauled off-site to create a large floodplain wetland habitat area (see Figure 6.23). Hauling all the material off-site would be required if the sediment and soils in the Mill Pond were found to be contaminated. An example of the proposed channel and floodplain cross section for Alternative 5A is shown on Figure 6.25 at the location indicated on Figure 6.23. This cross section is oriented looking downstream, or to the southeast, and depicts the conceptual cross section for the Alternative 5 options relative to the existing Mill Pond bottom. Under the Alternative 5B, the large floodplain wetland habitat area would be created by allowing a portion of the sediment removal to be achieved by gradually notching the dam and allowing the sediment to move downstream with Oak Creek flows. The remaining sediment removal for Alternative 5B would be achieved by earthwork onsite or hauling off-site. The lowered floodplain for Alternatives 5A and 5B would become wet during above-average flow conditions for Oak Creek (flows above 25 cfs), creating a more wetland-like environment that would be seeded with native wetland vegetation. The areas of fill for Alternative 5B were designed to not impact flood levels for the Oak Creek 1-percent-annual-probability (100-year recurrence interval) event.

Under Alternative 5C, the small floodplain habitat area would be created by allowing a portion of the sediment removal to be achieved by gradually notching the dam and allowing sediment to move downstream with Oak Creek flows (see Figure 6.26). The remaining sediment removal for Alternative 5C would be achieved by earthwork onsite or hauling off-site (see Figure 6.25). The lowered floodplain in Alternative 5C would become wet at approximately the 50-percent-annual-probability (2-year recurrence interval) event (flows above 878 cfs), and the floodplain would be seeded with native prairie vegetation. The areas of fill for Alternative 5C were designed to not impact flood levels for the Oak Creek 1-percent-annual-probability (100-year recurrence interval) event.

For all of the Alternative 5 options, the areas above the riffle pool complex would be restored with seeded native vegetation. Placing existing sediment material in the vegetated areas may enhance the ability of wetland and native vegetation to survive. Establishing native vegetation will be especially important for Alternative 5C as flood velocities are higher in the small floodplain habitat area as compared to the large floodplain habitat for Alternatives 5A and 5B. Alternative 5C may also require additional erosion control features in the floodplain habitat area due to higher flood velocities. It may also be required to place a soil

Figure 6.23
Alternative 5A/5B - Dam Removal and Channel Restoration, Creating Large Floodplain Habitat

Source: SEWRPC

cap over the vegetated areas before seeding to reduce human contact potential. The placement of additional erosion control features or a soil cap is not included in the planning level cost estimates for Alternatives 5A, 5B, or 5C.

Figure 6.24
Example of Creek Restoration Along Underwood Creek

Source: Milwaukee Metropolitan Sewerage District

The updated hydraulic model was used to size the Oak Creek channel restoration, which is the same for each of the Alternative 5 options. The hydraulic model estimated that the proposed riffle pool system would have a maximum flow velocity of about 4.6 fps near the former dam during normal Oak Creek flow conditions. The former dam location is the most constrained cross section for the Alternative 5 options, and thus it is the location with the highest flow velocity. The maximum prolonged swimming and swimming burst speeds of various migrating fish species found in southern Lake Michigan are shown in Table 6.18. Based upon these data, pike, salmon, trout, and most bass and sucker species would likely be able to pass through the Alternative 5 riffle pool system under normal flow conditions.

The restored channel bottom under each of the Alternative 5 options would drop approximately 11 feet over the length of the Mill Pond, in half-foot increments at each riffle to allow fish passage. The pools would provide resting areas for aquatic organisms and would have a maximum depth of about three feet. The restored channel would be armored with rounded stone, and large rock benches would anchor the riffles to ensure that they remain in place during higher flow events. All of the Alternative 5 options also include construction of a walking path to the northwest of the warming house.

As each of the Alternative 5 options eliminates the open water component of the previous alternatives, a potential location for a seasonal ice skating area was investigated. It was determined that a location in the vegetated floodplain habitat area just north of the warming house would be feasible (see Figure 6.27). This area could be flooded using water from Oak Creek or the City water utility. This would provide approximately 0.3 acres of skating area. A trail with switchbacks leading down to the ice skating area would be necessary to make the site accessible. The skating area option and associated trail are not included in the planning level costs discussed below.

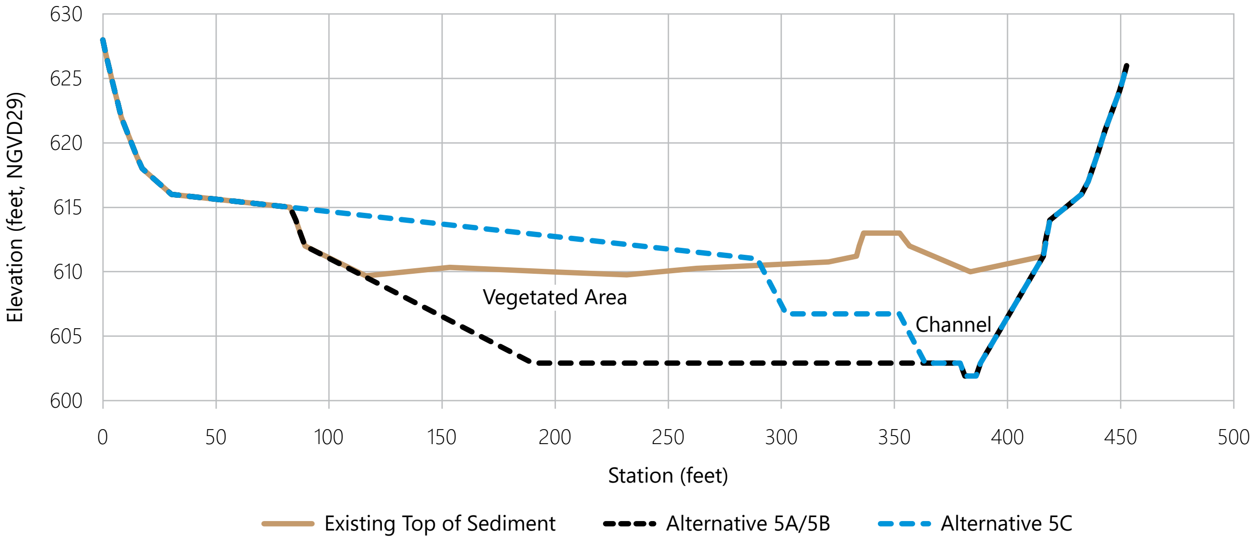
<u>Major Construction Components</u>

- DREDGE POND AREA (ALTERNATIVE 5A)
  - Dewater with pumping and cofferdam/piping around site
  - Dredge and haul away approximately 72,000 CY of sediment to create large floodplain habitat

- LOWER POND AREA (ALTERNATIVE 5B)
  - Dewater pond by notching dam in half-foot increments
  - Route streamflow during construction with cofferdam and pumping/piping around site
  - Create large floodplain habitat by allowing sediment to flow downstream and reworking a portion of remaining sediments
  - Dredge and haul away approximately 41,000 CY of sediment

- LOWER POND AREA (ALTERNATIVE 5C)
  - Dewater pond by notching dam in half-foot increments
  - Route streamflow during construction with cofferdam and pumping/piping around site
  - Create small floodplain habitat by allowing sediment to flow downstream and reworking a portion of remaining sediments
  - Dredge and haul away approximately 12,000 CY of sediment

Figure 6.25
Conceptional Cross Section for Alternative 5 Options[a]



[a] *This figure represents the conceptual cross sections for Alternatives 5A/5B and 5C as compared to the existing top of sediment in the Mill Pond. The figure orientation is looking downstream, or to the southeast. The location of the example cross section is shown on Figure 6.23 and Figure 6.26.*

Source: SEWRPC

- DAM REMOVAL

- ESTABLISH VEGETATION
  - Non-rock areas planted with native vegetation

- RIFFLE-POOL CHANNEL
  - Series of 22 riffle pools that drop 11 feet across project area, in half-foot steps
  - Each pool has a maximum depth of about three feet and a minimum length of about 50 feet
  - Each riffle has a minimum width of five feet
  - Channel lined with smooth boulders one to two feet in diameter
  - Channel riffles anchored with three-foot diameter boulders

Maintenance Requirements

The only maintenance requirement associated with the Alternative 5 options is vegetation maintenance. It is likely that some Oak Creek sediment would wash up onto the vegetated areas during flooding, but the volume deposited would probably be small enough to be incorporated into the floodplain bench habitat areas and would not require removal. The vegetation planted in the floodplain bench areas would require maintenance until desired species become established. The planning level cost estimate includes vegetation maintenance for the first five years after construction.

Planning Level Costs

The major construction components for the Alternative 5 options (5A, 5B, 5C) are listed above. The planning level cost estimate also included five sediment core samples (see Figure 6.23). The total estimated present worth cost for construction and maintenance is $11,926,000 (2019 dollars) for Alternative 5A, $7,906,000 (2019 dollars) for Alternative 5B, and $4,772,000 (2019 dollars) for Alternative 5C. A summary of the planning level costs can be found in Table 6.17. Detailed planning level cost estimates for Alternatives 5A, 5B, and 5C can be found in Appendix T.

Figure 6.26
Alternative 5C – Dam Removal and Channel Restoration, Creating Small Floodplain Habitat

Source: SEWRPC

Table 6.18
Swimming Speeds for Fish Passage

Fish Species	Prolonged Speed (feet per second)	Burst Speed (feet per second)
Smallmouth Bass	1.8-3.9[a]	3.6-7.8[a]
Longnose Sucker	2.5-5.0[b]	4.0-7.9[b]
Northern Pike	0.6-1.6[b]	5.0-13.0[c]
Brown Trout	2.3-7.5[b]	7.5-12.2[b]
Coho Salmon	3.4-10.6[b]	10.6-21.5[b]
Chinook Salmon	3.4-10.8[d]	10.8-22.4[d]
Steelhead Trout	4.6-13.7[b]	13.7-27.0[b]

[a] *Stephan Peake, An Evaluation of the Use of Critical Swimming Speed for Determination of Culvert Water Velocity Criteria for Smallmouth Bass, Transactions of the American Fisheries Society 133: 1472-1479, 2004 and Normandeau Associates, Inc., Claytor Hydroelectric Project Fish Entrainment and Impingement Assessment, Appalachian Power Company, R-20979.001, January 2009.*

[b] *Furniss, Michael, et al. "FishXing: Software and Interactive Learning for Fish Passage through Culverts." FishXing: Software and Learning Systems for Fish Passage through Culverts, 2.1, United State Fish & Wildlife Service, www.fs.fed.us/biology/nsaec/fishxing/index.html.*

[c] *Luther P. Aadland, Reconnecting Rivers: Natural Channel Design in Dam Removals and Fish Passage, Minnesota Department of Natural Resources, January 2010 and S.J. Peake, Swimming Performance and Behaviour of Fish Species Endemic to Newfoundland and Labrador: A Literature Review, Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2843, 2008.*

[d] *Gregory T. Ruggerone, Evaluation of Salmon and Steelhead Migration Through the Upper Sultan River Canyon Prior to Dam Construction, City of Everett, July 2006.*

Source: SEWRPC

Evaluation of Alternatives

The Mill Pond and Mill Pond dam planning level alternatives discussed above were evaluated based on their impact on flooding, environmental, and recreational components of the Mill Pond area. For each of these issues, the sections below first discuss the criteria used to evaluate the alternatives, then present the evaluation. A summary of the full evaluation is given in Table 6.19. This table presents a qualitative evaluation of positive (+) and negative (-) impacts as compared to existing conditions at the Mill Pond and dam.

Flooding

Impacts of the five proposed alternatives on flooding were evaluated. It was determined that a reduction in the flood elevation for the 1-percent-annual-probablity (100-year recurrence interval) floodplain upstream of the dam location as compared to existing conditions would constitute an improvement (see Figure 6.12). This reduction in flood elevation would be achieved by either increasing the spillway capacity or removing the dam. For the five proposed alternatives a reduction in the flood elevation will result in a reduced areal extent for the 1-percent-annual-probability (100-year recurrence interval) floodplain.

As was previously discussed, Alternatives 1, 2, and 3 would not increase the spillway capacity and would not reduce the flood elevation upstream of the dam unless the optional spillway enhancements were included (see Figure 6.28). The optional spillway enhancements to Alternatives 1, 2, and 3 would increase the overall Mill Pond dam spillway capacity as compared to existing conditions, lowering the 1-percent-annual-probability flood elevation by approximately 1.1 feet. This would reduce flooding on the Oak Creek Parkway. Alternative 4 would increase the overall spillway capacity significantly as compared to existing conditions, thus lowering the 1-percent-annual-probability flood elevation by approximately 2.5 feet. This would essentially eliminate flooding on the Oak Creek Parkway. Alternative 5 would lower the 1-percent-annual-probability flood elevation by up to 10.5 feet, which would significantly reduce the flooded area (see Figure 6.28).

Environmental

The evaluation of the environmental impacts of the Mill Pond and dam alternatives was based on the effects of the alternatives on water quality, sedimentation, fish passage, and habitat. These four categories were evaluated individually.

It was assumed that water quality in the Mill Pond would improve as a result of either an increase in pond depth or an improvement of flow and sediment transport through the area because these changes would improve water temperatures and dissolved oxygen conditions. Alternative 1, with repair to the sluice gate

Figure 6.27
Alternative 5 – Optional Skating Pond

Source: SEWRPC

Table 6.19
Mill Pond and Dam Alternatives Summary

	Flooding[a]		Environmental[a]				Recreation[a]					
Description	Flooding Impacts	Spillway Capacity (Percent-Annual-Probability)	Water Quality in Pond Area	Sediment Accumulation in Pond Area	Fish and Aquatic Species Passage at Dam	Habitat	Ice Skating	Fishing at Mill Pond	Use of Warming House	View of Waterfall	**Level of Maintenance for Alternative**	**Total Present Worth Cost (2019 Dollars)[b]**
Existing Condition	0	50%	0	0	0	0	0	0	0	0	--	NA
Alternative 1: Sluice Gate Repair	0[c]	50%[c]	0	0	0	0	0	0	+	0	low	542,000[d]
Alternative 2A: Partial Pond Restoration	0[c]	50%[c]	+	0	0	+	+	+	+	0	high	5,351,000[d]
Alternative 2B: Partial Pond Restoration and Fill	0[c]	50%[c]	+	0	0	++	+	+	++	0	high	4,315,000[d]
Alternative 3: Full Pond Restoration	0[c]	50%[c]	+	0	0	++	+++	++	++	0	high	12,410,000[d]
Alternative 4: Bypass Channel, Dam Lowering, and Pond Restoration	+	1% - 0.2%	+	+	0	++	++	++	++	-	medium	10,331,000
Alternative 5A/5B: Dam Removal and Channel Restoration – Large Floodplain Habitat	++	N/A	+	++	+	++	-	++	++	NA	low	(5A) 11,926,000 (5B) 7,906,000
Alternative 5C: Dam Removal and Channel Restoration – Small Floodplain Habitat	++	N/A	+	++	+	++	-	++	++	NA	low	4,772,000
Basis for Evaluation	Increase in outlet capacity and removal of dam will reduce flooding impacts.	Flow event that can be conveyed within the spillway. A lower percent is a larger event with greater flow.	Increase in water depth, flow, and transport of sediment will improve water quality.	Only Alts 4 and 5 provide a way for sediment to move past the pond and dam area.	Elimination of structure in river will allow fish and aquatic species passage.	Increase in pond water depth, flow, and vegetation bench will create and improve habitat.	Increase in pond water depth and restored pond area will improve ice skating. Assumes Alt 5 does not include optional small ice skate area.	Increase in pond depth will improve fishing. Removal of dam will provide fishing opportunities for migratory species.	Demand would increase with level of restoration in Mill Pond area.	Lack of regular flow in Mill Pond for Alt 4 may eliminate waterfall effect at times.	Includes annually exercising the sluice gate, future dredging, dam inspections, and vegetation maintenance.	--

Note: N/A means not applicable.

[a] *Alternatives are rated relative to the potential changes from the existing condition which is designated neutrally as "0". Positive (+) or negative (-) signs indicate a more positive or negative effect, respectively, on the issue of concern as compared to the existing condition. Additional positive (+) or negative (-) values are relative to the other alternatives in each column.*

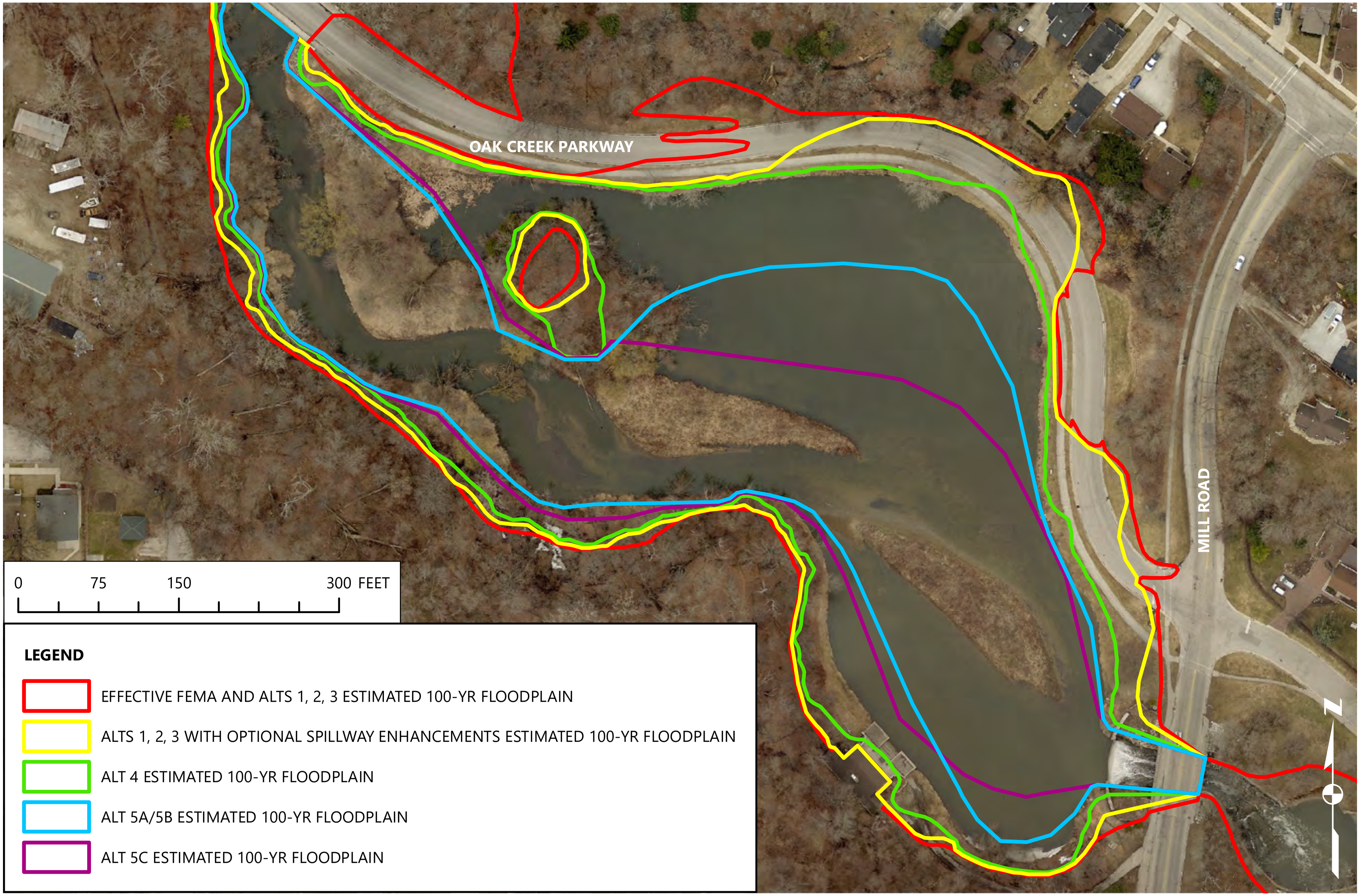
[b] *Costs based on an interest rate of 3.375% and a project life of 50 years.*

[c] *Adding the optional emergency spillway and abutment extension to these alternatives would improve flooding impacts. Adding the optional emergency spillway and abutment extension increases the total spillway capacity to the 2%-annual-probability event (50-year recurrence interval event). Adding either the emergency spillway or the abutment extension individually would increase the spillway capacity to about the 10%-annual-probability event (10-year recurrence event.)*

[d] *Costs do not include the optional emergency spillway or abutment extensions. An additional $736,000 would be added to these costs for these items.*

Source: SEWRPC

Figure 6.28
Floodplain Comparison by Alternative



Source: SEWRPC

only, would not improve water quality in the Mill Pond area. Alternatives 2 and 3 would improve water quality by increasing the depth of the Mill Pond. Alternative 4 would improve water quality in the Mill Pond by both increasing its depth and bypassing sediment past the pond area. The water quality improvement for Alternative 4 may be tempered by a reduction in dissolved oxygen due to less frequent baseflows to the pond area unless supplemental pumping is included. Alternative 5 would improve water quality by eliminating ponding and conveying Oak Creek flows downstream.

It was assumed that less sediment would accumulate in the Mill Pond under those alternatives that convey sediment past the Mill Pond dam area. Under Alternatives 1, 2, and 3, the Mill Pond will continue to accumulate sediment over time. Under Alternative 4, a large portion of sediment transported by Oak Creek would bypass the restored Mill Pond area, thus improving conditions in the Pond. Under Alternative 5, the majority of sediment would be conveyed past the pond area, which would also be an improvement for sediment conditions in the Mill Pond area.

Fish passage past the Mill Pond dam would only be improved under Alternative 5, in which the dam would be removed and the channel would be restored. As was discussed earlier in this section, it was determined that a fish passage channel would not be feasible for Alternatives 1, 2, 3, and 4 given the current constraints at the Mill Pond dam and Mill Road. Under Alternative 5, fish and aquatic species could move between Lake Michigan and the upper Oak Creek watershed, which would provide a variety of habitat and food sources and produce a healthier native fishery. However, this would also allow invasive aquatic species and viral hemorrhagic septicemia (VHS) to more easily travel upstream. VHS is a deadly infectious fish disease that occurs in the Lake Michigan fishery. Overall, the free movement of fish and aquatic species would be considered a positive for Alternative 5.

The criteria used to evaluate habitat improvements for the alternatives were based on whether implementing an alternative would increase habitat area available to aquatic species through increases in Mill Pond depth or flow and whether it would increase habitat area available to terrestrial species. Alternative 1 would not provide any habitat improvements over existing conditions. Alternatives 2A and 3 would improve habitat for fish and aquatic species by increasing water depth in the Mill Pond. Alternative 2B would also add vegetated benches in the original Mill Pond area, which would improve habitat for amphibians and terrestrial species. Alternative 4 would also improve habitat by increasing depths in the restored pond and creating a small area on the bypass channel berm for vegetation. Alternative 5 would improve flow conditions through the Mill Pond area significantly, increase the amount of terrestrial habitat, and improve the connections between that habitat and the restored Oak Creek channel. Alternatives 5A and 5B would also flood more frequently and may create a wetland area that could provide additional resting spots for fish and habitat for migratory birds.

Recreation

The Mill Pond and dam alternatives were evaluated based on their potential to improve recreational opportunities in the Mill Pond area. The main recreational opportunities evaluated included ice skating, fishing, use of the warming house, and viewing of the dam waterfall. As previously discussed, boating is prohibited on the ponds in the Milwaukee County Park System per Milwaukee County Code. The potential for adding walking paths to the alternatives was limited to a small additional walking path for Alternative 5 only, thus walking paths were excluded from the following evaluation.

Improvements in opportunities for ice skating were assessed by comparing the restored pond areas available for skating under each alternative. However, it should be noted that the potential for ice skating also depends on having freezing temperatures for a long enough duration to achieve safe ice thickness. Alternative 1 would not modify the Mill Pond, thus it would not improve skating opportunities. Alternatives 2, 3, and 4 would increase the area available for ice skating, with Alternative 3 providing the largest skating area. Alternative 5 would eliminate the Mill Pond, diminishing opportunities for ice skating. If the small optional ice skating area discussed above were implemented as part of Alternative 5, this would provide a smaller area for skating than the other alternatives.

The impact of the five planning level alternatives on fishing opportunities were evaluated based on potential changes to pond conditions and connectivity to Lake Michigan. Increases in water depth, water quality, pond area, and reconnection to Lake Michigan were considered to provide improvements in fishing opportunities.

Alternative 1 would not improve fishing conditions. Alternatives 2 and 3 would improve fishing conditions in the Mill Pond to varying degrees, depending on the size and depth of the restored pond. Alternative 4 may improve fishing conditions due to a deepened pond area, however dissolved oxygen levels in the pond may decrease due to intermittent flow in the pond. Flows into the restored pond could be increased by supplementing with City water. Alternative 5 would also improve fishing conditions in the Mill Pond area because flow conditions would improve with the restored channel, aquatic organisms would be able to move through the Mill Pond area and have access to both Lake Michigan and the upstream Oak Creek watershed.

Additional demand for use of the warming house was evaluated based on the level of improved water quality, habitat, and recreational conditions in the Mill Pond area. It was assumed improved conditions would translate to additional people using the area. Alternative 1 would not improve conditions at the Mill Pond area, thus there would not be additional demand for use of the warming house. Alternative 2 restored a portion of the Mill Pond area, which should slightly increase demand for use of the warming house. Alternatives 3, 4, and 5 improved the majority of the Mill Pond area, thus there should be a larger demand for use of the warming house.

The view of the waterfall would remain the same under Alternatives 1, 2, and 3, but it would be modified under Alternative 4. Because the bypass channel would convey the majority of Oak Creek baseflow, flows over the lowered dam under Alternative 4 may be intermittent during normal flows. This lack of flow over the dam could be mitigated by adding City water to the restored Alternative 4 pond.

Summary

Table 6.19 summarizes the evaluation of the Mill Pond and dam alternatives. It also includes a summary of the maintenance needs and planning level costs for each alternative.

Alternative 1 (sluice gate repair) would meet the requirements of the WDNR order for repairing the Mill Pond dam but would not improve conditions related to flooding, environmental concerns, or recreation as compared to existing conditions. Adding the optional emergency spillway and/or abutment extensions to Alternative 1 would reduce flooding impacts. Maintenance for Alternative 1 includes exercising the sluice gate, dam inspections, and periodic dredging, and the maintenance cost was low compared to the other alternatives. The total present worth planning level cost is $542,000 (2019 dollars) for Alternative 1. Including the optional emergency spillway and abutment extensions as part of Alternative 1 would add $736,000 (2019 dollars) to cost (see Table 6.19).

Alternative 2 (partial pond restoration) would include the sluice gate repair described in Alternative 1, thus it would also meet the requirements of the WDNR repair order for the Mill Pond dam. Alternative 2 would not improve flooding conditions as compared to existing conditions unless the optional emergency spillway and/or abutment extensions were added. Alternative 2A would improve environmental conditions and recreation to some degree with the smaller restored pond. Alternative 2B with the vegetated fill area would further improve environmental conditions. Maintenance for Alternative 2 includes exercising the sluice gate, dam inspections, vegetation maintenance (for Alternative 2B), and periodic dredging, and the maintenance cost was high compared to the other planning level alternatives. The total present worth planning level cost for Alternative 2A is $5,351,000 (2019 dollars) and for Alternative 2B is $4,315,000 (2019 dollars). Including the optional emergency spillway and abutment extensions would add $736,000 (2019 dollars) to the Alternative 2 costs (see Table 6.19).

Alternative 3 (full pond restoration) would include the sluice gate repair described in Alternative 1, thus it would also meet the requirements of the WDNR repair order for the Mill Pond dam. Alternative 3 would not improve flooding conditions as compared to existing conditions unless the optional emergency spillway and/or abutment extensions were included. Alternative 3 would improve environmental conditions and recreation within the larger restored pond. Maintenance for Alternative 3 includes exercising the sluice gate, dam inspections, and periodic dredging, and the maintenance cost was high compared to the other planning level alternatives. The total present worth planning level cost for Alternative 3 is $12,410,000 (2019 dollars). Including the optional emergency spillway and abutment extensions would add $736,000 (2019 dollars) to the Alternative 3 cost (see Table 6.19).

Alternative 4 (bypass channel, dam lowering, and pond restoration) would include the sluice gate repair described in Alternative 1, thus it would also meet the requirements of the WDNR repair order for the Mill Pond dam. Alternative 4 would reduce flooding conditions as compared to existing conditions. Alternative 4 would improve environmental conditions and recreation overall with the bypass channel and larger restored pond. Alternative 4 would have a negative impact on viewing of the waterfall. Maintenance for Alternative 4 includes exercising the sluice gate, dam inspections, vegetation maintenance, and periodic dredging, and the maintenance cost was medium compared to the other planning level alternatives. The total present worth planning level cost for Alternative 4 is $10,331,000 (2019 dollars) (see Table 6.19).

Alternative 5 (dam removal and channel restoration) would eliminate the need for the sluice gate repair. This alternative would meet the requirements of the WDNR repair order by removing the dam. Alternative 5 would considerably reduce flooding conditions as compared to existing conditions. Alternative 5 would improve environmental conditions and recreation overall with the restoration of the Oak Creek channel and floodplain. Alternative 5 would have a negative impact on the ability to ice skate in the former pond area, unless the optional small ice skating area is included. This also the only alternative that would restore fish passage between Lake Michigan and the Oak Creek watershed. Maintenance for Alternative 5 includes vegetation maintenance only, and the cost was low compared to the other planning level alternatives. The total present worth planning level costs for Alternative 5A is $11,926,000 (2019 dollars), Alternative 5B is $7,906,000 (2019 dollars), and Alternative 5C is $4,772,000 (2019 dollars) (see Table 6.19).

Recommended Actions

The alternatives for the Mill Pond and dam presented in this plan are planning-level conceptual alternatives. As summarized above, the planning level alternatives would improve conditions at the Mill Pond and dam to varying degrees for a wide range of costs. The decision regarding improvements to the Mill Pond and dam area ultimately rests with Milwaukee County as owner of the dam. An alternative or components of an alternative described in this plan will need to be refined based on environmental concerns, local input, maintenance requirements, and cost considerations. As part of this planning effort, one action is recommended and two other potential actions are offered in order to move closer to a preferred alternative for the Mill Pond and dam.

1. Sediment Core Sampling – **It is recommended that the County complete sediment core sampling and analysis for up to five locations in the project area at a planning level cost of $49,000 (2019 dollars).** This work will determine the level of sediment contamination and dredged material disposal options, both of which will impact the cost and feasibility of the Mill Pond and dam alternatives presented in this plan.

2. Sediment Transport Analysis – The County should consider completing a sediment transport analysis as part of refining the alternatives for the Mill Pond area. This analysis would provide a better estimate of the amount of sediment being delivered to the area by Oak Creek, which would help clarify the frequency of maintenance dredging that would be required for Alternatives 1 through 4. The complexity of this analysis could range from a simple land-use based model to detailed sediment measurements. A basic modeling effort would include a literature review of the amount of bedload and sediment delivered by similar current land uses and streams, and subsequent completion of a model such as a Unit Area Load model for the Oak Creek watershed. Field measurement efforts could include mapping the sediment accumulation in the Mill Pond over a longer period of time (years), or actual sampling of sediment in Oak Creek upstream of the pond for at least a year. It is estimated that the cost to complete a sediment transport analysis would range from $10,000 to $75,000 (2019 dollars).

3. Sluice Gate Repair – If it is determined in the future that Alternative 5 (dam removal and channel restoration) should not be pursued, repairs to the sluice gate could be completed prior to selecting a preferred alternative as this would be necessary for any modification that does not fully remove the dam. The total present worth cost for Alternative 1 for the sluice gate repair was $542,000 (2019 dollars).

   It should be noted that as the Oak Creek watershed continues to urbanize and add impervious area, sediment delivery and water quality to the Mill Pond area will continue to be an issue unless the recommended projects listed in previous sections of this plan are also implemented.

6.7 RECOMMENDED ACTIONS FOR PUBLIC AWARENESS AND PARTICIPATION IN WATERSHED RESTORATION ACTIVITIES

The Oak Creek Watershed Restoration Plan includes an information and education (I&E) element designed to enhance the understanding of the watershed plan recommendations and the measures to achieve its goals and objectives, and to increase public awareness and participation in watershed management activities. The I&E element is designed to encourage the public's early and continued participation in selecting, designing, and executing the nonpoint source management measures that will be implemented.

Civic Engagement

Civic engagement is essential to implementing watershed plans. Technical advisors and funding agencies are key to successfully completing watershed projects, but having an engaged core of committed municipalities, citizens, business leaders, grassroots organizations, and local agencies is paramount. When the entire group is willing and able to understand each other's goals and are committed to working together, implementation plans lead to successful on-the-ground projects. Stakeholders who are affected by the watershed plan, who can provide information on the issues in the watershed, and who work to implement existing programs or plans that incorporate similar goals should actively participate.

Efforts to educate, inform, and engage Oak Creek watershed stakeholders about the watershed restoration planning process have been accomplished through the convening of stakeholder and community meetings. Stakeholder input has been a key factor in developing plan objectives and refining priority projects and programs. Community input about issues of concern is reflected in the results of an online survey that was distributed early in the outreach effort. Community meetings have also provided a means to identify problems and potential solutions, share progress on the development of the restoration plan, and receive input from the public. The questionnaire results established that the Mill Pond dam, water quality, and habitat conditions were major concerns regarding the watershed. The responses indicated that the presence of invasive species, the die off of trees in the stream corridor, sediment accumulation in stream channels and the Mill Pond, and the poor quality of the fishery were specific issues of concern.

The following stakeholders were identified during the information and education process:

- Businesses
- Cities of Cudahy, Franklin, Greenfield, Milwaukee, Oak Creek, and South Milwaukee
- Friends of Grant Park
- Friends of the Mill Pond
- Landowners
- Milwaukee County
- Milwaukee Metropolitan Sewerage District
- Residents
- Restore the Lagoon
- Root-Pike Watershed Initiative Network (Root-Pike WIN)
- Southeastern Wisconsin Regional Planning Commission
- Southeastern Wisconsin Watersheds Trust (Sweet Water)
- Trout Unlimited

- Universities and Colleges
- U.S. Environmental Protection Agency
- Wisconsin Department of Natural Resources

Driving Forces

Stakeholders within the Oak Creek watershed have worked together at varying scales to improve conditions for many decades. In the early 1980s, the Commission developed a comprehensive plan for the watershed at the request of MMSD and the City of South Milwaukee.[183] This plan addressed flooding and stormwater drainage, water quality, changing land use as it related to flooding and water quality, and the deterioration of the natural resource base, particularly the loss of important natural areas and wildlife habitat. Aspects of this plan related to flooding were subsequently updated in several planning efforts conducted for MMSD.[184]

More recently, interest in improving conditions in coastal watersheds of Southeastern Wisconsin led to the formation of two organizations: Root-Pike WIN in 1998 and Sweet Water in 2010. The mission of Root-Pike WIN is to restore, protect, and sustain the Root-Pike basin watersheds, including the Oak Creek watershed, through the funding and facilitation of a regional network of locally initiated projects. Sweet Water's mission is to restore the greater Milwaukee watersheds, including Oak Creek, to conditions that are healthy for swimming and fishing through bringing diverse partners together and providing leadership and innovation. These two groups have collaborated with each other and with municipalities and counties within Southeastern Wisconsin to develop the Respect Our Waters campaign, a regional information and education effort to fulfill the public education requirements of municipal stormwater discharge permits.

The Milwaukee County Parks has been actively developing and implementing ecological restoration and management plans for county-owned natural areas within the watershed. Implementation of these plans and other natural area management activities has involved numerous partner organizations including park friends' groups, local universities and colleges, neighborhood associations, nature centers, and scouting groups.

In 2014, the USEPA directed that the majority of funds available through Section 319 of the Clean Water Act for nonpoint source pollution abatement projects are to be used in watersheds covered by watershed plans that have been found to be consistent with the nine key elements that the USEPA has identified as being critical for achieving improvements in water quality.[185] Since Oak Creek has been designated as impaired due to high concentrations of phosphorus and chloride and the North Branch of Oak Creek and Mitchell Field Drainage Ditch have been designated as impaired due to high concentrations of chloride, it is necessary to establish and implement a plan to meet the USEPA goal indicated in Section 101(a)(2) of the Clean Water Act: "water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water, wherever attainable." As a result, this watershed restoration plan has been designed to be consistent with USEPA's nine key elements.

Goal and Objectives

The goal of the I&E element of the Oak Creek watershed restoration plan is to provide information that local decision makers, landowners, and watershed residents can use to protect, restore, and improve the natural resources of the Oak Creek watershed. More specifically, this goal is to promote active stewardship among residents, landowners, businesses, community associations, and governmental and non-governmental organizations.

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[183] *SEWRPC Planning Report No. 36,* A Comprehensive Plan for the Oak Creek Watershed, August 1986.

[184] *Camp Dresser & McKee,* Oak Creek Phase 1 Watercourse System Management Plan, *prepared for the Milwaukee Metropolitan Sewerage District, August 2000; SEWRPC Memorandum No. 198,* Oak Creek Updated Phase 1 Watercourse System Management Plan, *December 2011, Revised May 2019 (draft); Short Elliot Hendrickson, Inc.,* Oak Creek Watershed Conceptual Floodproofing Designs, *Technical Memorandum to the Milwaukee Metropolitan Sewerage District, June 22, 2018.*

[185] *U.S. Environmental Protection Agency,* Handbook for Developing Watershed Plans to Restore and Protect Our Waters, *EPA 841-B-08-002, March 2008.*

The objectives of the I&E element are to:

- Make elected officials; county, municipal, and agency staffs; landowners; businesses; nongovernmental organizations; and the general public aware of the plan and its recommendations

- Encourage Milwaukee County and the municipalities in the watershed to adopt the plan and amend their relevant plans, ordinances, and municipal codes to recognize plan recommendations

- Educate the general public regarding conditions in the watershed and threats to water quality, habitat, biota, and recreation

- Inform staffs of relevant organizations including Milwaukee County, municipalities, public agencies, and nongovernmental organizations about specific plan recommendations that they are able to implement and to encourage them to include these recommendations in their activities and in proposals for funding and assistance

- Provide information on technical and funding assistance to County and municipal staffs, nongovernmental organizations, riparian landowners, and other organizations that have the capabilities to implement recommendations of this plan

- Provide information to homeowner and business associations on how to maintain their stormwater management practices

- Provide information and education to landowners and businesses about the impacts and management of nutrients, fertilizers, and pesticides to the watershed and measures that they can take to reduce the impacts and to encourage them to adopt the recommended management actions

- Provide information regarding plan recommendations to developers, contractors, engineers, and landscapers and to encourage them to adopt the recommended management activities and include them in their activities and proposals

- Provide information and education to County and municipal staffs, private applicators, businesses, property managers, and homeowners regarding application of chemical deicers to roads, driveways, parking lots, and sidewalks

- Measure information and education activities and outcomes

- Evaluate the effectiveness of the information and education element of the plan

Other Watershed Initiatives

Several other active initiatives provide public information and education and opportunities for public participation in watershed management in the Oak Creek watershed. These are mostly regional programs that address larger areas that contain the watershed. Because their activities encompass the Oak Creek watershed, they should be considered part of the I&E element of this plan.

Since 2012, Root-Pike WIN, Sweet Water, and several counties and municipalities in Southeastern Wisconsin have sponsored the Respect Our Waters campaign. This program is a joint effort to fulfill the public information and education requirements of the counties' and municipalities' MS4 discharge permits. This campaign has included broadcasting public service announcements on radio and television, giving interviews to media outlets, hosting and attending community events, and providing educational content on participating organizations' websites. Both Root-Pike WIN and Sweet Water have expressed interest in targeting the messaging in this campaign more finely through the use of social media and direct mail.

Sweet Water sponsors the annual Clean Rivers, Clean Lake conference. At this meeting, participants from nonprofit organizations, governmental units, businesses, academic organizations, and the general public discuss challenges facing the greater Milwaukee watersheds including the Oak Creek watershed, their impact upon Lake Michigan, and strategies to improve conditions in the watersheds and the Lake.

Sweet Water also sponsors the Adopt-Your-Drain program. Through this program, volunteers adopt a local storm drain. At least twice a month, the volunteers remove debris from the surface and vicinity of the drain and properly dispose of it. Depending on the type of debris removed, disposal may occur through composting, recycling, or placement in the trash. Volunteers are asked to track and report their progress, including the amount of time spent removing debris and the types and weight of debris removed.

MMSD sponsors the Fresh Coast Guardians Resource Center to support implementation of its green infrastructure plan. Through live events, webinars, and its website, the center provides information on green infrastructure to residents, municipalities, businesses, nonprofit organizations, developers, and contractors. This information includes discussions on the benefits of green infrastructure, guides to installing green infrastructure, and notices of funding opportunities to pay for green infrastructure installation. The website also has a link to a tool for selecting plants for green infrastructure projects and a list of vendors providing green infrastructure projects, products, and services. Property owners can also contact staff at the Center to obtain access to and instructions on how to use a tool for sizing green infrastructure projects.

Plastic-Free MKE is a collaborative of non-profit organizations, government agencies, and businesses working to reduce the use of single-use plastic items in order to reduce the amount of plastic entering local waterways. Their educational efforts provide information on plastic pollution and what can be done to address it through a number of communication vehicles including webinars, social media campaigns, and their website. They also ask individuals and businesses to pledge to take specific efforts to reduce their use of single-use plastics.

While Milwaukee Riverkeeper's main area of interest does not include the Oak Creek watershed, some of its programs provide information and education to the watershed. Milwaukee Riverkeeper sponsors annual workshops on snow and ice control practices, with separate workshops focusing on municipal practices for winter management of roads and parking lots, and practices by private applicators for winter management of parking lots and driveways. Milwaukee Riverkeeper's website also provides resources to support volunteer water quality monitoring. Riverkeeper also provides field and classroom programs for local schools.

Engagement Strategies

Specific measures recommended as part of the information and education element of this plan are summarized in Table 6.20.

Copies of the watershed plan are being provided to public officials in the civil divisions within the watershed as shown on Map 3.3 in Chapter 3 of this report. Individual meetings and presentations about the plan will be scheduled with public decision-making bodies at the request the County and municipalities, and adoption of the plan will be requested from each civil division in the watershed.

Additional targeted audiences include private landowners; commercial stakeholders including businesses, developers, engineers, and landscapers; professionals involved in nutrient, chemical, and snow and ice management; nature centers, service clubs, and potential grant recipients; the general public; and the media.

Integration of Potential Future Efforts in the Information and Education Element

There are several potential information and education efforts that should be considered for incorporation into the information and education element of the Oak Creek watershed plan when they come to fruition. Integrating them could enhance public knowledge of and involvement in watershed restoration efforts.

Recently reissued MS4 discharge permits have included additional public education and outreach requirements among the conditions set forth in the permits. For group permits some of these conditions apply to all of the municipalities covered. Examples of these permit conditions include requirements that each municipality:

- Evaluate its stormwater education needs and develop a prioritized list of those needs
- Complete targeted outreach and education within its MS4 boundary for at least one identified need
- Develop metrics to measure progress after the targeted education project has been completed

Table 6.20
Information and Education (I&E) Element Matrix for the Oak Creek Watershed Restoration Plan

Education Action[a]	Target Audience	Communication Vehicles	Schedule	Lead (Supporting) Organizations	Outcomes, Implementation Goals, Behavior Changes	Estimated Cost
(A) Educate elected officials about the completed plan and encourage them to: 1. Adopt the plan 2. Amend municipal, codes, ordinances, and comprehensive plans to recognize recommendations in the plan	Elected officials	Distribute copies of the plan and the brochure summarizing the plan Schedule meetings and presentations on the plan and its recommendations as requested Include elected officials in presentations on stormwater best management practices	Late 2021-2023	Milwaukee County, watershed municipalities, RPW, SWWT, (SEWRPC), (WDNR), (MMSD)	5 meetings, presentations, and workshops between late 2021 and mid-2022 Knowledge of the components and recommendations in the plan Adoption of plan by the County and municipalities by 2022 Revisions to municipal codes and ordnances	I&E to elected officials and municipal staffs $10,000 (200 hours) Printed copies of plan and brochure $1,000
(B) Provide the watershed plan to the general public and news media, inform and educate them about water pollution; the hazards of and management of yard debris, pet waste, fertilizers, and yard chemicals as they relate to stormwater runoff and groundwater contamination; green infrastructure such as rain barrels and rain gardens; nonnative and invasive species; and recreational opportunities in the watershed Encourage the public to include appropriate plan recommendations in their activities and to request assistance	General public News media	Publish and distribute a brochure summarizing the plan Make copies of the plan, summary brochure and related materials available on the SEWRPC website Post links to the plan and related materials on the Root-Pike WIN, SWWT, WDNR, municipal and other websites Announce the plan and activities related to plan implementation through municipal, SEWRPC, Root-Pike WIN, and SWWT websites, social media, newsletters, and multimedia. Update the websites on an ongoing basis Issue news releases announcing the plan, its recommendations, and implementation activities Provide media interviews, photo opportunities and tours Maintain and expand the Respect Our Waters multimedia and community outreach campaign Maintain Fresh Coast Resource Center and website	Fall 2021 and at intervals marking implementation progress, major initiatives, photo opportunities, events, and other newsworthy developments Beginning 2021 and continuing through 2031, present periodically at the Clean Rivers, Clean Lake conference Beginning 2022 and continuing through 2031, workshops addressing topics related to action items B through I	Watershed municipalities, MMSD, RPW, SWWT, (Milwaukee County), (SEWRPC), (SEWISC)	Ten news releases issued between fall 2021 and 2031 Ten news stories aired between fall 2021 and 2031 200 brochures distributed by email or downloaded between fall 2021 and 2027 16 presentations and workshops from 2022 through 2031	Cost includes items B through I, which would be accomplished through a coordinated, multi-purpose program which would include the communication vehicles for each of those action items, and which share outcomes, except where additional outcomes are noted for an action item Staff activities $25,000 (500 hours)

Table continued on next page.

Table 6.20 (Continued)

Education Action[a]	Target Audience	Communication Vehicles	Schedule	Lead (Supporting) Organizations	Outcomes, Implementation Goals, Behavior Changes	Estimated Cost
(C) Provide information on technical assistance and funding assistance to nongovernmental organizations that have the capabilities to implement expanded water quality monitoring, restoration, and other recommended management actions. Encourage them to: 1. Include the recommendations in their activities and proposals for funding and assistance 2. Coordinate their monitoring programs with existing MMSD, WDNR, and USGS programs	Nongovernmental organizations	Distribute letters, copies of the plan, and plan summary brochure Schedule meetings and tours on the plan and its recommendations Publish and distribute online and print materials on the plan on an ongoing basis	Fall 2021 through 2031	UWEX, WDNR, (RPW), (SWWT), (SEWRPC), (SEWISC), (WCBMN)	Shared outcomes listed under Action B above[a] Eight monitoring locations added Knowledge of components and recommendations of the plan	Included in Action B above
(D) Provide information and education to private landowners and businesses, including property, lawn maintenance, and golf course managers, about the watershed plan; impact and management of lawn chemicals; benefits of buffers and long-rooted native vegetation; green infrastructure; and technical and funding assistance. Encourage them to adopt the recommended management actions	Private landowners Businesses Property managers	Publish and distribute online and print material related to these topics Provide demonstration sites Provide presentations, workshops, and tours	Fall 2021 through 2031	Watershed municipalities, RPW, SWWT, (MMSD), (Milwaukee County), (SEWRPC), (WDNR)	Shared outcomes listed under Action B above[a] 15 projects initiated Knowledge of components and recommendations of the plan	Included in Action B above
(E) Provide information regarding plan recommendations to developers, engineers, and landscapers. Encourage them to adopt the recommended management actions and include them in their proposals	Developers Engineers Landscapers	Publish and distribute online and print material related to these topics Provide demonstration sites Provide presentations, workshops, and tours	Fall 2021 through 2031	Watershed municipalities, RPW, SWWT, (MMSD), (Milwaukee County), (SEWRPC), (WDNR)	Shared outcomes listed under Action B above[a] Knowledge of components and recommendations of the plan	Included in Action B above
(F) Provide information on technical and funding assistance for riparian buffers and stream rehabilitation to County and municipal staffs, riparian property owners, and landscapers. Encourage them to adopt the recommended management actions and include them in their activities and proposals	County and municipal staffs Riparian property owners Landscapers	Publish and distribute online and print material related to these topics Provide demonstration sites Provide presentations, workshops, and tours Distribute SEWRPC "Managing the Water's Edge" riparian buffer brochure	Fall 2021 through 2031	Milwaukee County Environmental Services, watershed municipalities RPW, SWWT, (MMSD), (SEWRPC), (WDNR)	Shared outcomes listed under Action B above[a] Knowledge of components and recommendations of the plan One demonstration site	Included in Action B above
(G) Provide homeowner, condominium, and business associations with the knowledge needed to properly maintain their stormwater management practices	Homeowner associations Condominium associations Business associations	Publish and distribute online and print material related to these topics Provide demonstration sites Provide presentations, workshops, and tours	Fall 2021 through 2031	Watershed municipalities, RPW, SWWT, (MMSD), (Milwaukee County), (WDNR)	Shared outcomes listed under Action B above[a] Knowledge of components and recommendations of the plan One demonstration site	Included in Action B above
(H) Provide information to the general public regarding trails and other recreational opportunities in the Oak Creek watershed.	General Public	Maintain website showing park and trail maps and other recreational information	Fall 2021 through 2031	Milwaukee County Parks, (watershed municipalities)	Shared outcomes listed under Action B above[a]	Included in Action B above

Table continued on next page.

Table 6.20 (Continued)

Education Action[a]	Target Audience	Communication Vehicles	Schedule	Lead (Supporting) Organizations	Outcomes, Implementation Goals, Behavior Changes	Estimated Cost
(I) Provide information and education assistance to County and municipal staffs and potential grant recipients regarding educational signs, kiosks, and multimedia	County and municipal staffs Potential grant recipients	Provide presentations, workshops, tours Provide technical assistance and information about financial assistance	Fall 2021 through 2031	RPW, SWWT, (SEWRPC), (WDNR)	Shared outcomes listed under Action B above[a] Seven projects initiated	Included in Action B above
(J) Provide information and education to County and municipal staffs, private applicators, businesses, and homeowners regarding the application of chemical deicers to roads, parking lots, driveways, and sidewalks	County and municipal staffs Private applicators Businesses Homeowners	Provide presentations and workshops Publish online and print materials	2022 through 2031	Milwaukee Riverkeeper, Wisconsin Salt Wise, (MMSD), (WDNR), (RPW), (SWWT), (watershed municipalities)	20 presentations and workshops[b]	$50,000[b]
(K) Measure information and education activities and outcomes	--	Stakeholders report information about their information and education activities Survey of households to collect information on residents' knowledge of watersheds, water quality, yard care impacts, and other issues.	2022 through 2031	RPW, SWWT, Milwaukee County Environmental Services	Conduct survey in 2027	$20,000
(L) Evaluate and adjust information and education element	--	Evaluation conducted at annual meeting of Oak Creek watershed plan advisory committee	Annually, 2022 through 2031	Milwaukee County Environmental Services, Oak Creek watershed advisory committee, (SEWRPC)	Make necessary adjustments to information and education element to achieve its goals	--

Note: Acronyms indicate the following:

MMSD = Milwaukee Metropolitan Sewerage District
RPW = Root-Pike Watershed Initiative Network
SEWRPC = Southeastern Wisconsin Regional Planning Commission
SEWISC = Southeastern Wisconsin Invasive Species Consortium
SWWT =Southeastern Wisconsin Watersheds Trust, Inc.
UWEX = University of Wisconsin-Madison Division of Extension
WCBMN = Wisconsin Citizen Based Monitoring Network
WDNR = Wisconsin Department of Natural Resources

[a] *The information and education program components described under the "Outcomes" section of Action B would be designed to reach multiple project stakeholders and plan implementation organizations. Thus, presentations, workshops, and educational materials would be designed to meet the interests of the general public, as well as the targeted entities identified under Actions B through I.*

[b] *Programs are available, and costs apply to multiple watersheds in the greater Milwaukee watersheds.*

Source: SEWRPC

The recently reissued MS4 permits also include conditions specific to individual municipalities. Examples of these types of conditions from the recently reissued Menomonee River Watershed-Based MS4 permit include that one or more municipality:

- Update the stormwater management page on its website
- Coordinate its education and outreach with planned IDDE screening efforts to supply education to residents and businesses in areas tributary to screening locations

It is anticipated that as additional MS4 permits are reissued for municipalities in the Oak Creek watershed, similar permit conditions will apply to these communities.

As part of the Respect Our Waters campaign, Root-Pike WIN is beginning to develop specific messaging targeted to individual subwatersheds. Root-Pike WIN is also placing greater emphasis on the use of social media for the delivery of this messaging.

Sweet Water is beginning to develop a library of high-quality, unbranded education and outreach materials that will be available to local communities and other groups for use in public education efforts. It is hoped that the availability of this library will encourage consistent messaging among public education campaigns.

As these various efforts reach completion, they should be considered for inclusion in the information and education element of this watershed restoration plan.

Renaming of the Mitchell Field Drainage Ditch

The official name of the Mitchell Field Drainage Ditch in State of Wisconsin records is Unnamed Tributary to Oak Creek. This stream is known locally as the Mitchell Field Drainage Ditch. This is an unfortunate name as drainage ditch carries a negative connotation that may lead the public to underestimate its value as a natural resource. Such an underestimation of its value could act to reduce support for projects seeking to restore this creek.

It is recommended that Milwaukee County submit a proposal to the Wisconsin Geographic Names Council to officially name the Mitchell Field Drainage Ditch "Mitchell Creek." This name would be consistent with policies of the U.S Board on Geographic Names that local usage be followed wherever possible and that names include only a single name followed by the generic feature name.

A proposal to rename this stream should be submitted to the Wisconsin Geographic Names Council through the WDNR.[186] The proposal would consist of completion of a standard form and submission of supporting information.

Renaming this stream would create a better connotation for it and raise public awareness of its value as a natural resource. It would be a positive step in promoting restoration of this stream and its surrounding habitat.

6.8 PRIORITY PROJECTS FOR IMPLEMENTATION

As previously described, Table 6.1 identifies specific projects that could be undertaken as part of implementing the general recommendations given in this chapter. Completion of these projects would produce improvements relative to the four focus areas of this watershed restoration plan. This list of projects was assembled from several sources including plans, engineering reports, and surveys developed for local governments; discussions with staff from State agencies, county and municipal departments, MMSD, and interested nongovernmental organizations; findings of an instream survey conducted by SEWRPC staff; and suggestions from members of the public. Because of the large number of projects listed in Table 6.1, it would be useful to identify a smaller number of high-priority projects that could be implemented early in the plan implementation period that would provide substantial benefits relative to the focus areas of the plan. This section identifies those high-priority projects.

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[186] *This can be done through the WDNR website at dnr.wi.gov/lakes/gnc.*

Because a large number and many different types of projects are listed in Table 6.1, projects were grouped into several classes of similar projects and prioritized within each class. While some projects could potentially be classified as more than one type, each project was assigned to only one class for the purpose of prioritization. Because of the differences among the types of projects, different criteria were used to prioritize each class of project. Where estimates of costs and benefits were available, the prioritization generally gave more weight to projects that could be expected to result in high levels of benefits at a relatively low cost. The projects were assigned a relative priority of high, medium, or low. Table 6.1 shows this priority for each project.

Within this prioritization framework, other opportunities may arise that should be acted upon. For example, even though it is a general principle of the strategy suggested for fish passage projects that activities progress from downstream to upstream, completing an action in a headwaters area or on a tributary stream should not be passed up or ignored simply because it does not conform to the downstream-to-upstream strategy. Rather, all opportunities should be acted upon as they become available. However, where multiple opportunities exist, and where limited funds are available, this prioritization is intended to assist decision-makers in allocating resources where they would be most appropriate and effective in achieving the goals of this watershed restoration plan. In addition, since this prioritization was conducted on a watershed level and not on a community, implementation organization, or assessment area level, some implementation organizations may find opportunities to implement medium or low priority projects relatively early during plan implementation.

High-priority projects for implementation are listed in the following tables. The prioritization criteria for each project class are noted under each table.

- Table 6.15 lists high-priority streambank stabilization projects
- Table 6.21 lists high-priority riparian buffer expansion projects
- Table 6.22 lists high-priority stream channel restoration projects
- Table 6.23 lists high-priority projects for management of the Mill Pond dam and Mill Pond area
- Table 6.24 lists high-priority debris jam modification and removal projects
- Table 6.25 lists high-priority stormwater drainage and flood relief projects
- Table 6.26 lists high-priority floodplain reconnection projects
- Table 6.27 lists high-priority illicit discharge detection and elimination projects
- Table 6.28 lists high-priority land restoration projects
- Table 6.29 lists high-priority outfall repair and replacement projects
- Table 6.30 lists high priority projects to address passage barriers to aquatic organisms
- Table 6.31 lists high-priority stormwater treatment projects
- Table 6.32 lists high-priority projects that do not fall into any of the above groups

Map 6.36 shows the locations of the high priority projects listed in Tables 6.15 and 6.21 through 6.32. These locations define critical areas in the watershed that need to be addressed in order to achieve the goals and objectives of this plan.

Table 6.21
High Priority Riparian Buffer Projects for the Oak Creek Watershed Restoration Plan[a,b]

ID Number (see Maps 6.1 – 6.13)	Location	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)[c]	Key Project Partners
MOC-23	Milwaukee County Parks Oak Creek Parkway Management Section 8	Shallow wetland design and installation of five acres; reforestation of 65.9 acres; rapid response invasive species management of 42.5 acres; floristic survey and wildlife inventory of 70.9 acres; survey and posting of property line	Habitat, Water Quality	Estimated annual pollutant load reductions of 107,400 pounds TSS, 40.1 pounds total phosphorus	478,500	Milwaukee County
MOC-31	Milwaukee County Parks Oak Creek Parkway Management Section 10	Rapid response invasive species management of 68.2 acres; forest stand improvement including supplemental canopy and understory planting of 7.3 acres; grassland management of 14 acres; grassland restoration of 19.7 acres; floristic survey and wildlife inventory of 65.3 acres	Habitat, Water Quality	Estimated annual pollutant load reductions of 40,180 pounds TSS, 7.3 pounds total phosphorus	331,700	Milwaukee County
MDD-01	Milwaukee County Parks Oak Creek Parkway Management Section 9	Reforestation of 35.2 acres; rapid response invasive species management of 92.4 acres; forest stand improvement including supplemental canopy and understory planting of 27.8 acres; floristic surveys and wildlife inventory of 120.6 acres; survey and posting of property lines	Habitat, Water Quality	Estimated annual pollutant load reductions of 98,810 pounds TSS, 7.3 pounds total phosphorus	492,700	Milwaukee County
UOC-04	Milwaukee County Parks Oak Creek Parkway Management Section 12	Rapid response invasive species management on 179.7 acres; forest stand improvement including supplemental canopy and understory planting of 65.4 acres; grassland management of 4 acres; grassland restoration of 3 acres; reforestation of 53.8 acres; floristic surveys and wildlife inventories of 200.6 acres; survey and posting of property lines	Habitat, Water Quality	Estimated annual pollutant load reductions of 50,970 pounds TSS, 27.4 pounds total phosphorus	899,700	Milwaukee County

Table continued on next page.

Table 6.21 (Continued)

ID Number (see Maps 6.1 – 6.13)	Location	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)[c]	Key Project Partners
DAT-10	Milwaukee County Parks Barloga Woods Management Unit Number 6	Invasive species control; invasive species monitoring and select control; reforestation of 18 acres; wildlife monitoring	Habitat, Water Quality	Estimated annual pollutant load reductions of 32,040 pounds TSS, 12.0 pounds total phosphorus	61,700	Milwaukee County

[a] *Table 6.1 provides more details on the priority projects.*

[b] *Prioritization based on size of buffer created and total load reductions of total suspended solids (TSS) and total phosphorus.*

[c] *Costs are given in 2019 dollars.*

Source: SEWRPC

Table 6.22
High Priority Stream Channel Restoration Projects for the Oak Creek Watershed Restoration Plan[a,b]

ID Number (see Maps 6.1 – 6.13)	Location	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)[c]	Key Project Partners
MOC-61	S. Howell Avenue bridge crossing of Oak Creek	Explore opportunities to improve fish passage under the bridge by improving water depths	Habitat	Improved quality of the fishery, increased connectivity	--[d]	Milwaukee County
RAT-01	Bridge crossing of Rawson Avenue Tributary at 7600 S. 6th Street	As part of bridge replacement, consider removing concrete from adjacent stream channel	Habitat, Stormwater and Flooding	Improved habitat, restore connection with groundwater	400,000	City of Oak Creek

[a] *Table 6.1 provides more details on the priority projects.*

[b] *Prioritization based on severity of passage impediment and potential to increase connectivity.*

[c] *Costs are given in 2019 dollars.*

[d] *Cost to be assigned during project development.*

Source: SEWRPC

Table 6.23
High Priority Mill Pond and Dam Projects for the Oak Creek Watershed Restoration Plan[a,b]

ID Number (see Maps 6.1 – 6.13)	Location	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)[c]	Key Project Partners
LMP-01	Oak Creek Mill Pond	Repair Oak Creek Mill Pond Sluice Gate if it is determined not to pursue dam removal	Stormwater and Flooding, Water Quality	Allows operation of sluice gate, lowering of pond water levels, and some sediment passage through Mill Pond	343,000	Milwaukee County
LMP-04	Oak Creek Mill Pond and vicinity	Conduct sediment core sampling and chemical analysis in the Mill Pond Project area	Water Quality	Allows determination of level of contamination of pond sediments and options for sediment removal	49,000	Milwaukee County

[a] *Table 6.1 provides more details on the priority projects.*

[b] *Prioritization based on steps necessary to comply with repair order issued by the Wisconsin Department of Natural Resources and to refine alternatives for Mill Pond and dam.*

[c] *Costs are given in 2019 dollars.*

Source: SEWRPC

Table 6.24
High Priority Debris Jam Modification Projects for the Oak Creek Watershed Restoration Plan[a,b]

ID Number (see Maps 6.1 – 6.13)	Location	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)	Key Project Partners
LMP-09	Oak Creek upstream of Mill Pond between the third and fourth Parkway crossing	Remove debris jam and sediment accumulations from main channel of Oak Creek and elevate channel invert of newly formed channel that is in close proximity to the Parkway road[c]	Habitat	Removes passage impediment, increases connectivity within Oak Creek; eliminates threat to Parkway road	--[d]	Milwaukee County
LMP-16	Oak Creek in Oak Creek Parkway north of Cherry Street (extended)	Remove or modify large woody debris jam	Habitat	Removes passage impediment, increases connectivity within Oak Creek	--[d]	Milwaukee County
LMP-18	Oak Creek in Oak Creek Parkway upstream of Chicago Avenue and south of Walnut Street (extended)	Remove or modify large woody debris jam	Habitat	Removes passage impediment, increases connectivity within Oak Creek	--[d]	Milwaukee County and City of South Milwaukee
LOC-29	Oak Creek about 630 feet downstream of S. Pennsylvania Avenue	Remove or modify large woody debris jam	Habitat	Removes passage impediment, increases connectivity within Oak Creek	--[d]	Milwaukee County and City of South Milwaukee
LOC-37	Oak Creek about 520 feet upstream from S. Pennsylvania Avenue	Remove or modify large woody debris jam	Habitat	Removes passage impediment, increases connectivity within Oak Creek	--[d]	Milwaukee County, City of Oak Creek, and MMSD[e]
LOC-48	Oak Creek about 650 feet downstream of the confluence with the Mitchell Field Drainage Ditch	Remove or modify large woody debris jam	Habitat	Removes passage impediment, increases connectivity within Oak Creek	--[d]	Milwaukee County, City of Oak Creek, and MMSD[e]

[a] *Table 6.1 provides more details on the priority projects.*

[b] *Prioritization based on severity of passage impediment and potential to increase connectivity.*

[c] *Implementation of this project would also result in implementation of projects LMP-05, LMP-06, and LMP-07.*

[d] *Cost to be assigned during project development.*

[e] *MMSD's involvement in projects to remove or modify large woody debris jams will be consistent with their Watercourse Flood Risk Reduction Policy that is focused on flood risk reduction from the regional flood (1-percent-annual-probability (100-year recurrence interval) flood). Specifically, MMSD will only remove debris if it is determined the debris will raise the water surface elevation during the regional flood to a level that either adds a structure to the regional floodplain or that increases the regional flood elevation by one tenth of a foot or more at a structure already within the regional floodplain.*

Source: SEWRPC

Table 6.25
High Priority Flood Relief Projects for the Oak Creek Watershed Restoration Plan[a,b]

ID Number (see Maps 6.1 – 6.13)	Location	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)[c]	Key Project Partners
GPR-04	Sanitary lift station near downstream-most crossing of the Oak Creek Parkway	Complete construction of designed lift station	Stormwater and Flooding	Protection of infrastructure, flood relief	4,800,000	City of South Milwaukee
LMP-41	College Avenue-Union Pacific Railroad underpass	Addition of 10 large capacity stormwater inlets to improve stormwater drainage	Stormwater and Flooding	Reduction of stormwater-related flooding	115,000	City of Cudahy

Note: Prioritization based on shovel-ready nature of projects.

[a] *Table 6.1 provides more details on the priority projects.*

[b] *Prioritization based on shovel-ready nature of projects.*

[c] *Costs are given in 2019 dollars.*

Source: SEWRPC

Table 6.26
High Priority Floodplain Reconnection Projects for the Oak Creek Watershed Restoration Plan[a,b]

ID Number (see Maps 6.1 – 6.13)	Location	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)[c]	Key Project Partners
LMF-23	Mitchell Field Drainage Ditch from about 1,000 feet upstream from the confluence with Oak Creek to E. College Avenue	Stream channel and riparian restoration of about 8,500 feet of channel	Habitat, Water Quality, Stormwater and Flooding	Reconnects this stream with the floodplain	4,250,000 to 11,560,000[d]	Milwaukee County, City of Oak Creek, MMSD, Private Landowners
MOC-04	Oak Creek through Abendschein Park from E. Drexel Avenue to the Union Pacific Railroad crossing downstream of E. Forest Hill Avenue	Stream channel and riparian restoration of about 3,800 feet of channel	Habitat, Water Quality, Stormwater and Flooding	Reconnects this stream with the floodplain	1,900,000 to 5,168,000[d]	City of Oak Creek and other watershed partners
MOC-19	Oak Creek from the Union Pacific Railway crossing downstream of E. Forest Hill Avenue to about 2,800 feet downstream of S. Shepard Avenue	Stream channel and riparian restoration of about 9,500 feet of channel and 320 acres of publicly owned adjacent land	Habitat, Water Quality, Stormwater and Flooding	Reconnects this stream with the floodplain	4,750,000 to 12,920,000[d]	Milwaukee County and other watershed partners
MOC-37	About 1,800 feet of Oak Creek east of Oak Creek East Middle School	Stream channel and riparian restoration of about 1,800 feet of channel	Habitat, Water Quality, Stormwater and Flooding	Reconnects this stream with the floodplain	900,000 to 2,448,000[d]	Oak Creek School District and other watershed partners

Note: Floodplain reconnection actions for the projects listed above could be broken into smaller reaches.

[a] *Table 6.1 provides more details on the priority projects.*

[b] *Prioritization based on length of disconnected stream reach, degree of channel incision, and potential for incorporating other recommended projects.*

[c] *Costs are given in 2019 dollars.*

[d] *Depending on the features incorporated, the estimated capital costs range between $500 and $1,360 per linear foot.*

Source: SEWRPC

Table 6.27
High Priority Illicit Discharge Detection and Elimination Projects for the Oak Creek Watershed Restoration Plan[a,b]

ID Number (see Maps 6.1 – 6.13)	Location[c]	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)	Key Project Partners
GPR-03	Oak Creek by Oak Creek Parkway north of Marquette Avenue (extended), Outfall Sequence Number 10	Investigate and remedy source of human contamination to outfall	Water Quality, Recreational Use	Reduce loads of fecal indicator bacteria and pathogens to surface waters	--[d]	City of South Milwaukee
GPR-16	Oak Creek downstream of 6th Avenue, Outfall Sequence Number 21	Investigate and remedy source of canine contamination to outfall	Water Quality, Recreational Use	Reduce loads of fecal indicator bacteria and pathogens to surface waters	--[d]	City of South Milwaukee
GPR-17	Oak Creek downstream of Mill Road, Outfall Sequence Number 22	Investigate and remedy source of human contamination to outfall	Water Quality, Recreational Use	Reduce loads of fecal indicator bacteria and pathogens to surface waters	--[d]	City of South Milwaukee
LMP-03	Oak Creek Mill Pond off Oak Creek Parkway, Outfall Sequence Number 27	Investigate and remedy source of human contamination to outfall	Water Quality, Recreational Use	Reduce loads of fecal indicator bacteria and pathogens to surface waters	--[d]	City of South Milwaukee
LOC-01	Oak Creek upstream of 15th Avenue, Outfall Sequence Number 72	Investigate and remedy source of human contamination to outfall	Water Quality, Recreational Use	Reduce loads of fecal indicator bacteria and pathogens to surface waters	--[d]	City of South Milwaukee
LOC-05	Oak Creek at Cherry Street (extended), Outfall Sequence Number 81	Investigate and remedy source of canine contamination to outfall	Water Quality, Recreational Use	Reduce loads of fecal indicator bacteria and pathogens to surface waters	--[d]	Milwaukee County
LOC-09	Oak Creek at Chestnut Street (extended), Outfall Sequence Number 86	Investigate and remedy source of canine contamination to outfall	Water Quality, Recreational Use	Reduce loads of fecal indicator bacteria and pathogens to surface waters	--[d]	City of South Milwaukee
LOC-25	Oak Creek between 16th Avenue (extended) and 17th Avenue (extended), Outfall Sequence Number 115	Investigate and remedy source of canine contamination to outfall	Water Quality, Recreational Use	Reduce loads of fecal indicator bacteria and pathogens to surface waters	--[d]	City of South Milwaukee
OCH-05	Oak Creek at Martinton Drive (extended), Outfall Sequence Number 295	Investigate and remedy source of canine contamination to outfall	Water Quality, Recreational Use	Reduce loads of fecal indicator bacteria and pathogens to surface waters	--[d]	City of Franklin
RAT-02	Tributary to Rawson Avenue Tributary to North Branch of Oak Creek south of Rawson Avenue, Outfall Sequence Number 218	Investigate and remedy source of human contamination to outfall	Water Quality, Recreational Use	Reduce loads of fecal indicator bacteria and pathogens to surface waters	--[d]	City of Oak Creek

Table continued on next page.

Table 6.27 (Continued)

ID Number (see Maps 6.1 – 6.13)	Location[c]	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)	Key Project Partners
RAT-03	Tributary to Rawson Avenue Tributary to North Branch of Oak Creek south of Rawson Avenue, Outfall Sequence Number 223	Investigate and remedy source of human contamination to outfall	Water Quality, Recreational Use	Reduce loads of fecal indicator bacteria and pathogens to surface waters	--[d]	Unknown
RAT-04	Tributary to Rawson Avenue Tributary to North Branch of Oak Creek south of Rawson Avenue, Outfall Sequence Number 224	Investigate and remedy source of human contamination to outfall	Water Quality, Recreational Use	Reduce loads of fecal indicator bacteria and pathogens to surface waters	--[d]	Unknown

[a] *Table 6.1 provides more details on the priority projects.*

[b] *Prioritization based on documented source of contamination (human versus canine), size of outfall, mean concentration of* E. coli, *and mean copy numbers of Bacteroides and Lachnospiraceae.*

[c] *Outfall sequence numbers are given in Appendix E.*

[d] *Costs to be assigned during project development.*

Source: SEWRPC

Table 6.28
High Priority Land Restoration Projects for the Oak Creek Watershed Restoration Plan[a,b]

ID Number (see Maps 6.1 – 6.13)	Location	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)[c]	Key Project Partners
LMP-44	Milwaukee County Parks Rawson Woods Management Unit 2	Vegetation survey; invasive species control; invasive species monitoring and select control; reforestation and inter-seeding of native plants on 20.2 acres; wildlife monitoring	Habitat	Improved habitat and recreational value. Potential educational opportunities	67,600	Milwaukee County Parks
LOC-14	Milwaukee County Parks Rawson Woods Management Unit 1	Invasive species monitoring and select control and reforestation with native tree and shrub species on 1.9 acres	Habitat	Improved habitat and recreational value. Potential educational opportunities	1,700	Milwaukee County Parks
DAT-04	Milwaukee County Parks Falk Park Management Unit 7	Vegetation survey; invasive species control; invasive species monitoring and select control on 16.8 acres; reforestation on 8.4 acres; wildlife monitoring	Habitat	Improved habitat and recreational value. Potential educational opportunities	19,900	Milwaukee County
DAT-07	Milwaukee County Parks Barloga Woods Management Unit 3	Vegetation survey; invasive species control; invasive species monitoring and select control on 33.8 acres; inter-seeding with native plants on 10 acres; reforestation on 1 acre; wildlife monitoring	Habitat	Improved habitat and recreational value. Potential educational opportunities	120,000	Milwaukee County
DAT-09	Milwaukee County Parks Barloga Woods Management Unit 5	Vegetation survey; invasive species control; invasive species monitoring and select control on 23.4 acres; inter-seeding with native plants on 10 acres; reforestation on 1 acre; wildlife monitoring	Habitat	Improved habitat and recreational value. Potential educational opportunities	88,500	Milwaukee County
RAT-06	Milwaukee County Parks Falk Park Management Unit 2	Vegetation survey; invasive species control; invasive species monitoring and select control; allowing succession to hardwood forest on 6.4 acres; wildlife monitoring	Habitat	Improved habitat and recreational value. Potential educational opportunities	6,200	Milwaukee County

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Table 6.28 (Continued)

ID Number (see Maps 6.1 – 6.13)	Location	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)[c]	Key Project Partners
RAT-08	Milwaukee County Parks Falk Park Management Unit 4	Vegetation survey; invasive species control; invasive species monitoring and select control on 83 acres; reforestation of understory on 5 acres; forest stand improvement of 8.3 acres; wildlife monitoring	Habitat	Improved habitat and recreational value. Potential educational opportunities	92,900	Milwaukee County

[a] *Table 6.1 provides more details on the priority projects.*

[b] *Prioritization based on area reforested.*

[c] *Costs are given in 2019 dollars.*

Source: SEWRPC

Table 6.29
High Priority Outfall Repair Projects for the Oak Creek Watershed Restoration Plan[a,b]

ID Number (see Maps 6.1 – 6.13)	Location[c]	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)[d]	Key Project Partners
GPR-07	Right bank of Oak Creek upstream of first Oak Creek Parkway crossing	Repair or replace failing portion of 24-inch RCP outfall (sequence number 14 in Appendix E)	Water Quality, Habitat	Preventing further damage to sewer infrastructure. Habitat and water quality improvements	4,000	Unknown
LMP-13	Right bank of Oak Creek upstream of N. Chicago Avenue	Repair or replace failing portion of 18-inch RCP outfall (sequence number 37 in Appendix E)	Water Quality, Habitat	Preventing further damage to sewer infrastructure. Habitat and water quality improvements	2,900	Milwaukee County
LMP-35	Left bank of Oak Creek downstream from 15th Avenue and across from South Milwaukee High School	Repair or replace failing portion of 27-inch CMP outfall (sequence number 60 in Appendix E)	Water Quality, Habitat	Preventing further damage to sewer infrastructure. Habitat and water quality improvements	4,000	Unknown
LMP-38	Right bank of Oak Creek downstream from 15th Avenue and across from South Milwaukee High School	Repair or replace failing portion of 24-inch CMP outfall (sequence number 62 in Appendix E)	Water Quality, Habitat	Preventing further damage to sewer infrastructure. Habitat and water quality improvements	3,700	Unknown
LOC-13	Left bank of Oak Creek at Maple Street (extended)	Repair or replace failing portion of 15-inch CMP outfall (sequence number 92 in Appendix E)	Water Quality, Habitat	Preventing further damage to sewer infrastructure. Habitat and water quality improvements	2,200	Milwaukee County
UOC-18	Left bank of Oak Creek under the southbound lanes of IH-94	Repair or replace failing portion of 27-inch RCP outfall (sequence number 271 in Appendix E)	Water Quality, Habitat	Preventing further damage to sewer infrastructure. Habitat and water quality improvements	4,000	Unknown
LNB-27	Right bank of North Branch of Oak Creek downstream of W. Drexel Avenue	Repair or replace failing portion of 36-inch RCP outfall (sequence number 192 in Appendix E)	Water Quality, Habitat	Preventing further damage to sewer infrastructure. Habitat and water quality improvements	5,000	City of Oak Creek
UNB-43	Downstream of W. Grange Avenue where North Branch of Oak Creek daylights in Copernicus Park	Repair or replace falling portion of outfall	Water Quality, Habitat	Preventing further damage to sewer infrastructure. Habitat and water quality improvements	--[e]	City of Milwaukee

Note: CMP indicates corrugated metal pipe, RCP indicates reinforced concrete pipe.

[a] *Table 6.1 provides more details on the priority projects.*

[b] *Prioritization based on degree of outfall degradation and outfall size.*

[c] *Right and left bank are defined when looking downstream.*

[d] *Costs are given in 2019 dollars.*

[e] *Cost to be developed during project development.*

Source: SEWRPC

Table 6.30
High Priority Aquatic Organism Passage Projects for the Oak Creek Watershed Restoration Plan[a,b]

ID Number (see Maps 6.1 – 6.13)	Location	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)[c]	Key Project Partners
LOC-15	Oak Creek at E. Rawson Avenue and 16th Avenue Crossing Culvert	Improve fish passage through triple cell culvert by retrofitting upstream channel to direct flow into two of the cells during lower flows, installing strategically placed cobble and bolder substrates within the culvert, and installing grade control downstream of culvert	Habitat	Removes passage impediment, improves connectivity within Oak Creek	--[d]	City of South Milwaukee
MOC-29	Oak Creek immediately downstream of the S. Nicholson Road bridge	Existing placement of rock across channel may obstruct passage for some fish species. Rearrange excess rubble to allow for better passage	Habitat	Improves passage, increases connectivity within Oak Creek	--[d]	Milwaukee County
UOC-07	Private farm road crossing of Oak Creek upstream of Canadian Pacific Railway	Outlet of culvert is completely submerged? by downstream ponding and concrete surrounding culvert is failing. Assess interest of landowner to remove culverts and stabilize adjacent streambank. If the farm road is still needed, replace culverts with an appropriately sized culvert or bridge	Habitat	Removes passage impediment, connects North Branch of Oak Creek to Oak Creek	--[d]	Private Landowner
UOC-15	Abandoned farm road crossing of Oak Creek downstream of S. 13th Street	Remove abandoned and failing wooden and steel crossing structure and rearrange rock rubble to improve fish passage	Habitat	Improves passage, increases connectivity within Oak Creek	--[d]	Milwaukee County or Amazon
UOC-30	31st Street culvert crossing of Oak Creek	Retrofit channel at culvert inlet to direct flow during fair weather conditions into one cell and allow flow into the second cell when needed during high flows	Habitat	Improves passage, increases connectivity within Oak Creek	--[d]	City of Franklin
UOC-40	35th Street culvert crossing of Oak Creek	Seal culvert wall joints; add grade control downstream to provide sufficient water depths through the culvert, add strategically placed cobble and boulder substates along both interior walls of the culvert; rearrange rock placement downstream of the culvert	Habitat	Removes passage impediment, increases connectivity within Oak Creek	--[d]	City of Franklin

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Table 6.30 (Continued)

ID Number (see Maps 6.1 – 6.13)	Location	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)[c]	Key Project Partners
LNB-03	North Branch of Oak Creek channel downstream of Canadian Pacific Railway crossing for about 400 feet	Channel bed erosion downstream of the culvert has caused about a 4-foot drop from the culvert to the downstream channel. Retrofit the downstream channel bed with a rock ramp with a slope of 1.5 percent	Habitat	Removes passage impediment, connects North Branch of Oak Creek to Oak Creek	387,500	Canadian Pacific Railway, Milwaukee County, Watershed partners
UNB-23	Abandoned private crossing on North Branch of Oak Creek downstream of W. College Avenue	Remove collapsing steel structure and stabilize the streambanks to prevent erosion	Habitat	Removes passage impediment, removes safety hazard, improves connectivity in North Branch of Oak Creek	--[d]	Private landowner
UNB-30	S. 20th Street culvert crossing of North Branch of Oak Creek	Remove accumulated debris at upstream end and within culverts	Habitat	Removes passage impediment, improves connectivity in North Branch of Oak Creek	--[d]	City of Milwaukee or Milwaukee County

[a] *Table 6.1 provides more details on the priority projects.*

[b] *Prioritization based on severity of passage impediment and potential to increase connectivity.*

[c] *Costs given in 2019 dollars.*

[d] *Costs to be assigned during project development.*

Source: SEWRPC

Table 6.31
High Priority Urban Stormwater Management Projects for the Oak Creek Watershed Restoration Plan[a,b]

ID Number (see Maps 6.1 – 6.13)	Location	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)[c]	Key Project Partners
LOC-04	Oak Creek Parkway from the entrance to Grant Park Beach to E. Rawson Avenue	Example Project – Install two-foot wide pervious pavement strips in the parking lanes adjacent to the curbs on both sides of the road along the parkway to treat runoff originating on the road[d]	Water Quality, Stormwater and Flooding	Average annual pollutant load reductions of 8,113 pounds TSS and 23.9 pounds total phosphorus	860,000	City of South Milwaukee
LOC-19	Alleyway between 15th Avenue on the west, 13th Avenue on the east, Madison Avenue on the north, and Michigan Avenue on the south	Example Project – Install a two-foot-wide strip of pervious pavement along the center of the alley to treat runoff originating in the alley	Water Quality, Stormwater and Flooding	Average annual pollutant load reductions of 186 pounds TSS and 0.5 pounds total phosphorus	34,000	City of South Milwaukee
UOC-21	Love's Travel Stop & Country Stores parking lot west of S. 20th Street and north of Oak Creek	Install bioretention, bioswale, or other appropriate green infrastructure to treat runoff from truck stop that currently flows directly to Oak Creek through the outfalls cited in projects UOC-20 and UOC-22	Water Quality	Decreased pollutant loading	--[e]	Love's Travel Stops & Country Stores, Inc.
LMF-06	Sub-basin M5-7[f] east of the intersection of S. Clement Avenue and E. Montana Avenue	Install 1.02-acre wet retention pond WQ-25	Water Quality	Average annual pollutant load reduction of 32,981 pounds TSS	200,700	City of Oak Creek
LMF-25	Sub-basin M2-2[f] south of E. College Avenue adjacent to the Mitchell Field Drainage Ditch	Install 0.47-acre wet retention pond WQ-23	Water Quality	Average annual pollutant load reduction of 20,404 pounds TSS	104,400	City of Oak Creek
LNB-29	Boulevard median of W. Drexel Avenue from S. 10th Street east to the crossing of the North Branch of Oak Creek	Example Project – Installation of bioswales in about 630 feet of W. Drexel Avenue to treat 50 percent of the boulevard runoff (1.0 acre)	Water Quality	Average annual pollutant load reductions of 432 pounds TSS, 0.8 pounds total phosphorus, 0.02 trillion cells of fecal coliform bacteria	38,000	City of Oak Creek

[a] *Table 6.1 provides more details on the priority projects.*

[b] *Prioritization based on total cost, total load reduction of total suspended solids (TSS), and cost-effectiveness of load reduction of total suspended solids.*

[c] *Costs are given in 2019 dollars.*

[d] *This project could be completed in phases or could be done for only a portion of the parkway.*

[e] *Cost to be assigned during project development.*

[f] *Subbasin designation follows the City of Oak Creek's nomenclature.*

Source: SEWRPC

Table 6.32
Other High Priority Projects for the Oak Creek Watershed Restoration Plan[a]

ID Number (see Maps 6.1 – 6.13)	Location	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)[b]	Key Project Partners
OCW-02	Watershed-wide	Develop and implement written dry-weather screening procedures for MS4 outfalls	Water Quality	Improved illicit discharge detection and elimination procedures, reduced loadings of pollutants and pathogens	--[c]	Municipalities and Milwaukee County
OCW-03	Watershed-wide	Develop and implement written procedures for investigating and responding to suspected or known illicit discharges into MS4	Water Quality	Improved illicit discharge detection and elimination procedures, reduced loadings of pollutants and pathogens	--[c]	Municipalities and Milwaukee County
OCW-04	Watershed-wide	Develop and implement a system for tracking and completing long-term inspections, maintenance, and enforcement of all public and private post-construction stormwater BMPs	Water Quality	Maintains performance of stormwater BMPs	--[c]	Municipalities and Milwaukee County
OCW-05	Watershed-wide	Develop and implement a written salt application or salt reduction strategy	Water Quality	Reductions in chloride loadings	--[c]	Municipalities and Milwaukee County
OCW-06	Watershed-wide	Annually calibrate deicing and anti-icing equipment	Water Quality	Reductions in chloride loadings	--[c]	Municipalities, Milwaukee County, and MMIA
OCW-07	Watershed-wide	Develop action benchmarks for bacteria for illicit discharge detection and elimination screening	Water Quality	Reductions in fecal indicator bacteria and pathogen loadings	--[c]	Municipalities and Milwaukee County
OCW-08	Watershed-wide	Develop an inventory and map of potential sources of fecal indicator bacteria for MS4	Water Quality	Reductions in fecal indicator bacteria and pathogen loadings	--[c]	Municipalities and Milwaukee County
OCW-09	Watershed-wide	Develop a fecal indicator bacteria elimination plan for MS4	Water Quality	Reductions in fecal indicator bacteria and pathogen loadings	--[c]	Municipalities and Milwaukee County
UOC-01	Area surrounding the confluence of the North Branch of Oak Creek and the mainstem of Oak Creek	Conduct a detailed survey of the mainstem of Oak Creek from S. 13th Street to S. Howell Avenue and the North Branch of Oak Creek from W. Puetz Road to its confluence with the mainstem	Habitat, Water Quality, Stormwater and Flooding	Address low flows, sedimentation, degraded habitat, and associated problems in this reach	20,000	Wisconsin Department of Transportation, Milwaukee County, City of Oak Creek, Canadian Pacific Railroad

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Table 6.32 (Continued)

ID Number (see Maps 6.1 – 6.13)	Location	Management Action	Focus Areas Addressed	Potential Benefits	Capital Cost (dollars)[b]	Key Project Partners
UOC-02	Area surrounding the confluence of the North Branch	Conduct a feasibility study to explore options to address impairments resulting from the channel modifications related to the W. Ryan Road and S. Howell Avenue expansion projects in the early 1970s	Habitat, Water Quality, Stormwater and Flooding	Address low flows, sedimentation, degraded habitat, and associated problems in this reach	70,000	Wisconsin Department of Transportation, Milwaukee County, City of Oak Creek, Canadian Pacific Railroad
LNB-06	North Branch of Oak Creek railroad culvert crossing 0.1 mile upstream from the confluence with Oak Creek	Conduct a detailed inspection and structural integrity analysis of the Canadian Pacific Railway culvert crossing of the North Branch of Oak Creek	Habitat Stormwater and Flooding	Protect infrastructure and public safety	25,000	Canadian Pacific Railway
LNB-07	North Branch of Oak Creek railroad culvert crossing 0.1 mile upstream from the confluence with Oak Creek	If the inspection called for in LNB-06 shows that the structure is still serviceable, action should be taken to protect the culvert bedding and foundation from further undermining and to halt flow of water under the culvert	Habitat Stormwater and Flooding	Protect infrastructure and public safety	470,400	Canadian Pacific Railway

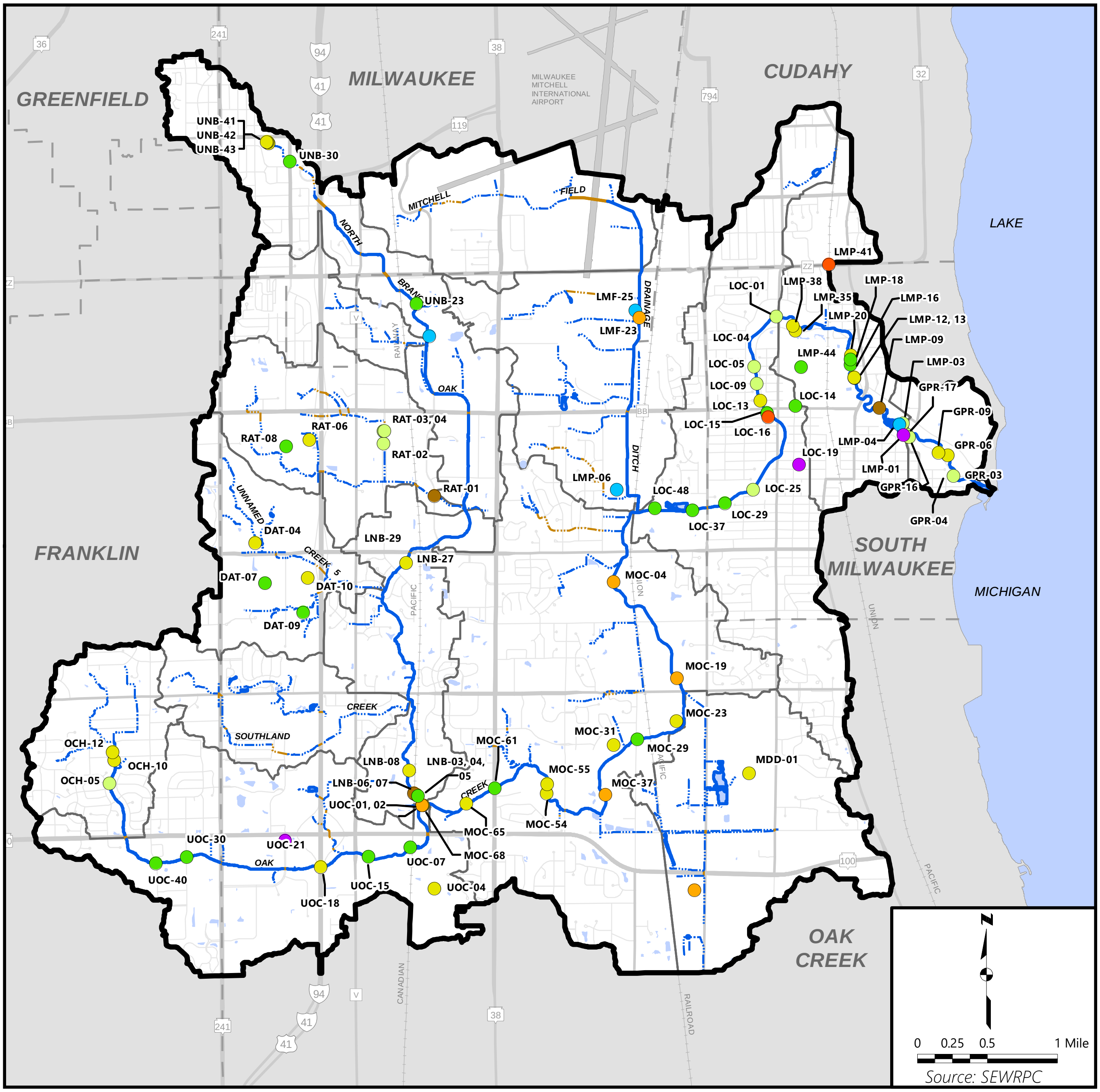
[a] *Table 6.1 provides more details on the priority projects.*

[b] *Costs are given in 2019 dollars.*

[c] *Cost to be assigned during project development.*

Source: SEWRPC

Map 6.36
Recommended High Priority Projects Within the Oak Creek Watershed



HABITAT AND WATER QUALITY PROJECT
HABITAT PROJECT
WATER QUALITY PROJECT
HABITAT, WATER QUALITY, AND STORMWATER DRAINAGE/FLOODING PROJECT
WATER QUALITY AND STORMWATER DRAINAGE/FLOODING PROJECT
HABITAT AND STORMWATER DRAINAGE/FLOODING PROJECT
WATER QUALITY AND RECREATIONAL USE AND ACCESS PROJECT
STORMWATER DRAINAGE/FLOODING PROJECTS
RECREATIONAL USE AND ACCESS PROJECT
LOC-53 PROJECT ID IN TABLE 6.1

OAK CREEK WATERSHED BOUNDARY
ASSESSMENT AREA BOUNDARIES
PERENNIAL STREAM
PERENNIAL STREAM (ENCLOSED)
INTERMITTENT STREAM
INTERMITTENT STREAM (ENCLOSED)
SURFACE WATER

Note: High priority watershed-wide projects including OCW-02, 03, 04, 05, 06, 07, 08, 09 are not shown on this map. Points on this map indicate general area of the project. Some projects include larger reaches of stream or portions of land. See Table 6.1 for project details.

6.9 MEASURING PLAN PROGRESS AND SUCCESS

Monitoring plan progress will be an essential component of achieving the plan's goals. Plan progress and success will be measured by adoption of the plan by County and municipal legislative bodies and concerned State and Federal agencies, participation rates in public awareness and education efforts, progress in implementing best management practices and other recommended projects and actions, and improved conditions within the watershed.

Adoption of the plan by local units of government in the watershed and concerned State and Federal agencies is an important measure of progress. Formal adoption demonstrates a commitment to the goals of the plan and will assist a unit or agency of government to more fully integrate the plan's elements into existing work plans and enable staffs to program the necessary implementation work. Adoption of this plan is discussed more fully later in this chapter.

As discussed in the previous section, public, stakeholder, and civic engagement is essential to the implementation of watershed plans. A high level of public and stakeholder engagement is a sign of public interest in the plan and of the level of the public's motivation to implement its recommendations. Recommendations for public awareness and participation activities were discussed in the previous section.

The general recommendations and specific projects called for in this chapter constitute the recommended actions to improve conditions in the Oak Creek watershed. Tracking implementation of these recommendations measures the effort being expended and constitutes a measure of progress towards restoring conditions in the watershed. While the ultimate test of success is shown through monitoring conditions in the watershed, over short time periods it can be difficult to detect the impact of watershed restoration activities due to factors such as the variability in water quality indicators, the relatively small pollutant load reductions associated with any single best management practice, and the presence of reservoirs of stored pollutants within the watershed. Tracking implementation of the recommendations of this plan can provide valuable information to assess the progress being made toward achieving restoration goals. Tracking of implementation is discussed in a later section of this chapter.

Monitoring and information collection programs are invaluable at helping planners, local officials, agency staff, and community members better understand the condition of the water resources of the Oak Creek watershed. These programs are necessary in order to assess and evaluate conditions within the watershed, and they can provide information to determine where management efforts should focus, help better target management programs, and help determine project feasibility. When conducted on an ongoing basis, monitoring programs can reveal trends and changes in watershed conditions, detect new and emerging water quality problems, assess long-term progress in plan implementation, and provide data for evaluating the success of management projects.

Monitoring Recommendations

At a conceptual level, future monitoring in the Oak Creek watershed needs to address the question of what conditions are like in the watershed. Addressing this question will require ongoing water quality monitoring within the watershed. This monitoring should encompass a number of indicators, including, but not limited to, water chemistry, stream flow, fecal indicator bacteria, and indicators of biological conditions. Due to the effects of the surrounding landscape upon the water resources of the watershed, this monitoring should also include indicators of conditions in the associated riparian and upland areas. This monitoring should encompass several indicators, including, but not limited to, land use and terrestrial invasive species. Several organizations are presently conducting these types of monitoring within the watershed.

It should be noted that many monitoring activities may provide data that address more than one focus area of this plan. For example, monitoring fish and macroinvertebrate communities in the watershed provides direct measures of both the state of water quality and the state of fishing-related recreational opportunities in the watershed, as well as indirect measures of the state of the habitat. Similarly, measurements of suspended solids or turbidity provide both direct measures of water quality conditions and indirect measures of habitat conditions. In view of this, the recommendations related to monitoring will be presented by type of monitoring and program, rather than by individual focus issue.

Evaluation of Existing Water Quality Monitoring and Data Collection Programs

Considerable effort has recently been expended on water quality monitoring in the Oak Creek watershed. During the period from 2015 through 2019, several agencies conducted monitoring in the watershed. Table 6.33 lists and Map 6.37 shows the stations regularly sampled as part of these monitoring efforts. Much of this monitoring was conducted specifically to support the development of this watershed restoration plan. The water quality indicators that were sampled by each agency are described below.

Milwaukee Metropolitan Sewerage District

The Milwaukee Metropolitan Sewerage District (MMSD) currently monitors water chemistry and bacteria at seven sampling stations along the mainstem of Oak Creek. One sample is collected at each of these stations each month during the months of March through November. MMSD is currently reviewing the placement of their sampling stations and considering moving one station from the mainstem of Oak Creek to the North Branch of Oak Creek. As part of the MMSD Corridor Study, the District in partnership with the USGS collects biological samples, including fish, macroinvertebrates, and algae, at one sampling station along the mainstem of Oak Creek at about three-year intervals. The Corridor Study also includes assessments of aquatic toxicity.

U.S. Geological Survey

The USGS monitors stream flow at one continuous recording stream gaging station in the watershed located along the mainstem of Oak Creek. On behalf of Milwaukee Mitchell International Airport (MMIA), the USGS also conducts water chemistry monitoring at one site along the Mitchell Field Drainage Ditch. As previously mentioned, the USGS in partnership with MMSD collects biological samples, including fish, macroinvertebrates, and algae, at one sampling station along the mainstem of Oak Creek at about three-year intervals as part of the Corridor Study. The Corridor Study also includes assessments of aquatic toxicity.

City of Racine Public Health Department

During 2015 and 2016, the City of Racine Public Health Department (RHD) monitored bacteria, temperature, and water chemistry at 18 sampling stations in the Oak Creek watershed—13 along the mainstem of Oak Creek including sites in the Mill Pond, two along the North Branch of Oak Creek, two along the Mitchell Field Drainage Ditch, and one along Unnamed Creek No. 5. As part of this project, RHD conducted several other studies in the watershed during this period including observation and sampling of flow from selected stormwater outfalls, microbial source tracking of discharge from outfalls showing high concentrations of fecal indicator bacteria, and characterization of bathymetry and water circulation patterns within the Mill Pond. RHD's study was funded through a grant from the Fund for Lake Michigan. This monitoring ended in 2016.

Wisconsin Department of Natural Resources

The Wisconsin Department of Natural Resources (WDNR) periodically conducts biological sampling in the Oak Creek watershed. In 2015, it conducted fish and macroinvertebrate surveys at nine sampling stations in the watershed—six along the mainstem of Oak Creek, two along the North Branch of Oak Creek, and one along the Mitchell Field Drainage Ditch. In 2018, the WDNR also sampled surface sediment for polychlorinated biphenyls (PCBs) in the Mill Pond and the mainstem of Oak Creek downstream of the Mill Pond.

Milwaukee Riverkeeper

Between 2015 and 2019, volunteers from Milwaukee Riverkeeper conducted monitoring at eight sampling stations in the Oak Creek watershed—two along the mainstem of Oak Creek, two along the North Branch of Oak Creek, two along the Mitchell Field Drainage Ditch, and one each along Southland Creek and Unnamed Creek No. 5. Monitoring at four stations was conducted as part of baseline monitoring. Five were monitored in support of an urban road salt study that Riverkeeper was conducting in cooperation with the USGS. As of the end of 2019, Riverkeeper's sampling in the Oak Creek watershed had ended.

Southeastern Wisconsin Regional Planning Commission

During 2016 and 2017, Commission staff deployed continuous temperature monitoring devices at 24 sites within the Oak Creek watershed. These sites included 12 sites along the mainstem of Oak Creek including sites in the Mill Pond, six sites along the North Branch of Oak Creek, two sites along the Mitchell Field Drainage Ditch, and one site each along Southland Creek, Unnamed Creek No. 5, an unnamed tributary to the North Branch of Oak Creek (the Rawson Avenue Tributary), and an unnamed tributary to the mainstem of

Table 6.33
Stream Water Quality Monitoring Stations in the Oak Creek Watershed: 2015-2019

Sampling Station	River Mile[a]	Water Temperature	Water Chemistry	Stream Flow	Bacteria	Biological	Ongoing[b]
Milwaukee Metropolitan Sewerage District							
Oak Creek at Ryan Road	10.1	Y	Y	N	Y	N	Y
Oak Creek at STH 38	9.2	Y	Y	N	Y	N	Y
Oak Creek at E. Forest Hill Avenue	6.3	Y	Y	N	Y	N	Y
Oak Creek at Pennsylvania Avenue	4.7	Y	Y	N	Y	N	Y
Oak Creek at 15th Avenue	2.8	Y	Y	N	Y	Y[c]	Y
Oak Creek at Parkway East of STH 32[d]	1.0	Y	Y	N	Y	N	Y
Oak Creek at Parkway East of Lake Drive	0.3	Y	Y	N	Y	N	Y
Milwaukee Riverkeeper							
Oak Creek east of S. 13th Street	10.6	Y	Y	N	N	N	N
Oak Creek at 15th Avenue	2.8	Y	Y	N	N	N	N
North Branch of Oak Creek along 6th Street	4.1	Y	Y	N	N	N	N
North Branch of Oak Creek 200 feet upstream of Puetz Road	1.0	Y	Y	N	N	N	N
Mitchell Field Drainage Ditch south of Rawson Avenue	0.6	Y	Y	N	N	N	N
Mitchell Field Drainage Ditch at Railroad Tracks	0.1	Y	Y	N	N	N	N
Southland Creek at 13th Street	0.5	Y	Y	N	N	N	N
Unnamed Creek No. 5 at S. Wake Forest Drive	0.1	Y	Y	N	N	N	N
City of Racine Public Health Department							
Oak Creek at Southwood Drive	12.8	Y	Y	N	Y	N	N
Oak Creek at CTH V	10.7	Y	Y	N	Y	N	N
Oak Creek at Oak Leaf Trail near STH 38	9.2	Y	Y	N	Y	N	N
Oak Creek at S. Nicholson Road	7.4	Y	Y	N	Y	N	N
Oak Creek at Drexel Avenue	5.6	Y	Y	N	Y	N	N
Oak Creek at Pennsylvania Avenue	4.7	Y	Y	N	Y	N	N
Oak Creek at 15th Avenue	2.8	Y	Y	N	Y	N	N
Oak Creek Parkway upstream of Mill Pond	1.2	Y	Y	N	Y	N	N
Oak Creek Mill Pond	1.1	Y	Y	N	Y	N	N
Oak Creek at the Falls	1.0	Y	Y	N	Y	N	N
Oak Creek at Hawthorne Avenue	0.3	Y	Y	N	Y	N	N
Oak Creek Mouth	0.1	Y	Y	N	Y	N	N
North Branch of Oak Creek at S. 6th Street	3.9	Y	Y	N	Y	N	N
North Branch of Oak Creek at Weatherly Drive	1.8	Y	Y	N	Y	N	N
Mitchell Field Drainage Ditch at College Avenue	1.8	Y	Y	N	Y	N	N
Mitchell Field Drainage Ditch at Rawson Avenue	0.8	Y	Y	N	Y	N	N
Unnamed Creek No. 5 at Willow Drive	0.3	Y	Y	N	Y	N	N
Southeastern Wisconsin Regional Planning Commission							
Oak Creek at W. Ryan Road	12.5	Y	N	N	N	N	N
Oak Creek at S. 13th Street	10.7	Y	N	N	N	N	N
Oak Creek at STH 38	9.2	Y	N	N	N	N	N
Oak Creek at Puetz Road	6.8	Y	N	N	N	N	N
Oak Creek at Drexel Avenue	5.6	Y	N	N	N	N	N
Oak Creek at Pennsylvania Avenue	4.7	Y	N	N	N	N	N
Oak Creek at Chestnut Street	3.5	Y	N	N	N	N	N
Oak Creek at 15th Avenue	2.8	Y	Y	N	N	N	Y
Oak Creek at Parkway upstream of Mill Pond	1.2	Y	N	N	N	N	N
Oak Creek at Parkway upstream of Mill Pond-Obstructed Channel	1.2	Y	N	N	N	N	N
Oak Creek at Parkway upstream of Mill Pond-New Channel	1.2	Y	N	N	N	N	N
Oak Creek Mill Pond upstream Channel	1.1	Y	N	N	N	N	N
Oak Creek Mill Pond North Lobe	1.1	Y	N	N	N	N	N
Oak Creek Mill Pond South Lobe	1.1	Y	N	N	N	N	N
Oak Creek Below Dam	1.0	Y	N	N	N	N	N
Oak Creek Mouth	0.1	Y	N	N	N	N	N
North Branch of Oak Creek at Maitland Park	5.3	Y	N	N	N	N	N

Table continued on next page.

Table 6.33 (Continued)

Sampling Station	River Mile[a]	Water Temperature	Water Chemistry	Stream Flow	Bacteria	Biological	Ongoing[b]
Southeastern Wisconsin Regional Planning Commission (continued)							
North Branch of Oak Creek at S. 6th Street	3.9	Y	N	N	N	N	N
North Branch of Oak Creek at Marquette Avenue	3.0	Y	N	N	N	N	N
North Branch of Oak Creek at Wildwood Drive	2.0	Y	N	N	N	N	N
North Branch of Oak Creek at Puetz Road	0.9	Y	N	N	N	N	N
North Branch of Oak Creek near Confluence with Oak Creek	0.1	Y	N	N	N	N	N
Mitchell Field Drainage Ditch at College Avenue	1.8	Y	N	N	N	N	N
Mitchell Field Drainage Ditch at Rawson Avenue	0.8	Y	N	N	N	N	N
Southland Creek at S. 13th Street	0.5	Y	N	N	N	N	N
Unnamed Creek 5 at Willow Drive	0.3	Y	N	N	N	N	N
Unnamed Tributary to North Branch of Oak Creek at S. 13th Street	0.8	Y	N	N	N	N	N
Unnamed Tributary to Oak Creek near Puetz Road	0.1	Y	N	N	N	N	N
U.S. Geological Survey							
Oak Creek at 15th Avenue	2.8	N	N	Y	N	Y[c]	Y
Mitchell Field Drainage Ditch at College Avenue	1.8	N	Y	N	N	N	Y
Wisconsin Department of Natural Resources							
Oak Creek at Ryan Road	12.5	Y	Y	N	N	Y	Y
Oak Creek at 13th Street	10.6	Y	Y	N	N	Y	Y
Oak Creek at Puetz Road	6.8	Y	Y	N	N	Y	Y
Oak Creek at Pennsylvania Avenue	4.7	Y	Y	N	N	Y	Y
Oak Creek at 15th Avenue	2.8	Y	Y	N	N	Y	Y
Oak Creek at Beach Bridge	0.1	Y	Y	N	N	Y	Y
North Branch of Oak Creek Along 6th Street	4.1	Y	Y	N	N	Y	Y
North Branch of Oak Creek 200 feet upstream of Puetz Road	1.0	Y	Y	N	N	N	Y
North Branch of Oak Creek at Puetz Road	0.9	Y	Y	N	N	Y	Y
Mitchell Field Drainage Ditch at College Avenue	1.8	N	Y	N	N	N	Y
Mitchell Field Drainage Ditch at Rawson Avenue	0.8	Y	Y	N	N	Y	Y

[a] *River mile is measured as the distance upstream from the confluence with the waterbody into which a stream flows.*

[b] *Ongoing indicates that it is anticipated that monitoring will continue to be conducted at this station during and/or beyond 2021.*

[c] *Biological sampling was conducted at this station under a joint project between the Milwaukee Metropolitan Sewerage District and the U.S. Geological Survey.*

[d] *The station name is historical. The station is located near the outlet to the Mill Pond.*

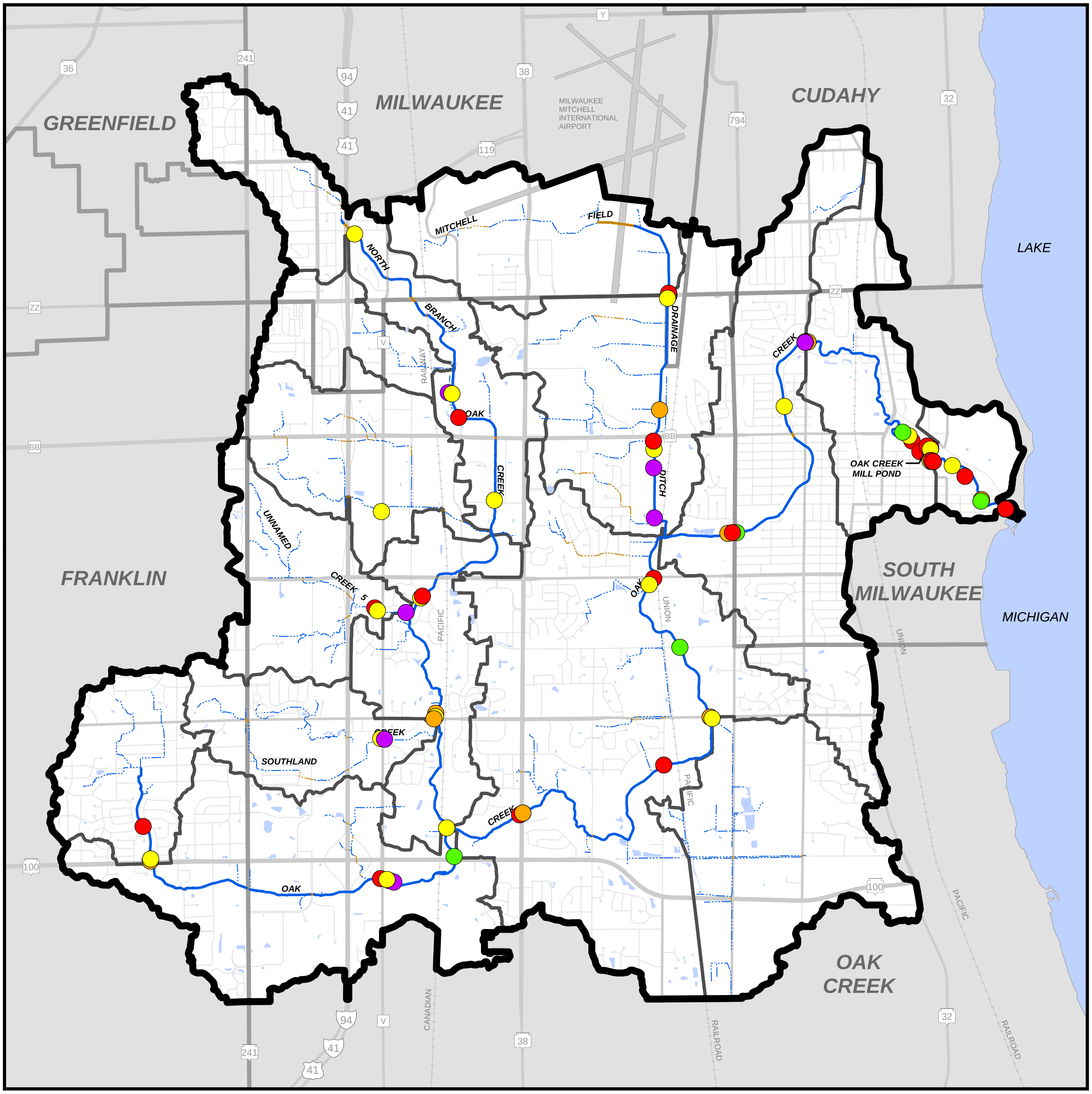
Source: SEWRPC

Oak Creek. Commission staff also deployed eight continuous temperature monitoring devices at sites within and immediately upstream and downstream of the Mill Pond during the summer and fall of 2019. During 2016 and 2017, Commission staff conducted instream surveys of channel and aquatic habitat conditions along the mainstem of Oak Creek, the North Branch of Oak Creek, and the Mitchell Field Drainage Ditch. As part of these surveys, Commission staff noted the presence of native freshwater mussels, but mussel distribution and populations were not surveyed.

In 2018, Commission staff installed continuous temperature and specific conductance monitoring equipment at one site along the mainstem of Oak Creek as part of the Commission's study on the environmental impacts of chlorides.[187] As part of this study's monitoring effort, Commission staff are also collecting water chemistry samples at this site. It is anticipated that this monitoring will continue into 2021.

[187] *Southeastern Wisconsin Regional Planning Commission,* Prospectus for a Chloride Impact Study for the Southeastern Wisconsin Region, *March 2016.*

Map 6.37
Water Quality Monitoring in Oak Creek: 2015-2019



CITY OF RACINE PUBLIC HEALTH DEPARTMENT
MILWAUKEE METROPOLITAN SEWERAGE DISTRICT
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
U.S. GEOLOGICAL SURVEY
WISCONSIN DEPARTMENT OF NATURAL RESOURCES
WISCONSIN DEPARTMENT OF NATURAL RESOURCES AND MILWAUKEE RIVERKEEPER

OAK CREEK WATERSHED BOUNDARY
ASSESSMENT AREA BOUNDARIES (SEE MAP 3.2 FOR ASSESSMENT AREA NAMES)
PERENNIAL STREAM
PERENNIAL STREAM (ENCLOSED)
INTERMITTENT STREAM
INTERMITTENT STREAM (ENCLOSED)
SURFACE WATER

N

0 0.25 0.5 1 Mile

Source: SEWRPC

Milwaukee County Department of Parks, Recreation and Culture

The Milwaukee County Department of Parks, Recreation and Culture (DPRC) conducts several types of surveys in County parks and natural areas in the Oak Creek watershed. These include surveys of wildlife, vegetative community, invasive plants, and ephemeral wetlands on sites owned by DPRC.

Identifying Additional Monitoring Needs

The 2007 SEWRPC RWQMPU included an evaluation of the existing water quality monitoring and data collection programs in the watersheds within its study area, including the Oak Creek watershed.[188] This evaluation identified several data gaps in the water quality monitoring data available for the Oak Creek watershed. These data gaps include:

- Most of the water quality monitoring conducted in the watershed had focused on the mainstem of Oak Creek
- Relatively few samples were collected from tributary streams and few tributary streams had been sampled. Between 1998 and 2001, samples were collected from only one tributary stream
- Relatively few samples had been collected during winter months

The monitoring conducted during the development of this watershed restoration plan made substantial progress toward filling these data gaps. During the period from 2016 through 2017, regular monitoring was conducted at stations along the mainstem of Oak Creek and six tributary streams, although the monitoring of some of these tributary streams was limited to continuous monitoring of water temperature. Winter sampling was conducted at several mainstem and tributary sampling stations, although not as frequently as it was during other seasons. These efforts have improved our knowledge of conditions in the watershed. Despite the considerable effort described above, the following gaps remain in the water quality data set for the Oak Creek watershed:

- Several tributary streams are not routinely monitored. This is especially the case for streams tributary to the North Branch of Oak Creek and for water entering the mainstem of Oak Creek through the ditches in the Oak Creek Drainage Ditches assessment area.
- The amount of sampling conducted during the winter has not been sufficient to determine the extent of problems posed by chloride concentrations in surface waters of the Oak Creek watershed. Direct measurements of chloride are available only for sites on the mainstem of Oak Creek and have rarely been collected during the months of January or February.
- Much of the recent monitoring was conducted as part of short-term projects initiated in support of the development of this watershed restoration plan. As of 2020, many of the monitoring sites established as part of these projects were no longer being actively monitored. Current monitoring is occurring mostly along the mainstem of Oak Creek and the Mitchell Field Drainage Ditch.
- Sediment sampling only consisted of surface grab samples.

Recommended Water Quality Monitoring Plan

It is important to assess the condition of water quality, biological communities, and habitat in the watershed and determine whether these conditions are improving or deteriorating. It is, therefore, important to establish and maintain a robust program to monitor and assess conditions within the watershed. Such a monitoring program should integrate and coordinate the use of the monitoring resources of multiple agencies and groups, generate monitoring data that are scientifically defensible and relevant to the decision-making process, and manage and report data in ways that are meaningful and understandable to decision makers and other affected parties. This watershed restoration plan recommends maintaining the existing monitoring network and expanding monitoring in the watershed to continue to fill data gaps. Toward these ends, the plan includes the following recommendations for water quality monitoring:

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[188] *SEWPRC Planning Report No. 50,* op. cit.

Maintaining Current Monitoring Activities

Continue the current ongoing monitoring activities in the Oak Creek watershed and support and maintain the efforts of the agencies conducting these activities. This includes several specific recommendations:

1. **Continue the current USGS stream gaging program in the watershed.** Stage and discharge monitoring should continue at the currently active gage on the mainstem of Oak Creek at 15th Avenue.

2. **Continue the MMSD Oak Creek survey monitoring program.** Monitoring of water temperature, water chemistry, and fecal indicator bacteria should continue at the District's existing sampling stations. At a minimum sampling frequency, the current sampling schedule in which samples are collected monthly should be continued. **MMSD should consider moving one of its monitoring stations that is currently located on the mainstem of Oak Creek to a site along the North Branch of Oak Creek.** This would help address the data gap due to there currently being no monitoring stations on this tributary.

3. **Continue the USGS monitoring of the Mitchell Field Drainage Ditch on behalf of MMIA.** Monitoring of water temperature and chemistry should continue at the existing sampling station.

4. **Continue the joint MMSD-USGS biological and toxicity sampling program in the watershed.** Sampling should be conducted at the existing sampling station at three-year intervals.

5. **Continue the WDNR's biological monitoring in the Oak Creek watershed.** Monitoring of fish and macroinvertebrates should continue at the nine sampling stations monitored in the Department's 2015 survey. At a minimum, sampling should occur every three-to-five years. In order to accomplish this amount of biological monitoring consideration could be given to monitoring sites on a rotating basis with two to three sites being sampled every year.

6. **Continue the Milwaukee County Park's monitoring of native plants, wildlife, and invasive species in County parks and natural areas of the Oak Creek watershed.** Surveys should be conducted in accordance with the schedules set forth in the ecological restoration and management plans developed for parks in the watershed.

Table 6.34 summarizes the monitoring stations at which it is recommended that existing monitoring efforts be continued. These stations are shown on Map 6.38.

Expanding Water Quality Monitoring Activities

It was previously noted that several gaps still remain in the water quality data set for the Oak Creek watershed. Most tributary streams are not currently being routinely monitored and, as of 2020, monitoring is no longer being conducted as several stations that were actively monitored during 2015 through 2017. **It is recommended that the water quality monitoring network in the Oak Creek watershed be expanded to fill these data gaps.** This includes the following specific recommendations which are also summarized in Table 6.34 and on Map 6.38:

1. **Establish or reactivate at least one water quality monitoring station on each of the following streams not currently being sampled for water temperature, water chemistry, and fecal indicator bacteria:** Southland Creek, Unnamed Creek No. 5, the Rawson Avenue tributary to the North Branch of Oak Creek, the College Avenue Tributary to the North Branch of Oak Creek, and the outlet of the Oak Creek drainage ditches into the mainstem of Oak Creek. On those streams that have been monitored in the past, siting monitoring stations at locations that have been previously monitored would allow for the assessment of temporal trends. Samples should be collected every month and analyzed for water temperature, water chemistry, and fecal indicator bacteria.

2. **Establish or reactivate at least two water quality monitoring stations on the North Branch of Oak Creek.** Siting monitoring stations on this stream at locations that have been previously monitored would allow for the assessment of temporal trends. Samples should be collected every month and analyzed for water temperature, water chemistry, and fecal indicator bacteria.

Table 6.34
Recommended Water Quality Monitoring Stations in the Oak Creek Watershed

Waterbody	Existing Stations to be Retained[a] MMSD Water Quality	USGS Stream Gage	USGS Water Quality	WDNR Biology	Water Quality Stations to Be Added	Potential Station Locations[b]
Oak Creek Mainstem	7	1	--	6	0	--
College Avenue Tributary	--	--	--	--	1	W. Pelton Drive, S. 13th Street
North Branch of Oak Creek	--	--	--	2	2	Weatherly Drive, Marquette Avenue
Mitchell Field Drainage Ditch	--	--	1	1	1	Rawson Avenue
Oak Creek Drainage Ditches	--	--	--	--	1	E. Puetz Road S. Pennsylvania Avenue
Rawson Avenue Tributary	--	--	--	--	1	S. 10th Street, S. 13th Street
Southland Creek	--	--	--	--	1	S. 13th Street
Unnamed Creek 5	--	--	--	--	1	Willow Drive, S. Wake Forest Drive

[a] *Some existing MMSD water quality sampling stations are located at the same site as the USGS stream gage or WDNR biology stations.*

[b] *Listing of sites for potential sampling stations is based upon examination of maps and locations where sampling has been conducted in the past. While the availability of historical data is an important consideration in selecting sampling station location, accessibility and safety should also be considered in the choice of sampling sites, especially if monitoring is to be done by volunteers. The final choice of sampling locations should be based upon field reconnaissance.*

Source: SEWRPC

3. **Establish one additional water quality monitoring station on the Mitchell Field Drainage Ditch.** Siting this station at a location that has been previously monitored would allow for the assessment of temporal trends. Samples should be collected every month and analyzed for water temperature, water chemistry, and fecal indicator bacteria.

4. **Survey the Oak Creek watershed for freshwater mussels every 10 years.** A standard protocol should be used to ensure the comparability of results among surveys. Mussel surveys could be conducted by the WDNR or by a consultant. It is suggested that future surveys record and report the amount of time spent surveying each sample site and the size of each area surveyed. This information would allow for the computation of the catch per unit effort at each site, which would make it possible to compare relative population sizes among sites.

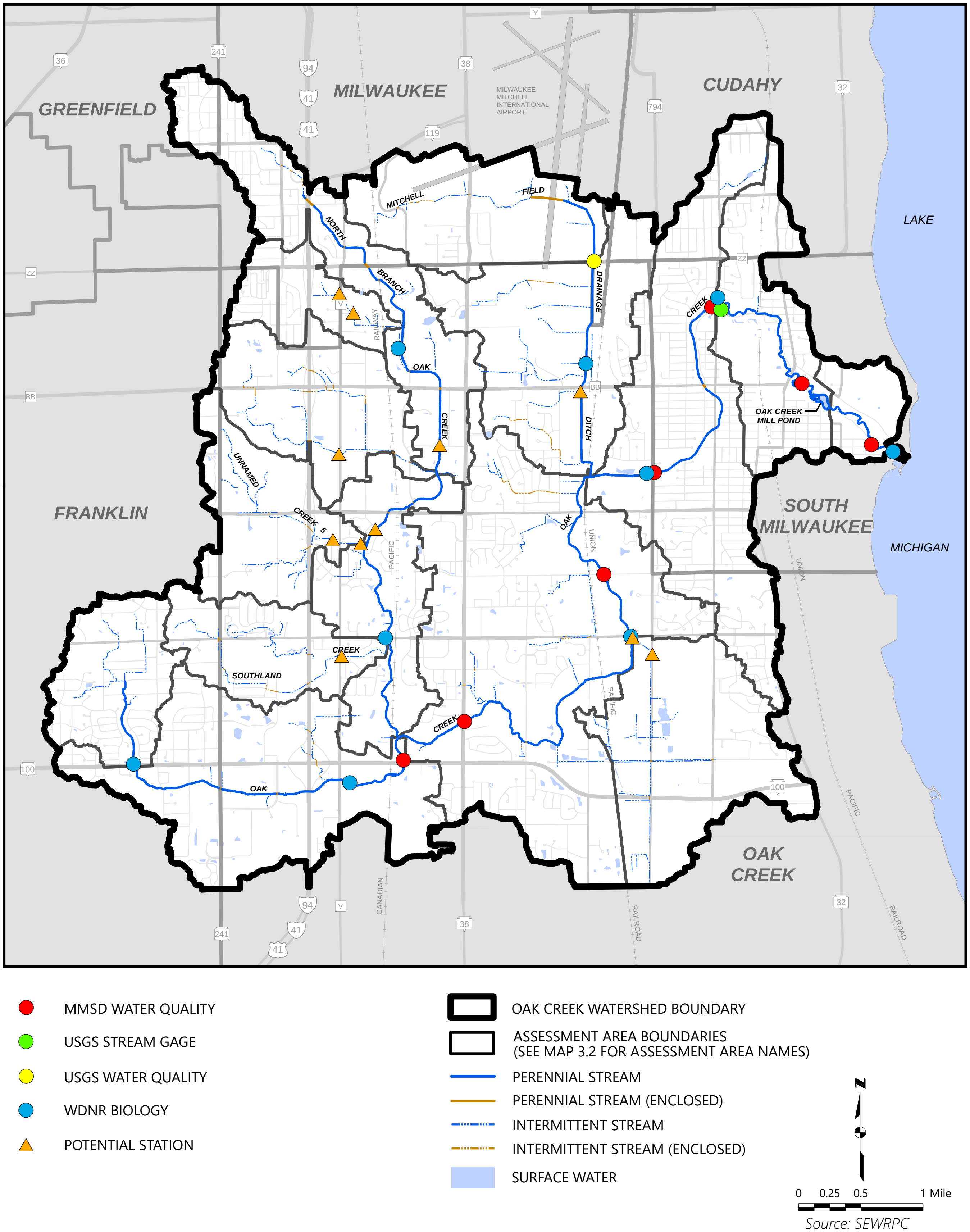
5. **Conduct additional sediment sampling in the lower reaches of the mainstem of Oak Creek within and downstream of the Mill Pond to determine the amount, extent, and source of PCB contamination.** This assessment should include collection and examination of sediment cores to characterize the extent, types, and amounts of contaminants within the sediment through its entire depth.

6. **Collect and analyze and evaluate sediment samples for contaminants from the Mill Pond in accordance with the requirements set forth in Chapter NR 347, "Sediment Sampling and Analysis, Monitoring Protocol and Disposal Criteria for Dredging Projects," of the *Wisconsin Administrative Code* prior to any dredging to remove sediment from the Mill Pond or prior to removal of the Mill Pond dam.**

7. **Deploy a continuous dissolved oxygen monitoring device in the Mitchell Field Drainage Ditch.** Deployment of such a device will help to better characterize causes and effects of low dissolved oxygen concentrations in this stream.

8. **Sample and analyze stream sediment in the Oak Creek watershed for PAHs.** In recent years, several municipalities in the Oak Creek watershed have banned the use of coal-tar-based pavement sealants, a major source of PAHs to waterbodies. Monitoring PAH concentrations in stream sediment

Map 6.38
Recommended Water Quality Monitoring Stations for the Oak Creek Watershed



Source: SEWRPC

over time will provide information on the length of time needed to result in improvements in sediment quality sufficient to avoid regular exceedance of sediment quality guidelines for aquatic life.

9. **Assess water samples from the Oak Creek watershed for concentrations of PFAS chemicals.** While PFAS contamination in soil and groundwater has been reported at some locations in the Oak Creek watershed, little is known about the concentrations of these chemicals in surface waters of the watershed. Such monitoring will establish baseline levels.

10. **Collect and analyze water and sediment samples for emerging pollutants such as pesticides, pesticide degradation products, pharmaceuticals, flame retardants, and sewage contamination indicators.** These data could be combined with water and sediment chemistry, biological, toxicity and other available data to better assess the integrity of the stream system.

11. **Assess the availability of phosphorus contained in sediment to algae and the potential for harmful blooms of cyanobacteria to occur in the Oak Creek watershed.** Such a monitoring project would provide data for assessing the amount of legacy phosphorus in streambed sediments and provide baseline data on the abundance of cyanobacteria that can produce harmful algal blooms.

Table 6.34 and Map 6.38 summarize the recommended expansion of the water quality monitoring network for the Oak Creek watershed and identify potential locations for establishing the additional sampling stations along tributary streams. Several factors should be considered when siting these stations, including the suitability of the stream for the type of sampling contemplated at the potential stations, the availability of past monitoring data from the site of the potential station, accessibility of the site, and safety considerations. The selection process for sites for monitoring stations should include a field examination of the sites. Final selection of sites for monitoring stations should be made in consultation with field staff.

The recommended expansion of water quality monitoring in the Oak Creek watershed will provide several benefits related to the management of surface waters in the watershed. First, this expansion of monitoring activities to additional tributaries will allow for the development of a more complete picture of the state of water quality conditions in the watershed. This more complete picture may be useful for determining the sources of local water quality problems. In addition, observed water quality data are essential to the calibration and validation of water quality models used to assess anticipated future water quality conditions. Expansion of the observed water quality database for the watershed would enable future refinement of the water quality models through additional calibrations. This will be especially valuable should the WDNR or some other party develop a Total Maximum Daily Load (TMDL) study to address water quality impairments in the watershed. Second, expansion of monitoring activities to additional tributaries will allow assessment of whether these waterbodies are meeting the water quality criteria that support their designated use objectives. Third, this expansion of monitoring activities to additional tributaries will provide information needed for informing the management of these waterbodies.

<u>Water Quality Indicators to Be Monitored</u>

There are numerous indicators available for measuring and describing water quality, including physical indicators such as water temperature, chemical indicators such as concentrations of suspended and dissolved substances, and biological indicators such as the abundance and taxonomic identities of the macroinvertebrates present. Historically, many different indicators have been used to assess the state of water quality in the Oak Creek watershed. The list of constituents given in Table 6.35 includes those physical and chemical indicators that were routinely monitored in the Oak Creek watershed by at least one monitoring program during the period 2015-2017.

As previously described, several agencies and organizations are currently conducting monitoring activities in the Oak Creek watershed. While there is overlap among these monitoring programs in which water quality constituents they sample and analyze, each program monitors a unique suite of indicators. There are several reasons for this.

In part, this reflects the natures of the constituents. Some constituents, such as water temperature, pH, and water transparency, can be assessed relatively easily and inexpensively in the field. Others, such as total phosphorus and fecal indicator bacteria, require that water samples be transported to laboratory facilities for chemical or biological analysis. Sampling and analysis of some constituents, such as many metals and organic compounds, may require the use of highly specialized sampling techniques and analytical equipment.

The differences in the constituents monitored by the different programs also reflect differences in the capacities of these programs. Some of the programs have greater analytical capabilities and more resources than others. The need to use highly specialized techniques and equipment for sampling and analyzing some constituents impacts the ability of monitoring programs to monitor these constituents. For example, programs that rely upon volunteers to conduct sampling will be less suited to monitoring constituents that require highly specialized sampling techniques than those that have highly trained professional staff.

Finally, it is important to recognize that each monitoring program has its own monitoring goals. These goals may differ from program to program and achieving different goals may require different monitoring strategies, including monitoring different constituents.

In an ideal situation, there would be coordination among monitoring programs such that a consistent set of water quality constituents would be monitored throughout the watershed. Because of the considerations discussed in the previous paragraphs, it seems unlikely that this ideal could be achieved in the Oak Creek watershed in the foreseeable future. Despite this, it should be possible to achieve some additional convergence among the sets of constituents monitored by the various programs active within the watershed.

It is recommended that each of the programs conducting water quality monitoring within the Oak Creek watershed continue monitoring the constituents that they are currently monitoring.

The list of physical and chemical indicators given in Table 6.35 is meant to provide guidance to monitoring programs in the Oak Creek watershed when they consider adding constituents to what they currently monitor. The table lists these in five tiers that roughly correspond to the priority for adding them to the suite of constituents in an existing program, with Tier 1 representing constituents of the highest priority for addition and Tier 5 representing constituents of the lowest priority.

The water quality constituents listed in Tier 1 are either easy to sample or important enough to sample that it is desirable that they be collected by all monitoring programs in the watershed. Several of the constituents listed in Tier 1 can be assessed in the field using hand-held meters or other field techniques. The main exceptions to this generalization are fecal indicator bacteria and total suspended solids which require that samples be transported to a laboratory for analysis. It should be noted that turbidity and water transparency assess the same factor. While assessment of turbidity gives a more precise measure, it generally requires that samples be transported to a laboratory for analysis. Water transparency can be measured in the field using a turbidity tube at stream and river sites or a Secchi disk at lake and pond sites. As part of Tier 1, one of these two constituents should be assessed.

It should also be noted that some constituents listed in Tier 1 such as water temperature, dissolved oxygen concentration, and specific conductance can be measured through the use of small, continuous monitoring devices. These devices can take measurements at finer time intervals than can be achieved through the collection and analysis of water samples.

The water quality constituents listed in Tier 2 represent the minimum set of additional water quality constituents that would be necessary to make assessments that are most critical to the water quality focus area of this plan. Assessing these constituents requires that samples be transported to a laboratory for analysis. As noted in Chapter 5 of this report, a major approach that this plan takes to address the impaired aquatic biological community in the Oak Creek watershed is to reduce phosphorus inputs into the surface water system. Monitoring of total phosphorus allows for a direct evaluation of the success of this approach. Monitoring of chlorophyll-*a* concentrations provides a check on this because this constituent is a measure of the biomass of the phytoplankton community. In freshwater systems, this community's growth is often limited by the availability of phosphorus and responds to additions of phosphorus. Monitoring chloride concentrations would help to address the water quality impairments related to chloride concentrations in the mainstem of Oak Creek, the North Branch of Oak Creek, and the Mitchell Field Drainage Ditch and allow for the refinement of statistical models relating specific conductance to chloride. Monitoring ethylene glycol

Table 6.35
Tiered List of Chemical and Related Water Quality Contituents for Monitoring

Tier 1			
Dissolved oxygen	pH	Suspended solids, total	Water Temperature
E. coli	Specific Conductance	Turbidity	Water Transparency
Tier 2			
5-day biochemical oxygen demand	Chloride	Chlorophyll-*a*	Ethylene glycol[a]
Phosphorus, total	Propylene glycol[a]		
Tier 3			
Alkalinity, total	Hardness	Magnesium, total	Nitrite-nitrogen[b,d]
Ammonia-nitrogen[b,c]	Kjeldahl nitrogen, total[b]	Nitrate-nitrogen[b,d]	Phosphorus, total dissolved
Calcium, total			
Tier 4			
20-day biochemical oxygen demand	Copper, total[e]	Organic carbon, total	Solids, total
Arsenic, total	Inorganic carbon, total	Organic carbon, total dissolved	Solids, total dissolved
Cadmium, total[e]	Lead, total[e]	Selenium, total	Solids, total volatile
Carbon, total	Nickel, total[e]	Silica, total dissolved	Zinc, total[e]
Chromium, total[e]	Mercury, total	Silver, total	
Tier 5			
Acenaphthene	Fluorene	2,2′,4,5′,6-pentachlorbiphenyl	PCB-1242
Acenaphthylene	Indeno-[1,2,3-c,d]-pyrene	3,3′,4,4′,5-pentachlorobiphenyl	PCB-1248
Anthracene	Naphthalene	2,2′,3,4,5,5′-hexachlorobiphenyl	PCB-1254
Benz-[a]-anthracene	Phenanthrene	2,2′,4,4′,5,6′-hexachlorobiphenyl	PCB-1260
Benzo-[a]-pyrene	Pyrene	3,3′,4,4′,5,5′-hexachlorobiphenyl	Perfluorobutane sulfonic acid (PFBS)
Benzo-[b]-fluoranthene	2,3-dichlorobiphenyl	2,2′,3,3′,4,4′,6′-heptachlorobiphenyl	Perfluoroheptanoic acid (PFHpA)
Benzo-[g,h,i]-perylene	2,4,5-trichlorobiphenyl	2,2′,3,3′,4,5,5′,6′-octachlorobiphenyl	Perfluorohexane sulfonic acid (PFHxS)
Benzo-[k]-fluoranthene	3,3′,5-trichlorobiphenyl	2,2′,3,3′,4,5,6,6′-octachlorobiphenyl	Perfluorononanoic acid (PFNA)
Chrysene	2,2′,4,4′-tetrachlorobiphenyl	PCB-1016	Perfluorooctane sulfonic acid (PFOS)
Dibenzo-[a,h]-anthrcene	3,3′,4,5′-tetrachlorobiphenyl	PCB-1221	Perfluorooctanoic acid (PFOA)
Fluoanthene	2,2′,3′,4,6-pentachlorbiphenyl	PCB-1232	

[a] *Ethylene glycol and propylene glycol are major components of deicing and anti-icing fluids. It is recommended that monitoring conducted at sites along the Mitchell Field Drainage include these compounds.*

[b] *In order to fully characterize nutrient conditions related to nitrogen, ammonia, total Kjeldahl nitrogen, nitrate, and nitrite should be collected together.*

[c] *The toxicity of ammonia to aquatic organisms is dependent upon ambient temperature and pH. Because of this, always sampling for water temperature and pH when ammonia samples are collected would aid in the interpretation of ammonia concentration data.*

[d] *Some monitoring programs sample for and report a combined concentration of nitrate plus nitrite.*

[e] *The toxicity of cadmium, chromium, copper, lead, nickel, and zinc to aquatic organisms is dependent on the hardness of the water. Because of this, always sampling for hardness when samples are collected for any of these metals would aid in the interpretation of the metal concentration data.*

Source: SEWRPC

and propylene glycol in the Mitchell Field Drainage Ditch would help to address the chronically low dissolved oxygen concentrations present in this stream. Given the high biochemical oxygen demand associated with these compounds, it may also be prudent to conduct some sampling for these compounds at a station along the mainstem of Oak Creek downstream from the confluence with the Mitchell Field Drainage Ditch.

The constituents listed in Tier 3 comprise those constituents needed to give a complete picture of the status of major plant nutrients within the surface water system and several constituents whose chemistries affect the chemistry of other substances in water. Assessing these constituents requires transporting samples to a laboratory for analysis. There are three issues that should be noted about the nitrogen-related constituents in this tier. First, the toxicity of ammonia to aquatic organism depends upon ambient water temperature and pH, as well as the ambient concentration of ammonia. Whenever sampling is conducted for ammonia, sampling should also be conducted for water temperature and pH. Second, some laboratories analyze and report combined concentrations of nitrate and nitrite. In order to get a complete picture of nitrogen conditions, sampling should be conducted either for combined nitrate-plus-nitrite or for both nitrate and nitrite. Third, complete characterization of nitrogen conditions within surface waters requires that ammonia, Kjeldahl nitrogen, nitrate, and nitrite be sampled simultaneously. This allows for the calculation of organic nitrogen and total nitrogen. These four constituents should be sampled together.

Tier 4 includes those constituents not included in higher priority tiers required to characterize conditions related to minor plant nutrients, solids, and several toxic metals in surface waters. Assessing these constituents requires transporting samples to a laboratory for analysis. Assessment of several of these constituents also requires using of highly specialized techniques and equipment for conducting sampling and analysis. It should be noted that the toxicity of cadmium, chromium, copper, lead, nickel, and zinc to aquatic organisms depends upon the hardness of the water, as well as the concentration of the metal. Whenever sampling is conducted for these metals, sampling should also be conducted for hardness.

The constituents listed in Tier 5 consist of several organic compounds of environmental concern that are classified either as polycyclic aromatic hydrocarbons (PAHs), individual polychlorinated biphenyl compounds (PCB congeners), commercial mixtures of PCB congeners, or perfluoroalkyl substances (PFAS). Assessing these constituents requires both transporting samples to a laboratory for analysis and using highly specialized techniques and equipment for conducting sampling and analysis.

While this watershed management plan envisions that monitoring programs will add constituents to the suites they sample on a tier-by-tier basis, it recognizes that particular management issues and the goals and objectives of individual monitoring programs may require that some constituents be added to sampling suites without regard to their presence or locations in this tiered list. **It is recommended that, in the absence of other such considerations, monitoring programs in the Oak Creek watershed follow this tiered scheme when adding constituents to the suite that they sample and analyze.**

Periodically Analyze Monitoring Data and Report Results

Data analysis is an integral component of the water quality management process. For monitoring programs to be useful in guiding management decisions, generating good data is not enough. The data must be processed and presented in a manner that aids understanding of the spatial and temporal patterns in water quality. The data must be placed into a context that reveals the existing state of water quality conditions and any changes or trends occurring in those conditions. This should be a context that takes the natural processes and characteristics of the watershed into account, that allows the impact of human activities upon the watershed to be understood, and that enables the consequences of management actions to be predicted. Establishing such a context requires that monitoring data be periodically analyzed, interpreted, and summarized. This should be done at a frequency that provides decision makers and managers with reasonably current information while recognizing the substantial effort that is required to analyze and interpret data from a watershed the size of the Oak Creek watershed.

Since 1964, eight studies, including this watershed restoration plan, have presented analyses, interpretations, and summaries of water quality conditions in the Oak Creek watershed. These studies are listed in Table 6.36. Most of these studies were conducted either as part of or in conjunction with major planning efforts, including efforts that developed a comprehensive watershed plan and that developed and updated the regional water quality management plan, the MMSD's facilities plan, and the State's basin plan. It should be noted that some of these studies examined subsets of the data that were available at the time of the study. For example, some studies examined data from only a portion of the available record, generally incorporating data collected since about 1976. Despite the narrow focus of some of these studies, there has been a tendency over time for studies examining water quality in the Oak Creek watershed to examine a larger set of water quality indicators and to incorporate data from a greater variety of sources.

Table 6.36
Studies Presenting Analyses of Water Quality in the Oak Creek Watershed

Study	Period of Record Examined	Sources of Water Quality Data	Water Quality Indicators Analyzed	Comments
SEWRPC Technical Report No. 4, *Water Quality and Flow of Streams in Southeastern Wisconsin,* April 1967	1964	SEWRPC, USGS	Water chemistry, stream flow	Initial regional benchmark study
SEWRPC Technical Report No. 17, *Water Quality of Lakes and Streams in Southeastern Wisconsin: 1964-1975,* June 1978	1964-1975	SEWRPC, USGS, WDNR	Water chemistry, stream flow, bacteria	Study supporting development of regional water quality management plan (SEWRPC PR-30)
SEWRPC Planning Report No. 36, *A Comprehensive Plan for the Oak Creek Watershed,* August 1986	1952-1983	SEWRPC, USGS, WDNR	Water chemistry, stream flow, bacteria, macroinvertebrates	Comprehensive watershed plan
SEWRPC Memorandum Report No. 93, *A Regional Water Quality Management Plan Update for Southeastern Wisconsin: An Update and Status Report,* March 1995	1976-1993	USGS, WDNR	Water chemistry, stream flow, bacteria, macroinvertebrates, toxicology	Update and status report on regional water quality management plan
Wisconsin Department of Natural Resources, *The State of the Root-Pike River Basin,* WDNR PUBL WT-700-2002, May 2002	Not specified	WDNR	Assessment of use impairments	WDNR basin plan for Root-Pike Basin
SEWRPC Technical Report No. 39, *Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds,* November 2007	1976-2001	MMSD, USGS, WDNR	Water chemistry, stream flow, bacteria, fisheries, macroinvertebrates, toxicology	Study supporting development of RWQMPU (SEWRPC PR-50)
Wisconsin Department of Natural Resources, *Oak Creek Frontal Lake Michigan TWA WQM Plan 2017,* EGAD 3200-2017-11, 2017	2015	WDNR	Fisheries, macroinvertebrates	WDNR targeted watershed assessment water quality management plan
SEWRPC Community Assistance Planning Report No. 330, *A Restoration Plan for the Oak Creek Watershed,* 2021	1952-2016	MMSD, MKER, RHD, SEWRPC, USGS, WDNR	Water chemistry, stream flow, bacteria, fisheries, macroinvertebrates, toxicology	Nine key element watershed restoration plan

Note: Acronyms indicate the following:

MMSD = Milwaukee Metropolitan Sewerage District
MKER = Milwaukee Riverkeeper
RHD = City of Racine Public Health Department
SEWRPC = Southeastern Wisconsin Regional Planning Commission
USGS = U.S. Geological Survey
WDNR = Wisconsin Department of Natural Resources

Source: SEWRPC

The intervals between the conduct and release of studies examining water quality in the Oak Creek watershed have been irregular. The interval between the release of this watershed restoration plan and the last major examination of water quality in the Oak Creek watershed is about 14 years. This is tied for the longest interval between studies that included examination of water chemistry. Other such intervals were on the order of eight to 11 years.

It is recommended that monitoring data for the Oak Creek watershed be collated, analyzed, and placed into context at an interval no greater than once every 10 years. This effort should include review and analysis of a wide variety of data and should include data from all publicly available sources. While the full range of data to be incorporated into these studies will depend upon availability, these studies should seek to include those data that have become available since the previous study, including such indicators as streamflow, water chemistry, fecal indicator bacteria, biological conditions, land use, stream channel conditions, habitat conditions, recreational use, and abundance and distribution of aquatic invasive species, as well as other indicators for which data that are deemed important or informative are available at the time the study is conducted. As part of collating and analyzing these data, they should be compared to historical data. Such a comparison is necessary, both to assess trends in conditions within the watershed and to determine and document whether those conditions are improving or worsening. These analyses should include an assessment of the achievement of water use objectives through a comparison of the data to the applicable water quality criteria. These studies should assess the adequacy of the data and identify any gaps in the data. Finally, the analyses, results, and conclusions of these studies should be published and made available to the public and to the agencies and organizations involved in the management of the Oak Creek watershed.

Costs of Monitoring Recommendations

The cost of maintaining the existing water quality monitoring network was estimated based upon consultations with the agencies conducting monitoring during development of the Oak Creek watershed restoration plan and the Root River watershed restoration plan.[189] Because these are existing stations, no capital costs are associated with maintaining the existing monitoring network in the Oak Creek watershed. The annual operations and maintenance costs for these stations is estimated to be about $183,400. Table 6.37 presents estimated costs attributable to each element of the existing monitoring network. Note that the cost estimate associated with biological monitoring conducted by the WDNR assumes that this monitoring will be conducted once every four years.

The cost of the recommended expansion of the water quality monitoring network in the Oak Creek watershed was estimated based upon consultations with the agencies that are anticipated to participate in this expansion. The capital costs associated with the expansion are estimated to be $3,900. These costs are associated with purchase of equipment and software for continuous monitoring of dissolved oxygen and for outfitting volunteer stream monitors. Annual operation and maintenance costs associated with the recommended expansion of the monitoring network are estimated to be $14,590. Table 6.37 presents estimated costs attributable to each element of the expanded monitoring network. These estimates assume that monitoring at the eight additional stream monitoring stations will be conducted through the UWEX/WDNR Water Action Volunteers Program, and that the mussel survey will be conducted once every 10 years. The mussel survey could be conducted by the WDNR, a local college or university, or a consultant.

The cost of the recommended collation and analysis of monitoring data is estimated at $39,000, which is anticipated to be incurred once every 10 years.

Tracking Implementation of Plan Recommendations

The ultimate test of whether watershed restoration activities are having a beneficial effect on conditions is the evidence of improvement in conditions shown in environmental monitoring data. Unfortunately, while this is simple in concept, several factors make it difficult to detect the impacts of restoration activities over a relatively short time period. An example of this is given by factors that complicate the interpretation of water quality monitoring data.

[189] *SEWRPC Community Assistance Planning Report No. 316,* A Restoration Plan for the Root River Watershed, *July 2014*.

Table 6.37
Capital and Annual Operations and Maintenance Costs Associated with the Water Quality Monitoring Recommendations of the Oak Creek Watershed

Recommendation	Capital Cost (dollars)	Annual Operations and Maintenance Cost (dollars)
Costs to Maintain Existing Monitoring System		
Existing USGS Stream Gage (one gage)	--	11,100
MMIA/USGS Monitoring (one sampling station)	--	37,000
MMSD Oak Creek Survey (seven sampling stations)	--	48,000
MMSD/USGS Toxicity Testing and Biological Monitoring (one sampling station)	--	6,700[a]
WDNR Biological Monitoring	--	1,750[b]
Milwaukee County Parks Vegetation and Floristic Surveys	--	44,600
Milwaukee County Parks Wildlife Monitoring	--	28,300
Milwaukee County Parks Invasive Species Monitoring[c]	--	5,900
Subtotal	--	183,350
Costs to Expand Existing Monitoring System		
Establishing Additional Stream Monitoring Stations (eight sampling stations)	2,400[d]	640[e]
Mussel Survey	--	1,000[f]
Continuous Dissolved Oxygen Monitoring (one sampling station)	1,500[g]	50[h]
Sediment Sampling for PAHs (two sampling stations)	--	2,360[i]
PFAS Sampling (two sampling stations)	--	3,800[j]
Emergent Pollutant Sampling (one sampling station)	--	4,030[k]
Sediment Phosphorus and Cyanobacteria Sampling (one sampling stations)	--	2,730[l]
Subtotal	3,900	14,590
Total	3,900	197,940

Note: Costs are given in 2019 dollars.

[a] *The cost of this monitoring is about $20,000 per season. The cost listed assumes that monitoring is conducted every third year.*

[b] *The cost of this monitoring is $7,000 for a season on monitoring. The cost listed assumes monitoring is conducted every fourth year. The annual cost would be $1,400 if monitoring is conducted every fifth year.*

[c] *This cost includes some select control of invasive species conducted as part of the monitoring effort.*

[d] *The cost is based on the assumption that monitoring at these stations will be conducted through the University of Wisconsin-Madison Division of Extension/Wisconsin Department of Natural Resources Water Action Volunteers program. It represents the cost of eight monitoring kits for WAV Level 1 monitoring.*

[e] *The cost is based on the assumption that monitoring at these stations will be conducted through the University of Wisconsin-Madison Division of Extension/Wisconsin Department of Natural Resources Water Action Volunteers program and that each station is sampled for total phosphorus for one summer every five years.*

[f] *The cost of this monitoring is about $10,000 per season. The cost listed assumes that monitoring is conducted every tenth year.*

[g] *The capital cost is based on the cost of a data logger for dissolved oxygen and associated software and equipment.*

[h] *Operation and maintenance cost is based on the cost of calibration solution for dissolved oxygen data logger. It is assumed that the logger will be deployed and recovered as part of other monitoring activities.*

[i] *This element is part of a proposed Phase VI to the MMSD/USGS Corridor Study. Costs assume that sampling is conducted three times over a 10-year period at two locations in the Oak Creek watershed. As of June 2021, MMSD and USGS have not chosen the number or locations of monitoring stations in the Oak Creek watershed.*

[j] *This would be a three-year study proposed as part of a potential Phase VI to the MMSD/USGS Corridor Study at a cost of about $9,490 per site. Costs assume that sampling is conducted at two locations in the Oak Creek watershed. As of June 2021, MMSD and USGS have not chosen the number or locations of monitoring stations in the Oak Creek watershed. Annual costs are spread over five years.*

[k] *This would be a three-year study at a cost of about $20,140 per site. Annual costs are spread over five years.*

[l] *This would be a three-year study proposed as part of a potential Phase VI to the MMSD/USGS Corridor Study at a cost of about $13,650 per site. Costs assume that sampling is conducted at one location in the Oak Creek watershed. As of June 2021, MMSD and USGS have not chosen the number or locations of monitoring stations in the Oak Creek watershed. Annual costs are spread over five years.*

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, University of Wisconsin-Madison Division of Extension, Milwaukee Metropolitan Sewerage District, Milwaukee Mitchell International Airport, Milwaukee Riverkeeper, and SEWRPC

First, many water quality indicators show high variability. This variability can obscure changes and trends. As a result, long-term data sets comprised of large numbers of samples can be required to detect the changes in water quality conditions resulting from the implementation of watershed restoration activities.

Second, there are likely to be reservoirs of pollutants stored within the watershed. Examples of these reservoirs in the Oak Creek watershed include legacy phosphorus contained in both soils and sediment deposits on streambeds and lakebeds, and chloride contained in groundwater. It can take time, sometimes years or decades, for these stored pollutants to pass through the system. Mobilization of pollutants from these reservoirs can cause reductions in water quality, even in the presence of reduced loadings from point and nonpoint sources. As a result, the presence of these reservoirs can produce time lags between the implementation of a watershed restoration activity and the impact of the activity upon ambient conditions.[190]

Third, the pollutant load reductions produced by any single practice installed in the watershed are relatively small when compared to the pollutant load reductions needed to produce the level of water quality envisioned in the RWQMPU or to meet water quality standards. For example, the results of the calibrated water quality model indicated that an annual reduction in the load of TSS of about two million pounds would be necessary to produce the envisioned level of water quality in the Oak Creek watershed. Preliminary studies of potential stormwater ponds for the City of South Milwaukee indicate that the range of reduction in TSS washed off the land surface each year achieved by these ponds could be expected to be between about 5,800 and 46,000 pounds TSS, depending upon factors such as pond size, location, tributary land use, and contributing area.[191] On a watershed basis, these reductions each represent less than about 2 percent of the needed reductions. While these reductions may represent somewhat larger fractions of the required load reductions on a subwatershed basis, they are still small relative to the needed reductions.

Fourth, it is important to recognize that water quality conditions at any site in a watershed reflect the cumulative effects of all the influences at the site and at all points in the watershed that are directly upstream of the site. Monitoring data will always reflect an integration of these influences.

As a result, though a management practice may be functioning to greatly improve the future water quality of a waterbody, the visible effects of the practice, such as an increase in water clarity or a reduction in the concentrations of a nutrient, may not be immediately apparent and may only become apparent at some future time as part of the cumulative effects of many projects. Because of this, it will be useful to have a measure of progress in addition to the water quality monitoring data. To address this, **it is recommended that tracking efforts for the implementation of this watershed restoration plan be completed**.

For this plan to be most effective, it is important to track the projects and recommendations that are implemented. This could be best accomplished by having a reporting mechanism in which the organizations implementing recommendations of this plan report the initiation and completion of projects to some agency or agencies that would oversee the tracking of implementation. The role of the overseeing agency or agencies would be to receive these reports, periodically compile this information, and evaluate the status of the implementation of the watershed restoration plan.

It is recommended that the Milwaukee County Environmental Services Division act as the entity overseeing tracking of plan implementation. It is further recommended that all organizations acting to implement this plan report the initiation, completion, and details of projects implementing plan recommendations to the Milwaukee County Environmental Services Division.

Interim Measurable Milestones

Interim measurable milestones for the Oak Creek watershed restoration plan are presented in Table 6.38. These milestones provide standards against which progress in implementing the plan and the success of the plan can be assessed. They establish expectations as to the minimum progress that should be made in restoring

[190] *For a discussion of time lags in the response of water quality to implementation of management measures, see D.W. Means and S.A. Dressing, "Lag Time in Water Quality Response to Land Treatment,"* National Nonpoint Source Monitoring Program Tech Notes 4, *U.S. Environmental Protection Agency, 2008, available at www.epa.gov/polluted-runoff-nonpoint-source-pollution/nonpoint-source-monitoring-technical-notes.*

[191] *AECOM,* Stormwater Water Quality Management Analysis: Prepared for the City of South Milwaukee, *November 2008.*

Table 6.38
Implementation Milestones for the Oak Creek Watershed Restoration Plan

Category	Action	Milestones
Specific Projects Listed in Table 6.1	High Priority Projects (89 projects)	35 percent of projects initiated by the end of 2026 50 percent of projects completed by the end of 2031 65 percent of projects completed by the end of 2036 75 percent of projects completed by the end of 2041 90 percent of projects completed by the end of 2046 100 percent of projects completed by the end of 2051
	Medium and Low Priority Projects (317 projects)	5 percent of projects initiated by the end of 2026 15 percent of projects completed by the end of 2031 30 percent of projects completed by the end of 2036 40 percent of projects completed by the end of 2041 50 percent of projects completed by the end of 2046 65 percent of projects completed by the end of 2051 100 percent of projects completed after 2051
Water Quality: Urban Nonpoint Source Pollution Control	1. MS4 Illicit Discharge Detection and Elimination Program Modifications	Modifications completed by all seven MS4s by the end of 2026
	2. Development and Implementation of BMP Maintenance Tracking Systems	Systems implemented by all seven MS4s by the end of 2026
	3. Iron-Enhanced BMP Pilot Projects	1 project installed by the end of 2026 3 projects installed by the end of 2031
Water Quality: Green Infrastructure Installation	1. MMSD Green Infrastructure Plan Implementation[a]	48 percent of recommended practices by the end of 2026 77 percent of recommended practices by the end of 2031 100 percent of recommended practices by the end of 2035
	2. City of South Milwaukee Urban Forestry Plan Implementation	200 dead or diseased tree removed and 625 tree plantings by the end of 2031 400 dead or diseased tree removed and 1,250 tree plantings by the end of 2031
	3. Development and Implementation of Green Infrastructure Tracking System	Full implementation by all six municipalities in the watershed by the end of 2026
Water Quality: Reducing Concentrations of Fecal Indicator Bacteria and Pathogens	1. Mycoremediation Pilot Projects	1 project installed by the end of 2031 3 projects installed by the end of 2036
Water Quality: Reducing Chloride Concentrations	1. Developing Winter Road Management Plans, Salt Application Strategies, or Salt Reduction Strategies	Plans or strategies completed and implemented by all seven MS4s by the end of 2031
Water Quality: Toxic Substances and Emerging Pollutants	1. Enact Ordinances Banning the Use of Coal-Tar Pavement Sealants	Ordinances enacted by all six municipalities in the watershed by the end of 2026
Habitat: Maintaining and Reestablishing Natural Surface Water Hydrology	1. Rain Garden Installation at Public Schools	1 rain garden installed at each public school in the watershed by the end of 2026
	2. Rain Barrel Installation at Public Schools	1 rain barrel installed at each public school in the watershed by the end of 2026
	3. Restoration of Milwaukee County Leased Agricultural Land to Forest, Grassland, or Wetland Conditions[b]	25 percent of leased agricultural lands restored by the end of 2026 100 percent of the leased agricultural lands restored by the end of 2031
Habitat: Protecting, Maintaining, Expanding, and Restoring Riparian Buffers[b]	1. Establish 75-foot Minimum Width Buffers Along Streams	Achieve the minimum buffer along 75 percent of stream length in the watershed by the end of 2026
Habitat: Invasive and Nonnative Species Management	1. Implementation of Guidelines in SEWISC Right of Way Invasive Species Management Plan	Implementation by Milwaukee County and all six municipalities in the watershed by the end of 2026

Table continued on next page.

Table 6.38 (Continued)

Category	Action	Milestones
Habitat: Restoring Degraded Stream Channels	1. Improve floodplain functionality for stream channels that are disconnected from their floodplains but confined by urban development[b]	1 project area addressed by the end of 2028 3 project areas addressed by the end of 2036 All project areas addressed by the end of 2041
Habitat: Remove or Modify Passage Impediments	1. Conduct Fish Passage Assessments for All Unassessed Stream Crossings in the Watershed[b]	All remaining crossings assessed by the end of 2026
	2. Develop Plans to Replace or Modify Identified Fish Passage Impediments[b]	Develop plans for all Tier 1 impediments excluding the Mill Pond dam by the end of 2026 Develop plans for all Tier 2 impediments by the end of 2031 Develop plans for all Tier 3 impediments by the end of 2036
	3. Address Major Woody Debris Jams that Constitute Passage Barriers[b]	Assess all major debris jams by the end of 2024 Selectively remove small sections of all debris jams found to be complete passage barriers by the end of 2026
Habitat: Address Streambank and Streambed Erosion[b]	1. Conduct Streambank Stability Surveys on Streams in the Watershed that Have Not Been Assessed	Assess all remaining streams by the end of 2026
	2. Conduct Survey of Outfalls That Were Not Assessed to Confirm Location, Dimensions, Materials, and Condition	Assess all remaining outfalls by the end of 2026
Mill Pond and Dam	1. Core Sampling and Analysis of Mill Pond Sediment	Complete sampling and analysis by the end of 2023
Monitoring	1. Stream Water Quality Monitoring Stations	Install 8 additional stations by the end of 2026
	2. Dissolved Oxygen Monitoring in the Mitchell Field Drainage Ditch	Install 1 data logger by the end of 2026
	3. Biological Monitoring	Conduct 1 fish and macroinvertebrate survey by the end of 2026 Conduct 2 fish and macroinvertebrate surveys by the end of 2031
	4. Mussel Survey	1 mussel survey by the end of 2026
	5. Collation and analysis of monitoring data	One report by the end of 2031
Plan adoption	1. Adoption of plan by local units of government	Adoption or endorsement by Milwaukee County and all 6 municipalities by the end of 2024

[a] *The implementation timeline for the MMSD green infrastructure plan is given in Table 6.10. Elements constituting full implementation are given in Table 6.9.*

[b] *Some actions in this category are also addressed by specific projects in Table 6.1.*

Source: SEWRPC

the watershed. If minimum progress is not being made, the plan will be reevaluated and revised with new interim milestones. Adjustments to this plan will be made based on measured progress towards plan interim milestones and also after any additional new water quality monitoring data, management tools, and/or BMPs are implemented or obtained over time. See "Evaluating the State of Plan Implementation and the Success of the Plan" section below for additional information on tracking progress against this plan's interim milestones.

Evaluating the State of Plan Implementation and the Success of the Plan

Evaluating a watershed restoration plan's implementation is a continuing function. Due to several factors including the inherent variability of water quality constituents, the variability in the reduction efficiencies of best management practices in this plan, and the presence of reservoirs of pollutants such as legacy phosphorus in the watershed, **it is recommended that an adaptive approach to management be followed in the Oak Creek watershed.**[192] An adaptive approach to management is a process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management activities and other events become better understood. It is an iterative approach that involves monitoring to learn about the impacts of management actions, evaluating the results of those actions, and adjusting actions based on what has been learned. The components of an adaptive approach to management are illustrated in Figure 6.29.

Following an adaptive approach to management requires that a body be designated to periodically evaluate the state of plan implementation. Given the continuing nature of planning, it would also be desirable that this body be available to coordinate and advise on the execution of this watershed restoration plan and to undertake plan updating as necessitated by changing events. Given the roles of local governments and private organizations in plan implementation, the active participation of representatives from these organizations in such a body is crucial.

Based on these considerations, **it is recommended that the Oak Creek Watershed Plan Advisory Group be maintained as a continuing advisory committee to provide advice and coordination for and to evaluate the state of implementation of this watershed restoration plan.** Consideration should be given to adding members to this group as needed, with these additional members being drawn primarily from local units of governments and private organizations that are actively implementing plan recommendations.

It is recommended that the Advisory Group meet annually at the request of the Milwaukee County Environmental Services Division to evaluate the status of plan implementation. This evaluation will include review of the project reports received by the Milwaukee County Environmental Services Division as well as other available information relevant to evaluating plan implementation. Examples of such information include, but are not limited to, annual reports that are submitted by land conservation departments and MS4 communities to the applicable regulatory agencies, annual reports submitted by parks departments to the public, summaries of water quality data, land use data, and updated information on BMP performance.

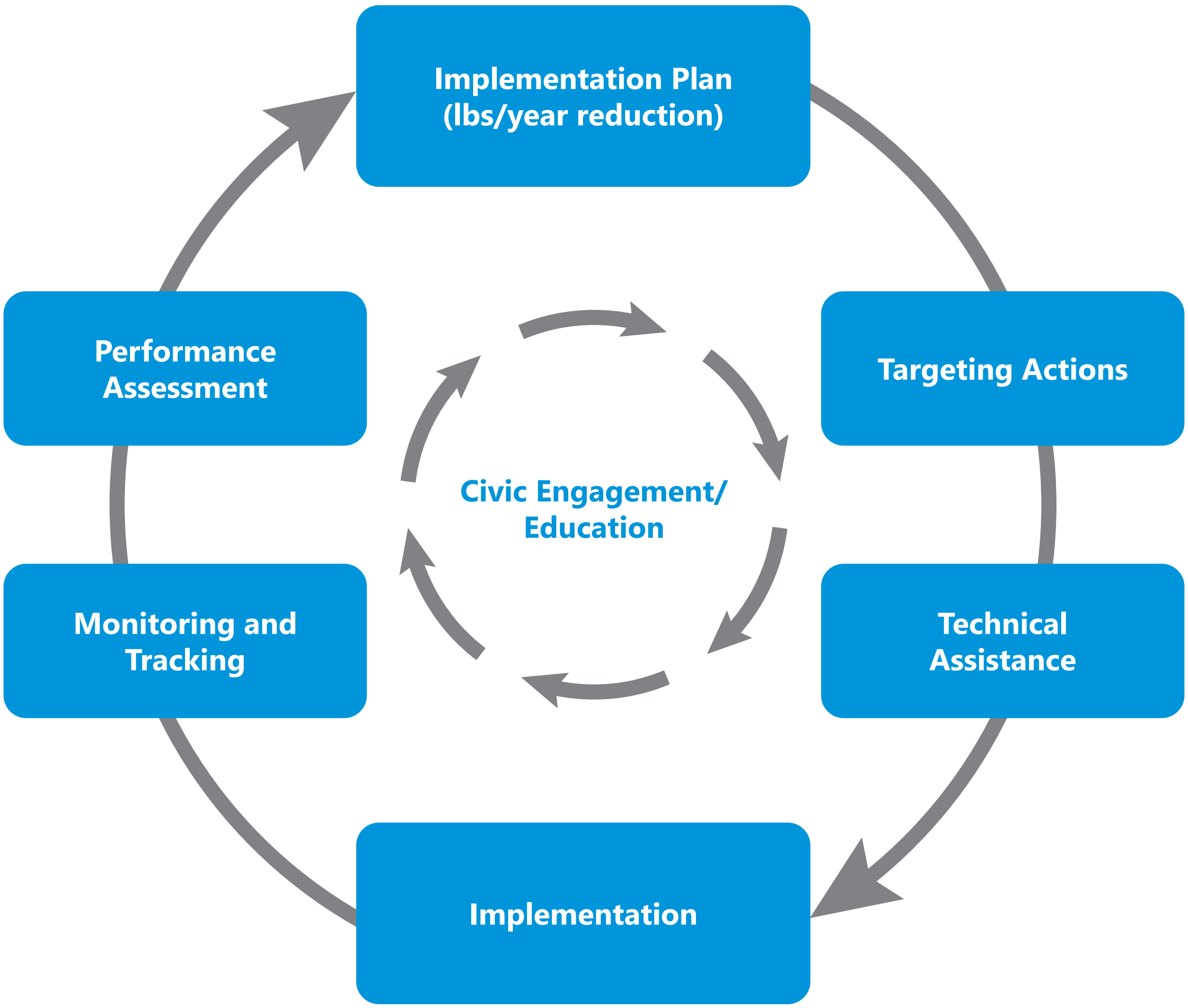
The Advisory Group will evaluate progress in plan implementation against the milestones set forth in Table 6.38. These milestones reflect the schedule for plan implementation given later in this chapter. Based upon its evaluation, the Advisory Group will determine whether plan implementation is proceeding in accordance with the schedule. Based upon this determination it will provide advice to organizations implementing the plan regarding implementation strategies.

As part of its review process the Advisory Group will examine the plan and efforts to implement it to determine whether any adjustments or modifications in plan recommendations or priorities are warranted. The issues that should be addressed in this review include, but are not limited to:

- Whether conditions within the watershed have changed in ways that require adjustment of the plan
- Whether public priorities with respect to the focus areas of the plan have changed
- Whether the regulatory environment with respect to the focus areas of the plan has changed
- The degree and extent of progress made in implementing recommended actions
- Whether recommended practices are performing as anticipated
- Whether the elements and priorities of the plan should remain unchanged or need modification
- Whether new plan elements are needed
- Whether applicable funding programs and levels of funding have changed

[192] *In much of the literature this is referred to as an adaptive management approach or adaptive management; however, it is referred to in this report as an adaptive approach to management in order to avoid confusion with the option described in Chapter NR 217 of the* Wisconsin Administrative Code *for point sources to comply with phosphorus discharge limits*.

Figure 6.29
Adaptive Approach to Management



Source: Adapted from the Implementation Plan for Lake St. Croix Nutrient Total Maximum Daily Load and SEWRPC

The review should pay particular attention to two issues: BMP depreciation and legacy phosphorus.

As discussed earlier in this chapter, BMPs can become less efficient over time due to factors such natural variability, lack of proper maintenance, and changing weather patterns.[193] Because of this, assessment of the performance of practices will be an important consideration in evaluating progress toward meeting the goals of this plan.

Legacy phosphorus consists of phosphorus that is retained in the watershed. Sources of legacy phosphorus include phosphorus stored in sediments in stream- and pond-beds, streambanks, and floodplains; phosphorus contained in aquatic plants and algae; and phosphorus that has accumulated in soils and groundwater. This stored phosphorus can be released into surface water at a later time. The release of legacy phosphorus may obscure the effects of reduced phosphorus loadings, creating time lags between reductions of loadings and improvement of water quality. As discussed in Chapter 4 of this report, limited sediment chemistry data suggest that a considerable amount of legacy phosphorus may have accumulated in sediments in stream channels and the Mill Pond in the Oak Creek watershed. Thus, it is likely that there will be a delay between reductions of phosphorus loading to waterbodies of the watershed and

[193] *D.A. Meals and S.A. Dressing 2015,* op. cit.

responses including reductions of instream total phosphorus concentrations and biological responses such as chlorophyll-*a* concentrations and fish, macroinvertebrate, and benthic diatom indices. The presence of legacy phosphorus in the watershed is a factor that will need to be considered when evaluating progress toward meeting water quality standards and the goals of this plan.

It is recommended that any adjustments to the plan be documented through a memorandum that would be sent to the groups represented on the Advisory Group. Since the Advisory Group currently includes or could be expanded to include the major stakeholders and likely implementers, this should provide notice of the changes to the groups who need it most. **It is also recommended to make this memorandum available to the public by posting it on the Environmental Services page of the County's website and the Oak Creek Watershed Restoration Plan page of the Commission's website and by including it as an appendix to the County's subsequent update of its land and water resource management plan.**

6.10 PLAN IMPLEMENTATION

While the recommended plan is designed to achieve the goals and management objectives related to the focus areas presented in Chapter 5, the plan is not complete in a practical sense until the steps required to implement the plan—that is, to convert the plan into action policies and programs—are specified. This section provides that information and is intended as a guide for use in implementing the plan. It outlines the actions that must be taken by the various levels and agencies of government in concert with private sector organizations to fully carry out this recommended watershed restoration plan. Those units and agencies of government that have adoption and implementation powers applicable to the plan are identified; necessary or desirable formal plan adoption actions are specified; and specific implementation actions are recommended for each of the units and agencies of government with respect to recommendations addressing the focus areas; and the coordinated roles of the public and private sectors are described.

This watershed restoration plan can be implemented in three principal ways: 1) inventory, or the collection, analysis, and dissemination of basic planning data on a uniform, areawide basis; 2) implementing general recommendations designed to guide management activities in the watershed; and 3) implementing specific projects designed to meet the management objectives established for this watershed restoration plan.

A great deal can be achieved in guiding watershed development into a more desirable pattern through the simple task of collecting, analyzing, and disseminating basic planning and engineering data on a continuing, uniform, areawide basis. Experience within the Southeastern Wisconsin Region has shown that, if this important inventory function is properly carried out, the resulting information will be used and acted upon by local, State, and Federal agencies of government; nongovernmental organizations; and private entities. A wealth of definitive information about the Oak Creek watershed, including natural and manmade features, hydrology and hydraulics, instream conditions, habitat, recreational access and opportunities, and water quality problems was assembled under this planning effort. The use of this information base in arriving at development decisions on a day-to-day basis by the public and private interests involved contributes substantially toward implementation of the recommended plan.

The general recommendations provided in this plan are intended to guide management activities in the watershed. Unless otherwise indicated, general recommendations are intended to be broadly applicable over the entire watershed. These recommendations provide guidance for the management of water resources within the watershed with respect to a variety of general and specific factors and issues that contribute to the problems related to each of the four focus areas that this plan addresses.

The specific projects recommended in this plan represent actions that could partially implement the general recommendations given in this plan. Implementing these projects will contribute to meeting the management objectives related to the focus areas established in Chapter 5.

Plan Adoption

Upon completion of the Oak Creek watershed restoration plan the Commission will transmit a copy of the plan to all local legislative bodies within the watershed and to all existing Federal, State, areawide, and local units and agencies of government that have potential plan implementation functions.

A copy will be transmitted to the WDNR with a request that the Department review the plan, find it consistent with the nine key elements required by the USEPA for watershed restoration plans, and forward it to USEPA for review.

Adoption of the watershed restoration plan by the local legislative bodies and the existing local, areawide, State, and Federal level agencies concerned is recommended and is considered highly desirable to assure a common understanding among the several governmental levels and to enable their staffs to program the necessary implementation work. In addition, formal plan adoption may also be required for some State and Federal financial aid eligibility. A model resolution for adoption of the Oak Creek watershed restoration plan is included in Appendix U. Adoption of the recommended watershed restoration plan by any unit or agency of government pertains only to the statutory duties and functions of the adopting agencies. Such adoption does not and cannot in any way preempt or commit action by another unit or agency of government acting within its own area of functional and geographic jurisdiction.

Upon adoption of the plan by a unit or agency of government, it is recommended that the policymaking body of the unit or agency direct its staff to review in detail the elements of the watershed restoration plan. Once such review is completed, the staff can propose to the policymaking body for its consideration and approval the steps necessary to fully integrate the watershed plan elements into the plans and programs of the unit or agency of government.

Responsible Parties and Other Plan Implementation Organizations

Although the Regional Planning Commission can promote and encourage the implementation of this watershed restoration plan in various ways, the advisory role of the Commission makes actual implementation of the recommended plan dependent upon action by local, areawide, State, and Federal agencies of government and private organizations with an interest in improving conditions related to the plan's four focus areas. Examination of the various public agencies that are available to implement elements of the recommended plan reveals an array of departments, commissions, committees, boards, and districts at all levels of government. These agencies range from general-purpose local units of government such as counties, cities, villages, and towns, to special-purpose districts, such as metropolitan sewerage districts. These agencies also include State regulatory bodies, such as the WDNR, and Federal agencies that provide financial and technical assistance for plan implementation, such as the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS).

Because of the many and varied public agencies in existence, it becomes important to identify those agencies having the legal authority and financial capability to most effectively implement the recommended watershed restoration plan elements. Accordingly, those agencies whose actions will have a significant effect, either directly or indirectly, upon the successful implementation of the recommended plan and whose full cooperation in plan implementation will be essential are listed and discussed below. The agencies are, for convenience, listed by level of government; however, interdependence between the various levels, as well as between agencies of government, and the need for close intergovernmental cooperation, is essential to the successful implementing the plan recommendations.

Numerous private and nonprofit organizations can play an important role in implementing recommendations of this watershed restoration plan. These organizations include local chapters of larger national or regional organizations as well as smaller, community-based groups. The roles that these organizations can play in plan implementation and examples of such groups are also described in this section.

Local-Level Agencies

Several County and municipal agencies have missions and powers that are important to the implementation of this watershed restoration plan. Statutory provisions exist for the creation at the County and municipal level of the following agencies having planning and plan implementation powers, including police powers and acquisition, condemnation (eminent domain), and construction (tax appropriation) powers, important to watershed restoration plan implementation.

Milwaukee County Parks

Milwaukee County Parks conduct land management activities that are important for the implementation of this watershed restoration plan. As shown on Map 4.48 in Chapter 4 of this report, County parks, parkways and open space sites comprise a substantial portion of the riparian lands along the mainstem of Oak Creek and some of its tributary streams. These park and open space sites provide riparian buffers, habitat for wildlife, and corridors for recreational activities, including access to surface waters. As discussed in Chapter 2 of this report, the County has developed restoration and management plans for several of these sites, elements of which have been incorporated into this watershed restoration plan. The management and restoration of these lands gives this department a major role in plan implementation.

County Land and Water Conservation Committees

County land and water conservation committees are responsible for land conservation programs within the County and are also responsible for implementing the State's soil and water resource management program. In Milwaukee County, the members of the Milwaukee County Board Parks, Energy & Environment Committee serve as the Milwaukee County Land Conservation Committee. This committee reports to the County Board. Sections 92.07 and 92.10 of the *Wisconsin Statutes* authorize the land and water conservation committees to have a broad range of powers and duties. These powers and duties include:

- Developing and adopting standards and specifications for management practices to control erosion, sedimentation, and nonpoint sources of water pollution
- Distributing and allocating of available Federal and State cost-sharing funds relating to soil and water conservation
- Presenting research and educational information programs relating to soil and water conservation
- Conducting programs designed to prevent flood damage, drainage, irrigation, groundwater, and surface water problems
- Providing financial, technical, and other assistance to landowners
- Acquiring land and other interests and property, machinery, equipment, and supplies required to carry out various land conservation programs
- Constructing, improving, operating, and maintaining structures needed for land conservation, flood prevention, and nonpoint source pollution control
- Preparing a long-range natural resource conservation plan for the County, including an erosion control plan and program

County land and water conservation committee activities are closely supervised by the County board and are subject to the fiscal resources made available by the board. Day-to-day administration of the programs overseen by the County land conservation committee is performed by the counties' land conservation departments or divisions. In Milwaukee County, the Environmental Services unit of the County's Division of Architecture, Engineering & Environmental Services serves as the County's land conservation department. This department acts through partnerships with local farmers, landowners, businesses, and State and Federal agencies, to address soil and water conservation issues. In addition, this watershed restoration plan specifically assigns the task of monitoring implementation of plan recommendations to the Environmental Services unit. The County land conservation committee and Environmental Services unit will have important responsibilities in the implementation of this watershed restoration plan.

Municipal Planning Agencies

Municipal planning agencies include city plan commissions created pursuant to Section 62.23(1) of the *Wisconsin Statutes*. Such agencies are important to integrating recommendations of this plan into local plans and ordinances and to implementation at the local level.

Stormwater Drainage Districts

The management of stormwater runoff is an important element in the implementation of this watershed restoration plan. Wisconsin Act 53, which was enacted on December 19, 1997, amended and expanded Section 66.0821 of the *Wisconsin Statutes* to specifically grant municipalities the legal authority to assess service charges to users of a stormwater and surface water sewerage system. This legislation granted municipalities essential authorities for the establishment of stormwater utilities. All the communities in the Oak Creek watershed have established stormwater utilities, a general stormwater fund, or a stormwater fee program.

Area-Wide Agencies

Statutory provisions exist for the creation of the following areawide agencies having both general and specific planning and plan implementation powers potentially applicable to the implementation of this watershed restoration plan.

Milwaukee Metropolitan Sewerage District

The MMSD is a special-purpose unit of government directed by an appointed Commission. In the Oak Creek watershed, the MMSD includes all the municipalities except for the City of South Milwaukee. The District has the authority to levy taxes to fund its capital improvement programs and operation and maintenance of its facilities.

The District has a number of important responsibilities in the area of water resources management, including the collection, transmission, storage, and treatment of domestic, industrial, and other sanitary sewage generated in the District and its contract service areas and the provision of watercourse management programs for most of the major streams within the District. This latter responsibility includes developing and implementing flood mitigation programs for portions of the mainstem of the Oak Creek and several tributary streams. The District also conducts several programs that are relevant to implementing this plan, including its water quality monitoring program, its Greenseams program, and its green infrastructure programs.

Southeastern Wisconsin Regional Planning Commission

The Regional Planning Commission has no statutory plan implementation powers. However, in its role as a coordinating agency for planning and development activities within the Southeastern Wisconsin Region, the Commission can influence and support plan implementation through the community planning assistance services that it renders to its constituent counties and municipalities, and through review and comment of Federal and State grant-in-aid applications, wastewater facility plan reviews, and sanitary sewer extensions.

State-Level Agencies

The following State agencies have either general or specific planning authority and hold certain plan implementation powers important to the implementation of this watershed restoration plan.

Wisconsin Department of Natural Resources

The WDNR has broad authority and responsibility in the areas of natural resources protection, water quality control, and water regulation. The WDNR has the obligation to develop long-range, statewide conservation and water resource plans. In addition, it has the authority to designate sites to protect, develop, and regulate the use of State parks, forests, fish, game, lakes, streams, certain plant life, and other outdoor resources, and to acquire conservation and scenic easements.

In its role of designating sites to protect the natural resources of the State, the WDNR can play an important part in implementing and funding the stream rehabilitation, prairie and wetland restoration, riparian buffer, and recreational use and access components of the Oak Creek watershed restoration plan. Implementation of these components may be accomplished as a whole, or in part, by creating a State Project Area within which the WDNR could acquire, develop, and manage properties. Section 23.09(2)(d) of the *Wisconsin Statues* lists purposes for which the State may acquire lands through purchase, lease, or gift. The listed purposes that may be applicable to the recommended plan components include State forests, State recreation areas, State natural areas, streambank protection, wildlife habitat areas and fisheries, and any other purpose for which gift lands are suitable, as determined by the WDNR.

Chapter NR 1 of the *Wisconsin Administrative Code* establishes priorities for WDNR acquisition of recreational lands. The categories that are applicable to recommended components of this watershed restoration plan, in descending priority, are:

- Land to protect rare and threatened natural resources; to protect genetic and biological diversity; and to protect, manage, or restore critical fish and wildlife habitat

- Water-based resources that include land important to protect and improve the quality of the State's surface and groundwater and land for recreation and management along streams, rivers, lakes, and flowages

- Lands to accommodate broad, natural resource-based outdoor recreation and State recreation trails

- Land within 40 miles of Wisconsin's 12 largest cities[194]

A proposed State Project Area is evaluated by the WDNR by preparing a feasibility study, following which the Project Area may be approved or rejected by the Natural Resources Board and the Governor.

The responsibility for water pollution control in Wisconsin is centered in the WDNR. The basic authority and accompanying responsibilities relating to the water pollution control function of the WDNR are set forth in Chapter 281 of the *Wisconsin Statutes*. Under that chapter, the WDNR is given broad authority regarding the following:

- Preparing water use objectives and supporting water quality standards

- Protecting water quality through abatement of nonpoint source pollution from construction site erosion, agricultural runoff, and nonagricultural (urban) runoff

- Protecting wetlands through enforcement of water quality standards

- Protecting navigable waters, including authorizing municipal shoreland zoning regulations

- Regulating groundwater withdrawals from high-capacity wells to ensure that operation of such wells do not adversely affect a public water supply, or regulating withdrawals when high-capacity wells are located in a groundwater protection area, which is defined as an area within 1,200 feet of an outstanding or exceptional resource water or Class I, II, or III trout streams[195]

- Conserving and managing water resources through regulation of withdrawals from waters of the State

- Reviewing and approving plans and specifications for components of sanitary sewerage systems

- Reviewing and approving the creation of joint sewerage systems

- Regulating the servicing of septic tanks, soil absorption fields, holding tanks, grease interceptors, privies, and other components of private sewage systems

- Regulating the disposal of septage in municipal sewerage systems

- Performing "activities to clean up or to restore the environment in an area that is in or adjacent to Lake Michigan or Lake Superior or a tributary of Lake Michigan or Lake Superior if the activities are included in a remedial action plan that is approved by the department" (Section 281.83(1))

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[194] *All portions of the Oak Creek watershed are within 40 miles of one or more of the Cities of Kenosha, Milwaukee, Racine, Waukesha, and West Allis—all of which are among the 12 largest cities in the State.*

[195] *Section 281.34(5)(b)1 requires that an "environmental impact report under s. 23.11(5) must be prepared for a proposed high capacity well located in a groundwater protection area."*

- Administering a financial assistance program for the construction of pollution prevention and abatement facilities

Each of the above authorities is important to implementing the recommended watershed restoration plan. The loans and grants available through the financial assistance program are particularly relevant, including those related to:

- Local water quality planning

- Facilities planning, engineering design, and construction of point source pollution abatement facilities

- Nonpoint source water pollution abatement "for the implementation of measures to meet nonpoint source water pollution abatement needs identified in areawide water quality management plans" (Section 281.65(1)(a))

- Lake management planning

- River protection

Under Chapter 283 of the *Statutes*, the WDNR is given broad authority to establish and carry out the Wisconsin Pollutant Discharge Elimination System (WPDES) program in accordance with the policy guidelines set forth by the U.S. Congress under the Federal Water Pollution Control Act Amendments of 1972 and 1987. This legislation establishes a waste discharge permit system and provides that no permit may be issued by the WDNR for any discharge from a point source of pollution that is in conflict with any areawide wastewater treatment and water quality management plan approved by the WDNR. This legislation and accompanying procedures comprise the primary enforcement tool of the WDNR in achieving the established water use objectives and supporting water quality standards.

The WDNR has the obligation to establish standards for floodplain and shoreland zoning and the authority to adopt, in the absence of satisfactory local action, shoreland and floodplain zoning ordinances. The WDNR also has authority to regulate the following: water diversions, shoreland grading, dredging, encroachments, and deposits related to navigable waters; the construction of neighboring ponds, lagoons, waterways, stream improvements, and pierhead and bulkhead lines; the construction, maintenance, and abandonment of dams; water levels of navigable lakes and streams; and lake and stream improvements, including the removal of certain lakebed materials. The WDNR also makes cost-share monies available for a number of activities, including dam removal, river protection, land and water conservation and stewardship activities, stormwater and runoff management, lake planning and protection, recreational trail development, and aquatic invasive species control. With such broad authority for the protection of the natural resources of the State and Region, the WDNR will be extremely important to the implementation of nearly all the major elements of this watershed restoration plan.

<u>Wisconsin Department of Administration</u>

The Wisconsin Department of Administration's Federally approved Coastal Zone Management Program for the Great Lakes was established in 1978 under the Federal Coastal Zone Management Act and has been revised over time. The program has identified wetlands protection, habitat restoration, public access, nonpoint source pollution control, coastal resource and community planning, historic preservation projects, and Great Lakes education projects as current priorities. The program also provides assistance to local governments in the management and protection of shorelands, wetlands, and floodplains through zoning and permitting.

<u>Wisconsin Department of Agriculture, Trade and Consumer Protection</u>

Under the Wisconsin Soil and Water Conservation Law, State-level soil and water conservation responsibilities have been placed under the Wisconsin Department of Agriculture, Trade and Consumer Protection's (DATCP) authority. Within that Department, the law created a seven-member advisory Land and Water Conservation Board. The Land and Water Conservation Board reviews and comments on rules relating to soil and water conservation, administers the State's Farmland Preservation Program, reviews all County erosion control plans and the annual County and long-range County land and water conservation plans, and generally advises the Secretary of DATCP and the University of Wisconsin on matters relating to soil and water conservation. DATCP also makes cost-share monies available for land and water resource management activities such as installation of agricultural best management practices. The DATCP rules require the preparation of county land and water conservation plans and provide for partial funding to administer and implement such county plans. The Department will have important responsibilities relative to implementing this watershed restoration plan.

Wisconsin Department of Safety and Professional Services

The Wisconsin Department of Safety and Professional Services has responsibility for regulating construction erosion control and private onsite wastewater treatment systems under Chapters SPS 360, "Erosion Control, Sediment Control and Storm Water Management," and SPS 383, "Private Onsite Wastewater Treatment Systems," of the *Wisconsin Administrative Code*. Department authority for construction site erosion control extends to issuing permits for single- and two-family residential building sites and commercial sites. This Department also sets minimum standards for the design, installation, and maintenance of sanitation devices and systems that are alternative to water-carried waste plumbing fixtures and drain systems in Chapter SPS 391, "Sanitation," of the *Wisconsin Administrative Code*. The Department also provides funding for the rehabilitating and replacing private onsite wastewater treatment systems through Chapter 387, "Private Onsite Wastewater Treatment System Replacement or Rehabilitation Financial Assistance Program," of the *Wisconsin Administrative Code*.

Wisconsin Department of Transportation

The Wisconsin Department of Transportation has important responsibilities related to this plan regarding 1) nonpoint source pollution abatement related to highway construction and maintenance, 2) constructing stream crossings that permit passage of fish and other aquatic organisms, 3) minimizing disturbance of existing natural stream channels and restoring disturbed stream channel reaches, and 4) managing roadside vegetation.

University of Wisconsin-Madison Division of Extension

A University of Wisconsin-Madison Division of Extension (UWEX) office is located within each county. Although the UWEX has no statutory plan implementation powers, it can aid communities in solving environmental problems by providing educational and informational programs to the general public, and by offering advice to local decision-makers and community leaders. The UWEX carries out these responsibilities by conducting meetings, tours, and consultations, and by providing newsletters, bulletins, and research information. In addition, the UWEX, along with the WDNR, sponsors citizen science programs such as the Water Action Volunteers Program (WAV), the Wisconsin Citizen Lakes Monitoring Program, and the Wisconsin First Detector Network. These sponsorships give the UWEX a role in implementing the recommendations of this plan that are related to water quality monitoring.

Federal-Level Agencies

The following Federal agencies have responsibilities and administer aid and assistance programs that may be applicable to implementing this watershed restoration plan. Funding from such programs may be used for land acquisition, constructing specific facilities, and other management activities.

Federal Emergency Management Agency

FEMA administers the National Flood Insurance Program (NFIP). As part of this, it sets minimum floodplain management standards for communities participating in the NFIP. It is also the lead Federal agency responsible for maintaining and updating the digital flood insurance rate maps (DFIRMs), which are used for floodplain management, flood mitigation planning, and other purposes. FEMA acts as the final reviewer for any changes to the effective maps. FEMA programs also provide funding for disaster relief and hazard mitigation, including relief from and mitigation of the impacts of flooding.

National Flood Insurance Program

The NFIP provides flood insurance to property owners, renters, and businesses in participating communities. The NFIP works with communities to adopt and enforce floodplain management regulations to mitigate the effects of flooding. This program is administered by FEMA.

U.S. Environmental Protection Agency

The USEPA administers water quality management planning grants and sanitary sewerage facility construction grants. In addition, this agency is responsible for the ultimate achievement and enforcement of water quality standards for all interstate waters, should the States not adequately enforce such standards. In this respect, the USEPA has delegated authority over the National Pollutant Discharge Elimination Systems permit issuance process whereby the WDNR issues discharge permits under both State and Federal authorities. Under guidelines promulgated by the USEPA, areawide water quality management and sanitary sewerage facilities plans must be prepared as prerequisites to the receipt of Federal capital grants in support of sewerage works construction.

The USEPA also administers grant funding for nonpoint source pollution control activities. The 1987 amendments to the Federal Clean Water Act established the Section 319 Nonpoint Source Management Program. Under this program, states, territories, and tribes receive grant money that supports a wide variety of activities, including technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific nonpoint source implementation projects.

U.S Department of Agriculture, Farm Services Agency

The USDA Farm Services Agency (FSA) administers the programs of the Federal Farm Bill that provide grants to rural landowners in partial support of carrying out approved land and water conservation practices. Grants from this program could be used for implementing some watershed restoration plan recommendations.

U.S Department of Agriculture, Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) provides financial and technical assistance to agricultural operators and landowners to install conservation practices. NRCS administers resource conservation and development projects and watershed projects under Federal Public Law 566 and provides technical and financial assistance to landowners through the county land conservation committees. Such assistance may include the planning and construction of measures for land treatment, agricultural water management, flood prevention, and public fish, wildlife, and recreational development. NRCS also conducts detailed soil surveys and provides interpretations as a guide to utilizing soil survey data in local planning and development. Certain programs administered by this agency, including those providing partial funding for land conservation practices, can contribute to implementing the land management and treatment measures recommended under this watershed restoration plan.

U.S Department of Interior, Geological Survey

The USGS conducts continuing programs on water resource appraisal and monitoring. The programs of the USGS are essential to implementing the watershed restoration plan recommendations to maintain the existing stream gaging and water quality monitoring capabilities and to expand the water quality monitoring network in the watershed.

U.S Department of Interior, Fish and Wildlife Service

The U.S. Fish and Wildlife Service has the mission of conserving, protecting, and enhancing fish, wildlife, and plants and their habitats. Thus, the Service would have a role in implementing the instream and riparian habitat measures recommended under this watershed restoration plan.

U.S Department of Transportation

The U.S. Department of Transportation, Federal Highway Administration, administers all Federal aid programs working through the Wisconsin Department of Transportation. Thus, this agency has nonpoint source pollution abatement responsibilities with regard to setting standards for highway construction and maintenance.

U.S. Army Corps of Engineers

The Corps of Engineers administers a regulatory program relating to the discharge of dredge and fill materials into the waters of the United States and adjacent wetlands. This program is administered pursuant to Section 404 of the Federal Water Pollution Control Act as amended in 1972. Under various programs, the Corps can also study, design, and construct projects such as emergency streambank and shoreline works to protect public infrastructure, restore degraded ecosystems, and address flooding.

Private Organizations

Organizations such as the Root-Pike Watershed Initiative Network (Root-Pike WIN) and the Southeastern Wisconsin Watersheds Trust (Sweet Water) have a broad focus on protecting, restoring, and sustaining the ecosystems of several adjacent watersheds to the Oak Creek watershed. These groups can have direct roles in plan implementation through considering the interrelationship between plan recommendations and their respective programs to improve conditions of their watersheds.

Land trusts and conservancies, such as the Milwaukee Area Land Conservancy, purchase, or obtain conservation easements for, environmentally valuable lands through member contributions, land or easement donations, and grants obtained from other sources. These organizations can play a significant part in plan implementation by coordinating of their land acquisition and easement programs with the recommendations of this plan.

Other environmental organizations may have roles in implementing specific recommendations. For example, 1000 Friends of Wisconsin assisted several municipalities in southeastern Wisconsin in auditing, revising, and prioritizing municipal codes and ordinances that prohibit or inhibit more widespread use of green infrastructure. More recently, Clean Wisconsin has been working with the participating municipalities to update municipal ordinances and codes.

Youth conservation corps, such as the Milwaukee Community Service Corps, the Wisconsin Youth Conservation Corps, and the Great Lakes Community Conservation Corps, which provide young adults with hands-on job training opportunities may be able to assist with implementing some recommendations such as invasive species removal, removal of small-scale aquatic organism passage impediments, and small-scale streambank stabilization projects.

The Friends of the Mill Pond & Oak Creek Watercourse, Inc. has been active in controlling litter and debris along the Mill Pond and the mainstem of Oak Creek. There is potential for park friends' groups associated with County and municipal parks located in the watershed to conduct similar activities. Through these activities, these groups can help to implement some of this plan's habitat-related recommendations.

Several organizations also conduct activities to remove invasive plant species from riparian and upland areas in the Oak Creek watershed. The Southeastern Wisconsin Invasive Species Consortium provides technical support and some funding for invasive species management. Other groups that have conducted invasive species management activities in the watershed include the Park People of Milwaukee County and the Friends of Grant Park. Through the continuation of activities to manage invasive species, these groups can help to implement some of this plan's habitat-related recommendations.

In Wisconsin, homeowners' associations (HOAs) and condominium associations are generally organized as nonprofit corporations. HOAs and condominium associations may have responsibilities for implementing some recommendations of this plan. The primary purposes of these associations include managing and maintaining common elements within a residential development or condominium and protecting property values. As part of management of common elements, an HOA or condominium association may have responsibilities for the maintenance of stormwater management practices within the development. This responsibility is usually determined during the planning and construction process.

Nature centers in nearby watersheds such as Wehr Nature Center and the Urban Ecology Center can support plan implementation through their educational programs. In addition, citizen-based monitoring programs, such as the WAV Program, generally require local coordinators and sponsors to operate in an area. This need creates a potential for these centers, or other groups, to support implementation of this watershed restoration plan through involvement in water quality monitoring.

Schedule

An implementation schedule is an important plan element which 1) provides coordination of implementation by indicating when particular management measures should be done relative to other management measures, and 2) organizes the implementation of projects by allowing a reasonable amount of time for developing the leadership, partnerships, capacity, and funding sources required for project implementation.

Table 6.39 presents a schedule for implementing general recommendations of the Oak Creek watershed restoration plan.

Several comments should be made on the timeline set forth in Table 6.39. First, some of the dates set forth for completion of implementing particular plan elements reflect regulatory requirements that impact upon those elements. For example, the dates given for implementing the changes to municipal separate storm sewer system (MS4) illicit discharge detection and elimination (IDDE) procedures recommended in this chapter are the anticipated dates of reissuance of the communities' MS4 discharge permits under the Wisconsin Pollutant Discharge Elimination System program. This reflects the fact that the recommended changes in IDDE procedures will require changes in these permits. Similarly, the date given to complete the recommended sediment core sampling reflects the need to move closer to a preferred alternative for the Mill Pond and dam to resolve the non-functional sluice gate issue of concern. Second, some of the dates set forth for the completion of other recommended plan elements reflect implementation schedules given in other plans. For example, the schedule for implementing green infrastructure practices in the portion of the watershed that is in the MMSD service area is based on the schedule given in the MMSD green infrastructure plan.

With respect to the specific projects recommended in Table 6.1, each project is given a priority rating of "high," "medium," or "low." The Oak Creek watershed restoration plan envisions that at least 35 percent of the high-priority projects will be initiated within the first five years of plan implementation. It envisions and additional 15 percent of high-priority projects will be completed during each of the next five 5-year periods with implementation of high-priority projects being completed by the end of 2051. For medium- and low-priority projects, it is envisioned that 65 percent of them will be completed by the end of 2051 with the balance being completed time after this date.

In addition to the schedule given in Table 6.39, a schedule for implementing education actions recommended as part of the information and education element of this watershed restoration plan was previously presented in Table 6.20.

The purpose of these implementation schedules is to provide guidance for implementing the Oak Creek watershed restoration plan. As the plan is implemented, it will be important to take a flexible approach to this schedule. One reason for this is that implementation of many of the recommendations provided in this plan require opportunities that may or may not present themselves within the time frames envisioned in the schedule. For example, recommendations that require the acquisition of land or easements for implementation need the opportunity to purchase lands or easements from landowners who are willing to sell. Similarly, the ability to install best management practices on private land is dependent upon the cooperation and participation of landowners. There may also be opportunities to achieve cost savings by implementing recommended projects in concert with, or as part of other, unrelated projects. Finally, it is important to note that the availability of funding is constantly changing. Opportunities to fund particular types of projects may be short-lived. Since these opportunities may not always be available, it is important to capitalize on them whenever possible. Because of this, it will be important to take a flexible rather than a rigid approach to the application of the implementation schedule.

Maintaining and Revising this Plan

Watershed restoration efforts are processes that can span decades. Even as restoration proceeds, conditions in the watershed can change in ways that can affect the restoration process. Because of this, it is important that a plan such as this one be treated as a living document that will adapt to these changing conditions. Implementation of this plan should include maintenance of the plan, including periodic review of plan goals, objectives, and elements and adjustment of them to changing conditions in the watershed.

The maintenance of the Oak Creek watershed restoration plan will include three components. The first component consists of monitoring the implementation of plan recommendations. The process for doing this was previously described in the section on tracking implementation of plan recommendations. This monitoring will provide information for evaluating the state of implementation, which is an important consideration for determining whether adjustments to the plan's recommendations or schedule are warranted.

Table 6.39
Implementation Schedule for General Recommendation of the Oak Creek Watershed Restoration Plan

Recommendation	Level of Implementation	Date to Complete Implementation	Comments
Water Quality: Urban Nonpoint Source Pollution Control Measures			
General Recommendations	--	Ongoing	There are also specific project recommendations that address these
MS4 IDDE Program Modifications[a]	Full	2026	Because implementation of this recommendation will require changes to the communities' MS4 discharge permits, it is anticipated that implementation will occur as part of the regular reissuance of the permits
Development of BMP maintenance tracking systems	Full	2026	
Iron-enhanced BMP Pilot Projects	1 project 3 projects	2026 2031	
Water Quality: Green Infrastructure Installation			
Implementation of MMSD Green Infrastructure Plan	48 percent 77 percent 100 percent	2026 2031 2035	Implementation schedule for MMSD green infrastructure plan is given in Table 6.10
Municipal Code Audit for City of South Milwaukee	--	2026	
Implementation of South Milwaukee Urban Forestry Plan	400 removals, 1,250 plantings	2031	
Develop and Implement Green Infrastructure Tracking System	Full	2026	
Water Quality: Rural Nonpoint Source Control Measures			
Install Practices to Reduce Soil Loss from Crop Land to Reduce Erosion Rates to Less than "T"	Full	2026	
Nutrient Management Plans	Full	2026	
Convert 10 Percent of Marginal Cropland to Wetland and Prairie	Full	2035	There are also specific projects that address this
Implement Expanded Private Onsite Wastewater Treatment System Programs	Full	2036	
Water Quality: Actions to Reduce Concentrations of Fecal Indicator Bacteria and Pathogens			
Reduce Impacts of Nuisance Waterfowl	--	As needed	Address as water quality problems are documented
Reduce Impacts of Pet Waste	--	As needed	Address as water quality problems are documented
Mycoremediation Pilot Projects	1 project 3 projects	2026 2031	
Water Quality: Actions to Reduce Chloride Concentrations			
General recommendation	--	Ongoing	
Develop and update winter road management plans, salt application strategies, or salt reduction strategies	Initial development Update	2026 Ongoing	
Water Quality: Point Source Control Measures			
General Recommendations	--	Ongoing	
Water Quality: Actions to Address Toxic Substances and Emerging Pollutants			
Household Hazardous Waste Collection Programs	--	Ongoing	
Unused Medication Collection Programs	--	Ongoing	
Enact Ordinances Banning Use of Coal-Tar Pavement Sealants[b]	Full	2026	

Table continued on next page.

Table 6.39 (Continued)

Recommendation	Level of Implementation	Date to Complete Implementation	Comments
Water Quality: Actions to Address Toxic Substances and Emerging Pollutants (continued)			
PFAS Investigations at MMIA	Full	2021[c]	Any follow-up investigations should be completed in accordance with the schedule set by the WDNR
Habitat: Actions to Maintain and Reestablish Natural Surface Water Hydrology			
Protect, restore, and enhance natural landscape elements to reduce magnitude of flashiness in stream flow	--	Ongoing	There are also specific projects that address this
Implement measures to promote stormwater storage and infiltration in existing and planned urban areas	--	Ongoing and as development occurs	There are also specific projects that address this
Implement at least one rain garden and one rain barrel at all public schools within the watershed	Full	2026	Funding for more extensive "greening" projects of schoolyards in the watershed should also be pursued
Reduce unnecessary drainage tile systems and retrofit need systems	--	Ongoing and as development occurs	There are also specific projects that address this
Restore leased agricultural fields owned by Milwaukee County Parks to forest, grassland, or wetland habitats	25 percent Full	2026 2031	There are also specific projects that address this
Restore marginal crop and pasture lands, farmed wetlands, and potentially restorable wetlands (particularly as areas are converted from ag to urban uses)	--	Ongoing and as development occurs	There are also specific projects that address this
Habitat: Actions to Protect Areas of High Groundwater Recharge			
Control new development in areas with the best remaining groundwater recharge potential	--	Ongoing	--
Implement mitigation measures to reduce impacts of any future urban development on groundwater recharge quantity and quality	--	Ongoing and as development occurs	--
Reduce impact of existing urban development on groundwater recharge quantity and quality	--	Ongoing	--
Implement pollution reduction measures in agricultural and other areas such as golf courses that are located in areas of high groundwater recharge	--	Ongoing	--
Habitat: Actions to Protect, Restore, Expand, and Connect Riparian Buffers			
Manage and/or restore the quality of existing riparian buffers	--	Ongoing	There are also specific projects that address this
Protect and preserve all existing riparian buffers with priority given to buffers considered to be vulnerable to urban development	--	Ongoing	There are also specific projects that address this
Expand existing or establish new riparian buffers	75-ft minimum width 1,000-ft optimum width	2026 Ongoing	There are also specific projects that address this
Establish connections between riparian buffer areas for continuity between habitat types	--	Ongoing	There are also specific projects that address this
Habitat: Actions to Preserve, Restore, Expand, and Connect Wildlife Habitat			
Pursue funding to continue the implementation of Milwaukee County DPRC ecological restoration and management plans	--	Ongoing	There are also specific projects that address this

Table continued on next page.

Table 6.39 (Continued)

Recommendation	Level of Implementation	Date to Complete Implementation	Comments
Habitat: Actions to Preserve, Restore, Expand, and Connect Wildlife Habitat (continued)			
Preserve and expand wildlife habitat through protection and establishment of riparian buffers as outlined above	--	Ongoing	There are also specific projects that address this
Reduce habitat fragmentation by preserving and enhancing connections between riparian buffers, open space, CSHS, and natural areas	--	Ongoing and as development occurs	There are also specific projects that address this
Implement BMPs aimed at maintaining and enhancing wildlife habitat including voluntary, educational and technical assistance, and incentive-based programs	--	Ongoing	--
Habitat: Actions to Control and Manage Invasive and Nonnative Species			
Pursue funding to continue the implementation of inventory, monitoring, and control of invasive species populations as outlined in Milwaukee County DPRC ecological restoration and management plans	--	Ongoing	There are also specific projects that address this
Continue to update the County's ecological restoration and management plans as conditions change	--	Ongoing	These plans are generally developed for ten-year periods and should be updated as the planning period is expiring
Conduct invasive species work days in parks and natural areas utilizing volunteers, partner organizations, and contractors in addition to governmental staff	4 work days annually	2026	--
Remove and/or manage invasive species using accepted management methods	--	Ongoing	There are also specific projects that address this
Continue and expand current monitoring for invasive species in the watershed	--	Ongoing	There are also specific projects that address this
Continue educational activities for the public related to nonnative and invasive species and control thereof	--	Ongoing	--
Municipal roadway managers should implement guidelines outlined in SEWISC Right of Way Invasive Species Management Plan	Full	2026	--
Habitat: Actions to Restore Degraded Stream Channels and Reestablish Connections Between Streams, Floodplains, and Adjacent Wetlands			
Install natural channel design elements such as meanders, grade control, and/or constructed riffles	--	As needed	There are also specific projects that address this
Restore connections between streams and their functional floodplains and adjacent wetlands	--	As needed	There are also specific projects that address this
Improve floodplain functionality for stream channels that are disconnected from their floodplain but confined by urban development with a two-stage channel design retrofit, where possible	1 project area 3 project areas All project areas	2028 2036 2041	There are also specific projects that address this
Consider regenerative stormwater conveyance restoration design for degraded headwater streams	1 project area All project areas	2031 2036	There are also specific projects that address this

Table continued on next page.

Table 6.39 (Continued)

Recommendation	Level of Implementation	Date to Complete Implementation	Comments
Habitat: Actions to Remove or Modify Impediments to Aquatic Organism Passage			
Conduct fish passage assessments for all remaining unassessed stream crossings in the watershed	Full	2024	There are also specific projects that address this
Develop plans to replace, retrofit, or modify identified fish passage impediments	Tier 1 (not including dam) Tier 2 Tier 3	2026 2031 2036	There are also specific projects that address this
Assess all major woody debris jams within the watershed to determine fish passage barriers	Full	2024	There are also specific projects that address this
Selective removal of small sections of woody debris for those large debris jams fount to be complete fish passage barriers	Full	2026	There are also specific projects that address this
Conduct periodic surveys to reassess accumulation of coarse woody debris to determine fish passage barriers; Selectively remove those considered barriers or accumulations at road crossings	--	Ongoing	--
Conduct periodic thinning of deceased ash trees within riparian lands adjacent to streams	--	Ongoing	--
Habitat: Actions to Address Streambank and Streambed Erosion			
Stabilize actively eroding streambanks that have been identified using design and implementation to ensure that the stream is reconnected to its floodplain whenever practicable	50 percent of high priority sites 100 percent of high priority sites	2026 2031	There are also specific projects that address this
Conduct streambank stability surveys on streams in the watershed that have not been assessed	Full	2026	--
Replace, repair, or retrofit outfalls identified as poor or failing condition	50 percent of high priority sites 100 percent of high priority sites	2026 2031	There are also specific projects that address this
Conduct surveys of outfalls that were not assessed to confirm location, dimensions, materials, and condition	Full	2026	--
Habitat: Actions to Reduce or Mitigate the Negative Physical, Chemical, and Biological Impacts Associated with Climate Change			
Implement actions to restore or simulate natural processes to slow down, detain, and treat runoff	--	Ongoing	There are also specific projects that address this
Consider planning for flooding impacts beyond the 1-percent-annual-probability-(100-year recurrence interval) event	--	Ongoing	--
Consider strengthening floodplain regulations and expanding planned Primary Environmental Corridors	Full	2026	--
Implement actions to promote stream shading, increase stormwater infiltration, maintain groundwater recharge, and improve access to cool water habitat	--	Ongoing	There are also specific projects that address this

Table continued on next page.

Table 6.39 (Continued)

Recommendation	Level of Implementation	Date to Complete Implementation	Comments
Habitat: Actions to Reduce or Mitigate the Negative Physical, Chemical, and Biological Impacts Associated with Climate Change (continued)			
Develop response plans for addressing new areas of invasive species infestations and for newly occurring invasive species when they are found	--	Ongoing	--
Habitat: Actions to Reduce Trash and Debris Within the Stream Channels and Riparian Areas			
Plan and organize annual or semi-annual stream cleanup days utilizing community volunteers and partner organizations	Full	2023	--
Conduct surveys and geolocate large trash items along streams that were not surveyed by Commission staff	Full	2023	--
Periodically reassess and geolocate large trash items along streams of the watershed to measure progress and provide targeted areas for future cleanup	--	Ongoing	--
Place and maintain additional trash receptacles along trails, parkways, and in parks	Full	2024	--
Watershed communities should hold free large trash pick-up days multiple times each year	Full	2023	--
Watershed communities should focus efforts on publicizing electronic recycling options for residents	Full	2022	--
Watershed communities should expand efforts to publicize hazardous waste disposal programs available to residents	Full	2022	--
Recreational Access and Use			
Additions to Oak Leaf Trail	Full	2041	--
Flooding and Stormwater Runoff			
Voluntarily acquire and remove remaining insurable structures from the regulatory floodplain	--	As opportunities arise	--
Evaluate opportunities to address road crossings impacted by flood elevations	--	Ongoing	--
Evaluate areas of stream flooding and opportunities to reduce flood impacts to public infrastructure and private property	--	Ongoing	--
Evaluate areas of stormwater flooding and opportunities to reduce flood impacts to public infrastructure and private property	--	Ongoing	--
Mill Pond and Mill Pond Dam			
Complete core sampling and analysis of Mill Pond sediment	Full	2023	--
Specific Projects Listed in Table 6.1			
High-Priority Projects (90 projects)	35 percent of projects initiated	2026	--
	50 percent of projects completed	2031	--
	65 percent of projects completed	2036	--

Table continued on next page.

Table 6.39 (Continued)

Recommendation	Level of Implementation	Date to Complete Implementation	Comments
Specific Projects Listed in Table 6.1			
High-Priority Projects (continued)	75 percent of projects completed	2041	--
	90 percent of projects completed	2046	--
	100 percent of projects completed	2051	--
Medium- and Low-Priority Projects (316 projects)	5 percent of projects initiated	2026	--
	15 percent of projects completed	2031	--
	30 percent of projects completed	2036	--
	40 percent of projects competed	2041	--
	50 percent of projects completed	2046	--
	95 percent of projects completed	2051	--
	100 percent of projects completed	After 2051	--
Monitoring Recommendations			
Continuation of Existing Monitoring Network	--	Ongoing	--
Installation of Additional Sampling Stations	Full	2026	--
Mussel Survey	--	2026	It is recommended that mussel surveys be conducted at 10-year intervals
Collation and Analysis of Monitoring Data	--	2031	It is recommended that monitoring data be collated, analyzed, and made available at 10-year intervals
Information and Education Plan			
Information and Education Plan	--	Ongoing	Schedule is given in Table 6.20

Note: Some recommended actions apply to multiple management categories but are only listed once in this table. Those recommendations are discussed in all of the sections that they apply to within the text.

[a] *This recommendation has been implemented for the MS4 communities in the watershed that are permitted under the Menomonee River Watershed-Based MS4 permit. In the Oak Creek watershed, these communities include Milwaukee County and the Cities of Greenfield and Milwaukee.*

[b] *The Cities of Franklin, Greenfield, Milwaukee, and Oak Creek have implemented this recommendation.*

[c] *It is anticipated that the investigations should be completed during summer or fall of 2021. This does not include any follow up that may be required by the WDNR.*

Source: SEWRPC

The second component consists of the annual review and evaluation of progress to be conducted by the Oak Creek Watershed Plan Advisory Group. This process was previously described in the section on evaluating the state of plan implementation and success. During its review, the Advisory Group will determine whether any adjustments or modifications to plan recommendations or priorities are warranted. Adjustments suggested by the Advisory Group will be documented and available in a timely manner to guide organizations implementing plan recommendations.

The third component consists of periodic updating of the plan and renewal of the finding that it is consistent with the nine key elements that USEPA considers important for watershed plans. In Wisconsin, a finding that a watershed plan is consistent with the nine key elements generally expires after a fixed period. While there have been some exceptions,[196] most nine key element plans in the State have been approved for 10 years. Given the size of the Oak Creek watershed and the limited funding currently available, it is unlikely that all of the recommendations of this plan will be implemented within 10 years. In particular, it is unlikely that projects designed to achieve all of the recommended reductions in nonpoint source pollutions loads needed to meet water quality standards will be implemented within 10 years. Full implementation of this plan is expected to take 20 years or more. Because of this it is expected that the Oak Creek watershed restoration plan will need to be updated, revised, and reapproved prior to its expiration.

While the WDNR has not issued guidance for the updating and renewal of nine key element plans, Department staff have indicated issues that they feel such an update should address.[197] They have indicated that these plans can be renewed the year of or after their expiration date. Part of the renewal process should include meeting with WDNR staff to discuss the status of the expiring or expired plan. Issues that an update should focus on include:

- Whether plan goals and objectives were met and reasons that any goals and objectives were not met
- Whether plan goals need to change to reflect new watershed conditions
- Whether plan milestones were achieved and reasons why any milestones were not achieved
- Evaluation of plan milestones to determine whether any should be repeated or whether new milestones are needed
- Whether there are other existing plans that apply to the watershed, including
  - Descriptions of such plans and the milestones they contain
  - A summary report on progress that has been made to meet the existing plan goals
- An updated inventory of watershed conditions, including but not limited to
  - Causes and sources of pollution
  - Discussion of recently adopted TMDLs applying to the watershed
  - Discussion of recent changes in impaired waters listings applying to the watershed
  - The status of MS4 permits applying to the watershed including incorporation of TMDLs and new or revised conditions into the permits
  - Revised pollutant load modeling to reflect practices that have been adopted over the plan schedule
  - Water quality monitoring results

6.11 REQUIRED TECHNICAL AND FINANCIAL ASSISTANCE

It is important for the units of government, agencies, and private organizations working within the Oak Creek watershed to effectively utilize all available sources of financial and technical assistance for the timely implementation of the recommended plan. In addition to utilizing current tax revenue sources, such as property taxes, fees, and State-shared taxes, the local units of government in the watershed can also make use of revenue sources, such as borrowing, special taxes and special assessments, areawide assessments, contributions in aid of construction, impact fees, establishment of stormwater utilities, State and Federal

[196] *For example, the plan for the Fredonia-Newburg portion of the Milwaukee River watershed was approved for a period of 20 years and the plan for the Pike River was approved for 35 years.*

[197] *Andrew D. Craig, WDNR staff, "RE: 9KE plan – 10 year renewal questions – WDNR response," electronic mail message to Laura K. Herrick, SEWRPC staff, December 7, 2020.*

grants, grants from foundations, and gifts. In addition to their regular resources, private organizations working in the watershed can also make use of State and Federal grants, grants from foundations, and gifts.

Various types of technical and financial assistance useful in plan implementation are also available from county, State, and Federal agencies. Examples of the types of assistance available include possible State and Federal cost-share funding for nonpoint source pollution control and habitat projects; technical advice on land water management practices provided by the USDA NRCS staff and county land conservation staffs; and education, advisory, and review services offered by University of Wisconsin-Madison Division of Extension and SEWRPC.

Cost Analysis

The capital costs of the general recommendations in this plan are given in this chapter. These costs are summarized in Table 6.40. The estimated capital cost of the Oak Creek watershed restoration plan through 2031 ranges between about $204 million and $216 million. This is given as a range because the costs of addressing the Mill Pond dam and Mill Pond will depend on which alternative Milwaukee County selects. Estimated costs for implementation of the MMSD green infrastructure plan for the portion of the watershed that is located within MMSD's service area, water quality and other monitoring, information and educational programming, and implementation of the City of South Milwaukee urban forestry plan are given through year 2031. The cost summary in Table 6.40 also includes capital costs for the specific projects recommended in Table 6.1.

The estimated costs of individual recommended specific projects are given in Table 6.1. A summary of the project capital costs by class of project used in the prioritization is given in Table 6.41. The total capital cost associated with the 51 high-priority projects for which costs were available is estimated at about $23.7 million. The total capital cost of 228 additional medium- and low-priority projects is estimated at about $33.1 million. Table 6.1 includes 38 high-priority and 89 medium- and low-priority projects for which sufficient information was unavailable to develop costs. Costs for these projects will need to be developed through additional planning or preliminary engineering.

The costs given in Tables 6.1, 6.40, and 6.41 are estimated and will need to be refined during preliminary engineering and project development. All costs are expressed in 2019 dollars.

Grant and Loan Programs

Identifying potential funding sources, including sources other than solely local-level sources, is an integral part of the implementation of a successful plan. The following description of funding sources includes those that appear to be applicable as of the year 2021. Funding programs and opportunities are constantly changing. Accordingly, the involved local staffs will need to continue to track the availability and status of potential funding sources and programs. This list is intended to facilitate implementation of the activities set forth in the recommended plan. Some of the programs described herein may not be available under all envisioned conditions for a variety of reasons, including local eligibility requirements or lack of funds in Federal or State budgets at a given time. Nonetheless, the list of sources and programs should provide a starting point to identify possible funding opportunities for implementing the watershed restoration plan recommendations. Note that Table 6.42 provides a website address and/or staff contact information for each program. This information should be used to find additional program information as well as the program's grant application process and requirements.

Numerous grant and local programs are offered through both public and private sources for many aspects of plan implantation. Table 6.42 summarizes many of the major grant and assistance programs available to implementation organizations such as the County, municipalities, State and local agencies, and nongovernmental organizations under the areas of wildlife and fish habitat preservation, water quality, soil protection and enhancement, land acquisition for park and open spaces, flood mitigation, and other areas such as education and sustainable development.

Table 6.40
Summary of Estimated Capital Costs for the Oak Creek Watershed Restoration Plan

Title	Cost (dollars)[a]
MMSD Green Infrastructure Plan through 2031[b]	131,260,000
City of South Milwaukee Urban Forestry Plan through 2031	917,000
Specific Projects in Table 6.1	65,828,300
Recreational Access and Use Recommendations	3,120,000
Monitoring Recommendations through 2031	2,012,700
Information and Education Element through 2031	106,000
Mill Pond and Dam Element[c]	542,000 – 12,410,000
Total	203,739,000 – 215,537,000

[a] *All costs are given in 2019 dollars.*

[b] *The capital cost of full implementation of the MMSD green infrastructure plan for the portions of the Oak Creek watershed that are located within the MMSD service area through 2035 is estimated as $170,241,000.*

[c] *The capital costs related to the Mill Pond and Dam are dependent upon the management alternative selected by Milwaukee County for implementation.*

Source: Milwaukee Metropolitan Sewerage District, City of South Milwaukee, SEWRPC

Captain Planet Foundation Small Grants Program

The Captain Planet Foundation (CPF) provides funding to support hands-on environmental projects designed to encourage innovative initiatives that inspire and empower children and youth to work at creating environmental solutions in their homes, schools, and communities. CPF grants are intended to:

- Empower youth by providing hands-on environmental stewardship opportunities
- Inspire youth and communities to become agents of change for their communities
- Serve as a catalyst for education that uses the environment as a context for science, technology, engineering, and mathematics (STEM) learning

As described below, CPF offers material and monetary support.

Material Support Program

CPF provides material support through its ecoSTEM Resource Kits. These kits provide material and activity supplies organized by environmental themes such as Renewable Energy, Water Quality, PolliNation, and Earth Soil & Decomposition. Additionally, ecoSTEM Kits provide a class sets of materials that can be used and reused to carry out investigations, engineering design challenges, citizen science projects, and stewardship projects. Grant application cycle is open from the beginning of September through the beginning of January.

Monetary Support

CPF provides monetary support through two grant programs: ecoTech Grants and ecoSolutions Grant.

Funding through ecoTech Grants is offered for programs that engage children in inquiry-based, STEM-related projects that leverage technology and/or use of nature-based designs to address environmental concerns in local communities. Grant applications are available in two cycles annually (September 15 through January 15 and March 15 through July 15) with a cash award amount of $2,500.

Funding through ecoSolution Grants provides support for youth-led environmental projects with cash grants ranging between $500-$2,500 during two annual cycles: September 15 through January 15 and March 15 through July 15.

Organizations exempt from federal taxation under the IRS Section 501 are eligible for monetary support as are those that have a fiscal sponsor that is exempt. This includes most schools and nonprofit organizations. Nonprofit organizations must also maintain an annual operating budget of less than $3 million to qualify.

Table 6.41
Summary of Estimated Capital Costs for Projects in Table 6.1

Title	Number of Projects	Cost (dollars)
Aquatic Organism Passage Projects		
High Priority Projects with Costs	0	--
High Priority Projects for which Costs will be Assigned During Project Development	9	--
Other Projects with Costs	0	--
Other Projects for which Costs will be Assigned During Project Development	19	--
Subtotal	28	--
Debris Jam Modification and Removal Projects		
High Priority Projects with Costs	0	--
High Priority Projects for which Costs will be Assigned During Project Development	6	--
Other Projects with Costs	0	--
Other Projects for which Costs will be Assigned During Project Development	33	--
Subtotal	39	--
Flood Relief Projects		
High Priority Projects with Costs	2	4,915,000
High Priority Projects for which Costs will be Assigned During Project Development	0	--
Other Projects with Costs	5	1,454,400
Other Projects for which Costs will be Assigned During Project Development	8	--
Subtotal	15	6,369,400
Floodplain Reconnection Projects		
High Priority Projects with Costs	4	21,948,000[a]
High Priority Projects for which Costs will be Assigned During Project Development	0	--
Other Projects with Costs	9	20,134,500[a]
Other Projects for which Costs will be Assigned During Project Development	0	--
Subtotal	13	42,082,500[a]
Illicit Discharge Detection and Elimination Projects		
High Priority Projects with Costs	0	--
High Priority Projects for which Costs will be Assigned During Project Development	12	--
Other Projects with Costs	0	--
Other Projects for which Costs will be Assigned During Project Development	0	--
Subtotal	12	--
Land Restoration Projects		
High Priority Projects with Costs	7	396,800
High Priority Projects for which Costs will be Assigned During Project Development	0	--
Other Projects with Costs	13	1,014,700
Other Projects for which Costs will be Assigned During Project Development	6	--
Subtotal	26	1,411,500
Mill Pond and Mill Pond Dam Projects		
High Priority Projects with Costs	1	49,000
High Priority Projects for which Costs will be Assigned During Project Development	0	--
Other Projects with Costs	2	570,500[b]
Other Projects for which Costs will be Assigned During Project Development	0	--
Subtotal	3	619,500[b]
Outfall Repair Projects		
High Priority Projects with Costs	7	28,800
High Priority Projects for which Costs will be Assigned During Project Development	1	--
Other Projects with Costs	37	93,700
Other Projects for which Costs will be Assigned During Project Development	0	--
Subtotal	45	122,500

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Table 6.41 (Continued)

Title	Number of Projects	Cost (dollars)
Recreational Access Projects		
High Priority Projects with Costs	0	--
High Priority Projects for which Costs will be Assigned During Project Development	0	--
Other Projects with Costs	0	--
Other Projects for which Costs will be Assigned During Project Development	2	--
Subtotal	2	--
Riparian Buffer Expansion Projects		
High Priority Projects with Costs	5	2,264,300
High Priority Projects for which Costs will be Assigned During Project Development	0	--
Other Projects with Costs	17	2,627,300
Other Projects for which Costs will be Assigned During Project Development	3	--
Subtotal	25	4,891600
Stream Channel Restoration Projects		
High Priority Projects with Costs	1	400,000
High Priority Projects for which Costs will be Assigned During Project Development	1	--
Other Projects with Costs	0	--
Other Projects for which Costs will be Assigned During Project Development	8	--
Subtotal	10	400,000
Streambank Stabilization and Protection Projects		
High Priority Projects with Costs	15	855,100
High Priority Projects for which Costs will be Assigned During Project Development	0	--
Other Projects with Costs	132	3,556,600
Other Projects for which Costs will be Assigned During Project Development	0	--
Subtotal	149	4,411,700
Urban Stormwater Management Projects		
High Priority Projects with Costs	5	1,237,100
High Priority Projects for which Costs will be Assigned During Project Development	1	--
Other Projects with Costs	12	3,686,600
Other Projects for which Costs will be Assigned During Project Development	0	--
Subtotal	18	4,923,700
Miscellaneous Projects		
High Priority Projects with Costs	4	585,400
High Priority Projects for which Costs will be Assigned During Project Development	8	--
Other Projects with Costs	1	10,500
Other Projects for which Costs will be Assigned During Project Development	10	--
Subtotal	23	595,900
Totals		
High Priority Projects with Costs	51	32,679,500
High Priority Projects for which Costs will be Assigned During Project Development	38	--
Other Projects with Costs	228	33,148,800
Other Projects for which Costs will be Assigned During Project Development	89	--
Total	406	65,828,300

Note: Costs are in 2019 dollars.

[a] *Depending on features incorporated, estimated capital costs range between $500 and $1,360 per linear foot. For the purposes of the cost analysis, the median value of $930 per linear foot was assumed.*

[b] *The cost of the sediment transport study in project LMP-02 ranges between $10,000 and $75,000, depending on the particular analysis methods chosen. For the purposes of the cost analysis, the median value of $42,500 was assumed.*

Source: SEWRPC

Table 6.42
Potential Funding Programs to Implement Recommendations of the Oak Creek Watershed Restoration Plan

ID	Administrator of Grant Program	Name of Funding Program(s)	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Cycle/Deadline	Contact Information
1	Captain Planet Foundation (CPF)	Small Grants Program (i.e., "ecoTech" and "ecoSolution" grants)	U.S.-based schools and nonprofit organizations with an annual operating budget of less than $3 million	1. Projects that provide hands-on environmental opportunities for youth 2. Projects that use the environment for applied and STEM learning 3. Projects that have real environmental outcomes 4. Projects that inspire youth and communities to participate in environmental stewardship activities	Grants range between $500 and $2,500	Two cycles: 1. September 15 through January 15 2. March 15 through July 15	info@captainplanetfdn.org (404) 522-4270
2	Charles Stewart Mott Foundation	Environmental Program (i.e., "Addressing the Freshwater Challenge" and "Special Initiatives")	Nonprofit conservation and environmental organizations	1. Projects that seek to strengthen the environmental community 2. Projects that implement effective public policies related to water conservation in the Great Lakes region	Grants - no maximum given	None	mott.org email: info@mott.org (800) 238-5651
3	Clif Bar Family Foundation	Clif Bar Family Foundation Small Grants	Nonprofit organizations	Projects that use a holistic approach toward: 1. Creating healthy food systems 2. Increasing outdoor activity 3. Reducing environmental health hazards 4. Building stronger communities	Average assistance of $7,000 provided	February 1 June 1 October 1	clifbarfamilyfoundation.org email: familyfoundation@clifbar.com (510) 596-6383
4	Cornell Douglas Foundation	Cornell Douglas Foundation	Environmental organizations	Funding areas include: 1. Environmental health and justice 2. Land conservation 3. Sustainability of resources 4. Watershed protection 5. Financial literacy for elementary and high school students	Grants range between $15,000 and $50,000	Announced by Foundation	cornelldouglas.org (301) 229-3008 email: cdf@cornelldouglas.org
5	Doris Duke Charitable Foundation	Environment Program	Nonprofit organizations	Projects that focus on: 1. Land conservation 2. Wildlife and energy development 3. Enhancing conservation	Multi-year grants averaging from $100,000 to $1 million	None	Ddcf.org Program Director for the Environment: (212) 974-7000 email: env@ddcf.org
6	Freshwater Future	Project Grant Program and Special Opportunity Grants (i.e., "Emergency Grant") Program	Community or nonprofit organizations	Projects that promote river, lake, shoreline, wetland, groundwater, and drinking water protection in the Great Lakes basin	Grants range between $500 and $5,000	Spring and Fall grant application cycles Special Opportunity grants available until funds run out	freshwaterfuture.org (231) 348-8200
7	Fund for Lake Michigan	Fund for Lake Michigan	Community or nonprofit organizations	Projects that: 1. Enhance the ecological health of nearshore coastal areas and rivers 2. Improve water quality flowing into Lake Michigan	Each quarter total grants range between $750,000 and $1 million	Pre-proposals accepted throughout the year Grant decisions made quarterly: March, June, September, and December	fundforlakemichigan.org Program Officer: Casey Eggleston (608) 334-7788
8	Great Lakes Commission	Great Lakes Sediment and Nutrient Reduction Program	Local and state governments and nonprofit organizations	Nutrient and sediment reduction projects that: 1. Support nutrient and sediment erosion control 2. Enhance stormwater runoff BMPs 3. Promote nutrient management planning 4. Improve restoration or protection of Great Lakes shoreline and riparian corridors	Assists up to $200,000 with a 25 percent match required	April 16	glc.org Program Manager: Nicole Zacharda (734) 396-6084 nzacharda@glc.org

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Table 6.42 (Continued)

ID	Administrator of Grant Program	Name of Funding Program(s)	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Cycle/Deadline	Contact Information
9	Great Lakes Fishery Trust (GLFT)	Great Lakes Fishery Trust	Nonprofit organizations, educational institutions, and government agencies	Projects associated with the following grant categories: 1. "Ecosystem Health and Sustainable Fish Populations" 2. "Great Lakes Stewardship" 3. "Special Projects"	Up to $1.3 million for ecological and biological research Up to $500,000 for habitat protection and restoration	Announced by grant program on website	glft.org (517) 371-7468
10	Great Lakes Protection Fund	Great Lakes Protection Fund	State and local units of government, nonprofit organizations, for-profit businesses, and individuals	Projects intended to: 1. Improve the health of the Great Lakes 2. Promote the interdependence of healthy ecological and economic systems 3. Support innovative and creative ideas	Awards the total cost of accepted projects	None	Glpf.org (847) 425-8150 Discuss a project idea: startaconverstaion@glpf.org To submit a pre-proposal: Preproposal@glpf.org Contact staff member: info@glpf.org
11	James E. Dutton Foundation	James E. Dutton Foundation	Organizations or individuals working on projects that benefit wildlife, animal causes, environmental preservation, and outdoor education	Support efforts for wildlife or animal rescue; enhancement of habitat conservation; responsible land management, increased public awareness of conservation and the environment	Awards the total cost of accepted projects	None	jameseduttonfoundation.org email: silvercreek.fenske@gmail.com (414) 640-0523
12	The Joyce Foundation	Environment Program (i.e., "The Great Lakes and Drinking Water" Program)	Nonprofit organizations, educational institutions, and government agencies	Efforts that will: 1. Improve water infrastructure 2. Prevent unsustainable diversions from the Great Lakes 3. Prevent groundwater depletion 4. Reduce polluted runoff in rural and urban areas 5. Prevent the introduction and spread of aquatic invasive species 6. Support equitable water policy 7. Ensure safe water systems and infrastructure	Awards the total cost of accepted projects	Grant proposals considered in April, July, and December	joycefdn.org email: info@joycefdn.org (312) 782-2464
13	Milwaukee Metropolitan Sewerage District (MMSD)- Fresh Coast Guardians Resource Center	Fresh Coast Guardians—Green Infrastructure Design Services	Nonprofit organizations, businesses, homeowners, and government agencies	Green infrastructure design projects that will ultimately improve the health of Lake Michigan	Up to $15,000	Open enrollment period	freshcoastguardians.com (441) 225-2222
14	Milwaukee Metropolitan Sewerage District	Green Infrastructure Partnership Program	Government agencies, nongovernmental organizations, private property owners within eligible municipalities	Installation of green infrastructure practices	Varies depending on project	Proposals due annually in early spring	www.mmsd.com/about-us/news/green-infrastructure-partnership-program-2021 (441) 225-2222 Manager of Sustainability: Bre Plier bplier@mmsd.com

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Table 6.42 (Continued)

ID	Administrator of Grant Program	Name of Funding Program(s)	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Cycle/Deadline	Contact Information
15	Natural Resources Foundation of Wisconsin	C.D. Besadny Conservation Fund	Public charities; federal, state, or local units of government; Indian tribes; and accredited schools, colleges, or universities	Grassroots conservation and education projects that benefit Wisconsin's lands, waters, and wildlife	Grants range from $500 to $2,000	September 1	www.wisconservation.org/grants/cd-besadny-conservation-grants Director of Conservation Programs: Caitlin Williamson Caitlin.Williamson@Wisconservation.org (608) 409-3109
16	Natural Resources Foundation of Wisconsin	The Go Outside Fund	Public charities, federal, state, or local units of government, Indian tribes; or accredited schools, colleges, or universities	Projects that engage children in significant outdoor, nature-based learning activities	Grants range from $100 to $500	Quarterly: March 31 June 30 September 30 December 31	www.wisconservation.org/grants/go-outside-fund Director of Conservation Programs: Caitlin Williamson Caitlin.Williamson@Wisconservation.org (608) 409-3109
17	Natural Resources Foundation of Wisconsin	The Norma and Stanley DeBoer Quiet Trails Fund	Public charities, federal, state, or local units of government, Indian tribes; or an accredited schools, colleges, or universities	1. Creating and maintaining public walking, hiking, or skiing trails 2. Increasing access for people with disabilities 3. Identification of trail locations and signage 4. Surveying 5. Purchasing trail materials 6. Construction 7. Trail maintenance	Grants range from $500 to $1,000	March 1	www.wisconservation.org/grants/quiet-trails-fund Director of Conservation Programs: Caitlin Williamson Caitlin.Williamson@Wisconservation.org (608) 409-3109
18	Natural Resources Foundation of Wisconsin	The Teachers Outdoor Environmental Education Fund	K-12 Wisconsin public school teachers	1. Projects that demonstrate a clear connection to classroom learning and standards 2. Projects that have a significant component of outdoor activity	Up to $1,000	May 1	wisconservation.org/grants/teachers-outdoor-environmental-education-fund Director of Conservation Programs: Caitlin Williamson Caitlin.Williamson@Wisconservation.org (608) 409-3109
19	Natural Resources Foundation of Wisconsin	Wisconsin Rare Plant Preservation Fund	Public charities, federal, state, or local units of government, Indian tribes; or an accredited schools, colleges, or universities	Projects that protect Wisconsin's rare plants and lichens through monitoring, inventorying, and preservation	$500-$1,000	February 1	wisconservation.org/grants/rare-plant-preservation-fund Director of Conservation Programs: Caitlin Williamson Caitlin.Williamson@Wisconservation.org (608) 409-3109
20	National Fish and Wildlife Foundation (NFWF)	Acres for America	State, local, municipal, and tribal governments and nonprofit organizations	1. Conserve critical habitats for birds, fish, plants, and wildlife 2. Connect existing protected lands and protect migration routes 3. Provide access to the outdoors 4. Ensure the future of local economies that depend on forestry, ranching and recreation	About $3.5 million total will be available in 2021	Grant pre-proposals due April 15	nfwf.org/programs/acres-america Conservation Programs Coordinator: Kimberly Shriner Kimberly.Shriner@nfwf.org
21	National Fish and Wildlife Foundation	Bring Back the Natives	Local, state, federal, and tribal governments and agencies; special districts such as conservation districts, planning districts, utility districts; nonprofit organizations; schools; and universities	Supports projects that conserve aquatic ecosystems such as: 1. Restoring connectivity 2. Restoring riparian and instream habitat and water quality 3. Invasive species management 4. Innovative approaches to fish conservation	Awards totaling $500,000 available in competitive grant proposals	None	nfwf.org/programs/bring-back-natives Water Investments Coordinator: Hannah Karlan Hannah.Karlan@nfwf.org

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Table 6.42 (Continued)

ID	Administrator of Grant Program	Name of Funding Program(s)	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Cycle/Deadline	Contact Information
22	National Fish and Wildlife Foundation	Five Star and Urban Waters Restoration Program	Nonprofit organizations, state government agencies, local governments, municipal governments, Indian tribes and educational institutions	Project priorities include: 1. On-the-ground projects that restore and create wetlands, coastal, or riparian areas 2. Environmental outreach, education, and training 3. Community partnership projects that involve five or more partners (public or private entities) 4. Measure results in specific, measurable ecological, educational and community benefits	Grant assistance between $20,000 and $50,000	January 28	nfwf.org/programs/five-star-and-urban-waters-restoration-grant-program Community Stewardship Program Coordinator: Carrie Clingan Carrie.Clingan@nfwf.org
23	National Fish and Wildlife Foundation	National Coastal Resilience Fund	Coastal communities	Projects that restore, increase, and strengthen natural infrastructure to protect coastal communities while improving habitat for fish and wildlife	Varies depending on project scope and work proposed	Pre-proposals April 7	nfwf.org/programs/national-coastal-resilience-fund
24	National Fish and Wildlife Foundation	Resilient Communities Program	Nonprofit organizations, tribes, and local, state, and federal government agencies	Projects that include: 1. Adaptation through conservation 2. Community capacity-building that helps communities understand environmental risks 3. Scalable, nature-based resilience solutions benefiting affordable housing and/or small businesses	Grants range from $100,000 to $500,000 depending on project	Announced on website	nfwf.org/programs/resilient-communities-program Community Stewardship Program Coordinator: Carrie Clingan Carrie.Clingan@nfwf.org
25	National Fish and Wildlife Foundation	Sustain Our Great Lakes Program	Nonprofit organizations, state government agencies, local governments, Indian tribes, and educational institutions.	Project priorities include: 1. Restore and enhance stream and riparian habitat 2. Restore and enhance coastal wetland habitat 3. Expand green stormwater infrastructure in Great Lakes communities 4. Maintain and enhance benefits of habitat restoration through invasive species control 5. Restore and preserve natural areas and biodiversity in Wisconsin's Lake Michigan watershed	Grants range between $25,000 and $1.5 million	April 20	nfwf.org/programs/sustain-our-great-lakes-program Great Lakes Programs Senior Manager: Traci Giefer Traci.Giefer@nfwf.org
26	Southeastern Wisconsin Invasive Species Consortium (SEWISC)	SEWISC Assistance Program	Individuals, nonprofit organizations, community and civic groups, private businesses, and units of government	Projects to lessen the impacts of invasive species in southeastern Wisconsin	Up to $2,000 provided in grant money with a required 25 percent match of the project budget	Announced on SEWISC website	sewisc.org
27	Southeastern Wisconsin Watersheds Trust (Sweet Water)	Sweet Water Mini-Grant Program	Nonprofit organizations, civic groups, and community groups within the greater Milwaukee watersheds	Projects that improve water quality, restore habitat, promote conservation and advance public education concerning water issues	Grants range between $1,000 to $5,000	Announced on website	swwtwater.org (414) 382-1766 Executive Director: Jake Fincher fincher@swwtwater.org Watershed Coordination Manager: Kristin Schoenecker kristin@swwtwater.org
28	U.S. Army Corps of Engineers (USACE)	Aquatic Ecosystem Restoration Program	State and local units of government	Modification of hydrology in and along water bodies	Planning costs after $100,000 is 50 percent cost-shared. Design and implementation are cost-shared 65 percent federal and 35 percent non-federal	None	CELRC_Planning_Econ@usace.army.mil (312) 846-5580

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Table 6.42 (Continued)

ID	Administrator of Grant Program	Name of Funding Program(s)	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Cycle/Deadline	Contact Information
29	U.S. Army Corps of Engineers	Emergency Streambank and Shoreline Protection Program	State and local units of government	Streambank or shoreline erosion projects that will help protect public buildings and infrastructure	Planning costs after $100,000 require 50 percent local cost-share. Implementation costs are shared at 65 percent federal and 35 percent non-federal contributions	None	CELRC_Planning_Econ@usace.army.mil (312) 846-5580
30	U.S. Army Corps of Engineers	Great Lakes Fishery and Ecosystem Restoration Program	State and local units of government, public agencies, private interests, nonprofit organizations	Projects to protect and/or restore the fishery, ecosystems and beneficial uses of the Great Lakes	Planning costs after $100,000 is cost-shared at 65 percent federal and 35 percent non-federal. Implementation is cost-shared at 65 percent federal and 35 percent non-federal	None	CELRC_Planning_Econ@usace.army.mil (312) 846-5580
31	U.S. Army Corps of Engineers	Small Flood Risk Management Program	State and local units of government	Construct site-specific flood protection projects or improvement of flood control works	Planning costs after the first $100,000 is 50 percent cost shared. Implementation is cost-shared at 65 percent federal and 35 percent non-federal	None	CELRC_Planning_Econ@usace.army.mil (312) 846-5580
32	U.S. Army Corps of Engineers	Snagging and Clearing for Flood Damage Reduction	State and local units of government	Removal of accumulated snags and debris from stream channels to prevent flooding	Planning costs after the first $100,000 is 50 percent cost shared. Implementation is cost-shared at 65 percent federal and 35 percent non-federal	None	CELRC_Planning_Econ@usace.army.mil (312) 846-5580
33	U.S. Department of Agriculture-Farm Services Agency (FSA)	Conservation Reserve Program (CRP)	Landowner or producer of the land for at least 12 months	1. Wildlife habitat improvement projects 2. Water quality improvement projects that reduce erosion, runoff, and leaching 3. Projects that will continue to benefit the land 4. Air quality improvement projects such as reducing wind erosion	Annual rental payments and 50 percent cost-share assistance	January 4 through February 12	fsa.usda.gov/programs-and-services/conservation-programs Local Farm Service Agency Office: fsa.uniongrove@usda.gov
34	U.S. Department of Agriculture-Farm Services Agency	Emergency Conservation Program (ECP)	Agricultural producers and ranchers	Practices that would recover and improve existing conservation practice(s) damaged by a natural disaster or severe drought	Assists up to 75 percent of approved restoration costs	None	fsa.usda.gov/programs-and-services/conservation-programs Local Farm Service Agency Office: fsa.uniongrove@usda.gov
35	U.S. Department of Agriculture-Forest Service	Community Forest Program	Tribal entities, local governments, and qualified conservation nonprofit organizations	Projects aimed to acquire and establish forests that will provide community and economic benefits through active forest management, clean water, wildlife habitat, educational opportunities, and public access for recreation	Program pays up to 50 percent of project costs and requires a 50 percent non-federal match	Announced annually by the U.S. Forest Service	fs.usda.gov/managing-land/private-land/community-forest Eastern Region Forest Legacy Program: Kirston Buczak kirston.buczak@usda.gov (414) 297-3609
36	U.S. Department of Agriculture-Natural Resources Conservation Service (NRCS)	Agricultural Conservation Easement Program: *Agricultural Lands*	Eligible lands for agricultural easements include cropland, rangeland, grassland, pastureland and non-industrial private forest	Projects that protect working agricultural lands	Assists up to 75 percent of the easement value depending on environmental significance of the land	None	nrcs.usda.gov Local NRCS Office Contact: Brandi Richter Brandi.richter@wi.usda.gov (262) 747-3010

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Table 6.42 (Continued)

ID	Administrator of Grant Program	Name of Funding Program(s)	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Cycle/Deadline	Contact Information
37	U.S. Department of Agriculture-Natural Resources Conservation Service	Agricultural Conservation Easement Program: *Wetlands Reserve*	Eligible lands include farmed or converted wetland that can be restored	Projects that restore, protect, and enhance wetlands	Assists 50 to 100 percent of the restoration costs and easement value	None	nrcs.usda.gov Local NRCS Office Contact: Brandi Richter Brandi.richter@wi.usda.gov (262) 747-3010
38	U.S. Department of Agriculture-Natural Resources Conservation Service	Conservation Stewardship Program (CSP)	Tribal entities, agricultural producers, ranchers, and private non-industrial forests	Maintain, improve, or expand conservation practices on agricultural lands	Assistance is based on conservation practices	None	nrcs.usda.gov Local NRCS Office Contact: Brandi Richter Brandi.richter@wi.usda.gov (262) 747-3010
39	U.S. Department of Agriculture-Natural Resources Conservation Service	Emergency Watershed Protection Program (EWP)	Public and private landowners after natural disaster Eligible sponsors include cities, counties, towns, conservation districts, or any federally-recognized Native American tribe or tribal organization	Projects that will: 1. Remove debris from stream channels, road culverts, and bridges 2. Reshape and protect eroded streambanks 3. Correct damaged or destroyed drainage facilities 4. Establish vegetative cover on critically eroding lands 5. Repair levees and structures 6. Repair conservation practices	Up to 75 percent provided in assistance	None	nrcs.usda.gov Local NRCS Office Contact: Brandi Richter Brandi.richter@wi.usda.gov (262) 747-3010
40	U.S. Department of Agriculture-Natural Resources Conservation Service	Environmental Quality Incentives Program (EQIP)	Tribal, agricultural producers, and private non-industrial forests, and degraded wetlands	Projects that will enhance wildlife habitat, soil, and water quality on working agricultural lands and forests	Up to $450,000 based on conservation practices	None	nrcs.usda.gov Local NRCS Office Contact: Brandi Richter Brandi.richter@wi.usda.gov (262) 747-3010
41	U.S. Department of Agriculture-Natural Resources Conservation Service	Regional Conservation Partnership Program (RCPP)	Landowners and agricultural producers, state, local, or tribal governments, nonprofits, and higher education	Conservation practices that will increase the restoration and sustainable use of soil, water, wildlife, and related natural resources on regional or watershed scales	Annual assistance of $300 million per year nationally	None	nrcs.usda.gov Local NRCS Office Contact: Brandi Richter Brandi.richter@wi.usda.gov (262) 747-3010
42	U.S. Department of Agriculture-Natural Resources Conservation Service	Watershed Protection and Flood Protection Program	Federal, state, and local government agencies, and tribal governments	Plans that will address: 1. The protection and restoration of watersheds from erosion, floodwater, and sediment impacts 2. Enhancement of water and land conservation practice 3. Economic impacts related to natural resources	Financial and technical assistance provided	None	nrcs.usda.gov Local NRCS Office Contact: Brandi Richter Brandi.richter@wi.usda.gov (262) 747-3010
43	U.S. Environmental Protection Agency (USEPA)	Environment-al Education Grants (EE)	Local educational institutions, environmental agencies, and nonprofit organizations	Projects that address one or more of the following: 1. Improving air quality 2. Clean and safe water 3. Safety of chemicals 4. Land revitalization	75 percent cost-share provided for a Federal total of $50,000 to $100,000	None	epa.gov/education/grants EPA Region 5: (312) 353-4293
44	U.S. Environmental Protection Agency	Environment-al Justice Small Grants Program	Incorporated nonprofit organizations —including, but not limited to, environmental justice networks, faith-based organizations, and tribal organizations	Community-driven projects that engage, educate, and empower communities to better understand local environmental and public health issues and develop strategies for addressing those issues	Up to $75,000 depending on availability of funds	None	epa.gov/environmentaljustice/environmental-justice-small-grants-program Office of Environmental Justice: (202) 564-2515 EPA Region 5: (312) 353-4293

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Table 6.42 (Continued)

ID	Administrator of Grant Program	Name of Funding Program(s)	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Cycle/Deadline	Contact Information
45	U.S. Environmental Protection Agency	Great Lakes Restoration Initiative Program (GLRI)	States, tribes, local governments, universities, and nongovernmental organizations in the Great Lakes region	Projects associated with: 1. Toxic substances and Areas of Concern (AOC) 2. Invasive species 3. Nonpoint source pollution impacts on nearshore health 4. Habitats and species restoration 5. Foundations for future restoration actions	After EPA and its partner agency agree on program and project, the EPA will appropriate the money to provide funding	Dependent on partner Federal agency	epa.gov/great-lakes-funding Michael Russ Russ.michael@epa.gov
46	U.S. Federal Emergency Management Agency (FEMA)	Building Resilient Infrastructure and Communities (BRIC)	Applicants: states, territories, and Tribal governments Sub-applicants: local and tribal governments and state and tribal agencies	Funds may be used for: 1. Capability- and capacity-building activities 2. Hazard mitigation projects 3. Management costs	FEMA will distribute up to $500 million with 25 percent local match required States distribute up to $600,000 per applicant	Announced on FEMA website	fema.gov/grants/mitigation/building-resilient-infrastructure-communities Wisconsin Division of Emergency Management dma.wi.gov/DMA/wem/mitigation/hma
47	U.S. Federal Emergency Management Agency	Hazard Mitigation Grant Program (HMGP)	State agencies and participating NFIP communities	1. Floodproofing 2. Relocation 3. Elevation of structures 4. Property acquisition	75 percent federal cost-share assistance, 12.5 percent state match, and 12.5 percent local match	Within 60 days of a Presidential disaster declaration	fema.gov/grants/mitigation/hazard-mitigation Wisconsin Division of Emergency Management dma.wi.gov/DMA/wem/mitigation/hma
48	U.S. Fish and Wildlife Service (USFWS)	National Fish Passage Program	Individuals, nonprofit or national organizations, and local governments	Projects that: 1. Restore fish passage 2. Develop community infrastructure resilience 3. Rebuild fish populations 4. Improve recreational and commercial fisheries 5. Restore free flowing waters	On average the program contributes about $70,000 per project. There is no upper limit to project funding. Generally, a 50 percent match is required from federal or non-federal sources	Announced on USFWS website	fws.gov/fisheries/fish-passage.html National Fish Passage and Aquatic Habitat Coordinator: Dr. Michael Bailey michael_bailey@fws.gov Regional Fish Passage Coordinator: Jessica Hogrefe jessica_hogrefe@fws.gov
49	U.S. Fish and Wildlife Service	Partners for Fish and Wildlife Program	Private landowners	Priority projects include: 1. Livestock fencing 2. Alternate water supply/construction 3. Streambank stabilization 4. Restoration of in-stream aquatic habitat planting 5. Prescribed burning 6. Native grass and forb planting 7. Wetland restoration 8. Riparian reforestation	Reimbursement of project expenses Cost-share varies, maximum project award of $25,000	September 30	fws.gov/partners/ USFWS State Coordinator: Kurt Waterstradt Kurt_Waterstradt@fws.gov (608) 221-1206
50	Wisconsin Board of Commissioners of Public Lands	State Trust Fund Loan Program	Municipalities and school districts	Any public purpose including infrastructure	Loans at competitive rates	Ongoing	bcpl.wisconsin.gov Richard Sneider: (608) 261-8001 Richard.sneider@wi.gov
51	Wisconsin Citizen-Based Monitoring Network	Wisconsin Citizen-Based Monitoring Partnership Program	Local units of government, lake districts and associations, school districts, river management organizations, colleges, universities, technical schools, nonprofit conservation organizations	Citizen-based monitoring of aquatic and terrestrial species, natural communities and environmental components such as water, soil, and air	Up to $5,000 per project in assistance	Spring application cycle announced by WDNR	wiatri.net dnr.wisconsin.gov Water Resources Management Specialist: Rachel Sabre Rachel.Sabre@Wisconsin.gov (262) 574-2133

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Table 6.42 (Continued)

ID	Administrator of Grant Program	Name of Funding Program(s)	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Cycle/Deadline	Contact Information
52	Wisconsin Coastal Management Program (WCMP)	Coastal Management Grant Program	Local governments, state agencies, colleges and universities, school districts, planning commissions serving coastal areas, tribal governments, and nonprofit organizations	Primary projects include: 1. Coastal wetland protection and habitat protection 2. Nonpoint source pollution control 3. Coastal resource and community planning 4. Great Lakes education 5. Public access and historic preservation projects	50 percent state match for projects with budgets of $60,000 or less; 40 percent state match for projects with budgets greater than $60,000	Periodic application announcement on website	doa.wi.gov/Pages/LocalGovtsGrants/CoastalManagement.aspx Staff contact: coastal@wisconsin.gov WCMP Program Manager: Michael Friis (608) 267-7982 Michael.friis@wisconsin.gov
53	Wisconsin Conservation & Education Foundation	Wisconsin Conservation & Education Foundation	Environmental and natural resources organizations, Wisconsin educators, and individuals	Projects that promote public education to enhance natural resources, environmental stewardship, and outdoor heritage through publications and events	Provides grant money through individual donations and the annual fundraiser banquet, which on average, brings in $20,000	None	wiconservationfoundation.org
54	Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP)	Clean Sweep Program	Counties, towns, villages, cities, tribes, sanitary and sewerage districts, or regional planning commissions	Collection and disposal of household hazardous wastes, agricultural pesticides, and prescription drugs	Grant program provides reimbursement	Announced on webpage	datcp.wi.gov/Pages/Programs_Services/CleanSweep.aspx Clean Sweep Program Coordinators: Monica Sipes (608) 224-4536 Sally Ballweg (608) 224-4522
55	Wisconsin Department of Agriculture, Trade and Consumer Protection	Nutrient Management Farmer Education Grants (NFME)	Local organizations	1. Providing nutrient management training, plan writing, soil testing, and training 2. Offer nutrient management training, education, and support	Provides assistance between $2,500 to $20,000	April 15	datcp.wi.gov/Pages/Programs_Services/NMFEGrants.aspx Contact: Mark Witecha (608) 224.4605 Markj.witecha@wisconsin.gov
56	Wisconsin Department of Agriculture, Trade and Consumer Protection	Soil and Water Resource Management Program	County conservation and resource management officials	1. Soil and water conservation on farms 2. Land and water resource management plans 3. Support of county conservation staff 4. Cost-share grants to landowners to implement conservation practices 5. Certifying designs by soil and water professionals	Pays for conservation staff and provides landowner cost-sharing to implement conservation practices	Ongoing	datcp.wi.gov Kim Carlson: kim.carlson@wisconsin.gov (608) 224-4610 Susan Mockert: susan.mockert@wisconsin.gov (608) 224-4648
57	Wisconsin Department of Natural Resources (WDNR)	Clean Water Fund Program (CWFP)	Municipalities, town sanitary districts, lake protection and rehabilitation districts, and metropolitan sewerage districts	Projects to control and treat urban stormwater runoff	Loans at an interest rate of 65 percent of the current market rate	Loan terms may not exceed 20 years	dnr.wisconsin.gov/aid/EIF.html
58	Wisconsin Department of Natural Resources	County Conservation Aids (CCA)	County and tribal governments	1. Aquatic habitat development 2. Aquatic vegetation management 3. Lake and stream rehabilitation and improvement	50 percent state cost-share	October 1	dnr.wisconsin.gov/aid/CountyConservation.html CCA Grant Program Manager: Beth Norquist (715) 839-3751 Elizabeth.Norquist@Wisconsin.gov

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Table 6.42 (Continued)

ID	Administrator of Grant Program	Name of Funding Program(s)	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Cycle/Deadline	Contact Information
59	Wisconsin Department of Natural Resources	Dam Removal Grant Program	Counties, cities, villages, towns, lake districts, and private dam owners	1. Dam removal planning 2. Dam removal 3. Restoration of impoundment	State covers 100 percent of project costs up to $50,000	Ongoing	dnr.wisconsin.gov/aid/DamRemoval.html State Dam Safety Engineer: Tanya Lourigan (608) 444-2089 Dam Grant Program Manager: Wendy Peich (608) 264-9207
60	Wisconsin Department of Natural Resources	Knowles-Nelson Stewardship Program	Local units of governments and qualified nonprofit organizations	1. Acquisition of land and easements for conservation and recreation 2. Developing and improving recreational facilities 3. Streambank protection 4. Restoring fish and wildlife habitat	50 percent cost-share assistance provided	May 1	dnr.wisconsin.gov/topic/Stewardship WDNR Regional Grant Specialist: Sara Debruijn (414) 263-8704 Sara.debruijn@wisconsin.gov
61	Wisconsin Department of Natural Resources	Land and Water Conservation Fund Program	State agencies and local units of government	1. Planning for acquisition of parks 2. Land acquisition for parks and open space 3. Supporting facilities that enhance recreational opportunities	50 percent cost-share assistance provided	May 1	dnr.wisconsin.gov/aid/LCWF.html WDNR Regional Grant Specialist: Sara Debruijn (414) 263-8704 Sara.debruijn@wisconsin.gov gov
62	Wisconsin Department of Natural Resources	Municipal Dam Grant Program	Cities, towns, villages, counties, tribes, and lake districts	1. Dam maintenance 2. Dam repair 3. Dam modification or abandonment 4. Dam removal	For repair the State covers 50 percent of the first $400,000; 25 percent of the next $800,000; and for removal the State covers 100 percent of the first $400,000	Announced online	dnr.wisconsin.gov/aid/DamMunicipal.html State Dam Safety Engineer: Tanya Lourigan (608) 444-2089 Dam Grant Program Manager: Wendy Peich (608) 264-9207
63	Wisconsin Department of Natural Resources	Municipal Flood Control Grants	Cities, villages, towns, tribes, and metropolitan sewerage districts	1. Structure and land acquisition 2. Structure floodproofing 3. Riparian restoration 4. Flood storage 5. Stormwater storage/detention 6. Flood mapping	State grant covers up to 70 percent of eligible costs	March of even-numbered years	dnr.wisconsin.gov/aid/MunFloodControl.html Elizabeth Kuisis Financial Assistance Specialist (608)-400-3005
64	Wisconsin Department of Natural Resources	Recreational Trails Program	Municipal governments, state and federal agencies, and incorporated organizations	1. Maintenance and restoration of existing trails 2. Development or rehabilitation of trailside and trailhead facilities 3. Construction of new trails 4. Land acquisition for trails	State grant covers up to 50 percent of eligible project costs	May 1	dnr.wisconsin.gov/aid/RTP.html Bobbi Winebar Wisconsin Department of Natural Resources 2984 Shawano Avenue Green Bay, WI 54313 (920) 461-2595

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Table 6.42 (Continued)

ID	Administrator of Grant Program	Name of Funding Program(s)	Eligibility	Types of Projects and Funding Eligibility Criteria	Assistance Provided	Application Cycle/Deadline	Contact Information
65	Wisconsin Department of Natural Resources	Surface Water Grants Program	Counties, municipalities, other local unites of government, lake districts, natural resource agencies, tribal governing agencies, higher educational institutions, town sanitary districts, and eligible organizations	1. Surface water education, planning, and restoration 2. Comprehensive Lake and watershed management planning 3. Aquatic invasive species prevention and control 4. Land acquisition	Planning grants may be awarded for up to 67 percent of total project costs, management grants cost-share of up to 75 percent, wetland restoration up to 100 percent cost share	November 1	dnr.wisconsin.gov/aid/SurfaceWater.html Grant Program Manager: Laura MacFarland (715) 499-0309 Regional Lake, Streams, or AIS biologist: Chrissy Kozik (414) 897-5776 Christine.Kozik@wisconsin.gov
66	Wisconsin Department of Natural Resources	Targeted Runoff Management Grant Program	Cities, villages, towns, counties, regional planning commissions, tribal governments and special purpose lake, sewerage and sanitary districts	1. Construction of structural BMPs 2. Implementation of nonstructural cropping practices 3. Implementation of State agricultural performance standards	State grant covers up to 70 percent of eligible costs. Funding is limited to $600,000 for large-scale projects and $225,000 for small-scale projects	May 15	dnr.wisconsin.gov/aid/TargetedRunoff.html Nonpoint Source Program Grant Manager: Corinne Johnson (608) 267-9385 Regional Nonpoint Source Coordinator: Jesse Bennett (414) 458.0448 Jessiah.Bennett@wisconsin.gov
67	Wisconsin Department of Natural Resources	Urban Nonpoint Source and Storm Water Management Grant Program	Cities, villages, towns, counties, regional planning commissions, tribal governments, and lake, sewage or sanitary districts	1. Stormwater Planning 2. Education and Information activities 3. Ordinance development and enforcement 4. Training 5. Construction of structural stormwater BMPs 6. Storm sewer rerouting and removal 7. Streambank stabilization	Planning grants – cost share up to 70 percent and reimbursement amount cannot exceed $85,000 Construction grants – cost share up to 50 percent and reimbursement amount cannot exceed $150,000	April 15	dnr.wisconsin.gov/aid/UrbanRunoff.html Nonpoint Source Program Grant Manager: Corinne Johnson (608) 267-9385
68	Wisconsin Department of Natural Resources	Wisconsin Forest Landowner Grant Program	Private non-industrial forest landowners	1. Stewardship plan preparation 2. Tree planting 3. Forest health improvement 4. Soil and water protection and improvement 5. Wetland and riparian protection 6. Wildlife habitat enhancement 7. Threatened and endangered resource maintenance and enhancement	Reimburses up to 50 percent of cost of eligible practices	Grants awarded on August 1st, November 1st, February 1st, and May 1st depending on funds available and the number of applications	dnr.wisconsin.gov/aid/ForestLandowner.html Program Manager Kristin Lambert (608) 212-0320
69	Wisconsin Department of Natural Resources	Wisconsin Wetland Conservation Trust	Wetland impacts requiring mitigation within the same watershed as the impact	Wetland restoration projects that align with other federal funding opportunities (i.e., USFWS Partners for Fish and Wildlife Habitat, Fish Passage Program, or Fish Habitat Partnership)	Sale of wetland credits	December 31	dnr.wisconsin.gov/topic/Wetlands/wwct James Brodzeller (608) 574-0573 James.brodzeller@wisconsin.gov
70	Wisconsin Department of Safety and Professional Services	Wisconsin Fund–Private Onsite Wastewater Treatment System Replacement or Rehabilitation Financial Assistance Program	Owners of principal residences and small businesses who meet income limits	Replacement or rehabilitation of failing onsite wastewater treatment systems that were built before July 1, 1978	Maximum grant award of $7,000	January 31	dsps.wi.gov/Pages/Programs/WisconsinFund/Default.aspx DSPS Division of Industry Services: Tanya Herranz Tanya.Herranz@wi.gov (608) 266-6796

Source: SEWRPC

Charles Stewart Mott Foundation

The Charles Stewart Mott Foundation (C.S. Mott Foundation) is a private grantmaking organization established in Flint, Michigan. The C.S. Mott Foundation supports efforts that promote a just, equitable, and sustainable society. The Foundation has four major grant programs: Civil Society Program, Education Program, Environment Program and Flint Area Program. The Environment Program seeks to protect communities and the ecosystems upon which they depend on. This program has four subgrant categories, two of which are relevant for funding projects recommended by this plan: "Addressing the Freshwater Challenge" and "Special Initiatives". Interested organizations must submit a letter of inquiry describing the purpose and objectives, general methodology, and total cost of the proposed project.[198]

<u>Addressing the Freshwater Challenge</u>

The goal of this grant program is to secure sustainable levels of clean water for people and the environment in the Great Lakes basin through strengthening the environmental community and informing sound public policies. The C.S. Mott Foundation seeks effective nongovernmental organizations and policies dedicated to long-term conservation of freshwater ecosystems.

<u>Special Initiatives</u>

The goal of the Special Initiatives grant program is to respond to unique opportunities to advance environmental protection in the U.S. and internationally that go beyond the Environment Program's major objectives.

Clif Bar Family Foundation

Clif Bar Family Foundation Small Grants are awarded for general organizational support or to fund specific projects. Grants average approximately $7,000 with priority given to applicants who:

- Address the funding priorities from a holistic approach
  - Protect Earth's beauty and bounty
  - Create a robust, healthy food system
  - Increase opportunities for outdoor activity
  - Reduce environmental health hazards
  - Build stronger communities
- Operate with clearly defined objectives
- Demonstrate strong community ties and operate at the community level
- Promote positive change through both the projects and their implementation process

Eligible grant applicants must be a 501(c)(3) organization. Application deadlines are February 1, June 1, and October 1. Grants awarded during a particular cycle will be announced at the beginning of the following cycle.

Cornell Douglas Foundation

The Cornell Douglas Foundation is a private, nonprofit organization that provides small grants to organizations that advocate for environmental health and justice, watershed protection, land conservation, and encourage environmental stewardship and sustainability. The average grant amount given is between $15,000 to $50,000.

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[198] *Jeff Alexander, Jessica Jones, Laurie Posner, Sarah Schuch,* Charles Stewart Mott Foundation Annual Report of 2019, *2020.*

Doris Duke Charitable Foundation

As described below, the Doris Duke Charitable Foundation's Environment Conservation Program provides several grant opportunities to individuals and nonprofit organizations seeking to improve and enhance conservation and wildlife habitat. Grants are awarded through invited proposals. Interested individuals or organizations must submit a letter of inquiry prior to grant proposal. The foundation generally awards multi-year grants that range from $100,000 to $1 million. Funding opportunities may also be available through organizations administering re-granting programs supported by the foundation. Because the foundation does not make direct grants for land acquisition projects, land funds are distributed through re-granting competitions administered by regional conservation organizations.

<u>Land Conservation in a Time of Climate Change</u>

The Doris Duke Foundation supports three critical land conservation activities supported by nonprofit organizations and environmental government agencies:

- Identifying resilient landscapes
- Protecting resilient landscapes
- Managing, restoring and adapting conserved lands to impacts of climate change

<u>Wildlife and Energy Development</u>

The continuing shift from carbon-based energy sources to renewable energy sources has increased the amount of funding needed to support renewable energy facilities. Because of this shift, the Foundation seeks efforts to ensure that renewable-energy facilities and infrastructure are built in ways and places that do not destroy or fragment wildlife habitat. Preserving intact landscapes through means such as conserving tree canopy within communities has multiple benefits including reducing greenhouse gas emissions, preserving wildlife habitat, and creating more livable, equitable communities. Funding priorities include projects that:

- Promote low-impact renewable energy development
- Minimize impacts of inappropriate bioenergy solutions
- Promote equitable urban forestry

<u>Strengthening the Conservation Field</u>

The Doris Duke Foundation's Strengthening the Conservation Field program supports efforts that increase public funding toward conservation as well as organizations focused on land protection. In addition, this program supports initiatives focused on increasing diversity, equity, and inclusion in the conservation field. Funding priorities include projects that:

- Diversify the conservation field and associated Programs:
    - Doris Duke Conservation Scholars Program
    - Building an Inclusive Conservation Movement Program
    - Diversity, Equity and Inclusion Capacity Building Program
- Increase public conservation funding
- Build the capacity of the land trust community
- Build a collaborative landscape conservation community

Freshwater Future

Freshwater Future is watershed-wide organization that supports community-based groups and actions to protect and restore the Great Lakes land and water resources, including advocacy efforts that promote clean drinking water and protection of the rivers, lakes, shorelines, wetlands, and groundwater within the Great Lakes Basin. This group's grant programs are described below.

<u>Project Grants Program:</u>

This program provides financial support for activities led by community groups working to promote river, lake, shoreline, wetland, groundwater, and drinking water protection in the Great Lakes Basin through grassroots advocacy efforts. Grant application deadlines are generally in spring and fall with an award between $500 to $5,000.

<u>Special Opportunity Grants Program:</u>

Special Opportunity Grants are "emergency grants" for projects working to protect drinking water, shorelines, inland lakes, rivers, groundwater, and wetlands that may not coincide with the application timeline or funding period of the Project Grant Program. Applications for grants of up to $500 are accepted until funds are depleted for the year.

Fund for Lake Michigan

The Fund for Lake Michigan was established in conjunction with the resolution of disputes concerning the We Energies Oak Creek Power Plant and Elm Road Generating Station. The agreement establishing the Fund for Lake Michigan provides for payments of $4 million each year from 2011 through 2035 to fund projects to improve the health of Lake Michigan. The Fund for Lake Michigan provides grants to nonprofit organizations and local government agencies for projects that will enhance the ecological health of the nearshore and coastal areas and rivers of southeastern Wisconsin through habitat preservation and restoration and for projects that improve the quality of the water flowing into Lake Michigan through reductions of pollutants, including toxins and nutrients. Examples of projects funded include habitat restoration projects, including restoration of woodlands, wetlands, beaches, instream and streambank sites, and brownfields; installation of riparian buffers, green infrastructure, and best management practices; removal of dams; development of watershed restoration plans; collection of water quality data in support of planning efforts; and small grant programs run by local watershed groups.

The Fund for Lake Michigan accepts grant pre-proposal applications on a rolling basis throughout the year. Grant decisions are made four times a year during quarterly meetings in March, June, September, and December. Each quarter The Fund for Lake Michigan awards between $750,000 to $1 million for accepted projects.

Great Lakes Commission

Funding for the Great Lakes Commission's Great Lakes Sediment and Nutrient Reduction Program (GLSNRP) is provided by the NRCS under the Great Lakes Restoration Initiative (GLRI).

Eligible applicants include local and state governments and nonprofit organizations. Grant application proposals must include nutrient and sediment reduction activities associated with one of three project types: 1) agricultural non-point; 2) stormwater; and 3) Great Lakes shoreline or streambanks. Applicants will be asked to identify the primary project type with the application. Projects are selected on a competitive basis. The maximum funding per project is $200,000 with a 25 percent match requirement. It should be noted that funds may be used for both technical and financial assistance; however, grant money cannot be used to fund technical assistance to implement Farm Bill cost-share programs.

Great Lakes Fishery Trust

The Great Lakes Fishery Trust (GLFT) was created in May 1996 as compensation to the residents of Michigan for the lost use and enjoyment of the fishery resources of Lake Michigan caused by the operation of the Ludington Pumped Storage Plant, located in Ludington, Michigan. The GLFT provides funding to nonprofit organizations, educational institutions, and government agencies to enhance, protect, and rehabilitate Great Lakes fishery resources. In 2021, The GLFT Board of Trustees set aside funding for grants in the following categories: Great Lakes Stewardship, Ecosystem Health and Sustainable Fish Populations, and

Special Projects. GLFT provides funding up to $1.3 million for ecological and biological research and up to $500,000 for habitat protection and restoration. The GLFT has an evaluation process for funding criteria associated to pre-proposal eligibility on their website.

Great Lakes Stewardship

The Great Lakes Stewardship request for proposals is released every other year beginning in 2021. This grant focuses on increasing awareness and understanding of the ecology of the Great Lakes so that citizens can be advocates for strategies that support long-term sustainability of the Great Lakes fishery and become stewards of the Great Lakes. This includes projects that:

- Build an understanding at the watershed level, and promote related actions on Great Lakes issues including:
    - Protecting biological diversity
    - Sustaining commercial and recreational fisheries
    - Controlling non-native nuisance species
    - Reducing pollution
- Promote environmental stewardship through direct experiences with natural resources
- Promote awareness of, and access to, existing Great Lakes education programs and resources

Ecosystem Health and Sustainable Fish Populations

The Ecosystem Health and Sustainable Fish Populations (EHSFP) grant supports the restoration and maintenance of the biological integrity of the Lake Michigan fish community. Currently, the GLFT is accepting proposals for the following funding themes under EHSFP:

- Ecological and Biological Fisheries Research to Inform Management
- Habitat Protection and Restoration

Special Projects

The GLFT considers proposals for special case or special project grants. To be considered for a special project grant, the proposed activity must generally fall outside of GLFT grant category and be nominated by a board member who is willing to support the proposal.

Great Lakes Protection Fund

The Great Lakes Protection Fund is a private, nonprofit corporation founded in 1989 by the Governors of the Great Lakes states. It is a permanent environmental endowment that supports collaborative actions to improve the health of the Great Lakes ecosystem. The Fund finances projects that advance the goals of the Great Lakes Toxic Substances Control Agreement and the Great Lakes Water Quality Agreement, notably restoring and maintaining the chemical, physical, and biological integrity of the Great Lakes basin ecosystem.

The Fund provides support to projects that create, test, and deploy new ways of improving the physical, chemical, and biological health of the basin ecosystem. Its investments reflect the nine priority areas the Great Lake's Governors have identified to guide government efforts to protect and restore the Great Lakes. These shared priorities are to:

- Ensure the sustainable use of water resources while confirming that the States retain authority over water use and diversions of Great Lakes waters
- Promote programs to protect human health against adverse effects of pollution in the Great Lakes ecosystem

- Control pollution from diffuse sources into water, land, and air
- Continue to reduce the introduction of persistent bioaccumulative toxics into the Great Lakes ecosystem
- Stop the introduction and spread of nonnative aquatic invasive species
- Enhance fish and wildlife by restoring and protecting coastal wetlands, fish, and wildlife habitats
- Restore to environmental health the areas of concern identified by the International Joint Commission as needing remediation
- Standardize and enhance the methods by which information is collected, recorded, and shared within the region
- Adopt sustainable use practices that protect environmental resources and may enhance the recreational and commercial value of the Great Lakes

The Fund can support specific projects through grants, loans, program-related investments, or other financial mechanisms. Nonprofit organizations, for-profit businesses, government agencies, and individuals are eligible to apply for project support. Applications for support are made by first discussing the potential project with Fund staff, followed by submission of a pre-proposal. Based upon the pre-proposal an applicant may be invited to submit a full proposal.

James E. Dutton Foundation

The James E. Dutton Foundation is a 501(c)(3) charitable private foundation established in 2005. The Foundation makes grants to organizations for programs that benefit wildlife, animal causes, the environment, and natural resources. The Foundation provides support for endeavors that provide care for wildlife and animals; provide animal rescue and/or shelter; enhance wildlife populations through habitat conservation, improvement, and/or restoration; promote sound land management; increase public awareness; and educate the public. The Foundation also provides assistance to organizations or programs that support individuals with their goals of caring for or enjoying wildlife, animals, and the outdoors; educating the public; preserving natural resources; and giving people the opportunity to experience animals, wildlife, and the outdoors. Projects funded in the past include wetland restorations, stream restorations, provision of trail markers at parks, and educational programs.

Grant requests should be submitted to the Foundation in writing and must include a description of the requesting organization and its mission. The request should also include a detailed description of the project or program for which the grant is being requested, along with the grant budget and schedule.

The Joyce Foundation

The Joyce Foundation is a charitable foundation based in Chicago, Illinois. It distributes about $45 million in grants each year. Its mission is to improve the quality of life, promote safe and healthy communities, and build a just society in the Great Lakes region. Throughout the year, funding is provided for many projects under the Foundation's Environment Program.

The Environment Program addresses three critical long-term environmental challenges: climate change, safety and accessibility of drinking water, and the health of the Great Lakes. Subsequently, the Joyce Foundation has two main environmental grant categories: "Climate Solutions" and "Great Lakes and Drinking Water" with the latter being most relevant to the Oak Creek watershed planning efforts.

<u>Great Lakes and Drinking Water</u>

The Great Lakes and Drinking Water focus area seeks to accelerate actions to protect the region's freshwater, upgrade water infrastructure, and improve access to safe, affordable drinking water. This focus area includes two initiatives:

- Addressing major threats to the health of the Great Lakes by:
  - Supporting efforts to reduce polluted runoff in rural and urban areas
  - Improving water infrastructure performance, management, and funding
  - Preventing the introduction and spread of aquatic invasive species
  - Preventing unsustainable diversion from the Great Lakes by enforcing the Great Lakes Compact
  - Preventing groundwater depletion
- Making certain that the next generation has access to safe, affordable drinking water by:
  - Supporting equitable water policy
  - Ensuring safe water systems and infrastructure
  - Providing affordable water services for everyone
  - Focusing on efforts to develop and support utility, municipal, state, and federal policies that reduce the risk of lead exposure in drinking water
  - Ensuring high quality, affordable water services

Because of its competitive application process, the Foundation encourages new applicants to send an email outlining the proposed project before submitting a letter of interest. Grant proposals are considered at the Foundation's Board of Directors meetings in April, July, and December.

Milwaukee Metropolitan Sewerage District (MMSD)

In 2017, MMSD created the Fresh Coast Resource Center (FCRC) to assist homeowners, businesses, nonprofits, and government agencies in protecting water resources. The FCRC provides communities with the education and tools needed to create successful green infrastructure projects such as rain barrels, rain gardens, porous pavement, bioswales, green roofs, and natural landscaping. The FCRC can also assist communities by making them aware of available funding opportunities. MMSD and FCRC programs supporting water quality are listed below.

Fresh Coast Guardians Resource Center- Design Services

Qualified nonprofit organizations can apply to the Fresh Coast Guardians-Design Services program in which a professional engineer provides a green infrastructure construction and maintenance plan specific to the organization's needs. This program is ongoing and makes awards up to $15,000.

Green Infrastructure Partnership Program

MMSD's Green Infrastructure Partnership Program provides funding to increase the application of natural stormwater management practices that capture, store, or filter rainwater. This program reimburses costs for eligible green infrastructure expenses including costs of materials, construction, and signage. Partners receive incentive funding for the installation of practices such as constructed wetlands, native landscaping, porous pavement, rain barrels, cisterns, green alleys, green streets, stormwater trees, bioswales, greenways, rain gardens, and green roofs. Some applicants may wish to apply for Signature Project Status to receive up to 50 percent in matching funds for eligible costs. Funding can be awarded to public or government agencies, nongovernmental organizations, and private property owners for projects located in the MMSD service area. Applications must be submitted by the property owner. Applications are due early spring of each year.

Green Solutions Program

MMSD's Green Solutions program provides financial incentives to the municipalities that MMSD serves for implementing green infrastructure and combined sewer separation to help achieve TMDL compliance while progressing toward MMSD's 2035 Vision's goals related to integrated watershed management, the MMSD green infrastructure plan, and MMSD's discharge permit. In projects within areas served by separate sewer systems, such as the Oak Creek watershed, this program's goals include providing incentives for installation of approved types of green infrastructure that reduce stormwater runoff, potentially reduce inflow and infiltration into sanitary sewers, and provide water quality benefits.

Natural Resources Foundation of Wisconsin

The Natural Resources Foundation of Wisconsin funds projects that have a significant and positive impact on Wisconsin's lands, waters, and wildlife. The Foundation provides grant funding to help cover the costs of on-the-ground conservation work including but not limited to habitat restoration, water quality monitoring, trail building, and rare plant preservation.[199] Foundation grant programs that may fund implementation of recommendations of the Oak Creek watershed restoration plan are described in the following sections.

<u>C.D. Besadny Conservation Fund</u>

The C.D. Besadny Conservation Fund was established to invest in grassroots conservation and education projects that benefit Wisconsin's lands, waters, and wildlife. Grants typically range from $500 to $2,000. Projects must benefit Wisconsin's natural resources or people and may not exceed $10,000. A one-to-one match is required. Match may include in-kind support such as volunteer hours or donated materials.

<u>The Go Outside Fund</u>

The Go Outside Fund provides support that helps connect youth to outdoor, nature-based learning experiences. Teachers or partner organizations may apply for funding to cover costs that facilitate getting kids outside and hands-on with nature, such as purchasing field supplies, or paying for transportation, substitute teachers, or educator costs. Grants between $100 and $500 are available.

<u>The Norma and Stanley DeBoer Quiet Trails Fund</u>

The Norma and Stanley DeBoer Quiet Trails Fund provides funding to support the creation and maintenance of walking, hiking, and skiing trails in Wisconsin. Grants range from $500 to $1,000.

<u>The Teachers Outdoor Environmental Education Fund</u>

The Teachers Outdoor Environmental Education Fund was established to provide meaningful outdoor environmental educational learning experiences for public school students. The fund provides grants of up to $1,000 for public elementary and secondary school teachers for outdoor environmental education projects. Examples of eligible projects include:

- Restoring native plants and removing invasive species at school forests
- Planting butterfly gardens to learn about native plants and pollinators
- Learning how to use GPS and geocaching
- Forestry management
- Overnight outdoor education camps
- Infrastructure improvements to school forests or wetlands to improve student access
- Student monitoring of stream water quality
- Conducting citizen science projects such as frog and toad monitoring

The grant requires a one-to-one match, which may consist of in-kind support such as volunteer hours or donated materials.

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[199] *See website for detailed information regarding the Natural Resources Foundation of Wisconsin www.wisconservation.org.*

Wisconsin Rare Plant Preservation Fund

The Wisconsin Rare Plant Preservation Fund provides grants to support projects that protect the State's rare plants and lichens through monitoring, inventorying, and preservation. Grants range from $500 to $1,000. Preference is given to projects addressing species listed on the WDNR's Natural Heritage Working List and to projects that demonstrate matching funds. Projects involving invasive species removal, gardening, or education are not eligible for funding.

National Fish and Wildlife Foundation

The National Fish and Wildlife Foundation (NFWF) is a nonprofit organization created by the U.S. Congress to protect and restore the Nation's fish, wildlife, plants, and critical ecosystem habitats. The Foundation works with Federal agencies and corporate and foundation partners offering a number of conservation initiatives. Through these initiatives, the Foundation provides funding on a competitive basis to support projects for wildlife and habitat conservation that include the following opportunities.

Acres for America

Walmart has worked with the NFWF to establish Acres for America, a commitment to purchase and preserve one acre of wildlife habitat for every acre of land developed by the company. The program protects critical habitat for birds, fish, plants, and wildlife, and includes providing funding for urban conservation efforts. The program has helped to permanently protect over 1.49 million acres and connect more than 10 million acres of public and private conservation lands across the country. Funding priorities include:

- Providing access for people to enjoy the outdoors
- Conserving critical habitats for birds, fish, plants, and wildlife
- Connecting existing protected lands to unify wild places and protect migration routes
- Ensuring the future of rural economies that depend on forestry, ranching, and recreation

Eligible applicants include nonprofit 501(c) organizations, state government agencies, local governments, municipal governments, Tribal governments and organizations, and educational institutions. Approximately $3.5 million will be available to support projects in 2021. All grant awards require a one-to-one match of cash or contributed goods and services. Federal funds may be considered as match. Due to the competitive nature of this program, successful Acres for America projects typically have matching funds at a 5 to 1 ratio or greater. Grant applications are typically announced in March, with pre-proposals due in April.

Bring Back the Natives

Bring Back the Natives (BBN) program is a partnership between U.S. Fish and Wildlife Service and U.S. Forest Service that seeks to restore, protect, and enhance native fish species of conservation concern nationwide. BBN supports projects that conserve aquatic ecosystems, increase in-stream flows, and build partnerships that benefit native fish species throughout the United States. Up to $500,000 in funding is available through a competitive pre-proposal grant application process. This program focuses on four key strategies: restoring connectivity, restoring riparian and instream habitat and water quality, invasive species management, and innovation. Within the Great Lakes Region, projects that benefit native fishes, including lake sturgeon, northern pike and eastern brook trout are priorities for funding. The program also provides grants to projects that support the National Fish Habitat Action Plan.

Five Star and Urban Waters Restoration Program

Major funding for the Five Star and Urban Waters Restoration grant program is provided by the USEPA, the U.S. Forest Service, the U.S. Fish and Wildlife Service, Southern Company, FedEx, BNSF Railway, Shell Oil Company, and PG&E. This program seeks to develop community capacity to sustain local natural resources for future generations by providing financial assistance to diverse local partnerships for wetland, forest, riparian, and coastal habitat restoration; stormwater management; outreach; and stewardship with a particular focus on water quality, watersheds, and the habitats they support.

Each Five Star and Urban Waters project must incorporate four of the main fundamental elements that tie together sustainable community-based conservation projects. These elements include:

- Conducting on-the-ground activities such as wetland, river, or coastal habitat restoration and/or targeted green infrastructure creation and monitoring

- Uniting community partners to achieve ecological and educational outcomes

- Integrating education, outreach, and training into the restoration project through broad community engagement activities or participation and integration with K-12 environmental curriculum

- Defining measurable ecological, educational, and community benefits

It should be noted that the Five Star and Urban Waters Restoration program has separate programs related to different funders. Each funder has set specific requirements for projects supported by their program. NFWF matches applications to all funding sources applicable to that project's activities, location, and type.

<u>National Coastal Resilience Fund</u>

In partnership with the National Oceanic and Atmospheric Administration (NOAA), Shell Oil Company, TransRe, the USEPA, and AT&T, the National Coastal Resilience Fund invests in projects that plan for, design, build, and monitor the restoration or expansion of natural features such as coastal marshes and wetlands, dune and beach systems, oyster and coral reefs, forests, coastal rivers, and barrier islands that minimize the impacts of storms, flooding, and other naturally occurring events on nearby coastal communities through its National Coastal Resilience program. The National Coastal Resilience program aims to:

- Benefit coastal communities by reducing the impact of coastal flooding and associated threats to property and key assets, such as hospitals and emergency routes

- Benefit coastal communities by improving water quality and recreational opportunities

- Benefit fish and wildlife by enhancing the ecological integrity and functionality of coastal and inland ecosystems

Current funding priorities include community capacity building and planning to support the development of prioritized coastal resilience strategies and projects, site assessment and preliminary design, final design and permitting, and implementation of restoration projects and associated monitoring. While the amount of support awarded will vary depending on the scope of the project and the nature of the work proposed, the NFWF anticipates that it will issue average awards of $250,000 for capacity building, planning, site assessment, and preliminary design, $350,00 for final design and permitting, and $1,000,000 to $5,000,000 for restoration and monitoring.

<u>Resilient Communities Program</u>

In 2017, Wells Fargo and NFWF launched the Resilient Communities Program, designed to prepare for future environmental challenges by enhancing communities to plan and implement resiliency projects and improve natural ecosystems by investing in green infrastructure and other measures. Specific funding priorities for this program include:

- High-impact resiliency adaptations to help communities prepare for fire in the U.S West, floods and droughts in the Midwest, and sea-level rise on the East coast. Grants in this category will range from $200,000 to $500,000.

- Community demonstration and capacity-building projects that help communities understand environmental risks and opportunities to organize and take actions to improve local resiliency by enhancing natural buffers and system functions. These projects will range from $100,000 to $250,000 and should address multiple communities.

- Scalable, nature-based resilience solutions benefitting affordable housing and/or small businesses in communities vulnerable to impacts from natural disasters. Grants in this category will range from $100,000 to $500,000.

Grants are offered once a year to support the above listed projects in states and communities associated with Wells Fargo operations. It is expected that supported projects will leverage other public and private sources of funding to help achieve project objectives.

<u>Sustain Our Great Lakes Program</u>

Administered by NFWF, the Sustain Our Great Lakes (SOGL) grant program is a bi-national (Canada and United States), public–private partnership that supports restoration in the Great Lakes basin. This program receives funding and other support from ArcelorMittal, the Careus Foundation, the Crown Family, MMSD, the Walder Foundation, the USEPA, the U.S. Fish and Wildlife Service, the USDA Forest Service, NOAA, and the USDA Natural Resources Conservation Service. The goal of this program is to restore and enhance fish, wildlife, and habitat in the Great Lakes basin by leveraging funding, building conservation capacity, and focusing partners and resources toward vital ecological issues. A significant portion of program funding is provided by the GLRI.

SOGL achieves its mission primarily by awarding grants for on-the-ground habitat restoration. The program offers funding annually with awards ranging from $25,000 to $1.5 million. Eligible recipients include nonprofit organizations; state, tribal and local governments; and educational institutions. Funding priorities for this program include restoring and enhancing stream and riparian habitat, restoring and enhancing coastal wetland habitat, expanding green stormwater infrastructure in Great Lakes communities, maintaining and enhancing the benefits of habitat restoration through invasive species control, and restoring and preserving natural areas and biodiversity in Wisconsin's Lake Michigan watershed.

Southeastern Wisconsin Invasive Species Consortium, Inc.

The Southeastern Wisconsin Invasive Species Consortium, Inc. (SEWISC) periodically has funds available to support projects designed to lessen the impacts of invasive species in southeastern Wisconsin. SEWISC assistance funds are most often designated for on-the-ground invasive species control work and must be used in the eight-county SEWISC region. Grant funds may be used to accomplish a specific project or to support an ongoing program; however, preference is given to projects that demonstrate a long-term commitment to invasive species control, especially continued control of the particular invasive species populations targeted by the project. Depending on the source of the funding, individuals, established nonprofit organizations, community and civic groups, private businesses, or units of government may be eligible to receive funds. SEWISC provides grant assistance of up to $2,000 with a required match that equals at least 25 percent of the total project budget. In-kind services such as volunteer labor can be used for this match. When funds become available, SEWISC posts notice on their website and makes announcements via their newsletter and electronic mail lists.

Southeastern Wisconsin Watersheds Trust, Inc. (Sweet Water) Mini-Grant Program

The Sweet Water Mini-Grant program supports local, nonprofit efforts to improve water quality, restore habitat, promote conservation, and advance public education concerning water issues in the Greater Milwaukee watersheds, including the Oak Creek watershed. A special focus of this program is the use of green infrastructure practices. The program provides grants ranging from $1,000 to $5,000 to established nonprofit organizations, community groups, and civic groups for projects and activities that advance the objectives of achieving healthy and sustainable water resources. Projects should also advance the following goals:

- Making measurable progress in improving regional water resources
- Supporting land use practices that improve water quality
- Forging relationships to find and leverage funding
- Implementing cost-effective projects resulting in measurable water quality improvements

Sweet Water announces the opening of application periods for its mini-grant program on its website and through its newsletter and email list.

U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (USACE) has several programs that can provide funding and assistance for projects such as aquatic ecosystem protection and restoration, streambank and shoreline restoration to protect public infrastructure, protection and restoration of Great Lakes fisheries and ecosystems, and flood land management. Prior to implementing projects, USACE requires that a feasibility study[200] be conducted to determine whether the project is practical and whether there is enough federal interest in regard to cost-sharing. The latter is necessary because projects are undertaken on a cost-share basis. Several USACE programs may provide assistance for implementing projects recommended in the Oak Creek watershed restoration plan. These programs are described in the following sections.

<u>Aquatic Ecosystem Restoration</u>

USACE aquatic ecosystem restoration and protection projects generally include modification of the hydrology in and along bodies of water, including wetlands and riparian areas. A project is approved for construction only after a detailed investigation determines that the project will improve the quality of the environment and is in the best interest of the public.

USACE will provide 100 percent of the funds for the required feasibility study, up to a maximum of $100,000. Costs of the study that exceed $100,000 must be shared at 50 percent federal share and 50 percent non-federal share. The USACE will provide 65 percent of the cost of project implementation with a federal cost limit of $10 million per project. The local sponsor is required to provide the remaining 35 percent of implementation costs. The non-federal cost-share can consist of contributions of lands, easements, rights-of-way, relocations, and disposal areas necessary for the project.

<u>Emergency Streambank and Shoreline Protection Program</u>

USACE is authorized to construct bank protection projects to protect endangered public works such as highways, highway bridges, municipal water supply systems, and sewage disposal plants, as well as churches, hospitals, schools, for-profit public services, and known cultural sites that are endangered by flood-caused streambank or shoreline erosion. Privately-owned property and facilities are not eligible for protection.

USACE will provide 100 percent of the funds for the required feasibility study, up to maximum of $100,000. Costs of the feasibility study that exceed $100,000 must be shared equally by the federal government and non-federal sponsor. The USACE will provide 65 percent of the cost of project implementation with a federal cost limit is $5 million per project. The local sponsor is required to provide the remaining 35 percent of the implementation costs. The non-federal share can consist of contributions of lands, easements, rights-of-way, relocations, and disposal areas necessary for the project.

<u>Great Lakes Fishery and Ecosystem Restoration Program</u>

The USACE can assist in planning, design, and constructing projects to protect and restore fisheries, ecosystems, and beneficial uses of the Great Lakes.

USACE will provide 100 percent of the funds for the required feasibility study, up to maximum of $100,000. Costs of the feasibility study that exceed $100,000 must be shared with a federal contribution of 65 percent and non-federal contribution of 35 percent. The USACE will provide 65 percent of the cost of project design and implementation with a federal cost limit of $10 million per project. The non-federal share can consist of contributions of lands, easements, rights-of-way, relocations, and disposal areas, cash, work-in-kind, or any combination thereof.

<u>Small Flood Risk Management Program</u>

USACE is able to construct or improved local flood protection or control works. The projects are tailored to the specific site. Typical structural flood risk management projects may include levees, floodwalls, impoundments, pumping stations, and channel modifications. Non-structural measures include flood proofing, relocation of structures, flood response and preparedness plans, and warning systems. USACE oversees planning, design, and construction of flood risk management projects in close coordination with the project sponsor.

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[200] *A feasibility study formulates alternatives to complete the restoration, evaluates the environmental effects of each alternative, documents the project requirements, and provides a scope and cost estimate for project implementation.*

USACE will provide 100 percent of the funds for the required feasibility study, up to a maximum of $100,000. Costs of the feasibility study that exceed $100,000 must be shared equally between the Federal government and the local sponsor. The USACE will provide 65 percent of the cost of design and implementation up to a federal cost limit is $10 million. The local sponsor is required to provide 35 percent of the costs. The non-federal cost-share can consist of contributions of lands, easements, rights-of-way, relocations, and disposal areas necessary for the project.

Snagging and Clearing for Flood Damage Reduction

USACE is authorized to plan for and provide removal of accumulated snags and other debris from waterways and to clear stream channels in the interest of flood control. Each project must be complete within itself, and not part of a larger project. The limited scope of these projects allows for prompt action to eliminate the threat of flooding.

USACE will provide 100 percent of the funds for the required feasibility study, up to maximum of $100,000. Costs of the feasibility study that exceed $100,000 must be shared equally by the federal government and the local sponsor. The USACE will provide 65 percent of the cost of the project up to a federal cost limit is $500,000. The local sponsor is required to provide 35 percent of the costs. The non-federal cost-share of project implementation may include the costs of developing plans and specifications; construction costs; and contribution of lands, easements, rights-of-way, relocations, and disposal areas necessary for the project.

U.S. Department of Agriculture (USDA)

The USDA administers a number of agricultural conservation programs to assist private landowners and producers with natural resource concerns. The primary agricultural conservation agencies within the USDA are the Natural Resources Conservation Service (NRCS), which provides technical assistance and administers most conservation programs, and the Farm Service Agency (FSA), which administers the Conservation Reserve Program (CRP). Currently, the NRCS and FSA administer over 20 programs and subprograms that are directly or indirectly available to landowners and producers. In addition, agricultural conservation programs involve a large range of partners, including other federal agencies, state and local governments, and private organizations, among others, who provide funds, expertise, and other forms of assistance to further conservation efforts.

Farm Service Agency (FSA)

The Farm Services Agency (FSA) administers domestic commodity price and income support, farm loan, disaster assistance, and conservation cost-share programs for USDA. These programs work to address a large number of agriculture-related conservation issues including protecting drinking water, reducing soil erosion, preserving wildlife habitat, and aiding farmers whose farms are damaged by natural disasters. Several FSA programs that may provide funds or assistance for efforts in the Oak Creek watershed are described below.

Conservation Reserve Program

The Conservation Reserve Program (CRP) is a voluntary program for agricultural producers. It encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as a prairie-compatible, noninvasive forage mix; wildlife plantings; trees; filter strips; or riparian buffers. Farmers receive an annual rental payment for the 10- to 15-year term of their contract based on the agriculture rental value of the land. CRP also provides up to 50 percent costs of establishing vegetative cover. CRP's goals are to reduce soil erosion, protect the nation's ability to produce food and fiber, reduce sedimentation in streams and lakes, improve water quality, establish wildlife habitat, and enhance forest and wetland resources. FSA administers the program while NRCS provides technical assistance. NRCS works with landowners to develop their application, and to plan, design, and install the conservation practices on the land.

The CLEAR30 Program is a CRP pilot subprogram that provides cost-share funds for long-term maintenance of selected BMPs for protecting water quality. CLEAR30 is available for some acres currently enrolled in CRP and requires that the landowner enter into a 30-year contract. Practices eligible for cost-share under CLEAR30 include grass waterways, contour grass strips, prairie strips, filter strips, riparian buffers, wetland restoration practices, and similar water quality practices. Landowners with expiring continuous CRP contracts for fields with eligible practices may enroll in CLEAR30 during the last year of their existing contract. Participants receive three annual rental payments, at rates similar to those calculated under general CRP a rental rate enhancement of 27.5 percent to account for inflation. The program requires that land be maintained in accordance with an approved conservation plan. Compatible economic uses such as hunting, fishing, managed timber harvest, or periodic haying or grazing are allowed if they are included in the conservation plan. States located within the Great Lakes and Chesapeake Bay areas are currently eligible.

The Farmable Wetland Program (FWP) is a CRP subprogram designed to restore previously farmed wetlands and wetland buffers to improve both vegetation quality and water flow. FWP is a voluntary program. Participants agree to restore the wetlands, establish plant cover, and to not use enrolled land for commercial purposes. In return they receive annual rental payments. Applications for FWP are accepted throughout the year with contracts lasting between 10 to 15 years. Eligible land must have been used for agricultural purposes for three of the past 10 crop years and can include man-made wetlands used to process water flow for crop drainage, areas used for aqua farming purposes, or areas used for prairie wetland overflow purposes.

Emergency Conservation Program

NRCS' Emergency Conservation Program (ECP) provides emergency funding and technical assistance to producers to rehabilitate farmland damaged by natural disasters including floods, droughts, and wildfires through activities such as removing debris, restoring fences and conservation structures, and implementing emergency water conservation measures. Upon application, the FSA County Committee inspects the damage to determine if land is eligible. For land to qualify for ECP funds, the damage from the natural disaster or severe drought must create new conservation problems that if not dealt with would further damage the land, significantly affect the land's productive capacity, represent damage from a natural disaster unusual for the area, and/or would be too costly to repair and to return the land to agricultural production without Federal assistance. Conservation problems that existed before the disaster or severe drought are ineligible for ECP assistance. Funding for the ECP is determined by Congress. Up to 75 percent of the cost to implement emergency conservation practices can be provided; however, the final amount is determined by the committee reviewing the application. Qualified limited resource producers may earn up to 90 percent cost-share. The FSA County Committee is able to approve applications up to $50,000 while $50,001 to $100,000 requires state committee approval. Amounts over $100,000 require the approval of the national FSA office.

<u>U.S. Forest Service (USFS)</u>

The Community Forest and Open Space Conservation Program

The U.S. Forest Service Community Forest and Open Space Conservation Program (Community Forest Program) offers communities the opportunity to acquire and conserve forests that provide public access and recreational opportunities, protect vital water supplies and wildlife habitat, serve as demonstration sites for private forest landowners, and provide economic benefits from timber and non-timber products. Under this program, community forests can be owned by local governments, tribal governments, and qualified nonprofit entities. Land that is not held in trust by the Federal Government; that is threatened with conversion to non-forest use; that provides defined community benefits; and that is at least five acres in size, suitable to sustain natural vegetation, and at least 75 percent forested is eligible for funding for acquisition. The program provides up to 50 percent of project costs and requires a 50 percent non-federal match. Public access is required for Community Forest Program projects. The Forest Service publishes an annual request for applications for the Community Forest Program in the Federal Register.

<u>Natural Resources Conservation Service (NRCS)</u>

The USDA's NRCS agency develops and implements voluntary soil and water conservation programs in cooperation with landowners, agricultural operators, developers, and other users of land. It works in cooperation with community planning agencies; regional resource groups; and Federal, State, and local government agencies. NRCS programs provide assistance in controlling agricultural pollution, improving the environment, and developing rural communities. NRCS programs can provide assistance for preserving, protecting, and restoring wetlands; improving wildlife habitat; conserving water; preserving, maintaining and improving habitat for migratory waterfowl and other wildlife; and encouraging good forestry management through the development, management, and protection of non-industrial private forest lands. Several NRCS programs that may provide funds or assistance for efforts in the Oak Creek watershed are described below.

Agricultural Conservation Easement Program

The Agricultural Conservation Easement Program (ACEP) helps landowners, land trusts, and other entities protect, restore, and enhance wetlands, grasslands, and working farms and ranches through conservation easements. ACEP provides financial and technical assistance through the two types of easement programs described below.

The Agricultural Land Easement program helps state and local governments, American Indian tribes, and non-governmental organizations protect working agricultural lands and limit nonagricultural uses of the land. In the case of working farms, the program helps farmers and ranchers keep their land in agriculture. The NRCS may contribute up to 50 percent of the fair market value of the agricultural land easement. When protecting grasslands of special environmental significance, the NRCS may contribute up to 75 percent of the fair market value of the agricultural land easement.

The Wetlands Reserve Easements program helps to restore, protect, and enhance enrolled wetlands. The NRCS provides technical and financial assistance directly to private landowners and Indian tribes to restore, protect, and enhance wetlands through the purchase of wetland reserve easements. NRCS may enroll eligible land through three types of easements. For permanent easements, NRCS pays 100 percent of the easement value for purchase of the easement and 75 to 100 percent of the restoration costs. for 30-year easements, NRCS pays 50 to 75 percent of the easement value for the purchase of the easement and 50 to 75 percent of the restoration costs. For term easements, NRCS pays 50 to 75 percent of the easement value for the purchase of the easement and 50 to 75 percent of the restoration costs.

Conservation Stewardship Program

The Conservation Stewardship Program (CSP) helps producers and ranchers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns, such as water quality or soil erosion. Participants earn CSP payments for conservation performance, with higher payments being made for higher performance. CSP contracts are for five years. Successfully fulfilling the initial contract allows the opportunity to compete for an additional five-year term. To qualify for contract renewal, the participant must agree to meet or exceed two additional priority resource concerns or to adopt or improve conservation activities to achieve higher levels of conservation on two existing priority resource concerns. Contract payments are based upon the existing level of conservation on the land uses included in the contract, an NRCS assessment of the existing stewardship at the time of enrollment and implementing additional conservation activities.

The 2018 Farm Bill created the Grassland Conservation Initiative (GCI), a new initiative under the CSP that assists producers in protecting grazing land uses; conserving and improving soil, water and wildlife resources; and achieving related conservation values by conserving eligible land through grassland conservation contracts. Eligible lands are limited to cropland for which base acres have been maintained under FSA's Agricultural Risk Coverage and Price Loss Coverage programs and were planted to grass or pasture, including idle or fallow, during a specific period. Enrolled acreage must be managed consistently with a grassland conservation plan. Producers will have a single opportunity to enroll eligible land in a five-year contract.

Emergency Watershed Protection Program

The Emergency Watershed Protection Program (EWP) was established by Congress to respond to emergencies created by natural disasters and to take emergency measures to safeguard lives and property after a natural occurrence has caused a sudden impairment of a watershed. Hazards include floods and the products of erosion created by floods, fire, windstorms, or other natural disasters. Local entities such as city, county, state, and tribal governments sponsor Emergency Watershed Protection projects. Sponsors are responsible for 25 percent of the construction costs, which can be direct cash expenditures or in-kind materials or services. NRCS provides financial assistance up to 75 percent of the construction costs for installing eligible emergency measures to protect lives and property. The NRCS works with the sponsors to identify watershed impairments that threaten life and/or property such as significant infrastructure such as dwellings, office buildings, utilities, bridges, and roads. Funds from the program cannot be used to address problems or remedy conditions that existed before the disaster or event. Through the Floodplain Easement portion of the program, the NRCS may purchase easements on any floodplain lands that have a history of repeated flooding.

Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) is a voluntary conservation program that supports agriculture and environmental quality as compatible goals. Through EQIP, producers and landowners may receive financial and technical help with structural and management conservation practices on agricultural land. EQIP offers contracts through the NRCS for conservation practice implementation for periods ranging from one to 10 years, and it pays up to 75 percent of the costs of eligible conservation practices. Incentive payments and cost-share payments may also be made to encourage a farmer to adopt land management practices such as nutrient management, manure management, integrated pest management, or wildlife habitat management. EQIP requires that farmers have or develop a conservation plan for the acreage affected by the EQIP practices. Conservation practices must meet NRCS technical standards.

The Conservation Innovative Grant Program (CIG) is a competitive EQIP subprogram associated with the 2018 Farm Bill. This grant program supports the development of new tools, approaches, practices, and technologies to further natural resource conservation on private lands. Through creative problem solving and innovation, CIG addresses water quality, air quality, soil health, and wildlife habitat challenges while improving agricultural operations. Eligible applicants include accepted state or local governments, federally recognized American Indian tribes, non-governmental organizations, and individuals.

Regional Conservation Partnership Program

The Regional Conservation Partnership Program (RCPP) promotes coordination between NRCS and its partners to deliver conservation assistance to producers and landowners. NRCS helps producers through partnership agreements and RCPP conservation program contracts. The program encourages partners to join in efforts with producers to increase the restoration and sustainable use of soil, water, wildlife, and related natural resources on regional or watershed scales. Eligible partners include agricultural or silvicultural producer associations, farmer cooperatives or other groups of producers, state or local governments, American Indian tribes, municipal water treatment entities, water and irrigation districts, conservation-driven non-governmental organizations, and institutions of higher education. Eligible participants may enter into conservation program contracts or easement agreements under the framework of a partnership agreement.

Watershed Protection and Flood Prevention Program

The Watershed Protection and Flood Prevention Program provides assistance to federal, state, local, and tribal governments and agencies to protect and restore watersheds up to 250,000 acres in area. Eligible projects include those related to erosion and sediment control, watershed protection, flood prevention, water quality improvements, water management, and fish and wildlife habitat enhancement. The program provides technical and financial assistance to local landowners or project sponsors, builds partnerships, and requires local and state funding contributions. Project sponsors can propose land treatment or structural solutions. An approved watershed plan must be in place prior to initiation of any corrective land treatment or structural solution.

U.S. Environmental Protection Agency (USEPA)

USEPA's mission is to protect human health and the environment. USEPA has several programs that provide grants to state environmental programs, local units of government, nonprofit organizations, and educational institutions. USEPA programs that may provide assistance in implementing the Oak Creek watershed restoration plan are described below.

<u>Environmental Education Grants</u>

The Environmental Education (EE) grants program supports education projects that promote environmental awareness and stewardship and help provide people with the skills to take responsible actions to protect the environment. This grant program provides financial support for projects that design, demonstrate, or distribute environmental education practices, methods, or techniques. Projects must address at least one USEPA educational priority and one USEPA environmental priority. Recent educational priorities have included projects that educate students of any age or train their educators about environmental issues related to agriculture in rural, suburban, and urban settings; projects that increase public understanding of the benefits of participation in environmental or conservation stewardship through community collaboration; and projects that educate students about environmental and conservation issues for the purpose of encouraging interest in careers in environmental fields. Recent environmental priorities have included ensuring air quality, ensuring clean and safe water, ensuring safety of chemicals, revitalizing land, and preventing contamination. Eligible organizations include local education agencies, state education or environmental agencies, colleges and universities, nonprofit organizations with tax-exempt status under Section 501(c)(3) of the Internal Revenue Code, noncommercial educational broadcasting entities, and tribal education agencies. EE grants require a non-federal match consisting of 25 percent of the total cost of the project.

Environmental Justice Small Grants Program

The EPA's Environmental Justice Small Grant Program provides financial assistance to community-based organizations that work on local solutions that address local environmental or public health issues. The primary purpose of proposed projects should be to develop a comprehensive understanding of environmental and public health issues, identify ways to address these issues at the local level, and educate and empower the community. The long-term goals of the program are to help build the capacity of the affected community and create self-sustaining, community-based partnerships that will continue to improve local environments in the future. Funds from this program can be used to support nonprofit organizations with activities that address environmental justice concerns, including but not limited to: increasing awareness of and lessening impacts from stormwater; actively addressing harmful air particles that affect the health and well-being of residents; building capacity of community leaders, adults, and youth through health data collection activities and watershed education; promoting the connection of health issues to environmental quality through comprehensive outreach and education; reducing pesticide exposure and improving health of farm workers by training health care providers about pesticide exposure; monitoring farm workers' working conditions; and encouraging healthy, environmentally friendly alternatives to industrially produced agriculture.

Incorporated nonprofit organizations and Federally recognized Native American tribal governments are eligible to apply. Applicants must be located within the state, territory, commonwealth, or tribe in which the proposed project will be located. In addition, an eligible applicant must be able to demonstrate that it has worked directly with the affected community.[201] Project grants are awarded for a one-year project period. Grants range from $20,000 to $50,000, with an average grant of $30,000. The program has no matching fund requirements.

Great Lakes Program (i.e., Great Lakes Restoration Initiative)

The Great Lakes Restoration Initiative (GLRI) builds on the prior efforts of Federal, State, and local agencies, Indian tribes, businesses, public interest groups, interested residents and others to restore and protect the Great Lakes. Initiated by the USEPA, the GLRI is a multi-agency Federal effort that targets significant environmental problems affecting the Great Lakes. The program priorities and goals for years 2020–2024 include five focus areas: Toxic Substances and Areas of Concern; Invasive Species; Nonpoint Source Pollution Impacts on Nearshore Health; Habitat and Wildlife Protection and Restoration; and Accountability, Education, Monitoring, Evaluation, Communication, and Partnerships. Grant opportunities for restoration projects are available, primarily through the USEPA. Specifically, the EPA and its partner agencies agree on program and project priorities to implement the GLRI Action Plan. The EPA then appropriates money, which in turn provides funding to other federal government agencies. Those agencies, and the EPA, use that money to fund restoration projects, which the federal agencies themselves, or other entities such as states, tribes, local governments, universities, or nongovernmental organizations then complete.

U.S. Federal Emergency Management Agency

Several FEMA programs provide funding for flood and urban stormwater flooding mitigation activities. In the State of Wisconsin, these programs are administered through the Wisconsin Department of Military Affairs, Division of Emergency Management (WEM). These programs are described below.

Building Resilient Infrastructure and Communities

The Building Resilient Infrastructure and Communities (BRIC) is a new FEMA pre-disaster hazard mitigation program that replaced the Pre-Disaster Mitigation program. The BRIC program assists states, local communities, tribes, and territories participating in hazard mitigation projects that reduce the risks faced by disasters and natural hazards including capability- and capacity-building, encouraging and enabling innovation, promoting partnerships, enabling large projects, maintaining flexibility, and providing consistency. Projects eligible under BRIC must:

[201] *An "affected community" for the purposes of this assistance program is a community that is disproportionately impacted by environmental harms and risks and has a local environmental and public health issue that is identified in the proposal.*

- Be cost-effective
- Reduce or eliminate risk and damage from future natural hazards
- Meet either of the two latest International Building Codes (i.e., 2015 or 2018)
- Align with the applicable hazard mitigation plan
- Meet all environmental and historic preservation (EHP) requirements

Eligible applicants include states, territories, and Tribal governments. These entities can submit applications on behalf of sub-applicants such as local units of government and state and tribal agencies. BRIC grants require a non-federal share of 25 percent of the project costs.

Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) can provide up to 75 percent of the costs of certain natural hazard mitigation projects. In the case of flood mitigation, projects can include floodproofing, acquisition and relocation, or demolition of flood-prone properties, elevation of structures in compliance with NFIP standards, and other flood control measures, where identified as cost-effective. To be eligible for mitigation activities with FEMA funding, structures must be insured under the NFIP. The HMGP requires a non-federal match of 25 percent of project costs. In Wisconsin half of this match is provided by the WEM HMGP funds become available only after a Presidential disaster declaration has been issued within the State. Applications must be submitted to WEM within 60 days of the declaration. Eligible projects must be included as part of the grantee's all-hazard mitigation plan and must meet cost-benefit criteria established by FEMA. HMGP funds can be used on private property for eligible projects. The HMGP gives priority to properties identified by FEMA as repetitive-loss properties.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service (USFWS) oversees several programs that provide funding and technical support for the conservation, protection, and enhancement of fish and wildlife and their habitat.

National Fish Passage Program

The National Fish Passage Program provides financial and technical assistance in support of fish passage projects. This program works to restore rivers and conserve aquatic resources by removing or bypassing barriers, including obsolete and dangerous dams, ultimately eliminating public safety hazards, and restoring river ecosystems. The program also works with transportation agencies and others to improve road stream crossings so that the streams can flow naturally beneath them.

The National Fish Passage Program partners with individuals; nonprofit organizations; national organizations such as Trout Unlimited, The Nature Conservancy, and American Rivers; cities and towns; local government agencies; regional or state fish and wildlife departments; other federal agencies; and tribes.

Grant proposals are accepted year-round; however, the funding cycle for Fish Passage projects begins each year in the fall with funding generally becoming available the following spring. Funding is administered through Regional and local Fish and Wildlife Conservation Offices. On average the program contributes about $70,000 per project. There is no upper limit to project funding. The National Fish Passage Program has flexibility on matching funds from project to project but attempts to achieve a 50 percent match from federal or non-federal sources.

Partners for Fish and Wildlife Program

The Partners for Fish and Wildlife (PFW) Program is a voluntary, incentive-based program that provides direct technical assistance and financial assistance in the form of cooperative agreements to private landowners to restore and conserve fish and wildlife habitat. Locally based field biologists work one-on-one with private landowners and other partners to plan, implement, and monitor their projects. Any privately owned land is potentially eligible for restoration, including working farms and recreation lands. Program priorities in the Midwest include the restoration of wetlands, grasslands, forests, and stream corridors. Prior to implementation of habitat projects, the program requires that the landowner and project biologist sign an agreement that specifies the work to be done and financial contributions. The minimum length of the agreement is 10 years. There is no minimum cost-share requirement. Cost-share may be provided as in-kind services or cash and the landowner must maintain the restoration project throughout the agreement period. Funds for individual projects are limited to $25,000.

Wisconsin Board of Commissioners of Public Lands

The Board of Commissioners of Public Lands (BCPL) provides loans to municipalities and school districts for public purpose projects including economic development, local infrastructure, capital equipment and vehicles, building repairs and improvements, and refinancing existing liabilities to reduce future borrowing costs.

Wisconsin Citizen-Based Monitoring Partnership Program

Since 2004, the Wisconsin Department of Natural Resources and the Wisconsin Citizen-Based Monitoring Network have sought to expand citizen and volunteer participation in natural resource monitoring by providing funding and assistance with high-priority projects. Qualifying projects include monitoring of aquatic and terrestrial species; natural communities; and environmental components such as water, weather, and soil. Eligible projects include those that:

- Have direct, substantial citizen involvement or are relevant to the conduct of citizen-based projects
- Are specifically intended for Wisconsin and, in most cases, carried out in Wisconsin
- Address priority Wisconsin natural resource monitoring needs or issues
- Are current with all deliverables for past Partnership Program projects

Requests for proposals are issued in the spring of each year. In recent years, a total of $100,000 has been available annually for projects throughout the State, with a maximum of $5,000 per project.

Wisconsin Coastal Management Program

The Wisconsin Department of Administration, Bureau of Intergovernmental Relations administers the Wisconsin Coastal Management Program (WCMP) for the 15 Wisconsin coastal counties. The program provides funds to local governments and other entities for implementing initiatives related to managing coastal zones in the State. The program offers approximately $1.5 million annually in WCMP Grants. Current priorities include projects related to wetland protection, habitat restoration, public access, land acquisition, nonpoint source pollution control, land use and community planning, natural hazards, and Great Lakes education. The program also aids local governments in managing and protecting shorelands, wetlands, and floodplains through zoning and permitting. Eligible applicants include local units of government, State agencies, colleges and universities, school districts, regional planning commissions serving coastal areas, tribal units of government, and private nonprofit organizations. Applicants requesting more than $100,000 should contact the WCMP. WCMP Grant projects totaling $60,000 or less require a 50 percent match. Projects with a total budget larger than $60,000 require a 60 percent match. Match may be in-kind, cash, or a combination of the two. Request for proposals for year 2022 to 2023 will be announced August 2021.

Wisconsin Conservation & Education Foundation

Wisconsin Conservation & Education Foundation (WCEF) is a 501(c)(3) nonprofit organization that provides grants to various conservation and natural resources focused organizations and individuals within Wisconsin. These are grants are used to promote public education to enhance natural resources, environmental stewardship, and outdoor heritage through publications, events, and projects.

Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP)

<u>Clean Sweep Program</u>

The Wisconsin Clean Sweep grant program provides reimbursement to communities that collect and dispose of household hazardous wastes, agricultural pesticides, and prescription drugs. Eligible grant recipients can include counties, towns, villages, cities, tribes, sanitary and sewerage districts, or regional planning commissions. Grants can support collection and disposal of these products. Additionally, prescription drug grants can be used to buy drop boxes. Businesses that generate very small quantities of hazardous waste may also use these collections. Note that collections may be one-day events or may be year-round sites.

Nutrient Management Farmer Education Program

Wisconsin DATCP provides nutrient management farmer education (NMFE) grants to local organizations to teach farmers to develop their own nutrient management plans. This program offers two funding options: Tier 1 funding which provides producers with nutrient management plan writing, soil testing, and training courses with funds up to $20,000 and Tier 2 funding which provides nutrient management training, education, and support costs of up to $2,500 in grant funding. Grant applications are accepted beginning on January 31st and are due on April 15th.

Soil and Water Resource Management Program

DATCP administers Wisconsin's soil and water resource management program (SWRM) under the provisions of Chapter 92 of the *Wisconsin Statutes* and Chapter ATCP 50 of the *Wisconsin Administrative Code*. The SWRM grant program supports locally led conservation efforts. Awarding grant funds to counties pays for conservation staff and provides landowner cost-sharing to implement their LWRMP. The current version of Chapter ATCP 50, revised in February 2018, relates specifically to agricultural programs and establishes requirements and/or standards for:

- Soil and water conservation on farms
- County soil and water programs, including land and water resource management plans
- Grants to counties to support county conservation staff
- Cost-share grants to landowners for implementing conservation practices
- Design certifications by soil and water professionals
- Local regulations and ordinances
- Cost-share practice eligibility and design, construction, and maintenance

Wisconsin Department of Natural Resources (WDNR)

The WDNR administers several grant and loan programs that support efforts by local governments, private organizations, and private landowners to protect public health, the environment, and outdoor recreation. Several WDNR programs that may provide funds or assistance for efforts in the Oak Creek watershed are described below.

Clean Water Fund Program

The Clean Water Fund Program (CWFP) provides financial assistance to municipalities for the planning, design, and construction of projects to control and treat urban stormwater runoff. Eligible applicants include counties, cities, villages, towns, town sanitary districts, public inland lake protection and rehabilitation districts, and metropolitan sewerage districts. Eligible projects must relate to either a WPDES permit, a performance standard, or a plan approved by the WDNR. The primary purpose of an eligible urban runoff project must be to improve water quality. Eligible projects include:

- Construct municipal wastewater facilities
- Control nonpoint sources of pollution
- Build decentralized wastewater treatment systems
- Create green infrastructure projects
- Protect estuaries
- Fund other water quality projects

The program provides loans at an interest rate of 65 percent of the current market rate. The CWFP also has a Small Loan Program that provides interest rate subsidies to municipalities that have a loan from the State Trust Fund Loan Program for the planning, design, and construction of urban runoff projects with total estimated costs of $1 million or less.

County Conservation Aids

The County Conservation Aids program provides financial assistance to counties to enhance county fish and wildlife programs. Funds are provided as cost-share for fish and wildlife habitat projects. Eligible projects include development of structures, utilities, facilities, or landscaping necessary for outdoor recreation use of an area; implementation of specific activities to restore or enhance fish or wildlife habitat, natural communities, or shorelines; the placement of fish or wildlife into their natural environment to improve population numbers; and repair or refurbishment of structures, fixtures, or substrates to functional conditions in a routine, scheduled, or anticipated fashion.

Dam Removal Grant Program

The Dam Removal Grant Program provides reimbursement for 100 percent of eligible project costs up to a maximum of $50,000 to remove a dam. Applications are accepted on a continual basis. Counties, cities, villages, towns, tribes, public inland lake protection and rehabilitation districts, and private dam owners can apply for grant funds to remove a dam they own. Any person can apply to receive funds to remove an abandoned dam if they have obtained legal access to the property on which the dam is located. Awards are made on a first come first served basis until all of the funding is obligated.

Knowles-Nelson Stewardship Program

Local units of government are eligible to apply for funding through four stewardship grant programs and two related federal programs administered by the WDNR. The WDNR programs include the Aids for the Acquisition and Development of Local Parks, the Urban Green Space, the Urban Rivers, and the Acquisition of Development Rights programs. The WDNR also administers the Federal Land and Water Conservation Fund and Recreational Trails Act programs. These programs provide 50 percent matching grants to cities, villages, towns, counties, public inland lake protection and rehabilitation districts, and qualified nonprofit conservation organizations. Eligible activities include acquiring land; development and renovation projects for nature-based outdoor recreation; developing, maintaining, and restoring trails; river habitat restoration projects that serve public recreation or resource conservation purposes; and purchasing land for noncommercial gardening in urban areas. The administrative rules for the program are set forth in Chapter NR 50 and NR 51 of the *Wisconsin Administrative Code*. The annual application deadline is May 1.

Qualified nonprofit organizations are eligible for funding through eight stewardship grant programs. Eligible activities include the acquisition of land or easements to conserve wildlife habitat, preserve native natural communities and habitat for rare plant and animal species, protect streambanks, complete the State Trail system, develop local parks, protect agricultural or forest lands that provide or enhance nature-based outdoor recreation, provide open natural space within or near urban areas, and restore or preserve the character of urban riverways.

Land and Water Conservation Fund Program

The WDNR administers the Federal Land and Water Conservation Fund (LWCF) program which supports land acquisition and development of high-quality outdoor recreation amenities in local communities. In addition, projects that provide outdoor recreation facilities that are not exclusively nature-based, such as active sports facilities, are eligible for LWCF grants. The program provides grants to local units of government and school districts that cover 50 percent of the costs of eligible projects. LWCF funding priorities include projects that:

- Meet the needs of urban areas
- Provide recreation opportunities for diverse populations
- Acquire land in areas with limited outdoor recreation facilities

- Provide multi-use and multi-season facilities
- Enhance or preserve natural beauty
- Are proposed by applicants which have financial resources to adequately maintain and operate the project

Municipal Dam Grant Program

The Municipal Dam grant program provides a cost-sharing opportunity for eligible engineering and construction costs for dam maintenance, repair, modification, or abandonment and removal up to a maximum of $400,000. Funding sources outside the applicant's own resources can be used toward the local match for this grant. Applicants must have an engineer's inspection order or directive and a dam failure analysis sufficient to identify the hazard potential based on the current development in the hydraulic shadow downstream of the dam. Dam repair/reconstruction/modification project grant awards cover:

- 50 percent of the first $400,000 of eligible project costs
- 25 percent of the next $800,000 of eligible project costs
- Dam abandonment and removal project grant awards will cover 100 percent of the first $400,000 of eligible project costs

Cities, towns, villages, counties, tribes, and public inland lake protection and rehabilitation districts (i.e., lake districts) may apply for grants to conduct dam maintenance, repair, modification or abandonment and removal on dams that they own.

Municipal Flood Control Grant Program

Under Chapter NR 199, "Municipal Flood Control Grants," of the *Wisconsin Administrative Code,* municipalities, including cities, villages, towns, and metropolitan sewerage districts are eligible for cost-sharing grants from the State for projects to minimize flooding and flood-related damages. Projects may include acquisition and removal of structures; floodproofing of structures; riparian restoration projects, including removal of dams and other artificial obstructions, restoration of fish and native plant habitat, erosion control, and streambank restoration projects; acquiring vacant land to create open-space flood storage areas; constructing structures for collecting, retaining, storing, and transmitting stormwater and groundwater for flood control; and preparing flood insurance studies and other flood mapping projects. Municipalities and metropolitan sewerage districts are eligible for up to 70 percent State cost-share funding for eligible projects and have to provide at least a 30 percent local match.

Recreational Trails Program

In Wisconsin, the WDNR administers this federal program. Municipal governments, counties, school districts, and organizations incorporated under Section 181.32 of the *Wisconsin Statutes* whose primary purpose is promoting, encouraging, or engaging in outdoor trails activities are eligible to receive reimbursement for the development and maintenance of recreational trails and trail-related facilities for both motorized and non-motorized recreational trail uses. Eligible sponsors may be reimbursed for up to 50 percent of project costs. Funds from this program may be used in conjunction with funds from the state snowmobile or ATV grant programs and Knowles-Nelson Stewardship development projects. Eligible projects include development and rehabilitation of existing trails, development and rehabilitation of trailside and trailhead facilities and trail linkages, construction of new trails, and acquisition of land and easements for recreational trails or recreational trail corridors.

Surface Water Grants

The surface water grant program provides cost-sharing grants for surface water protection and restoration. Funding is available for education, ecological assessments, planning, implementation, and aquatic invasive species prevention and control. This program supports surface water management at any stage: from organization capacity development to project implementation. Funds can be used for a wide variety of projects related to surface water under one of two general categories: education and planning projects that help communities understand surface water conditions, determine management goals, and develop strategic management plans and management projects that protect and improve water quality and aquatic habitat and prevent and control aquatic invasive species (AIS). Some projects require an approved recommendation in a management plan to be eligible for funding.

Eligible applicants include counties, municipalities, and other local units of government; lake districts; natural resource agencies; tribal governing bodies; accredited colleges, universities, and technical schools; and town sanitary districts. Most grants are required to be cost-shared. All planning grants provide a 67 percent cost-share, while most management grants provide a cost-share of 75 percent. Wetland restoration incentives provide 100 percent cost-share.[202] Funding caps for specific project types and other information about this program is available in guidance from the WDNR.[203]

<u>Targeted Runoff Management Grant Program</u>

The Targeted Runoff Management (TRM) Grant Program provides technical and financial assistance to local governments for managing nonpoint source pollution. Grants reimburse project costs for agricultural or urban runoff management practices in targeted, critical areas with surface water or groundwater quality concerns. Cities, villages, towns, counties, regional planning commissions, tribal governments, lake districts, metropolitan sewerage districts, and sanitary districts are eligible to apply for funding under this program. The program provides up to 70 percent of eligible costs and requires at least 30 percent local match.

The TRM program provides assistance for four types of projects. Grants for large-scale TMDL projects provide support to agricultural projects designed to meet USEPA-approved TMDLs. Costs eligible for reimbursement include construction of structural BMPs, implementation of non-structural cropping practices, and some staffing costs for planning and installing management practices. Grants for large-scale non-TMDL projects provide support to agricultural projects implementing State agricultural performance standards and prohibitions. The areas addressed by these projects must be between eight and 39 square miles. Costs eligible for reimbursement include construction of structural BMPs, implementation of non-structural cropping practices, and some staffing costs for planning and installing management practices. Grants for small-scale TMDL projects provide support to agricultural and urban nonpoint source control designed to meet USEPA-approved TMDLs. Eligible costs include construction of structural BMPs and acquisition of land or land rights needed to support the practices. Grants for small-scale non-TMDL projects support agricultural projects implementing State agricultural performance standards and prohibitions. Funding for large-scale projects is limited to $600,000 and funding for small-scale projects is limited to $225,000.

<u>Urban Nonpoint Source and Storm Water Management Grant Program</u>

The Urban Nonpoint Source and Storm Water Management Grant Program provides cost-share funds for planning or construction activities for controlling nonpoint source pollution from urban areas. Projects funded by this program are site-specific, serve areas smaller in size than a sub-watershed, and target high priority problems. Eligible applicants include cities, villages, towns, counties, regional planning commissions, and special purpose districts such as lake districts, sewerage districts, and sanitary districts. In addition, an "urban project area" must meet at least one of the following criteria:

- The area has a residential population density of at least 1,000 people per square mile
- The area has a commercial land use
- The area is a portion of a privately-owned industrial site not covered by a WPDES permit issued under Chapter NR 216 of the *Wisconsin Administrative Code*
- The area is a municipally owned industrial site

The maximum cost-share rate available for planning grants is 70 percent of eligible costs. The cap on the total State share for planning projects is $85,000. The maximum cost-share rate available for construction

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[202] *dnr.wi.gov.*

[203] *Wisconsin Department of Natural Resources,* Surface Water Grant Program Applicant Guide and Program Guidance, *August 26, 2020.*

grants are 50 percent of eligible costs, with a total State share for a construction project of $150,000 and a potential grant of an additional $50,000 for land acquisition, where needed. Planning grants can pay for a variety of eligible activities, including stormwater management planning for existing and new development, related information and education activities, ordinance and utility district development, illicit discharge detection and elimination program design, and enforcement. Construction grants can pay for construction of best management practices to control stormwater pollution from existing urban areas, storm sewer rerouting, and streambank and shoreline stabilization. Projects may be eligible for funding whether or not they are designed to meet the performance standards identified in Section NR 151.13 of the *Wisconsin Administrative Code*, but the highest priority in selecting projects under this program is given to projects that implement performance standards and prohibitions contained in Chapter NR 151 or that address waterbodies listed on the Federal Section 303(d) list of impaired waters.

Wisconsin Forest Landowner Grant Program

The Wisconsin Forest Landowner Grant Program (WFLGP) is a cost-share program offered by WDNR. It is designed to assist owners in protecting and enhancing their woodlands. This program reimburses woodland owners up to 50 percent of the cost of eligible practices. Non-industrial private forest landowners in Wisconsin are eligible for WFLGP and must meet the following criteria:

- Own at least 10 contiguous acres of forest but not more than 500 acres within Wisconsin
- Have a forest stewardship plan in place or prepared through the WFLGP program
- WFLGP funding can only be cost-shared for non-commercial practices

Applications can be submitted at any time. Funding is awarded on a first come, first-served basis. Grants are typically awarded on the first days of August, November, February, and May, depending on the funds available and the number of applications.

Wisconsin Wetland Conservation Trust (Wetland Mitigation Program)

The WDNR's Wisconsin Wetland Conservation Trust (WWCT) program sells wetland credits to permittees needing to offset authorized wetland impacts. As of December 1, 2020, the WWCT has allocated $18 million to 14 different mitigation projects and completed over 500 acres of construction. Eligible applicants include public agencies, municipalities, private landowners, environmental consultants, nonprofit conservation organizations, Wisconsin tribes, or any entity registered with the Wisconsin Department of Financial Institutions. Projects must be protected by a conservation easement and remain as a mitigation site in perpetuity. In regard to the Oak Creek watershed restoration plan, the service area for this program is the "Southwestern Lake Michigan" area. Prospective applicants are encouraged to discuss potential projects with WWCT staff prior to submitting an application.

Wisconsin Department of Safety and Professional Services

Wisconsin Fund

The Wisconsin Fund for Private Onsite Wastewater Treatment System (POWTS) Replacement or Rehabilitation Financial Assistance Program provides financial assistance for the replacement or rehabilitation of failing POWTS serving homeowners or small commercial business. Applicants must meet specified income limits. In addition, the failing system serving the residence or business must have been constructed prior to July 1, 1978. Septic systems that fail by discharging to surface water, groundwater, or zones of seasonally saturated soils receive funding priority. The maximum grant award is $7,000.