Alliance of Downriver Watersheds
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Alliance of Downriver Watersheds (ADW)

Stormwater, Asset Management, and Wastewater

Stormwater Management Plan

FINAL REPORT

December 2019

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Alliance of Downriver Watersheds

SAW Stormwater Management Plan

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Executive Summary

Formed in January 2007, the Alliance of Downriver Watersheds (ADW) members have been working together for over 12 years to manage resources on a watershed scale and to comply with state and federal regulations regarding the elimination of pollutants from stormwater discharge. The ADW currently consists of 20 municipalities and 2 public agencies in the Ecorse Creek, Combined Downriver, and Lower Huron River watersheds, located in southeast Michigan. The physical boundaries of the ADW are depicted in Figure 1-1. The agencies and municipalities that comprise the ADW believe there are substantial benefits that can be derived by joining together and cooperatively managing the rivers, lakes, and streams within the watersheds and in providing mutual assistance in meeting state stormwater discharge permit requirements of each of the member communities.

This stormwater plan was funded in 2016 through the Michigan Department of Environment, Great Lakes, and Energy's (EGLE) Stormwater, Asset Management, and Wastewater (SAW) program. In order to be funded, the ADW agreed to develop this Stormwater Management Plan (SWMP) to meet requirements set by EGLE. This SAW project covers both the urbanized and non-urbanized areas of the ADW combined watersheds. ADW member communities are independently responsible for their own MS4 compliance; however, the SAW grant allowed the ADW entity to develop and coordinate specific aspects of MS4 permit requirements. The ADW applied for and received SAW grant funding to develop a SWMP other than an MS4 Permit or NPS SWMP. The ADW is presenting this SWMP that contain the following minimum requirements as described in the SAW guidance document.

For this SAW grant, the ADW focused on developing the collaborative components of MS4 permit requirements, including a collaborative Illicit Discharge Elimination Plan (IDEP), a collaborative Public Education Plan, a collaborative Total Maximum Daily Load (TMDL) Implementation Plan, participation in the development of regional post-construction stormwater standards, and developing a framework for stormwater funding.

Efforts undertaken in the development of a collaborative IDEP included a thorough review of existing water quality monitoring data and historic knowledge to identify priority areas. Field evaluations were performed within the identified priority areas to locate discharge points into the receiving stream and screen for potential illicit discharges. This effort resulted in the location of an additional 265 stormwater outfalls and screening of outfalls along approximately 36 miles of streams. This culminated in the development, submittal, and subsequent approval of a collaborative IDEP.

The collaborative Public Education Plan process consisted of research and citizen surveys to identify priority goals and the development of a 5-year communication plan/Public Education Plan of specific activities required to address watershed threats. The activities range from support for the Michigan Green Schools Program through incentives and recognition for participating schools to organizing and running focused-topic pollution prevention campaigns and watershed community calendars.

The ADW municipalities have put forth substantial effort and resources to reduce the sources of impairments of the listed TMDLs within the ADW watersheds. A collection of activities and best management practices (BMPs) intended to further reduce the sources of impairments was developed as part of the collaborative TMDL Implementation Plan, funded through this SAW program. A subset of the activities and BMPs was further developed through this SAW program and includes a three-pronged approach summarized below.

First, a field assessment of current stormwater detention/retention structures was completed to ensure existing infrastructure functions as intended. Deficiencies were recorded in a GIS database and recommended corrections are included. Second, opportunities to implement green stormwater infrastructure on municipal properties were identified in collaboration with each community. Concept plans and cost opinions were developed for each proposed green infrastructure treatment. Third, priority BMP projects were identified in each watershed. These are projects that will require significant collaboration and funding to complete, but that will provide far-reaching water quality benefits by addressing known problem areas. Concept plans and cost opinions for these projects were developed for each of these projects. This work concluded with the development, submittal and subsequent approval by EGLE of a collaborative TMDL Implementation Plan.

The ADW also participated in a regional committee that developed MS4 post-construction stormwater standards for water quality and channel protection that require new and redevelopment projects to manage site stormwater runoff for the MS4 permit areas. The goal of this process was to identify stormwater standards that are straight forward, easy to implement, meet MS4 program goals, and improve water quality and protect stream channels. The proposed standards that were developed have been accepted by EGLE for Wayne County and will improve upon existing water quality, channel protection, and flood control standards.

The ADW has been monitoring water quality across the watershed for many years. Historic and recent water quality data trends indicate that while some improvements have been made over the years, much work still needs to be done to achieve water quality that supports designated uses and eliminates impairments. Activities and efforts performed under this SAW program identify implementation activities to continue the water quality improvements.

In order to transition from planning activities to implementation, a funding mechanism is necessary. The ADW prepared sustainable stormwater funding options for three communities who requested a detailed study of their community assets. Through this SAW project, a projection of annual stormwater costs for each of the ADW member communities was prepared that used the community specific data discussed above and stormwater costs developed for other Michigan communities through previous SAW grant projects. Results of the projected annual stormwater costs indicate a substantial gap in funding across all ADW communities. Options for bridging the funding gap were developed and are included in this plan.

Table A identifies the locations where the requirement SWMP elements can be found in this document.

Table A – Stormwater Management Plan Required Elements

Stormwater Management Plan Required Element (EGLE)	**Location in this SWMP**
A description and map of the jurisdictional boundaries and the area to be covered by the plan (typically a sewershed and/or drainage district). The planning area should be hydrologically based and include the entire collection and conveyance system (open and closed) as well as the contributing area.	Section 1
A description of the major components of the stormwater system and/or county drainage district, including sewershed and watershed boundary and internal sub-boundaries, surface water hydrology, mapping of stormwater conveyance (pipes and channels), existing storage, regulatory or other mapped floodplains, flood control facilities and treatment components.	Section 1 and 2.1
A description of publicly owned BMPs and private BMPs that significantly affects the stormwater system.	Section 2.3 and 2.4
A description of all stormwater sources and all known stormwater related water quality problems within the planning area (for example, surface flooding, hydraulic restriction, erosion, water quality, etc.).	Section 1
Include recommendations and an analysis of projects to correct stormwater and known stormwater related water quality problems. a. This includes project identification, preliminary sizing and description of proposed activities. Proposed activities could consist of capital improvements (i.e. culvert replacement, channel modification, structural BMPs, etc.) or changes to inspection or maintenance activities (i.e. stream bank assessments, detention basin inspections, floodplain or floodway encroachment surveys, etc.). b. Provide estimated operation, maintenance and capital costs for all recommendations	Section 2
Include a timeline for implementation of the plan. The extent of the timeline is at the applicant's discretion (i.e., 5-year, 10-year, etc.).	Section 6
SAW optional items that are strongly encouraged to be included in the SWMP:	
A general maintenance plan	*Section 2.4*
The desired level of service should be determined through a public involvement process	*Section 6*
A public education program or activities	*Section 5*
A general description of land use percentages	*Section 1*

1 Introduction and Background

In 2013, the Alliance of Downriver Watersheds applied for a Stormwater, Asset Management, and Wastewater (SAW) grant from the Michigan Department of Environment, Great Lakes and Energy (EGLE), formerly the MDEQ, in order to develop a comprehensive Stormwater Management Plan (SWMP) for the ADW members. In 2016, EGLE awarded the ADW with SAW grant funding to develop a SWMP. This SWMP summarizes the stormwater related pollutants of concern (water quality and water quantity) in the three major watersheds of the ADW and documents the strategy to address the threats.

Based on the work done to date within the watershed, it is apparent that implementing methods to reduce the water quality effects of urban stormwater runoff are essential to further improving the water quality within the ADW. The ADW has worked together to develop a plan for public education, illicit discharge elimination, TMDL implementation, pollution prevention/good housekeeping standards, and water quality monitoring. By fulfilling these tasks, the ADW is herein presenting the collaborative set of documents and standards that can be utilized by the municipalities as they need to apply for their MS4 permits and select actionable tasks for implementation to address the ongoing water quality issues in the ADW watershed.

The goals of this SWMP are to:

- Improve water quality in the ADW
- Minimize pollutants in stormwater runoff from sources within the jurisdiction of ADW member municipalities
- Develop collaborative plans for public education, illicit discharge elimination and TMDL implementation, pollution prevention/good housekeeping standards, and water quality monitoring requirements
- Identify actionable tasks for implementation to address the ongoing water quality issues in the ADW watershed
- Build database and fill in gaps of existing stormwater infrastructure and BMP data
- Begin to address financial hindrances to improving water quality

To achieve these goals, this plan includes a description of the major components of the stormwater system, a description of the major threats to the watershed, summary of significant publicly and privately owned best management practices, an analysis of the stormwater sources and water quality related problems, and recommendations of future activities to address pollutants in the watershed.

1.1 ADW and Watershed Overview

The Alliance of Downriver Watersheds (ADW) is a permanent watershed organization in southeast Michigan and formed under Public Act 517 of the Public Laws of 2004. The ADW formally established themselves in 2007 but have been working together for many years to manage the area's water resources. The ADW currently consists of 22 public agencies in the Ecorse Creek, Combined Downriver and Lower Huron River watersheds within Wayne County. The consortium of agencies that make up the ADW work together to cooperatively manage the rivers, lakes and streams within the watershed.

The ADW is relatively urban in nature consisting of approximately 203 square miles and more than 350,000 people (2010 census). Major watercourses within the ADW watershed that drain to the Detroit River and Lake Erie include the Ecorse Creek, Sexton-Kilfoil Drain, Frank and Poet Drain, Blakely Drain, Brownstown Creek, Huron River, Silver Creek and Woods Creek.

The challenges in the ADW watershed are typical of urban watersheds. Stream flows are more erratic than state average; nutrient runoff is high; pathogen and bacteria levels are high in Ecorse River and Combined Downriver; and conductivity levels (a general measure of chemical pollution) are high.

The ADW watershed has several TMDLs including:

- Biota (Excessive Sediment): (Ecorse River, 2003) (Frank & Poet Drain, 2007) (Blakely Drain, Brownstown Creek, 2007)
- *E. coli (*Excessive Bacteria)*:* (Ecorse River, 2008) (Wagner-Pink Drain, 2003) (Detroit River, 2008)

Current ADW Membership

Allen Park
Belleville
Dearborn Heights
Ecorse
Flat Rock
Gibraltar
Grosse Ile Township
Inkster
Lincoln Park
Melvindale
Riverview
Rockwood
Romulus
Southgate
Sumpter Township
Taylor
Van Buren Township
Wayne County
Westland
Woodhaven
Woodhaven-Brownstown School District
Wyandotte

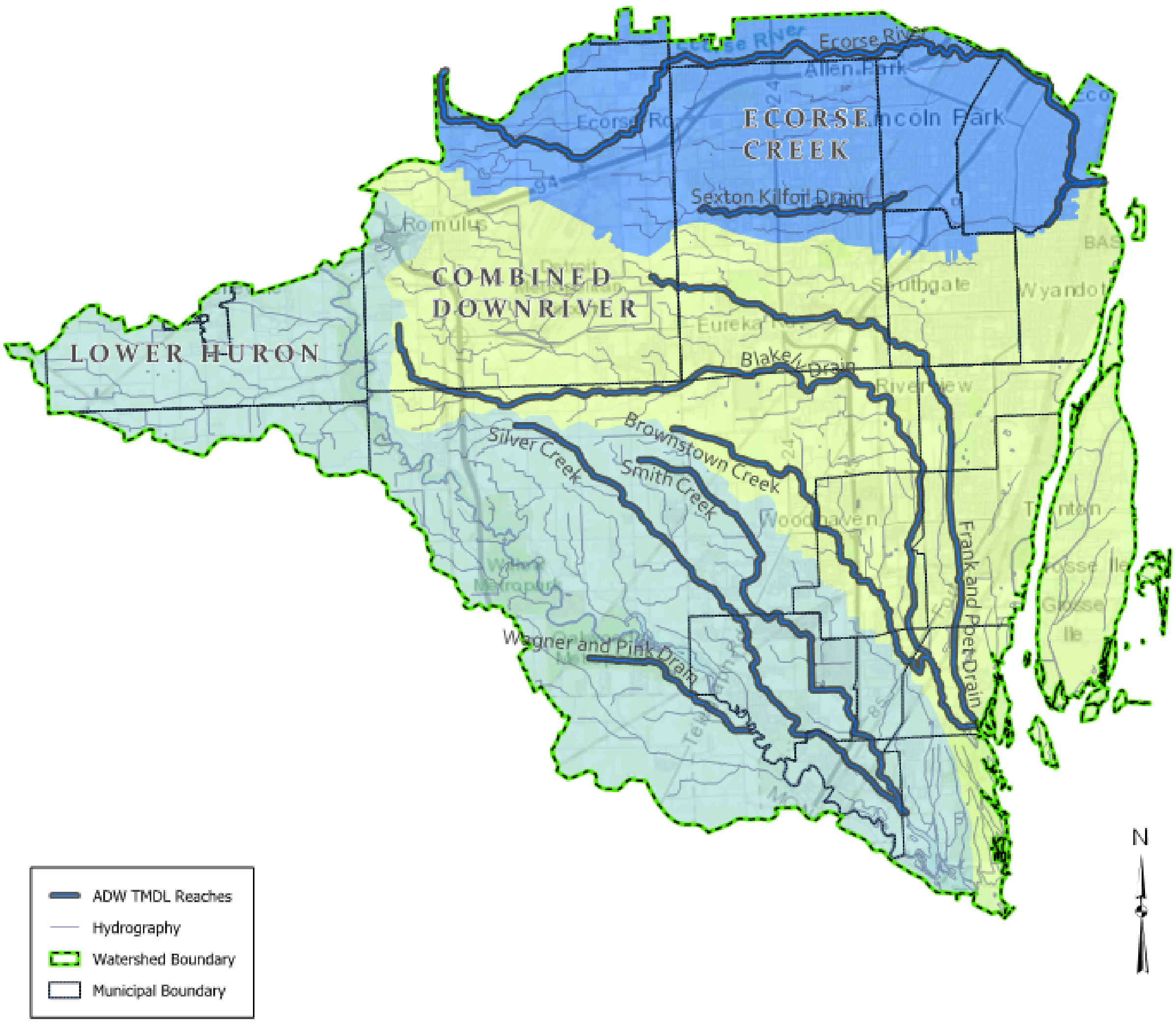

Figure 1-1 Watershed and Jurisdictional Boundaries of the ADW

1.2 Major Elements of the ADW

The Ecorse Creek and Combined Downriver watersheds are located entirely within Wayne County as is the vast majority of the Lower Huron River watershed. The southernmost portion of the Lower Huron River is located in Monroe County and the far western portion lies in Washtenaw County's Ypsilanti Charter Township (non-ADW member).

The Ecorse Creek watershed includes 11 municipalities (ADW members and non-members) as well as the Wayne County Airport Authority (Detroit Metropolitan Airport), which is located within Romulus. The watershed encompasses 27,791 acres or 43.4 square miles. The cities of Allen Park, Lincoln Park, Taylor, and Romulus have the greatest amount of land area within the watershed. The North Branch of the Ecorse Creek and the Sexton-Kilfoil Drain (South Branch) join each other in Lincoln Park and Ecorse and flow east for a half mile before reaching the Detroit River. The watershed drains an area of approximately 43.4 square miles in a heavily urbanized region, including a portion of the Detroit Metropolitan Airport in the headwater region of the Sexton-Kilfoil Drain.

The Combined Downriver watershed includes 11 municipalities (including Trenton and Brownstown Township, who are not members of the ADW), as well as the Detroit Metropolitan Airport (which is located within Romulus). The Detroit River, the Frank & Poet Drain, and the Blakely Drain are the three primary water courses within the watershed. The watershed drains an area of approximately 85.9 square miles in a relatively urbanized region, including a portion of the Detroit Metropolitan Airport in the headwater region of the Frank & Poet Drain. The watershed encompasses 54,944 acres or 85.9 square miles. Brownstown Township, Taylor, Romulus, and Grosse Ile Township have the greatest amount of land area within the watershed. It should be noted that nearly all of Wyandotte, and a portion of Southgate, are located in the Southgate-Wyandotte Drainage District. The majority of the flows in this area go directly to the Downriver Utility Wastewater Authority (DUWA) Wastewater Treatment Plant.

Lower Huron River watershed is 74 square miles, representing approximately 8% of the 908-square-mile Huron River basin. The watershed includes large portions of Belleville, Brownstown Township (non-ADW member), Huron Township (non-ADW member), Flat Rock and Rockwood, the southern half of Van Buren Charter Township, the northeastern edge of Sumpter Township, the western edge of Romulus, the northeastern portion of Ash Township (non-ADW member), the southern portions of Woodhaven and Gibraltar, and the northern portions of Berlin Charter Township (non-ADW member) and South Rockwood (non-ADW member). The Lower Huron River begins downstream of the French Landing Dam that creates Belleville Lake in Van Buren Charter Township and flows to Lake Erie. More than a dozen tributaries flow into the Lower Huron River including the more significant Silver Creek that drains the eastern areas of the watershed and has 81 miles of streams and Woods Creek that drains the northwestern area of the watershed and has 27 miles of streams. The main stem of the Huron River itself is 28.5 miles long with an additional 145 miles of streams.

Table 1-1 ADW Watershed Population (2010 Census)

Community*	2010 Population	2010 Population in ADW by Watershed			Total Population in ADW
		Ecorse Creek	Lower Huron River	Combined Downriver	
Allen Park*	28,210	27,428			27,428
Ash Twp	7,698		805		805
Belleville*	3,869		2,386		2,386
Berlin Twp	6,924		643		643
Brownstown Twp	30,627		17,360	12,106	29,466

Community*	2010 Population	2010 Population in ADW by Watershed			Total Population in ADW
		Ecorse Creek	Lower Huron River	Combined Downriver	
Dearborn Heights*	57,774	18,998			18,998
Ecorse*	9,512	5,995			5,995
Flat Rock*	9,872		9,827		9,827
Gibraltar*	4,656		462	4,656	5,118
Grosse Ile Twp*	10,371			10,371	10,371
Huron Twp	15,879		11,121	1,440	12,561
Inkster*	25,369	2,201			2,201
Lincoln Park*	38,144	38,142			38,142
Melvindale*	10,715	73			73
Riverview*	12,486			12,486	12,486
Rockwood*	3,281		3,289		3,289
Romulus*	23,989	7,026	1,570	11,018	19,614
South Rockwood	1,675		615		615
Southgate*	30,047	5,620		24,427	30,047
Sumpter Twp*	9,521		1,393		1,393
Taylor*	63,131	43,258		19,873	63,131
Trenton	18,853			18,853	18,853
Van Buren Charter Twp*	28,778		7,774		7,774
Westland*	84,094	2,193			2,193
Wayne County*					0
Woodhaven*	12,875		1,144	11,158	12,302
Woodhaven-Brownstown Schools*					0
Wyandotte*	25,883	1,367		24,516	25,883
Ypsilanti Twp			254		254
Total	**574,233**	**152,301**	**58,643**	**150,904**	**361,848**
***Current ADW members**					

1.3 General Description of Land Use

The ADW (Ecorse Creek, Combined Downriver and Lower Huron River watersheds) comprises 203 square miles of land and water. Based on 2015 land cover data, published by SEMCOG, approximately 32% is residential (65.16 sq. miles), 41% is industrial, transportation, communication and utility (TCU), or vacant (84.62 sq. miles), and 4.5% commercial (9.1 sq. miles). Overall, the ADW watershed is highly urbanized with over 90% of the land area developed.

Table 1-2 ADW Watershed Land Use Summary

Land Use Category	Area (sq. miles)	Percent of Total	Percent of Total by Watershed		
			Ecorse	Combined Downriver	Lower Huron River
Agricultural	19.83	9.8%	4%	4%	23%
Commercial	9.1	4.5%	8%	7%	2%
Governmental/Institutional	6.35	3.1%	6%	4%	2%
Industrial, TCU	84.62	41.6%	32%	44%	21%
Parks, Recreation, Open Space	17.64	8.7%	4%	10%	15%
Residential	65.16	32.1%	47%	31%	37%
Water	0.51	0.3%	0.4%	0.3%	0.3%
Totals	**203.21**	**100%**	**21%**	**42%**	**36%**

Ecorse Creek Watershed

The types of urban and suburban development found in the Ecorse Creek watershed have dramatic effects on surface waters in terms of altered runoff patterns, increased flashiness, increased suspended solids loadings, and shifts in temperature characteristics, as well as other impacts. The almost complete loss of vegetated riparian zone throughout the watershed, combined with substantial land coverage by surfaces impervious to precipitation (roads, parking lots, roof tops) and a curb, gutter, and storm drain system, produce rapid runoff rates. This efficient movement of water directly to the stream channel results in unstable and flashy flow conditions, stream bank erosion, and sedimentation of in-stream habitats. Existing Land use data (2015) from the Southeast Michigan Council of Governments (Table 1-3) was utilized to gain a general understanding of existing land use patterns throughout the watershed. The predominant land use is residential, with more than 40% of the watershed occupied by this use. Transportation, Communication and Utilities (TCU) comprise the second largest land use with more than 8,600 acres, including I-75, I-94, and a portion of Detroit Metropolitan Airport.

Table 1-3 Land Use in the Ecorse Creek Watershed

Land Use	Acreage	% of Total
Agricultural	1,065.1	3.9%
Commercial	2,157.6	7.9%

Land Use	Acreage	% of Total
Governmental/Institutional	1,502.1	5.5%
Industrial, TCU	8,657.8	31.8%
Parks, Recreation, Open Space	1,092.5	4.0%
Residential	12,727.1	46.6%
Water	109.2	0.4%
Totals	**27,311.4**	**100.%**

Combined Downriver Watershed

Like the Ecorse Creek, the types of urban and suburban development found in the Combined Downriver watershed have dramatic effects on surface waters in terms of altered runoff patterns, increased flashiness, increased suspended solids loading, and shifts in temperature characteristics, as well as other effects. The loss of vegetated riparian zone throughout the watershed, combined with substantial land coverage by surfaces impervious to precipitation (roads, parking lots, roof tops) and a curb, gutter, and storm drain system, combine to increase runoff rates. This efficient movement of water directly to the stream channel results in unstable and flashy flow conditions, stream bank erosion, and sedimentation of instream habitats. Based on the 2015 SEMCOG land use data, the predominant land use is industrial/transportation/utility, with more than 40% of the watershed occupied by this use. Residential areas comprise the second largest category with over 16,000 acres or 31% of the watershed. Table 1-4 details the existing land use for the watershed.

Table 1-4 Land Use in the Combined Downriver Watershed (2015)

Land Use	Acreage	% of Total
Agricultural	1,921.8	3.5%
Commercial	3,669.7	6.7%
Governmental/Institutional	2,249.5	4.1%
Industrial, TCU	24,197.9	44.3%
Parks, Recreation, Open Space	5,476.9	10.0%
Residential	16,933.1	31.0%
Water	173.9	0.3%
Totals	**54,622.8**	**100%**

Lower Huron River Watershed

The Lower Huron River watershed contains a wide range of land uses, from active agriculture and low-density residential lands in Sumpter and Huron Townships to dense suburban development and industrial areas in downriver municipalities such as Flat Rock and Rockwood. The various land use types described by SEMCOG have been condensed into seven land use types: active agriculture, commercial; industrial; governmental; open; residential; and water. In order to understand land use changes in the

Lower Huron River watershed, it is useful to look at growth trends across the five-county southeast Michigan region.

The trends identified by SEMCOG are reflected in the Lower Huron River watershed, which is located on the southwestern edge of metropolitan Detroit. Housing stock is dominated by single family, detached homes. The trend toward larger homes on larger pieces of land with fewer people living in them has serious implications in terms of infrastructure costs, environmental impacts and sense of community. Table 1-5 presents the distribution of current land uses in the Lower Huron River watershed.

Table 1-5 Land Use (2015) in the Lower Huron River Watershed

Land Use	Acreage	% of Total
Agricultural	10,909.0	23.3%
Commercial	936.4	2.0%
Government/Institutional	1,170.5	2.5%
Industrial, TCU	9,598.0	20.5%
Parks, Recreation, Open Space	6,788.8	14.5%
Residential	17,323.2	37.0%
Water	93.6	0.2%
Totals	**46,819.58**	**100%**

Active agricultural fields, grasslands/old agricultural fields and low-density residential areas are found throughout the watershed while medium- and high-density residential and commercial and industrial areas are focused in the downstream municipalities and in the villages and cities. Included in the watershed are four Metroparks (Lower Huron; Willow; Oakwoods; and Lake Erie), and the Pointe Mouillée State Game Area providing over 6,700 acres of public land for recreation and natural resource protection.

1.4 Pollutants and Threats to Watershed Health, and their Sources and Causes

The ADW conducts an annual chemistry and flow monitoring program to collect data and assess water quality within the three watersheds. The ADW executes monitoring during the growing season at nine long-term sites, which help track changing conditions over time. Additionally, up to four sites each year are selected for one-season investigations, which provide useful data to gain a better understanding of upstream conditions regarding pollutant sources. These sites are usually located upstream of long-term sites or at locations of particular interest to ADW members. All sites are sampled regularly twice per month from April through September by volunteers. Program volunteers collect water samples, which are analyzed by municipal wastewater treatment plant laboratories for total phosphorus, total suspended solids, and *Escherichia coli* concentrations. Volunteers also directly measure conductivity, pH, and dissolved oxygen with handheld sondes.

In total, 17 sites were sampled in 2018 and 2019. Since the beginning of the chemistry and flow monitoring program, 33 sites have been sampled and over 100 volunteers have been trained and involved in the program. To view a map of the monitoring sites, please visit www.hrwc.org/chemistryandflow. The subsections below include a summary of monitoring data through 2019.

Ecorse Creek Watershed

The Ecorse Creek watershed is identified on Michigan's list of water-quality limited or threatened waters as failing to meet Michigan water quality standards for pathogens and for the protection of warm water aquatic life. Flooding and erosion due to urbanization is the main focus for the watershed, a secondary focus has turned to water quality.

Previous studies, sampling efforts and the results of the ADW 2012 Watershed Management Plan (WMP) point to the impairment as being caused by unstable flows and excessive sedimentation, which are resulting in the loss of stable habitat for aquatic life. It is apparent that implementing methods to reduce the effects of urban stormwater runoff are essential to further improving the water quality of the Ecorse Creek watershed.

Combined Downriver Watershed

Portions of the Combined Downriver watershed are identified on Michigan's list of water-quality limited or threatened waters as failing to meet Michigan water quality standards for the protection of warm water aquatic life. The biota and *E. coli* TMDLs, which EGLE has developed, identify water quality indicators, and quantifiable pollutant load reductions to protect aquatic life and recreational uses.

The water quality of the Combined Downriver watershed is still threatened, and in some cases impaired, by urban stormwater runoff. Many of the drains within the watershed were originally designed to accept agricultural flows. As development increased and the watershed became urbanized, the ability of the historically small drains to handle the new, higher peak flows is insufficient which isresults in flooding and erosion. Conversely, the urbanization of the watershed led to an increase in impervious surface area that result in less rainwater being infiltrated into the ground which results in lower creek base flows. The combination of these two effects, higher peak flows during storm events and lower creek base flows, is devastating to the aquatic life in the streams.

Previous studies, sampling efforts, and the results of the ADW 2012 Watershed Management Plan work point to the impairment as being caused by unstable flows and excessive sedimentation, which are resulting in the loss of stable habitat for aquatic life. General findings revealed minimal riparian buffers, significant sedimentation and turbid water, evidence of flashy flows, eroded banks and debris piles. It is apparent that implementing methods to reduce the effects of urban stormwater runoff are essential to further improving the water quality of the watershed.

Lower Huron River Watershed

The entire Huron River watershed is listed on the 2010 Integrated Report from EGLE as failing to meet water quality standards for mercury. The watershed is identified on Michigan's list of water-quality limited or threatened waters as failing to meet Michigan water quality standards for the protection of indigenous aquatic life and wildlife. Previous Integrated Reports listed portions of the lower Huron River watershed as impaired due to pathogens (bacteria). Further, portions of the Lower Huron River watershed, and its tributaries are listed as impaired due to Polychlorinated biphenyls (PCBs).

EGLE determined that illicit discharges to the storm sewer drains and failing on-site septic systems are the main sources of *E. coli* to the watershed.

Goals for the ADW watershed (Ecorse Creek, Combined Downriver and Lower Huron River watersheds) as a result of previous studies, sampling efforts and the 2012 WMP efforts, include:

- Reduce flooding and stream flow variability
- Increase watershed management sustainability
- Improve water quality
- Protect, enhance, and restore riparian and in-stream habitat
- Preserve, increase, and enhance recreational opportunities
- Protect public health
- Increase public education understanding and participation regarding watershed issues
- Address PFAS contamination issues

1.4.1 Sediment

The principal physical function of a stream or river system is the upstream to downstream transport of water and sediment. However, sediment inputs to the system in excess of equilibrium conditions can result in increased in-stream erosion, deposition of fine sediments, changes in stream morphology, and impacts to fish and invertebrates. Deposition of finer-grained sediment, such as silts, clays, or sand, can fill the pore spaces between, or even bury gravels and other coarse substrates and fill pool habitat. Stream habitat is therefore simplified or made homogenous, resulting in the loss of aquatic species that require a variety of particle sizes and coarse substrates for colonization.

High sediment loads also degrade water quality. During high flow conditions, in-stream erosion is accelerated, adding more sediment to the system. Erosion can scour the channel bottom (downcutting or degradation) or actively erode streambanks (widening and undercutting). This results in excess lateral erosion, warmer streams and lower dissolved oxygen levels. Macroinvertebrate communities also exhibit reduced densities at TSS concentrations greater than 80 mg/l.

Sediment is transported through a stream system either along the bottom (bed-load) or mixed in the water column (stream-load). The latter component is more readily sampled and is measured as total suspended solids (TSS). A European Inland Fisheries Advisory Commission (EIFAC) report established tentative criteria for TSS concentrations:

- Continuous TSS concentrations less than 25 mg/l were found not harmful to fish,
- Concentrations between 25 and 80 mg/l were found to reduce fish yields,
- Good fisheries were unlikely at concentrations between 80 and 400 mg/l, and
- Concentrations greater than 400 mg/l resulted in poor fish populations.

The Biota TMDL (for excessive sediment) establishes a numeric target for mean, annual, in-stream TSS concentrations of less than or equal to 80 mg/l during wet weather and snowmelt events, as a secondary means of documenting the re-attainment of designated uses.

Historic studies that measured TSS in the Ecorse Creek and Combined Downriver watersheds indicated that pre-rain concentrations were below the 80 mg/L target and increased 10 to 20 times background levels during and following the rain event.

Historical observed data in the Lower Huron River watershed is limited to monitoring conducted in 2007 by Wayne County at 12 stations (average of five events) and by Woods Creek Friends in 2008-09 at seven stations along Woods Creek. Levels of TSS were well within the optimal category.

Current Monitoring Data

Generally, streams throughout the ADW watershed are low in turbidity and suspended sediments. Since 2012, the nine long-term sampling sites have mean TSS measured between 13.5 and 32.4 mg/l – well below the 80 mg/l threshold. Figure 1-2 depicts the full range of TSS data for the nine long-term monitoring sites. The target threshold has only been exceeded occasionally, during or following large storm events. Three of the sites only exceeded the threshold once over the seven year (2012-18) period. At worst, Blakely and South Ecorse Creek sites exceeded the threshold a total of four times, or a little more than once every two years. This return interval for a turbidity event is roughly the same as the return interval for bankfull or channel-forming events.

There are no statistical trends in TSS data over time. Figure 1-3 depicts a typical long-term site (South Ecorse Creek), with the green line indicating the trend. Sample results vary over each year (with some seasonal pattern), but the data generally stays within a similar range, except during or following large storms (bankfull or greater).

While historical data indicates that some of the ADW streams were transporting large amounts of sediments in the past, it appears that these streams may have stabilized in their current form. Erosion and sediment accumulation only appear to be happening during or following channel-forming events. Such a pattern would be expected for most streams (including natural streams) in the southern Great Lakes coastal plain ecotype.

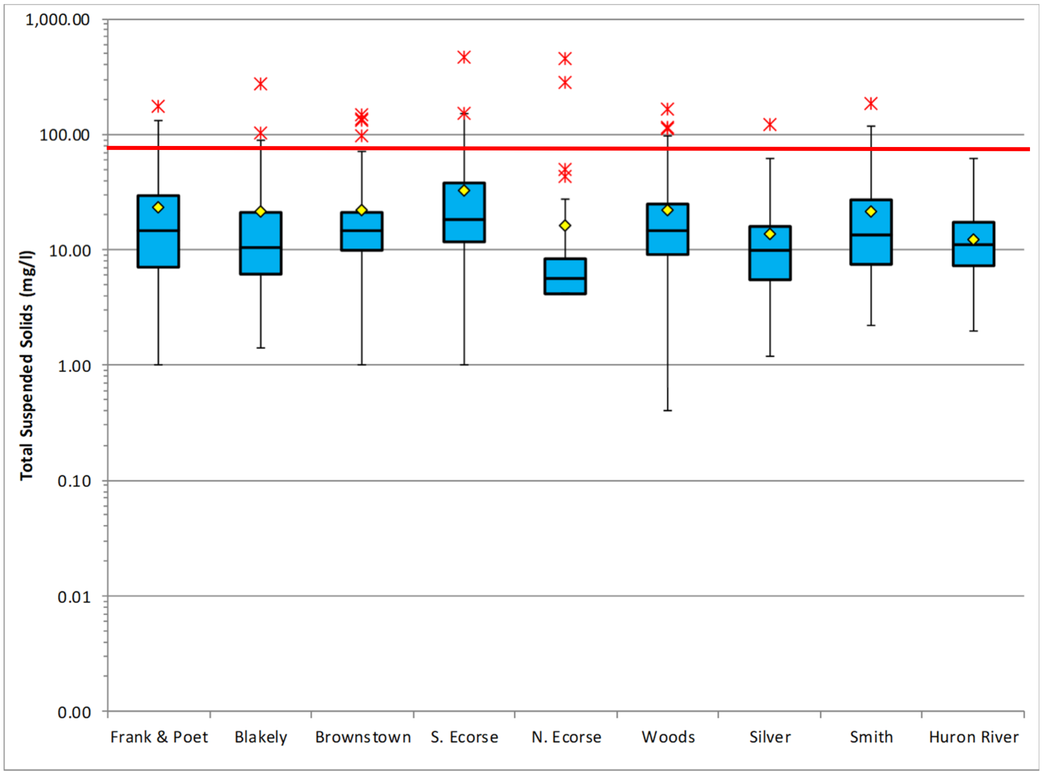

Figure 1-2 Ranges of TSS monitoring results for long-term sites in the ADW. Blue boxes represent interquartile range. Yellow diamonds are the mean values. Red stars are extreme measures. The red line indicates the 80 mg/l target threshold.

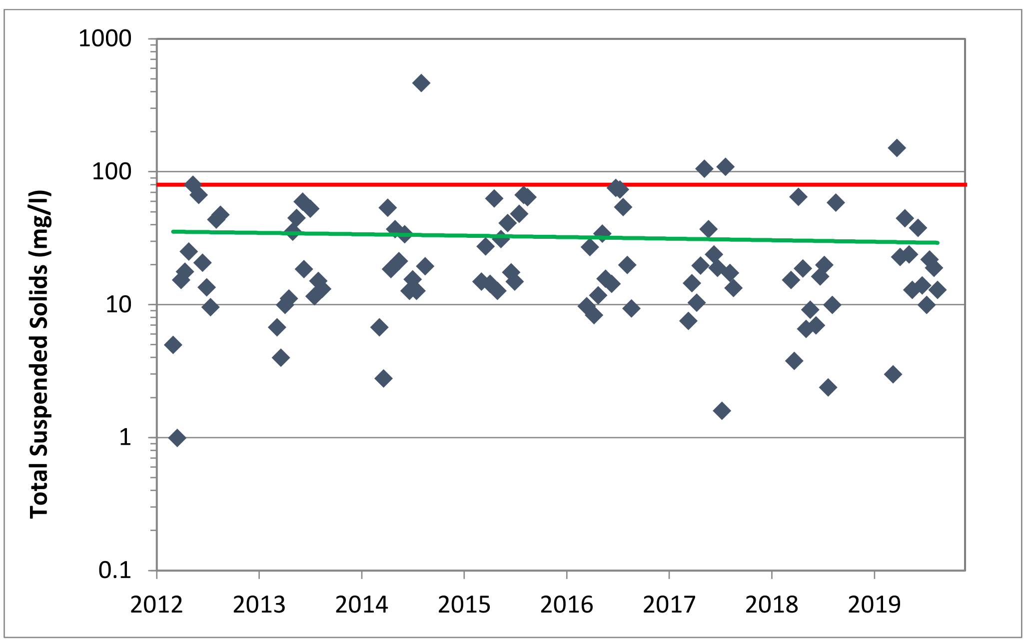

Figure 1-3. TSS sample results at South Ecorse Creek from 2012-2019. The red line indicates the 80 mg/L threshold. The green line indicates the trend.

1.4.2 Biological Community

Native species of benthic macroinvertebrates, mollusks, crustaceans, and fish, have varying habitat requirements and tolerances of ecological degradation. The diversity and composition of these biological communities, therefore, tend to integrate the cumulative effects of chemical, physical, and biological conditions within a lake or steam over time. As such, the biological assessment of these communities can be used for the evaluation of water resources and serve as a top-level indicator of water and habitat quality for ADW streams. In Michigan, EGLE conducts biological assessments of streams and river biota. Several ADW streams are listed as impaired for poor biota, as measured by benthic macroinvertebrate surveys. ADW waters that are impaired for poor biotic diversity include the following:

- Ecorse River
- Brownstown Creek
- Blakely Drain, Marsh Creek
- Frank & Poet Drain
- Silver Creek
- Smith Creek

Current Monitoring Data

Monitoring the diversity of benthic macroinvertebrates is a staple of the ADW monitoring program. The ADW has been monitoring macroinvertebrate diversity at over 30 sites across the ADW. Most sites have three or more years of data.

Macroinvertebrate diversity is measured twice a year (augmented by winter stonefly collections in January). Multiple diversity measures provide a reasonable estimate of stream conditions. Stream habitat is also evaluated directly every 3-5 years. Changes in site quality measures may indicate habitat improvements. Two metrics are used to determine site diversity. First, the Stream Quality Index (SQI) is a composite biotic integrity score developed for the Michigan Clean Water Corps (MiCorps).[1] The SQI is based on order-level identification; however, and does not take advantage of family-level identification performed by ADW programs. The second metric is total taxa diversity (TD), which counts the number of different families of aquatic macroinvertebrates found at each site. This measure utilizes the higher resolution of family identification but does not account for the sensitivities of different families. Taken in tandem, these two metrics provide a good measure of aquatic biotic integrity over time. Further, the ADW uses a rolling 3-year mean SQI to determine site status to remove the effect of climatic variation.

The SQI metric can be classified into four categories based on sampling of sites across the state of Michigan. Sites have excellent quality if they have an SQI above 48, good quality above 33, fair quality above 19, and a site is considered of poor quality if it has a score below 19. In the fall, ADW sites range from 17 (poor) to 40 (good), with the vast majority of sites falling in the fair to good range. Six of 28 (21%) sites sampled fall in the poor category. Spring SQI scores are more variable, ranging from 12 to 43,

[1] Jo Latimore, Huron River Watershed Council. *MiCorps Volunteer Stream Monitoring Procedures.* August 2006. Available at http://micorps.net/streamresources.html.

with only 2 of 38 (5%) sites falling in the poor range. Statistically, only one site is showing an improving trend over time, with six sites (16%) getting worse in either the fall or spring over time. The majority (82%) of sites show no statistical trend.

Findings are similar for taxa diversity. 22-23% of sites in the ADW are rated with poor diversity in both seasons. Poor-rated sites are spread fairly evenly across the three watersheds. One site in the Combined Downriver watershed (the same site with improving SQI scores) has an improving trend, while four sites are getting worse. The majority (86%) of sites are staying the same, statistically.

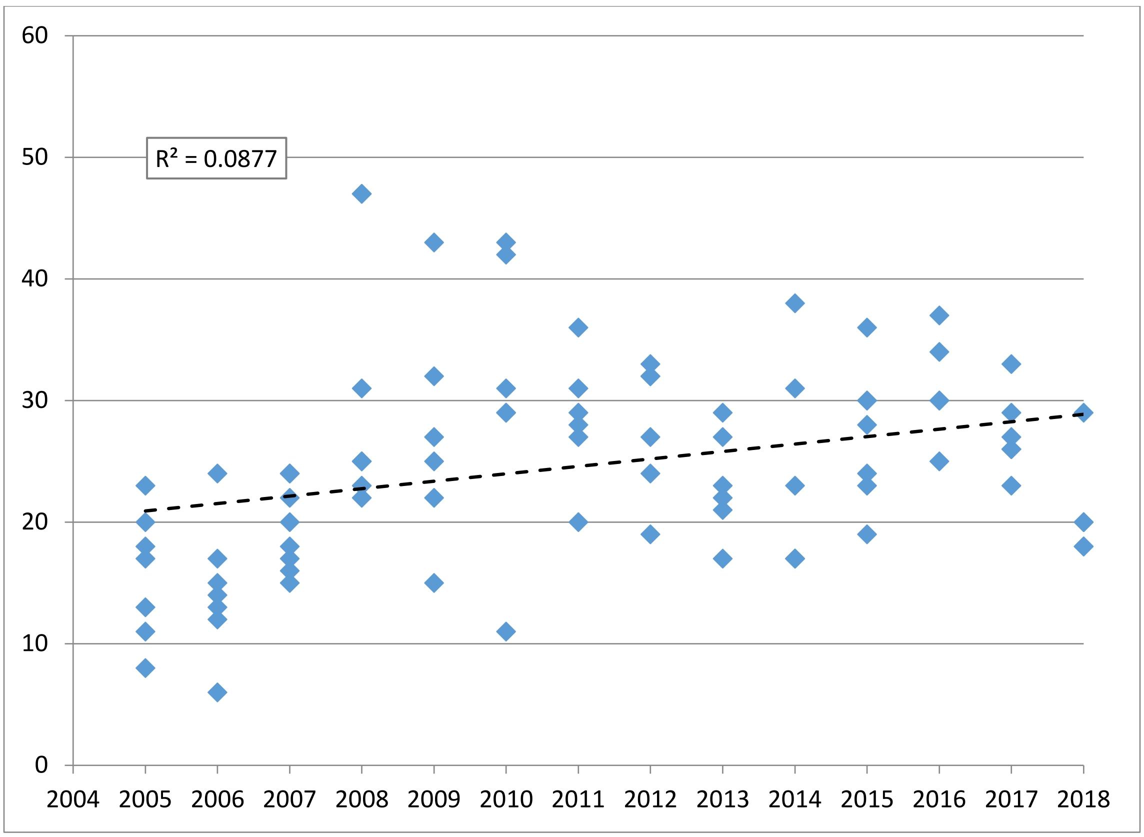

Figure 1-4. Spring Stream Quality Index (SQI) ratings for sites in the Combined Downriver watershed

When sites are combined and examined by watershed, however, trends emerge. Sites in both the Combined Downriver and Ecorse Creek watersheds show statistically significant improving trends in spring samples over time, while the Lower Huron River watershed sites show no discernable trend. Looking more closely, it appears that sites in the two watersheds improved significantly from 2005 through 2010 and then stabilized. Further, many of the sites started with ratings in the poor range and were able to improve to fair ratings. In contrast, Lower Huron River sites, on average, rated in the good range from the start of monitoring. There are no apparent trends in fall sampling in any of the three watersheds. The data suggest that some of the sites that were originally listed as impaired, may have improved enough to no longer be considered impaired and should be re-evaluated.

1.4.3 Hydrologic Modification/Impervious Surfaces

The shape and dimensions of stream systems change over time to be in equilibrium with the amount of water and sediment the stream normally carries. Stream channels are generally formed to carry the largest flows experienced every one to two years (referred to as bankfull or channel forming flows). As a stream's watershed is developed, more and more water and sediment are carried to the stream, increasing both the magnitude and frequency of those channel-forming storms. Larger storm events, such as the "5-year storm," (that storm event that normally would have a 1 in 5 chance of occurring in any given year), become the norm – occurring as many as five (5) times per year. The result is that the streams become "flashy" and they experience higher highs, being driven by overland runoff and flood flows, and lower lows, since hard surfaces lower infiltration rates and reduce groundwater recharge and baseflow inputs to streams during summer low flow periods or drought. Additionally, these changes to stream channel morphology and hydrology lead to greater erosion, deposition, and pollution.

Flow stability, incorporating the relative magnitude, pattern, frequency, and duration of high and low stream flows, is a critical factor in determining the chemical, physical, and biological integrity of river systems. Streams that exhibit rapid fluctuations in flow are described as "flashy." Flashy flows destabilize banks, scour, dislodge and destroy habitat, strand and kill organisms, and inhibit recreational uses of rivers.

Imperviousness, which is a measure of the amount of non-porous surfaces (e.g. rooftops, roads, parking lots, driveways, etc.) in a watershed, is a driving factor in the degradation of stream and river systems in urban areas. The amount of imperviousness in a watershed has been shown to be directly related to the physical, chemical, and biological quality or integrity of aquatic ecosystems.

The overall picture painted by the data is evident; watershed imperviousness coverage is already high and current development trends will result in notably higher impervious coverage across the watershed.

Current Monitoring Data

Eight water-level stations are monitored at sites throughout the ADW (2 in Ecorse Creek, 3 in Combined Downriver, and 2 in Lower Huron River, with an additional sensor used to provide atmospheric pressure). All stations have at least an 8-year record of continuous flow data generally covering the April through September time period. Stream discharge was measured numerous times at different water levels at all the sites to allow translation from water level to discharge and calibrate annual changes in site characteristics as illustrated in Table 1-6. The USGS station at the North Branch of Ecorse Creek was monitored as the longitudinal flow sensor for the ADW and for the purpose of tracking storm data as indicated in Figure 1-5. A storm flow sensor was also installed to track flow in real time at this site to assist with storm sample selection. Stream discharge is also measured at each water chemistry site to pair with data in storm and baseline conditions.

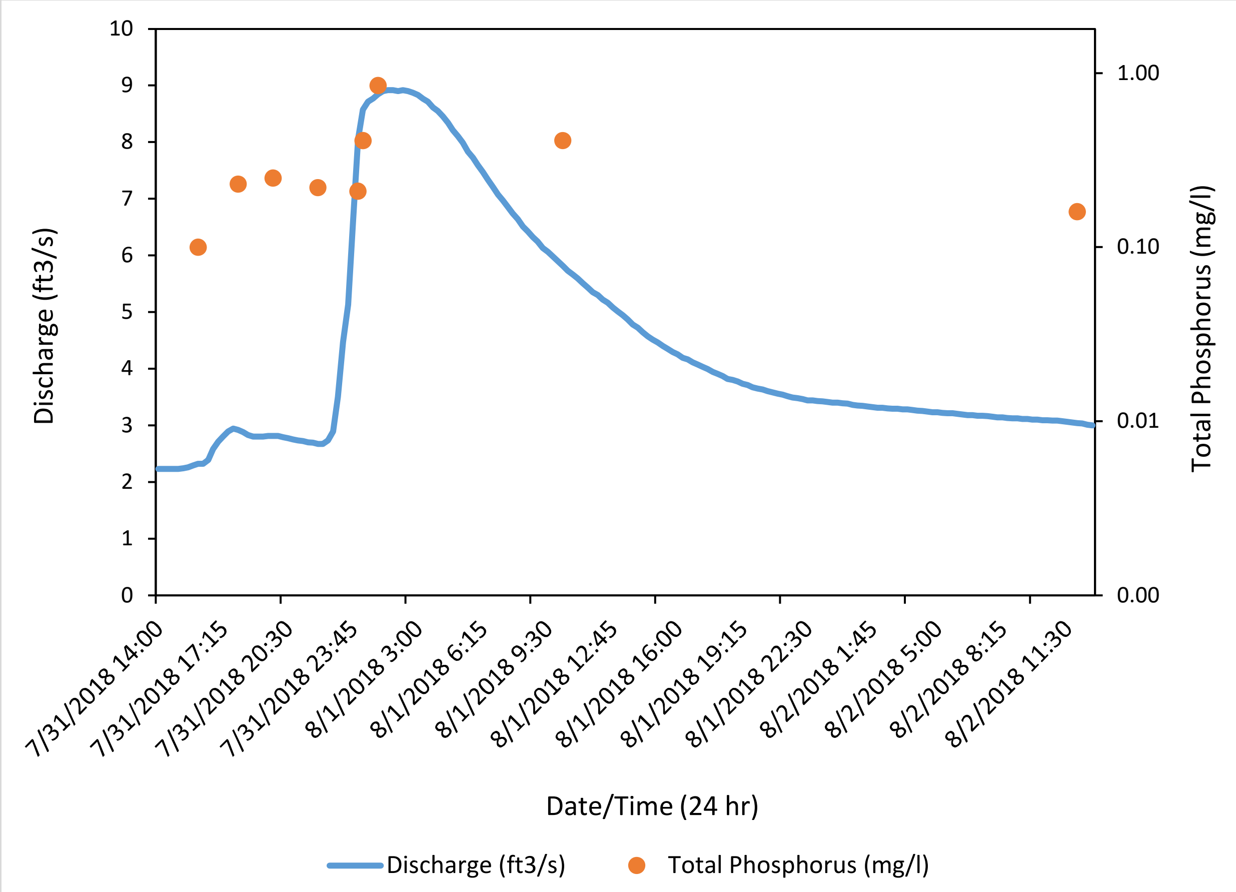

Figure 1-5. Data from 1-inch storm event at N. Branch Ecorse Creek between July 31 and August 2, 2018. Graph illustrates discharge over time with individual TP results from water quality samples on the right axis. Results illustrate the strong role increased flow plays in water quality impairments and nutrient loading.

Table 1-6. Discharge Statistics for Gaged Streams in the ADW from 2008 through 2011

Site	Drainage Area (sq. mi.)	Median Flow (cfs)	Peak Flow* (cfs)	Minimum Flow* (cfs)	Flashiness (Quartile)†
Frank & Poet	27	4.33	754.25	0.00	0.56 (4)
Blakely	32	4.05	251.89	0.00	0.53 (4)
Brownstown	27	3.03	77.48	0.00	0.45 (3)
S. Branch Ecorse	12	3.65	142.50	0.33	0.58 (4)
N. Branch Ecorse	18	1.70	291.00	0.16	0.88 (4)

Site	Drainage Area (sq. mi.)	Median Flow (cfs)	Peak Flow* (cfs)	Minimum Flow* (cfs)	Flashiness (Quartile)†
Woods	21	2.12	44.80	0.00	0.31 (2)
Silver	7.9	1.54	312.35	0.00	0.72 (4)
Smith	9	2.19	122.95	0.00	0.67 (4)

** Peak flow and minimum flow are extracted from the complete, sub-daily flow record, whereas the other statistics are based on mean daily discharge.*

† The flashiness quartile is the number of the quartile where the flashiness index would place the stream compared to sites across Michigan, where 1=lowest or most natural quartile and 4=highest or most impacted quartile.

1.4.4 Phosphorous

Phosphorus and other nutrients are essential for plant growth. In Michigan waters, phosphorus is generally considered the limiting nutrient, meaning that the amount of available phosphorus generally determines the rate and amount of plant growth. As such, phosphorus is a key water quality concern. Phosphorus binds to soil particles, and is thereby delivered to streams and lakes with eroded soil. Phosphorus is also a chief component of lawn, garden, and agricultural fertilizers, detergents, fuels, and animal wastes. Phosphorus from these sources is carried in stormwater runoff, and enters rivers and lakes from stormwater outfalls, failing septic tanks and from wastewater treatment plants. Excessive phosphorus can, in turn, lead to excessive growth of algae and other aquatic plants, which can then deplete the available dissolved oxygen in the water (i.e. eutrophic conditions). This can result in a change in the species composition of fish and aquatic invertebrates or even result in fish kills. High nutrient concentrations and the resulting growth of nuisance plant levels can also inhibit recreation and enjoyment of our waters. The EGLE considers total phosphorus concentrations higher than 0.05 mg/L to have the potential to cause eutrophic conditions.

Current Monitoring Data

Total phosphorus concentration ranges across the nine long-term sites in the ADW vary quite a bit year to year. The mean TP concentration across all long-term sites for 2018 was 0.14 mg/l with a median of 0.11 mg/l, both of which are above the target concentration of 0.05 mg/l (based on phosphorus TMDLs in the area). The bulk of the TP concentrations in the ADW range between 0.07 mg/l and 0.14 mg/l, with a few samples exceeding this range by a considerable margin as seen in Figure 1-7. Typically, these high concentrations are measured during or following storm events. As such, stormwater runoff is still a major pathway of overall phosphorus loading to the ADW waterways as illustrated by Figure 1-6.

At most long-term sites, there are no statistically significant trends in TP as concentrations vary year to year or remain in the same concentration range. Notably, the long-term site at Blakely Creek has shown increasing TP concentrations as illustrated in Figure 1-6. Conversely, the Woods Creek long-term monitoring site within the Lower Huron watershed illustrates declining TP concentrations with mean and median TP concentrations at the target of 0.05 mg/l.

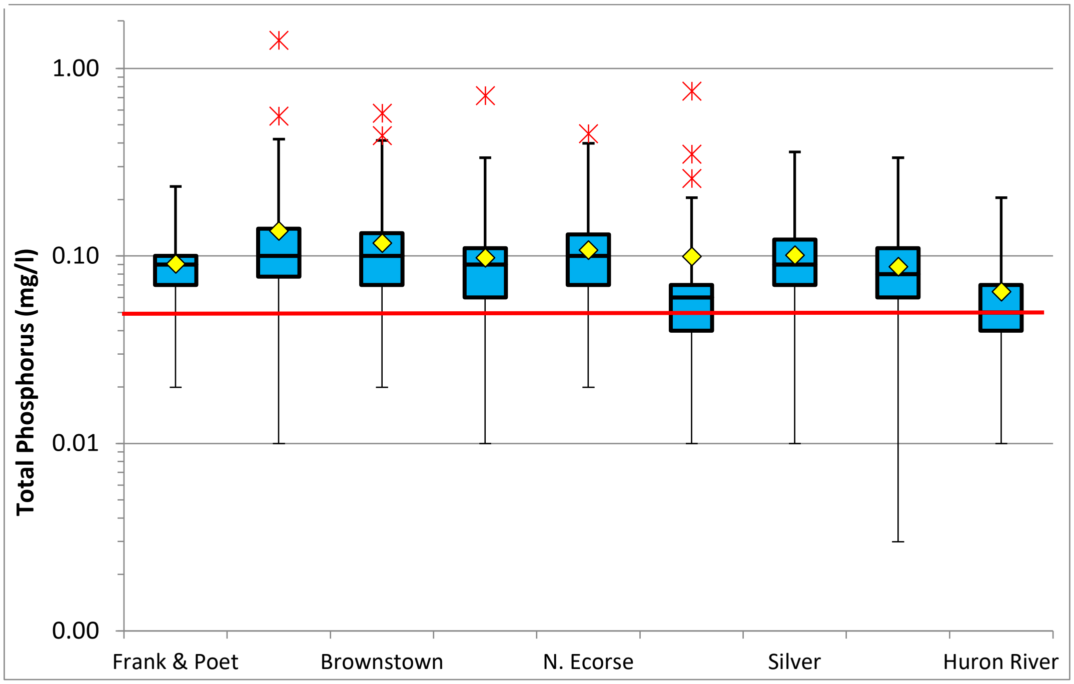

Figure 1-6. Ranges of TP monitoring results for long-term sites in the ADW. *Blue boxes illustrate the interquartile range with the median. Yellow points indicate the mean value. Outliers are indicated by red stars. The target concentration of 0.05 mg/l is illustrated by the red line.*

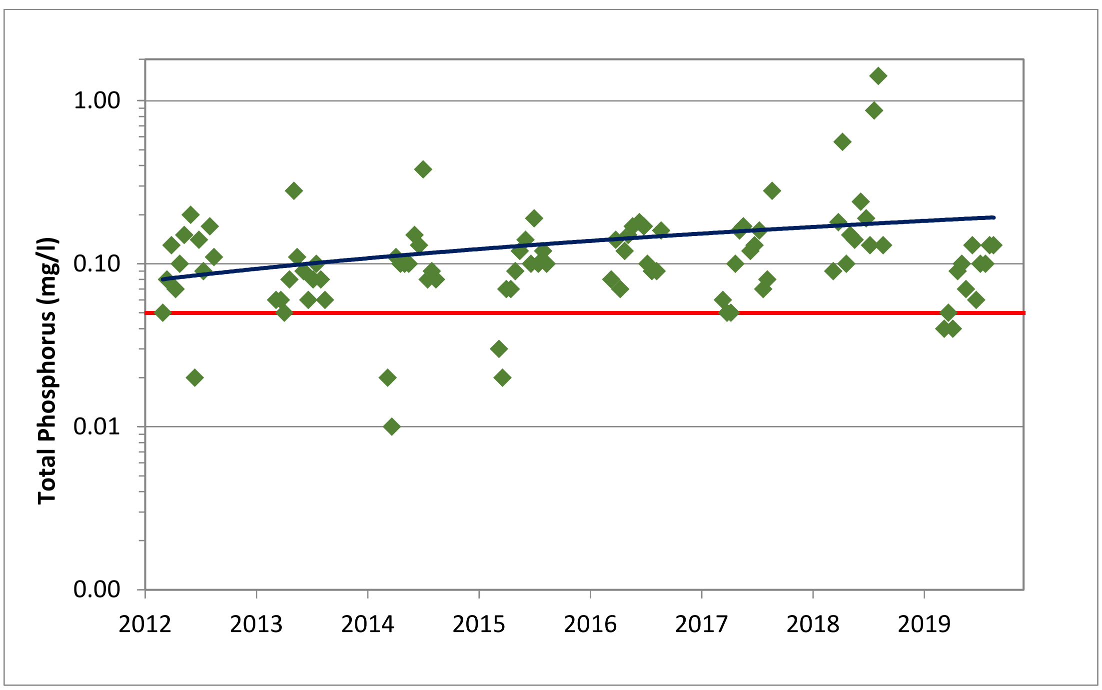

Figure 1-7. TP concentrations at Blakely Creek *Total phosphorus concentrations at Blakely Creek indicate increasing trends away from the target concentration of 0.05 mg/l. which is indicated by the red line.*

1.4.5 Dissolved Oxygen

Oxygen dissolved in water is necessary for life of both aquatic plants and animals. Oxygen enters water either through plant photosynthesis or across the air-water interface through turbulence and osmosis. The amount of oxygen that can be held by the water is temperature dependent. Solubility increases with decreasing temperature (colder water holds more oxygen). Oxygen is lost or reduced when water temperatures rise, when plants and animals respire, and when aerobic microorganisms decompose organic matter. Plants produce excess oxygen during the daylight hours through photosynthesis. During the night, they must continue to use oxygen while no photosynthesis is occurring. Thus, DO levels decrease at night, and are generally lowest just before dawn.

As stated above, introduction of excess nutrients (driving nuisance plant growth) and/or excess warming may result in oxygen depletion. Prolonged exposure to low dissolved oxygen levels (less than 5 to 6 mg/l oxygen) may not directly kill organisms, but can increase their susceptibility to environmental stresses. Exposure to less than 30% saturation (less than 2 mg/l oxygen) for periods of one to four days may kill most life in aquatic systems.

Rule 64 of the Michigan Water Quality Standards (Part 4 of Act 451) includes minimum concentrations of dissolved oxygen which must be met in Michigan surface waters. This rule states that surface waters protected for warmwater fish and aquatic life must meet a minimum dissolved oxygen standard of 5 mg/l.

Current Monitoring Data

Most measurements at the nine long-term monitoring sites had values for dissolved oxygen that were within the normal range for Michigan surface waters. However, several measurements at the Silver Creek, Brownstown Creek, and N. Ecorse Creek long-term monitoring sites routinely did not meet the state standard of 5 mg/l.

1.4.6 Conductivity

Conductivity is a measure of the ability of water to pass an electrical current and, as such, is an indirect measurement of the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). Conductivity is affected by temperature: the warmer the water, the higher the conductivity. Conductivity is frequently measured as micro-Siemens per centimeter (µS/cm). Because it is related to temperature, conductivity is generally standardized as conductivity at 25 degrees Celsius (25^{o}C).

Conductivity of rivers in the United States generally ranges from 50 to 1,500 µs/cm. Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 µS/cm. Industrial waters can range as high as 10,000 µS/cm. Conductivity values outside of 150 to 500 µS/cm range may indicate the presence of anthropogenic inputs and water unsuitable for certain species of fish or macroinvertebrates. In the Huron River, in southeast Michigan, average conductivity values less than or equal to 800 µS/cm are considered natural. Conductivity values greater than 800 µS/cm were correlated with imperviousness values greater than 8% and impaired macroinvertebrate communities.

Current Monitoring Data

All long-term monitoring sites in the ADW except Woods Creek have average and median conductivity values that exceeded the 800 µS/cm standard for southeast Michigan. Despite the high values at most ADW monitoring sites, Woods Creek was below the conductivity standard for nearly all measurements. While still above the 800 µS/cm standard, the long-term monitoring site at the Huron River has shown a statistically significant decline in conductivity as illustrated in Figure 1-8. Conductivity values at the main Huron River monitoring site in Rockwood between 2016 and 2019.

. For the long-term monitoring sites in the Combined Downriver and Ecorse Creek watersheds, no discernible trends have been detected in conductivity data. Nearly all monitored values at these sites are above the 800 µS/cm standard.

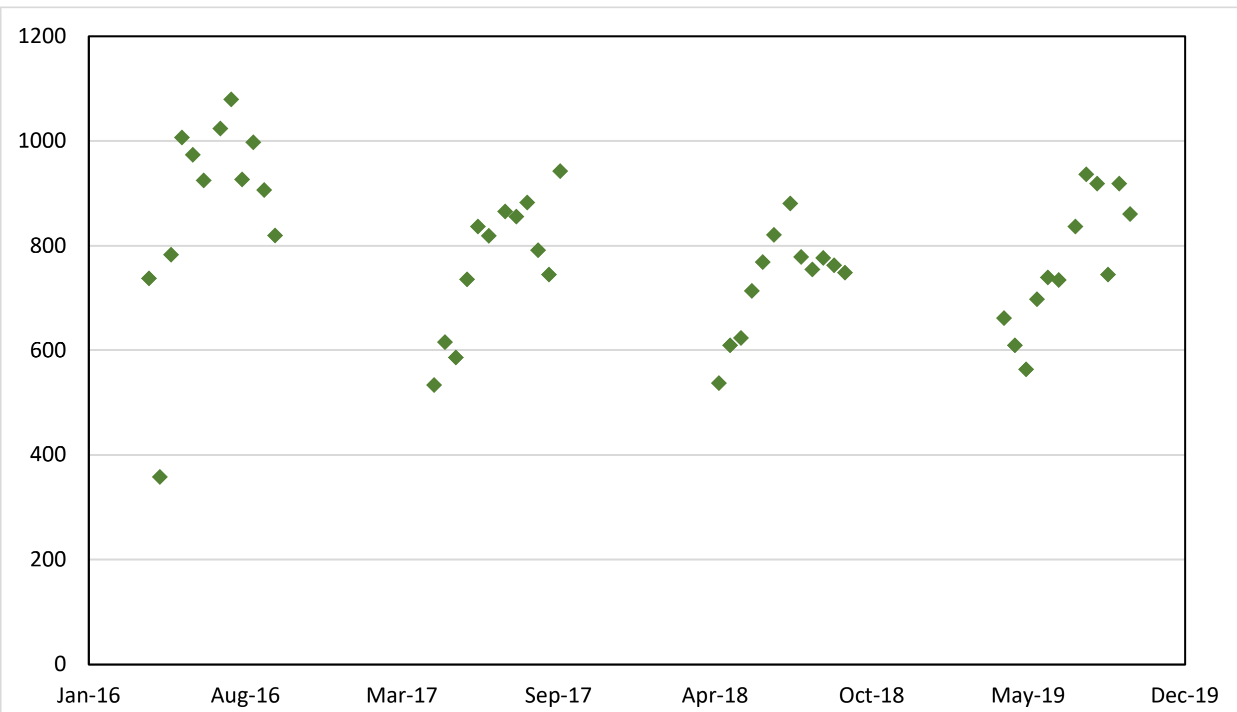

Figure 1-8. Conductivity values at the main Huron River monitoring site in Rockwood between 2016 and 2019.

1.4.7 Pathogens

Bacteria from human sources can enter waters through either point or nonpoint sources of contamination. Point sources are those that are readily identifiable and typically discharge water through a system of pipes (e.g. an industrial or wastewater discharge). Point source discharges can also include "illicit" connections to storm drainage systems, wherein wastewater that would normally require treatment prior to discharge is instead routed through storm drains without treatment. Nonpoint sources are diffuse, with contamination entering waters through overland runoff or seepage through the soil. Failed septic systems in residential or rural areas can contribute bacteria to surface water and groundwater. Animal wastes from livestock, pets, wildlife and waterfowl are also sources of bacteria.

Most bacteria are harmless, however some have the potential to cause illness or disease in humans. These are referred to as pathogens. Examples of waterborne diseases caused by bacteria include cholera, dysentery, shigellosis and typhoid fever. Minor gastro-intestinal discomfort is probably the most common ailment associated with water-borne bacteria; however, pathogens that cause only minor discomfort to some may cause serious illness or even death in other individuals, particularly those with compromised immune systems or the young and elderly.

Of particular interest or concern is a sub-group called coliform bacteria, typically found in the digestive systems of warm-blooded animals. Coliform bacteria include total coliforms, fecal coliforms, and the group Escherichia coli (*E. coli*). Each of these indicates the presence of fecal waste in surface waters. The fecal-coliform bacteria group was the preferred indicator for potential water quality concerns; however, recent advances in the use and analysis of indicator bacteria have shown that *E. coli* are more reliable for predicting the presence of disease causing organisms.

Rule 62 of the Michigan Water Quality Standards (Part 4 of Act 451) limits the allowable concentration of microorganisms in surface Waters of the State and surface water discharges. Waters of the State which are protected for total body contact recreation must meet limits of 130 *Escherichia coli* (*E. coli*) per 100 milliliters (ml) water as a 30-day average and 300 *E. coli* per 100 ml water at any time. The limit for Waters of the State which are protected for partial body contact recreation is 1000 *E. coli* per 100 ml water during any one sampling event.

Current Monitoring Data

The data collected in the ADW on pathogens (as *E. coli*) indicate that all long-term sites except two (Woods Creek and the Huron River) regularly exceed state standards. Long-term trends for *E. coli* in the ADW show no significant improvements and are either increasing bacteria counts or maintaining a consistent range. *E. coli* concentrations at Blakely Creek, Brownstown Creek, S. Ecorse Creek and N. Ecorse Creek (see Figure 1-9) are increasing, with most samples above the state single sample standards for Full Body Contact (300 *E. coli* cfu per 100 ml) and Partial Body Contact (1000 *E. coli* cfu per 100 ml). Mean *E. coli* concentrations in the ADW across all long-term sites for 2018 was 1,519 *E. coli* cfu per 100 ml with a median of 821.2 *E. coli* cfu per 100 ml, indicating consistently high *E. coli* concentrations across the ADW in exceedance of state standards.

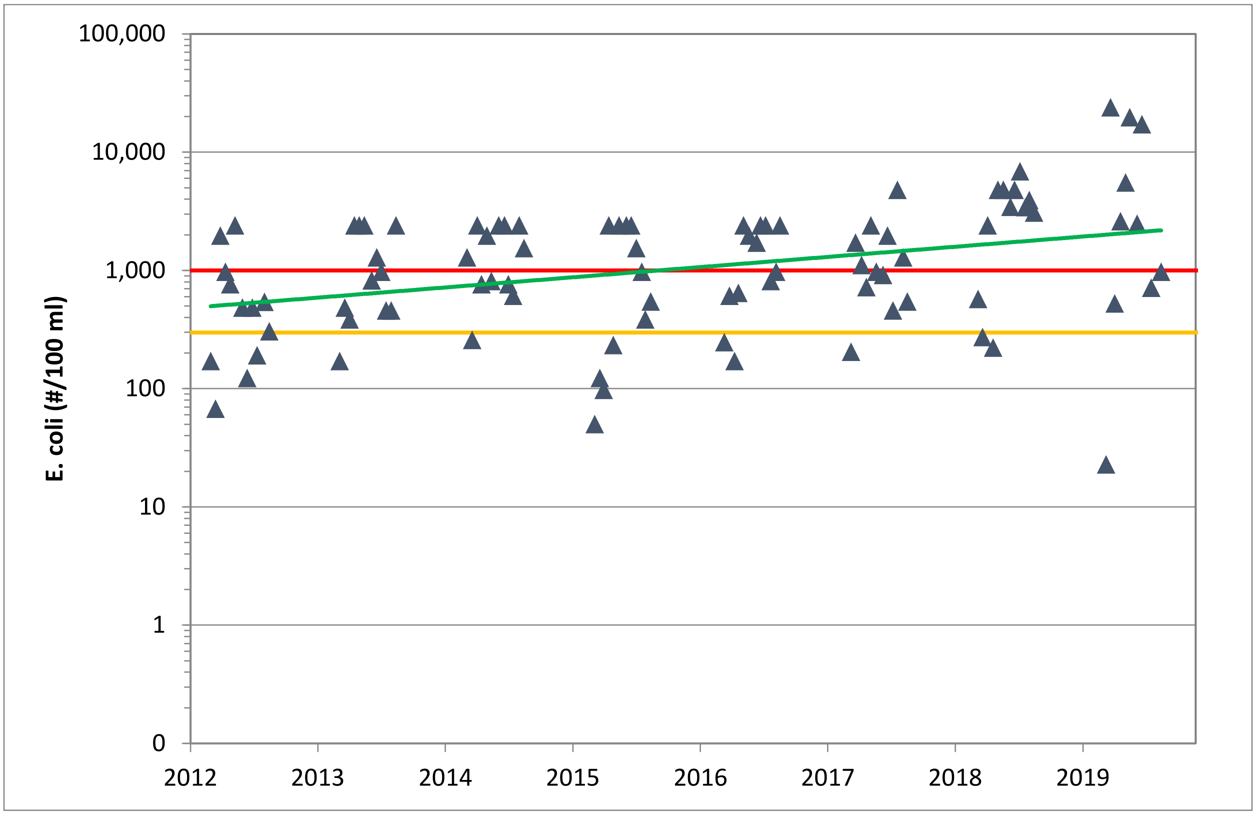

Figure 1-9. E. coli concentrations at N. Ecorse Creek from 2011 to 2019. E. coli concentrations at N. Ecorse Creek between 2011 and 2019. Michigan's single-sample standards for full body (yellow) and partial body (red) contact are indicated by colored lines. The green line indicates the trend.

Conclusion

The synthesis of the information listed above outlines the historic and ongoing impact of stormwater management across the ADW municipalities. The plethora of monitoring data collected demonstrates that positive trends are being observed across subwatersheds and at several individual sites. Across the entire ADW watershed, some sites are getting better, but there are also some that are trending downward. Without continued coordinated efforts to manage stormwater effectively and repair erosive conditions in ADW streams and drains, the impacts of sediment, impervious surface, nutrients, and pathogens will reverse the upward trends and impair the designated use of ADW waterbodies.

2 Stormwater Management Activities

Activities completed both individually by ADW municipalities and collaboratively through the ADW contribute to improving water quality and addressing TMDLs in the watersheds. These activities range from policies and procedures such as ordinances requiring stormwater management for new and redevelopment projects, to field investigation and monitoring activities such as outfall inspections for potential illicit discharges and water quality sampling, as well as site-specific implementation projects such as tree plantings and green infrastructure practices. Municipal level policies related to development and stormwater management work to reduce impact to streams and improve water quality through reduced volumes and capture of contaminants in practice areas while promoting infiltration and a stable groundwater table. Regular inspection of stormwater appurtenances, such as outfalls to Waters of the State, and sampling of water quality at strategic locations across the combined watersheds, arms communities within the ADW with valuable information that can lead to the elimination of illicit discharges and effective planning of abatement and restoration activities that can improve water in impacted reaches. Utilizing green infrastructure, including tree plantings, bioswales, and raingardens allows for improvements to water quality by returning stormwater to the atmosphere and groundwater table through interception, infiltration, and evapotranspiration. The reduced volume of stormwater reaching the downstream receiving streams due to these efforts can work to relieve streambank erosion and associated nutrient loads, contaminant loads from impervious runoff, and impacts to water quality from increased water temperature and turbidity. This section summarizes all the activities undertaken through the SAW grant to improve water quality.

2.1 Collaborative Illicit Discharge Elimination Plan (IDEP)

As discussed in the aforementioned sections of this SWMP, there is evidence of elevated levels of *E. coli* throughout portions of the ADW communities. An *E. coli* total maximum daily load (TMDL) allocation plan was developed for the Ecorse Creek watershed by EGLE in 2008. ADW member municipalities support a robust program to monitor surface waters for chemistry, biology, and stream flow. Monitoring conducted by citizen volunteers, HRWC, Wayne County, and EGLE staff have established baseline conditions, current status, and trends over the previous six years across the ADW. Analysis of the monitoring data has allowed the ADW Technical Committee to prioritize IDEP work areas. The data used includes: EGLE Bacterial Source Tracking (BST) studies conducted in 2007 within the Ecorse Creek watershed; monitoring conducted by Wayne County across the ADW through the EGLE grant in 2007-2008; monitoring conducted by Wayne County in 2015 through a SAW grant; and annual volunteer and staff monitoring funded by the ADW beginning in 2012 that continues through the present.

To identify priority IDEP work areas, the ADW Technical Committee uses the following process and criteria.

- Multiple events with *E. coli* concentrations in excess of 1,000 cfu/100 mL during dry weather
- Dry weather human *E. coli* (based on EGLE 2007 BST studies)
- Upstream of known combined sewer overflow (CSO) areas
- High mean *E. coli* concentrations from sampling
- Elevated mean total phosphorus level results from sampling
- Wayne County's IDEP Monitoring found 3 or more monitoring events with one or more elevated IDEP monitoring parameters
- Areas upstream of sites with unexplained, declining macroinvertebrate populations

At the end of each sampling season (usually in February or March), the committee evaluates the past year's surface water monitoring results. The monitoring includes a number of long-term sampling stations and 3-5 one-season investigative stations. Investigative stations are used to subdivide watersheds to narrow in on potential pollutant sources. New or unusual results are flagged and discussed. The team evaluates the biological and chemical status at each monitoring site and summarizes results for sub-watersheds across the three ADW watersheds. The direction and amplitude of trends are also evaluated. Sub-watersheds with the worst current conditions and trends are listed for prioritization according to the below criteria. Observations by the monitoring team and volunteer data participants about short-term conditions, climatic variables and other influences are also discussed. The criteria are regularly evaluated for revision.

Eight stream segments were identified by the ADW Technical Committee as Priority IDEP Work Areas (Figure 2-1). Three of the eight areas are within the Ecorse Creek watershed (North Branch Ecorse Creek, LeBlanc Drain, S. Branch Ecorse Creek); four areas are within the Combined Downriver watershed (Blakely Drain, Frank & Poet Drain and Brownstown Creek); and 1 of the 8 areas are within the Lower Huron River watershed (Silver Creek). The areas that drain to these eight stream segments constitute approximately 28% of the total ADW area.

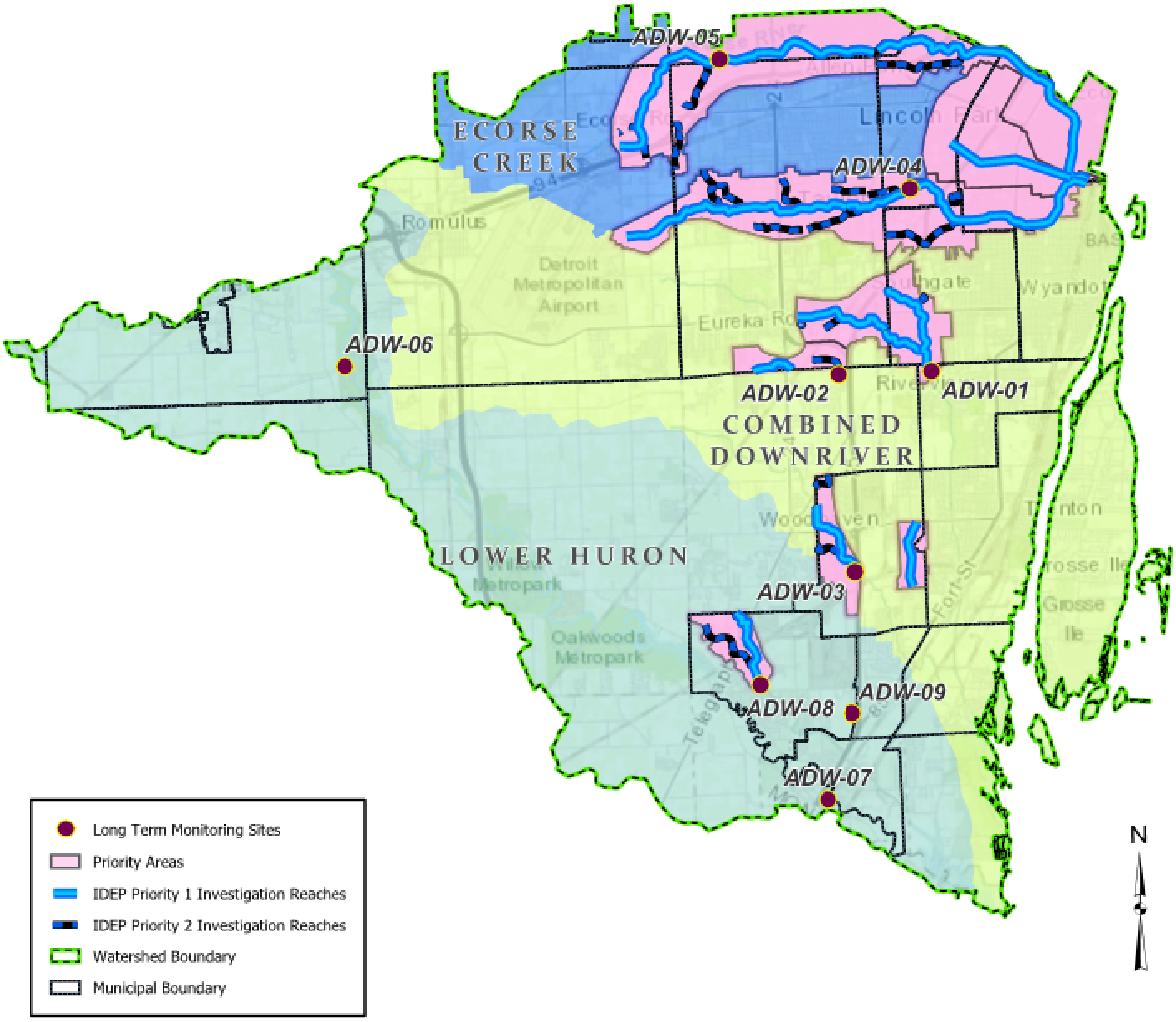

Figure 2-1 Priority IDEP Work Areas Map

In order to build understanding of the Priority IDEP Work Areas identified by the ADW Technical Committee, the development of an ADW GIS database and outfalls and stormwater discharge points to Waters of the State mapping was initiated. In order to assess existing data, Wayne County collected stormwater GIS datasets from contributing municipalities (Table 2-1). Some municipalities have extensive stormwater systems and developed GIS data, while others have no stormwater related GIS data available.

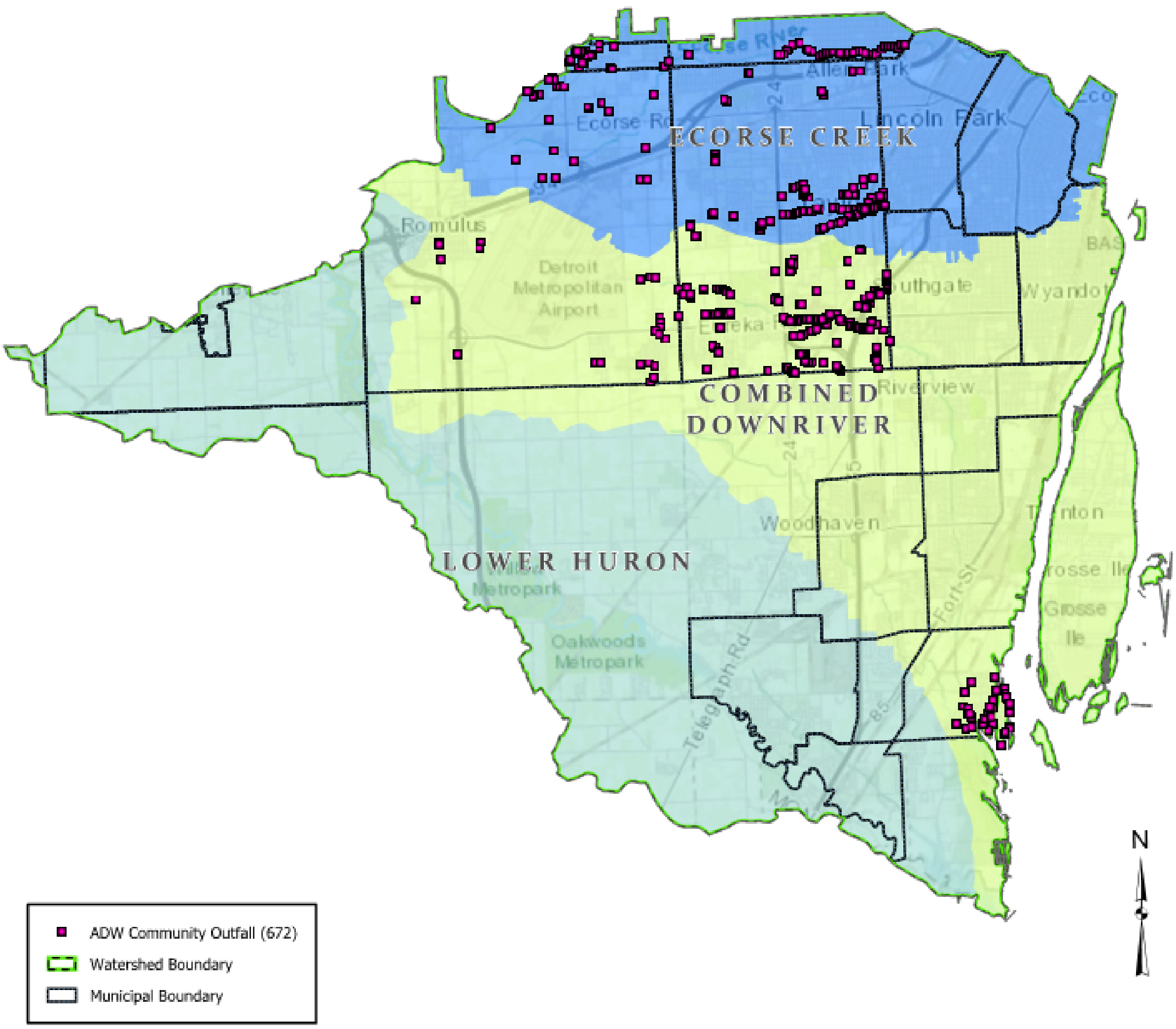

Figure 2-2 ADW Community Submitted Stormwater GIS Dataset

Referencing available stormwater data from municipalities, the Priority IDEP Work Areas, as well remote sensing to identify locations within these priority areas that lack stormwater data and have high potential for stormwater discharge, field survey of drains and streams was conducted to locate outfalls and stormwater discharge points within the ADW municipalities. During field inspections, outfalls were structurally evaluated, and locations were surveyed using GPS equipment capable of sub-foot accuracy. Attributes were collected at individual structures such as diameter, material, condition, presence of erosion, and repair recommendations. Outfalls were also visually inspected for signs of a potential illicit discharge during the evaluation. Via work completed under this SWMP, the ADW conducted outfall investigations along approximately 40 miles of ADW drainage courses and waterways locating an additional 265 discharge locations (previously unmapped) across ADW streams and drains (*Figure 2-3*).

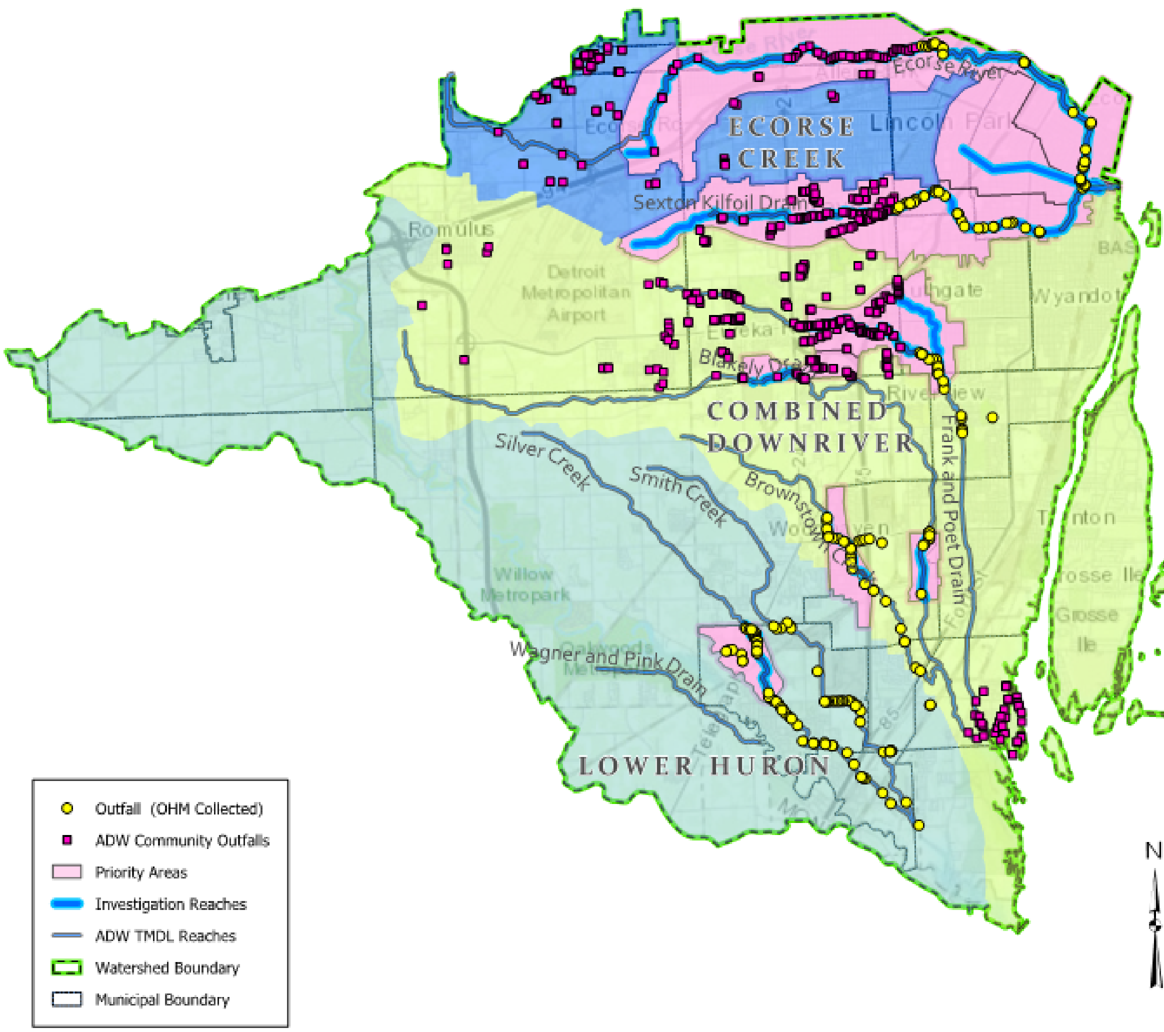

Figure 2-3 ADW Outfall Investigation Areas

After identifying areas where an outfall investigation was needed and then performing field evaluations, the spatial data was used to further categorize collected outfall GIS points as municipal- or agency-owned or privately-owned. Of the 265 discharge structures that were found, 30 were determined to be private while 235 were determined to be municipal- or agency-owned (*Table 2-1*).

Table 2-1 Outfall Discharge Structure Summary by ADW Community from provided data

Current ADW Members	Provided Outfall Locations	Located Outfalls		Grand Total (Provided + Located)
		Private	Municipal	
Allen Park	0	1	37	38
Belleville	0	0	0	0
Dearborn Heights	56	0	0	56
Ecorse	0	0	2	2
Flat Rock	0	17	65	82
Gibraltar	37	0	2	39
Grosse Ile Township	0	0	0	0
Inkster	0	0	0	0
Lincoln Park	0	1	39	40
Melvindale	0	0	3	3
Riverview	0	2	9	11
Rockwood	0	4	17	21
Romulus	90	0	0	90
Southgate	0	0	16	16
Sumpter Township	0	0	0	0
Taylor	467	0	0	467
Van Buren Township	336	0	0	336
Wayne County	0	0	0	0
Westland	48	0	0	0
Woodhaven	0	3	41	44
Woodhaven-Brownstown School District	37	2	0	39
Wyandotte	0	0	4	4
Total	**1,015**	**30**	**235**	**1,280**

Under this SWMP effort, newly collected outfall data was edited and collated with existing community submitted datasets to create the most up-to-date GIS database in one repository. Community specific databases were also created and disseminated to ADW municipalities for incorporation into municipal

GIS. An overall map depicting all existing and newly located stormwater outfalls was created and made available to all ADW member municipalities, shown on *Figure 2-3*.

A collaborative IDEP was developed by the ADW Technical Committee, reviewed by the ADW membership and approved by EGLE in July 2019. The collaborative IDEP presents the watershed-wide priority action plan that is being pursued to effectively and efficiently identify and eliminate illicit discharges within the ADW. The plan consists of existing and planned activities and strategies, anticipated through the duration of the new permits, that ADW members are individually and collectively implementing to identify and eliminate illicit discharges and reduce pathogen levels in the Ecorse Creek, Combined Downriver, and Lower Huron River watersheds. The collaborative plan builds on the collective knowledge of the ADW members and facilitation team. Specifically, the plan starts by evaluating the status and trends of surface waters in the ADW to identify priorities, followed by investigation and remediation of problem areas. Such a strategy focuses resources on the most likely sources of pollution or illicit discharge, rather than on areas with low likelihood of problems.

In addition, SOPs and forms were developed and included in the Collaborative IDEP. These SOPs and forms can be utilized by ADW members and include:

- Pollution Complaint Tracking Form
- Routine Fieldwork Log
- Dye Testing Form
- Outfall Screening Form
- Corrective Action Notification Sample Letter
- Outfall Screening Procedure
- Advanced Investigation Procedure for Identifying Sources of Suspicious Discharges

In order to evaluate effectiveness of the IDEP, records for each of the IDEP activities identified in the Collaborative IDEP will be kept and a biennial summary report will document the output of each activity as well as the summary number of illicit discharges identified and eliminated. Overall effectiveness will be based on the long-term natural resource response as determined through the progress evaluation monitoring described below.

ADW ongoing responsibilities include:

- Conducting instream monitoring for select indicators to determine the effectiveness of IDEP efforts. The monitoring information will be evaluated and assessed during future priority area discussions.
- Continue watershed-wide monitoring for select parameters to assess the general health of the rivers.

The complete ADW Collaborative IDEP plan (approved by EGLE July 2019) can be found in Appendix A.

2.2 Post-Construction Stormwater Standards

The National Pollutant Discharge Elimination System (NPDES) permit program helps address water pollution by regulating point sources that discharge pollutants to Waters of the State. Wayne County, along with several ADW municipalities have a municipal separate storm sewer system permit through the NPDES program. Substantial regulatory changes are proposed for the MS4 permit program that will affect municipalities and Wayne County for new development and redevelopment projects. These changes offer an opportunity to streamline regulations across municipal boundaries to ensure that important considerations for economic development and efficient implementation are reflected in the new standards. This section summarizes the regional coordination efforts to revise post-construction stormwater management standards.

A Regional Stormwater Standards Coordination Committee ("Committee") was formed and includes representatives from Wayne (including a representative of the ADW Facilitation Team), Oakland, Macomb and Livingston Counties. The Committee worked collaboratively over an approximately 18 month period in 2018 and 2019 to develop MS4 post-construction stormwater standards for water quality and channel protection that require new and redevelopment projects to manage site stormwater runoff for the MS4 permit areas. The Committee meets monthly to discuss regional stormwater standards and coordination with Michigan Department of Environment, Great Lakes and Energy (EGLE). The goals of the Committee included developing a set of stormwater standards that:

1. Are straight-forward and easy to implement for both the development community and review agency
2. Improve water quality and protect stream channels
3. Provide a level playing field for development projects across municipal and County borders
4. Address current watershed issues with stream flashiness and increased stormwater runoff
5. Meet or improve upon the MS4 Program goals
6. Reduce the chances that the development community can misinterpret or misuse the standards

The Committee represents 40% of the entire population of Michigan in less than three percent of the total land area. As such, the Committee represents a significant portion of the state's regulated MS4 urbanized area, understands the need to protect and improve water quality, and has developed a proposed set of effective water quality and channel protection standards for development projects across the region.

All of the ADW municipalities are located (at least in part) in Wayne County. The County's stormwater ordinance applies to the following construction activities impacting stormwater runoff:

- Into or around new or existing road rights-of-way within the County's jurisdiction (including County roads)
- Into or around County drains or County property or County owned and operated storm sewer system
- From projects that are subject to the Subdivision Control Act and Mobile Home Commission Act

- Or water resources in watersheds or sub-watersheds included in the County's MS4 permit Certificate of Coverage

A majority of the ADW municipalities that have their own MS4 permit reference the County's stormwater standards to meet post-construction stormwater requirements of the MS4 program. Regional collaboration efforts proved to be worthwhile for Wayne County and the ADW municipalities as a set of simple, yet effective stormwater standards were developed that can be applied across the ADW. The proposed stormwater standards are discussed in detail below.

Channel Protection Volume Control (CPVC)

Channel Protection Volume Control is a new requirement under the National Pollutant Discharge Elimination System Municipal Separate Storm Sewer System Permit. Channel Protection Volume Control will focus on site runoff resulting from the 1-inch rainfall event. New and redeveloped sites, regardless of existing runoff volume potential, should be required, to the Maximum Extent Practicable (MEP), to capture and infiltrate the site runoff from the first inch of rainfall. Redevelopment projects represent a significant component of the site plan submittals within Wayne County municipalities (approximately 80% of site plans). Urbanized areas produce a significant amount of runoff, so requiring redevelopment sites to control the 1-inch rainfall event on their site helps reduce stormwater runoff and makes strides to protect infrastructure, improve water quality and reduce flooding conditions from what they are today.

The County has identified three components to determine the Maximum Extent Practicable (MEP) on a development or redevelopment site. Below is the list of considerations that factor into a MEP determination analysis that shall be completed by the applicant.

- In-situ infiltration capacity
  > 0.5 inch/hour = Yes, capacity to infiltrate
  < 0.5 but > 0.1 inch/hour = Yes, with an elevated underdrain
  < 0.1 inch/hour = No, not feasible to infiltrate the first 1-inch of rainfall
- Presence of high groundwater
- Wide-spread site soil contamination

Test pits and soil borings are required methods to verify infiltration capacity and groundwater levels.

Green infrastructure practices, including but not limited to bioretention, permeable surfaces, and tree wells are common green infrastructure approaches that can be used to meet channel and infrastructure protection volume control requirements. If green infrastructure-based infiltration is implemented on a site, a volume credit will be given towards the detention storage volume needed to meet rate and flood control requirements.

Channel Protection Rate Control (CPRC)

Channel Protection Rate Control consists of extended detention (i.e. 48-hour dewatering) of the site runoff volume generated from a 1.9-inch rainfall event. Under the proposed National Pollutant

Discharge Elimination System Municipal Separate Storm Sewer System Permit, extended detention will be required to be provided on all sites to the Maximum Extent Practicable.

1.9 inches was selected as the basis for determining the extended detention storage volume to satisfy the CPRC standard. This rainfall depth is based on the calculated 2-year, 24-hour infiltration volume on a greenfield site (i.e. meadow) with Type B soils (Curve Number = 58). In this scenario, about 1.9 inches of the 2.35 inches (2-year, 24-hour storm) is infiltrated and does not become runoff. Based on the analysis conducted by the Regional Stormwater Standards Committee, the 1.9 inches reflects a maximum existing condition infiltration volume for potential sites in the Regional Stormwater Standards Committee area. Requiring this storage volume for all sites would guarantee that the 2-year, 24-hour peak flow rate would be maintained or reduced in all scenarios, which meets the MS4 program minimum requirements for new development sites.

EGLE Coordination

The Committee submitted the above channel protection volume control and rate control standards to EGLE in November 2018 for review and approval. For the past year, a substantial effort has gone into various iterations with EGLE and detailed hydrologic calculations and analyses to support the proposed standards. As of the date of this report, EGLE staff has not approved the proposed standards for the entire region but has indicated the approach is a viable alternative and that these volume and rate control levels/standards are approvable for at least Wayne and Macomb Counties.

Stakeholder and public outreach were conducted in summer and fall 2019. This effort included an ADW municipality update and input session along with a county-wide stormwater update meeting. During both outreach activities, feedback was gathered on the draft stormwater standards which was taken into consideration during the development of the proposed stormwater standards presented in this SWMP. Additional ADW specific and county-wide updates will continue through the remainder of 2019 and into 2020 when the standards are intended to be codified.

2.3 Pollution Prevention/Good Housekeeping

An inventory of ADW member owned municipal facilities was performed. For each of their facilities, ADW members completed a form identifying the types of stormwater controls at the site, and the pollutants stored at the site. The form was developed to aid in determining which facilities fell under the guidelines for high, medium, and low priority facilities. Each facility was evaluated based on the following criteria:

1. Amount of urban pollutants stored at the site (i.e. sediment, nutrients, metals, hydrocarbons, pesticides, fertilizers, herbicides, chlorides, trash, bacteria, or other site-specific pollutants)
2. Identification of improperly stored materials
3. Potential for polluting activities to be conducted outside (i.e. vehicle washing)
4. Proximity to waterbodies
5. Poor housekeeping practices
6. Discharge of pollutants of concern to impaired waters

Based on these criteria, the potential for each facility to discharge pollutants to the Waters of the State were rated high, medium, or low. Overall, a total of 200 sites were categorized. Of these 200 sites, 20 were categorized as high priority, 27 were considered medium priority and the remaining were categorized as low priority. For "low" priority facilities where no assessment factors are present, appropriate BMPs (such as catch basin cleaning and street sweeping) should be performed as indicated in the applicable procedures for these activities. For "medium" priority facilities, appropriate BMPs are considered based on the assessment factors present to prevent or minimize the potential for pollutants from entering surface Waters of the State. "High" priority facilities have specific procedures in place in order to ensure that proper steps are followed in order to minimize and prevent the discharge of pollutants to stormwater from the site. Therefore, if a Standard Operating Procedure (SOP) for a high priority facility did not already exist, one was developed.

In 2017, site visits were made to each high priority facility. At each site, the following assessments were made:

- Number and type of stormwater controls on the site
- List of significant materials stored on-site that could pollute stormwater; the description of the handling and storage requirements for each significant material; and the potential to discharge the significant material
- Routine and comprehensive inspection schedule
- Methods for training employees on good housekeeping practices

SOPs for 15 facilities were developed as part of this task.

Each individual MS4 is ultimately responsible for their own catch basin cleaning and street sweeping. Due to differences in budget, staffing, and equipment, each ADW member determined their individual catch basin and street sweeping strategies. However, catch basin cleaning and street sweeping guidance was developed and provided to ADW members, who could then use these templates to cater their strategy for their own community based on need and resources available. These strategies were incorporated in ADW members' MS4 permit application and include prioritization of catch basins and streets for cleaning, inspection, maintenance and cleaning procedures, as well as disposal of collected material.

Guidance on employee training was developed and provided to ADW members to incorporate into their MS4 permit application. The employee training guidance outlined which employees should be trained, a description of the type of training, and the frequency as suggested below.

Employees Trained	Training Description and Frequency
New DPW/DPS Employees	Upon hire, employees should: • View the Municipal Stormwater Pollution Prevention Storm Watch training video.

	• Read and become familiar with the City/Village/Township's SOPs. • Participate in a job shadow program where new staff is paired with an experienced staff member for 30 days.
All DPW/DPS Field Employees	Annually, employees should: • View the Municipal Stormwater Pollution Prevention Storm Watch training video. • Review proper materials storage and handling. • Review good housekeeping and pollution prevention practices. • Review examples of illicit discharges to the storm sewer system • Review City/Village/Township Spill Response Procedures
Key staff	Once per permit cycle: • Attendance of key staff to relevant training workshops by the Alliance of Downriver Watersheds, Wayne County, SEMCOG, EGLE, or others, when available.

Contractors were also addressed, and the developed guidance suggested that the contractors hired by the ADW members to perform municipal operations that potentially impact stormwater are required to follow appropriate pollution prevention BMPs indicated in the ADW member's contract language. In cases where an outside contractor is hired to perform services that could impact stormwater, the contracting company will be required to follow appropriate pollution prevention BMPs. All work performed by outside contractors are monitored by ADW member staff through daily observation to ensure quality of work, adherence to the specified contract language, and to ensure that potential impacts to stormwater are minimized.

The ultimate goal for ADW members is to minimize stormwater pollution from their own facilities. As part of the guidance/template that was developed to assist ADW members with their Pollution Prevention/Good housekeeping procedures, measurable goals for various Pollution Prevention/Good housekeeping tasks were suggested:

> Measurable Goals – To demonstrate the effectiveness of these procedures, the following metrics will be tracked by ADW members for reporting purposes.
>
> - Number of catch basins repaired/cleaned
> - Summary of frequency of street sweeping, or total miles swept
> - Number of inspections of stormwater controls as identified above
>   - Number of problems identified
>   - Number of problems resolved
> - Number of new employees trained

- Number of existing field employees trained
- Number of key staff trained
- Number of stormwater pollution related incidents pertaining to activities or work performed by the contractor.
- Number of incidents where the ADW member required corrective action by the contractor

As mentioned, a guidance document/template was developed and provided to ADW members to assist with meeting the Pollution Prevention/Good Housekeeping requirements of the MS4 permit application. Please see Appendix B for an example of this template. By utilizing a common template, ADW members should have similar approaches to the required tasks. In addition, permit documents should follow a similar format, creating more cohesion for the ADW. The main sections of the template are:

- Purpose
- Facility Assessment and Prioritization
- Updates and Priority Revision
- Municipal Inventory and Assessment
- Site Specific SOP for High Priority Sites
- Catch Basin Maintenance Priority
- Catch Basin Inspection, Maintenance, and Cleaning
- Disposal of Collected Material
- Street Sweeping Prioritization
- Other Structural Stormwater Controls
- New Applicant Owned Facilities
- Certified Pesticide Applicator
- Employee Training
- Contractor Requirements and Oversight
- Process for Revision

2.4 Collaborative TMDL Implementation Plan

Total maximum daily loads (TMDLs) have been established for *E. coli* (excessive bacteria) and biota (excessive sediment) for the below listed waterbodies within the ADW watershed:

Biota (Excessive Sediment)	***E. coli* (Excessive Bacteria)**
Ecorse Creek	Ecorse Creek
Brownstown Creek and Blakely Drain (Marsh Creek)	Detroit River
Frank and Poet Drain	Wagner-Pink Drain

The ADW municipalities have put forth substantial effort and resources to reduce the sources of impairments of these listed TMDLs. The suite of projects and programs already put in place contributed to significant impairment reduction, as evidenced by data collected through on-going monitoring, which is discussed in detail in Section 4 of this SWMP. A collection of activities and best management practices (BMPs) intended to further reduce the sources of impairments was developed as part of the collaborative MS4 permit requirement for a TMDL Implementation Plan, funded through this SAW program. The full collaborative TMDL implementation plan is in Appendix C. A subset of the activities and BMPs was further developed through this SAW program and includes a three-pronged approach summarized below.

First, a field assessment of current stormwater detention/retention structures was completed to ensure existing infrastructure functions as intended. Any deficiencies were recorded in a GIS database and recommended corrections are included. Second, opportunities to implement green stormwater infrastructure on municipal properties were identified in collaboration with each community. Concept plans and cost opinions were developed for each proposed practice and are included in section 2.4.2 of this report. Third, priority BMP projects were identified in each subwatershed. These are projects that will require significant collaboration and funding to complete, but that will provide far-reaching water quality benefits by addressing known problem areas. Concept plans and cost opinions for these projects were developed and are included in section 2.4.3 of this report.

2.4.1 Stormwater BMP Field Assessment

In order to develop an understanding of the current condition of detention/retention structures across the ADW, 218 basins in seventeen ADW municipalities were assessed by performing field investigations and recording data associated with various criteria of each BMP. The goal of these assessments was to develop an understanding of overall condition relative to the original design and intent of the stormwater structure and apply a rating system in order to prioritize maintenance activities. An inventory protocol for field data collection was developed to evaluate important attributes of each basin. These attributes were scored on a numerical scale and further processed using a weighted scoring methodology, which provided an overall rating for each detention basin. The overall ratings were then classified into three categories: high, moderate, and low priority which were then used to rank the basins based on the severity of their need for maintenance in the watershed.

In order to achieve the goals of the field assessments, the following specific objectives were developed:

- Determine if detention basins were achieving full hydraulic functionality, meaning the inlets and outlets were functioning correctly and holding capacity was not impacted by debris, plants, or sediment
- Evaluate shoreline (water line and embankment) conditions of wet basins and identify and quantify slumping and erosion
- Evaluate bottom of dry detention basins and identify poor grading conditions, siltation, and lack of vegetation
- Evaluate condition of overall vegetation, including vegetative cover, quality of maintenance, impact on hydraulic characteristics, and occurrence and percent coverage of invasive species
- Evaluate debris management of basins, including location, distribution, buildup, and impact on hydraulic functionality

Other information related to each detention basin was recorded or verified during the course of the field data collection process. Basin ownership, type of development in which the basin exists, whether the basin was used for a source for irrigation, and the presence of aeration systems and perimeter fences were all recorded as applicable. Comments on occurrence of any other notable characteristics not included above were recorded (e.g. presence of koi fish, aqueous foam, recent invasive species treatment, detrimental animal impacts, etc.). Photographic documentation was also gathered during field data collection where poor conditions were noted. Each basin outlet and inlet was individually evaluated and conditions were then included in the overall weighted methodology for rating basins.

The methodology employed for rating detention basin attributes is based upon overall impact on hydraulic functionality while being objective, effective, easily applicable, and understandable. Detention basin attributes were scored on a numerical scale by field staff and recorded in the ADW Collector GIS map.

The following attributes were assigned scores during field data collection and used in the subsequent scoring methodology:

- Wet Shoreline
- Dry Basin Bottom Condition
- Vegetation Condition
- Debris Management
- Outlet Overall Condition
- Inlet Overall Condition

Each attribute of the 218 detention basins and associated outlets and inlets were evaluated and rated on a numerical scale from one to five, with a score of one denoting "new condition", or lowest priority, and five denoting "failed condition" or highest priority. Rating scores of two (good), three (fair), and four (poor) denote conditions of intermediate severity and reduction in functionality. Note that each individual attribute listed above was rated using the 1-5 scoring criteria in the field, each basin overall was rated 1-5 in the field, and only later were the attribute scores used to arrive at an "overall basin score" of 1-5 using a weighted scoring system. This stepwise approach allowed for field staff to make a preliminary determination of overall condition in the field and a processed final overall rating to be determined. These values were then compared and contrasted and data reviewed in order to resolve discrepancy and arrive at an accurate final condition rating.

After determination of numerical rating values during field inspections, each one of the individual attribute categories was assigned a weighted value. Though each characteristic is important to overall hydraulic functionality, some are more significant than others. Based on the significance of outlet functionality on the overall efficacy of detention basin operation, the rating of Outlet Overall Condition was assigned the highest value (0.40 multiplier), and the remaining attributes were assigned lower values (0.15 multiplier). The resulting scores for each attribute were then summed to provide the overall weighted basin rating. Of the six possible attributes listed above, only five were scored for each individual basin, as either wet basins or dry basins were only rated for either shoreline condition (wet) or basin bottom (dry).

Table 2-2 shows the weighting factors applied to the rated attributes.

Table 2-2 Criteria for Attribute Evaluation

Attribute Category	Scoring Criteria	Weighting Factor
Shoreline Condition (Wet)	• Presence, pattern, and degree of erosion • Presence, pattern, and degree of bank slumping	0.15
Basin Bottom (Dry)	• Occurrence of siltation • Grade quality • Presence and quality of vegetation • Presence of standing water	0.15
Vegetation	• Quality and distribution of vegetation • Occurrence of nuisance vegetation • Quality of vegetation maintenance • Occurrence and percentage of invasive species	0.15
Debris Management	• Debris distribution • Degree of debris buildup • Degree of impact on basin functionality	0.15
Outlets	• Functionality • Required maintenance • Erosion, sedimentation, and structural damage • Hydraulic conditions meeting design intent	0.40
Inlets	• Functionality • Required maintenance • Erosion, sedimentation, and structural damage • Hydraulic conditions meeting design intent	0.15

Weighted overall scores for the 218 detention basins were divided into three classifications (high, medium and low) based on prioritization of maintenance and repair. Detention basins rated higher than 3 overall were determined to be of the highest priority. Highest priority describes detention basins that were considered failing hydraulically or in poor condition and in need of immediate maintenance or repair to restore hydraulic functionality. Moderate priority describes detention basins in fair to good condition in need of minor maintenance or repair, and includes basins scored between 2 and 3 overall. Lowest priority describes those detention basins in new, well graded condition with full healthy vegetation and full hydraulic functionality, and includes basins scored less than 2 overall.

Results

Results for the classification of the 218 detention basins inspected for this SWMP have been summarized and are explained below. For detailed information about each individual basin, please see Appendix D.

The field data collection of the 218 detention basins in the ADW watershed and subsequent scoring and classification returned results in all three of the priority classes. The low priority classification contained the greatest total number of detention basins, 114, and represented 52% of the total. The moderate priority classification held a total of 93 detention basins, representing 43% percent of the total, while the 11 basins fell into the highest priority classification, or 5% of all detention basins. Forty-eight basins could not be fully assessed due to locked fences or other issues with working on private property but were still given a score based on the portion of the basin that was assessed. The priority classifications with total number of detention basins in each and the percentage it represents are shown in Table 2-3.

Table 2-3 Priority Ranking of Basins

Priority	Weighted Score	Number of Basins	Percentage of Total
Highest	>3	11	5%
Moderate	2-3	93	43%
Lowest	<2	114	52%
Total		**218**	**100%**

Inlets and outlets for basins were also rated on a scale of one to five, with one being new condition, and five being failing hydraulically and in need of repair or maintenance to restore functionality.

Table 2-4 summarizes the ratings of each individual attribute.

A total of 241 inlets were inspected as some detention basins had more than one inlet. Twenty-five (25) of the 241 inlets could not be accurately assessed due to submersion, fences, or other obstructions and were rated as Unknown.

A total of 226 outlets were inspected as some detention basins had more than one outlet. Six (6) of the 226 outlets could not be accurately assessed due to submersion, fences, or other obstructions and were rated as Unknown. See Appendix D for the full field inspection reports on all basins, inlets, and outlets.

All 218 basins were also rated based on their vegetation condition. Vegetation condition can impact the hydraulic functionality of a detention basin in several ways. Lack of vegetation can allow for shoreline erosion which can contribute to sedimentation, impact inlet and outlet function, and even compromise the structural integrity of inlets, outlets, and other structures. Excessive vegetation, especially overgrown emergent invasive species like *Phragmites* or cattail, can significantly decrease the storage capacity of a basin as well as hydraulic conductivity. Forty-seven basins were not fully inspected for vegetation condition due to fences or other visual obstructions but were still given a score based on the areas that were able to be inspected.

Table 2-4 Detention Basin Attribute Rating Summary

	Number of Basins with Rating					
Attribute	Failing (5 Rating)	Poor (4 Rating)	Moderate (3 Rating)	Good (2 Rating)	New (1 Rating)	Total Inspected
Inlet	24	18	38	90	46	**241**
Outlet	16	11	20	126	47	**226**
Vegetation	29	34	53	84	19	**218**

Observations and Recommendations

Structural Deficiencies

Of the 218 basins inspected, 15% had structural deficiencies of some kind. The most common structural deficiencies were inlets and outlets with detached or missing grates, misaligned outlets or standpipes, and inlets or outlets with loose or detached end sections. Other structural deficiencies were related to poor basin design or construction, such as inlets submerged due to standpipes installed too far above the water level of the basin. For recommendations on fixing these structural issues, please see Appendix E regarding basin maintenance.

Figure 2-4 Detention Basin Maintenance Examples (Left) detached inlet end section from basin TY-03S10E27SWNW-2, (right) crooked standpipe from basin SG-03S10E35SWNW-1.

Vegetation Deficiencies

Of the 218 basins inspected, 54 had severe issues relating to vegetation. Most basins with vegetation deficiencies suffered from overgrowth of invasive species, either Phragmites or narrow-leaf or hybrid cattail. Some were so overgrown that inlets and outlets could not be found, and in some cases, basins could not be reliably inspected at all. Often, this overgrowth clogs inlets and outlets, affecting the hydraulic functionality of the basin. These species grow large rhizomatic masses which may reduce the hydraulic capacity of the basins in which they grow. Occasionally, basins suffer from a lack of vegetation, which can allow for increased erosion and sedimentation and is typically caused by improper rates of infiltration. Most basins have some instance of invasive species, and the general recommendation is these be treated as quickly as possible to avoid further and prolonged impact on functionality. For specific recommendations on how to manage detention basin vegetation, please see Appendix E.

Figure 2-5 Basin Maintenance Vegetation Examples (Left) basin TY-03S10E28NWNE-3 is overgrown with phragmites. (Right) Vegetation in new basin FR-04S10E32NENE-1 has failed to establish, resulting in erosion and sedimentationFR-04S10E32NENE-1

Erosion, Sedimentation, and Debris

Of the 218 basins inspected 68 had enough debris or sedimentation to affect inlets, outlets, or overall basin hydraulic capacity. Generally, debris fell into two categories: trash or vegetative matter. Both have been found clogging inlets and outlets. This issue is common, and is usually fixed by removal of debris, although in some cases, more action is needed to prevent recurring problems. Some sedimentation in a detention basin is normal, as basins are designed to slow water flow and reduce sediment and nutrient loads in the stormwater system. However, when erosion occurs, the process of sedimentation can occur more quickly and begin to affect basin hydraulic capacity. This erosion has many possible causes, including lack of appropriate shoreline vegetation, inadequate sediment capacity in the basin design, or basin maintenance issues leading to fluctuating water levels. Of the basins inspected, 8% are showing excessive signs of erosion and are in need of shoreline stabilization. For recommendations on how to keep debris out of detention basins and to remedy erosion and sedimentation issues, see Appendix E.

Figure 2-6 Sediment and Erosion issues (Left) Excessive sediment deposition at basin inlet BV-03S08E27NENW-1. (Right) Basin RM-03S09E09NWNE-1 has devastating shoreline erosion near its largest inlet, and the water from this inlet has eroded away the basin's spillway (not pictured).

Basin Inspection & Maintenance

As communities grow, so does the need to manage stormwater runoff effectively. Increased impervious surface within these communities results in greater stormwater runoff which overwhelms sewers, damages nearby streams and rivers through erosion and pollution, and can result in flooding if not properly addressed. Developing and properly implementing stormwater mitigation practices can save communities thousands of dollars in costly repairs to infrastructure and the environment. A practical and widely used method for controlling stormwater runoff is the implementation of Retention and Detention Basins. These basins are designed to divert stormwater runoff from storm sewers, streams and rivers, and release it at a rate that prevents flooding and erosion.

The USEPA recommends that Detention/Retention Basins should be inspected on a monthly basis for minor items, and annually for structural components. However, many communities are unable to inspect all of their basins, especially as new basins are added as communities grow. In such cases, a less frequent full inspection can be supplemented with a routine inspection conducted by a property owner or contractor.

Table 2-5 provides a recommended inspection frequency timeline with suggested maintenance items to address impairments to functionality. The inspection frequency may be refined if the maintenance history of the practice has been supplemented with routine maintenance and mowing by a property owner or maintenance contractor. A log should be kept for all inspection and maintenance work performed for each basin for ease of reference.

Table 2-5 Recommended Inspection Frequency

Item	Inspection Items	Frequency	Maintenance Items
1	Check for invasive wetland plants	One time - After First Year	Remove invasive plants following EGLE BMPs
2	Inspect low flow orifices and other pipes for clogging. Check for floating debris, undesirable vegetation. Investigate the shoreline for erosion	Monthly/Quarterly or After Major Storms (>1")	Mowing – minimum Spring and Fall. Remove debris. Repair undercut, eroded, and bare soil areas.
3	Inspect basins for mosquito production	Multiple per Hot/Warm Season	Install aerator.
4	Identify invasive plants. Ensure mechanical components are functional.	Semi-annual to annual	Setup a trash and debris clean-up day. Remove invasive plants. Repair broken mechanical components if needed
5	Complete all routine inspection items above. Inspect riser, barrel, and embankment for damage. Inspect all pipes.	Every 1 to 3 years	Pipe and Riser Repair. Complete forebay maintenance and sediment removal when needed Monitor sediment deposition in facility and forebay.
6	Monitor sediment deposition in facility and forebay.	2-7 years	Complete forebay maintenance and sediment removal when needed.
7	Remote television inspection of reverse slope pipes, underdrains, and other hard to access piping	5-25 years	Sediment removal from main basin. Pipe replacement if needed

While all inspection and maintenance items are important, there are some maintenance concerns that pose an immediate threat to safety. In most cases, design elements of the Detention/Retention Basin that would normally prevent public access are missing or damaged. Examples include missing manhole covers or trash racks, missing or damaged fencing, or a missing or damaged grate at a large inlet or outlet pipe. When an inspector believes a basin poses a threat to the safety of the community immediate action should be taken to resolve the problem. Detailed maintenance and inspection activities associated with particular items are included in the full detention basin inspection report in Appendix D.

Figure 2-7. (Left) Detention Basin with invasive vegetation; (Right) Dislodged end section with severe erosion

2.4.2 ADW Municipal Property Green Stormwater Infrastructure Planning

Under this task of the SAW grant, the Alliance of Downriver Watersheds identified nineteen conceptual green stormwater infrastructure opportunities for ADW maintenance facilities, municipal park lands, and open spaces. Concept drawings sufficient for preparing cost opinions were prepared for each of these sites. The site selection process began with soliciting suggestions from municipalities for sites where green stormwater infrastructure would be most feasible and effective. A desktop review of possible sites for each municipality was then conducted. Based on this desktop review, three sites were chosen for each municipality and were visited by field staff to further investigate the feasibility of green stormwater infrastructure at each location. Based on the field investigations, sites were chosen based on runoff volume needing treatment, probable practice cost, presence of existing infrastructure, and the preference for practices in municipal parks listed in the SAW Grant application. Once final sites were chosen, potential green stormwater infrastructure practices were evaluated for applicability at each site.

Descriptions of each green stormwater infrastructure practice follow.

Permeable pavement (PP) can take several forms such as pervious asphalt, pervious concrete, or permeable paver blocks with open joints. These systems are typically comprised of a porous pavement surface course, underlain by a stone filled storage bed, underlain by geotextile placed on native ground material. The intent of the permeable pavement is to simply act as a means for transferring runoff from the pavement surface to the underlying stone storage bed. The underlying stone filled bed provides temporary storage for peak rate control and promotes infiltration.

Rain Gardens and Bioretention (RG) are generally considered to be interchangeable. These practices consist of a shallow surface depression which is planted with specially selected native vegetation to treat and capture surface runoff. The underlying soil layer can be amended with compost and sand to increase its water absorbing capabilities and improve plant growth. Evaporation and root uptake also help to manage the water entering the practice. Each rain garden area should include an overflow device to safely pass large storms as well as an underdrain to provide system redundancy.

Bioswales (BS) are open channel linear conveyance systems that use soil filter media to increase water intake at the soil surface, resulting in improved water quality, reduced runoff volume and attenuated peak runoff rates for small storms while also safely conveying flows greater than the infiltration capacity.

Sizing of the green stormwater infrastructure practices were designed to maximize the runoff volume treated at each site while minimizing the cost of the practice per gallon of runoff treated. Practice cross-sections are estimated to treat the runoff generated from a 1" storm event and the layers are sized to drain the surface within 24 hours and the entire cross section within 72 hours. For some sites the total treated volumes computed are higher than the runoff volume, which assumes that these practices would be able to handle larger storm events. Further, soil types and infiltration rates vary across the watershed, which affects how much water a practice can infiltrate. As such, cross sections at individual sites differ in soil and aggregate layer depth.

The final site recommendations are summarized in Table 2-6. Further details, including site plans for each location and cost opinions are included in Appendix D.

Table 2-6 Municipal Property Green Stormwater Infrastructure Summary

ADW	Site Location	Practice Type	Total Practice Area (ft^2)	Total Runoff Vol* (gal)	Total Treated Vol (gal)	Cost Opinion for Practice**	$/Gal Treated
Allen Park	Public Library	RG	1,040	8,925	7,909	$23,058	$2.92
Belleville	Veterans Memorial in Horizon Park	PP	1,050	5,730	4,712	$24,221	$5.14
Dearborn Heights	Eton Senior Center	BS, PP	6,200	5,294	3,970	$122,250	$30.79
Ecorse	John D. Dingell Park	RG	1,219	6,042	5,471	$16,919	$3.09
Flat Rock	Public Library	RG	4,700	28,469	21,094	$50,332	$2.40
Gibraltar	Community Center	RG, PP	5,450	23,982	24,460	$86,878	$3.55
Grosse Isle Twp.	Fire Station	RG	2,460	16,164	18,707	$24,560	$1.31
Inkster	City Hall	RG, PP	3,550	21,245	15,932	$63,512	$3.99
Lincoln Park	Council Point Park	BS	5,500	48,913	47,311	$93,486	$1.98
Melvindale	Public Library	RG	500	4,869	4,301	$12,565	$2.92

ADW	Site Location	Practice Type	Total Practice Area (ft^2)	Total Runoff Vol* (gal)	Total Treated Vol (gal)	Cost Opinion for Practice**	$/Gal Treated
Riverview	Community Center	RG	3,850	19,552	19,507	$36,641	$1.88
Rockwood-1	Community Center	BS	7,091	32,000	32,000	$78,300	$2.46
Rockwood-2	Community Center	BS	13,891	56,000	60,000	$170,300	$2.85
Romulus	Oakbrook Dog Park	BS	700	6,965	7,069	$13,000	$1.88
Southgate A	Animal Control	RG	5,823	35,735	36,310	$72,487	$2.0
Southgate B	Animal Control	RG	5,712	29,234	35,615	$70,705	$1.99
Sumpter Twp.	Admin Bldg.	RG	1,900	19,322	22,030	$31,126	$1.41
Taylor	Heritage Park	BS	6,880	3,600	6,800	$153,000	$22.50
Van Buren Twp.	Police Station	RG, BS	4,007	18,705	26,960	$43,734	$1.62
Woodhaven	Civic Center Park	RG	7,087	26,469	37,111	$64,776	$1.75
Wyandotte	Beaver Park	RG	4,279	20,775	26,683	$42,705	$1.60
Westland	Fire Station 3	RG	1,000	3,314	5,738	$10,593	$1.85
*For 1-inch design storm event **Includes Engineering (15%) and Contingency (30%)							

2.4.3 Priority BMP Implementation Plan to Address TMDLs

In order to significantly reduce the pollutant sources and the threats to watershed health outlined in Section 1.4 of this document, concept level planning for priority BMP implementation at strategic locations has been included in this SWMP. In general, these threats begin with increased flows during precipitation events caused by increased areas of impervious surface within the watershed. Increase in volume is accompanied by an increase in flow velocity that can erode sediment from channel banks, creating unstable channel conditions, highly turbid water, and impaired habitat. High turbidity has been shown to adversely affect fish health by decreasing feeding efficiency and increasing disease, toxicity, and gill and tissue injury. Increased particle load in the water also means increased surface area available to bind with nutrients and microbes. Sediment and pollutants eventually settle on stream bed, where they bury pools and courser stream bed materials that serve as habitat for macroinvertebrates and juvenile fish. Channel widening also leads to shallower flow regimes during dry weather conditions which leads to higher water temperature and an associated decrease in dissolved oxygen, which further inhibits the ability of macroinvertebrates, fish, mollusks, and crustaceans to effectively utilize the habitat. Bacteria and algae present in stormwater flourish in warmer water temperatures and increased nutrient loads, creating potential public health threats. The conditions present as a result of these processes are reflected in the goals of the watershed management plans in all three watersheds, which include:

- Reduce flooding and stream flow variability
- Improve water quality
- Protect, enhance, and restore riparian and in-stream habitat
- Protect public health
- Reduce pathogen and nutrient loading
- Promote educated, informed, and involved watershed citizenry

To apply these goals to the Alliance of Downriver Watersheds, four locations were identified for nonpoint source TMDL reduction projects. The sites were selected to target areas within each ADW watershed that have the greatest potential for total maximum daily load (TMDL) reduction based on information provided by stakeholders such as Wayne County and the Friends of the Detroit River. Site selections also considered overall feasibility and potential for future grant funds. After identifying potential sites, desktop data review and field investigations were conducted in order to establish a preliminary baseline of conditions and potential for BMP implementation and TMDL reduction projects. Restoration concepts and opinions of probable cost for these projects were then developed The map in *Figure 2-8* shows the project site locations and Table 2-7 lists the proposed sites, the improvements recommended, and the overall opinions of probable cost for each project. Please see Appendix F for further background information on each of the concepts described below.

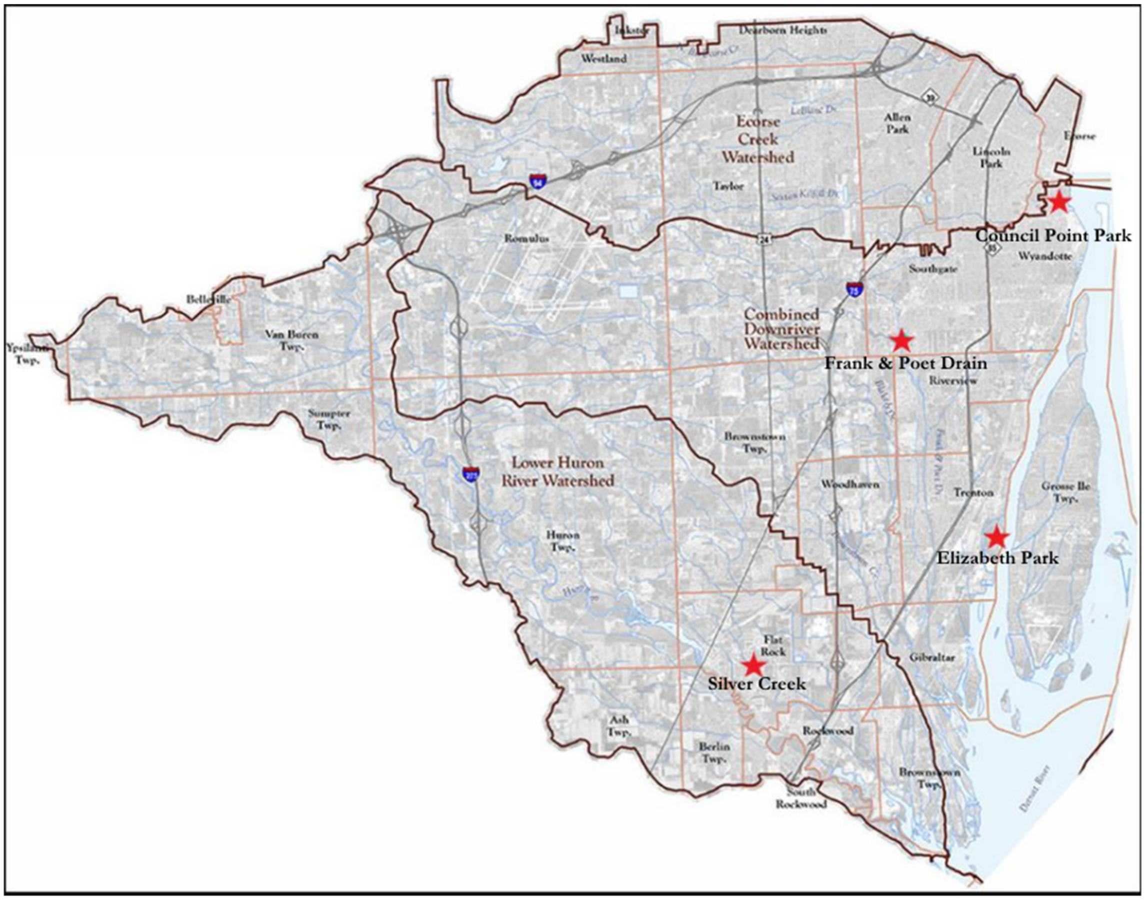

Figure 2-8. Selected Site Locations for Stormwater BMPs to Address total maximum daily load (TMDL). Listed north to south: Council Point Park, Frank & Poet Drain, Elizabeth Park, and Silver Creek

Treatment Types

There are many options available to help mitigate the damaging effects of urbanization on stream health. The feasibility of implementing these projects depends on many factors, including the amount of space available for restoration projects, land use, available funding, future maintenance needs, and property owner cooperation. Outlined below are restoration options recommended to address TMDL load reduction at the four project sites chosen.

Pavement Removal

Pavement removal is a simple and effective way to reduce potential TMDL loads within a watershed. Removing the impervious surface allows for stormwater interception and infiltration reducing the amount of water running directly into streams. It also reduces surface area for warming and pollutant and sediment build-up. This can result in higher dissolved oxygen content due to cooler temperatures and lower sediment and biota loads. This increase in water quality and decrease in sediment settling improves habitat for macroinvertebrates, fish, mollusks, and crustaceans, resulting in an increase in the diversity and population size of aquatic organisms.

Stream Restoration

Stream restoration projects reshape and stabilize banks to accommodate periods of high flow caused by increased impervious surface in the watershed while minimizing the damaging effects of a channel that is overly wide during periods of lower flow. This is often accomplished by creating a series of steps on either bank using coir block, geotextile socks, or engineered soil lifts. When flow is low, the narrow area between the lowest steps allows for sufficient depth to maintain lower stream temperatures and the dissolved oxygen high enough to support fish and macroinvertebrate populations. As flow increases, the steps are slowly covered in water, providing flood relief by providing space for the increased flow volume. The steps are protected from erosion by engineered construction materials such as geotextile fabric or coir block and by well-established plant communities. Native plant communities are chosen carefully based on site conditions and for characteristics that will further stabilize and protect the streambank. Deep root structures work to stabilize bank material and allow for increased groundwater recharge along root channels, reducing the amount of water that reaches the stream. Sturdy above-ground plant material creates flow resistance, slowing water velocity and thus further protecting downstream banks from erosion. Reduced flow velocity also allows sediment to settle out more readily, along with the nutrients and microbes that bind to them, potentially reducing nutrient and bacteria loading downstream. Abundant plant material along the engineered steps provides juvenile fish habitat and decreases nutrient loading and algae reproduction by competing for available nutrients. All of these improvements culminate in improved water quality, increased aquatic life, and more stable bank structure.

Wetland Restoration

Wetland restoration projects reconnect incised stream channels to historic floodplains or other low-lying areas. Once connected, these floodplains slowly fill with water during periods of increased flow, reducing the volume of water travelling in the stream channel. This reduction in volume helps protect the stream channel from erosion and thus downstream sedimentation. The water entering the floodplain is likely carrying sediment and pollutants from further upstream. Once the water enters the floodplain, its velocity is dramatically reduced, allowing the sediment and pollutants to settle out of the water. This reduction in velocity allows time for the water to percolate into the soil, recharging groundwater and protecting downstream banks from erosion. Plants chosen for floodplain restoration have deep roots that create channels to further encourage groundwater recharge. They also compete for nutrients present in the settled sediment, reducing algae and bacteria populations. Floodplains are also excellent habitat for a variety of aquatic and terrestrial organisms. These benefits can also be provided by engineered green infrastructure projects such as rain gardens or bioswales.

Reforestation

Reforestation projects primarily help reduce the volume of water that reaches streams, thus reducing the volume and velocity of water as well as its erosive potential. A single mature tree can soak up an average of 11,000 gallons of water during a single growing season. Additionally, the vast root systems of trees provide many deep channels for groundwater recharge. Trees also provide shade, which reduces the amount of heat absorbed by the ground, thus reducing the temperature of runoff and increasing the amount of dissolved oxygen present in the water, which improves water quality. Trees also absorb nutrients that might otherwise contribute to nutrient loading downstream, and can provide habitat for juvenile fish if they are in close proximity to the water.

Invasive Species Removal

Invasive plant species are damaging to native ecosystems for a variety of reasons, but they affect waterways negatively in four main ways. First, uncontrolled spread of invasive species can increase sedimentation in areas that were previously high quality habitat for juvenile fish or macroinvertebrates. This effectively buries the habitat in sediment and root growth may also disrupt or change the microbial community in the area. Second, high densities of invasive species produce a large amount of senescent material, which can dramatically decrease the amount of dissolved oxygen available in the waterway and may also contribute to burying aquatic habitat. Third, native organisms prefer not to use most invasive species as habitat. This means that as invasive plants out-compete native ones, the amount of habitat available continually decreases, reducing the diversity of aquatic and terrestrial flora and fauna in the area. Fourth, invasive species are often managed with herbicides. If left unchecked, invasive species will continue to take over more area along streambanks or in adjacent floodplains, thus increasing the risk of further degrading water quality with the chemical pollutants needed to control the invasive population. Because of these negative effects, invasive species removal is recommended in project areas that were found to contain them.

Project Areas

Project site selection and recommendations were informed by stakeholder input, past water quality data, watershed management plan goals, potential for TMDL reduction, field investigation, and possible grant eligibility. Table 2-7 below summarizes the proposed sites, the improvements recommended, and the overall cost opinion for each project. Please see the text below and attached maps for greater project concept detail and associated detailed cost opinions.

Table 2-7 Selected Site Locations for Stormwater BMPs to Address Total Maximum Daily Load (TMDL)

Site Location	Recommended Improvements	Cost Opinion
Council Point Park	-Streambank Restoration -Rain garden and Bioswale Practices -Invasive Species Removal	$4,750,000
Frank & Poet Drain	-Wetland Restoration -Streambank Restoration -Invasive Species Removal	$2,962,000

Site Location	Recommended Improvements	Cost Opinion
Elizabeth Park	-Forested Area Restoration -Pavement Removal -Streambank and Oxbow Restoration - Wet Prairie Creation	$1,195,000 (1 inch)* $1,465,000 (2 inch)*
Silver Creek	-Streambank Restoration - Wetland Restoration -Invasive Species Removal	$1,725,000

*Cost varies based on the size of trees chosen for installation.

Council Point Park

Council Point Park is a heavily used 27-acre park located along the banks of Ecorse Creek in the City of Lincoln Park. Recreation activities in the park include a 2-mile jogging track, two baseball diamonds, two soccer fields, a picnic pavilion, a playground, an inline hockey arena, and a restroom facility. Ecorse Creek in this area is deeply incised and typically experiences a highly variable flow regime. This instability results in sediment eroding from the streambanks and being transported downstream, impacting water quality and aquatic habitat. Water fills the incised banks during the spring wet season, but surface elevation typically drops dramatically and presents very little to no flow in summer. This mucky water has low dissolved oxygen and is problematic for macroinvertebrates living in the stream. The main restoration goals for Ecorse Creek, based on the ADW's TMDL Implementation plan, are a macroinvertebrate Procedure 51 score of at least -4 (or a rating of acceptable) and a mean annual wet weather total suspended solids (TSS) concentration of 80 mg/l or less. As part of this SAW Grant task, the ADW has identified three restoration techniques to help achieve these goals.

Streambank Restoration

The entire length of Ecorse Creek chosen for restoration (2,400 ft) has a Rosgen Modified BEHI method erosion score of Moderate. The higher the erosion score, the worse the condition of the streambank. For scores of Moderate combined with the stream depth onsite, restoration with soil lifts planted with live stakes is recommended ($650/ft). This method will lower the bank angle and will help restore flow in drier months which will provide increased oxygenation for macroinvertebrates, and slow flow using vegetation, which will reduce total suspended solids (TSS) by allowing sediment and other particulates to catch on plant material or settle out of the water column. This restoration plan accounts for restoring only the bank that is part of the park as the opposite bank is private property. Due to this fact, the unit cost for restoration can be halved ($325/ft).

Invasive Species Removal

Along the banks of Ecorse Creek in the project area, there is growth of invasive shrub species including buckthorn and honeysuckle. These growths cover approximately 160,000 ft^2 and are relatively inexpensive to treat (about $0.06/$ft^2$). Their removal and replacement with native plant species as part of the streambank restoration is recommended to improve wildlife habitat and further improve water quality by increasing infiltration and bank stabilization. Invasive species removal often takes multiple years of treatment and can be done as part of an invasive species management plan.

Large Scale Bioretention Practice Installation

Several large rain gardens are proposed for installation in Council Point Park due to the large area of impervious surface present in the park and surrounding areas. These gardens are designed to compliment the bioswales proposed around the parking lot in Council Point Park discussed in section 2.4.3 of this report. The bioretention practice will provide storage and infiltration of water coming from the parking lot and street, allowing sediment and pollutants to settle out of the water and promoting infiltration of stormwater runoff into the ground. This retention will reduce the volume of water that drains directly into Ecorse Creek, helping to reduce flashiness and erosion while improving water quality. Catch basins will be retrofit as needed to provide outlet structures for these rain gardens, and curb cuts and drain tile will be installed to direct flow into these practices where necessary. Rain garden costs were estimated assuming 6 inches of ponding, 12 inches of amended soil, and 6 inches of aggregate stone for additional storage. Assuming these parameters are true of the 353,600 ft² of rain garden area proposed, the cost for rain garden installation is approximately $9.00/ft². The rain garden sizes are approximate and may change during project design and engineering. These proposed bioretention practice areas represent overall potential for stormwater management through green infrastructure at Council Point Park and were conceptualized assuming that implementation may be for part or all, depending on further engineering analysis and available funds.

Council Point Park Cost Opinion Summary

Restoration Recommendation	Quantity	Unit	Cost Per	Cost Opinion
Streambank Restoration: Soil Lifts with Live Stakes	2,400	ft*	$325	$776,000
Invasive Species Removal: Shrubs	160,000	ft²	$0.06	$9,600
Bioretention: Includes 12 gardens of varying sizes	353,600	ft²	$9	$3,157,650
Drain Tile	750	ft	$30	$22,500
Curb Cuts	6	cuts	$50	$282
Total (rounded):				**$3,970,000**

* Streambank Restoration cost is for 2 banks. Because of this, if only one bank is being repaired, or different treatments are being proposed for different areas of bank, the total bank length being treated is divided by 2 to estimate cost.

Elizabeth Park Restoration Project

Elizabeth Park is a popular and frequently visited park located in the City of Trenton, along the Detroit River in the Combined Downriver watershed. The park is owned and maintained by Wayne County and is home to a marina on the southern end of the park. The interior of the park contains hiking and cycling trails, a baseball field, skatepark, playground and a large picnic area. In 2003, a large investment was made at the park to renovate the crumbling Riverwalk. While the target for this park restoration plan is to reduce non-point source pollution as outlined in the Alliance of Downriver Watershed's Total Maximum Daily Load (TMDL) Implementation Plan, an additional goal is to achieve this in a way that maintains the usability of the park and improves habitat and beautifies the landscape.

Tree Infill

Elizabeth Park has many grassy and tree covered areas that serve multiple recreational uses. However, over the years many trees have died or been removed for various reasons, leaving bare patches between. Currently there are no understory trees present to replace the older, larger trees, so a large portion of this proposed plan includes tree planting to replace the trees that have begun to decline and succumb to senescence. Replacing these trees will prevent overland erosion and allow infiltration of water deep into the soil due to the presence of extensive root systems. Overall, the proposed plan calls for 1,129 trees planted in a 15 foot on-center layout among the existing trees. Specific locations are shown on the maps located in Appendix F. Costs for trees are variable depending on species and size desired. On average, a 1-inch caliper tree, delivered and installed has an estimated cost of \$110, while a 2-inch caliper tree has an estimated cost of \$350. Costs for both options have been provided in the project budget.

Figure 2-9 Area in need of tree infill in Elizabeth Park Area 6.

Pavement Removal

At the park entrance, there is a deteriorating section of road (26,000 ft^2) that is no longer used. This excess impervious surface exacerbates issues caused by runoff while providing no current benefit as infrastructure. Removing this pavement (\$1.00/ft^2) and establishing wet prairie in its place will reduce the stormwater runoff on the property, promote infiltration, and provide beautiful blooms all season that visitors can enjoy from the nearby walking path as well as improved habitat for native flora and fauna.

Streambank Restoration

The entire length of the Detroit River canal chosen for restoration (985 ft) has a Rosgen Modified BEHI method erosion score of High. The higher the erosion score, the worse the condition of the streambank. For scores of Very High or High, restoration with soil lifts planted with live stakes is recommended (\$650/ft). This method will lower the bank angle which will help reconnect the river to a small floodplain area on either bank. The historic oxbows will be restored in the same manner to restore fish and invertebrate habitat. This method will also slow flow using vegetation, which will reduce TSS by allowing sediment and other particulates to catch on plant material or settle out of the water column.

Wet Prairie Restoration

During site visits at Elizabeth Park, approximately 263,700 ft² (6.05 acres) of grassy area was saturated or underwater. These areas are recommended for restoration as native wet prairie ($1.50/ft²). The larger root systems of the native plants will promote better infiltration, and the plant material will slow the flow of water into the river, allowing particulate matter to settle out. Establishing these areas as prairies will also reduce maintenance costs by eliminating the need to mow and prevent the soil from being disturbed when wet by lawn mowers and other heavy equipment.

Elizabeth Park Cost Opinion

Restoration Recommendation	Quantity	Unit	Cost Per	Cost Opinion
Tree Infill: 1 inch	1,129	trees**	$110	$124,200
Tree Infill: 2 inch	1,129	trees**	$350	$395,150
Pavement Removal	26,000	ft²	$1.00	$26,000
Wet Prairie Restoration	263,700	ft²	$1.50	$395,550
Streambank Restoration: Soil Lifts with Live Stakes	985	ft*	$650	$637,300
Total w/ 1 inch (rounded):				**$1,185,000**
Total w/ 2 inch (rounded):				**$1,455,000**

* Streambank Restoration cost is for both banks.

** One inch caliper trees are estimated at $110 per tree delivered and installed, while 2 inch caliper trees are estimated at $350. These costs may vary depending on the size and species of tree chosen for the area and the contractor chosen for installation. Total trees are 1,129.

Frank & Poet Drain Restoration Project

Frank and Poet Drain, located in the Combined Downriver watershed, is an established County drain that varies in flow over the course of a year and has experienced the effects of urbanization. Frank & Poet Drain is deeply incised and typically experiences highly variable flow regimes, resulting in sediment being readily eroded and transported downstream. Water fills the incised banks in the spring but dries out quickly and there is much less flow (muck) in the summer. This mucky water has low dissolved oxygen and is problematic for macroinvertebrates living in the stream. The main restoration goals for Frank & Poet Drain are a macroinvertebrate Procedure 51 score of at least -4 (or a rating of acceptable) and a mean annual wet weather total suspended solids (TSS) concentration of 80 mg/l or less. As part of this SAW Grant task, the Alliance of Downriver Watersheds has identified three restoration techniques to help achieve these goals.

Streambank Stabilization and Restoration

The length of the Frank & Poet Drain chosen for restoration (3,600 ft) has a Rosgen Modified BEHI method erosion score of High. Of the 3,600 ft of bank experiencing high erosion, concrete revetment ($730/ft) is recommended for 1,200 feet on the east bank where the high erosion is slowly putting the houses backing up to the drain at risk and there is not enough space to execute soil lifts appropriately. Because unit costs for streambank revetment considers two banks, this price can be halved to represent one bank treatment over this reach ($365/ft). This will reduce erosion and protect homeowners from potential future critical damage. The remaining 3,000 feet of stream reach with High BEHI score will be treated with soil lifts and live stakes ($650/ft). These methods will restore floodplain connectivity which will help reduce downstream flooding and continued erosion of Frank and Poet Drain. Native plant installation will also reduce flow velocities, which can work to reduce total suspended solids (TSS) by allowing sediment and other particulates to catch on plant material or settle out of the water column.

Wetland Restoration

Once the streambank is appropriately restored, there are multiple segments of the historic (now disconnected) floodplain in the project area at which connectivity to Frank & Poet Drain will be restored as a result of the decreased bank slope and strategic bank restoration. These will be restored as riverine floodplain wetlands. Wetlands within stream floodplains reduce flow velocities and allow sediment to settle out of the water column and water to infiltrate slowly back into the ground, reducing flashiness during wet periods and decreasing sediment loads carried downstream. These proposed wetland restoration areas (see maps in Appendix F) cover an area of approximately 344,000 ft^2 (roughly 7.8 acres) and sections are owned by Christ the King Lutheran Church in Trenton and the Southgate Nature Center. The section of the map highlighted in purple is especially problematic in the Frank & Poet Drain. Large volumes of water from the Sutliff and Kenope Drain flows quickly into the Frank & Poet Drain, further eroding the already compromised streambank. Planting willow (*Salix*) or other woody species here will help slow flow and cushion the streambank from damage. Wetland restoration introduces plant species that can tolerate the periods of inundation that are frequent in a floodplain through a combination of seed mixes, plant plugs, and larger shrubs or trees. The cost for this restoration is approximately $1.50/$ft^2$ but may change drastically based on the planting methods chosen and potential excavation.

Figure 2-10 Sutliff and Kenope Drain outlet.

Invasive Species Removal

Along the banks of Frank & Poet Drain, as well as in potential wetland areas, there is growth of invasive species like buckthorn, honeysuckle, and phragmites. These dense growths cover approximately 344,000 ft^2 (7.9 acres) and are relatively inexpensive to treat (about $0.06/$ft^2$). Their removal will allow for establishment of native plant species which will better serve the goals of this project, as well as improve wildlife habitat. Invasive species removal often takes multiple years of treatment and can be done as part of an invasive species management plan.

Frank & Poet Drain Cost Opinion

Restoration Recommendation	Quantity	Unit	Cost Per	Cost Opinion
Streambank Restoration: Soil Lifts with Live Stakes	3,000	ft*	$650	$1,941,000
Streambank Restoration: Concrete Revetment	1,200	ft	$365	$438,000
Wetland Restoration	344,000	ft²	$1.50	$516,000
Invasive Species Removal: Shrub	344,000	ft²	$0.06	$20,640
Total (rounded):				**$2,915,600**

* Streambank Restoration cost is for both banks.

Silver Creek Restoration Project

Silver Creek, located in the Lower Huron River watershed, is an ephemeral stream that varies in flow over the course of a year and has experienced the effects of urbanization. The project area chosen on Silver Creek is deeply incised and experiences a highly variable flow regime. This instability results in sediment eroding from the streambanks and being carried downstream, impacting water quality and aquatic habitat. Water fills the incised banks during the spring wet season but surface elevation typically drops dramatically and presents very little to no flow in summer. This mucky water has low dissolved oxygen and is problematic for macroinvertebrates living in the stream. The main restoration goals for Silver Creek, based on the ADW's total maximum daily load (TMDL) Implementation plan, are a macroinvertebrate Procedure 51 score of at least -4 (or a rating of acceptable) and a mean annual wet weather total suspended solids (TSS) concentration of 80 mg/l or less. As part of this SAW Grant task, the Alliance of Downriver Watersheds has identified three restoration techniques to help achieve these goals.

Figure 2-11 Spring seasonal flow in the deeply incised Silver Creek channel.

Streambank Restoration

The Rosgen Modified BEHI method is a common standard used to measure streambank conditions and potential for erosions along streams. Utilizing ratings from Very Low to Extreme, this methodology categorizes erosion hazard in easy to understand groupings. The area of Silver Creek chosen for streambank restoration has the following distribution of erosion hazard conditions according to this method:

- Very High: 100 ft
- High: 450 ft
- Moderate: 1,705 ft
- Low: 150 ft

The higher the erosion hazard score (e.g. very high), the greater the potential for streambank erosion. For scores of Very High or High, restoration with encapsulated soil lifts planted with live stakes is recommended ($650 ft). For scores of Moderate or Low, soil lifts planted with herbaceous vegetation is recommended ($540/ft). Installing soil lifts involves creating a stair-step formation along the banks that decreases the channel size at the bottom, but widens as the steps rise to accommodate high flow volumes when needed and provides a stable bank angle, root density and depth, and surface protection in support of a healthy stream channel. These methods also restore floodplain connectivity which will help reduce downstream flooding and continued incision at Silver Creek. Strategic woody debris management incorporated with soils lifts can be utilized to lower overall costs and should be considered in further planning and design efforts here. Native plant installation will also reduce flow velocities, which can work to reduce total suspended solids (TSS) by allowing sediment and other particulates to catch on plant material or settle out of the water column.

Wetland Restoration

There are two segments of the historic (now disconnected) floodplain in the project area which will be reconnected to Silver Creek as a result of the decreased bank slope and strategic bank restoration implementation. These will be restored as riverine floodplain wetlands. Wetlands within stream floodplains reduce flow velocities and allow sediment to settle out and water to infiltrate slowly back into the ground, reducing flashiness during wet periods and decreasing sediment loads carried downstream. These proposed wetland restoration areas (see maps in Appendix F) cover an area of approximately 240,000 ft² (roughly 5.5 acres) and are located on property owned by the City of Flat Rock. Wetland restoration introduces plant species that can tolerate periods of inundation that are frequent in a floodplain through a mixture of seed mixes, plant plugs, and larger shrubs or trees. The cost for this wetland restoration is has been estimated at $1.50/ft² but may be significantly reduced based on the planting methods chosen and realization of project efficiencies.

Invasive Species Removal

Along the banks of Silver Creek in the proposed project area (see maps in Appendix F), there is dense growth of shrubs including invasive species like common buckthorn and honeysuckle. These dense growths cover approximately 124,500 ft² and are relatively inexpensive to treat (about $0.06/ft²). Their removal will allow for establishment of native plant species which will better serve the goals of this project, as well as improve wildlife habitat. Invasive species removal often takes multiple years of treatment and can be done as part of a comprehensive invasive species management plan.

Silver Creek Cost Opinion

Restoration Recommendation	Quantity	Unit	Cost Per	Cost Opinion
Streambank Restoration: Soil Lifts with Vegetation	1,855	ft*	$540	$1,003,550
Streambank Restoration: Soil Lifts with Live Stakes	550	ft	$650	$355,850
Wetland Restoration	240,000	ft²	$1.50	$360,000
Invasive Species Removal: Shrubs	124,500	ft²	$0.06	$8,550
Total (Rounded):				**$1,750,000**

* Streambank Restoration cost is for both banks.

Conclusions

The Council Point Park, Elizabeth Park, Frank & Poet Drain, and Silver Creek stream sites chosen for restoration suffer from the effects of urbanization. Their waters display high turbidity, high nutrient and microbial loading, low dissolved oxygen, and flashiness. Their banks are plagued by invasive species, erosion, and sedimentation. The diversity of organisms that use these streams for habitat continues to decrease and public health concerns prevent most people from using many of them recreationally. Implementing the restoration projects outlined above will meet previously stated watershed management goals by reducing stream flow variability, improving water quality, supporting a greater diversity of native aquatic and terrestrial species, reducing threats to public health in the form of nutrient and microbial loading, and providing opportunities for public education and engagement along the way.

3 Sustainable Stormwater Funding

3.1 Introduction

Any action or activity requires a financial investment. Activities performed to improve water quality and better manage stormwater are no exception. Historically, communities in Michigan fund stormwater-related activities through General Funds, supplemented by street/road funding, when available. However, the stormwater system tends to be the first to be "cut off" from General Funds when priorities change, and funds are diverted to other programs. Stormwater infrastructure suffers when priorities are shifted, and stormwater systems become obsolete and/or ineffective as they exist without an adequate source of funding.

In addition to this, increased regulatory pressures on the continual operations and maintenance (O&M) is further burdening communities with the responsibility of inspecting and enforcing the maintenance of privately-owned stormwater practices, such as detention basins and other Best Management Practices (BMPs).

According to the latest annual Stormwater Utility Survey from Western Kentucky University (Campbell, Dymond, et. al., 2018), there are over 1,600 cities in the United States with a stormwater utility (i.e. enterprise fund for stormwater infrastructure). However, only eight cities in Michigan have stormwater utilities while our neighbor to the south, Ohio, has nearly 110 cities with stormwater utilities and Wisconsin has over 125 cities with stormwater utilities.

The lack of stormwater utilities in Michigan is primarily due to judicial precedent stemming from the following two cases:

- Bolt v Lansing, Michigan Supreme Court (1998)
- Jackson County v City of Jackson, Michigan Court of Appeals (2013)

These cases deemed the stormwater fee an "illegal tax" and a violation of the Headlee Amendment.

There is currently a push for enabling legislation in Michigan to establish a legal framework for developing a stormwater utility. House Bill 4691, the "Stormwater Utility Act", was introduced in early June 2019. Should this legislation pass, it will provide a clear path to the establishment of stormwater utilities throughout Michigan (see Section III for additional information on the proposed legislation).

As momentum grows for changing the legislative climate to better support communities who seek to implement a stormwater utility, the ADW leveraged SAW grant funding to develop the framework for a plan to identify sustainable stormwater funding sources. Specific activities performed under this task are listed below and summarized in detail in the following list:

1. Identify interested municipalities.
2. Identify planning-level ranges of stormwater billing units for individual municipalities based on number of parcels and approximate impervious coverage for each zoning/land-use classification.
3. Evaluate a range of revenue potential for ADW municipalities using the billing unit calculations developed above. Evaluate revenue ranges based on a scenario that includes a flat residential rate and non-residential billings based on impervious coverage as compared to a single-family residential parcel (Equivalent Residential Unit, or ERU, method).
4. Identify top potential ratepayers in each ADW community based on the revenue calculations developed above.
5. Develop a framework for stakeholder involvement and public education on stormwater enterprise funds (a/k/a stormwater utilities).
6. Develop recommendations for structuring revenue options.

In August 2018, the Alliance of Downriver Watersheds met with representative municipalities to discuss the framework for a plan to identify sustainable stormwater funding sources and determine which municipalities were willing to participate. Three municipalities were interested including the City of Romulus, City of Taylor, and the Charter Township of Van Buren.

In order to develop planning-level ranges of stormwater billing units, an understanding of current stormwater-related activities and their cost is needed, as well as an understanding of the desired level of service and associated investment. Once the "need" is determined, a preliminary rate analysis is developed. The rate analysis for the three municipalities focused on impervious area as the key metric for determining the impact on the stormwater system. Parcels with more impervious surfaces discharge higher volumes of stormwater runoff. This, in turn, increases the demand on the system of pipes, manholes and culverts.

A crucial component of this study is to determine how a stormwater user fee would be distributed among a community's property owners: residents, business owners, and key ratepayers such as industries or large facilities with significant amounts of impervious surfaces.

3.2 ERU Methodology

An analysis of existing land use and magnitude of impervious areas for individual parcels was used to evaluate how a stormwater billing program might impact typical property owners in each of the three municipalities. This process utilized existing GIS database information and the SEMCOG land use database that contained the size and location of impervious areas on all parcels, including rooftops, driveways, patios, etc. A map showing the impervious areas overlaid with the parcel zoning was generated; an example of which is below.

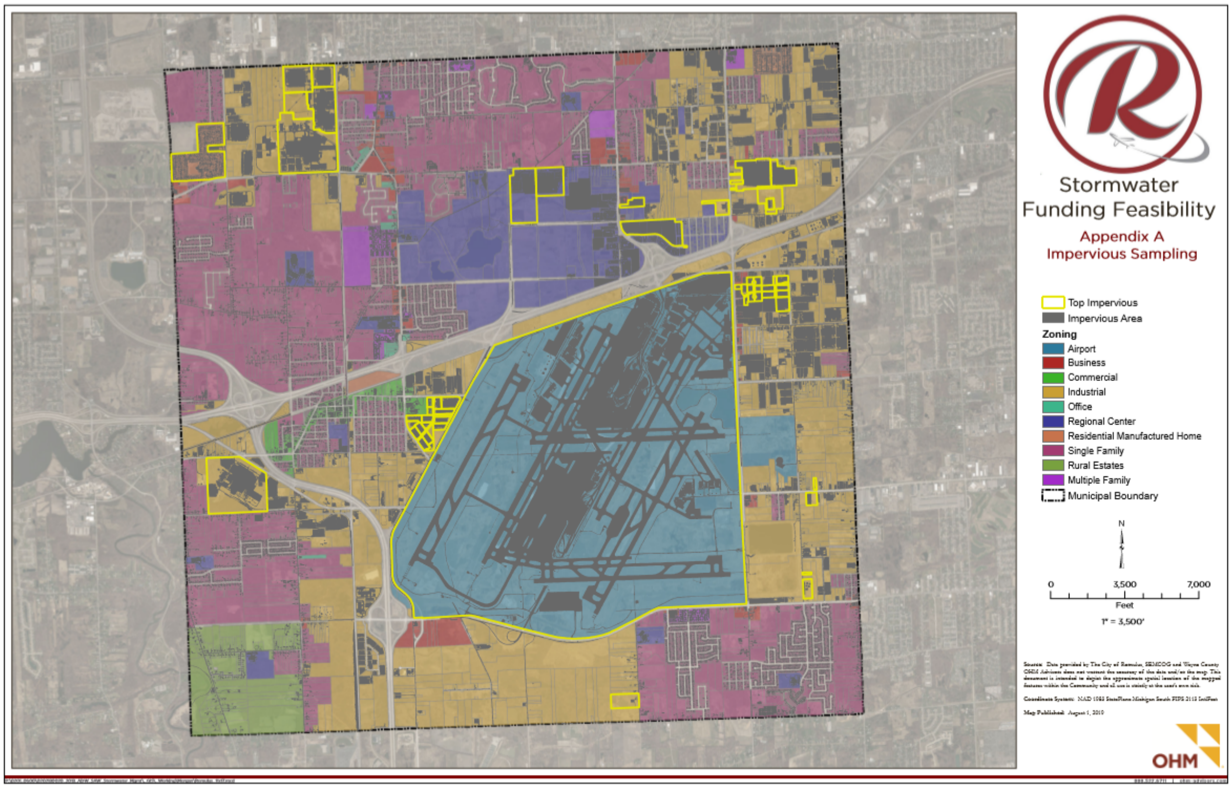

Figure 3-1 Impervious Area overlain with Parcel Zoning

An Equivalent Residential Unit (ERU) was determined from the average impervious area calculated by using the sum of single-family residential parcel impervious area divided by the number of parcels within each community. The ERU factor can be applied to non-residential parcels to determine the approximate number of ERUs (or billing units) within each community. The information produced at this step is a summary of parcels, impervious area, number of ERUs and the percent of total ERUs that each zoning classification represents (non-residential, single family residential, other residential, agricultural and estates) and a list of the top "potential" key rate payers.

3.3 Projected Annual Costs

Due to the lack of inventory and physical assessment data of the existing stormwater system in each of the three municipalities, a projection of annual costs was made based on known information and known annual stormwater costs and impervious areas for similar Michigan communities for which funding feasibility studies have been conducted (Battle Creek, Auburn Hills and Rochester Hills). Four different methods were used and averaged to obtain reasonable projected annual stormwater costs, including:

1. Per Capita – calculated based on estimated population and the cost per capita trendline for similar Michigan communities
2. Per Zone – calculated based on total area per zoning classification and a projection trendline of stormwater costs for similar Michigan communities
3. Per Impervious Area – calculated based on total impervious area and a projection trendline from similar Michigan communities
4. Total ERUs – calculated based on the total number of estimated local billing units discussed above and a projection trendline from similar Michigan communities
5. Average Annual Costs – calculated using all four methods of stormwater cost trending allowed for a range of potential stormwater costs for each community. In two of the three municipalities, the Per Zone method revealed an outlier annual stormwater cost and was removed from the average projected annual stormwater cost.

Table 3-1 below summarizes the range of projected annual stormwater costs calculated for the three municipalities that participated in this funding study.

Table 3-1 Projected Annual Stormwater Costs by Trendline

Trendline Type	Projected Annual Stormwater Cost Range
Per Capita	$3.0M - $3.5M
Per Impervious Area	$2.9M - $3.6M
Total ERUs	$2.8M - $3.1M
Average	**$3.1M - $3.4M**

One additional analysis was performed to calculate a projected annual stormwater cost for the remaining 17 ADW member municipalities (excluding Wayne County) using impervious area data and a projection trendline from similar Michigan communities. The table below (*Table 3-2*) lists each of the remaining municipalities not included in the more detailed study outlined in this section, along with the total parcel-based impervious area (located in the ADW watershed) and projected annual stormwater cost. The projected annual stormwater cost is based on an annual cost per impervious area range of $600 to $1,200 and an annual cost per capita range of $60 to $110.

Table 3-2 Projected Annual Stormwater Costs by ADW Community

ADW Community	Impervious Area (acre)	$/Impervious Area		Population (2017)	$/ Capita	
		Low	High		Low	High
Allen Park	2,140	$1,284,000	$2,568,000	27,156	$1,629,000	$2,987,000
Belleville	280	$168,000	$336,000	3,869	$232,000	$426,000
Dearborn Heights	3,340	$2,004,000	$4,008,000	55,758	$3,345,000	$6,133,000
Ecorse	790	$474,000	$948,000	9,226	$554,000	$1,015,000

ADW Community	Impervious Area (acre)	$/Impervious Area		Population (2017)	$/ Capita	
		Low	High		Low	High
Flat Rock	1,180	$708,000	$1,416,000	9,955	$597,000	$1,095,000
Gibraltar	430	$258,000	$516,000	4,495	$270,000	$494,000
Inkster	1,410	$846,000	$1,692,000	24,453	$1,467,000	$2,690,000
Lincoln Park	1,890	$1,134,000	$2,268,000	36,655	$2,199,000	$4,032,000
Melvindale	900	$540,000	$1,080,000	10,341	$620,000	$1,138,000
Riverview	890	$534,000	$1,068,000	12,107	$726,000	$1,332,000
Rockwood	320	$192,000	$384,000	3,183	$191,000	$350,000
Southgate	2,020	$1,212,000	$2,424,000	29,084	$1,745,000	$3,199,000
Westland	5,070	$3,042,000	$6,084,000	81,747	$4,905,000	$8,992,000
Woodhaven	1,490	$894,000	$1,788,000	12,486	$749,000	$1,373,000
Wyandotte	1,620	$972,000	$1,944,000	24,977	$1,499,000	$2,747,000
Grosse Ile Twp	980	$588,000	$1,176,000	10,155	$609,000	$1,117,000
Sumpter Twp	1,000	$600,000	$1,200,000	9,382	$563,000	$1,032,000

3.4 Recommendations and Next Steps

Based on the analysis of similar systems in Michigan, the existing budget for stormwater management in the three studied municipalities will not be adequate for future maintenance, capital and flood control needs. It is expected that this finding applies to most of the municipalities in the ADW. Municipalities that are interested in pursuing a stormwater utility through a rate ordinance, should consider the following next steps:

1. Complete an inventory of the community's stormwater system infrastructure and assess the condition of the system's components. This may include the development of a Community-wide hydrologic/hydraulic model to identify flood-prone system components.
2. Refine and complete the rate model using the following information:
    - Final recommended stormwater budget based on the inventory and assessment
    - Estimated revenue reductions due to stormwater credits
    - Desired fund balance needs (using a 10-year cash flow analysis)
3. Finalize ERU coverage and a final measurement of impervious surfaces on all parcels with a leaf-off fly over of the community.

4 Watershed Monitoring Plan

The ADW municipalities have worked collaboratively to monitor the collective watersheds since the beginning in 2007. Since that beginning, the ADW maintained a consistent annual collection of physical, biological and chemical monitoring and expanded investigations to include new parameters, sites and strategies. Currently, the ADW conducts annual monitoring in three constituent areas: benthic macroinvertebrates (biology), stream flow and temperature (physical), and chemistry. This monitoring plan is designed to:

- Build awareness and stewardship by involving students and adult volunteers
- Determine the ecological status of the watersheds annually
- Detect trends in ecological indicators
- Identify critical areas for focusing management actions
- Evaluate the success of management actions

The subsections below describe each of the three monitoring efforts and the long-term strategy for conducting the monitoring.

4.1 Benthic Macroinvertebrates

Monitoring the diversity of benthic macroinvertebrates is a staple of the ADW monitoring program. Monitoring changes in macroinvertebrates over time provides a basic measure of stream habitat and water quality. The ADW has been monitoring macroinvertebrate diversity, with the involvement of students and volunteers, at many sites across the ADW. Most sites have five or more years of data.

Macroinvertebrate diversity is measured twice a year (augmented by winter stonefly collections in January). Multiple diversity measures provide a reasonable estimate of stream conditions. Changes in site quality measures may indicate habitat improvements or degradation. Two metrics are evaluated each year. First, the Stream Quality Index (SQI) is a composite biotic integrity score developed for the Michigan Clean Water Corps (MiCorps). The SQI is based on order-level identification, however, and does not take advantage of family-level identification performed by ADW programs. The second metric is total taxa diversity (TD), which counts the number of different families of aquatic macroinvertebrates found at each site. This measure utilizes the higher resolution of family identification, but does not account for the sensitivities of different families. Taken in tandem, these two metrics provide a good measure of aquatic biotic integrity over time.

4.2 Stream Flow

Pressure sensors and staff gages were deployed at multiple monitoring locations in each watershed to monitor stream water levels over the course of 3-4 running seasons each at the beginning of the monitoring program. The pressure sensors recorded water levels every ten minutes. In order to translate pressure (water level) data to stream discharge, staff and volunteers measured discharge during a range of flow levels. Rating curves were developed for both staff gages and pressure sensors to estimate discharge from water level. Flow records were developed at a total of eight sites across the watershed.

Stream discharge over time is averaged to generate mean daily discharge. A Richards-Baker Flashiness Index was computed for each year's set of daily mean discharges, based on a method from an EGLE study. An increase in flashiness, due to higher peak flows and lower base flows, will likely result in measurable changes to the channel shape – width, depth, sinuosity, and slope. Seasonal average, peak and base flow estimates were determined utilizing the Indicators of Hydrologic Alteration (IHA) software.

Six of the eight sites had 3-year records developed by 2011. In 2012 and 2013, two remaining sites were monitored for continuous flow: sites at Silver Creek and Smith Creek in the Lower Huron River watershed. Since the initial flow records were recorded, HRWC began working with a team of researchers from the University of Michigan Environmental Engineering Laboratory. The team deployed a smaller ultrasonic (sonar) sensor at one location in combination with an automatic water sampler (autosampler) to study storm dynamics. Currently, the ADW plans to add autosampler stations at each of the eight flow locations over time. Additionally, stream flow is measured or estimated during each chemistry sampling visit at long-term stations.

Ultimately, a before and after approach will be used to evaluate changes in stream flow dynamics. Comparisons of the above measures before and after management actions are taken should yield a measure of their impact on stream flow dynamics. However, as with most efforts, it will take years to show such an effect.

4.3 Chemistry and Flow Monitoring

On behalf of the municipalities of the ADW, HRWC conducts chemistry, bacteria and flow monitoring with assistance from Wayne County staff and volunteers to assess conditions of the area waterways, including Blakely Creek, Brownstown Creek, Ecorse Creek, Frank & Poet Drain, the Huron River, Silver Creek, Smith Creek, and Woods Creek. Water quality data from these locations facilitate the establishment of relationships between land cover and ecological stream health, capturing the range of subwatershed and upstream conditions.

Monitoring occurs twice monthly from April through September at nine long-term sites and four single-season investigative sites in Wayne County. Since its inception in 2012, the Chemistry and Flow Monitoring program has collected water quality data at 33 sites. The monitoring activities, including sample collection, flow measurements, and chemistry parameter testing, is largely conducted by volunteers from ADW communities. Currently, water samples are analyzed for chemical parameters by the laboratory at the Downriver Utility Wastewater Authority (DUWA) on behalf of ADW municipalities.

The ADW Chemistry and Flow Monitoring program provides ADW municipalities data and analysis on a variety of water parameters, including water temperature, conductivity, dissolved oxygen, total phosphorus, total suspended solids, and Escherichia coli bacteria. Efforts are made to collect water samples and make stream flow measurements during wet and dry weather for comparison.

4.4 The Monitoring Plan

These data inform analyses concerning water quality, stream health, pollutant hot spots, and effectiveness of best management practices. Monitoring results guide management decisions by ADW communities, future monitoring sites, and stormwater projects. See Section 1.4 for a summary of results from some of this data collection. The ADW maintains a running 5-year Monitoring Plan that is adapted as new discoveries are made and new techniques are discovered or developed. The current 5-year plan is included below (Table 4-1).

Table 4-1 Five Year Monitoring Plan Summary (2020-2024)
Ecorse Creek, Combined Downriver and Lower Huron River Watersheds

Monitoring Activity	Sites/Frequency/Season	Year Performed				
		2020	2021	2022	2023	2024
Planning & Reporting						
ADW develops/refines monitoring plan	Not applicable	x	x	x	x	x
Data handling, data management & analysis	Not applicable	x	x	x	x	x
Prepare monitoring reports and publish results	Not applicable				x	
Physical Monitoring						
Precipitation	April-Sep at numerous sites	x	x	x	x	x
Flow	Apr-Sep at up to 8 sites	x	x	x	x	x
Temperature	Apr-Sep at 12 sites	x	x	x	x	x
Geomorphology/habitat assessment	12 representative sites			x		
Biological Monitoring						
Macroinvertebrates	3x per year at 28 sites	x	x	x	x	x
E. coli bacteria	Apr-Sep at 12 sites 2x per month	x	x	x	x	x
Water Chemistry						
Dissolved Oxygen (DO), pH, Conductivity	Apr-Sep at 12 sites 2x per month	x	x	x	x	x
Total Phosphorous (TP)	Apr-Sep at 12 sites 2x per month; wet event sampling	x	x	x	x	x
Total Suspended Solids (TSS)	Apr-Sep at 12 sites 2x per month; wet event sampling	x	x	x	x	x

5 Public Education Plan

The ADW municipalities have elected to conduct public education activities by working together with each other and regional partners to develop, submit and implement a PEP.

In 2016, the ADW conducted a mix of research efforts to help members thoroughly understand their residents' demographic makeup and the attitudes and behaviors that are relevant for stormwater outreach and education, collecting the information and insights needed to meet permit requirements going forward. Activities and work product included:

- ADW Communities Online Survey, results and recommendations from an online panel survey of 400 Wayne County residents, an opt-in survey circulated by ADW members (158 responses) with comparison to a national survey conducted by Water Words That Work in 2014
- Target Audience Analysis, demographics, lifestyle interest, business profiles for each of the 22 member municipalities (plus capture of regional online groups and forums in use)

- Communications Check Up, an assessment of ADW strengths and weaknesses and recommended strategies for public communication and outreach
- Literature Review, a literature review to determine if “off the shelf” social and market research can help the ADW achieve its goals (publicly available surveys, polls, focus group reports, campaign summary reports, and peer-reviewed academic papers)
- Survey Instrument, A 25-question survey to measure resident water quality attitudes and awareness

Survey findings included: (1) local residents express faith that individual and collective action can make a difference for local waterways; (2) they appear to be less knowledgeable about water problems than U.S. residents as whole, and are confused about what actions to take; and (3) they report comparable levels of environmental concern, to U.S. residents as a whole, but have higher recognition of the impacts.

Based on these findings and others from the research, the Public Education (PE) Committee worked with Water Words That Work to prepare a 5-year communications plan for the ADW that recommends a suite of public education activities including strategies, timelines, deliverables and milestones, projected costs and messaging. Activities in the plan include:

- Biennial production of the watershed community calendar with an online photo contest
- Three focused-issue digital pledge campaigns
- Outreach activities for community venues and events

Activities were developed to meet MS4 permit needs and to be incorporated in the ADW’s collaborative Public Education Plan for the stormwater permit.

5.1 Consensus Goals

The procedure for identifying high-priority watershed-wide or targeted issues suited for collaborative public education efforts includes:

- A review of Watershed Management Plans for the Ecorse Creek, Combined Downriver and Lower Huron River watersheds including any established Total Maximum Daily Loads for waterbodies in each area.
- A review of data from on-going Stream Monitoring and Water Quality Monitoring Programs.
- A review of public opinion surveys on watershed issues and water quality concerns conducted by the Southeast Michigan Council of Governments (SEMCOG) in 2004 and the ADW in 2016.
- Topics identified by permittees at quarterly group meetings, in periodic subcommittee meetings and in permittee opinion surveys prior to and throughout the permit cycle.
- Discussion and input from the permitted entities regarding individual jurisdictional versus watershed-wide needs, potential public outreach opportunities, and existing and future programs.

The ADW’s high priority community-wide and targeted issues for collaborative efforts are:

- High yet stable levels of phosphorus in stormwater runoff from most monitored streams indicating broad sources;
- High and increasing *E. coli* counts in most monitored streams;
- High conductivity levels (indicating potential dissolved contaminants) in most monitored streams;
- Moderate to high flashy flows in monitored streams indicating the need for infiltration and storage across the watersheds;
- A need for greater protection of riparian areas to reduce erosion and slow and treat stormwater runoff; and
- Target audience research and public survey results indicating a need for continued education about stormwater pollution and specific residential responsibilities.

The high priority community-wide and targeted issues were used to prioritize topics for the collaborative PEP efforts.

5.2 Collaborative PEP

Existing and proposed collaborative public education BMPs include in some way all prioritized topics, but the emphasis will be on Collaborative High Priority Topics.

Table 5-1 Collaborative PEP Priority Topics

Collaborative Priority Level	Topic Letter	Topic Description
High	A	Public responsibility and stewardship in the watershed
High	B	The connection of the MS4 to area waterbodies and the potential impacts of discharges
High	C	Illicit discharges and public reporting of illicit discharges and improper disposal of materials
Med	D	Promote preferred cleaning materials and procedures for car, pavement and power washing
High	E	Inform and educate the public on proper application and disposal of pesticides, herbicides and fertilizers
High	F	Promote proper disposal practices for grass clippings, leaf litter and animal wastes that may enter into the MS4
High	G	Identify and promote the availability, location, and requirements of facilities for collection or disposal of household hazardous wastes, travel trailer sanitary wastes, chemicals, yard wastes, and motor vehicle fluids
Low	H	Proper septic system care and maintenance, and how to recognize system failure
Med	I	Benefits of green infrastructure and low impact development
Med	J	Promote methods for managing riparian lands to protect water quality

Collaborative Priority Level	Topic Letter	Topic Description
Med	K	Identify and educate commercial, industrial, and institutional entities likely to contribute pollutants to stormwater runoff

Based on the priority topics outlined above, a set of activities were developed to be implemented by ADW municipalities individually or collaboratively. The activities range from support for the Michigan Green Schools Program through incentives and recognition to participating schools to organizing and running focused-topic pollution prevention campaigns and watershed community calendars. Specific activities and implementation timeline are presented in Section 6 – Plan Implementation of this SWMP.

6 Plan Implementation

6.1 Plan Summary

Maps contained in this plan identify the jurisdiction and location of established drains and stormwater outfalls as well as any known and mapped storm sewer networks, the location of known and investigated detention basins and watershed management planning areas.

Field investigations of stormwater system components were completed for 218 detention basins, 21 municipal facilities, and 265 stormwater outfalls along over 36 miles of drains. Results of the field investigations were used to assess conditions, and identify maintenance actions, repairs or improvement needs to restore system capacity and performance for those components. Maintenance activities were ranked for implementation action with details of required immediate and long-term maintenance activities.

Site development and redevelopment standards to manage stormwater runoff have been in place since the early 2000's. The technical details, criteria and trigger threshold to meet the new EGLE criteria are drafted at the County-level. Public and stakeholder involvement is being conducted to gain input on the draft standards. Finalization of the draft standards and subsequent adoption by individual municipalities will occur in 2020.

6.2 Implementation Timeline

Work performed through this SAW grant has informed the ADW of activities and efforts needed to continue improving water quality within the combined watershed area. The timeline for implementing results and recommendations from this plan is dependent on available staff resources and funding. As such, implementation activities have been split into two categories, committed activities and additional activities. Committed activities are the MS4 permit items that the ADW collaboratively developed and is now implementing. Additional activities are desired activities that the ADW would like to achieve as resources and funding become available but are outside of the MS4 permit required activities.

6.2.1 Ongoing Activities Related to MS4 Permit Requirements

Illicit Discharge Elimination activities will continue with prioritized efforts informed by ongoing watershed monitoring activities.

Post-Construction Stormwater - The draft post-construction stormwater standards will be made available for public review and comment once EGLE has accepted the proposed approach. A county-wide update workshop was held in November 2019. This was an initial opportunity for each community, engineers and the development community to provide input on the draft standards. The County is on track to codify the proposed standards in 2020.

Watershed Monitoring – Past monitoring results guide management decisions by ADW communities, future monitoring sites, and stormwater projects. The ADW maintains a running 5-year Monitoring Plan that is adapted as new discoveries are made and new techniques are discovered or developed. The current 5-year plan is included in the Watershed Monitoring Plan section and shown in the table below.

Table 6-1 Watershed Monitoring Plan

Monitoring Activity	Sites/Frequency/Season	Year Performed				
		2020	2021	2022	2023	2024
Planning & Reporting						
ADW develops/refines monitoring plan	Not applicable	x	x	x	x	x
Data handling, data management & analysis	Not applicable	x	x	x	x	x
Prepare monitoring reports and publish results	Not applicable				x	
Physical Monitoring						
Precipitation	April-Sep at numerous sites	x	x	x	x	x
Flow	Apr-Sep at up to 8 sites	x	x	x	x	x
Temperature	Apr-Sep at 12 sites	x	x	x	x	x
Geomorphology/habitat assessment	12 representative sites			x		
Biological Monitoring						
Macroinvertebrates	3x per year at 28 sites	x	x	x	x	x
E. coli bacteria	Apr-Sep at 12 sites 2x per month	x	x	x	x	x
Water Chemistry						
Dissolved Oxygen (DO), pH, Conductivity	Apr-Sep at 12 sites 2x per month	x	x	x	x	x
Total Phosphorous (TP)	Apr-Sep at 12 sites 2x per month; wet event sampling	x	x	x	x	x
Total Suspended Solids (TSS)	Apr-Sep at 12 sites 2x per month; wet event sampling	x	x	x	x	x

Public Education – The ADW has begun implementing all of the recommendations and proposed collaborative public education activities, producing and distributing a printed watershed community calendar and sponsoring a social media driven photo contest in 2018 and 2020. Additionally, the ADW has committed 2020 funding to organize and run focused-topic pollution prevention campaigns. Displays for community venues and outreach activities have been produced and are in use, the green schools program is supported with annual incentives, a stream and river road crossing signs inventory was completed in 2019, and the volunteer stream and water quality monitoring program is supported with funding to conduct public relations and outreach that raises the program's profile and helps recruits volunteer participation through 2020.

A summary of the collaborative activities and the priority topic the activity addresses, is detailed below:

Table 6-2 Proposed Collaborative Public Education Activities

Activity #	Description	Topics Addressed	Implementation Timeline/Frequency
1	Produce and distribute a printed watershed community calendar and social media-driven photo contest	A-J	Biannually (even calendar years)
2	Organize and run focused-topic pollution prevention campaigns	A-J	Biannually (odd calendar years)
3	Provide displays for community venues and outreach activities at events	A-J	2-3 events annually
4	Support green schools program with incentives to qualifying ADW schools	A, B, I	Annually
5	Support and promote volunteer stream and water quality monitoring	A (B-J)	Stream monitoring = annually in winter, spring, fall WQ monitoring = annually spring through fall
6	Stream and river crossing road signs	A	Ongoing
7	Participate in regional partnership activities	A-K	3-4 meetings annually
8	Promote county-wide complaint tracking and response system	B, C, K	Ongoing promotional efforts
9	Promote water resource protection workshops	K (A-J)	Ongoing as needed

*See Table 5-1 for topic description

Pollution Prevention includes proactive activities to prevent pollutants from entering the drainage system and watercourses. Each ADW community performs

- Detention basin maintenance
- Municipal facility good housekeeping

TMDL Implementation activities are centered around ongoing public education and illicit discharge elimination activities. Immediate efforts include identification of grant funding opportunities to begin implementation of conceptual green infrastructure projects identified in this SWMP.

6.2.2 Additional Activities (Beyond Permit Requirements)

Green Infrastructure Projects – the recommendation is for the ADW to identify grant and community funding opportunities to begin implementation of the BMP conceptual designs prepared as part of this SAW grant, discussed in Section 2.4. The conceptual projects include a variety of stormwater management practices, in various locations to achieve water quality improvements and water quantity reductions. As more and more discrete projects are implemented, the watershed-wide benefits will be visible and measured through the on-going watershed monitoring efforts.

Public Education - the recommendation is for the ADW to engage in another 5-year communications planning effort in 2021 at the end of the first 5-year communications plan. The effort should include a comparable evaluation of resident attitudes and awareness and exposure to ADW outreach efforts. This kind of review and planning should be regularly completed to evaluate effectiveness of current collaborative public education activities and seek new and effective approaches that support the shared goals of improving water quality and addressing TMDL's in the watersheds.