

A scenic view of a river with a dam and autumn foliage. The water is flowing over the dam, creating a series of small cascades. The background is filled with trees in various shades of green and yellow, suggesting an autumn setting. The sky is a clear, bright blue.

City of Anoka

Local Surface Water Management Plan

July 2015

Revised May 8, 2019

Adopted: May 21, 2015

City of Anoka

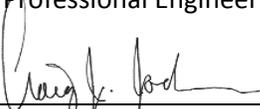
Local Surface Water Management Plan

Prepared for City of Anoka

April 2015

Revised May 8, 2019

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

	23461	5/8/19
_____ CRAIG J. JOCHUM, P.E.	_____ LIC. NO.	_____ DATE

By:



3601 Thurston Avenue
Anoka, MN 55303
Phone: 763-427-5860
Fax: 763-427-0520

City of Anoka

Stormwater Management Plan

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0.0 Executive Summary

This Local Surface Water Management Plan (Plan) serves as a comprehensive planning document to guide the City of Anoka in protecting, restoring, and conserving its surface water resources. This plan was prepared to fulfill the legal requirements of the Metropolitan Surface Water Rules as well as the policies and requirements of the Lower Rum River Watershed Management Organization (LRRWMO) and other local, state, and federal agencies. The plan includes the following sections:

Section 1: Introduction – presents background information regarding the city, general watershed information, and plan purposes.

Section 2: Land and Water Resources Inventory – provides an inventory of the water resources within the city, the physical environment, and pertinent water resources data.

Sections 3 through 12: Watershed Descriptions and Recommendations – describes the general watershed area, drainage patterns, flood protection concerns, stormwater system analysis and results, and implementation recommendations for each of the major watersheds in the city.

Section 13: Goals and Policies – presents the city’s goals as they relate to water resource planning and the policies that they will implement to achieve its goals.

Section 14: Implementation – discusses the implementation components of the Plan.

Section 15: Technical Methods and Assumptions – describes the data, methods and assumptions used for the stormwater analyses.

Section 16: System Maintenance – discusses the city’s responsibilities with respect to maintenance of stormwater facilities.

Section 17: Amendments – discusses the amendment procedures for this Plan.

This Local Surface Water Management Plan was adopted by the City Council on May 21, 2015. As part of the City’s 2040 Comprehensive Plan Update, the City updated this document.

1.1 Study Area General Description and Watershed Nomenclature

The City of Anoka is bisected by the Rum River, and its southern limits are situated along the Mississippi River. Early-development occurred along the southern portion of the Rum River. The city has since expanded northward to the most recent development in the northwest corner. The city's land use plan is shown on Figure 1-1. The majority of the city is developed except for a portion located north of Bunker Lake Road.

All of the land in the City of Anoka eventually drains to the Mississippi River. The northwest corner and southernmost regions of the city are directly tributary to the Mississippi, which flows southeasterly. The downtown and remaining portions of the city are directly tributary to the Rum River, which joins the Mississippi at the southern edge of the city.

Based on drainage divides, the city has been divided into ten major watersheds. State Statutes requires "issues and corrective actions" as components of Local Surface Water Management Plans. The issues and corrective actions have been analyzed on a watershed basis, and are summarized in their respective sections. The ten major watersheds are as follows:

1. Mississippi River East
2. Mississippi River West
3. Anoka Enterprise
4. Rum River Northeast
5. Rum River Northwest
6. Rum River Southeast
7. Rum River Southwest
8. U.S. Highway 169 and 10
9. Coon Rapids Tributary
10. Rum River North

These ten watersheds are shown on Figure 1-2. Sections 3 through 12 describe the stormwater management requirements and recommended system improvements for each of these

watersheds. The ten major watersheds were subdivided into minor watersheds and subwatersheds. In most cases, watershed divides were determined using USGS quadrangle maps (10-foot contour interval), and field verified. Other watershed divides were determined using construction plans and lidar 2 foot contours. Minor watersheds in each of the major watersheds were designated according to the street or other location where the watershed outlets. For example, the Jefferson Street subwatersheds are labeled JF-1,2,3,...etc., the Porter Avenue watersheds are labeled PTR-1,2,3,... etc., and the Moore Middle School watersheds are labeled MMS-1,2,3,... etc. The City of Anoka is entirely within the jurisdiction of the Lower Rum River Watershed Management Organization (LRRWMO).

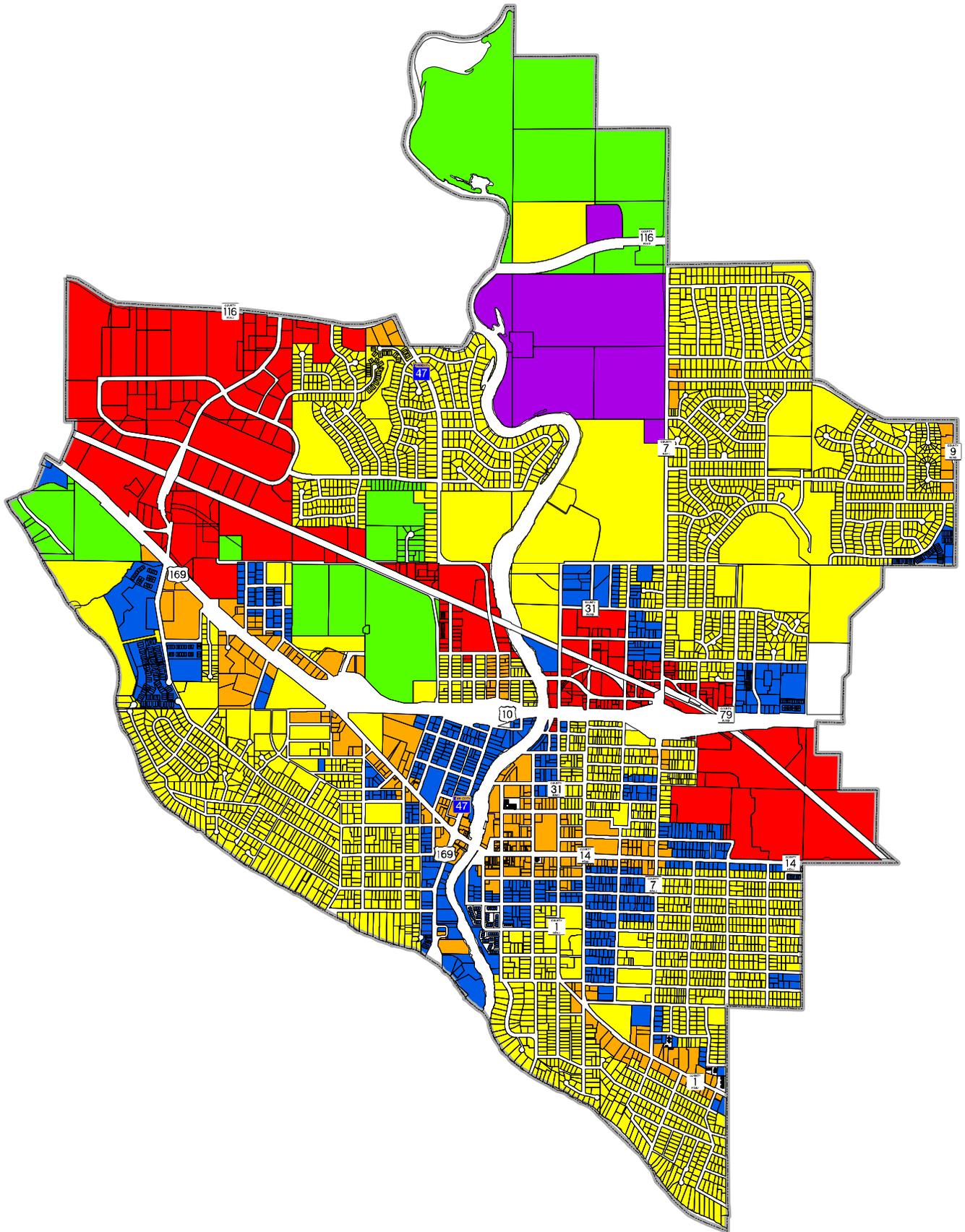
1.2 Plan Purposes

This plan provides the City of Anoka with an overall comprehensive stormwater management plan. This plan was developed to address current and future stormwater issues, especially those related to future development and redevelopment.

This plan will assist the City of Anoka in defining and implementing a comprehensive and environmentally sound system of surface water management. It is intended to be used as a tool to:

1. Plan for projects and other water management activities so as to correct existing problems and prevent foreseeable future problems from occurring.
2. Assist the city in considering water resource impacts resulting from variances to the city's long-range land use plan.
3. Enable the city to grow/redevelop in a systematic and orderly manner while protecting its vital water resources.

In order to accomplish these objectives, the plan considers a specific array of land uses within the city's legal boundary. If and when land uses change, this plan provides the means to (1) address the proposed changes; (2) determine the impact of the changes on the city's infrastructure, flooding, and natural resources; and (3) determine the actions needed within the proposed areas of land use change to prevent undesirable impacts.

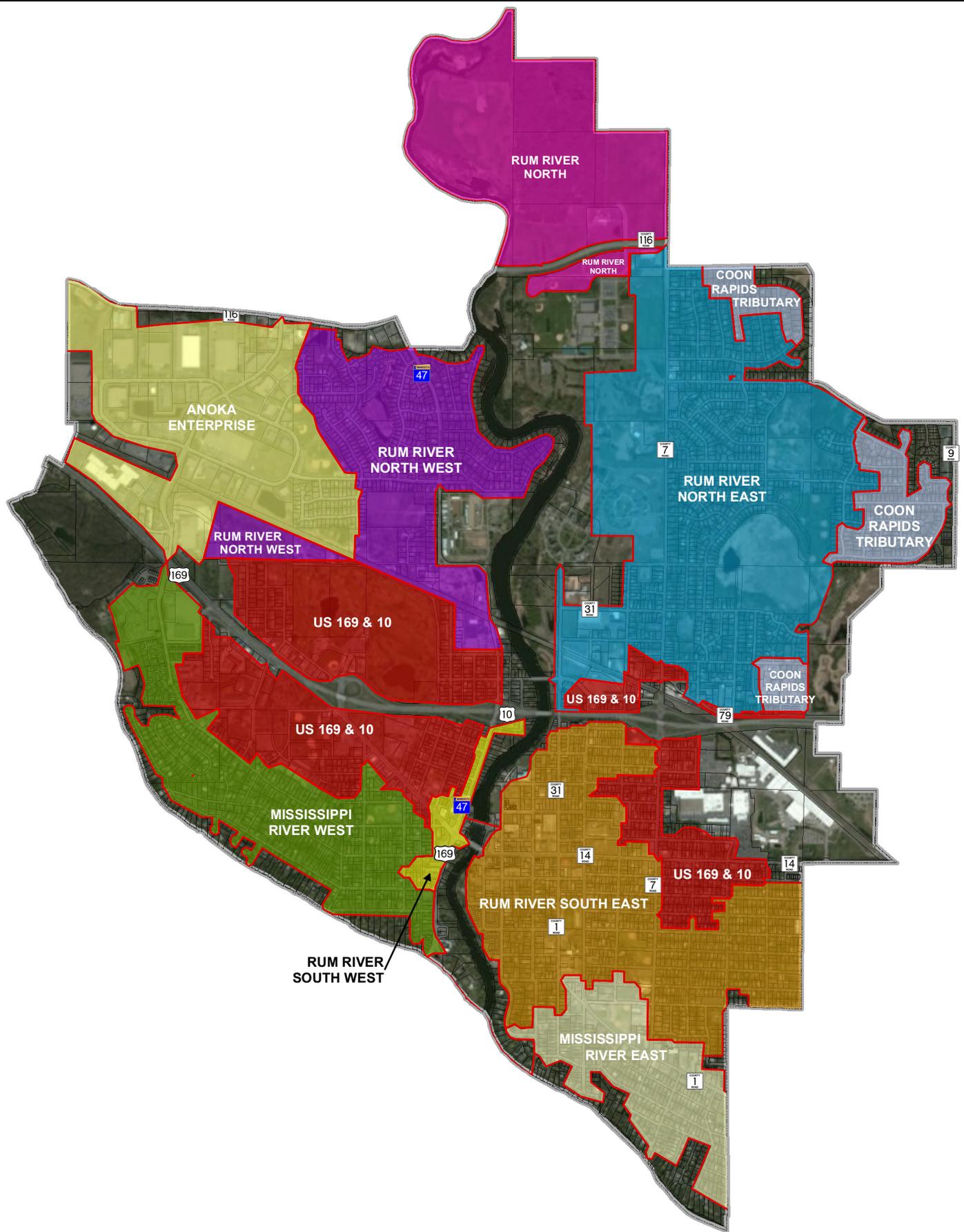


Land Use

- | | |
|---|---|
|  Agricultural/Open |  Institutional |
|  Commercial |  Multiple Family Residence |
|  Industrial |  Single Family Residential |

FIGURE 1-1

**LAND USE
CITY OF ANOKA**



Major Watersheds

- | | | |
|------------------------|----------------------|----------------------|
| Anoka Enterprise | Rum River North East | Rum River South East |
| Coon Rapids Tributary | Rum River North West | US 169 and US 10 |
| Mississippi River East | Rum River South West | |
| Mississippi River West | Rum River North | |

**FIGURE 1-2
MAJOR
WATERSHEDS
CITY OF ANOKA**

2.0 Land and Water Resources Inventory

This section provides a summary of the climate, precipitation, geology and soils information. The City of Anoka and the Twin Cities Metropolitan Area have a climate that is characterized by wide variations in temperature, ample rainfall and moderate snowfall.

2.1 Climate

The total average annual precipitation in the Twin Cities Metropolitan Area is 30.61 inches. The total average annual snowfall is 54.4 inches. Mean daily temperature, average precipitation, and average snowfall are shown in Table 2-1.

Table 2-1 Average Monthly Climate Data for Minneapolis/St. Paul, 1981 - 2010

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Daily Temperature (°F)	15.6	20.8	32.8	47.5	59.1	68.8	73.8	71.2	62.0	48.9	33.7	19.7	46.2
Average Precipitation (inches)	0.90	0.77	1.89	2.66	3.36	4.25	4.04	4.30	3.08	2.43	1.77	1.16	30.61
Average Snowfall (inches)	12.2	7.7	10.3	2.4	0.0	0.0	0.0	0.0	0.0	0.6	9.3	11.9	54.4

Source: Minnesota Climatology Working Group

2.2 Precipitation

Rainfall frequencies are often used in the design of storm sewer, conveyances, stormwater ponds, and other features that are used to convey, store, or treat stormwater. Until recently, the city relied on *Technical Paper No. 40, Rainfall Frequency Atlas of the United States, published by the U.S. Weather Bureau*. Recently, the *National Oceanic and Atmospheric Administration (NOAA) released Atlas 14, Volume 8*. The precipitation frequency estimates as presented in *NOAA Atlas 14, Volume 8* indicate that rainfalls have generally become more intense over the

recent years. The precipitation frequency estimates for the Cedar station located in Oak Grove, Minnesota are shown in Table 2-2.

Table 2-2 – Rainfall Frequency

Recurrence Intervals (years)	1-Hour Duration	24-Hour Duration
1	1.18	2.45
2	1.39	2.84
10	2.06	4.21
50	2.87	6.07
100	3.25	6.99

Source: NOAA Atlas 14, Volume 8

2.3 Topography

The topography in Anoka was shaped by several ice advances into east-central Minnesota during the last (Wisconsin) glaciation, which occurred about 10,000 years ago. A large glacial outwash deposit, called the Anoka sandplain, is the dominant geomorphic feature. It was formed largely by glacial drainage (melt-water) from the receding Grantsburg sublobe of the Des Moines glacier. The surface of the Anoka sandplain is flat to moderately undulating. Low regions of upland represent areas of till left from previous ice movements that were not buried by the outwash sand. Other features of positive relief are patches of sand dunes formed by southwesterly winds after the sandplain was abandoned by the outwash streams. Landscape features of negative relief include numerous lakes and marshes which formed as ice blocks, originally buried by the outwash sand that melted to create the depressions and are now filled with water or organic soils.

2.4 Soils

The United States Department of Agriculture, Soil Conservation Service published the Soil Survey of Anoka County in 1977. The majority of the city is occupied by the Hubbard-Nymore Association. This association is nearly level to slightly sloping and contains excessively drained

soils that are sandy throughout. Hubbard soils are black and dark grayish brown at the surface and are underlain by dark brown and yellowish brown coarse sand. Nymore soils are very dark gray and black to very dark grayish brown loamy sand underlain by dark brown loamy sand. Soils of the Hubbard-Nymore Association are well-suited to urban uses and moderately well-suited to farming and recreation. Control of wind erosion and the water table in low-lying areas is often necessary. Due to the permeable nature of the soils, it may be possible for contaminants in stormwater to be transported through the soil to the aquifers which are used for drinking water. The Drinking Source Water Protection Areas, and their corresponding vulnerability, are shown in Figure 2-4. Most of the soils within the city are Hydrologic Soil Group A or B.

2.5 Land Use

The current Land Use within the city includes residential, commercial, industrial, agricultural, and public open spaces. The city is mostly developed, with some agricultural and public open space (conservation easement) uses located within the Rum River North watershed. The existing Land Use is shown in Figure 1-1. The proposed 2030 Land Use is shown in Figure 2-1.

2.6 Watersheds and Drainage Patterns

The drainage boundaries for the City of Anoka have been delineated and ten major watersheds have been identified. In general, the surface water generally drains to the Rum River and the Rum River flows south until it converges with the Mississippi River at its southern most point. A relatively small portion of the city drains directly into the Mississippi River. The major watersheds are shown on Figure 1-2.

2.7 MnDNR Protected Waters, Wetlands and Watercourses

The Minnesota Department of Natural Resources (MnDNR) has designated certain waters of the state as public waters (Minn. Rules 6115.1060). MnDNR "Protected Waters and Wetlands" maps show public waters within the city. A MnDNR permit is required for work within designated public water.

Public waters wetlands means all types 3, 4 and 5 wetlands, as defined in United States Fish and Wildlife Service Circular 39 (USDI, 1971), that are ten or more acres in size in unincorporated areas, or 2.5 acres in incorporated areas.

Figure 2-2 shows the protected waters, wetlands, and water courses located in the city.

2.8 Other Regulated Wetlands

In addition to the MnDNR waters discussed in Section 2.7, many additional wetlands are located within the city. The National Wetland Inventory (NWI) maps, included as Figure 2-3, depicts some of these wetlands. The following three characteristics make these water bodies exclusive from the MnDNR public waters and public waters wetlands.

- First, an individual basin may be dominated by wetland habitat (Types 1, 2, 6, and 7 [USDI, 1971] not statutorily covered by MnDNR and yet is immediately adjacent to an inventoried MnDNR basin or watercourse.
- Second, an individual isolated wetland basin may be smaller than the minimum MnDNR size (2.5 or 10 acres) as discussed previously.
- Third, an individual isolated wetland basin may be dominated by habitat types (Types 1, 2, 6, and 7) not statutorily covered by MnDNR.

Excavation, filling, grading and/or development actions which may adversely affect these resources may be subject to federal permitting authority under Sections 404 and 401 of the Clean Water Act, (33 USC 125 et. seq.) and LRRWMO approval under the 1991 Wetland Conservation Act, as amended. Prior to any site disturbing activity, wetlands must be determined on a case by case basis and delineated using methodology approved by the MN Wetland Conservation Act.

The wetlands within the City of Anoka were previously classified by Barr Engineering Company using a Modified Routine Assessment Method to determine the Functions and Value. The results from the evaluation are shown on the following page in Table 2-3. The wetlands listed on Table 2-3 may not be a comprehensive list of all of the wetlands within the city.

Sensitivity levels and associated wetland standards have been developed that are based on the functions and values. Refer to Table 2-4 for the City of Anoka Wetland Management Standards.

Table 2-3 – City of Anoka Wetland Classifications

ID Number	Circular 39	National Wetlands Inventory Code (NWI)	Modified Routine Assessment ¹									Sensitivity*
			Date	Hydrology	Vegetation	Wildlife	Fisheries	Attenuation	Quality	Shore Protection	Aesthetics	
Anoka-1	TypeS	PEMC & PUBG	10/9/98	2	2	2	2	3	3	0	2	Moderate
Anoka-3	TypeS	PUBF	10/9/98	1	1	1	0	3	3	0	1	Least
Anoka-4	TypeS	PEMF, PUBF, & PEMC	10/9/98	2	3	2	0	2	3	0	3	Moderate
Anoka-S	Type3	PEMC & PSS1C	10/9/98	1	3	2	0	2	4	0	2	Moderate
Anoka-6	Types 3 & S	PEMF & PUBF	10/9/98	1	3	3	0	2	4	0	3	Moderate
Anoka-7	Type3	PSS6Cd & PEMCd	10/22/98	1	1	1	0	4	4	0	2	Least
Anoka-8	Types 3 & 6	No information available	10/22/98	1	1	1	0	2	4	0	2	Least
Anoka-9	Types 3 & 6	PEMCd	10/22/98	1	1	1	0	2	1	1	2	Least
Anoka-10	Type3	PEMC, PF01C, PEMF, PUBFx, & PEMCd	10/22/98	1	2	2	0	2	4	0	3	Moderate
Anoka-11	Types 3 & 6	PEMC	10/22/98	1	1	2	0	3	3	0	3	Least
Anoka-12	Type2	PEMCd	10/22/98	1	1	2	0	2	3	0	2	Least
Anoka-13	Types 2 & 3	PEMCd	10/22/98	1	1	1	0	3	3	0	2	Least
Anoka-14	Types 1 & 2	PEMU	10/22/98	1	1	2	0	3	3	0	2	Least
Anoka-1S	TypeS	No information available	10/9/98	1	1	1	0	3	2	0	2	Least
Anoka-16	TypeS	No information available	10/9/98	1	2	2	0	4	2	0	2	Moderate
Anoka-18	Types 2, 3 & 6	PEMC, PF01B, PEMF, & PUBF	10/22/98	2	2	3	0	3	4	3	3	Moderate
Anoka-19	TypeS	PEMC	10/20/98	1	1	1	0	2	1	0	1	Least
Anoka-20	Types 1 & 2	PSS1B	10/20/98	2	1	1	0	2	3	0	3	Least
Anoka-21	Types 2, 3 & 6	PSS6C, PEMC, PEMF, PF06C, & PSS1C	10/22/98	1	1	1	0	2	3	0	2	Least
Anoka-22	Types2, S&6	PF01Ch, PSS1C, PUBFh, PUBF, & L1UBHh	10/1S/98	1	3	3	2	4	3	3	3	Moderate
Anoka-23	TypeS	PUBG	10/9/98	1	1	1	0	3	2	2	2	Least
Anoka-24	TypeS	PUBG	10/9/98	1	1	1	0	3	2	2	2	Least
Anoka-2S	Types 2 & 7	PF01C	10/20/98	1	1	2	1	2	3	0	2	Least
Anoka-26	Types 6 & 7	PF01C	10/1S/98	3	2	2	4	1	1	3	3	Moderate
Anoka-27	TypeS	PSS1C	10/20/98	1	2	2	0	2	3	0	2	Moderate
Anoka-28	Types 3 & S	PSS1C	10/20/98	1	1	2	0	3	3	0	2	Least
Anoka-30	Type2	PEMC	10/20/98	2	1	2	0	2	3	0	2	Moderate
Anoka-32	Types 3, S&6	No information available	10/1S/98	2	3	3	3	1	3	2	3	Moderate
Anoka-33	TypeS	No information available	10/1S/98	1	1	2	2	1	2	2	2	Least
Anoka-34	TypeS	No information available	10/1S/98	1	1	2	2	1	1	2	1	Least

*See Table 2-4

Source: City of Anoka Stormwater Plan, August 2000, Barr Engineering Company

0 = N/A	3 = High
1 = Low	4 = Exceptional
2 = Medium	

Based upon the functions and values, wetland management standards have been developed. These standards are shown below in Table 2-4.

Table 2-4 – City of Anoka Wetland Management Standards

High	Moderate	Least
Special consideration must be given to avoid altering these wetland types. Inundation must be avoided. Water chemistry due to alteration by stormwater impacts can also cause adverse impacts.	These wetlands can tolerate only moderate alterations in hydrology. They have very good wildlife habitat value and a relatively diverse plant community. They will tolerate an additional 6 inches of inundation, but will be adversely impacted by sediment and/or nutrient loading and prolonged high water levels.	These wetlands are usually so degraded that input of urban stormwater may not have adverse impacts.
Maintain the existing Storm Water Bounce or degree of water level fluctuation.	Maintain the existing Storm Water Bounce or degree of water level fluctuation. Limit the maximum addition of water to 6 inches.	No limit for Storm Water Bounce or degree of water level fluctuation.
Maintain the existing Discharge Rate .	Maintain the existing Discharge Rate .	Maintain or decrease the existing Discharge Rate .
For 1& 2 year storm events, maintain existing Inundation periods .	For 1 & 2 year storm events maintain existing Inundation periods . Limit maximum inundation to one additional day.	For 1 & 2 year storm events, maintain existing Inundation periods . Limit maximum inundation to an additional 7 days.
For 10 year storm events and greater, maintain existing Inundation periods .	For 10 year storm events and greater maintain existing Inundation periods . Limit maximum inundation to an additional 7 days.	For 10 year storm events and greater, maintain existing Inundation periods . Limit maximum inundation to an additional 21 days.
Do not change the outlet control elevation .	Do not change the outlet control elevation .	May raise outlet control elevation up to 4 feet above existing outlet elevation.
For landlocked wetlands, keep the Run-out control elevations above the delineated wetland edge.	For landlocked wetlands, keep the Run-out control elevations above the delineated wetland edge.	For landlocked wetlands, keep the Run-out control elevations above the delineated wetland edge.
<u>Recommendations</u> : If not already implemented, a preservation program should be initiated. Active protection from invasive plant species should begin. Purple Loosestrife, reed canary grass, and hybrid cattail should be eradicated from these wetlands.	<u>Recommendation</u> : These wetlands have good potential to restore native plant communities. It is well worth the effort to control invasive species (especially purple loosestrife) in these wetlands.	<u>Recommendation</u> : These wetlands could be altered to improve stormwater storage and to improve water quality and not severely impact the wetland quality.
Sedge Meadows, Open Bogs, Coniferous Bogs, Calcareous Fens, Low Prairies, Coniferous Swamps, Lowland Hardwood Swamps, Seasonally Flooded Basins.	Shrub-carrs, Alder Thickets, Fresh (Wet) Meadows, Shallow Marshes, Deep Marshes	Gravel Pits, Cultivated Hydric Soils, Dredged Material/Fill material Disposal Sites.

Note:

These management levels are based on the criteria set forth in the “Storm-water and Wetlands: Planning and Evaluations Guidelines for addressing Potential Impacts of Urban Storm-water and Snow-melt Runoff on Wetlands” prepared by the State of Minnesota Storm-Water Advisory Group, published June 1997.

Source: City of Anoka Stormwater Plan, August 2000, Barr Engineering Company

2.9 Impaired Waters

The Rum River and the Mississippi River are both listed on the Minnesota Pollution Control’s list of impaired waters. It is required that waters that do not meet the federal water quality standards be listed. Impaired waters in the City of Anoka are listed in table 2-5 below.

Table 2-5 – Impaired Waters

Watercourse	Affected Use	Pollutant or Stressor	TMDL Status
Rum River	Aquatic Consumption	Mercury	Approved 2008
Mississippi River	Aquatic Consumption	Mercury PCB in Fish Tissue	Approved 2007 Target Completion 2020
	Aquatic Life	Nutrients	Target Completion 2018
	Aquatic Recreation	Fecal Coliform	Target Completion 2024

Both the Rum River and the Mississippi River are impaired for Mercury. Most of the mercury that impairs our lakes and rivers is delivered by the atmosphere. Mercury is carried down into our lakes and rivers by rain and snow. Once in the water, the mercury is converted by bacteria in highly organic portions of the aquatic systems into methylmercury. Zooplankton pick up the methylmercury as they filter water and feed on algae. When small fish eat the Zooplankton, the mercury builds up in their bodies. When larger fish eat the smaller fish, the mercury continues to accumulate all of the way up the food chain. Therefore, the longest living fish at the top of the food chain tend to have the highest concentrations of mercury in their bodies.

Studies indicate that human consumption of fish with high levels of mercury is linked to impaired neurological development and is particularly critical to fetuses, infants, and children. Since the mercury comes from the atmosphere, the only way to reduce the levels is by reducing at the source. Although the primary source of mercury in Minnesota comes from coal-fired electric generation plants, the following sources have also been found to introduce mercury into the atmosphere: industrial/commercial and institutional boilers, petroleum refining, ferrous mining/processing, sewage sludge incineration, cremation, and dental preparations.

The Mississippi River is also impaired for polychlorinated biphenyls (PCB) in fish tissue. PCB's are a group of chemicals that have extremely high boiling points and are practically non-flammable. Because of these properties, PCB's were used in many industrial and commercial products such as electrical components, heat transfer, and hydraulic equipment until they were banned in the late 1970's. PCB's accumulates in fish much like mercury does and has been classified as a probable human carcinogen and is listed in the top ten percent of the EPA's most toxic chemicals. Much like mercury, PCB's are nearly impossible to remove from the environment.

For both impairments, following the Minnesota Department of Health's guidelines for fish consumption is the recommended best management practice for minimizing potential adverse impacts to human health.

The Mississippi River in 2006 was listed as impaired for fecal coliform. However, in 2012, a section of the Mississippi River was delisted for fecal coliform concerns due to the water quality standard being met. This section includes the northwest city limits of Anoka to the Rum River. Areas downstream of the Rum River are still considered to be impaired for fecal coliform. Fecal coliform is commonly found in human and animal feces and is an indicator that possible pathogenic bacteria and viruses that also live in human and animal digestive systems are present in the water. Therefore, swimming in the river may pose a health risk if water is digested. The following sources may contribute to higher levels of fecal coliform: malfunctioning wastewater treatment plants, faulty on-site septic systems, domestic and wild animal manure, and stormwater runoff.

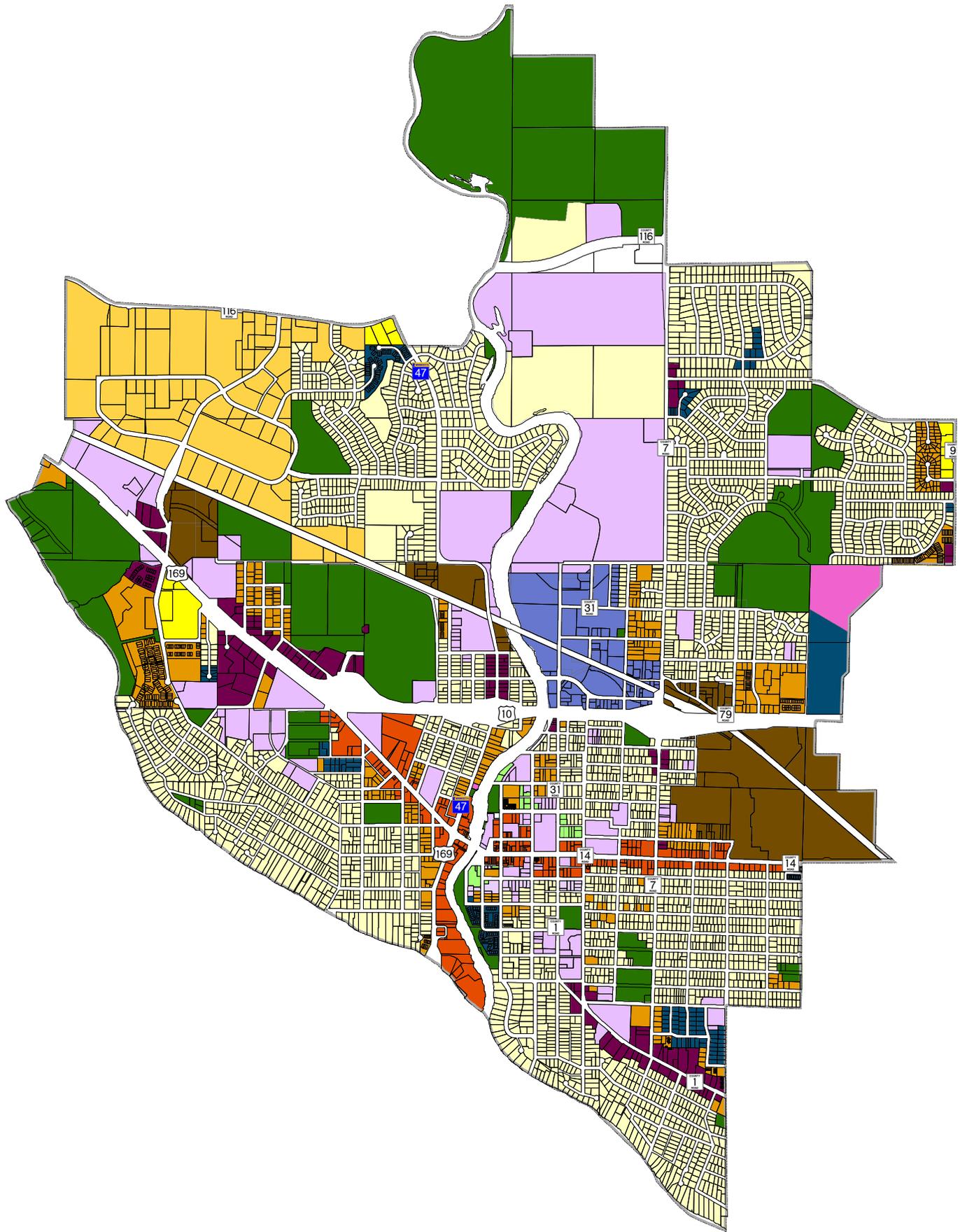
In the most recent approved 2016 impaired waters list added a nutrient impairment to the Mississippi River. Nutrient impairment occurs when there is abundant phosphorus, which is a food source for algae, in the water. Not only is algae aesthetically disagreeable, but algae can also block sunlight for aquatic plants and deplete oxygen levels for other species living in the river. Most organic material contain phosphorus, so leaves, grass clipping, fertilizer, and pet waste that enter the stormwater can contribute to nutrient impairment. Additionally, phosphorus can bind to sediment, so sediment from noncompliant construction sites or exposed stockpiles can also lead to increases in nutrient concentrations in downstream waters.

Currently, there are no TMDL requirements for the City of Anoka. There was a 2014 TMDL report for bacteria in the Upper Mississippi River Basin, but the two stream reaches in the City of Anoka,

07010206-568 and 07010206-511, were considered protection reaches. There were no TMDL requirements for areas within the protection reaches.

2.10 Scenic and Recreational Rivers

The segment of the Rum River that bisects Anoka from its northern border to Madison and Rice Streets in Anoka is designated as a scenic and recreational river and is subject to MN Rules 6105.1440-1480. The City will implement land use ordinances and all other activities consistent with the management plan as prepared by the Minnesota Department of Natural Resources. Also, because the Rum River is listed as an Outstanding Value Resource Water (ORVW), no person may cause a new or expanded discharge of any sewage, industrial waste, or other waste unless there is not a prudent and feasible alternative.



2030 Land Use

- | | | |
|--------------------------|----------------------------|------------------------------|
| General Commercial | Limited Commercial | Planning Area |
| General Industrial | Local Commercial | Shopping Center |
| High Density Residential | Medium Density Residential | Single Family Residential |
| Institutional | Mixed Use | Transit Oriented Development |
| Light Industrial | Park and Recreation | Undeveloped Space |

FIGURE 2-1

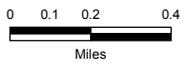
**2030 LAND USE
CITY OF ANOKA**



LEGEND

-  Protected Water
-  Ditches
-  Parcels

**FIGURE 2-2
PUBLIC WATERS
& DITCHES
CITY OF ANOKA**

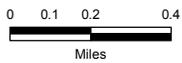
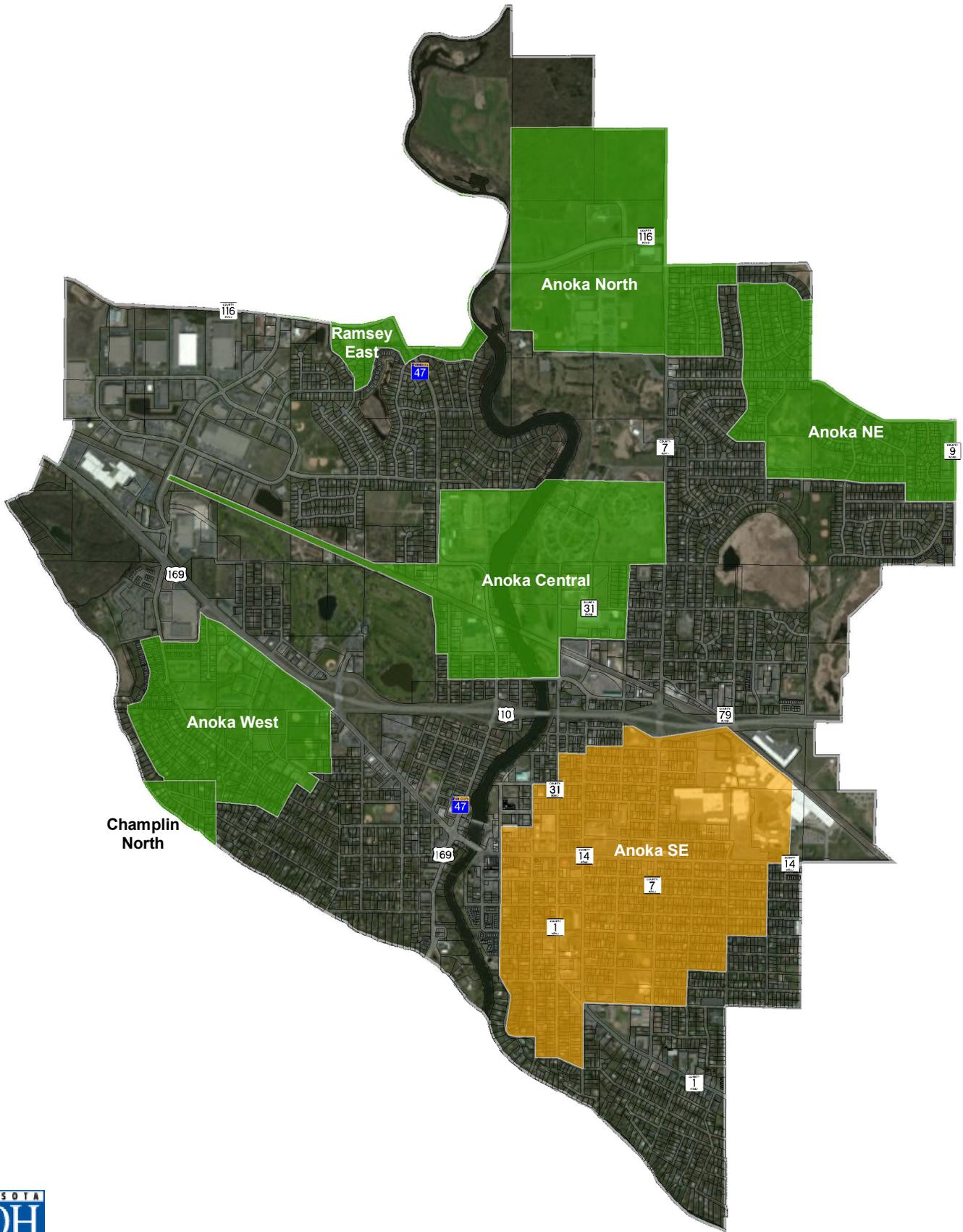


LEGEND

- NWI System Type
- Lacustrine
- Palustrine
- Parcels

**FIGURE 2-3
NWI (WETLAND)
MAP
CITY OF ANOKA**





LEGEND

- | | | |
|----------------------------|----------|----------|
| DWSMA Vulnerability | High | Low |
| Very High | Moderate | Very Low |

**FIGURE 2-4
DWSMA
VULNERABILITY
CITY OF ANOKA**

3.1 General Watershed Description

The Mississippi River East Watershed and the subwatersheds that comprise it are shown in detail in Figure 3-1. This watershed consists of the land in the City of Anoka that drains directly to the Mississippi River on the east side of the Rum River.

The Mississippi River East Watershed includes the southernmost portion of the city. The area of this watershed is approximately 445 acres. The watershed is mostly developed, with land use consisting of single family residential, multiple family residential, and a small section of commercial land use. The city has made various stormwater related improvements within this watershed over the past decade as part of its annual street renewal program. Four water quality treatment structures have been constructed within this watershed to treat the stormwater and remove pollutants prior to discharging into the Mississippi River.

3.1.1 Drainage Patterns

This watershed drains south via storm sewers to the Mississippi River. There are eight stormwater outfalls that discharge to the Mississippi River, east of Rum River. From east to west, the eight storm sewer network minor watersheds modeled for this project are:

River Lane (RVR)

Eastwood Lane (EWD)

Kings Lane (KGS)

Oakwood Drive (OWD)

5th Avenue (5TH)

3rd Avenue (3RD)

Oakwood Lane (OWL)

Washington Street (WAS)

Each storm sewer system is named for the location of the minor watershed outlet. Subwatersheds within these minor watersheds were delineated, named and numbered according to the minor watershed. For example, the system draining to 5th Avenue is so named because the outlet for the stormwater system is on 5th Avenue. The eleven subwatersheds are numbered consecutively from the outlet.

There are no existing stormwater detention basins within this subwatershed.

3.1.2 Flood Protection Concerns

Where the storm sewer system capacity is not sufficient, surface overflow will occur via the streets to the lowest point within the watershed. For the Mississippi River East Watershed, overflow occurs toward the river. If sufficient capacity for the critical 10-year storm at these outlet points is not maintained, it is possible ponding will occur in the street and yards at this storm frequency until surface overflow occurs. It appears that flooding of homes or businesses will not occur since the surface overflow is at an elevation below the lowest structure.

3.2 Stormwater System Analysis and Results

The 10-year and 100-year event flood analyses were performed for the Mississippi River East Watershed. Table 3-1 presents watershed information and the peak runoff rates of the 10-year and 100-year critical storm events.

3.3 Implementation Considerations

When originally constructed, many of the storm sewer outfalls discharged storm water directly into the Mississippi River. Several of the outfalls have been retrofitted to provide stormwater treatment prior to discharging to the Mississippi River. One additional water quality structure and one stormwater basin are proposed. These issues are discussed in the following paragraphs.

3.3.1 Construction of Additional Stormwater Basins

The construction of a stormwater basin located in subwatershed 9th_5 would allow for smaller pipe sizes to be used while also providing treatment to the runoff before it discharges into the river. Table 3-2 lists the necessary storage for the basin.

3.3.2 Construction of Water Quality Structures

As depicted in Figure A (in Appendix A), one additional water quality structure is proposed which will reduce the amount of suspended solids and phosphorus load to the Mississippi River. Water quality structures will be designed to achieve an annual removal efficiency of 60% of the total phosphorus and 90% of the total suspended solids.

3.3.3 Storm Sewer Capacity

As shown on Figure B (Appendix A), storm sewer upgrades are proposed on South Street to provide capacity for the 10-year storm event.

Table 3-1: Results of the Mississippi River East Watershed

10-Year and 100-Year Critical Storm Events (TP-40)

Minor Watershed	Subwatershed	Drainage Area (acres)	Impervious Percentage	Peak Runoff Rate (cfs) 10-yr storm	Peak Runoff Rate (cfs) 100 yr storm
3RD	1	2.3	47	4	10
3RD	2	1.1	42	2	3
3RD	3	5.4	51	9	18
5TH	1	4.9	100	10	20
5TH	2	1.9	38	2	5
5TH	3	6.7	36	7	17
5TH	4	8.8	38	12	27
5TH	5	4.1	38	4	10
5TH	6	2.9	30	6	12
5TH	7	3.6	0	8	15
5TH	8	2.3	60	5	9
5TH	9	7.0	45	20	34
5TH	10	5.4	38	5	13
5TH	11	6.5	33	7	14
EWD	1	38	38	4	9
KGS	1	2.0	37	2	6
KGS	2	4.5	31	4	10
KGS	3	2.9	22	1	5
KGS	4	3.3	36	3	9
KGS	5	1.5	43	2	5
KGS	6	2.2	35	2	6
KGS	7	2.1	46	3	7
KGS	8	4.4	31	3	10
KGS	9	4.1	33	3	7
KGS	10	1.3	32	1	3
KGS	11	1.4	37	2	4
KGS	12	1.2	35	1	3
KGS	13	0.7	21	0	1
KGS	14	3.1	32	3	7
KGS	15	5.4	35	5	13
KGS	16	3.2	40	4	9
KGS	17	1.7	13	0	2
KGS	18	3.3	26	2	6
KGS	19	1.9	40	2	5
KGS	20	1.6	47	3	5

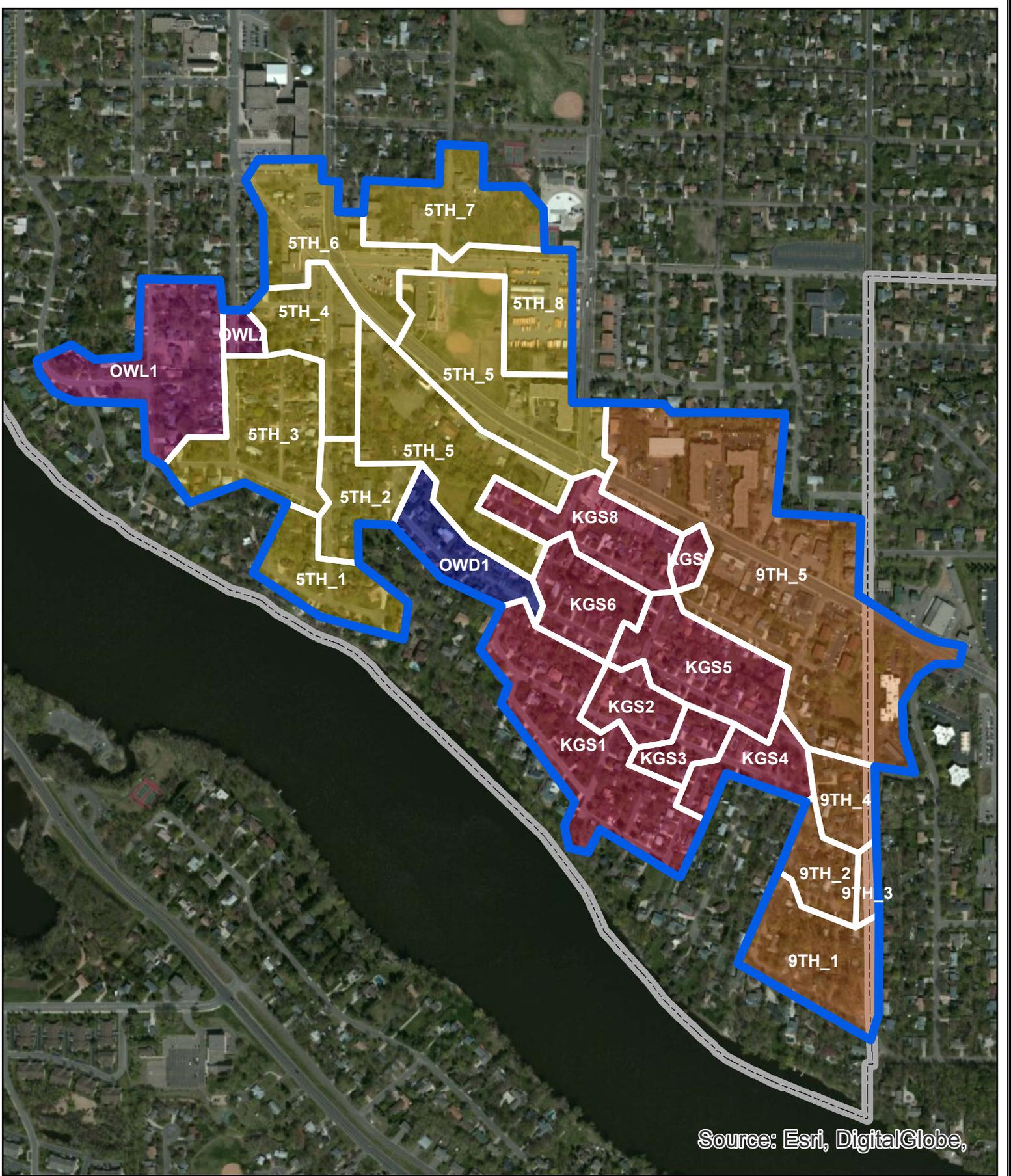
Table 3-1: Results of the Mississippi River East Watershed (continued)**10-Year and 100-Year Critical Storm Events (TP-40)**

Minor Watershed	Subwatershed	Drainage Area (acres)	Impervious Percentage	Peak Runoff Rate (cfs) 10-yr storm	Peak Runoff Rate (cfs) 100 yr storm
KGS	21	8.3	38	8	20
KGS	22	2.2	51	4	9
KGS	23	5.3	55	12	22
KGS	24	2.5	56	6	11
KGS	25	1.0	57	2	4
KGS	26	6.3	48	11	22
KGS	27	1.9	89	10	15
KGS	28	8.1	44	11	24
KGS	29	2.2	79	10	14
KGS	30	8.8	73	34	56
KGS	31	4.9	79	21	34
OWL	1	2.4	37	3	7
OWL	2	1.9	32	1.5	4
OWL	3	5.2	28	4	14
OWD	1	1.3	31	1	3
OWD	2	2.6	38	3	7
RVR	1	8.7	38	8	20
WAS	1	6.6	28	4	13

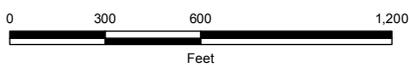
Table 3-2: Results of 100-Year Storm Event (TP 40) Basin Requirements for Mississippi River East Watershed

Subwatershed	Drainage Area acres	Dead Storage acre-feet	Live Storage acre-ft	Total Storage acre-ft	100yr Discharge cfs	Outlet Size
Proposed Ponds						
9TH_5	30.8	2.0	4.8	6.8	3	12"

Source: Anoka Stormwater Plan, August 2000, Barr Engineering Company



Source: Esri, DigitalGlobe,



**Hakanson
Anderson**

K:\cad_eng\PROJECTS\GIS\AN409\Mississippi River East

LEGEND

- Major Watershed
- Sub Watershed
- Minor Watersheds**
- 5TH
- 9TH
- KGS
- OWB
- OWD

**FIGURE 3-1
MISSISSIPPI RIVER
EAST WATERSHED
CITY OF ANOKA**

4.1 General Watershed Description

The Mississippi River West Watershed includes the southern portion of the city west of the Rum River, which drains directly into the Mississippi River. This watershed is approximately 287 acres. It is made up of mostly single-family residential with small sections of multiple-family residential and commercial land use. Figure 4-1 shows the watershed and subwatershed boundaries. The city has made various stormwater related improvements within this watershed recently as part of its annual street renewal program. Two water quality treatment structures have been constructed within this watershed to treat the stormwater and remove pollutants prior to discharging into the Mississippi River.

4.1.1 Drainage Patterns

Portions of the Mississippi River West Watershed are serviced by storm sewers. Subwatersheds within this watershed were delineated and named according to the location of the minor watershed outlet. For example, the Levee Avenue subwatershed is so named because the outlet for the stormwater system is on Levee Avenue. All of the subwatersheds ultimately discharge to the Mississippi River. This watershed has two existing stormwater and remove pollutants basins in the private town home development.

There are eight stormwater outfalls that discharge to the Mississippi River, west of Rum River. From east to west, the storm sewer network minor watersheds modeled for this project are:

Mississippi West (MW)

Levee Avenue (LEV)

Shaw Avenue (SHAW)

West Lane (WEST)

Porter Avenue (PTR)

Benton Street (BEN)

Private Town Home Development (PV)

4.1.2 Flood Protection Concerns

Where the storm sewer system capacity is not sufficient, surface overflow will occur via the streets to the lowest point within the watershed. For the Mississippi River West Watershed, the water reaching the low points is conveyed via pipe to the Mississippi River. If sufficient capacity for the critical 10-year storm at these outlet points is not maintained, it is possible that ponding will occur in the streets and yards at this storm frequency until the surface overflow occurs. However, as with the Mississippi River East watershed, it appears that flooding of homes is not likely to occur as the land is sloped towards the Mississippi River and the surface overflow is at an elevation below the lowest structure.

4.2 Stormwater System Analysis and Results

The 10-year and 100-year event analyses were performed for the Mississippi River West Watershed. Table 4-1 presents watershed information and the peak runoff rates of the 10-year and 100-year flood analyses for each of the subwatersheds.

4.3 Implementation Considerations

When originally constructed, many of the storm sewer outfalls discharged storm water directly into the Mississippi River. However, two of the outfalls have been retrofitted with water quality structures to treat the stormwater and reduce pollutants prior to discharging to the Mississippi River. Three additional water quality structures are proposed within this watershed as well as one stormwater basin. These issues are discussed in the following paragraphs.

4.3.1 Construction of Additional Stormwater Basins

Currently, Sorensen Park is sufficient for stormwater storage for the 100-year event. Table 4-2 lists the necessary storage for the 100-year event. Construction of a basin at this location may reduce the recommended pipe upgrade sizes downstream while also providing water quality treatment.

4.3.2 Construction of Water Quality Structures

As depicted in Figure A (in Appendix A), three additional water quality structures are proposed which will greatly reduce the amount of suspended solids and phosphorus load to the Mississippi

River. Water quality structures will be designed to achieve an annual removal efficiency of 60% of the total phosphorus and 90% of the total suspended solids.

4.3.3 Storm Sewer Capacity

From the hydraulic model results, many of the city's storm sewer pipes cannot handle the runoff from a 10-year event. This may not be a serious problem, but more of an inconvenience since this area of the city is fortunate enough to be sloped towards the river. In the areas of steep slopes, much of the excess stormwater runoff that cannot be managed in the existing pipes, can flow downstream in the system of roads, curbs and gutters, and overflow swales. The areas where the overflow system may create problems are: (1) where the natural terrain is too flat, (2) where low areas exist and unwanted ponding occurs (i.e. at intersections and in developed parts of the city), and (3) when roads carrying the excess runoff make sharp turns.

As depicted on Figure B (Appendix A) upgrades to the storm sewer on Porter Avenue and West Lane are necessary to accommodate the 10-year storm event.

**Table 4-1: Results of the Mississippi River West Watershed
10-Year and 100-Year Critical Storm Events (TP 40)**

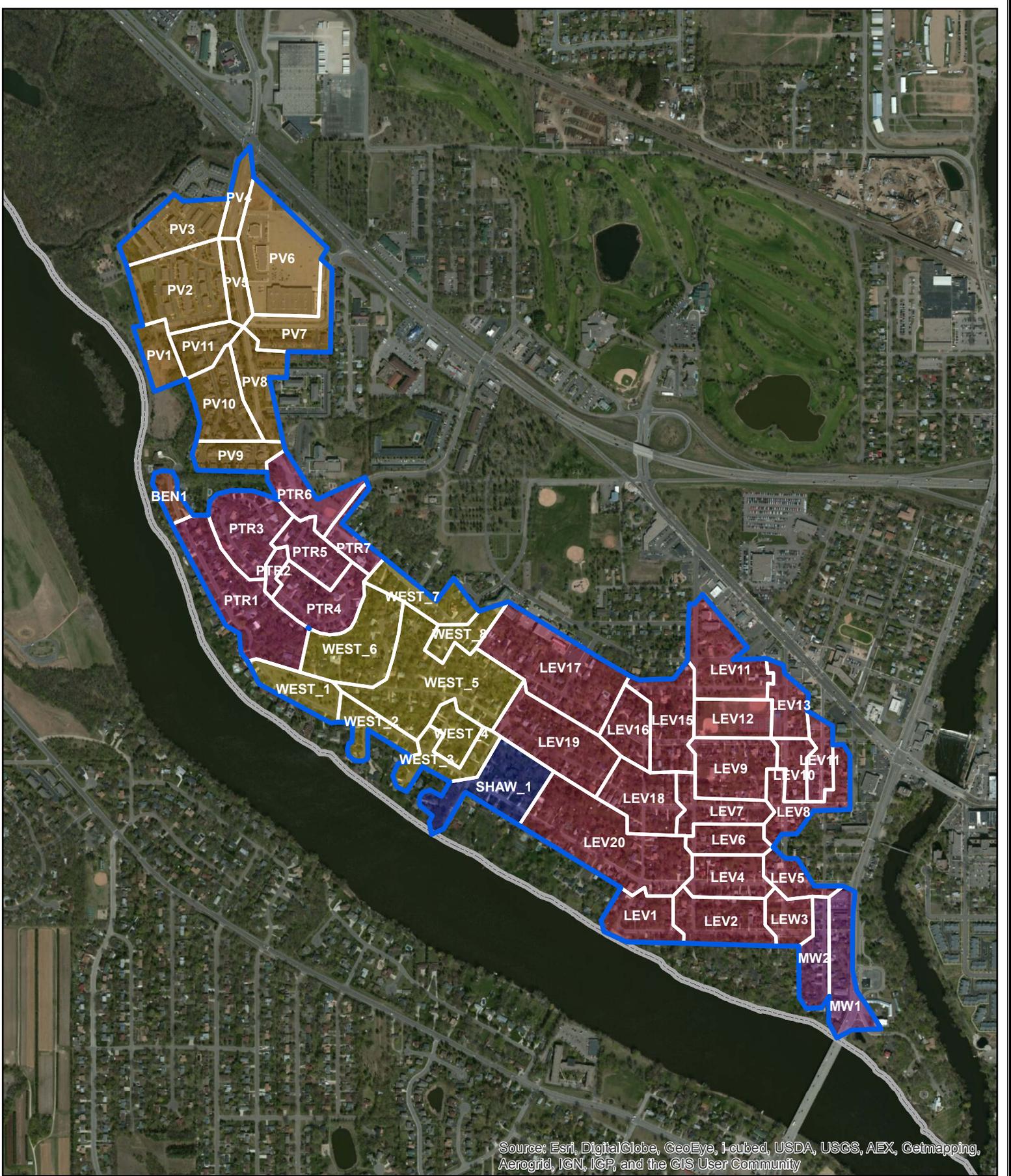
**Table 4-1: Results of the Mississippi River West Watershed (continued)
10-Year and 100-Year Critical Storm Events (TP 40)**

Minor Watershed	Subwatershed	Drainage Area (acres)	Impervious Percentage	Peak Runoff Rate (cfs) 10-yr storm	Peak Runoff Rate (cfs) 100 yr storm
PV	9	4.0	65	12	20
SHAW	1	1.0	100	1	3
SHAW	2	10.3	38	10	24
SHAW	3	3.0	38	3	8
SHAW	4	15.4	38	15	36
SHAW	5	1.9	38	2	5
SHAW	6	4.3	38	4	10
SHAW	7	4.0	38	3	8
SHAW	8	8.3	38	5	14
WEST	1	5.4	38	6	15
WEST	2	6.0	38	7	17
WEST	3	11.1	38	11	26
LEV	15	12.1	38	12	27
LEV	16	2.5	38	3	7
LEV	16A	2.8	100	14	20
LEV	17	10.9	54	5	17
LEV	18	3.9	51	1	6
LEV	19	3.8	38	4	11
LEV	20	1.4	38	2	4
BEN	1	1.9	38	2	5
BEN	2	5.5	38	6	15
CG	1	6.9	38	7	16
MW	1	6.6	52	12	22
PTR	1	8.5	38	8	20
PTR	2	8.0	38	9	22
PTR	3A	1.7	100	9	12
PTR	3B	6.3	0	0	1
PTR	4	5.7	38	7	16
PTR	5	8.7	38	10	25
PV	1	9.4	65	27	47
PV	2	2.3	100	11	16
PV	3	10.6	85	45	69
PV	4	4.4	65	12	22
PV	5	5.0	38	5	12
PV	6	8.5	65	21	37
PV	7	7.4	63	17	31
PV	8	5.2	84	18	29

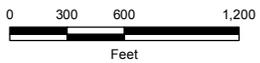
Table 4-2: Results of 100-Year Storm Event (TP 40) Basin Requirements for Mississippi River West Watershed

Subwatershed	Drainage Area acres	Dead Storage acre-feet	Live Storage acre-ft	Total Storage acre-ft	100yr Discharge cfs	Outlet Size
<i>Existing Basins with Improvements</i>						
PV3	18.7	1.6	0.8	2.4	20	36"
PV11	35.0	2.4	6.2	8.6	65	
<i>Proposed Ponds</i>						
LEV12	37.5	1.0	15.4	16.4	5	

Source: Anoka Stormwater Management Plan, August 2000, Barr Engineering Company



Source: Esri, DigitalGlobe, GeoEye, I-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



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LEGEND

- Major Watershed
- Sub Watershed
- Minor Watersheds**
- BEN
- LEV
- MW
- PTR
- PV
- SHAW
- WEST

**FIGURE 4-1
MISSISSIPPI RIVER
WEST WATERSHED
CITY OF ANOKA**

5.1 General Watershed Description

Figure 5-1 shows the Anoka Enterprise Watershed and its subwatersheds. This region is located in the northwest corner of the city. It is routed to the Mississippi River through a significant storm sewer network.

This watershed includes the industrial park of the city and the Anoka-Hennepin Technical College. The 362-acre watershed includes a small area of single family residential with the remainder classified as industrial land use. This watershed has remained largely unchanged over the past 10 years, and therefore it was not necessary to remodel the entire watershed with this study.

5.1.1 Drainage Patterns

The Anoka Enterprise watershed is served by the city's stormwater system. The stormwater system is comprised of storm sewers, ditches, and basins. Anoka Enterprise watershed is made up of one minor watershed that discharges to the Mississippi River near King's Island. The minor watershed is:

Anoka Enterprise (AEP)

There are four existing basins in this watershed which can be used for stormwater treatment and detention.

5.1.2 Flood Protection Concerns

Where the storm sewer system capacity is not sufficient, surface overflow will occur via the streets to the lowest point within the subwatershed. Unlike the other Mississippi River watersheds, the Anoka Enterprise Watershed will not overflow to the river, but rather to the existing basins. There are no known problems in this watershed. Structures surrounding the basins appear to have sufficient freeboard for flood protection.

5.2 Stormwater System Analysis and Results

The 10-year and 100-year flood events were analyzed for the Anoka Enterprise Watershed. Table 5-1 presents watershed information and the peak flow rates of the 10-year and 100-year analyses for each of the subwatersheds shown on Figure 5-1.

5.3 Implementation Considerations

This region of the city provides sufficient storm sewer capacity to meet the 10-year level of service and 100-year level of protection downstream of the basins. Both the basin storage capacity and outlet sizes are adequate. The other basins will be sufficient with the existing outlet if the necessary storage in Table 5-2 is provided.

5.3.1 Construction of Water Quality Basins

The existing basins will provide sufficient water quality treatment if the necessary “dead storage” volume as stated in Table 5-2 is provided. No new basins are required although the storm sewer network should have an added water quality structure to treat the stormwater and reduce the pollutants that discharge into the river from those watersheds downstream of the water quality basins. Table 5-2 lists the necessary “dead storage” required to achieve an annual removal efficiency of 60% of the total phosphorus and 90% of the total suspended solids.

**Table 5-1: Results of the Anoka Enterprise Watershed
10-Year and 100-Year Critical Storm Events (TP 40)**

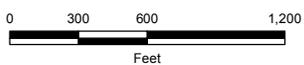
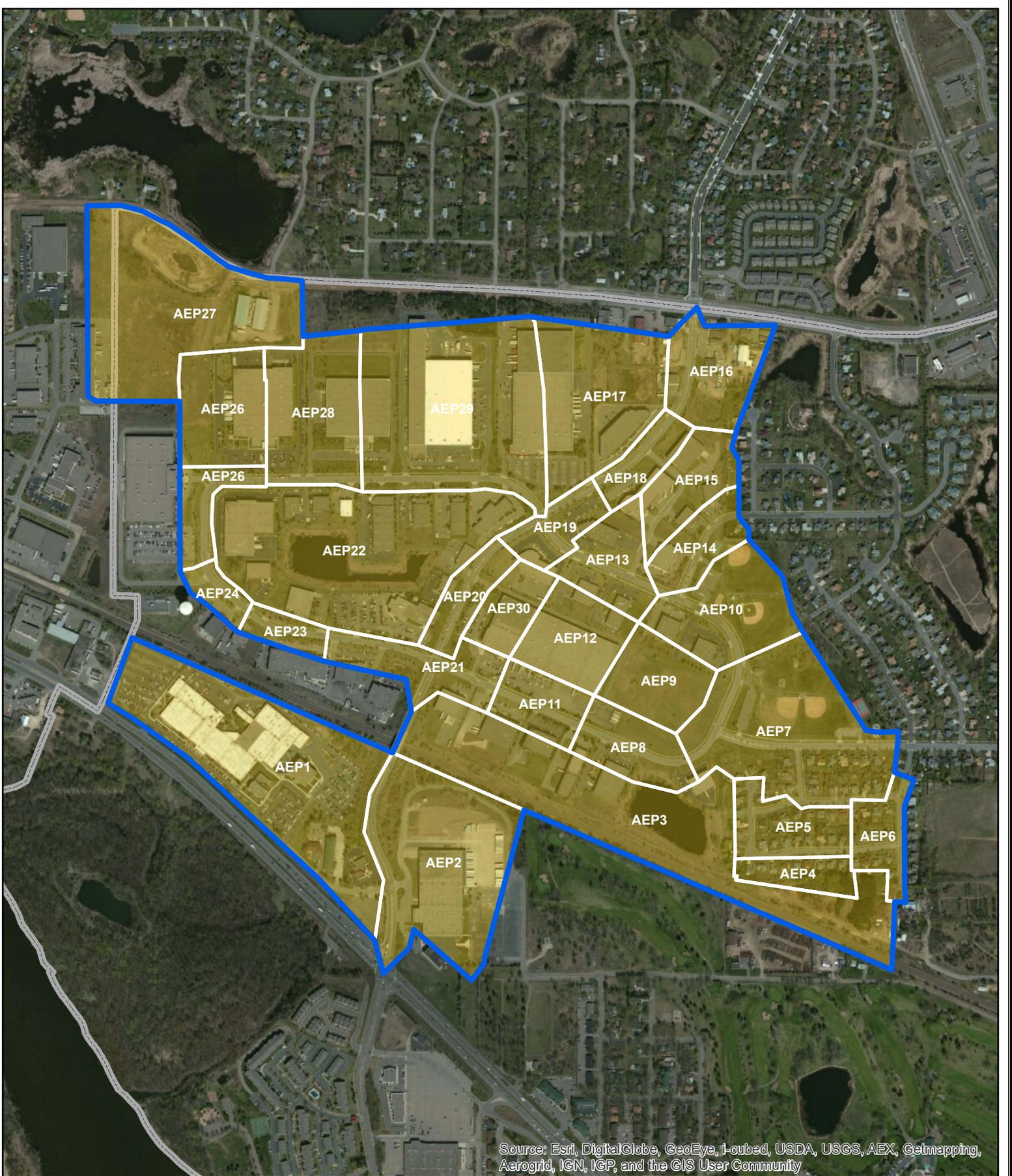
Minor Watershed	Subwatershed	Drainage Area (acres)	Impervious Percentage	Peak Runoff Rate (cfs) 10-yr storm	Peak Runoff Rate (cfs) 100 yr storm
AEP	1	2.5	90	5	8
AEP	2	23.8	65	70	115
AEP	3	27.1	48	44	75
AEP	4	3.0	20	5	9
AEP	5	6.3	20	8	17
AEP	6	5.7	20	10	20
AEP	7	25.5	16	25	53
AEP	8	6.5	65	26	29
AEP	9	6.5	65	17	28
AEP	10	11.4	35	24	39
AEP	11	6.7	65	23	18
AEP	12	8.4	65	33	312
AEP	13	7.2	65	25	56
AEP	14	5.1	65	13	22
AEP	15	6.8	65	18	29
AEP	16	6.2	63	15	24
AEP	17	23.3	62	57	94
AEP	18	6.5	65	24	53
AEP	19	4.7	65	17	16
AEP	20	4.0	65	3	21
AEP	21	7.6	65	20	35
AEP	22	28.7	65	79	341
AEP	23	2.8	65	13	21
AEP	24	2.4	65	11	17
AEP	25	5.5	65	16	26
AEP	26	13.6	65	39	64
AEP	27	31.0	57	77	129
AEP	28	15.8	65	63	104
AEP	29	22.9	65	54	89
AEP	30	3.9	65	16	27

Source: City of Anoka Stormwater Plan, August 2000, Barr Engineering Company

Table 5-2: Results of 100-Year Storm Event (TP 40) Basin Requirements for Anoka Enterprise Watershed

Subwatershed	Drainage Area acres	Dead Storage acre-feet	Live Storage acre-ft	Total Storage acre-ft	100yr Discharge cfs	Outlet Size
<i>Existing Basins with Improvements</i>						
AEP22	100.2	6.5	17.0	23.5	24	30" & 24"
AEP17	23.3	3.0	3.1	6.1	12	
AEP27	31.0	2.4	5.2	7.6	6	24"
AEP3	131.9	7.0	18.2	25.2	32	36"

Source: City of Anoka Stormwater Plan, August 2000, Barr Engineering Company



**Hakanson
Anderson**

LEGEND

-  Major Watershed
-  Sub Watershed
-  Minor Watersheds
-  AEP

**FIGURE 5-1
ANOKA ENTERPRISE
WATERSHED
CITY OF ANOKA**

6.1 General Watershed Description

Figure 6-1 shows the Rum River Northeast minor watersheds and subwatersheds. The region is located north of U.S. Highway 169 and 10 and east of the Rum River.

The Rum River Northeast Watershed is the largest with an area of 670 acres, approximately 1 square mile. The general land uses of this watershed include single family residential and multiple family residential. This drainage basin includes the new high school and library facilities. This watershed has remained largely unchanged over the past 10 years, and therefore it was not necessary to remodel the entire watershed with this study.

6.1.1 Drainage Patterns

This entire watershed is serviced by the city's storm sewer. There are a series of basins which provide both quantity and quality control. Ultimately, surface water is conveyed via storm sewer west to the Rum River.

There are three stormwater outlets that discharge directly to the Rum River; however the watershed was divided into five minor watershed because of the complexity and large area of the systems. From north to south, the storm sewer minor watersheds modeled for this project are:

38th Lane (38TH)

Bryant Avenue (BRY)

Sunny Acres Pond (SA)

Grant Street (GRT)

4th Avenue (4AV)

This watershed has four existing basins, two of which were designed as stormwater detention basins. The Anoka High School and Anoka Metro Regional Treatment Center located immediately east of the Rum River were not analyzed. Both of these facilities drain directly to the Rum River. If future improvements are made to the existing system at these facilities, water quality

treatment must be provided. Because surface overflow of these areas will drain to the river, flooding of the structures is not a concern.

6.1.2 Flood Protection Concerns

Excess water that the existing storm sewer system cannot handle flows toward the basins within this watershed. If the storage and outflow capacities of the basins in this watershed are not sufficient, the basins will overflow, which could impact existing structures adjacent to these ponding basins. Detailed survey information is required to determine the capacity of the existing basins.

6.2 Stormwater System Analysis and Results

The 10-year and 100-year events were previously analyzed for the Rum River Northeast Watershed. Table 6-1 summarizes the peak runoff rates of the 10-year and 100-year analyses for each of the subwatersheds shown on Figure 6-1.

6.3 Implementation Considerations

Existing and future drainage problems within the watershed can be resolved with a combination of increased storm sewer capacity and storage volume within the existing basins. These are discussed in the following paragraphs.

6.3.1 Construction of Additional Stormwater Basins

New stormwater detention basins are not necessary if the existing basins provide the required amounts of storage. Table 6-2 lists the stormwater storage volumes necessary for 100-year storage.

6.3.2 Construction of Water Quality Basins

The construction of additional water quality basins is not necessary within this watershed.

6.3.3 Storm Sewer Capacity

As shown in Figure B (Appendix A), storm sewer upgrades are proposed on Ninth Lane, Grant Street, Grant Circle, Garfield Street, Bryant Circle, and 7th Avenue.

Table 6-1: Results of the Rum River Northeast Watershed

10-Year and 100-Year Critical Storm Events (TP 40)

Minor Watershed	Subwatershed	Drainage Area (acres)	Impervious Percentage	Peak Runoff Rate (cfs) 10-yr storm	Peak Runoff Rate (cfs) 100 yr storm
4AV	1	15.1	61	34	56
38 TH	1	27.3	12	52	97
38 TH	2	13.2	34	28	49
38 TH	3	13.6	21	16	32
38 TH	4	10.9	20	14	28
38 TH	5	29.6	20	27	56
38 TH	6	13.8	20	20	39
38 TH	7	13.1	14	13	26
38 TH	8	5.5	5	6	14
38 TH	9	6.3	20	9	18
BRY	1	50.8	18	58	113
BRY	2	7.8	20	12	23
BRY	3	1.3	20	3	51
BRY	4	1.8	25	4	9
BRY	5	10.8	20	15	31
BRY	6	7.9	20	14	25
BRY	7	3.7	21	7	13
BRY	8	10.4	20	29	50
BRY	9	46.4	14	106	198
BRY	10	9.9	20	12	24
BRY	11	8.1	20	10	20
BRY	12	23.1	20	27	54
BRY	13	3.7	20	6	11
BRY	14	3.5	20	7	13
BRY	15	12.4	20	13	28
BRY	16	5.7	20	14	26
GRT	1	27.5	54	29	53
GRT	2	15.4	35	25	47
GRT	3	3.1	32	7	13
GRT	4	3.3	41	15	24
GRT	5	9.0	63	17	28
SA	1	97.7	11	225	401
SA	2	48.6	20	55	112
SA	3	5.5	20	7	14
SA	4	7.3	45	13	23
SA	5	39.7	20	50	101
SA	6	17.8	37	24	46
SA	7	7.5	36	14	26

Table 6-1: Results of the Rum River Northeast Watershed (continued)**10-Year and 100-Year Critical Storm Events (TP 40)**

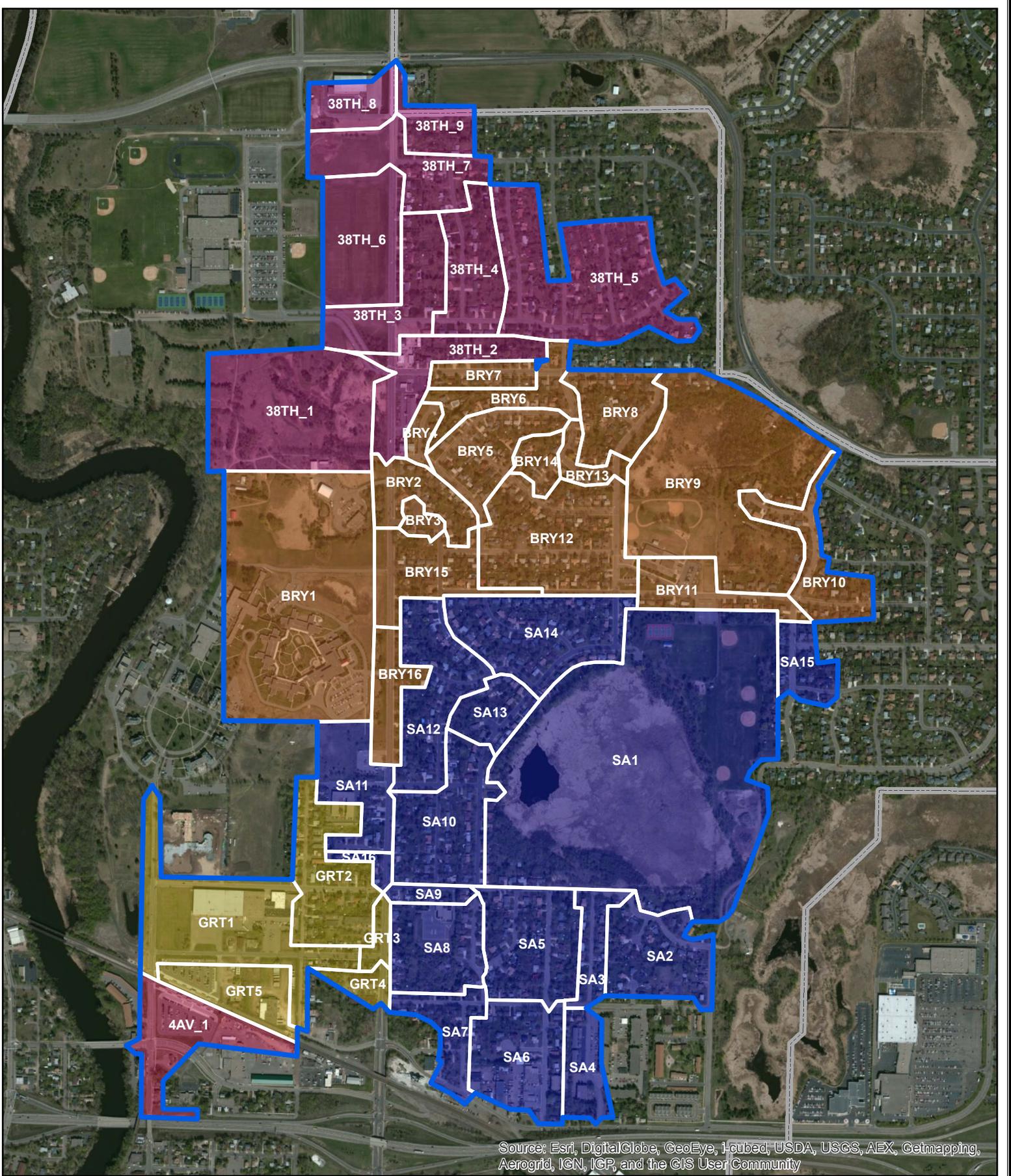
Minor Watershed	Subwatershed	Drainage Area (acres)	Impervious Percentage	Peak Runoff Rate (cfs) 10-yr storm	Peak Runoff Rate (cfs) 100 yr storm
SA	8	11.3	20	20	40
SA	9	3.1	20	5	11
SA	10	15.0	20	16	32
SA	11	9.2	15	13	27
SA	12	15.6	20	21	42
SA	13	5.3	20	9	18
SA	14	20.2	20	22	46
SA	15	5.2	20	6	12
SA	16	2.0	21	3	7

Source: City of Anoka Stormwater Plan, August 2000, Barr Engineering Company

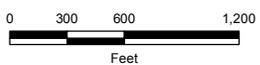
Table 6-2: Results of 100-Year Storm Event (TP 40) Basin Requirements for Rum River Northeast Watershed

Subwatershed	Drainage Area acres	Dead Storage acre-feet	Live Storage acre-ft	Total Storage acre-ft	100yr Discharge cfs	Outlet Size
<i>Existing Basins with Improvements</i>						
SA1	290.1	12.0	43.9	55.9	6	24"
38TH_1	133.2	4.8	33.0	37.8	3	
BRY9	86.3	3.0	23.8	26.8	5	
BRY1	50.8	1.8	31.7	33.5	3	
GRT1	60.4	4.0	-	4.0		

Source: City of Anoka Stormwater Plan, August 2000, Barr Engineering Company



Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



Hakanson
Anderson

LEGEND

-  Major Watershed
-  Sub Watershed
-  Minor 38TH
-  4AV
-  BRY
-  GRT
-  SA

FIGURE 6-1
**RUM RIVER NORTH-
EAST WATERSHED**
CITY OF ANOKA

7.0 Rum River Northwest Watershed

7.1 General Watershed Description

The Rum River Northwest Watershed is 276 acres. Figure 7-1 shows the Rum River Northwest minor watersheds modeled for this plan. The general land uses in this watershed include single family residential, industrial, and open/agricultural. This watershed has remained largely unchanged over the past 10 years, and therefore it was not necessary to remodel the entire watershed with this study.

7.1.1 Drainage Patterns

From the industrial park limits, the runoff from the watershed flows east to the Rum River, which then flows south to the Mississippi River. The majority of the Rum River Northwest Watershed drains through storm sewer systems.

One extensive storm sewer network exists in this watershed, while the remainder is serviced by outlets which flow directly to the Rum River. Modeling was previously performed for these two minor watersheds:

McKinley Street (MK)

Rum Northwest (RNW)

The McKinley Street network includes two basins within its system.

7.1.2 Flood Protection Concerns

There are no known existing problems in this watershed. The subwatersheds that directly outfall into the river will not have any flooding problems as it appears the overflow will drain to the river. For the remaining watersheds, any excess water that the existing storm sewer system cannot handle flows toward the basins within this watershed. If the storage and outflow capacities are not sufficient, the basins will overflow, which could result in impacts to the existing structures. Detailed survey information is required to determine the capacity of the existing basins.

7.2 Stormwater System Analysis and Results

The 10-year and 100-year events were analyzed for the portions of the Rum River Northwest Watershed that are served by the city's storm sewer system. Table 7-1 summarizes the peak runoff rates of the 10-year and 100-year analyses for each of the subwatersheds shown on Figure 7-1.

7.3 Implementation Considerations

The city's existing storm sewer systems are adequate for this watershed. The necessary storage and outlet sizes were determined to provide adequate detention for the storm sewer network to function and are given in Table 7-2.

7.3.1 Construction of Water Quality Structures

Figure A (Appendix A) shows the locations where water quality structures in the storm sewer would reduce the amount of suspended solids and phosphorus load to the Rum River. As shown, six water quality structures are proposed. Water quality structures will be designed to achieve an annual removal efficiency of 60% of the total phosphorus and 90% of the total suspended solids.

7.3.2 Storm Sewer Capacity

The storm sewer crossing Ferry Street from the Anoka Hennepin Learning Center to the Rum River does not provide capacity for the 10-year storm.

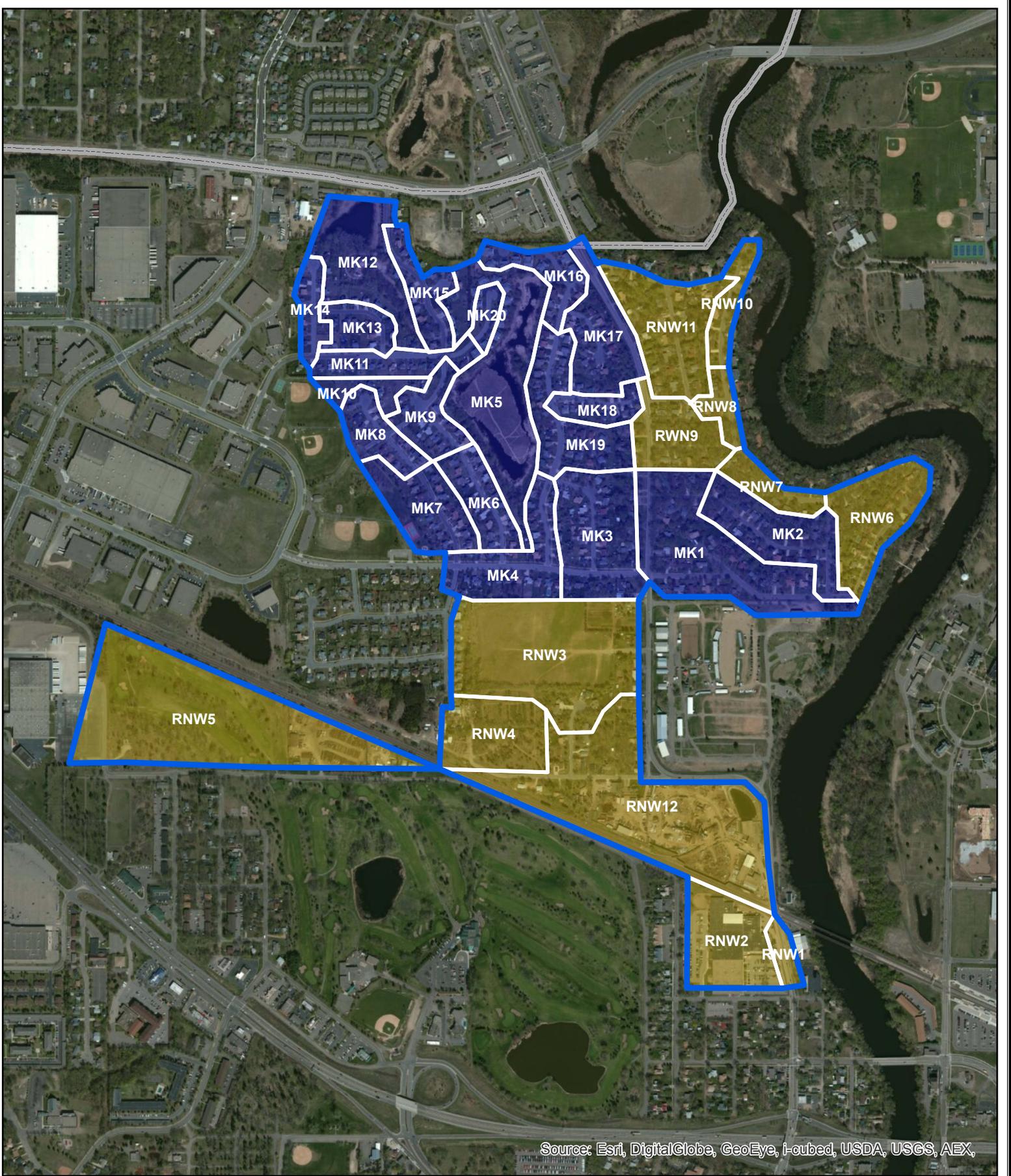
Table 7-1: Results of the Rum River Northwest Watershed**10-Year and 100-Year Critical Storm Events (TP 40)**

Minor Watershed	Subwatershed	Drainage Area (acres)	Impervious Percentage	Peak Runoff Rate (cfs) 10-yr storm	Peak Runoff Rate (cfs) 100 yr storm
MK	1	18.2	20	19	39
MK	2	9.9	20	11	22
MK	3	11.1	20	14	28
MK	4	7.4	17	10	20
MK	5	23.5	13	62	112
MK	6	4.9	20	10	20
MK	7	6.9	15	10	21
MK	8	5.3	20	11	21
MK	9	4.5	20	8	15
MK	10	2.7	20	8	17
MK	11	4.2	20	6	11
MK	12	17.4	21	66	114
MK	13	2.6	20	6	11
MK	14	3.87	20	9	17
MK	15	4.5	29	7	14
MK	16	5.6	22	8	16
MK	17	9.9	20	16	31
MK	18	3.6	20	7	14
MK	19	10.3	20	13	27
MK	20	1.8	45	6	11
RNW	1	2.2	65	9	15
RNW	2	9.3	65	23	38
RNW	3	28.2	8	86	209
RNW	4	10.0	52	28	48
RNW	5	33.0	5	37	83
RNW	6	9.7	20	13	26
RNW	7	3.6	20	6	12.5
RNW	8	3.0	20	6	11
RNW	9	7.7	20	14	27
RNW	10	4.5	20	6	13
RNW	11	11.7	20	17	34
RNW	12	34.0	51	70	120

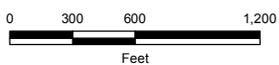
Source: City of Anoka Stormwater Plan, August 2000, Barr Engineering Company

Table 7-2: Results of 100-Year Storm Event (TP 40) Basin Requirements for Rum River Northwest Watershed						
Subwatershed	Drainage Area acres	Dead Storage acre-feet	Live Storage acre-ft	Total Storage acre-ft	100yr Discharge cfs	Outlet Size
<i>Existing Basins with Improvements</i>						
MK5	88.5	3.0	14.0	17.0	5	30"
MK12	22.7	1.0	3.3	4.3	5	

Source: City of Anoka Stormwater Plan, August 2000, Barr Engineering Company



Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX,



**Hakanson
Anderson**

LEGEND

-  Major Watershed
-  Sub Watershed
-  Minor MK
-  RNW

**FIGURE 7-1
RUM RIVER NORTH-
WEST WATERSHED
CITY OF ANOKA**

8.1 General Watershed Description

Figure 8-1 shows the Rum River Southeast minor watershed and its subwatersheds. This region is located south of U.S. Highway 169 and 10 and east of the Rum River and it is the oldest part of the city.

This watershed includes Moore Middle School, Washington Elementary School, the City of Anoka offices, and the downtown area. General land uses in this watershed vary from single-family residential to multiple-family residential and commercial. This watershed has remained largely unchanged over the past 10 years, and therefore it was not necessary to remodel the entire watershed with this study.

8.1.1 Drainage Patterns

The Rum River Southeast watershed is served by the city's storm sewer system. The stormwater system is complex because there are two trunk systems that carry the majority of the runoff. The Rum River Southeast watershed is made up of 12 minor watersheds. From north to south the subwatersheds are:

- Polk Street (POLK)
- Tyler Street (TY)
- Harrison Street (HAR)
- Main Street (MAIN)
- Monroe Street (MON)
- Jefferson Street (JF)
- Moore Middle School (MMS)
- Adams Street (ADAMS)
- Washington Street (WASH)
- 6th Avenue (6TH)
- 10th Avenue (10TH)
- Brisbin Street (BRIS)

8.1.2 Flood Protection Concerns

Where the storm sewer system capacity is not sufficient, surface overflow will occur via the streets to the lowest point within the subwatershed. The Rum River Southeast Watershed has some areas which will not overflow to the river. The proposed and existing storage and outflow capacities are necessary to prevent basin overflow and the flooding of existing structures. Detailed survey information is required to determine the capacity of the existing basins.

8.2 Stormwater System Analysis and Results

The 10-year and 100-year events were previously analyzed for the Rum River Southeast Watershed. Table 8-1 presents watershed information and the peak runoff rates of the 10-year and 100-year analyses for each of the subwatersheds shown on Figure 8-1.

8.3 Implementation Considerations

As a part of the surface water management planning process, the problem areas were investigated to determine possible mitigation alternatives. Two water quality structures have already been retrofitted in this watershed to treat the stormwater and remove pollutants prior to discharging into the Rum River. Additional water quality structures and storm sewer upgrades are proposed and are discussed in the following paragraphs.

8.3.1 Increased Storm Sewer Capacity Projects

Pipe carrying capacity needs to be increased in parts of this watershed to provide 10-year level of service for the city's storm sewer system. Modifications are necessary because all of the watershed does not naturally flow to the Rum River. The limited capacity could result in flooding of homes and businesses. As shown in Figure B (Appendix A), storm sewer upgrades are proposed on Tenth Avenue, Brisbin Street, Seventh Avenue, Fifth Avenue, Washington Street, Adams Street, and Harrison Street. The pipes will be analyzed in detail as the city prepares plans and specifications for street reconstruction projects within this watershed.

8.3.2 Construction of Water Quality Structures

As depicted in Figure A (in Appendix A), five additional water quality structures are proposed which will greatly reduce the amount of suspended solids and phosphorus load to the Mississippi River. Water quality structures will be designed to achieve an annual removal efficiency of 60% of the total phosphorus and 90% of the total suspended solids.

Table 8-1: Results of the Rum River Southeast Watershed

10-Year and 100-Year Critical Storm Events (TP 40)

Minor Watershed	Subwatershed	Drainage Area (acres)	Impervious Percentage	Peak Runoff Rate (cfs) 10-yr storm	Peak Runoff Rate (cfs) 100 yr storm
10 TH	1	11.6	51	21	45
10 TH	2	12.75	20	17	34
10 TH	3	4.94	20	8	16
10 TH	4	3.51	20	5	10
10 TH	5	2.97	20	5	11
10 TH	6	6.86	20	8	17
10 TH	7	4.78	20	7	14
10 TH	8	9.88	20	12	24
10 TH	9	5.10	20	8	15
10 TH	10	9.57	20	13	26
10 TH	11	7.17	20	9	17
ADAMS	1	3.2	20	5	11
ADAMS	2	7.6	20	12	24
6 TH	1	6.5	5	8	47
6 TH	2	11.5	20	18	35
6 TH	3	1.2	25	3	6
6 TH	4	3.6	40	9	16
6 TH	5	1.7	31	5	9
6 TH	6	1.7	20	4	9
6 TH	7	2.8	20	6	11
6 TH	8	8.4	20	12	35
6 TH	9	5.1	20	9	21
6 TH	10	4.0	20	8	16
6 TH	11	4.3	20	6	13
6 TH	12	2.9	48	7	11
6 TH	13	1.6	20	4	8
BRS	1	4.0	20	7	15
BRS	2	9.6	24	17	32
BRS	3	7.1	20	13	25
BRS	4	9.6	21	12	24
HAR	1	5.7	90	18	28
HAR	2	5.0	57	15	26
HAR	3	2.2	67	11	17
HAR	4	4.7	90	15	23
JF	1	5.1	39	9	9
JF	2	7.6	54	13	23
JF	3	6.4	37	13	24
JF	4	6.5	46	16	28

Table 8-1: Results of the Rum River Southeast Watershed (continued)

10-Year and 100-Year Critical Storm Events (TP 40)

Minor Watershed	Subwatershed	Drainage Area (acres)	Impervious Percentage	Peak Runoff Rate (cfs) 10-yr storm	Peak Runoff Rate (cfs) 100 yr storm
JF	5	3.6	26	8	15
JF	6	7.7	20	14	27
JF	7	4.5	44	11	20
JF	8	5.9	20	10	21
MAIN	1	1.5	90	8	12
MAIN	2	3.5	90	14	21
MAIN	3	1.8	90	8	12
MAIN	4	4.3	90	16	25
MAIN	5	6.6	90	21	32
MAIN	6	2.1	68	7	11
MAIN	7	3.0	58	9	16
MAIN	8	5.4	90	19	30
MAIN	9	2.9	90	16	25
MAIN	10	4.3	90	18	27
MAIN	11	0.9	30	3	5
MAIN	12	0.9	47	3	6
MAIN	13	1.0	90	6	9
MAIN	14	0.9	90	5	8
MAIN	15	3.4	90	13	20
MAIN	16	3.7	59	13	22
MAIN	17	6.6	87	22	35
MAIN	18	4.7	71	15	24
MAIN	19	3.1	40	8	15
MAIN	20	2.9	22	6	12
MAIN	21	5.0	20	9	18
MAIN	22	4.1	20	9	18
MAIN	23	2.0	90	17	26
MAIN	24	2.7	82	12	19
MAIN	25	1.6	45	6	11
MAIN	26	5.7	76	18	28
MAIN	27	1.6	85	8	13
MAIN	28	2.5	67	10	17
MAIN	29	3.7	90	21	33
MMS	1	6.7	20	19	40
MMS	2	2.0	34	5	10
MMS	3	1.8	55	7	13
MMS	4	3.3	39	8	15
MMS	5	12.2	42	23	41

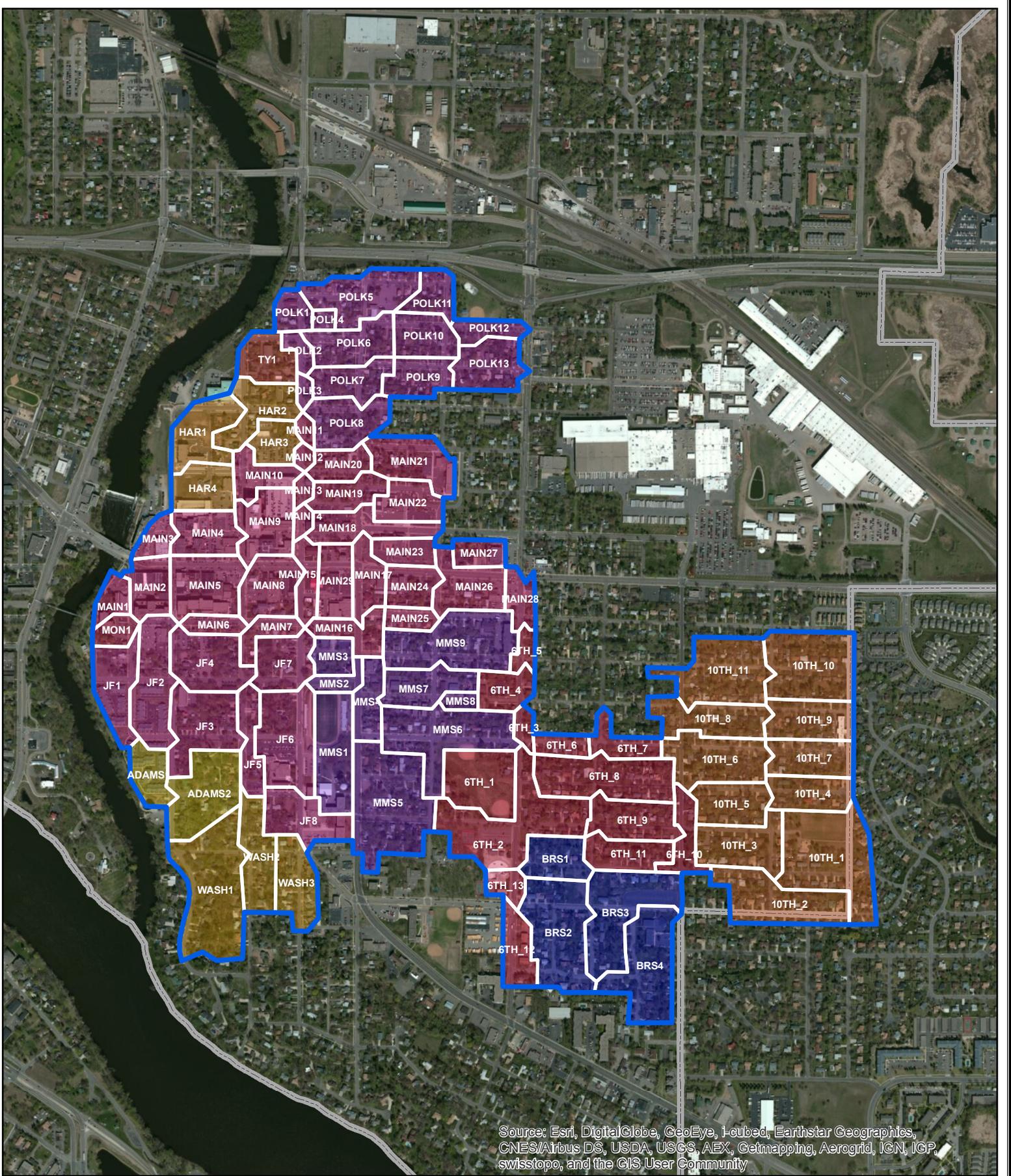
Table 8-1: Results of the Rum River Southeast Watershed (continued)**10-Year and 100-Year Critical Storm Events (TP 40)**

Minor Watershed	Subwatershed	Drainage Area (acres)	Impervious Percentage	Peak Runoff Rate (cfs) 10-yr storm	Peak Runoff Rate (cfs) 100 yr storm
MMS	6	9.6	35	19	36
MMS	7	4.0	45	9	16
MMS	8	1.2	45	4	8
MMS	9	9.5	45	21	37
MON	1	1.8	68	8	13
POLK	1	2.3	46	12	22
POLK	2	1.5	38	5	8
POLK	3	1.0	31	3	6
POLK	4	1.0	20	3	6
POLK	5	7.3	23	15	29
POLK	6	4.4	20	8	15
POLK	7	4.0	20	9	18
POLK	8	4.9	20	8	16
POLK	9	4.0	20	7	14
POLK	10	3.8	20	7	14
POLK	11	4.3	20	8	15
POLK	12	2.7	24	7	14
POLK	13	4.5	25	11	23
TY	1	3.6	47	8	14
WASH	1	11.5	20	14	29
WASH	2	6.3	20	12	23
WASH	3	4.8	20	8	16

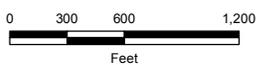
Source: City of Anoka Stormwater Plan, August 2000, Barr Engineering Company

Table 8-2: Results of 100-Year Storm Event (TP 40) Basin Requirements for Rum River Southeast Watershed						
Subwatershed	Drainage Area acres	Dead Storage acre-feet	Live Storage acre-ft	Total Storage acre-ft	100yr Discharge cfs	Outlet Size
<i>Existing Basins with Improvements</i>						
6 TH _1	73.7	2.0	8.4	10.4	30	36"
BRS2	33.0	1.2	4.0	5.2	3	15"
10 TH _1	141.4	4.0	10.5	14.5	5	42"

Source: City of Anoka Stormwater Plan, August 2000, Barr Engineering Company



Source: Esri, DigitalGlobe, GeoEye, I-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Hakanson
Anderson

LEGEND

- | | | | |
|------------------------|-------|------|------|
| Major Watershed | 6TH | JF | POLK |
| Sub Watershed | ADAMS | MAIN | TY |
| Minor Watershed | BRS | MMS | WASH |
| 10TH | HAR | MON | |

FIGURE 8-1
**RUM RIVER SOUTH-
EAST WATERSHED**
CITY OF ANOKA

9.0 Rum River Southwest Watershed

9.1 General Watershed Description

Figure 9-1 shows the Rum River Southwest Watershed and its subwatersheds. This region is located south of U.S. 10 and west of the Rum River.

This watershed includes only a very small area and consists of single-family residential land use. This watershed has remained largely unchanged over the past 10 years, and therefore it was not necessary to remodel the entire watershed with this study.

9.1.1 Drainage Patterns

The Rum River Southwest Watershed flows east directly into the Rum River either via storm sewer or overland flow. The watershed follows the Highway 169 corridor; therefore the storm sewer network is predominately owned and maintained by Mn/DOT.

9.1.2 Flood Protection Concerns

The low point on Franklin Avenue where it intersects with the alley does not have any means of discharge according to the information provided. This could be an area of flooding and a pipe is necessary to direct flows away from the homes surrounding the low point. This is discussed in the following sections. The remainder of the watershed overflows to the river.

9.2 Stormwater System Analysis and Results

The 10-year and 100-year storm events were previously analyzed for the portions of the Rum River Southwest Watershed that are served by the city's storm sewer system. Table 9-1 presents watershed information and the peak runoff rates of the 10-year and 100-year analyses for each of the subwatersheds shown on Figure 9-1. There are no existing basins in this watershed.

9.3 Implementation Considerations

Existing and future drainage problems within the watershed can be resolved the construction of a new storm sewer. These are discussed in the following paragraphs.

9.3.1 Increased Storm Sewer Capacity Projects

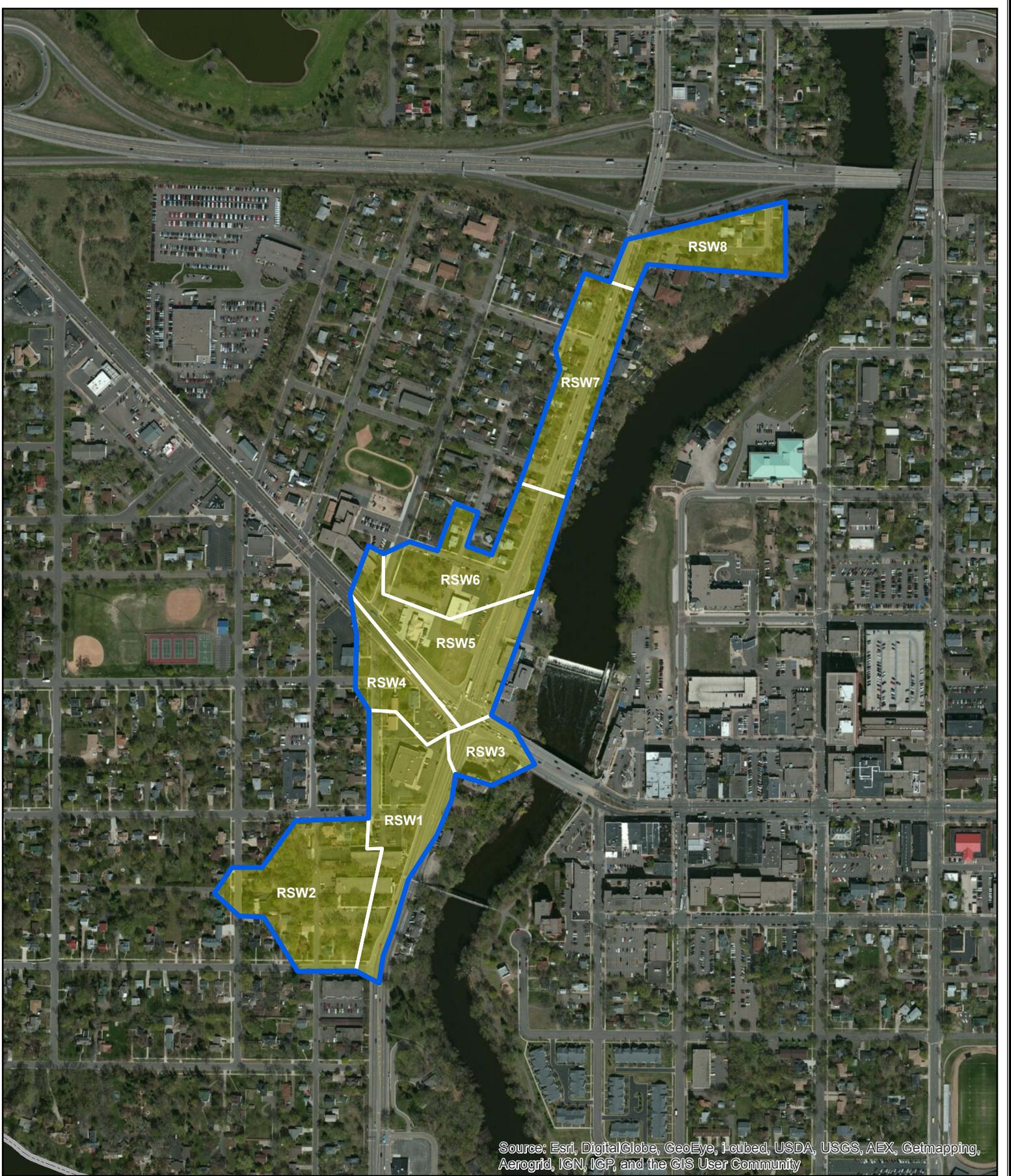
Previous analysis has indicated that the carrying capacity of the existing city storm sewer system needs to be increased on Franklin Avenue. The pipes will be analyzed in detail as the city prepares plans and specifications for street reconstruction projects within this watershed.

9.3.2 Construction of Water Quality Structures

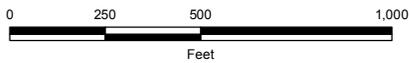
Most of the storm sewer network in this watershed is owned and maintained by Mn/DOT, and determination of water quality structures will be considered as projects are proposed.

Table 9-1: Results of the Rum River Southwest Watershed					
10-Year and 100-Year Critical Storm Events (TP 40)					
Minor Watershed	Subwatershed	Drainage Area (acres)	Impervious Percentage	Peak Runoff Rate (cfs) 10-yr storm	Peak Runoff Rate (cfs) 100 yr storm
RSW	1	5.4	57	10	17
RSW	2	5.8	36	14	25
RSW	3	1.2	65	6	11
RSW	4	1.0	20	2	4
RSW	5	5.2	90	14	22
RSW	6	3.7	55	11	20
RSW	7	3.4	45	9	15
RSW	8	3.0	45	7	13

Source: City of Anoka Stormwater Plan, August 2000, Barr Engineering Company



Source: Esri, DigitalGlobe, GeoEye, I-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



LEGEND

-  Major Watershed
-  Sub Watershed
-  Minor Watershed
-  RSW

**FIGURE 9-1
RUM RIVER SOUTH-
WEST WATERSHED
CITY OF ANOKA**

10.0 U.S. Highway 169 and 10 Watershed

10.1 General Watershed Description

Figure 10-1 shows the U.S. Highway 169 and 10 minor watersheds and its subwatersheds. This region includes the areas tributary to the storm sewer network maintained by the state for Highway 169 and 10 which extends through the entire city from east to west. This watershed includes the golf course and cemeteries. General land uses in this watershed are varied, with a combination of commercial, open/agricultural, single family residential, and multiple family residential. This watershed has remained largely unchanged over the past 10 years, and therefore it was not necessary to remodel the entire watershed with this study.

10.1.1 Drainage Patterns

The U.S. Highway 169 and 10 watershed was previously analyzed only for the portions of storm sewer maintained by the City of Anoka. The state's system for the highway was not evaluated and assumed adequate. Flows at the discharge locations into the highway system are given, and the networks upstream of the discharge points were analyzed. U.S. Highway 169 and 10 watershed is made up of nine minor watersheds that are serviced by city storm sewer systems that discharge into the highway system. From east to west the minor watersheds are:

Fairoak Avenue, south of Hwy 10 (FOS)

Fairoak Avenue, north of Hwy 10 (FON)

Church Street (CH)

Golf Course (GC)

State Avenue (STA)

Branch Avenue (BRC)

Highway 169 (US169)

7th Avenue (7TH)

8th Avenue (8TH)

10.1.2 Flood Protection Concerns

This watershed also has low points that may lead to flooding during the 100-year storm event. The subwatersheds where this is a concern are FON3 (intersection of Verndale and Jerome Street) and STA7 (alley section south of Clay and east of Branch Avenue). These areas do not have an overland flow route for runoff exceeding the 10-year storm event. Pipes with 100-year capacity are necessary to direct flows away from the homes surrounding the low points.

10.2 Stormwater System Analysis and Results

The 10-year and 100-year storm events were previously analyzed for the portions of the U.S. Highway 169 and 10 Watershed that are served by the city's storm sewer system. Table 10-1 presents watershed information and the peak runoff rates of the 10-year and 100-year flood analyses for each of the subwatersheds shown on Figure 10-1.

10.3 Implementation Considerations

This region of the city requires several upgrades to the existing system as discussed below.

10.3.1 Increased Storm Sewer Capacity Projects

Pipe capacity needs to be increased in parts of this watershed to provide 10-year level of service for the city's storm sewer system. As shown on Figure B, storm sewer upgrades are proposed on Clay Street, State Avenue, Calhoun Street, Fairoak Street, Euclid Avenue, Pleasant Street, Wingfield Avenue, Branch Avenue, and Eighth Avenue. The pipes will be analyzed in detail as the city prepares plans and specifications for street reconstruction projects within this watershed.

10.3.2 Construction of Additional Stormwater Basins

The existing basins in this watershed will be sufficient if the necessary storage and outlet sizes are provided as given in Table 10-2. Further investigation of these basins is necessary to determine their actual storage capacity. Pond GC-1 is proposed to be expanded in 2015 in conjunction with the reconstruction of the streets to the east.

10.3.3 Construction of Water Quality Structures

As depicted in Figure A (in Appendix A), two water quality structures are proposed where the runoff receives no treatment prior to entering the highway system. Water quality structures will be designed to achieve an annual removal efficiency of 60% of the total phosphorus and 90% of the total suspended solids.

Table 10-1: Results of the U.S. Highway 169 and 10 Watershed

10-Year and 100-Year Critical Storm Events (TP 40)

Minor Watershed	Subwatershed	Drainage Area (acres)	Impervious Percentage	Peak Runoff Rate (cfs) 10-yr storm	Peak Runoff Rate (cfs) 100 yr storm
7TH	1	8.6	34	12	23
7TH	2	8.2	32	15	27
7TH	3	3.3	34	8	16
7TH	4	5.3	45	18	28
7TH	5	4.1	24	8	16
7TH	6	4.6	27	10	19
7TH	7	2.0	20	5	11
7TH	8	2.0	20	5	10
7TH	9	6.3	52	17	29
7TH	10	1.0	61	5	8
8TH	1	9.8	34	15	29
8TH	2	4.8	40	10	18
8TH	3	1.5	57	5	9
8TH	4	12.2	41	18	34
8TH	5	3.2	20	6	11
8TH	6	4.5	20	9	17
8TH	7	9.3	20	14	27
8TH	8	2.0	20	4	9
BRC	1	4.3	20	5	85
BRC	2	6.8	41	17	30
BRC	3	5.1	20	9	42
BRC	4	6.9	65	26	43
BRC	5	5.2	18	5	11
BRC	6	4.2	45	9	16
CH	1	19.8	75	45	73
CH	2	19.4	7	24	53
CH	3	12.1	5	13	30
CH	4	5.9	61	14	24
CH	5	10.4	21	11	23
CH	6	4.5	20	8	16
FON	1	5.9	50	15	26
FON	2	6.6	51	14	24
FON	3	10.5	45	24	42
FON	4	5.5	23	9	18
FON	5	5.9	18	9	20
FON	6	10.8	33	40	79
FON	7	59.5	5	88	185

Table 10-1: Results of the U.S. Highway 169 and 10 Watershed

10-Year and 100-Year Critical Storm Events (TP 40)

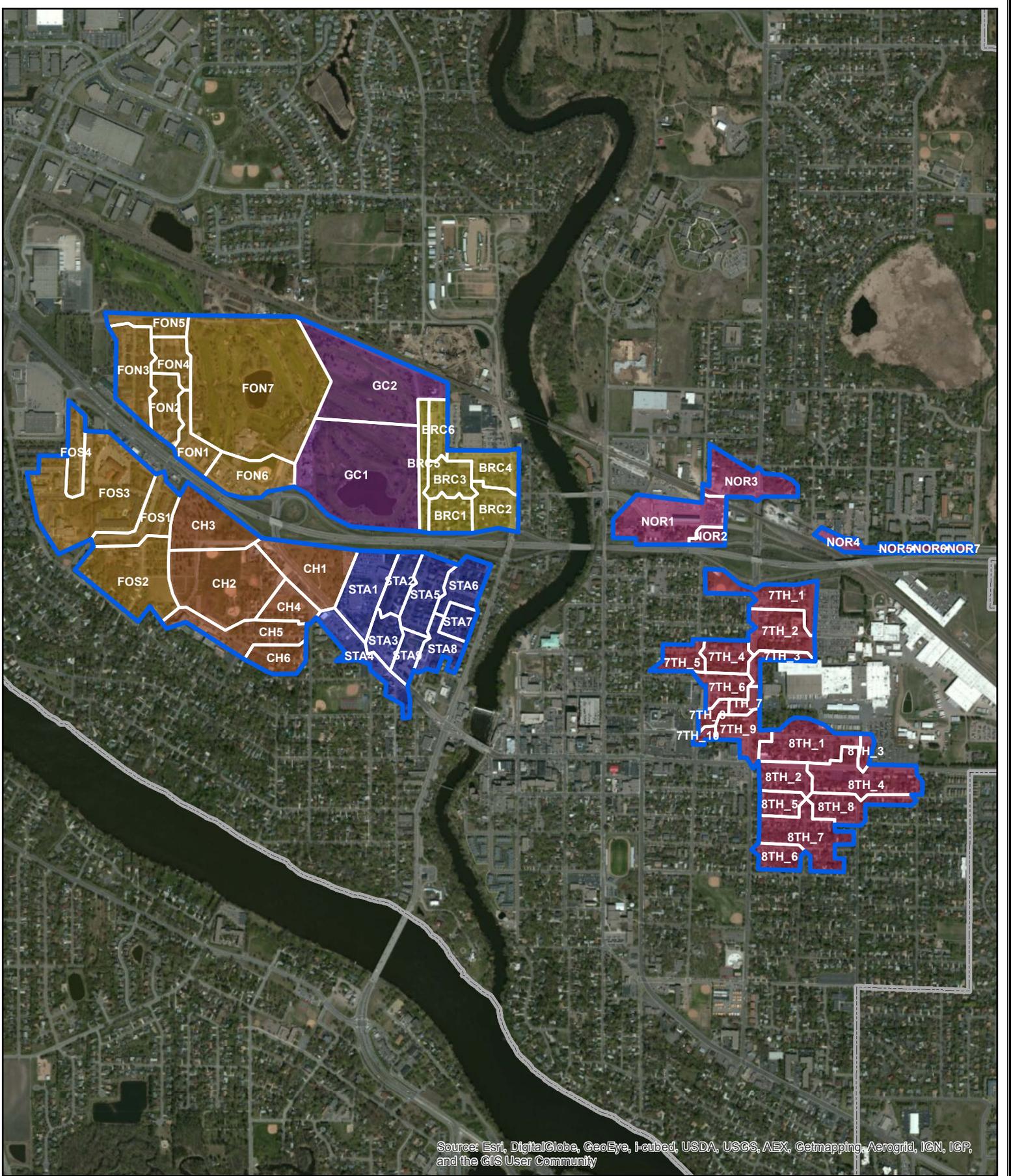
Minor Watershed	Subwatershed	Drainage Area (acres)	Impervious Percentage	Peak Runoff Rate (cfs) 10-yr storm	Peak Runoff Rate (cfs) 100 yr storm
FOS	1	4.7	39	11	20
FOS	2	16.4	13	24	51
FOS	3	27.9	53	56	95
FOS	4	3.5	20	5	9
GC	1	36.7	4	60	121
GC	2	25.7	5	76	188
STA	1	4.9	45	15	26
STA	2	10.3	86	30	47
STA	3	5.0	52	12	20
STA	4	9.2	75	22	35
STA	5	5.6	45	12	20
STA	6	6.1	45	13	23
STA	7	3.0	45	11	19
STA	8	5.1	45	15	25
STA	9	5.6	45	13	23
NOIR	1	13.8	61	28	47
NOIR	2	2.0	45	6	11
NOIR	3	8.3	58	20	33
NOIR	4	2.5	65	6	10
NOIR	5	1.4	45	5	8
NOIR	6	0.8	45	3	5
NOIR	7	1.2	45	4	7

Source: City of Anoka Stormwater Plan, August 2000, Barr Engineering Company

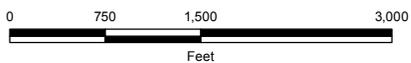
Table 10-2: Results of 100-Year Storm Event (TP 40) Basin Requirements for U.S. Highway 169 and 10 Watershed

Subwatershed	Drainage Area acres	Dead Storage acre-feet	Live Storage acre-ft	Total Storage acre-ft	100yr Discharge cfs	Outlet Size
<i>Existing Basins with Improvements</i>						
GC1	148.7	6.0	24.0	30.0	20	44"
FOS3	30.1	3.1	4.4	7.5	14	30"
FON7	92.5	1.6	6.3	7.9	5	
<i>Proposed Ponds</i>						
8TH_1	54.2	1.2	8.0	9.2	5	
CH2	46.5	0.6	5.4	6.0	3	

Source: City of Anoka Stormwater Plan, August 2000, Barr Engineering Company



Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



LEGEND

- | | | | |
|-----------------|-------------------------|-----|-----|
| Major Watershed | Minor Watersheds | BRC | GC |
| Sub Watershed | 7TH | CH | NOR |
| | 8TH | FON | STA |

**FIGURE 10-1
US 169 AND US 10
WATERSHED
CITY OF ANOKA**

11.0 Coon Rapids Tributary Watershed

11.1 General Watershed Description

Figure 11-1 shows the Coon Rapids Tributary minor watersheds and subwatersheds. This watershed is comprised of the sections of Anoka which drain into the storm sewer network of the city of Coon Rapids. General land use in this watershed is single-family residential. This watershed has remained largely unchanged over the past 10 years, and therefore it was not necessary to remodel the entire watershed with this study.

11.1.1 Drainage Patterns

There are portions of Anoka which ultimately flow into Coon Rapids, but have storm sewer in the City of Anoka extending to the city border. These regions continue into the neighboring city and enter its network. These regions were evaluated only for the sections within Anoka city limits. Downstream of the city limits, the adequacy of the system is unknown. From north to south the subwatersheds are:

41st Street (41ST)

Bunker Lake Road (BL)

Coon Rapids (CR)

11.1.2 Flood Protection Concerns

This watershed consists of areas that either flow into a bordering basin or into the Coon Rapids storm sewer system. Capacity of the basin located within Coon Rapids must be evaluated for adequacy to determine if flooding is a valid concern for the structures within the area.

11.2 Stormwater System Analysis and Results

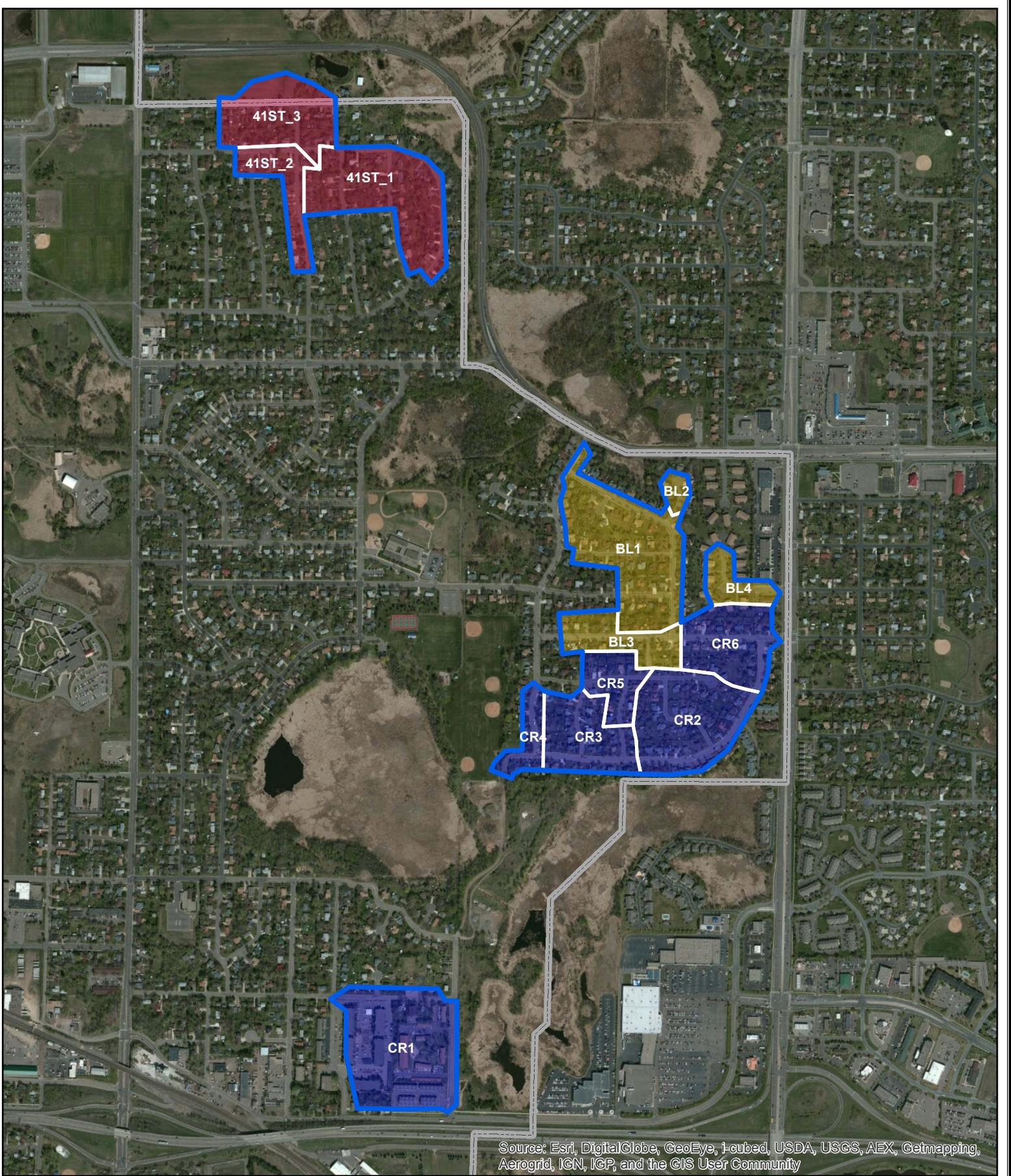
The 10-year and 100-year flood events were previously analyzed for the portions of the Coon Rapids Tributary Watershed that are served by the city's storm sewer system. Table 11-1 presents watershed information and the peak runoff rates of the 10-year and 100-year flood analyses for each of the subwatersheds shown on Figure 11-1.

11.3 Implementation Considerations

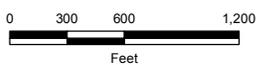
This region of the city provides sufficient storm sewer capacity to meet the 10-year level of service upstream of the Coon Rapids system.

Table 11-1: Results of the Coon Rapids Tributary Watershed					
10-Year and 100-Year Critical Storm Events (TP 40)					
Minor Watershed	Subwatershed	Drainage Area (acres)	Impervious Percentage	Peak Runoff Rate (cfs) 10-yr storm	Peak Runoff Rate (cfs) 100 yr storm
BL	1	18.6	20	22	45
BL	2	1.2	20	3	7
BL	3	7.1	20	9	18
BL	4	3.6	37	11	21
CR	1	20.4	40	25	46
CR	2	14.8	24	21	41
CR	3	9.7	20	19	38
CR	4	5.2	20	11	23
CR	5	5.9	20	12	25
CR	6	9.6	25	18	34
41ST	1	18.2	20	18	37
41ST	2	6.6	20	9	18
41ST	3	18.0	20	25	51

Source: City of Anoka Stormwater Plan, August 2000, Barr Engineering Company



Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



LEGEND

- | | | |
|---|--|---|
|  Major Watershed |  Minor Watersheds |  BL |
|  Sub Watershed |  41ST |  CR |

**FIGURE 11-1
COON RAPIDS
TRIBUTARY
WATERSHED
CITY OF ANOKA**

12.1 General Watershed Description

Figure 12-1 shows the Rum River North Watershed and its 3 minor watersheds and subcatchments. This region includes the areas tributary to the storm sewer network maintained by Anoka County for CSAH 116 and a small portion of 7th Avenue. The watershed is bound by the Rum River on the West, the city limits to the North, 7th Avenue to the East and Anoka High School to the South.

This watershed includes the Rum River Library. General land uses in this watershed are varied, with a combination of single family residential, park and recreational, institutional and agriculture. The undeveloped portion of the watershed is guided for a shopping center.

12.2.1 Drainage Patterns

The Rum River North watershed was analyzed only for the portions of storm sewer maintained by the City of Anoka. The county's system for the county road was not evaluated and assumed adequate. The Rum River North Watershed flows west into the Rum River either via storm sewer or overland flow. This watershed has three existing stormwater basins which provide both quantity and quality control. Two of them are located in the single family residential development while the other is located on the library property. There are two existing stormwater outfalls that discharge directly to the Rum River. Because one of the outfalls belongs to the county's storm sewer system, only one outfall was modeled in this project. The outfall modeled for this project is for the Rum River Shores (RRS) single family development. The Anoka High School located immediately south of the watershed was not included in this analysis.

12.1.2 Flood Protection Concerns

There are no known problems in this watershed. The minor watersheds that directly outfall into the river will not have any flooding problems as it appears the overflow will drain to the river. Where the storm sewer capacity is not sufficient, surface overflow will occur via the streets or designed overflows to the lowest point within the watershed. The water reaching

the low points is conveyed via pipe to the Rum River.

12.2 Stormwater System Analysis and Results

The 10-year and 100-year events were analyzed for the Rum River North Watershed. Table 12-1 summarizes the peak runoff rates of the 10-year and 100-year analyses for each of the subcatchments shown on Figure 12-1.

12.3 Implementation Considerations

The city's existing storm sewer systems are adequate for this watershed. Upon development, it is assumed that three additional basins will be necessary. The necessary storage and outlet sizes were determined to provide adequate detention for the storm sewer network to function and are given in Table 12-2.

12.3.1 Construction of Water Quality Basins

Figure A shows the location of water quality basins that would greatly reduce the amount of suspended solids and phosphorous load to the Rum River. These new basins are necessary when the property east of 6th Avenue and west of 7th Avenue is developed. Table 12-2 lists the necessary "dead storage" required to achieve an annual removal efficiency of 60% of the total phosphorous and 90% of the total suspended solids. The basins will provide sufficient water quality treatment if the necessary "dead storage" volume as shown in Table 12-2 is provided.

Table 12-1: Results of the Rum River North Watershed

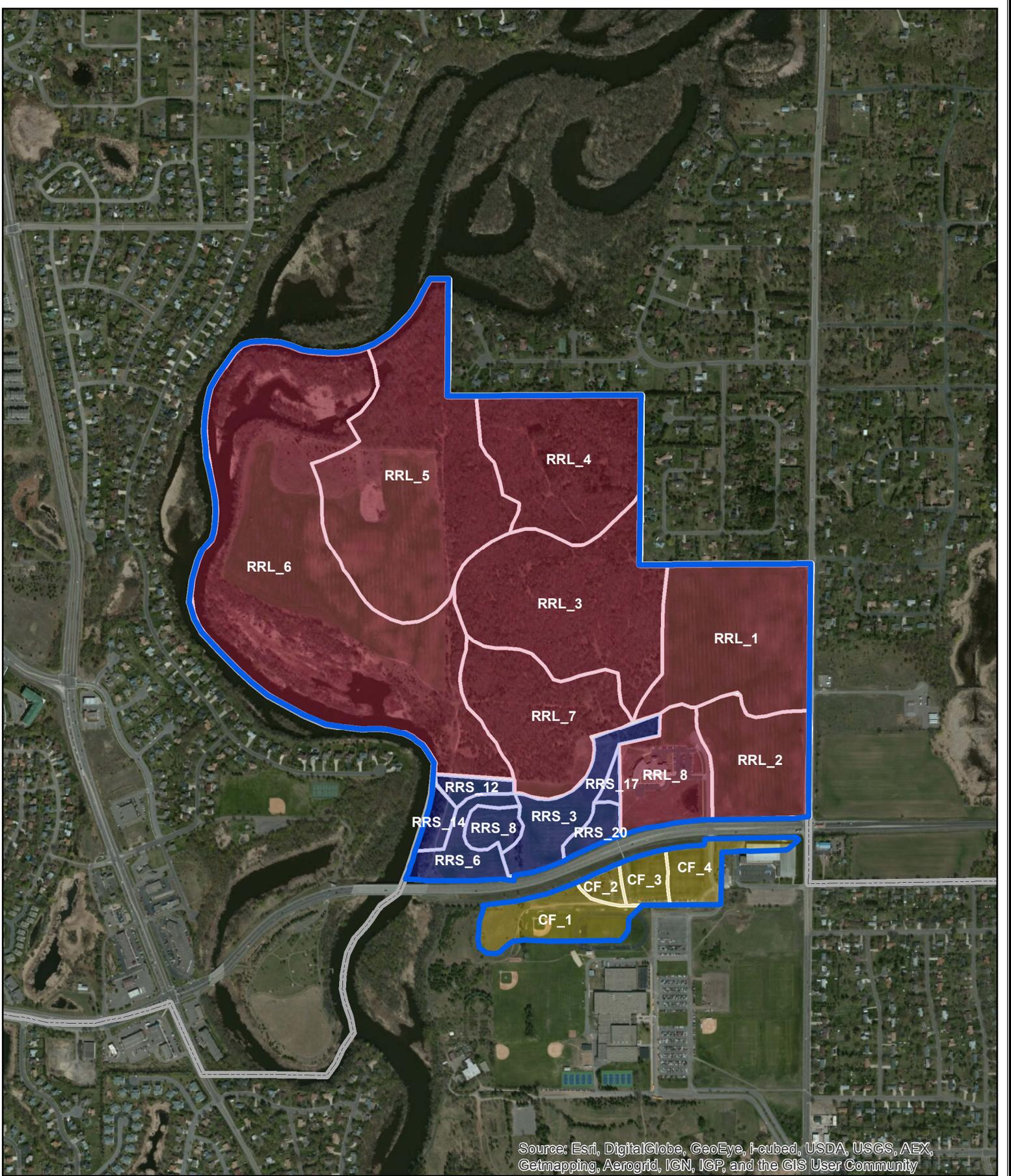
10-Year and 100-Year Critical Storm Events (TP 40)

Minor Watershed	Subwatershed	Drainage Area (acres)	Impervious Percentage	Peak Runoff Rate (cfs) 10-yr storm	Peak Runoff Rate (cfs) 100 yr storm
CF	1	2.3	4	1	1
CF	2	0.9	16	1	1
CF	3	2.6	12	1	2
CF	4	1.9	27	2	4
RRL	1	30.9	82	142	264
RRL	2	13.6	85	69	126
RRL	3	37.6	0	2	27
RRL	4	36.2	0	1	59
RRL	5	29.0	0	41	135
RRL	6	69.0	0	84	338
RRL	7	26.4	2	1	48
RRL	8	14.3	36	27	77
RRS	3	8.6	38	9	22
RRS	6	7.1	25	6	15
RS	8	2.8	38	2	6
RRS	12	1.6	8	1	2
RRS	14	0.9	11	1	3
RRS	17	1.2	14	1	2
RRS	20	1.2	11	1	2

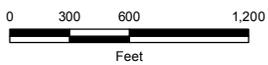
Table 12-2: Results of 100 Year Storm Event (TP 40) Basin Requirements for Rum River North Watershed

Subwatershed	Drainage Area acres	Dead Storage acre- feet	Live Storage acre-ft	Total Storage acre-ft	100yr Discharge cfs	Outlet Size
<i>Existing Basins with Improvements</i>						
RRL8	27.9	3.1	3.8	6.9	6	15"
RRS3	15.5	2.1	1.4	3.5	2	12"
RRS6	12.4	0.6	0.5	1.1	5	12"
<i>Proposed Ponds</i>						
RRL8-INF*	0	2.0	1.3	3.3	8	18"
RRL1	30.9	4.2	6.0	10.2	17	
RRL1-INF*	0	1.0	3.7	4.7	2	

* Note: Drainage area is listed as zero (0) acres as proposed infiltration basins are second device in treatment train and they received treated stormwater from upstream NURP Ponds with no additional contributing drainage area.



Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community



Hakanson
Anderson

K:\cad_eng\PROJECTS\GIS\AN409\Rum River North

LEGEND

-  Major Watershed
-  Sub Watershed
-  Rum River North Sub
-  CF
-  RRL
-  RRS

**FIGURE 12-1
RUM RIVER NORTH
WATERSHED
CITY OF ANOKA**

This section presents the goals and policies developed for the management of water resources within Anoka. Goals and policies are provided for new development and redevelopment, linear projects, flood protection, wetlands, water quality, flood plain and shoreland management, recreation, open space and wildlife management, groundwater protection, erosion and sedimentation control, public education and outreach, and illicit discharge detection and elimination. Goals propose the desired end and policies provide the means to achieve the goals. Section 14.0 provides more specific detail on how the goals and policies will be implemented.

13.1 New Development and Redevelopment

Goal: Manage new development and re-development activities to prevent / reduce flooding and achieve non-degradation of surface waters.

Policy: For new development projects with land disturbances greater than or equal to one acre, there shall be no net increase from pre-project conditions (on an average annual basis) of:

1. Stormwater discharge volume, unless precluded by site limitations
2. Stormwater discharges of Total Suspended Solids (TSS)
3. Stormwater discharges of Total Phosphorous (TP)

Policy: For redevelopment projects with land disturbances greater than or equal to one acre, there shall be a net decrease from pre-project conditions (on an average annual basis) of:

1. Stormwater discharge volume, unless precluded by site limitations.
2. Stormwater discharges of Total Suspended Solids (TSS).
3. Stormwater discharges of Total Phosphorous (TP).

Policy: Per LRRWMO requirements, a volume equal to one inch of runoff from all impervious surfaces shall be infiltrated on-site. In cases of redevelopment, this volume control requirement applies only if greater than 50% of the project area is disturbed.

Policy: For new development and redevelopment projects that disturb more than 10,000 square feet but less than one acre, the following requirements shall be enforced:

1. There shall be no net increase from pre-project conditions (on an average annual basis) of stormwater discharge volume, unless precluded by site limitations
2. There shall be no net increase in peak runoff rates for the 2-year, 10-year, and 100 year return frequency storm events.

Policy: Promote ground water recharge in areas without site limitations.

Policy: Consistent with Minnesota Rules 7050.0180, no person may cause or allow a new or expanded discharge to the Rum River unless there is not a prudent and feasible alternative because of its classification as an Outstanding Resource Value Water. Determinations about discharges that may or may not impact the Rum River are made by the MPCA and shall be addressed through the MPCA's regulatory process.

Policy: Facilitate LRRWMO review of all projects requiring a LRRWMO permit.

13.2 Linear Projects

Goal: Maintain existing runoff volume and rate characteristics unless mitigation measures are utilized to ensure no downstream impacts.

Goal: Upgrade storm sewer to provide capacity for 10 year return frequency.

Policy: Implement volume reduction strategies for new impervious surfaces such that the new surfaces cause no increase on an average annual basis of runoff volume.

Policy: Replace storm sewer that does not provide capacity for the 10 year return frequency storm event as streets are re-constructed.

Policy: Anoka will consider retrofits on existing systems prior to discharging to a surface water in areas where no treatment currently exists.

13.3 Flood Protection

Goal: Provide flood protection for the 100-year return frequency event.

Policy: The lowest floor elevation for all structures, including basements, must be at least 3 feet above the highest anticipated ground water table, 2 feet above the designated or designed 100-year flood elevation, or 1 foot above the emergency overflow, whichever is higher as per LRRWMO requirements.

Policy: Flood levels in landlocked basis shall be determined as per LRRWMO standards.

Policy: Promote the preservation and retention capacities of wetlands, streams, rivers, other conveyances and floodplain areas.

Policy: Provide a positive overflow for stormwater ponds and wetlands to the maximum extent practicable.

Policy: Trunk storm drainage systems that serve as the outlet for areas where flooding of structures or where significant flood damage is likely to occur will typically be designed to meet freeboard protection standards for the critical duration 1 percent chance flood. The design shall be based on a hydrograph method for appropriate rainfall and snowmelt events. The design shall be based on proposed ultimate land use. The design shall consider potential flood, wetland, and water quality impacts to upstream and downstream areas.

13.4 Water Quality

Goal: Manage activities within the city such that there is no net increase in sediment and nutrient loading.

Policy: Infiltration of stormwater shall be required prior to discharging stormwater to a lake, stream, or wetland and prior to discharge from the site.

Policy: Facilities shall be designed to provide annual removal efficiencies of 60% of total phosphorous and 90% of total suspended solids.

Policy: Require skimmer structures to prevent floatable materials and debris from entering surface waters.

Policy: Continue to implement a city wide street sweeping program to capture the sediment prior to entering conveyance systems.

Policy: Implement an Erosion and Sediment Control inspections program to ensure that sites are controlling erosion and sediment to the Maximum Extent Practicable.

Policy: Cooperate with the LRRWMO in water quality monitoring, modeling and planning to protect water resources.

Policy: Implement Projects identified in the City of Anoka Stormwater Retrofit Analysis, which is included as Appendix C, when possible.

13.5 Erosion and Sediment Control

Goal: Prevent sediment from entering the storm water conveyance systems and surface waters to the Maximum Extent Practicable.

Policy: Require development and redevelopment to implement construction site erosion and sediment control practices to minimize erosion and trap sediment.

Policy: Implement an Erosion and Sediment Control inspection program as required by the city's MS4 permit.

13.6 Wetland Protection

Goal: Manage activities adjacent and tributary to wetlands to maintain their function and value.

Policy: The city will require that a field wetland delineation and report detailing the findings of the delineation shall be submitted prior to development activities. Wetland delineations shall be conducted using methodology approved by the MN Wetland Conservation Act (1987 US Army Corps of Engineers Wetland Delineation Manual, along with any regional supplements, or other methodology approved by WCA in the future).

Policy: The city will continue to cooperate with the LRRWMO in administering the Wetland Conservation Act to ensure no net loss of functions and values.

Policy: Areas within 16.5 feet of a wetland boundary must be protected from land grading and other disturbances by a temporary wetland buffer during construction.

Policy: The city will require, through future development proposals, that a permanent upland wetland buffer 16.5 feet in width from the wetland edge be provided. The buffer shall not be

mowed or fertilized and the construction of structures, retaining walls, and septic systems shall be prohibited within the buffer, consistent with LRRWMO requirements.

Policy: The city will require the permanent wetland buffer to be within a drainage and utility easement.

Policy: A performance surety shall be collected to ensure the proper execution of wetland protection measures.

Policy: The city requires that stormwater runoff be pre-treated prior to discharge to wetlands for new development proposals. Stormwater discharge must comply with LRRWMO standards.

Policy: Consider retrofits in existing systems to provide pre-treatment prior to discharging to wetlands where no treatment currently exists for redevelopment projects.

13.7 Floodplain Management

Goal: Manage activities within the floodplain in accordance with the city's ordinance and state and federal regulations.

Policy: The city shall prohibit encroachment into the floodway that will reduce storage capacity unless the storage volume is mitigated.

Policy: The city shall manage the land use within the 100-year flood level as designated by this plan or the National Flood Insurance Program Flood Insurance Rate Maps (FIRM).

13.8 Shoreland Management

Goal: Manage activities within the shoreland districts to preserve the functions and values of the resource.

Policy: The city will manage activities within the shoreland overlay district in accordance with the city ordinances.

13.9 Recreation, Open Space and Wildlife Management

Goal: Protect and restore natural areas for recreation and wildlife habitat.

Policy: The city shall seek opportunities for integration of recreation open space and wildlife management facilities in conjunction with possible future water resource capital improvement projects.

Policy: The city shall encourage protection and/or preservation of wetlands and uplands that provide habitat for game fish spawning and wildlife, especially in the residential development areas.

13.10 Groundwater Protection

Goal: Manage surface water in a manner that prevents contamination in groundwater and promotes groundwater recharge.

Policy: The evaluation and control of development in groundwater recharge areas shall be protected from potential sources of contamination in accordance with Minnesota Statutes section 103H.001 and the city ordinances.

Policy: The disposal of any solid or liquid wastes shall be controlled as necessary to ensure that the underground waters of the watershed are maintained within the range of natural background quality.

Policy: Cooperate with the Anoka County Health Department in ensuring that abandoned wells are properly sealed according to the Minnesota Department of Health Well Code.

13.11 Maintenance of Stormwater Systems

Goal: Maintain the design capacity and treatment effectiveness of stormwater conveyances and BMP's through inspections and maintenance.

Policy: The city shall maintain public water quality structures, sedimentation ponds and regional detention basins.

Policy: Maintain, clean, and replace storm drainage systems as needed to preserve the initial design capacity.

Policy: For privately owned stormwater ponds, basins and treatment structures; require a maintenance agreement that is recorded against the property.

13.12 Public Education and Outreach and Public Participation

Goal: Educate the public about the impacts of stormwater discharges on receiving waters.

Policy: Implement the public education and outreach strategies outlined in the city's SWPPP.

Policy: Implement the public participation strategies outlined in the city's SWPPP.

13.13 Illicit Discharge Detection and Elimination

Goal: Eliminate or reduce illicit discharges into surface waters to the maximum extent practicable.

Policy: Implement and enforce the illicit discharge detection and elimination strategies outlined in the city's SWPPP.

Policy: Provide training opportunities to city employees to prevent or reduce pollutant runoff from municipal operations.

13.14 Stormwater Pollution Prevention Program

Goal: Continue to develop, implement and enforce a storm water pollution prevention program to reduce the discharge of pollutants to the Maximum Extent Practicable.

Policy: Develop a program which meets or exceeds the requirements as stated in the MPCA's General MS4 Permit.

Policy: Regional detention areas receiving runoff from more than one acre of surface area will comply with MS4 requirements.

To uphold the goals and policies of this Plan, the city will review all proposed developments and improvements. Approvals for BMPs relating to water quality, wetland protection, and erosion and sediment control and rate control will be required.

The city has established the following regulatory controls and criteria relating to its policies. These controls and criteria apply to the management of: wetlands, floodplains, shorelands, water quantity and quality, groundwater, soil erosion and sedimentation control and recreation, open space and wildlife and municipal operations. While these controls and criteria relate to one of the policy areas, it should be noted that they are interrelated and may serve multiple purposes.

The criteria, as a minimum, establish the degree of performance necessary to achieve improvements in water quantity and quality management. These criteria are not intended to dictate or preempt the design process, but rather provide a guide to proper development.

14.1 LRRWMO Permit Program

The city will require that all projects that disturb more than one acre of surface area, or propose wetland impacts that meet the requirements of the WCA, obtain a permit from the LRRWMO unless eligible for an exemption. If necessary, the city will enforce the permit requirements through its ordinances and mechanisms.

14.2 Water Quantity and Quality Management

The water quantity and quality management strategies are guided by requiring all projects, including redevelopment, disturbing 10,000 square feet or more to adhere to this Plan's policies and criteria for the control of surface runoff. This includes a disturbance to the land that results in a change in the topography, existing soil cover (both vegetative and non vegetative), or the existing soil topography that may result in accelerated stormwater runoff, leading to soil erosion and movement of sediment into surface waters or drainage systems. Examples of construction activity may include clearing, grading, filling and excavating.

The following order preference for stormwater quantity and quality management techniques shall be followed:

- 1st - Better site design (as defined in the Minnesota Stormwater Manual)
- 2nd - Infiltration
- 3rd - Biofiltration, filtration, wetland treatment systems, extended detention basins, or NURP ponds (in no particular order of preference)
- 4th - Hydrodynamic Separators

It is expected that a combination of techniques, used in series, will be necessary. The design of stormwater BMPs, including infiltration basins, shall be in accordance with the MN Stormwater Manual and the standards as described herein. Hydrodynamic separators will be considered when a storm water basin is not feasible. During the design and selection of hydrodynamic separators, the designer shall estimate removal efficiencies by the use of a model, such as SHSAM developed by Barr Engineering, or other similar studies or reports.

14.3 Volume Control

For all projects that disturb or alter one acre or more, including common plans of development that disturb or alter one acre or more, a volume equal to one inch of runoff from all impervious surfaces shall be retained on the site through infiltration or other volume reduction BMPs as approved by the city. In cases of redevelopment, this volume control requirement only applies if >50% of the project area is disturbed.

14.3.1 Infiltration Basin Design and Construction

Infiltration basin design and construction shall be in accordance with the MN Stormwater Manual Chapter 12-INF, Volume 2 as amended. Construction of an approved pre-treatment device or BMP shall be required prior to discharging stormwater into the infiltration basin.

Soil borings shall be conducted on the site to determine soil types, groundwater elevations, seasonally high water table elevations, and impeding layers. Infiltration rates shall be per Table 14.3.1 below or as published in the most current version of the MN Stormwater Manual, or measured on-site with a double ring infiltrometer at the elevation of the proposed BMP and adjusted appropriately to account for sediment accumulation. A maximum infiltration rate of 3 in/hr is allowed.

Table 14.1 Infiltration Rates for Hydrologic Soil Groups

Hydrologic Soil Group	Soil Textures	Corresponding Unified Soil Classification	Infiltration Rate (in/hr)
A	Gravel, sand, sandy gravel, silty gravel, loamy sand, sandy loam	GW – Well graded gravel or well-graded gravel with sand GP – Poorly graded gravel or poorly graded gravel with sand GM – Silty gravel or silty gravel with sand SW – Well graded sand or well graded sand with gravel	1.63
		SP – Poorly graded sand or poorly graded sand with gravel	0.8
B	Loam, silt loam	SM – Silty sand or silty sand with gravel	0.45
		MH – Micaceous silts, diatomaceous silts	0.3
C	Sandy clay loam	ML – Silts, very fine sands, silty or clayey fine sands	0.2
D	Clay, clay loam, silty clay loam, sandy clay, silty clay	GC – clayey gravels, clayey sandy gravels SC – clayey sands, clayey gravelly sands CL – Low plasticity clays, sandy or silty clays OL – Organic silts and clays CH – Fat clay or fat clay with sand or gravel or gravelly fat clay OH – Organic silts and clays	0.06

14.3.2 Infiltration in Drinking Water Supply Management Area (DWSMA)

Infiltration may not be suitable within a Drinking Water Supply Management Area due to elevated risk of groundwater contamination. The site designer shall verify DWSMA boundaries for each site. DWSMA boundaries are available from the Minnesota Department of Health (<http://www.health.state.mn.us/divs/eh/water/swp/maps/index.htm>). Projects within a DWSMA should refer to Minnesota Department of Health guidance entitled “Evaluating Proposed Stormwater Infiltration Projects in Vulnerable Wellhead Protection Areas” (<http://www.health.state.mn.us/divs/eh/water/swp/stormwater.pdf>) to determine if infiltration techniques are appropriate.

14.3.3 Sites with Other Restrictions for Infiltration

Infiltration may also be infeasible or inappropriate for sites in the following cases:

- Physical limitations including soils or insufficient separation to the seasonally high water table
- Physical limitations of space in the case of redevelopment
- Stormwater discharges from potential stormwater hotspots, such as fueling stations, vehicle service or washing areas, vehicle fleet storage areas, auto recycling or salvage, stockpiled snow from salted roadways, construction site inputs, manufacturing sites, public works storage areas, facilities that generate or store hazardous waste materials, and others determined by the city or LRRWMO.
- Conflicts with underground utilities
- Sites with contaminated soils

14.3.4 Exceptions to On-Site Infiltration

In the cases where infiltration is infeasible or inappropriate due to the circumstances as described above, the required volume shall be treated as per the following techniques, in order of preference:

1. On site infiltration of the entire, or a portion of the required volume, in combination with methods 3, 4 or 5 as described below.
2. On site filtration of the required volume or off site infiltration of the required volume at another project site within the boundaries of the LRRWMO.

3. Other non-volume control treatment on site.
4. Contribution to a stormwater impact fund held by the LRRWMO. This fund is used for projects that offset the volume reduction that permitted projects were unable to achieve. Such projects may occur throughout the LRRWMO, but funds are favored in the city where they originated. The LRRWMO determines the contribution amount necessary per acre of impervious surface.
5. Infiltration credits from the City of Anoka may be available for purchase. Applicants would need to verify with the City of Anoka engineering department regarding credit availability. At the time of this publication, the City had an excess of 2,838 cubic feet of excess infiltration volume. The Summary of Infiltration Credits is included on Table D.1 in Appendix D.

14.4 Wet Sedimentation Basins

In situations where wet sedimentation is allowed, permanent pool volume shall be provided which is equal to or greater than the volume of stormwater runoff from a 2.5 inch storm over the entire contributing area. Facilities shall be designed to provide annual removal efficiencies of 60% of total phosphorous and 90% of total suspended solids. The permanent pool average depth shall be greater than 3 feet, with a maximum depth of 10 feet.

14.5 Peak Flow Rate Control

Post-development peak runoff rates shall not exceed the existing rates for the 2-year, 10-year, and 100 year return frequency storm events. In determining the existing condition in the case of redevelopment, the city may consider the condition immediately prior to the start of construction as well as the condition in the year 1984, which is the year that the Rum River was listed as an Outstanding Resource Value Water in Minn. R. 7050.0470.

14.6 Flood Protection

Consistent with state and federal regulations, Anoka requires that the level of flood protection along all ditches, detention basins, streams and wetlands be established based upon the 1 percent (100-year frequency) storm event utilizing NOAA Atlas 14, Volume 8 precipitation amounts. Land use within floodplains shall be regulated in accordance with city ordinances and state floodplain zoning regulations. The following freeboard values are required for the City of Anoka:

- Landlocked Basins (no outlet) 2.0 feet (Established high water)
- Non-Landlocked Basins 2.0 feet (100-year frequency)

14.7 Storm Sewer Design

Generally speaking, storm sewer shall be designed for the 10-year return frequency event. The designer shall evaluate overflow elevations to ensure flood protection standards are met for larger storms. In some circumstances, when there is not an overland overflow location, it may be necessary to design for a larger storm, such as the 100-year return frequency event.

14.8 Water Quality Monitoring Program

The city will continue to cooperate with the LRRWMO for matters including water quality monitoring, modeling, and planning to protect priority resources. The LRRWMO in cooperation with the Anoka Conservation District will continue to monitor water quality.

14.9 Floodplains and Shoreland Management

Various levels of government are involved in regulation of surface water, wetlands and floodplain. As previously discussed, the MnDNR has inventoried and classified water bodies and wetlands in the State of Minnesota. The “protected waters and wetlands” program identifies water bodies and wetlands that require DNR permits for activities like draining, filling, dredging, and diverting of water. The MnDNR Shoreland Management Program has also established a classification system for lakes greater than 10 acres in size and rivers with a drainage area two square miles or greater. Floodplain and shoreland areas are governed by the city’s Shoreland

and Floodplain Ordinances, which regulate activities adjacent to water bodies classified by the Minnesota DNR.

14.10 Recreation, Open Space and Wildlife Management

Through development review the city shall encourage protection and/or preservation of wetlands and uplands that provide habitat for fish and wildlife.

14.11 Groundwater Management

The City of Anoka contains natural characteristics that result in moderate to very high sensitivity for groundwater contamination. Infiltration practices and other structural BMPs in Drinking Water Supply Management Areas (DWSMA) will be evaluated as per the Minnesota Department of Health's guidelines entitled "Evaluating Proposed Stormwater Infiltration Projects in Vulnerable Wellhead Protection Areas". The DWSMA's Vulnerability, as per the Minnesota Department of Health, is depicted in Figure 2-4.

14.12 Well Abandonment

The city will develop, in cooperation with the Anoka Conservation District and Anoka County Extension, an education program relating to land use control practices and proper well abandonment procedures in accordance with Minn. Rules 4725.2700.

14.13 Anoka Dam

The City of Anoka has been the sole owner of the Anoka Dam located on the Rum River since 1935. The City of Anoka will continue to perform all regular inspections, maintenance and repairs as necessary.

14.14 Wetland Protection

Wetland protection standards, as discussed in Section 13.11, shall be applicable for all projects that disturb/alter one acre or more of land, or are part of a common plan of development or sale that disturbs/alters one acre or more of land. The following activities are exempt:

- Road reconstruction
- Utility construction/reconstruction within the road right-of-way and utility easement

- Agricultural operations > 300 feet from the Rum River and not creating impervious area
- Gardens
- Pole setting
- Emergency activities immediately necessary for the protection of life, property, or natural resources
- In circumstances in which the LRRWMO board determines that the proposed project is not likely to impair attainment of the purpose and intent of the wetland management standards

Projects exempt from wetland protection standards must still comply with any applicable local, state, or federal requirements. The LRRWMO is the local governmental unit (LGU) administering the requirements of the Wetland Conservation Act (WCA) in the City of Anoka.

14.15 Soil Erosion and Sediment Control

Although development and redevelopment is moderate within the City of Anoka, the control of erosion and sedimentation remains important to maintaining water quality in the area. Of paramount importance to the maintenance of water quality in the city is the proper enforcement of erosion and sediment controls. Enforcement will involve indirect and direct approaches.

14.15.1 Indirect Approach

The indirect approach includes incentives within the ordinance such as the requirement for a performance bond equal to the work to be performed and civil penalties.

14.15.2 Direct Approach

The direct approach involves the inspection and enforcement of the sediment control elements in the Plan to ensure compliance with the principles and standards. The inspection and enforcement will be undertaken by the city or its representative.

14.15.3 Erosion and Sediment Control Plans & SWPPPs

For applicable land disturbance activities, the applicant shall prepare and implement an erosion and sediment control plan and Storm Water Pollution Prevention Plan (SWPPP). The plans shall include the necessary erosion and sediment control practices, implementation schedule and other necessary items to conform to the General Stormwater Permit for Construction Activity (MN R100001) and city ordinances.

14.16 Implementation Program

Table 14.2 below presents the City of Anoka’s Implementation Program. The table includes the planned year of the activity and budgeted cost for each item, as well as a total for the five year period. The City of Anoka generally replaces storm sewer infrastructure and constructs water quality BMPs in conjunction with its street renewal program.

Table 14.2 City of Anoka Implementation Program

Description	2019	2020	2021	2022	2023	2019-2023 Total
2019 SSIP Infiltration Trench	\$15,000	-	-	-	-	\$15,000
2019 SRP Infiltration Trench on South Street	\$25,000	-	-	-	-	\$25,000
2020 SSIP Rain Gardens	-	\$50,000	-	-	-	\$50,000
Mississippi River Bank Stabilization	\$200,000	\$300,000	\$350,000	-	-	\$850,000
Outfall Repairs, Planning and Stabilization	\$10,000	\$95,000	-	-	-	\$105,000
Expand Pond GRT-1	-	\$150,000	-	-	-	\$150,000
Trunk storm sewer Improvements	\$40,000	\$250,000	\$150,000	-	-	\$440,000
Trunk Hwy 10 Pond and Infiltration Basin Construction	-	-	-	\$200,000	\$200,000	\$400,000
Drainage Enhancement at Pond CH 2	-	-	-	-	\$70,000	\$70,000
Survey ponds to determine treatment effectiveness	-	-	\$10,000	\$5,000	-	\$15,000
Inspection of Outfalls ponds, and water quality structures	\$6,000	\$6,000	\$6,000	\$6,000	\$6,000	\$30,000
Educational Program, Newsletter and Website	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$25,000
Establish No Wake Zone on Mississippi River and Implementation	\$5,000	\$5,000	\$3,000	\$3,000	\$3,000	\$19,000

Description	2019	2020	2021	2022	2023	2019-2023 Total
Street Sweeping	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$50,000
General stormwater maintenance and repairs	\$40,000	\$40,000	\$40,000	\$40,000	\$40,000	\$200,000
General storm sewer and catch basin repairs	\$20,000	\$20,000	\$20,000	\$20,000	\$20,000	\$100,000
Construction Site Erosion and Sediment Control Implementation	\$8,000	\$8,000	\$8,000	\$8,000	\$8,000	\$40,000
Post Construction Stormwater Management and Implementation	\$6,000	\$6,000	\$6,000	\$6,000	\$6,000	\$30,000
Illicit Discharge Implementation	\$6,000	\$6,000	\$6,000	\$6,000	\$6,000	\$30,000

14.17 Funding Sources

The City of Anoka will fund the plans and programs herein primarily through use of its stormwater utility fund. If appropriate, the city may also consider grant monies that may be available from various other agencies, including the MPCA, the MnDNR, and BWSR and may partner with the LRRWMO to obtain the funds. Certain activities, such as construction site erosion control and post construction stormwater, may be funded by developer escrows. Improvements and BMPs on private property as a result of development and/or redevelopment will be funded by developers.

15.0 Technical Methods and Assumptions

15.1 General Overview

The need for stormwater modeling has increased as new construction changes the usage of the surrounding land. For example, replacing a stand of trees with a parking lot has a dramatic effect on runoff, greatly increasing its total volume and the rate of runoff. The potential for erosion and flooding is increased in areas downstream of construction. To prevent such damage, the runoff must be predicted before construction so that suitable steps can be taken to handle the runoff in a safe and effective manner.

HydroCAD, a hydrologic computer modeling program, was used for the watersheds modeled in this management plan. The three watersheds that were modeled are as follows: Mississippi River East Watershed, Mississippi River West Watershed, and Rum River North Watershed. Hydraulic evaluations of pipes, ditches, and other structures were performed using standard engineering procedures. The Flood Insurance Study for the Rum River and the Mississippi River was adopted by this plan and was not restudied.

To determine the critical flood levels for each subwatershed, runoff volumes from pervious and impervious areas were determined for the 24-hour, 100-year storm event.

The remaining seven watersheds which were previously modeled in detail in 2000, were not remodeled. The methodology for the seven watersheds previously modeled is discussed in Section 13.0 of the City of Anoka Stormwater Plan, August 2000, by Barr Engineering Company.

15.2 Hydrologic Model (HydroCAD)

Stormwater modeling and drainage design techniques can be divided into two basic groups:

- 1) Steady-state (constant flow) methods, such as the Rational Method as applied to storm sewer pipe networks.
- 2) Hydrograph generation and routing procedures designed to simulate the time varying nature of actual runoff.

Although HydroCAD can be used for steady-state designs, it is designed primarily as a hydrograph generation and routing program. It is based primarily on hydrology techniques developed by the Soil Conservation Service (SCS) combined with standard hydraulic calculations. For any given storm these techniques are used to generate hydrographs throughout a watershed.

15.2.1 Runoff Volumes

The volume and rate of runoff from a subwatershed are affected by the runoff curve number (CN), soil group classification and antecedent soil moisture condition.

The soil group classification used for this study is Group B. Soil Group B contains shallow, sandy loams. The antecedent soil moisture condition (AMC) is a measure of how much rain falls five days before a 24-hour storm. For this study, AMC II was used. The total 5 day antecedent rainfall, for AMC II, is 0.5-1.1” during the dormant season and 1.4 – 2.1” during the growing season. From this information a CN, which indicates the percentage of runoff from a subwatershed, can be determined. For this study, the CN’s range from 69-100. With the CN and the rainfall distribution and duration information, the runoff from each subwatershed can be determined using the SCS TR-20 method.

15.2.2 Rainfall Distribution and Duration

Design storm characteristics must be determined for the model. This requires determining both the amount of precipitation and the intensity distribution of the precipitation. Atlas 14, Volume 8 as published by the National Oceanic and Atmospheric Administration (NOAA) is used to determine the amount of precipitation.

The SCS Type II rainfall intensity distribution was used for this study. The SCS Type II distribution is used for the continental U.S. east of the Sierra Nevada and Cascade Mountains in California, Oregon, and Washington. The Type II distribution is based on the generalized rainfall depth-duration frequency relationships shown in technical publications of the Weather Bureau.

15.2.3 Flood Elevations

After the hydrographs are created for each subwatershed, they are routed through storage areas (wetlands, lakes, detention ponds, etc.) and conveyance systems (storm sewers and ditches) and combined with other hydrographs at junctions with other subwatersheds. Specific characteristics

of the water body and its outlet are input into the elevation-flood storage-discharge relationship used in the routing through each water body.

The storm duration that is critical for a watershed is dependent on the watershed size and slope, the volume of storage available in the system, and the outlet capacity. The critical duration is determined by routing several different duration storms of a given frequency and determining which duration produces the greatest peak discharge or flood elevation. A small watershed with little available storage will have a critical storm of shorter duration than a large watershed with abundant storage.

The elevations reported in this plan have been derived using limited topographic information and shall not be used for the purpose of establishing flood protection standards of new or existing structures. As development/building applications are submitted, the applicants will be required to further investigate the drainage patterns to more accurately determine flood elevations using Atlas 14 precipitation amounts.

15.3 Water Quality

A combination of computer models and standards will be utilized to determine if water quality goals have been met. For determining annual removal efficiencies of 60% of total phosphorous and 90% of total suspended solids a computer model that generates average annual rainfalls and removal efficiencies, such as the P8 Urban Catchment Model by William W. Walker, Jr., Ph.D. may be utilized. Alternatively, wet sedimentation basins may be designed to NURP standards as stated in Section 13.4 of this plan and infiltration BMPs can be sized to infiltrate the first inch of runoff as discussed in Section 14.3 of this plan.

For determining removal efficiencies for hydrodynamic separators, the designer shall estimate removal efficiencies of Total Suspended Solids by the use of a model, such as SHSAM developed by Barr Engineering, or other similar studies or reports.

16.1 Maintenance of Stormwater Facilities

The City of Anoka stormwater system includes not only pipes and constructed basins, but also wetlands, ditches, swales, and other drainageways. In addition to more typical maintenance measures, maintenance of the stormwater system may also mean maintaining or restoring the ecological characteristics of the natural portions of the stormwater system. The City of Anoka recognizes that maintenance of the all of the city's stormwater facilities is an important part of stormwater management. Proper maintenance will ensure that the stormwater system provides the necessary flood control and water quality treatment.

16.2 Private Stormwater Facilities

Owners of private storm water facilities are responsible for maintaining the facilities in proper condition, consistent with the original performance design standards. Owners of private stormwater facilities must provide the city with a maintenance plan that defines who will conduct the maintenance, the type of maintenance and the maintenance intervals and will be required to record a Maintenance Agreement against the property at the office of the Anoka County Recorder.

16.3 Publicly Owned Stormwater Facilities

The City of Anoka is responsible for performing the maintenance of the stormwater facilities under city ownership. The city will conduct regular inspections of its stormwater infrastructure per MS4 Permit requirements and schedule maintenance as required. In general, the city will plan to perform maintenance on its swirl structures, hydraulic separators, and sump manholes bi-annually, unless inspections warrant an adjustment. Sediment basins will be scheduled for dredging on 15-25 years intervals.

The Minnesota Department of Transportation is responsible for maintaining road ditches and culverts along U.S. Highway 169/10. Anoka County is responsible for maintaining road ditches and culverts along C.S.A.H. 1, C.S.A.H. 18, C.S.A.H. 21, C.R. 45, C.R. 46, C.R. 53, and C.S.A.H. 66.

16.4 Street Sweeping

Street sweeping serves an important role in reducing the amount of sediment, organic matter, and solids that enter the storm sewer conveyance system and ultimately our surface waters. Sediment accumulation in the conveyance system has the potential to reduce the hydraulic capacity and increase the risk for flooding. Further, accumulation of sediment and organic matter in conveyance systems, sediment ponds and structural BMPs has a negative impact on water quality. Therefore, the city will adopt a pro-active plan to sweep streets and parking lots at least twice a year— generally once after snowmelt and again after leaf drop.

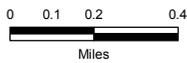
17.0 Amendments

This plan is based on information that was current at the time of plan preparation and is therefore subject to change. Changes in land use, zoning, watersheds, and drainage patterns, and revisions to governmental regulations/rules could affect all or part of this plan. As a result, the city may need to revise the plan to keep it current. The city expects that most revisions to will be minor (i.e. minor changes to the implementation program) and not require formal revision to the plan. Plan amendments, if required, will follow the procedures as outlined in Minnesota Statutes 103B.235.

APPENDIX A



WQS = Water Quality Structure



LEGEND

- Existing WQS
- Proposed WQS
- ★ Proposed Pond
- Storm Sewer
- Abandoned Pipe
- Existing Basins

FIGURE A

PROPOSED SYSTEM IMPROVEMENTS

APPENDIX B



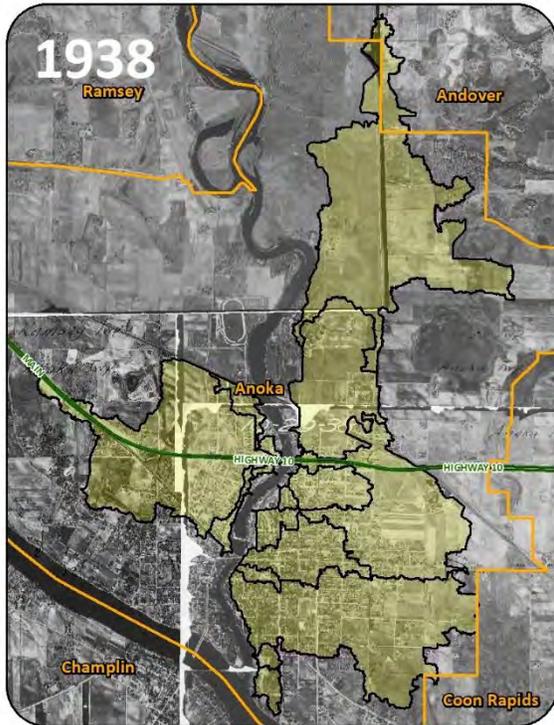
LEGEND

- Storm Sewer**
- Storm Sewer
- Upgrade Storm Sewer
- Proposed Storm Sewer

FIGURE B

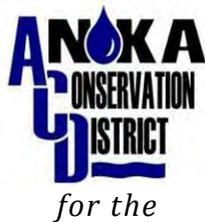
PROPOSED STORM SEWER UPGRADES

APPENDIX C



City of Anoka Stormwater Retrofit Analysis

Prepared by:



CITY OF ANOKA AND

LOWER RUM RIVER WATERSHED MANAGEMENT ORGANIZATION

August 2016

Cover photo: Aerial images from 1938 and 2014 showing the change in land use within the subwatersheds analyzed in this report.

Disclaimer: At the time of printing, this report identifies and ranks potential BMPs for selected subwatersheds in the City of Anoka that drain to the Rum River. This list of practices is not all-inclusive and does not preclude adding additional priority BMPs in the future. An updated copy of the report shall be housed at either the Anoka Conservation District or the City of Anoka.

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Executive Summary

The City of Anoka and the Lower Rum River Watershed Management Organization (LRRWMO) contracted the Anoka Conservation District (ACD) to complete this stormwater retrofit analysis (SRA) for the purpose of identifying and ranking water quality improvement projects in selected subwatersheds that drain to the Rum River. The subwatersheds are located on the western and eastern side of the Rum River within the City of Anoka and consist of commercial, industrial, and residential land uses. Volume, total phosphorus (TP), and total suspended solids (TSS) were the target parameters analyzed.

This analysis is primarily intended to identify potential projects within the target area to improve water quality in the Rum River through stormwater retrofits. Stormwater retrofits refer to best management practices (BMPs) that are added to an already developed landscape where little open space exists. The process is investigative and creative. Stormwater retrofits can be improperly judged by the total number of projects installed or by comparing costs alone. Those approaches neglect to consider how much pollution is removed per dollar spent. In this SRA, both costs and pollutant reductions were estimated and used to calculate cost-effectiveness for each potential retrofit identified.

Water quality benefits associated with the installation of each identified project were individually modeled using the Source Loading and Management Model for Windows (WinSLAMM). WinSLAMM uses an abundance of stormwater data from the Upper-Midwest and elsewhere to quantify runoff volumes and pollutant loads from urban areas. It has detailed accounting of pollutant loading from various land uses, and allows the user to build a model “landscape”. WinSLAMM uses rainfall and temperature data from a typical year (1959 data from Minneapolis for this analysis), routing stormwater through the user’s model for each storm.

WinSLAMM estimates volume and pollutant loading based on acreage, land use, and soils information. Therefore, the volume and pollutant estimates in this report are not waste load allocations, nor does this report serve as a TMDL for the study area. The WinSLAMM model was not calibrated and was only used as an estimation tool to provide relative ranking across potential retrofit projects. Specific model inputs (e.g. pollutant probability distribution, runoff coefficient, particulate solids concentration, particle residue delivery, and street delivery files) are detailed in Appendix A – Modeling Methods.

The costs associated with project design, administration, promotion, land acquisition, opportunity costs, construction oversight, installation, and maintenance were estimated. The total costs over the assumed effective life of each project were then divided by the modeled benefits over the same time period to enable ranking by cost-effectiveness.

A variety of stormwater retrofit approaches were identified. They included:

- Bioretention,
- Hydrodynamic devices,
- Permeable Pavement,
- Iron enhanced sand filter pond benches,
- Existing stormwater pond modifications,
- New stormwater ponds, and

- Water reuse.

If all of these practices were installed, significant volume and pollutant reductions could be accomplished. However, funding limitations and landowner interest make this goal unlikely. Instead, it is recommended that projects be installed in order of cost effectiveness (pounds of pollution reduced per dollar spent). Other factors, including a project's educational value/visibility, construction timing, total cost, or non-target pollutant reduction also affect project installation decisions and need to be weighed by resource managers when selecting projects to pursue.

For each type of recommended retrofit, conceptual siting is provided in the project profiles section. The intent of these figures is to provide an understanding of the approach. If a project is selected, site-specific designs must be prepared. In addition, many of the proposed retrofits (e.g. new ponds) will require a more detailed feasibility analysis and engineered plan sets if selected. This typically occurs after committed partnerships are formed to install the project. Committed partnerships must include willing landowners, both public and private.

The 1,474-acre target study area was consolidated into four drainage networks and 17 catchments. Based on WinSLAMM model results, the total study area contributes an estimated 941 acre-feet of runoff, 299,153 pounds of TSS, and 807 pounds of TP annually.

The tables in the Project Ranking and Selection section (pages 13-18) summarize potential projects ranked by cost effectiveness with respect to either TP or TSS. Potential projects are organized from most cost effective to least based on pollutants removed.

Installation of projects in series will result in lower total treatment than the simple sum of treatment achieved by the individual projects due to treatment train effects. Reported treatment levels are dependent upon optimal site selection and sizing. More detail about each project can be found in the catchment profile pages of this report. Projects that were deemed unfeasible due to prohibitive size, number, or expense were not included in this report.

Document Organization

This document is organized into five sections, plus references and appendices. Each section is briefly discussed below.

Background

The background section provides a brief description of the landscape characteristics within the study area.

Analytical Process and Elements

The analytical process and elements section overviews the procedures that were followed when analyzing the subwatershed. It explains the processes of retrofit scoping, desktop analysis, field investigation, modeling, cost/treatment analysis, project ranking, and project selection. Refer to Appendix A – Modeling Methods for a detailed description of the modeling methods.

Project Ranking and Selection

The project ranking and selection section describes the methods and rationale for how projects were ranked. Local resource management professionals will be responsible to select and pursue projects, taking into consideration the many possible ways to prioritize projects. Several considerations in addition to project cost-effectiveness for prioritizing installation are included. Project funding opportunities may play a large role in project selection, design, and installation.

This section also ranks stormwater retrofit projects across all catchments to create a prioritized project list. The list is sorted by the amount of pollutant removed by each project over 30 years. The final cost per pound treatment value includes installation and maintenance costs over the estimated life of the project. If a practice's effective life was expected to be less than 30 years, rehabilitation or reinstallation costs were included in the cost estimate. There are many possible ways to prioritize projects, and the list provided in this report is merely a starting point.

BMP Descriptions

For each type of project included in this report, there is a description of the rationale for including that type of project, the modeling method employed, and the cost calculations used to estimate associated installation and maintenance expenses.

Catchment Profiles

The drainage areas targeted for this analysis were consolidated into 17 catchments distributed between four drainage networks and assigned unique identification numbers. For each catchment, the following information is detailed:

Drainage Network

Catchments were grouped into drainage networks based on their geographic distribution throughout the study area and drainage to a common waterbody (i.e. the Rum River). The drainage networks were used to further subdivide the report to aid with organization and clarity.

Catchment Description

Within each catchment profile is a table that summarizes basic catchment information including acres, land cover, parcels, and estimated annual pollutant and volume loads under existing conditions. Existing conditions included notable stormwater treatment practices for which information was available from the City of Anoka. Small, site-specific practices (e.g. rain-leader disconnect rain gardens) were not included in the existing conditions model. A brief description of the land cover, stormwater infrastructure, and any other important general information is also described in this section. Notable existing stormwater practices are explained and their estimated effectiveness presented.

Retrofit Recommendations

Retrofit recommendations are presented for each catchment and include a description of the proposed BMP, cost-effectiveness table including modeled volume and pollutant reductions, and an overview map showing the contributing drainage area for each BMP.

References

This section identifies various sources of information synthesized to produce the protocol used in this analysis.

Appendices

This section provides supplemental information and/or data used during the analysis.

Background

Many factors are considered when choosing which subwatersheds to analyze for stormwater retrofits. Water quality monitoring data, non-degradation report modeling, and TMDL studies are just a few of the resources available to help determine which water bodies are a priority. Stormwater retrofit analyses supported by a Local Government Unit with sufficient capacity (staff, funding, available GIS data, etc.) to greater facilitate the process also rank highly. For some communities a stormwater retrofit analysis complements their MS4 stormwater permit. The focus is always on a high priority waterbody.

The drainage areas studied for this analysis are located in the City of Anoka and discharge to the Rum River. The total area of the 17 catchments is 1,474 acres. Six of the catchments lie on the western side of the Rum River and are roughly bound by Greenhaven Road to the north and Park Street to the south. The remaining eleven catchments are on the eastern side of the Rum River. These catchments are bound roughly by Bunker Lake Boulevard to the north and East River Road to the south.

These catchments were selected for analysis because they drain to a high priority waterbody, and existing treatment in many of the catchments could be supplemented. Stormwater retrofits may provide cost-effective options for additional treatment of runoff, thereby improving water quality in the Rum River.

The catchments analyzed are urbanized. Development throughout the City of Anoka has resulted in the installation of subsurface drainage systems (i.e. stormwater infrastructure) to convey stormwater runoff, which increased due to the coverage of impervious surfaces throughout the catchments. The runoff generated within the areas targeted for this analysis is still conveyed to the Rum River, as it was historically. However, the runoff is now captured by catch basins and directed underground before being discharged to the Rum River via stormwater pipes.

Stormwater runoff from impervious surfaces can carry a variety of pollutants. While stormwater treatment to remove these pollutants is adequate in some areas, other areas were built prior to modern-day stormwater treatment technologies and requirements. The City of Anoka and LRRWMO contracted the ACD to complete this SRA for the purpose of identifying and analyzing projects to improve the quality of stormwater runoff to the Rum River. Overall subwatershed loading of TP, TSS, and stormwater volume were estimated for selected drainage areas. Proposed retrofits were modeled to estimate each practice's capability for removing pollutants and reducing volume. Finally, each project was ranked based on the estimated cost-effectiveness of the project to reduce pollutants.

Analytical Process and Elements

This stormwater retrofit analysis is a watershed management tool to identify and prioritize potential stormwater retrofit projects by performance and cost-effectiveness. This process helps maximize the value of each dollar spent. The process used for this analysis is outlined in the following pages and was modified from the Center for Watershed Protection's Urban Stormwater Retrofit Practices, Manuals 2 and 3 (Schueler & Kitchell, 2005 and Schueler et al. 2007). Locally relevant design considerations were also incorporated into the process (Technical Documents, Minnesota Stormwater Manual, 2014).

Scoping includes determining the objectives of the retrofits (volume reduction, target pollutant, etc.) and the level of treatment desired. It involves meeting with local stormwater managers, city staff and watershed management organization members to determine the issues in the subwatershed. This step also helps to define preferred retrofit treatment options and retrofit performance criteria. In order to create a manageable area to analyze in large subwatersheds, a focus area may be determined.

In this analysis, the focus areas were the contributing drainage areas to storm sewer outfalls that discharge directly into the Rum River. More specifically, outfalls with limited existing treatment were selected. Included are areas of residential, commercial, industrial, and institutional land uses. Existing stormwater infrastructure maps and topography data were used to determine drainage boundaries for the 17 catchments included in this analysis. Street reconstruction plan sets were also digitized by ACD where updated stormwater infrastructure GIS data was lacking.

The targeted pollutants for this study were TP and TSS, though volume was also estimated and reported. Volume of stormwater was tracked throughout this study because it is necessary for pollutant loading calculations and potential retrofit project considerations. Table 1 describes the target pollutants and their role in water quality degradation. Projects that effectively reduce loading of multiple target pollutants can provide greater immediate and long-term benefits.

Table 1: Target Pollutants

Target Pollutant	Description
Total Phosphorus (TP)	Phosphorus is a nutrient essential to plant growth and is commonly the factor that limits the growth of plants in surface water bodies. TP is a combination of particulate phosphorus (PP), which is bound to sediment and organic debris, and dissolved phosphorus (DP), which is in solution and readily available for plant growth (active).
Total Suspended Solids (TSS)	Very small mineral and organic particles that can be dispersed into the water column due to turbulent mixing. TSS loading can create turbid and cloudy water conditions and carry with it PP. As such, reductions in TSS will also result in TP reductions.
Volume	Higher runoff volumes and velocities can carry greater amounts of TSS to receiving water bodies. It can also exacerbate in-stream erosion, thereby increasing TSS loading. As such, reductions in volume may reduce TSS loading and, by extension, TP loading. However, in-stream erosion is not an issue in these catchments because stormwater is piped directly to the Rum River.

Desktop analysis involves computer-based scanning of the subwatershed for potential retrofit catchments and/or specific sites. This step also identifies areas that do not need to be analyzed because of existing stormwater treatment or disconnection from the target water body. Accurate GIS data are

extremely valuable in conducting the desktop retrofit analysis. Some of the most important GIS layers include: 2-foot or finer topography (Light Detection and Ranging [LiDAR] was used for this analysis), surface hydrology, soils, watershed/subwatershed boundaries, parcel boundaries, high-resolution aerial photography, and the stormwater drainage infrastructure (with invert elevations).

Field investigation is conducted after potential retrofits are identified in the desktop analysis to evaluate each site and identify additional opportunities. During the investigation, the drainage area and surface stormwater infrastructure mapping data were verified. Site constraints were assessed to determine the most feasible retrofit options as well as eliminate sites from consideration. The field investigation may have also revealed additional retrofit opportunities that could have gone unnoticed during the desktop search.

Modeling involves assessing multiple scenarios to estimate pollutant loading and potential reductions by proposed retrofits. WinSLAMM (version 10.2.0), which allows routing of multiple catchments and stormwater treatment practices, was used for this analysis. This is important for estimating treatment train effects associated with multiple BMPs in series. Furthermore, it allows for estimation of volume and pollutant loading at the outfall point to the waterbody, which is the primary point of interest in this type of study.

WinSLAMM estimates volume and pollutant loading based on acreage, land use, and soils information. Therefore, the volume and pollutant estimates in this report are not waste load allocations, nor does this report serve as a TMDL for the study area. The WinSLAMM model was not calibrated and was only used as an estimation tool to provide relative ranking across potential retrofit projects. Soils throughout the study area were predominantly sandy based on the information available in the Anoka County soil survey. Specific model inputs (e.g. pollutant probability distribution, runoff coefficient, particulate solids concentration, particle residue delivery, and street delivery files) are detailed in Appendix A – Modeling Methods.

The initial step was to create a “base” model which estimates pollutant loading from each catchment in its present-day state without taking into consideration any existing stormwater treatment. To accurately model the land uses in each catchment, drainage area delineations were completed using the watershed delineation tool in ArcSWAT. The drainage areas were then consolidated into catchments using geographic information systems (specifically, ArcGIS). Land use data (based on 2010 Metropolitan Council land use file) were used to calculate acreages of each land use type within each catchment. Each land use polygon classification was compared with 2014 aerial photography, the most recent available at the time of this analysis, and corrected if land use had changed since 2010. This process addressed recent development throughout the study area by reclassifying land use types accordingly. Soil types throughout the subwatershed were modeled as sand and silt in this analysis based on the information available in the Anoka County soil survey. Entering the acreages, land use, and soil data into WinSLAMM ultimately resulted in a model that included estimates of the acreage of each type of source area (roof, road, lawn, etc.) in each catchment.

Once the “base” model was established, an “existing conditions” model was created by incorporating notable existing stormwater treatment practices in the catchment for which data were available from the City of Anoka (Figure 1 and Figure 2). For example, street cleaning with mechanical or vacuum street sweepers, stormwater treatment ponds, hydrodynamic devices, and others were included in the “existing conditions” model if information was available.

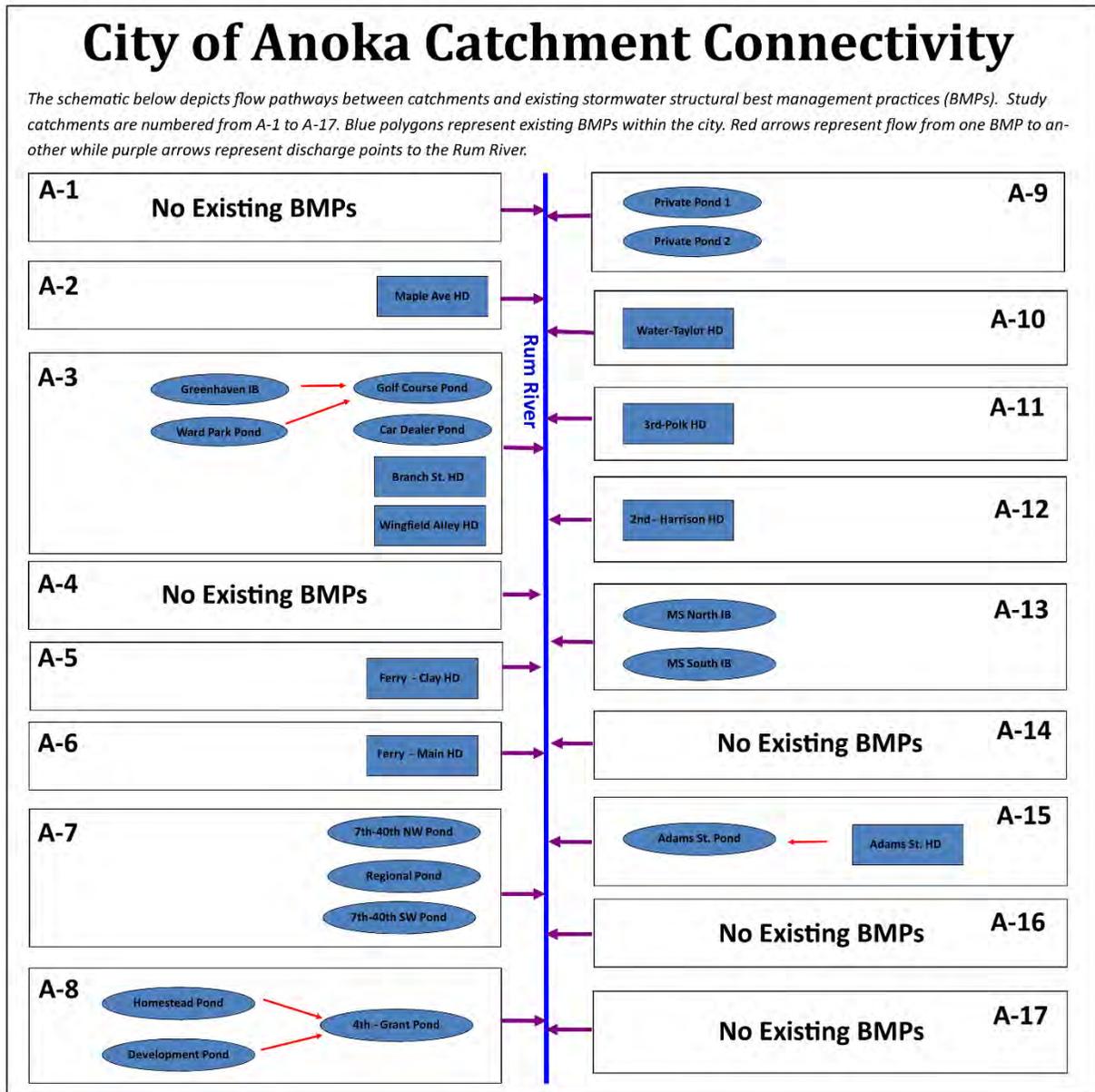


Figure 1: Schematic showing the existing BMPs in each catchment and their connectivity.

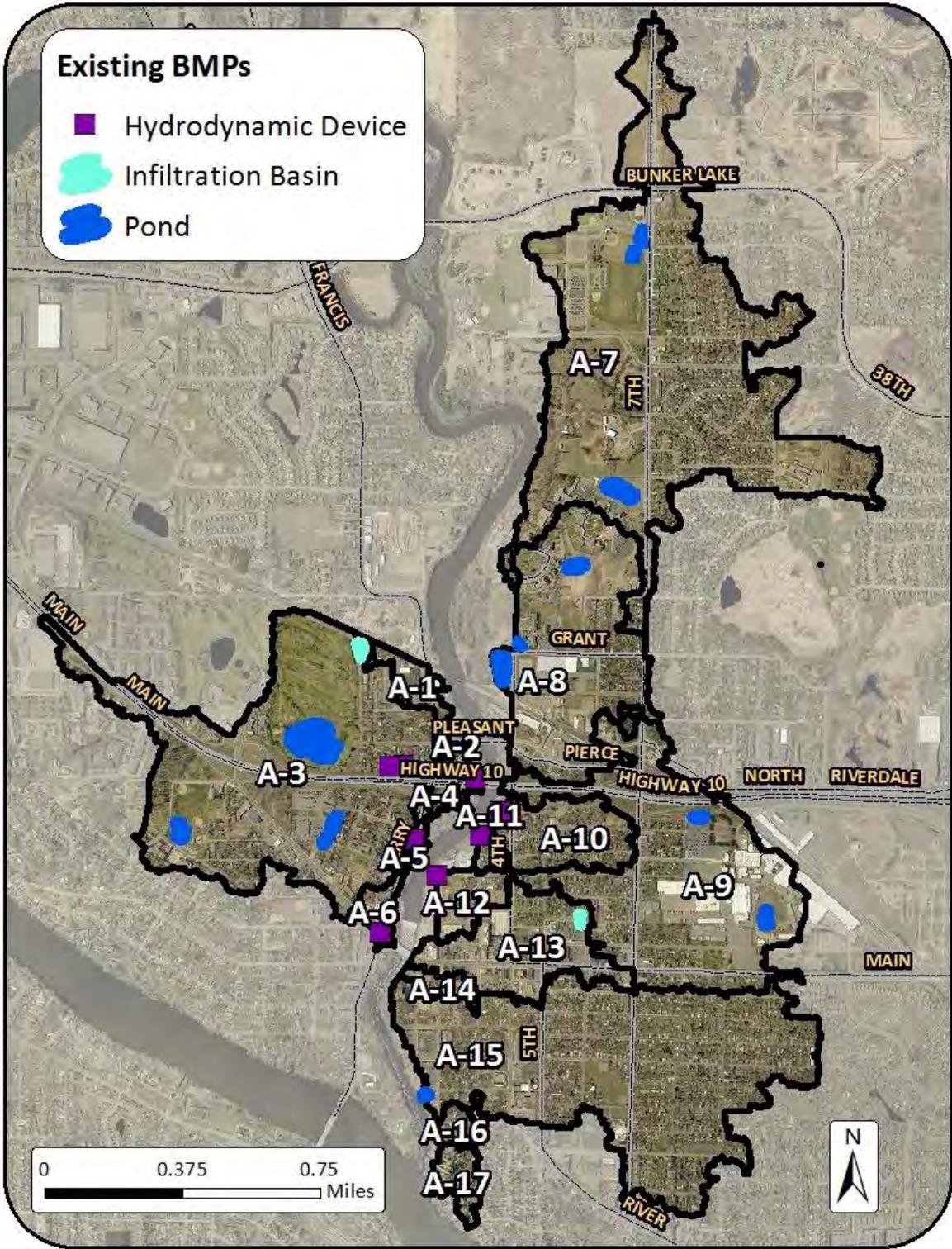


Figure 2: Study area map showing existing BMPs included in the WinSLAMM model. Street sweeping is not shown on the map but was included throughout the study area.

Finally, each proposed stormwater retrofit practice was added individually to the “existing conditions” model and pollutant reductions were estimated. Because neither a detailed design of each practice nor in-depth site investigation was completed, a generalized design for each practice was used. Whenever possible, site-specific parameters were included. Design parameters were modified to obtain various levels of treatment. It is worth noting that each practice was modeled individually, and the benefits of projects may not be additive, especially if serving the same area (i.e. treatment train effects). Reported treatment levels are dependent upon optimal site selection and sizing. Additional information on the WinSLAMM models can be found in Appendix A – Modeling Methods.

Cost estimating is essential for the comparison and ranking of projects, development of work plans, and pursuit of grants and other funds. All estimates were developed using 2016 dollars. Costs throughout this report were estimated using a multitude of sources. Costs were derived from The Center for Watershed Protection’s Urban Subwatershed Restoration Manuals (Schueler & Kitchell, 2005 and Schueler et al. 2007) and recent installation costs and cost estimates provided to the ACD by personal contacts. Cost estimates were annualized costs that incorporated the elements listed below over a 30-year period.

Project promotion and administration includes local staff efforts to reach out to landowners, administer related grants, and complete necessary administrative tasks.

Design includes site surveying, engineering, and construction oversight.

Land or easement acquisition cover the cost of purchasing property or the cost of obtaining necessary utility and access easements from landowners.

Construction calculations are project specific and may include all or some of the following; grading, erosion control, vegetation management, structures, mobilization, traffic control, equipment, soil disposal, and rock or other materials.

Maintenance includes annual inspections and minor site remediation such as vegetation management, structural outlet repair and cleaning, and washout repair.

In cases where promotion to landowners is important, such as rain gardens, those costs were included as well. In cases where multiple, similar projects are proposed in the same locality, promotion and administration costs were estimated using a non-linear relationship that accounted for savings with scale. Design assistance from an engineer is assumed for practices in-line with the stormwater conveyance system, involving complex stormwater treatment interactions, or posing a risk for upstream flooding. It should be understood that no site-specific construction investigations were done as part of this stormwater retrofit analysis, and therefore cost estimates account for only general site considerations. Detailed feasibility analyses may be necessary for some projects.

Project ranking is essential to identify which projects could be pursued to achieve water quality goals. Project ranking tables are presented based on cost per pound of TP and per 1,000 pounds of TSS removed.

Project selection involves considerations other than project ranking, including but not limited to total cost, treatment train effects, social acceptability, and political feasibility.

Project Ranking and Selection

The intent of this analysis is to provide the information necessary to enable local natural resource managers to successfully secure funding for the most cost-effective projects to achieve water quality goals. This analysis ranks potential projects by cost-effectiveness to facilitate project selection. There are many possible ways to prioritize projects, and the list provided in this report is merely a starting point. Local resource management professionals will be responsible to select projects to pursue. Several considerations in addition to project cost-effectiveness for prioritizing installation are included.

Project Ranking

If all identified practices were installed (Figure 3), significant pollution reduction could be accomplished. However, funding limitations and landowner interest will likely be limiting factors for implementation. The tables on the following pages rank all modeled projects by cost-effectiveness.

Projects were ranked in two ways:

- 1) Cost per pound of total phosphorus removed (Table 2, Table 3, and Table 4) and
- 2) Cost per 1,000 pounds of total suspended solids removed (Table 5, Table 6, and Table 7).

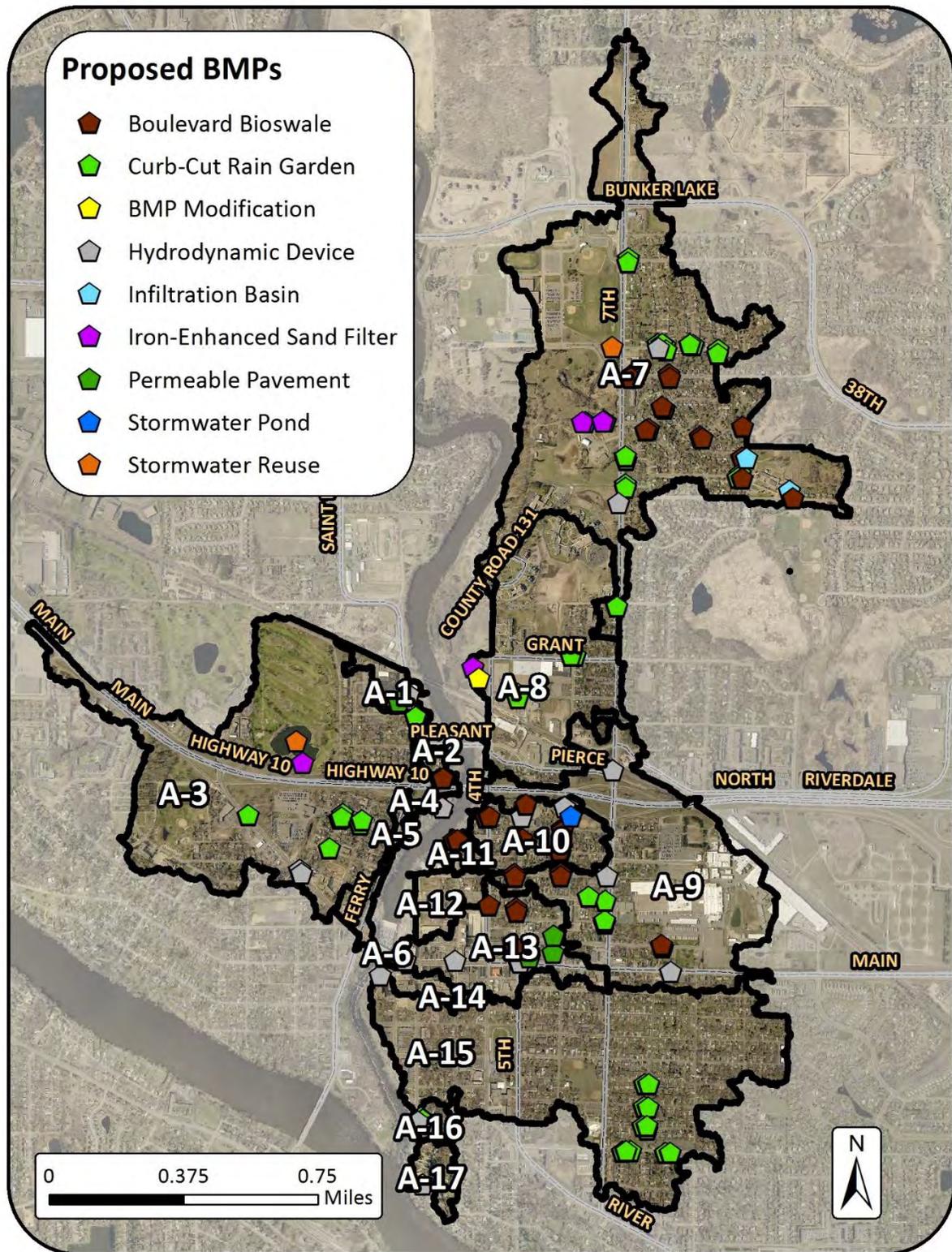


Figure 3: Study area map showing the proposed retrofits included in this report.

Table 2: Cost-effectiveness of retrofits with respect to TP reduction. Projects ranked 1 – 16 are shown on this table. TSS and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Retrofit Location	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/lb-TP/year (30-year) ¹
1	7-H1	73	New Pond	7th Ave.	A-7	111.6	54,558	0.9	\$802,138.00	\$5,500.00	\$289.00
2	7-D	69	Infiltration Basin	Colfax Ave. and Blackoaks Ln.	A-7	9.6	3,256	8.1	\$118,796.00	\$225.00	\$436.00
3	7-H2	74	New Pond	7th Ave.	A-7	31.5	13,452	0.4	\$360,484.00	\$1,800.00	\$439.00
4	7-E	70	Infiltration Basin	Sunny Ln.	A-7	1.7	676	1.8	\$22,796.00	\$225.00	\$579.00
5	10-C	97	Infiltration Basin	5th Ave. and Polk St.	A-10	2.6	808	2.1	\$43,796.00	\$225.00	\$648.00
6	7-I1	75	IESF Bench	7th Ave.	A-7	26.6	0	0	\$580,991.00	\$4,591.00	\$902.00
7	16-A	128	Curb-Cut Rain Garden	Washington St.	A-16	0.5-1.0	157-315	0.4-0.8	\$8,982-\$17,234	\$225-\$450	\$1,024-\$1,049
8	1-A	38	Curb-Cut Rain Garden	Ferry St. and Front Ave.	A-1	0.5	187	0.5	\$8,982.00	\$225.00	\$1,049.00
9	3-A	48	Curb-Cut Rain Garden	Various locations in catchment	A-3	0.5-3.5	157-1,089	0.4-2.7	\$15,844-\$65,356	\$225-\$1,575	\$1,072-\$1,506
10	7-A	66	Curb-Cut Rain Garden	Various locations in catchment	A-7	0.5-8.1	153-2,539	0.4-6.2	\$15,844-\$147,876	\$225-\$3,825	\$1,081-\$1,506
11	9-A	87	Curb-Cut Rain Garden	Various locations in catchment	A-9	0.5-2.0	155-623	0.4-1.5	\$15,844-\$40,600	\$225-\$900	\$1,127-\$1,506
12	8-B	81	Pond Modification	4th Ave. and Grant St.	A-8	10.5	6,443	0	\$330,840-\$690,840	\$1,300.00	\$1,174-\$2,317
13	15-A	125	Curb-Cut Rain Garden	Various locations in catchment	A-15	0.4-4.4	135-1,343	0.4-3.7	\$15,844-\$90,112	\$225-\$2,250	\$1,194-\$1,883
14	3-D	51	IESF Bench	Green Haven Golf Course Pond	A-3	10.4	0	0	\$282,955.00	\$3,214.00	\$1,216.00
15	3-E	52	Stomwater Reuse	Green Haven Golf Course Pond	A-3	18.2	3,409	46.4	\$608,760.00	\$3,000.00	\$1,280.00
16	8-A	80	Curb-Cut Rain Garden	Various locations in catchment	A-8	0.7-0.8	190-301	0.7-1.1	\$17,234.00	\$450.00	\$1,281-\$1,464

¹ [(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TP Reduction)]

Table 3: Cost-effectiveness of retrofits with respect to TP reduction. Projects ranked 17 – 31 are shown on this table. TSS and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Retrofit Location	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/lb-TP/year (30-year) ¹
17	8-C	82	IESF Bench	4th Ave. and Grant St.	A-8	7.2	0	0	\$282,955.00	\$1,607.00	\$1,534.00
18	7-I2	76	IESF Bench	7th Ave.	A-7	7.2	0	0	\$305,875.00	\$1,837.00	\$1,669.00
19	7-G	72	Stomwater Reuse	38th Ave. and 7th Ave.	A-7	17.5	5,987	18.7	\$958,760.00	\$3,000.00	\$1,998.00
20	10-E	99	New Pond	Rudy Johnson Park	A-10	4	1,712	0.1	\$239,925.00	\$300.00	\$2,074.00
21	9-E	91	Boulevard Bioswale	Various locations in catchment	A-9	0.2	112	0.2	\$8,526.00	\$225.00	\$2,131.00
22	13-D	112	Hydrodynamic Device	5th Ave. and Main St.	A-13	1.4	644	0	\$109,752.00	\$630.00	\$3,063.00
23	2-A	44	Boulevard Bioswale	Maple Ave.	A-2	0.2	55	0.1	\$8,526.00	\$225.00	\$3,140.00
24	7-F	71	Boulevard Bioswale	Various locations in catchment	A-7	0.2	61	0.1	\$8,526.00	\$225.00	\$3,264.00
25	10-D	98	Boulevard Bioswale	Various locations in catchment	A-10	0.1	52	0.1	\$8,526.00	\$225.00	\$3,427.00
26	11-A	102	Boulevard Bioswale	3rd Ave.	A-11	0.1	49	0.1	\$8,526.00	\$225.00	\$3,523.00
27	7-B	67	Hydrodynamic Device	38th Ln. and 8th Ave.	A-7	1.2	491	0	\$109,752.00	\$630.00	\$3,574.00
27	9-B	88	Hydrodynamic Device	7th Ave. and Pierce St.	A-9	1.2	686	0	\$109,752.00	\$630.00	\$3,574.00
29	9-D	90	Hydrodynamic Device	Main St. and 8 1/2 Ave.	A-9	1.1	777	0	\$109,752.00	\$630.00	\$3,899.00
30	3-C	50	Hydrodynamic Device	Main St. and State Ave.	A-3	0.6	302	0	\$55,752.00	\$630.00	\$4,147.00
31	1-B	39	Hydrodynamic Device	Ferry St.	A-1	1	584	0	\$109,752.00	\$630.00	\$4,288.00
31	9-C	89	Hydrodynamic Device	7th Ave. and Harrison St.	A-9	1	407	0	\$109,752.00	\$630.00	\$4,288.00

¹ [(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TP Reduction)]

Table 4: Cost-effectiveness of retrofits with respect to TP reduction. Projects ranked 33 – 48 are shown on this table. TSS and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Retrofit Location	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/lb-TP/year (30-year) ¹
33	13-C	111	Hydrodynamic Device	Main St. and 5th Ave.	A-13	0.9	427	0	\$109,752.00	\$630.00	\$4,765.00
34	13-A	109	Hydrodynamic Device	Main St. and 1st Ave.	A-13	0.5	272	0	\$55,752.00	\$630.00	\$4,977.00
34	13-B	110	Hydrodynamic Device	Main St. and 3rd Ave.	A-13	0.5	285	0	\$55,752.00	\$630.00	\$4,977.00
34	3-B	49	Hydrodynamic Device	Main St. and State Ave.	A-3	0.5	280	0	\$55,752.00	\$630.00	\$4,977.00
37	13-H	116	Boulevard Bioswale	Various locations in catchment	A-13	0.1	22	0.1	\$8,526.00	\$225.00	\$5,092.00
38	4-A	55	Hydrodynamic Device	Maple Ln.	A-4	0.3	113	0	\$28,752.00	\$630.00	\$5,295.00
39	14-A	121	Hydrodynamic Device	Parking lot off 1st Ave.	A-14	0.8	385	0	\$109,752.00	\$630.00	\$5,361.00
39	7-C	68	Hydrodynamic Device	7th Ave.	A-7	0.8	383	0	\$109,752.00	\$630.00	\$5,361.00
41	17-A	133	Hydrodynamic Device	Oakwood Dr.	A-17	0.6	244	0	\$109,752.00	\$630.00	\$7,147.00
42	10-A	95	Hydrodynamic Device	6th Ave. and Taylor St.	A-10	0.5	211	0	\$109,752.00	\$630.00	\$8,577.00
43	10-B	96	Hydrodynamic Device	5th Ave. and Taylor St.	A-10	0.5	195	0	\$109,752.00	\$630.00	\$8,577.00
44	16-B	129	Hydrodynamic Device	Oakwood Dr. and Washington St.	A-16	0.4	163	0	\$109,752.00	\$630.00	\$10,721.00
45	13-F	114	Permeable Pavement	St. Stephen's Catholic School	A-13	1.6	562	1.6	\$282,796.00	\$20,925.00	\$18,970.00
46	13-E	113	Permeable Pavement	St. Stephen's Catholic Church	A-13	0.9	320	0.9	\$162,796.00	\$11,925.00	\$19,279.00
47	13-G	115	Permeable Pavement	St. Stephen's Catholic School	A-13	1.9	672	1.9	\$343,796.00	\$25,500.00	\$19,453.00
48	1-C	40	Permeable Pavement	Anoka-Hennepin Education Center	A-1	2.9	1,325	3.5	\$552,656.00	\$41,165.00	\$20,547.00

¹ [(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TP Reduction)]

Table 5: Cost-effectiveness of retrofits with respect to TSS reduction. Projects ranked 1 – 16 are shown on this table. TP and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Retrofit Location	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ 1,000lb-TSS/year (30-year) ¹
1	7-H1	73	New Pond	7th Ave.	A-7	111.6	54,558	0.9	\$802,138.00	\$5,500.00	\$591.00
2	7-H2	74	New Pond	7th Ave.	A-7	31.5	13,452	0.4	\$360,484.00	\$1,800.00	\$1,027.00
3	7-D	69	Infiltration Basin	Colfax Ave. and Blackoaks Ln.	A-7	9.6	3,256	8.1	\$118,796.00	\$225.00	\$1,285.00
4	7-E	70	Infiltration Basin	Sunny Ln.	A-7	1.7	676	1.8	\$22,796.00	\$225.00	\$1,457.00
5	8-B	81	Pond Modification	4th Ave. and Grant St.	A-8	10.5	6,443	0	\$330,840-\$690,840	\$1,300.00	\$1,913-\$3,776
6	10-C	97	Infiltration Basin	5th Ave. and Polk St.	A-10	2.6	808	2.1	\$43,796.00	\$225.00	\$2,085.00
7	1-A	38	Curb-Cut Rain Garden	Ferry St. and Front Ave.	A-1	0.5	187	0.5	\$8,982.00	\$225.00	\$2,804.00
8	16-A	128	Curb-Cut Rain Garden	Washington St.	A-16	0.5-1.0	157-315	0.4-0.8	\$8,982-\$17,234	\$225-\$450	\$3,252-\$3,340
9	8-A	80	Curb-Cut Rain Garden	Various locations in catchment	A-8	0.7-0.8	190-301	0.7-1.1	\$17,234.00	\$450.00	\$3,404-\$5,392
10	3-A	48	Curb-Cut Rain Garden	Various locations in catchment	A-3	0.5-3.5	157-1,089	0.4-2.7	\$15,844-\$65,356	\$225-\$1,575	\$3,447-\$4,797
11	7-A	66	Curb-Cut Rain Garden	Various locations in catchment	A-7	0.5-8.1	153-2,539	0.4-6.2	\$15,844-\$147,876	\$225-\$3,825	\$3,448-\$4,922
12	9-A	87	Curb-Cut Rain Garden	Various locations in catchment	A-9	0.5-2.0	155-623	0.4-1.5	\$15,844-\$40,600	\$225-\$900	\$3,617-\$4,859
13	15-A	125	Curb-Cut Rain Garden	Various locations in catchment	A-15	0.4-4.4	135-1,343	0.4-3.7	\$15,844-\$90,112	\$225-\$2,250	\$3,912-\$5,579
14	9-E	91	Boulevard Bioswale	Various locations in catchment	A-9	0.2	112	0.2	\$8,526.00	\$225.00	\$4,561.00
15	10-E	99	New Pond	Rudy Johnson Park	A-10	4	1,712	0.1	\$239,925.00	\$300.00	\$4,847.00
16	9-D	90	Hydrodynamic Device	Main St. and 8 1/2 Ave.	A-9	1.1	777	0	\$109,752.00	\$630.00	\$5,519.00

¹ [(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TSS Reduction/1,000)]

Table 6: Cost-effectiveness of retrofits with respect to TSS reduction. Projects ranked 17 – 32 are shown on this table. TP and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Retrofit Location	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/1,000lb-TSS/year (30-year) ¹
17	7-G	72	Stomwater Reuse	38th Ave. and 7th Ave.	A-7	17.5	5,987	18.7	\$958,760.00	\$3,000.00	\$5,839.00
18	9-B	88	Hydrodynamic Device	7th Ave. and Pierce St.	A-9	1.2	686	0	\$109,752.00	\$630.00	\$6,251.00
19	13-D	112	Hydrodynamic Device	5th Ave. and Main St.	A-13	1.4	644	0	\$109,752.00	\$630.00	\$6,659.00
20	3-E	52	Stomwater Reuse	Green Haven Golf Course Pond	A-3	18.2	3,409	46.4	\$608,760.00	\$3,000.00	\$6,833.00
21	1-B	39	Hydrodynamic Device	Ferry St.	A-1	1	584	0	\$109,752.00	\$630.00	\$7,343.00
22	3-C	50	Hydrodynamic Device	Main St. and State Ave.	A-3	0.6	302	0	\$55,752.00	\$630.00	\$8,240.00
23	7-F	71	Boulevard Bioswale	Various locations in catchment	A-7	0.2	61	0.1	\$8,526.00	\$225.00	\$8,352.00
24	13-B	110	Hydrodynamic Device	Main St. and 3rd Ave.	A-13	0.5	285	0	\$55,752.00	\$630.00	\$8,731.00
25	7-B	67	Hydrodynamic Device	38th Ln. and 8th Ave.	A-7	1.2	491	0	\$109,752.00	\$630.00	\$8,734.00
26	3-B	49	Hydrodynamic Device	Main St. and State Ave.	A-3	0.5	280	0	\$55,752.00	\$630.00	\$8,887.00
27	13-A	109	Hydrodynamic Device	Main St. and 1st Ave.	A-13	0.5	272	0	\$55,752.00	\$630.00	\$9,149.00
28	2-A	44	Boulevard Bioswale	Maple Ave.	A-2	0.2	55	0.1	\$8,526.00	\$225.00	\$9,202.00
29	10-D	98	Boulevard Bioswale	Various locations in catchment	A-10	0.1	52	0.1	\$8,526.00	\$225.00	\$9,853.00
30	13-C	111	Hydrodynamic Device	Main St. and 5th Ave.	A-13	0.9	427	0	\$109,752.00	\$630.00	\$10,043.00
31	11-A	102	Boulevard Bioswale	3rd Ave.	A-11	0.1	49	0.1	\$8,526.00	\$225.00	\$10,342.00
32	9-C	89	Hydrodynamic Device	7th Ave. and Harrison St.	A-9	1	407	0	\$109,752.00	\$630.00	\$10,537.00

¹ [(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TSS Reduction/1,000)]

Table 7: Cost-effectiveness of retrofits with respect to TSS reduction. Projects ranked 33 – 48 are shown on this table. TP and volume reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Retrofit Location	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/1,000lb-TSS/year (30-year) ¹
33	14-A	121	Hydrodynamic Device	Parking lot off 1st Ave.	A-14	0.8	385	0	\$109,752.00	\$630.00	\$11,139.00
34	7-C	68	Hydrodynamic Device	7th Ave.	A-7	0.8	383	0	\$109,752.00	\$630.00	\$11,197.00
35	4-A	55	Hydrodynamic Device	Maple Ln.	A-4	0.3	113	0	\$28,752.00	\$630.00	\$14,057.00
36	17-A	133	Hydrodynamic Device	Oakwood Dr.	A-17	0.6	244	0	\$109,752.00	\$630.00	\$17,575.00
37	10-A	95	Hydrodynamic Device	6th Ave. and Taylor St.	A-10	0.5	211	0	\$109,752.00	\$630.00	\$20,324.00
38	10-B	96	Hydrodynamic Device	5th Ave. and Taylor St.	A-10	0.5	195	0	\$109,752.00	\$630.00	\$21,992.00
39	13-H	116	Boulevard Bioswale	Various locations in catchment	A-13	0.1	22	0.1	\$8,526.00	\$225.00	\$23,072.00
40	16-B	129	Hydrodynamic Device	Oakwood Dr. and Washington St.	A-16	0.4	163	0	\$109,752.00	\$630.00	\$26,309.00
41	1-C	40	Permeable Pavement	Anoka-Hennepin Education Center	A-1	2.9	1,325	3.5	\$552,656.00	\$41,165.00	\$44,971.00
42	13-F	114	Permeable Pavement	St. Stephen's Catholic School	A-13	1.6	562	1.6	\$282,796.00	\$20,925.00	\$54,006.00
43	13-E	113	Permeable Pavement	St. Stephen's Catholic Church	A-13	0.9	320	0.9	\$162,796.00	\$11,925.00	\$54,224.00
44	13-G	115	Permeable Pavement	St. Stephen's Catholic School	A-13	1.9	672	1.9	\$343,796.00	\$25,500.00	\$55,000.00
48	3-D	51	IESF Bench	Green Haven Golf Course Pond	A-3	10.4	0	0	\$282,955.00	\$3,214.00	N/A
48	7-11	75	IESF Bench	7th Ave.	A-7	26.6	0	0	\$580,991.00	\$4,591.00	N/A
48	7-12	76	IESF Bench	7th Ave.	A-7	7.2	0	0	\$305,875.00	\$1,837.00	N/A
48	8-C	82	IESF Bench	4th Ave. and Grant St.	A-8	7.2	0	0	\$282,955.00	\$1,607.00	N/A

¹ [(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual TSS Reduction/1,000)]

Project Selection

The combination of projects selected for pursuit could strive to achieve TSS and TP reductions in the most cost-effective manner possible. Several other factors affecting project installation decisions should be weighed by resource managers when selecting projects to pursue. These factors include but are not limited to the following:

- Total project costs
- Cumulative treatment
- Availability of funding
- Economies of scale
- Landowner willingness
- Project combinations with treatment train effects
- Non-target pollutant reductions
- Timing coordination with other projects to achieve cost savings
- Stakeholder input
- Number of parcels (landowners) involved
- Project visibility
- Educational value
- Long-term impacts on property values and public infrastructure

BMP Descriptions

BMP types proposed throughout the target areas are detailed in this section. This was done to reduce duplicative reporting. For each BMP type, the method of modeling, assumptions made, and cost estimate considerations are described.

BMPs were proposed for a specific site within the research area. Each of these projects, including site location, size, and estimated cost and pollutant reduction potential are noted in detail in the Catchment Profiles section. Project types included in the following sections are:

- Bioretention
 - Curb-cut Rain Garden
 - Boulevard Bioswale
 - Infiltration Basin
- Hydrodynamic Device
- Permeable Pavement
- Iron-Enhanced Sand Filter Pond Bench
- Modification to an Existing Pond
- New Stormwater Pond
- Stormwater Reuse

Bioretention

Bioretention is a BMP that uses soil and vegetation to treat stormwater runoff from roads, driveways, roof tops, and other impervious surfaces. Differing levels of volume and/or pollutant reductions can be achieved depending on the type of bioretention selected.

Bioretention can function as either filtration (biofiltration) or infiltration (bioinfiltration). Biofiltration BMPs are designed with a buried perforated drain tile that allows water in the basin to discharge to the stormwater drainage system after having been filtered through the soil. Bioinfiltration BMPs have no underdrain, ensuring that all water that enters the basins will either infiltrate into the soil or be evapotranspired into the air. Bioinfiltration provides 100% retention and treatment of captured stormwater, whereas biofiltration basins provide excellent removal of particulate contaminants but limited removal of dissolved contaminants, such as DP (Table 8).

Table 8: Matrix describing curb-cut rain garden efficacy for pollutant removal based on type.

Curb-cut Rain Garden Type	TSS Removal	PP Removal	DP Removal	Volume Reduction	Size of Area Treated	Site Selection and Design Notes
Bioinfiltration	High	High	High	High	High	Optimal sites are low enough in the landscape to capture most of the watershed but high enough to ensure adequate separation from the water table for treatment purposes. Higher soil infiltration rates allow for deeper basins and may eliminate the need for underdrains.
Biofiltration	High	Moderate	Low	Low	High	

The treatment efficacy of a particular bioretention project depends on many factors, including but not limited to the pollutant of concern, the quality of water entering the project, the intensity and duration of storm events, project size, position of the project in the landscape, existing downstream treatment, soil and vegetation characteristics, and project type (i.e. bioinfiltration or biofiltration). Optimally, new bioretention will capture water that would otherwise discharge into a priority waterbody untreated.

The volume and pollutant removal potential of each bioretention practice was estimated using WinSLAMM. In order to calculate cost-benefit, the cost of each project had to be estimated. To fully estimate the cost of project installation, labor costs for project outreach and promotion, project design, project administration, and project maintenance over the anticipated life of the practice were considered in addition to actual construction costs. If multiple projects were installed, cost savings could be achieved on the administration and promotion costs (and possibly the construction costs for a large and competitive bid).

Please note infiltration examples included in this section would require site specific investigations to verify soils are appropriate for infiltration.

Curb-cut Rain Gardens

Curb-cut rain gardens capture stormwater that is in roadside gutters and redirects it into shallow roadside basins. These curb-cut rain gardens can provide treatment for impervious surface runoff from one to many properties and can be located anywhere sufficient space is available. Because curb-cut rain gardens capture water that is already part of the stormwater drainage system, they are more likely to provide higher benefits. Generally, curb-cut rain gardens were proposed in areas without sufficient existing stormwater treatment and located immediately up-gradient of a catch basin serving a large drainage area. Bioinfiltration was solely proposed (as opposed to biofiltration) as the available soil information suggested infiltration rates could be sufficient to allow complete draw-down within 24-48 hours following a storm event (Figure 4).



Figure 4: Rain garden before/after and during a rainfall event

All curb-cut rain gardens were presumed to have a 12" ponding depth, pretreatment, mulch, and perennial ornamental and native plants. The useful life of the project was assumed to be 30 years and so all costs are amortized over that time period. Additional costs were included for rehabilitation of the gardens at years 10 and 20. Annual maintenance was assumed to be completed by the landowner of the property at which the rain garden could be installed.

Boulevard Bioswale

One option for retrofitting a stormwater BMP within an existing boulevard is a bioswale. This practice is similar to the curb-cut rain garden in its orientation and size. Bioswales typically range from 5-30' in length, house a rich native plant community, and are installed between the existing sidewalk and roadway curb (Figure 5). Unlike rain gardens, these practices are typically much shallower (1-3" in depth) and have a curb-cut inlet and outlet (Figure 5). Although many rain gardens have outlets in the form of underdrains or risers, the bioswale outlet allows for a nearly continuous flow of

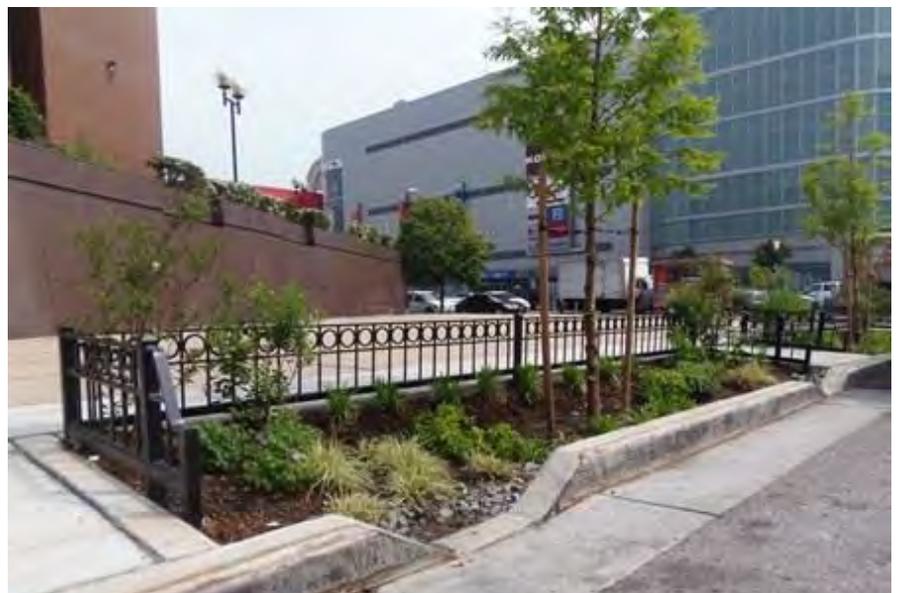


Figure 5: Right-of-way bioswale installed in New York City (NYC Environmental Protection, 2013)

stormwater through the practice. Although some infiltration does occur, the primary form of treatment is the settling of pollutants as stormwater flows through the dense plant community.

This practice was modeled to estimate the pollutant reduction capacity for TSS, TP, and stormwater volume in medium density residential drainage areas ranging from 0.25 to 4 acres (Table 9). A 20' long (parallel to roadway), 4' wide (perpendicular to roadway), and 3" deep bioswale was modeled with an infiltration rate of 2.5"/hour. No underdrain was modeled with this practice as they are designed to be flow-through systems with limited ponding ($\leq 3''$). Additional model inputs are noted in Appendix A – Modeling Methods.

Table 9: WinSLAMM model results for the boulevard bioswale with a 2.5"/hour infiltration rate.

Drainage Area (acres)	<i>Standard Boulevard Bioswale</i>					
	TP Removal		TSS Removal		Volume Removal	
	lbs-TP	%	lbs-TSS	%	ac-ft	%
0.25	0.07	33.3%	43	38.0%	0.058	21.9%
0.5	0.09	23.7%	61	28.3%	0.067	12.6%
1	0.08	13.0%	53	15.6%	0.074	7.0%
2	0.07	8.0%	45	9.8%	0.082	3.8%
3	0.08	6.8%	47	8.6%	0.087	2.7%
4	0.08	6.2%	48	8.0%	0.09	2.1%

Infiltration Basin

Infiltration basins function identically to the curb-cut rain gardens previously described in this bioretention section. However, these basins are proposed in locations where a large amount of space is available. This presents an opportunity to construct a large-scale (i.e. > 500 sq.-ft.) infiltration basin. This allows stormwater runoff to fill the basin and be filtered by the soil and vegetation.

Probable project cost includes installation of the project as well as promotion, administrative, and design costs, all in 2016 dollars. A reduced construction cost (i.e. \$15 to \$20 per ft.²) relative to other bioretention practices was proposed for the infiltration basin because of assumed cost savings with a larger project. Furthermore, the large open spaces available at each of the proposed project locations could allow the basins to be constructed without retaining walls, which would result in a significant cost savings. Maintenance was assumed to be completed by city public works crews. Maintenance costs were also included for rehabilitation of the basin every 10 years for the life of the project.

Hydrodynamic Devices

In heavily urbanized settings stormwater is immediately intercepted along roadway catch basins and conveyed rapidly via storm sewer pipes to its destination. Once stormwater is intercepted by catch basins, it can be very difficult to supply treatment without large end-of-pipe projects such as regional ponds. One of the possible solutions is the hydrodynamic device (Figure 6). These are installed in-line with the existing storm sewer network and can provide treatment for up to 10-15 acres of upland drainage. This practice applies some form of filtration, settling, or hydrodynamic separation to remove coarse sediment, litter, oil, and grease. These devices are particularly useful in small but highly urbanized drainage areas and can be used as pretreatment for other downstream stormwater BMPs.

Each device's pollutant removal potential was estimated using WinSLAMM. Devices were sized based on upstream drainage area to ensure peak flow does not exceed each device's design guidelines. For this analysis, Downstream Defender devices were modeled based on available information and to maintain continuity across other SRAs. Devices were proposed along particular storm sewer lines and often just upstream of intersections with another, larger line. Model results assume the device is receiving input from all nearby catch basins noted.

In order to calculate the cost-benefit, the cost of each project had to be estimated. To fully estimate the cost of project installation, labor costs for project outreach, promotion, design, administration, and maintenance over the anticipated life of the practice were considered in addition to actual construction costs. Load reduction estimates for these projects are noted in the Catchment Profiles section.

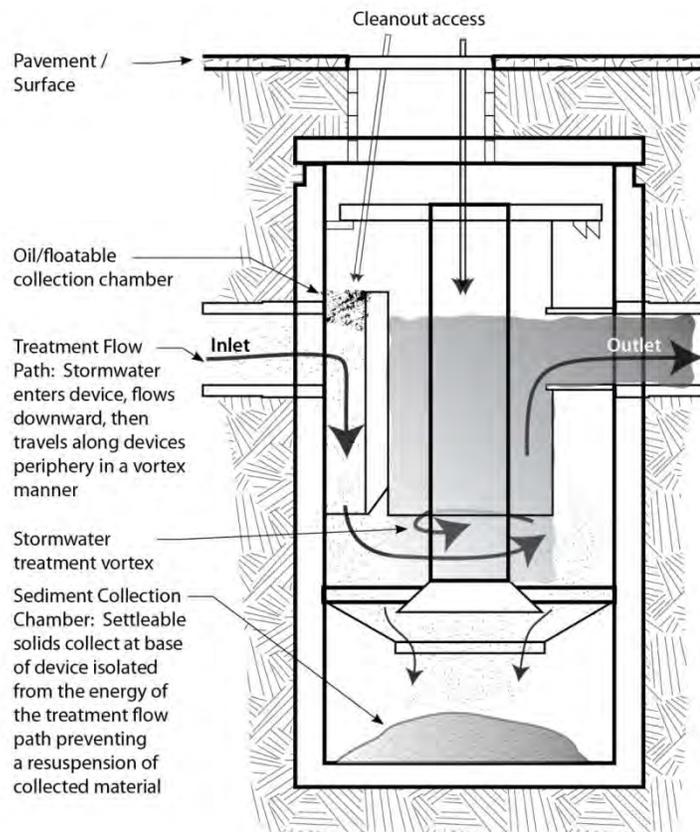
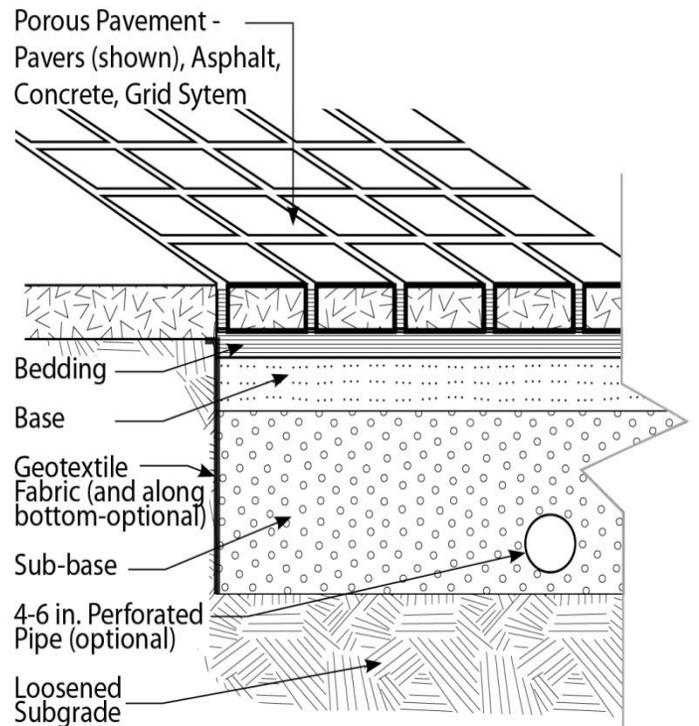


Figure 6: Schematic of a typical hydrodynamic device

Permeable Pavement

Relatively flat, low traffic areas provide a suitable location for diverting stormwater runoff from impervious surfaces to porous pavement. Void space between concrete pavers or within permeable asphalt and concrete allow water to percolate through the surface to an underlying layer(s) of coarse aggregate rock (Figure 7). This aggregate can act as a reservoir providing water quality and quantity benefits by filtering the stormwater and creating storage. From here water can either be stored temporarily or can infiltrate into the ground to recharge local groundwater aquifers. Many designs include permeable geotextile fabric to separate the un-compacted soil subgrade from the coarse aggregate and to facilitate infiltration. If soils don't allow for infiltration, a liner can be installed with an underdrain attached to nearby storm sewers or additional stormwater BMPs. This still allows for filtration through the pavement and aggregate, and reduces peak discharge from the site.

This practice is ideally suited for small drainage areas flowing to low traffic pavement surfaces (Figure 8). For a residential property, roof runoff can be diverted via rain leaders to a permeable driveway. On a commercial property, parking spaces within a large parking lot could be converted to permeable pavement to capture runoff from the parking lot, sidewalks, and any buildings on the property. On a residential roadway, parking spaces on either side of the street could be converted to permeable pavement. In this case the practice could treat not just the roadway but multiple properties along the street. Permeable pavement can be used for many



Graphic adapted from the Charles River Watershed Association - Information Sheet

Figure 7: Schematic of typical permeable pavement surface and subgrade.



Figure 8: Photo comparing conventional and permeable asphalt

other scenarios in areas where soil type, seasonal water table, and frost line allow for groundwater recharge.

The capacity for this practice is completely dependent on the reservoir size within the aggregate and whether or not infiltration can occur on the site. In most cases the permeable pavement treats stormwater received from just the surface itself and adjacent impervious surfaces. A general design guideline used in this analysis is a ratio between the permeable pavement surface area and the area of the impervious surface draining to the practice of 1:2. Other than reservoir capacity, this ratio also depends on the infiltration rate (in the case that the BMP allows for infiltration) or drainage time (if an underdrain is installed) and how well the practice is maintained as clogging can greatly decrease the ability of the practice to capture runoff.

The pollutant removal potential of permeable pavement was estimated using WinSLAMM. A detailed account of the methodologies used is included in Appendix A – Modeling Methods. In order to calculate cost-benefit, the cost of each project had to be estimated. To fully estimate the cost of project installation, labor costs for project outreach, promotion, design, administration, and maintenance over the anticipated life of the practice were considered in addition to actual construction costs. Load reduction estimates for these projects are noted in the Catchment Profiles section.

Iron-Enhanced Sand Filter Pond Bench

Wet retention ponds, although very effective in treating stormwater for suspended sediment and nutrients bound to sediment, have shown a limited ability at retaining dissolved species of nutrients. This is most notable for phosphorus, which easily adsorbs to sediment when in particulate form. Median values for pollutant removal percentage by wet retention ponds are 84% for TSS and 50% for TP (MN Stormwater Manual). For the case of phosphorus, dissolved species typically constitute 40-50% of TP in urban stream systems, but only 34% (median efficiency; Weiss et al., 2005) of dissolved phosphorus is treated by the pond. Thus, a majority of the phosphorus escaping wet retention ponds is in dissolved form. This has important effects downstream as dissolved phosphorus is a readily available nutrient for algal uptake in waterbodies and can be a main cause for nutrient eutrophication.

To address this deficiency, researchers at the University of Minnesota developed a method to augment phosphorus retention within a sand filter. They've named this technology the "Iron Enhanced Sand Filter" (IESF; Figure 9). Locally, this practice has also been identified as the "Minnesota Filter." IESFs rely on the properties of iron to bind dissolved phosphorus as it passes through an iron rich medium. Depending on topographic characteristics of the installation sites, IESFs can rely on gravitational flow and natural water level fluctuation, or water pumping to hydrate the IESF. IESFs must be designed to prevent anoxic conditions in the filter medium because such conditions will release the bound phosphorus. Because IESFs are intended to remove dissolved phosphorus and not organic phosphorus, they are typically constructed just downstream of stormwater ponds, minimizing the amount of suspended solids that could compromise their efficacy and drastically increase maintenance. As an alternative to an IESF, a ferric-chloride injection system could be installed to bind dissolved phosphorus into a flocculent, which would settle in the bottom of the new pond.

Figure 9 shows an IESF that is installed at an elevation slightly above the normal water level of the pond so that following a storm event the increase in depth of the pond would be first diverted to the IESF. The filter would have drain tile installed along the base of the trench and would outlet downstream of the current pond outlet. Large storm events that overwhelm the IESF's capacity would exit the pond via the existing outlet.

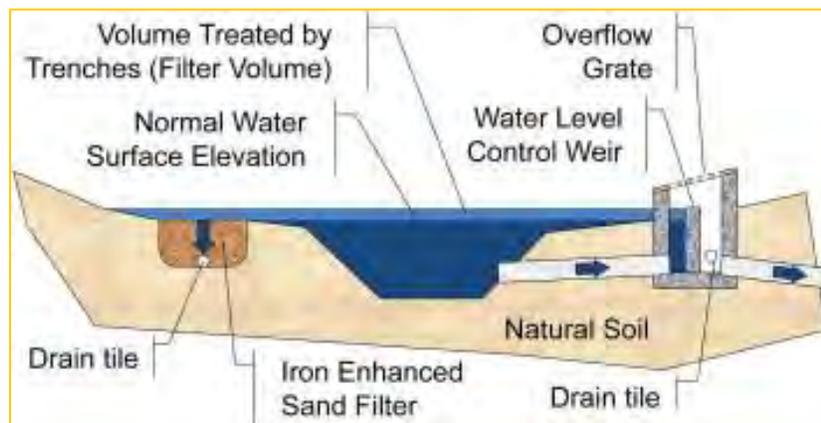


Figure 9: Iron Enhanced Sand Filter Concept (Erickson & Gulliver, 2010)

Benefits for stormwater ponds were modeled utilizing WinSLAMM. After selecting an optimal pond configuration in terms of cost-benefit, or by using the existing pond configuration if no updates are needed, modeling for an IESF was also completed in WinSLAMM. WinSLAMM is able to calculate flow through constructed features such as rain gardens with underdrains, soil amendments, and controlled

overflow elevations. An IESF works much the same way. Storm event based discharge volumes and phosphorus concentrations estimated by WinSLAMM at the pond outlet were entered into WinSLAMM as inputs into the IESF. Various iterations of IESFs were modeled to identify an optimal treatment level compared to construction costs and space available. A detailed account of the methodologies used is included in Appendix A – Modeling Methods.

To account for the DP treated by the IESF, an additional 80% DP removal was assumed for each IESF in addition to any removal by the pond. This value is based on laboratory and field tests performed by the University of Minnesota (Erickson & Gulliver, 2010) and assumes only removal of DP species within the device. Load reduction estimates for these projects are noted in the Catchment Profiles sections.

In order to calculate cost-benefit, the cost of each project had to be estimated. IESF projects were assumed to involve some excavation and disposal of soil, land acquisition (if necessary), erosion control, and vegetation management. Additionally, project engineering, promotion, administration, construction oversight, and long-term maintenance had to be considered in order to capture the true cost of the effort. Annual maintenance costs were estimated to be \$10,000 per acre of IESF based on information received from local, private consulting firms. Additional costs associated with specific projects are listed in Appendix B – Project Cost Estimates.

Modification to an Existing Pond

Developments prior to enactment of contemporary stormwater rules often included wet detention ponds which were frequently designed purely for flood control based on the land use, impervious cover, soils, and topography of the time. Changes to stormwater rules since the early 1970's have altered the way ponds are designed.

Enactment of the National Pollution Discharge Elimination System (NPDES) in 1972 followed by research conducted by the Environmental Protection Agency in the early 1980's as part of the Nationwide Urban Runoff Program (NURP) set standards by which stormwater best management practices should be designed. Municipal Separate Storm Sewer System (MS4) guidelines issued in 1990 (affecting cities with more than 100,000 residents) and 1999 (for cities with less than 100,000 residents) required municipalities to obtain an NPDES permit and develop a plan for managing their stormwater.

Listed below are five strategies which exist for retrofitting a stormwater pond to increase pollutant retention (modified from *Urban Stormwater Retrofit Practices*):

- Excavate pond bottom to increase permanent pool storage
- Raise the embankment to increase flood pool storage
- Widen pond area to increase both permanent and flood pool storage
- Modify the riser
- Update pool geometry or add pretreatment (e.g. forebay)

These strategies can be employed separately or together to improve BMP effectiveness. Each strategy is limited by cost-effectiveness and constraints of space on the current site. Pond retrofits are preferable to most new BMPs as additional land usually does not need to be purchased, stormwater easements already exist, maintenance issues change little following project completion, and construction costs are greatly cheaper. There can also be a positive effect on reducing the rate of overflow from the pond, thereby reducing the risk for erosion (and thus further pollutant generation) downstream.

For this analysis, all existing ponds were modeled in the water quality model WinSLAMM to estimate their effectiveness based on best available information for pond characteristics and land use and soils. One proposed modification, excavating the pond bottom to increase storage, often has a very wide range in expected cost due to the nature of the excavated soil. If the soil has been contaminated and requires landfilling, the cost for disposal can quickly lead to a doubling in project cost. For this reason, projects which include the excavation of ponds have been priced based on the following criteria:

- Management Level 1: Dredged pond soil is suitable for use or reuse on properties with a residential or recreational use
- Management Level 2: Dredged pond soil is suitable for use or reuse on properties with an industrial use
- Management Level 3: Dredged pond soil is considered significantly contaminated and must be managed specifically for the contaminants present

Costs within each of these levels can even range widely, but were estimated to be \$20/cu-yd., \$35/cu-yd., and \$50/cu-yd. for levels 1, 2, and 3, respectively. Additional costs associated with specific projects are listed in Appendix B – Project Cost Estimates.

New Stormwater Pond

If properly designed, wet retention ponds have controlled outflows to manage discharge rates and are sized to achieve predefined water quality goals. Wet retention ponds treat stormwater through a variety of processes, but primarily through sedimentation. Ponds are most often designed to contain a permanent pool storage depth; it is this permanent pool of water that separates the practice from most other stormwater BMPs, including detention ponds (Figure 10).

Wet retention pond depth generally ranges from 3-8' deep. If ponds are less than 3' deep, winds can increase mixing through the full water depth and re-suspend sediments, thereby increasing turbidity. Scour may also occur during rain events following dry periods. If more than 8' deep, thermal stratification can occur

creating a layer of low dissolved oxygen near the sediment that can release bound phosphorus. Above the permanent pool depth is the flood depth, which provides water quality treatment directly following storm events. Separating the permanent pool depth and the flood depth is the primary outlet control, which is often designed to control outflow rate. Configurations for the outlet control may include a V-notch or circular weir, multiple orifices, or a multiple-stage weir. Each of these can be configured within a skimmer structure or trash rack to provide additional treatment for larger, floatable items. Above the flood depth is the emergency control structure, which is available to bypass water from the largest rainfall events, such as the 100-year precipitation event. Ponds also often include a pretreatment practice, either a forebay or sedimentation basin adjacent to the pond or storm sewer sumps, hydrodynamic devices, or other basins upstream of the practice.

Outside of sedimentation, other important processes occurring in ponds are nutrient assimilation and evapotranspiration by plants. The addition of shoreline plants to pond designs has increased greatly since the 1980's because of the positive effects these plants were found to have for both water quality purposes and increasing terrestrial and aquatic wildlife habitat. The ability of the pond to regulate discharge rates should also be noted. This can reduce downstream in-channel erosion, thereby decreasing TSS and TP loading from within the channel.

With the multitude of considerations for these practices, ponds must be designed by professional engineers. This report provides a rudimentary description of ponding opportunities and cost estimates for project planning purposes. Ponds proposed in this analysis are designed and simulated within the water quality model WinSLAMM, which takes into account upland pollutant loading, pond bathymetry, and outlet control device(s) to estimate stormwater volume, TSS, and TP retention capacity. The model was run with and without the identified project and the difference in pollutant loading was calculated.

In order to calculate cost-benefit, the cost of each project had to be estimated. All new stormwater ponds were assumed to involve excavation and disposal of soil, installation of inlet and outlet control structures and emergency overflow, land acquisition, erosion control, and vegetation management.

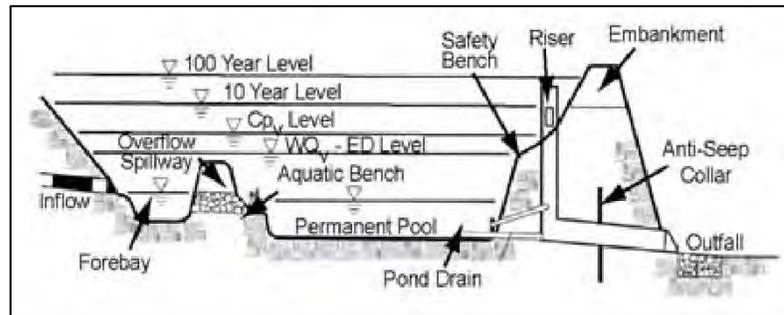


Figure 10: Schematic of a stormwater retention pond.

Additionally, project engineering, promotion, administration, construction oversight, and long-term maintenance (including annual inspections and removal of accumulated sediment/debris from the pretreatment area) had to be considered in order to capture the true cost of the effort. Complete pond dredging is not included in the long-term maintenance cost because project life is estimated to be 30 years. Load reduction estimates for these projects are noted in the Catchment Profiles section. Additional costs associated with specific projects are listed in Appendix B – Project Cost Estimates.

Stormwater Reuse

Some of the major water resource issues today include improving stormwater treatment (quantity and quality), increasing groundwater recharge, and decreasing public water usage. Stormwater reuse is a powerful BMP strategy that can be applied to address each of these on a scale ranging from a single property to an entire neighborhood. Stormwater reuse allows for the utilization of stormwater to supplement potable sources, in applications that do not require water to be at a standard set for consumption. An example of this might be using captured stormwater to irrigate a golf course or recreational fields.

Benefits from this practice are twofold. First, stormwater runoff is given multiple opportunities for treatment. Treatment through settling, filtering, or hydrodynamic separation at the BMP site provides initial treatment of particulates, litter, and other debris. Application of the stormwater as irrigation allows for infiltration through the soil layer and treatment of the dissolved load of pollutants that may have remained. The second benefit is the reduced usage of potable water. As there is no need for highly treated water when irrigating a lawn, the stress placed on water treatment facilities and the water distribution network can be reduced.

The concept for this practice at its smallest scale is that of a rain barrel on a residential property. Runoff from the impervious roof is captured by gutters and diverted to the rain barrel until it is needed for watering the lawn or garden. At a larger scale, runoff from roofs, driveways, sidewalks, and roadways is diverted to roadway catch basins and to the storm sewer network. A cistern or similar containment unit holds water from storm sewers until it is needed for irrigation. These structures can vary in size from tens of gallons to hundreds of thousands of gallons. Stormwater detention and retention ponds are also popular choices as construction and maintenance costs are often much cheaper than underground cisterns.

These practices often require significant capital investment as updates to the local stormwater infrastructure may be needed. Large cisterns, whether made of concrete or plastic, can require high transportation and installation costs. Additional infrastructure may also be necessary, including a foundation to sustain the weight of the cistern (whether above or below ground), pump, and conveyance system. A detailed maintenance plan is also necessary even if other forms of pretreatment (e.g. hydrodynamic device, baffle, etc.) are installed. Lastly, during dry periods potable water may still be needed to supplement stormwater when the containment unit is empty.

The pollutant removal potential of stormwater reuse devices was estimated using the stormwater model WinSLAMM. In order to calculate cost-benefit, the cost of each project had to be estimated. To fully estimate the cost of project installation, labor costs for project outreach, promotion, design, administration, and maintenance over the anticipated life of the practice were considered in addition to actual construction costs. Costs for projects are listed in detail in Appendix B – Project Cost Estimates. Load reduction estimates for these projects are noted in the Catchment Profiles section.

Catchment Profiles

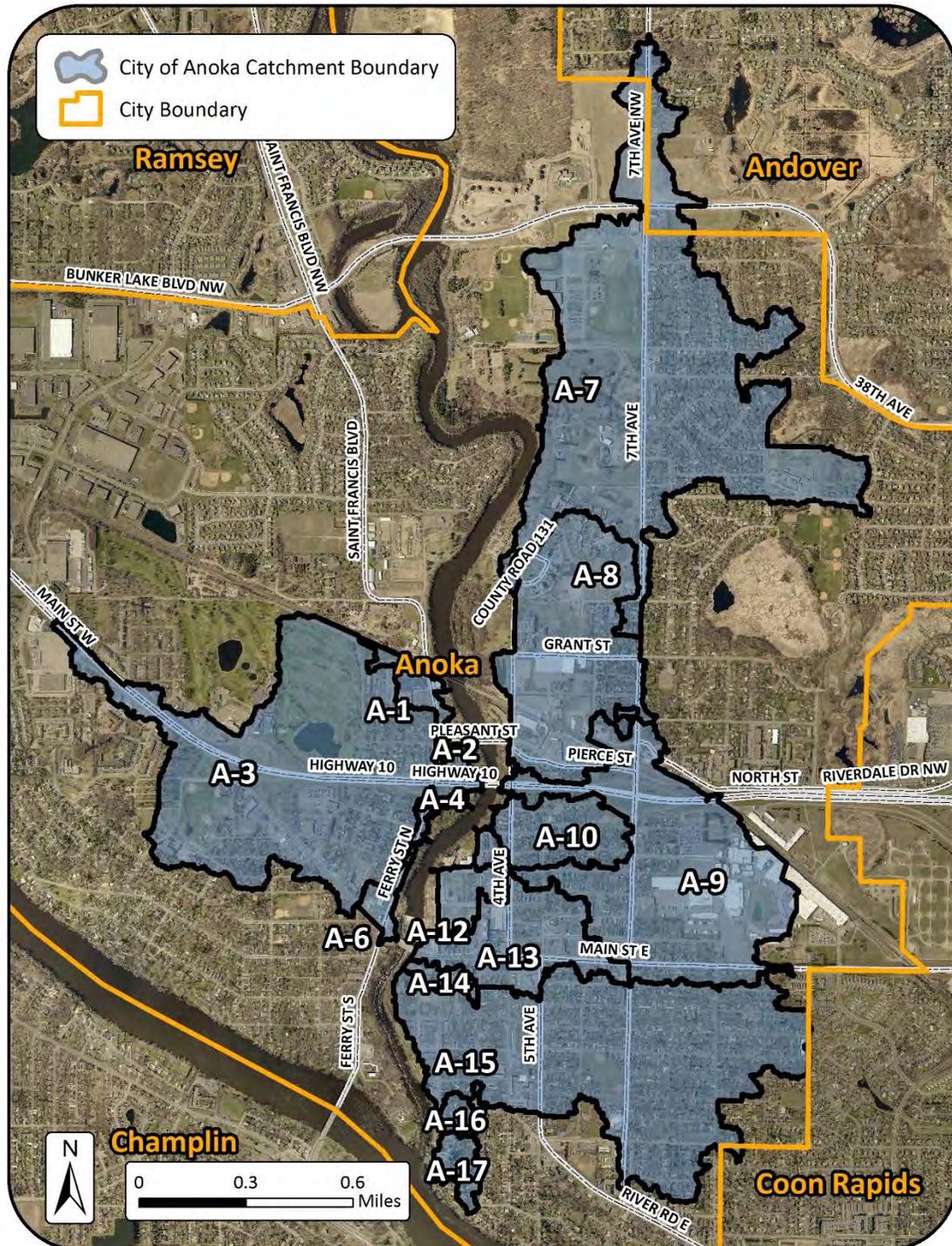


Figure 11: The 1,469-acre drainage area was divided into 17 catchments for this analysis. Catchment profiles on the following pages provide additional information.

Western Drainage Network

Catchment ID	Page
A-1	35
A-2	41
A-3	45
A-4	53
A-5	56
A-6	59

Existing Network Summary	
Acres	313.2
Dominant Land Cover	Residential
Volume (ac-ft/yr)	208.0
TP (lb/yr)	151.3
TSS (lb/yr)	50,263



DRAINAGE NETWORK SUMMARY

The western drainage network includes all areas of the City of Anoka draining to the western shores of the Rum River south of the Burlington Northern railroad tracks to approximately Main St. Six catchments lie within this drainage network, each with their own outfall to the Rum River. These outfalls are located at (from north to south) Ferry Street 200' south of the Burlington Northern railroad tracks (Catchment A-1), Maple Avenue (A-2), US-10 (A-3), Maple Lane (A-4), Clay Street (A-5), and Main St. (A-6).

Catchment size varies greatly, from just over two acres to up to 280 acres. Notable areas of the drainage network include the US-10 and US-169 highway corridors, the public golf course, Ward Park, and commercial properties along Main St. and US-169.

EXISTING STORMWATER TREATMENT

Stormwater runoff generated across the network is, for the most part, quickly intercepted within either municipal, county, or MNDOT storm sewer and conveyed to one of six stormwater outfalls to the Rum River. Nine stormwater treatment devices exist throughout the network which treat stormwater prior to discharge into the Rum River. Most of these treat relatively small drainage areas (<15 acres). Exceptions to this include Ward Park pond, which treats 25 acres of residential streets and parkland, and the Green Haven Golf Course pond, which treats 177 acres of golf course, US-10, parkland, commercial, and residential land uses. Both of these ponds are in Catchment A-3. Additional detail on these ponds and other stormwater BMPs are provided in the Catchment Profiles.

Catchment A-1

Existing Catchment Summary	
Acres	14.8
Dominant Land Cover	Institutional
Parcels	25
Volume (ac-ft/yr)	12.4
TP (lb/yr)	10.4
TSS (lb/yr)	4,826

CATCHMENT DESCRIPTION

This catchment drains nearly 15 acres of public-institutional and industrial land uses along Ferry Street between the Burlington Northern railroad tracks and Highway 10. The catchment is highly impervious, predominantly due to the Anoka-Hennepin Education Service Center building and parking lot comprising about 50% of the geographical area of the catchment.

Stormwater generated in Catchment A-1 is directed to a storm sewer network beginning under the parking lot of the Anoka-Hennepin Education Service Center and flowing east to an outfall to the Rum River east of the A1 Recycling Center.



EXISTING STORMWATER TREATMENT

No existing treatment exists in this catchment beyond street cleaning provided by the City of Anoka two times per year. Present-day stormwater pollutant loading and treatment is summarized in the table below.

<i>Existing Conditions</i>		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	11.1	0.7	6%	10.4
	TSS (lb/yr)	5,278	452	9%	4,826
	Volume (acre-feet/yr)	12.4	0.0	0%	12.4

PROPOSED RETROFITS OVERVIEW

As no existing treatment exists in this catchment, in-line treatment along the main storm sewer line was proposed in a hydrodynamic device installed along Ferry St. within the road right-of-way. This unit could treat up to 14.8 acres of the predominantly impervious catchment.

To help reduce peak flows to the storm sewer network (and a potential hydrodynamic device installed along the network), permeable pavement was also proposed for the eastern parking lot of the Anoka-

Hennepin Education Service Center. A rain garden was also proposed to be along Ferry Street to also reduce peak flows as well as to capture TSS and TP.

RETROFIT RECOMMENDATIONS



Project ID: 1-A

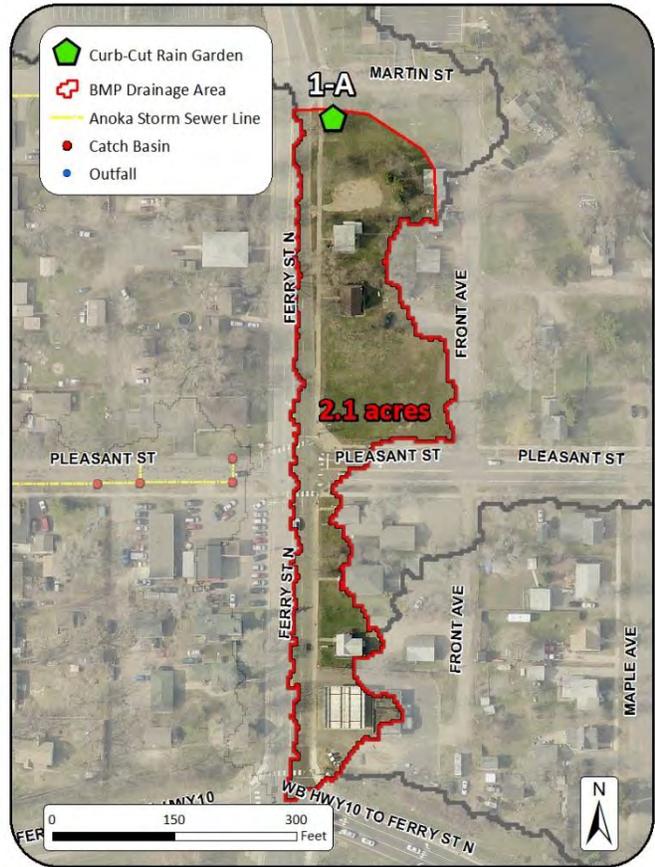
Ferry St. & Front Ave. Curb-Cut Rain Garden

Drainage Area – 2.1 acres

Location – On Ferry Street at Front Avenue

Property Ownership – Public (City of Anoka)

Site Specific Information – One location was identified along Ferry Street on public property for a curb-cut rain garden. This retrofit could treat stormwater pollutants originating from Ferry Street and from surrounding residential properties.



Curb-Cut Rain Garden				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1		
	Total Size of BMPs	250 sq-ft		
	TP (lb/yr)	0.5	4.8%	
	TSS (lb/yr)	187	3.9%	
	Volume (acre-feet/yr)	0.5	3.9%	
Cost	Administration & Promotion Costs*	\$1,606		
	Design & Construction Costs**	\$7,376		
	Total Estimated Project Cost (2016)	\$8,982		
	Annual O&M***	\$225		
Efficiency	30-yr Average Cost/lb-TP	\$1,049		
	30-yr Average Cost/1,000lb-TSS	\$2,804		
	30-yr Average Cost/ac-ft Vol.	\$1,090		

*Indirect Cost: (10 hours at \$73/hour base cost) + (12 hours/BMP at \$73/hour)

**Direct Cost: (\$26/sq-ft for materials and labor) + (12 hours/BMP at \$73/hour for design)

***Per BMP: (\$150/year for rehabilitations at years 10 and 20) + (\$75/year for routine maintenance)

Project ID: 1-B

Ferry Street Hydrodynamic Device

Drainage Area – 14.8 acres
Location – Ferry Street
Property Ownership – Public
Site Specific Information – A hydrodynamic device could be installed on Ferry Street at the outlet of the catchment. A device at this location would be able to accept and treat runoff from the entire catchment.



Hydrodynamic Device				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMPs		10 ft diameter	
	TP (lb/yr)	1.0	9.6%	
	TSS (lb/yr)	584	12.1%	
	Volume (acre-feet/yr)	0.0	0.0%	
Cost	Administration & Promotion Costs*	\$1,752		
	Design & Construction Costs**	\$108,000		
	Total Estimated Project Cost (2016)	\$109,752		
	Annual O&M***	\$630		
Efficiency	30-yr Average Cost/lb-TP	\$4,288		
	30-yr Average Cost/1,000lb-TSS	\$7,343		
	30-yr Average Cost/ac-ft Vol.	N/A		

*Indirect Cost: (24 hours at \$73/hour)

**Direct Cost: (\$72,000 for materials) + (\$36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Project ID: 1-C

Anoka-Hennepin Education Center Permeable Pavement

Drainage Area – 3.8 acres
Location – Eastern parking lot of the Anoka-Hennepin Education Service Center
Property Ownership – Public
Site Specific Information – Permeable pavement is proposed for the eastern parking lot of the Anoka-Hennepin Education Services Center. This practice allows the treatment of a large surface area with minimal impact on the usable space. In order to treat the 3.8-acre drainage area, 54,886 sq.-ft. of permeable pavement is proposed.



Permeable Pavement			
		Cost/Removal Analysis	
		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMP	54,886 sq-ft	
	TP (lb/yr)	2.9	27.9%
	TSS (lb/yr)	1,325	27.5%
	Volume (acre-feet/yr)	3.5	28.2%
Cost	Administration & Promotion Costs*	\$2,920	
	Design & Construction Costs**	\$549,736	
	Total Estimated Project Cost (2016)	\$552,656	
	Annual O&M***	\$41,165	
Efficiency	30-yr Average Cost/lb-TP	\$20,547	
	30-yr Average Cost/1,000lb-TSS	\$44,971	
	30-yr Average Cost/ac-ft Vol.	\$17,044	

*Indirect Cost: 40 hours at \$73/hour

**Direct Cost: (\$10/sq-ft for materials and labor) + (12 hours at \$73/hour for design)

***(\$0.75/sq-ft for routine maintenance)

Catchment A-2

Existing Catchment Summary	
Acres	3.7
Dominant Land Cover	Residential
Parcels	16
Volume (acre-feet/yr)	2.0
TP (lb/yr)	2.1
TSS (lb/yr)	678



CATCHMENT DESCRIPTION

Catchment 2 is bounded by residences on Polk Street NE, 39th Avenue NE, Johnson Street NE, and the railroad tracks. 37th Avenue NE bisects the catchment from east to west. The catchment is comprised primarily of single family residential properties. There are a few multi-family homes and one commercial property.

All stormwater runoff generated in this catchment flows overland to the south and is collected by catch basins. The stormwater is then conveyed east to the Rum River.

EXISTING STORMWATER TREATMENT

As part of a roadway reconstruction project in 2015, a subsurface treatment system was installed along the Maple Avenue storm sewer network just upstream of the outfall to the Rum River. This subsurface treatment system consists of a St. Anthony Falls Laboratory (SAFL) Baffle installed within a manhole. In addition to this structural stormwater treatment, the City of Anoka conducts street cleaning two times per year. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	2			
	BMP Types	1 Hydrodynamic Device, Street Cleaning			
	TP (lb/yr)	2.5	0.4	16%	2.1
	TSS (lb/yr)	881	203	23%	678
	Volume (acre-feet/yr)	2.0	0.0	0%	2.0

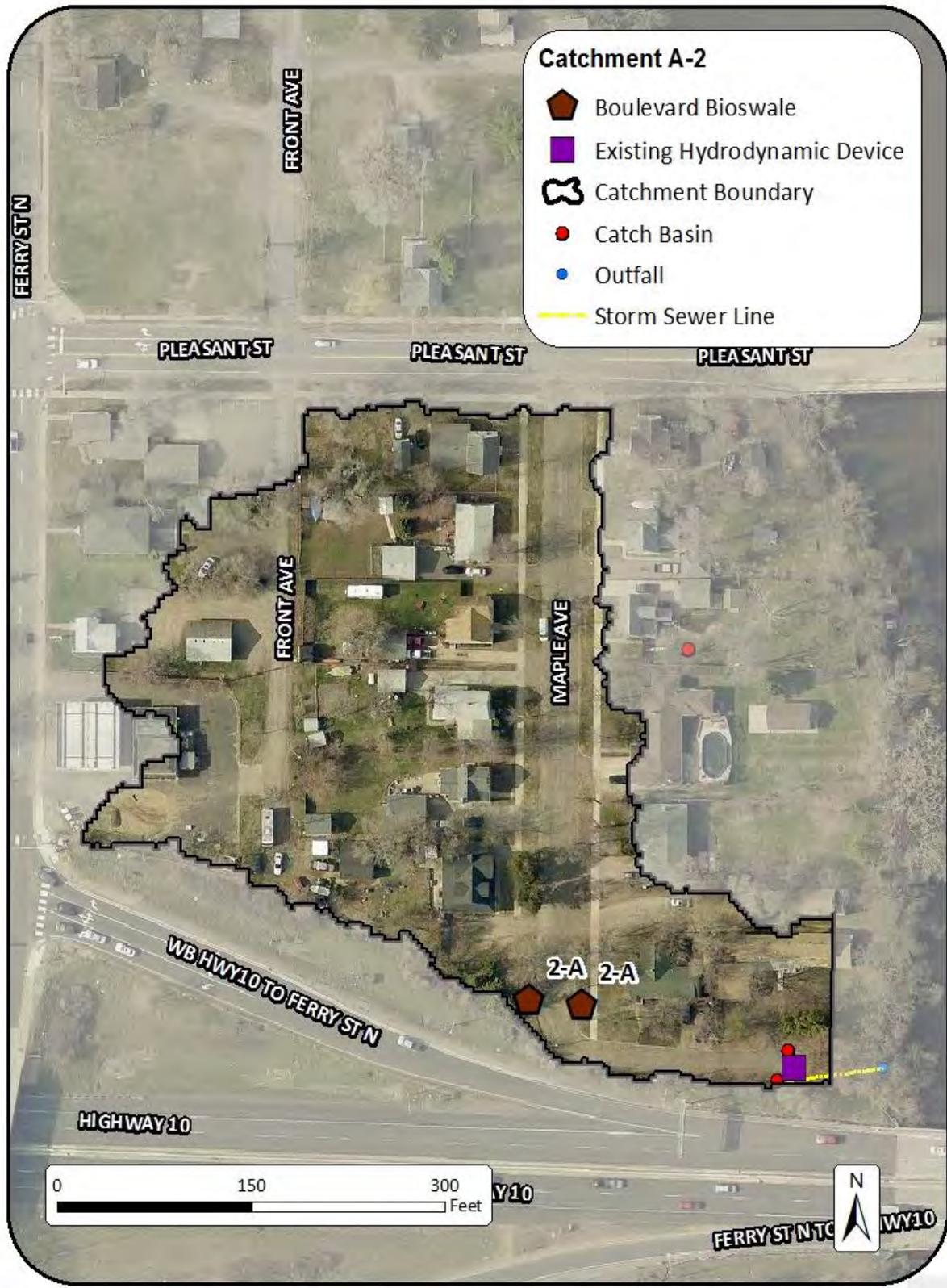
PROPOSED RETROFITS OVERVIEW

Two bioswales are proposed to supplement the treatment provided by the baffle. Infiltration rates should be sufficient enough to support infiltration practices considering the sandy Hubbard soils throughout the area.

RETROFITS CONSIDERED BUT REJECTED

Due to the small size of this catchment and its existing treatment no other retrofits were considered besides small bioretention practices.

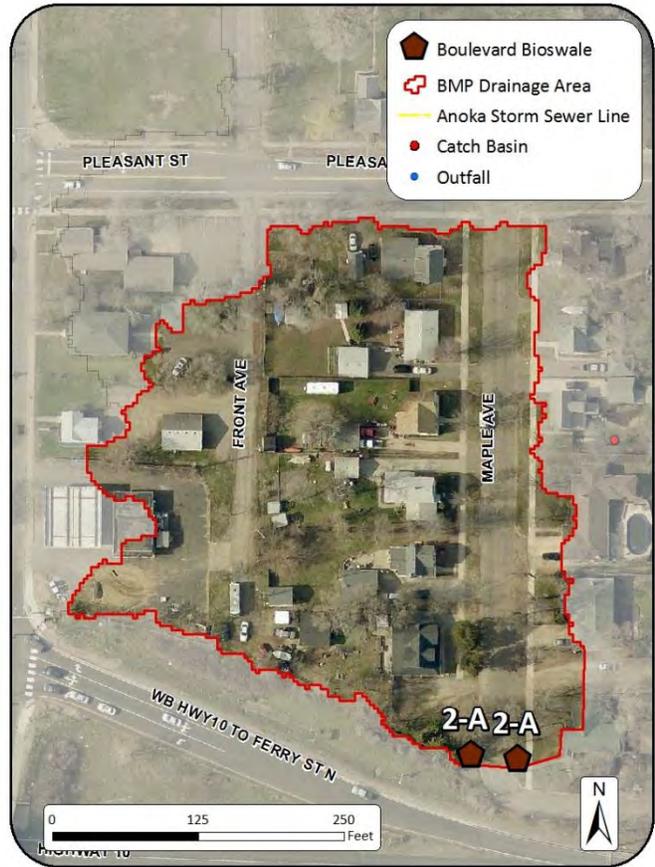
RETROFIT RECOMMENDATIONS



Project ID: 2-A

Maple Avenue Boulevard Bioswale

Drainage Area – 0.5 acre
Location – At southern end of Maple Avenue
Property Ownership – Public
Site Specific Information – Bioswales are proposed for installation along Maple Avenue to reduce sediment and phosphorus loads. The existing sidewalks along Maple Ave. make boulevard bioswales a viable option. Locations for up to two bioswales are sited, where they will serve to treat runoff from the streets and the surrounding private properties. The table below shows the estimated cost and pollutant removal amounts based on treatment of the 0.5-acre drainage area.



Boulevard Bioswale			
		2.5"/hr Infiltr. Rate	
		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	80 sq-ft	
	TP (lb/yr)	0.2	7.7%
	TSS (lb/yr)	55	8.2%
	Volume (acre-feet/yr)	0.1	6.5%
Cost	Administration & Promotion Costs*	\$3,650	
	Design & Construction Costs**	\$4,876	
	Total Estimated Project Cost (2016)	\$8,526	
	Annual O&M***	\$225	
Efficiency	30-yr Average Cost/lb-TP	\$3,140	
	30-yr Average Cost/1,000lb-TSS	\$9,202	
	30-yr Average Cost/ac-ft Vol.	\$3,859	

*Indirect Cost: (50 hours at \$73/hour)

**Direct Cost: (\$50/sq-ft for materials and labor) + (12 hours/BMP at \$73/hour for design)

***Per BMP: (\$150/year for 10-year rehabilitation)+ (\$75/year for routine maintenance)

Catchment A-3

Existing Catchment Summary	
Acres	286.1
Dominant Land Cover	Residential
Parcels	322
Volume (acre-feet/yr)	179.9
TP (lb/yr)	127.4
TSS (lb/yr)	40,532

CATCHMENT DESCRIPTION

Catchment A-3 contains all of Highway 10 and most of Main Street in the City of Anoka research area west of the Rum River. Highway 10 bisects the catchment from east to west. Within the catchment north of Highway 10 is the public golf course, east of the clubhouse, the Anoka-Hennepin Education Center western parking lot, and approximately 25 acres of single-family residential housing. On the south side of this catchment is parkland, large commercial lots, Franklin Elementary School, and additional single-family residential housing.



Stormwater generated within this catchment flows through various municipal storm sewer networks to a state line running east below Highway 10. This network discharges into the Rum River through a 60" diameter pipe just south of Highway 10.

EXISTING STORMWATER TREATMENT

Five existing structural BMPs are installed on city-owned property throughout the catchment. On the south side of Ward Park is a depression acting as a pond. Stormwater along Western Street and Forest Avenue is directed towards this depression and overflow appears to only occur overland through the park. A second retention pond is located in the southeastern corner of the golf course. This pond treats 202 acres of the Green Haven Golf Course, Highway 10, Ward Park, and commercial properties along Main Street.

The three remaining city-owned structural BMPs were installed as part of a roadway reconstruction project in 2015. On the northern edge of the catchment, State Avenue was shortened by about 250' south of Greenhaven Road, creating a dead end. In place of the roadway, a swale was installed that treats runoff from State Avenue and Greenhaven Road. This swale discharges west into the Green Haven Golf Course, and likely only during very large storm events due to its ponding depth and small contributing drainage area.

Two SAFL Baffles were also installed in new manholes as part of the 2015 reconstruction projects. These are located along storm sewer lines under Branch Avenue and the alleyway between Wingfield Avenue and Branch Avenue.

A single privately-owned BMP was modeled as part of this analysis. This is a large pond located on the Main Motor Sales Company property adjacent to State Avenue. This pond currently only treats runoff from the Main Motors property and discharges to the municipal storm sewer line running north to Highway 10.

Lastly, street cleaning is provided by the City of Anoka two times per year. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	<i>Existing Conditions</i>	Base Loading	Treatment	Net Treatment %	Existing Loading
<i>Treatment</i>	Number of BMPs	7			
	BMP Types	3 Ponds, 1 Infiltration Basin, 2 HDs, Street Cleaning			
	TP (lb/yr)	228.5	101.1	44%	127.4
	TSS (lb/yr)	88,416	47,884	54%	40,532
	Volume (acre-feet/yr)	181.0	0.0	0%	179.9

PROPOSED RETROFITS OVERVIEW

A variety of new stormwater treatment practices were proposed to supplement the existing treatment systems as well as to provide new opportunities to land uses that currently discharge untreated to the Rum River. Two BMPs were proposed at the golf course pond. The first project is an IESF bench along the golf course pond. If installed, this device could increase the retention of phosphorus from over 200 acres in the catchment. Secondly, stormwater reuse may also be an option for the golf course pond through using stormwater (in lieu of potable drinking water) to irrigate the grass on the course.

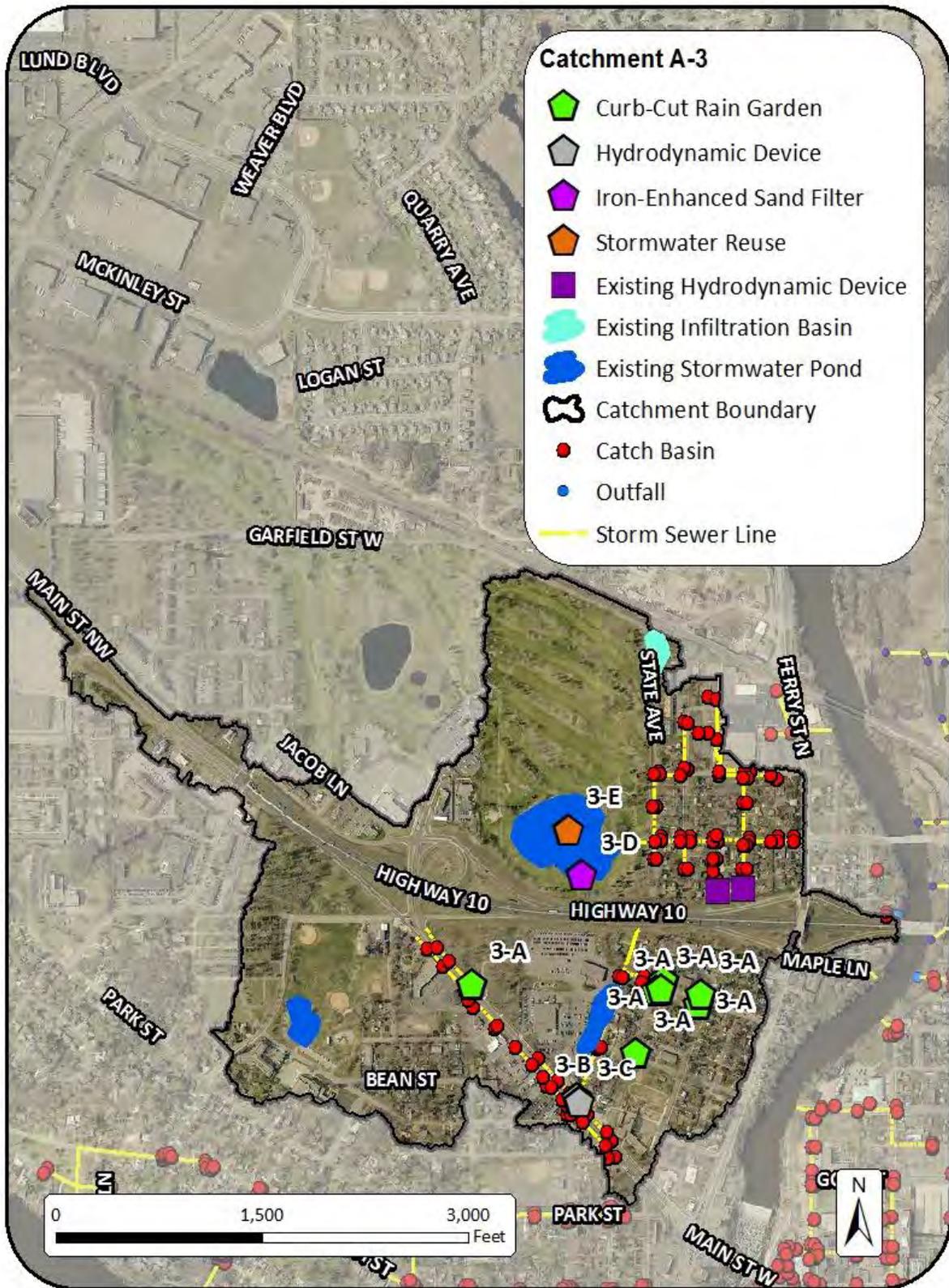
Two hydrodynamic devices are proposed to treat runoff generated along Main Street before it reaches the State Avenue line.

Bioretention practices were also explored throughout the catchment due to sandy soils found throughout the area. Up to seven curb-cut rain gardens were proposed for the residential and commercial areas south of Highway 10.

RETROFITS CONSIDERED BUT REJECTED

Curb-cut rain garden and boulevard bioswales were considered for the single-family residential housing area east of the golf course but were not proposed as drainage areas to the bioretention basins would be quite small due to the large number of catch basins throughout the area. Additionally, two hydrodynamic devices were proposed to be installed south of the Main St – Highway 10 interchange to treat storm sewer lines along Main Street. However, due to the number of retention ponds in the catchment, with modeling these hydrodynamic devices proved to be ineffective.

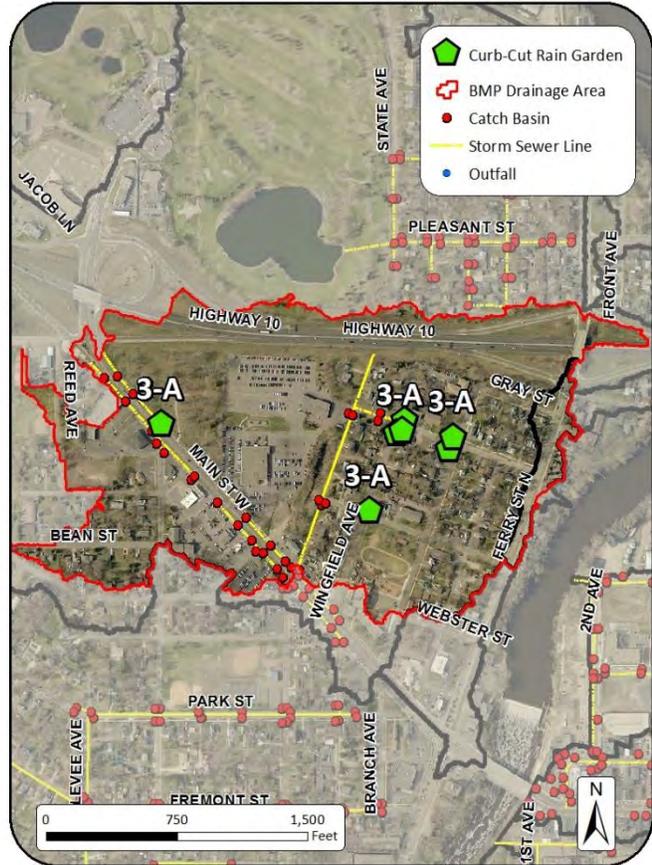
RETROFIT RECOMMENDATIONS



Project ID: 3-A

Curb-Cut Rain Gardens

Drainage Area – 1.5 - 10.5 acres
Location – Various locations throughout catchment
Property Ownership – Private
Site Specific Information – Single-family lots and a cemetery in the catchment provide various locations for curb-cut rain gardens to treat stormwater pollutants originating from private properties. Considering typical private landowner participation rates, scenarios with one, three, and seven rain gardens were analyzed to treat the contributing drainage areas.



Curb-Cut Rain Garden							
Cost/Removal Analysis		New Treatment	% Reduction	New Treatment	% Reduction	New Treatment	% Reduction
Treatment	Number of BMPs	1		3		7	
	Total Size of BMPs	250 sq-ft		750 sq-ft		1,750 sq-ft	
	TP (lb/yr)	0.5	0.4%	1.5	1.2%	3.5	2.7%
	TSS (lb/yr)	157	0.4%	468	1.2%	1,089	2.7%
	Volume (acre-feet/yr)	0.4	0.2%	1.1	0.6%	2.7	1.5%
Cost	Administration & Promotion Costs*	\$8,468		\$10,220		\$13,724	
	Design & Construction Costs**	\$7,376		\$22,128		\$51,632	
	Total Estimated Project Cost (2016)	\$15,844		\$32,348		\$65,356	
	Annual O&M***	\$225		\$675		\$1,575	
Efficiency	30-yr Average Cost/lb-TP	\$1,506		\$1,169		\$1,072	
	30-yr Average Cost/1,000lb-TSS	\$4,797		\$3,746		\$3,447	
	30-yr Average Cost/ac-ft Vol.	\$2,052		\$1,558		\$1,410	

*Indirect Cost: (104 hours at \$73/hour base cost) + (12 hours/BMP at \$73/hour)
 **Direct Cost: (\$26/sq-ft for materials and labor) + (12 hours/BMP at \$73/hour for design)
 ***Per BMP: (\$150/year for rehabilitations at years 10 and 20) + (\$75/year for routine maintenance)

Project ID: 3-B

Main St. & State Ave.
Hydrodynamic Device

Drainage Area – 5.0 acres
Location – Northwestern corner of the Main Street and State Avenue intersection
Property Ownership – Public
Site Specific Information – A hydrodynamic device could be installed on Main Street and would accept runoff from areas primarily west of Main St. and the surrounding land uses. It could provide treatment to stormwater prior to discharging into the State Avenue stormwater pipe.



Hydrodynamic Device			
	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	8 ft diameter	
	TP (lb/yr)	0.5	0.4%
	TSS (lb/yr)	280	0.7%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	Administration & Promotion Costs*	\$1,752	
	Design & Construction Costs**	\$54,000	
	Total Estimated Project Cost (2016)	\$55,752	
	Annual O&M***	\$630	
Efficiency	30-yr Average Cost/lb-TP	\$4,977	
	30-yr Average Cost/1,000lb-TSS	\$8,887	
	30-yr Average Cost/ac-ft Vol.	N/A	

*Indirect Cost: (24 hours at \$73/hour)

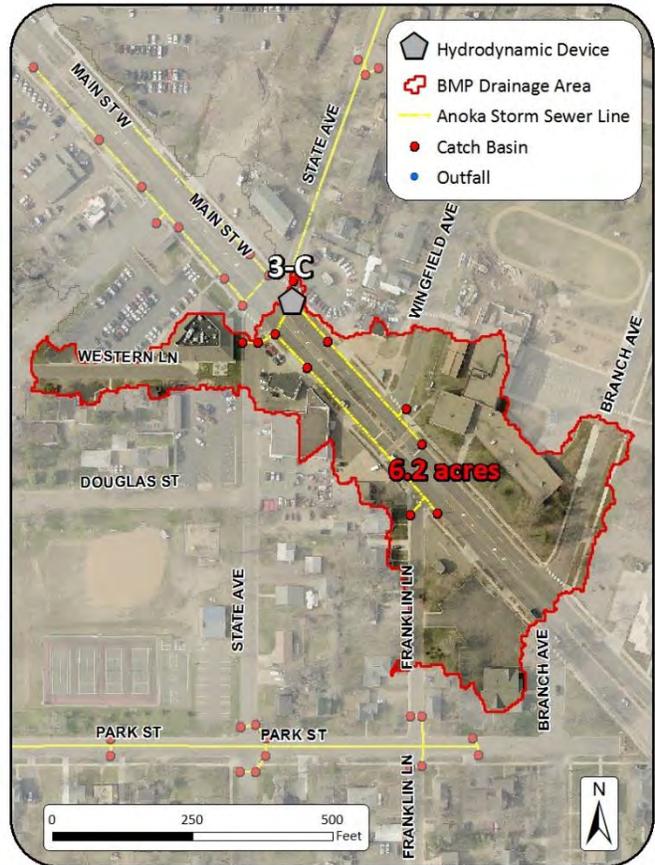
**Direct Cost: (\$36,000 for materials) + (\$18,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Project ID: 3-C

Main St. & State Ave.
Hydrodynamic Device

Drainage Area - 6.2 acres
Location – Northeastern corner of the Main Street and State Avenue intersection
Property Ownership – Public
Site Specific Information – A hydrodynamic device could be installed on Main Street and would accept runoff from the southern portion of Main Street and the surrounding land uses. It could provide stormwater treatment prior to discharging into the State Avenue stormwater pipe.



Hydrodynamic Device			
Cost/Removal Analysis		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	8 ft diameter	
	TP (lb/yr)	0.6	0.5%
	TSS (lb/yr)	302	0.7%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	Administration & Promotion Costs*	\$1,752	
	Design & Construction Costs**	\$54,000	
	Total Estimated Project Cost (2016)	\$55,752	
	Annual O&M***	\$630	
Efficiency	30-yr Average Cost/lb-TP	\$4,147	
	30-yr Average Cost/1,000lb-TSS	\$8,240	
	30-yr Average Cost/ac-ft Vol.	N/A	

*Indirect Cost: (24 hours at \$73/hour)

**Direct Cost: (\$36,000 for materials) + (\$18,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Project ID: 3-D

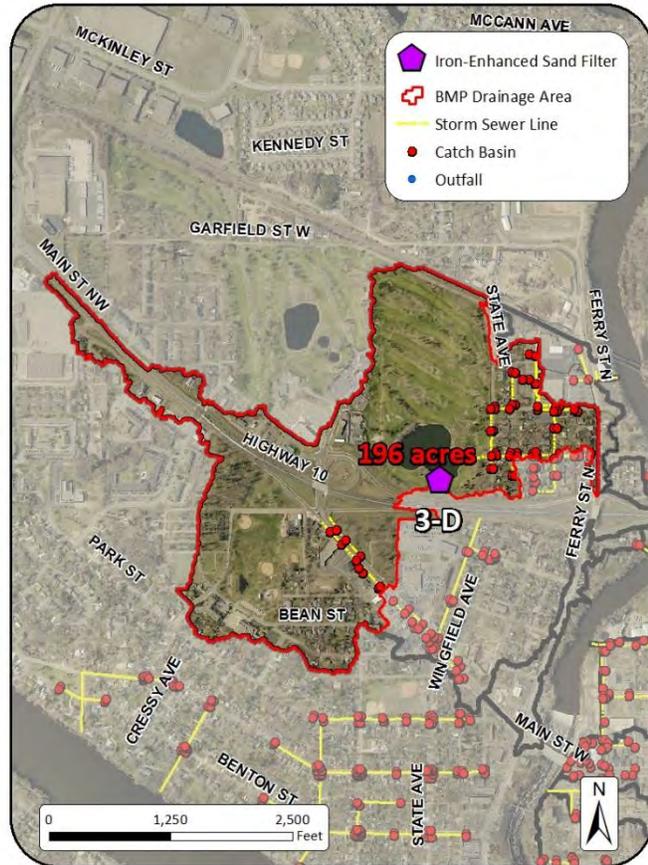
Golf Course Pond IESF Bench

Drainage Area – 196.0 acres

Location – South side of Green Haven Golf Course pond

Property Ownership – Public (City of Anoka)

Site Specific Information – An IESF bench is proposed as an improvement to the existing pond Green Haven Golf Course Pond. The pond currently provides treatment through retention and settling. However, the addition of an IESF will increase removal of dissolved phosphorus. The project is proposed on the south shore of the Green Haven Golf Course Pond. The IESF was sized to 14,000 sq.-ft. based on available space between the existing pond and the roadway.



IESF Bench				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMPs		14,000	sq-ft
	TP (lb/yr)	10.4		8.2%
	TSS (lb/yr)	0		0.0%
	Volume (acre-feet/yr)	0.0		0.0%
Cost	Administration & Promotion Costs*		\$5,475	
	Design & Construction Costs**		\$277,480	
	Total Estimated Project Cost (2016)		\$282,955	
	Annual O&M***		\$3,214	
Efficiency	30-yr Average Cost/lb-TP		\$1,216	
	30-yr Average Cost/1,000lb-TSS		N/A	
	30-yr Average Cost/ac-ft Vol.		N/A	

*Indirect Cost: 75 hours at \$73/hour

**Direct Cost: See Appendix B for detailed cost information

***\$10,000/acre for IESF

Project ID: 3-E

Golf Course Pond Stormwater Reuse

Drainage Area – 196.0 acres
Location – Green Haven Golf Course
Property Ownership – Public (City of Anoka)
Site Specific Information – A stormwater reuse project was proposed for the Green Haven Golf Course Pond. The golf course could reuse the runoff captured in this pond to irrigate approximately 20-acres of the golf course. The pond currently provides storage for approximately 8.5 million gallons of water, and this system could use 500,000 gallons per week. This practice could provide water quality treatment as well as water conservation benefits.



Stormwater Reuse			
Cost/Removal Analysis		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	500,000	gallons
	TP (lb/yr)	18.2	14.3%
	TSS (lb/yr)	3,409	8.4%
	Volume (acre-feet/yr)	46.4	25.8%
Cost	Administration & Promotion Costs*	\$8,760	
	Design & Construction Costs**	\$600,000	
	Total Estimated Project Cost (2016)	\$608,760	
	Annual O&M***	\$3,000	
Efficiency	30-yr Average Cost/lb-TP	\$1,280	
	30-yr Average Cost/1,000lb-TSS	\$6,833	
	30-yr Average Cost/ac-ft Vol.	\$503	

*120 hours at \$73/hour
 **See Appendix B for detailed cost information
 ***Includes cleaning of unit and disposal of sediment/debris

Catchment A-4

Existing Catchment Summary	
Acres	2.2
Dominant Land Cover	Residential
Parcels	11
Volume (acre-feet/yr)	1.3
TP (lb/yr)	1.7
TSS (lb/yr)	573



CATCHMENT DESCRIPTION

This is the smallest catchment in this analysis, totaling just over two acres. The catchment consists only of drainage to two catch basins at the southeast corner of Maple Lane. The catch basins drain east and discharge directly to the Rum River.

EXISTING STORMWATER TREATMENT

No treatment currently exists in this catchment other than street cleaning, which is conducted two times per year. Present-day stormwater pollutant loading and treatment is summarized in the table below.

<i>Existing Conditions</i>		Base Loading	Treatment	Net Treatment %	Existing Loading
<i>Treatment</i>	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	1.8	0.1	6%	1.7
	TSS (lb/yr)	618	45	7%	573
	Volume (acre-feet/yr)	1.3	0.0	0%	1.3

PROPOSED RETROFITS OVERVIEW

A single hydrodynamic device was proposed to treat drainage from the entire catchment.

RETROFITS CONSIDERED BUT REJECTED

Curb-cut rain gardens were considered in this catchment but were not proposed due to the steep slopes on the 2-3 properties with sufficient drainage areas to warrant a rain garden.

RETROFIT RECOMMENDATIONS



Project ID: 4-A

Maple Lane Hydrodynamic Device

Drainage Area – 2.2 acres
Location – Maple Lane
Property Ownership – Public
Site Specific Information – A hydrodynamic device could be installed on Maple Lane to accept runoff from the entire catchment. This device could provide treatment before the water discharges into the Rum River.



Hydrodynamic Device				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMPs		6 ft diameter	
	TP (lb/yr)	0.3		17.6%
	TSS (lb/yr)	113		19.7%
	Volume (acre-feet/yr)	0.0		0.0%
Cost	Administration & Promotion Costs*			\$1,752
	Design & Construction Costs**			\$27,000
	Total Estimated Project Cost (2016)			\$28,752
	Annual O&M***			\$630
Efficiency	30-yr Average Cost/lb-TP		\$5,295	
	30-yr Average Cost/1,000lb-TSS		\$14,057	
	30-yr Average Cost/ac-ft Vol.		N/A	

*Indirect Cost: (24 hours at \$73/hour)

**Direct Cost: (\$18,000 for materials) + (\$9,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Catchment A-5

Existing Catchment Summary	
Acres	3.7
Dominant Land Cover	Residential
Parcels	21
Volume (acre-feet/yr)	3.1
TP (lb/yr)	3.2
TSS (lb/yr)	1,051

CATCHMENT DESCRIPTION

This catchment consists primarily of paved surfaces, specifically the Ferry Street/Highway 169 corridor between Highway 10 and Calhoun Street. Overland runoff generated in the catchment is intercepted quickly in catch basins along Ferry Street and discharges into the Rum River from an outfall located just south of Clay Street.



EXISTING STORMWATER TREATMENT

A hydrodynamic device was installed along Ferry Street by the Minnesota Department of Transportation during a recent reconstruction of Ferry Street/Highway 169. As installed, this device treats the entire catchment.

Street cleaning was only included for the very small amount of municipal roadway located within this catchment. The largest roadway, Ferry Street/Highway 169, is a state-owned highway and was not modeled with municipal street cleaning.

Present-day stormwater pollutant loading and treatment is summarized in the table below.

<i>Existing Conditions</i>		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	2			
	BMP Types	1 Hydrodynamic Device, Street Cleaning			
	TP (lb/yr)	3.8	0.6	16%	3.2
	TSS (lb/yr)	1,293	242	19%	1,051
	Volume (acre-feet/yr)	3.1	0.0	0%	3.1

PROPOSED RETROFITS OVERVIEW

No stormwater retrofits were proposed in this catchment.

RETROFITS CONSIDERED BUT REJECTED

Curb-cut rain gardens and boulevard bioswales were considered along Ferry Street but were not proposed due to (1) the lack of boulevard to accommodate a bioswale and (2) the increased cost to divert water through a sidewalk and into a curb-cut rain garden makes the practice cost-prohibitive.

Therefore, the map below was included solely to provide additional detail of the catchment boundary, associated land uses, and streets.

RETROFIT RECOMMENDATIONS



Catchment A-6

Existing Catchment Summary	
Acres	8.7
Dominant Land Cover	Commercial
Parcels	28
Volume (acre-feet/yr)	9.3
TP (lb/yr)	6.5
TSS (lb/yr)	2,603



CATCHMENT DESCRIPTION

Catchment A-6 contains nearly 9 acres of heavily impervious area. The catchment is dominated by commercial properties and the Ferry Street/Highway 169 and Main Street roadways. Runoff generated in this area flows to a storm sewer below Ferry Street/Highway 169 and discharges into the Rum River just north of Main Street.

EXISTING STORMWATER TREATMENT

A hydrodynamic device was installed by the Minnesota Department of Transportation during a recent reconstruction of Ferry Street/Highway 169. The device is located along the Main Street storm sewer line just east of its intersection with Ferry Street/Highway 169 and treats the entire catchment.

Street cleaning was only included for the small amount of municipal roadways located within this catchment. The largest roadway, Ferry Street/Highway 169, is a state-owned highway and was not modeled with municipal street cleaning.

Present-day stormwater pollutant loading and treatment is summarized in the table below.

<i>Existing Conditions</i>		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	2			
	BMP Types	1 Hydrodynamic Device, Street Cleaning			
	TP (lb/yr)	7.7	1.2	16%	6.5
	TSS (lb/yr)	3,178	575	18%	2,603
	Volume (acre-feet/yr)	9.3	0.0	0%	9.3

PROPOSED RETROFITS OVERVIEW

No stormwater retrofits were proposed in this catchment.

RETROFITS CONSIDERED BUT REJECTED

Curb-cut rain gardens and boulevard bioswales were considered along Ferry Street but were not proposed due to (1) the lack of boulevard to accommodate a bioswale and (2) the increased cost to divert water through a sidewalk and into a curb-cut rain garden makes that practice cost-prohibitive. Permeable pavement was also considered for many of the private parking lots in the catchment but was not considered cost effective due to their small size.

Therefore, the map below was included solely to provide additional detail of the catchment boundary, associated land uses, and streets.

RETROFIT RECOMMENDATIONS



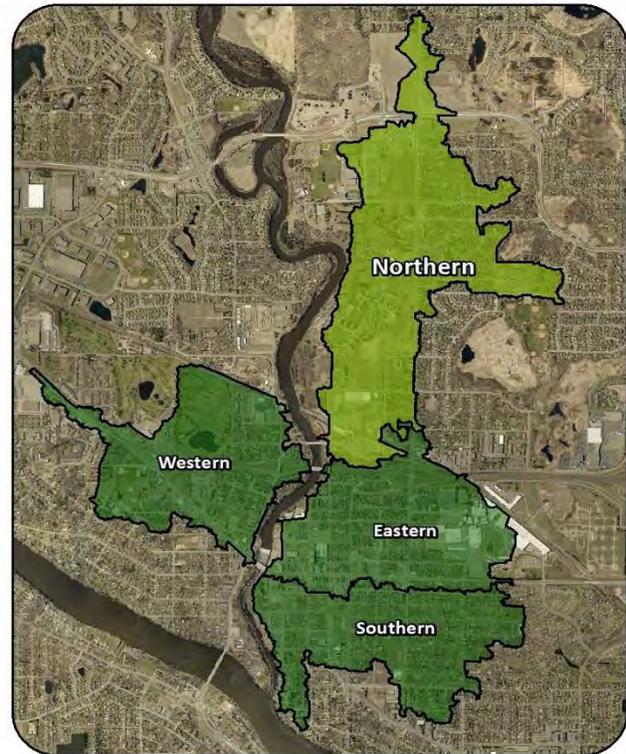
Northern Drainage Network

Catchment ID	Page
A-7	63
A-8	77

Existing Network Summary	
Acres	525.5
Dominant Land Cover	Residential
Volume (ac-ft/yr)	319.6
TP (lb/yr)	266.2
TSS (lb/yr)	99,514

DRAINAGE NETWORK SUMMARY

This network comprises most of the research area north of Highway 10 and east of the Rum River. The network is split into two catchments, each with a respective outfall to the Rum River. The northern outfall is located west of the 7th Avenue – Bryant Street intersection (Catchment A-7). The southern outfall is located west of the 4th Avenue – Grant Street intersection (A-8). This network includes many of the new developments in the city, as well as the Anoka High School and the Anoka Metro Regional Treatment Center. Land use in this network is primarily residential with small lots east of 7th Avenue and commercial or public properties with large campuses west of 7th Avenue.



EXISTING STORMWATER TREATMENT

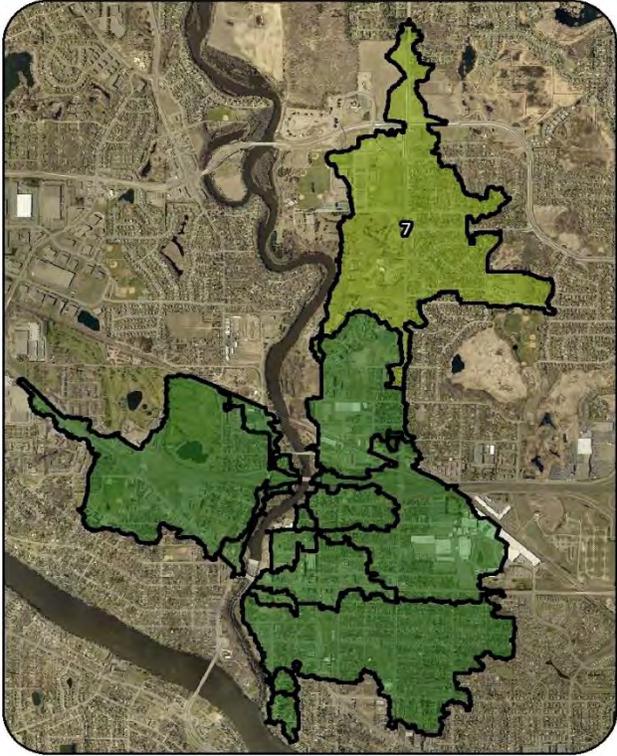
Six stormwater retention ponds are located across the two catchments in this drainage network. Five of these only treat runoff from the properties they were built upon and some adjoining properties. The sixth, a large, city-owned regional pond west of the 4th Avenue and Grant Street intersection treats 147 acres of commercial and residential properties in its catchment. Street cleaning is also conducted by the City of Anoka two times annually.

Catchment A-7

Existing Catchment Summary	
Acres	378.3
Dominant Land Cover	Residential
Parcels	448
Volume (acre-feet/yr)	213.6
TP (lb/yr)	207.4
TSS (lb/yr)	76,598

CATCHMENT DESCRIPTION

Catchment A-7 is the northernmost and largest catchment in this analysis. It spans from 145th Lane in the north to Garfield Street in the south and includes 378 acres of residential, commercial, and public properties. All stormwater runoff generated within this catchment drains to a single outfall to the Rum River located west of the MNDOT Truck Station at the intersection of 7th Avenue and Bryant Avenue.



The area within this catchment is not the only area that drains to the Bryant Avenue stormwater outfall. The area draining to this pipe is actually much larger, an additional 1,600 acres, and includes properties from the Cities of Anoka, Andover, and Coon Rapids. This additional area includes drainage to wetlands along Bunker Lake Boulevard., Riverdale Drive (west of the Riverdale Crossing Shopping Center), and south of Sunny Acres Park. The additional acreage was not included within this analysis as (1) much of the area was outside of the City of Anoka, and (2) stakeholders determined project dollars were better used when dedicated to protecting the Rum River, as opposed to the upstream wetlands. All areas included within this catchment are “downstream” (or do not drain to) of these wetland complexes.

EXISTING STORMWATER TREATMENT

This catchment has three ponds that provide treatment. The ponds are located on the Anoka Ice Arena, Anoka High School baseball field, and the Anoka Metro Regional Treatment Center. These ponds treat only the properties they were installed upon. The other catchment-wide stormwater treatment is street cleaning provided by the City of Anoka two times per year. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	<i>Existing Conditions</i>	Base Loading	Treatment	Net Treatment %	Existing Loading
<i>Treatment</i>	Number of BMPs	4			
	BMP Types	3 Ponds, Street Cleaning			
	TP (lb/yr)	233.6	26.2	11%	207.4
	TSS (lb/yr)	90,369	13,771	15%	76,598
	Volume (acre-feet/yr)	214.6	0.9	0%	213.6

PROPOSED RETROFITS OVERVIEW

Due to the prevalence of sandy, Hubbard soils throughout the residential areas of the catchment, infiltration practices were pursued. Up to 15 curb-cut rain gardens and 14 boulevard bioswales were proposed across the catchment. Campus retrofit opportunities at Wilson Elementary School are proposed which would divert stormwater runoff from paved surfaces to two large infiltration basins. The Anoka High School property was flagged as a location for stormwater reuse. Stormwater from the large paved surfaces at the school, including building roofs, sidewalks, and parking areas, could be diverted to a holding structure to be later used to irrigate the soccer and baseball fields on the property.

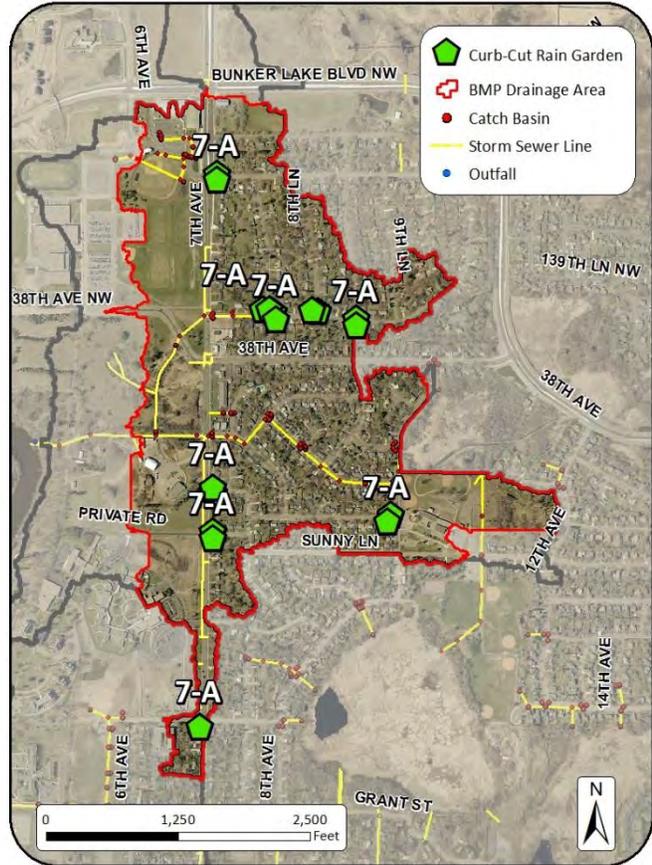
Hydrodynamic devices were proposed in two locations. The first would be located along 38th Lane between 7th Avenue and 8th Avenue. The second would be located along 7th Avenue east of the Anoka Metro Treatment Center.

Catchment-wide treatment was proposed through the installation of a new pond west of 7th Avenue. This pond could be installed on currently undeveloped, state-owned land. This pond was modeled once with a smaller drainage, accepting water from just the eastern portion of the catchment and modeled with a larger drainage, runoff from almost the entire 378-acre drainage area. To help promote phosphorus retention, an IESF bench could also be included with this pond.

Project ID: 7-A

Curb-Cut Rain Gardens

Drainage Area – 1.5 – 25.5 acres
Location – Various locations throughout catchment
Property Ownership – Private
Site Specific Information – Single-family lots in the catchment provide various locations for curb-cut rain gardens to treat stormwater pollutants originating from private properties and streets. Considering typical landowner participation rates, scenarios with one, ten, and seventeen rain gardens were analyzed to treat the drainage area.



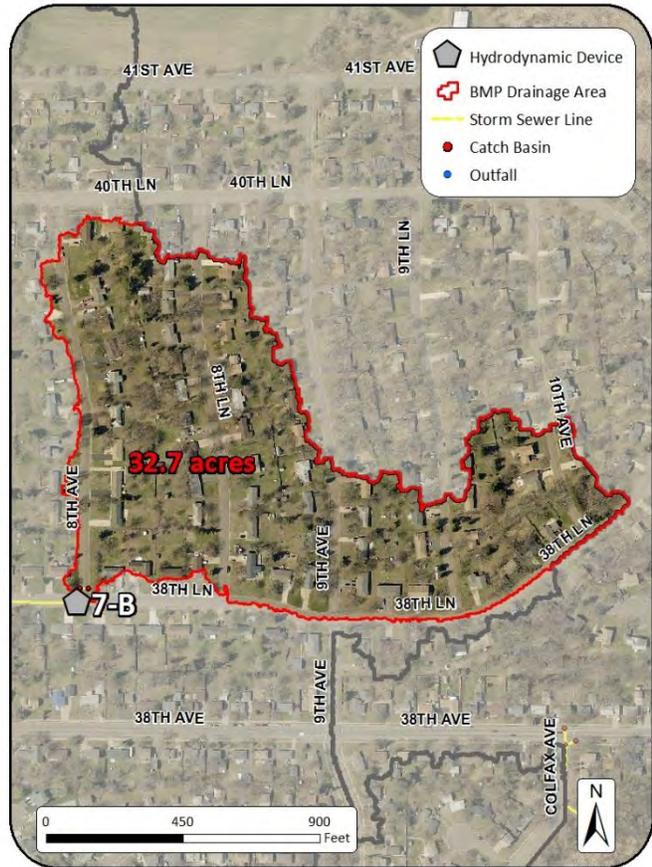
Curb-Cut Rain Garden									
Cost/Removal Analysis		New Treatment		% Reduction		New Treatment		% Reduction	
Treatment	Number of BMPs	1		10		17			
	Total Size of BMPs	250	sq-ft	2,500	sq-ft	4,250	sq-ft		
	TP (lb/yr)	0.5	0.2%	4.6	2.2%	8.1	3.9%		
	TSS (lb/yr)	153	0.2%	1,454	1.9%	2,539	3.3%		
	Volume (acre-feet/yr)	0.4	0.2%	3.5	1.7%	6.2	2.9%		
Cost	Administration & Promotion Costs*	\$8,468		\$16,352		\$22,484			
	Design & Construction Costs**	\$7,376		\$73,760		\$125,392			
	Total Estimated Project Cost (2016)	\$15,844		\$90,112		\$147,876			
	Annual O&M***	\$225		\$2,250		\$3,825			
Efficiency	30-yr Average Cost/lb-TP	\$1,506		\$1,142		\$1,081			
	30-yr Average Cost/1,000lb-TSS	\$4,922		\$3,613		\$3,448			
	30-yr Average Cost/ac-ft Vol.	\$1,931		\$1,486		\$1,407			

*Indirect Cost: (104 hours at \$73/hour base cost) + (12 hours/BMP at \$73/hour)
 **Direct Cost: (\$26/sq-ft for materials and labor) + (12 hours/BMP at \$73/hour for design)
 ***Per BMP: (\$150/year for rehabilitations at years 10 and 20) + (\$75/year for routine maintenance)

Project ID: 7-B

38th LN. & 8th Ave.
Hydrodynamic Device

Drainage Area – 32.7 acres
Location – 38th Lane at 8th Avenue
Property Ownership – Public
Site Specific Information – A hydrodynamic device could be installed on 38th Lane to accept runoff from residential properties and streets in the northeast portion of the catchment.



Hydrodynamic Device				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMPs		10 ft diameter	
	TP (lb/yr)	1.2		0.6%
	TSS (lb/yr)	491		0.6%
	Volume (acre-feet/yr)	0.0		0.0%
Cost	Administration & Promotion Costs*			\$1,752
	Design & Construction Costs**			\$108,000
	Total Estimated Project Cost (2016)			\$109,752
	Annual O&M***			\$630
Efficiency	30-yr Average Cost/lb-TP		\$3,574	
	30-yr Average Cost/1,000lb-TSS		\$8,734	
	30-yr Average Cost/ac-ft Vol.		N/A	

*Indirect Cost: (24 hours at \$73/hour)

**Direct Cost: (\$72,000 for materials) + (\$36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Project ID: 7-C

7th Avenue
Hydrodynamic Device

Drainage Area – 14.5 acres
Location – 7th Avenue
Property Ownership – Public
Site Specific Information – A hydrodynamic device could be installed on 7th Avenue between Hull Road and Sunny Lane. This device would accept runoff from residential properties and from 7th Avenue.



Hydrodynamic Device

Cost/Removal Analysis		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	10 ft diameter	
	TP (lb/yr)	0.8	0.4%
	TSS (lb/yr)	383	0.5%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	Administration & Promotion Costs*	\$1,752	
	Design & Construction Costs**	\$108,000	
	Total Estimated Project Cost (2016)	\$109,752	
	Annual O&M***	\$630	
Efficiency	30-yr Average Cost/lb-TP	\$5,361	
	30-yr Average Cost/1,000lb-TSS	\$11,197	
	30-yr Average Cost/ac-ft Vol.	N/A	

*Indirect Cost: (24 hours at \$73/hour)
 **Direct Cost: (\$72,000 for materials) + (\$36,000 for labor and installation costs)
 ***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Project ID: 7-D

Colfax Ave. & Blackoaks Ln. Infiltration Basin

Drainage Area – 22.2 acres

Location – NW side of Wilson Elementary School

Property Ownership – Public

Site Specific Information – An infiltration basin is proposed for the northwest corner of Wilson Elementary School where open space is available between baseball fields and a walking path. This project would involve “daylighting” the storm sewer line to the north (line runs east-west) and directing it to the proposed infiltration basin. The feasibility of this project is dependent on further soil testing to determine the infiltration capacity in this area (e.g. soil composition and separation from the water table) and further examination of the wetland complex to the south to determine the frequency with which that complex contributes flood water to the storm sewer line that would discharge to the proposed basin.



Infiltration Basin			
Cost/Removal Analysis		New Treatment	% Reduction
Treatment	Ponding Depth of BMP	1 foot	
	Total Size of BMP	5,000 sq-ft	
	TP (lb/yr)	9.6	5%
	TSS (lb/yr)	3,256	4%
	Volume (acre-feet/yr)	8.1	4%
Cost	Administration & Promotion Costs*	\$2,920	
	Design & Construction Costs**	\$115,876	
	Total Estimated Project Cost (2016)	\$118,796	
	Annual O&M***	\$225	
Efficiency	30-yr Average Cost/lb-TP	\$436	
	30-yr Average Cost/1,000lb-TSS	\$1,285	
	30-yr Average Cost/ac-ft Vol.	\$515	

*Indirect Cost: 40 hours at \$73/hour

**Direct Cost: (\$20/sq-ft for materials and labor) + (12 hours at \$73/hour for design) + \$15,000 for construction costs relating to daylighting stormwater pipe

***(\$150/year for rehabilitations at years 10 and 20) + (\$75/year for routine maintenance)

Project ID: 7-E

Sunny Lane Infiltration Basin

Drainage Area – 2.7 acres
Location – SE side of Wilson Elementary School
Property Ownership – Public
Site Specific Information –An infiltration basin is proposed for the southeast corner of Wilson Elementary School adjacent to the main school parking lot. Open space is available between the parking lot and the road for the installation of this practice. This basin would accept stormwater from the elementary school property and Sunny Lane. A rain garden at this location would require an inlet that allows runoff to pass under the existing sidewalk.



Infiltration Basin				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Ponding Depth of BMP	1 foot		
	Total Size of BMP	700 sq-ft		
	TP (lb/yr)	1.7		1%
	TSS (lb/yr)	676		1%
	Volume (acre-feet/yr)	1.8		1%
Cost	Administration & Promotion Costs*	\$2,920		
	Design & Construction Costs**	\$19,876		
	Total Estimated Project Cost (2016)	\$22,796		
	Annual O&M***	\$225		
Efficiency	30-yr Average Cost/lb-TP	\$579		
	30-yr Average Cost/1,000lb-TSS	\$1,457		
	30-yr Average Cost/ac-ft Vol.	\$547		

*Indirect Cost: 40 hours at \$73/hour

**Direct Cost: (\$20/sq-ft for materials and labor) + (12 hours at \$73/hour for design)

+ \$5,000 for rain garden inlet under existing sidewalk

***(\$150/year for rehabilitations at years 10 and 20) + (\$75/year for routine maintenance)

Project ID: 7-F

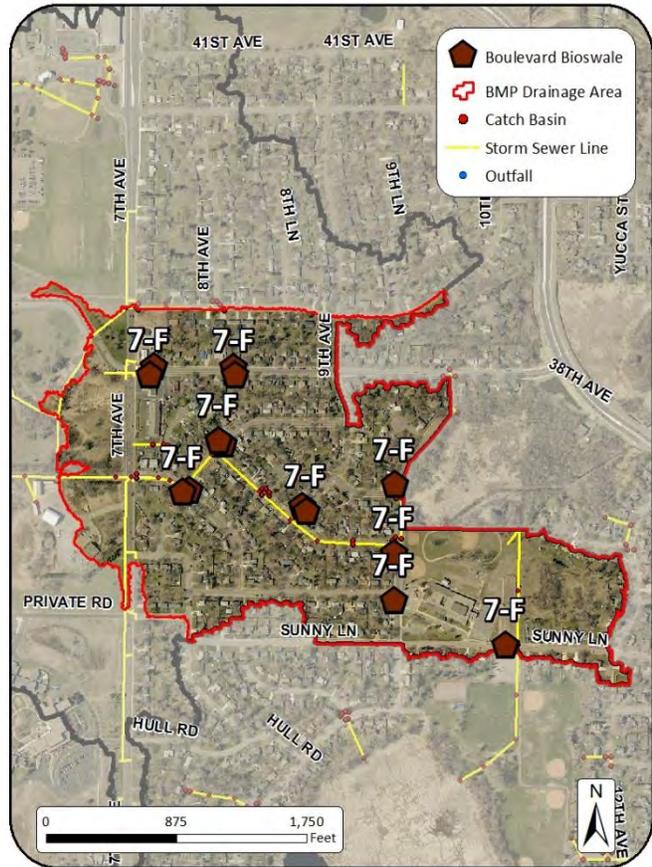
Boulevard Bioswales

Drainage Area – 0.5 acre

Location –Various locations in SE portion of catchment

Property Ownership – Public

Site Specific Information – Bioswales are proposed for installation in various locations in the southeast portion of the catchment to accept runoff from residential and commercial properties. Locations for up to 14 bioswales are sited within the catchment. The table below shows the estimated cost and pollutant removal based on treatment of a 0.5-acre contributing drainage area.



Boulevard Bioswale			
		2.5"/hr Infiltration Rate	
		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	80 sq-ft	
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	61	0.1%
	Volume (acre-feet/yr)	0.1	0.1%
Cost	Administration & Promotion Costs*	\$3,650	
	Design & Construction Costs**	\$4,876	
	Total Estimated Project Cost (2016)	\$8,526	
	Annual O&M***	\$225	
Efficiency	30-yr Average Cost/lb-TP	\$3,264	
	30-yr Average Cost/1,000lb-TSS	\$8,352	
	30-yr Average Cost/ac-ft Vol.	\$3,704	

*Indirect Cost: (50 hours at \$73/hour)

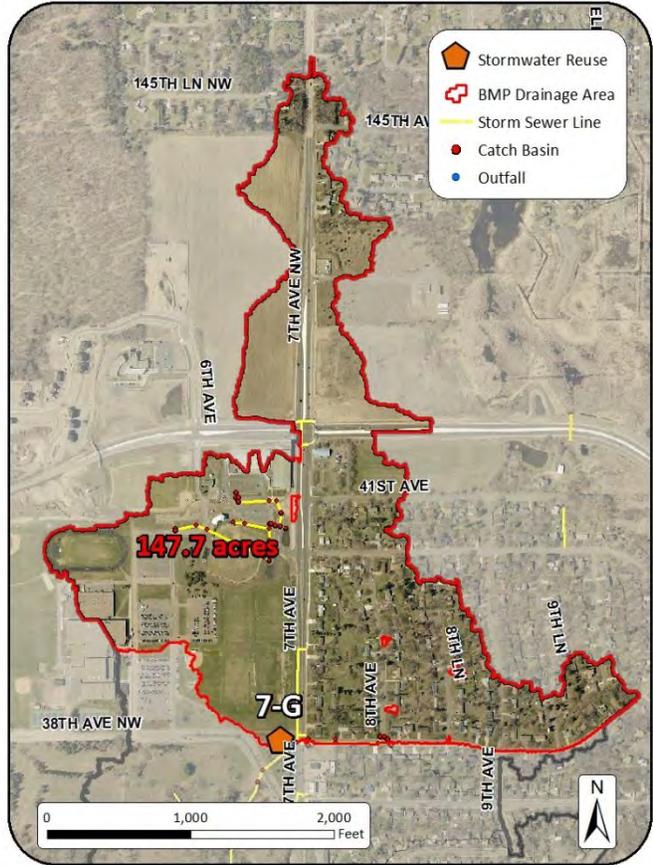
**Direct Cost: (\$50/sq-ft for materials and labor) + (12 hours/BMP at \$73/hour for design)

***Per BMP: (\$150/year for 10-year rehabilitation)+ (\$75/year for routine maintenance)

Project ID: 7-G

38th Ave. & 7th Ave.
Stormwater Reuse

Drainage Area – 147.7 acres
Location –Interchange of 38th Avenue NW and 7th Avenue
Property Ownership – Public
Site Specific Information – A water reuse system has been proposed for the southeastern corner of Anoka High School. An irrigation system could reuse the rainfall captured in this system which would provide water quality treatment as well as water conservation benefits. The proposed 500,000-gallon cistern would capture water from the northern portion of the catchment. The captured water could then be reused on approximately 20 acres of sports fields at Anoka High School.



Stormwater Reuse			
Cost/Removal Analysis		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	500,000	gallons
	TP (lb/yr)	17.5	8.4%
	TSS (lb/yr)	5,987	7.8%
	Volume (acre-feet/yr)	18.7	8.8%
Cost	Administration & Promotion Costs*	\$8,760	
	Design & Construction Costs**	\$950,000	
	Total Estimated Project Cost (2016)	\$958,760	
	Annual O&M***	\$3,000	
Efficiency	30-yr Average Cost/lb-TP	\$1,998	
	30-yr Average Cost/1,000lb-TSS	\$5,839	
	30-yr Average Cost/ac-ft Vol.	\$1,869	

*120 hours at \$73/hour

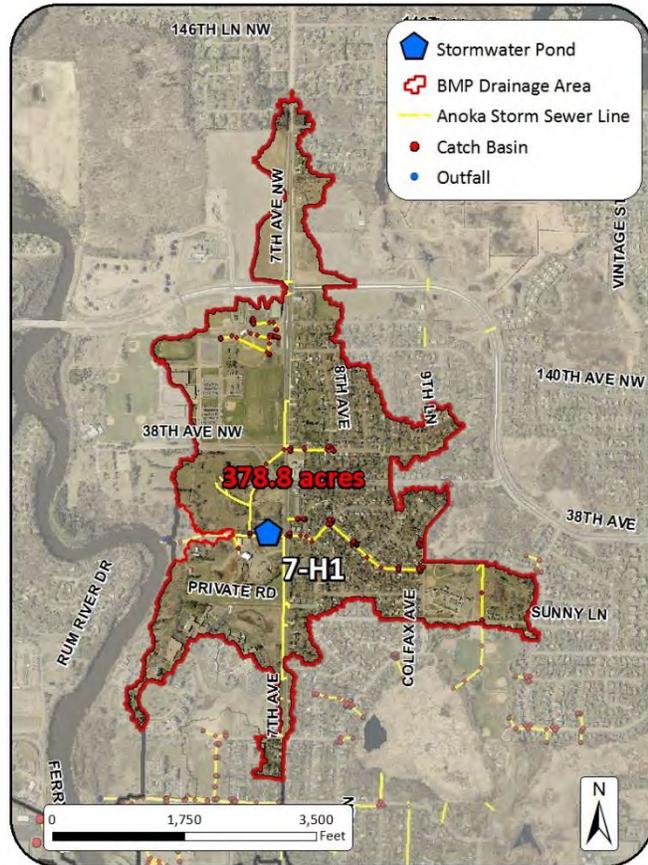
**See Appendix B for detailed cost information

***Includes cleaning of unit and disposal of sediment/debris

Project ID: 7-H1

7th Avenue.
New Pond

Drainage Area – 378.8 acres
Location – West side of 7th Avenue
Property Ownership – Public (State of Minnesota)
Site Specific Information – A new pond is proposed for public property on the western side of 7th Avenue. One proposed scenario would be for the installation of a large pond that would accept water from almost the entire catchment. Currently, water from the catchment flows through a large storm sewer line and then into the Rum River. The proposed pond would receive water from the storm sewer line, providing additional treatment to the whole catchment.



New Pond			
		Cost/Removal Analysis	
		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	5.5 acres	
	TP (lb/yr)	111.6	53.8%
	TSS (lb/yr)	54,558	71.2%
	Volume (acre-feet/yr)	0.9	0.4%
Cost	Administration & Promotion Costs*	\$7,300	
	Design & Construction Costs**	\$794,838	
	Total Estimated Project Cost (2015)	\$802,138	
	Annual O&M***	\$5,500	
Efficiency	30-yr Average Cost/lb-TP	\$289	
	30-yr Average Cost/1,000lb-TSS	\$591	
	30-yr Average Cost/ac-ft Vol.	N/A	

*Indirect Cost: 100 hours at \$73/hour

**Direct Cost: See Appendix B for detailed cost information

***\$1,000/acre - Annual inspection and sediment/debris removal from pretreatment area

Project ID: 7-H2

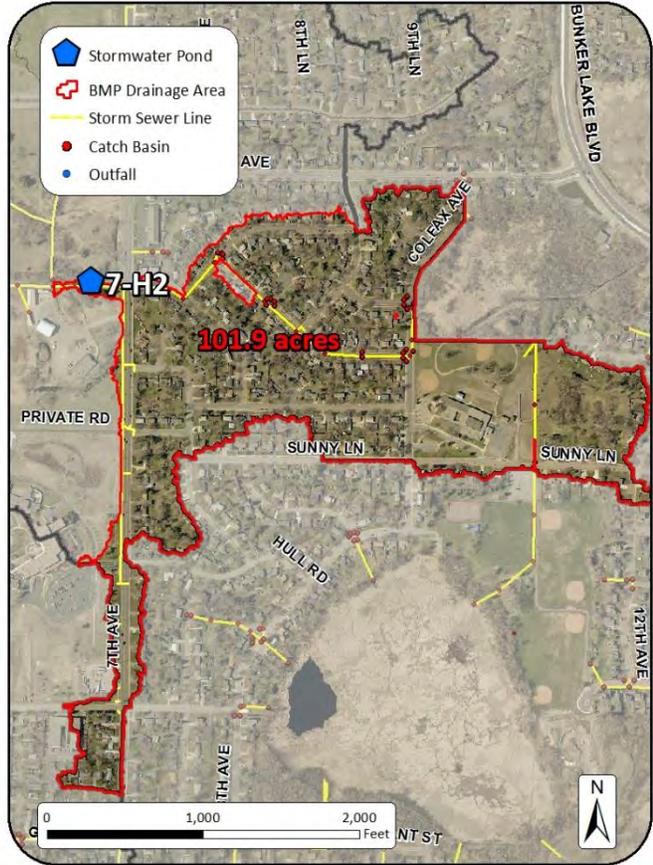
7th Avenue.
New Pond

Drainage Area – 101.9 acres

Location –West side of 7th Avenue

Property Ownership – Public (State of Minnesota)

Site Specific Information – A new pond is proposed for public property on the western side of 7th Avenue. This scenario includes a smaller pond that would accept water from the eastern portion of the catchment and provide additional treatment to water from approximately a quarter of the catchment.



New Pond			
		Cost/Removal Analysis	
		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	1.8 acres	
	TP (lb/yr)	31.5	15.2%
	TSS (lb/yr)	13,452	17.6%
	Volume (acre-feet/yr)	0.4	0.2%
Cost	Administration & Promotion Costs*	\$7,300	
	Design & Construction Costs**	\$353,184	
	Total Estimated Project Cost (2015)	\$360,484	
	Annual O&M***	\$1,800	
Efficiency	30-yr Average Cost/lb-TP	\$439	
	30-yr Average Cost/1,000lb-TSS	\$1,027	
	30-yr Average Cost/ac-ft Vol.	N/A	

*Indirect Cost: 100 hours at \$73/hour

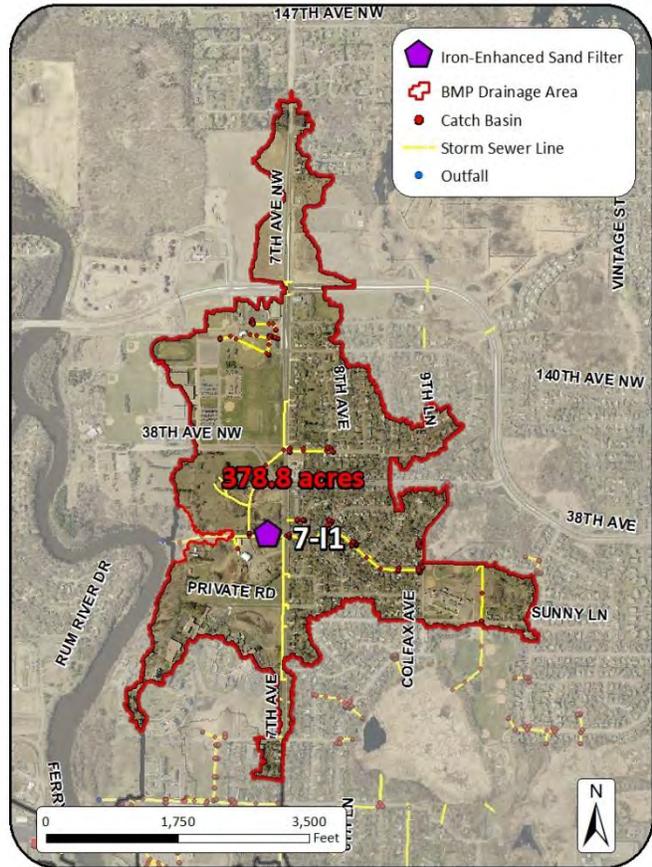
**Direct Cost: See Appendix B for detailed cost information

***\$1,000/acre - Annual inspection and sediment/debris removal from pretreatment area

Project ID: 7-I1

7th Avenue.
IESF Bench

Drainage Area – 378.8 acres
Location –West side of 7th Avenue
Property Ownership – Public (State of Minnesota)
Site Specific Information – An IESF bench is proposed as an improvement to the proposed pond with the larger drainage area (i.e. Project ID 7-H1). The pond would provide treatment through retention and settling. However, the addition of an IESF will increase removal of dissolved phosphorus. The IESF was sized to 20,000 sq.-ft. based on available space and the proposed size of the new pond.



IESF Bench				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMPs		20,000	sq-ft
	TP (lb/yr)	26.6		12.8%
	TSS (lb/yr)	0		0.0%
	Volume (acre-feet/yr)	0.0		0.0%
Cost	Administration & Promotion Costs*			\$5,475
	Design & Construction Costs**			\$575,516
	Total Estimated Project Cost (2016)			\$580,991
	Annual O&M***			\$4,591
Efficiency	30-yr Average Cost/lb-TP		\$902	
	30-yr Average Cost/1,000lb-TSS		N/A	
	30-yr Average Cost/ac-ft Vol.		N/A	

*Indirect Cost: 75 hours at \$73/hour
 **Direct Cost: See Appendix B for detailed cost information
 ***\$10,000/acre for IESF

Project ID: 7-I2

7th Avenue.
IESF Bench

Drainage Area – 101.9 acres

Location –West side of 7th Avenue

Property Ownership – Public (State of Minnesota)

Site Specific Information – An IESF bench is proposed as an improvement to the proposed pond with the smaller drainage area (i.e. Project ID 7-H2). The pond would provide treatment through retention and settling. However, the addition of an IESF will increase removal of dissolved phosphorus. The IESF was sized to 8,000 sq.-ft. based on available space and the proposed size of the new pond.



IESF Bench				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMPs		8,000	sq-ft
	TP (lb/yr)		7.2	3.5%
	TSS (lb/yr)		0	0.0%
	Volume (acre-feet/yr)		0.0	0.0%
Cost	Administration & Promotion Costs*			\$5,475
	Design & Construction Costs**			\$300,400
	Total Estimated Project Cost (2016)			\$305,875
	Annual O&M***			\$1,837
Efficiency	30-yr Average Cost/lb-TP		\$1,669	
	30-yr Average Cost/1,000lb-TSS		N/A	
	30-yr Average Cost/ac-ft Vol.		N/A	

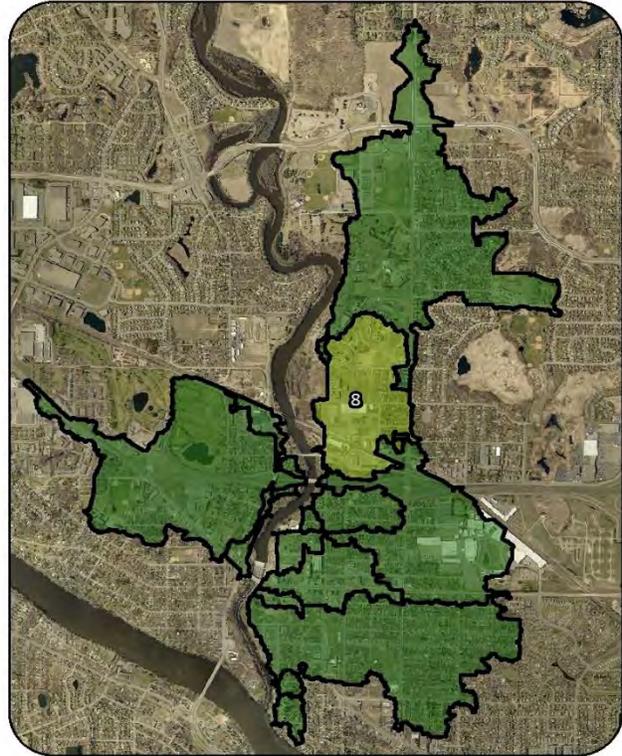
*Indirect Cost: 75 hours at \$73/hour

**Direct Cost: See Appendix B for detailed cost information

***\$10,000/acre for IESF

Catchment A-8

Existing Catchment Summary	
Acres	147.0
Dominant Land Cover	Residential
Parcels	163
Volume (acre-feet/yr)	106.0
TP (lb/yr)	58.8
TSS (lb/yr)	22,916



CATCHMENT DESCRIPTION

The southern of the two catchments in the northern drainage network is Catchment A-8. This catchment is bounded by the Anoka Metro Regional Treatment Center and county offices to the north, 7th Avenue to the east, and US-10 to the south. Runoff generated within the catchment flows through municipal storm sewer lines to a retention pond west of the 4th Avenue and Grant Street intersection. This pond treats the entire 147-acre catchment, and discharges directly into the Rum River 300 ft. west of the pond.

EXISTING STORMWATER TREATMENT

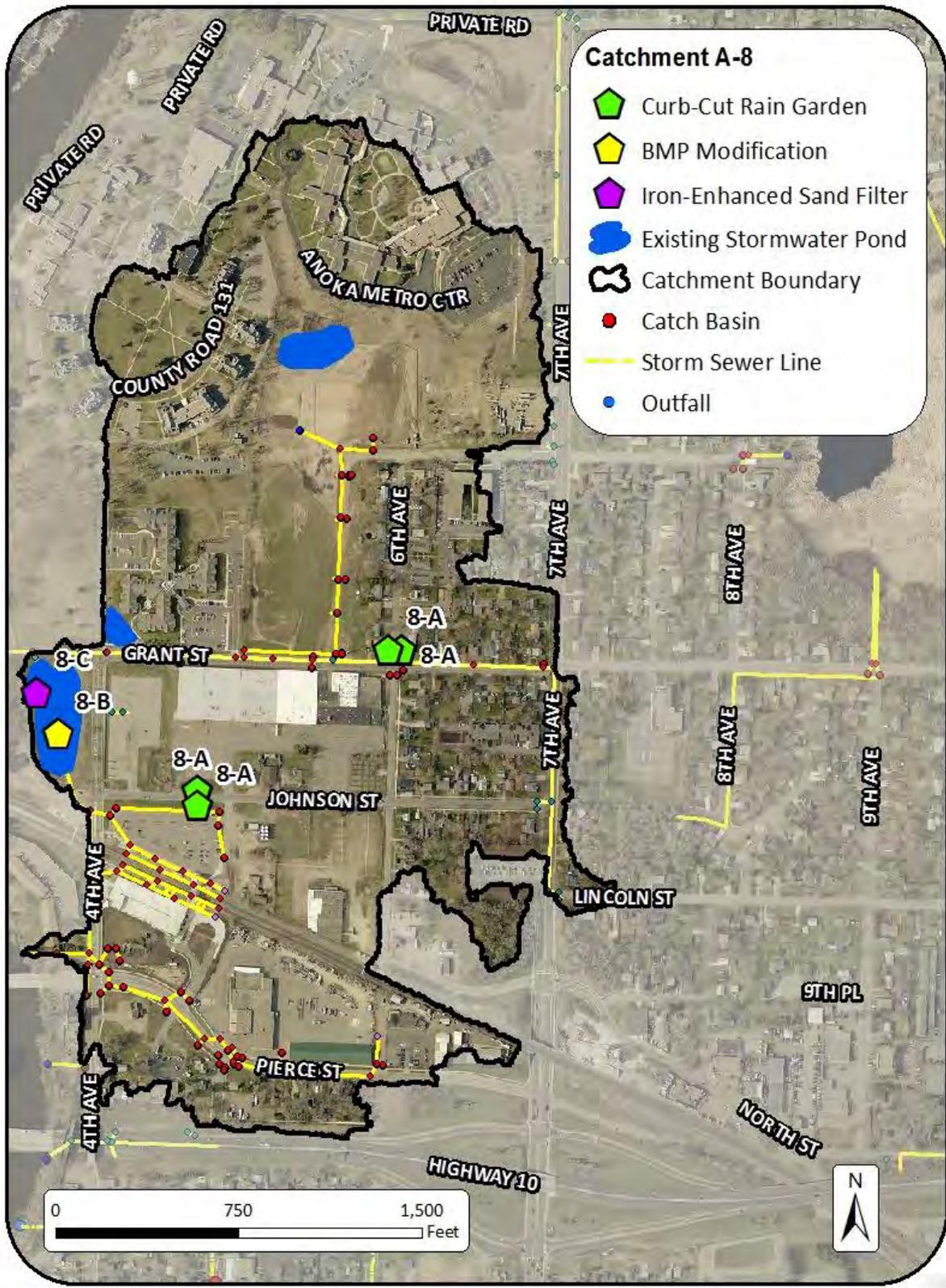
Most stormwater treatment in this catchment is supplied by the 4th Avenue and Grant Street. municipal retention pond. Upstream of this pond are two other retention ponds. The first is located on a City of Anoka development property on Garfield Street. The second pond is located on the Volunteers of America’s Homestead of Anoka apartment complex. Each of these ponds treats only the property it was installed upon. Outside of the 4th Avenue and Grant Street retention pond, the only other catchment-wide treatment is provided by the City of Anoka in the form of street cleaning two times per year. Present-day stormwater pollutant loading and treatment are summarized in the table below.

<i>Existing Conditions</i>		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	4			
	BMP Types	3 Ponds, Street Cleaning			
	TP (lb/yr)	101.5	42.7	42%	58.8
	TSS (lb/yr)	48,067	25,151	52%	22,916
	Volume (acre-feet/yr)	107.0	1.1	1%	106.0

PROPOSED RETROFITS OVERVIEW

Proposed stormwater retrofit practices were focused on improving treatment within the catchments largest existing structure, the 4th Avenue and Grant Street municipal retention pond. The first proposed practice looks to modify the pond by increasing its storage capacity. This would be done to improve

treatment of the existing landscape and to better prepare the pond for accommodating runoff from future development. The second practice would add an IESF bench along the western banks of the pond, increasing TP retention through the pond system. Upstream of the regional municipal pond, up to four curb-cut rain garden were proposed. These were proposed to supplement treatment provided by the pond in residential and commercial areas with soils that are conducive to infiltration practices.



Project ID: 8-A

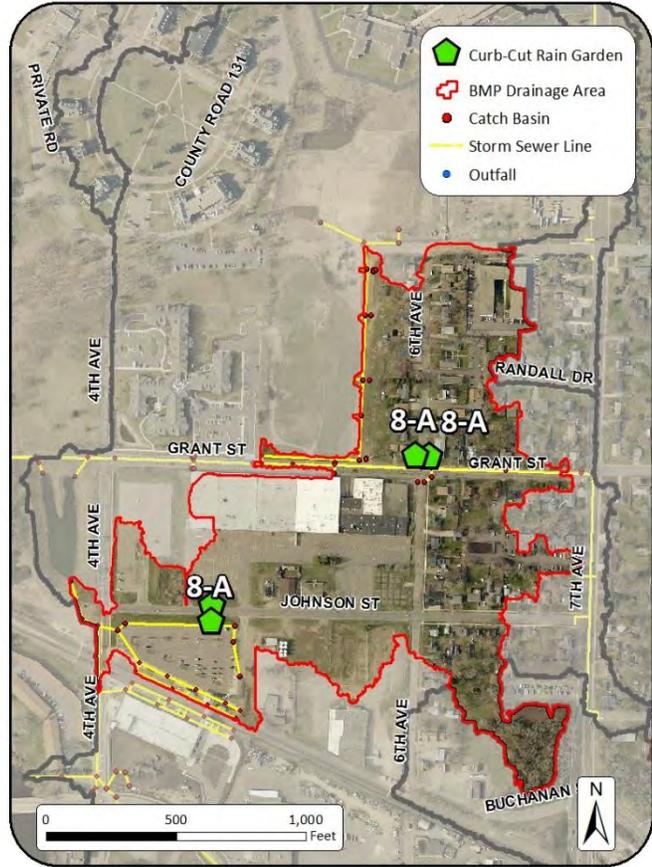
Curb-Cut Rain Gardens

Drainage Area – 1.5 – 6.0 acres

Location – Various locations throughout catchment

Property Ownership – Private

Site Specific Information – Various locations for curb-cut rain gardens are proposed on residential and light industrial properties to treat stormwater pollutants. Considering private landowner participation rates, scenarios were run with two rain gardens placed on light industrial properties and two placed on residential properties.



Curb Cut Rain Garden					
Cost/Removal Analysis		New Treatment		% Reduction	
Treatment	Number of BMPs	2		2	
	Land Use	LI		MDRNA	
	Total Size of BMPs	500 sq-ft		500 sq-ft	
	TP (lb/yr)	0.8	1.4%	0.7	1.2%
	TSS (lb/yr)	301	1.3%	190	0.8%
	Volume (acre-feet/yr)	1.1	1.0%	0.7	0.7%
Cost	Administration & Promotion Costs*	\$2,482		\$2,482	
	Design & Construction Costs**	\$14,752		\$14,752	
	Total Estimated Project Cost (2016)	\$17,234		\$17,234	
	Annual O&M***	\$450		\$450	
Efficiency	30-yr Average Cost/lb-TP	\$1,281		\$1,464	
	30-yr Average Cost/1,000lb-TSS	\$3,404		\$5,392	
	30-yr Average Cost/ac-ft Vol.	\$931		\$1,394	

*Indirect Cost: (10 hours at \$73/hour base cost) + (12 hours/BMP at \$73/hour)

**Direct Cost: (\$26/sq-ft for materials and labor) + (12 hours/BMP at \$73/hour for design)

***Per BMP: (\$150/year for rehabilitations at years 10 and 20) + (\$75/year for routine maintenance)

Project ID: 8-B

4th Ave. & Grant St. Pond Modification

Drainage Area – 147.1 acres
Location – 4th Ave. and Grant St.
Property Ownership – Public
Site Specific Information – A modification is proposed for the pond at 4th Avenue and Grant Street. This pond currently treats water from the entire catchment. Excavating 12,000 cubic yards of material would increase the size of the pond and improve the treatment efficiency. The price of the pond modification is shown below with three different management levels based on the contamination level of the excavated soil.



BMP Modification									
Cost/Removal Analysis		New Treatment		% Reduction		New Treatment		% Reduction	
Treatment	Pond Management Level	1		2		3			
	Amount of Soil Excavated	12,000 cu-yards		12,000 cu-yards		12,000 cu-yards			
	TP (lb/yr)	10.5	17.9%	10.5	17.9%	10.5	17.9%		
	TSS (lb/yr)	6,443	28.1%	6,443	28.1%	6,443	28.1%		
	Volume (acre-feet/yr)	0.0	0.0%	0.0	0.0%	0.0	0.0%		
Cost	Administration & Promotion Costs*	\$5,840		\$5,840		\$5,840			
	Design & Construction Costs**	\$325,000		\$505,000		\$685,000			
	Total Estimated Project Cost (2016)	\$330,840		\$510,840		\$690,840			
	Annual O&M***	\$1,300		\$1,300		\$1,300			
Efficiency	30-yr Average Cost/lb-TP	\$1,174		\$1,746		\$2,317			
	30-yr Average Cost/1,000lb-TSS	\$1,913		\$2,845		\$3,776			
	30-yr Average Cost/ac-ft Vol.	N/A		N/A		N/A			

*Indirect Cost: 80 hours at \$73/hour

**Direct Cost: See Appendix B for detailed cost information

***\$1,000/acre of pond surface area - Annual inspection and sediment/debris removal from pretreatment area

Project ID: 8-C

4th Ave. & Grant St.
IESF Bench

Drainage Area – 147.1 acres
Location – 4th Ave. and Grant St.
Property Ownership – Public
Site Specific Information – An IESF bench is proposed as an improvement to the existing pond at 4th Avenue and Grant Street. The pond provides treatment through retention and settling. However, the addition of an IESF Pond Bench will increase removal of dissolved phosphorus. The IESF was sized to 7,000 sq.-ft. based on available space and the size of the existing pond.



IESF Bench				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMPs		7,000 sq-ft	
	TP (lb/yr)	7.2	12.2%	
	TSS (lb/yr)	0	0.0%	
	Volume (acre-feet/yr)	0.0	0.0%	
Cost	Administration & Promotion Costs*		\$5,475	
	Design & Construction Costs**		\$277,480	
	Total Estimated Project Cost (2016)		\$282,955	
	Annual O&M***		\$1,607	
Efficiency	30-yr Average Cost/lb-TP		\$1,534	
	30-yr Average Cost/1,000lb-TSS		N/A	
	30-yr Average Cost/ac-ft Vol.		N/A	

*Indirect Cost: 75 hours at \$73/hour
 **Direct Cost: See Appendix B for detailed cost information
 ***\$10,000/acre for IESF

Eastern Drainage Network

Catchment ID	Page
A-9	84
A-10	92
A-11	100
A-12	103
A-13	106

Existing Network Summary	
Acres	327.1
Dominant Land Cover	Residential
Volume (ac-ft/yr)	265.5
TP (lb/yr)	247
TSS (lb/yr)	104,999

DRAINAGE NETWORK SUMMARY

The eastern drainage network includes all areas draining to the Rum River between US-10 and Main Street. The network has five major outfalls to the Rum River. Each of these outfalls has an upstream drainage area which was identified as a catchment and provided with a unique catchment name. These include (from north to south) US-10 (Catchment A-9), Taylor Street (A-10), Polk Street (A-11), Harrison Street (A-12), and Main Street (A-13).

EXISTING STORMWATER TREATMENT

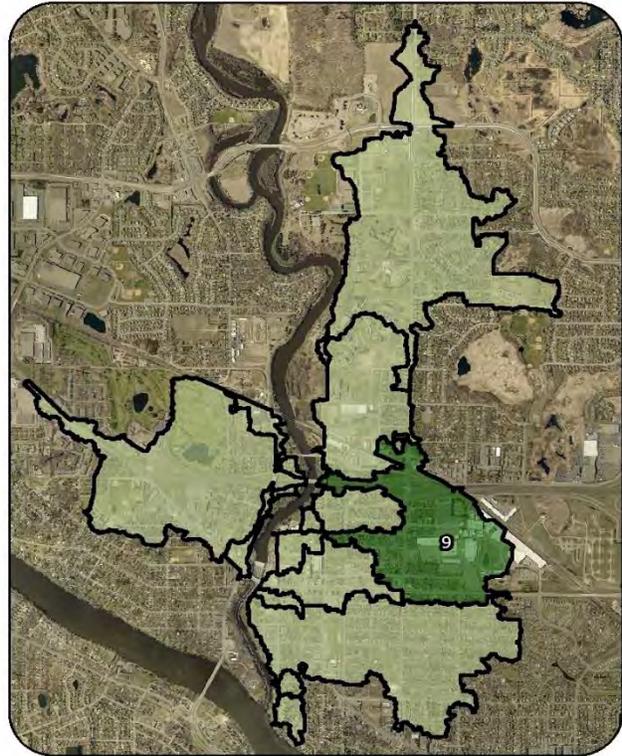
Existing treatment in this network is comprised primarily of subsurface treatment systems at the three smaller outfalls to the Rum River on Taylor Street, Polk Street, and Harrison Street. Each of these were installed during recent roadway projects. On the larger industrial properties in Catchment A-9 are stormwater retention ponds which provide treatment to portions of the industrial buildings and parking lots.

Street cleaning is also conducted by the City of Anoka two times monthly in the downtown region (A-12 and A-13) and two times annually in the rest of the drainage area.



Catchment A-9

Existing Catchment Summary	
Acres	196.7
Dominant Land Cover	Industrial
Parcels	332
Volume (acre-feet/yr)	165.8
TP (lb/yr)	165.3
TSS (lb/yr)	72,929



CATCHMENT DESCRIPTION

Catchment A-9 is characterized by all of the geographic area flowing to storm sewer pipes along the US-10 highway corridor. This includes runoff from municipal and county storm sewer pipes from as far south as Main Street. The catchment includes the large industrial facilities for companies such as Pentair and the Federal Cartridge Corporation, commercial properties along Main Street and 7th Avenue, and residential properties on and adjacent to 7th Avenue between Main Street and Lincoln Street.

EXISTING STORMWATER TREATMENT

Only two structural BMPs were identified in this analysis for Catchment A-9, and both are located on industrial parcels in the eastern portion of the catchment. The first (the southern pond) treats nearly 20 acres of the Pentair property. The second (the northern pond) treats primarily parking lot runoff from the Federal Cartridge Corporation. The only form of catchment-wide treatment is provided by the City of Anoka in the form street cleaning two times annually. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	3			
	BMP Types	2 Ponds, Street Cleaning			
	TP (lb/yr)	181.9	16.6	9%	165.3
	TSS (lb/yr)	85,163	12,234	14%	72,929
	Volume (acre-feet/yr)	166.0	0.2	0%	165.8

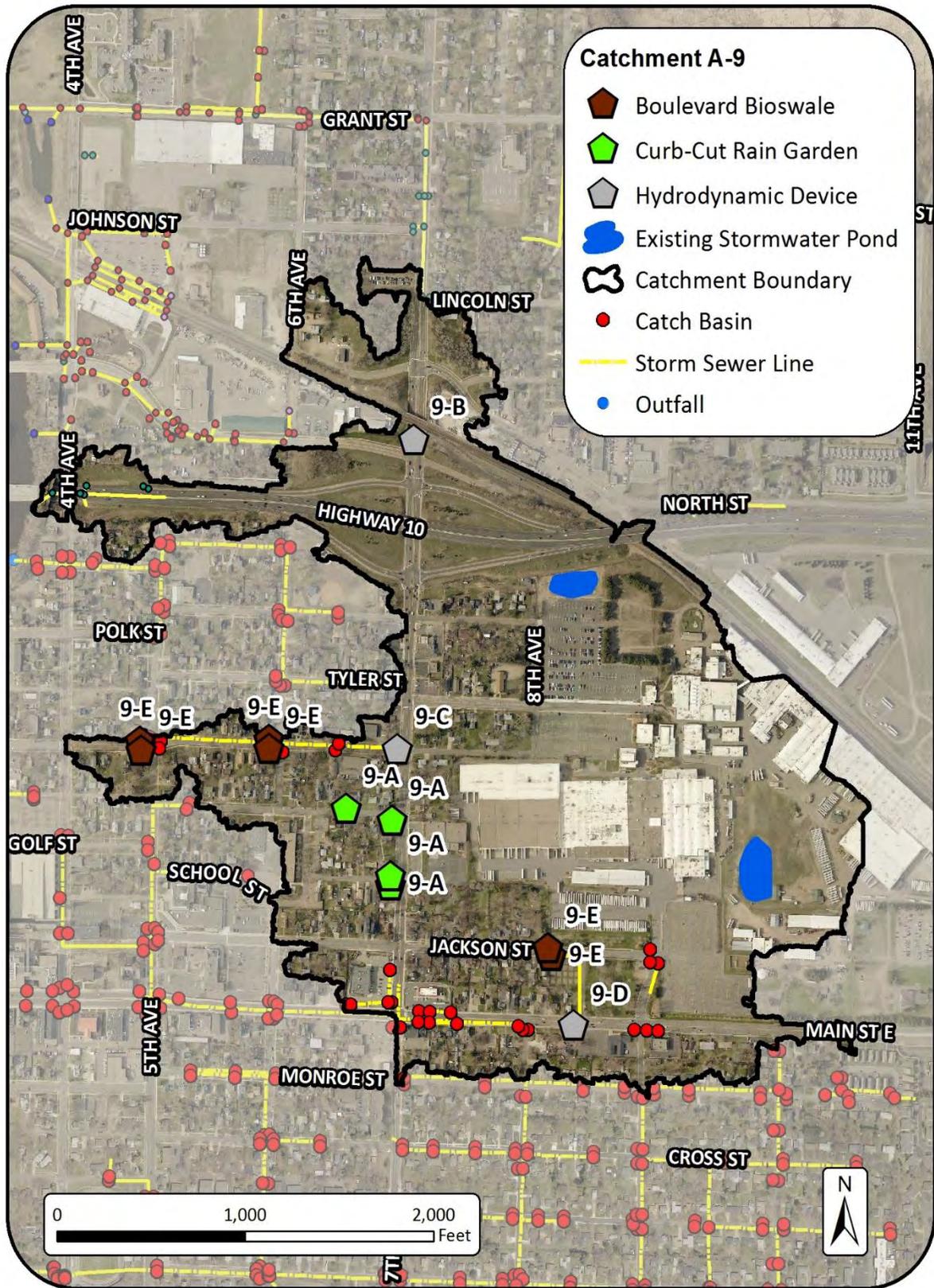
PROPOSED RETROFITS OVERVIEW

Surface and subsurface BMPs were proposed to treat stormwater prior to reaching the Rum River. These practices could include three hydrodynamic devices, curb-cut rain gardens, boulevard bioswales, and an infiltration basin. The curb-cut rain gardens, boulevard bioswales, and the infiltration basin were all proposed in residential neighborhoods with sandy soils favoring infiltration practices. Hydrodynamic

devices were proposed along or adjacent to major roadways (specifically 7th Avenue and Main Street) to treat commercial and highway runoff.

RETROFITS CONSIDERED BUT REJECTED

Large, regional treatment was explored in and along the US-10 corridor. This included diverting and/or “daylighting” stormwater into large open spaces along the interstate, specifically within the US-10 – 7th Avenue interchange and Rudy Johnson Park south of the interstate. Practices were deemed infeasible as there was not enough room within the open spaces of the corridor to daylight deep county and state storm sewer pipes.



Project ID: 9-A

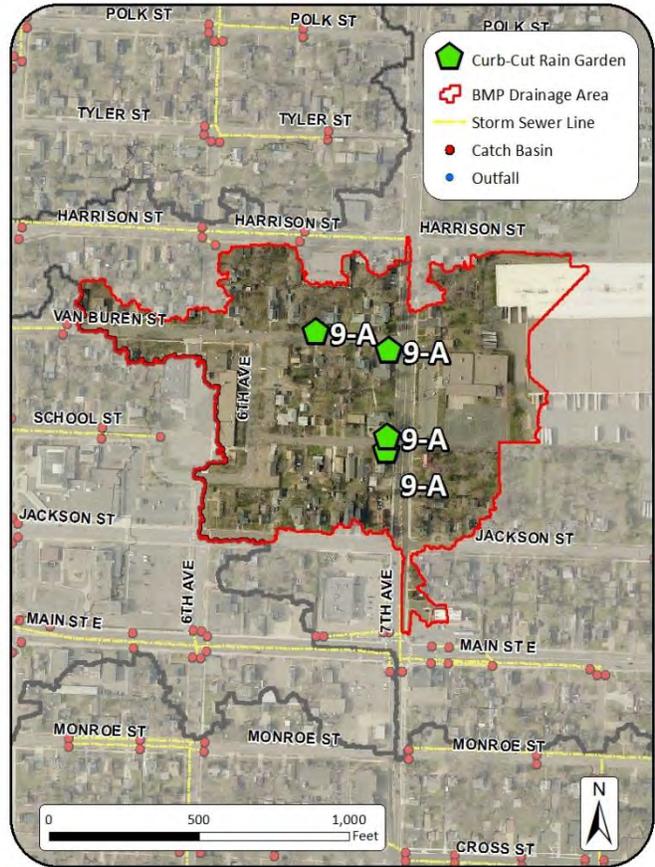
Curb-Cut Rain Gardens

Drainage Area – 1.5-6.0 acres

Location – Various locations in residential areas of catchment

Property Ownership – Public

Site Specific Information-Various locations for curb-cut rain gardens are proposed in residential areas to treat stormwater pollutants originating from streets and single-family residences. Considering typical landowner participation rates, scenarios with one, two, and four rain gardens were analyzed.



Curb-Cut Rain Garden									
Cost/Removal Analysis		New Treatment		% Reduction		New Treatment		% Reduction	
Treatment	Number of BMPs	1		2		4			
	Total Size of BMPs	250 sq-ft		500 sq-ft		1,000 sq-ft			
	TP (lb/yr)	0.5	0.3%	1.0	0.6%	2.0	1.2%		
	TSS (lb/yr)	155	0.2%	313	0.4%	623	0.9%		
	Volume (acre-feet/yr)	0.4	0.2%	0.8	0.5%	1.5	0.9%		
Cost	Administration & Promotion Costs*	\$8,468		\$9,344		\$11,096			
	Design & Construction Costs**	\$7,376		\$14,752		\$29,504			
	Total Estimated Project Cost (2016)	\$15,844		\$24,096		\$40,600			
	Annual O&M***	\$225		\$450		\$900			
Efficiency	30-yr Average Cost/lb-TP	\$1,506		\$1,253		\$1,127			
	30-yr Average Cost/1,000lb-TSS	\$4,859		\$4,004		\$3,617			
	30-yr Average Cost/ac-ft Vol.	\$1,931		\$1,605		\$1,465			

*Indirect Cost: (104 hours at \$73/hour base cost) + (12 hours/BMP at \$73/hour)

**Direct Cost: (\$26/sq-ft for materials and labor) + (12 hours/BMP at \$73/hour for design)

***Per BMP: (\$150/year for rehabilitations at years 10 and 20) + (\$75/year for routine maintenance)

Project ID: 9-B

7th Ave. & Pierce St.
Hydrodynamic Device

Drainage Area – 13.1 acres
Location – 7th Avenue and Pierce Street
Property Ownership – Public
Site Specific Information-A hydrodynamic device is proposed for the 7th Avenue and Highway 10 interchange. The device would accept runoff from the northern section of the catchment, which includes residential, industrial, freeway, and open land uses.



Hydrodynamic Device				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMPs		10	ft diameter
	TP (lb/yr)	1.2		0.7%
	TSS (lb/yr)	686		0.9%
	Volume (acre-feet/yr)	0.0		0.0%
Cost	Administration & Promotion Costs*			\$1,752
	Design & Construction Costs**			\$108,000
	Total Estimated Project Cost (2016)			\$109,752
	Annual O&M***			\$630
Efficiency	30-yr Average Cost/lb-TP		\$3,574	
	30-yr Average Cost/1,000lb-TSS		\$6,251	
	30-yr Average Cost/ac-ft Vol.		N/A	

*Indirect Cost: (24 hours at \$73/hour)

**Direct Cost: (\$72,000 for materials) + (\$36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Project ID: 9-C

7th Ave. & Harrison St.
Hydrodynamic Device

Drainage Area – 14.8 acres
Location – 7th Avenue and Harrison Street
Property Ownership – Public
Site Specific Information-A hydrodynamic device is proposed for the intersection of 7th Avenue and Harrison Street. The device would accept runoff from the western section of the catchment, which is composed of residential properties.



Hydrodynamic Device				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMPs		10	ft diameter
	TP (lb/yr)	1.0		0.6%
	TSS (lb/yr)	407		0.6%
	Volume (acre-feet/yr)	0.0		0.0%
Cost	Administration & Promotion Costs*			\$1,752
	Design & Construction Costs**			\$108,000
	Total Estimated Project Cost (2016)			\$109,752
	Annual O&M***			\$630
Efficiency	30-yr Average Cost/lb-TP		\$4,288	
	30-yr Average Cost/1,000lb-TSS		\$10,537	
	30-yr Average Cost/ac-ft Vol.		N/A	

*Indirect Cost: (24 hours at \$73/hour)

**Direct Cost: (\$72,000 for materials) + (\$36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Project ID: 9-D

Main St. & 8 1/2 Ave.
Hydrodynamic Device

Drainage Area – 51.0 acres
Location – Main Street and 8 ½ Avenue
Property Ownership – Public
Site Specific Information-A hydrodynamic device is proposed for the intersection of Main Street and 8 ½ Avenue. The device would accept runoff from light industrial and residential areas in the eastern portion of the catchment.



Hydrodynamic Device			
		New Treatment	% Reduction
Cost/Removal Analysis			
Treatment	Number of BMPs	1	
	Total Size of BMPs	10 ft diameter	
	TP (lb/yr)	1.1	0.7%
	TSS (lb/yr)	777	1.1%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	Administration & Promotion Costs*	\$1,752	
	Design & Construction Costs**	\$108,000	
	Total Estimated Project Cost (2016)	\$109,752	
	Annual O&M***	\$630	
Efficiency	30-yr Average Cost/lb-TP	\$3,899	
	30-yr Average Cost/1,000lb-TSS	\$5,519	
	30-yr Average Cost/ac-ft Vol.	N/A	

*Indirect Cost: (24 hours at \$73/hour)

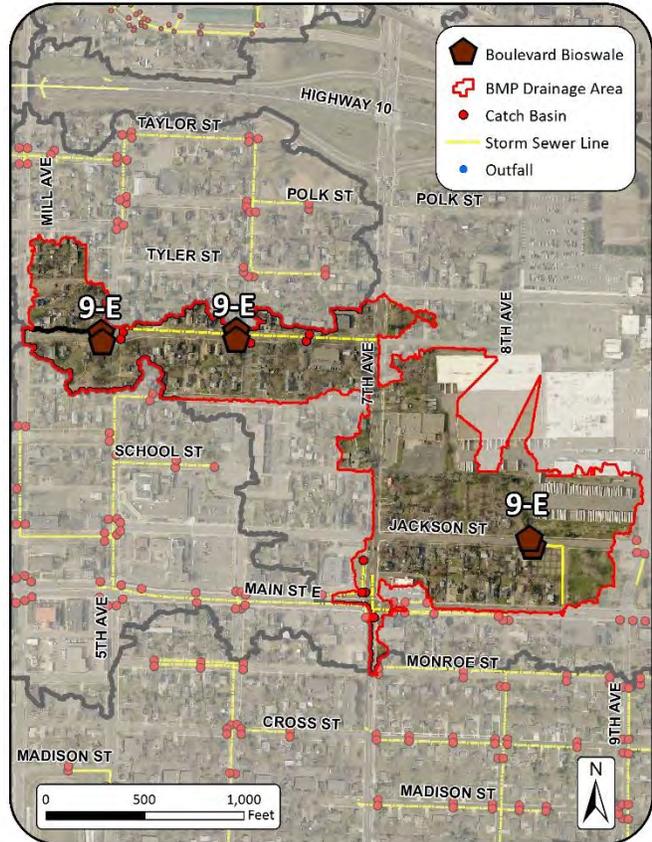
**Direct Cost: (\$72,000 for materials) + (\$36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Project ID: 9-E

Boulevard Bioswales

Drainage Area – 0.5 acre
Location – Throughout catchment
Property Ownership – Public
Site Specific Information – Bioswales are proposed for installation throughout the catchment. Locations for up to six bioswales are sited, where they will serve to treat runoff from residential properties. The table below shows the estimated cost and pollutant removal amounts based on treatment of a 0.5-acre drainage area.



Boulevard Bioswale			
		2.5"/hr Infiltr. Rate	
		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	80 sq-ft	
	TP (lb/yr)	0.2	0.1%
	TSS (lb/yr)	112	0.2%
	Volume (acre-feet/yr)	0.2	0.1%
Cost	Administration & Promotion Costs*	\$3,650	
	Design & Construction Costs**	\$4,876	
	Total Estimated Project Cost (2016)	\$8,526	
	Annual O&M***	\$225	
Efficiency	30-yr Average Cost/lb-TP	\$2,131	
	30-yr Average Cost/1,000lb-TSS	\$4,561	
	30-yr Average Cost/ac-ft Vol.	\$2,482	

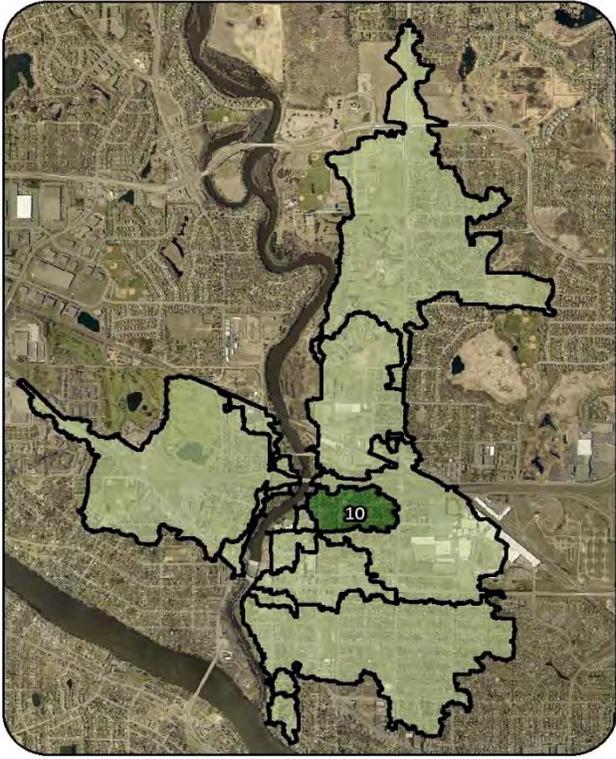
*Indirect Cost: (50 hours at \$73/hour)

**Direct Cost: (\$50/sq-ft for materials and labor) + (12 hours/BMP at \$73/hour for design)

***Per BMP: (\$150/year for 10-year rehabilitation)+ (\$75/year for routine maintenance)

Catchment A-10

Existing Catchment Summary	
Acres	42.0
Dominant Land Cover	Residential
Parcels	150
Volume (acre-feet/yr)	20.4
TP (lb/yr)	21.9
TSS (lb/yr)	7,209



CATCHMENT DESCRIPTION

Catchment A-10 includes portions of the City of Anoka south of US-10, west of 7th Avenue, and north of Harrison Street. All area within the catchment drains to a single outfall located west of the Water Avenue and Taylor Street intersection. Land use in the catchment is predominantly single family residential, with parcels of parkland (Rudy Johnson Park), institutional, and multi-family residential housing.

EXISTING STORMWATER TREATMENT

Runoff generated within the catchment is quickly intercepted in the city storm sewer network and routed to a single subsurface treatment device installed at the intersection of Water Avenue and Taylor Street. This device provides treatment to virtually the entire 42-acre catchment. Stormwater leaving this device is discharge into the Rum River directly west of the device location. In addition to this hydrodynamic device, street cleaning is performed two times per year by the City of Anoka. Present-day stormwater pollutant loading and treatment is summarized in the table below.

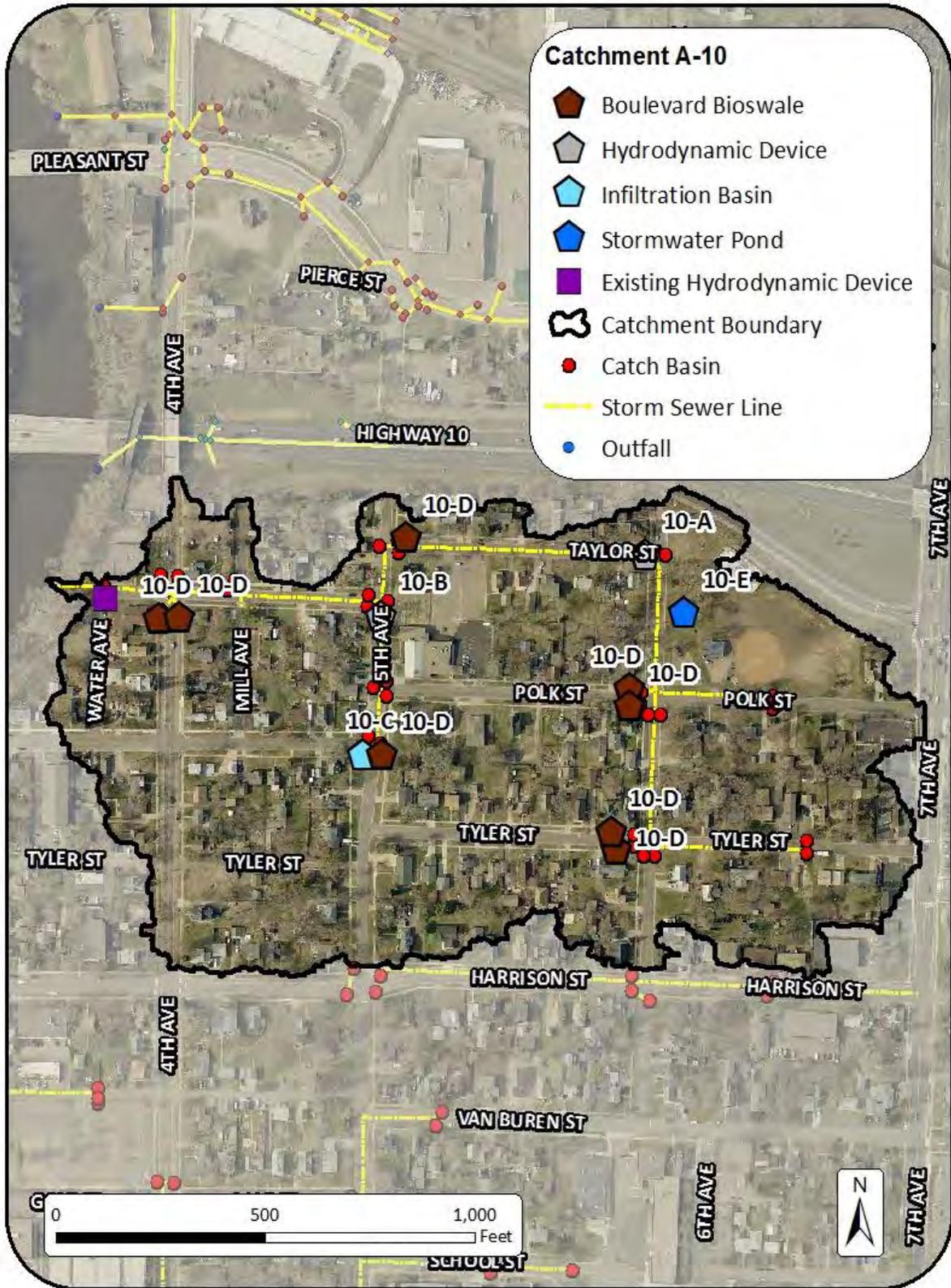
	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	2			
	BMP Types	1 Hydrodynamic Device, Street Cleaning			
	TP (lb/yr)	25.0	3.1	12%	21.9
	TSS (lb/yr)	8,604	1,395	16%	7,209
	Volume (acre-feet/yr)	20.4	0.0	0%	20.4

PROPOSED RETROFITS OVERVIEW

Retrofits proposed in Catchment A-10 would supplement treatment already provided by the hydrodynamic device located near the outfall to the Rum River. Most proposed practices look to infiltrate water at the surface, thereby reducing the peak discharge at the hydrodynamic device downstream and increasing pollutant retention. These practices include up to 8 boulevard bioswales, and an infiltration basin. There is also a new pond proposed in Rudy Johnson Park. Additional

subsurface hydrodynamic devices were also proposed to reduce the pollutant load to the downstream device and increase catchment-wide pollutant retention.

RETROFIT RECOMMENDATIONS



Project ID: 10-A

6th Ave. & Taylor St.
Hydrodynamic Device

Drainage Area – 17.5 acres
Location – 6th Avenue and Taylor Street
Property Ownership – Public
Site Specific Information-A hydrodynamic device is proposed for the intersection of 6th Avenue and Taylor Street. The device would accept runoff from the eastern section of the catchment, which is composed of a park, residential properties and institutional land uses.



Hydrodynamic Device			
Cost/Removal Analysis		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	10 ft diameter	
	TP (lb/yr)	0.5	2.3%
	TSS (lb/yr)	211	2.9%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	Administration & Promotion Costs*	\$1,752	
	Design & Construction Costs**	\$108,000	
	Total Estimated Project Cost (2016)	\$109,752	
	Annual O&M***	\$630	
Efficiency	30-yr Average Cost/lb-TP	\$8,577	
	30-yr Average Cost/1,000lb-TSS	\$20,324	
	30-yr Average Cost/ac-ft Vol.	N/A	

*Indirect Cost: (24 hours at \$73/hour)

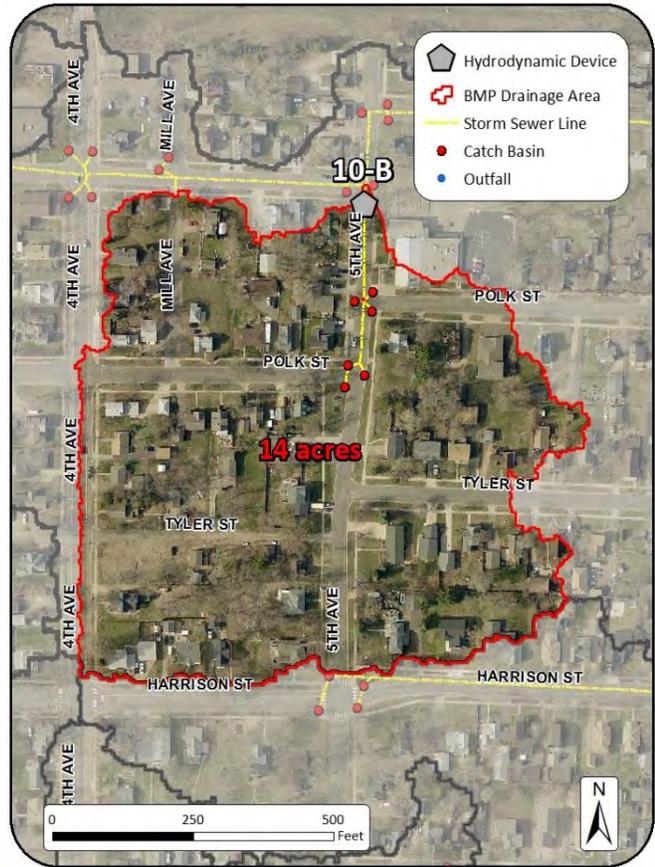
**Direct Cost: (\$72,000 for materials) + (\$36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Project ID: 10-B

5th Ave. & Taylor St.
Hydrodynamic Device

Drainage Area – 14.0 acres
Location – 5th Avenue and Taylor Street
Property Ownership – Public
Site Specific Information-A hydrodynamic device is proposed for the intersection of 5th Avenue and Taylor Street. The device would accept runoff from predominately residential land uses.



Hydrodynamic Device				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMPs		10 ft diameter	
	TP (lb/yr)	0.5	2.3%	
	TSS (lb/yr)	195	2.7%	
	Volume (acre-feet/yr)	0.0	0.0%	
Cost	Administration & Promotion Costs*	\$1,752		
	Design & Construction Costs**	\$108,000		
	Total Estimated Project Cost (2016)	\$109,752		
	Annual O&M***	\$630		
Efficiency	30-yr Average Cost/lb-TP	\$8,577		
	30-yr Average Cost/1,000lb-TSS	\$21,992		
	30-yr Average Cost/ac-ft Vol.	N/A		

*Indirect Cost: (24 hours at \$73/hour)

**Direct Cost: (\$72,000 for materials) + (\$36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Project ID: 10-C

5th Ave. & Polk St.
Infiltration Basin

Drainage Area – 5.9 acres
Location – 5th Avenue and Polk Street
Property Ownership – Public
Site Specific Information – An infiltration basin is proposed for the southwest corner of the 5th Avenue and Polk Street intersection. Open space is available between the parking lot and the road for the installation of this practice. This basin would accept stormwater from residential properties.



Infiltration Basin				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Ponding Depth of BMP	1 foot		
	Total Size of BMP	2,000 sq-ft		
	TP (lb/yr)	2.6		12%
	TSS (lb/yr)	808		11%
	Volume (acre-feet/yr)	2.1		10%
Cost	Administration & Promotion Costs*	\$2,920		
	Design & Construction Costs**	\$40,876		
	Total Estimated Project Cost (2016)	\$43,796		
	Annual O&M***	\$225		
Efficiency	30-yr Average Cost/lb-TP	\$648		
	30-yr Average Cost/1,000lb-TSS	\$2,085		
	30-yr Average Cost/ac-ft Vol.	\$803		

*Indirect Cost: 40 hours at \$73/hour

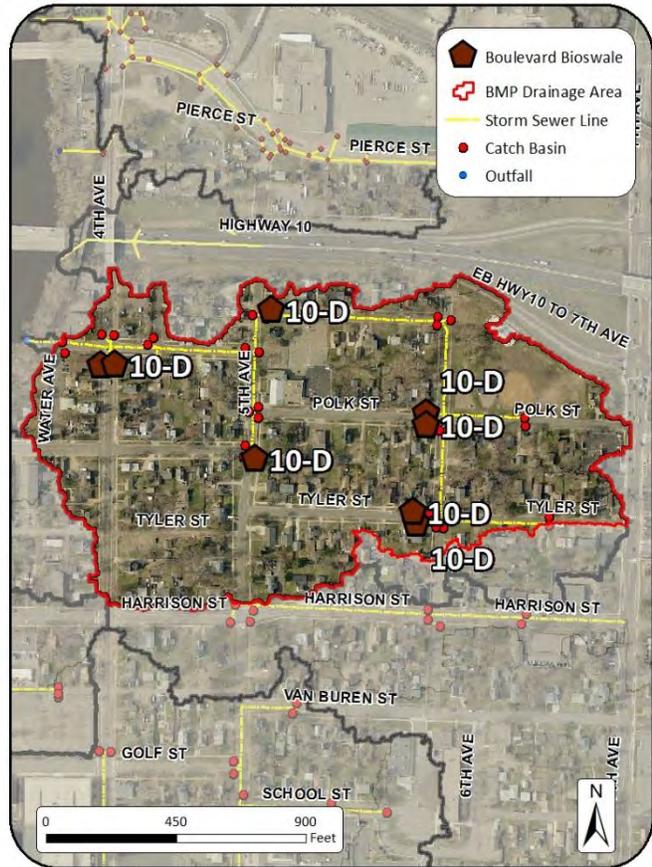
**Direct Cost: (\$20/sq-ft for materials and labor) + (12 hours at \$73/hour for design)

***(\$150/year for rehabilitations at years 10 and 20) + (\$75/year for routine maintenance)

Project ID: 10-D

Boulevard Bioswales

Drainage Area – 0.5 acre
Location – Throughout catchment
Property Ownership – Public
Site Specific Information – Bioswales are proposed for installation throughout the catchment. Locations for up to eight bioswales are sited, where they will serve to treat runoff from residential properties. The table below shows the estimated cost and pollutant removal amounts based on treatment of a 0.5-acre drainage area.



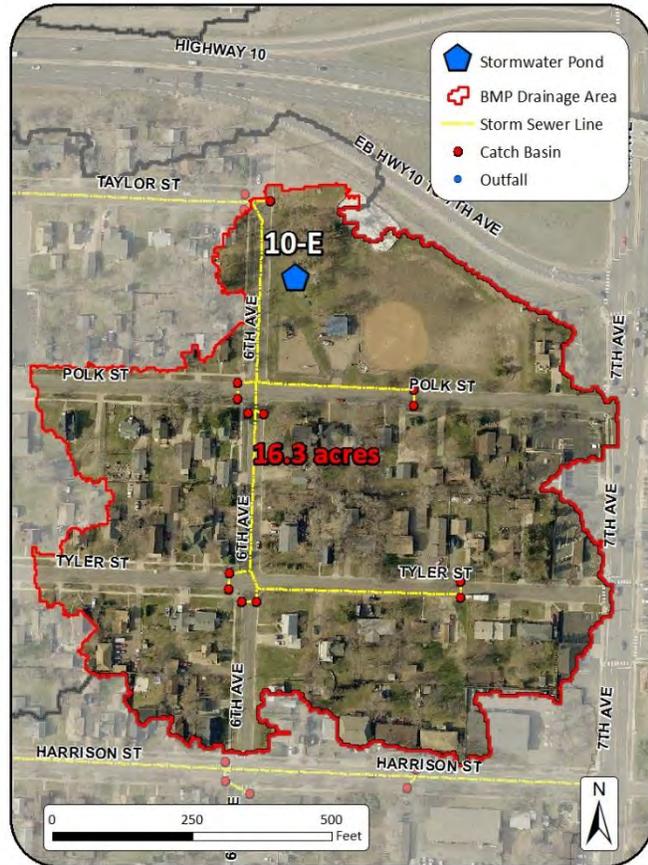
Boulevard Bioswale			
<i>Cost/Removal Analysis</i>		2.5"/hr Infil. Rate	
		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	80 sq-ft	
	TP (lb/yr)	0.1	0.7%
	TSS (lb/yr)	52	0.7%
	Volume (acre-feet/yr)	0.1	0.6%
Cost	Administration & Promotion Costs*	\$3,650	
	Design & Construction Costs**	\$4,876	
	Total Estimated Project Cost (2016)	\$8,526	
	Annual O&M***	\$225	
Efficiency	30-yr Average Cost/lb-TP	\$3,427	
	30-yr Average Cost/1,000lb-TSS	\$9,853	
	30-yr Average Cost/ac-ft Vol.	\$4,302	

*Indirect Cost: (50 hours at \$73/hour)
 **Direct Cost: (\$50/sq-ft for materials and labor) + (12 hours/BMP at \$73/hour for design)
 ***Per BMP: (\$150/year for 10-year rehabilitation)+ (\$75/year for routine maintenance)

Project ID: 10-E

Rudy Johnson Park
New Pond

Drainage Area – 16.3 acre
Location – 6th Avenue and Taylor Street
Property Ownership – Public
Site Specific Information – A new pond is proposed for the northwest corner of Rudy Johnson Park. The pond would accept runoff from primarily residential properties. It will provide additional treatment to the catchment by allowing TSS and TP to settle out. The storm sewer line that runs north-south along 6th Ave. could be redirected into the proposed pond.



New Pond			
		<i>Cost/Removal Analysis</i>	
		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	0.3 acres	
	TP (lb/yr)	4.0	18.3%
	TSS (lb/yr)	1,712	23.7%
	Volume (acre-feet/yr)	0.1	0.3%
Cost	Administration & Promotion Costs*	\$7,300	
	Design & Construction Costs**	\$232,625	
	Total Estimated Project Cost (2016)	\$239,925	
	Annual O&M***	\$300	
Efficiency	30-yr Average Cost/lb-TP	\$2,074	
	30-yr Average Cost/1,000lb-TSS	\$4,847	
	30-yr Average Cost/ac-ft Vol.	N/A	

*Indirect Cost: 100 hours at \$73/hour

**Direct Cost: See Appendix B for detailed cost information

***\$1,000/acre - Annual inspection and sediment/debris removal from pretreatment area

Catchment A-11

Existing Catchment Summary	
Acres	4.9
Dominant Land Cover	Residential
Parcels	22
Volume (acre-feet/yr)	2.8
TP (lb/yr)	2.5
TSS (lb/yr)	806

CATCHMENT DESCRIPTION

Catchment A-11 is the smallest catchment east of the Rum River, and includes all of the geographic area draining to the Polk Street outfall. This outfall only receives water draining to the storm sewer network at this intersection. Land use in the catchment is only residential, but includes both single family homes and multifamily units.



EXISTING STORMWATER TREATMENT

A single hydrodynamic device treats most of this catchment, and is located at the intersection of Polk Street and 3rd Avenue. In addition to this hydrodynamic device, street cleaning is performed two times per year by the City of Anoka. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	2			
	BMP Types	1 Hydrodynamic Device, Street Cleaning			
	TP (lb/yr)	3.1	0.6	19%	2.5
	TSS (lb/yr)	1,084	278	26%	806
	Volume (acre-feet/yr)	2.8	0.0	0%	2.8

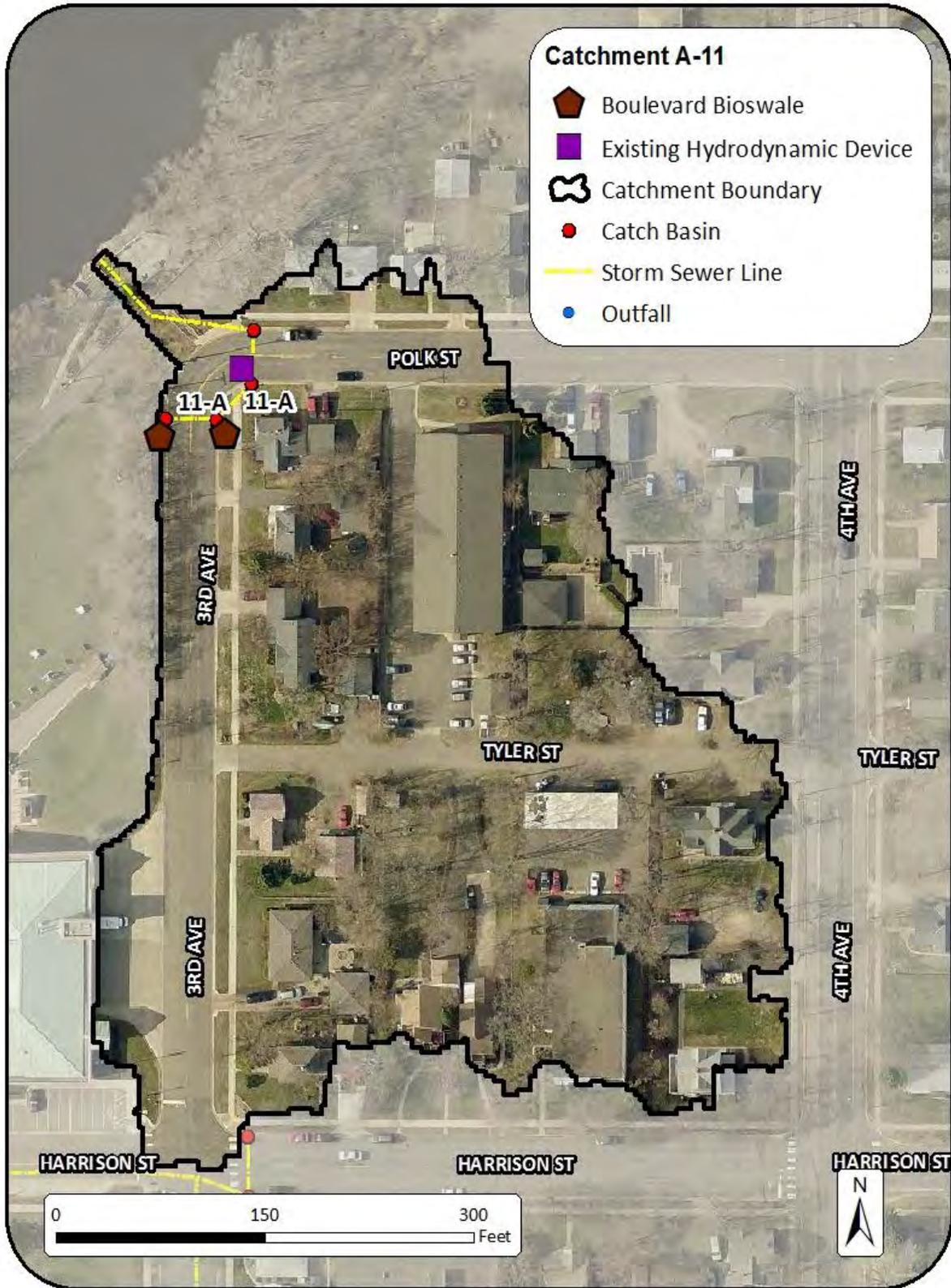
PROPOSED RETROFITS OVERVIEW

Two boulevard bioswales were proposed along 3rd Avenue to increase pollutant retention upstream of the hydrodynamic device.

RETROFITS CONSIDERED BUT REJECTED

Additional bioretention opportunities were explored throughout the catchment but drainage areas to the practices were too small to warrant the installation costs.

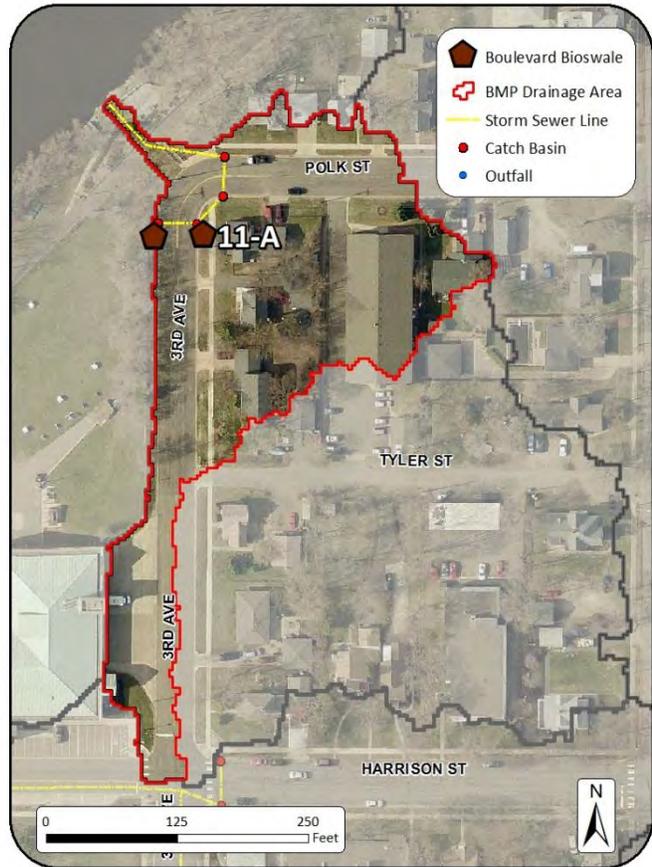
RETROFIT RECOMMENDATIONS



Project ID: 11-A

3rd Avenue
Boulevard Bioswales

Drainage Area – 0.5 acres
Location – 3rd Avenue
Property Ownership – Public
Site Specific Information – Bioswales are proposed for installation, preferably at the northern end of 3rd Avenue. Locations for two bioswales are sited, where they will serve to treat runoff from residential properties. The table below shows the estimated cost and pollutant removal amounts based on treatment of a 0.5-acre drainage area.



Boulevard Bioswale			
		2.5"/hr Infil. Rate	
		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	80 sq-ft	
	TP (lb/yr)	0.1	5.8%
	TSS (lb/yr)	49	6.1%
	Volume (acre-feet/yr)	0.1	4.9%
Cost	Administration & Promotion Costs*	\$3,650	
	Design & Construction Costs**	\$4,876	
	Total Estimated Project Cost (2016)	\$8,526	
	Annual O&M***	\$225	
Efficiency	30-yr Average Cost/lb-TP	\$3,523	
	30-yr Average Cost/1,000lb-TSS	\$10,342	
	30-yr Average Cost/ac-ft Vol.	\$3,717	

*Indirect Cost: (50 hours at \$73/hour)

**Direct Cost: (\$50/sq-ft for materials and labor) + (12 hours/BMP at \$73/hour for design)

***Per BMP: (\$150/year for 10-year rehabilitation)+ (\$75/year for routine maintenance)

Catchment A-12

Existing Catchment Summary	
Acres	17.6
Dominant Land Cover	Commercial
Parcels	145
Volume (acre-feet/yr)	12.4
TP (lb/yr)	9.0
TSS (lb/yr)	3,427



CATCHMENT DESCRIPTION

Catchment A-12 includes portions of Harrison Street, Golf Street, 2nd Avenue, and 3rd Avenue in downtown Anoka. Stormwater runoff generated on the commercial, institutional, and multi-family residential properties of the catchment is quickly intercepted by municipal storm sewers and directed to a subsurface treatment device west of the intersection of 2nd Avenue and Harrison Street. Once stormwater leaves this device it is almost immediately discharged to the Rum River.

EXISTING STORMWATER TREATMENT

The hydrodynamic device located just west of the 2nd Avenue and Harrison Street intersection was installed during a recent roadway reconstruction and treats the entire 17.6-acre catchment. The only other form of stormwater treatment in the catchment is street cleaning, provided by the City of Anoka two times per month. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	2			
	BMP Types	1 Hydrodynamic Device, Street Cleaning			
	TP (lb/yr)	11.4	2.4	21%	9.0
	TSS (lb/yr)	4,694	1,267	27%	3,427
	Volume (acre-feet/yr)	12.4	0.0	0%	12.4

PROPOSED RETROFITS OVERVIEW

No retrofits were proposed in this catchment.

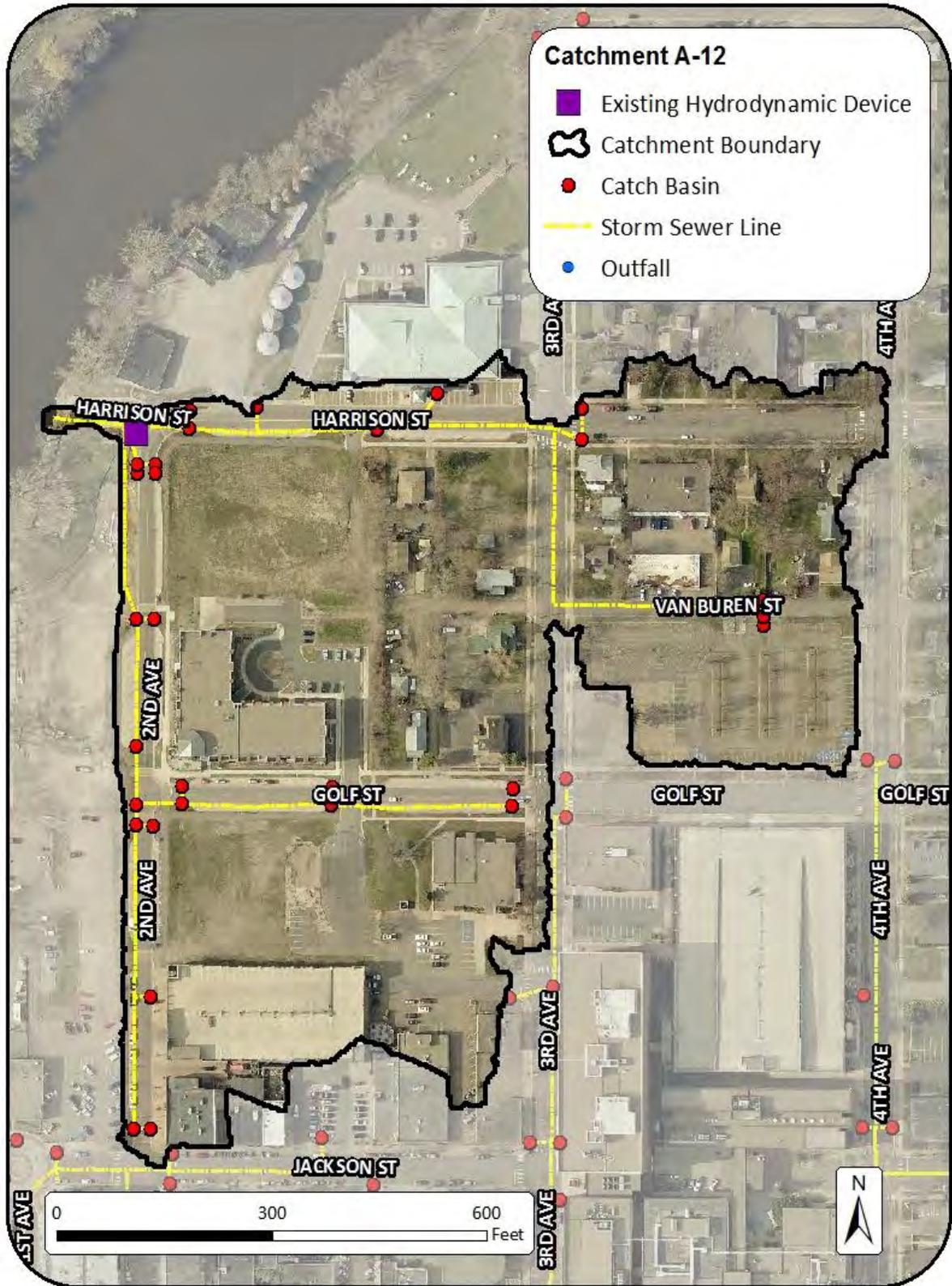
RETROFITS CONSIDERED BUT REJECTED

Permeable pavement was considered for the county-owned property between 3rd Avenue and 4th Avenue north of Golf Street. The practice was removed from consideration during conversations with City officials as the County intends to use this parking lot for future building development, not as its current use for street-level parking.

Bioretention practices, including curb-cut rain gardens and boulevard bioswales, were considered to supplement treatment provided by the hydrodynamic device and to reduce peak flows. These were not proposed as a retrofit option as the number of surface catch basins meant that drainage areas to each basin were too small to make the project cost-effective.

Therefore, the map below was included solely to provide additional detail of the catchment boundary, associated land uses, and streets.

RETROFIT RECOMMENDATIONS



Catchment A-13

Existing Catchment Summary	
Acres	65.8
Dominant Land Cover	Commercial
Parcels	214
Volume (acre-feet/yr)	6.3
TP (lb/yr)	4.3
TSS (lb/yr)	1,971

CATCHMENT DESCRIPTION

Catchment A-13 is the southernmost catchment in the eastern drainage network. It includes most of downtown Anoka, and is the most heavily-paved catchment in this analysis. Land use in the catchment is predominantly commercial and institutional. Publically-owned properties in this catchment include both the Anoka County Government Center and portions of the Anoka City Hall.



EXISTING STORMWATER TREATMENT

Stormwater runoff generated within the catchment flows to municipal and county storm sewers, eventually discharging into the Rum River south of Main Street. No catchment-wide treatment is available besides street cleaning, performed by the City of Anoka two times per month. Two small infiltration basins are located on the Anoka Middle School property, but only treat runoff from the school buildings and parking lot. Present-day stormwater pollutant loading and treatment is summarized in the table below.

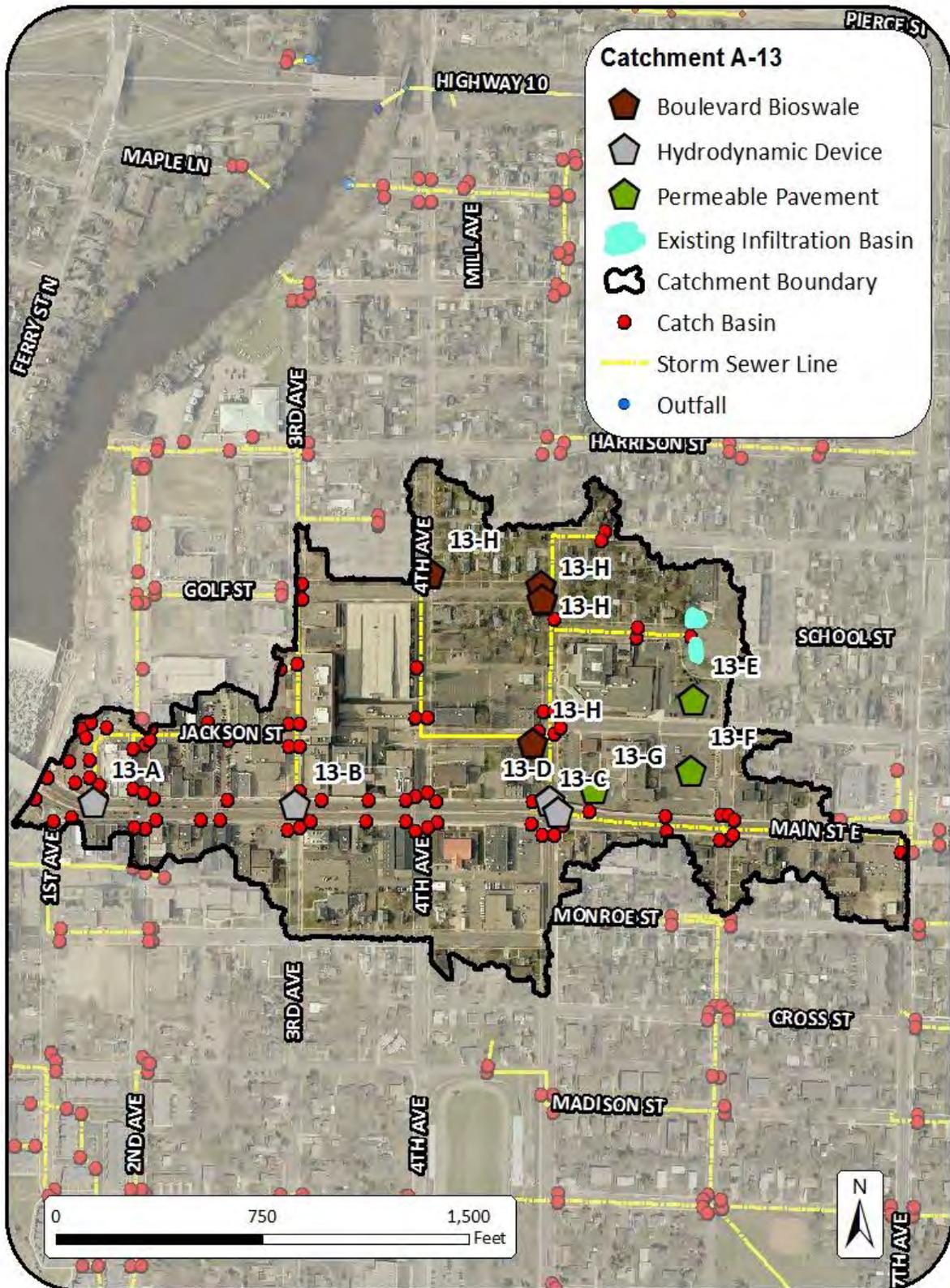
<i>Existing Conditions</i>		Base Loading	Treatment	Net Treatment %	Existing Loading
<i>Treatment</i>	Number of BMPs	3			
	BMP Types	2 Infiltration Basins, Street Cleaning			
	TP (lb/yr)	54.5	6.2	11%	48.3
	TSS (lb/yr)	24,065	3,437	14%	20,628
	Volume (acre-feet/yr)	65.3	1.2	2%	64.1

PROPOSED RETROFITS OVERVIEW

Four hydrodynamic devices were proposed to treat storm sewer lines along Main Street, 5th Avenue, 3rd Avenue, and the Anoka City Hall. These devices were proposed in locations with drainage areas less than 10 acres to reduce resuspension from high peak flows. Bioretention practices were also proposed in the form of boulevard bioswales (up to four).

Permeable pavement was also proposed on three parking lots on the St. Steven's Church and School properties. This practice would look to increase volume, TSS, and TP retention prior to discharge into the Rum River.

RETROFIT RECOMMENDATIONS



Project ID: 13-A
 Main St. & 1st Ave.
 Hydrodynamic Device

Drainage Area – 4.6 acres
Location – Main Street and 1st Avenue
Property Ownership – Public
Site Specific Information – A hydrodynamic device could be installed at the intersection of Main Street and 1st Avenue. This device would accept runoff from the commercial properties and would provide additional treatment just before the catchment discharges into the Rum River.



Hydrodynamic Device				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMPs		8	ft diameter
	TP (lb/yr)	0.5		1.0%
	TSS (lb/yr)	272		1.3%
	Volume (acre-feet/yr)	0.0		0.0%
Cost	Administration & Promotion Costs*			\$1,752
	Design & Construction Costs**			\$54,000
	Total Estimated Project Cost (2016)			\$55,752
	Annual O&M***			\$630
Efficiency	30-yr Average Cost/lb-TP		\$4,977	
	30-yr Average Cost/1,000lb-TSS		\$9,149	
	30-yr Average Cost/ac-ft Vol.		N/A	

*Indirect Cost: (24 hours at \$73/hour)

**Direct Cost: (\$36,000 for materials) + (\$18,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Project ID: 13-B

Main St. & 3rd Ave.
Hydrodynamic Device

Drainage Area – 6.4 acres
Location – Main Street and 3rd Avenue
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed at the intersection of Main Street and 3rd Avenue. This device would accept runoff from the Anoka County Government Center.



Hydrodynamic Device			
Cost/Removal Analysis		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	8 ft diameter	
	TP (lb/yr)	0.5	1.0%
	TSS (lb/yr)	285	1.4%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	Administration & Promotion Costs*	\$1,752	
	Design & Construction Costs**	\$54,000	
	Total Estimated Project Cost (2016)	\$55,752	
	Annual O&M***	\$630	
Efficiency	30-yr Average Cost/lb-TP	\$4,977	
	30-yr Average Cost/1,000lb-TSS	\$8,731	
	30-yr Average Cost/ac-ft Vol.	N/A	

*Indirect Cost: (24 hours at \$73/hour)
 **Direct Cost: (\$36,000 for materials) + (\$18,000 for labor and installation costs)
 ***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Project ID: 13-C

Main St. & 5th Ave.
Hydrodynamic Device

Drainage Area – 9.9 acres
Location – Main Street and 5th Avenue
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed for Main Street at 5th Avenue to accept runoff from the eastern portion of the catchment. This portion of the catchment is composed of a school property, residential properties, and commercial properties.



Hydrodynamic Device			
		Cost/Removal Analysis	
		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	10 ft diameter	
	TP (lb/yr)	0.9	1.9%
	TSS (lb/yr)	427	2.1%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	Administration & Promotion Costs*	\$1,752	
	Design & Construction Costs**	\$108,000	
	Total Estimated Project Cost (2016)	\$109,752	
	Annual O&M***	\$630	
Efficiency	30-yr Average Cost/lb-TP	\$4,765	
	30-yr Average Cost/1,000lb-TSS	\$10,043	
	30-yr Average Cost/ac-ft Vol.	N/A	

*Indirect Cost: (24 hours at \$73/hour)

**Direct Cost: (\$36,000 for materials) + (\$18,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Project ID: 13-D

5th Ave. & Main St. Hydrodynamic Device

Drainage Area – 25.1 acres
Location – 5th Avenue and Main Street
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed for 5th Avenue at Main Street to accept runoff from the northern portion of the catchment. This portion of the catchment is composed of a school property, residential properties, and commercial properties.



Hydrodynamic Device				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMPs		10 ft diameter	
	TP (lb/yr)	1.4		2.9%
	TSS (lb/yr)	644		3.1%
	Volume (acre-feet/yr)	0.0		0.0%
Cost	Administration & Promotion Costs*		\$1,752	
	Design & Construction Costs**		\$108,000	
	Total Estimated Project Cost (2016)		\$109,752	
	Annual O&M***		\$630	
Efficiency	30-yr Average Cost/lb-TP		\$3,063	
	30-yr Average Cost/1,000lb-TSS		\$6,659	
	30-yr Average Cost/ac-ft Vol.		N/A	

*Indirect Cost: (24 hours at \$73/hour)

**Direct Cost: (\$36,000 for materials) + (\$18,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Project ID: 13-E

St. Stephen's Catholic Church.
Permeable Pavement

Drainage Area – 1.1 acres
Location – Jackson Street and School Street
Property Ownership – Private
Site Specific Information – Permeable pavement is proposed for the parking lot of St. Stephen's Catholic Church. This could be a favorable option as permeable pavement allows for the treatment of a large surface area with minimal impact on the usable space. In order to treat the 1.1-acre drainage area, 15,900 sq.-ft. of permeable pavement is proposed.



Permeable Pavement				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMP		15,900 sq-ft	
	TP (lb/yr)	0.9		8.7%
	TSS (lb/yr)	320		6.6%
	Volume (acre-feet/yr)	0.9		7.3%
Cost	Administration & Promotion Costs*		\$2,920	
	Design & Construction Costs**		\$159,876	
	Total Estimated Project Cost (2016)		\$162,796	
	Annual O&M***		\$11,925	
Efficiency	30-yr Average Cost/lb-TP		\$19,279	
	30-yr Average Cost/1,000lb-TSS		\$54,224	
	30-yr Average Cost/ac-ft Vol.		\$19,279	

*Indirect Cost: 40 hours at \$73/hour

**Direct Cost: (\$10/sq-ft for materials and labor) + (12 hours at \$73/hour for design)

***(\$0.75/sq-ft for routine maintenance)

Project ID: 13-F

St. Stephen's Catholic School Permeable Pavement

Drainage Area – 1.9 acres
Location – Jackson Street and 6th Avenue
Property Ownership – Private
Site Specific Information – Permeable pavement is proposed for the eastern parking lot of St. Stephen's Catholic School. This could be a favorable option as permeable pavement allows for the treatment of a large surface area with minimal impact on the usable space. In order to treat the 1.9-acre drainage area, 27,900 sq.-ft. of permeable pavement is proposed.



Permeable Pavement				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMP		27,900 sq-ft	
	TP (lb/yr)		1.6	15.4%
	TSS (lb/yr)		562	11.6%
	Volume (acre-feet/yr)		1.6	12.9%
Cost	Administration & Promotion Costs*			\$2,920
	Design & Construction Costs**			\$279,876
	Total Estimated Project Cost (2016)			\$282,796
	Annual O&M***			\$20,925
Efficiency	30-yr Average Cost/lb-TP			\$18,970
	30-yr Average Cost/1,000lb-TSS			\$54,006
	30-yr Average Cost/ac-ft Vol.			\$18,970

*Indirect Cost: 40 hours at \$73/hour

**Direct Cost: (\$10/sq-ft for materials and labor) + (12 hours at \$73/hour for design)

***(\$0.75/sq-ft for routine maintenance)

Project ID: 13-G

St. Stephen's Catholic School Permeable Pavement

Drainage Area – 2.3 acres
Location – Jackson Street and 6th Avenue
Property Ownership – Private
Site Specific Information – Permeable pavement is proposed for the western parking lot of St. Stephen's Catholic School. This could be a favorable option as permeable pavement allows for the treatment of a large surface area with minimal impact on the usable space. In order to treat the 2.3-acre drainage area, 34,000 sq.-ft. of permeable pavement is proposed.



Permeable Pavement			
Cost/Removal Analysis		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMP	34,000	sq-ft
	TP (lb/yr)	1.9	18.3%
	TSS (lb/yr)	672	13.9%
	Volume (acre-feet/yr)	1.9	15.3%
Cost	Administration & Promotion Costs*	\$2,920	
	Design & Construction Costs**	\$340,876	
	Total Estimated Project Cost (2016)	\$343,796	
	Annual O&M***	\$25,500	
Efficiency	30-yr Average Cost/lb-TP	\$19,453	
	30-yr Average Cost/1,000lb-TSS	\$55,000	
	30-yr Average Cost/ac-ft Vol.	\$19,453	

*Indirect Cost: 40 hours at \$73/hour

**Direct Cost: (\$10/sq-ft for materials and labor) + (12 hours at \$73/hour for design)

***(\$0.75/sq-ft for routine maintenance)

Project ID: 13-H

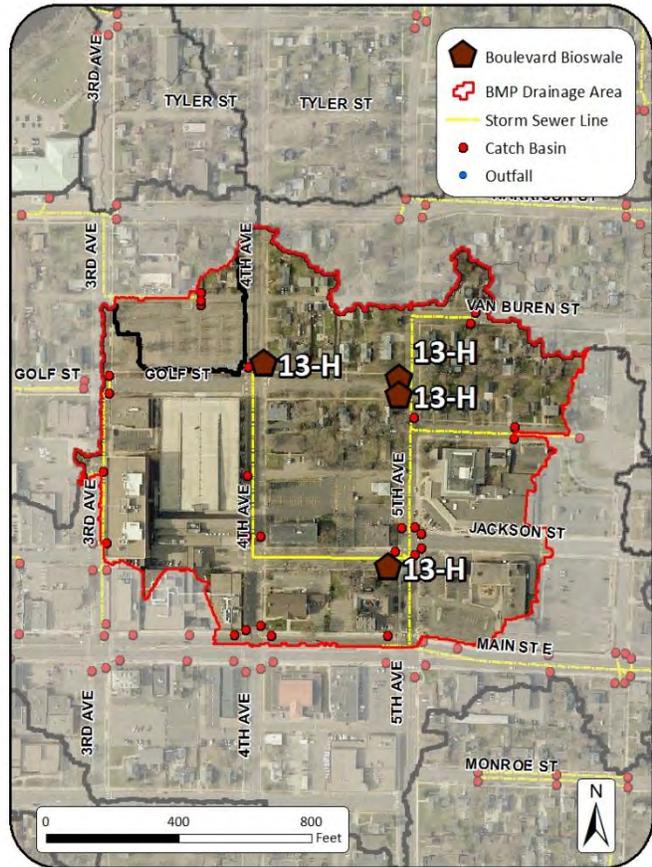
Boulevard Bioswales

Drainage Area – 0.5 acres

Location – Various locations throughout catchment

Property Ownership – Public

Site Specific Information – Boulevard bioswales are proposed for installation, preferably in the northern portion of the catchment. Locations for up to four bioswales are sited, where they will serve to treat runoff primarily from residential properties. The table below shows the estimated cost and pollutant removal amounts based on treatment of a 0.5-acre drainage area.



Boulevard Bioswale			
		2.5"/hr Infiltr. Rate	
		New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	80 sq-ft	
	TP (lb/yr)	0.1	1.0%
	TSS (lb/yr)	22	0.5%
	Volume (acre-feet/yr)	0.1	0.8%
Cost	Administration & Promotion Costs*	\$3,650	
	Design & Construction Costs**	\$4,876	
	Total Estimated Project Cost (2016)	\$8,526	
	Annual O&M***	\$225	
Efficiency	30-yr Average Cost/lb-TP	\$5,092	
	30-yr Average Cost/1,000lb-TSS	\$23,072	
	30-yr Average Cost/ac-ft Vol.	\$5,092	

*Indirect Cost: (50 hours at \$73/hour)

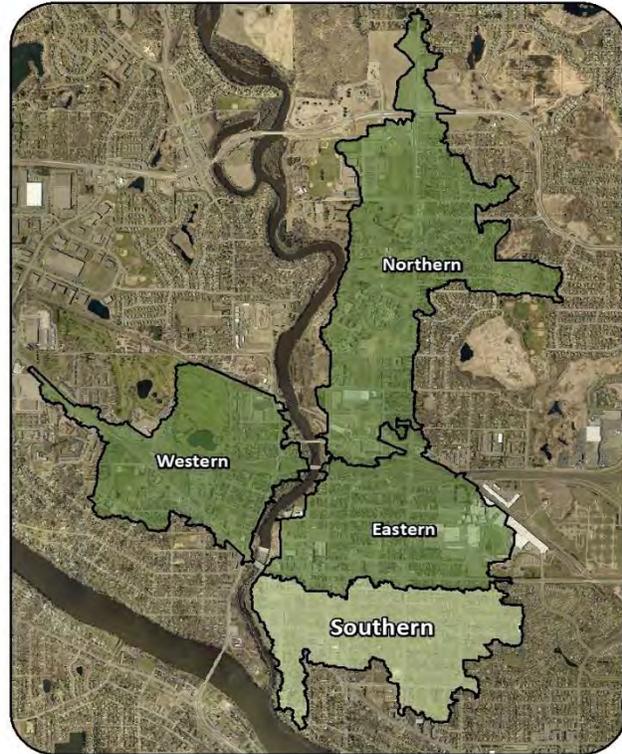
**Direct Cost: (\$50/sq-ft for materials and labor) + (12 hours/BMP at \$73/hour for design)

***Per BMP: (\$150/year for 10-year rehabilitation)+ (\$75/year for routine maintenance)

Southern Drainage Network

Catchment ID	Page
A-14	118
A-15	122
A-16	126
A-17	130

Existing Network Summary	
Acres	302.7
Dominant Land Cover	Residential
Volume (ac-ft/yr)	148.2
TP (lb/yr)	142.9
TSS (lb/yr)	44,377



DRAINAGE NETWORK SUMMARY

The southern drainage network consists of catchments A-14, A-15, A-16, and A-17. These catchments comprise all areas in the City of Anoka draining to the Rum River south of Main Street. The four Rum River outfalls are located west of 1st Avenue about 200’ south of Main Street (A-14) and at Adam’s Street (A-15), Washington Street (A-16), and Oakwood Drive (A-17). The southern drainage network is predominantly residential housing unlike the other three drainage networks, which have a much larger variety of land uses.

EXISTING STORMWATER TREATMENT

The only form of network-wide treatment is street cleaning performed by the City of Anoka twice monthly in Catchment A-14 and two times annually in Catchment A-15, A-16, and A-17. Only two other forms of treatment exist in the network. The first is a treatment system in Catchment A-15 at 2nd Avenue and Adams Street which includes a series of sedimentation chambers as well as a retention pond.

Catchment A-14

Existing Catchment Summary	
Acres	7.8
Dominant Land Cover	Commercial
Parcels	45
Volume (acre-feet/yr)	8.3
TP (lb/yr)	6.4
TSS (lb/yr)	2,636

CATCHMENT DESCRIPTION

Catchment A-14 includes areas of downtown Anoka south of Main Street along 1st Avenue, 2nd Avenue, 3rd Avenue, and Monroe Street. The catchment includes all geographic area draining to an outfall along the Rum River about 200' south of Main Street. Stormwater runoff is primarily overland east of 2nd Avenue, but is then collected through a series of municipal storm sewer pipes, and discharged at the Rum River outfall west of 1st Avenue.



EXISTING STORMWATER TREATMENT

No stormwater treatment exists in this catchment besides street cleaning, conducted two times per month by the City of Anoka. Present-day stormwater pollutant loading and treatment is summarized in the table below.

<i>Existing Conditions</i>		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	7.2	0.8	11%	6.4
	TSS (lb/yr)	3,108	472	15%	2,636
	Volume (acre-feet/yr)	8.3	0.0	0%	8.3

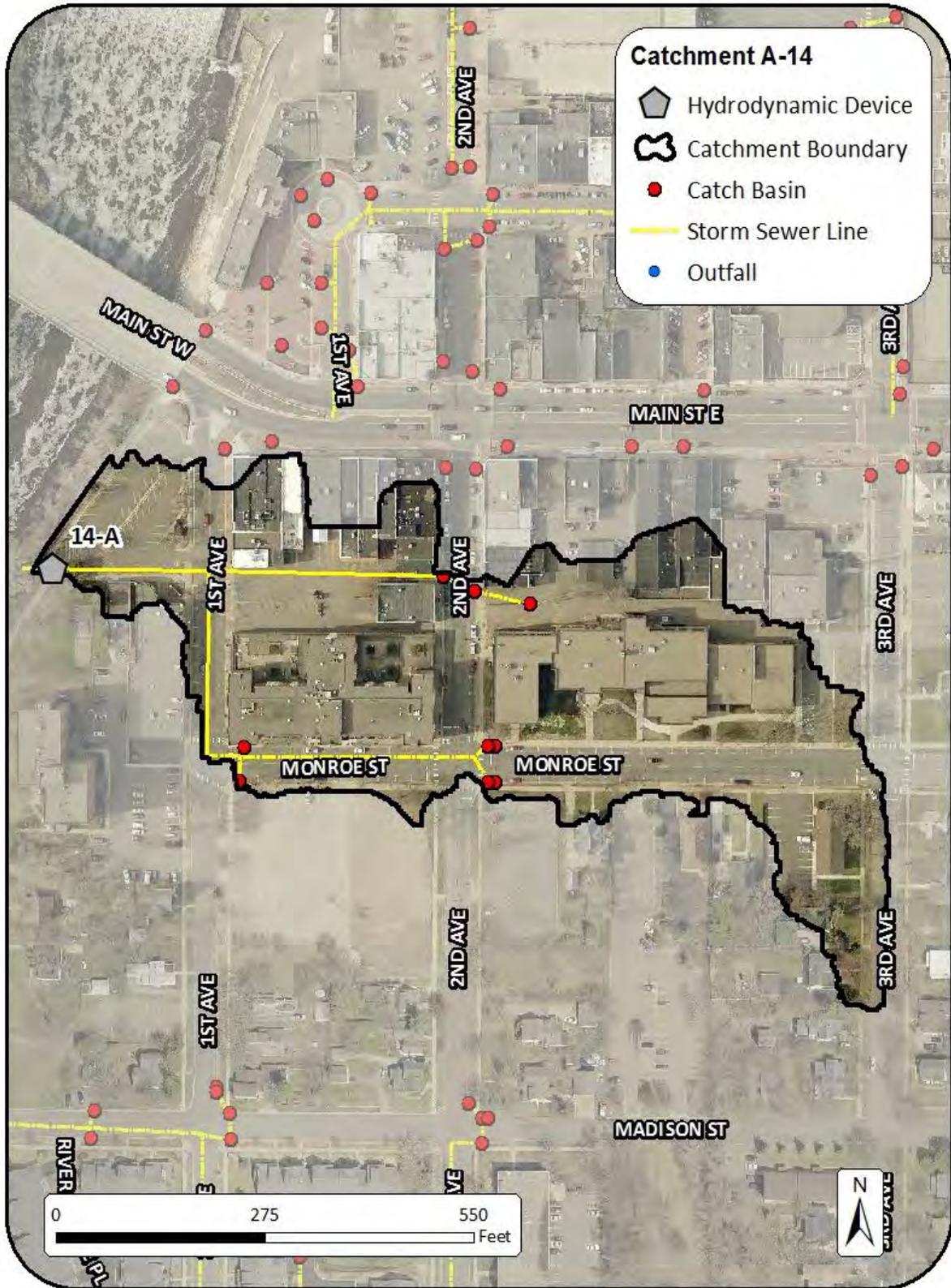
PROPOSED RETROFITS OVERVIEW

A single hydrodynamic device was proposed upstream of the outfall to the Rum River. If properly designed and installed, this structure should be able to treat nearly all of the surficial area of this catchment.

RETROFITS CONSIDERED BUT REJECTED

Bioretention practices, specifically boulevard bioswales, were considered but were not proposed as insufficient space exists within boulevards of this catchment to accommodate a practice. Due to the limited space, subsurface practices were instead proposed.

RETROFIT RECOMMENDATIONS



Project ID: 14-A

1st Avenue.
Hydrodynamic Device

Drainage Area – 7.8 acres
Location – Parking lot off 1st Avenue
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed for the parking lot west of 1st Avenue and south of Main Street. This device would accept and treat runoff from the entire catchment.



Hydrodynamic Device				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMPs		10 ft diameter	
	TP (lb/yr)	0.8		12.5%
	TSS (lb/yr)	385		14.6%
	Volume (acre-feet/yr)	0.0		0.0%
Cost	Administration & Promotion Costs*			\$1,752
	Design & Construction Costs**			\$108,000
	Total Estimated Project Cost (2016)			\$109,752
	Annual O&M***			\$630
Efficiency	30-yr Average Cost/lb-TP		\$5,361	
	30-yr Average Cost/1,000lb-TSS		\$11,139	
	30-yr Average Cost/ac-ft Vol.		N/A	

*Indirect Cost: (24 hours at \$73/hour)

**Direct Cost: (\$72,000 for materials) + (\$36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Catchment A-15

Existing Catchment Summary	
Acres	275.9
Dominant Land Cover	Residential
Parcels	845
Volume (acre-feet/yr)	131.8
TP (lb/yr)	125.3
TSS (lb/yr)	38,609

CATCHMENT DESCRIPTION

Catchment A-15 is the largest catchment in the southern drainage network, extending from the Coon Rapids municipal boundary in the east to the Rum River in the west and from Main Street in the north to Southview Road in the south. The catchment is predominantly single-family residential, but includes larger publically-owned parcels such as the Anoka High School football field, Middle School for the Arts, and Aquatic Center and privately owned multifamily developments.



Stormwater runoff generated within the catchment is collected quickly from street catch basins and conveyed to the Rum River. The catchment includes areas of downtown Anoka south of Main St. along 1st Avenue, 2nd Avenue, 3rd Avenue, and Monroe Street. The catchment includes all geographic areas draining to an outfall along the Rum River about 200' south of Main Street. Stormwater runoff is primarily overland east of 2nd Avenue, but is then collected through a series of municipal storm sewer pipes, and discharged at the Rum River outfall west of 1st Avenue.

EXISTING STORMWATER TREATMENT

Stormwater runoff generated within the catchment is collected quickly from roadway catch basins and conveyed to a stormwater treatment system on Adams Street west of 2nd Avenue. Upon entering the system stormwater is first passed through a grit chamber, which is a series of baffles and trash racks acting as sedimentation cells. Once through this structure stormwater is discharged into a retention pond, which subsequently outlets into the Rum River. The only other form of stormwater treatment in this catchment is street cleaning, conducted two times per year by the City of Anoka. Present-day stormwater pollutant loading and treatment is summarized in the table below.

<i>Existing Conditions</i>		Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	5			
	BMP Types	3 Hydrodynamic Devices, 1 Pond, Street Cleaning			
	TP (lb/yr)	163.3	38.0	23%	125.3
	TSS (lb/yr)	54,890	16,281	30%	38,609
	Volume (acre-feet/yr)	134.6	2.8	2%	131.8

PROPOSED RETROFITS OVERVIEW

Infiltration practices were pursued in areas outside of the Drinking Water Supply Management Areas. Up to ten curb-cut rain gardens were proposed in the residential neighborhood east of 5th Avenue and south of Jefferson Street. This neighborhood was chosen due to its sandy soils, relatively small slopes, and older infrastructure. Recent roadway improvements to the north increased the density of catch basins, which can make curb-cut rain garden projects less beneficial by decreasing potential drainage areas.

A pair of hydrodynamic devices were proposed along tertiary storm sewer lines on 5th Avenue and Jefferson Street. Drainage areas to each of these devices were kept below ten acres to limit peak stormwater volume discharge to each device as high flows can promote the resuspension of accumulated sediment.

RETROFITS CONSIDERED BUT REJECTED

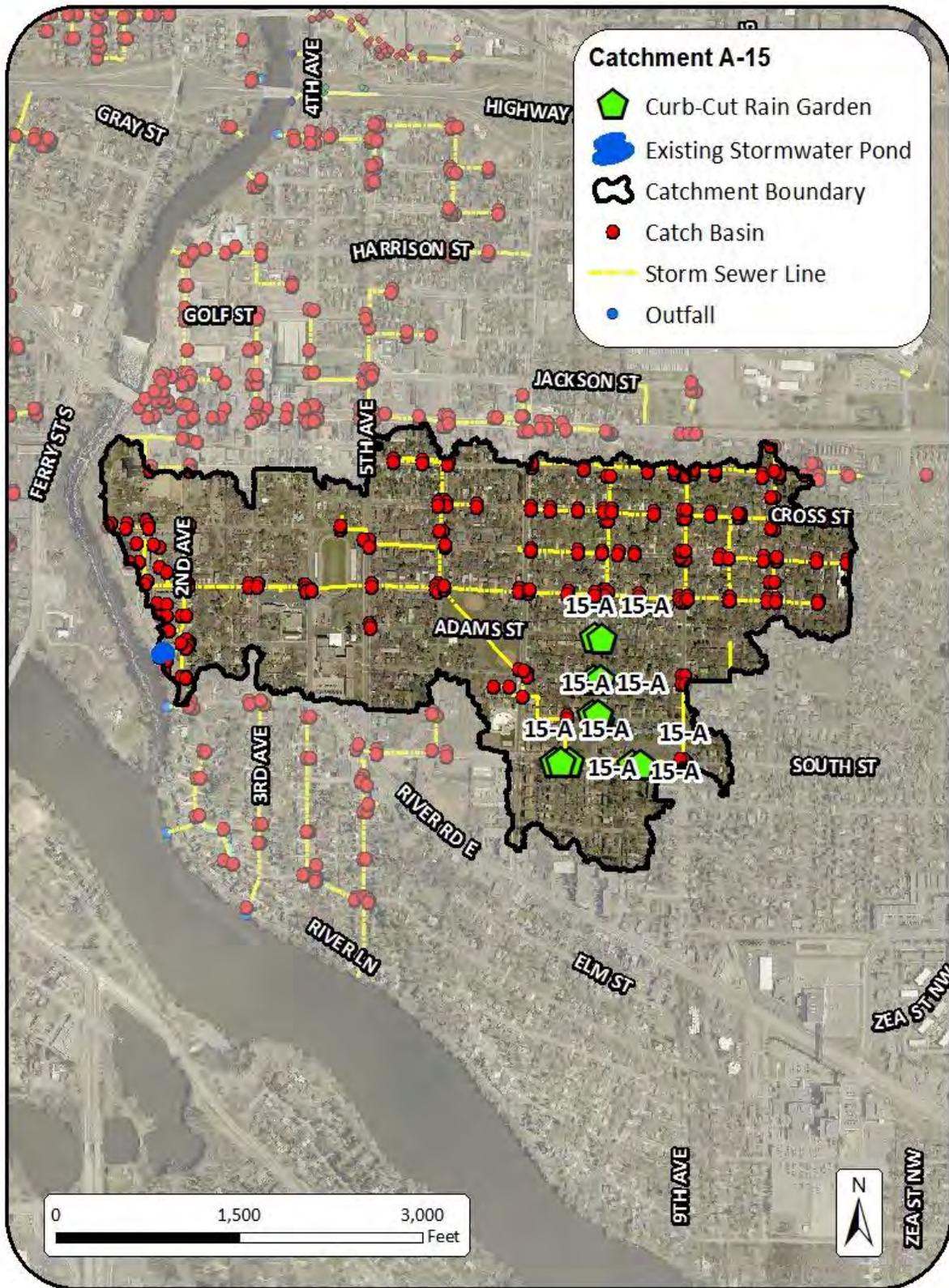
Permeable pavement opportunities sited at public, school, and church properties throughout the Adams Street catchment were removed due to the risk of contamination to local groundwater resources. The Minnesota Department of Health Wellhead Protection Area (WHPA) throughout most of the Adams Street catchment has a high risk for aquifer vulnerability. Because long-term paved parking areas can be sources for heavy metals, hydrocarbons, and road salt this location was removed as a potential area for an infiltration practice such as permeable pavement.

Similarly, underground infiltration practices located at two city-owned properties (the baseball fields west of 7th Avenue and north of Brisbin Street, and the open green space east of 7th Avenue and north of South Street) were removed from consideration because of their location relative to the WHPA within an area of high groundwater vulnerability.

A pair of hydrodynamic devices were also proposed along tertiary storm sewer lines on 5th Avenue and Jefferson Street. Drainage areas to each of these devices were kept below ten acres to limit peak stormwater volume discharge to each device as high flows can promote the resuspension of accumulated sediment. However, after modeling these devices showed to remove minimal TP and TSS.

Lastly, a stormwater reuse practice on the high school football field was also excluded from consideration as increased infiltration at this site from repurposed stormwater would likely require filtering and tertiary treatment that would deem the practice cost-prohibitive. Because this practice also lies within the Emergency Response Area (area where time of travel for infiltrated water from the ground surface to the aquifer is within 1 year) the installation of any infiltration practice is not recommended.

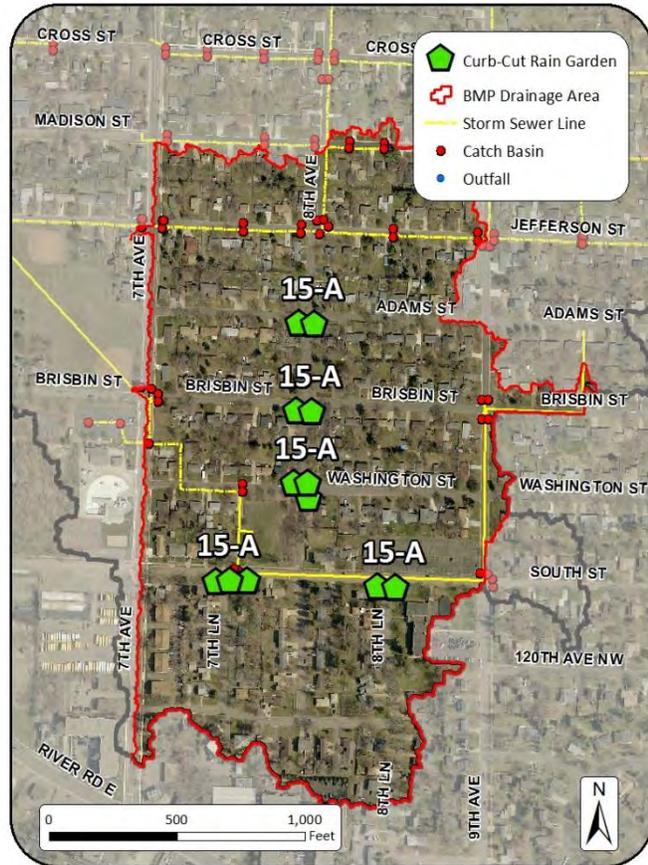
RETROFIT RECOMMENDATIONS



Project ID: 15-A

Curb-Cut Rain Gardens

Drainage Area – 1.5 – 15 acres
Location – Various locations in southeastern portion of catchment
Property Ownership – Private
Site Specific Information – Single-family lots in the catchment provide various locations for curb-cut rain gardens to treat stormwater pollutants originating from private property. Considering typical landowner participation rates, scenarios with one, five, and ten rain gardens were analyzed to treat the drainage area.



Curb-Cut Rain Garden									
Cost/Removal Analysis		New Treatment		% Reduction		New Treatment		% Reduction	
Treatment	Number of BMPs	1		5		10			
	Total Size of BMPs	250	sq-ft	1,250	sq-ft	2,500	sq-ft		
	TP (lb/yr)	0.4	0.4%	2.2	1.8%	4.4	3.5%		
	TSS (lb/yr)	135	0.3%	671	1.7%	1,343	3.5%		
	Volume (acre-feet/yr)	0.4	0.3%	1.9	1.4%	3.7	2.8%		
Cost	Administration & Promotion Costs*	\$8,468		\$11,972		\$16,352			
	Design & Construction Costs**	\$7,376		\$36,880		\$73,760			
	Total Estimated Project Cost (2016)	\$15,844		\$48,852		\$90,112			
	Annual O&M***	\$225		\$1,125		\$2,250			
Efficiency	30-yr Average Cost/lb-TP	\$1,883		\$1,252		\$1,194			
	30-yr Average Cost/1,000lb-TSS	\$5,579		\$4,103		\$3,912			
	30-yr Average Cost/ac-ft Vol.	\$1,931		\$1,480		\$1,413			

*Indirect Cost: (104 hours at \$73/hour base cost) + (12 hours/BMP at \$73/hour)
 **Direct Cost: (\$26/sq-ft for materials and labor) + (12 hours/BMP at \$73/hour for design)
 ***Per BMP: (\$150/year for rehabilitations at years 10 and 20) + (\$75/year for routine maintenance)

Catchment A-16

Existing Catchment Summary	
Acres	6.7
Dominant Land Cover	Residential
Parcels	19
Volume (acre-feet/yr)	2.8
TP (lb/yr)	3.8
TSS (lb/yr)	1,066



CATCHMENT DESCRIPTION

Catchment A-16 is defined by all of the geographical area draining stormwater to the Washington Street outfall. This outfall collects stormwater from a single storm sewer line located at the intersection of Oakwood Drive and Washington Street and discharges it into the Rum River 150' west of the intersection. This catchment is the smallest in the southern network and provides drainage from less than 20 single family residential properties. Soils within the historic Rum River floodplain (along and west of Oakwood Drive) are sandy loams, while soils east of Oakwood Drive are predominantly coarse and sandy.

EXISTING STORMWATER TREATMENT

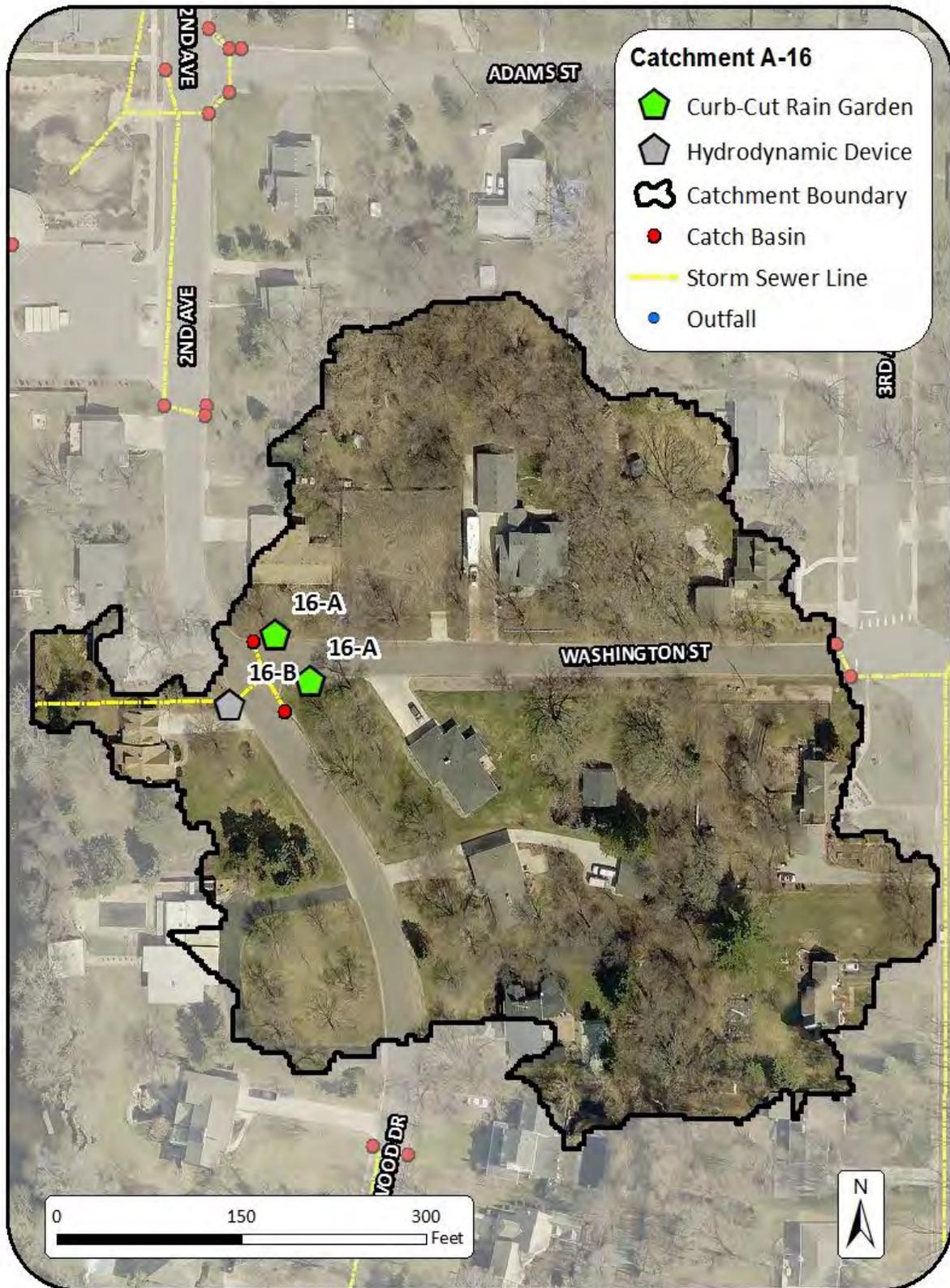
The only form of stormwater treatment in this catchment is street cleaning, conducted two times per year by the City of Anoka. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	4.1	0.3	7%	3.8
	TSS (lb/yr)	1,208	142	12%	1,066
	Volume (acre-feet/yr)	2.8	0.0	0%	2.8

PROPOSED RETROFITS OVERVIEW

A hydrodynamic device and a pair of curb-cut rain gardens are proposed to provide treatment to stormwater prior to discharge to the Rum River. The curb-cut rain gardens are proposed just upstream of catch basins to maximize drainage area to each basin. The hydrodynamic device should be installed such that it treats all catch basins at the Oakwood Drive and Washington Street intersection.

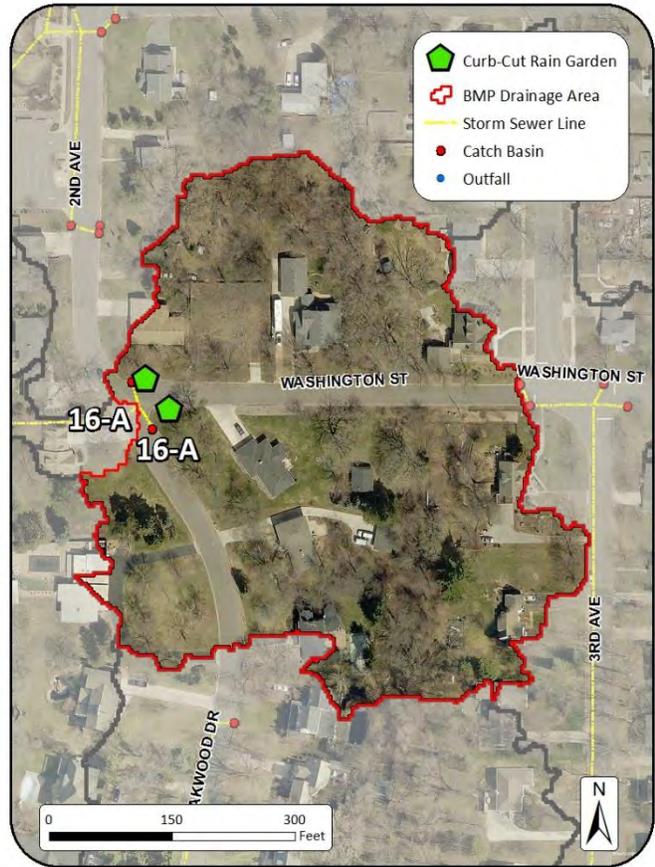
RETROFIT RECOMMENDATIONS



Project ID: 16-A

Washington St. Curb-Cut Rain Gardens

Drainage Area – 1.5 – 3 acres
Location – Washington Street and Oakwood Drive
Property Ownership – Private
Site Specific Information – Single-family lots in the catchment provide locations for curb-cut rain gardens to treat stormwater pollutants originating from private property. Preferably the rain gardens would be placed on private properties at the western end of Washington Street at Oakwood Drive in order to treat a larger drainage area. Considering typical landowner participation rates, scenarios with one and two rain gardens were analyzed to treat the drainage area.



Curb Cut Rain Garden					
Cost/Removal Analysis		New Treatment		% Reduction	
Treatment	Number of BMPs	1		2	
	Total Size of BMPs	250 sq-ft		500 sq-ft	
	TP (lb/yr)	0.5	13.2%	1.0	26.3%
	TSS (lb/yr)	157	14.7%	315	29.5%
	Volume (acre-feet/yr)	0.4	13.9%	0.8	27.8%
Cost	Administration & Promotion Costs*	\$1,606		\$2,482	
	Design & Construction Costs**	\$7,376		\$14,752	
	Total Estimated Project Cost (2016)	\$8,982		\$17,234	
	Annual O&M***	\$225		\$450	
Efficiency	30-yr Average Cost/lb-TP	\$1,049		\$1,024	
	30-yr Average Cost/1,000lb-TSS	\$3,340		\$3,252	
	30-yr Average Cost/ac-ft Vol.	\$1,369		\$1,339	

*Indirect Cost: (10 hours at \$73/hour base cost) + (12 hours/BMP at \$73/hour)

**Direct Cost: (\$26/sq-ft for materials and labor) + (12 hours/BMP at \$73/hour for design)

***Per BMP: (\$150/year for rehabilitations at years 10 and 20) + (\$75/year for routine maintenance)

Project ID: 16-B

Oakwood Dr. & Washington St.
Hydrodynamic Device

Drainage Area – 6.3 acres
Location –Oakwood Drive and Washington Street
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed for Oakwood Drive at Washington Street. A device at this location would capture and treat runoff from almost the entire catchment. The catchment is composed of all residential properties.



Hydrodynamic Device				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMPs		10	ft diameter
	TP (lb/yr)	0.4		10.5%
	TSS (lb/yr)	163		15.3%
	Volume (acre-feet/yr)	0.0		0.0%
Cost	Administration & Promotion Costs*			\$1,752
	Design & Construction Costs**			\$108,000
	Total Estimated Project Cost (2016)			\$109,752
	Annual O&M***			\$630
Efficiency	30-yr Average Cost/lb-TP		\$10,721	
	30-yr Average Cost/1,000lb-TSS		\$26,309	
	30-yr Average Cost/ac-ft Vol.		N/A	

*Indirect Cost: (24 hours at \$73/hour)

**Direct Cost: (\$72,000 for materials) + (\$36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

Catchment A-17

Existing Catchment Summary	
Acres	12.5
Dominant Land Cover	Residential
Parcels	32
Volume (acre-feet/yr)	5.3
TP (lb/yr)	7.4
TSS (lb/yr)	2,066



CATCHMENT DESCRIPTION

Catchment A-17 is the southernmost catchment in this analysis. Stormwater generated within the catchment drains to municipal storm sewer lines along Oakwood Drive and Oakwood Lane and is conveyed to an outfall which discharges near the confluence of the Rum River with the Mississippi River. Land use within the catchment is solely single family residential. Soils transition from coarse and sandy Hubbard soils in the east to silty loam Becker soils in the west.

EXISTING STORMWATER TREATMENT

The only existing BMP in this catchment is street cleaning, which is conducted two times per year by the City of Anoka. Present-day stormwater pollutant loading and treatment is summarized in the table below.

	<i>Existing Conditions</i>	Base Loading	Treatment	Net Treatment %	Existing Loading
<i>Treatment</i>	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	8.0	0.6	8%	7.4
	TSS (lb/yr)	2,334	268	11%	2,066
	Volume (acre-feet/yr)	5.3	0.0	0%	5.3

PROPOSED RETROFITS OVERVIEW

A single hydrodynamic device was proposed along the Oakwood Drive storm sewer line. Installation of this device should try to include drainage from each of the catch basins within Catchment A-17 along Oakwood Drive.

RETROFITS CONSIDERED BUT REJECTED

Bioretention basins, specifically curb-cut rain gardens, were considered in this catchment but were not proposed as the drainage area to each basin was not enough to offset the cost of installation, making the practice cost-prohibitive.

Project ID: 17-A
 Oakwood Drive
 Hydrodynamic Device

Drainage Area – 11.9 acres
Location –Oakwood Drive and Oakwood Lane
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed for Oakwood Drive. A device at this location would capture and treat runoff from almost the entire catchment. The catchment is composed of all residential properties.



Hydrodynamic Device				
		Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs		1	
	Total Size of BMPs		10 ft diameter	
	TP (lb/yr)		0.6	8.1%
	TSS (lb/yr)		244	11.8%
	Volume (acre-feet/yr)		0.0	0.0%
Cost	Administration & Promotion Costs*			\$1,752
	Design & Construction Costs**			\$108,000
	Total Estimated Project Cost (2016)			\$109,752
	Annual O&M***			\$630
Efficiency	30-yr Average Cost/lb-TP		\$7,147	
	30-yr Average Cost/1,000lb-TSS		\$17,575	
	30-yr Average Cost/ac-ft Vol.		N/A	

*Indirect Cost: (24 hours at \$73/hour)

**Direct Cost: (\$72,000 for materials) + (\$36,000 for labor and installation costs)

***Per BMP: (3 cleanings/year)*(3 hours/cleaning)*(\$70/hour)

References

- Erickson, A.J., and J.S. Gulliver. 2010. *Performance Assessment of an Iron-Enhanced Sand Filtration Trench for Capturing Dissolved Phosphorus*. University of Minnesota St. Anthony Falls Laboratory Engineering, Environmental and Geophysical Fluid Dynamics Project Report No. 549. Prepared for the City of Prior Lake, Prior Lake, MN.
- Minnesota Pollution Control Agency (MPCA). 2014. *Design Criteria for Stormwater Ponds*. Web.
- New York City Environmental Protection. 2013. *NYC Green Infrastructure 2013 Annual Report*. 36 pp.
- Schueler, T. and A. Kitchell. 2005. *Methods to Develop Restoration Plans for Small Urban Watersheds. Manual 2, Urban Subwatershed Restoration Manual Series*. Center for Watershed Protection. Ellicott City, MD.
- Schueler, T., D. Hirschman, M. Novotney, and J. Zielinski. 2007. *Urban Stormwater Retrofit Practices. Manual 3, Urban Subwatershed Restoration Manual Series*. Center for Watershed Protection. Ellicott City, MD.
- Weiss, P.T., J.S. Gulliver, A.J. Erickson. 2005. *The Cost and Effectiveness of Stormwater Management Practices*. Minnesota Department of Transportation.

Appendix A – Modeling Methods

The following sections include WinSLAMM model details for each type of best management practice modeled for this analysis.

WinSLAMM

Pollutant and volume reductions were estimated using the stormwater model Source Load and Management Model for Windows (WinSLAMM). WinSLAMM uses an abundance of stormwater data from the Upper-Midwest and elsewhere to quantify runoff volumes and pollutant loads from urban areas. It has detailed accounting of pollutant loading from various land uses, and allows the user to build a model “landscape”. WinSLAMM uses rainfall and temperature data from a typical year (1959 data from Minneapolis for this analysis), routing stormwater through the user’s model for each storm. WinSLAMM version 10.2.0 was used for this analysis to estimate volume and pollutant loading and reductions. Additional inputs for WinSLAMM are provided in Table 10.

Table 10: General WinSLAMM Model Inputs (i.e. Current File Data)

Parameter	File/Method
Land use acreage	ArcMap, Metropolitan Council 2010 Land Use
Precipitation/Temperature Data	Minneapolis 1959 – best approximation of a typical year
Winter season	Included in model. Winter dates are 11-4 to 3-13.
Pollutant probability distribution	WI_GEO01.ppd
Runoff coefficient file	WI_SL06 Dec06.rsv
Particulate solids concentration file	WI_AVG01.psc
Particle residue delivery file	WI_DLV01.prr
Street delivery files	WI files for each land use

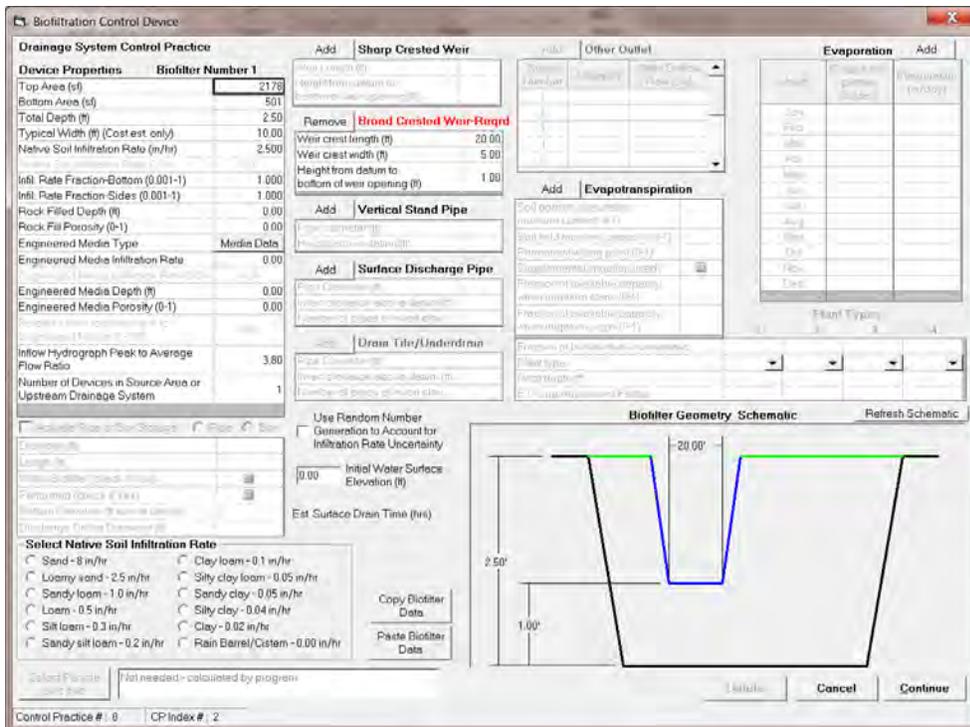


Figure 13: Infiltration Basin at Anoka Middle School for the Arts (Northern Basin) in A-13 (WinSLAMM).

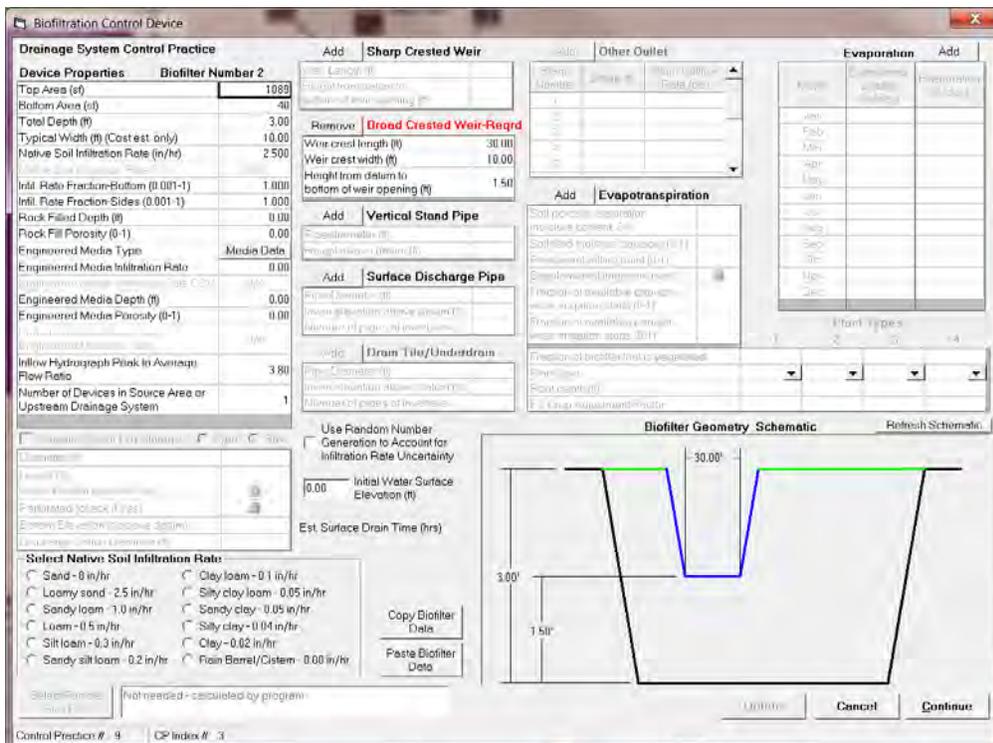


Figure 14: Infiltration Basin at Anoka Middle School for the Arts (Southern Basin) in A-13 (WinSLAMM).

Hydrodynamic Device

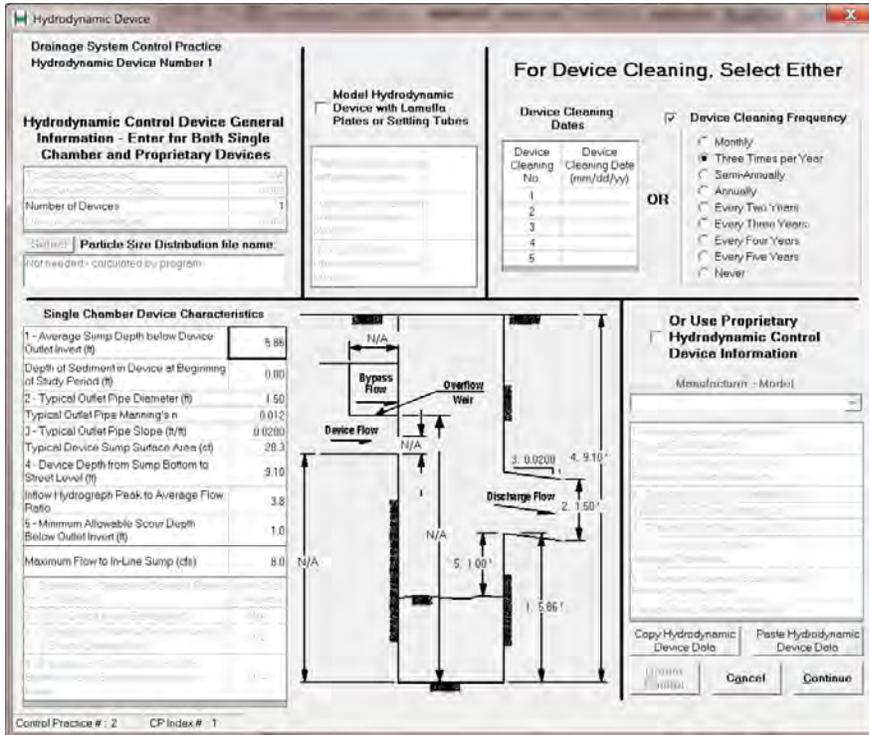


Figure 15: Hydrodynamic Device at Maple Avenue in A-2 (WinSLAMM).

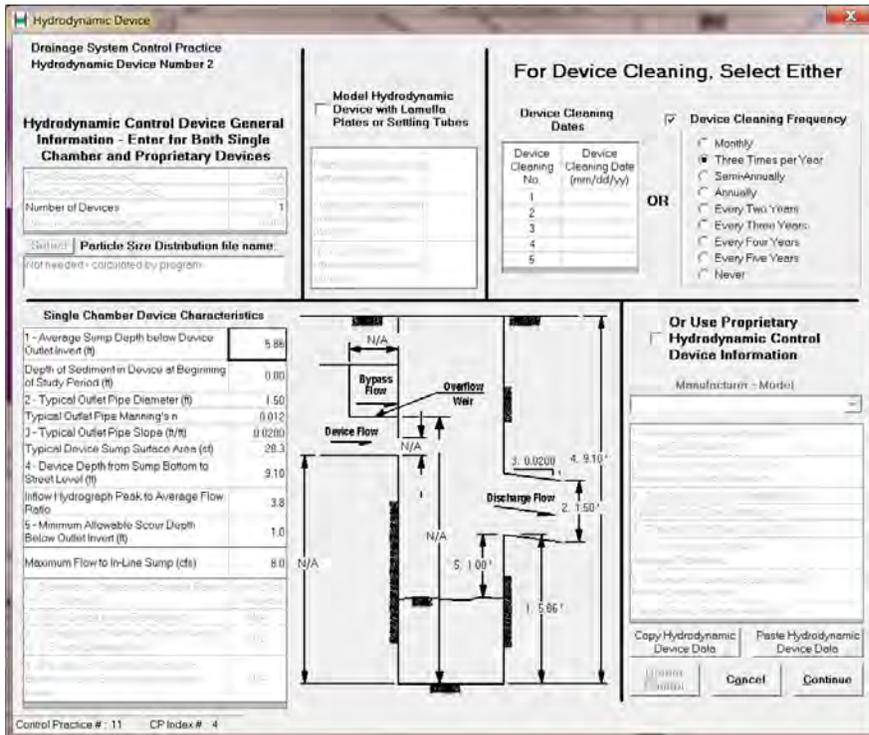


Figure 16: Hydrodynamic Device at Branch Avenue in A-3 (WinSLAMM).

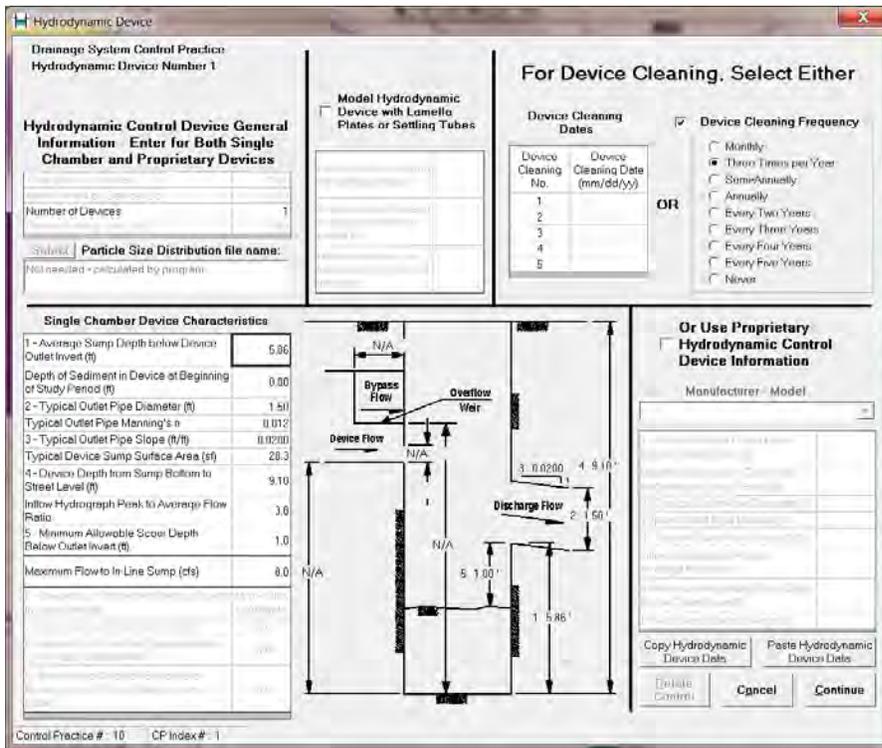


Figure 17: Hydrodynamic Device at Wingfield Alley in A-3 (WinSLAMM).

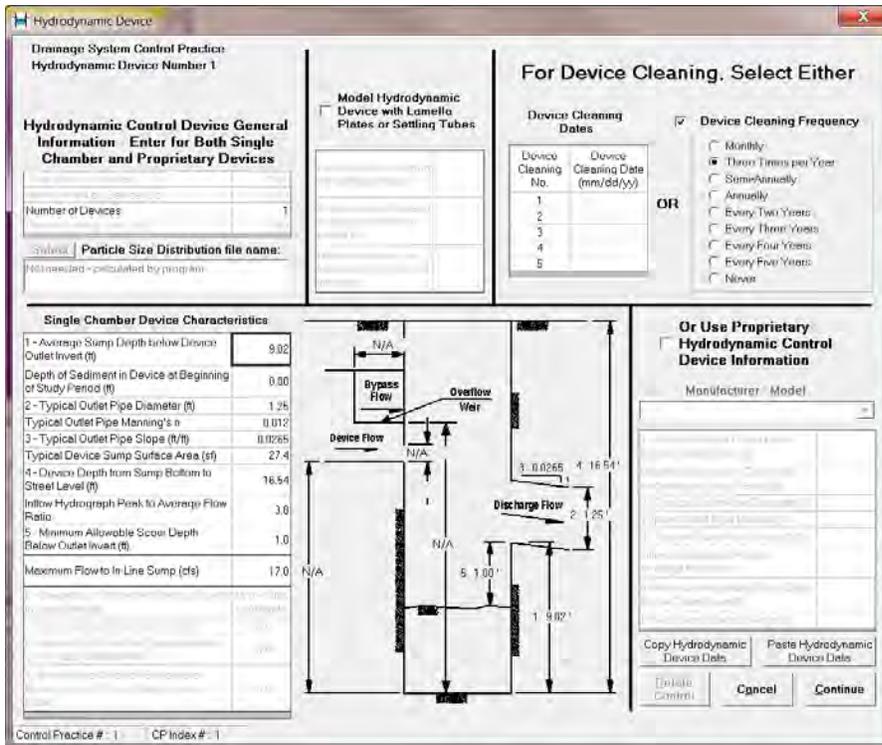


Figure 18: Hydrodynamic Device at Ferry Street in A-5 (WinSLAMM).

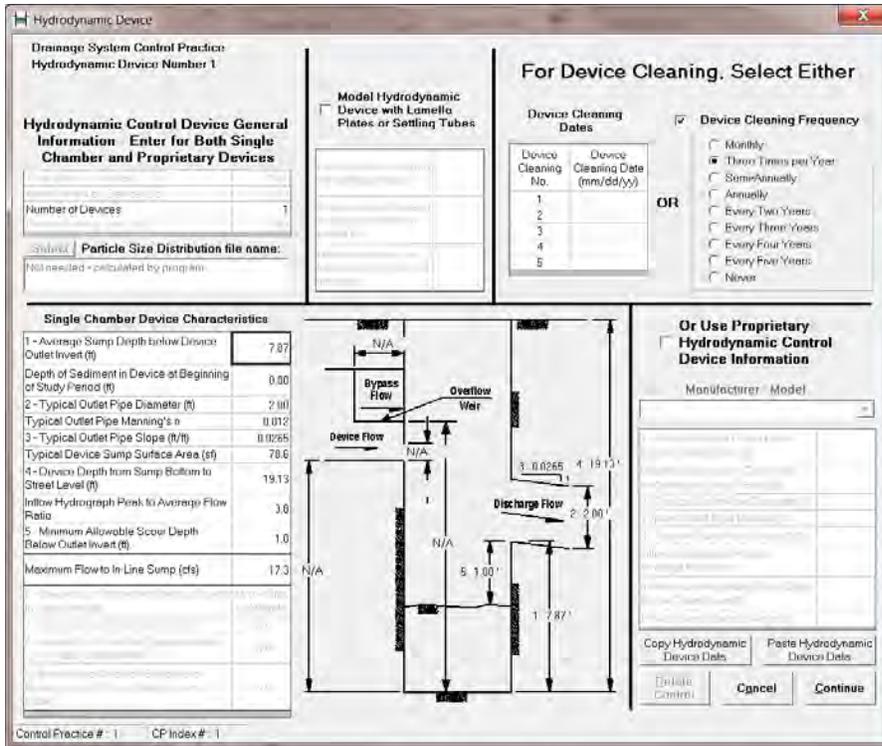


Figure 19: Hydrodynamic Device at Main Street in A-6 (WinSLAMM).

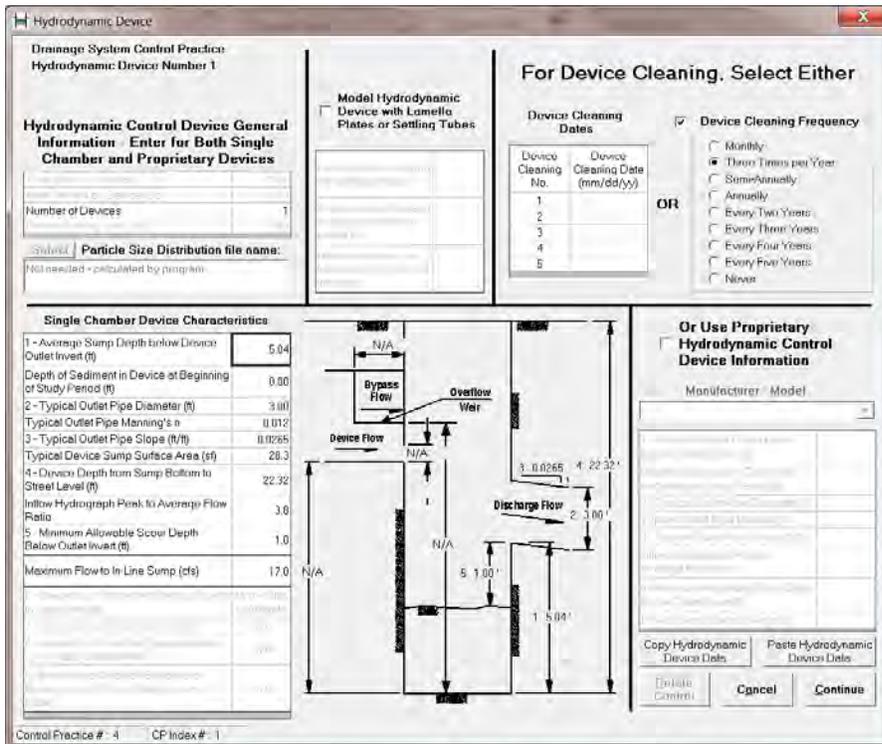


Figure 20: Hydrodynamic Device at Water Avenue and Taylor Street in A-10 (WinSLAMM).

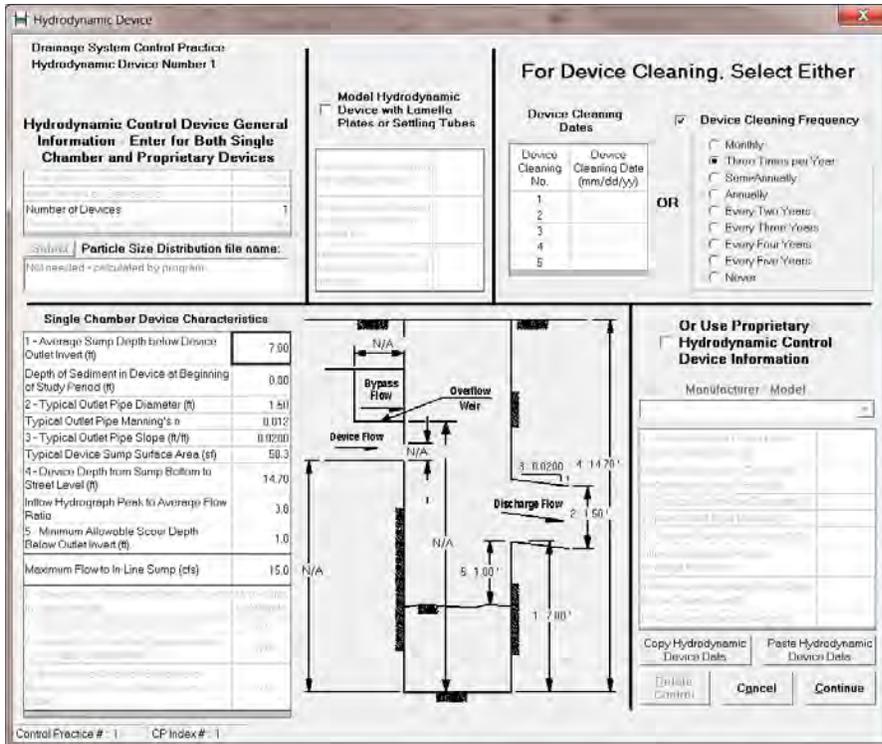


Figure 21: Hydrodynamic Device at Polk Street and 3rd Avenue in A-11 (WinSLAMM).

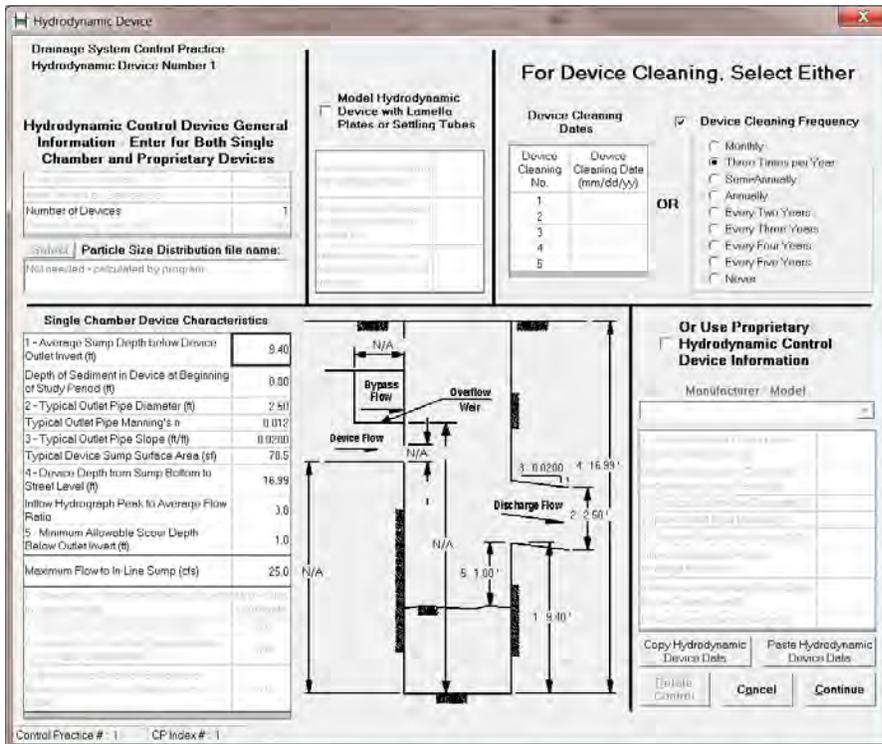


Figure 22: Hydrodynamic Device at Harrison Street and 2nd Avenue in A-12 (WinSLAMM).

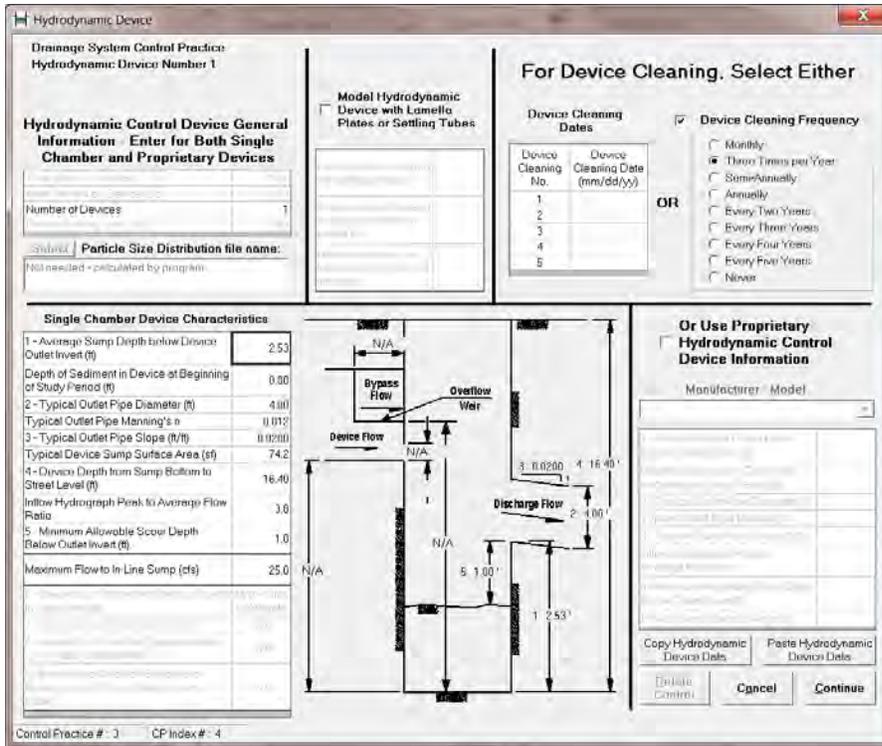


Figure 23: Hydrodynamic Device (1 of 3) at Adams Street and 2nd Avenue in A-15 (WinSLAMM).

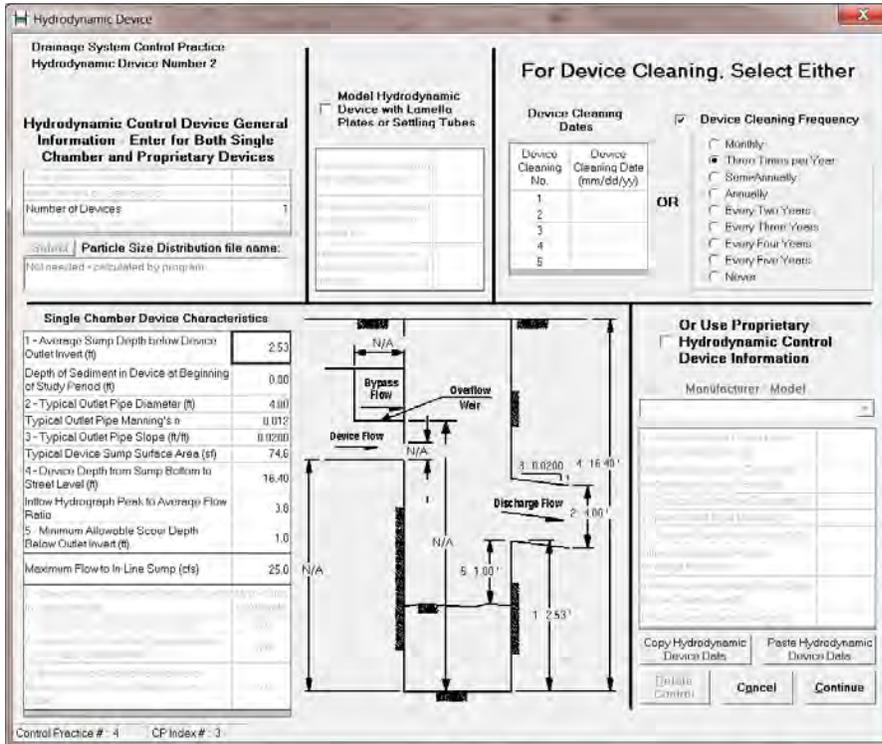


Figure 24: Hydrodynamic Device (2 of 3) at Adams Street and 2nd Avenue in A-15 (WinSLAMM).

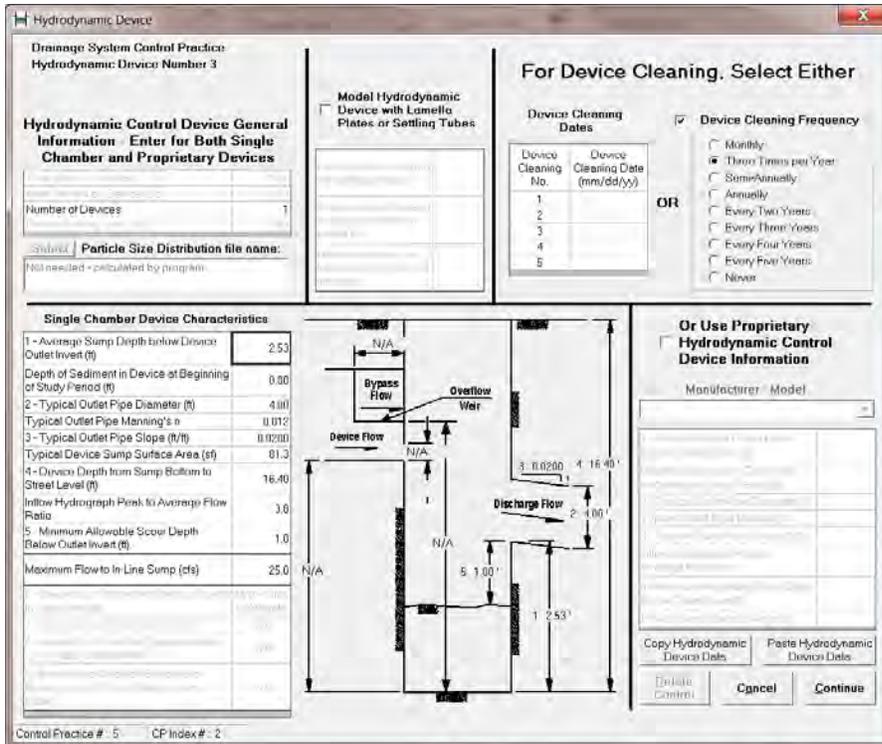


Figure 25: Hydrodynamic Device (3 of 3) at Adams Street and 2nd Avenue in A-15 (WinSLAMM).

Ponds

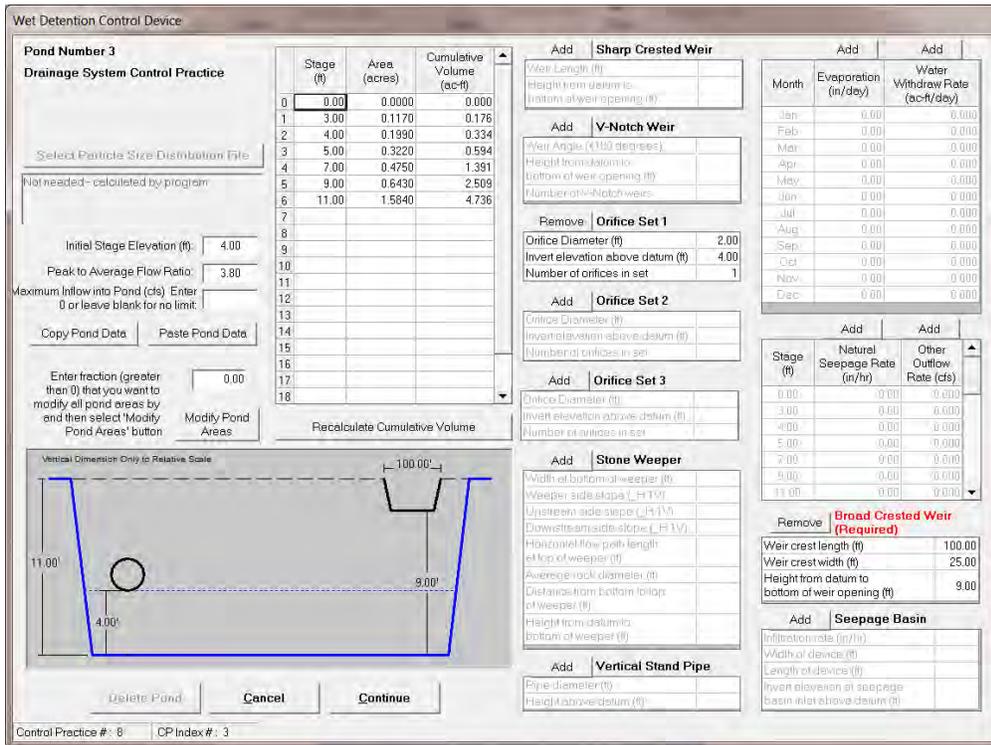


Figure 26: Stormwater Pond at Car Dealership in A-3 (WinSLAMM).

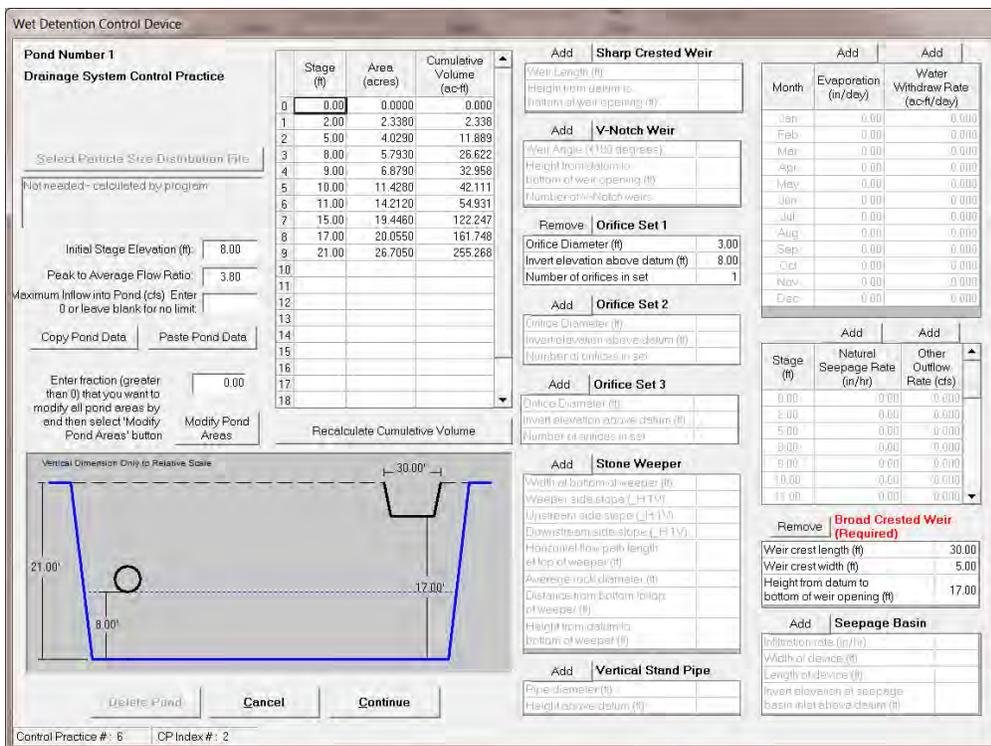


Figure 27: Stormwater Pond at Green Haven Golf Course in A-3 (WinSLAMM).

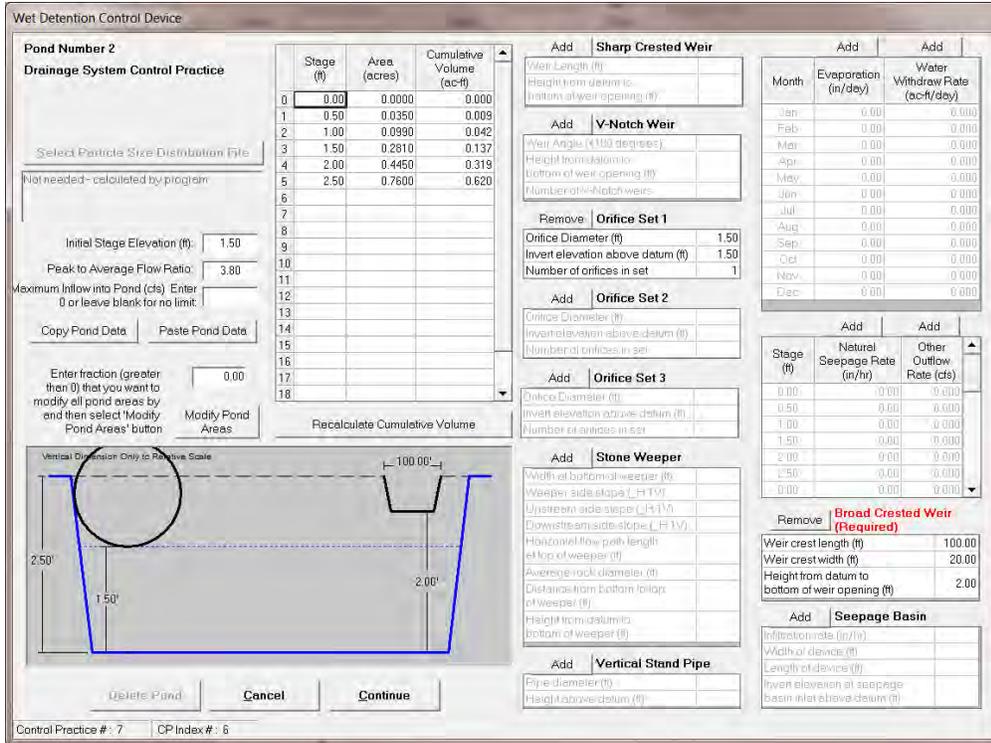


Figure 28: Stormwater Pond at Ward Park in A-3 (WinSLAMM).

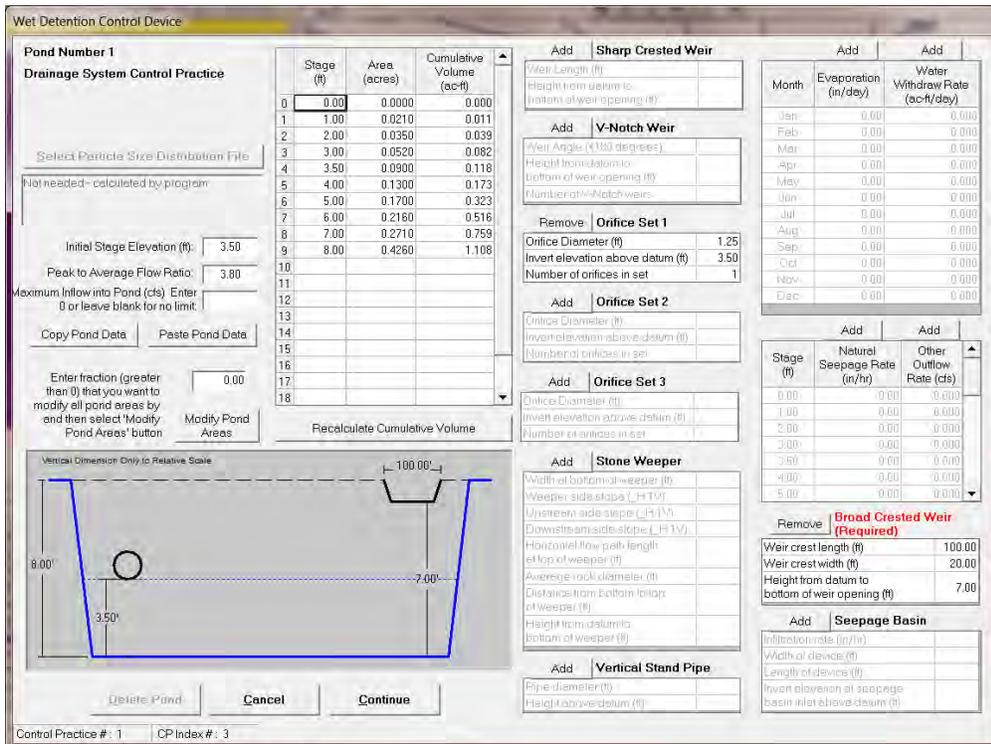


Figure 29: Stormwater Pond at 7th Avenue (NW) in A-7 (WinSLAMM).

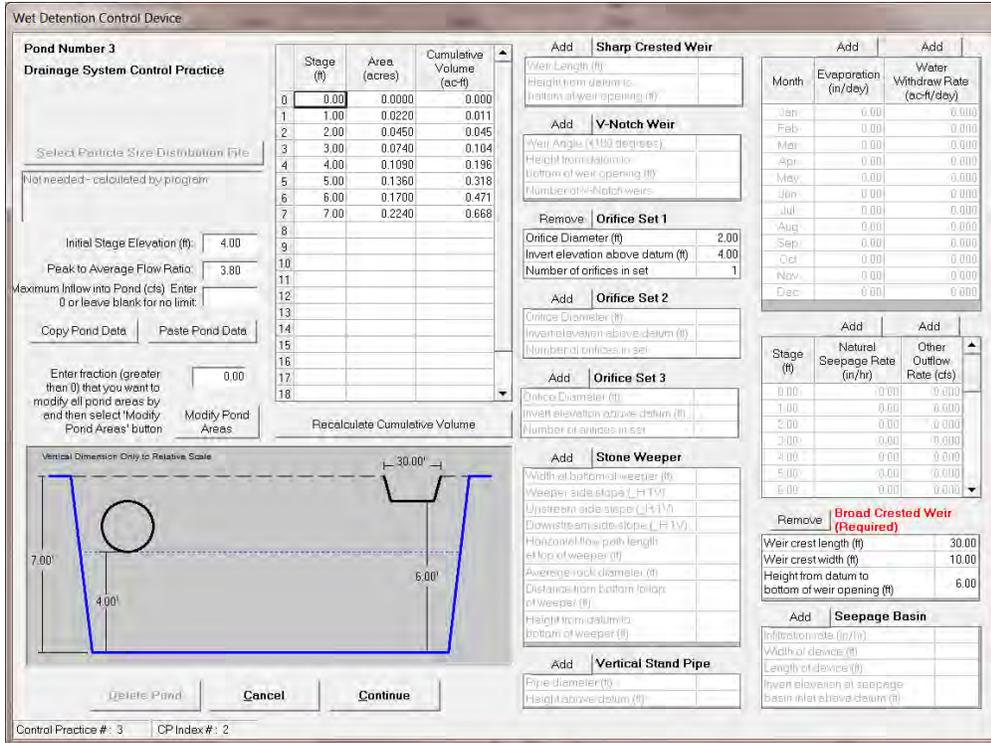


Figure 30: Stormwater Pond at 7th Avenue (SW) in A-7 (WinSLAMM).

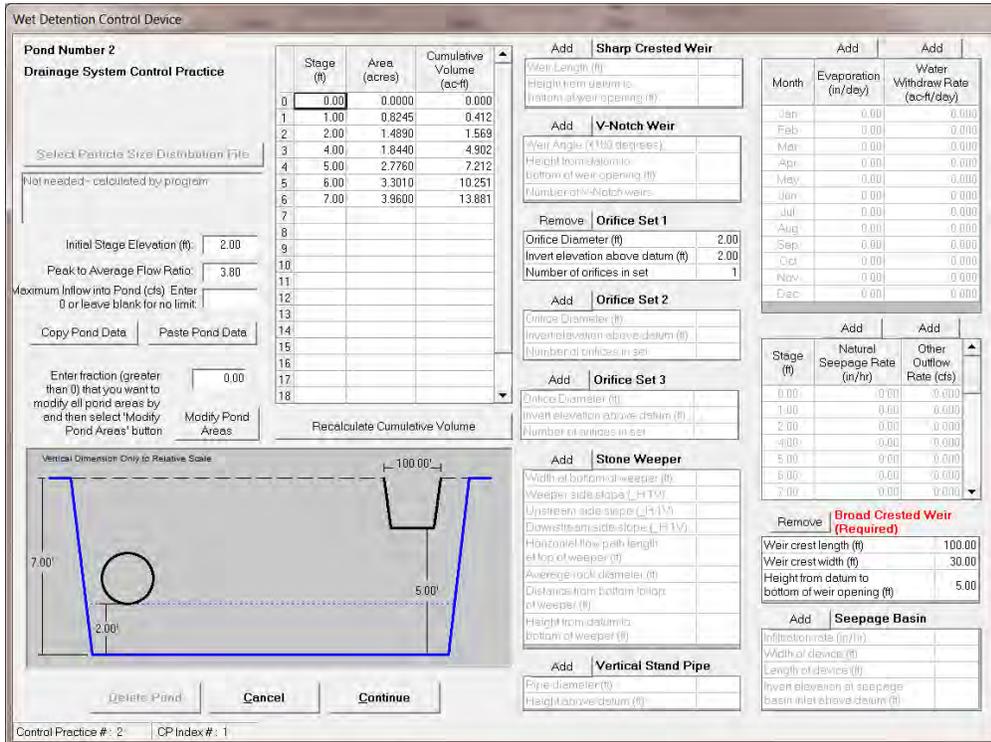


Figure 31: Stormwater Pond at Anoka Regional Treatment Center in A-7 (WinSLAMM).

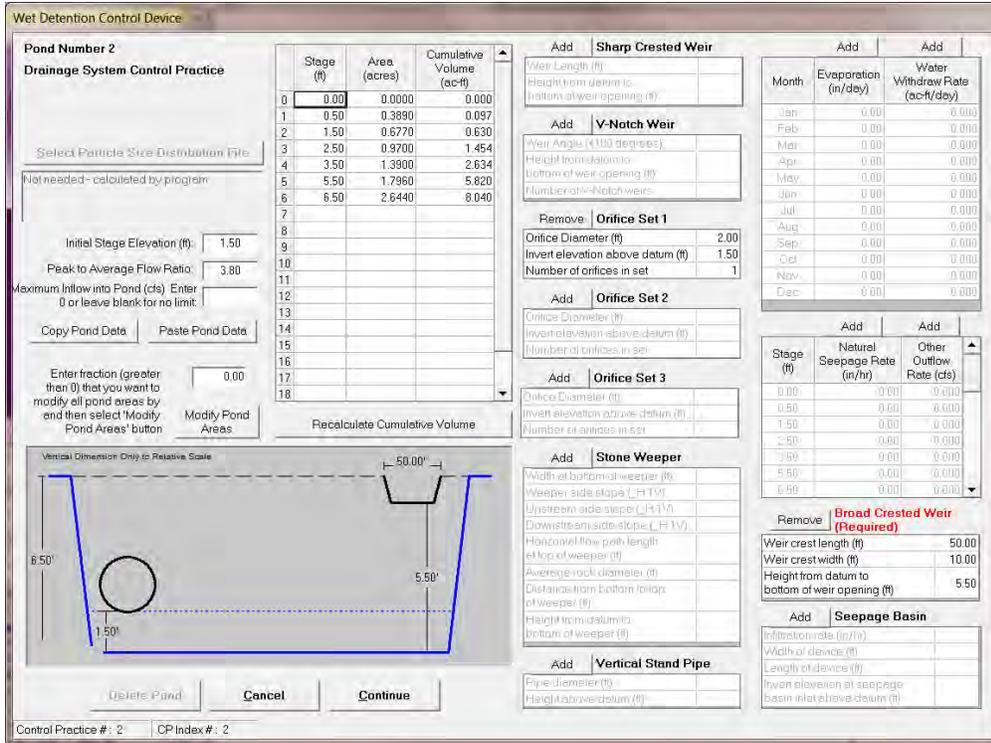


Figure 32: Stormwater Pond at Anoka Development in A-8 (WinSLAMM).

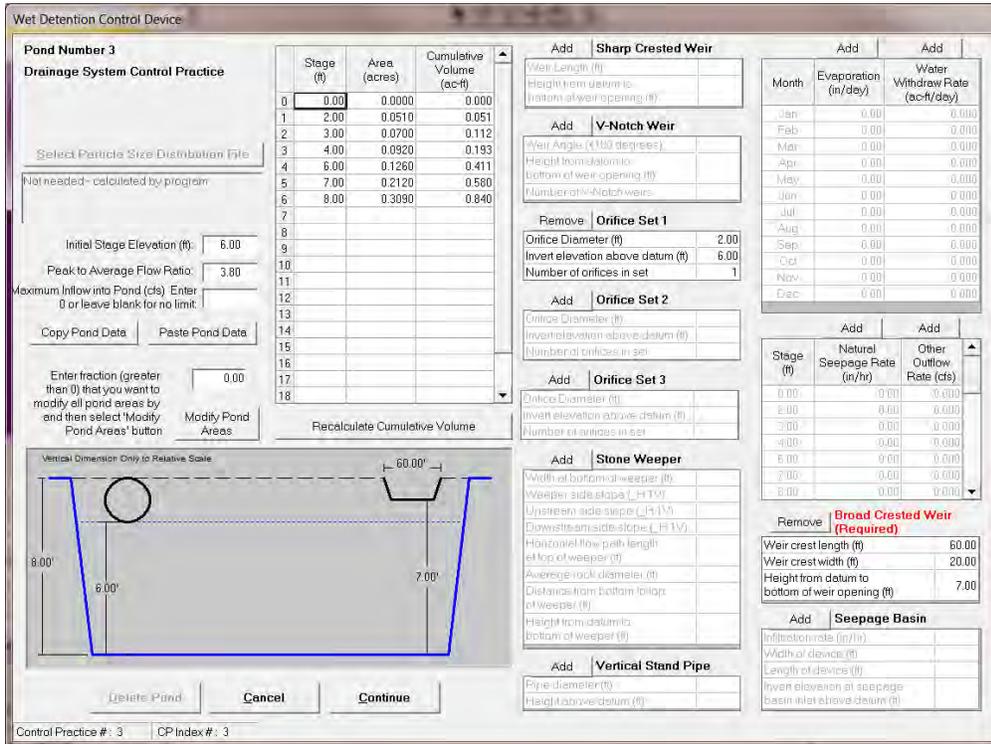


Figure 33: Stormwater Pond at The Homestead at Anoka in A-8 (WinSLAMM).

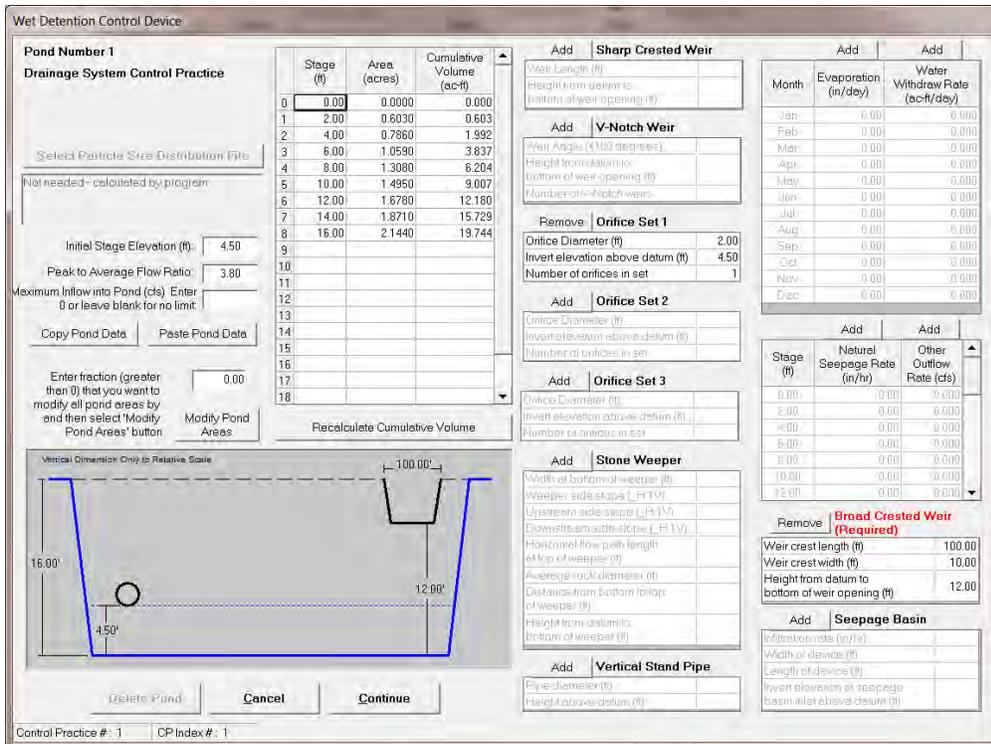


Figure 34: Stormwater Pond at 4th Avenue and Grant Street in A-8 (WinSLAMM).

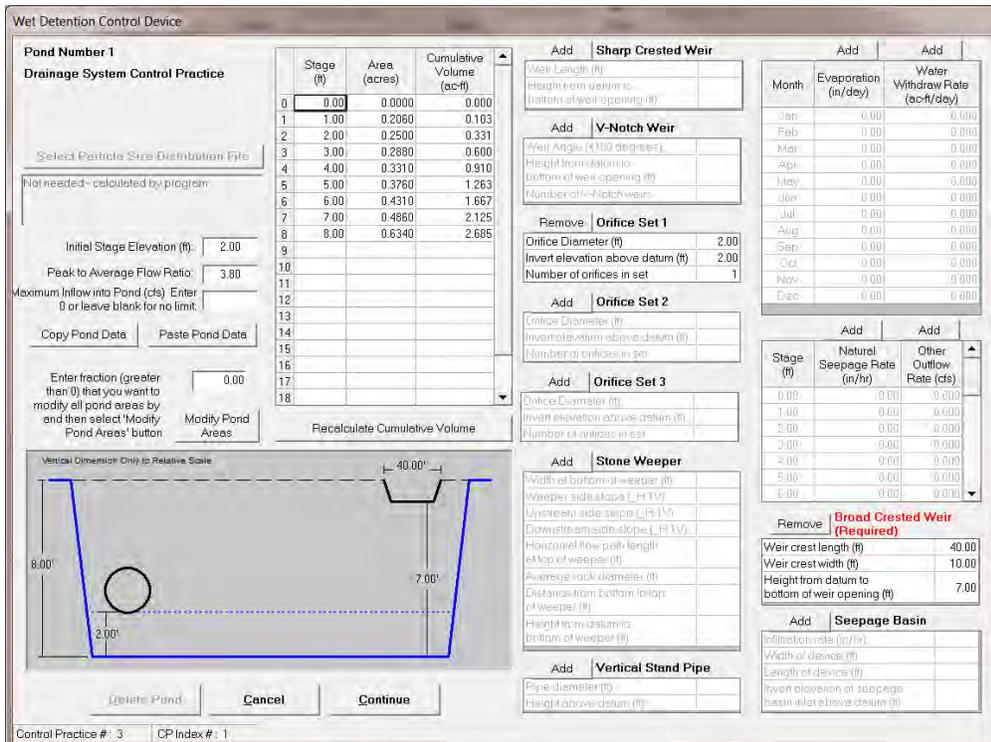


Figure 35: Stormwater Pond at Federal Cartridge Corporation parking lot in A-9 (WinSLAMM).

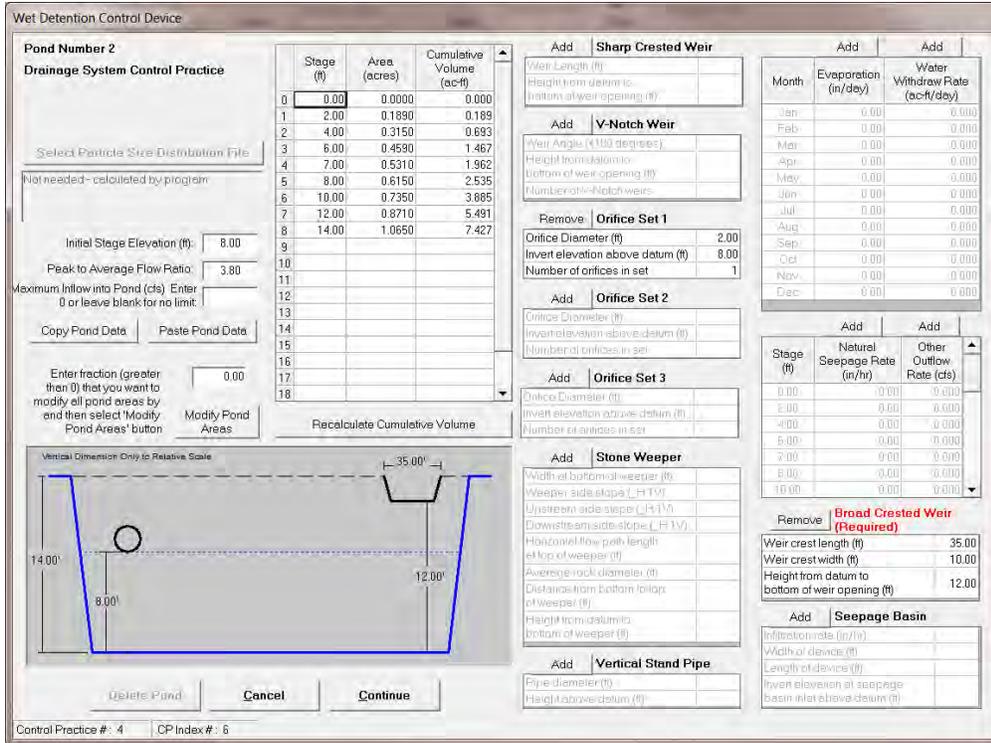


Figure 36: Stormwater Pond at Pentair Property in A-9 (WinSLAMM).

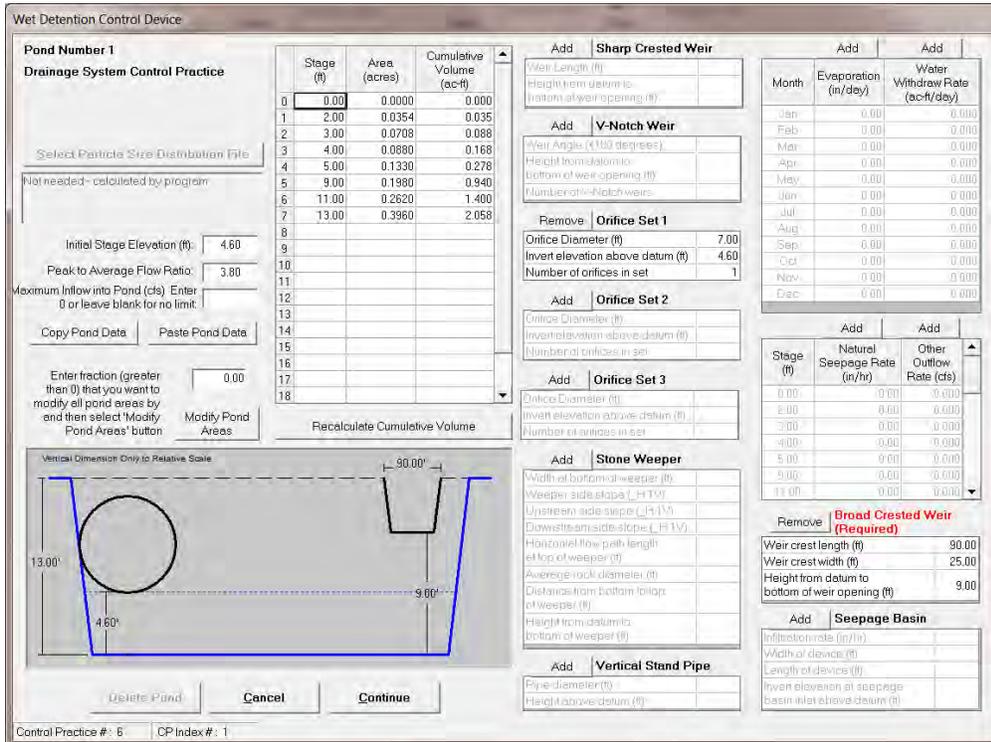


Figure 37: Stormwater Pond at Adams Street and 2nd Avenue in A-15 (WinSLAMM).

Street Cleaning

Street Cleaning Control Device

Land Use: Medium Density Res. No Alleys Total Area: 0.157 acres
 Source Area: Streets 1

First Source Area Control Practice

Select Street Cleaning Dates OR Street Cleaning Frequency

Line Number	Street Cleaning Date	Street Cleaning Frequency
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

7 Passes per Week
 5 Passes per Week
 4 Passes per Week
 3 Passes per Week
 2 Passes per Week
 One Pass per Week
 One Pass Every Two Weeks
 One Pass Every Four Weeks
 One Pass Every Eight Weeks
 One Pass Every Twelve Weeks
 Two Passes per Year (Spring and Fall)
 One Pass Each Spring

Model Run Start Date: 01/02/59 Model Run End Date: 12/28/59

Final cleaning period ending date (MM/DD/YY):

Selected Particle Size Distribution file name:
 Not needed - calculated by program

Type of Street Cleaner:
 Mechanical Broom Cleaner
 Vacuum Assisted Cleaner

Street Cleaner Productivity:
 1. Coefficients based on street texture, parking density and parking controls
 2. Other (specify equation coefficients)
 Equation coefficient M (slope, M<1) 0.44
 Equation coefficient B (intercept, B>1) 245

Parking Densities:
 1. None
 2. Light
 3. Medium
 4. Extensive (short term)
 5. Extensive (long term)

Are Parking Controls Imposed?
 Yes No

Copy Cleaning Data Paste Cleaning Data Delete Control Cancel Edits Clear Continue

Control Practice #: 2 Land Use #: 1 Source Area #: 37

Figure 38: Street cleaning parameters used in A-1 to A-11 and in A-15 to A-17 (WinSLAMM).

Street Cleaning Control Device

Land Use: Multi Family Residential Total Area: 0.060 acres
 Source Area: Streets 1

First Source Area Control Practice

Select Street Cleaning Dates OR Street Cleaning Frequency

Line Number	Street Cleaning Date	Street Cleaning Frequency
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

7 Passes per Week
 5 Passes per Week
 4 Passes per Week
 3 Passes per Week
 2 Passes per Week
 One Pass per Week
 One Pass Every Two Weeks
 One Pass Every Four Weeks
 One Pass Every Eight Weeks
 One Pass Every Twelve Weeks
 Two Passes per Year (Spring and Fall)
 One Pass Each Spring

Model Run Start Date: 01/02/59 Model Run End Date: 12/28/59

Final cleaning period ending date (MM/DD/YY):

Selected Particle Size Distribution file name:
 Not needed - calculated by program

Type of Street Cleaner:
 Mechanical Broom Cleaner
 Vacuum Assisted Cleaner

Street Cleaner Productivity:
 1. Coefficients based on street texture, parking density and parking controls
 2. Other (specify equation coefficients)
 Equation coefficient M (slope, M<1) 0.44
 Equation coefficient B (intercept, B>1) 245

Parking Densities:
 1. None
 2. Light
 3. Medium
 4. Extensive (short term)
 5. Extensive (long term)

Are Parking Controls Imposed?
 Yes No

Copy Cleaning Data Paste Cleaning Data Delete Control Cancel Edits Clear Continue

Control Practice #: 67 Land Use #: 24 Source Area #: 37

Figure 39: Street cleaning parameters used in A-12 to A-14 (WinSLAMM).

Proposed Conditions

Curb-Cut Rain Garden

Curb-cut rain gardens were modeled as drainage area control practices within WinSLAMM. Each was modeled without an underdrain based on available soil information. If based on soil tests it is determined that an underdrain would be necessary, then estimated reductions for volume, TP, and TSS will be lower.

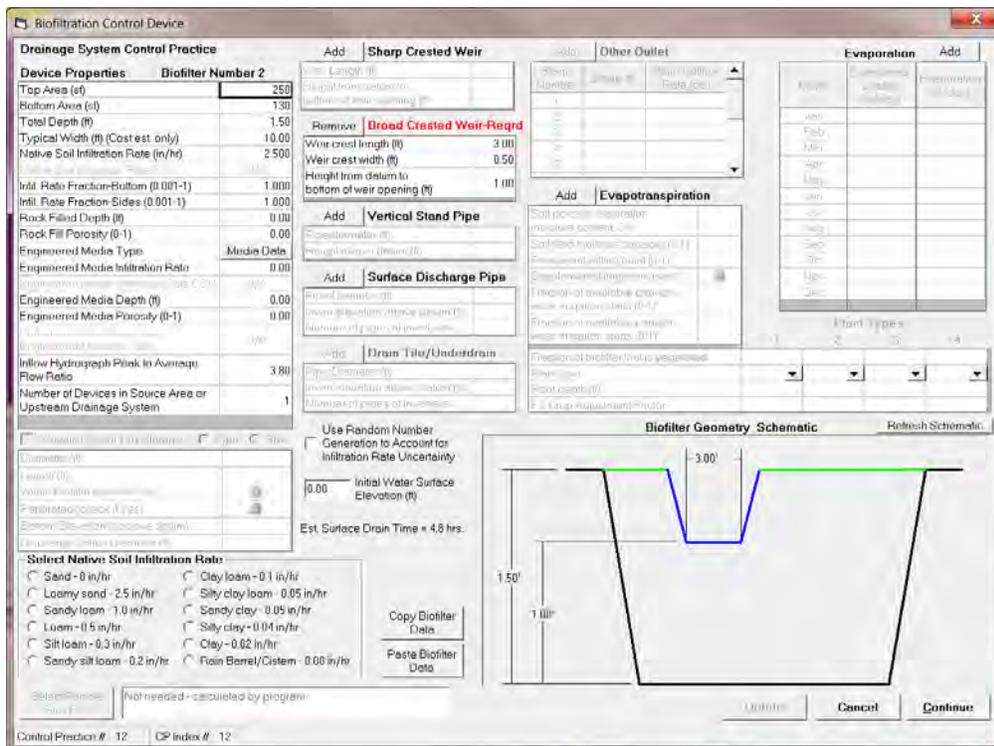


Figure 40: Curb-cut Rain Garden (WinSLAMM)

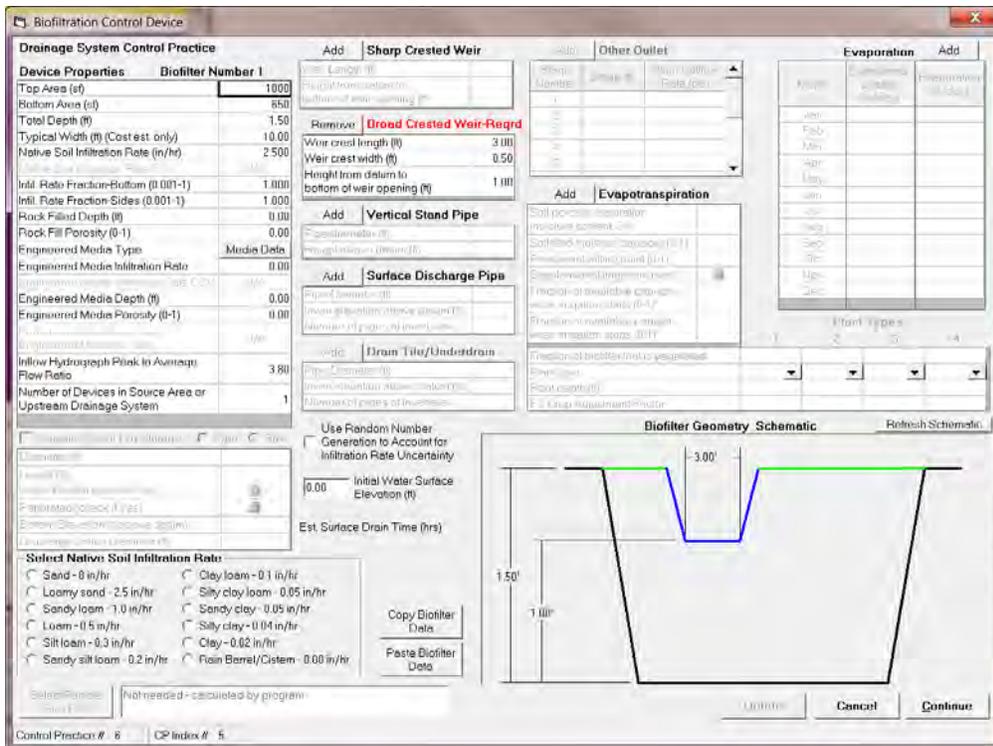


Figure 43: Infiltration Basin (1,000 sq.-ft.) in A-9 (WinSLAMM).

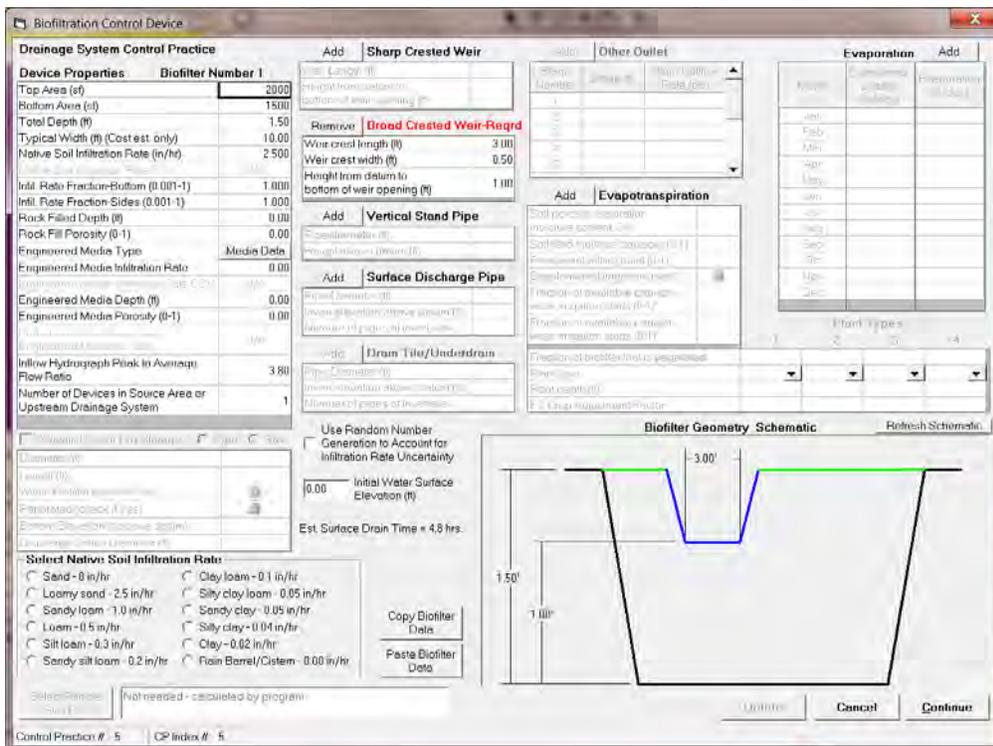


Figure 44: Infiltration Basin (2,000 sq.-ft.) in A-10 (WinSLAMM).

Hydrodynamic Device

Table 11: Hydrodynamic Device Sizing Criteria

Drainage Area (acres)	Peak Q (cfs)	Hydrodynamic Device Diameter (ft)
1	1.97	4
2	3.90	6
3	5.83	6
4	7.77	6
5	9.72	8
6	11.68	8
7	13.65	8
≥8	15.63	10

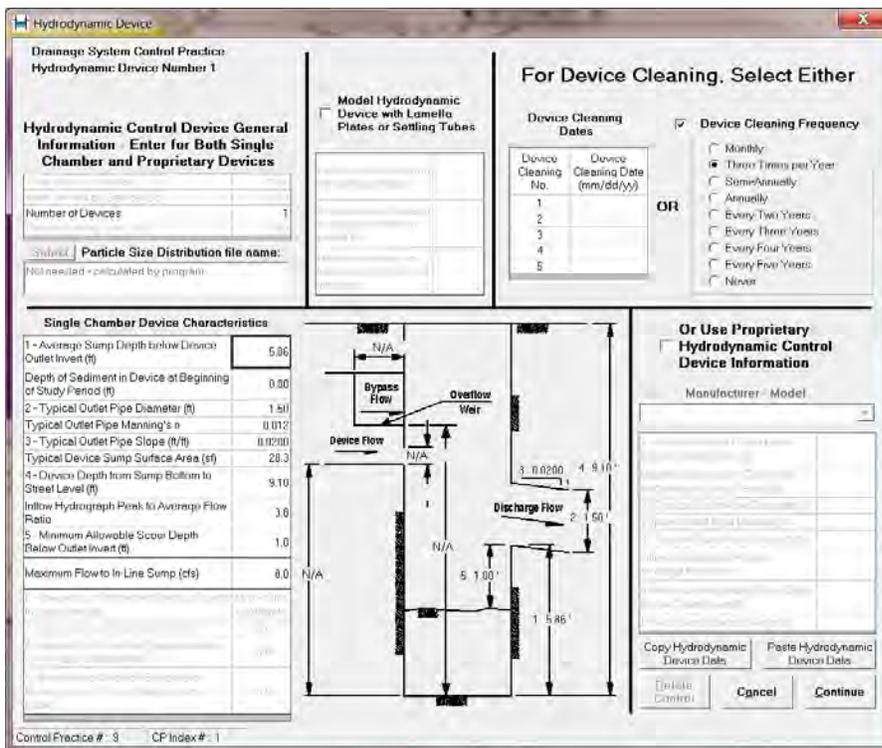


Figure 45: Hydrodynamic Device - 6' diameter (WinSLAMM).

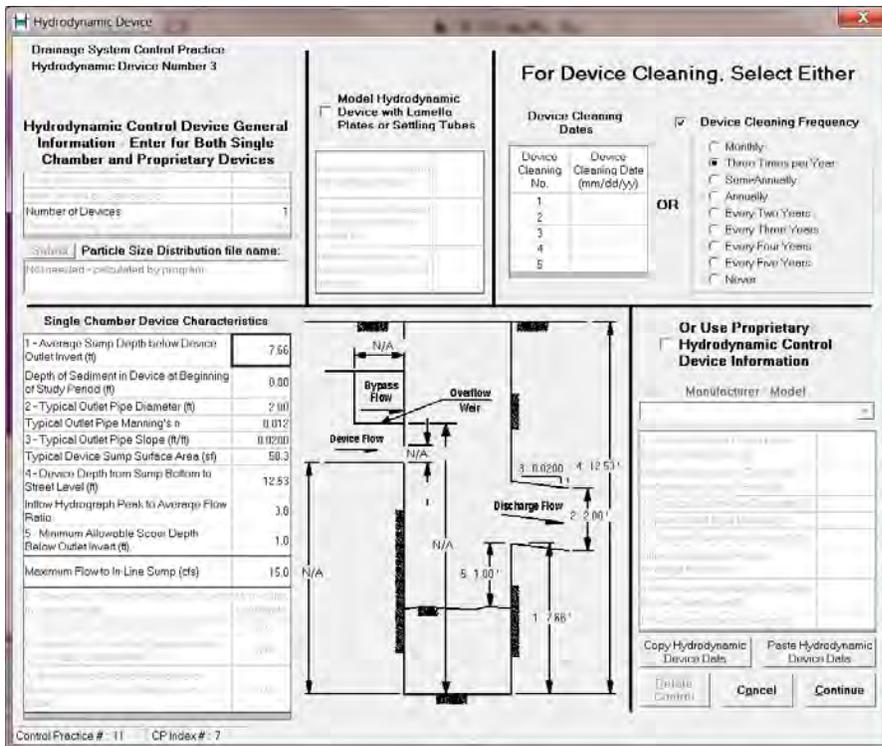


Figure 46: Hydrodynamic Device - 8' diameter (WinSLAMM).

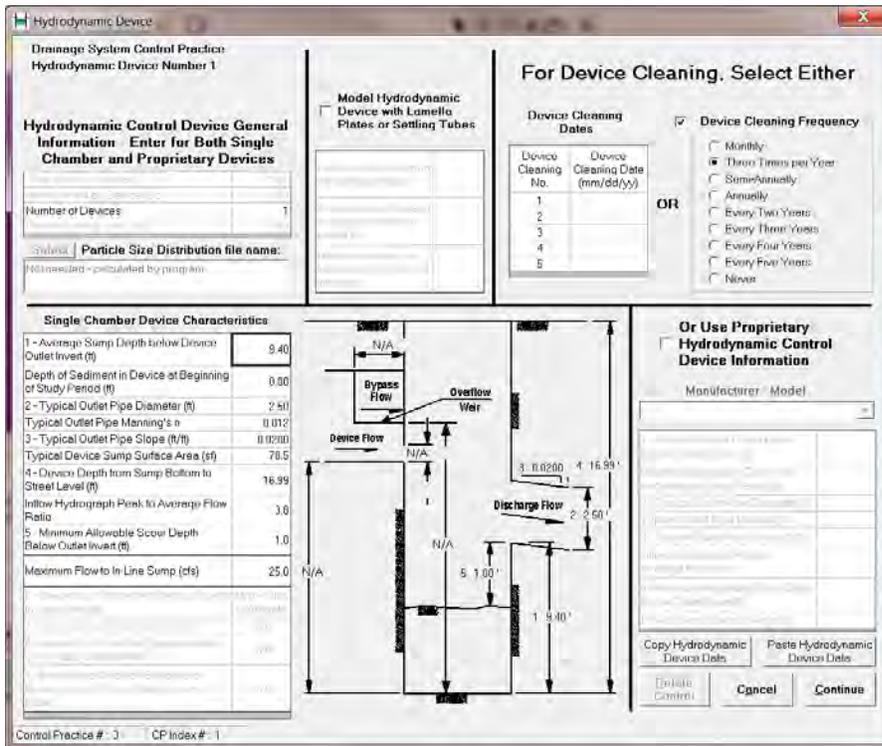


Figure 47: Hydrodynamic Device - 10' diameter (WinSLAMM).

Ponds

Ponds were proposed in the landscape where sufficient drainage area could sustain a permanent pool of water. Ponds were proposed following guidance from the Minnesota Pollution Control Agency, in which depths are equal to or less than 8-10' to prohibit stratification and at least 1,800 cu-ft. of pond storage is available for each acre of drainage area.

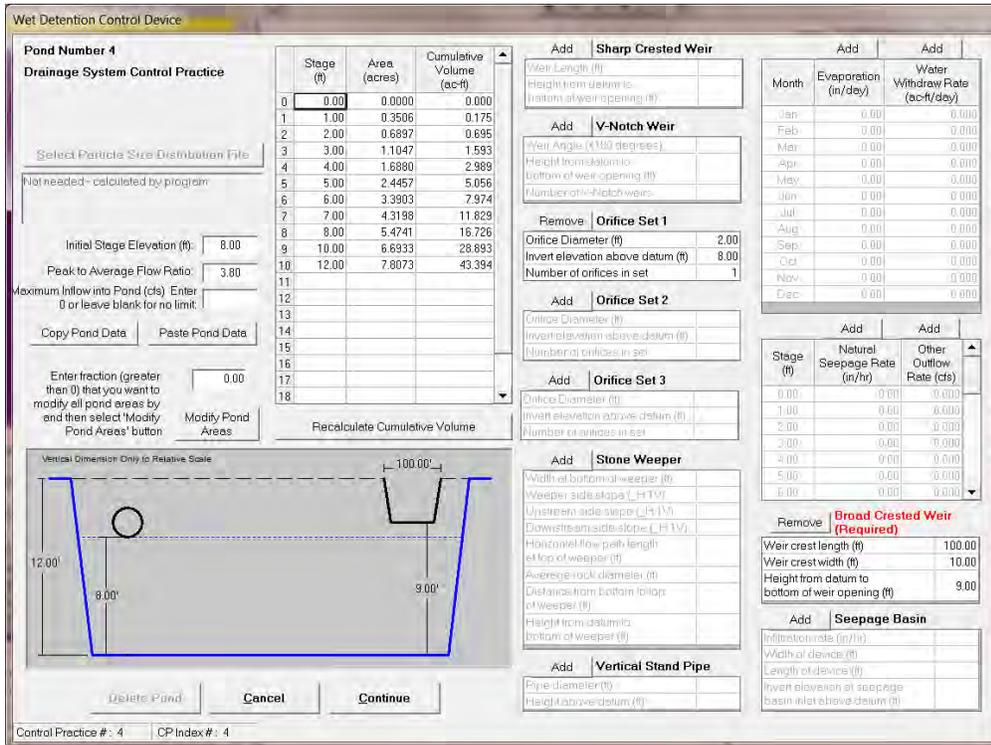


Figure 48: Stormwater Pond (Larger Drainage) at A-7(WinSLAMM).

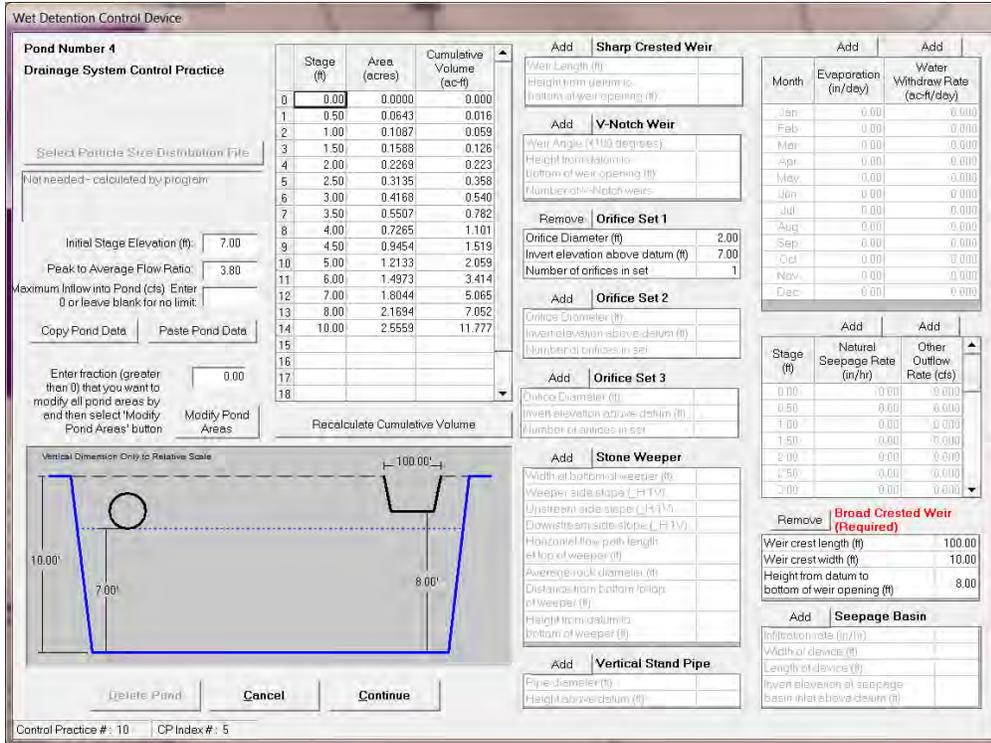


Figure 49: Stormwater Pond (Smaller Drainage) at A-7 (WinSLAMM).

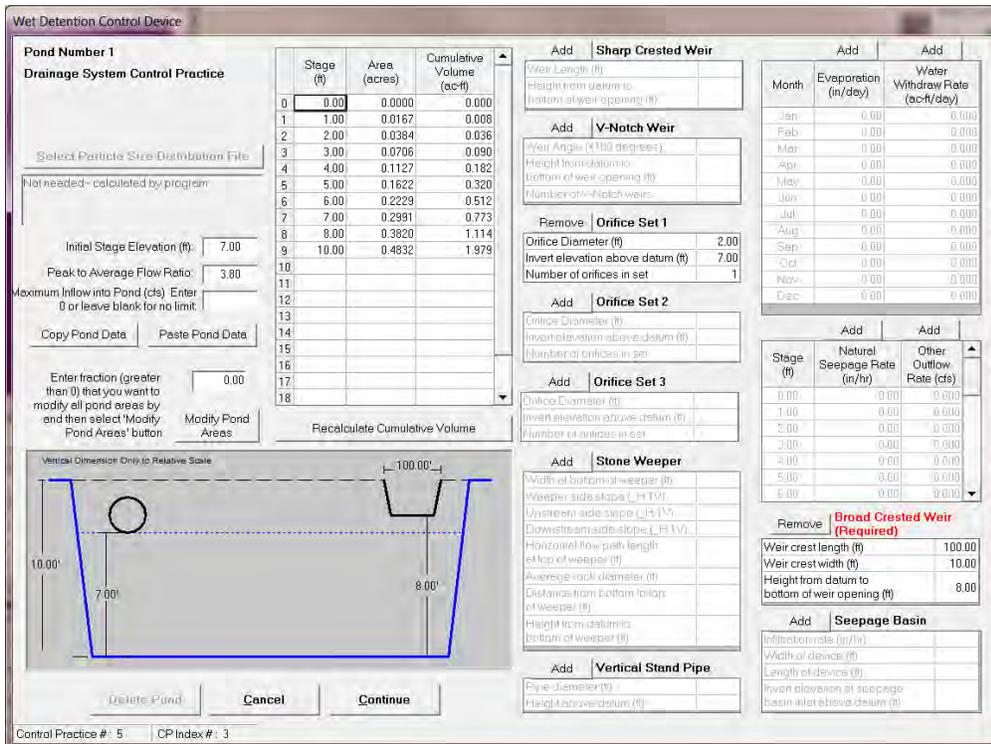


Figure 50: Stormwater Pond at Rudy Johnson Park at A-10 (WinSLAMM).

Iron Enhanced Sand Filter

Wet ponds, by design, allow for sediments and other bound pollutants to drop out of suspension. This practice, though, often allows dissolved pollutants to advect through the system untreated. Iron-enhanced sand filters (IESF) can be retrofitted to or installed with wet ponds to treat this dissolved load.

During a storm event, the pond increases from its permanent-pond stage to its flood stage. The IESF is designed to accept input from the wet pond during storm events, allowing for infiltration of water through its iron rich media, where dissolved pollutants (particularly dissolved phosphorus (DP)) adsorb to the iron filings. DP is then retained within the media while the stormwater can seep into an underdrain. Lastly, the underdrain discharges downstream of the wet pond. IESFs can be installed without ponds, although it is recommended that some form of pretreatment is available to remove sediment, which can deposit within the pore space of the filter and clog the practice over time.

There is currently no drainage practice input for these features in WinSLAMM. As they behave similarly to a bioretention cell, they can be modeled as such. But, as they often operate in tandem with stormwater ponds, estimating when and how much water and pollutants they will receive can be problematic. WinSLAMM was utilized to estimate what percentage of the stormflow could be treated by the filter. Stormflow input into the practice is most dependent upon the volume which can be passed through the system's underdrains. Stormflow treated by the device is a function of total area, depth, infiltration rate, and engineered media characteristics.

Field tests of installed sand trenches conducted by the University of Minnesota concluded that a sand media mixed with 5% iron filings is capable of retaining 80% (or more) of the DP load of stormwater flowing through the media (Erickson and Gulliver, 2010). Thus, DP retention by the IESF can be estimated by the equation,

$$P_{RET} = 0.8 * [P_{IN}] * q_S$$

where P_{RET} is the DP load removed by the IESF, $[P_{IN}]$ is the concentration of the DP input, and q_S is the volume of stormflow passing through the IESF. q_S is a function of the storm event duration and intensity, stormwater pond storage (if in-line with a pond), and IESF storage volume (bottom area, top area, and depth). The 0.8 multiplier assumes the IESF removes 80% of the DP load.

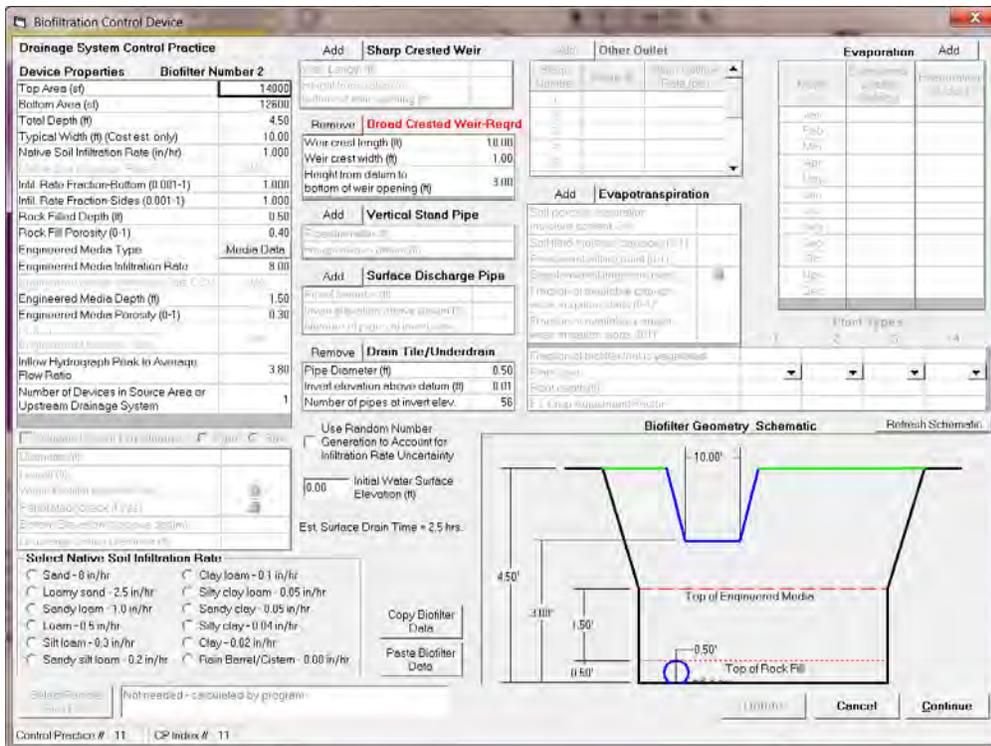


Figure 51: Iron Enhanced Sand Filter Pond Bench at Golf Course Pond in A-3 (WinSLAMM).

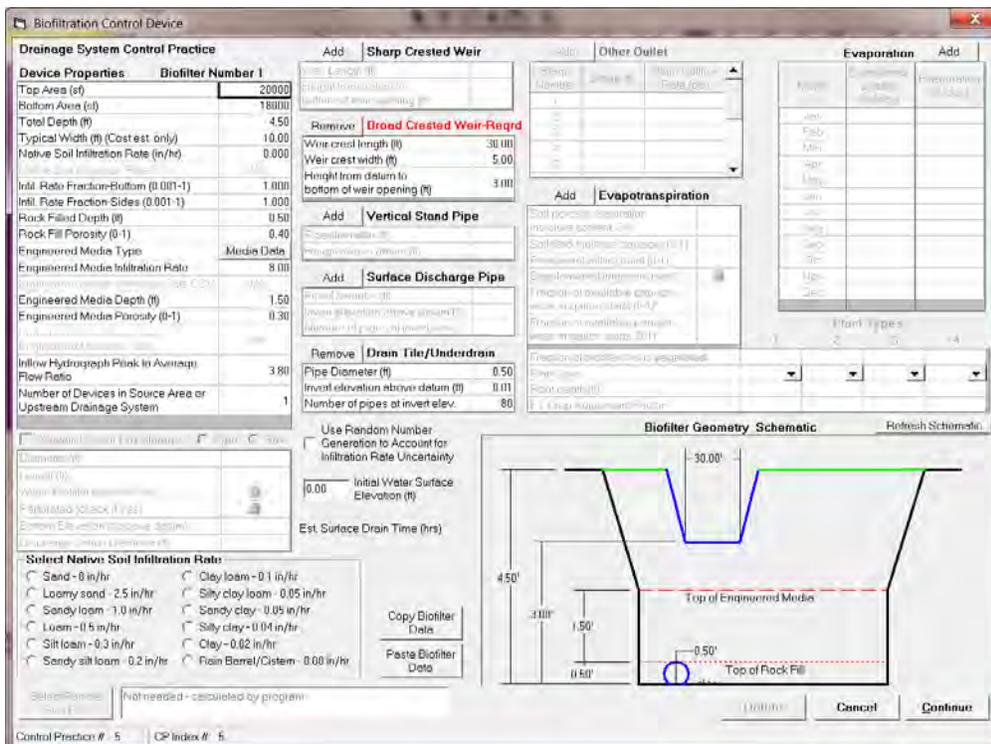


Figure 52: Iron Enhanced Sand Filter Pond Bench at proposed larger drainage pond in A-7 (WinSLAMM).

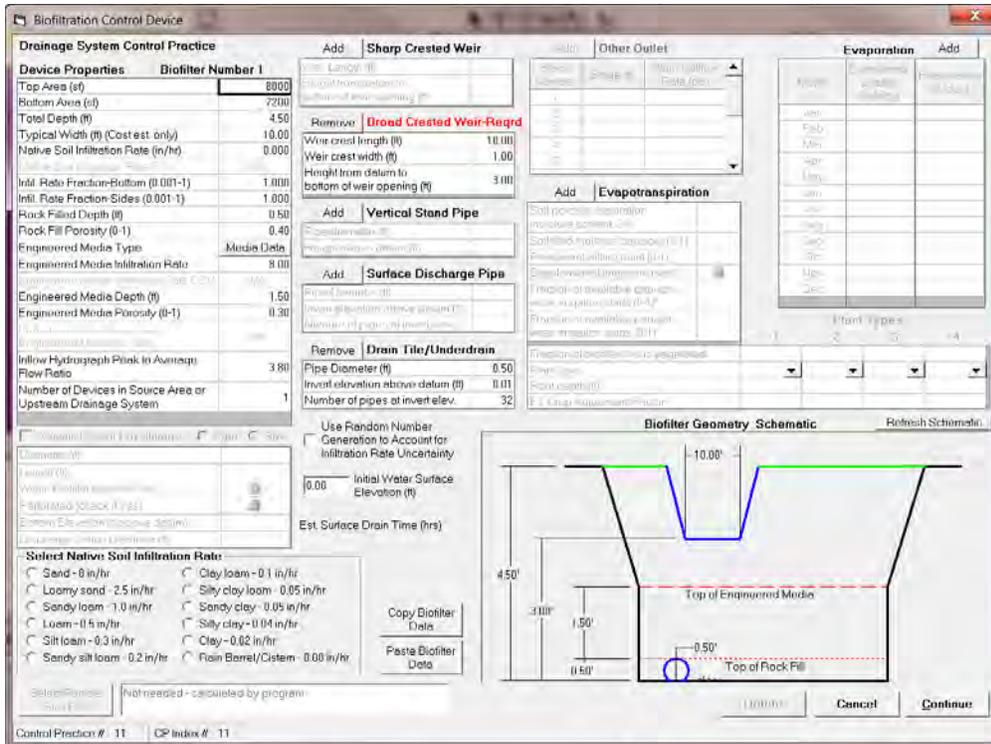


Figure 53: Iron Enhanced Sand Filter Pond Bench at the proposed smaller drainage pond in A-7 (WinSLAMM).

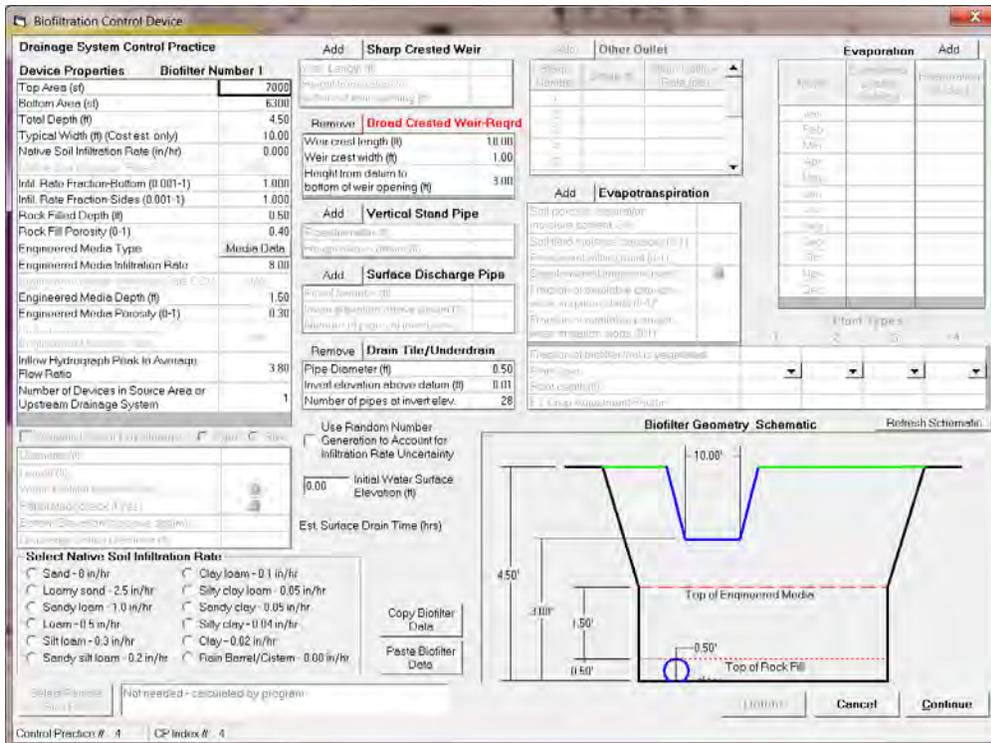


Figure 54: Iron Enhanced Sand Filter Pond Bench at 4th Avenue and Grant Street Pond in A-8 (WinSLAMM).

Permeable Pavement

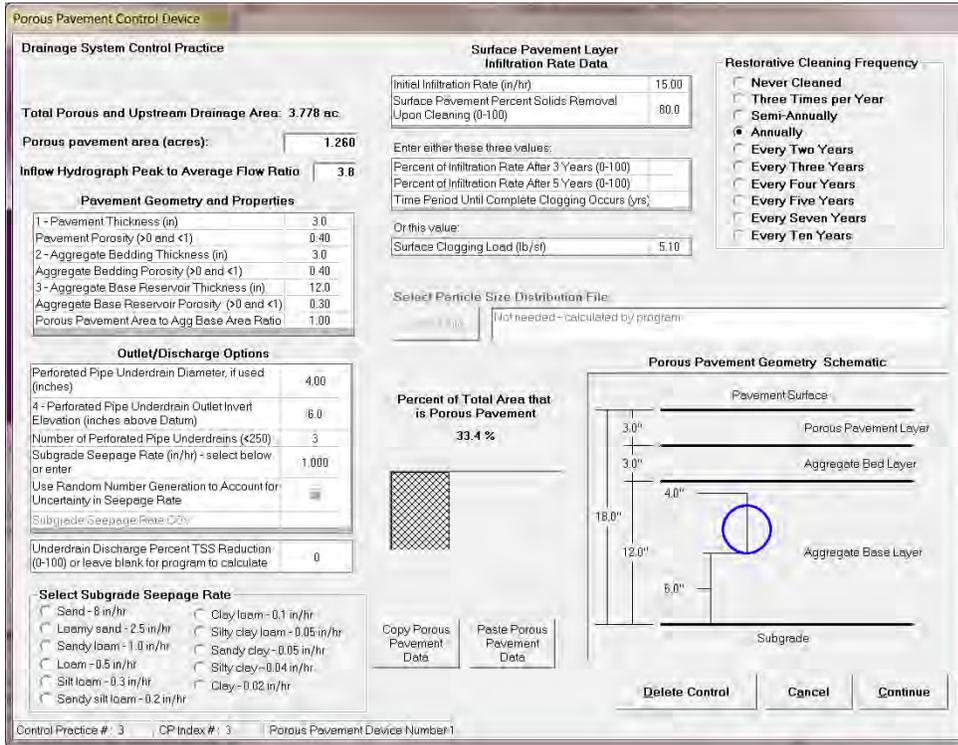


Figure 55: Permeable Pavement in A-1 (WinSLAMM).

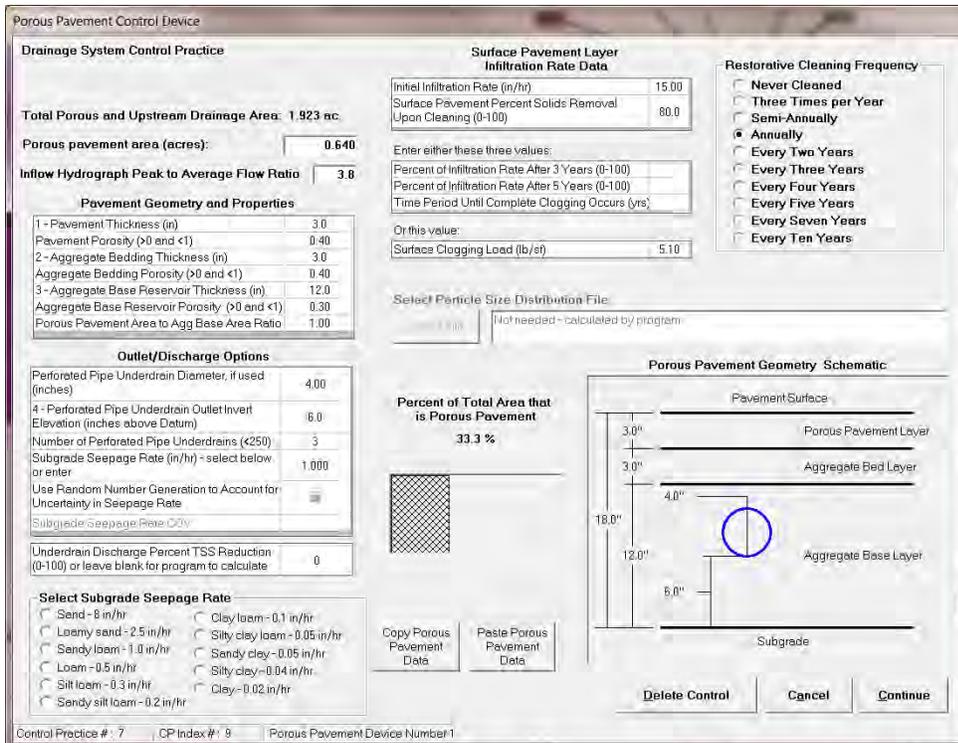


Figure 56: Permeable Pavement at St. Stephen’s Catholic School eastern parking lot in A-13 (WinSLAMM).

Porous Pavement Control Device

Drainage System Control Practice

Total Porous and Upstream Drainage Area: 1.095 ac

Porous pavement area (acres): 0.365

Inflow Hydrograph Peak to Average Flow Ratio: 3.8

Pavement Geometry and Properties

1 - Pavement Thickness (in)	3.0
Pavement Porosity (>0 and <1)	0.40
2 - Aggregate Bedding Thickness (in)	3.0
Aggregate Bedding Porosity (>0 and <1)	0.40
3 - Aggregate Base Reservoir Thickness (in)	12.0
Aggregate Base Reservoir Porosity (>0 and <1)	0.30
Porous Pavement Area to Agg Base Area Ratio	1.00

Outlet/Discharge Options

Perforated Pipe Underdrain Diameter, if used (inches)	4.00
4 - Perforated Pipe Underdrain Outlet Invert Elevation (inches above Datum)	6.0
Number of Perforated Pipe Underdrains (x250)	3
Subgrade Seepage Rate (in/hr) - select below or enter	1.000
Use Random Number Generation to Account for Uncertainty in Seepage Rate	<input type="checkbox"/>
Subgrade Seepage Rate COV	
Underdrain Discharge Percent TSS Reduction (0-100) or leave blank for program to calculate	0

Select Subgrade Seepage Rate

<input type="checkbox"/> Sand - 8 in/hr	<input type="checkbox"/> Clay loam - 0.1 in/hr
<input type="checkbox"/> Loamy sand - 2.5 in/hr	<input type="checkbox"/> Silty clay loam - 0.05 in/hr
<input type="checkbox"/> Sandy loam - 1.0 in/hr	<input type="checkbox"/> Sandy clay - 0.05 in/hr
<input type="checkbox"/> Loam - 0.5 in/hr	<input type="checkbox"/> Silty clay - 0.04 in/hr
<input type="checkbox"/> Silt loam - 0.3 in/hr	<input type="checkbox"/> Clay - 0.02 in/hr
<input type="checkbox"/> Sandy silt loam - 0.2 in/hr	

Surface Pavement Layer Infiltration Rate Data

Initial Infiltration Rate (in/hr)	15.00
Surface Pavement Percent Solids Removal Upon Cleaning (0-100)	80.0

Enter either these three values:

Percent of Infiltration Rate After 3 Years (0-100)	
Percent of Infiltration Rate After 5 Years (0-100)	
Time Period Until Complete Clogging Occurs (yrs)	

Or this value:

Surface Clogging Load (lb/ft)	5.10
-------------------------------	------

Select Particle Size Distribution File: (Not needed - calculated by program)

Restorative Cleaning Frequency

- Never Cleaned
- Three Times per Year
- Semi-Annually
- Annually
- Every Two Years
- Every Three Years
- Every Four Years
- Every Five Years
- Every Seven Years
- Every Ten Years

Percent of Total Area that is Porous Pavement

33.3 %

Porous Pavement Geometry Schematic

Copy Porous Pavement Data | Paste Porous Pavement Data

Delete Control | Cancel | Continue

Control Practice #: 7 | CP Index #: 5 | Porous Pavement Device Number: 1

Figure 57: Permeable Pavement at St. Stephen’s Catholic Church Parking Lot in A-13 (WinSLAMM).

Porous Pavement Control Device

Drainage System Control Practice

Total Porous and Upstream Drainage Area: 2.331 ac

Porous pavement area (acres): 0.780

Inflow Hydrograph Peak to Average Flow Ratio: 3.8

Pavement Geometry and Properties

1 - Pavement Thickness (in)	3.0
Pavement Porosity (>0 and <1)	0.40
2 - Aggregate Bedding Thickness (in)	3.0
Aggregate Bedding Porosity (>0 and <1)	0.40
3 - Aggregate Base Reservoir Thickness (in)	12.0
Aggregate Base Reservoir Porosity (>0 and <1)	0.30
Porous Pavement Area to Agg Base Area Ratio	1.00

Outlet/Discharge Options

Perforated Pipe Underdrain Diameter, if used (inches)	4.00
4 - Perforated Pipe Underdrain Outlet Invert Elevation (inches above Datum)	6.0
Number of Perforated Pipe Underdrains (x250)	3
Subgrade Seepage Rate (in/hr) - select below or enter	1.000
Use Random Number Generation to Account for Uncertainty in Seepage Rate	<input type="checkbox"/>
Subgrade Seepage Rate COV	
Underdrain Discharge Percent TSS Reduction (0-100) or leave blank for program to calculate	0

Select Subgrade Seepage Rate

<input type="checkbox"/> Sand - 8 in/hr	<input type="checkbox"/> Clay loam - 0.1 in/hr
<input type="checkbox"/> Loamy sand - 2.5 in/hr	<input type="checkbox"/> Silty clay loam - 0.05 in/hr
<input type="checkbox"/> Sandy loam - 1.0 in/hr	<input type="checkbox"/> Sandy clay - 0.05 in/hr
<input type="checkbox"/> Loam - 0.5 in/hr	<input type="checkbox"/> Silty clay - 0.04 in/hr
<input type="checkbox"/> Silt loam - 0.3 in/hr	<input type="checkbox"/> Clay - 0.02 in/hr
<input type="checkbox"/> Sandy silt loam - 0.2 in/hr	

Surface Pavement Layer Infiltration Rate Data

Initial Infiltration Rate (in/hr)	15.00
Surface Pavement Percent Solids Removal Upon Cleaning (0-100)	80.0

Enter either these three values:

Percent of Infiltration Rate After 3 Years (0-100)	
Percent of Infiltration Rate After 5 Years (0-100)	
Time Period Until Complete Clogging Occurs (yrs)	

Or this value:

Surface Clogging Load (lb/ft)	5.10
-------------------------------	------

Select Particle Size Distribution File: (Not needed - calculated by program)

Restorative Cleaning Frequency

- Never Cleaned
- Three Times per Year
- Semi-Annually
- Annually
- Every Two Years
- Every Three Years
- Every Four Years
- Every Five Years
- Every Seven Years
- Every Ten Years

Percent of Total Area that is Porous Pavement

33.5 %

Porous Pavement Geometry Schematic

Copy Porous Pavement Data | Paste Porous Pavement Data

Delete Control | Cancel | Continue

Control Practice #: 7 | CP Index #: 6 | Porous Pavement Device Number: 1

Figure 58: Permeable Pavement at St. Stephen’s Catholic School western parking lot in A-13 (WinSLAMM).

Stormwater Reuse

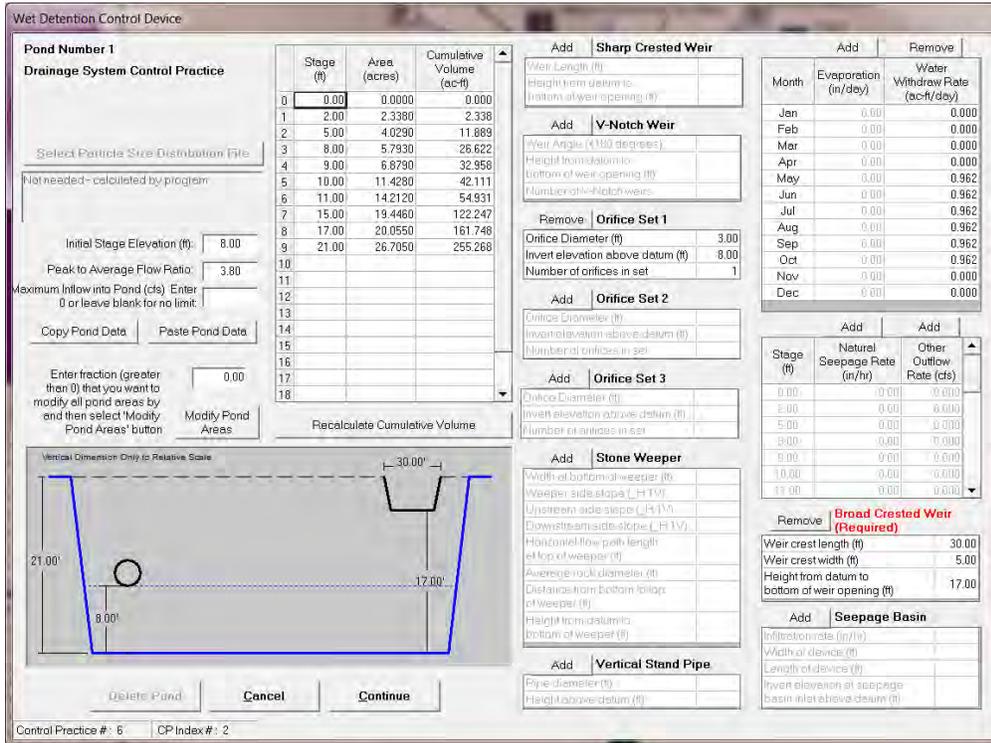


Figure 59: Stormwater Reuse at Green Haven Golf Course Pond in A-3 (WinSLAMM).

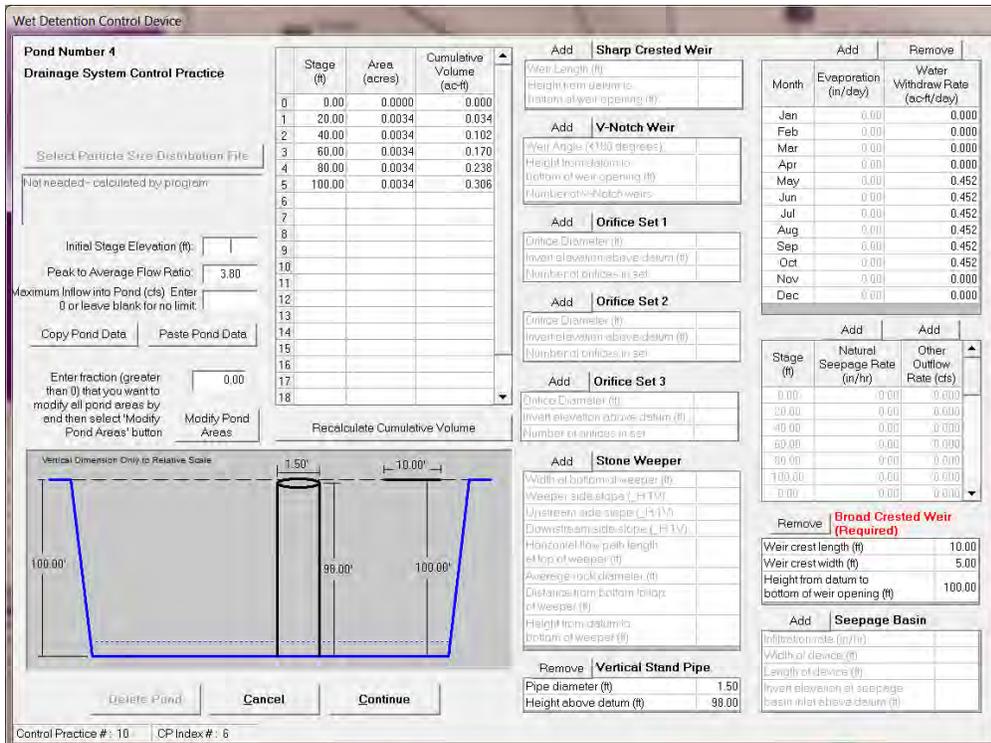


Figure 60: Stormwater Reuse in A-7 (WinSLAMM).

Boulevard Bioswale

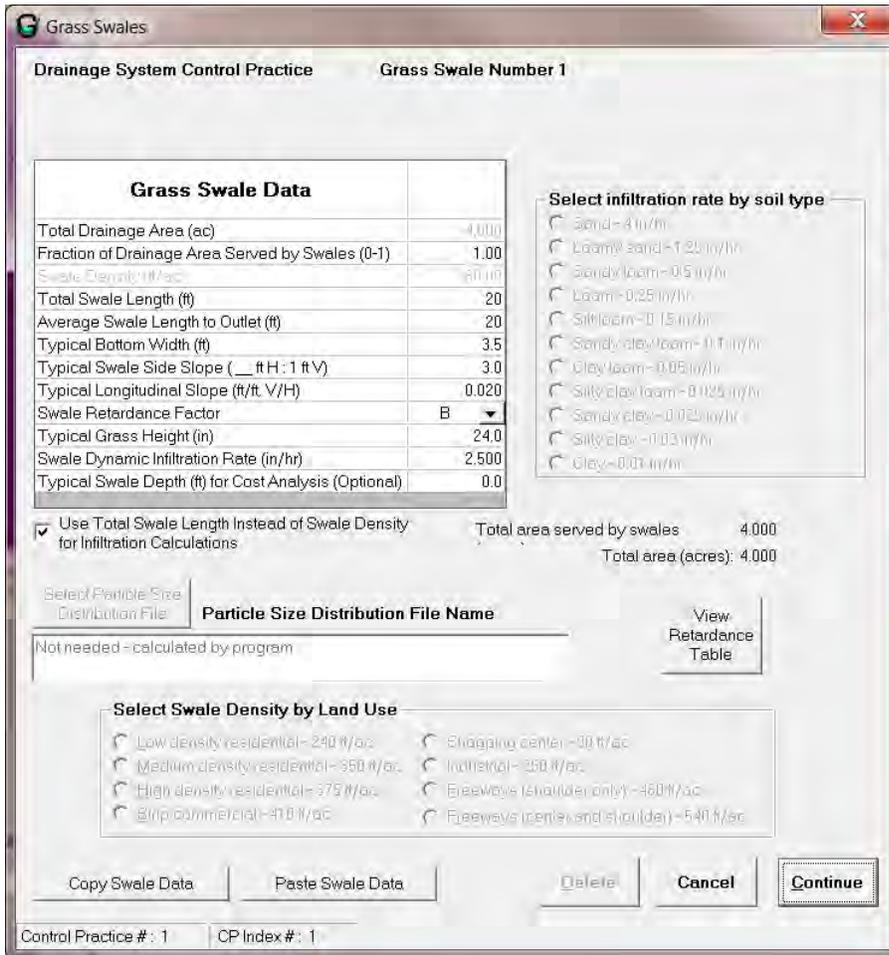


Figure 61: Boulevard Bioswale – not site specific (WinSLAMM).

Appendix B – Project Cost Estimates

Introduction

The ‘Cost Estimates’ section on page 10 explains the elements of cost that were considered and the amounts and assumptions that were used. In addition, each project type concludes with budget assumptions listed in the footnotes. This appendix is a compilation of tables that shows in greater detail the calculations made and quantities used to arrive at the cost estimates for practices where the information provided elsewhere in the document is insufficient to reconstruct the budget. This section includes ponds, iron enhanced sand filters, and stormwater reuse.

Ponds

Table 12: Catchment A-7 – New Pond (Smaller Drainage)

Activity	Units	Unit Price	Quantity	Unit Price
Design	Each	\$ 25,000.00	1	\$ 25,000.00
Mobilization	Each	\$ 10,000.00	1	\$ 10,000.00
Site Prep	Each	\$ 10,000.00	1	\$ 10,000.00
Excavation	cu-yards	\$ 12.50	11,455	\$ 143,183.75
Outlet Control Structure	Each	\$ 10,000.00	1	\$ 10,000.00
Existing Infrastructure Retrofit	Each	\$ 50,000.00	1	\$ 50,000.00
Site Restoration/Revegetation	Each	\$ 5,000.00	1	\$ 5,000.00
Property Purchase		\$ 100,000.00	1	\$ 100,000.00
Total for project =				\$ 353,183.75

Table 13: Catchment A-7 – New Pond (Larger Drainage)

Activity	Units	Unit Price	Quantity	Unit Price
Design	Each	\$ 25,000.00	1	\$ 25,000.00
Mobilization	Each	\$ 10,000.00	1	\$ 10,000.00
Site Prep	Each	\$ 10,000.00	1	\$ 10,000.00
Excavation	cu-yards	\$ 12.50	46,787	\$ 584,837.50
Outlet Control Structure	Each	\$ 10,000.00	1	\$ 10,000.00
Existing Infrastructure Retrofit	Each	\$ 50,000.00	1	\$ 50,000.00
Site Restoration/Revegetation	Each	\$ 5,000.00	1	\$ 5,000.00
Property Purchase		\$ 100,000.00	1	\$ 100,000.00
Total for project =				\$ 794,837.50

Table 14: Catchment A-8 – Pond Modification at 4th Avenue and Grant Street Pond

Activity	Units	Unit Price	Quantity	Unit Price
Feasibility Study and Project Design	Each	\$ 15,000.00	1	\$ 15,000.00
Mobilization	Each	\$ 10,000.00	1	\$ 10,000.00
Site Prep	Each	\$ 10,000.00	1	\$ 10,000.00
Brush Removal	Each	\$ 15,000.00	1	\$ 15,000.00
Sediment Testing	Each	\$ 10,000.00	1	\$ 10,000.00
Existing Infrastructure Retrofit	Each	\$ 5,000.00	1	\$ 5,000.00
Outlet Control Structure	Each	\$ 10,000.00	1	\$ 10,000.00
Site Restoration	Each	\$ 10,000.00	1	\$ 10,000.00
Project Total Before Excavation =				\$ 85,000.00

Activity	Management Levels		
	1	2	3
Soil To Excavate (cu-yds)	12,000	12,000	12,000
Cost To Excavate (\$/cu-yd)	\$20	\$35	\$50
Cost To Excavate (Total \$)	\$240,000	\$420,000	\$600,000
Other Construction Costs (\$)	\$85,000	\$85,000	\$85,000
Total Project Cost (\$)	\$325,000	\$505,000	\$685,000

Table 15: Catchment A-10 – New Pond at Rudy Johnson Park

Activity	Units	Unit Price	Quantity	Unit Price
Design	Each	\$ 25,000.00	1	\$ 25,000.00
Mobilization	Each	\$ 10,000.00	1	\$ 10,000.00
Site Prep	Each	\$ 10,000.00	1	\$ 10,000.00
Excavation	cu-yards	\$ 12.50	1,810	\$ 22,625.00
Outlet Control Structure	Each	\$ 10,000.00	1	\$ 10,000.00
Existing Infrastructure Retrofit	Each	\$ 50,000.00	1	\$ 50,000.00
Site Restoration/Revegetation	Each	\$ 5,000.00	1	\$ 5,000.00
Property Purchase		\$ 100,000.00	1	\$ 100,000.00
Total for project =				\$ 232,625.00

Iron Enhanced Sand Filters

Table 16: Catchment A-3 – IESF Pond Bench at Green Haven Golf Course Pond

Activity	Units	Unit Price	Quantity	Unit Price
Design/Bidding/Construction Oversight	Each	\$ 40,000.00	1	\$ 40,000.00
Mobilization	Each	\$ 20,000.00	1	\$ 20,000.00
Land Acquisition (owned by City of Anoka)	acres	\$ -	0	\$ -
Clearing, Removal of Existing Infrastructure, and Pond Dewatering	Each	\$ 12,000.00	1	\$ 12,000.00
Common Excavation & Disposal	cu-yards	\$ 40.00	2,074	\$ 82,960.00
IESF Materials and Installation	sq-ft	\$ 17.00	14,000	\$ 238,000.00
Outlet/Inlet Control Structures	Each	\$ 30,000.00	1	\$ 30,000.00
Site Restoration	Each	\$ 15,000.00	1	\$ 15,000.00
Total for project =				\$ 437,960.00

Table 17: Catchment A-7 – IESF Pond Bench (Smaller Drainage Pond)

Activity	Units	Unit Price	Quantity	Unit Price
Design/Bidding/Construction Oversight	Each	\$ 40,000.00	1	\$ 40,000.00
Mobilization	Each	\$ 20,000.00	1	\$ 20,000.00
Land Acquisition (owned by State of Minnesota)	acres	\$ -	0	\$ -
Clearing, Removal of Existing Infrastructure, and Pond Dewatering	Each	\$ 12,000.00	1	\$ 12,000.00
Common Excavation & Disposal	cu-yards	\$ 40.00	1,185	\$ 47,400.00
IESF Materials and Installation	sq-ft	\$ 17.00	8,000	\$ 136,000.00
Outlet/Inlet Control Structures	Each	\$ 30,000.00	1	\$ 30,000.00
Site Restoration	Each	\$ 15,000.00	1	\$ 15,000.00
Total for project =				\$ 300,400.00

Table 18: Catchment A-7 – IESF Pond Bench (Larger Drainage Pond)

Activity	Units	Unit Price	Quantity	Unit Price
Design/Bidding/Construction Oversight	Each	\$ 40,000.00	1	\$ 40,000.00
Mobilization	Each	\$ 20,000.00	1	\$ 20,000.00
Land Acquisition (owned by State of Minnesota)	acres	\$ -	0	\$ -
Clearing, Removal of Existing Infrastructure, and Pond Dewatering	Each	\$ 12,000.00	1	\$ 12,000.00
Common Excavation & Disposal	cu-yards	\$ 40.00	2,963	\$ 118,516.00
IESF Materials and Installation	sq-ft	\$ 17.00	20,000	\$ 340,000.00
Outlet/Inlet Control Structures	Each	\$ 30,000.00	1	\$ 30,000.00
Site Restoration	Each	\$ 15,000.00	1	\$ 15,000.00
Total for project =				\$ 575,516.00

Table 19: Catchment A-8 – IESF at 4th Avenue and Grant Street.

Activity	Units	Unit Price	Quantity	Unit Price
Design/Bidding/Construction Oversight	Each	\$ 40,000.00	1	\$ 40,000.00
Mobilization	Each	\$ 20,000.00	1	\$ 20,000.00
Land Acquisition (owned by City of Anoka)	acres	\$ -	0	\$ -
Clearing, Removal of Existing Infrastructure, and Pond Dewatering	Each	\$ 12,000.00	1	\$ 12,000.00
Common Excavation & Disposal	cu-yards	\$ 40.00	1,037	\$ 41,480.00
IESF Materials and Installation	sq-ft	\$ 17.00	7,000	\$ 119,000.00
Outlet/Inlet Control Structures	Each	\$ 30,000.00	1	\$ 30,000.00
Site Restoration	Each	\$ 15,000.00	1	\$ 15,000.00
Total for project =				\$ 277,480.00

Stormwater Reuse

Table 20: Catchment A-3 –Stormwater Reuse at Green Haven Golf Course Pond

Activity	Price
Project Planning	\$ 30,000.00
Easement	\$ 45,000.00
Design, Surveying and Permitting	\$ 85,000.00
Construction Oversight	\$ 30,000.00
Monitoring	\$ 20,000.00
Construction	\$ 390,000.00
Total for project = \$ 600,000.00	

Table 21: Catchment A-7– Stormwater Reuse System

Activity	Price
Project Planning	\$ 30,000.00
Easements	\$ 75,000.00
Design, Surveying and Permitting	\$ 85,000.00
Construction Oversight	\$ 40,000.00
Monitoring	\$ 20,000.00
Cisterns	\$ 250,000.00
Construction	\$ 450,000.00
Total for project = \$ 950,000.00	

Appendix C – Volume Reduction Ranking Tables

Introduction

Volume reduction was not identified as a primary reduction target during the scoping phase of this project. This section is intended to serve as a quick reference if questions related to volume reduction arise. Projects are ranked based on cost per acre-foot of volume reduced.

Table 22: Cost-effectiveness of retrofits with respect to volume reduction. Projects 1 - 16. TP and TSS reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Retrofit Location	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ ac-ft Vol./year (30-year) ¹
1	3-E	52	Stomwater Reuse	Green Haven Golf Course Pond	A-3	18.2	3,409	46.4	\$608,760.00	\$3,000.00	\$503.00
2	7-D	69	Infiltration Basin	Colfax Ave. and Blackoaks Ln.	A-7	9.6	3,256	8.1	\$118,796.00	\$225.00	\$515.00
3	7-E	70	Infiltration Basin	Sunny Ln.	A-7	1.7	676	1.8	\$22,796.00	\$225.00	\$547.00
4	10-C	97	Infiltration Basin	5th Ave. and Polk St.	A-10	2.6	808	2.1	\$43,796.00	\$225.00	\$803.00
5	8-A	80	Curb-Cut Rain Garden	Various locations in catchment	A-8	0.7-0.8	190-301	0.7-1.1	\$17,234.00	\$450.00	\$931-\$1,394
6	1-A	38	Curb-Cut Rain Garden	Ferry St. and Front Ave.	A-1	0.5	187	0.5	\$8,982.00	\$225.00	\$1,090.00
7	16-A	128	Curb-Cut Rain Garden	Washington St.	A-16	0.5-1.0	157-315	0.4-0.8	\$8,982-\$17,234	\$225-\$450	\$1,339-\$1,369
8	7-A	66	Curb-Cut Rain Garden	Various locations in catchment	A-7	0.5-8.1	153-2,539	0.4-6.2	\$15,844-\$147,876	\$225-\$3,825	\$1,407-\$1,931
9	3-A	48	Curb-Cut Rain Garden	Various locations in catchment	A-3	0.5-3.5	157-1,089	0.4-2.7	\$15,844-\$65,356	\$225-\$1,575	\$1,410-\$2,052
10	15-A	125	Curb-Cut Rain Garden	Various locations in catchment	A-15	0.4-4.4	135-1,343	0.4-3.7	\$15,844-\$90,112	\$225-\$2,250	\$1,413-\$1,931
11	9-A	87	Curb-Cut Rain Garden	Various locations in catchment	A-9	0.5-2.0	155-623	0.4-1.5	\$15,844-\$40,600	\$225-\$900	\$1,465-\$1,931
12	7-G	72	Stomwater Reuse	38th Ave. and 7th Ave.	A-7	17.5	5,987	18.7	\$958,760.00	\$3,000.00	\$1,869.00
13	9-E	91	Boulevard Bioswale	Various locations in catchment	A-9	0.2	112	0.2	\$8,526.00	\$225.00	\$2,482.00
14	7-F	71	Boulevard Bioswale	Various locations in catchment	A-7	0.2	61	0.1	\$8,526.00	\$225.00	\$3,704.00
15	11-A	102	Boulevard Bioswale	3rd Ave.	A-11	0.1	49	0.1	\$8,526.00	\$225.00	\$3,717.00
16	2-A	44	Boulevard Bioswale	Maple Ave.	A-2	0.2	55	0.1	\$8,526.00	\$225.00	\$3,859.00

¹ [(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual Volume Reduction)]

Table 23: Cost-effectiveness of retrofits with respect to volume reduction. Projects 17 - 32. TP and TSS reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Retrofit Location	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ ac-ft Vol./year (30-year) ¹
17	10-D	98	Boulevard Bioswale	Various locations in catchment	A-10	0.1	52	0.1	\$8,526.00	\$225.00	\$4,302.00
18	13-H	116	Boulevard Bioswale	Various locations in catchment	A-13	0.1	22	0.1	\$8,526.00	\$225.00	\$5,092.00
19	1-C	40	Permeable Pavement	Anoka-Hennepin Education Center	A-1	2.9	1,325	3.5	\$552,656.00	\$41,165.00	\$17,044.00
20	13-F	114	Permeable Pavement	St. Stephen's Catholic School	A-13	1.6	562	1.6	\$282,796.00	\$20,925.00	\$18,970.00
21	13-E	113	Permeable Pavement	St. Stephen's Catholic Church	A-13	0.9	320	0.9	\$162,796.00	\$11,925.00	\$19,279.00
22	13-G	115	Permeable Pavement	St. Stephen's Catholic School	A-13	1.9	672	1.9	\$343,796.00	\$25,500.00	\$19,453.00
48	1-B	39	Hydrodynamic Device	Ferry St.	A-1	1	584	0	\$109,752.00	\$630.00	N/A
48	3-B	49	Hydrodynamic Device	Main St. and State Ave.	A-3	0.5	280	0	\$55,752.00	\$630.00	N/A
48	3-C	50	Hydrodynamic Device	Main St. and State Ave.	A-3	0.6	302	0	\$55,752.00	\$630.00	N/A
48	3-D	51	IESF Bench	Green Haven Golf Course Pond	A-3	10.4	0	0	\$282,955.00	\$3,214.00	N/A
48	4-A	55	Hydrodynamic Device	Maple Ln.	A-4	0.3	113	0	\$28,752.00	\$630.00	N/A
48	7-B	67	Hydrodynamic Device	38th Ln. and 8th Ave.	A-7	1.2	491	0	\$109,752.00	\$630.00	N/A
48	7-C	68	Hydrodynamic Device	7th Ave.	A-7	0.8	383	0	\$109,752.00	\$630.00	N/A
48	7-H1	73	New Pond	7th Ave.	A-7	111.6	54,558	0.9	\$802,138.00	\$5,500.00	N/A
48	7-H2	74	New Pond	7th Ave.	A-7	31.5	13,452	0.4	\$360,484.00	\$1,800.00	N/A
48	7-I1	75	IESF Bench	7th Ave.	A-7	26.6	0	0	\$580,991.00	\$4,591.00	N/A

¹ [(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual Volume Reduction)]

Table 24: Cost-effectiveness of retrofits with respect to volume reduction. Projects 33 – 48. TP and TSS reductions are also shown. For more information on each project refer to either the Catchment Profile or BMP Descriptions pages in this report. Volume and pollutant reduction benefits cannot be summed with other projects that provide treatment for the same source area.

Project Rank	Project ID	Page Number	Retrofit Type	Retrofit Location	Catchment	TP Reduction (lb/yr)	TSS Reduction (lb/yr)	Volume Reduction (ac-ft/yr)	Probable Project Cost	Estimated Annual Operations & Maintenance	Estimated cost/ ac-ft Vol./year (30-year) ¹
48	7-I2	76	IESF Bench	7th Ave.	A-7	7.2	0	0	\$305,875.00	\$1,837.00	N/A
48	8-B	81	Pond Modification	4th Ave. and Grant St.	A-8	10.5	6,443	0	\$330,840-\$690,840	\$1,300.00	N/A
48	8-C	82	IESF Bench	4th Ave. and Grant St.	A-8	7.2	0	0	\$282,955.00	\$1,607.00	N/A
48	9-B	88	Hydrodynamic Device	7th Ave. and Pierce St.	A-9	1.2	686	0	\$109,752.00	\$630.00	N/A
48	9-C	89	Hydrodynamic Device	7th Ave. and Harrison St.	A-9	1	407	0	\$109,752.00	\$630.00	N/A
48	9-D	90	Hydrodynamic Device	Main St. and 8 1/2 Ave.	A-9	1.1	777	0	\$109,752.00	\$630.00	N/A
48	10-A	95	Hydrodynamic Device	6th Ave. and Taylor St.	A-10	0.5	211	0	\$109,752.00	\$630.00	N/A
48	10-B	96	Hydrodynamic Device	5th Ave. and Taylor St.	A-10	0.5	195	0	\$109,752.00	\$630.00	N/A
48	10-E	99	New Pond	Rudy Johnson Park	A-10	4	1,712	0.1	\$239,925.00	\$300.00	N/A
48	13-A	109	Hydrodynamic Device	Main St. and 1st Ave.	A-13	0.5	272	0	\$55,752.00	\$630.00	N/A
48	13-B	110	Hydrodynamic Device	Main St. and 3rd Ave.	A-13	0.5	285	0	\$55,752.00	\$630.00	N/A
48	13-C	111	Hydrodynamic Device	Main St. and 5th Ave.	A-13	0.9	427	0	\$109,752.00	\$630.00	N/A
48	13-D	112	Hydrodynamic Device	5th Ave. and Main St.	A-13	1.4	644	0	\$109,752.00	\$630.00	N/A
48	14-A	121	Hydrodynamic Device	Parking lot off 1st Ave.	A-14	0.8	385	0	\$109,752.00	\$630.00	N/A
48	16-B	129	Hydrodynamic Device	Oakwood Dr. and Washington St.	A-16	0.4	163	0	\$109,752.00	\$630.00	N/A
48	17-A	133	Hydrodynamic Device	Oakwood Dr.	A-17	0.6	244	0	\$109,752.00	\$630.00	N/A

¹ [(Probable Project Cost) + 30*(Annual O&M)] / [30*(Annual Volume Reduction)]

Appendix D – Soil Information

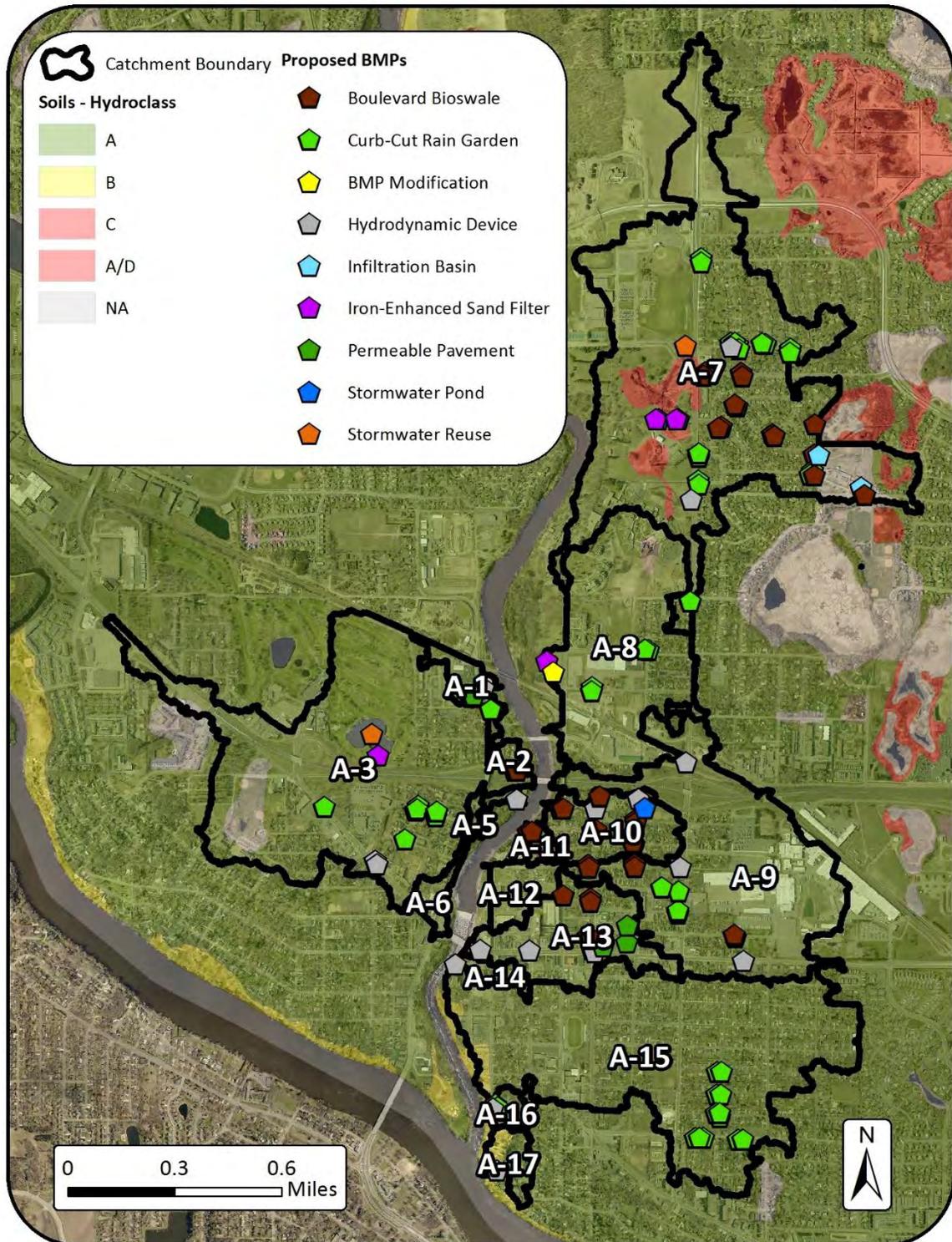


Figure 62: Soil hydroclass and proposed retrofit locations in the City of Anoka.

Appendix E – Wellhead Protection Areas

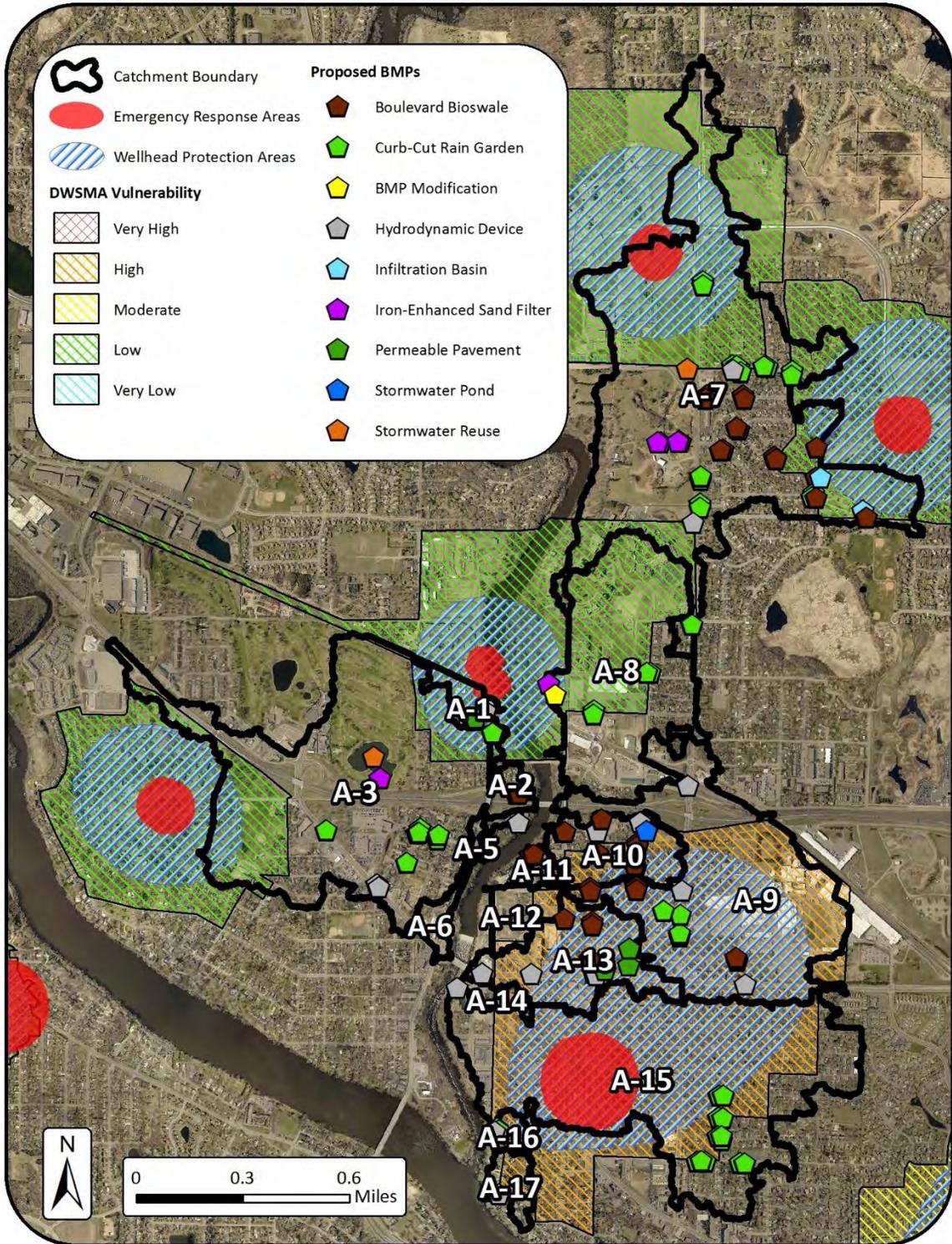


Figure 63: Wellhead protection areas and proposed retrofit locations in the City of Anoka.

APPENDIX D

LOWER RUM RIVER WATERSHED MANAGEMENT ORGANIZATION
ANDOVER - ANOKA - RAMSEY
2015 First Avenue • Anoka, MN 55303

January 18, 2019

Mr. Ben Nelson
City of Anoka
2015 First Avenue
Anoka, MN 55303

Subject: LRRWMO Permit #2018-22 ~ Anoka Infiltration Credits ~ Anoka

Dear Mr. Nelson,

The LRRWMO, at its January 17, 2019 meeting, addressed the permit indicated above.

The Board has taken action to authorize the creation of excess volume retention credits as detailed in the enclosed Barr Engineering memorandum dated January 16, 2019.

If you have any questions regarding this process, please contact Mr. Obermeyer of Barr Engineering.

Sincerely,



Todd Haas
Chair

Attachments: Approved Permit 18-22
Barr Engineering Memo

cc: LRRWMO
Bob Obermeyer, Barr Engineering

Lower Rum River Watershed Management Organization ("LRRWMO")

Andover—Anoka—Ramsey
2015 First Avenue • Anoka, MN 55303

PERMIT APPLICATION

Permit # <u>18-22</u>

The \$100.00 application fee and the \$700.00 escrow deposit must accompany this permit application. Applications for projects involving wetlands and/or involving a Wetland Replacement Plans must include an additional \$75 application fee plus an escrow deposit as determined in accordance with Attachment D.

Permits are to be processed at the same time as the site plan, preliminary plat or other city land use or building application submitted to the city in which the work or project is located.

The permit and supporting documentation must be submitted to the LRRWMO by the **THIRD THURSDAY OF THE MONTH TO BE ON THE FOLLOWING REGULARLY SCHEDULED MONTHLY LRRWMO MEETING AGENDA. A PERMIT NUMBER WILL NOT BE ASSIGNED UNTIL CITY AUTHORIZATION IS RECEIVED.**

Project Name: Anoka Infiltration Credits

Address/Location: Multipliable Project Locations within City Limits

Project Description/Purpose: Infiltration Credits for Volume Control/Retention

Ben Nelson	
Name of Applicant (Site Owner or Property Owner)	
<u>2015 First Avenue</u>	
Address	
<u>Anoka, MN 55303</u>	
City, State, Zip	
<u>763-576-2980</u>	
Phone	Fax
<u>bnelson@ci.anoka.mn.us</u>	
Email	

Ben Nelson	City of Anoka
Applicant's Contact	Organization Name
<u>2015 First Avenue</u>	
Address	
<u>Anoka, MN 55303</u>	
City, State, Zip	
<u>763-576-2980</u>	
Phone	Fax
<u>bnelson@ci.anoka.mn.us</u>	
Email	

Submittal Requirements

Complete applications are to be submitted as per attachments A (Permit Requirements), B (Office Procedure), C (LRRWMO Permit Standards). Projects involving wetlands and/or involving a Wetland Replacement Plan have special notice requirements and require submittal of four copies (4) and an electronic copy of all wetland-related submittal materials.

PROJECT SUBMITTALS (check all that apply):

- | |
|--|
| <input type="checkbox"/> GRADING PLAN: Including existing and proposed contours and boundaries of all wetlands and surface waters. |
| <input type="checkbox"/> STORM SEWER/ DRAINAGE PLAN: Including all permanent drainage features and all permanent water quality features. |
| <input type="checkbox"/> STORM DRAINAGE CALCULATIONS: Design computations as required by the LRRWMO (see attachment C). |
| <input type="checkbox"/> EROSION CONTROL PLAN: Including all temporary measures proposed to retain all sediment on site. |
| <input type="checkbox"/> MITIGATION PLAN*/WETLAND DETERMINATION: Quality level of mitigated wetland(s) shall be determined by the LRRWMO. |
| <input type="checkbox"/> REQUEST FOR EXEMPTION UNDER THE WETLAND CONSERVATION ACT (WCA) |
| <input checked="" type="checkbox"/> OTHER <u>Memo</u> |

**NOTE: Four copies of permit submittals are required for projects involving wetland replacement plans.*

Lower Rum River Watershed Management Organization ("LRRWMO")

Andover—Anoka—Ramsey
2015 First Avenue • Anoka, MN 55303

START OF PROJECT: n/a

EST. COMPLETION DATE: n/a

APPROVAL DATE: 1/17/19

By signing this Permit Application, the undersigned consents and agrees on behalf of the Applicant that:

1. The permit application fee is non-refundable. Escrow deposits will be held by the LRRWMO until the project has been completed and all conditions of issuance of the permit are satisfied. The Applicant is responsible for all expenses incurred by the LRRWMO in the processing, administration and enforcement of the permit application and permit. The escrow deposit will be used to reimburse the LRRWMO for all expenses incurred by the LRRWMO in processing, administering and enforcing the permit application and permit, including engineering, legal and other consultant costs. If such expenses exceed the escrow deposit, the LRRWMO will bill the Applicant or Permittee for such excess amount and payment will be due within twenty (20) days of mailing the invoice. Timely payment of such invoices is a condition of all permits and work may be stopped on the project for failure to make payments when due.
2. The undersigned, its agents, principal, assigns and/or representatives (hereinafter "Permittee") shall abide by all the standard conditions and special terms and conditions of the LRRWMO.
3. Any work that violates the terms of the permit may result in the LRRWMO or the City in which the work is being done immediately causing the work on the project relating to the permit to cease and desist. All work on the project shall cease until the permit conditions are met and approved by the LRRWMO and/or the City in which the work is being done.
4. The Permittee agrees to be bound by the terms of the LRRWMO permit requirements, final permit, standard conditions, and special conditions required by the LRRWMO for approval of the permit. The undersigned has the authority to bind the permit holder, the owner of the property and/or any entity performing work on the property pursuant to the terms of LRRWMO permit, and shall be responsible for complying with terms of the LRRWMO permit.

"I certify that I have thoroughly read and understand the above information."

	12-21-2018		
Signature of property owner or designated Agent (no agent without a letter of authority)	Date	Signature of applicant if different from property owner	Date

Ben Nelson	
Print Signer's name	Print Signer's name

Application Acknowledged by City: 	Anoka	12-21-2018
Name of City Official	City	Date

SIGNATURE OF LRRWMO CHAIRMAN: ** 

****NOTE: Subject to conditions recommended by Bob Obermeyer, Barr Engineering (see attached)**

PERMIT IS NOT VALID IF PROJECT HAS NOT STARTED WITHIN ONE YEAR FROM DATE OF APPROVAL

Lower Rum River Watershed Management Organization

Andover–Anoka–Ramsey
2015 First Avenue; Anoka, MN 55303

To: Lower Rum River Water Management Organization
From: Barr Engineering Company
Date: Revised January 16, 2019
Re: Permit #2018-22: Anoka Infiltration Credits: Anoka

A LRRWMO permit application has been received for the review and comment of the City of Anoka's plan to create a bank for volume retention credits for compliance with LRRWMO requirements. The Kwik Trip project, Permit #2018-15, because of the fuel distribution proposed, the Minnesota Pollution Control Agency and LRRWMO criteria prohibits on-site volume retention by infiltration. The City of Anoka (City) has identified, in correspondence dated December 21, 2018, four projects that did not require a permit from the LRRWMO however on-site basins for stormwater management were constructed. Permits from the LRRWMO were not required for these projects since three were road reconstruction that did not trigger the one acre increase in impervious area and the other was a parking lot mill and overlay that does not require a permit. The constructed on-site basins therefore have excess retention volume available for banking. These sites are; 1) Tyler Street Alley, 2) City Hall North Parking Lot, 3) Sunny Acres Park and 4) State Avenue Reconstruction Project. The City is requesting that the volume credits be banked and used for future projects where volume retention because of site constraints cannot be provided on-site. This is similar to the commitment made by the City of Ramsey for projects in the Town Center that were located within a Drinking Water Supply Management Area (DWSMA) and would provide the volume retention required for these projects with a future municipal project. Anoka's December 21st submittal and e-mail correspondence dated January 16, 2019 from Hakanson Anderson identifies that approximately 10,933 cubic-feet of excess volume retention would be available for banking.

If acceptable to the LRRWMO and prior to establishment of these credits, it is recommended that as-built plans for these areas including documentation showing the basins are functioning as approved are provided to the LRRWMO.

LOWER RUM RIVER WATERSHED MANAGEMENT ORGANIZATION
ANDOVER - ANOKA - RAMSEY
2015 First Avenue • Anoka, MN 55303

January 18, 2019

Mr. Steven Lowe slowe@kwiktrip.com
Kwik Trip, Inc.
1626 Oak Street
La Crosse, WI 54603-2308

Subject: LRRWMO Permit #2018-15 ~ Kwik Trip 1017 ~ Anoka

Dear Mr. Lowe,

The LRRWMO, at its January 17, 2019 meeting, addressed the permit indicated above.

The Board has taken action to approve the referenced permit application, subject to the seven (7) conditions, as detailed in the attached Barr Engineering memorandum dated January 10, 2019.

If you have any questions regarding this process, please contact Mr. Obermeyer of Barr Engineering.

Sincerely,



Todd Haas
Chair

Attachment: Approved Permit Application 18-15
Barr Engineering Memo 1/10/19

cc: Joseph Radach, Carlson McCain jradach@carlsonmccain.com
Ben Nelson, City of Anoka
LRRWMO

Lower Rum River Watershed Management Organization ("LRRWMO")

Andover—Anoka—Ramsey
2015 First Avenue • Anoka, MN 55303

PERMIT APPLICATION

Permit # 18-15

The \$100.00 application fee and the \$700.00 escrow deposit must accompany this permit application. Applications for projects involving wetlands and/or involving a Wetland Replacement Plans must include an additional \$75 application fee plus an escrow deposit as determined in accordance with Attachment D.

Permits are to be processed at the same time as the site plan, preliminary plat or other city land use or building application submitted to the city in which the work or project is located.

The permit and supporting documentation must be submitted to the LRRWMO by the **THIRD THURSDAY OF THE MONTH TO BE ON THE FOLLOWING REGULARLY SCHEDULED MONTHLY LRRWMO MEETING AGENDA. A PERMIT NUMBER WILL NOT BE ASSIGNED UNTIL CITY AUTHORIZATION IS RECEIVED.**

Project Name: KWIK TRIP 1017
Address/Location: NWC OF 7TH AVENUE + BUCHANAN STREET
Project Description/Purpose: CONSTRUCTION OF NEW 9,210 S.E CONVENIENCE STORE / CARWASH + FUELING ISLAND -

STEVEN LOWE - KWIK TRIP, INC.
Name of Applicant (Site Owner or Property Owner)
1626 OAK ST
Address
LA CROSSE, WI 54602
City, State, Zip
608-793-5954
Phone **Fax**
slowe@kwiktrip.com
Email

Applicant's Contact **Organization Name**
Address
City, State, Zip
Phone **Fax**
Email

Submittal Requirements

Complete applications are to be submitted as per attachments A (Permit Requirements), B (Office Procedure), C (LRRWMO Permit Standards). Projects involving wetlands and/or involving a Wetland Replacement Plan have special notice requirements and require submittal of four copies (4) and an electronic copy of all wetland-related submittal materials.

PROJECT SUBMITTALS (check all that apply):

- GRADING PLAN:** Including existing and proposed contours and boundaries of all wetlands and surface waters.
- STORM SEWER/ DRAINAGE PLAN:** Including all permanent drainage features and all permanent water quality features.
- STORM DRAINAGE CALCULATIONS:** Design computations as required by the LRRWMO (see attachment C).
- EROSION CONTROL PLAN:** Including all temporary measures proposed to retain all sediment on site.
- MITIGATION PLAN*/WETLAND DETERMINATION:** Quality level of mitigated wetland(s) shall be determined by the LRRWMO.
- REQUEST FOR EXEMPTION UNDER THE WETLAND CONSERVATION ACT (WCA)**
- OTHER**

**NOTE: Four copies of permit submittals are required for projects involving wetland replacement plans.*

Lower Rum River Watershed Management Organization ("LRRWMO")

Andover—Anoka—Ramsey
2015 First Avenue • Anoka, MN 55303

START OF PROJECT: 7/22/2019

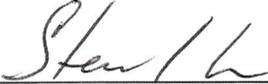
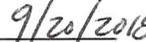
EST. COMPLETION DATE: 11/29/2019

APPROVAL DATE: 1/17/2019

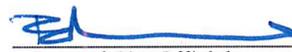
By signing this Permit Application, the undersigned consents and agrees on behalf of the Applicant that:

1. The permit application fee is non-refundable. Escrow deposits will be held by the LRRWMO until the project has been completed and all conditions of issuance of the permit are satisfied. The Applicant is responsible for all expenses incurred by the LRRWMO in the processing, administration and enforcement of the permit application and permit. The escrow deposit will be used to reimburse the LRRWMO for all expenses incurred by the LRRWMO in processing, administering and enforcing the permit application and permit, including engineering, legal and other consultant costs. If such expenses exceed the escrow deposit, the LRRWMO will bill the Applicant or Permittee for such excess amount and payment will be due within twenty (20) days of mailing the invoice. Timely payment of such invoices is a condition of all permits and work may be stopped on the project for failure to make payments when due.
2. The undersigned, its agents, principal, assigns and/or representatives (hereinafter "Permittee") shall abide by all the standard conditions and special terms and conditions of the LRRWMO.
3. Any work that violates the terms of the permit may result in the LRRWMO or the City in which the work is being done immediately causing the work on the project relating to the permit to cease and desist. All work on the project shall cease until the permit conditions are met and approved by the LRRWMO and/or the City in which the work is being done.
4. The Permittee agrees to be bound by the terms of the LRRWMO permit requirements, final permit, standard conditions, and special conditions required by the LRRWMO for approval of the permit. The undersigned has the authority to bind the permit holder, the owner of the property and/or any entity performing work on the property pursuant to the terms of LRRWMO permit, and shall be responsible for complying with terms of the LRRWMO permit.

"I certify that I have thoroughly read and understand the above information."

	<u>9/20/2018</u>		Date
Signature of property owner or designated Agent (no agent without a letter of authority)	Date	Signature of applicant if different from property owner	Date

<u>STEVEN I. LOWE</u>	<u>Anoka</u>
Print Signer's name	Print Signer's name

Application Acknowledged by City:  Anoka 9/28/18
Name of City Official City Date

SIGNATURE OF LRRWMO CHAIRMAN: ** 

****NOTE: Subject to conditions recommended by Bob Obermeyer, Barr Engineering (see attached)**

PERMIT IS NOT VALID IF PROJECT HAS NOT STARTED WITHIN ONE YEAR FROM DATE OF APPROVAL

Lower Rum River Watershed Management Organization

Andover–Anoka–Ramsey
2015 First Avenue; Anoka, MN 55303

To: Lower Rum River Water Management Organization
From: Barr Engineering Company
Date: January 10, 2019
Re: Permit #2018-15: Kwik Trip: Anoka



We have received plans and a LRRWMO permit application for the construction of a Kwik Trip convenience store, car wash, and fueling station to be located in the northwest corner of 7th avenue and Buchanan Street in Anoka. The 4.1 acre site is currently undeveloped.

Because of the fuel distribution proposed, the Minnesota Pollution Control Agency and LRRWMO criteria prohibits on-site volume retention by infiltration. The City of Anoka (City) has stated, in correspondence dated December 21, 2018, that four constructed volume retention areas on projects approved by the LRRWMO once constructed have excess retention volume available. These site are; 1) Tyler Street Alley, 2) City Hall North Parking Lot, 3) Sunny Acres Park and 4) State Avenue Reconstruction Project. The City is requesting that the additional volume credits be banked and used for this and future projects where volume retention because of site constraints cannot be provided on-site. This is similar to the commitment made by the City of Ramsey for projects in the Town Center that were located within a Drinking Water Supply Management Area (DWSMA). Ramsey committed to provide the volume retention required for these projects with a future municipal project. Anoka's December 21st submittal identifies that approximately 3,795 cubic-feet of excess volume retention would be available for banking. Permit #2018-22 would establish this bank if approved by the LRRWMO.

For the Kwik Trip project, a volume retention required from 1-inch of runoff from the 2.23 acres (97,139 square feet) of proposed site impervious area is 8,095 cubic feet. An on-site lined stormwater basin is to be constructed to provide water quality management and rate control. The results of a P8 model indicates that the basin will provide an annual removal efficiency of 60% for total phosphorous and 90.5% annual removal efficiency of total suspended solids, complying with LRRWMO criteria.

The following table summarizes the existing and proposed discharges from the site the 2, 10, and 100-year frequency storm events leaving the site:

Frequency	Existing Discharge c.f.s.	Proposed Discharge c.f.s
2-Year	<1.0	<1.0
10-Year	1.0	<1.0
100-Year	5.6	2.6

The HydroCAD model shows the calculated 100-year frequency flood elevation of the proposed on-site basin as 870.6 M.S.L. The plans show the proposed finish floor elevation of the store as 876.0 M.S.L. and the car wash as 875.3 M.S.L. The required 2 feet of separation between the flood elevation of a basin and the finished floor elevation of riparian structures is met.

Silt fence at the limits of construction and a rock construction entrance are shown to be installed for erosion control during construction.

It is our recommendation that the LRRWMO approve of the permit for this project subject to the following conditions:

1. Erosion control measures need to be installed prior to the commencement of construction.
2. Upon completion of construction and restoration of disturbed areas, the permit applicant is responsible for the removal of all erosion control measures installed throughout the construction site.
3. To minimize the potential of material from leaving the site and being tracked onto the roadway, a rock filter dike being a minimum of two feet in height and having side slopes of 4:1 must be constructed at the entryway onto the site. The rock filter dike will provide an erosion control facility and also enable construction traffic to enter the site.
4. Street sweeping must be undertaken and completed on an as needed basis.
5. Compliance with the storm water management requirements of the Lower Rum River Watershed Management Organization are to be administered for this project by the City of Anoka.
6. The city of Anoka must provide documentation to the LRRWMO that the retention volume of 8,095 cubic feet required of this project to comply with LRRWMO criteria has been provided within two years (2021) of the issuance of this permit.
7. In all cases where the doing by the permittee of anything authorized by this permit shall involve the taking, using, or damaging of any property, rights or interests of any other person or persons, or of any publicly owned lands or improvements or interests, the permittee; before proceeding; shall obtain the written consent of all persons, agencies, or authorities concerned, and shall acquire all necessary property rights and interest.