SURFACE WATER MANAGEMENT PLAN

City of St. Francis

November 2019

Prepared By:

Hakanson Anderson

The City of St. Francis Surface Water Management Plan (SWMP)

St. Francis, Minnesota

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

By: Craig J. Jochum
License Number: 23461
Date: 11/15/2019

TABLE OF CONTENTS

I. PURPOSE OF PLAN

The purpose of this Surface Water Management Plan (SWMP) is to promote, preserve, and enhance the natural resources within the City of St. Francis. The City will protect water quality and unique, environmentally sensitive land from adverse effects that can potentially be caused by poorly sited development or incompatible activities. The City proposes to accomplish this by regulating land disturbances and development activities.

Minnesota Rules Chapter 8410 (Metropolitan Area Local Water Management) requires specific elements to be addressed in local water management plans. The various sections of this plan are designed to address each element required under these rules. In addition, this plan follows the Metropolitan Council's 2040 Water Resources Management Policy Plan requirements.

The Minnesota Pollution Control Agency (MPCA) has designated the City of St. Francis as a mandatory Municipal Separate Storm Sewer System (MS4) community, which required submission of a National Pollutant Discharge Elimination System (NPDES) permit regulating its stormwater runoff. The City has submitted the MS4 Permit Application and Storm Water Pollution Prevention Plan (SWPPP) to the MPCA and received coverage in the year 2017. Accordingly, an additional purpose of this SWMP is to control or eliminate stormwater pollution.

The City's goal is to minimize conflicts and encourage compatibility between land disturbing activities, water quality, and environmentally sensitive lands. This will be accomplished through detailed development ordinances, plan review standards, and recommended pollution control procedures in an effort to strike a balance between urban growth and the protection of water quality and natural areas. This SWMP, in conjunction with the policies set forth in the City ordinances, establishes standards and specifications for conservation practices and planning activities to minimize stormwater pollution, soil erosion, and sedimentation.

This submittal is a culmination of research, mapping, land use analysis/planning, and hydraulic design. The end product is a design tool that can be used by the City of St. Francis in planning growth and infrastructure replacement. The current City ordinances have also been revisited as part of this process, as they are the best means to implement the recommendations made in this plan.

Following the approval of this SWMP and ordinances by the Upper Rum River Watershed Management Organization (URRWMO), the City will have administrative authority for the approved SWMP and ordinances. The City will also have the duty to enforce the SWMP and associated ordinances. The City places a high priority on improving impaired waters and intends to work with the URRWMO and other agencies to achieve water quality goals by reducing the impact created by activities within the City.

II. EXECUTIVE SUMMARY

A. Plan Purpose and Background

Stormwater regulations have changed significantly over the years. The following is a listing of those regulatory changes:

1. <u>1982</u>

The *Metropolitan Surface Water Management Act* was passed. The Act was originally included in Chapter 509. The Act was recreated and modified in 1990 and became Minnesota Statue 103B.205 to 103B.255.

Originally, the former Water Resources Board oversaw implementation of the Act. When that board was merged with two other boards to form the Minnesota Board of Water and Soil Resources (BWSR) in 1987, BWSR assumed responsibility for the Act. Forty-six watershed management organizations (36 joint powers Watershed Management Organizations and 10 Watershed Districts) were originally responsible for preparing plans to:

- protect, preserve, and use natural surface and groundwater storage and retention systems
- minimize public capital expenditures needed to correct flooding and water quality problems
- identify and plan for means to effectively protect and improve surface and groundwater quality
- establish more uniform local policies and official controls for surface and groundwater management
- prevent erosion of soil into surface water systems
- promote groundwater recharge
- protect and enhance fish and wildlife habitat and water recreational facilities
- secure the other benefits associated with the proper management of surface and groundwater. [1]

2. <u>1987</u>

The Federal Clean Water Act was amended to address stormwater as a pollution source. This resulted in the Environmental Protection Agency (EPA) developing a National Pollutant Discharge Elimination System (NPDES) Phase I permit that targeted cities with populations in excess of 100,000. As a result in 1991, Minneapolis and St. Paul were required to apply for permits. One permit requirement was the development of a city-wide Storm Water Pollution Prevention Plan (SWPPP) that included approximately 30 mandatory Best Management Practices (BMPs) addressing everything from education and good housekeeping for municipal operations to mandatory city ordinances.

[1] Excerpt taken from the Minnesota Board of Water & Soil Resources Website: Metro Watershed Management Plan http://www.bwsr.state.mn.us/metro-watershed-management-plan

3. 1991

The Upper Rum River Water Management Organization (URRWMO) was formed to meet the requirements of the Metropolitan Surface Water Management Act. The URRWMO is a joint powers organization including the cities of St.
Francis, Oak Grove, and Nowthen, and portions of the City of East Bethel. A small corner of the City of Ham Lake also falls within the URRWMO. The URRWMO Board is made up of representatives from each of these cities.

4. 1991

The Minnesota Legislature passed the Wetlands Conservation Act (WCA). The WCA is administered according to Minnesota Rules Chapter 8420, the purpose of which is to:

- Achieve no net loss in the quantity, quality, and biological diversity of Minnesota's existing wetlands;
- Increase the quantity, quality, and biological diversity of Minnesota wetlands by restoring or enhancing diminished or drained wetlands;
- Avoid direct and indirect impacts from activities that destroy or diminish the quantity, quality, or biological diversity of wetlands;
- Replace wetland values where avoidance of activities is not feasible and prudent. [2]

5. 1992

The Board of Water and Soil Resources (BWSR) developed Minnesota Rules Chapter 8410. This set of rules consists of 18 parts that define the scope, general structure, and content required for BWSR approval of a Local Surface Water Management Plan. The table of contents of this plan and the content within each chapter has been structured to meet MN Rule 8410.

6. 2003

NPDES Phase II, the second round of the 1987 Federal Clean Water Act amendment, targeted cities referred to as Small MS4s. These cities were required to apply for an MS4 general permit under several criteria. Cities with a population of at least 50,000 and a population density of at least 1000 per square mile were covered in this phase. Other cities with populations over 10,000 and a population density of at least 1000 per square mile were also covered. In addition, several smaller cities consisting of municipalities with population of at least 5000 that discharge or have the potential to discharge to an outstanding resource value water, trout lake, trout stream, or a water listed as impaired were included.

7. 2005

The Metropolitan Council has requirements for local water management plans.
This Surface Water Management Plan Update is designed to address current requirements governing local water management plans. The general boundary of the plan includes all property within the city limits of St. Francis. When accepted by all local, regional, state, and federal agencies having jurisdiction, the City of St. Francis will be the sole responsible party for administering this plan.

[2] Wetland Conservation Act, Minn. Rule 8420.0100

8. 2017

The City of St. Francis received coverage under the National Pollution Discharge Elimination System/State Disposal System General Permit MNR040000 for small MS4s.

9. 2017

The Rum River Watershed Total Maximum Daily Load Report (TMDL) was approved by the U.S. Environmental Protection Agency (EPA). The City of St. Francis is responsible for meeting the Wasteload Allocations (WLAs) stated in the TMDL.

B. General Content of Required Local Plans

This SWMP follows the general report structure listed in Minnesota Rules Chapter 8410.0160, the general requirements in Minnesota Statute sections 103B.205 - 103B.255, and the Metropolitan Council's requirements for local water management plans as outlined in the City of St. Francis' 2015 System Statement.

C. Summary of the Goals, Problems, and Potential Solutions

The general findings of this Surface Water Management Plan are summarized as follows:

1. St. Francis is located in the Anoka Sand Plain. The area is well known for its highly permeable soil. As such, the runoff from significant rainfalls is generally reduced to the extent that the existing drainage network functions well. There is no significant flooding along the Rum River floodplain, but during large storm events there is some significant flooding along Seelye Brook and in wetlands.

   Because of the pervious nature of the Anoka Sand Plain, the City will need to review its development ordinances to mitigate the adverse effect that a significant increase in impervious surfacing and mass grading can have on runoff conditions. The addition of significant amounts of impervious surfaces and the reduced permeability associated with the soil compaction in mass grading without a reasonable attempt to restore or duplicate the current infiltration pattern could create very significant increases in runoff volumes and downstream flooding.

   This is especially true where improvements in uppermost watershed limits must flow a significant distance to the ultimate watershed outlet. The longer flow path associated with each of these watersheds allows greater opportunities for peak flows from conventional detention ponds to coincide.

   One solution to the problem of coincident peak flows is the use of low impact development techniques. The current low-density residential developments in the areas outside of the downtown corridor and areas surrounding the Rum River are a close approximation of what a low impact development can be like. This area has a noticeably lesser stormwater impact than that of either high-density residential developments or commercial/industrial developments.

   This plan recommends modifying the current development ordinances to require infiltration and soil ripping of mass grading to compensate for lost infiltration conditions as well as requiring oversized retention ponding to mitigate and compensate for increases in runoff. Innovative solutions to the stormwater runoff increases associated with the increase in impervious surface will be investigated and encouraged when deemed appropriate. Potential solutions include pervious pavements, infiltration basins, and low impact development among others.

2. The City of St. Francis MS4 has three wasteload allocations (WLAs) from the Rum River TMDL Report, which was approved by the EPA on September 26, 2017. Two of the WLAs are for *E. coli*, one for Cedar Creek and one for Seelye Brook. Both streams were listed as impaired for *E. coli* in 2016.

3. An integral part of this SWMP is the comprehensive stormwater runoff modeling of the existing conditions throughout the entire city. This modeling includes:

    a. Mapping major drainage outfalls from the City as well as more detailed mapping in higher density residential areas with storm sewer and pond systems.

    b. Estimating the runoff from the 100-year rainfall event.

    c. Routing the runoff through the existing system.

    The existing system may be a pipe network, pond, wetland, or waterway. The modeling predicts the peak flows based on the 100-year rainfall event.

    This modeling will provide a baseline for comparison purposes as new developments change the drainage pattern. With this modeling information, City staff can readily review the cumulative impacts of large developments for effects on the baseline conditions across the entire watershed.

    StormNET software was used in the comprehensive modeling. This software is based on the industry standard EPASWMM process and the St. Vennant equations. The model can be used to input actual rainfall events from rain gauges and can model the transport of pollutants through the system. This will be very useful in evaluating the BMP measures to address future TMDLs.

4. Where the cumulative effect of regulated development is potential flooding, the recommended practice is the construction of infiltration basins, retention ponds, or detention basins as a requirement of further development of the outlying growth areas. It is further recommended that the post-construction peak outflows from new developments be limited to 90 percent of the existing peak flow for the 2, 10, and 100-year storms in areas where infiltration is possible. Where infiltration is not permitted/possible, post-construction flows shall not exceed existing discharge rates. This will better mitigate the cumulative effects of increased impervious surfacing and increased runoff volume from new developments.

    Because the majority of the area is served by large stream/wetland complexes, regional ponding is not possible for a significant part of the City. Where they are possible, the creation of regional ponds is preferred because of the limited maintenance (compared to a multitude of individual development ponds) and the opportunity to control larger drainage areas. By contrast, a multitude of scattered ponds associated with each individual site development may be designed to reduce the peak outflow for its smaller area, by storing the excess runoff and releasing it at a lesser rate for a longer duration. This longer pond outflow duration may coincide with the reduced peak flows from other individual site ponds and create a larger combined peak flow than the original undeveloped condition. Hence, regional ponds are recommended where physically possible, because of the opportunity to control the runoff on a larger scale and ensure that the downstream system is not adversely impacted by uncoordinated development that meets a typical runoff ordinance. The greater control afforded by regional ponds may also reduce the flows to the downstream system and allow for decreased costs in downstream infrastructure improvements.

5. The proposed infiltration requirements and pond network is part of the goal of accommodating continued responsible growth. Revisions will be required as formal developer layouts are presented to the City. Although this plan forms a sound basis for future development, it is important to remain flexible in finding ways to manage runoff while still accommodating the continued development of the City.

6. The maps attached at the end of this plan are for general illustration purposes. As part of the plan development, large scale maps and GIS compatible files have also been prepared.

7. The City will pursue outside funding to help finance the recommended capital improvements described in this plan. Local financing will most likely come from a combination of stormwater trunk fees and stormwater utility funds.

   Any determined stormwater management charges or area charges to new developments should be reviewed on an annual basis to ensure that changes in land acquisition, construction cost, bonding cost, legal cost, etc. are included in the computed fee.

8. The use of native vegetation for buffers in undeveloped and previously developed areas is strongly recommended in accordance with regulatory requirements and accepted practices. This plan requires the protection of the City's wetlands through the use of wetland buffers. New developments will be required to provide native vegetated buffers around wetlands. The City will also encourage the landowners around existing wetlands in developed areas to add buffers to their wetlands. Wetlands are to be further protected by controlling discharges from developing areas. The proposed controls include pretreatment BMPs and runoff controls designed to maintain the current hydrology and maintain or improve the current functions and values of the wetland.

D. Amendments and Updates

This plan is intended for the coverage period to 2028. It should be considered as a working document that should be updated and amended in accordance with the procedures described in Section IX. Amendment will be needed as development progresses and actual new development data is integrated into the overall model.

III. REGULATORY REQUIREMENTS AFFECTING PLAN

The requirements outlined in this plan were guided by Minnesota Rules Chapter 8410, Minnesota Statute 103B, the MPCA Construction Stormwater General Permit issued August 1, 2018, St. Francis Code Section 10 – Chapter 93 "Stormwater Management – Stormwater Pollution Prevention", City of St. Francis SWPPP (approved in 2017), the Rum River TMDL dated July 2017, and the requirements of the Upper Rum River Watershed Management Organization.

IV. LAND AND WATER RESOURCES INVENTORY

Each plan must contain an inventory of water resources and physical factors affecting the water resources based on existing records and publications. If data publications and maps are available at a convenient central location, they may be included by reference. The plan must include a brief summary of the data and must identify where the publication can be obtained. The following subsections are required.

A. Precipitation

The state climatology office has records of all official rain gauges throughout Anoka County. The monthly precipitation totals and county-wide monthly averages are available online at:

climateapps.dnr.state.mn.us

Information is available from 1898 to the present. Between 1981–2010, the estimated aggregate annual precipitation for St. Francis ranged as follows:

Lowest annual precipitation.................... 22.68 inches in 1988

Highest Annual Precipitation.................. 46.35 inches in 2002

Average Annual Precipitation .... 33.27 inches per year

The following is the average annual precipitation for Anoka County per decade:

1970s.. 30.4 inches per year

1980s.. 29.9 inches per year

1990s.. 34.5 inches per year

2000s.. 33.9 inches per year

2010-2018..35.6 inches per year

On the average, June is the wettest month, followed by August and July.

B. General Geology and Topographic Data

The Rum River flows through the City of St. Francis. The general terrain is relatively flat and is often referred to as the Anoka Sand Plain. The elevations range from approximately 1100 feet above mean sea level in northwestern St. Francis to near 880 feet at the most downstream point of the Rum River before leaving the City. The straight-line distance between these points is approximately 35,000 feet, making the average slope less than 1 percent. In general, the land slope ranges from less than 1 percent to 2 percent. Steep slopes exist along the Rum River, as well as in other locations scattered throughout the City.

Virtually all of the St. Francis city limits is within the Anoka Sand Plain, which consists of highly permeable soils. The Anoka Sand Plain is part of the undifferentiated drift (Layer 1). The Minnesota Department of Natural Resources and the Minnesota Geological Survey generated Figure 1 as part of the Regional Hydrogeologic Assessment for the Anoka Sand Plain[3]. Based on Figure 1, waterborne contaminants in the St. Francis area can reach upper aquifers within hours or months of release, necessitating additional care in regulating surface water

[3] Minn. Dept. of Natural Resources. Website: https://www.dnr.state.mn.us/waters/programs/gw_section/mapping/platesum/rha_asp.html

contamination. The majority of St. Francis is rated with the highest geologic sensitivity to pollution in the uppermost aquifer with a portion in the west rated in the moderate to high sensitivity.

The City Wellhead Protection Plan was completed in 2015. See Appendix C for the map showing the 10-year capture zone (Well Head Protection Area, WHPA) as well as the Drinking Water Supply Management Area (DWSMA) for the three municipal drinking water wells in St. Francis.

C. Surface Water Resource Data

1. Public Waters

A map of the public waters, streams, lakes, and public ditch systems established under Minnesota Statutes chapter 103D or 103E is shown in Figure 3.

The Minnesota Department of Natural Resources (DNR) uses the U.S. Fish and Wildlife classification system (Circular 39) for wetlands and currently requires a permit for alteration of wetland types 3-5 that are 2.5 acres or larger. St.
Francis City Code Chapter 10, Section 91 includes provisions designed to further protect wetlands.

In addition to the protected waters list, the Rum River is designated as a Wild & Scenic Outstanding Resource Value Water (it is classified as Scenic and Recreational from the Highway 27 bridge in Onamia to Madison and Rice streets in Anoka) and is therefore a “special water” (see Figure 2 – Parks Map).

2. Shoreland

In order to control the development and utilization of shoreland along protected waters thereby preserving the water quality, natural characteristics, economic values, and the general health, safety, and welfare, the City of St. Francis implemented the Rum River Scenic District and Urban Stormwater Ordinances. These ordinances are intended to control the utilization of shoreland areas and to preserve the quality and natural character of these waters within the City.

3. Minnesota Wetlands Conservation Act

The National Wetlands Inventory (NWI) map is attached as Figure 4.

According to City Code Chapter 13, pretreatment of all stormwater from new developments is required prior to discharge into any wetlands.

The Minnesota Wetland Conservation Act (WCA) requires the designated Local Governmental Unit (LGU) in charge of administering the WCA to generate a Notice of Decision for any impact to wetlands within the City of St. Francis. In all but minor decisions, the LGU will call for a Technical Evaluation Panel (TEP) review of the application or impact prior to issuing a decision. The LGU may give notice of proposed actions affecting wetlands to all of the following:

a. The Minnesota Board of Water and Soil Resources
b. The Soil and Water Conservation District
c. The Minnesota Department of Natural Resources

d. The Upper Rum River Watershed Management Organization

e. The U.S. Army Corps of Engineers

f. Interested citizens requesting notification of such actions

If a TEP meeting is required, all listed parties are invited to review the proposed action. However, it is not uncommon for a TEP meeting to consist of only a small contingent of this list, as some invitees may have no jurisdiction over the proposed action.

4. Watersheds

A general watershed map is attached as Figures 8A and 8B. The City of St. Francis was broken into 9 larger watersheds based on general drainage patterns, topography, and the waterway to which they drain. The major watersheds were further delineated into subwatersheds based on topography and the type of stormwater management systems. Watersheds that primarily use storm sewer and detention ponds for stormwater management were delineated. The map shows the major watersheds and subwatersheds as well as modeled open channel segments, stream junctions, and outfalls.

5. Flood Levels

Floodplains are covered by City of St. Francis Code Chapter 10, Section 81. A comprehensive map showing all of the FEMA (Federal Emergency Management Agency) Flood Insurance Rate Map (FIRM) floodplains is attached as Figure 5. Flood studies have been performed (with elevations determined) for the following waterways:

a. Rum River

b. Seelye Brook

Flood zones have been mapped for County Ditch 18 and 19, but elevations have not been established. Copies of the flood studies and maps are available at City Hall or online at the FEMA Map Service Center.

6. Water Quality Information

a. Impaired Waters

Section 303d of the Clean Water Act requires that each state submit a list of Impaired Waters. The MPCA website lists the impaired waters as officially designated in 2018. Table 1 lists the impaired waters found in St. Francis:

Table 1

303d Impaired Waters List Excerpt from MPCA

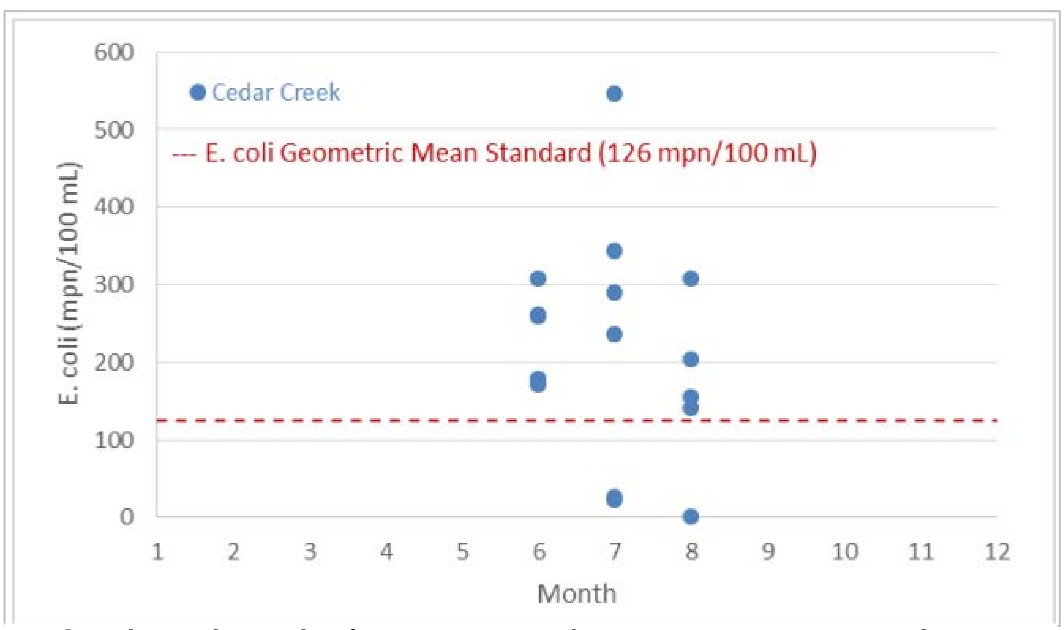
Name	Affected Use	Pollutant or Stressor	Year Designated	TMDL (to be) Competed
Cedar Creek	Aquatic Recreation	Nutrient/eutrophication biological indicators	2016	2017

Rum River	Aquatic Consumption	Hg	2008	NA
Seelye Brook	Aquatic Recreation	*Escherichia coli*	2016	2017
Trott Brook	Aquatic Life	Aquatic macroinvertebrate bioassessments	2016	2027
		Dissolved oxygen		2017
		Nutrient/eutrophication biological indicators		2027

b. Waste Load Allocations

The City of St. Francis MS4 has three wasteload allocations (WLAs) from the Rum River TMDL Report, which was approved by the EPA on September 26, 2017. Two of the WLAs are for *E. coli* (Cedar Creek and Seelye Brook), and one WLA for dissolved oxygen (DO) for Trott Brook.

Cedar Creek is approximately 28.6 miles long and begins near the City of Isanti, flows south into East Bethel and Oak Grove, and eventually joins the Rum River. Around 618 acres of the southeast corner of St. Francis is within Cedar Creek's subwatershed. Monthly samples were taken from June through August between 2006 and 2015. The standard for *E. coli* should not exceed 126 colony-forming units (or most probable number) per 100 mL. All but two data points were above the standard, as shown in Graph 1.



Graph 1. This graph was taken from Figure 3-14 in the Rum River TMDL Report and represents single sample *E. coli* concentrations by month in Cedar Creek (S003-203) from 2006 through 2015.

St. Francis's contributing area to Cedar Creek's subwatershed is 1.2%, so the City's *E. coli* allocation is 1.2% of the allowable load. *E. coli* loads correlate with the flow of the stream. There are five levels of flow: very high, high, mid, low, and very low. There is a corresponding *E. coli* allocation for each of the five flow levels, as shown in the table below.

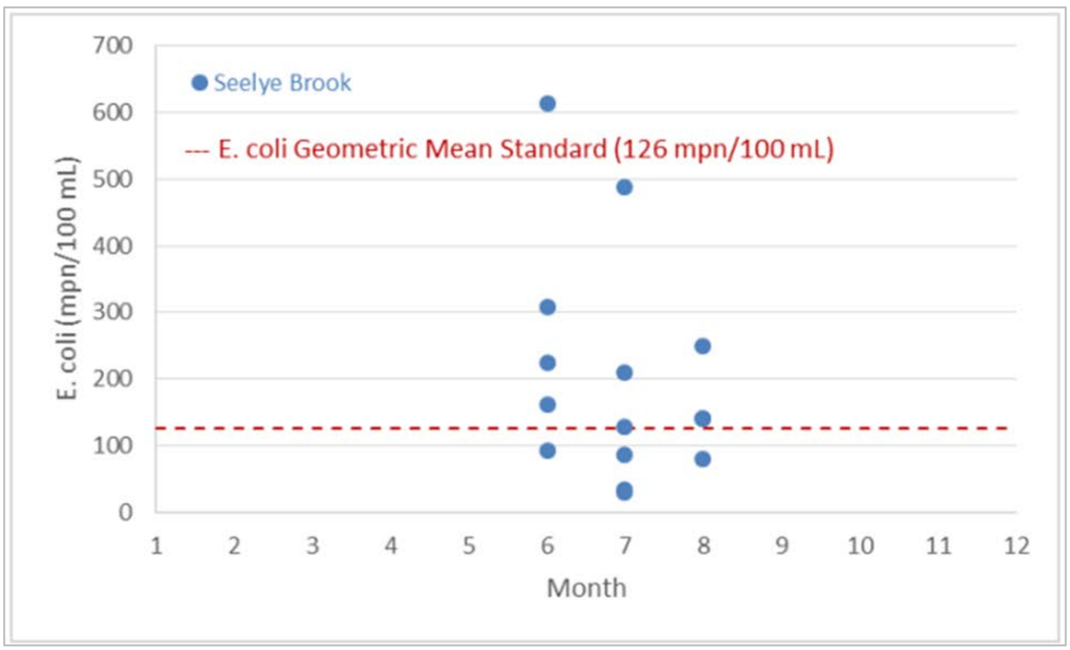
Table 2

Cedar Creek *E. coli* Total Maximum Daily Load Summary for St. Francis*

Source: Rum River Watershed TMDL Report, Table 4-4

	***E. coli* TMDL Component (billions of organisms/day)**				
Flow Zone	Very High	High	Mid	Low	Very Low
St. Francis MS4	3.59	1.88	1.16	0.82	0.43

Seelye Brook is approximately 12.4 miles long and begins in Isanti County, flows through the west side of St. Francis, and joins the Rum River in Oak Grove. More than half of the samples points taken in the summer months between 2006-2015 exceeded the 126 mpn/100mL *E. coli* standard as shown in the Graph 2.



Graph 2. This graph was taken from Figure 3-15 in the Rum River TMDL Report and represents single sample *E. coli* concentrations by month in Seelye Brook (S003-204) from 2006 through 2015.

Around 6,481 acres of St. Francis contributes to Seelye Brook's subwatershed, which is 25% of the contributing watershed. Therefore, St. Francis MS4 has 25% of the allowable load for their *E. coli* allocation.

Table 3

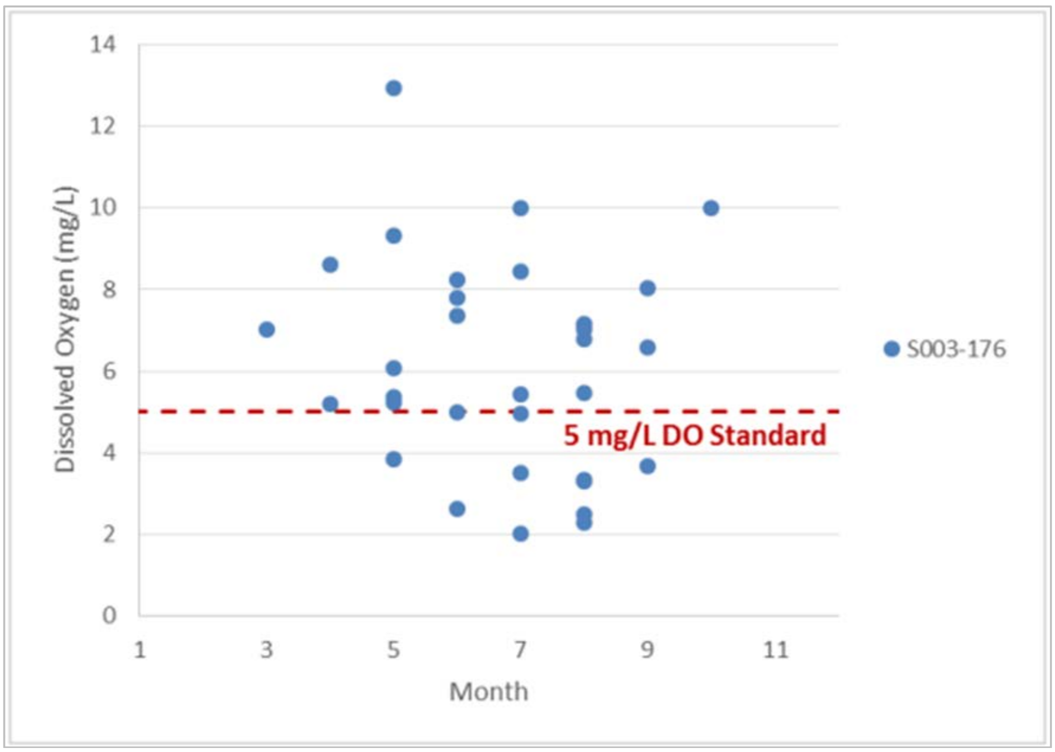
Seelye Brook E. coli Total Maximum Daily Load Summary for St. Francis

Source: Rum River Watershed TMDL Report, Table 4-6

	E. coli **TMDL Component (billions of organisms/day)**				
Flow Zone	Very High	High	Mid	Low	Very Low
St. Francis MS4	104.73	45.84	26.10	14.65	7.20

The 4.4-mile length of Trott Brook begins in Sherburne County, travels south, turns east into the City of Ramsey, and then flows into Rum River. The DO monitoring consisted of 33 samples between 2006 – 2015. Approximately 33 percent of the sample points fell below the minimum daily standard of 5 mg/L for DO, as shown in Graph 3.

The City of St. Francis has 47 acres of contributing area to the Trott Brook watershed, which is less than one-percent of the MS4 load. The allowable oxygen demand, consisting of sediment oxygen demand (SOD); nitrogenous oxygen demand (NOD); and biochemical oxygen demand (BOD) combined, is 1 pound per day.



Graph 3. This graph was taken from Figure 3-18 in the Rum River TMDL Report and represents seasonal variation of dissolved oxygen samples in Trott Brook from 2006 to 2015.

c. Other Data

The Minnesota DNR maintains a database on all Minnesota lakes. Some of this data is very limited or not available, while other lakes have been studied in great detail. To find the most current data on the lakes around St. Francis, access the Lake Finder on the DNR Website.

The WMO document in Appendix B has a list of monitoring locations. The Anoka Conservation District (ACD) has water quality information. The ACD has also published a water atlas.

7. Water Appropriations

The City's Wellhead Protection Plan was completed in 2015 and includes three municipal water wells. The Wellhead Protection Plan is incorporated into this plan by reference. At present, the plan includes all of the current municipal ground water appropriations.

8. Soil Data

The Anoka County soil survey map of the St. Francis area is shown in Figure 6. In general, the City of St. Francis has soils in Soil Conservation Service (SCS) Hydrologic Soil Type A and A/D. In the western portion of St. Francis, large areas of Type B soils exist, as well as some Type C. Table 4 lists the recommended infiltration rates based on SCS hydrologic soil types.

Table 4

Infiltration Rates Per Soil Type

Source: MPCA Stormwater Manual

Hydrologic Soils Type	**Infiltration Rate**	**Soil Texture**
A	0.80 inches/hour	Sand, loamy sand, or sandy loam
B	0.30 inches/hour	Silt loam or loam
C	0.20 inches/hour	Sandy clay loam
D	0.06 inches/hour	Clay loam, silty clay loam, sandy clay, silty clay, or clay

9. Land Use and Public Utility Services

Necessary land use and public utility services information is limited to information that existed at the time the plan or plan amendment was developed, including a general map of the existing land cover in St. Francis (Figure 7).

Land use is one of the primary mechanisms that affect flooding and water quality. As prairie and forested areas are converted to agricultural and urban uses, the volume and rate of stormwater runoff increases. This increase in stormwater runoff can cause a change in the bank-full flow of area streams and conveyances. This can cause stream bank erosion and deterioration of the stream. In addition, increased area runoff can cause erosion in steep areas. The conversion of natural land cover also increases the amount of pollutants in stormwater runoff such as the levels of pesticides and nutrients from agricultural land use and trace metal concentrations from urban land use. Pollutant loading analysis has not been included within this plan. This plan estimates the future land use throughout the study area in order to evaluate the drainage system needs.

Although pollutant concentrations may not vary greatly between land uses, pollutant loadings are a function of both runoff volume and concentration. The volume of runoff is directly related to the amount of impervious surface from a particular land use. For example, if a fictitious *Area A* has twice the runoff due to higher impervious land cover as *Area B* with the same pollutant concentration, *Area A* will have twice the pollutant loading. This is the basis for the major difference in water quality between residential and commercial land uses and affects surface water planning strategies for the different land uses.

10. Water-based Recreation Areas and Land Ownership

Figure 2 – Parks Map shows the location of all parks and all DNR public water accesses within the City of St. Francis.

11. Fish and Wildlife Habitat

Per Figure 4-2 of the December 2017 SWMP draft URRWMO, no outstanding or high biodiversity significant sites exists within the community.

12. Unique Features and Scenic Areas

The Rum River Corridor within the City has unique and valuable local, state, regional, and national resources. The river is an essential element in the local, regional, and state economy; sewer and water and recreational systems and serves important biological and ecological functions. The prevention and mitigation of irreversible damage to these resources and the preservation and enhancement of their natural, aesthetic, cultural, and historic values is in furtherance of the health, safety, and general welfare of the City. The Rum River Scenic River is protected under St. Francis City Ordinance.

City Code Chapter 10, Section 82 regulates bluff land and river land development in order to protect and preserve the outstanding scenic, recreational, natural, historical, and scenic values of the Rum River in the City of St. Francis.

13. Pollutant Sources

The City is not aware of any landfills or significant sources of high nitrate concentrations.

The City does not keep a list of storage tanks. These records are currently kept at the Anoka County Environmental Services office.

The MPCA "What's in My Neighborhood?" website lists known and potential sources for soil and groundwater contamination. The majority of the sites listed are Voluntary Investigation and Cleanup (VIC) sites. A text based search for Anoka County and Zip code 55070 listed 4 sites; however, one site is in the City of Anoka. A city dump is listed even though there is no known landfill within the city limits. The other two sites listed in the City of St. Francis are displayed in Table 5.

Table 5

Known or Potential Sources of Soil or Groundwater Contamination

Site ID	Site Name	Address	City, State, Zip
VP7491 (4854)	St. Francis Auto Part	4140 Saint Francis Boulevard NW	St. Francis, MN 55070
No MPCA ID	St. Francis Sewage Ponds	Adjacent to South City Limits, Just West of Rum River Blvd NW	St. Francis, MN 55070

D. Design Requirements

Chapter 10, Section 93 of the City Code outlines the requirements for water quality and water quantity. This section summarizes those requirements. The St. Francis SWMP has a dual purpose: 1) It will serve as a guide for the construction of storm drainage facilities, and 2) it will provide a basis for a consistent approach to the preservation of lakes, wetlands, streams, and the Rum River. The following issues have been incorporated into this plan:

1. Division of the City into major watersheds based on contour maps and natural topography
2. Recommendations to accommodate the ultimate land use conditions
3. Recommendations for the revision of the current development ordinances
4. Recommendations for standard Operations and Maintenance procedures
5. Recommendations for specific construction site erosion control practices
6. Estimated construction and implementation costs of the SWMP
7. Recommendations for education of City residents, staff, and development community
8. Recommendations to meet TMDL requirements

The primary function of an urban stormwater drainage system is to minimize economic loss and inconvenience due to periodic flooding of streets and other low-lying areas.
Adequately designed stormwater drainage facilities provide flood control, minimize hazards and inconvenience associated with flooding, and protect or enhance water quality. The SWMP takes the entire drainage basin with future saturation development into consideration.

To provide flood protection for adjacent property, the design storm interval for ponding areas is a 100-year storm as compared to a 10-year storm for design of storm sewer piping. Any new residential, commercial, industrial, and other habitable structures shall be constructed with the following low floor elevations:

1. Minimum building (low floor) elevations shall be above in-situ, designed or designated water levels. The lowest building floor elevation shall be three (3) feet above mottled soils or the highest known or anticipated water table, whichever is higher. The City Engineer may allow deviation from these separations if the applicant submits evidence certified by a Licensed Geotechnical Engineer that a lesser separation can be achieved. Certification by a Licensed Geotechnical Engineer shall include field monitoring of the groundwater with piezometers to establish the highest anticipated ground water elevation.

2. Minimum opening elevations shall be above designed or designated flood levels. The minimum building opening elevation shall be one and a half (1.5) feet above the 100-year flood level or emergency overflow elevation. The 100-year flood level shall be the highest 100-year level resulting from a single event analysis; the 100-year, 10-day snowmelt event; a multiple day runoff event analysis, or the critical event analysis.

3. Landlocked runoff basins shall be sized to handle back-to-back 100-year SCS twenty-four (24) hour rainfall events, the ten (10) inch SCS twenty-four (24) hour rainfall event or the 100-year, 10-day snowmelt snow melt event, whichever produces the higher peak pond elevation (landlocked high water level). The lowest building floor elevation around landlocked basins shall be two (2) feet above the landlocked high water level.

Emergency overflows or outlets to drainage systems shall be provided to any landlocked area if the available stormwater storage capacity is inadequate to prevent flooding of residences and if the available downstream conveyance system capacity is adequate to accept additional flow.

The area of a pond's high water level (HWL) plus one (1) foot of freeboard shall be contained entirely within an outlot that is owned by the City or within a drainage and utility easement.

In areas adjacent to designated floodplains as mapped on a Flood Insurance Rate Map, the Regulatory Flood Protection Elevation (RFPE) applies. The RFPE is defined as the mapped 100-year flood elevation plus 1 foot. The URRWMO requires that the low floor elevation of structures be 1 foot above the 100-year high water level or regional flood level for the adjacent water or wetland. City policy requires all structures, including accessory structures, be elevated on fill so that the lowest floor including basement floor is 1 foot above the Regulatory Flood Protection Elevation or 1 foot above the mapped 100-year flood elevation. The finished fill elevation for structures shall be no lower than the Regulatory Flood Protection Elevation and the fill shall extend at such elevation at least fifteen (15) feet beyond the outside limits of the structure erected thereon.

The effective use of ponding areas enables the installation of outflow sewers with reduced capacities since the design storm duration is effectively increased over the total time required to fill and empty the ponding reservoirs. Storm sewers represent a sizable investment for the community and this investment can be more efficiently utilized by ponding stormwater in designated ponding areas and allowing smaller diameter pipes to be used as outfall lines.

Equally as important as flood control and cost considerations, is the use of ponding areas to:

1. Improve water quality;
2. Return stormwater to the groundwater table;
3. Increase water amenities in developments for aesthetic, recreational and wildlife purposes.

For water quality ponds, the storage below the outlet is the most important consideration. The area and depth of the ponds may differ from the values presented here. Storage below the outlet must be provided so that the prescribed pollutant loading of the system is not exceeded.

Amenity aspects are maximized by careful planning in the initial development of any residential, commercial, or industrial area and by integrating the ponding system into a regional SWMP. However, care should be given to make the developer responsible for the design water level. If development plans show a permanent water level, the City will include a provision in its development agreements requiring the developer and ultimately the subdivision or development area to be responsible for maintaining the water level.

The City's review will address water quality and hydraulics and not the permanent water level. The Anoka Sand Plain is known for its high infiltration capacity as well as its fluctuating water levels. The City of St. Francis will not participate in maintaining or engineering water levels.

The wildlife aspects of ponding areas shall be maximized through the design and proper placement of a trail system, if included in the development layout, which will allow access to these areas for wildlife observation.

It is extremely important that each area be re-evaluated at the time of final design to confirm the criteria used in this study and to make any changes that a proposed development may dictate. Special consideration must be given to areas that develop differently than shown in the Comprehensive SWMP, especially when a higher runoff coefficient (higher impervious surface ratio) is likely to result from development.

All storm sewer facilities, especially those conveying large quantities of water at high velocities, shall be designed with efficient hydraulic characteristics. Special attention shall be given during final design to those lines that have extreme slopes and create high hydraulic heads.

The Best Management Practices (BMPs) recommended by the MPCA shall be followed wherever necessary. These items should be incorporated into the design and operation of any new or existing stormwater systems.

Infiltration basins will be required in lieu of wet sedimentation basins in all areas where practical. By incorporating infiltration, the basin provides volume control and water quality management. The infiltration requirements are summarized below:

1. Volume, total suspended solids, and total phosphorous may not increase on an average annual basis.
2. An instantaneous stormwater volume calculated as one inch of runoff from the new impervious surface shall be retained onsite.
3. Infiltration may be prohibited. Infiltration shall be prohibited if one or more of the following circumstances are present:
    a. The site is required to obtain a NPDES/SDS Industrial Stormwater Permit and the permit prohibits infiltration;
    b. Where vehicle fueling and maintenance occur;
    c. Less than three (3) feet of separation is present from the bottom of the infiltration practice to the elevation of the seasonally saturated soils or top of bedrock;
    d. Where high levels of contaminants in the soil or groundwater will be mobilized by infiltrating stormwater.
4. Infiltration may be restricted. Higher engineering review shall be required when the infiltration device will be constructed in areas:

a. Within a Drinking Water Supply Management Area (DWSMA) as defined in Minn R. 4720.5100, subp. 13;

b. Where soil infiltration rates are more than 8.3 inches per hour;

c. Other areas as determined by the City Engineer.

5. For redevelopment stormwater runoff rates, volume, total suspended solids, and total phosphorus must be managed from the predevelopment values, based on the last 10-years of how that land was used. Also accelerated channel erosion must not occur as a result of the proposed activity.

a. Stormwater peak discharge rates shall not increase for the 24-hour, 2-year, 10-year, and 100-year storm events.

b. Volume, total suspended solids, and total phosphorous must show a net reduction on an average annual basis.

c. An instantaneous stormwater volume calculated as one inch of runoff from the new impervious surface shall be retained on-site.

6. For projects where site constraints limit the ability to provide the required control practices within the project boundary; the project shall provide for downstream improvements for that portion that cannot be treated within the project boundaries. Such projects may include:

a. Linear projects where reasonable effort has been made to obtain sufficient right-of-way to install required control practices and said efforts have been unsuccessful;

b. Sites where infiltration is prohibited;

c. Other locations as determined by the City.

7. Sequencing. Projects that cannot fully meet the stormwater requirements of this section must demonstrate the site constraints through a sequencing analysis subject to review and approval of the City Engineer. Prior to consideration of off-site mitigation, the applicant must demonstrate on-site treatment to the maximum extent practicable given the site constraints.

8. Projects that have made reasonable effort but have been unable to fully meet volume, total suspended solids, and total phosphorus requirements within the project limits may, upon authorization by the City, utilize the following methods to meet that portion not met onsite, listed by priority:

a. Provide treatment that yields the same benefits in an offsite location to the same receiving water that receives runoff from the project site. If this is not feasible then;

b. Provide treatment that yields the same benefits in an offsite location within the same Minnesota Department of Natural Resources catchment area as the project site. If this is not feasible then;

c. Provide treatment that yields the same benefits in an offsite location within an adjacent Minnesota Department of Natural Resources catchment area up-stream of the project site. If this is not feasible then;

d. Provide treatment that yields the same benefits at a site approved by the City.

e. Offsite mitigation authorized by the City shall be completed within 24-months of the beginning of construction on the permitted site.

9. Applicants shall provide documentation showing compliance with the rate and quality requirements of this section. Acceptable documentation shall be:

a. For Rate and Volume. Calculations shall be by a methodology listed in the Minnesota Pollution Control Agency's publication, "The Minnesota Stormwater Manual" or other method approved by the City.

b. For total suspended solids and total phosphorus: Calculations shall be done using the Minimal Impact Design Standards (MIDS) Calculator available on the MPCA website, P8, or other method approved by the City.

c. Prepared and certified by a Professional Engineer.

E. Stormwater Modeling

1. Runoff

Stormwater runoff is defined as that portion of precipitation which flows over the ground surface during, and for a short time after, a storm. The quantity of runoff is dependent on the intensity of the storm, the length of storm, the amount of rainfall, the type of ground cover, and the slope of the ground surface.

The intensity of a storm is described by the amount of rainfall that occurs during a specific time interval. A specific rainfall amount occurring during a given time interval will statistically recur, on the average, at a certain frequency (usually measured in years). This is called a return frequency. A return frequency designates the average time span during which a single storm of a specific magnitude is likely to occur. For example, a 100-year rainfall event in St. Francis is that 24-hour rainfall amount (5.9 inches) that recurs, on the average, once in 100 years.

The degree of protection afforded by storm sewer facilities is determined by selecting a return frequency to be used for design based on good economic sense and current engineering practices. See section E.4 for further discussion.

2. Hydrographs

Storm sewer and associated detention basin design is typically based on hydrograph analysis. A hydrograph is a graphical depiction of the time versus rate of runoff for a particular area. For example, if a rainstorm started at midnight, the first few minutes is spent with sprinkles and wetting the various surfaces. As the storm intensifies, the rainfall overwhelms the ability of the pavement and adjacent ground to absorb it, and water begins to flow across the surface. At the peak of the storm, the water runs off at its greatest rate. Finally, as the storm passes, the runoff begins to slowly taper off. The U.S. Soil Conservation Service (SCS) has performed extensive research in hydrograph analysis and developed a standard hydrograph. Technical Release No. 20 (SCS TR 20) describes a methodology that is generally accepted by the reviewing authorities and hydrologic engineers across the United States. The SCS procedure is based on a standard rainfall hydrograph that is modified by local parameters (i.e., rainfall, soil type, watershed size, watershed shape, the fall across the watershed, etc.). Based on local conditions, the SCS hydrograph was used for development of the

St. Francis stormwater model in this plan.

A SCS 24-hour Type II storm distribution with 100-year frequency was used for the model. The Soil Conservation Service has determined from National Weather Bureau data that a Type II distribution is the storm event recommended for the upper-Midwestern United States.

The SCS hydrograph method is based on sound hydrologic theory and is commonly used to analyze runoff for the design and analysis of flows and water levels. The detailed modeling computations for this plan have been performed using the StormNET Modeling Software as developed by Boss International, Inc.

3. Rainfall Probability

NOAA Atlas 14 rainfall data for the United States shows that a 6.91-inch rainfall has a statistical probability of occurring once every 100 years in the St. Francis area. This is not to say that a 6.91-inch rainfall cannot occur more often, in subsequent years, or even on multiple occasions within the same year; it is just to say that a 6.91-inch rainfall will occur *on the average* once every 100 years. It is generally more accurate to refer to the 100-year rainfall as that event having a 1 percent chance of occurring in any given year.

The SCS National Engineering Handbook snowmelt data shows the 100-year, 10-day snowmelt event is 7.4 inches over 10 days.

4. Pond and Pipe Design Criteria

To provide reasonable protection of downstream facilities, analysis of flood levels, storage volumes, and flow rates for water bodies and detention basins shall be based on the range of rainfall and snow melt durations producing the critical flood levels and discharges. This plan recommends a 10-year frequency design for storm sewer pipe using the Rational Method[4]. It is further recommended that pond design be based on the greater of the 100-year, 24-hour frequency SCS rainfall event or the 100-year, 10-day snowmelt event for overland drainage and pond storage design. In comparing the peak pond elevations for each of these events, the 100-year SCS rainfall event, with the assumption that the infiltration rate was negligible, created the highest peak pond elevations. Hence, throughout the remainder of this plan, the peak 100-year pond rates are discussed for typical pond High Water Levels (HWLs). These design criteria were selected for the analysis of the drainage system for this SWMP.

Stormwater detention facilities with peak discharge rates less than 2 cubic feet per second (cfs)/40 acres are typically susceptible to high water levels during snowmelt conditions.

Special consideration of the snowmelt condition becomes critical for areas like the Anoka Sand Plain where infiltration dampens the effect of runoff from rainfall. These areas can accept high amounts of rainfall during the warm, summer months, but often remain frozen later in the season and are relatively impervious in the spring

[4] The Rational Method is markedly different than SCS methodology in that it does not deal with runoff volumes, only flow rates. An explanation of the Rational Method is made later in this plan.

during the snowmelt. Hence, snowmelt runoff can be a greater flood hazard than a large summer rainfall due to the impermeable nature of frozen soil. Accordingly, final basin design must consider snowmelt conditions when sizing storage and outlet structures.

When rainfalls exceed the recommended 10-year storm sewer infrastructure design, the excess runoff will be accommodated by ponding in low spots in streets for short periods of time and outflow through overland drainage routes and/or emergency overflows (EOFs). With proper planning, this short-term flooding and overland drainage should minimize damage to property that would occur if those facilities were not provided. Drainage routes and EOF locations should be protected and preserved either by ordinance or through recorded permanent easements. Where possible, stormwater pond designs shall include an emergency overflow to provide an outlet at a minimum of 1-foot below the lowest floor elevation of any adjacent structure for added safety.

The Rational Method is a flow rate design method that ignores volumes and assumes a peak flow to each pipe based on hydrologic parameters such as watershed area, time of concentration, and standard rainfall intensity curves. This design method requires the selection and/or computation of a time of concentration and a runoff coefficient. The time of concentration is the time required for the runoff from a storm to become established and for the flow from the most remote point (in time, not distance) of the drainage area to reach the design point. The time of concentration will vary with the slope and type of surface that the rain falls on. Rational Method design including design methodology and hydrologic references should be based on the Minnesota Department of Transportation Drainage Manual.

A minimum concentration time of fifteen minutes for residential areas and ten minutes for commercial/industrial areas shall be used for design of the trunk storm sewer systems. These minimum times shall be considered in the design of lateral systems. As the stormwater runoff enters the system, the flow time in the storm sewer is then added to the concentration time and compared to the downstream drainage area concentration time. The maximum of these values is used downstream, which results in a longer concentration time and peak runoff rate as the flow moves downstream from the initial design point.

5. Land Use Factors in Modeling (Runoff Coefficients)

The percentage of rainfall falling on an area that must be collected by a hydraulic facility is dependent on watershed variables such as soil permeability, ground slope, vegetation, surface depressions, type of development, and antecedent rainfall. These factors are taken into consideration when selecting a runoff coefficient for the Rational Method or a runoff curve number (CN) for use in SCS methodology.

Under ultimate (fully developed) conditions, the values of the coefficient will increase with increases in the amount of impervious surfaces caused by street surfacing, building construction, and grading.

The antecedent moisture condition (AMC) relates to the moisture content of the soil prior to a given storm event. CNs based on land use can be adjusted based on an assumed moisture condition. For purposes of the model, normal antecedent moisture condition (AMC II) was assumed. CN values can be adjusted for dry conditions (AMC I) or wet conditions (AMC III).

CNs are also dependent on the type of soil in a given drainage area. Soil types are classified into four basic hydrologic groups as follows:

Group A - Includes soils consist of deep sand and aggregated silts. Group

B - Includes sandy loam soils.

Group C - Includes soils that are low in organic content and made up of clay loams and soils high in clay.

Group D - Includes soils consisting of heavy plastic type clay soils.

CNs that were assumed in the development of the model were based on the hydrologic soil group for each watershed based on the information contained in the County Soil Survey. Development plans shall consider post- development site soil conditions when choosing runoff CNs for final design.

CNs are given in SCS TR-55. Average CN values for each land use type are used in the design of the storm drainage facilities in undeveloped areas. For the modeling of existing facilities, CN values were determined for each type of development and current zoned land use in each subwatershed. In general, the unpaved, non-wetland areas were modeled with curve numbers that most closely represent the Anoka Sand Plain. The curve numbers were then adjusted to reflect the percentage of impervious surfacing.

It should be noted that if land use changes to more or less impervious surfacing than the model, it will affect the model, and updates may be needed.

V. GOALS AND POLICIES Problem

Statement

The increase in urbanization, with its associated runoff and sediment-related pollutants will have an impact on wetlands and other water resources including the Rum River.

Mission Statement

The City of St. Francis, in cooperation with the URRWMO, Anoka County, and state and federal agencies, will prepare a Surface Water Management Plan which will accommodate anticipated community development and redevelopment while providing clear direction to the developers for controlling the quality and quantity of stormwater runoff and properly managing surface and groundwater resources and the physical habitat of existing wetlands, lakes and the Rum River in a consistent fashion. The City is committed to a goal of no adverse impact to, and non-degradation of, its water resources.

Goals

This plan identifies several specific goals to control the City's water resources planning and management functions. The goals of this plan were established in accordance with the purposes of the water management programs required by Sections 103B.201 to 103B.251. The goals of the City of St. Francis are:

1. Protect, preserve, and use natural surface and groundwater storage and retention systems;

2. Minimize public capital expenditures needed to correct flooding and water quality problems;
3. Identify and plan for means to effectively protect and improve surface and groundwater quality;
4. Establish more uniform local policies and official controls for surface and groundwater management;
5. Prevent erosion of soil into surface water systems;
6. Promote groundwater recharge;
7. Protect and enhance fish and wildlife habitat and water recreational facilities; and
8. Secure the other benefits associated with the proper management of surface and ground water.

Policies

Each goal has several corresponding policies. A policy is a governing principle that provides the means for achieving established goals.

Standards

Standards are an extension of the policies. They provide specific, detailed guidance regarding water management practices. Plan standards are included in the Implementation Program (Section VIII) of this document.

A. Water Quantity

The following runoff quantity goals and policies are considered part of this plan. Goal

1: Control flooding and minimize public capital expenditures.

Policy 1.1: Natural stormwater storage areas and manmade detention areas should be utilized to control flooding.

Policy 1.2: The storage capacity of the natural drainage system will be utilized to control rates of runoff. The City will jointly define and adhere to flow rates at municipal boundaries as established in this plan.

Policy 1.3: The City will encourage regional infiltration/detention basins whenever possible.

Policy 1.4: All hydrologic studies will be based on standard hydrologic criteria and ultimate or anticipated development of the entire tributary drainage area.

Policy 1.5: Major stormwater facilities (i.e., ponds, pond outlet systems, and major conveyance systems) shall be designed using a return period of 100 years.

Policy 1.6: The peak outflow from all new developments shall be limited to 90 percent of the existing peak outflow for the 2-, 10- and 100- year SCS 24-hour rainfall events in areas where infiltration is permitted. In areas where infiltration is not permitted/possible, proposed discharge rates shall not exceed existing rates.

Policy 1.7: All minor drainage system analyses and design (i.e., piped collection systems and minor conveyance systems) will be based on a return period of 10 years unless otherwise specified. The minor drainage system pipe will be sized using the full gravity flow capacity of the pipe. Pressure flow based on surcharging the upstream manhole or structure near the street surface will not be allowed.

Policy 1.8: Infiltration/detention facility design will include a paved access route or an approved equal stabilized access route and dedicated right-of-way, outlot access, and/or drainage and utility easement for maintenance of the outlet structure and to the facility in general.

Policy 1.9: Newly constructed stormwater management ponds, and existing or constructed wetlands, and their required buffers shall be contained within outlots or drainage & utility easements and shall be dedicated to the City.

Policy 1.10: The design of stormwater facilities will consider and identify location(s) of overflow(s) that prevent property damage to adjacent properties from extreme water levels.

Policy 1.11: Minimum building elevations should be above designed or designated flood levels. The minimum building floor elevation shall be one and a half (1.5) feet above the 100-year level. The 100-year level shall be on the highest 100-year level resulting from a single event analysis: the 100-year, 10-day snowmelt event, a multiple day runoff event analysis, or the critical event analysis.

Policy 1.12: Landlocked runoff basins shall be sized to handle back-to-back 100-year SCS 24-hour rainfall events, the 10-inch SCS 24-hour rainfall event, or the 100-year, 10-day snowmelt snow melt event, whichever produces the higher peak pond elevation (landlocked HWL). The minimum building floor elevation around landlocked basins shall be two (2) feet above the landlocked HWL.

Policy 1.13: Emergency overflows or outlets to drainage systems will be provided to any landlocked area if the available stormwater storage capacity is inadequate to prevent flooding of residences and if the available downstream conveyance system capacity is adequate to accept additional flow.

Policy 1.14: The City will have standard hydrologic design criteria for all stormwater systems to assure consistency. Drainage calculations for the 2, 10, and 100-year events shall be approved by the City Engineer prior to the issuance of a grading permit.

Policy 1.15: The City will perform maintenance measures to assure proper function of the drainage system. Such maintenance measures include the investigation of all infiltration/detention systems a minimum of once every 5 years.

Policy 1.16: The City has adopted ordinances that control peak runoff consistent with standards and recommendations in the URRWMO Policies.

Policy 1.17: The City has amended the current Urban Storm Water Pollution Control for New Developments to require infiltration whenever possible for new development or redevelopment projects that increase stormwater volume runoff.

B. Water Quality

Goal 2: Achieve water quality standards in City streams, rivers, and wetlands consistent with intended use and classification, which include quantifiable limits on specific pollutants (i.e., phosphorus, turbidity, excess nutrients, etc). The City's ultimate goal is to meet these standards.

Policy 2.1: The ranking system established by the URRWMO shall dictate intended use and water quality standards.

Policy 2.2: Future outlets to DNR protected waters must first pass through a sediment pond/trap prior to discharging into the protected water body.

Policy 2.3: Phosphorus and *E. coli* loading to a drainage system or water body will be reduced to the greatest practical extent through the use of Best Management Practices (BMPs).

Policy 2.4: All construction plans developed for the maintenance and/or improvement of water quality will include a detailed access and maintenance plan and shall require approval by the City.

Policy 2.5: A community education program relating to preserving and improving water quality will be developed and implemented.

Policy 2.6: All on-site waste water systems will be the responsibility of the owner. The owner shall be responsible for maintaining the systems and providing maintenance records to the City.

Policy 2.7: The URRWMO and the City should take an active role in implementing the necessary policies to allow development of regional water quality ponds.

Policy 2.8: A vegetated buffer strip is required between natural water bodies and improved areas to limit phosphorus loadings in accordance with the stormwater and drainage design performance standards of this plan.[5] Buffers also help meet the City's required *E. coli* TMDLs.

Policy 2.9: The City will perform maintenance measures to minimize pollutant loadings to local water bodies. This includes implementing programs and BMPs to assist in controlling sediment. An example of an item covered as part of the maintenance program would be the inspection of sump manholes a minimum of once per year. Additionally, all urban section streets with curb and gutter will be swept a minimum of once annually, and twice annually in priority areas. Priority areas are areas that drain directly to high public use water bodies and/or high-quality wetlands without pretreatment of stormwater runoff.

[5] Reference the Current Urban Stormwater Pollution Control for New Developments.

Policy 2.10: The City will adopt best management practices for redevelopment that will result in total suspended soils (TSS) and total phosphorus (TP) reductions consistent with the Minnesota Stormwater Manual.

C. Recreation, Fish, and Wildlife

Goal 3: Protect and enhance water recreational facilities, fish, and wildlife habitat.

Policy 3.1: Natural areas, wildlife habitat, and wetlands to be protected during construction should be clearly marked and/or fenced in the field.

Policy 3.2: Buffer zones of natural vegetation are required around ponds and wetlands located within current wildlife corridors to provide habitat for wildlife. These areas are recommended to include slopes 4: 1 or flatter near these features.

Policy 3.3: The water level fluctuation of a wetland or pond shall be maintained consistent with the management function of the water body. Wetlands used for stormwater overflow purposes shall be limited to a maximum bounce of 2-feet between the normal water level (NWL) and HWL.

Policy 3.4: Documentation of existing habitat, both graphically and in writing by the owner or developer, prior to modifying wetlands or stream banks, or constructing stormwater facilities is encouraged. Remaining habitat will be maintained and enhanced, or new habitat will be developed to replace lost habitat.

Policy 3.5: The City supports programs for controlling purple loose strife.

Policy 3.6: The City supports programs for controlling Eurasian water milfoil.

Policy 3.7: The City supports programs for controlling Curly leaf pond weed.

Policy 3.8: Activities related to recreation, fish, and wildlife should be consistent with the Anoka County Regional Park objectives and the City’s comprehensive plan.

Policy 3.9: The existing wetland ranking system, as shown in the Table 6, and all subsequent revisions established by the URRWMO shall dictate allowable wetland management activities.

Policy 3.10: BMPs that reduce phosphorus in the Cedar Creek and Trott Brook subwatersheds are recommended. Reducing phosphorus will assist the City in meeting its DO TMDL as well. Potential projects can be selected from the City of St. Francis Stormwater Retrofit Analysis Report in Appendix D.

Table 6
Wetland Classification per URRWMO*

Wetland Classes	Purpose
High Priority Wetlands	Wetlands that highly serve both water quality treatment and wildlife habitat target functions
Moderate Priority Wetlands	Wetlands that highly serve one of the two above reference target functions
Low Priority Wetlands	Wetlands that do not highly perform either of the target functions
Use Wetlands	Wetlands created for stormwater management

*See the URRWMO Wetland Standards attachment in Appendix A for more information related to wetland classification.

D. Public Participation, Information, and Education

Goal 4: Increase public participation and knowledge in management of the water resources of the community.

Policy 4.1: The City will develop a public education outreach program.

Policy 4.2: The City will utilize available resources and input from the public to address local water resources issues.

Policy 4.3: Citizen water quality monitoring is encouraged and supported by the City.

Policy 4.4: The City will distribute educational material aimed at fostering responsible water quality management practices. Example topics include wetland buffers, groundwater quality and protection, water conservation, proper hazardous waste management, yard waste management, pet waste disposal, and agricultural BMPs.

Policy 4.5: The City supports Anoka County's recreation and educational programs related to the water resources of the community.

Policy 4.6: The City will support natural environment programs in the public schools.

E. Public Ditch System

Goal 5: Maintain the current ditch system to convey water and maintain the current defined maximum flood levels to protect businesses and residences.

Policy 5.1: The City will perform the maintenance of public ditches, with the exception of county ditches, to provide protection of private property and structures from flooding, provided that such maintenance is in accordance with the Minnesota Wetlands Conservation Act, Minnesota Statute 103E governing agricultural drainage, is acceptable to the U.S. Army Corps of Engineers, and does not adversely affect the value of wetlands or water quality.

Policy 5.2: Anoka County is recognized as having authority over all public ditches within the watershed in accordance with Minnesota Statute 103E.

F. Groundwater

Goal 6: Promote groundwater recharge and prevent contamination of the aquifers.

Policy 6.1: Anoka County is recognized as the lead agency regarding groundwater controls.

Policy 6.2: Recharge areas identified by Anoka County shall be protected from adverse development and from potential contamination.

Policy 6.3: Infiltration of the first 1.0-inch of runoff from new impervious areas will be required wherever the soils are appropriately permeable (i.e., hydrologic soil types A and B) to promote groundwater recharge and volume controls. However, in certain circumstances this requirement may be waived if the proposed pond is in a wellhead protection zone.

Policy 6.4: The use of grassed waterways shall be encouraged to maximize infiltration. Proper grades shall be maintained or underdrain systems installed as part of an overall site plan to insure positive drainage.

Policy 6.5: Any spring area should be identified in the field, denoted on maps by the City, and protected from development within the watershed.

Policy 6.6: The appropriate jurisdiction shall use both regulatory (ordinances, permits, etc.) and non-regulatory (Best Management Practices) tools to protect the land area within designated wellhead protection areas.

G. Wetlands

Goal 7: Maintain the amount of wetland acreage and try to increase the wetland values within the watershed.

Policy 7.1: The City of St. Francis will act as the LGU which administers the Minn. Wetland Conservation Act.

Policy 7.2: Restoration of poor quality wetlands shall be encouraged.

Policy 7.3: The City or Anoka County shall identify areas that can be used for wetland mitigation.

Policy 7.4: Wetland mitigation criteria will be established consistent with the Minnesota Wetland Conservation Act of 1991 and subsequent amendments and associated rules thereto (e.g., Minnesota Rule 8420), state and federal regulations, the URRWMO, and the needs of the City.

Policy 7.5: Alteration of wetlands is discouraged unless for restoration.

Alteration may be allowed on an individual basis if the alteration can be properly mitigated in accordance with the Wetland Conservation Act (WCA). Allowable alternatives must comply with WCA sequencing requirements including, in order, avoidance, minimization, and mitigation. In general, it will require a full Technical Evaluation Panel meeting and majority approval before any wetland impact is allowed.

Policy 7.6: The City will begin developing a Wetland Management Plan as new development occurs. Developers will be required to inventory existing wetlands within the development for function and value according to the Minnesota Routine Assessment Method (MnRAM). Pretreatment of stormwater prior to discharge is required for discharge into all wetland types.

Buffers should be consistent with the functions and values identified by the URRWMO. The use of native vegetation buffers for all wetlands shall be written into the Code for new developments.

Policy 7.7: The use of native vegetation for buffers in undeveloped and previously developed areas is strongly recommended.

Policy 7.8: Wetland buffer widths will be based on wetland value; the higher the value of the wetland the greater width required, with a buffer width listed based on wetland classification. See the Table 7 for wetland classification and corresponding minimum buffer width requirements.

Table 7

Wetland Classification per URRWMO and Required Buffer Width*

Wetland Classes	**Minimum Buffer Width**
High Priority Wetlands	25 ft
Moderate Priority Wetlands	20 ft
Low Priority Wetlands	15 ft
Use Wetlands	15 ft

*See the URRWMO Wetland Standards attachment in Appendix A for more information related to wetland classification and buffer requirements.

H. Erosion Control

Goal 8: Prevent soil erosion.

Policy 8.1: In conformance with MPCA/NPDES rules, erosion and sediment control plans shall be submitted to the City for review for all land disturbance activities of one acre or more in size.

Policy 8.2: The City encourages the preservation of natural vegetation.

Policy 8.3: Soil erosion shall be prevented through the installation of erosion control practices in accordance with MPCA's Best Management Practices Handbook.

Policy 8.4: Topsoil stockpiled for reuse shall be protected from erosion.

Policy 8.5: It shall be the responsibility of the developer/contractor to keep streets and property adjacent to construction areas free from sediment carried by construction traffic at site entrances and access points, from sediment laden site runoff, and blowing dust.

Policy 8.6: The MPCA Storm Water Permit Program for Construction Activities shall be followed.

Policy 8.7: The City has adopted an erosion and sediment control ordinance including provisions that are consistent with the NPDES Construction Stormwater permit.

I. Development Standards

Goal 9: Residential Grading

Policy 9.1: Residential lots shall have a minimum surface slope of 2 percent in all directions. Lesser slopes, between 1 percent and 2 percent may be allowed with a certificate of grading.

Policy 9.2: Four inches of topsoil shall be placed in the turf restoration areas of all new residential lots.

Policy 9.3: Where residential lots are newly graded and there is no immediate plan for new housing within the lot, the entire lot shall be covered with 4 inches of topsoil and seeded within 14 days.

Policy 9.4: When grading is proposed in high slope areas, the appropriate City Ordinance shall govern.

J. Regulatory Responsibility

Goal 10: Recognize the regulatory authority of other local, state, and federal entities.

Policy 10.1: The City will implement a local permitting program for water resources management.

Policy 10.2: The City recognizes the following agencies with natural resource conservation priorities:

- The Upper Rum River Watershed Management Organization (URRWMO)
- Minnesota Department of Natural Resources (DNR)
- United States Army Corps of Engineers (USACE)
- Minnesota Board of Water and Soil Resources (BWSR)
- Minnesota Pollution Control Agency (MPCA)
- Anoka Conservation District (ACD)

K. Finance

Goal 11: Equitably finance water resources.

Policy 11.1: All developments shall to the extent determined by the City, provide land, funding, or a combination of both for management of local water resources, which includes development of regional facilities and planning studies.

Policy 11.2: The City may establish a fee structure charged to developers for analyzing the impacts of the proposed development.

Policy 11.3: The City may establish a fee structure charged to developers for constructing capital improvements (i.e., trunk conveyance systems).

Policy 11.4: Grants may be sought by the City to fund watershed related projects.

Policy 11.5: The City has established a Stormwater utility fee for all properties within St. Francis.

Policy 11.6: The City should encourage donations and in-kind contributions of public and private organizations and the school systems for plan implementation.

Policy 11.7: The City shall investigate and evaluate other funding mechanisms that support implementation and enforcement.

L. Records Management and Documentation

Goal 12: The City shall preserve historic data, records, and files pertaining to the water resources of the URRWMO.

Policy 12.1: Engineering calculations will be required in a standard format. Policy

12.2: Past studies will be documented and filed by the City.

Policy 12.3: Immediately after extreme rainfall events, high water elevations will be noted and investigated for potential problems by the City.

Policy 12.4: The City will develop a history of flooding and water quality problems by noting past events and logging complaints received from residents.

Policy 12.5: The City will perform regular wet storage volume surveys of its stormwater quality ponds on a 20-year rotating basis. If the water quality storage volume is being lost to sedimentation, the City will clean out the pond to reestablish the design storage volume below the outlet and consequently reestablish the design residence time.

Policy 12.6: The City will document all items/BMPs provided.

VI. ASSESSMENT OF PROBLEMS AND CORRECTIVE ACTIONS

This section assesses the water-related problems in the City, prioritizes the problems and includes actions to adequately solve each identified problem.

A. Impaired Waters

St. Francis has three impaired waters with TMDLs: Cedar Creek, Seelye Brook, and Trott Brook (Table 1) with WLAs for *E. coli*, nutrients, and DO. The sources for *E. coli* are most likely from human and/or animal waste. The City will continue to enforce its ordinances regulating subsurface sewage treatment systems (3-4) and pet waste (8-3-4). Additionally, the wetland buffer requirements should help reduce the amount of *E. coli*, as well as phosphorus, entering our waterbodies. The 2016 City of St. Francis Stormwater Retrofit Analysis (Appendix D) identifies and ranks potential projects that reduce phosphorus loads within the Rum River subwatershed. By reducing phosphorus, and thus algae and other invasive aquatic plants, the oxygen demand in the water column should also decrease, which will assist the City in meeting its DO WLA.

B. Impacts of Water Quality and Quantity Management Practices on Recreation Opportunities

The current and proposed City ordinances together with the URRWMO, County, regional, state, and federal rules and laws are designed to protect the existing land and water resources within the City of St. Francis. The City believes that it can allow continued development while maintaining or improving its resources including water quality and recreation opportunities. With the implementation of this plan and the recommended policy and ordinance changes, the developers will be held responsible for protecting water quality, mitigating the runoff quantity, and ensuring that there will continue to be recreation opportunities in St. Francis. In addition, the City will partner with the URRWMO to educate the public to better protect the city's water resources, to implement temporary and permanent erosion and sediment controls for new developments, to ensure good housekeeping of the City's municipal operations, and to detect and eliminate illicit discharges.

C. Impacts of Stormwater Discharges on Water Quality and Fish and Wildlife Resources

As stated in Section VI. B above, the current and proposed ordinances are designed to protect the existing land and water resources within the City of St. Francis. This includes measures that are designed to maintain or improve the habitat of the fish and wildlife throughout the area.

D. Impacts of Soil Erosion on Water Quality and Quantity

The City established an erosion and sediment control ordinance governing construction practices. The City will also evaluate existing erosion control problem areas that may not be associated with recent construction and formulate mitigation plans to rectify those issues. Given increased regulation of the typical causes of soil erosion and sediment transport, it is anticipated impacts of soil erosion on water quality in the St. Francis area will be greatly diminished.

E. General Impact of Land Use Practices

As stated in Section VI.B, increases in impervious surfaces will require mitigation to reduce the impacts related to change in permeability from the natural Anoka Sand Plain conditions. The preferred mitigation method is to require infiltration, where appropriate, to duplicate the existing conditions. This preference will be incorporated into the development ordinance revisions that will be updated to meet the recommendations of this SWMP. In addition to infiltration, the City will consider low impact alternatives and oversized regional retention basins to mitigate potential downstream flow changes.

F. Adequacy of Existing Regulatory Controls

With the current code, the City of St. Francis believes it has adequate policies in place to self-regulate the anticipated growth without sacrificing its abundant water resources. In addition to its ordinances, the existing greater area regulatory controls of the URRWMO, BWSR, the Metropolitan Council, the DNR, the U.S. Army Corps of Engineers, Anoka County, etc. are more than adequate to properly manage or mitigate adverse impacts on public waters and wetlands.

The City must rely on the regulatory authority of Anoka County, the URRWMO, and the regional, state, and federal plans to monitor and control the runoff entering the City from outside its jurisdiction. The City understands that it will also need to address issues brought to its attention by these outside regulating authorities.

The City is also concerned that the current codes and various permit fees and charges needed to finance the code will adversely affect development in St. Francis. To ensure that St. Francis has an equal chance of attracting development, the City must rely on outside agencies and Water Management Organizations (WMOs) in the area to regionally enforce similar environmental requirements with comparable financing obligations.

G. Adequacy of Programs

The City of St. Francis believes that this Plan and any other BMPs deemed appropriate by the City will be adequate to:

1. Limit soil erosion and water quality degradation
2. Maintain the tangible and intrinsic values of natural storage and retention systems
3. Maintain water level control structures

H. Future Potential Problems

The greatest potential for future problems with stormwater planning is associated with the ever-growing impervious footprint that is inevitable with growth. As stated earlier, highly pervious nature of the Anoka Sand Plain means that the cumulative effect of development could result in drastically increased runoff volume and flow rates.

The recommended ordinance revisions are designed to:

1. Encourage infiltration and soil ripping of newly graded sites so that developed sites can adequately mimic unimproved site runoff and flow rates.
2. In areas where infiltration is possible, limit post development runoff rates to 90-percent of the existing condition so that multiple developments do not cause cumulative increases in the downstream condition. In areas where infiltration is not permitted/possible, post development rates shall not exceed existing rates.

In addition, regional pond modifications are also recommended where plausible because of the economic and runoff management capabilities of larger scale hydrologic systems. By implementing the recommendations in the SWMP, these potential future problems are being anticipated and adequately addressed within the City of St. Francis. As stated earlier, the City must rely on the regulatory authority of Anoka County, the URRWMO and the regional, state, and federal agencies to monitor and control the runoff entering the City from outside its jurisdiction. The City understands that it will also need to address issues brought to the attention by these outside regulating authorities.

VII. FINANCIAL CONSIDERATIONS

Typically, a Capital Improvement Program (CIP) is an itemized program for at least a five-year prospective period. The items and associated costs are subject to at least a biennial review. The benefits include setting forth the schedule, timing, and details of specific contemplated capital improvements by year, together with their estimated cost, the need for each improvement, financial sources, and the financial effect that the improvements will have on the local government unit or watershed management organization.

A. 5-year Capital Improvement Program

The current 5-year Capital Improvement Program includes the following:

1. Kings Highway and Riverbank Lane Improvement Project................................$150,000
2. Drainage Easement Maintenance $10,000
3. Jet Vac Equipment.. $250,000
4. District 3 Drainage Improvements.. $100,000
5. District 4 Drainage Improvements... $100,000

Total Current 5-year Plan Expenditures.. $610,000

In addition to the current 5-year Capital Improvement Plan, the following improvements are recommended to rectify the potential problems identified in Section VI of this plan:

1. Annual Sediment Pond Cleaning (1/20th of sites).. $15,000/year
2. Annual Storm Sewer/Sump Catch Basin Cleaning (1/5th of structures).... $20,000/year
3. Annual Street Sweeping.. $15,000/year
4. Retrofit Existing BMPs.. $5,000/year

Total Additional 5-year Plan Expenditures.. $275,000

The financial impact of implementation of the proposed regulatory controls and programs identified in Section VI is anticipated to include the following:

1. Updating this SWMP $20,000
2. Adopting and Enforcing the SWMP Local Controls and Standards[6] $25,000/year
3. Total Current Five Year Plan Expenditures.. $610,000
4. Total Additional Five Year Plan Expenditures.. $275,000

Total 5-year Financial Impact $1,030,000.00

Although the cost associated with these recommendations can be financed locally, the City will pursue all opportunities for outside funding. Without outside financing the City will need to finance the adoption of, and enforcement of, the local controls and standards, implementation of the specified programs, and capital improvements recommended in this SWMP using one or more of the following:

1. Establish stormwater development charges (stormwater trunk fees)
2. Continue the collection of stormwater utility fees
3. Create stormwater assessment districts
4. Accessing funds from other City projects and funds
5. Increasing the general levy (within levy limits)

[6] Estimated cost is based on one half-time employee at salaries (plus benefits) of $50,000 per year.

Outside funding is greatly desired as the impact of increasing these taxes, fees, and charges will increase tax burden against homes and farmsteads, increase the utility burden for all parcels or postpone other necessary improvements currently scheduled in the City's Capital Improvement Plan.

The following are potential sources of outside funding that may be available to assist in the financing of the various stormwater related issues:

1. Minnesota Clean Water Legacy funds
2. Clean Water Partnership Funds
3. Clean Water Act, Section 319 funds, administered by the MPCA
4. Minnesota Public Facilities Authority (PFA) grants and low interest loans

There is significant competition for these limited funding sources. If these sources are pursued by the City, it will likely involve innovative treatment technologies in addition to timely requests for funding.

B. Local Financing Options

1. Development Charges or Trunk Fees

   The City of St. Francis will pursue a policy where trunk storm sewer costs would be assessed on an area basis as determined by a resolution. Total lateral cost would be assessed to a development on an area basis. In lieu of paying a future charge, developers may, before a final plan is signed, agree to pay the City the storm drainage improvement charge established by Council resolution. The charge would be based upon the number of total gross square feet in the plat.
   The developer would be given a credit of over-sizing storm improvements in the plat. The charges collected would be deposited into a special storm drainage improvement fund and would only be used to pay for storm drainage financing and improvements. Maintenance of the storm sewer system is expected to be paid for through revenue generated from the Stormwater Utility Fund.

   Since the recommended additional costs are predominantly associated with continued new development, it is presumed to be fair and equitable to have the developers pay for their impacts. Hence, the use of a stormwater area development charge (or trunk fee), based on the cost of rectifying the downstream impact associated with the development is recommended.

2. Stormwater Utility Fees

   The City of St. Francis has established a stormwater utility fee. The City Stormwater Utility fee is intended to finance infrastructure maintenance, upgrading, reconstruction, and new construction serving previously developed areas. It is not typically used to finance retrofitting the existing system to accommodate new developments. Most cities require the developer to finance the entire new storm sewer system associated with the development. Then once the new system is accepted and turned over to the City, the municipal maintenance funds (typically stormwater utility funds) are used to maintain the new system.

3. Accessing funds from other City Projects and Funds

   The costs of improvements to undeveloped land shall be borne by the developer.

4. Creating a Stormwater Assessment District or Stormwater Tax District

If a watershed is well defined and the greater majority of the property owners have a share in the benefit of the proposed storm sewer improvement, the City could form a stormwater assessment district. When improvements or repairs are needed within the district, an advertisement hearing process is required similar to that used for assessments in Minnesota Statute 429. Many cities are not choosing this financing option because it can be cumbersome. Cities also find it difficult, on occasion, to legally prove the level of benefit associated with the assessment.

5. Increasing the General Levy

This option is not favored because it resembles duplication of costs for property owners who have either directly or indirectly already financed their own developments. Unless tax expenditures for stormwater needs can be uniformly spread to all properties, political opposition is expected from entities that have already invested in stormwater facilities.

C. Recommended Local Financing

1. The cost of retrofitting the downstream system to accommodate new developments should be borne by newly established new development charges or trunk fees.
2. The cost of existing system retrofitting and maintenance projects should be borne by the Stormwater Utility fund as this is the primary focus of these funds.
3. The cost of new improvements in undeveloped land should be borne by the developer.
4. Creating a storm sewer assessment district is not recommended.
5. Increasing the general levy for storm sewer related costs is not recommended.

VIII. IMPLEMENTATION OF PRIORITIES AND PROGRAMS

A. Special Waters

According to the MPCA's Special Waters list, special waters in the St. Francis area include:

1. The **Rum River** is considered Scenic/Recreational from Highway 27 bridge in Onamia to Madison and Rice Streets in Anoka.

The City will meet state requirements for development near these waters as identified in the Minnesota Stormwater Manual by designing stormwater basins using the sizing criteria described in *Design Calculations for Wet Detention Ponds*, by William Walker Jr. The City will also require stormwater practices that promote infiltration/filtration and decrease impervious areas (better site design and integrated stormwater management), where practical. In addition, the City will assist with enforcement of any NPDES Phase II permit requirements for new ponding areas when new impervious surface is created.

B. Implementation Schedule

In accordance with Minnesota Rule 8410.0010, the City of St. Francis must provide for the adoption of necessary regulatory controls, stormwater design standards, education programs, data collection programs, and maintenance programs. This SWMP must clearly distinguish the City's responsibilities versus the responsibilities of the URRWMO and Anoka County with respect to implementing each program element.

According to Minnesota Rule 8410, each organization plan must include a schedule for implementation by the organization, joint powers agreement members, and affected local units of government. All plan controls and programs to be implemented by the organization must be in effect within one year of plan adoption. All local plan controls and programs must be developed and in effect within two years of adoption of the last organization plan in the local unit of government.

The City of St. Francis fully intends to implement the ordinance revisions recommended in this plan within 180 days of plan acceptance by all regulatory agencies having jurisdiction and the City Council.

C. Enforcement

This SWMP must identify the procedure to be followed to enforce violations of the controls of the organization as well as those of the local unit of government.

The City uses a permitting process with a bond/Irrevocable Letter of Credit requirement for new developments. If the developer fails to follow the conditions of the permit, the City can contact the bonding company requesting immediate rectification or act on the letter of credit.

The City will amend existing ordinances and adopt others necessary to enforce requirements identified in this plan.

In addition, the City will work with the DNR to satisfy shoreland requirements. Each of these ordinances will be (is) enforceable locally and will carry penalties for failure to adhere to them. In addition, the MPCA can impose significant fines for pollution discharges associated with these ordinance controls as well as any unauthorized pollution discharge.

D. Administration Process

This SWMP must specify the administrative process and timelines for the submittal, review, and approval of local plans and variances by the organization.

Requirement 1: All communities need to include information on the types of best management practices to be used to improve stormwater quality and quantity and the maintenance schedule for the best management practices (BMPs).

Solution 1: The City's current development ordinances are designed to regulate stormwater quantity in accordance with the URRWMO requirements. Within a year after the acceptance of this plan, the City will review its ordinances controlling development to include the recommendations of this SWMP, chiefly the recommended runoff volume controls. In addition, the City will implement various BMPs and determine if other BMPs will be needed on an ongoing basis.

Requirement 2: All communities need to include a Wetland Management Plan or a process and timeline to prepare a plan. The Wetland Management Plan should incorporate a function and value assessment for wetlands. Pretreatment of stormwater prior to discharge is required for discharge into all wetland types. Buffers should be consistent with the functions and values identified in the plan. The use of native vegetation as buffers for high quality wetland is strongly encouraged.

Solution 2: *This process is proposed to move forward as development occurs. A complete evaluation of wetlands on a site will be performed as development occurs, and a Wetland Management Plan for the affected wetlands will be completed.*

Requirement 3: The City needs to include funding sources for the various required activities.

Solution 3: *The required funding sources are described in detail in Section VII of this SWMP.*

Requirement 4: The City needs to include activities to be undertaken along with numerical goals, strategies, and timelines.

Solution 4: *This Plan and the City's ordinances include policies and BMPs describing the necessary activities, numerical goals, strategies, and timelines.*

Table 8 is an implementation process list of the recommended actions, timing, responsible party, and the cost or funding sources based upon the data compiled in this plan.

Table 8

Implementation Process List

Action	Timing	Responsible Party	Cost/Funding Source
Maintain and implement Capital Improvement Program.	On-going, updated as needed	City of St. Francis	Stormwater utility fee and enterprise funds
Implement a stormwater maintenance program to ensure the successful operation of the drainage system.	On-going.	City of St. Francis	Stormwater utility fee
Corrective actions for stormwater problem areas.	On-going, as problems come up.	City of St. Francis	Stormwater utility fee
Enforce erosion and sedimentation control criteria for new developments.	On-going, as developments are submitted to the City for approval.	City of St. Francis	Funding by development fees
Sweeping Urban Streets	Once annually in all areas and twice annually in priority areas	City of St. Francis	Stormwater utility fee

Action	Timing	Responsible Party	Cost/Funding Source
Establish regional ponding areas as described herein and implement as part of the stormwater management system.	On-going, as developments are submitted to the City for approval. Right of first refusal purchasing at time of sale of property.	City of St. Francis	Stormwater utility fees/cost sharing with neighboring jurisdictions
Standardize review procedures in-place to ensure all development within the City is in compliance with proper erosion control practices.	Currently in place. Update as necessary.	City of St. Francis	Funding by development fees
Require detailed hydrologic analysis of all ponding areas prior to final plat approval.	Currently in place. Update as necessary.	Developer's Engineers, City of St. Francis	Developers pay for design and construction of developments. City staff funding by development fees.
Establish high water elevations governing building floor elevations adjacent to ponding areas and floodplains as development occurs and prior to drainage facility construction.	On-going.	Developer's Engineers, City of St. Francis	Developers pay for design and construction of developments. City staff funding by development fees.
Establish overflow routes and maintain them to provide relief during extreme storm conditions, which exceed design conditions.	On-going, as developments are submitted to the City for approval.	City of St. Francis	Developers pay for design and construction of overflow routes. City-conducted maintenance funded by development and stormwater utility fees.
Implement an education program for City residents, staff, and the development community.	On-going.	City of St. Francis	City of St. Francis, with help from URRWMO, DNR, University of Minnesota Extension Service, SWCD, NRCS

Action	Timing	Responsible Party	Cost/Funding Source
Low impact development/better site design for new developments encouraged.	On-going, as developments are submitted to the City for approval.	Developer's	City staff funding by development fees. Developers pay for design and construction of developments.
Regulate construction and land uses along the bluff, to prevent erosion.	On-going, as developments are submitted to the City for approval.	City of St. Francis	Funding by development fees.
Encourage landowners to retain any areas of native vegetation, and to plant species native to the area, to protect and improve wildlife habitat and maintain the historic ecological role and appearance of the steeper riverbanks.	On-going, as developments are submitted to the City for approval.	Land Owners, Developers, City of St. Francis	Landowner, City of St. Francis, Future grant opportunities
Adopt and implement amendments to the SWMP and update the SWMP as necessary.	As warranted by future standards or regulations	City of St. Francis	Stormwater utility fees
Develop an implementation strategy for TMDLs.	On-going	City of St. Francis, working with URRWMO	MPCA, URRWMO, BWSR, DNR, City of St. Francis

IX. AMENDMENT PROCEDURES

Amendments to this plan may be adopted and implemented as warranted by future standards or regulations. The City is aware that the Upper Rum River Watershed Management Organization is in the process of updating its current watershed management plan which will trigger the mandatory re-evaluation and update of this SWMP. The City will initiate any amendments by resolution of the City Council. The citizens of St. Francis, City Staff, the City Council, or any of the review authorities having jurisdiction may submit amendment requests.

The amendment request will be evaluated by City staff and a recommendation will be made to the City Council. If the Council deems the amendment necessary, it will order City staff and/or the City attorney to draft an amendment.

The draft amendment will be brought to the Council for review. If approved, the Council will pass a resolution calling for a hearing on the amendment. The amendment must be forwarded to each organization affected by the amendment. The proposed amendment will be published in the official city newspaper not less than 10 days before the hearing.

The hearing will be held in a public place, typically in the City Council chambers. At the hearing, all interested citizens will be given the opportunity to submit a written statement or voice their opinion on the acceptability of the proposed amendment.

When all have been heard, the City Council will close the hearing and vote their decision on whether to pass a resolution accepting the amendment as written.

According to State Statute 103B.235, Subd. 5, Amendments, to the extent and in the manner required by the URRWMO, all major amendments to the SWMP shall be submitted to the URRWMO for review and approval in accordance with the provisions of State Statute 103B.235, subdivisions 3 and 3a for the review of plans. All major plan updates and amendments will be submitted to the Upper Rum River Watershed Management Organization and the Metropolitan Council simultaneously. All minor amendments will be reviewed and approved by the City Council.

X. SUMMARY AND RECOMMENDATIONS

A. Summary

The St. Francis SWMP has a dual purpose: it will serve as a guide for the construction of storm drainage facilities and provide a basis for a consistent approach to the preservation of wetlands, streams, and the Rum River. The following issues have been incorporated into this plan:

1. Division of the City into major watersheds based on contour maps and natural topography
2. Determination of stormwater runoff under ultimate land use conditions
3. High water levels of major ponding areas
4. Recommendations for the revision of the current development ordinances
5. Recommendations for standard Operations and Maintenance procedures
6. Recommendations for specific construction site erosion control practices
7. Estimated construction and implementation costs of the SWMP
8. Recommendations for education of City residents, staff, and development community.

The primary function of an urban storm drainage system is to minimize economic loss and inconvenience due to periodic flooding of streets and other low-lying areas. Adequately designed storm drainage facilities provide flood control, minimize hazards and inconvenience associated with flooding, and protect or enhance water quality. The SWMP takes the entire drainage basin with future saturation development into consideration.

Wet water quality ponds upstream or dry regional infiltration basins (where possible) will help control the rate and the volume of stormwater runoff. To provide flood protection for adjacent property, the design storm interval for ponding areas with a known outfall is a 100-year storm as compared to a 10-year storm for design of storm sewer piping. For land locked ponds or wetlands, the design storm interval is a back-to-back 100-year storm or the 100-year, 10-day snow melt event, whichever is larger. Any new residential, commercial, industrial and other habitable structures shall be constructed with the following low floor elevation: Elevation of the lowest floor of a structure shall be a minimum of 1 foot above the emergency overflow, or 1 foot above the HWL of the nearby pond or waterbody, whichever is higher. The area of a pond's HWL plus 1 foot of freeboard shall be contained entirely within an outlot, or drainage and utility easement, that is owned and maintained by the City.

In areas adjacent to designated floodplains as mapped on a Flood Insurance Rate Map, the Regulatory Flood Protection Elevation (RFPE) applies. The RFPE is defined as the mapped 100-year flood elevation plus 1 foot. The URRWMO requires that the low floor elevation of structures be 1 foot above the 100-year high water level or regional flood level for the adjacent water or wetland. City policy requires all structures, including accessory structures, to be elevated on fill so that the lowest floor including basement floor is 1 foot above the Regulatory Flood Protection Elevation or 1 foot above the mapped 100-year flood elevation. The finished fill elevation for structures shall be no lower than the Regulatory Flood Protection Elevation and the fill shall extend at such elevation at least fifteen (15) feet beyond the outside limits of the structure erected thereon.

The numerous natural depressions found throughout St. Francis have been incorporated into the SWMP as ponding areas. Wetlands may be, and are currently being used for stormwater storage for larger rainfall events. They may continue to be used for this purpose – even after upstream development, provided that:

1. There is acceptable Best Management Practice pretreatment of the runoff.
2. The bounce from the normal water level to the high water level does not exceed two feet.

The effective use of ponding areas enables the installation of outflow sewers with reduced capacities since the design storm duration is effectively increased over the total time required to fill and empty the ponding reservoirs. Storm sewers represent a sizable investment for the community and this investment can be more efficiently utilized by ponding stormwater in designated ponding areas and allowing smaller diameter pipes to be used as outfall lines.

Equally as important as flood control and cost considerations, is the use of ponding areas to:

1. Improve water quality;
2. Return stormwater to the groundwater table;
3. Increase water amenities in developments for aesthetic, recreational, and wildlife purposes.

For water quality ponds, the storage below the outlet is the most important consideration. The area and depth of the ponds may differ from the values presented here, storage below the outlet must be provided so that the prescribed pollutant loading of the system is not exceeded.

Amenity aspects are maximized by careful planning in the initial development of any residential or industrial area and by integrating the ponding system into an overall comprehensive SWMP.

The wildlife aspects of the ponding areas shall be maximized in design and the proper location of a trail system will allow access to these areas for wildlife observation.

B. Model Results

Figures 8A and 8B are watershed maps containing major watershed and subbasin boundaries that were modeled using StormNET. The main hydraulic elements used in the modeling were open channel sections, including portions of Seelye Brook and Rum River, roadside ditches, junctions, and outfalls. Pond elements were also used. However, detention storage was not modeled. The ponds instead represent a runoff convergence point of one or more watersheds in the location of a pond. A simple outfall was used in most situations were a detention pond exists. In all other cases, outfalls represent the subbasin outlet.

Although detailed survey information and storm sewer inventory was not available, the time of concentration was adjusted to reflect storage in the watershed, land cover, and pipe or channel flow.

Minnesota Regional Regression Equations:

Regional regression equations were developed for estimating peak flow on small, ungaged streams in Minnesota in “Techniques for Estimating Peak Flow on Small Streams in Minnesota” (USGS, Water-Resources Investigations Report 87-4170 and 97- 4249). The regression equations are typically used for watersheds greater than 50 acres, where SCS methodologies tend to over- estimate peak discharge rates. Report 87-4170 uses watershed area, percent storage (lakes and wetlands), and slope to calculate the peak discharge. The 97-4249 uses percent lakes instead of overall storage to calculate peak runoff. Due to the large percentage of wetlands in St. Francis, the ’87 regression equations were used to estimate the peak runoff for larger subcatchments. Figures 8A and 8B show watershed IDs and area. Table 9 is a summary of the regression analysis using equations from Report 87-4170.

Table 9

Regional Regression Equation Analysis, Report 87-4170

WATERSHED DESCRIPTION	AREA (S.M.)	STORAGE (PCT)	SLOPE (FT/MI)	RUNOFF (IN.)	Q2 (CFS)	Q5 (CFS)	Q10 (CFS)	Q25 (CFS)	Q50 (CFS)	Q100 (CFS)
SB10	0.89	27.2	26.4	6	15.71	30.40	42.07	59.83	74.31	89.94
SB13	0.88	33.7	19.6	6	13.17	25.24	34.75	49.16	60.85	73.43
SB16	1.12	21.2	6.8	6	13.52	25.46	34.75	48.66	59.83	71.73
SB21	1.05	15.6	15.8	6	18.56	35.76	49.41	70.08	86.92	104.97
SB23	3.09	28.8	10.6	6	29.27	55.06	75.01	104.81	128.72	153.99
SB24	2.38	31.6	31.7	6	32.49	62.61	86.36	122.34	151.61	182.89
SB26	2.39	25.6	58.1	6	42.25	82.77	115.14	164.55	205.16	248.74
SB28	1.13	8.7	89.8	6	40.55	81.80	115.72	168.23	212.23	259.92
SB29	0.90	11	68.6	6	29.17	58.38	82.27	119.14	149.89	183.24
SB30	0.73	12.5	52.3	6	22.03	43.80	61.53	88.82	111.50	136.09
SB31	0.50	7.4	116	6	25.34	51.77	73.78	108.15	137.17	168.94
SB32	1.21	25	95	6	29.91	59.51	83.47	120.43	151.07	184.31
SB46	0.64	27.2	10.6	6	9.35	17.77	24.38	34.34	42.39	51.04
SB52	1.26	30.5	7.9	6	13.53	25.40	34.60	48.37	59.40	71.16
SB53	0.95	31.5	10.6	6	11.86	22.44	30.70	43.12	53.11	63.82
SB55	2.27	55.7	5.3	6	14.84	27.27	36.71	50.68	61.72	73.38

Percent storage was taken for the NWI data for each watershed, as the NWI data contains areas of both lakes and wetlands. Slope was calculated based on 10' topographic contours. The values of Q2, Q5, Q10, Q25, Q50, and Q100 were used to back calculate a time of concentration for the watershed that produced peak runoff values that were relatively close to those provided by the regression.

<u>Curve Numbers:</u>

Anoka County has detailed Minnesota Land Cover Classification (MLCCS) data. The City of St. Francis has roughly 180 unique land cover classes, each with its own associated CN depending on soil type. Using GIS, the watershed areas were intersected with hydrologic soil groups and MLCCS data. An Excel spreadsheet was then used to apply CNs to each polygon in the watershed with a unique land cover and soil group combination. From there, an overall weighted CN was calculated for each watershed and used in the modeling. MLCCS data was not available in Isanti County, so only the portions of the watershed in Anoka County were calculated. CNs for the watersheds with portions in Isanti County were adjusted in the model.

<u>Watershed Modeling:</u>

Each subbasin falls in one of six larger watershed areas. These areas include West St. Francis, Seelye Brook, Rum River, County Ditch (CD) 18, CD 19, and Cedar Creek. Figure 9 is a map of the major watersheds within the City. Each of these subbasins are further described below. Table 10, found on page 49 of this plan, is a summary of the watershed characteristics for each subbasin.

West St. Francis:

On the west side of St. Francis, that is west of the Seelye Brook watershed to the city limits, a small portion of the city discharges to the west into Stone Lake (Sherburne County) and ultimately into the Trott Brook System. The area of this major watershed is 771 acres. Land cover is predominantly herbaceous and nonvascular vegetation with some forest resulting in a weighted CN of 46.

Seelye Brook:

Roughly 8280 acres of St. Francis, especially west of town, drains to Seelye Brook. This area includes some drainage into tributaries. Land cover consists primarily of herbaceous nonvascular vegetation, cultivated vegetation, and some forests. Also, some higher density residential development exists along the east side of the watershed. Weighted curve numbers range from 41 to 60 depending on soil type and land cover. A portion of Seelye Brook was modeled, but lacks accuracy because of the large wetland areas not modeled that would provide large amounts of storage.

The larger subbasins used regression analysis to determine times of concentration. In the residential and commercial areas, SCS methods discussed in TR-55 were used to calculate time of concentration based on sheet flow, shallow concentrated flow, and channel flow. Although storm sewer was not modeled, the time of concentration for the subbasin has a storm sewer component factored in.

Rum River:

The Rum River corridor discharges through the center of the city, with much of the high density residential flowing to it. A portion of this watershed drains to a tributary that joins the Rum River north of the city limits. The total area of this major watershed is roughly 4120 acres. Land cover is high density residential near the south edge of town and cultivated vegetation and woodlands on the north. A low density residential development exists along the north city limits, with ponds and storm sewer as the stormwater conveyance system. Weighted CNs range from 52 to 85 in the residential and commercial areas of the south, and from 30 to 57 in the north. Again, a portion of the Rum River was modeled, but contour information lacked enough detail to model an accurate floodplain and channel cross section.

The primary stormwater conveyance system is storm sewer discharging into detention and treatment ponds before discharging into the Rum River. Times of concentration and peak runoff rates were calculated the same as with Seelye Brook.

CD 18:

CD 18 drains roughly 1085 acres of low density residential, herbaceous, and cultivated vegetation areas. CD 18 flows to the south and eventually drains into the Rum River. Weighted curve numbers range from 56 to 73. Some higher curve numbers, around 93, exists in some smaller subbasins that have a high percentage of open water. A portion of CD 18 was modeled as an open channel section, but requires additional survey to accurately model floodplain storage.

Times of concentration and peak runoff rates were calculated the same as with Seelye Brook and Rum River.

CD 19:

CD 19 also drains primarily low density residential areas. St. Francis contributes roughly 1530 acres to the headwaters of CD 19, which eventually flows into the Rum River south of the city limits. Land cover is woodland, herbaceous, and cultivated vegetation, with some low density residential development. Weighted curve numbers range from 43 to 52.

Regression analysis was used to calibrate the time of concentration.

Cedar Creek:

Roughly 807 acres drains to Cedar Creek in the southeast corner of St. Francis. Cedar Creek is a tributary of the Rum River; the confluence is south of Oak Grove. Land cover is primarily woodland and herbaceous, resulting in weighted curve numbers ranging from 47 to 49.

Regression analysis was used to calibrate the time of concentration.

General:

Information included in the model will continue to be updated as development occurs and additional information becomes available.

Table 10

Summary of watershed characteristics, 100-year rainfall event.

Element ID	Area (acres)	Weighted CN	Time of Concentration (days hh:mm:ss)	Total Runoff (inches)	Peak Runoff (cfs)
SB1	38.6	77	0 03:22:21	3.35	28.5
SB2	24.9	85	0 03:22:21	4.16	23.0
SB3	12.6	66	0 03:22:21	2.33	6.2
SB4	47.5	72	0 00:16:44	2.87	162.3
SB5	31.9	48	0 00:32:42	0.94	17.6
SB6	75.5	78	0 00:21:11	3.45	278.5
SB7	139.9	75	0 00:20:10	3.16	484.6
SB8	88.2	52	0 00:23:15	1.21	90.3
SB9	241.6	64	0 01:12:29	2.16	237.5
SB10	572.1	55	0 03:17:03	1.43	157.8
SB11	267.9	57	0 01:28:31	1.59	153.6
SB12	142.9	52	0 01:48:32	1.21	49
SB13	564.8	42	0 01:26:43	0.56	72.85
SB14	49.6	75	0 00:58:01	3.16	88.7
SB15	36.9	52	0 00:17:54	1.21	44.1
SB16	36.4	75	0 00:32:37	3.16	96.1
SB17	64.2	63	0 00:20:43	2.07	139.3
SB18	58.3	58	0 00:21:54	1.66	94.4
SB19	8.5	59	0 00:14:21	1.74	17.9

Element ID	Area (acres)	Weighted CN	Time of Concentration (days hh:mm:ss)	Total Runoff (inches)	Peak Runoff (cfs)
SB20	23.5	57	0 00:18:07	1.59	39.7
SB21	670.4	57	0 03:32:06	1.59	198.8
SB22	97.2	56	0 00:34:08	1.51	104.3
SB23	1975.5	46	0 04:02:11	0.81	225.3
SB24	1523.6	51	0 02:12:51	1.14	415.9
SB25	124.9	49	0 02:55:18	1.00	23.6
SB26	1529.4	52	0 01:43:32	1.21	543
SB27	229.5	60	0 01:10:02	1.82	188.4
SB28	722.4	41	0 01:22:17	0.51	81.1
SB29	572.9	46	0 01:07:05	0.81	152.2
SB30	468.1	50	0 01:51:21	1.07	132.8
SB31	322.4	34	0 00:43:19	0.18	7.1
SB32	771.8	46	0 01:30:42	0.81	167.3
SB33	4.1	73	0 02:55:18	2.96	3.00
SB34	32	73	0 00:41:40	2.97	67.6
SB35	11	93	0 00:40:20	5.04	38.5
SB36	4	93	0 00:14:28	5.04	23.5
SB37	13.6	75	0 00:15:43	3.16	52.2
SB38	15.2	75	0 00:17:58	3.16	55.5
SB39	58.8	57	0 00:37:26	1.59	63.4
SB40	11.4	73	0 00:15:54	2.97	40.9
SB41	27.2	59	0 00:21:16	1.74	47.3
SB42	45.6	74	0 00:19:31	3.06	155.3
SB43	164.6	51	0 02:55:18	1.14	36.8
SB44	6.1	75	0 00:18:36	3.16	21.9
SB45	283.4	60	0 01:47:08	1.82	168.6
SB46	407	56	0 04:03:02	1.51	102.5
SB47	79.8	59	0 00:20:42	1.74	141
SB48	141.5	47	0 00:30:40	0.87	72.5
SB49	34.7	52	0 00:16:48	1.21	42.8
SB50	41.2	50	0 00:22:17	1.07	36.2
SB51	33.7	50	0 00:20:41	1.07	31.1
SB52	807.8	43	0 04:19:46	0.62	63.6
SB53	608	49	0 03:42:39	1.00	97.3
SB54	198.9	47	0 00:35:10	0.87	92.6
SB55	1452.6	30	0 06:34:31	0.06	8.1
SB56	719	52	0 05:06:14	1.21	116.5

It is extremely important that each area be re-evaluated at the time of final design to confirm the criteria used in this study and to make any changes that a proposed development may dictate.

All storm sewer facilities, especially those conveying large quantities of water at high velocities, should be designed with efficient hydraulic characteristics. Special attention should be given during final design to those lines that have extreme slopes and create high hydraulic heads.

The Best Management Practices (BMPs) recommended by the MPCA should be followed wherever necessary.

C. Recommendations

The following items are included based upon the data compiled in this plan:

1. The SWMP as presented herein will be adopted by the City of St. Francis.
2. The current ordinances will be reviewed and the recommended ordinance revisions should be addressed.
3. Standard review procedures will be established, where feasible, to ensure all development within the City is in compliance with proper erosion control practices.
4. Detailed topographic surveys and storm sewer inventory should be incorporated into the hydrologic and hydraulic model when available.
5. Detailed hydrologic analysis will be required, where feasible, during final design of all new developments and ponding areas.
6. Final high water levels governing building elevations adjacent to ponding areas and floodplains will be established as development occurs or when drainage facilities are constructed.
7. Overflow routes will be established and maintained, where feasible, to provide relief during extreme storm conditions, which exceed design conditions.
8. A stormwater maintenance program will be implemented to ensure the successful operation of the drainage system.
9. The erosion and sedimentation control criteria for new developments will be enforced.
10. An education program for City residents, staff, and development community will be implemented, where feasible.
11. Amendments to the plan should be adopted and implemented as warranted by future standards or regulations, where feasible.
12. That the plan should be updated within 2-years of adoption of the final Watershed Management Plan by the URRWMO.

The existing storm sewer system of the City of St. Francis is not adequate to handle the continued development around the presently developed area. If development continues, the existing system will need major improvement and enlargements to effectively serve the community without excessive flooding. The proposed infiltration and oversized ponding development scenario together with strategically located regional ponds presents one method of accommodating the present growth of St. Francis. However, this plan and the proposed scenario is not necessarily the only method of accomplishing the goal of comprehensive stormwater management.

Given this, it is imperative that this plan and the StormNET model of the City is continually updated on a regular basis and compared to the baseline runoff of the existing conditions model to ensure that any adjustments in area developments continue to be coordinated. In addition, the proposed stormwater development charges should be updated annually to ensure that the associated City costs are fully financed. In this manner, the plan can maintain its usefulness as a current document.

Finally, the EPA has initiated the NPDES Phase II requirements whereby cities in several previously mentioned categories are required to apply for a Phase II permit. The City of St. Francis is a mandatory small MS4 community and is permitted as such through the MPCA.

XI. ACRONYMS AND GLOSSARY

A. Acronyms

ACD	-	Anoka Conservation District
AMC	-	Antecedent Moisture Condition
BMP	-	Best Management Practices
BWSR	-	Board of Water and Soil Resources
CD	-	County Ditch
CN	-	Curve Number
DNR	-	Minnesota Department of Natural Resources
DO	-	Dissolved Oxygen
DWSMA	-	Drinking Water Supply Management Area
EOF	-	Emergency Overflow
EPA	-	United States Environmental Protection Agency
FEMA	-	Federal Emergency Management Agency
GIS	-	Geographic Information System
GPS	-	Geographic Positioning System
HWL	-	High Water Level
IDF	-	Intensity-Duration-Frequency
LGU	-	Local Government Unit
MLCCS	-	Minnesota Land Cover Classification
MnRAM	-	Minnesota Routine Assessment Method
MPCA	-	Minnesota Pollution Control Agency
MS4	-	Municipal Separate Storm Sewer System
NOAA	-	National Oceanic and Atmospheric Administration
NPDES/SDS	-	National Pollutant Discharge Elimination System/State Disposal System
NRCS	-	Natural Resources Conservation Service
NWI	-	National Wetland Inventory
RFPE	-	Regulatory Flood Protection Elevation
SCS	-	Soil Conservation Service
SWCD	-	Soil and Water Conservation District
SWMP	-	Surface Water Management Plan
SWPPP	-	Storm Water Pollution Prevention Program
TEP	-	Technical Evaluation Panel
TMDL	-	Total Maximum Daily Load
URRWMO	-	Upper Rum River Watershed Management Organization
USACE	-	U.S. Army Corps of Engineers
USGS	-	U.S. Geological Survey
WCA	-	The Minnesota Wetland Conservation Act
WHPA	-	Well Head Protection Area
WLA	-	Wasteload Allocation

B. Glossary

100-Year Flood: The flood reaching water levels or flow rates with a one-percent (1%) chance of occurring in any given year. On the average, a 100-year flood is statistically probable to occur only once in a 100-year period. A 100-year flood is synonymous with Base Flood, Regional or 1% Chance Flood.

100-Year Storm Event: The rainfall event having a total precipitation over a 24-hour period with a one-percent (1%) chance of occurring in any given year. On the average, a 100-year storm event is statistically probable to occur only once in a 100-year period. The value for the St. Francis area is taken from Soil Conservation Service Technical Paper No. 40 (SCS TP-40). For the St. Francis Area, a 100-year Storm Event is a 5.9- inch rainfall in 24 hours.

100-Year, 10-Day Snowmelt Event: The storm event having a total precipitation over a 10-day period with a one-percent (1%) chance of occurring in any given year. On the average, a 100-year snowmelt event is statistically probable to occur only once in a 100-year period. The value for the St. Francis area is taken from the SCS National Engineering Handbook, which shows the 100-year, 10-day snowmelt event is 7.3 inches over 10 days.

Agricultural Land: Any land designated specifically for agricultural production. This may include row crops, pasture, hay land, orchards, or land used for horticultural purposes.

Anaerobic: Conditions either in water or soil where there is a lack of oxygen.

Army Corps of Engineers (COE or USACE): The United States Army Corps of Engineers is a regulatory agency involved in design, permitting and construction projects related to or impacting navigable waters of the United States including lakes, waterways and wetlands.

Best Management Practice (BMP): An action, procedure, or structural improvement designed to improve water quality. BMPs include schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the discharge of pollutants to waters of the State. BMPs also include treatment practices such as ponds, rain gardens, vegetated buffers and vegetated swales, treatment requirements, operating procedures, and practices to control runoff, spillage or leaks, or drainage from raw material storage.

Buffer: A vegetated area immediately adjacent to a wetland that is not mowed and/or managed. Buffers are ideally dominated by native vegetation and add to the ecological health of the wetland by adding habitat and assisting and filtering pollutants from surface water runoff.

BWSR: Board of Water and Soil Resources. This is the lead regulatory agency that oversees Minnesota Statue 103B.205 to 103B.255, Minnesota Rule 8410 and the Minnesota Wetland Conservation Act.

Circular 39: A wetland classification system developed by United States Fish and Wildlife Service in 1956 that categorizes wetlands into eight types. This is the same classification system generally accepted by the State of Minnesota for wetland classification.

Comprehensive Plan: As defined in Minnesota Statutes 394.21, a Comprehensive Plan defines a City's policies, statements, goals and interrelated plans for private and public land and water use, transportation and community facilities to assist in guiding future development and growth.

Cowardin Classification: A wetland classification system developed by the United States Fish and Wildlife Service in 1979. This system defines wetlands by a tiered system and is more detailed than the Circular 39 method. The Cowardin System is the classification system used in the National Wetlands Inventory.

Design Storm: A rainfall event of specified size and return frequency that is used to calculate the runoff volume and peak discharge rate to a BMP. In St. Francis, a 10-year design storm is 4.1-inches in 24-hours and a 100-year storm is 5.8-inches in 24-hours. If designing piped storm sewer, a 10-year design storm may also refer to an Intensity-Duration-Frequency (IDF) curve used in the Rational Method of storm sewer design.

Detention: The temporary storage of runoff from rainfall and snowmelt events to control peak discharge rates and provide an opportunity for treatment to occur. Detention storage is typically designed in basins.

Development: The construction, installation or alteration of any structure, the extraction, clearing or other alteration of terrestrial or aquatic vegetation, land or the course, current or cross section of any water body or water course or division of land into two (2) or more parcels. See also re-development, new development and existing development.

Dissolved Oxygen (DO): The amount of oxygen in the water column is called the dissolved oxygen. DO standard can vary, but no site-specific standard shall be less than 5 mg/L as a daily average and 4 mg/L as a daily minimum. Compliance with this standard is required 50% of days for flows of the receiving water equal to the lowest 7-day average flow that occurs on average once every 10 years ($7Q_{10}$). DO levels that are too low affect aquatic life.

Draining: The removal of surface water or ground water.

Easement: A grant of one or more property rights by a property owner for use by the public, a corporation, or another person or entity.

Escherichia coli**:** *E. coli* is a naturally occurring bacteria that can be harmful to humans at increased levels. Sources of high levels of *E. coli* are typically from fecal matter, either humans, wildlife, or pets. The Minnesota water quality rules state "*E. coli* bacteria shall not exceed 126 organisms per 100 milliliters (mL) as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than 10% of all samples taken during any calendar month individually exceed 1,260 organisms per 100 mLs. The standard applies only between April 1 and October 31."

Emergency Overflow (EOF): A hydraulic channel, swale, weir, etc. that provides an outlet from a pond or flooded area at an elevation below the point where property damage can occur.

Erosion: The wearing away of land surface and soil by the action of natural elements (wind and/or water).

Eutrophication: Process by which overabundance of nutrients in a waterbody lead to accelerated productivity and general decrease in water clarity and quality.

Exfiltration: The downward movement of runoff through the surface and into the subsoil.

Existing Development: A property or parcel of land that has previously been subject to development and no major changes are anticipated to the property in the near future.

Extended Detention: A stormwater design feature that provides for the gradual release of a volume of water (typically 0.25 to 1.0 inches per impervious acre) over a 12 to 48 hour time period. With proper design, the extended detention period allows for an increased settling of pollutants, and can protect channels from frequent flooding or scour.

Filtration Basin: A treatment area designed to treat stormwater by a process that physically removes particles from the water.

Flood: A temporary rise in stream flow or stage that results in inundation of the areas adjacent to the channel or water body.

Flood Frequency: The statistically determined average time period between events where a specific flood stage or discharge may be equaled or exceeded.

Flood Fringe: That portion of the 100-year floodplain outside of the floodway.

Floodplain: Floodplains are lowland areas adjoining lakes, wetlands, and rivers that are susceptible to inundation of water during a flood. For regulatory purposes, the floodplain is the area covered by the 100-year flood and it is usually divided into districts called the floodway and flood fringe. Areas where floodway and flood fringe have not been determined are called approximate study areas or general floodplain.

Floodplain (General) Area: The general floodplain area is determined using the best available data, in lieu of performing a detailed engineering study. These data may be from soils mapping, experienced high water profiles, aerial photographs of previous floods, or other appropriate sources. There are no associated published 100-year flood elevations with general floodplain delineations, unlike detailed study areas. General floodplain area is synonymous with approximate study area and unnumbered A-Zone.

Floodway: The floodway is the channel of a river or other watercourse and the adjacent land areas which must remain open in order to discharge the 100-year flood.

Freeboard: A factor of safety usually expressed in feet above a certain flood level. Freeboard compensates for the many unknown factors (e.g., waves, ice, debris, etc.) that may increase flood levels beyond the calculated level.

Geographic Information System (GIS): Computer databases of georeferenced information on the cities various resources.

Global Positioning System (GPS): Network of satellites used to map and identify locations on the earth.

Hydric Soil: Soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part. Hydric soil is one of the three criteria that define wetlands

Hydrophytic Vegetation: Macrophytic plant life growing in water, soil, or a substrate that is at least periodically deficient in oxygen as a result of excessive water content.

Hypereutropic: A very nutrient-rich lake characterized by frequent and severe nuisance algae blooms and low transparency.

Intensity-Duration-Frequency (IDF) Curve: A graphical representation of the rainfall intensity versus time of concentration for an area. The IDF curve is typically used in the Rational Method of storm sewer design to determine design rainfall intensity in inches per hour. The following IDF curve is taken from the Minnesota Department of Transportation Drainage Manual and applies is used in the rational method of storm sewer design for the St. Francis area.

3.5.4(2) **DRAINAGE MANUAL** August 30, 2000

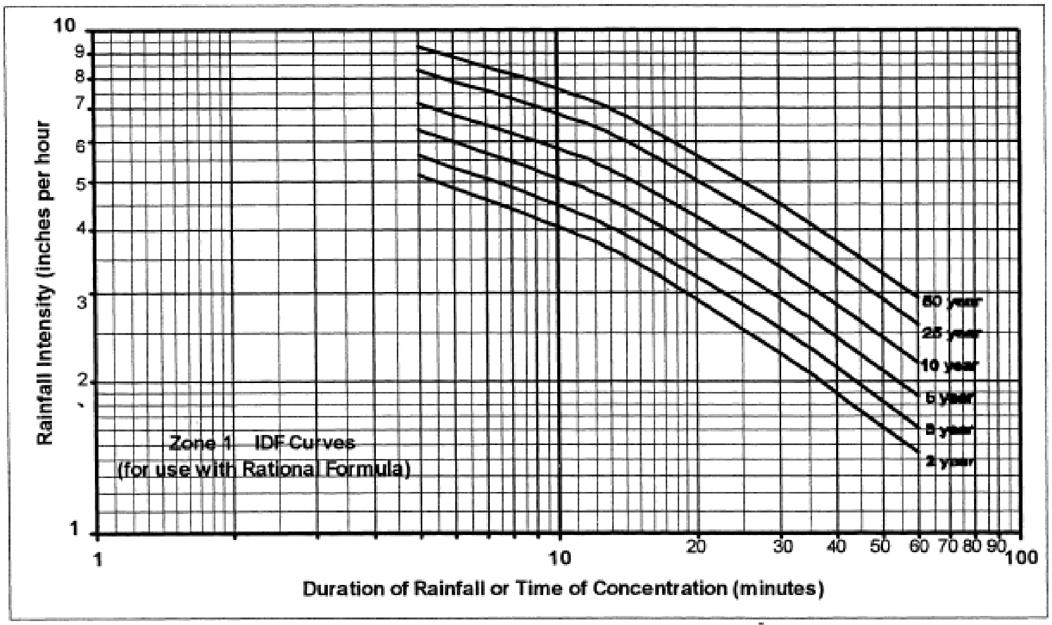


Figure 3.4 Zone 1 Southern Minnesota Rainfall Intensity - Duration - Frequency (IDF) Curves

Impervious Surface: The portion of the buildable parcel that has a covering which does not permit water to percolate into the natural soil. Impervious surface shall include, but not be limited to, buildings, all driveways and parking areas (whether paved or not), sidewalks, patios, swimming pools, tennis and basketball courts, covered decks, porches, and other structures. Open, uncovered decks are not considered impervious for the purposes of this ordinance. The use of patio blocks, paver bricks or class 5 gravel material are considered impervious surfaces as a majority of water runs-off the surface rather than being absorbed into natural soils underneath. Some exceptions to these conditions may include paver blocks or pavement systems engineered to be permeable with the underlying soils suitable for infiltration.

Infiltration Basin: An impoundment where incoming stormwater runoff is stored until it gradually infiltrates into and through the soil of the basin floor.

Landlocked High Water Level or Landlocked HWL: The peak water level or high water level in a land locked basin. The HWL is the highest peak ponding elevation generated by the back-to-back 100-year SCS 24-hour rainfall events, the 10-inch SCS 24- hour rainfall event or the 100-year, 10-day snowmelt snow melt event.

Local Government Unit (LGU): Agency that has the primary responsibility of administering the Wetland Conservation Act. The City of St. Francis acts as LGU for all wetlands within the City limits and shares responsibility for basins that border adjacent municipalities.

Lowest Floor: The lowest floor of a structure, including basement.

MNRAM: The Minnesota Routine Assessment Methodology as referenced by Minnesota Rules 8420. MNRAM is the primary tool used to assess wetland functions and values on a qualitative basis. MNRAM evaluates wetlands based on vegetation, wildlife habitat, water quality, flood and stormwater attenuation, recreational opportunities, aesthetics, fishery habitat, groundwater interactions, and commercial use. The result of a MNRAM evaluation is a ranking of the wetland quality that can be used to monitor the wetland changes over time and to set appropriate protection needs and techniques. The version referenced in this plan is Version 3.0.

Navigable Waters: Waters defined by the United States, 33 Code of Federal Regulations Section 329.4 as those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. The U.S. Corps of Engineers has Federal Jurisdiction over Navigable Waters.

New Development: Development of a property or portion thereof that is currently undeveloped property.

Ordinary High Water Level (OHWL or OHW): The Minnesota DNR jurisdictional boundary of public waters and wetlands that is depicted by an elevation delineating the highest water level which has been maintained for a sufficient period of time to leave evidence upon the landscape, commonly that point where the natural vegetation changes from predominantly aquatic to predominantly terrestrial. For watercourses, the ordinary high water level is the elevation of the top of the bank of the channel. For reservoirs and flowage, the ordinary high water level is the operating elevation of the normal summer pool. In St. Francis all of the lakes have an OHW established. For streams and waterways, the OHW is considered the top of bank. Areas below the OHW are under the jurisdiction of the Minnesota Department of Natural Resources and are not regulated by the Wetland Conservation Act.

Permanent Pool: A 3- to 10-foot deep pool in a stormwater pond system that provides removal of urban pollutants through settling and biological uptake (also referred to as a wet pond).

Porous Pavement: An alternative to conventional pavement whereby runoff is diverted through a porous asphalt or concrete layer and into an underground stone reservoir. The stored runoff then gradually infiltrates into the subsoil.

Protected Water: Any water or wetland designated by the Minnesota Department of Natural Resources and identified by statute on the Protected Waters Inventory.

Public Waters: Those waters of the state identified as public waters or wetlands under Minnesota Statutes, Section 103G.005.

Rational Method: A method of estimating the peak runoff from a watershed that is based on the formula $Q = CIA$. Where:

Q = peak flow rate in cubic feet per second

C = a runoff coefficient based on the percentage of impervious surface, type of vegetative cover, and soil type

I = rainfall intensity in inches per hour as determined from an area IDF curve

A = watershed area in acres

Reach: A hydraulic engineering term to describe a longitudinal segment of a stream or river influenced by the natural or man-made obstruction. In an urban area, the segment of a stream or river between two consecutive bridge crossings or between two reservoirs would most typically constitute a reach.

Redevelopment: Any development including but not limited to rebuilding, renovation, revision, remodeling, reconstruction or redesign of or at an existing development.

Regional Flood: A flood which is representative of large floods known to have occurred generally in Minnesota and reasonably characteristics of what can be expected to occur on an average frequency in the magnitude of the 100-year recurrence interval. A regional flood is synonymous with the term "base flood" used in the Flood Insurance Study.

Regulatory Flood Protection Elevation: A point not less than one-foot above the water surface profile associated with the 100-year flood as determined by the use of the 100-year flood profile and surrounding technical data in the Flood Insurance Study plus any increase in flood heights attributable to encroachments on the floodplain. It is the minimum elevation the DNR requires Cities to regulate by ordinance.

Retention: The permanent storage of runoff from rainfall and snowmelt events with volume reduction coming from infiltration, evaporation or emergency release.

Runoff (Stormwater): The overland and near surface flow from rainfall and snowmelt.

Runoff Coefficient: A measure of the rate of runoff that isstatistically generated from a parcel of land that is based on the land use, percent of impervious surfacing, soil type and vegetative cover. The higher the coefficient, the higher the amount of runoff anticipated from the parcel. Rational method runoff coefficients range from 0.2 for meadow lands to
0.95 for paved surfaces.

Runoff Conveyance: Methods for safely conveying runoff to a BMP to minimize disruption of the stream network, and promote infiltration or filtering of the runoff.

Runoff Pretreatment: Techniques to capture or trap coarse sediments before they enter a BMP to preserve storage volumes or prevent clogging within the BMP. Examples include forebays and micropools for pond BMPs, and plunge pools, grass filter strips and filter fabric for infiltration BMPs.

Sequencing: The process used by the Local Government Unit to evaluate the necessity of an activity relative to its impact on a wetland. The party proposing the impact must demonstrate that the activity proposed complies with the following principles in descending order of priority.

1. Avoids direct or indirect impacts to the wetlands that may diminish or destroy them;
2. Minimizes the impact to the wetland by limiting the degree or magnitude of the wetland activity and its implementation;
3. Rectifies the impacts by repairing, rehabilitating, or restoring the affected wetland;
4. Reduces or eliminates the impact to the wetland over time by preservation and maintenance operations; and,
5. Replaces unavoidable wetland impacts to the wetland by restoring or, if wetland restoration opportunities are not reasonably available, creating substitute wetland areas having equal or greater public value as provided for under the Wetland Conservation Act.

Shoreland: Land located within the following distances from public waters:

1. One thousand feet from the ordinary high water level of a lake, pond, or flowage
2. Three hundred feet from a river or stream, or the landward extent of a floodplain designated by ordinance on a river or stream, whichever is greater.

The limits of shoreland may be reduced whenever the waters involved are bounded by topographic divides which extend landward from the waters for lesser distances and when approved by the Commissioner of the DNR.

Shoreland Wetland Protection Zone: The land located within 1,000 feet from the Ordinary High Water Elevation of a Protected Water, 500 feet from the Rum River or the landward extent of the designated floodplain, and 300 feet from any stream designated in the shoreline management ordinance.

Stormwater Treatment: The use of accepted BMPs to treat runoff including detention, retention, filtering or infiltration of a given volume of stormwater to remove pollutants.

Structure: Anything manufactured, built, constructed, erected, or a portion thereof which is normally attached to or positioned on land, whether temporary or permanent in character, including but not limited to buildings, fences, sheds, advertising signs, dog kennels, hard surface parking areas, boardwalks, playground equipment, concrete slabs.

Stormwater: (See Runoff)

Stormwater Treatment Pond: Any waterbody that has been specifically created to remove sediment and nutrients and "treat" surface water runoff. Stormwater ponds that were created from existing wetland are still regulated as jurisdictional wetlands. Stormwater ponds created from upland areas are not wetland and are exempt from regulatory jurisdiction.

Subwatershed: A subdivision based on hydrology corresponding to a smaller drainage area within a larger watershed.

Technical Evaluation Panel (TEP): A panel of technical professionals from the Board of Water and Soil resources, the Anoka County SWCD, the URRWMO and the LGU (City of St. Francis) at a minimum. This panel may also be expanded to include a Minnesota Department of Natural Resources representative, the U.S. Army Corps of Engineers and interested citizens requesting to participate in the wetland decision making process. Invitations to a TEP meeting are typically sent to all parties listed. The DNR, USACE and interested citizens (if any) may elect not to attend. The TEP provides decision making support for the LGU for many wetland and regulatory issues.

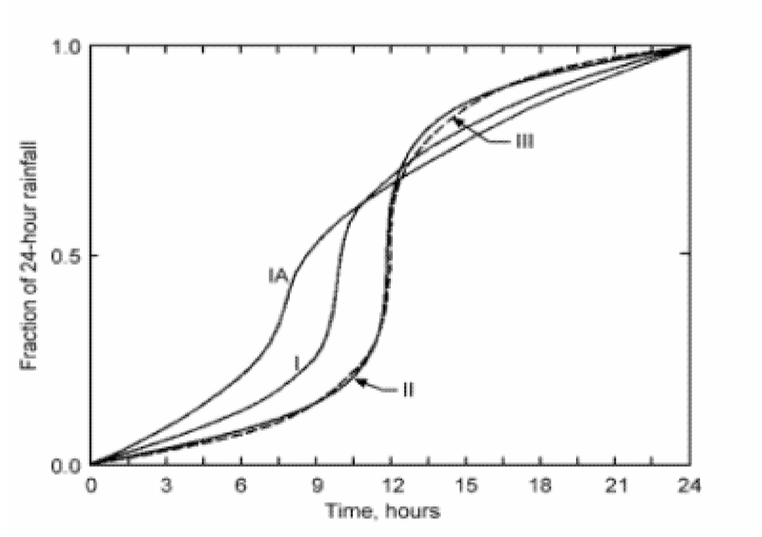
Ten-Day Snow Melt Runoff with Type "C" Distribution (100-Year/10-day snow melt runoff): A modeled runoff event that represents snowmelt conditions over a 10-day period for a return period snow depth of 100 years. The runoff event is simulated for a curve number (CN) of 100 which represents frozen soil conditions or where all surfaces are considered impervious. For some cities like St. Francis, the ten-day runoff event is critical event for identifying the high water level of the basin or water body because the Anoka Sand Plain typically reduces runoff under unfrozen conditions. The Type C distribution is similar in concept to the Type I and II distributions, and for this event, establishes the time distribution of runoff volume over the ten-day period.

Total Maximum Daily Load (TMDL): is a regulatory term in the U.S. Clean Water Act, describing a plan for restoring impaired waters that identifies the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards.

Treatment Volume (Vt): The volume of stormwater runoff that is treated within a BMP or IMP stormwater treatment facility. Typically the volume is expressed in terms of inches of runoff per impervious acre.

Type I, IA, II and III Storm Distributions - NRCS: These storm types represent the time distribution of a 24-hour rainfall event for areas throughout the United States. The total storm depth is distributed according to the diagram in subpart A. Type II storms are more "flashy" (i.e., convective/thunderstorms) than a Type I or IA storm. Subpart B illustrates that all of Minnesota is within the Type II rainfall distribution area.

A. SCS 24-hour rainfall distributions (SCS, 1986):



B. Approximate geographic boundaries for SCS rainfall distributions (SCS, 1986):

Underdrain: Typically perforated plastic pipes installed on the bottom of a filtration of infiltration BMP, or sand filter. The under drain is used to collect and remove treated stormwater that exceeds the water holding and/or infiltration capacity of the soil.

Upland: General term to describe any area that is not a wetland.

Vegetated Filter Strip: A vegetated section of land designed to accept runoff as overland sheet flow from upstream development. It may adopt any natural vegetated form, from grassy meadow to small forest. The dense vegetative cover facilitates pollutant removal. Vegetated filter strips cannot treat high velocity flows; therefore, they have generally been recommended for use in agriculture and low-density development.
A filter strip can also be an enhanced natural buffer, whereby the removal capability of the natural buffer is improved through engineering and maintenance activities such as land grading or the installation of a level spreader. A filter strip differs from a grassed swale in that a swale is a concave vegetated conveyance system, whereas a filter strip

has a fairly level surface.

Wasteload Allocation (WLA): A receiving water has a limit to how much pollutant it can accept and still meet water quality standards. TMDLs allocate a maximum load to each point source for each waterbody so that the sum of point sources do not exceed the pollutant limit. The allotted amount is called the WLA.

Watershed: A topographically defined area within which all runoff water drains to a point.

Water Quality Volume: A design volume of water as defined by the MPCA that is required to be treated from a new development site. The MPCA defines the water quality volume as 0.5-inches of runoff from all new impervious surfaces associated with the development in the watershed.

Watershed-to-Lake Ratio: The relative surface area of the contributing watershed to the surface area of the lake or water body. In terms of water quality, generally the smaller the watershed-to-lake ratio, the better the quality of the lake. For example a lake with a ratio of 4 to 1 means that the watershed is four times the size of the lake (i.e., 200 acres contributing to a 50 acre lake).

Wetland: Transitional land between terrestrial and aquatic systems where the water table is at or near the surface or the land is covered by shallow water. The jurisdictionally accepted definition of a wetland includes the following three characteristics:

1. Have a predominance of hydric soil
2. Be inundated or saturated within 1-foot of the surface for at least 5 percent of the growing season. The inundation refers to a single continuous episode.
3. Support a prevalence of hydrophytic vegetation typically adapted for life in saturated soils.

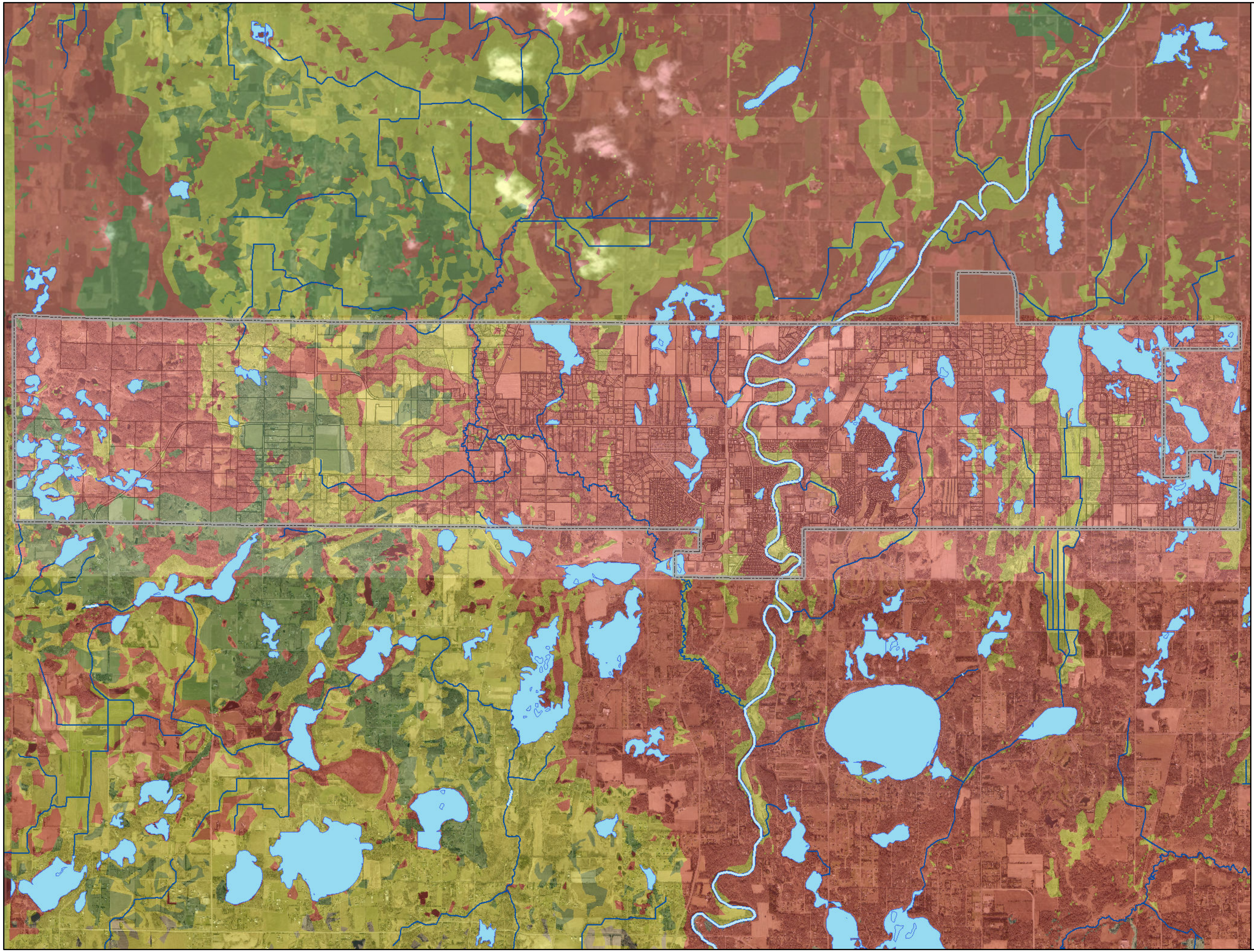
Wetland Conservation Act (WCA): In 1991 Minnesota adopted the initial Wetland Conservation Act (Minnesota Laws Chapter 354) to protect the states wetland resources. This act has been amended and updated periodically, typically under Minnesota Rule 8420, and is used by reference to the current program, as well as any future amendments.

Wetland Delineation: The process and procedure by which an area is determined a wetland or non-wetland including a determination of the wetland boundary based on the point where the non-wetland areas shift to wetlands or aquatic habitats.

Wetland Mitigation: Wetlands created to replace wetland areas destroyed or impacted by land disturbances.

Wet Pond: A conventional wet pond has a permanent pool of water for treating incoming stormwater runoff and a live storage component for flood storage and additional water quality treatment detention.

FIGURES



City of St. Francis

SURFACE WATER MANAGEMENT PLAN

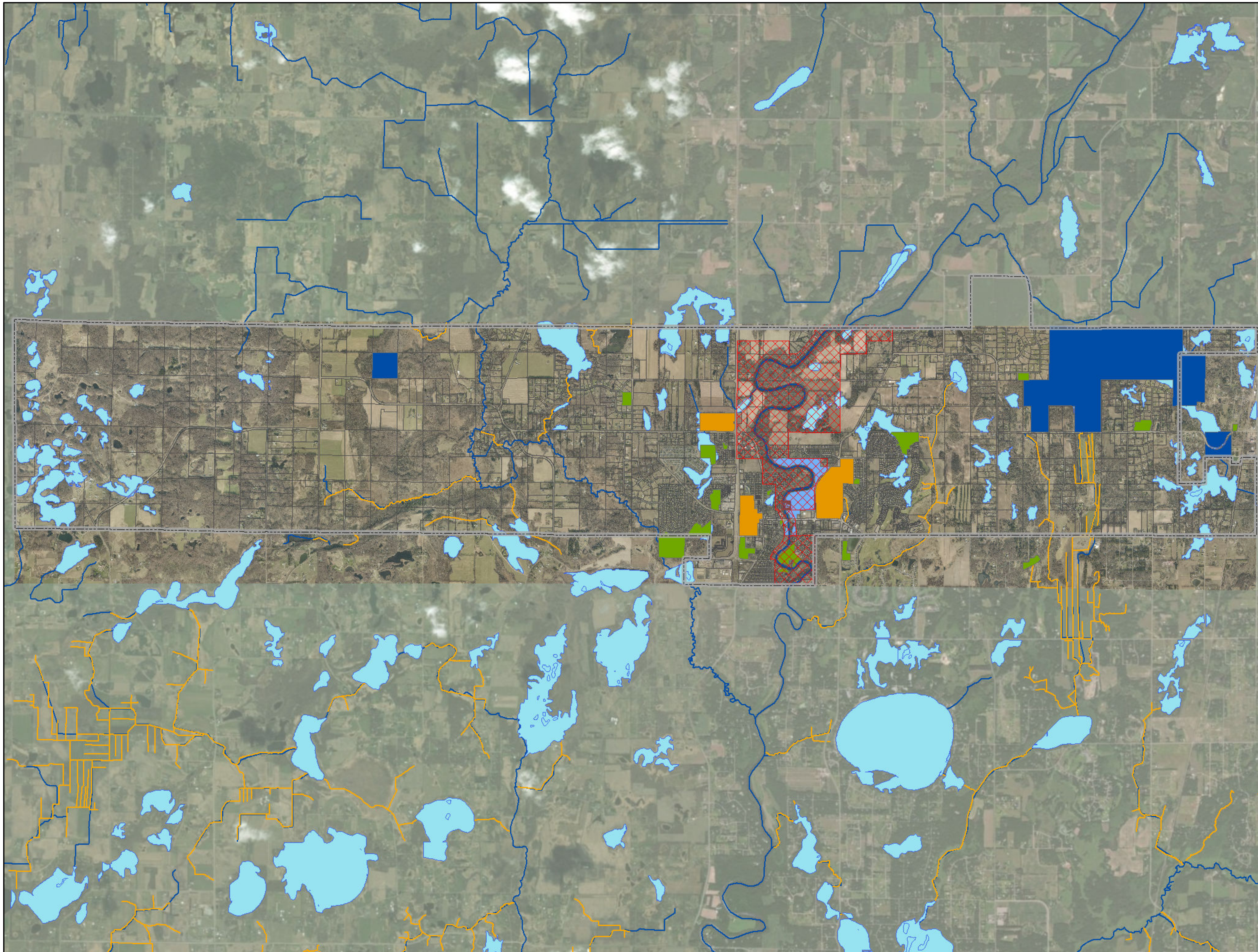
GEOLOGIC SENSITIVITY OF THE UPPERMOST AQUIFER TO POLLUTION

Figure 1

May, 2018

Hakanson Anderson

K:\cad_eng\PROJECTS\GIS\SF908\Sensitivity to Aquifer Pollution Fig 3.mxd



City of St. Francis

SURFACE WATER MANAGEMENT PLAN

Legend

- City Limits
- PWI
- Ditch or Canal
- Streams (or river)
- St Francis Parcels

Parks

- City Parks
- City Parks (undeveloped)
- County Parks
- School Land
- State Land
- Wild and Scenic River Districts
- Boat Launches

N W E S

0 0.5 1 1.5 2 MILES

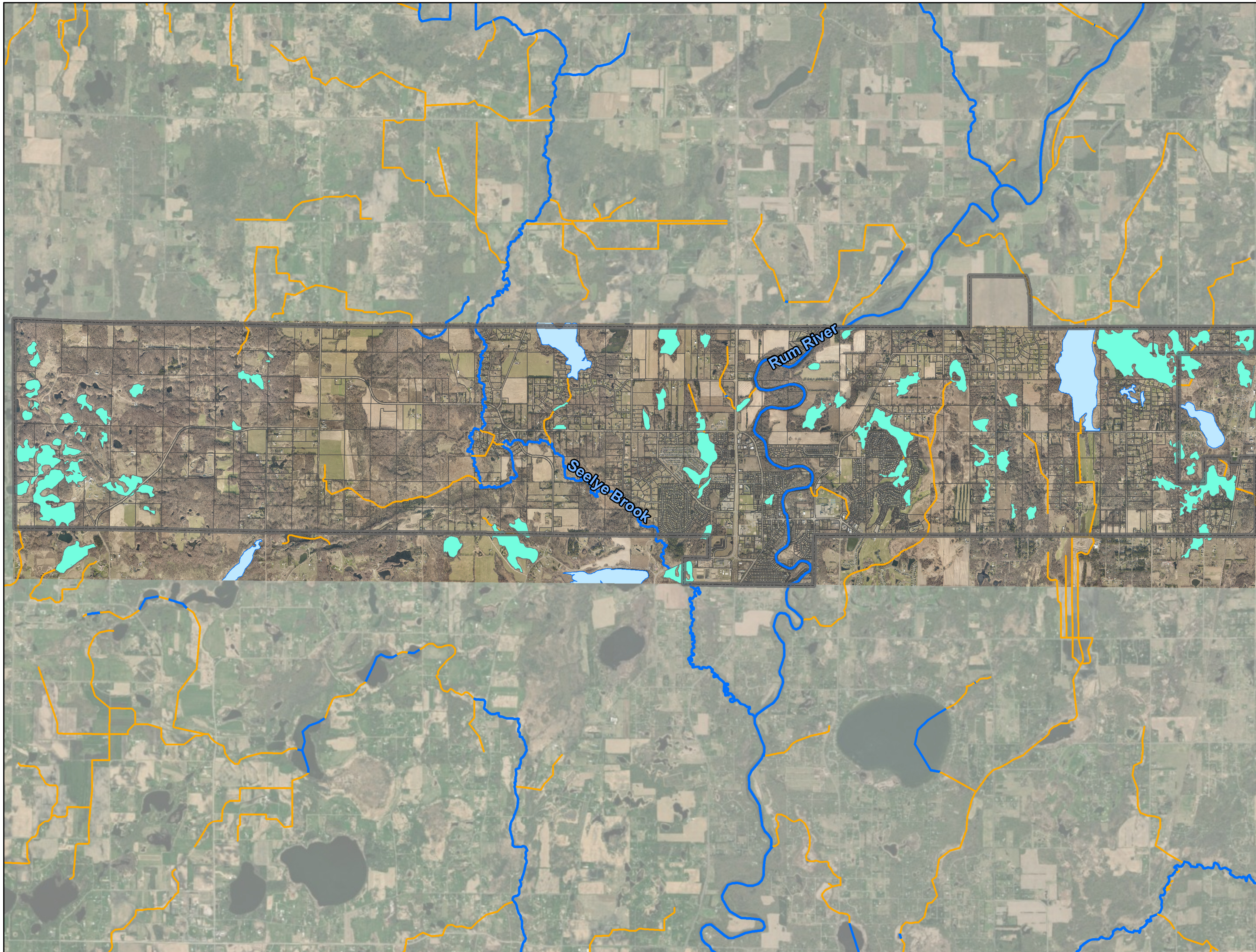
PARKS MAP

Figure 2

May, 2018

Hakanson Anderson

K:\cad_eng\PROJECTS\GIS\SF908\Parks Map Fig 4.mxd



City of St. Francis

SURFACE WATER MANAGEMENT PLAN

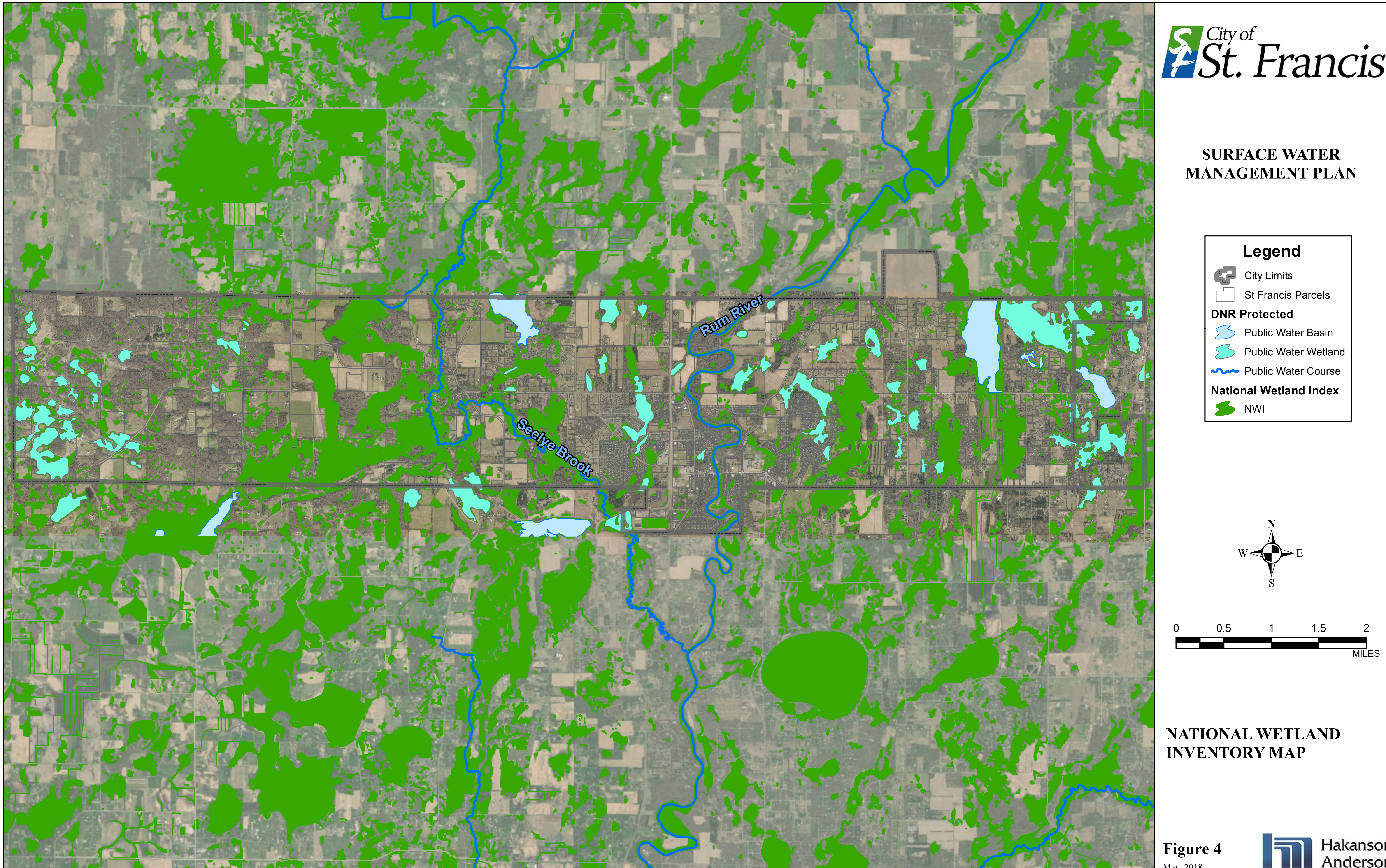
PUBLIC WATERS INVENTORY MAP

Figure 3

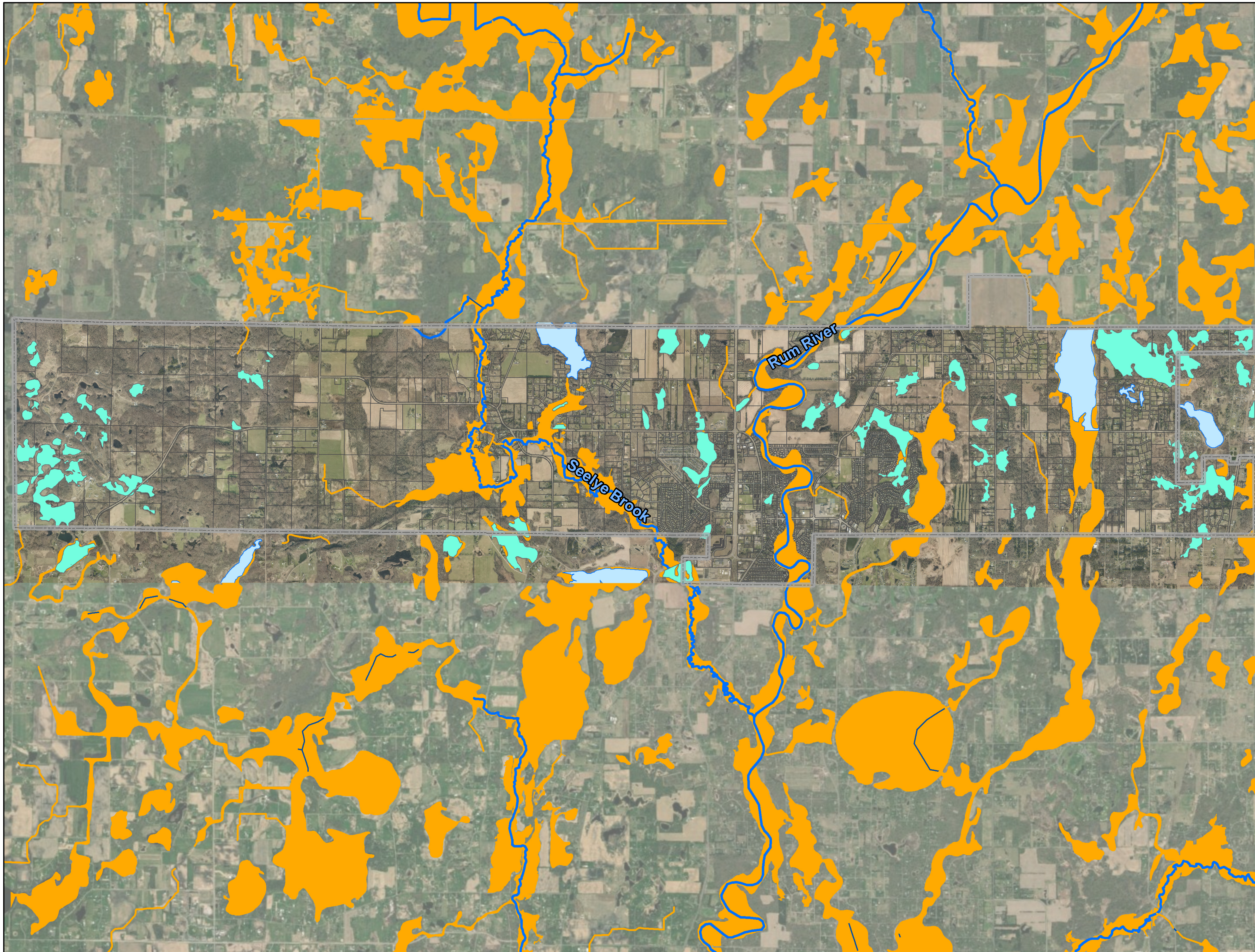
May, 2018

Hakanson Anderson

K:\GIS\Projects\Municpial\SF908\Public Water Inventory Fig 5.mxd



K:\GIS\Projects\Municpial\SF908\National Wetland Inventory Fig 6.mxd



City of St. Francis

SURFACE WATER MANAGEMENT PLAN

Legend

City Limits
St Francis Parcels
DNR Protected
Public Water Basin
Public Water Wetland
Public Water Course
FEMA Floodplain
100-Year

N
W E
S

0 0.5 1 1.5 2
MILES

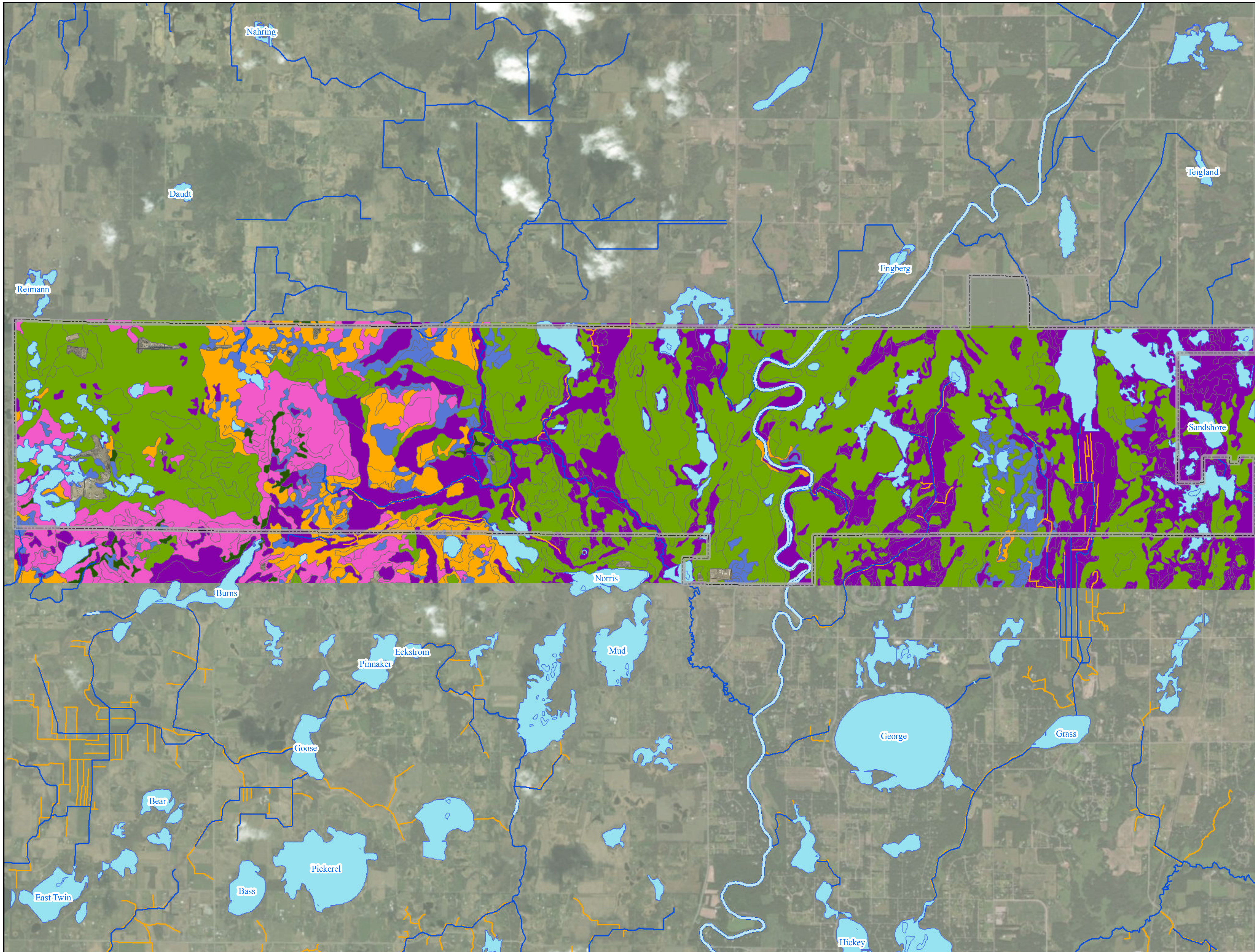
FEMA FLOODPLAIN BOUNDARIES

Figure 5

May, 2018

Hakanson Anderson

K:\GIS\Projects\Municpial\SF908\FEMA Floodplain Boundaries Fig 7.mxd



City of St. Francis

SURFACE WATER MANAGEMENT PLAN

Legend

- City Limits
- St Francis Parcels
- Ditch or Canal
- Streams
- River

Hydrolic Soil Group

- Water
- A
- A/D
- B
- B/D
- C
- C/D

N W E S

0 0.5 1 1.5 2 MILES

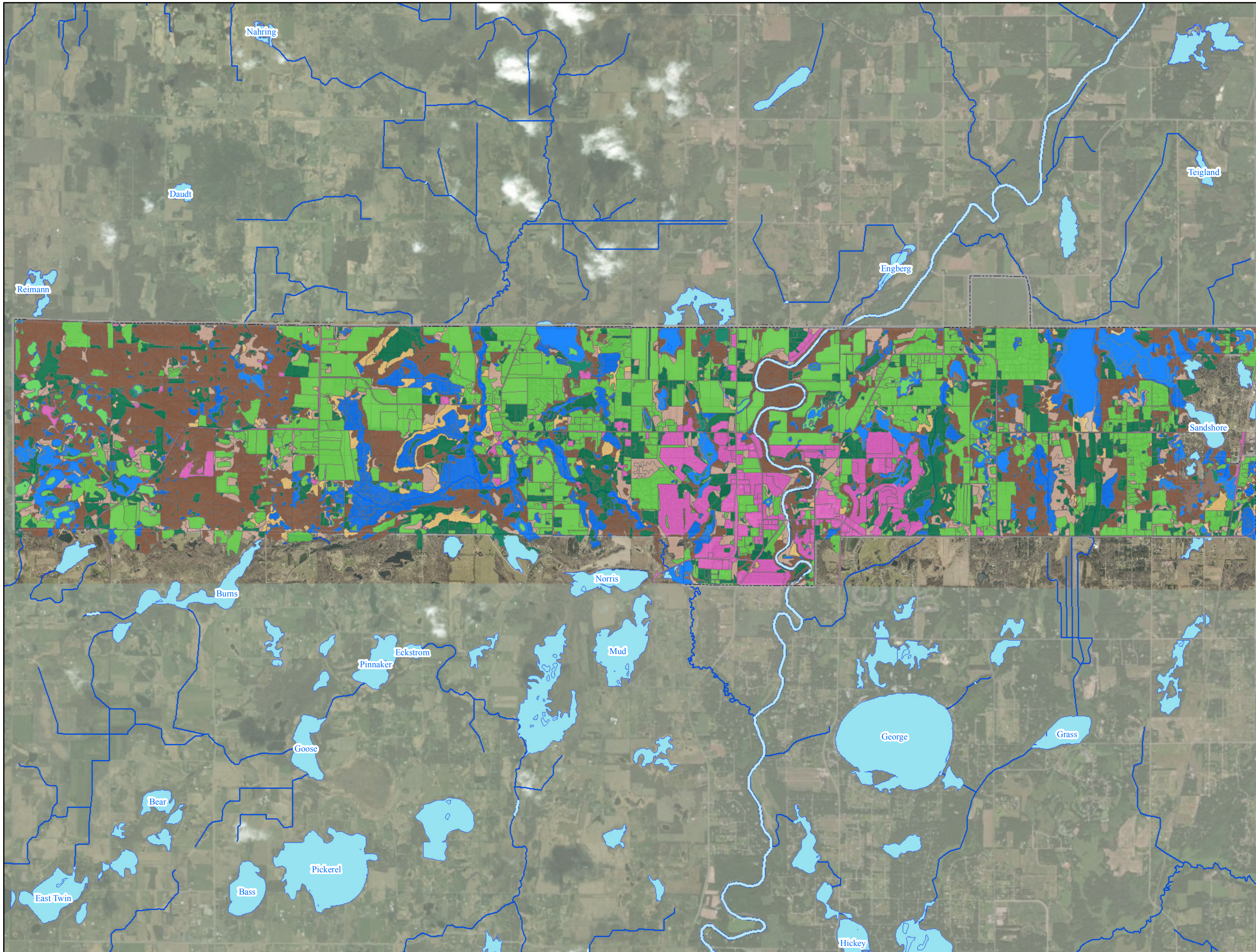
HYDROLOGIC SOILS MAP

Figure 6

May, 2018

Hakanson Anderson

K:\cad_eng\PROJECTS\GIS\SF908\Hydraulic soils Fig 8.mxd



City of St. Francis

SURFACE WATER MANAGEMENT PLAN

Legend

- City Limits
- St Francis Parcels
- River

Land Cover

- Atificial Surfaces and Associated Areas
- Forests
- Herbaceous
- Marsh/Swamp
- Planted or Cultivated Vegitation
- Schrubland
- Woodland

N W E S

0 0.5 1 1.5 2 MILES

LAND COVER MAP

Figure 7

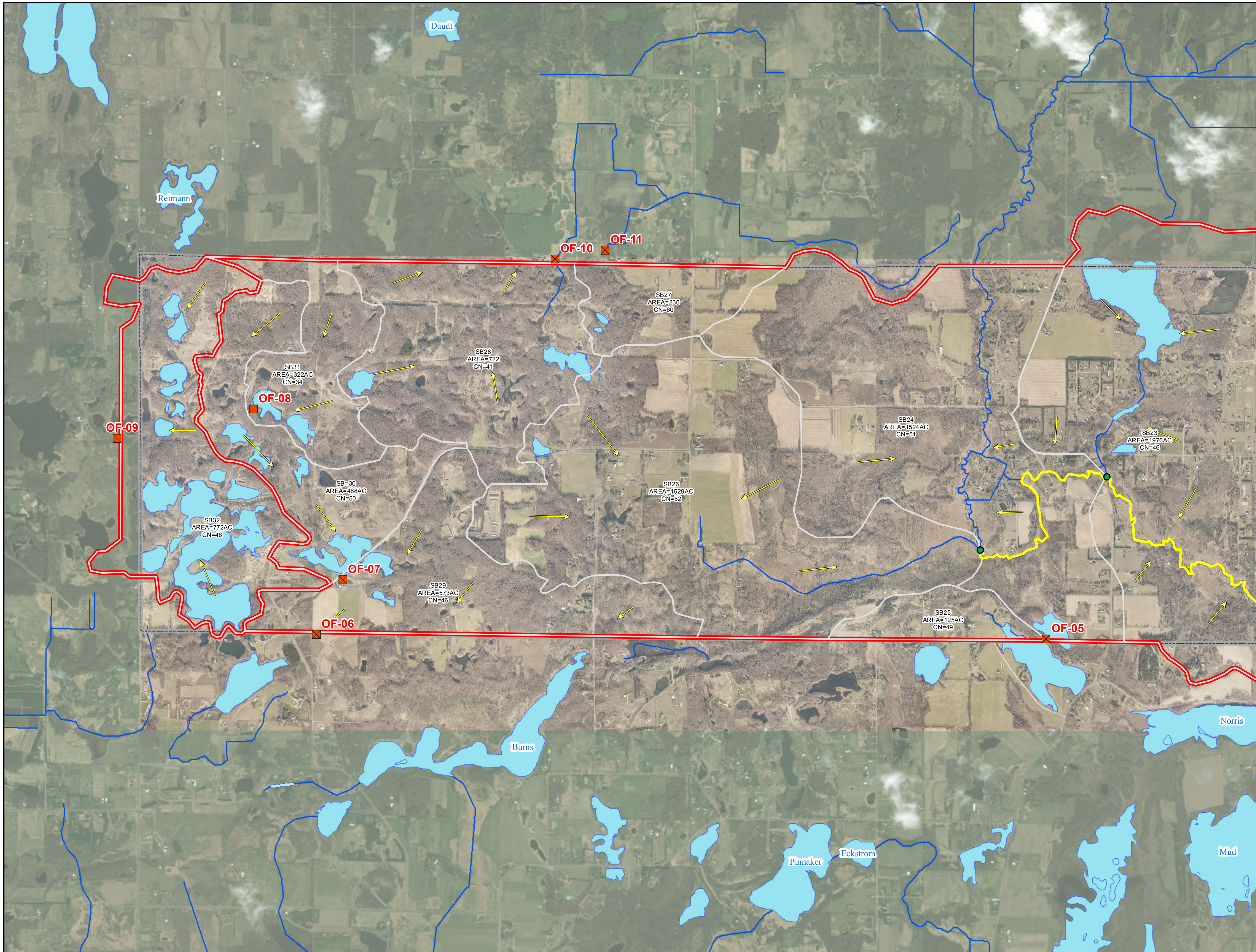
May, 2018

Hakanson Anderson

K:\cad_eng\PROJECTS\GIS\SF908\Land Cover Map Fig 9.mxd

City of St. Francis

SURFACE WATER MANAGEMENT PLAN



Legend

- City Limits
- **Rivers & Streams**
- Rivers & Streams
- Streams
- PWI
- Major Watersheds
- Subbasin
- Flow Direction
- Channel
- Junction
- Outfall
- Pond

N
W E
S

0 0.5 1
MILES

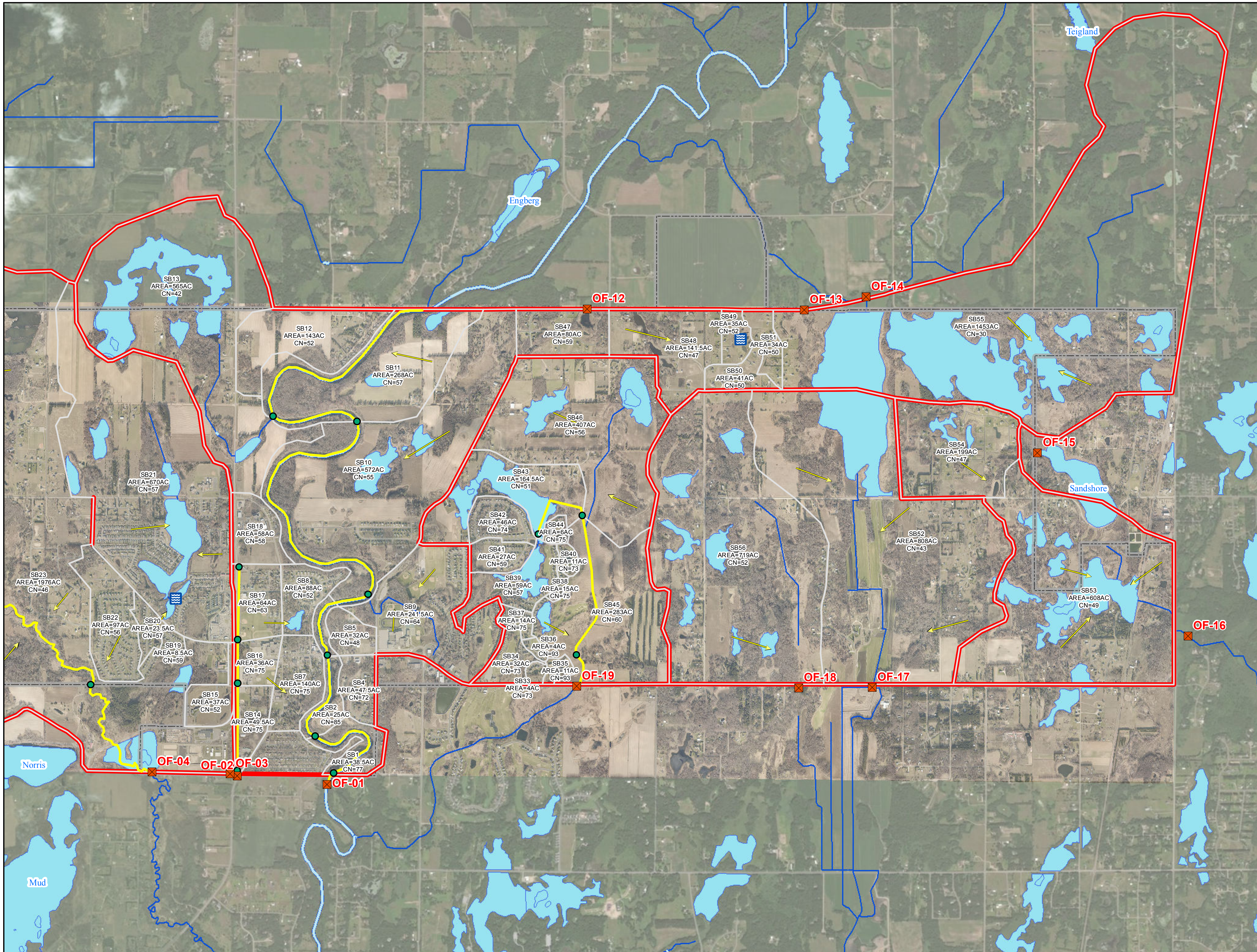
WATERSHED MAP

Figure 8A

May, 2018

Hakanson Anderson

K:\cad_eng\PROJECTS\GIS\SF908\Watershed Map Fig 10A.mxd



City of St. Francis

SURFACE WATER MANAGEMENT PLAN

Legend

- City Limits
- **Rivers & Streams**
- Rivers & Streams
- Streams
- PWI
- Major Watersheds
- Subbasin
- Flow Direction
- Channel
- Junction
- Outfall
- Pond

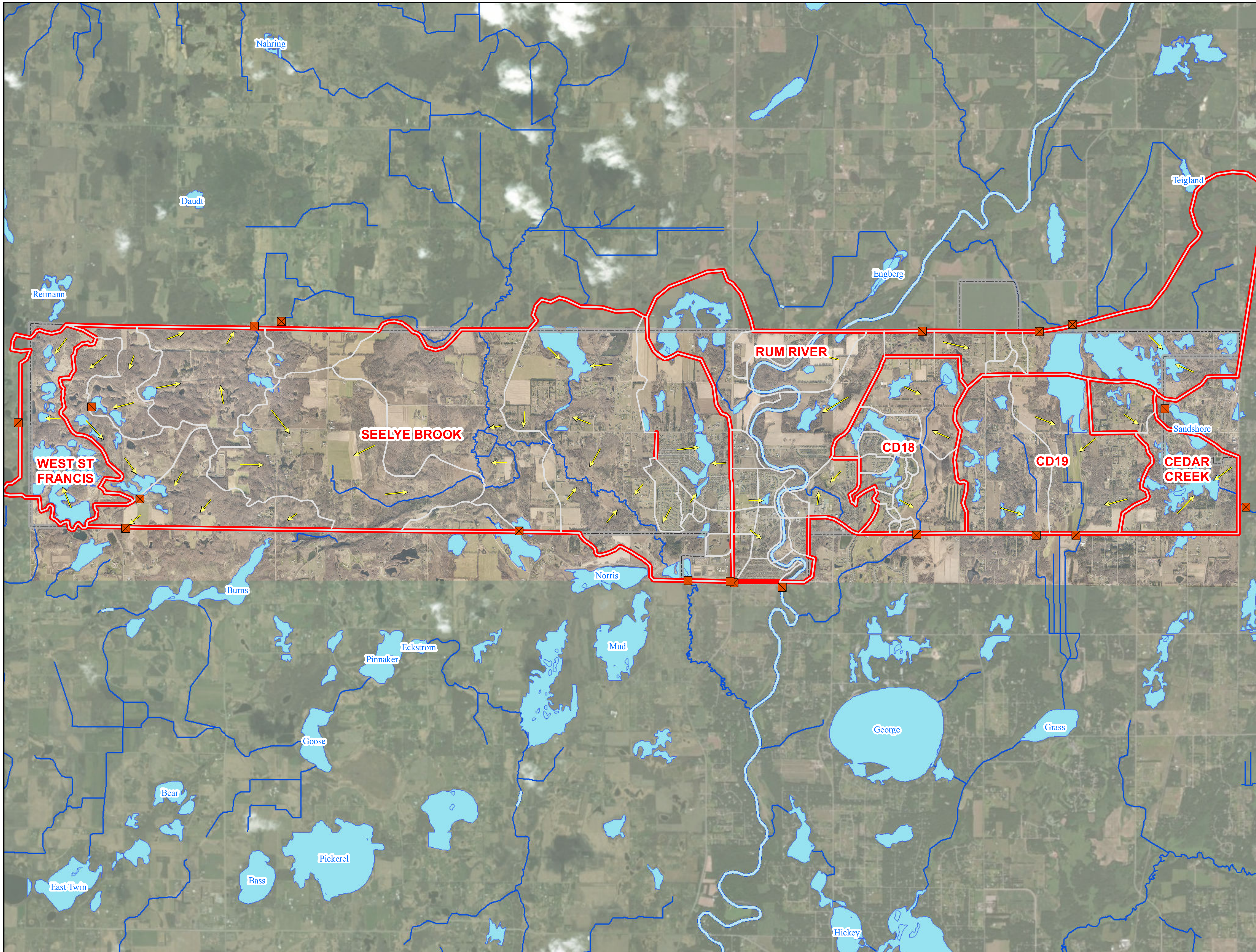
WATERSHED MAP

Figure 8B

May, 2018

Hakanson Anderson

K:\cad_eng\PROJECTS\GIS\SF908\Watershed Map Fig 10B.mxd



City of St. Francis

SURFACE WATER MANAGEMENT PLAN

Legend

- City Limits
- **Rivers & Streams**
- Rivers & Streams
- Streams
- PWI
- Major Watersheds
- Subbasin
- Flow Direction
- Outfall

N W E S

0 0.5 1 1.5 2 MILES

MAJOR WATERSHED MAP

Figure 9

May, 2018

Hakanson Anderson

K:\cad_eng\PROJECTS\GIS\SF908\Major Watershed Fig 13.mxd

APPENDICES

APPENDIX A

URRWMO Wetland Standards

Amendment

to the

Upper Rum River Watershed Management Organization (URRWMO) Watershed Management Plan

Wetland Standards

The following standards were recommended by a Technical Advisory Committee including representation from each URRWMO member city, local and state agencies, and the Builders Association of the Twin Cities. Each member community must update their local water plan and ordinances for consistency with this amendment within two years of the effective date. However, municipalities are encouraged to do amendment-related updates with updates related to the new URRWMO Plan (deadline for those updates is 4-25-09).

Effective date: Feb. 3, 2009 (date of URRWMO Board adoption)

Background

The URRWMO finds that wetlands serve a variety of beneficial functions. Wetlands within the URRWMO maintain water quality, reduce flooding and erosion, are groundwater recharge areas, provide food and habitat for wildlife, provide open space, and contribute to the area's rural "feel." Therefore, wetlands are important to the health, safety, economy, and general welfare of the communities. Regulating wetlands and the land uses around them is therefore in the public interest.

The state Wetland Conservation Act (WCA) provides many protections of the public benefits of wetlands, but does not address all areas of concern. These areas are left to local control. Topics not addressed by state law but considered by the URRWMO include special protections for the wetland types that are most highly valued locally, buffers, setbacks, excavations, and others. The URRMWO has set local standards and incentives for several of these topics. Each municipality must adopt standards at least as protective as the URRWMO standards in their local water plan and implement them.

Applicability

The following standards apply to all parcels where any of the following activities are proposed:

- Subdivision
- Any project with wetland impacts as defined by WCA (Minnesota Rules 8420).
- Wetland excavations >0.5 acres

Wetland Definition

For the purpose of these standards, wetlands:

- are defined in MN Statutes section 103G.005, subdivision 19
- include public waters wetlands defined in MN Statutes section 103G.005, subdivision 15a.

Wetland Classification

All wetlands do not have equal value. Some are healthier and provide more benefits to the community than others. The URRWMO seeks to identify these highly-valued wetlands and give them greater protections, and allow more flexibility in and around lower-valued wetlands. The URRWMO most highly values wetlands that provide (in order of preference):

1. Water quality treatment
2. Groundwater recharge
3. Wildlife habitat

The URRWMO allows more flexibility for wetlands that poorly provide these functions.

<u>Classification Methodology</u>

Proposers of applicable projects must hire a certified wetland delineator to perform a wetland delineation and MnRAM (the Minnesota Routine Assessment Method for Evaluating Wetland Functions) version 3.1 or newer. The results should be reported to the permitting authority, which will assign an appropriate wetland classification.

MnRAM scores 15 wetland functions. The URRWMO will use scores from five of these functions to classify wetlands, including:

<u>Water Quality Treatment</u>

1. Downstream water quality protection
2. Maintenance of wetland water quality

<u>Wildlife Habitat</u>

3. Vegetative diversity/integrity
4. Maintenance of characteristic wildlife habitat structure
5. Maintenance of characteristic amphibian habitat

Groundwater recharge functions will not be used in classifying wetlands because almost all URRWMO wetlands provide groundwater recharge functions and therefore the URRWMO will be protective of this function in all wetlands.

<u>Classifications</u>

Four wetland classes will be utilized:

1. High Priority Wetlands
2. Moderate Priority Wetlands
3. Low Priority Wetlands
4. Use Wetlands

The defining characteristics of each wetland class are summarized in the table below.

TABLE 1. Wetland Classifications

	High Priority Wetlands	Moderate Priority Wetlands	Minor Priority Wetlands	Use Wetlands
Description →	High quality natural basins that serve both target wetland functions of water quality treatment and wildlife habitat.	Wetlands that highly perform one of the two target wetland functions (water quality treatment or wildlife habitat).	Wetlands that do not highly perform either of the two target wetland functions (water quality treatment or wildlife habitat).	Wetlands created for stormwater management. These wetlands usually need periodic maintenance.

Targeted Wetland Functions	MnRAM Category	High Priority Wetlands	Moderate Priority Wetlands	Minor Priority Wetlands	Use Wetlands
Water Quality Treatment	Downstream water quality protection	MnRAM Score is "high" for at least one of these two MnRAM categories	MnRAM Score is "high" for at least one of these two MnRAM categories	Does not score "exceptional" or "high" for any of these MnRAM categories	Wetlands created for stormwater management. MnRAM scores are irrelevant.
	Maintenance of wetland water quality				
		AND	**OR**		
Wildlife Habitat	Vegetative diversity/integrity	MNRAM Score is "exceptional" or "high" for one or more of these three MnRAM Categories	MNRAM Score is "exceptional" or "high" for one or more of these MnRAM Categories		
	Maintenance of characteristic wildlife habitat structure				
	Maintenance of characteristic amphibian habitat				

Almost all wetlands in the URRWMO serve a groundwater recharge function, so wetland standards were designed to be protective of this function in all wetlands.

Appeals of Wetland Classification

If an applicant disagrees with a wetland classification, s/he bears the burden of supplying detailed information supporting their assertion. This may include historical aerial photography, topographic, hydrologic, floristic, or soils data deemed necessary by the permitting authority. The municipality or other permitting authority will review the appeal.

Wetland Buffers

Wetland buffers are unmowed areas adjacent to wetlands that contain non-invasive vegetation, preferably dense native vegetation. Buffers filter pollutants before they can enter the wetland, reduce erosion, protect vegetation diversity and wildlife habitat, and minimize human impacts to the wetland. The URRWMO requires buffers on wetlands, with the width dependent upon wetland classification. The buffer widths were selected based upon research literature, experiences in other communities, practical limitations, and city staff input. The largest buffers are needed to achieve wildlife habitat goals, but in sandy soils water quality goals can be achieved with lesser buffers.

Buffer Widths

The URRWMO allows minimum buffer widths and such that each municipality can choose a buffer width equal or greater that is most appropriate for their community based upon soil types, slopes, development rules, and other factors. Allowed buffer width ranges are shown in TABLE 2.

Buffer Averaging

Buffers are encouraged to have a meandering shape for a more natural appearance and in order to make reasonable accommodations for nearby features of the development or landscape. The buffer width may vary around the wetland such that:

- it may be 10 feet less than the minimum allowable (see TABLE 2), but not less than 5 feet.
- the total acreage of buffer cannot be reduced.
- in areas of concentrated inflow to the wetland the buffer cannot be less than the minimum allowable buffer width in TABLE 2 or the minimum allowed by the municipality, whichever is greater.

Buffer Variances

Variances of buffer width may, at the permitting authority's discretion, be granted for the following reasons:

- Part of the required buffer is outside of the wetland's watershed. Due to topography near the wetland, runoff flows away from and never enters the wetland through surface flows. Variances should only be for that portion of the buffer that would be outside of the wetland's watershed.

- If drainage is redirected to an area where a buffer is feasible.
- Non-conforming lots, as defined by the permitting authority.
- If the site is not generating stormwater or is using storm water minimizing techniques such as rain gardens, rain barrels, vegetated swales, and other Best Management Practices (BMP's) replace the functions of buffers.
- If the applicant is protecting additional upland, beyond that required by other ordinances or control measures, to connect existing wildlife habitat.
- Undue hardship.
- Others as determined by the permitting authority.
- Roads and other linear projects.

No Buffers Required

No buffers are required for small wetlands where the entire wetland area is less than or equal to the area of wetland impact allowed without replacement as *de minimis* under WCA.

Activities Prohibited within Buffers

Activities that disturb the roots or influence the growth of vegetation are prohibited, including:

- Mowing (except as part of municipality-approved wetland buffer management or for pedestrian trails)
- Structures
- Paving (except as allowed below in the "Activities Allowed within Buffers" section)
- Retaining walls
- Clearing and removal of vegetation (except selective clearing and pruning of individual trees and shrubs which are dead, diseased, hazards, or removal of noxious or invasive weeds)
- Introduction of non-native vegetation
- Filling, dumping, or yard waste disposal
- Fertilization
- Removal of buffer monuments
- Septic systems

Activities Allowed within Buffers

- Management needed to establish the buffer, such as mowing or burning.
- Activities consistent with municipal park management plans.
- Plantings that enhance the natural vegetation
- Selective clearing and pruning of individual trees and shrubs which are dead, diseased, or hazards
- Noxious or invasive vegetation removal
- Use and maintenance of an unimproved access strip not more than 10 ft wide for recreational access and the exercise of riparian rights
- Pedestrian trails, provided that at least 10 feet of buffer remains between the trail and wetland

- Placement, maintenance, or repair of utility and drainage systems that exist on creation of the buffer strip or are required by a permitting agency, as long as any adverse impacts have been avoided or minimized.
- Construction, maintenance, repair, or reconstruction of existing and future public roads as long as any adverse impacts have been avoided or minimized
- Others as approved by the municipality

<u>Buffer Easements</u>
A conservation easement (preferred), or functional equivalent such as a drainage and utility easement or outlot, is required on the wetland and buffer.

<u>Use of Existing Vegetation as the Buffer</u>
The existing vegetation is acceptable for a buffer and must not be disturbed if:
- It is continuous, dense perennials (can be trees and shrubs with 60% canopy cover), and
- <30% invasive plant species, and
- Not disturbed <u>or mowed</u> within the last 5 years, and
- Topography does not channelize runoff

<u>Buffer Establishment and Seed</u>
All buffers (natural or created) must be protected during construction with erosion control.

When existing vegetation is not acceptable for use as the buffer, then a buffer must be established by planting. Planting must meet these criteria:
- Planting must be identified on the wetland replacement plan or grading plan.
- Planting must be done by a qualified contractor.
- Install in accordance most current BWSR guidance.
- Replant vegetation that is unsuccessful during the first two growing seasons.
- No fertilizer may be used unless prescribed by accredited soil testing lab.
- The seed planted must be:
    i. a 100% native BWSR seed mix or equivalent approved by permitting authorities, with the exception of a 1-time annual nurse or cover crop such as oats or rye.
    ii. of local ecotype originating within 300 miles.
- Native trees/shrubs may substitute forbs at 60 per acre.

<u>Buffer Monuments</u>
Buffers shall be adequately marked with signage at a maximum 200 ft spacing. Signs should be erected before occupation of new developments. Monument requirements can be waived where the permitting authority deems they would serve no practical purpose.

<u>Buffer Maintenance</u>
First two full growing seasons –

During first two full growing seasons the applicant must replant any vegetation that does not survive.
Municipalities are encouraged to consider buffer establishment and management in escrows.

After the first two full growing seasons-
After the first two full growing seasons the buffer must be reseeded if the buffer changes at any time through human intervention or activities.

Buffer Requirements for Mitigation Wetlands
Mitigation wetlands must have equal or better functions and values than the wetlands they replace. Buffers are required on mitigation wetlands. The buffer width must be the larger of the buffer required for:
(a) the impacted wetland being replaced or
(b) if mitigation is an expansion of an existing wetland with higher classification then meet that wetland's buffer requirement.
See TABLE 2 for buffer requirements.

Structure Setbacks
Each municipality may, at its own discretion, choose to establish structure setbacks from the wetland buffer, however none is required by the URRWMO.

Sequencing
Sequencing is the process under the state Wetland Conservation Act (WCA) of evaluating wetland impacts for just cause, first by trying to avoid wetland impact, then minimizing any impacts, and finally mitigating for impacts. The URRWMO restricts the use of sequencing in their most highly valued wetlands (see TABLE 2). No impacts (as defined by WCA) are allowed in the "high priority" wetland class unless significant public benefit can be demonstrated. WCA sequencing applies for impacts to all other wetlands.

Excavations
State law restricts excavations in some wetland types, but not in other wetlands. Pond digging and excavation are common in the URRWMO and have the potential for significant negative impacts if done improperly or in improper locations.

Excavations must be denied when the following conditions exist:
- Excavation in sedge meadow wetlands.
- Excavation in forested wetlands.
- Excavation in bogs.
- Excavations in wetlands identified as Natural Heritage Communities by the Minnesota County Biological Survey.

- Excavations in wetlands deemed natural community, supporting ecologically sensitive flora and fauna, based on field visit by the Soil and Water Conservation District.
- The excavation will not provide diversity to the wetland basin or complex (e.g. excavation in the fringe of a type 3, 4 5 wetland with standing open water throughout much of the growing season).
- Wetlands which support a wide variety of plant species (i.e. approximately 50% of the area supports species which individually comprise <5% of the wetland).
- Wetlands that score high on the MnRAM vegetative diversity criteria.
- Excavations for the purpose of creating aesthetic reflecting pools.

Performance Bonds

Municipalities are encouraged to consider costs associated with compliance with these standards (for example, buffer establishment and maintenance) when determining performance bonds and escrows required of applicants.

Reporting to the Upper Rum River Watershed Management Organization

State Rules 8410 require the URRWMO inventory the functions and values of wetlands. All member municipalities must include in their annual reports to the URRWMO a summary wetlands inventoried by MnRAM, including the functions and values and assigned classifications.

TABLE 2. Summary of Wetland Standards

Wetland Class	Minimum Buffer (municipalities set buffer width equal or greater)	Structure Setbacks	Sequencing and Avoidance	Wetland Replacement Ratios	Excavation
High Priority Wetlands	25 ft	At each municipality's discretion	No impacts allowed without demonstrating significant public benefit.	Minnesota Wetland Conservation Act (WCA) ratios apply	All excavations >0.5 acres regulated per text
Moderate Priority Wetlands	20 ft		WCA sequencing applies.		
Minor Priority Wetlands	15 ft		WCA sequencing applies.		
Use Wetlands	At each municipality's discretion		WCA sequencing applies.		

APPENDIX B

URRWMO Joint Powers Agreement

AMENDED
JANUARY 2011

UPPER RUM RIVER WATERSHED MANAGEMENT ORGANIZATION
JOINT POWERS AGREEMENT

THIS AGREEMENT, made and entered into as of the date of execution by and between the Local Government Units of: City of Bethel, City of East Bethel, City of Ham Lake, City of Nowthen, City of Oak Grove, and City of St. Francis for the establishment of a watershed management organization. The purpose of this Joint Powers Agreement is to establish a Water Management Organization to assist the member local units of government with surface water, ground water, water quality and water usage issues.

WHEREAS, the parties to this Agreement have authority pursuant to Minnesota Statutes, Chapter 471.59 to jointly or cooperatively by agreement exercise any power common to the contracting parties and pursuant to Minnesota Statutes, Sections 103B.201 to 103B.255 have authority to jointly or cooperatively manage or plan for the management of surface water;

WHEREAS the parties to this Agreement desire to prepare a surface water management plan for the purpose of management and implementation of the programs required by Minnesota Statutes, Sections 103B.201 to 103B.255.

NOW, THEREFORE, the parties to this Agreement do mutually agree as follows:

SECTION I
General Purpose

1.1 It is the general purpose of the parties to this Agreement to establish an organization to jointly and cooperatively develop a Watershed Management Plan and an Implementation Program and a Capital Improvement Program for the purposes of (a) protecting, preserving, and using natural surface and groundwater storage and retention systems in the Upper Rum River Watershed; (b) minimizing public capital expenditures needed to correct flooding and water quality problems; (c) identifying and planning for means to effectively protect and improve surface and groundwater quality; (d) establishing more uniform local policies and official controls for surface and ground water management; (e) preventing erosion of soil into surface water systems; (f) promoting groundwater recharge; (g) protecting and enhancing fish and wildlife habitat and water recreational facilities; and (h) securing the other benefits associated with the proper management of surface and groundwater. The plan and programs shall operate within the boundaries of the Upper Rum River Watershed as set forth in Addendum 1 attached hereto (hereinafter "Area").

SECTION II
Upper Rum River Watershed Management Organization

2.1 <u>Establishment</u>: There is hereby established the "Upper Rum River Watershed Management Organization" whose membership shall be appointed in accordance with the provisions of this section and whose duties shall be to carry out the purposes contained herein. The Upper Rum River Watershed Management Organization (hereinafter "Organization") shall be constituted as described in Section 2.2.

2.2 Membership Appointment: Each party to this Agreement shall appoint two (2) representatives to serve as members of the Organization board. Each representative of a party to this agreement who is current in the payment of their share of operating expenses shall have one (1) vote. Representatives appointed to the Organization board shall be evidenced by a resolution or certified copy of official meeting minutes of the governing body of each party and filed with the Organization.

2.3 Alternate Members: One (1) alternate member of the Organization board may be appointed by appropriate resolution or certified copy of official meeting minutes of the governing body of each party to this Agreement, filed with the Organization. The alternate member may attend any meeting of the Organization board when a regular member representing that party is absent and vote on behalf of the party the member represents. If an Organization board member is also an officer of the Organization, the alternate member shall not be entitled to serve as such officer.

2.4 Term: The members of the Organization board shall be filled by the governing body of the party whose membership position on the board is vacant. Removal of a board member or alternate board member shall be at the sole discretion of the appointing authority. The term of appointment is at the sole discretion of the appointing authority.

2.5 Vacancies: The Organization shall notify the Board of Water and Soil Resources of member appointments and vacancies in member positions within thirty (30) days. A vacancy on the Organization board shall be filled by ninety (90) days after the vacancy occurs by the governing body of the party whose membership position on the board is vacant.

Vacancies resulting from expiration of members' terms and other reasons shall be filled only after published notice of the vacancy once a week for two (2) successive weeks in a newspaper of general circulation in the watershed management organization area; the notices must state that the party is considering applications for appointment of a member to the Organization board and that persons interested in being appointed to serve on the board may submit their names to the appointing authority for consideration. A vacancy shall not be filled until at least fifteen (15) days have elapsed after the last published notice.

2.6 Additional Parties – Membership: The Organization, with the ratification of the governing bodies of all voting members of the Organization, may invite other local government units within the Upper Rum River Watershed to also become parties to this Agreement. The governing body of any such additional party shall appoint a member to the Organization who shall have voting rights in accordance with the provisions of Section 2.2 and in all respects thenceforth enjoy the full rights, duties, and obligations of this Agreement.

2.7 Compensation and Expenses: The Organization members shall not be entitled to compensation or reimbursement for expenses incurred in attending meetings, except to the extent that the governing body of a party may determine to compensate or reimburse the expenses of the member(s) it appoints, in which case the obligation to make such payments shall be that of the party and not that of the Organization.

2.8 Officers: The Organization board shall elect from its membership a chair, a vice-chair, a secretary. All such officers shall hold office for a term of one (1) year and until their successors have been qualified and duly elected by the board. An officer may serve only while a member of the Organization. A vacancy in an office shall be filled from the membership of the board by election for the remainder of the unexpired term of such office.

2.9 Duties of Officers: The duties of the officers of the Organization shall be as outlined in Robert's Rules of Order Newly Revised 10th Edition.

2.10 Quorum: Voting members of the Organization board representing a majority of the parties to this Agreement shall constitute a quorum. Less than a quorum may adjourn a scheduled meeting.

2.11 Meetings:

A. Annual Meeting. The annual meeting of the Organization board will be held in May of each year at Oak Grove City Hall. At the annual meeting the board, at a minimum, shall:

1. Elect officers;
2. Establish the annual budget and work plan;
3. Hear recommendations on amendments to this agreement and the watershed management plan;
4. Biennially renew or decide on contracts for professional, legal, and administrative services; and
5. Decide on regular meeting dates.

B. Meeting Notices. Notice of all regular and special meetings shall be provided with a minimum of seventy-two (72) hours advance notice of the meeting to all parties of this agreement. Such meeting notice shall be posted on the official notification board for each party to this Agreement.

C. Special meetings may be held at the call of the chair or by any three (3) members of the board giving not less than seventy-two (72) hours written notice of the time, place and purpose of such meeting delivered, mailed or e-mailed to the residence of each Organization member and delivered, mailed or e-mailed to the City Hall of each party to this Agreement.

D. All meetings of the board are subject to Minnesota Statutes and the notice provisions contained therein. Posted notice, when required, shall be given separately by each party to this Agreement.

2.12 Conduct of Meetings: The Organization board shall adopt rules of order and procedure for the conduct of its meetings in accordance with Robert's Rules of Order Newly Revised 10th Edition; the board may adopt any such rules as a majority the parties to this Agreement shall agree. Decisions by the board may not require more than a majority vote, except a decision on a capital improvement project may require no more than a two-thirds vote. All meetings of the board are subject to Minn. Stat. 13D (Minnesota Open Meeting Law).

2.13 Organization Office: The office of the Organization shall be the Oak Grove City Hall, 19900 Nightingale Street NW, Cedar, Minnesota 55011. All notices to the Organization shall be delivered or served at said office.

SECTION III

Organization Powers and Duties

3.1 Authority: Upon execution of the Agreement by the parties, the Organization shall have authority provided for in Minnesota Statures, Chapter 103B.211 through 103B.255 that provides for, in part:

A. The authority to prepare, adopt, and implement a plan for the Upper Rum River Watershed meeting the requirements of Minnesota Statutes, Section 103B.231.

B. The authority to review and approve local water management plans as provided in Minnesota Statutes, Section 103B.235C. This is subject to amendment by the legislature.

3.2 Watershed Management Plan: The Organization shall prepare a Watershed Management Plan for the Upper Rum River Watershed. The plan shall be in compliance with Minnesota Statutes, Chapter 103B.231, Subd. 4 and 6 as from time to time amended. The Chapter describes plan contents to include but not limited to the following.

A. Describe the existing physical environment, land use and development in the Upper Rum River Watershed, and shall further describe the environment, land use and development proposed in existing local and metropolitan comprehensive plans;

B. Present information on the hydrologic system in the Upper Rum River Watershed and its components, including any drainage systems previously constructed under Minnesota Statutes, Chapter 103E, and existing and potential problems relating thereof;

C. State objectives and policies, including management principles, alternatives and modifications, water quality, and protection of natural characteristics;

D. Set forth a management plan, including the hydrologic and water quality conditions that will be sought and significant opportunities for improvement;

E. Describe the effect of the Watershed Management Plan on existing drainage systems;

F. Describe conflicts between the Watershed Management Plan and existing plans of local government units;

G. Set forth an Implementation Program consistent with the Watershed Management Plan, which includes a Capital Improvement Program and standards and schedules for amending the comprehensive plans and official controls of local government units in the watershed to bring about conformance with the Watershed Management Plan; and

H. Set out a procedure for amending the Watershed Management Plan.

The plan shall be amended as required from time to time.

3.3 Employment: The Organization may contract for services from parties to this Agreement, or may employ such other persons as it deems necessary. Where staff services of a party are utilized, such services shall not reduce the financial commitment of such party to the operating fund of the Organization unless the Organization so authorizes.

3.4 Committees: The Organization may appoint such committees and sub-committees as it deems necessary. The Organization shall establish citizen and technical advisory committees unless other means of public participation are established. See Addendum 2 attached.

3.5 Rules and Regulations: The Organization may prescribe and promulgate such rules and regulations as it deems necessary or expedient to carry out its powers and duties and the purpose of the Agreement.

3.6 Review and Recommendations: Review and Recommendations: Where the Organization is authorized or requested to review and make recommendations on any matter relating to the Watershed Management Plan, the Organization shall act on such matter within sixty (60) days of receipt of the matter referred. Failure of the Organization to act within sixty (60) days shall constitute approval of the matter referred, unless the Organization requests and receives from the referring unit of government an extension of time to act on the matter referred. Such extension shall be in writing and acknowledged by both parties.

The Board shall adopt an appeal procedure for any party aggrieved by a decision of the Board or an alleged failure to implement the Plan pursuant to Minnesota Statutes, Chapter 103B.231, Subd. 13.

3.7 Ratification: The Organization may, and where required by this Agreement shall, refer matters to the governing bodies of the parties for review, comment or action.

3.8 Financial Matters:

Subdivision 1 - Method of Operation: The Organization may collect and receive money and contract for services subject to the provision of the Agreement from the parties and from any other sources approved by the Organization. The Organization may incur expenses and make disbursements necessary and incidental to the effectuation of the purposes of this Agreement. Funds may be expended by the Organization in accordance with procedures established herein. Upon Board approval, invoices shall be initialed by the chair or vice-chair for payment by the Organization office. Other legal instruments shall be executed on behalf of the Organization by the chair, vice-chair or an appointed Board member.

Subdivision 2 - Operating Funds : On or before June 1 of each year, Organization shall prepare a work plan and an operating budget for the following year. The annual budget shall budget provide details to support the proposed revenues and expenditures for the Organization. This detail shall be sufficient to meet standard budget and/or accounting principles generally recognized for governmental organizations. Expenditures may include administrative expenses, plan development costs, review expenses, capital improvement costs, Management Programs, Management Studies costs in Section 3.12, and insurance costs as authorized in Section 3.14. Upon the approval of the majority of voting members of the Organization, the budget shall be recommended to the parties for ratification along with a statement showing each party's proposed share of the budget. The budget shall be implemented only after ratification by each party to this Agreement. Failure to ratify or pay its share of the budget by any party to this Agreement shall be subject to the procedures in Section 3.6. Each party shall contribute funds toward the budget according to the following methods:

Work Plan – ((PA / WA) + (PV / WV)) / 2 = the party's percentage share of the organization's operating budget.

PA = Party's area within the watershed organization area
WA = watershed organization area
PV = party's market valuation within the watershed organization area
WV = market valuation of the watershed organization area

Operating Costs – Total amount to be divided equally between each community member of the Joint Powers Agreement. Operating costs per the operating budget are defined as copies, postage, recording secretary fees, insurance, and administrative fee charged to each member community.

After ratification the chair or vice-chair shall certify the recommended budget to each party on or before June 1 of each year together with a statement showing the amounts due from each party. Each party shall pay over to the Organization the amount owing in two equal installments, the first on or before January 1 and second on or before July 1 in accordance with the tax year for which the amount due is being paid.

Subdivision 3 - Review Services: When the Organization is authorized or requested to undertake a review and submit recommendations to a party as provided in this Agreement, the Organization shall conduct such review, without charge, except as provided below. Where the project size and complexity of review are deemed by the Organization to be extraordinary and substantial, the Organization may charge a fee for such review services, the amount to be based upon direct and indirect costs attributable to that portion of review services determined by the Organization to be extraordinary and substantial. Where the

Organization determines that a fee will be charged for extraordinary and substantial review services, or where the flowage enters the Upper Rum River, but the party is not a member of the Upper Rum River Watershed Management Organization, the party to be charged shall receive written notice from the Organization of the services to be performed and the fee therefore, prior to undertaking such review services. Unless the party to be charged objects within fifteen (15) days of receipt of such written notice to the amount of the fee to be charged, such review services shall be performed and the party shall be responsible for the cost thereof. If the party to be charged objects to the proposed fee for such services within fifteen (15) days, and the party and the Organization are unable to agree on a reasonable alternative amount for review services, such extraordinary and substantial review services shall not be undertaken by the Organization.

3.9 Annual Audits: The Organization shall annually prepare a comprehensive financial report on operations and activities for the fiscal year defined as January 1 through December 31. An annual audit shall be provided that includes a full and complete audit of all books and accounts the Organization office is charged with maintaining. Such audits shall be conducted in accordance with generally accepted auditing principles and guidelines. A copy of the annual financial report and auditor's statement shall be provided to all parties and to the Board of Water and Soil Resources. The report to the Board of Water and Soil Resources shall include an annual activity report. All of its books, reports, and records shall be available for and open to examination by any party at all reasonable times.

3.10 Gifts, Grants, Loans: The Organization may, within the scope of this Agreement, accept gifts; may apply for and use grants of money or other property from the United States, the State of Minnesota, a local government unit or other governmental unit or organization or any person or entity for the purpose described herein. The Organization may enter into any reasonable agreement required in connection therewith. The Organization shall comply with any laws or regulations applicable to grants, donations and agreements. The Organization may hold, use, and dispose of such money or property in accordance with the terms of the gift, grant, or agreement relating thereto.

3.11 Contracts: The Organization may make such contracts and enter into any such agreements as it deems necessary to make effective any power granted to it by this Agreement. Every contract for the purchase or sale of merchandise, materials, or equipment by the Organization shall be let in accordance with the Uniform Municipal Contracting Law, Minnesota Statutes, Section 471.345 and the Joint Exercise of Powers Statute, Minnesota Statues, Section 471.59. No member or employee of the Organization or officer or employee of any of the parties shall have direct or indirect interest in any contract made by the Organization.

3.12 Works of Improvement: Works of improvement for protection and management of the natural resources of the Area, including, but not limited to, improvements to property, land acquisition, easements, or right-of-way, may be initiated by:

A. Recommendation of the Organization to a party or parties; or

B. Petition to the Organization by the governing body of a party or parties.

Where works of improvement are recommended by the Organization, the Organization shall first determine whether such improvement will result in a local or regional benefit to the Area. Where the Organization determines that the benefits from the improvement will be local or not realized beyond the boundaries of the party in which the improvement is to be established, the Organization shall recommend such improvement to the governing body of the unit of government which the Organization determines will be benefited thereby, with the total estimated cost of the improvement and a description of the benefits to be realized.

The Organization shall recommend such improvement to each governing body of the units of government which the Organization determines will be benefited thereby. The recommendation of the Organization shall include the total estimated cost of the improvement, a description of the extent of the benefits to be realized by each unit of government and the portion of the cost to be borne by each party benefited in accordance with the extent of the benefit of each unit of government as described by the Organization.

Each party to whom the Organization submits such recommendation shall respond within sixty (60) days from receipt of such recommendation. Where the Organization determines that the benefits of such improvement will be local, the unit of government to whom such recommendation is made may decline to ratify and undertake said improvement. Where the Organization determines that the benefits of such improvement will be regional, unless all parties to whom such recommendation is directed decline to ratify and undertake said improvement, the Organization shall continue to review and recommend alternative methods of cooperation and implementation among those parties ratifying the recommendation of the Organization, unless and until the Organization determines that said improvement is no longer feasible.

When works of improvement are initiated by the governing body of a party or parties to this Agreement, said governing body or bodies shall submit a petition to the Organization setting forth a description of the proposed work of improvement, the benefits to be realized by said improvement, its total estimated cost and a proposed cooperative method for implementation of the improvement, if applicable. The Organization shall review and make recommendations on the proposed improvement and its compliance with the Organization's management plan in accordance with the provisions of Section 3.5 of this Agreement.

When a proposed improvement may be eligible for federal or state funds as a cost-share project, the Organization may undertake a proposed work of improvement for the area, subject to Organization recommendation to and ratification by the parties to this Agreement, as required for an improvement of regional benefit.

The Organization is further authorized to undertake experimental improvement projects within the Area to serve as a basis for evaluation of other improvements by the parties. When the Organization determines to undertake an experimental improvement project, the costs of such project shall be the obligation of the Organization and not of the parties to this Agreement.

3.13 Claims: The Organization or its agents may enter upon lands within or without the Upper Rum River Watershed to make surveys and investigations to accomplish the purpose of the Organization. The Organization shall be liable for actual damages resulting there from, but every person who claims damages shall serve the Chairperson or Secretary of the Organization with a notice of claim as required by Minnesota Statutes, Section 466.05. The Organization shall obtain court orders authorizing and directing such entries when necessary due to refusals of landowners to allow the same.

3.14 Indemnification and Insurance: Any and all claims that arise or may arise against the Organization, its agents or employees as a consequence of any act or omission on the part of the Organization or its agents or employees while engaged in the performance of this Agreement shall in no way be the obligation or responsibility of the parties. The Organization shall indemnify, hold harmless and defend the parties, their officers and employees against any and all liability, loss, costs, damages, expenses, claims, or actions, including attorney's fees which the parties, their officers, or employees may hereafter sustain, incur, or be required to pay, arising out of or by reason of any act or omission of the Organization, its agents or employees in the execution, performance, or failure to adequately perform the Organization's obligations and understandings pursuant to the Agreement.

The Organization agrees that in order to protect itself as well as the parties under the indemnity provision set forth above, it will at all times during the term of this Agreement keep in force the following protection in the limits specified:

A. Commercial General Liability / Professional Liability ($500,000 per individual; $1,500,000 per incident) including the following endorsements:

B. Automobile Coverage ($0)

C. Worker's Compensation Coverage (statutory minimum)

The minimum liability limits shall be increased to the statutory limits provided for member local units of government in Minnesota Statutes.

Any policy obtained and maintained under this clause shall provide that it shall not be cancelled, materially changed or not renewed without thirty (30) days prior notice thereof to each of the parties.

Prior to the effective date of this Agreement, and as a condition precedent to this Agreement, the Organization will furnish the parties with certificates of insurance listing each party to the Agreement as an additional insured.

3.15 General: The Organization may take all such other actions as are reasonably necessary and convenient to carry out the purpose of this Agreement.

SECTION IV
Mediation

4.1 The parties agree that any controversy that cannot be resolved shall be submitted for mediation. Mediation shall be conducted by a mutually agreeable process by all parties.

SECTION V
Termination of Agreement

5.1 This Agreement may be terminated by approval of two-thirds vote of the governing bodies of each party hereto, provided that all such approvals occur within a ninety (90) day period. Withdrawal of any party may be accomplished by filing written notice with the Organization and the other parties 60 days prior to the effective date of termination. No party may withdraw from this Agreement until the withdrawing party has met its full financial obligations through the effective date of such withdrawal.

SECTION VI
Dissolution of Organization

6.1 The Organization shall be dissolved under any of the following conditions:

A. Upon termination of this Agreement;

B. Upon unanimous agreement of all parties; or

C. Upon the membership of the Organization being reduced to fewer than three (3) parties.

At least 90 days notice of the intent to dissolve shall be given to affected counties and the Board of Water and Soil Resources. Upon dissolution, all personal property of the Organization shall be sold, and the proceeds thereof, together with monies on hand after payment of all obligations, shall be distributed to the parties. Such distribution of Organization assets shall be made in proportion to the total contributions to the Organization for such costs made by each party. All payments due and owing for operating costs under Section 3.8,B or other unfilled financial obligations, shall continue to be the lawful obligation of the parties.

SECTION VII
Amendment

7.1 The Organization may recommend changes and amendments to this Agreement to the governing bodies of the parties. Amendments shall be adopted by a two-thirds majority vote of the governing bodies of the parties as evidenced by meeting minutes of the governing body, within ninety (90) days of referral. Amendments shall be evidenced by appropriate resolutions or certified copies of meeting minutes of the governing bodies of each party filed with the Organization and shall, if no effective date is contained in the amendment, become effective as of the date all such filings have been completed.

SECTION VIII
Counterparts

8.1 This Agreement may be executed in several counterparts and all so executed shall constitute one Agreement, binding on all of the parties hereto. Each party to the agreement shall receive a fully executed copy of the entire document following adoption by all parties.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the _____________ day of ____________________________, 2010.

CITY OF BETHEL

By:______________________________________
Mayor

By:______________________________________
City Administrator / City Clerk

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the _____________ day of ____________________________, 2010.

CITY OF EAST BETHEL

By:______________________________________
Mayor

By:______________________________________
City Administrator / City Clerk

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the _____________ day of ____________________________, 2010.

CITY OF HAM LAKE

By:_______________________________________
Mayor

By:_______________________________________
City Administrator / City Clerk

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the _____________ day of ____________________________, 2010.

CITY OF NOWTHEN

By:_______________________________________
Mayor

By:_______________________________________
City Administrator / City Clerk

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the _____________ day of ____________________________, 2010.

CITY OF OAK GROVE

By:_______________________________________
Mayor

By:_______________________________________
City Administrator / City Clerk

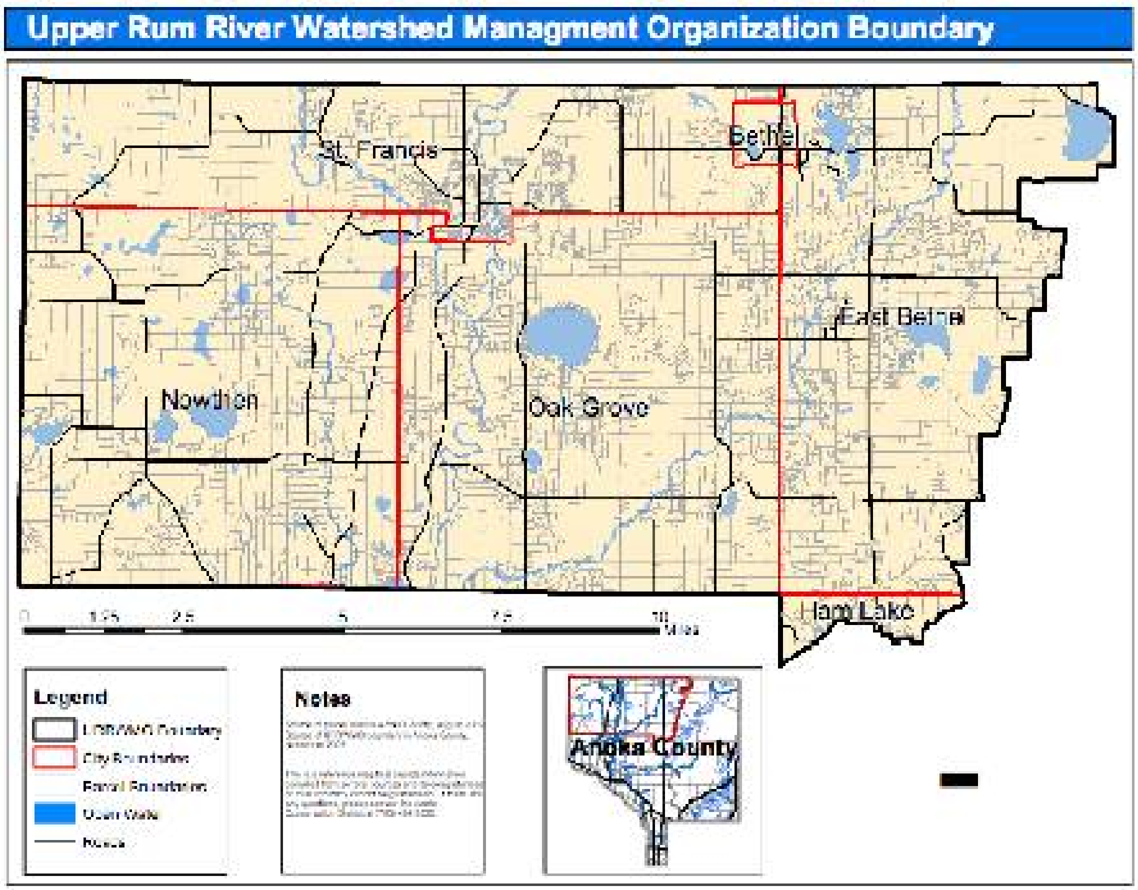
IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the _____________ day of ____________________________, 2010.

CITY OF ST. FRANCIS

By:_______________________________________
Mayor

By:_______________________________________
City Administrator / City Clerk

Addendum 1



Upper Rum River Watershed Managment Organization Boundary
St. Francis
Bethel
East Bethel
Nowthen
Oak Grove
Ham Lake
Miles
Legend
City Boundaries
Notes
Anoka County

Addendum 2

The Organization shall establish citizen and technical advisory committees and other means of public participation.

Regular, recurring public participation opportunities shall include:

- Open mike at each Organization meeting,
- Contact information posted on the Organization website, such that the public may contact an Organization representative outside of public meetings.

Citizen and/or technical advisory committees will be formed from time-to-time as deemed appropriate by the Organization and shall be issue-specific. Committees may be formed that include both citizens and technical experts. Committees shall operate by seeking consensus, while noting any dissenting opinions. Committee findings shall be reduced to writing and submitted to the Organization Board. In all cases, committees shall be advisory and their findings shall be referred to the Organization Board for final decision-making.

Issues that may warrant formation of advisory committees include:

- Amendments or updates to the Organization's watershed Management Plan
- Lake level or water quality issues,
- A total maximum daily load (TMDL) impaired waters study or implementation of the study,
- Capital improvement projects,
- Major hydrological changes in the watershed,
- Others as deemed appropriate by the Organization Board.

Technical advisory committees shall include technical experts, and invited members may include:

- Staff and/or elected officials from affected communities,
- MN Department of Natural Resources,
- MN Pollution Control Agency,
- MN Board of Water and Soil Resources,
- Metropolitan Council,
- Anoka Conservation District,
- Others, as deemed appropriate by the Organization Board.

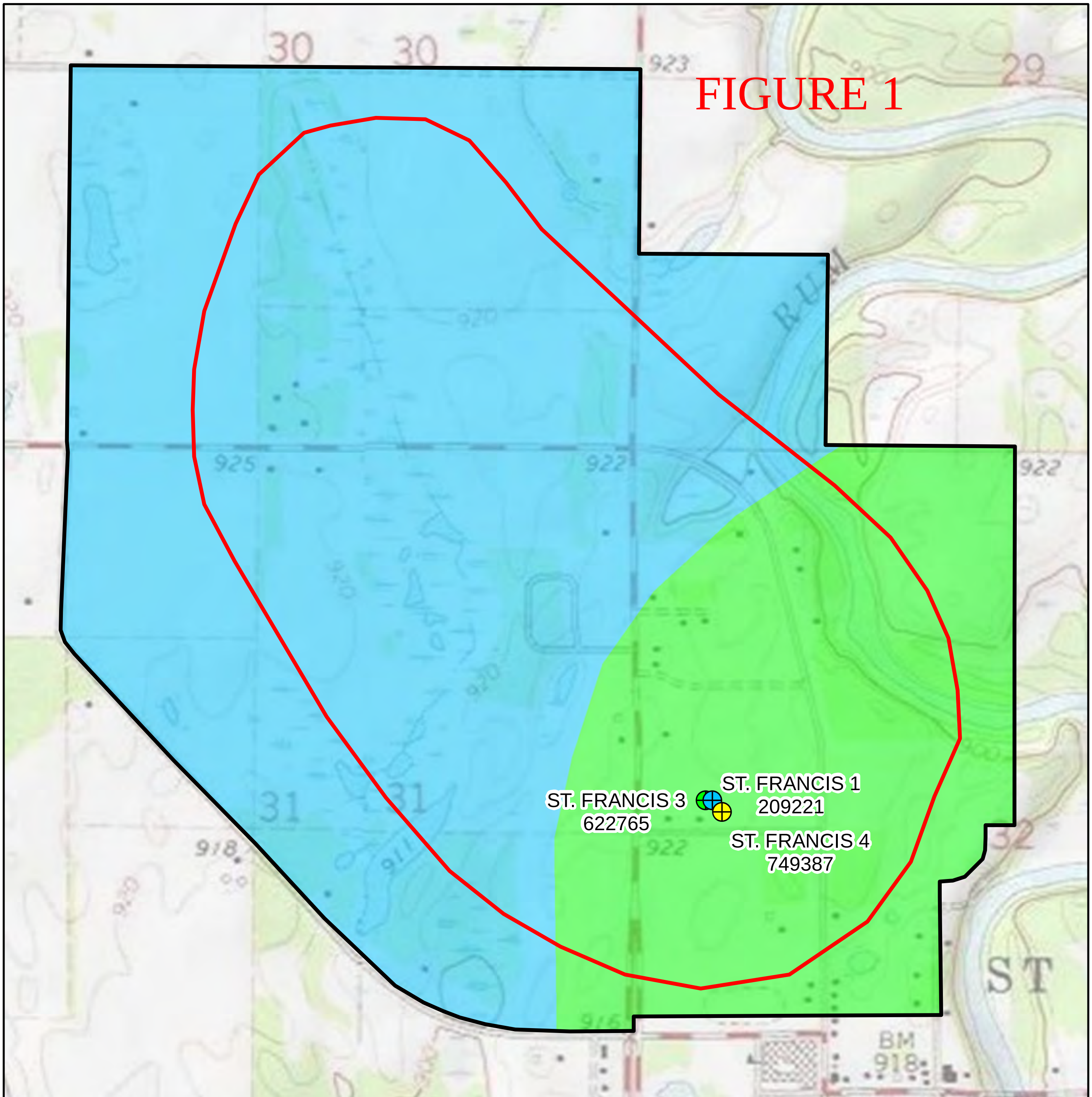
Citizen advisory committees shall include residents and elected officials from the affected area, and invited members may include:

- Homeowners,
- Business owners
- Lake association or lake improvement district representatives,
- Others, as deemed appropriate by the Organization Board.

All advisory committees shall include at least one URRWMO Board member.

APPENDIX C

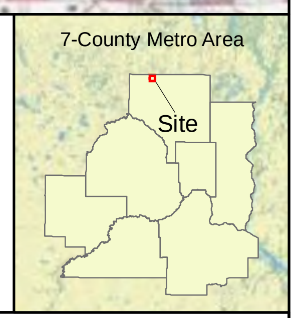
DWSMA Map



City Well
Combined Wellhead Protection Area
Drinking Water Supply Management Area

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

0 1,000 Feet



Source: ESRI Online Imagery: Copyright 2010 National Geographic Society, MN CWI.

Prepared By:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Groundwater and
Environmental Engineering Services
8 Pine Tree Drive, Suite 250
St. Paul, Minnesota 55112
(651) 490-1405

CITY OF ST. FRANCIS
ST. FRANCIS, MINNESOTA

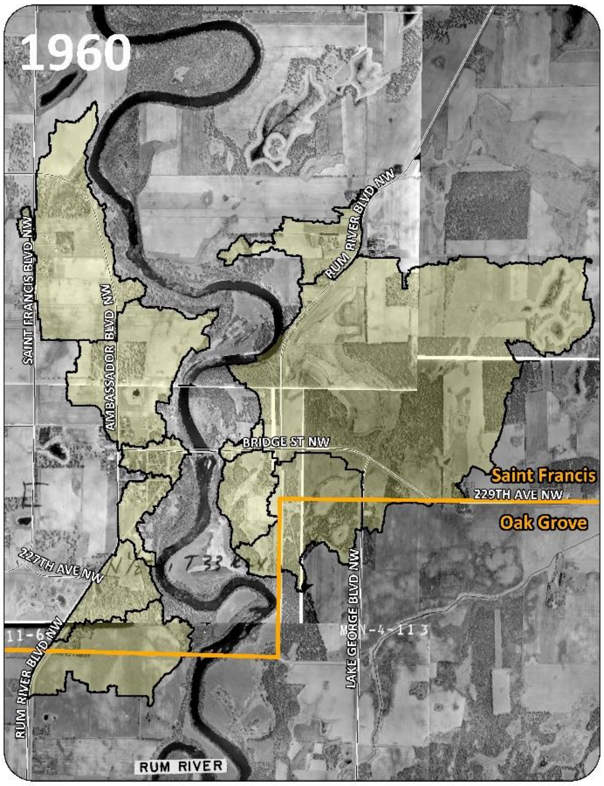
DRINKING WATER SUPPLY MANAGEMENT AREA
VULNERABILITY ASSESSMENT

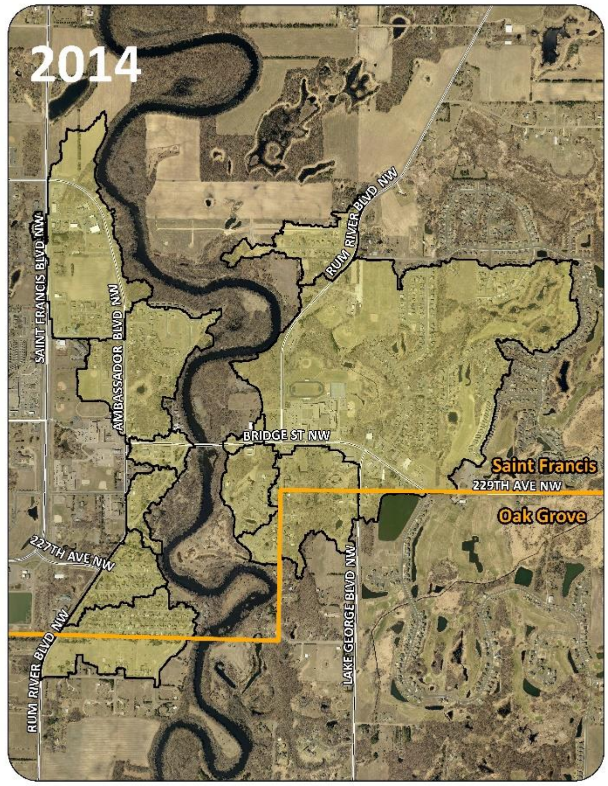
FILE:	g3stfranciswhp01N.MXD	DATE:	3/24/2014	FIGURE:	16

G:\GIS\St_Francis_WHP\maps\g3stfranciswhp01N.mxd, 3/24/2014, 2:57:05 PM, NAD 1983 UTM Zone 15N

APPENDIX D

St. Francis
Stormwater
Retrofit Analysis





City of St. Francis Stormwater Retrofit Analysis

Prepared by:

ANOKA CONSERVATION DISTRICT

for the

CITY OF ST. FRANCIS

August 2016

Cover photo: Aerial photos from 1960 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 St. Francis 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 St. Francis.

Table of Contents

List of Figures

List of Tables

Intentionally Blank

Executive Summary

The City of St. Francis 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 and consist of residential, commercial, industrial, and undeveloped land uses. Total phosphorus (TP), total suspended solids (TSS), and volume 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,
- Iron-enhanced sand filter check dam,
- Existing stormwater pond modifications, 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 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 736-acre study area was divided into 11 catchments. Based on WinSLAMM model results, the study area contributes an estimated 252 acre-feet of runoff, 59,493 pounds of TSS, and 214 pounds of TP annually.

The tables in the Project Ranking and Selection section (pages 13-14) 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 (pages 31-76). 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 11 catchments and assigned unique identification numbers. For each catchment, the following information is detailed:

Drainage Network

The cumulative estimated volume and pollutant loading from the 11 catchments is presented.

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 St. Francis. 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 St. Francis and discharge to the Rum River. The total area of the 11 catchments is 736 acres. Six of the catchments lie on the western side of the Rum River and are roughly bound by Ambassador Boulevard to the north and 224th Avenue NW to the south. The remaining five catchments are on the eastern side of the Rum River. These catchments are bound roughly by 235th Avenue NW to the north and 227th Avenue NW 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 is lacking. 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 St. Francis 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 St. Francis 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 directly into the Rum River. More specifically, outfalls with limited existing treatment were selected. Included are areas of residential, commercial, industrial, institutional and undeveloped land uses. Existing stormwater infrastructure maps and topography data were used to determine drainage boundaries for the 11 catchments included in this analysis.

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.

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 infrastructure 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) 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 St. Francis (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.

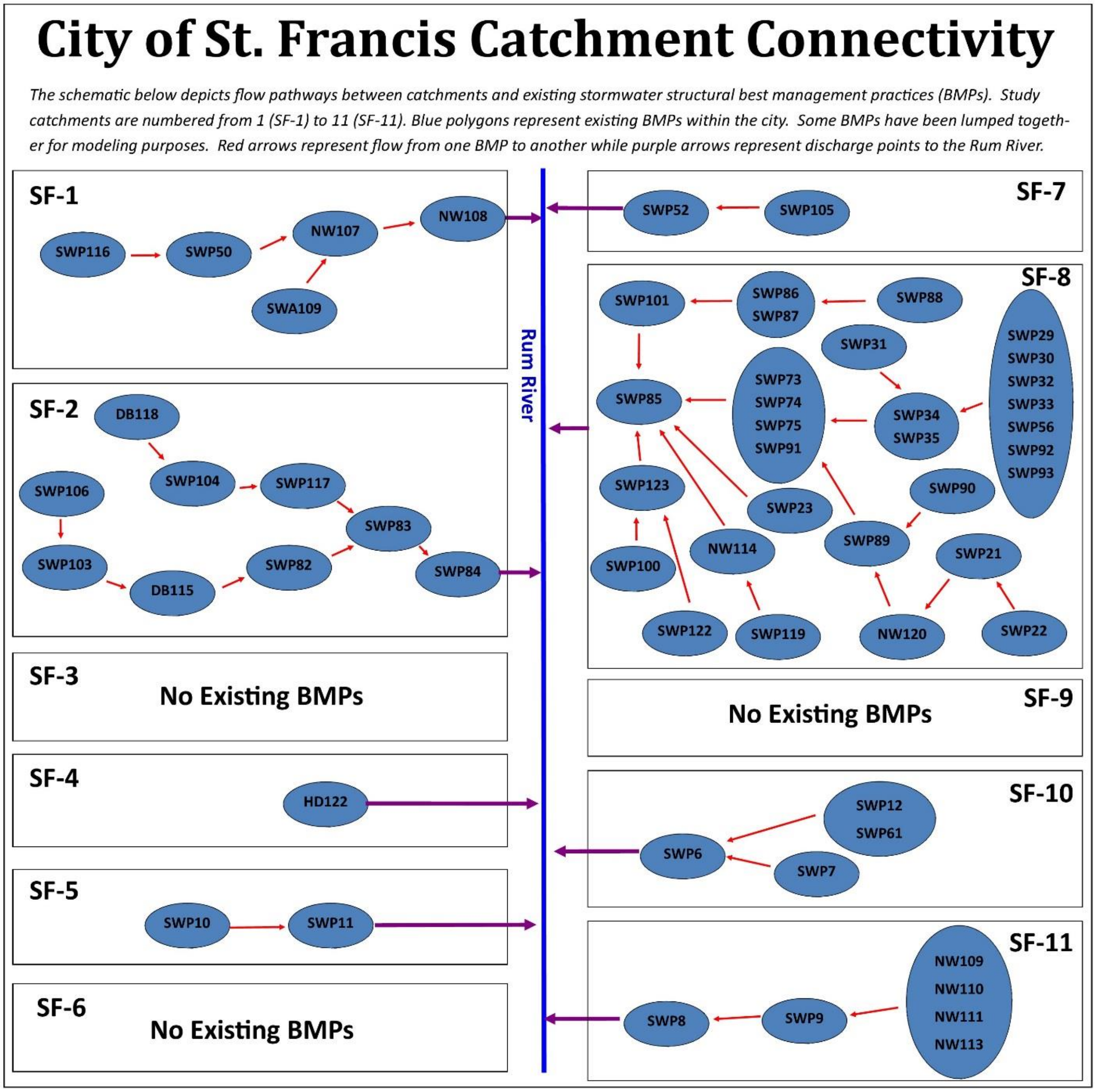


Figure 1: Schematic showing the existing BMPs in each catchment and their connectivity.

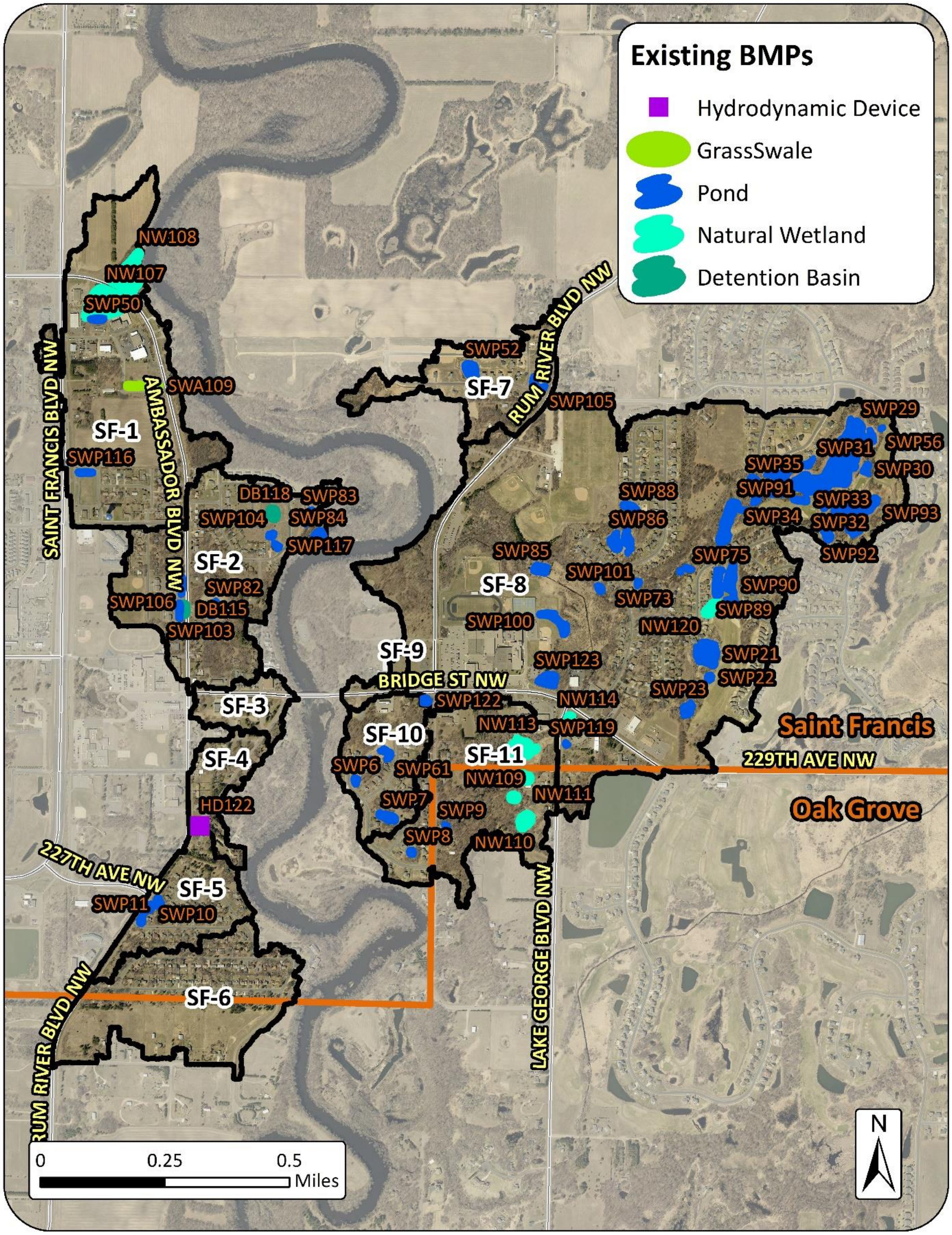


Figure 2: Study area map showing existing BMPs included in the WinSLAMM model. Street cleaning is not shown on the map but was included throughout the study area.

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.

> **<u>Project promotion and administration</u>** includes local staff efforts to reach out to landowners, administer related grants, and complete necessary administrative tasks.
> **<u>Design</u>** includes site surveying, engineering, and construction oversight.
> **<u>Land or easement acquisition</u>** cover the cost of purchasing property or the cost of obtaining necessary utility and access easements from landowners.
> **<u>Construction</u>** 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.
> **<u>Maintenance</u>** 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 may 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 be a limiting factor in 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) and
2) Cost per 1,000 pounds of total suspended solids removed (Table 3).

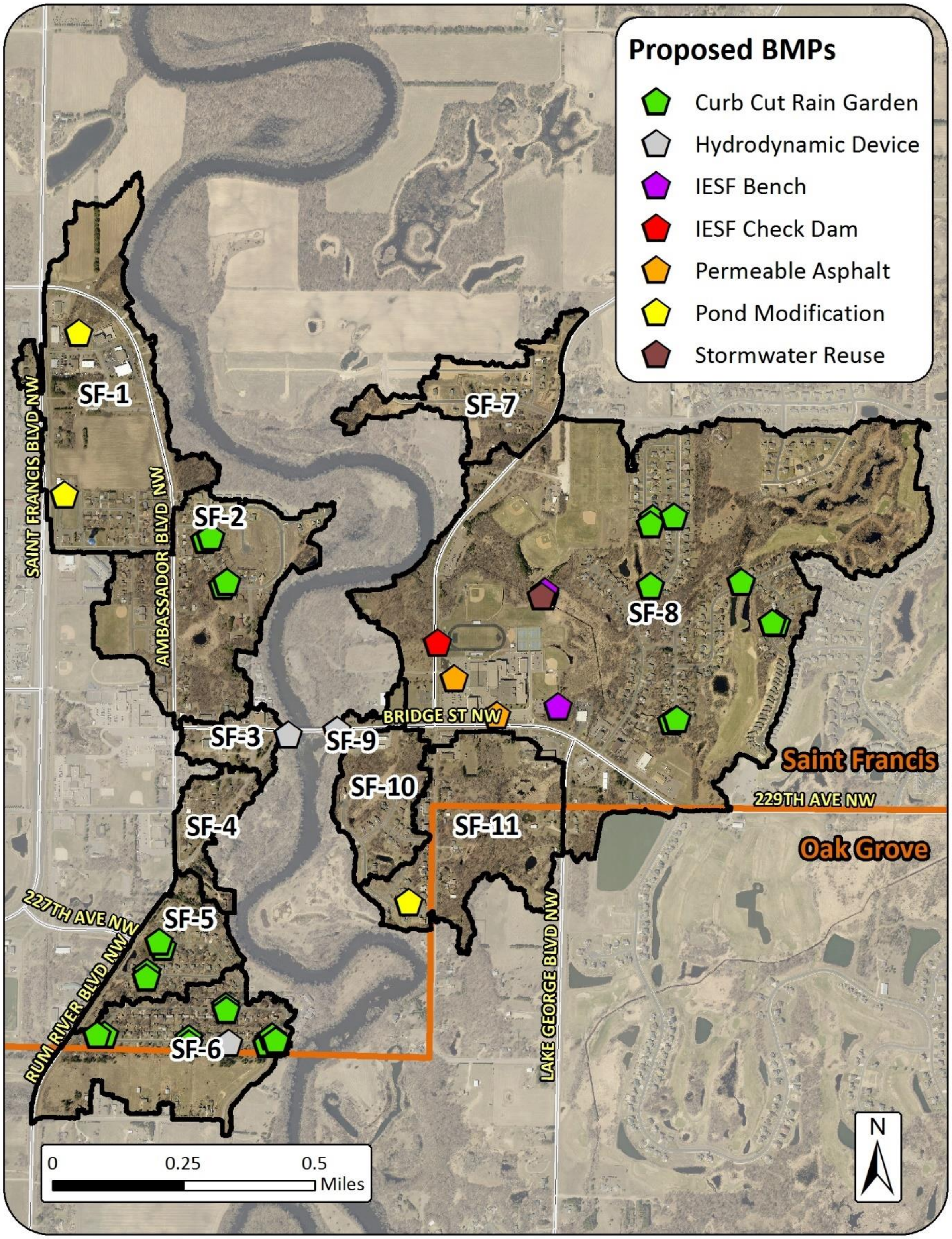


Figure 3: Catchment-wide map showing the proposed retrofits included in this report.

Table 2: Cost-effectiveness of retrofits with respect to TP reduction. Projects ranked 1 – 17 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	8-H	69	IESF Check Dam	Rum River Blvd. & Park Rd.	8	1.8	459	0	$15,448	$365	$500
2	6-A	54	Curb-Cut Rain Garden	Various locations in catchment	6	0.9-7.4	223-1,906	0.9-4.5	$15,844-$90,112	$225-$2,250	$710-$837
3	8-E	66	IESF Bench	St. Francis High School	8	8.5	0	0	$191,075	$689	$830
4	8-A	62	Curb-Cut Rain Garden	Various locations in catchment	8	0.5-3.7	82-659	1.1-3.8	$32,348-$81,860	$675-$2,025	$1,285-$3,507
5	5-A	50	Curb-Cut Rain Garden	227th Ct. & 227th Ave.	5	0.4-1.6	56-358	0.5-1.7	$8,982-$35,928	$225-$900	$1,311-$1,498
6	1-A	34	Pond Modification	St. Francis Blvd. & Stark Dr.	1	3.1	1,760	0	$122,840-$170,840	$1,300	$1,740-$2,256
6	8-D	65	Pond Modification	St. Francis High School	8	3.1	1,760	0	$122,840-$170,840	$1,300	$1,740-$2,256
8	8-G	68	Stormwater Reuse	St. Francis High School	8	12.3	2,434	20.7	$608,760	$3,000	$1,894
9	2-A	39	Curb-Cut Rain Garden	Woodbine St. & 232nd Ave.	2	0.3-1.1	69-270	0.4-1.5	$15,844-$40,600	$225-$900	$2,048-$2,510
10	1-B	35	Pond Modification	St. Francis Blvd. & 233rd Ave.	1	1.9	782	0	$116,840-$155,840	$1,300	$2,734-$3,418
11	6-B	55	Hydrodynamic Device	225th Lane	6	1.2	433	0	$109,752	$630	$3,574
12	8-F	67	IESF Bench	St. Francis High School	8	1.8	0	0	$179,775	$574	$3,648
13	11-A	79	Pond Modification	227th Ave. & Poppy St.	11	0.9	343	0	$104,840-$125,840	$1,300	$5,327-$6,105
14	3-A	43	Hydrodynamic Device	Bridge St. & Rum River Blvd.	3	0.7	374	0	$109,752	$630	$6,126
15	9-A	72	Hydrodynamic Device	Bridge Street	9	0.2	103	0	$28,752	$630	$7,942
16	8-B	63	Permeable Pavement	St. Francis High School	8	5.3	1,586	4.1	$643,796	$48,000	$13,106
17	8-C	64	Permeable Pavement	St. Francis High School	8	1.4	420	1.9	$313,796	$23,250	$24,078

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

Table 3: Cost-effectiveness of retrofits with respect to TSS reduction. Projects ranked 1 – 17 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	8-H	69	IESF Check Dam	Rum River Blvd. & Park Rd.	8	1.8	459	0	$15,448	$365	$1,917
2	6-A	54	Curb-Cut Rain Garden	Various locations in catchment	6	0.9-7.4	223-1,906	0.9-4.5	$15,844-$90,112	$225-$2,250	$2,756-$3,377
3	1-A	34	Pond Modification	St. Francis Blvd. & Stark Dr.	1	3.1	1,760	0	$122,840-$170,840	$1,300	$3,065-$3,974
3	8-D	65	Pond Modification	St. Francis High School	8	3.1	1,760	0	$122,840-$170,840	$1,300	$3,065-$3,974
5	5-A	50	Curb-Cut Rain Garden	227th Ct. & 227th Ave.	5	0.4-1.6	56-358	0.5-1.7	$8,982-$35,928	$225-$900	$5,859-$9,364
6	1-B	35	Pond Modification	St. Francis Blvd. & 233rd Ave.	1	1.9	782	0	$116,840-$155,840	$1,300	$6,643-$8,305
7	8-A	62	Curb-Cut Rain Garden	Various locations in catchment	8	0.5-3.7	82-659	1.1-3.8	$32,348-$81,860	$675-$2,025	$7,213-$21,381
8	2-A	39	Curb-Cut Rain Garden	Woodbine St. & 232nd Ave.	2	0.3-1.1	69-270	0.4-1.5	$15,844-$40,600	$225-$900	$8,346-$10,915
9	8-G	68	Stormwater Reuse	St. Francis High School	8	12.3	2,434	20.7	$608,760	$3,000	$9,569
10	6-B	55	Hydrodynamic Device	225th Lane	6	1.2	433	0	$109,752	$630	$9,904
11	3-A	43	Hydrodynamic Device	Bridge St. & Rum River Blvd.	3	0.7	374	0	$109,752	$630	$11,466
12	11-A	79	Pond Modification	227th Ave. & Poppy St.	11	0.9	343	0	$104,840-$125,840	$1,300	$13,979-$16,019
13	9-A	72	Hydrodynamic Device	Bridge Street	9	0.2	103	0	$28,752	$630	$15,421
14	8-B	63	Permeable Pavement	St. Francis High School	8	5.3	1,586	4.1	$643,796	$48,000	$43,796
15	8-C	64	Permeable Pavement	St. Francis High School	8	1.4	420	1.9	$313,796	$23,250	$80,262
17	8-E	66	IESF Bench	St. Francis High School	8	8.5	0	0	$191,075	$689	N/A
17	8-F	67	IESF Bench	St. Francis High School	8	1.8	0	0	$179,775	$574	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, and
- 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
- Hydrodynamic Device,
- Permeable Pavement,
- Iron-Enhanced Sand Filter Pond Bench,
- Iron-Enhanced Sand Filter Check Dam,
- Modification to an Existing Pond, and
- 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 4).

Table 4: 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 garden 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.

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 5). 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.

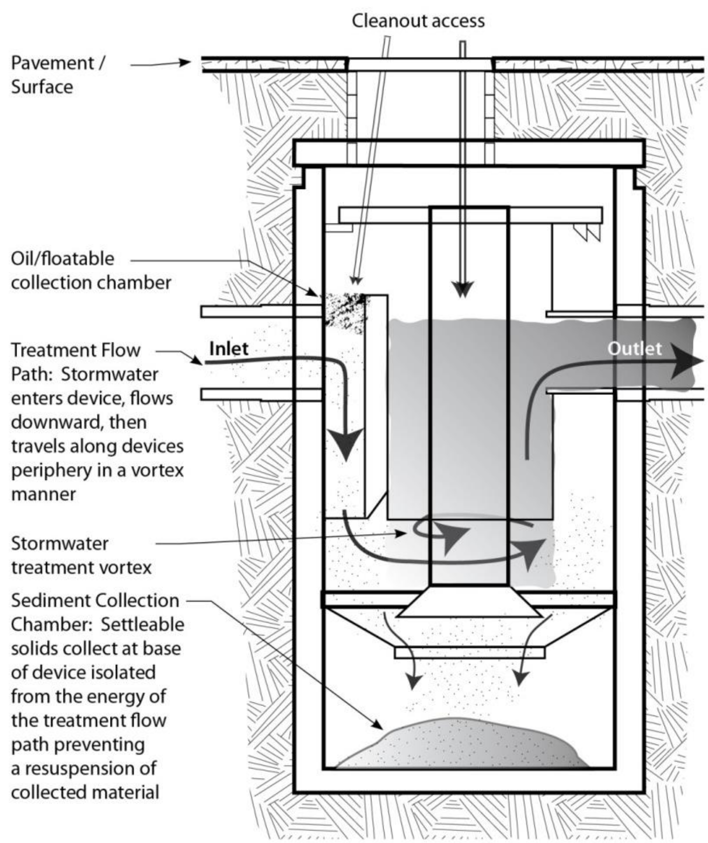


Figure 5: Schematic of a typical hydrodynamic device

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 6). 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 do not 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 the peak discharge from the site.

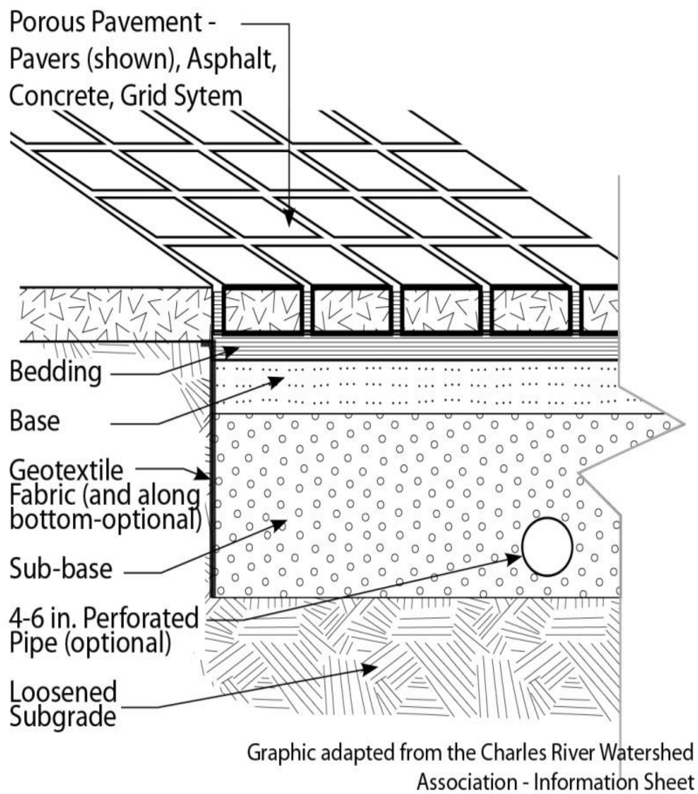


Figure 6: Schematic of typical permeable pavement surface and subgrade.

This practice is well suited for small drainage areas flowing to low traffic pavement surfaces (Figure 7). 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

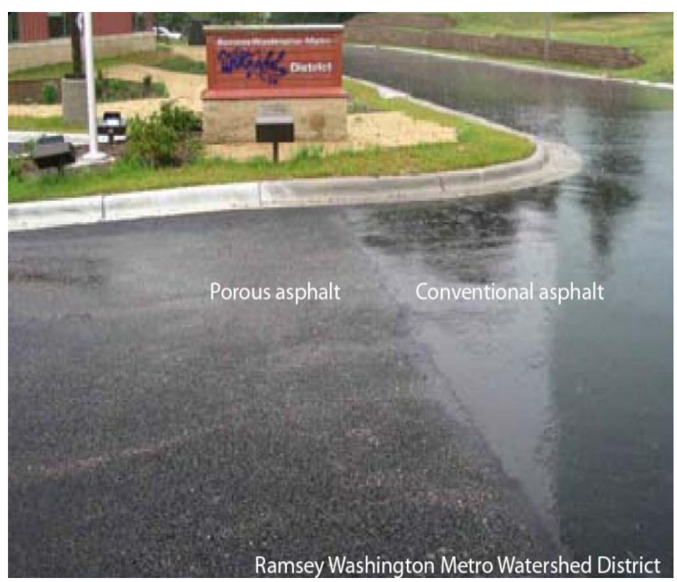


Figure 7: Photo comparing conventional and permeable asphalt

street. Permeable pavement can be used for many 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 8). Locally, this practice has also gone by the name "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 8 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.

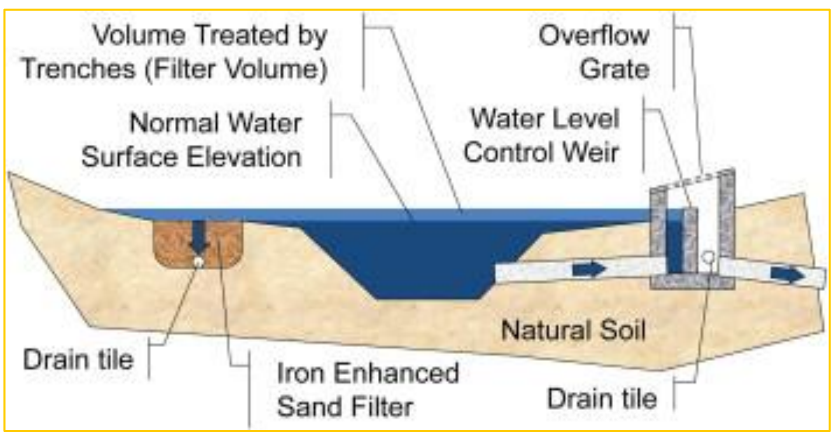


Figure 8: Iron Enhanced Sand Filter Concept (Erickson & Gulliver, 2010)

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.

Iron Enhanced Sand Filter Check Dam

Permeable check dams provide additional treatment for pollutants within ditches and grassed waterways through two processes. First, the dams act as a barrier to flow through the channel, allowing sediment and particulate pollutants to drop out of solution upstream of the dam. This promotes infiltration and evaporation of stormwater as well. Second, any water retained behind the dam can seep through a sand filter located within the rock dam. The sand, mixed with iron filings (similar to an IESF pond bench), creates an opportunity for dissolved pollutant species to be filtered out of the stormwater runoff.

Figure 9: Rock check dams in a small ditch (www.casfm.org/stormwater_committee/LID-Summary.htm)

These practices are often installed in a series, from two to a dozen practices depending on the length and slope of the ditch or waterway (Figure 9). For short ditch lengths a single check dam is often sufficient. The dams include an inner sand filter mixed with iron filings. The ratio of iron filings to sand should be between 5-8% by weight and these should be mixed thoroughly prior to installation. The sand-iron mix should be encased within a permeable membrane allowing for flow in and out of the filter. This filter is surrounded by rocks to promote settling and inhibit clogging of the filter.

It is recommended that these dams are installed such that the buried rock toe of the upstream dam is at the same elevation as the top of any downstream dams (Figure 10). This reduces the likelihood of scouring downstream of dams as water flowing over the dam intercepts ponded water rather than erodible soil. Also, the top of the most upstream dam should be installed below the outlet elevation of any pipe draining to the practice to ensure water does not back up into the upstream storm sewer infrastructure.

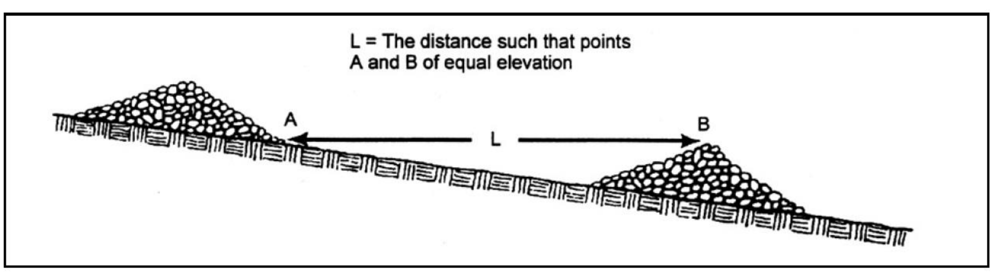


Figure 10: Check dam schematic (MPCA 2000)

The pollutant removal potential of permeable check dams was estimated using WinSLAMM. The ponding volume behind the dams was determined using LIDAR. Based on results of other IESFs, it was assumed that 80% of DP flowing through the dam was retained (Erickson & Gulliver, 2010). 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.

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 greatly 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, and
- 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, or
- 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.

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 hefty 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

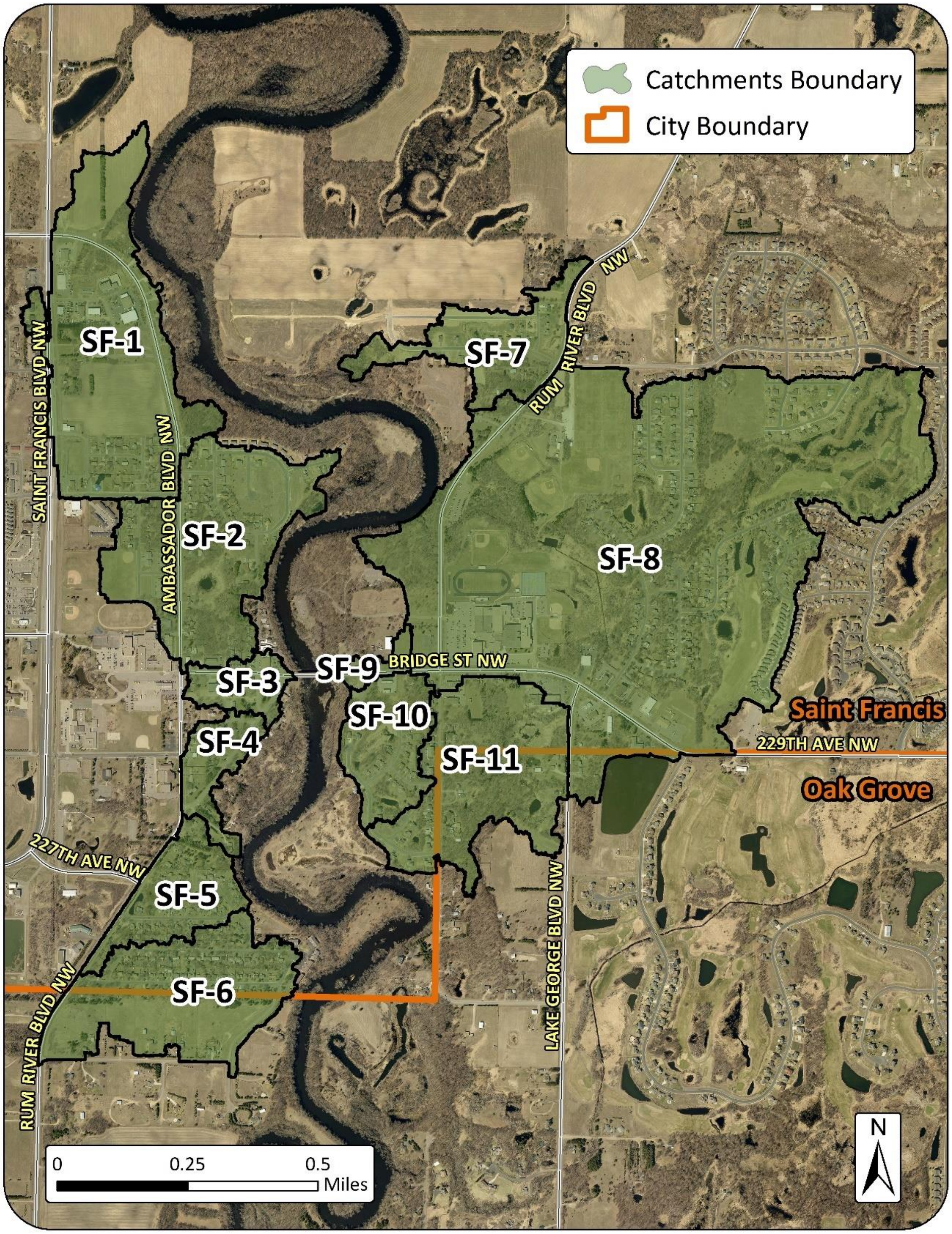
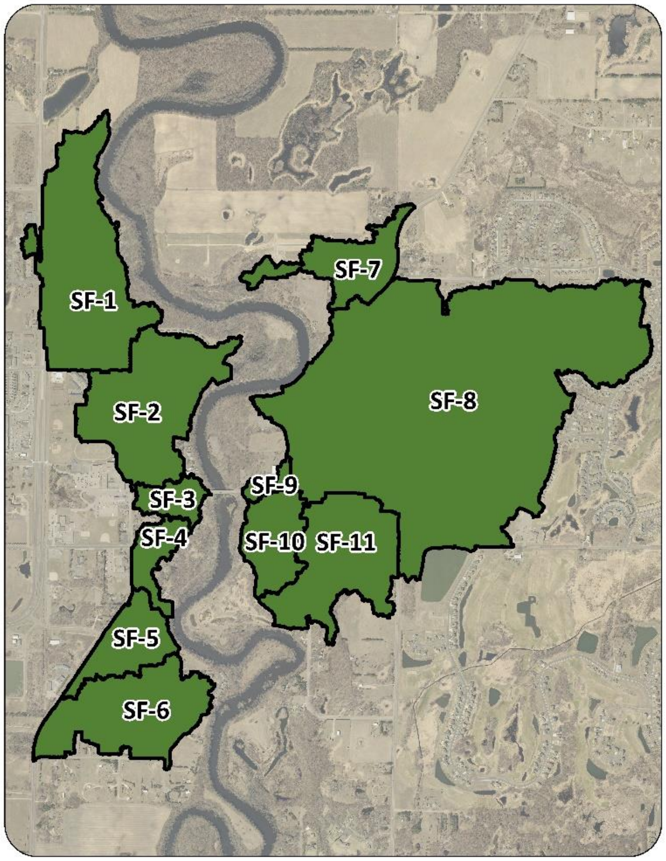


Figure 11: The 736-acre drainage area was divided into 11 catchments for this analysis. Catchment profiles on the following pages provide additional information.

St. Francis Research Area Drainage Network



Existing Network Summary	
Acres	735.8
Dominant Land Cover	Residential
Volume (ac-ft/yr)	252.3
TP (lb/yr)	214.2
TSS (lb/yr)	59,493

DRAINAGE NETWORK SUMMARY

The research area chosen for this stormwater retrofit analysis includes developed areas of the City of St. Francis draining directly to the Rum River. Generally speaking, this has excluded areas draining to Seelye Brook (west of the Rum River) or Anoka County Ditch 18 (east of the Rum River). Taking into account these factors, 735.8 acres were included for analysis. Catchments were chosen based on each major outfall to the Rum River, and were numbered in order from the western Rum River banks to the eastern Rum River banks and from north to south on each bank. The outfalls on the western banks of the Rum River are located at the outlet of natural wetland NW108 (Catchment SF-1), at the outlet of retention pond SWP84 (SF-2), southeast of the Rum River Boulevard - Bridge Street intersection (SF-3), southeast of the Rum River Boulevard – River Drive intersection (SF-4), northeast of the Vintage Street – 227th Avenue intersection (SF-5), and east of the Tulip Street – 225th Lane, intersection. The outfalls on the eastern banks are located southwest of 235th Avenue – 235th Lane intersection (SF-7), west of Rum River Boulevard within Rum River North Park (SF-8), southwest of Bridge Street (SF-9), southwest of the Silverado Street - Quay Street intersection, and southwest of the Poppy Street – 227th Avenue intersection (SF-10).

Land use in the catchments contributing stormwater pollutants to the river system (Catchments SF-1 to SF-11) are predominantly single family and multi-family residential. Other land uses include commercial, institutional (primarily the high school), industrial, and park. The land use in the catchment is 43%

residential, 6% institutional, 4% commercial, 2% industrial, and the remaining 45% is open space, park or water. Soils in the area are generally sandy but also include hydric zones in and around major wetland complexes (such as in Catchment SF-8).

EXISTING STORMWATER TREATMENT

Forty-four existing BMPs were identified within the study area and modeled in WinSLAMM. SF-1 has two natural wetlands (NW108 and NW107), a grass swale (SWA109), and two stormwater ponds (SWP50 and SWP116). All the stormwater runoff generated within this 92-acre catchment receives some treatment from one of the mentioned BMPs.

Nine existing BMPs are within SF-2. These BMPs include two infiltration basins (DB118 and DB115) and seven stormwater ponds (SWP103, SWP106, SWP82, SWP117, SWP104, SWP83, and SWP84). All of the stormwater runoff generated within this 72-acre catchment receives some treatment from one of these BMPs.

SF-4 has an existing hydrodynamic device (HD122), which treats stormwater runoff from 11.6 acres of the 14.3-acre catchment.

SF-5 has two existing stormwater ponds (SWP10 and SWP11), which treat stormwater runoff from the majority of the 25.6-acre catchment.

SF-7 has two existing stormwater ponds (SWP52 and SWP105), which treat stormwater from 26 acres of the 31-acre catchment.

Thirty existing BMPs are in SF-8 and nineteen individual BMPs were modeled (hydrologically connected BMPs were modeled as a single BMP). These BMPs include two natural wetlands (NW114 and NW120), and seventeen stormwater ponds (SWP101, SWP86/SWP87, SWP88, SWP31, SWP29/SWP30/SWP32/SWP33/SWP56/SWP92/SWP93, SWP34/SWP35, SWP73/SWP74/SWP75/SWP91, SWP85, SWP123, SWP23, SWP90, SWP100, SWP89, SWP21, SWP22, SWP119, and SWP122). Stormwater generated from all but 86.3 acres of the 341.7-acre catchment receives some treatment by these existing BMPs.

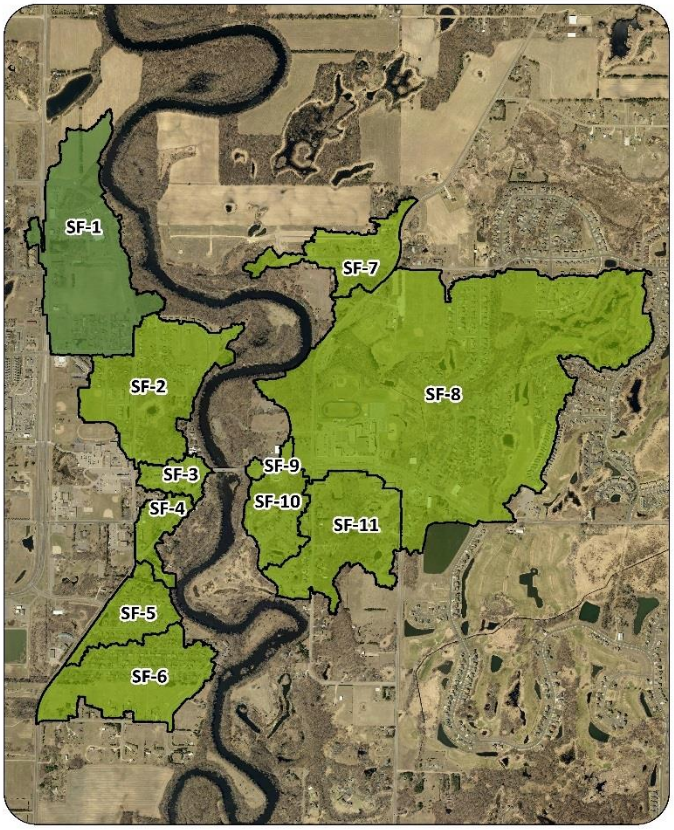
SF-10 has four existing stormwater ponds (SWP6, SWP7, and SWP12/SWP61), two of which were modeled as one stormwater pond in WinSLAMM. All the stormwater runoff generated within the 25.6-acre catchment receives some treatment by these stormwater ponds.

SF-11 has two existing stormwater ponds (SWP8 and SWP9) and four natural wetlands (NW109, NW110, NW111, and NW113). The wetlands were modeled as a single BMP in WinSLAMM due to their hydrologic connectivity. These existing BMPs treat stormwater runoff generated from 58.1 acres of the 59.3-acre catchment.

SF-3, SF-6, and SF-9 do not have any existing BMPs.

Catchment SF-1

Existing Catchment Summary	
Acres	92.1
Dominant Land Cover	Open
Parcels	68
Volume (ac-ft/yr)	31.9
TP (lb/yr)	23.7
TSS (lb/yr)	7,687



CATCHMENT DESCRIPTION

Catchment SF-1 is the northernmost catchment in this analysis and includes a variety of land uses such as single family residential, commercial, industrial, agricultural, and undeveloped parcels. The catchment is bound by Ambassador Boulevard (and its adjacent properties) to the north and east, 233rd Avenue to the south, and St. Francis Boulevard to the west. The northern border includes approximately 13 acres of agricultural land which drains to the NW108 wetland. Soils in the catchment are generally sandy, with loamy fine sands (Braham series; hydrologic group B) near 233rd Avenue and loamy sands (Zimmerman and Nymore Series, hydrologic group A) to the north. Wetland soils (Seelyeville series; hydrologic group A/D) are also prevalent within natural wetlands NW107 and NW108.

EXISTING STORMWATER TREATMENT

A series of four BMPs, including two retention ponds (SWP 50 and SWP116) and two natural wetlands (NW107 and NW108), treat a storm sewer line draining residential, commercial, and industrial properties between 233rd Avenue and Ambassador Drive. A grass swale (SWA109) also treats residential and industrial properties along Zea St. prior to discharging into a ditch along Ambassador Drive. In addition to these five structural BMPs, street cleaning is provided by the City of St. Francis twice per year using mechanical sweepers.

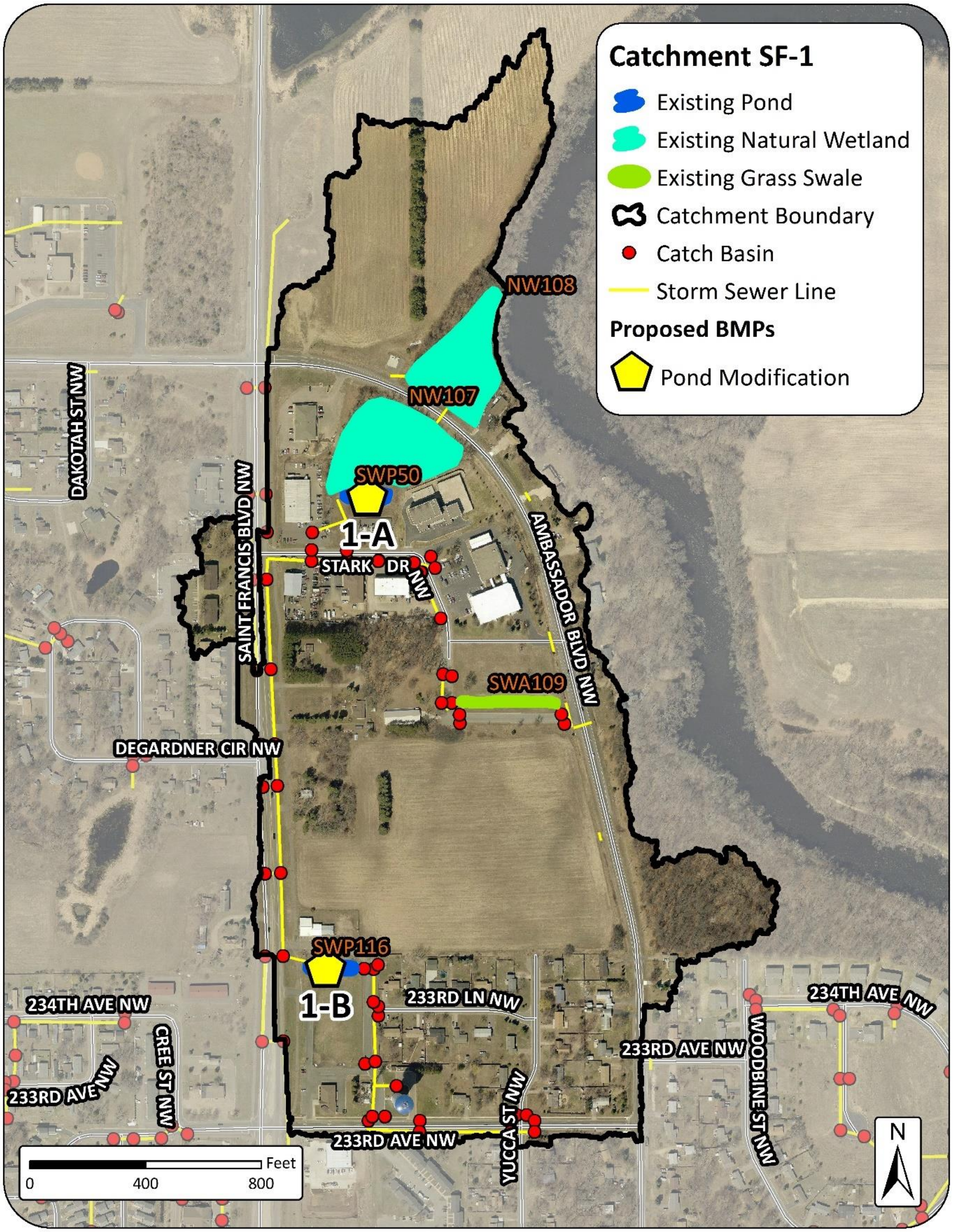
Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	6			
	BMP Types	2 Wetlands, 2 Ponds, 1 Grass Swale, Street Cleaning			
	TP (lb/yr)	36.9	13.2	36%	**23.7**
	TSS (lb/yr)	14,770	7,083	48%	**7,687**
	Volume (acre-feet/yr)	33.3	1.4	4%	**31.9**

PROPOSED RETROFITS OVERVIEW

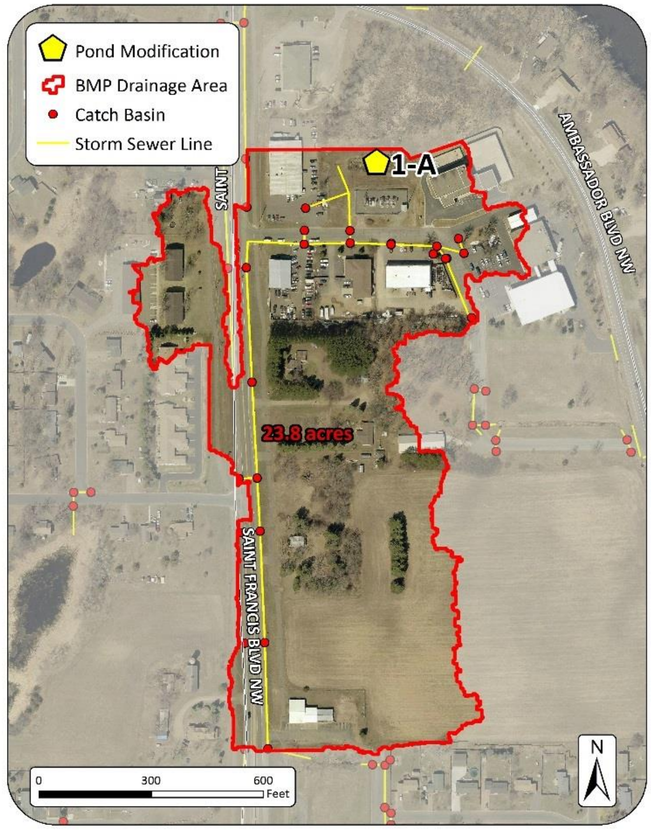
Modifications to stormwater retention ponds SWP50 and SWP116 were proposed to take advantage of available area and ponding depth, which was not currently being utilized. These modifications could improve the treatment efficiency of the stormwater ponds and the increased storage will improve volume reductions within the catchment.

RETROFIT RECOMMENDATIONS



Project ID: 1-A

St. Francis Blvd. & Stark Dr. Pond Modification



Drainage Area – 23.8 acres
Location – SWP50
Property Ownership – Private (Connexus Energy)
Site Specific Information – A modification is proposed for SWP50, which is located on Connexus Energy Property, roughly at St. Francis Boulevard and Stark Drive. This pond currently treats water from 23.8 acres but is undersized relative to the contributing drainage area. Excavating 1,600 cubic yards of material could 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 of the excavated soil.

BMP Modification

	Cost/Removal Analysis	New Treatment	% Reduction	New Treatment	% Reduction	New Treatment	% Reduction
Treatment	Pond Management Level	1		2		3	
	Amount of Soil Excavated	1,600	cu-yards	1,600	cu-yards	1,600	cu-yards
	TP (lb/yr)	3.1	13.1%	3.1	13.1%	3.1	13.1%
	TSS (lb/yr)	1,760	22.9%	1,760	22.9%	1,760	22.9%
	Volume (acre-feet/yr)	0.0	0.1%	0.0	0.1%	0.0	0.1%
Cost	Administration & Promotion Costs*	$5,840		$5,840		$5,840	
	Design & Construction Costs**	$117,000		$141,000		$165,000	
	Total Estimated Project Cost (2016)	**$122,840**		**$146,840**		**$170,840**	
	Annual O&M***	$1,300		$1,300		$1,300	
Efficiency	30-yr Average Cost/lb-TP	**$1,740**		**$1,998**		**$2,256**	
	30-yr Average Cost/1,000lb-TSS	**$3,065**		**$3,520**		**$3,974**	
	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: 1-B

St. Francis Blvd. & 233rd Ave.
Pond Modification

Drainage Area – 15.8 acres
Location – SWP116
Property Ownership – Public (City of St. Francis)
Site Specific Information – A modification is proposed for SWP116, which is located on City of St. Francis property, roughly at St. Francis Boulevard and 233rd Drive. This pond currently treats water from 15.8 acres but is undersized relative to the contributing drainage area. Excavating 1,300 cubic yards of material could 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 of the soil.

	BMP Modification						
	Cost/Removal Analysis	**New Treatment**	**% Reduction**	**New Treatment**	**% Reduction**	**New Treatment**	**% Reduction**
Treatment	**Pond Management Level**	1		2		3	
	Amount of Soil Excavated	1,300	cu-yards	1,300	cu-yards	1,300	cu-yards
	TP (lb/yr)	1.9	8.0%	1.9	8.0%	1.9	8.0%
	TSS (lb/yr)	782	10.2%	782	10.2%	782	10.2%
	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**	$111,000		$130,500		$150,000	
	Total Estimated Project Cost (2016)	**$116,840**		**$136,340**		**$155,840**	
	Annual O&M***	$1,300		$1,300		$1,300	
Efficiency	**30-yr Average Cost/lb-TP**	**$2,734**		**$3,076**		**$3,418**	
	30-yr Average Cost/1,000lb-TSS	**$6,643**		**$7,474**		**$8,305**	
	30-yr Average Cost/ac-ft Vol.	**N/A**		**N/A**		**N/A**	

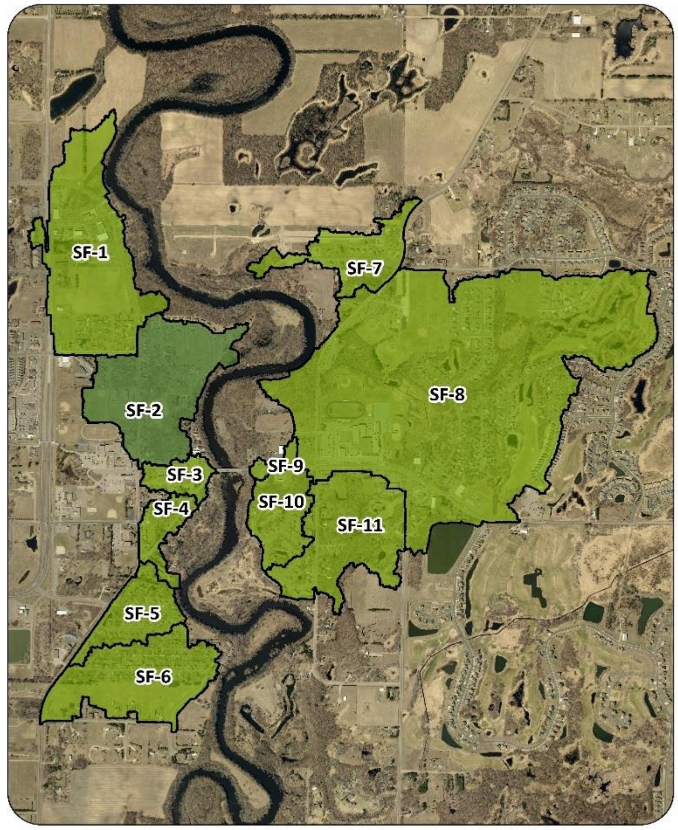
*Indirect Cost: 80 hours at $73/hour

**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

Catchment SF-2

Existing Catchment Summary	
Acres	72.1
Dominant Land Cover	Residential
Parcels	201
Volume (acre-feet/yr)	24.6
TP (lb/yr)	13.9
TSS (lb/yr)	1,988



CATCHMENT DESCRIPTION

Catchment SF-2 spans from portions of St. Francis Middle School in the west to the Rum River in the east. Land use in the catchment is primarily single family residential. Other land uses include multi-family residential apartments west of Ambassador Boulevard., St. Francis Middle School, and undeveloped parcels scattered throughout the catchment. One of these undeveloped areas, the Rum River Terrace Development, has been parceled-out and may see development soon. Upland soils in SF-2 are exclusively of the sandy Braham and Zimmerman series.

EXISTING STORMWATER TREATMENT

A total of ten BMPs treat stormwater throughout the catchment. Multi-family and single family residential properties west of Ambassador Boulevard. are treated by retention ponds SWP103 and SWP106. These ponds flow through the detention basin DB115 before passing into the pond/wetland SWP82. This pond eventually overflows into the 232nd Avenue storm sewer network and into retention pond SWP83.

In the Rum River Terrace Development three retention ponds, SWP83, SWP104, and SWP117, as well as infiltration basin DB118 all treat drainage from developed and as of yet undeveloped parcels. SWP83, the furthest downstream, overflows into retention pond SWP84, which subsequently discharges directly into the Rum River.

In addition to these ponds, street cleaning is provided by the City of St. Francis twice per year using street sweepers.

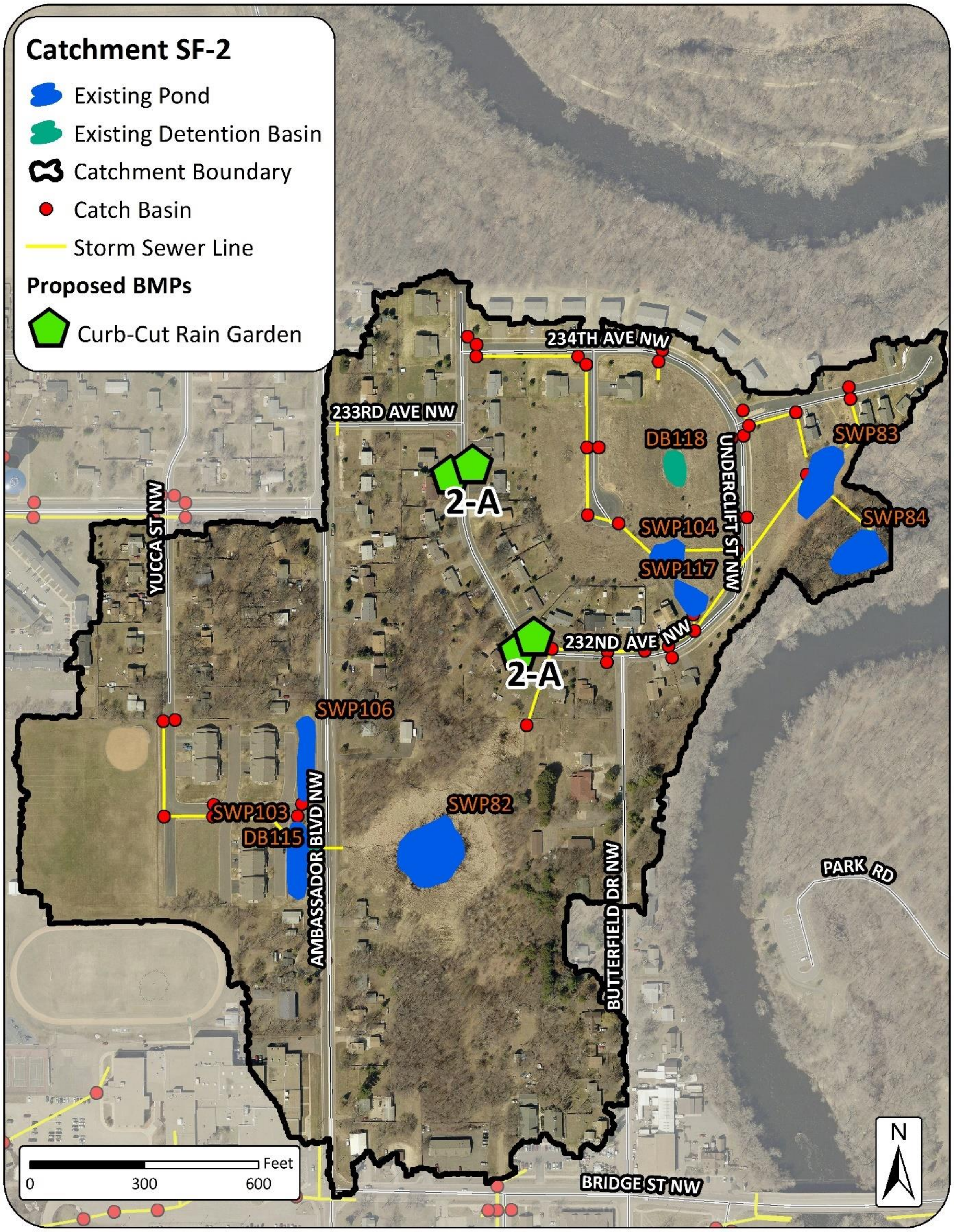
Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	10			
	BMP Types	2 Bioretention Basins, 7 Ponds, Street Cleaning			
	TP (lb/yr)	37.4	23.5	63%	**13.9**
	TSS (lb/yr)	11,176	9,188	82%	**1,988**
	Volume (acre-feet/yr)	27.0	2.3	9%	**24.6**

PROPOSED RETROFITS OVERVIEW

Curb-cut rain gardens are proposed in the developed areas of Rum River Terrace where soils are conducive to infiltration practices. Up to four rain gardens were proposed along Woodbine Street and 232nd Avenue.

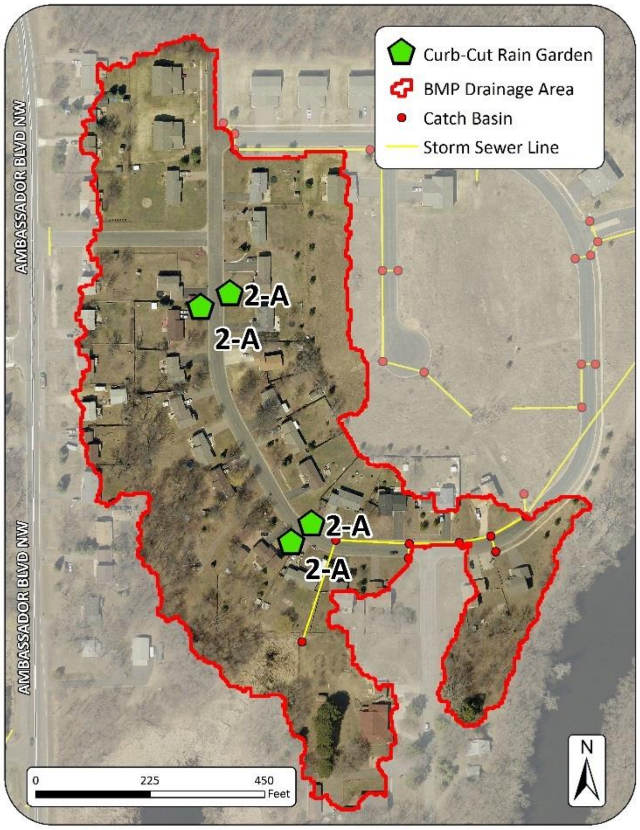
RETROFIT RECOMMENDATIONS



Project ID: 2-A

Curb-Cut Rain Gardens

Drainage Area – 1.5 – 6.0 acres
Location – Woodbine Street NW and 232nd Avenue NW
Property Ownership – Private
Site Specific Information – Single-family lots in the northeastern portion of the catchment provide various locations for curb-cut rain gardens to treat stormwater pollutants originating from private properties. Considering typical landowner participation rates, scenarios with one, two, and four rain gardens were analyzed to treat the drainage area.



Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction	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)	0.3	2.2%	0.6	4.3%	1.1	7.9%
	TSS (lb/yr)	69	3.5%	136	6.8%	270	13.6%
	Volume (acre-feet/yr)	0.4	1.6%	0.8	3.2%	1.5	6.1%
Cost	Administration & Promotion Costs*	$1,606		$3,212		$6,424	
	Design & Construction Costs**	$7,376		$14,752		$29,504	
	Total Estimated Project Cost (2016)	**$8,982**		**$17,964**		**$35,928**	
	Annual O&M***	$225		$450		$900	
Efficiency	30-yr Average Cost/lb-TP	**$1,748**		**$1,748**		**$1,907**	
	30-yr Average Cost/1,000lb-TSS	**$7,600**		**$7,712**		**$7,769**	
	30-yr Average Cost/ac-ft Vol.	**$1,345**		**$1,384**		**$1,408**	

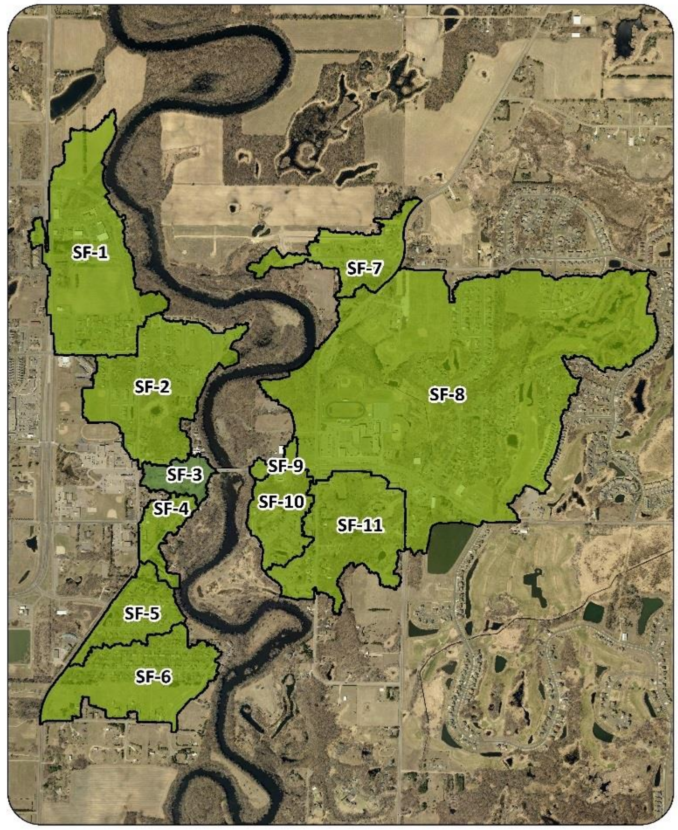
*Indirect Cost: (10 hours/BMP at $73/hour base cost) + (12 hours/BMP at $73/hour)

**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 SF-3

Existing Catchment Summary	
Acres	11.6
Dominant Land Cover	Commercial
Parcels	38
Volume (acre-feet/yr)	7.6
TP (lb/yr)	6.5
TSS (lb/yr)	2,475



CATCHMENT DESCRIPTION

Catchment SF-3 includes all of the geographical area that drains stormwater to an outfall just south of Bridge Street. The catchment includes commercial, institutional, single family residential, multi-family residential, park, and undeveloped land uses. Due to the high density of businesses and residences in SF-3, this is one of the more impervious catchments in this analysis.

EXISTING STORMWATER TREATMENT

Street cleaning is provided by the City of St. Francis twice per year using street sweepers. No structural stormwater devices exist within this catchment.

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)	6.8	0.3	4%	**6.5**
	TSS (lb/yr)	2,650	175	7%	**2,475**
	Volume (acre-feet/yr)	7.6	0.0	0%	**7.6**

PROPOSED RETROFITS OVERVIEW

A hydrodynamic device was proposed upstream of the Bridge Street outfall. As proposed, this device could treat the full 11.6 acres draining to the Rum River outfall in Catchment SF-3.

RETROFITS CONSIDERED BUT REJECTED

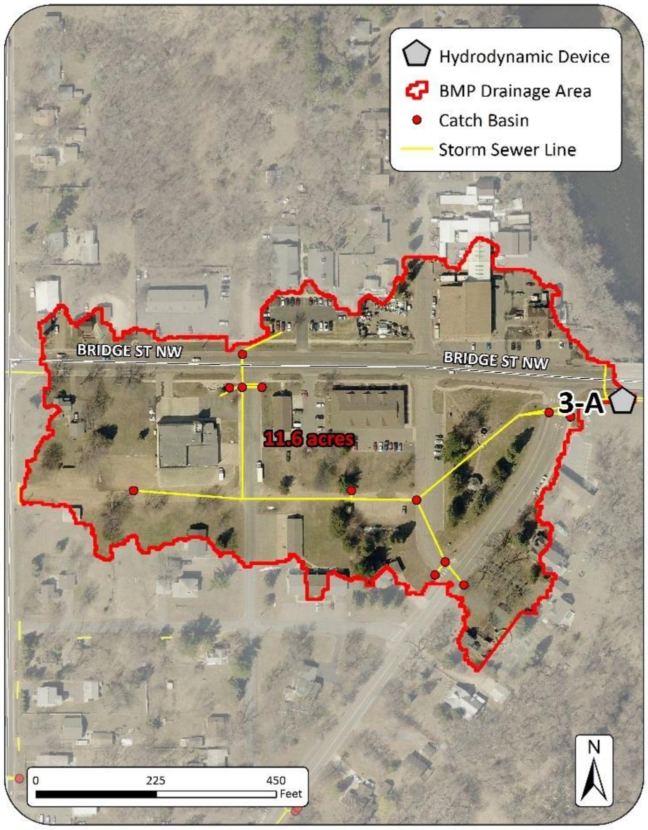
Bioretention practices, including curb-cut rain gardens and boulevard bioswales, were considered for various public and private properties across the catchment. These BMPs were not proposed as the drainage areas to these practices were not large enough to justify the installation of the BMP.

RETROFIT RECOMMENDATIONS

Project ID: 3-A

Bridge St. & Rum River Blvd.
Hydrodynamic Device

Drainage Area – 11.6 acres
Location – Bridge Street NW and Rum River Boulevard NW
Property Ownership – Public
Site Specific Information – A hydrodynamic device could be installed on the southeast corner of Bridge Street and Rum River Boulevard. This device would accept runoff from the entire catchment. It could remove TP and TSS from stormwater runoff prior to discharging into the Rum River.



Hydrodynamic Device

	Cost/Removal Analysis	New Treatment	% Reduction
Treatment	Number of BMPs	1	
	Total Size of BMPs	10	ft diameter
	TP (lb/yr)	0.7	10.8%
	TSS (lb/yr)	374	15.1%
	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**	**$6,126**	
	30-yr Average Cost/1,000lb-TSS	**$11,466**	
	30-yr Average Cost/ac-ft Vol.	**N/A**	

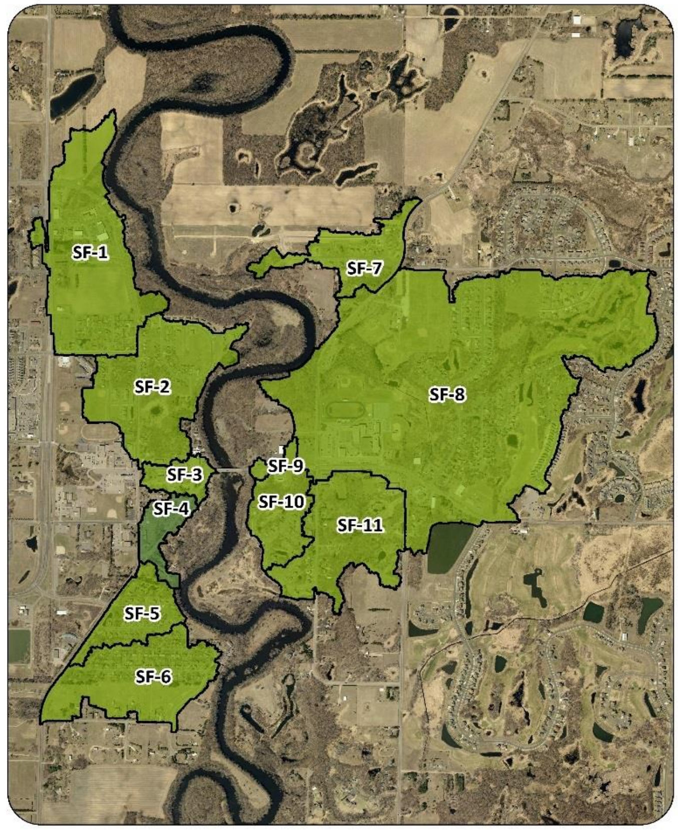
*Indirect Cost: (24 hours at $73/hour)

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

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

Catchment SF-4

Existing Catchment Summary	
Acres	14.3
Dominant Land Cover	Residential
Parcels	28
Volume (acre-feet/yr)	7.6
TP (lb/yr)	9.4
TSS (lb/yr)	2,520



CATCHMENT DESCRIPTION

Catchment SF-4 extends from 229th Avenue in the north to River Drive in the south and from Ambassador Boulevard. in the west to Rum River Boulevard. in the east. The catchment is predominantly single family lots overlying sandy soils.

EXISTING STORMWATER TREATMENT

Stormwater generated within the catchment first flows to either (1) the ditch east of Ambassador Boulevard or (2) the storm sewer line below Rum River Boulevard. At the Ambassador Boulevard – Rum River Boulevard intersection stormwater from both the ditch and the Rum River Boulevard storm sewer line are directed through a hydrodynamic device (HD122). Storm flow leaving the device is discharged into the Rum River approximately 600' east of the BMP.

In addition to the hydrodynamic device, street cleaning is provided twice annually by the City of St. Francis with mechanical sweepers.

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	Hydrodynamic Device, Street Cleaning			
	TP (lb/yr)	10.8	1.4	13%	**9.4**
	TSS (lb/yr)	3,101	581	19%	**2,520**
	Volume (acre-feet/yr)	7.6	0.0	0%	**7.6**

PROPOSED RETROFITS OVERVIEW

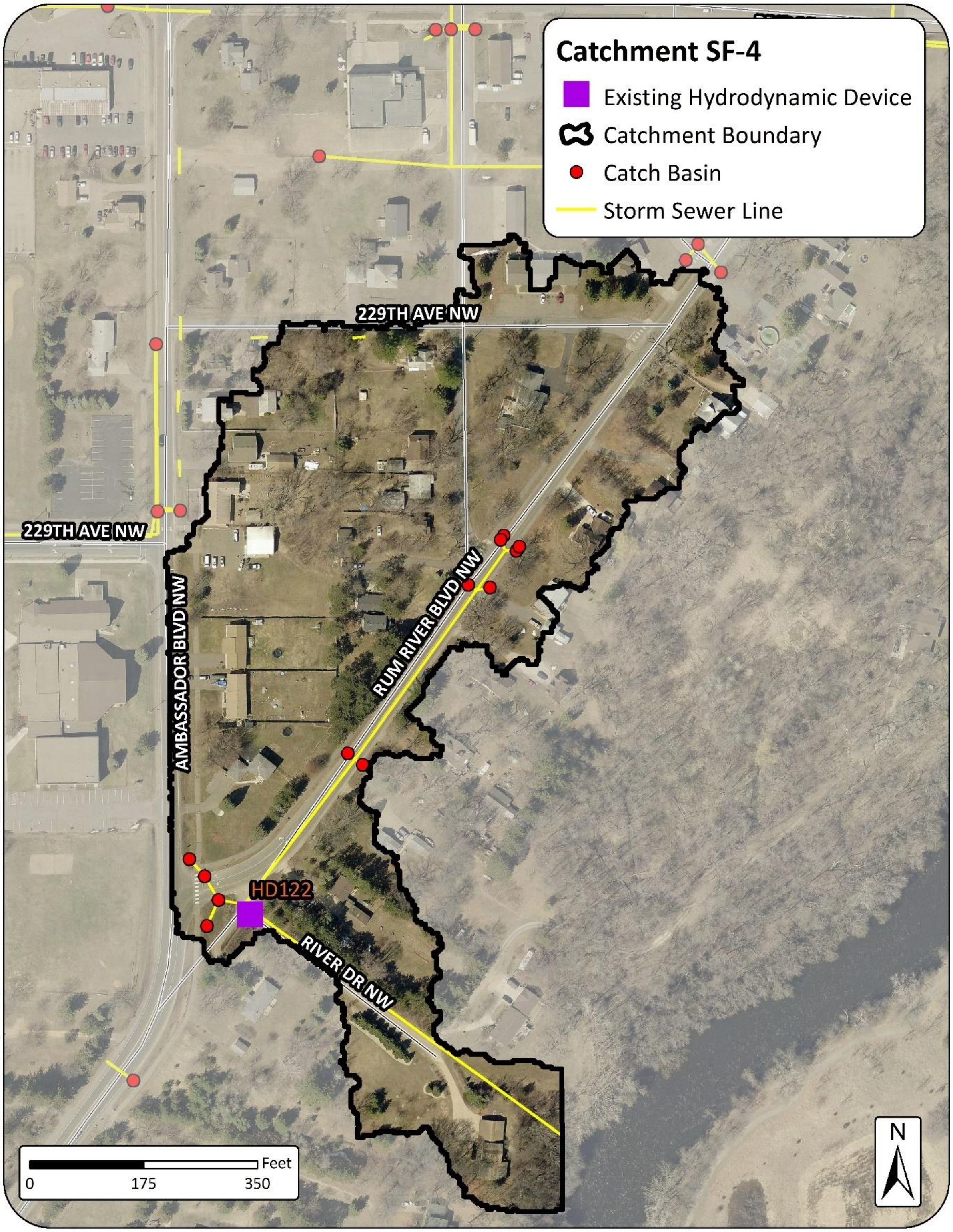
No stormwater retrofits were proposed in this catchment.

RETROFITS CONSIDERED BUT REJECTED

Bioretention practices, including curb-cut rain gardens and boulevard bioswales, were considered for various private properties across the catchment. These BMPs were not proposed as the drainage areas and the amount of impervious surface upstream of these practices were not large enough to justify the installation of the BMP.

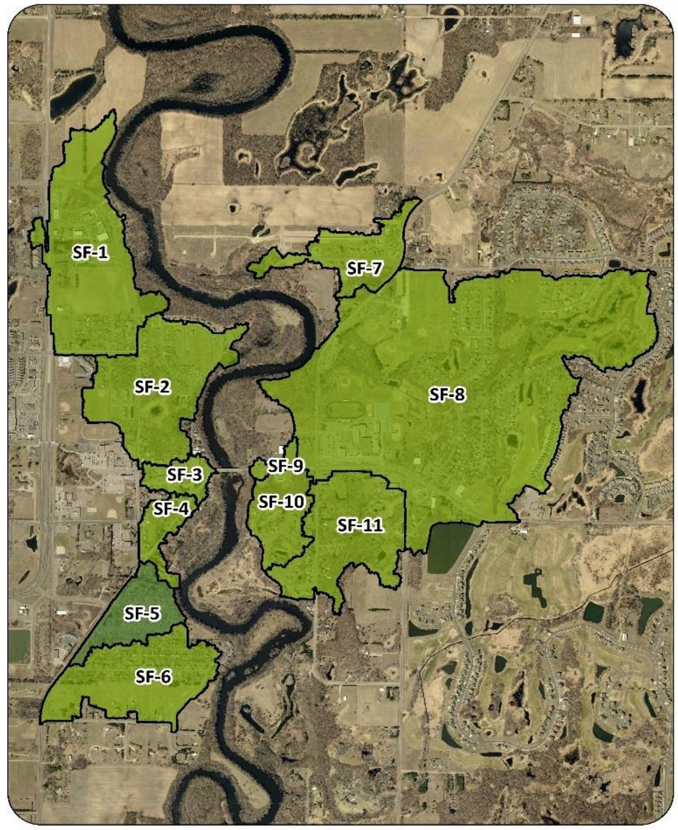
Therefore, the map below was included solely to provide additional detail of the catchment boundary, associated land uses, and streets.

RETROFIT RECOMMENDATIONS



Catchment SF-5

Existing Catchment Summary	
Acres	25.6
Dominant Land Cover	Residential
Parcels	62
Volume (acre-feet/yr)	10.3
TP (lb/yr)	10.9
TSS (lb/yr)	2,184



CATCHMENT DESCRIPTION

Catchment SF-5 includes all of the geographical area draining stormwater to the Rum River outfall located east of the Vintage Street – 227th Avenue intersection. Outside of a few open lots the 26-acre catchment is exclusively single family residences on sandy Zimmerman and Braham Soils.

EXISTING STORMWATER TREATMENT

Roadway and residential stormwater runoff from 227th Avenue and Rum River Boulevard flows to retention pond SWP10. SWP10 overflows into retention pond SWP11, which also collects runoff from residences along 227th Court and Vintage Street. SWP11 discharges into a storm sewer line running east below 227th Avenue and eventually outlets into the Rum River east of Vintage Street.

In addition to the pair of retention ponds, street cleaning conducted by the City of St. Francis provides stormwater treatment on residential roads. This service is provided twice annually using mechanical sweepers.

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)	17.1	6.2	36%	**10.9**
	TSS (lb/yr)	4,514	2,330	52%	**2,184**
	Volume (acre-feet/yr)	10.4	0.1	1%	**10.3**

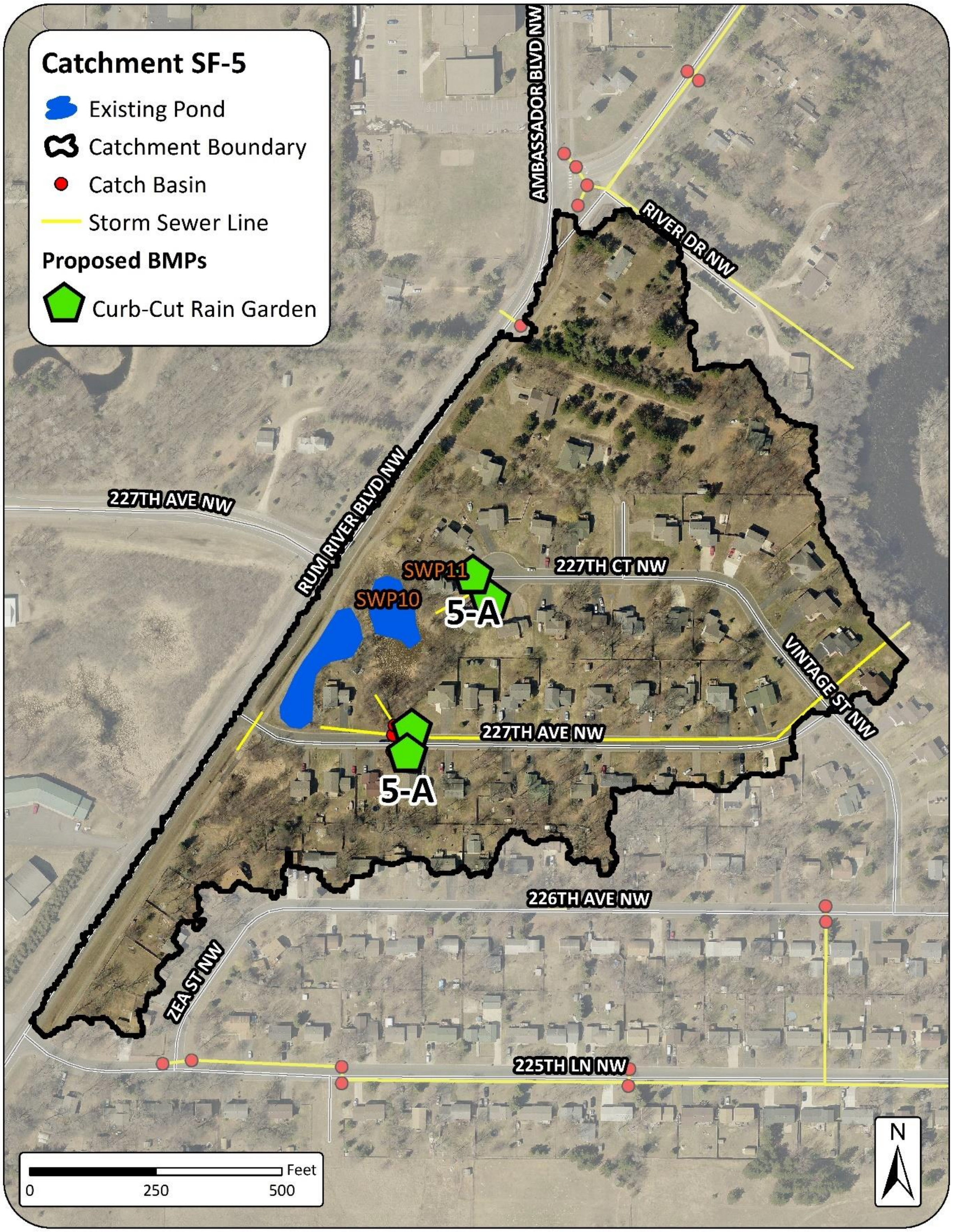
PROPOSED RETROFITS OVERVIEW

Up to four curb-cut rain gardens were proposed on 227th Court and 227th Avenue to treat stormwater prior to discharge into the ponds. The curb-cut rain gardens should be installed as close to the roadway catch basins as possible to maximize their drainage areas.

RETROFITS CONSIDERED BUT REJECTED

A single hydrodynamic device was proposed at the intersection of Vintage Street and 227th Avenue. However, due to the presence of existing BMPs, SWP10 and SWP11, WinSLAMM estimated this device would capture minimal quantities of TSS and TP and did not warrant the cost of installation.

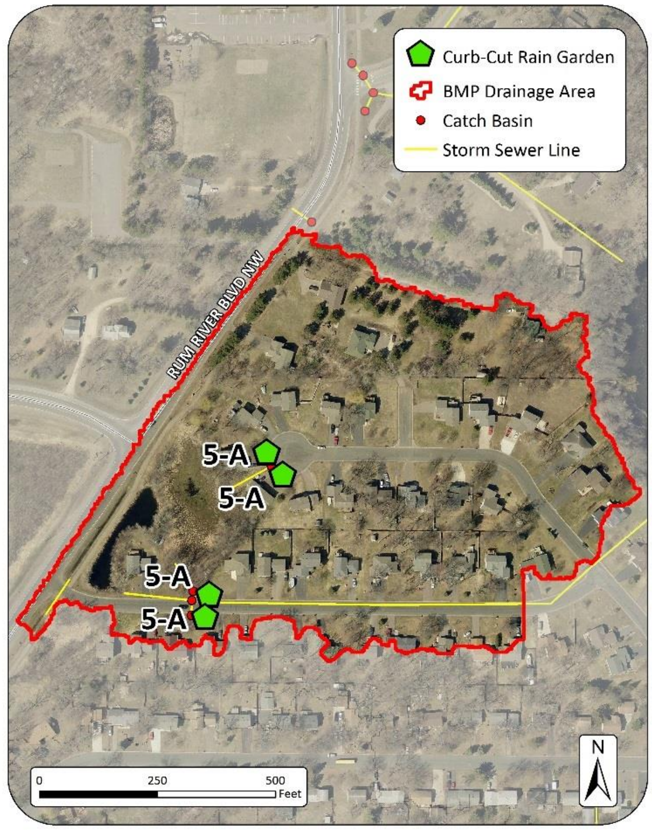
RETROFIT RECOMMENDATIONS



Project ID: 5-A

Curb-Cut Rain Gardens

Drainage Area – 1.5-6.0 acres
Location – 227th Court NW and 227th Avenue NW
Property Ownership – Private
Site Specific Information – Single-family lots within 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, two, and four rain gardens were analyzed to treat the catchment.



Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction	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)	0.4	3.7%	0.7	6.4%	1.6	14.7%
	TSS (lb/yr)	56	2.6%	169	7.7%	358	16.4%
	Volume (acre-feet/yr)	0.5	4.7%	0.8	7.7%	1.7	16.5%
Cost	Administration & Promotion Costs*	$1,606		$3,212		$6,424	
	Design & Construction Costs**	$7,376		$14,752		$29,504	
	Total Estimated Project Cost (2016)	**$8,982**		**$17,964**		**$35,928**	
	Annual O&M***	$225		$450		$900	
Efficiency	30-yr Average Cost/lb-TP	**$1,311**		**$1,498**		**$1,311**	
	30-yr Average Cost/1,000lb-TSS	**$9,364**		**$6,206**		**$5,859**	
	30-yr Average Cost/ac-ft Vol.	**$1,077**		**$1,250**		**$1,217**	

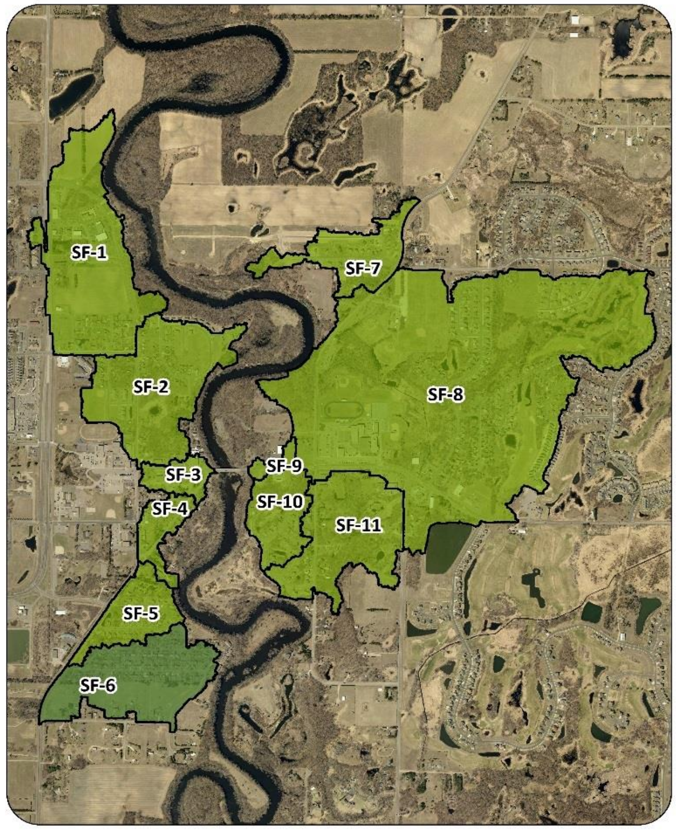
*Indirect Cost: (10 hours/BMP at $73/hour base cost) + (12 hours/BMP at $73/hour)

**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 SF-6

Existing Catchment Summary	
Acres	58.2
Dominant Land Cover	Residential
Parcels	119
Volume (acre-feet/yr)	17.6
TP (lb/yr)	25.7
TSS (lb/yr)	6,541



CATCHMENT DESCRIPTION

Catchment SF-6 is bounded by Rum River Boulevard. to the west, 224th Avenue to the south, Tulip Street to the east, and 227th Avenue to the north. The catchment is exclusively single family residential lots. These parcels are 1/8-acre in size along 226th Avenue and 225th Lane but grow to nearly 5-acres per parcel along 224th Avenue. Soils in the catchment are primarily Braham (hydrologic group B) and Zimmerman (hydrologic group A) well-drained, loamy sand soils, but also include some Blomford (hydrologic group B/D) poorly-drained, fine sand soils.

EXISTING STORMWATER TREATMENT

Street cleaning is provided by the City of St. Francis twice per year with mechanical sweepers. No structural stormwater devices exist within this catchment. Present-day stormwater pollutant loading and treatment is summarized in the table below.

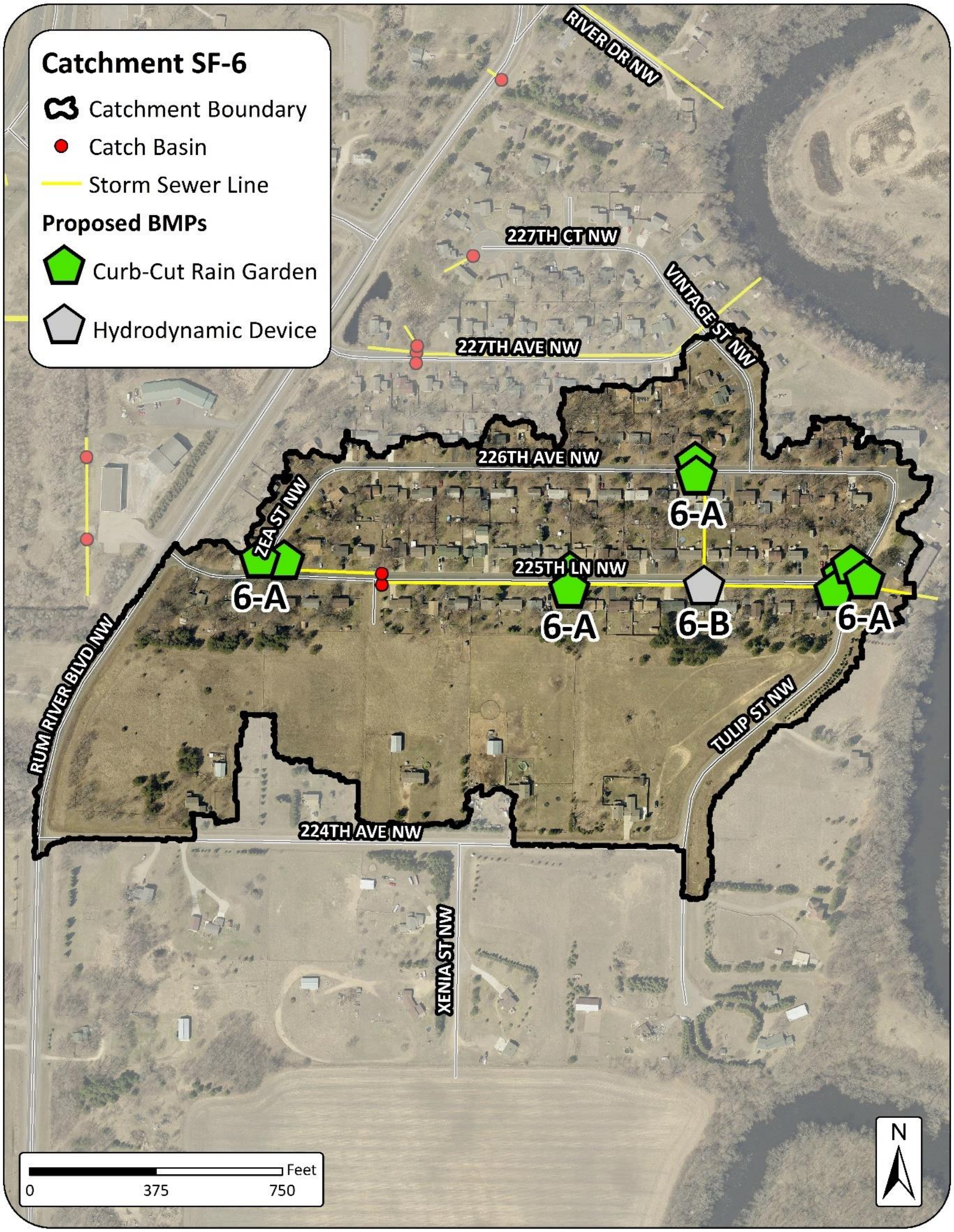
	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	1			
	BMP Types	Street Cleaning			
	TP (lb/yr)	27.7	2.0	7%	**25.7**
	TSS (lb/yr)	7,419	878	12%	**6,541**
	Volume (acre-feet/yr)	17.6	0.0	0%	**17.6**

PROPOSED RETROFITS OVERVIEW

Up to 10 curb-cut rain gardens were proposed in this catchment to facilitate infiltration of stormwater volume and retention of pollutants. These were located upstream of catch basins to maximize drainage area and, where possible, outside of areas with poorly-drained soils. Soil tests should be conducted prior to installation to ensure sufficient drainage.

In addition to the curb-cut rain gardens, a hydrodynamic device was proposed along 225th Lane to treat stormwater from only the 225th Lane pipe. This practice was placed upstream of the connection with the 226th Avenue storm sewer pipe to reduce the potential for resuspension from high peak discharges.

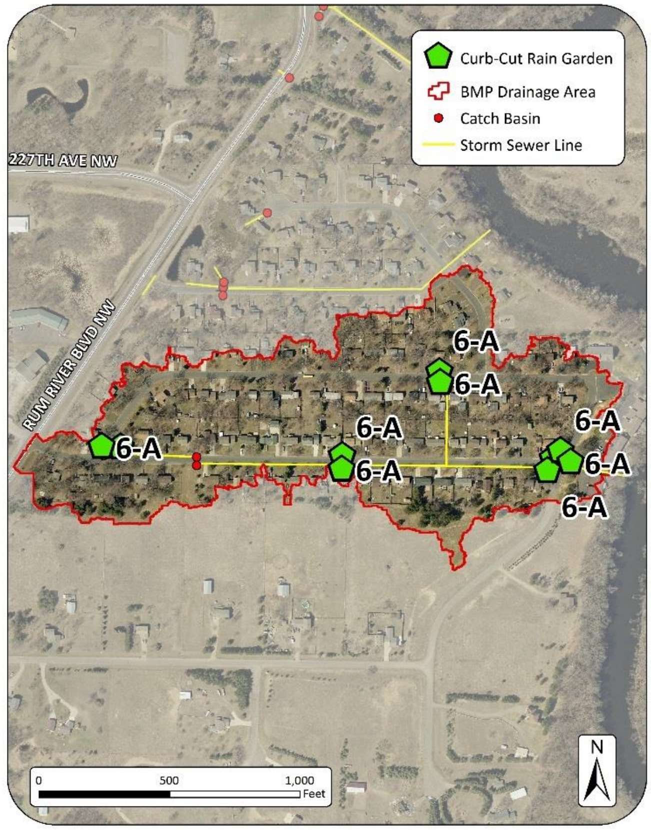
RETROFIT RECOMMENDATIONS



Project ID: 6-A

Curb-Cut Rain Gardens

Drainage Area – 1.5-15.0 acres
Location – Various locations throughout catchment
Property Ownership – Private
Site Specific Information – Single-family lots within the catchment provide various locations for curb-cut rain gardens to treat stormwater pollutants originating from private properties. Considering typical landowner participation rates, scenarios with one, five, and ten rain gardens were analyzed to treat the catchment.



Curb-Cut Rain Garden

	Cost/Removal Analysis	New Treatment	% Reduction	New Treatment	% Reduction	New Treatment	% Reduction
Treatment	Number of BMPs	1		5		10	
Treatment	Total Size of BMPs	250	sq-ft	1,250	sq-ft	2,500	sq-ft
Treatment	TP (lb/yr)	0.9	3.5%	3.2	12.5%	7.4	28.8%
Treatment	TSS (lb/yr)	223	3.4%	871	13.3%	1,906	29.1%
Treatment	Volume (acre-feet/yr)	0.9	5.1%	2.1	12.0%	4.5	25.6%
Cost	Administration & Promotion Costs*	$8,468		$11,972		$16,352	
Cost	Design & Construction Costs**	$7,376		$36,880		$73,760	
Cost	**Total Estimated Project Cost (2016)**	**$15,844**		**$48,852**		**$90,112**	
Cost	Annual O&M***	$225		$1,125		$2,250	
Efficiency	30-yr Average Cost/lb-TP	**$837**		**$860**		**$710**	
Efficiency	30-yr Average Cost/1,000lb-TSS	**$3,377**		**$3,161**		**$2,756**	
Efficiency	30-yr Average Cost/ac-ft Vol.	**$837**		**$1,298**		**$1,159**	

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

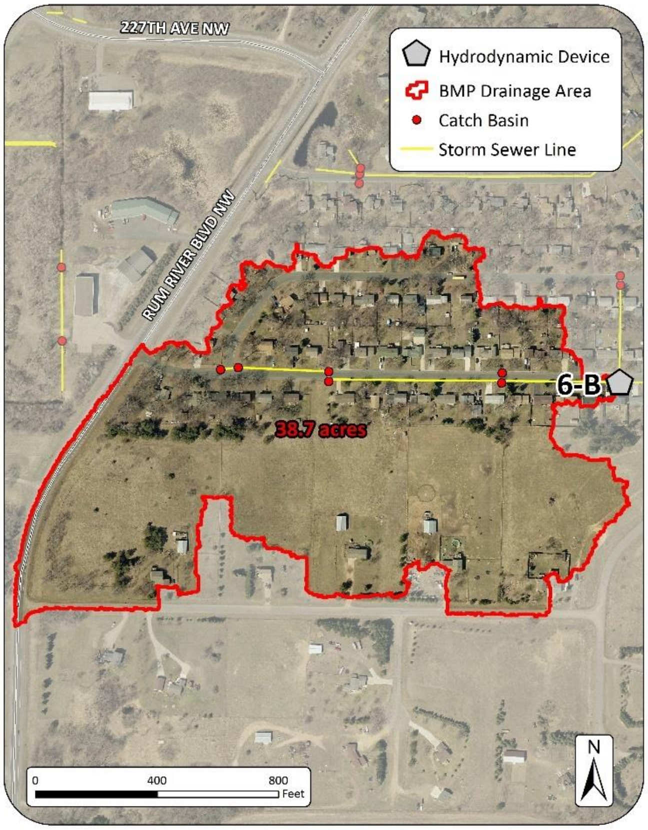
**Direct Cost: ($26/sq-ft for materials and labor) + (12 hours/BMP at $73/hour for design)

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

Project ID: 6-B

225th LN.

Hydrodynamic Device



Drainage Area – 38.7 acres
Location – 225th Lane NW
Property Ownership – Public
Site Specific Information – A hydrodynamic device is proposed for 225th Lane between Tulip Street and Zea Street. This device could be installed to treat 38.7 acres of runoff from residential 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	4.7%
	TSS (lb/yr)	433	6.6%
	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	**$9,904**	
	30-yr Average Cost/ac-ft Vol.	**N/A**	

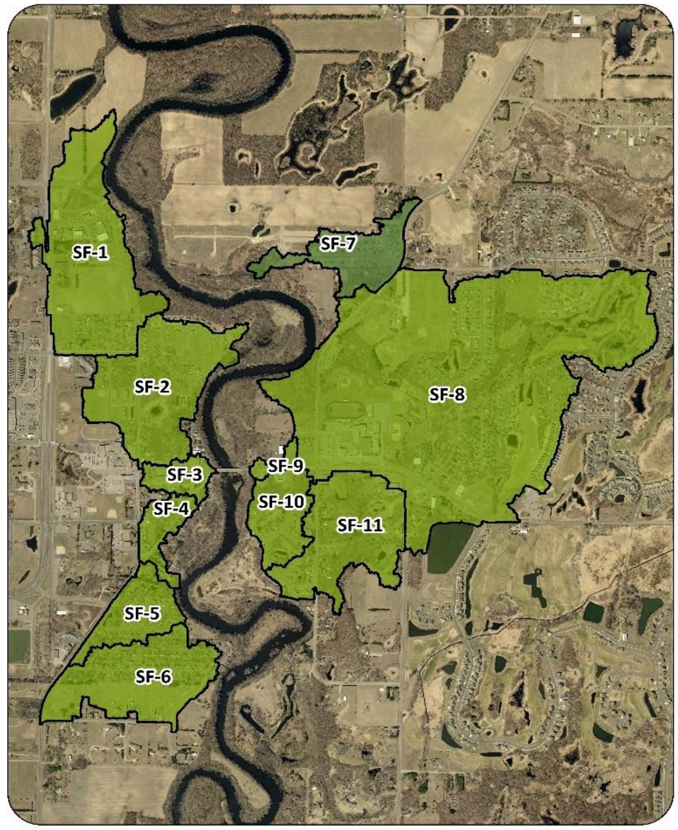
*Indirect Cost: (24 hours at $73/hour)

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

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

Catchment SF-7

Existing Catchment Summary	
Acres	31.0
Dominant Land Cover	Residential
Parcels	70
Volume (acre-feet/yr)	9.0
TP (lb/yr)	7.7
TSS (lb/yr)	1,714



CATCHMENT DESCRIPTION

Catchment SF-7 includes portions of the new Rum River Bluffs Development west of Rum River Boulevard. The catchment includes all of the area in the development and along Rum River Boulevard. draining to the 235th Avenue storm sewer. This pipe carries runoff from single family residential lots to an outfall south and west of the development. Soils in the catchment are predominantly coarse sand (Zimmerman series; hydrologic group A) with more poorly-drained wetland soils (Rifle and Kratka series; hydrologic groups A/D and B/D, respectively) within the Rum River corridor to the west. Additional, undeveloped portions of the development north of the Catchment SF-7 boundary were not included in this analysis as the final plat and stormwater infrastructure plan were yet completed at the time of this analysis.

EXISTING STORMWATER TREATMENT

Two structural stormwater BMPs provide treatment to stormwater prior to discharge into the Rum River. The first of these, a stormwater retention pond on the northwestern corner of the Rum River Boulevard – 235th Avenue intersection, treats 10.9 acres of properties on Rum River Boulevard., 235th Avenue, 235th Lane, and Marigold Street. This pond discharges into the 235th Avenue storm sewer line and into another pond 600' to the west. This western pond, SWP52, also treats stormwater from 15.2 acres of residential properties in the development.

In addition to these ponds, street cleaning is provided by the City of St. Francis twice per year with mechanical sweepers.

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)	13.2	5.5	42%	**7.7**
	TSS (lb/yr)	3,942	2,228	57%	**1,714**
	Volume (acre-feet/yr)	9.0	0.1	1%	**9.0**

PROPOSED RETROFITS OVERVIEW

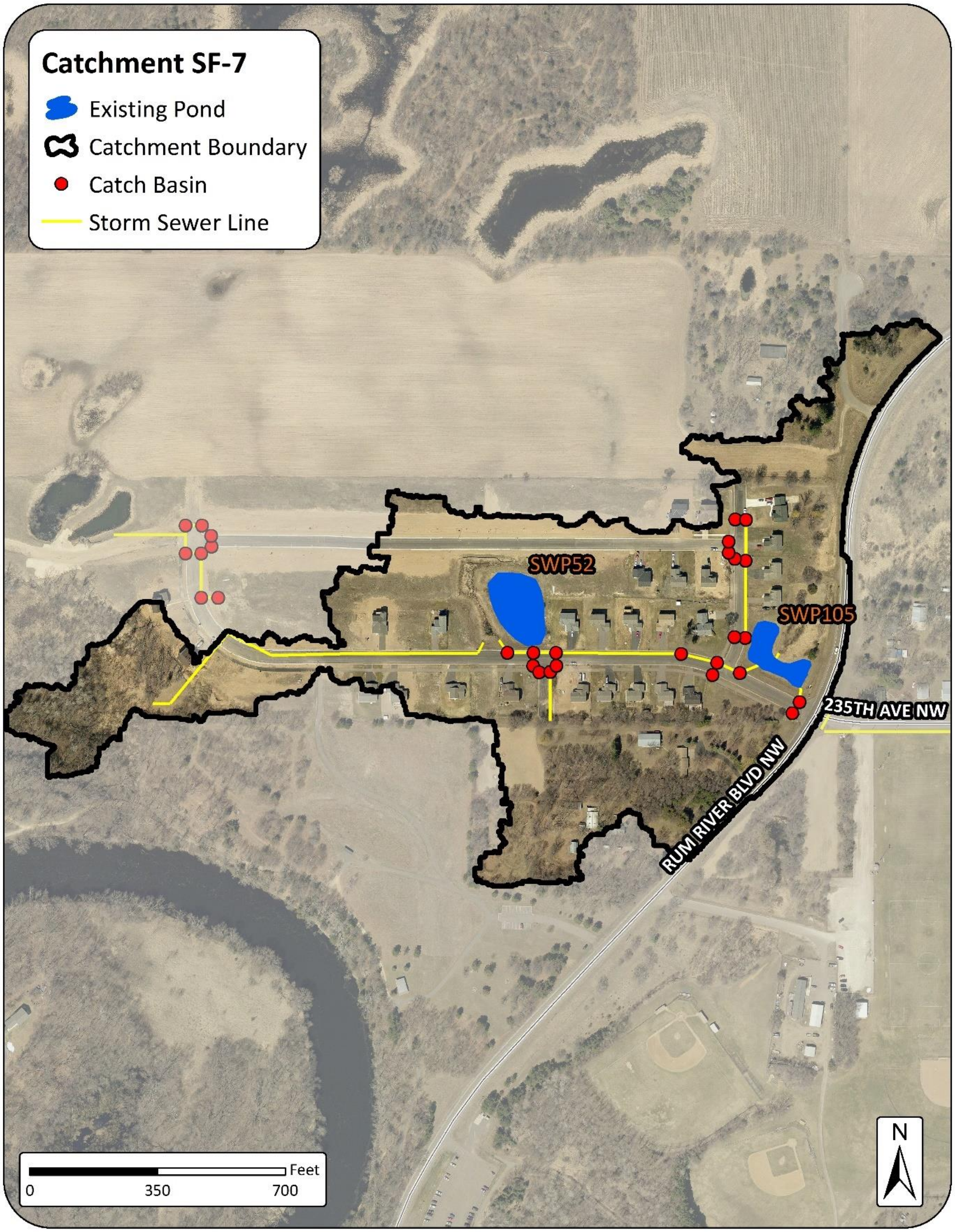
No retrofits were proposed in this catchment due to the treatment already provided by municipal street cleaning and the pair of retention ponds.

RETROFITS CONSIDERED BUT REJECTED

Bioretention practices, such as curb-cut rain gardens and boulevard bioswales, were considered but are not practical because of the high density of roadway catch basins. The higher density of catch basins in the catchment reduces the drainage area to each practice, thereby making bioretention basins cost-prohibitive.

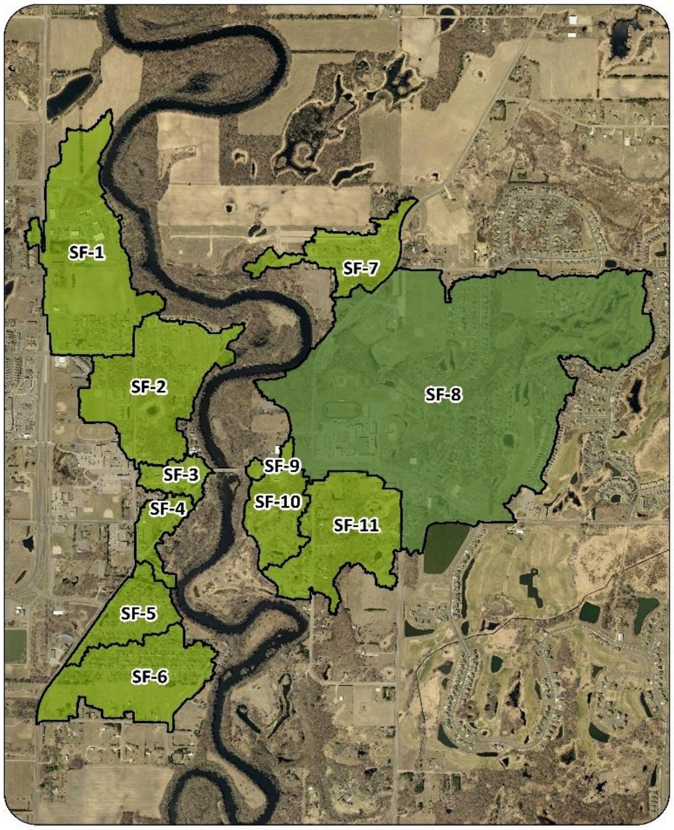
Therefore, the map below was included solely to provide additional detail of the catchment boundary, associated land uses, and streets.

RETROFIT RECOMMENDATIONS



Catchment SF-8

Existing Catchment Summary	
Acres	341.70
Dominant Land Cover	Residential
Parcels	350
Volume (acre-feet/yr)	126.6
TP (lb/yr)	104.3
TSS (lb/yr)	25,698



CATCHMENT DESCRIPTION
Catchment SF-8 is the largest catchment. The catchment is defined as all of the geographic area draining to a ditch east of the high school. This ditch crosses Rum River Boulevard through a culvert directly west of the high school baseball field and flows through Rum River North County Park, eventually draining into the Rum River 400' northwest of the Rum River Blvd. crossing.

The 368.7-acre catchment is primarily residential, but also includes a wide variety of commercial, institutional, park, and undeveloped parcels. Soils are predominantly silty sands, and range in size from fine loams (Lino series; hydrologic group B) to fine sands (Zimmerman series; hydrologic group A). The extensive wetland network upstream and adjacent to the ditch overlays more poorly-drained soils (Isanti and Rifle series; hydrologic group A/D).

EXISTING STORMWATER TREATMENT
The catchment is composed of 24.8 acres of open water, which includes natural wetlands and constructed features such as stormwater retention ponds and detention/infiltration basins. Both the natural and constructed features provide stormwater treatment, and each were modeled within WinSLAMM to determine their impact on downstream water quality. A total of 30 distinct features were located and deemed large enough to include in this analysis. Basins that were closely hydrologically connected were grouped together for modeling purposes. Figure 1 shows all 30 BMPs, and the hydrologic connections and flow pathways between these connections. Those listed within the same polygon were lumped together and modeled as a single retention device. In total, 19 different retention devices were modeled in WinSLAMM in Catchment SF-8.

In addition to the retention devices, street cleaning is provided by the City of St. Francis twice per year with mechanical sweepers.

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

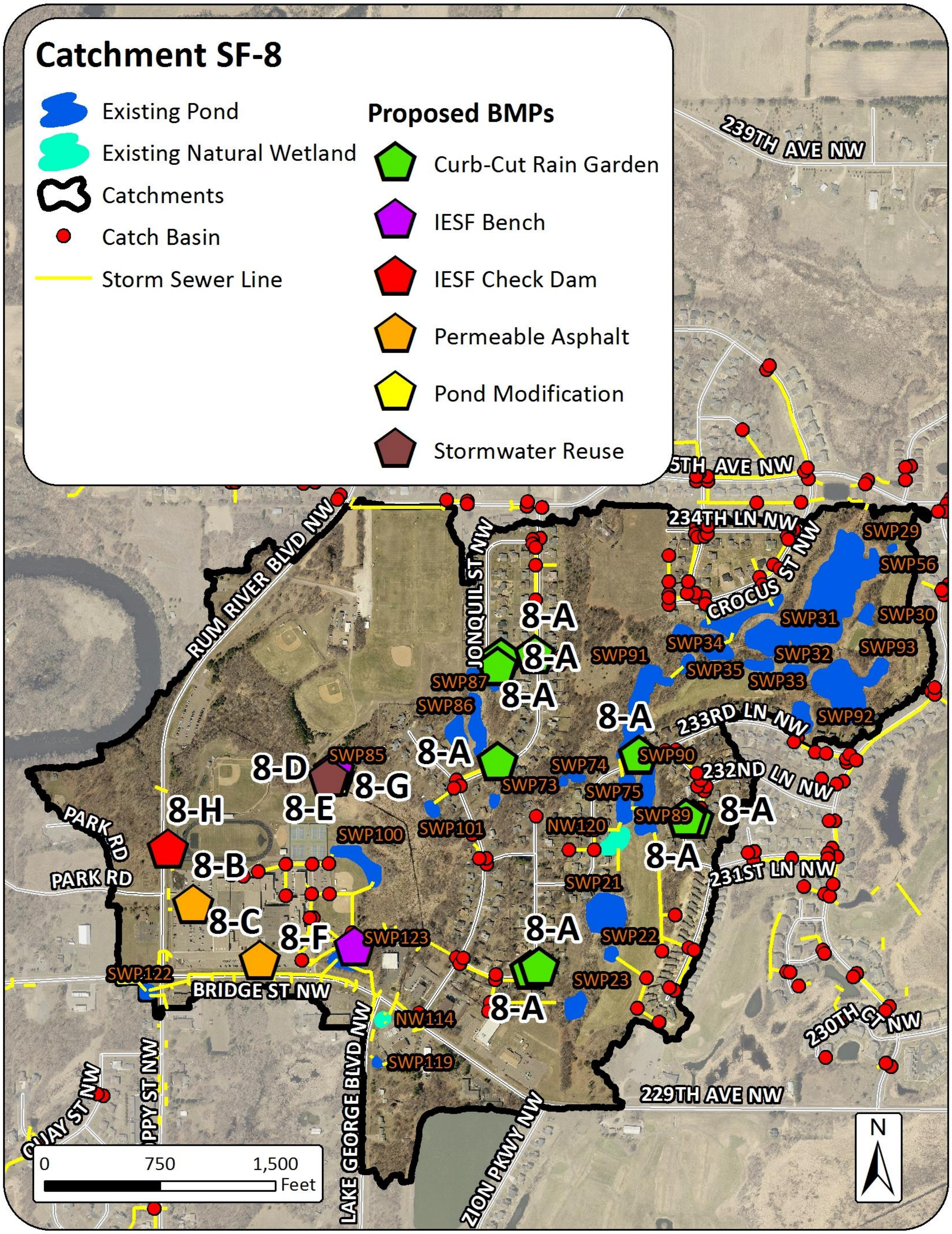
	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	31			
	BMP Types	2 Wetlands, 28 Ponds, Street Cleaning			
	TP (lb/yr)	166.2	61.9	37%	**104.3**
	TSS (lb/yr)	51,389	25,691	50%	**25,698**
	Volume (acre-feet/yr)	128.0	1.4	1%	**126.6**

PROPOSED RETROFITS OVERVIEW

A variety of stormwater practices were proposed throughout the catchment, the largest of which are proposed at SWP85, which is located on St. Francis High School property. At this stormwater pond, three different practices were proposed. The first is a pond modification to increase the size of the pond based on available space, in order for the pond to store more water and to more effectively treat TP and TSS. The second practice is an IESF bench to assist the pond in treating dissolved phosphorus. The third practice would reuse stormwater by pumping it from the pond to use as irrigation in nearby recreational fields.

On the St Francis High School property four additional practices were proposed. One iron-enhanced sand filter check dam within the Rum River Boulevard eastern ditch could better reduce high flows through the roadway ditch by increasing retention time and the iron-enhanced sand filter would help to reduce TP. Two permeable pavement practices were also proposed on the high school property to reduce runoff from the site and increase infiltration. Additionally, at stormwater pond, SWP123, which is located on the southeast side of the St. Francis High School property, an iron enhanced sand filter bench was proposed to treat dissolved phosphorus.

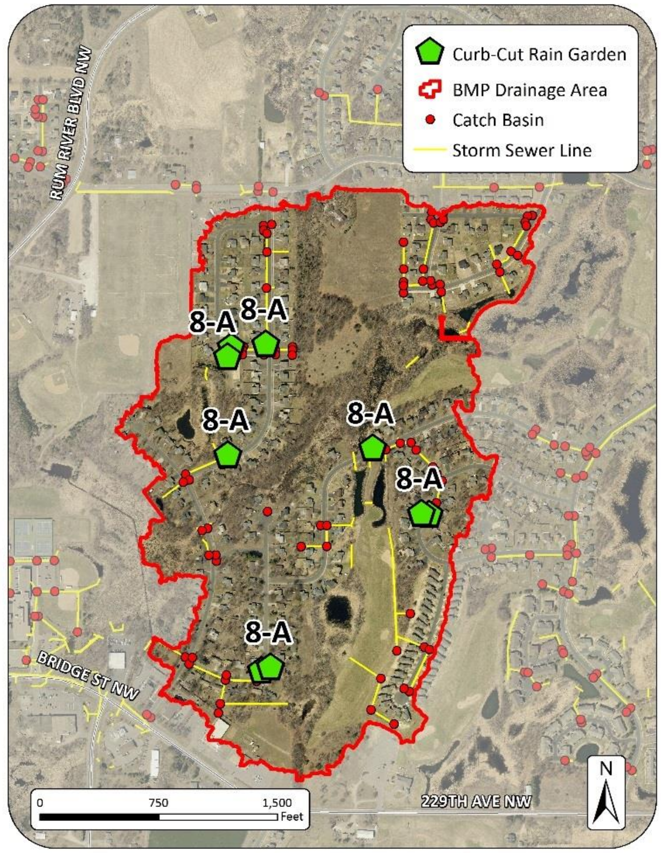
Lastly, up to nine curb-cut rain gardens were proposed throughout the catchment. These were proposed adjacent to catch basins as poorly-drained soils and a high water table across the catchment could require the installation of an underdrain within each garden.


Catchment SF-8
Existing Pond
Existing Natural Wetland
Catchments
Catch Basin
Storm Sewer Line
Proposed BMPs
Curb-Cut Rain Garden
IESF Bench
IESF Check Dam
Permeable Asphalt
Pond Modification
Stormwater Reuse
239TH AVE NW
234TH LN NW
CROCUS ST NW
RUM RIVER BLVD NW
JONQUIL ST NW
233RD LN NW
232ND LN NW
231ST LN NW
230TH CT NW
229TH AVE NW
PARK RD
BRIDGE ST NW
LAKE GEORGE BLVD NW
ZION PKWY NW
QUAY ST NW
8-A
8-B
8-C
8-D
8-E
8-F
8-G
8-H
SWP29
SWP56
SWP30
SWP31
SWP32
SWP33
SWP34
SWP35
SWP91
SWP93
SWP92
SWP87
SWP86
SWP85
SWP90
SWP74
SWP73
SWP75
SWP89
SWP100
SWP101
NW120
SWP21
SWP22
SWP23
SWP123
SWP122
NW114
SWP119
0
750
1,500
Feet
N

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 – Single-family lots within 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 three, five, and nine rain gardens were analyzed to treat the catchment.



	Curb-Cut Rain Garden						
	Cost/Removal Analysis	**New Treatment**	**% Reduction**	**New Treatment**	**% Reduction**	**New Treatment**	**% Reduction**
Treatment	**Number of BMPs**	3		5		9	
	Total Size of BMPs	750	sq-ft	1,250	sq-ft	2,250	sq-ft
	TP (lb/yr)	0.5	0.5%	1.7	1.6%	3.7	3.5%
	TSS (lb/yr)	82	0.3%	313	1.2%	659	2.6%
	Volume (acre-feet/yr)	1.1	0.9%	2.1	1.7%	3.8	3.0%
Cost	**Administration & Promotion Costs***	$10,220		$11,972		$15,476	
	Design & Construction Costs**	$22,128		$36,880		$66,384	
	Total Estimated Project Cost (2016)	**$32,348**		**$48,852**		**$81,860**	
	Annual O&M***	$675		$1,125		$2,025	
Efficiency	**30-yr Average Cost/lb-TP**	**$3,507**		**$1,620**		**$1,285**	
	30-yr Average Cost/1,000lb-TSS	**$21,381**		**$8,797**		**$7,213**	
	30-yr Average Cost/ac-ft Vol.	**$1,558**		**$1,333**		**$1,240**	

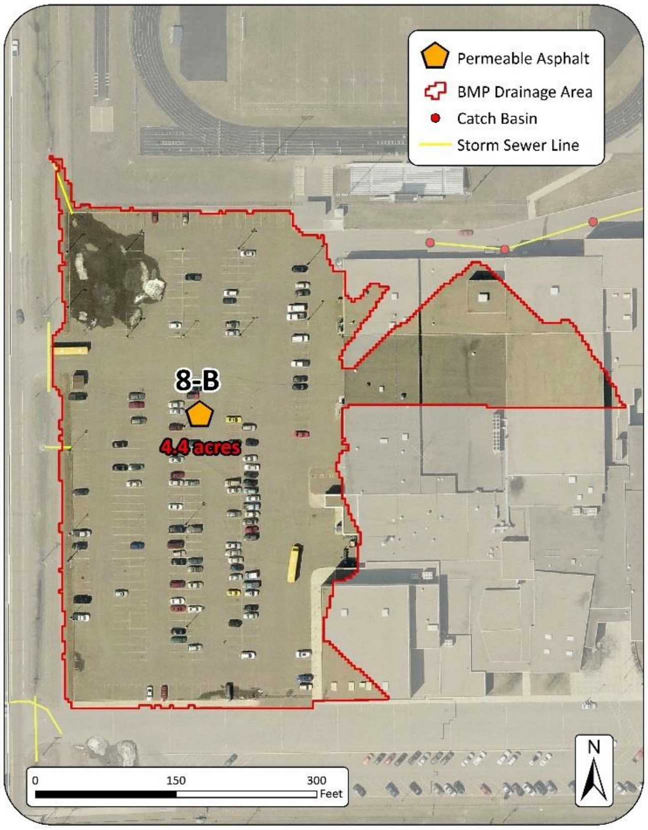
*Indirect Cost: (104 hours at $73/hour base cost) + (12 hours/BMP at $73/hour)

**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: 8-B

St. Francis High School
Permeable Pavement



Drainage Area – 4.4 acres
Location – Large western parking lot at St. Francis High School on Rum River Boulevard and Park Road
Property Ownership – Public
Site Specific Information – Permeable pavement is proposed for the large western parking lot of St. Francis High School. This practice allows the treatment of a large surface area with minimal impact on the usable space. In order to treat the 4.4-acre drainage area, 64,000 sq.-ft. of permeable pavement is proposed.

	Permeable Pavement		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Number of BMPs**	1	
	Total Size of BMP	64,000	sq-ft
	TP (lb/yr)	5.3	5.1%
	TSS (lb/yr)	1,586	6.2%
	Volume (acre-feet/yr)	4.1	3.2%
Cost	**Administration & Promotion Costs***	$2,920	
	Design & Construction Costs**	$640,876	
	Total Estimated Project Cost (2016)	**$643,796**	
	Annual O&M***	$48,000	
Efficiency	**30-yr Average Cost/lb-TP**	**$13,106**	
	30-yr Average Cost/1,000lb-TSS	**$43,796**	
	30-yr Average Cost/ac-ft Vol.	**$17,096**	

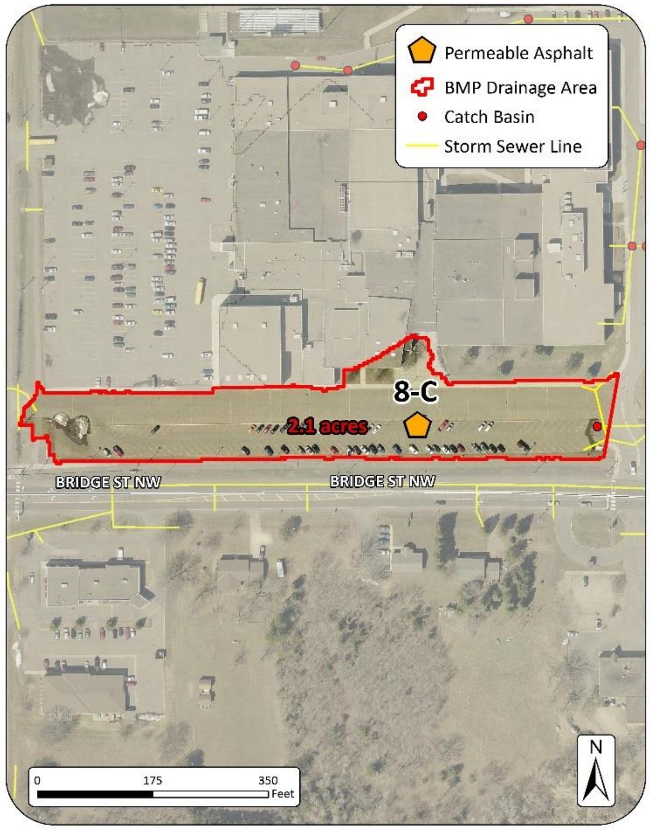
*Indirect Cost: 40 hours at $73/hour

**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: 8-C

St. Francis High School Permeable Pavement



Drainage Area – 2.1 acres
Location – Southern parking lot at St. Francis High School on Rum River Boulevard and Bridge Street
Property Ownership – Public
Site Specific Information – Permeable pavement is proposed for the southern parking lot of St. Francis High School. This practice allows the treatment of a large surface area with minimal impact on the usable space. In order to treat the 2.1-acre drainage area, 31,000 sq.-ft. of permeable pavement is proposed.

Permeable Pavement			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Number of BMPs**	1	
	Total Size of BMP	31,000	sq-ft
	TP (lb/yr)	1.4	1.3%
	TSS (lb/yr)	420	1.6%
	Volume (acre-feet/yr)	1.9	1.5%
Cost	**Administration & Promotion Costs***	$2,920	
	Design & Construction Costs**	$310,876	
	Total Estimated Project Cost (2016)	**$313,796**	
	Annual O&M***	$23,250	
Efficiency	**30-yr Average Cost/lb-TP**	**$24,078**	
	30-yr Average Cost/1,000lb-TSS	**$80,262**	
	30-yr Average Cost/ac-ft Vol.	**$18,124**	

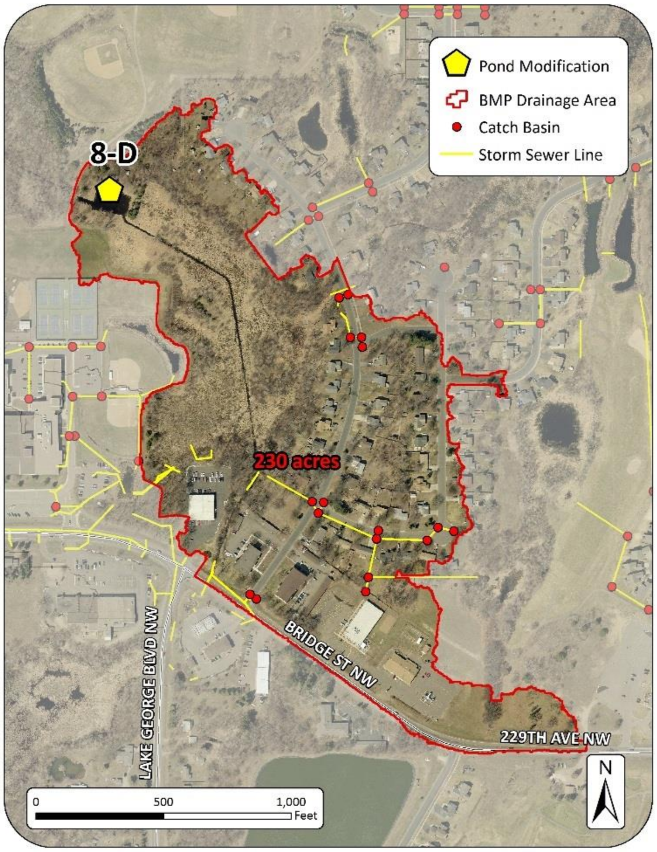
*Indirect Cost: 40 hours at $73/hour

**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: 8-D

St. Francis High School
Pond Modification



Drainage Area – 230.0 acres
Location – SWP85
Property Ownership – Public (School District)
Site Specific Information – A modification is proposed for SWP85, which is located on St. Francis High School property, between Rum River Boulevard and Kerry Street. This pond currently treats stormwater generated from 230 acres and is undersized to provide proper treatment for the contributing drainage area. Excavating 1,600 cubic yards of material could 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 of the soil.

	BMP Modification						
	Cost/Removal Analysis	**New Treatment**	**% Reduction**	**New Treatment**	**% Reduction**	**New Treatment**	**% Reduction**
Treatment	**Pond Management Level**	1		2		3	
	Amount of Soil Excavated	1,600	cu-yards	1,600	cu-yards	1,600	cu-yards
	TP (lb/yr)	3.1	3.0%	3.1	3.0%	3.1	3.0%
	TSS (lb/yr)	1,760	6.8%	1,760	6.8%	1,760	6.8%
	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**	$117,000		$141,000		$165,000	
	Total Estimated Project Cost (2016)	**$122,840**		**$146,840**		**$170,840**	
	Annual O&M***	$1,300		$1,300		$1,300	
Efficiency	**30-yr Average Cost/lb-TP**	**$1,740**		**$1,998**		**$2,256**	
	30-yr Average Cost/1,000lb-TSS	**$3,065**		**$3,520**		**$3,974**	
	30-yr Average Cost/ac-ft Vol.	**N/A**		**N/A**		**N/A**	

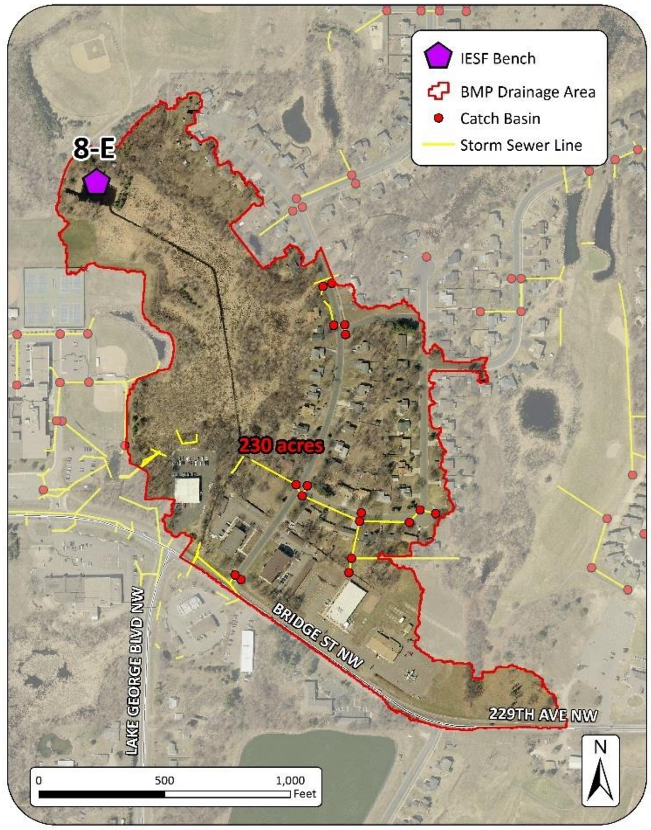
*Indirect Cost: 80 hours at $73/hour

**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-E

St. Francis High School North
IESF Bench



Drainage Area – 230.0 acres
Location – SWP85
Property Ownership – Public (School District)
Site Specific Information – An IESF bench is proposed as an improvement to stormwater pond, SWP85. The pond currently provides treatment through retention and settling. However, the addition of an IESF could increase removal of dissolved phosphorus. The project is proposed on the northern shore of the pond. The IESF was sized to 3,000 sq.-ft. based on available space between the existing pond and the path.

	IESF Bench		
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Number of BMPs**	1	
	Total Size of BMPs	3,000	sq-ft
	TP (lb/yr)	8.5	8.1%
	TSS (lb/yr)	0	0.0%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	**Administration & Promotion Costs***	$5,475	
	Design & Construction Costs**	$185,600	
	Total Estimated Project Cost (2016)	**$191,075**	
	Annual O&M***	$689	
Efficiency	**30-yr Average Cost/lb-TP**	**$830**	
	30-yr Average Cost/1,000lb-TSS	**N/A**	
	30-yr Average Cost/ac-ft Vol.	**N/A**	

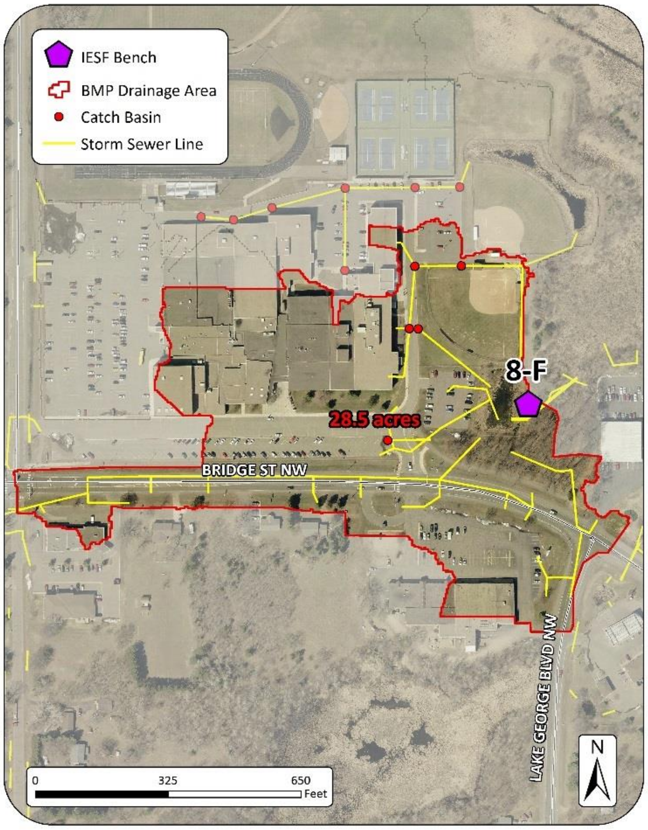
*Indirect Cost: 75 hours at $73/hour

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

***$10,000/acre for IESF

Project ID: 8-F

St. Francis High School East
IESF Bench



Drainage Area – 28.5 acres
Location – SWP123
Property Ownership – Public (School District)
Site Specific Information – An IESF bench is proposed as an improvement to the existing pond, SWP123, which is located north of Bridge Street and west of Kerry Street. The pond currently provides treatment through retention and settling. However, the addition of an IESF could increase removal of dissolved phosphorus. The project is proposed on the eastern shore of the pond. The IESF was sized to 2,500 sq.-ft. based on available space between the existing pond and the parking lot.

IESF Bench			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Number of BMPs**	1	
	Total Size of BMPs	2,500	sq-ft
	TP (lb/yr)	1.8	1.7%
	TSS (lb/yr)	0	0.0%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	**Administration & Promotion Costs***	$5,475	
	Design & Construction Costs**	$174,300	
	Total Estimated Project Cost (2016)	**$179,775**	
	Annual O&M***	$574	
Efficiency	**30-yr Average Cost/lb-TP**	**$3,648**	
	30-yr Average Cost/1,000lb-TSS	**N/A**	
	30-yr Average Cost/ac-ft Vol.	**N/A**	

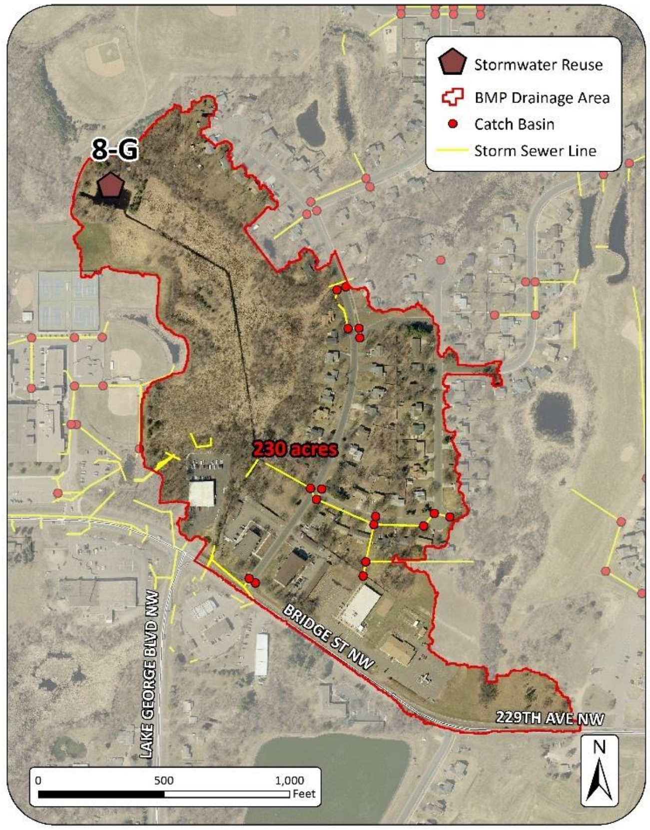
*Indirect Cost: 75 hours at $73/hour

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

***$10,000/acre for IESF

Project ID: 8-G

St. Francis High School
Stormwater Reuse



Drainage Area – 230.0 acres
Location – SWP85
Property Ownership – Public (School District)
Site Specific Information – Stormwater reuse is proposed for SWP85, which is located on St. Francis High School property, between Rum River Boulevard and Kerry Street. St. Francis High School could reuse the runoff captured in this pond to irrigate approximately 20-acres of the high school fields. This practice would 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)	12.3	11.8%
	TSS (lb/yr)	2,434	9.5%
	Volume (acre-feet/yr)	20.7	16.3%
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**	**$1,894**	
	30-yr Average Cost/1,000lb-TSS	**$9,569**	
	30-yr Average Cost/ac-ft Vol.	**$1,125**	

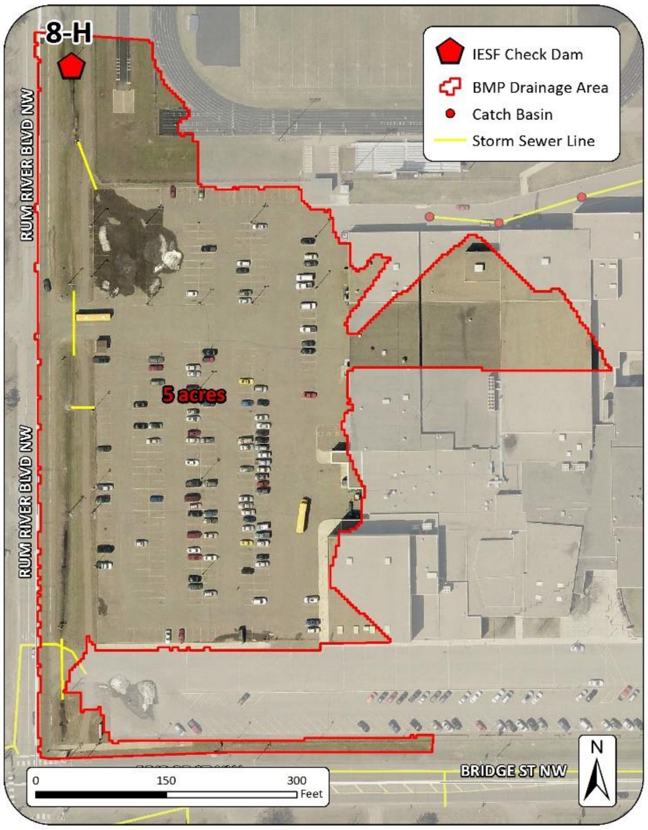
*120 hours at $73/hour

**See Appendix B for detailed cost information

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

Project ID: 8-H

Rum River Blvd. & Park Rd.
IESF Check Dam



Drainage Area – 5.0 acres
Location – Rum River Blvd. eastern ditch
Property Ownership – Public
Site Specific Information – One IESF check dam is proposed as an improvement to the Rum River Boulevard eastern ditch, adjacent to St. Francis High School. An IESF check dam could increase dissolved phosphorous removal and could increase the retention time of stormwater within the ditch. Increased retention time would promote some additional settling of TSS and TP.

IESF Check Dam			
	Cost/Removal Analysis	**New Treatment**	**% Reduction**
Treatment	**Number of BMPs**	1	
	Total Size of BMP	150	cu-ft
	TP (lb/yr)	1.8	1.7%
	TSS (lb/yr)	459	1.8%
	Volume (acre-feet/yr)	0.0	0.0%
Cost	**Administration & Promotion Costs***	$2,920	
	Design & Construction Costs**	$12,528	
	Total Estimated Project Cost (2015)	**$15,448**	
	Annual O&M***	$365	
Efficiency	**30-yr Average Cost/lb-TP**	**$500**	
	30-yr Average Cost/1,000lb-TSS	**$1,917**	
	30-yr Average Cost/ac-ft Vol.	**N/A**	

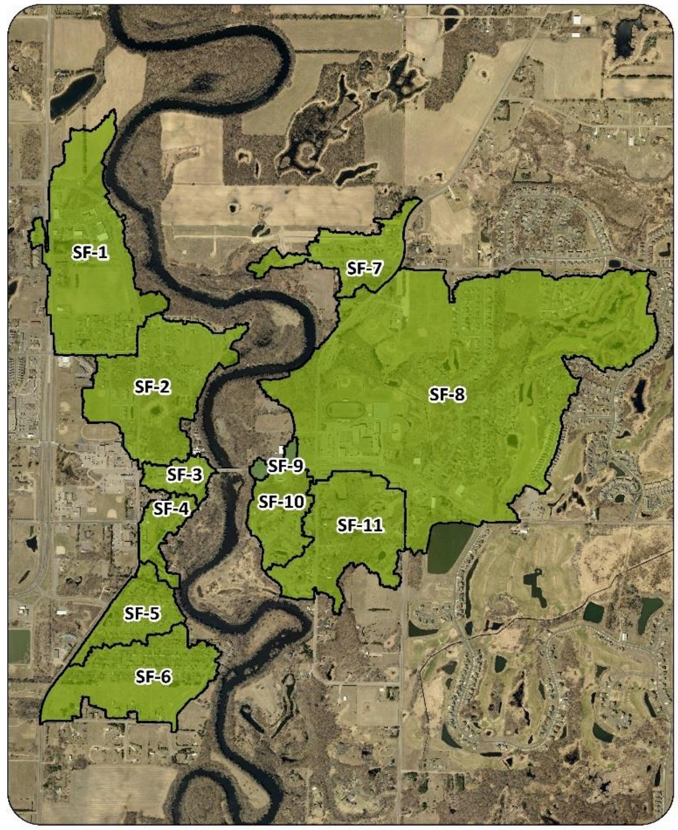
*Indirect Cost: 40 hours at $73/hour

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

***(5 hours for each dam at $73/hour for cleaning sediment/debris and maintenance)

Catchment SF-9

Existing Catchment Summary	
Acres	4.3
Dominant Land Cover	Residential
Parcels	9
Volume (acre-feet/yr)	1.6
TP (lb/yr)	1.5
TSS (lb/yr)	585



CATCHMENT DESCRIPTION

Catchment SF-9 is the smallest catchment. It is just 4.3 acres in size. This small area was separated as a distinct catchment because all of the area within the catchment boundary conveys stormwater to a single outfall south of Bridge Street. The catchment includes residential, commercial, industrial, and undeveloped land uses. Soils are exclusively fine Zimmerman series sands.

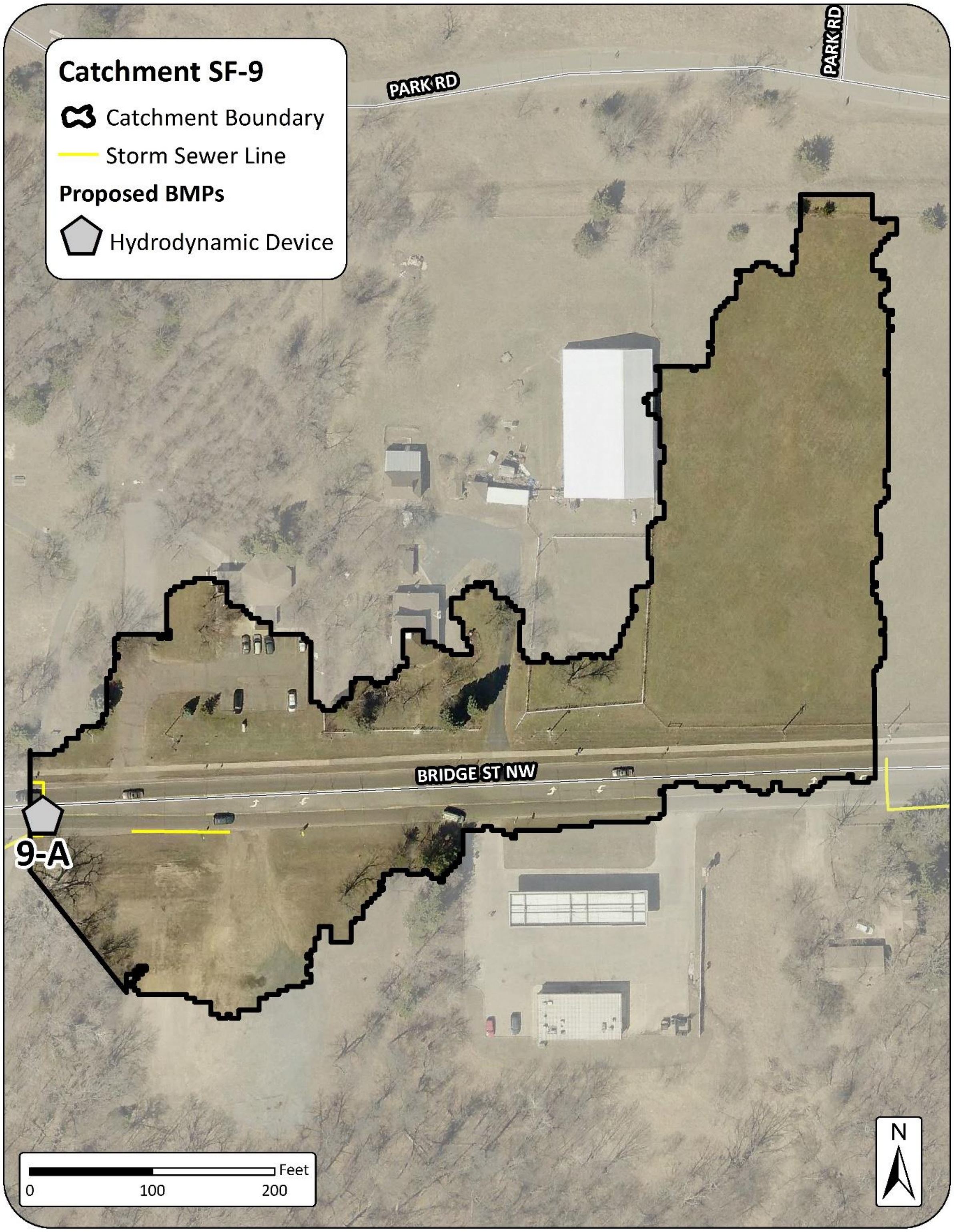
EXISTING STORMWATER TREATMENT

Street cleaning is provided by the City of St. Francis twice per year with mechanical sweepers. No structural stormwater devices exist within this catchment. 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)	1.6	0.1	6%	**1.5**
	TSS (lb/yr)	638	53	8%	**585**
	Volume (acre-feet/yr)	1.6	0.0	0%	**1.6**

PROPOSED RETROFITS OVERVIEW

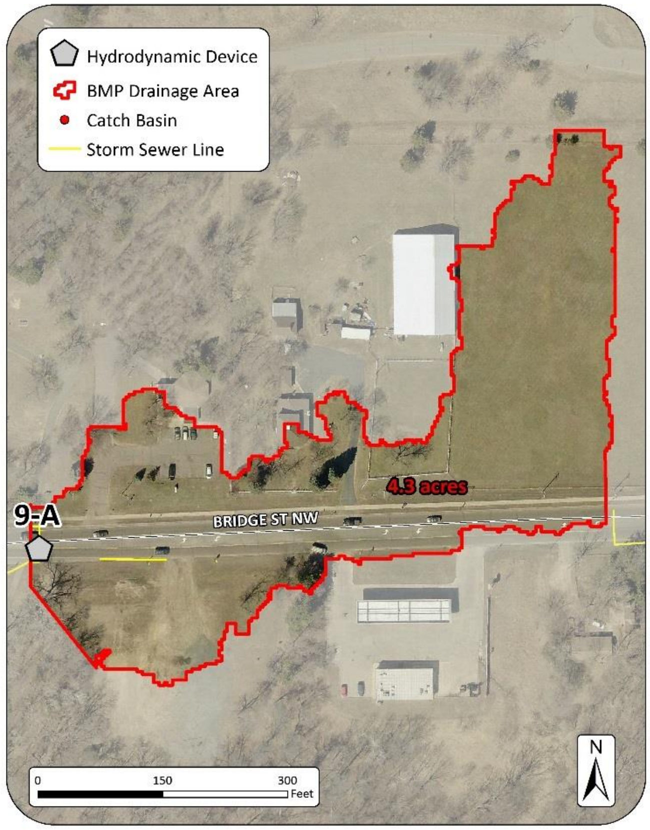
A single hydrodynamic device is proposed upstream of the Rum River outfall to treat the stormwater runoff generated within the catchment.


Catchment SF-9
Catchment Boundary
Storm Sewer Line
Proposed BMPs
Hydrodynamic Device
PARK RD
PARK RD
BRIDGE ST NW
9-A
Feet
0
100
200
N

Project ID: 9-A

Bridge Street
Hydrodynamic Device

Drainage Area – 4.3 acres
Location – Bridge Street NW
Property Ownership – Public
Site Specific Information- A hydrodynamic device is proposed for Bridge Street. The device would accept runoff from the entire catchment before discharging 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)	0.2	13.3%
	TSS (lb/yr)	103	17.6%
	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	**$7,942**	
	30-yr Average Cost/1,000lb-TSS	**$15,421**	
	30-yr Average Cost/ac-ft Vol.	**N/A**	

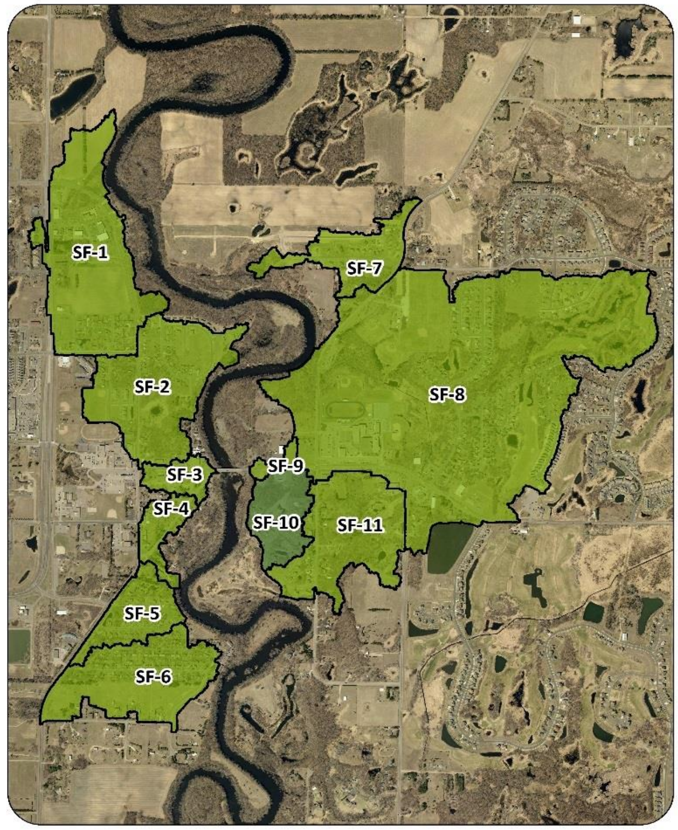
*Indirect Cost: (24 hours at $73/hour)

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

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

Catchment SF-10

Existing Catchment Summary	
Acres	25.6
Dominant Land Cover	Residential
Parcels	57
Volume (acre-feet/yr)	8.0
TP (lb/yr)	4.5
TSS (lb/yr)	692



CATCHMENT DESCRIPTION

Catchment SF-10 is bounded by Bridge Street to the north, Poppy Street to the east, Silverod Street to the south, and the Rum River corridor to the west. Stormwater runoff generated on the single family and multi-family lots of the catchment flow to roadway catch basins and a series of four waterbodies: SWP6, SWP7, SWP12, and SWP61. Upland soils in the catchment are exclusively fine Zimmerman Sands.

EXISTING STORMWATER TREATMENT

Stormwater retention ponds SWP12 and SWP61 were determined to be hydrologically connected during storm events and were therefore modeled as a single waterbody in WinSLAMM. These BMPs provide stormwater treatment to runoff from primarily single family residential lots along Quay Street and 229th Lane. These ponds, along with runoff from Silverod Street, Quay Street, and 228th Avenue as well as overflow from SWP7, discharge into retention pond SWP6. Pond SWP6 provides treatment to the full 25.6 acres of Catchment SF-10.

In addition to these ponds, the City of St. Francis conducts street cleaning twice per year using mechanical sweepers.

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

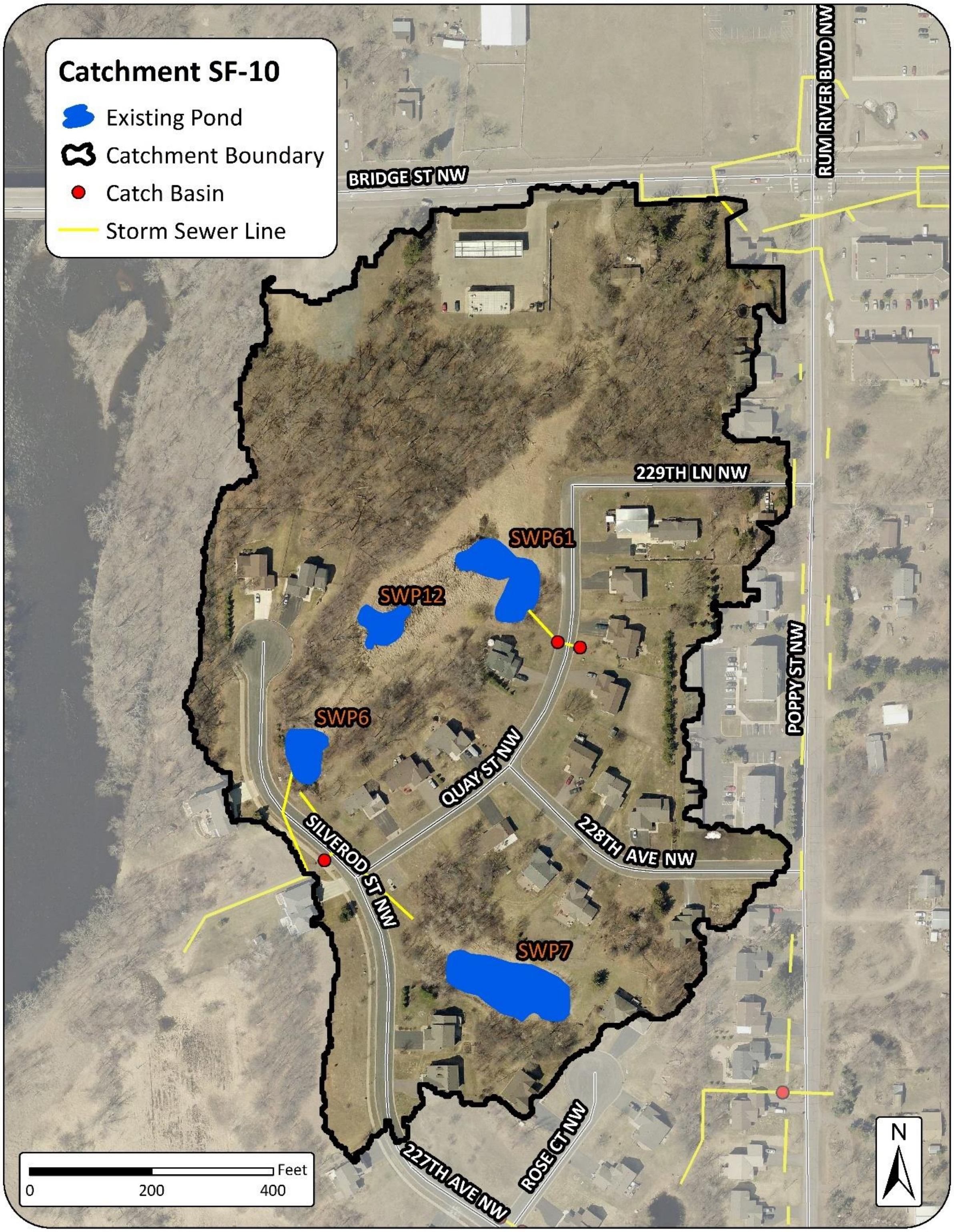
	Existing Conditions	Base Loading	Treatment	Net Treatment %	Existing Loading
Treatment	Number of BMPs	4			
	BMP Types	3 Ponds, Street Cleaning			
	TP (lb/yr)	10.5	6.0	57%	**4.5**
	TSS (lb/yr)	3,437	2,745	80%	**692**
	Volume (acre-feet/yr)	8.0	0.0	1%	**8.0**

RETROFITS CONSIDERED BUT REJECTED

A single hydrodynamic device was proposed upstream of the Rum River outfall to supply treatment. However, because of the four retention ponds already in the catchment this device showed to reduce minimal TP and TSS and therefore was not cost effective.

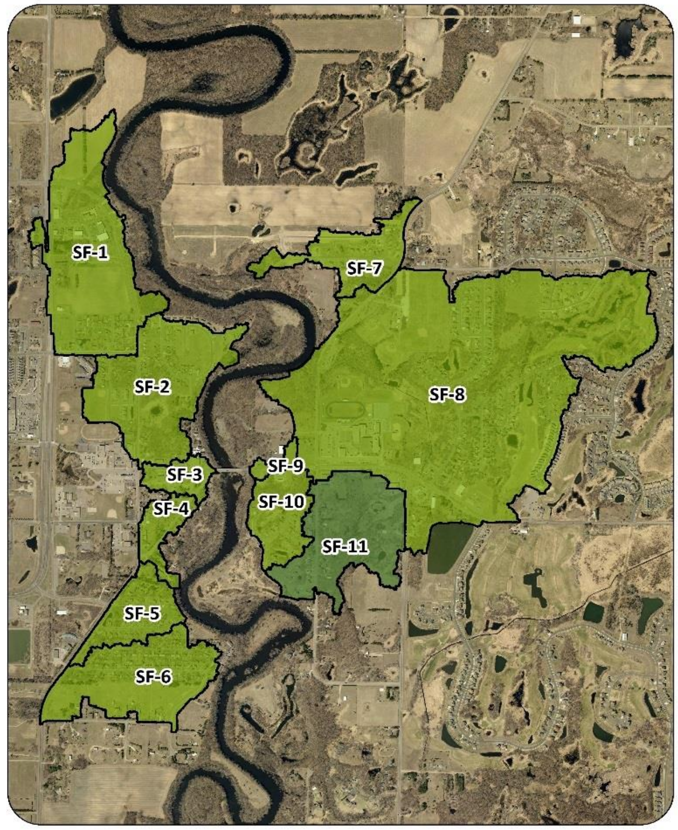
Therefore, the map below was included solely to provide additional detail of the catchment boundary, associated land uses, and streets.

RETROFIT RECOMMENDATIONS



Catchment SF-11

Existing Catchment Summary	
Acres	59.3
Dominant Land Cover	Open
Parcels	65
Volume (acre-feet/yr)	7.6
TP (lb/yr)	6.1
TSS (lb/yr)	1,409



CATCHMENT DESCRIPTION

This catchment includes two major land uses. The first is undeveloped land behind properties on Lake George Boulevard., Bridge Street, and Poppy Street. Within these parcels are five waterbodies, including four natural wetlands (NW109, NW110, NW111, and NW113) and a stormwater retention pond (SWP9). The second major land use is residential properties along Poppy Street and 227th Avenue. These parcels drain to a stormwater pond (SWP8) north of 227th Avenue, which subsequently outlets into the Rum River south of 227th Avenue. Soils in the catchment are poorly-drained Markey and Isanti series (hydrologic group A/D) within the wetland-pond complex and well-drained, Zimmerman fine sands on the upland properties surrounding the wetlands and ponds.

EXISTING STORMWATER TREATMENT

As noted in the Catchment Description, stormwater retention ponds SWP8 and SWP9 as well as NW109, NW110, NW111, and NW113 all provide treatment to stormwater generated within the catchment. The four natural wetlands were modeled as a single BMP within WinSLAMM as they were deemed hydrologically connected.

In addition to these ponds and wetlands, street cleaning is provided by the City of St. Francis twice per year with mechanical sweepers.

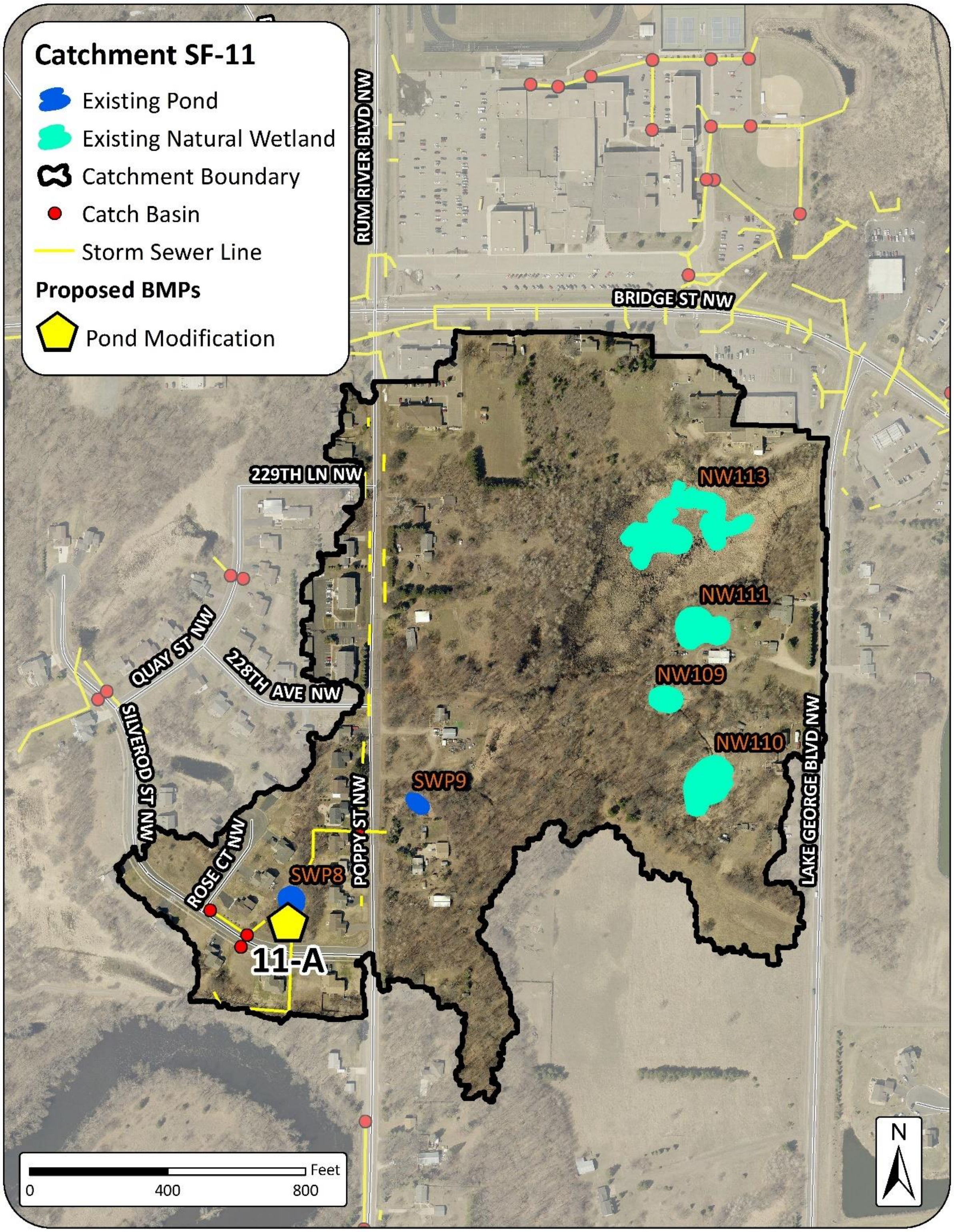
Present-day stormwater pollutant loading and treatment is summarized in the table below.

	Existing Conditions	Base Loading	Treatment	Net Treatment	Existing Loading
Treatment	Number of BMPs	7			
	BMP Types	4 Wetlands, 2 Ponds, Street Cleaning			
	TP (lb/yr)	22.2	16.1	73%	**6.1**
	TSS (lb/yr)	6,858	5,449	79%	**1,409**
	Volume (acre-feet/yr)	17.8	10.2	57%	**7.6**

PROPOSED RETROFITS OVERVIEW

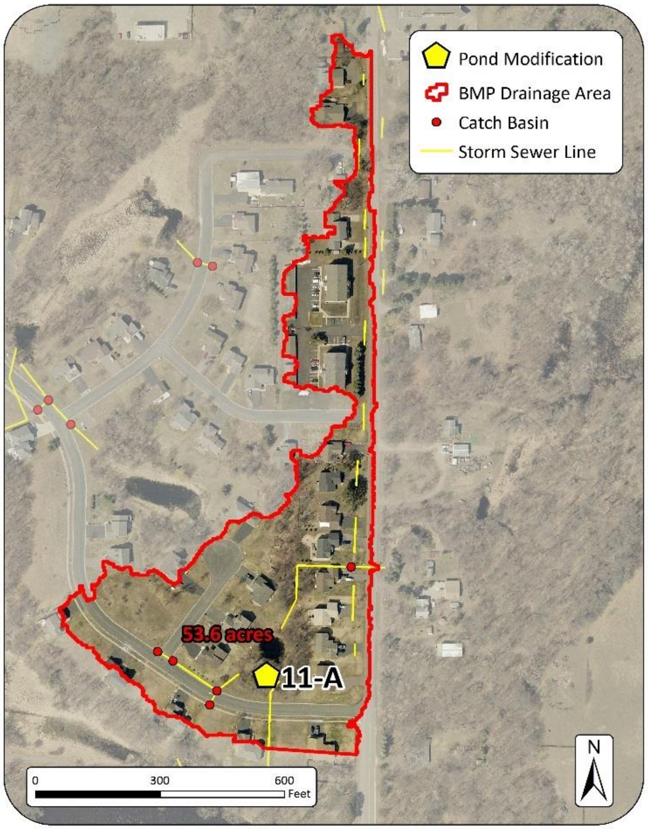
A pond modification was proposed for stormwater retention pond SWP8 to take better advantage of available area and storage. The existing pond outlet is set very low, providing little dead storage for sedimentation. The proposed practice would replace the pond outlet with another that would increase the outlet elevation by three feet. Because of the location of this BMP, at the most downstream point within the catchment, a retrofit to this pond could improve stormwater treatment catchment-wide.

RETROFIT RECOMMENDATIONS



Project ID: 11-A

227th Ave. & Poppy St.
Pond Modification



Drainage Area – 53.6 acres
Location – SWP8
Property Ownership – Private
Site Specific Information – A modification is proposed for SWP8, which is located on private property at the intersection of 227th Avenue NW and Poppy Street NW. This pond currently treats water from 53.6 acres but is undersized relative to the contributing drainage area. Excavating 700 cubic yards of material could 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 of the excavated soil.

	BMP Modification						
	Cost/Removal Analysis	New Treatment	% Reduction	New Treatment	% Reduction	New Treatment	% Reduction
Treatment	Pond Management Level	1		2		3	
	Amount of Soil Excavated	700	cu-yards	700	cu-yards	700	cu-yards
	TP (lb/yr)	0.9	14.8%	0.9	14.8%	0.9	14.8%
	TSS (lb/yr)	343	24.3%	343	24.3%	343	24.3%
	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**	$99,000		$109,500		$120,000	
	Total Estimated Project Cost (2016)	**$104,840**		**$115,340**		**$125,840**	
	Annual O&M***	$1,300		$1,300		$1,300	
Efficiency	30-yr Average Cost/lb-TP	**$5,327**		**$5,716**		**$6,105**	
	30-yr Average Cost/1,000lb-TSS	**$13,979**		**$14,999**		**$16,019**	
	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

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 offers 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 5.

Table 5: 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

Existing Conditions

Existing stormwater BMPs were included in the WinSLAMM model for which information was available from the state (MNDOT), county (Anoka County), and the City of St. Francis. The practices listed below were included in the existing conditions model.

Grass Swale

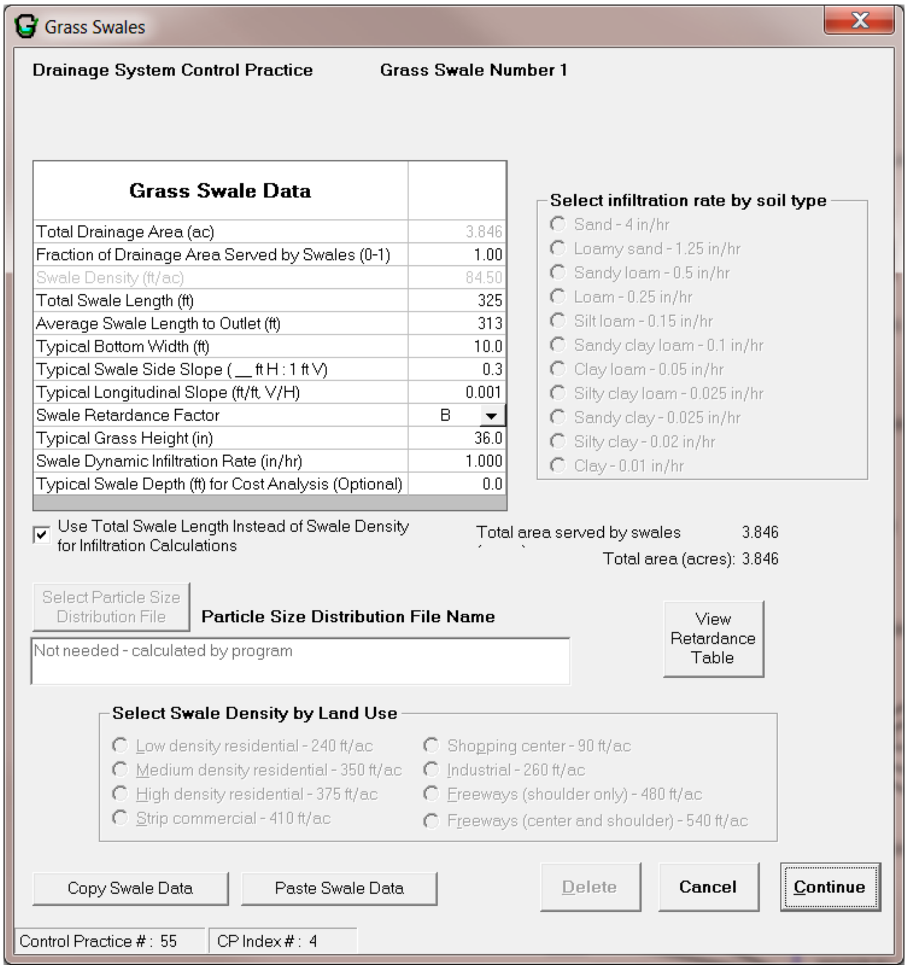


Figure 12: Grass Swale SWA109 in SF-1 (WinSLAMM).

Detention Basin

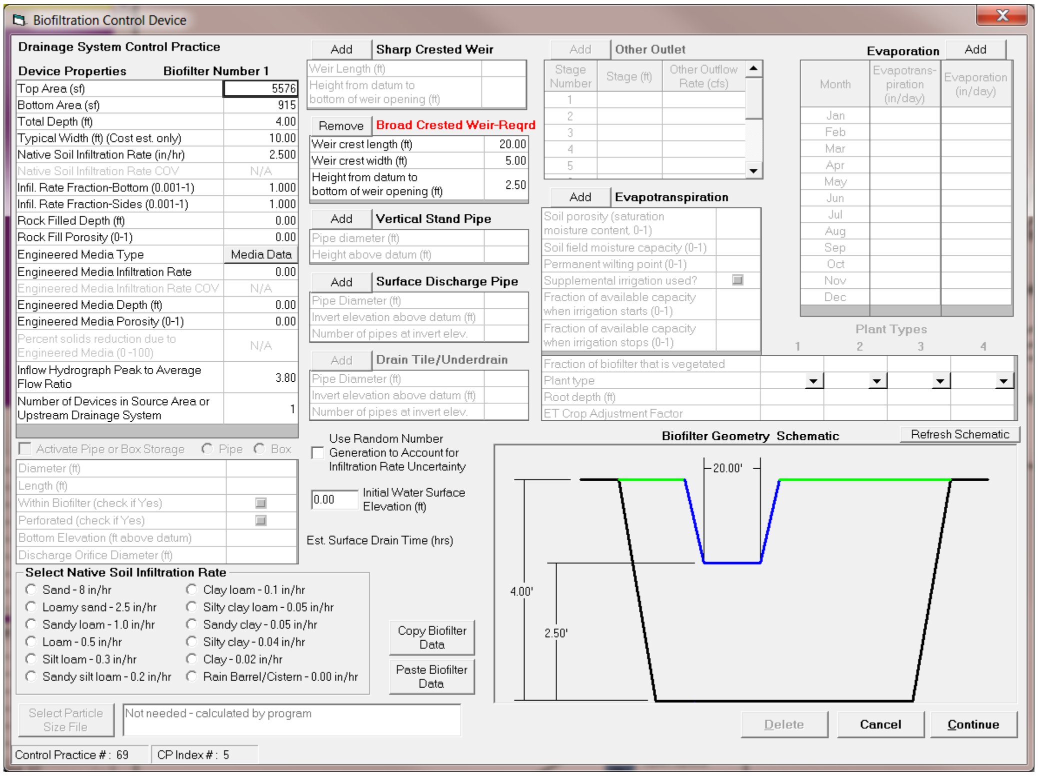


Figure 13: Detention Basin DB118 in SF-2 (WinSLAMM).

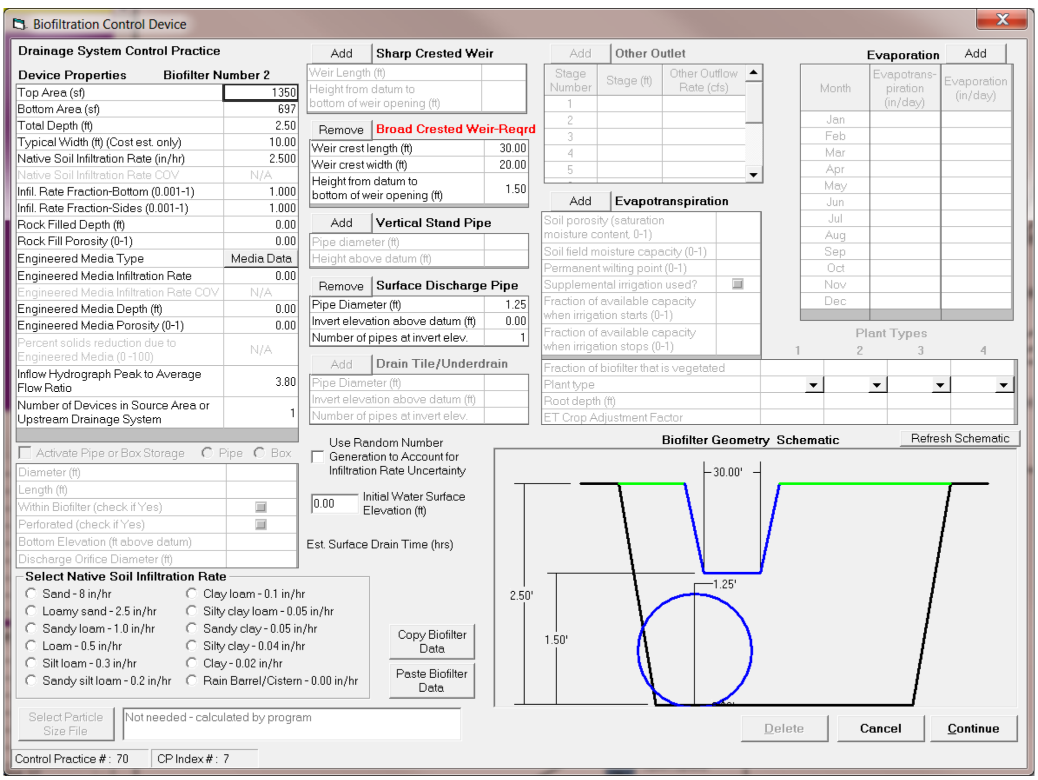


Figure 14: Detention Basin DB115 in SF-2 (WinSLAMM).

Hydrodynamic Device

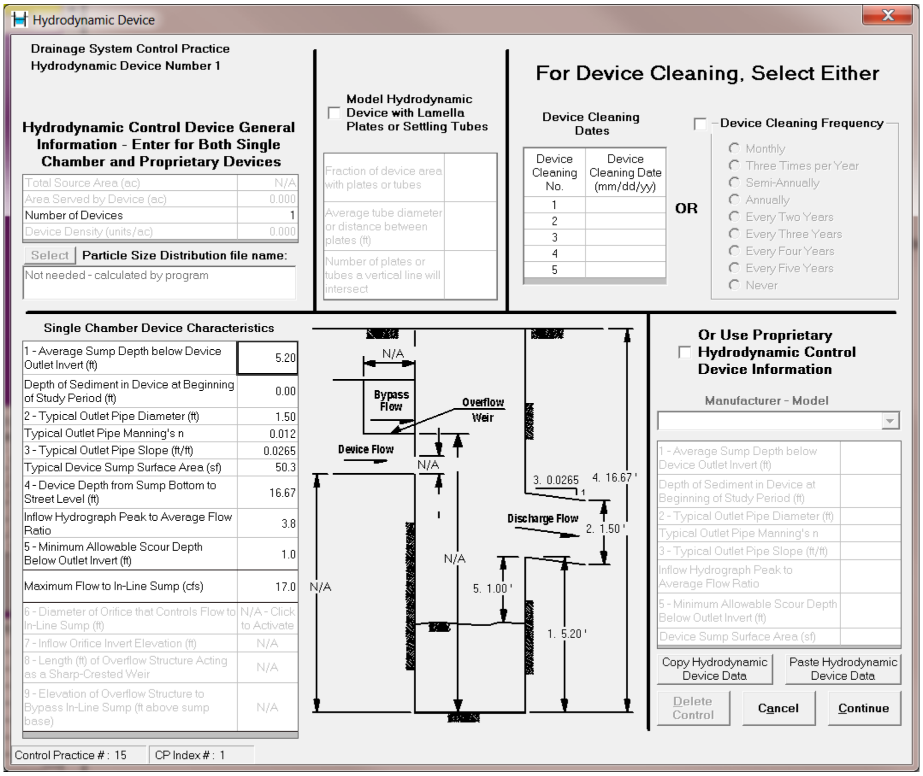


Figure 15: Hydrodynamic Device at River Drive and Rum River Boulevard in SF-2 (WinSLAMM).

Ponds

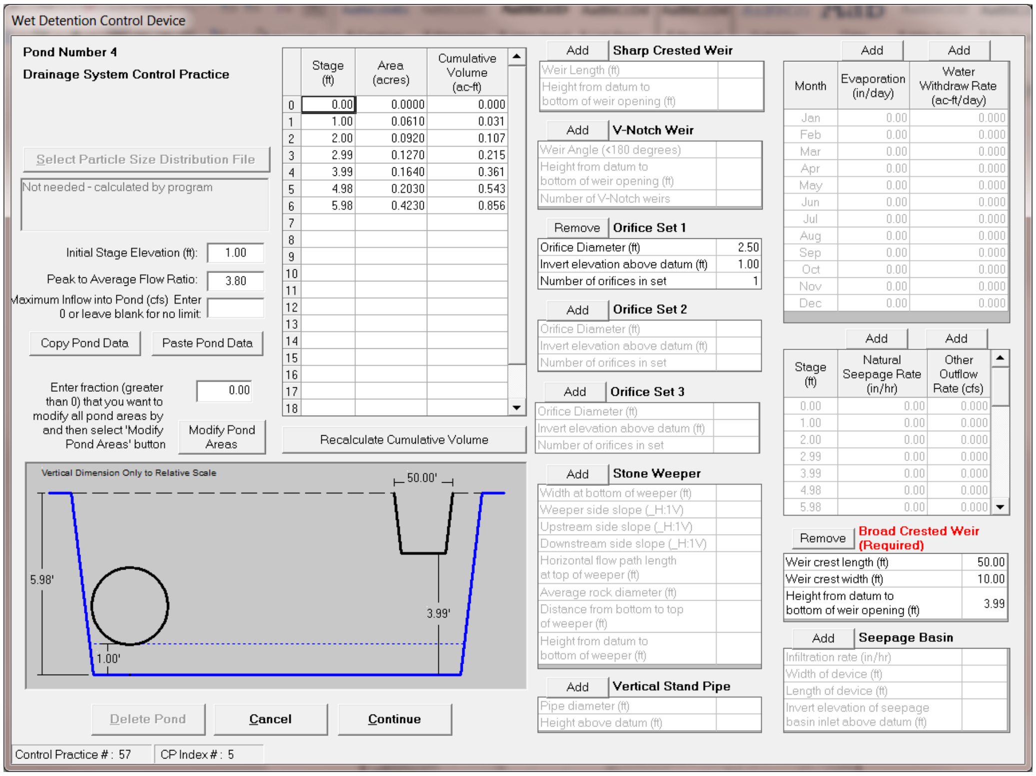


Figure 16: Stormwater Pond SWP116 in SF-1 (WinSLAMM).

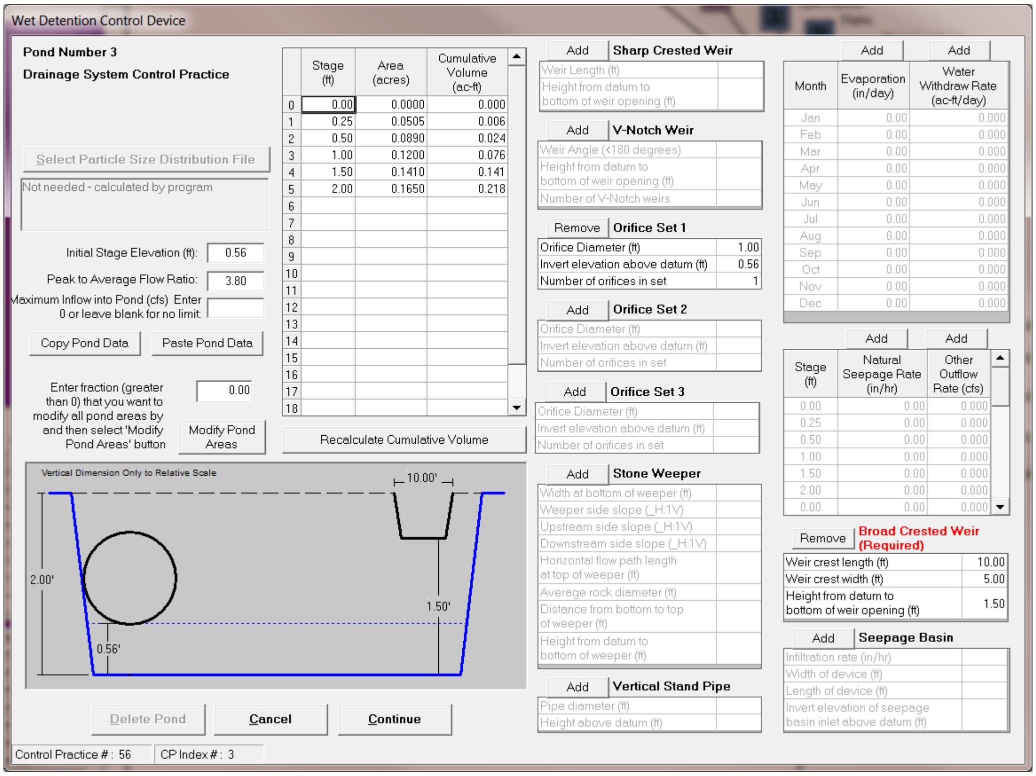


Figure 17: Stormwater Pond SWP50 in SR-1 (WinSLAMM).

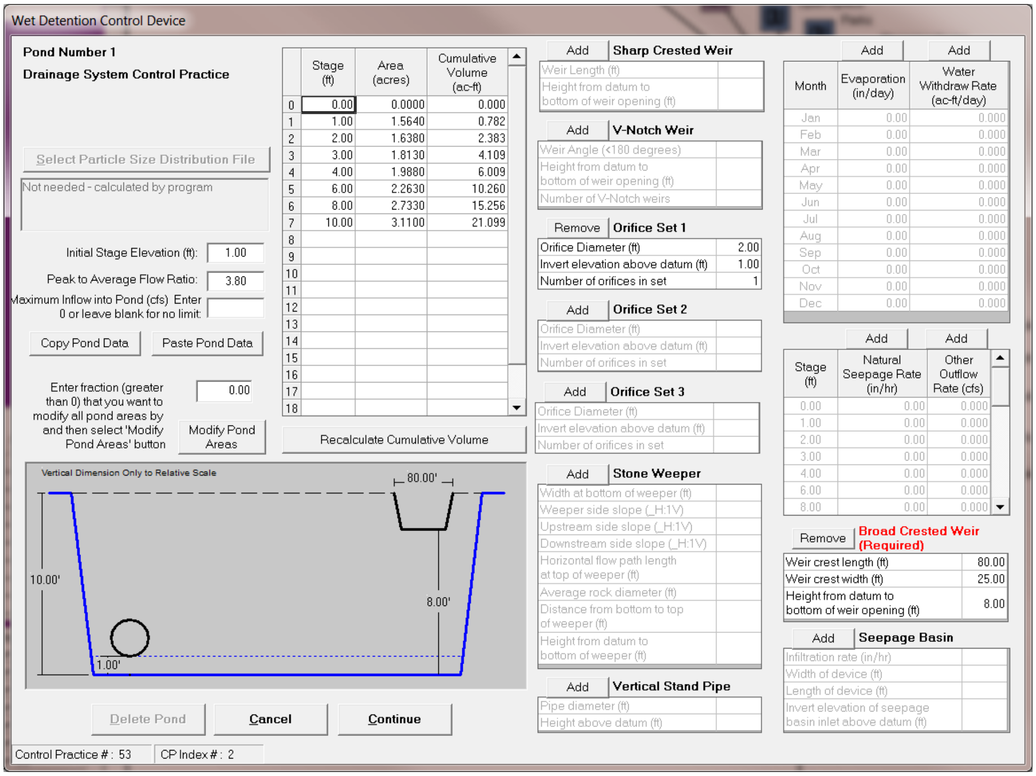


Figure 18: Stormwater Pond NW107 in SF-1 (WinSLAMM).

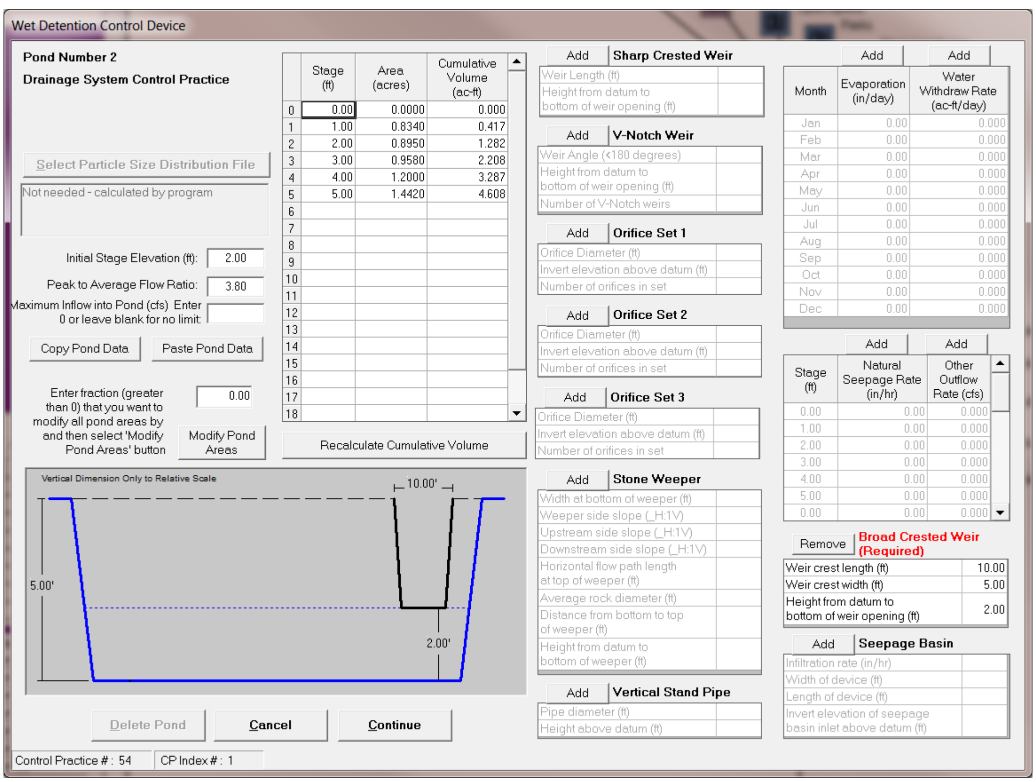


Figure 19: Stormwater Pond NW108 in SF-1 (WinSLAMM).

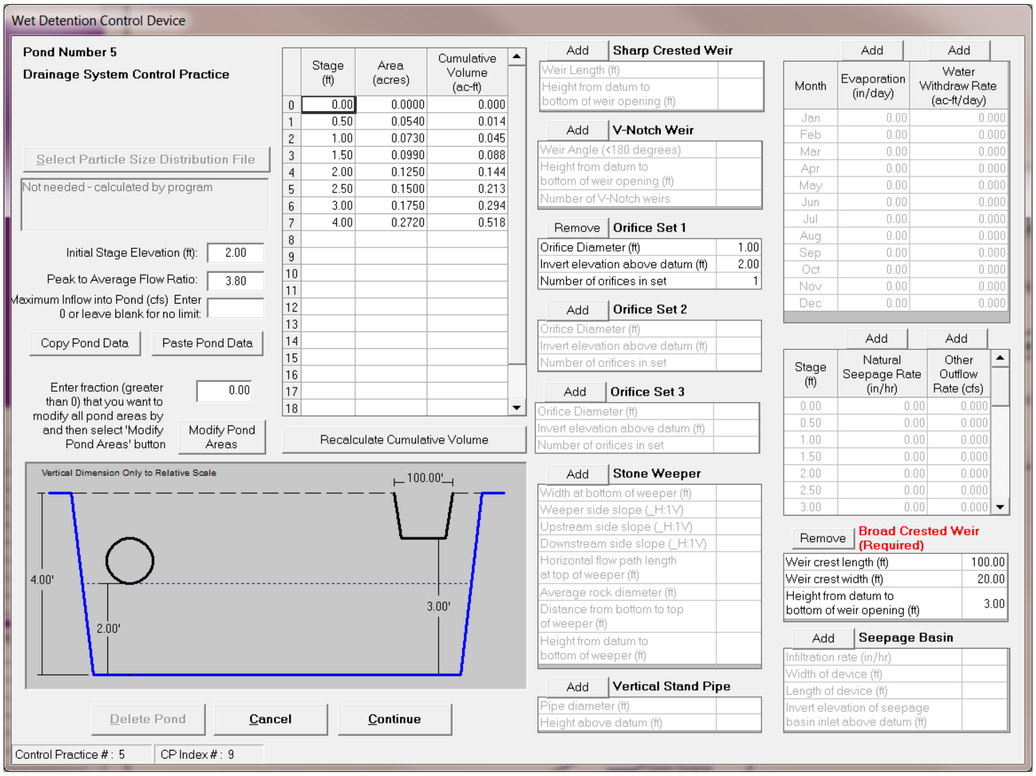


Figure 20: Stormwater Pond SWP106 in SF-2 (WinSLAMM).

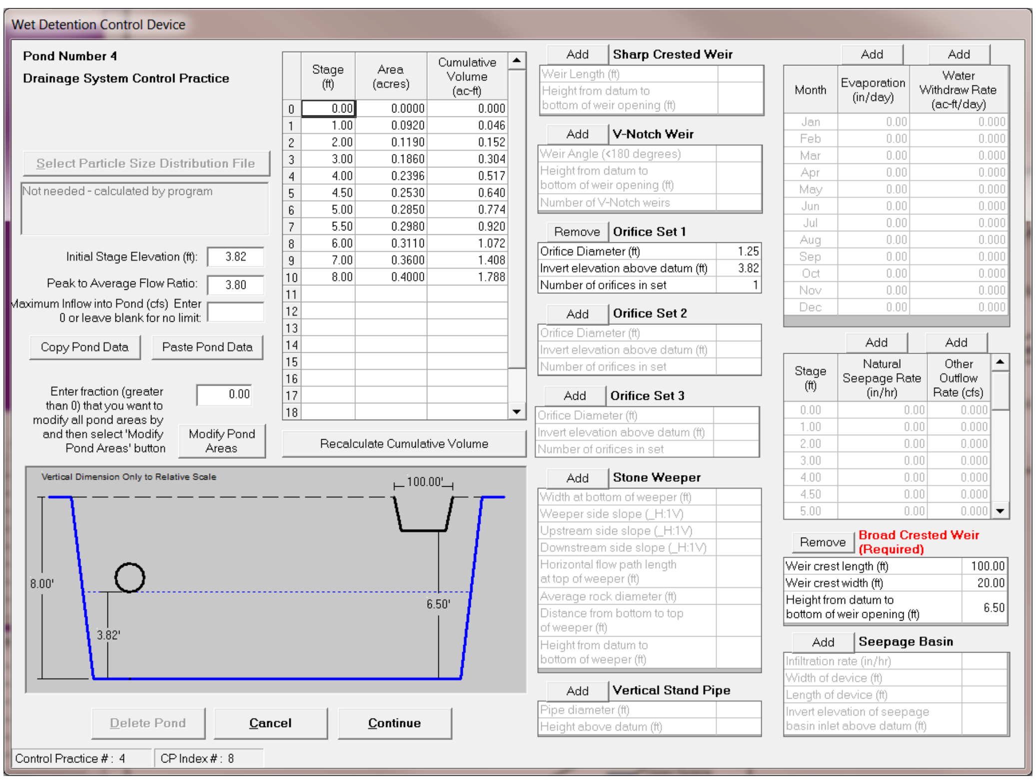


Figure 21: Stormwater Pond SWP103 in SF-2 (WinSLAMM).

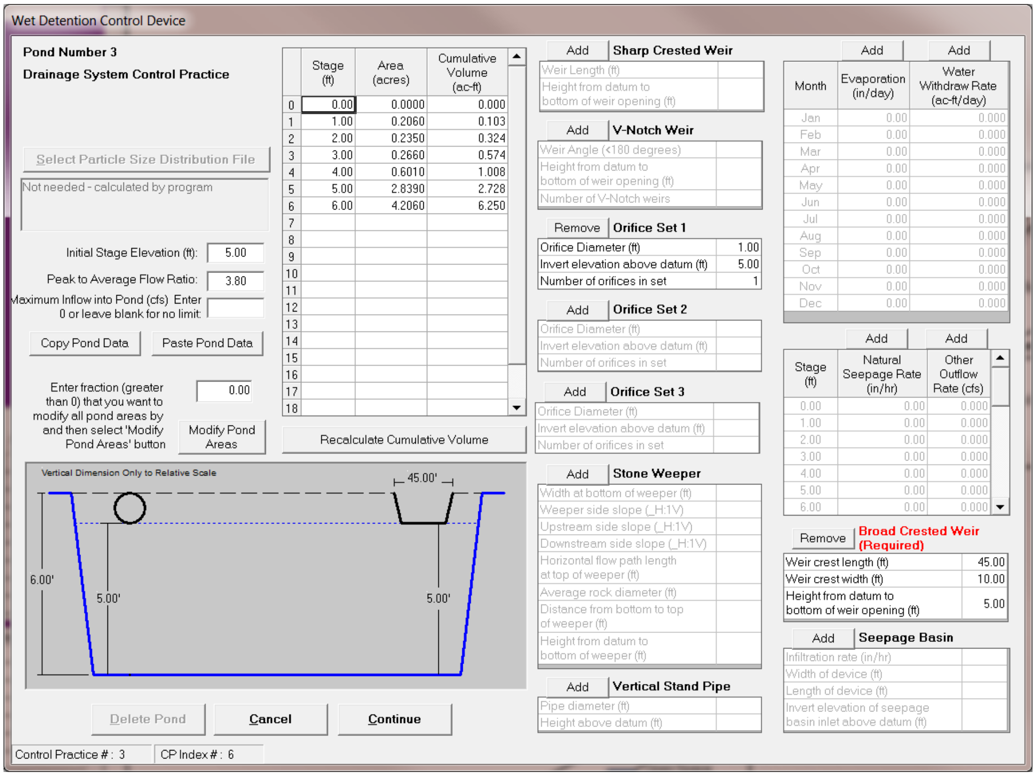


Figure 22: Stormwater Pond SWP82 in SF-2 (WinSLAMM).

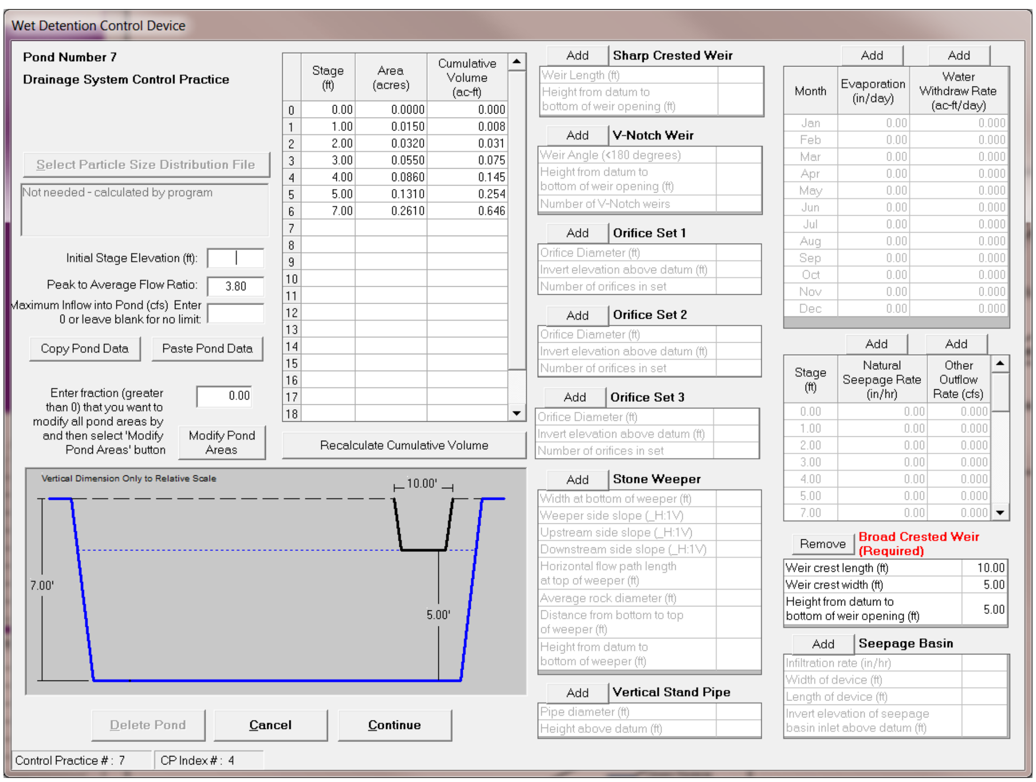


Figure 23: Stormwater Pond SWP104 in SF-2 (WinSLAMM).

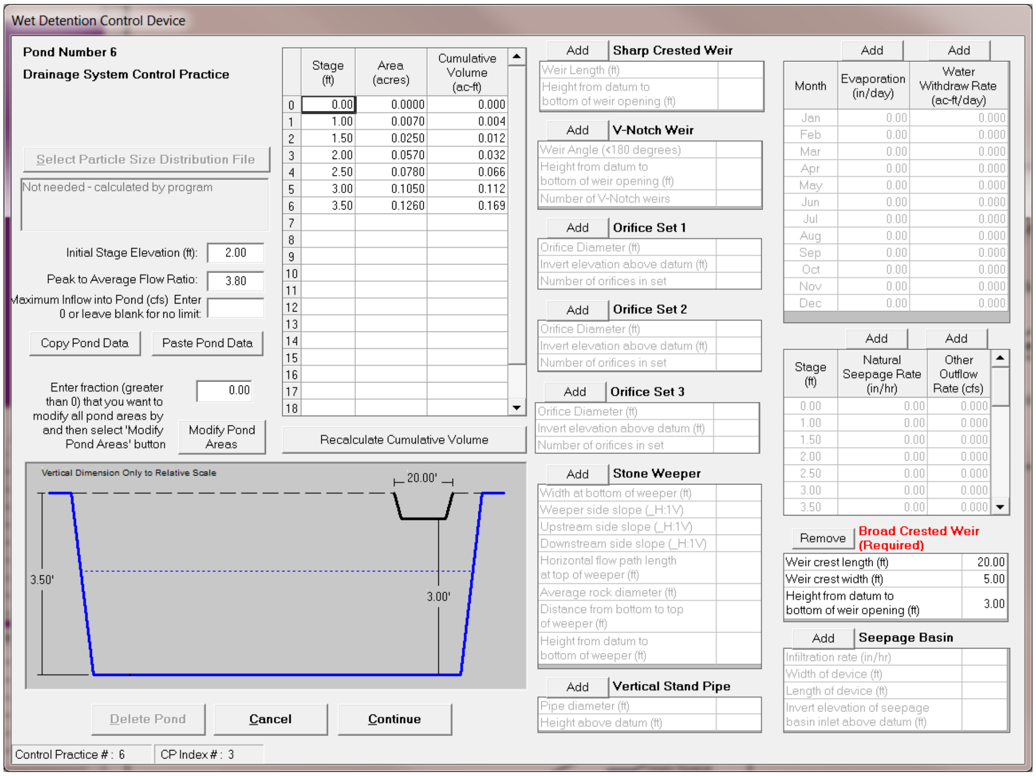


Figure 24: Stormwater Pond SWP117 in SF-2 (WinSLAMM).

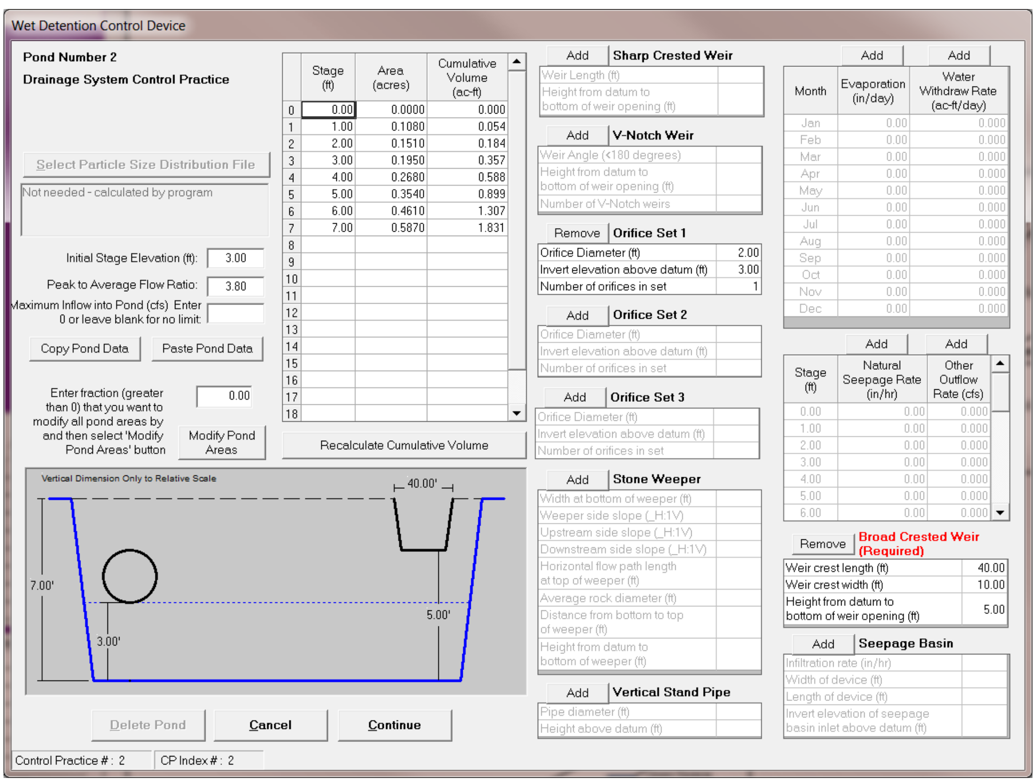


Figure 25: Stormwater Pond SWP83 in SF-2 (WinSLAMM).

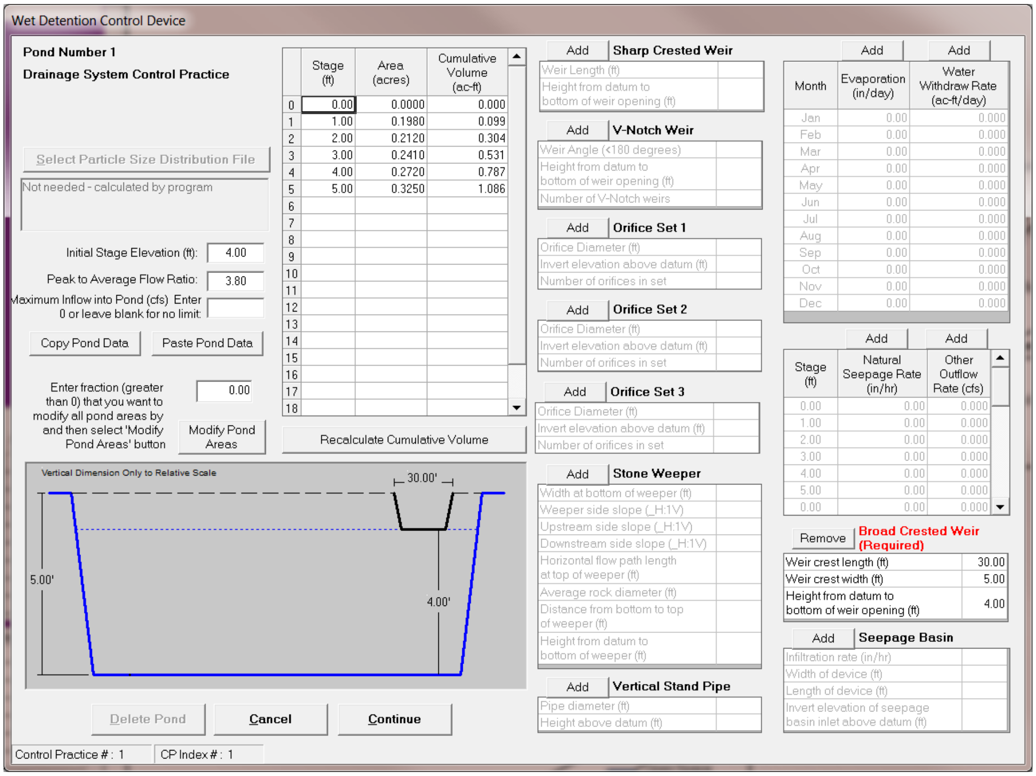


Figure 26: Stormwater Pond SWP84 in SF-2 (WinSLAMM).

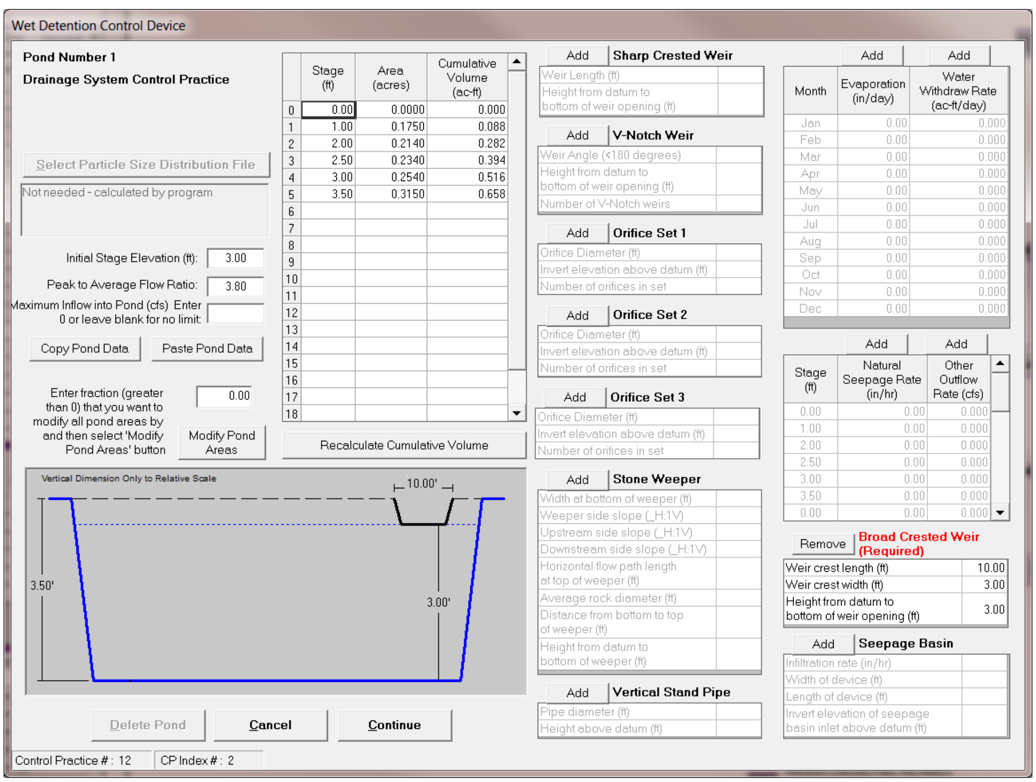


Figure 27: Stormwater Pond SWP10 in SF-5 (WinSLAMM).

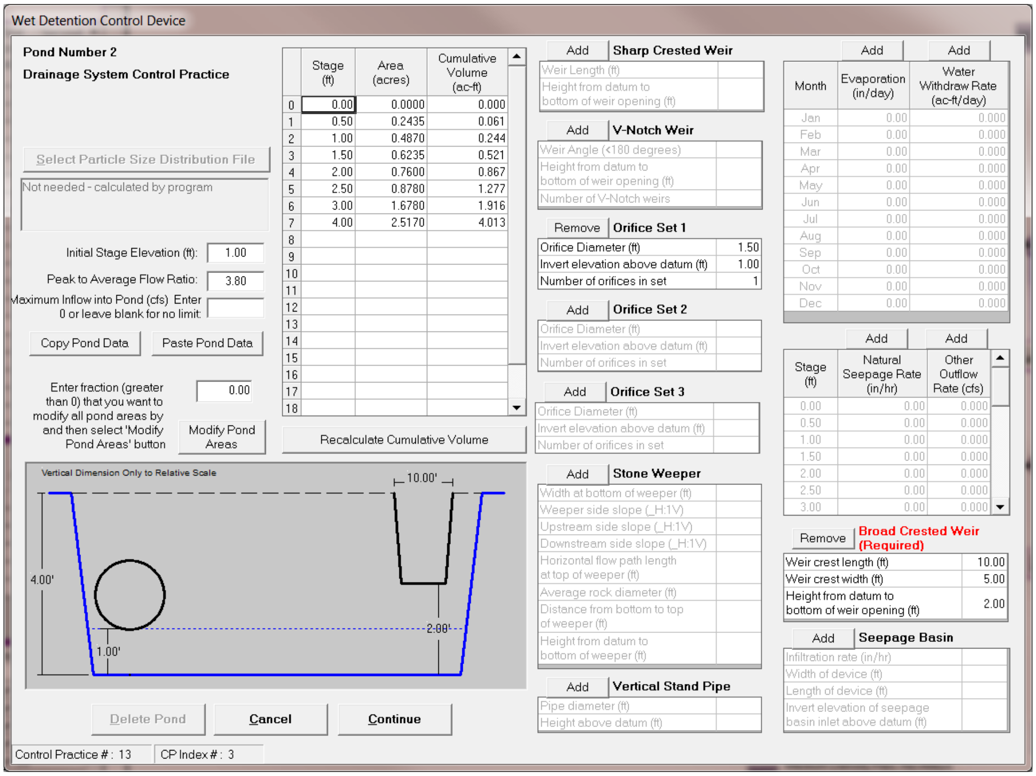


Figure 28: Stormwater Pond SWP11 in SF-5 (WinSLAMM).

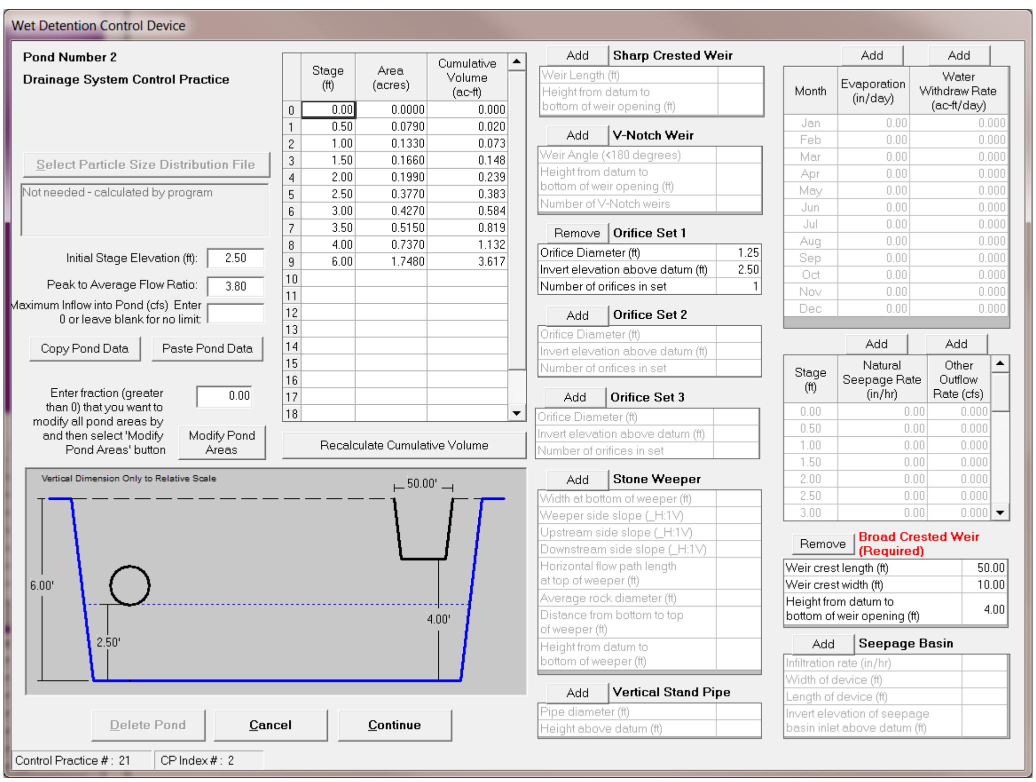


Figure 29: Stormwater Pond SWP105 in SF-7 (WinSLAMM).

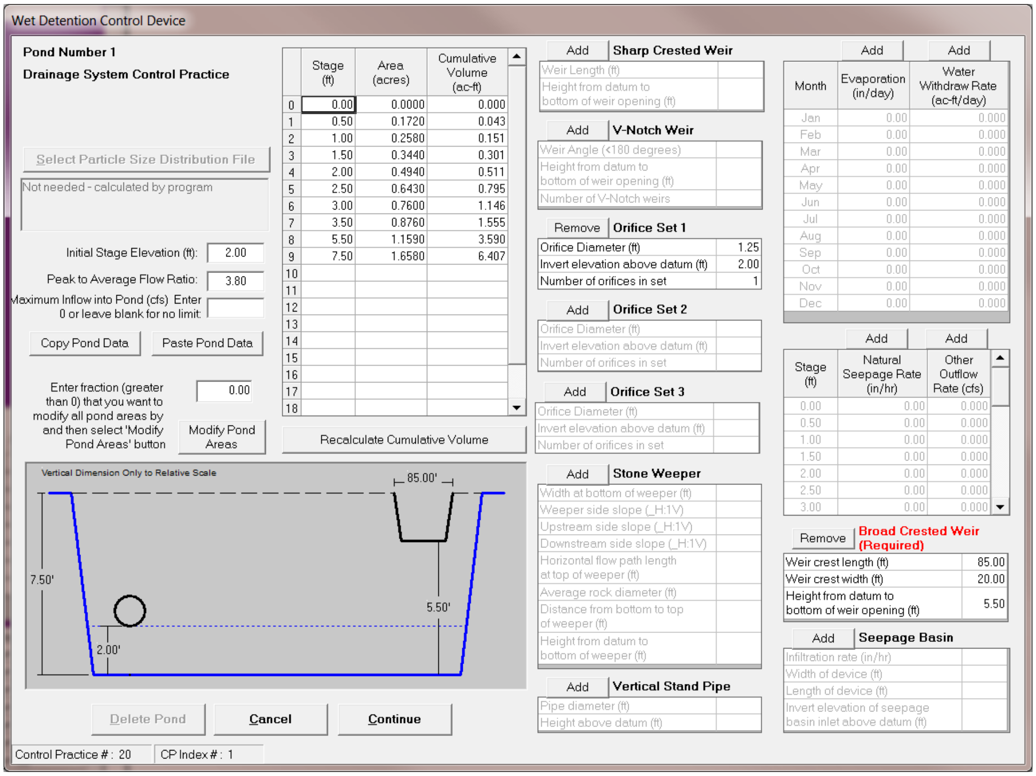


Figure 30: Stormwater Pond SWP52 in SF-7 (WinSLAMM).

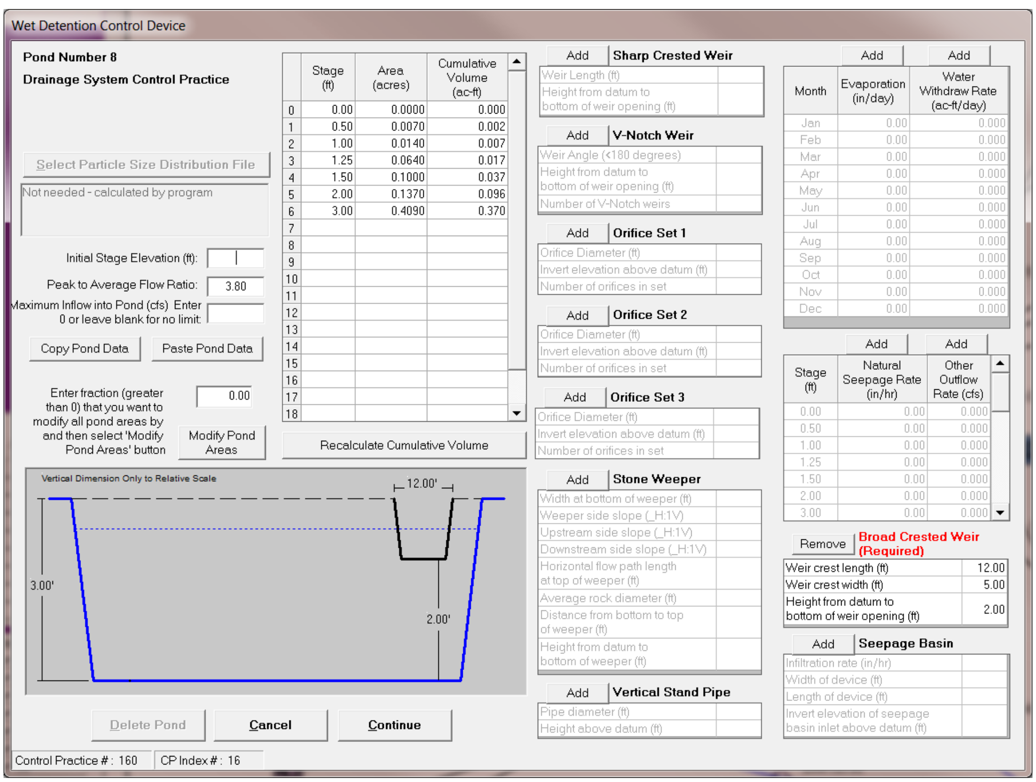


Figure 31: Stormwater Pond SWP22 in SF-8 (WinSLAMM).

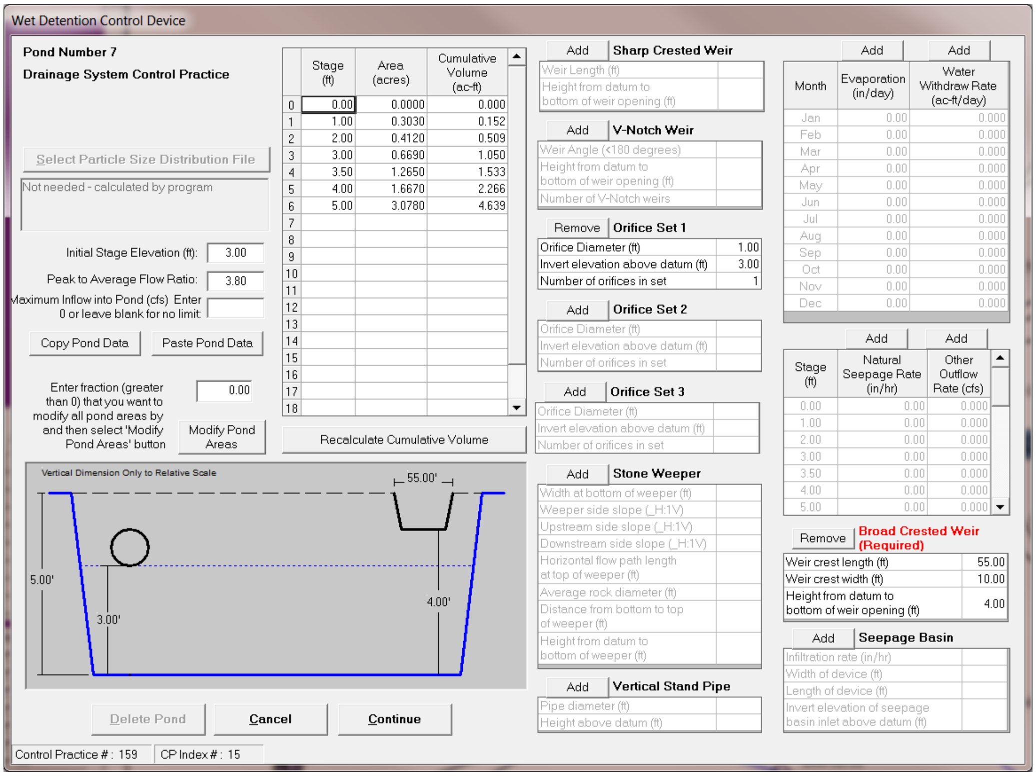


Figure 32: Stormwater Pond SWP21 in SF-8 (WinSLAMM).

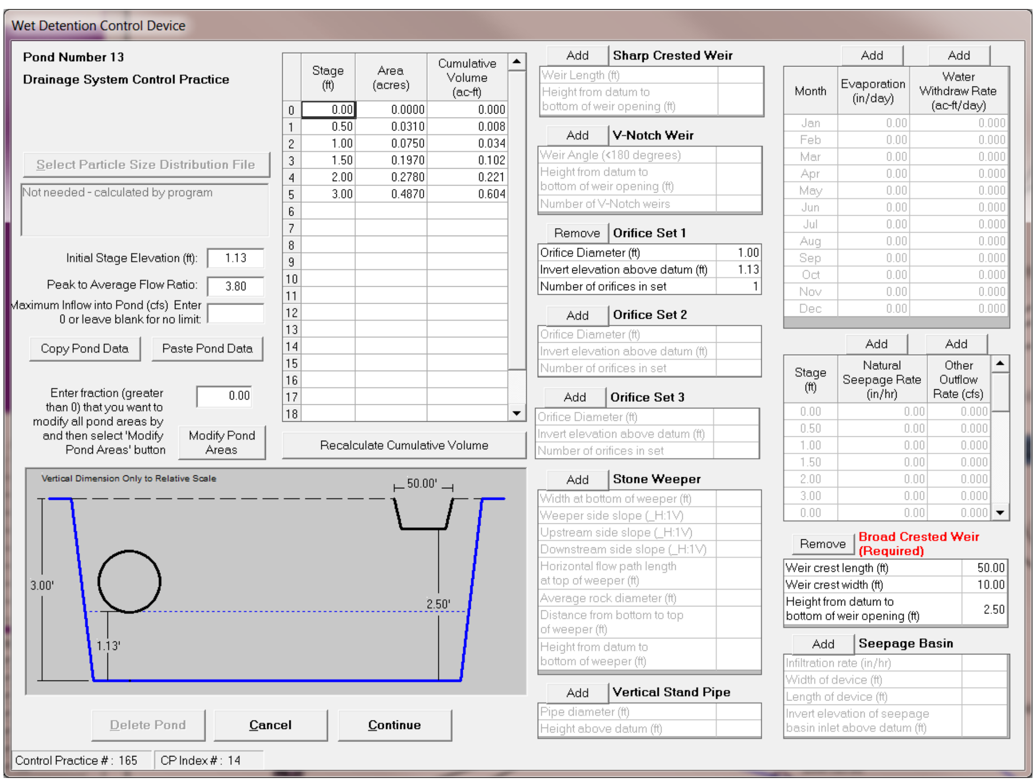


Figure 33: Stormwater Pond NW120 in SF-8 (WinSLAMM).

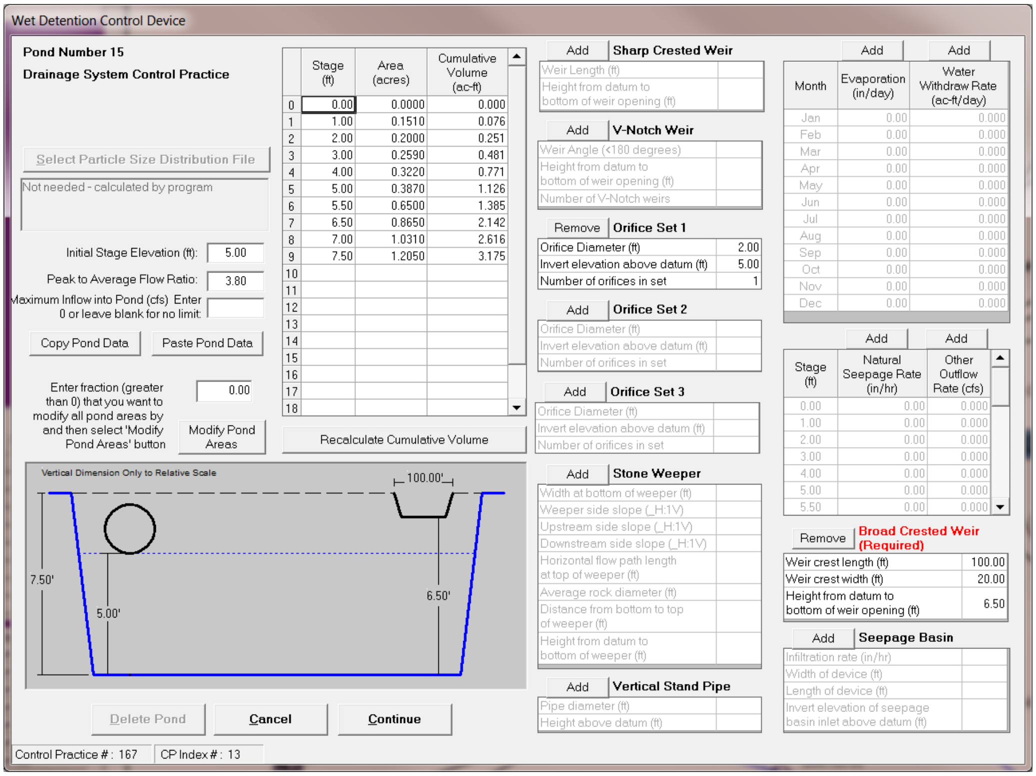


Figure 34: Stormwater Pond SWP90 in SF-8 (WinSLAMM).

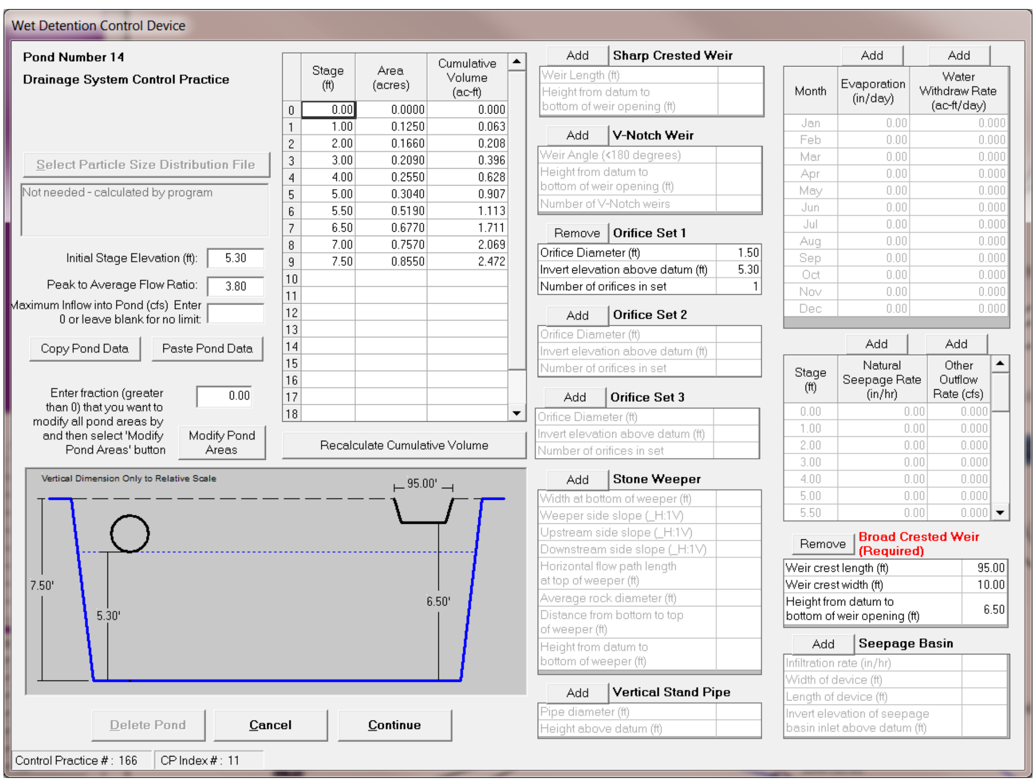


Figure 35: Stormwater Pond SWP89 in SF-8 (WinSLAMM).

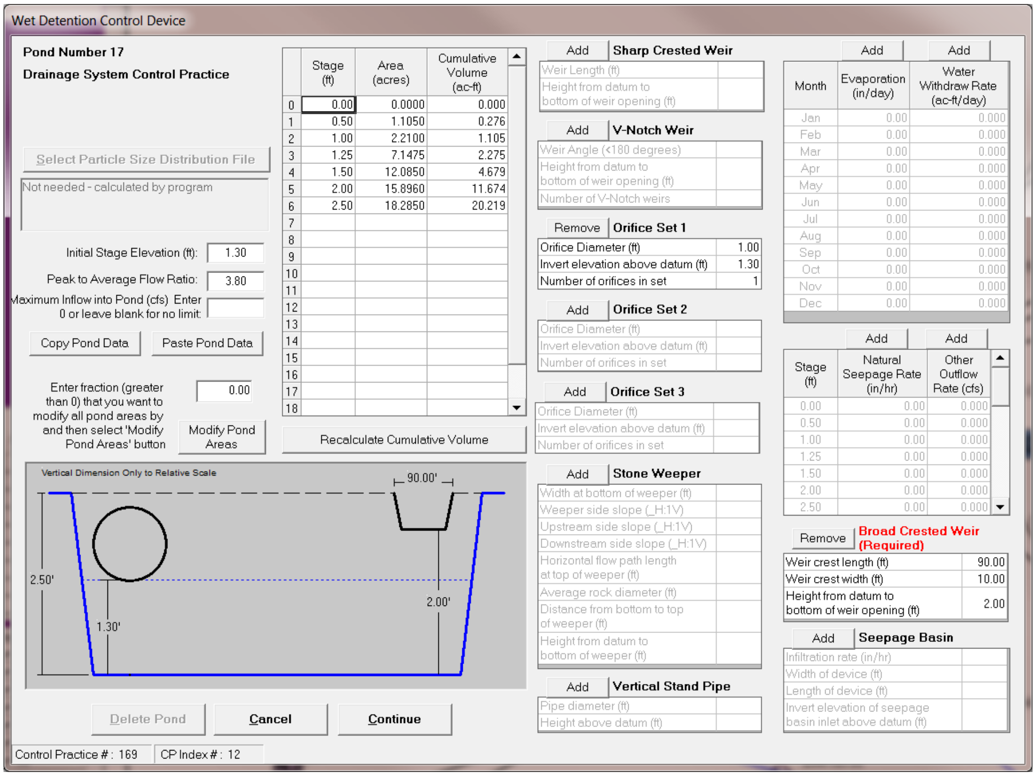


Figure 36: Stormwater Pond SWP29, SWP30, SWP32, SWP33, SWP56, SWP92, SWP93 in SF-8 (WinSLAMM).

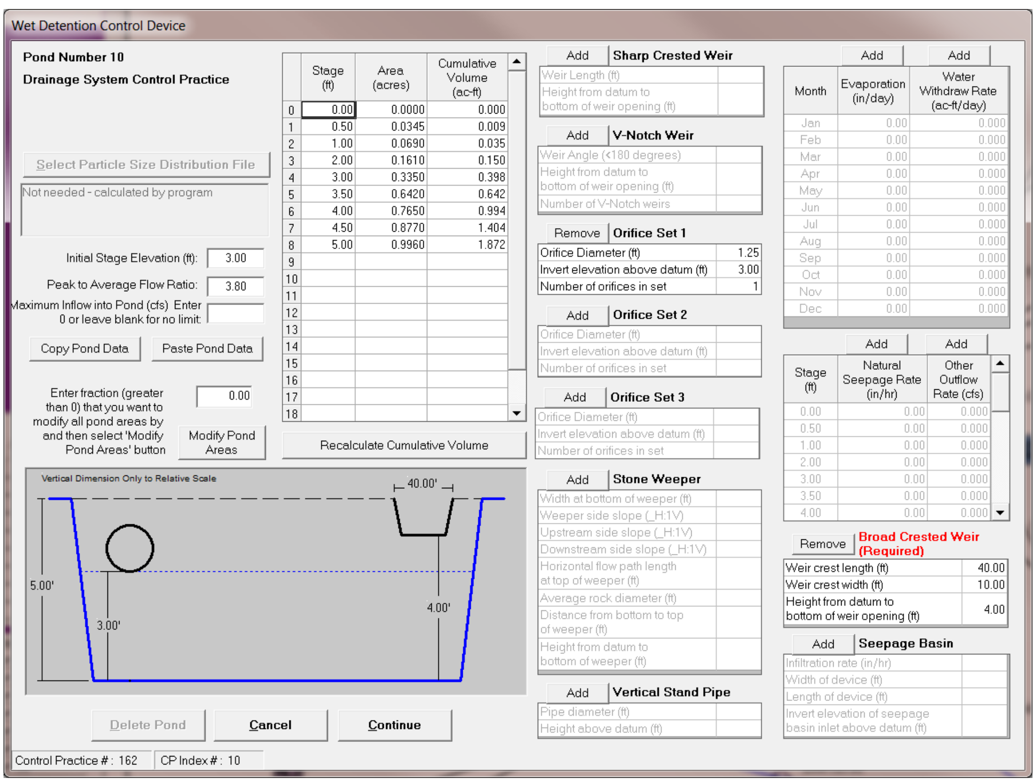


Figure 37: Stormwater Pond SWP31 in SF-8 (WinSLAMM).

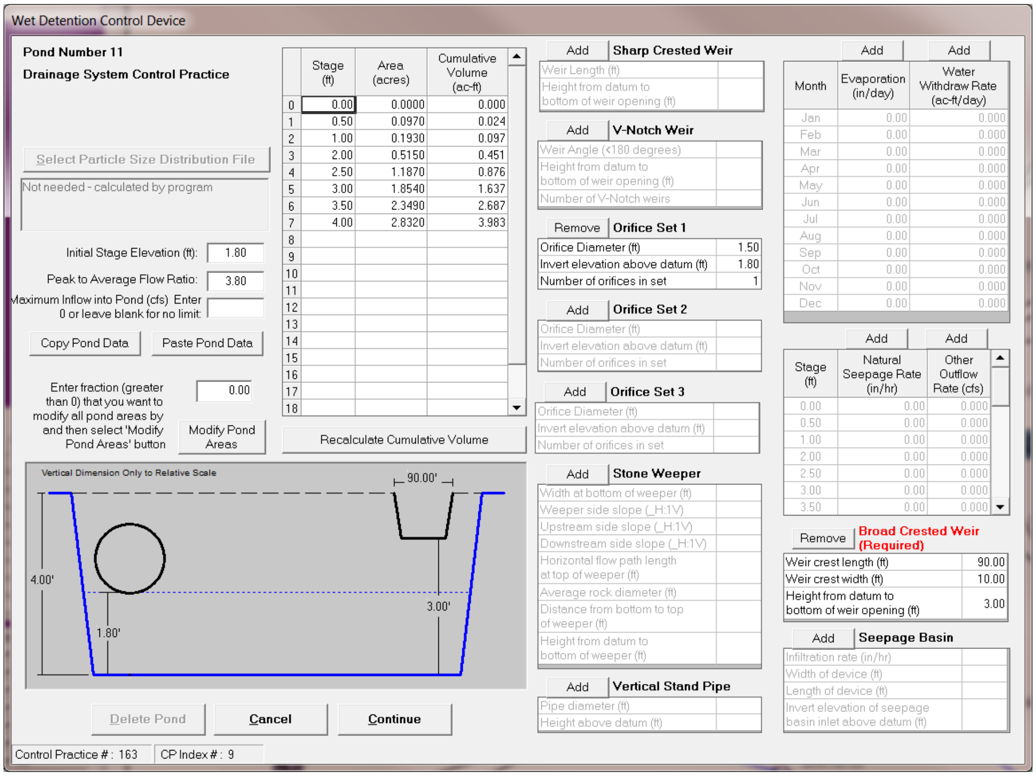


Figure 38: Stormwater Pond SWP34, SWP35 in SF-8 (WinSLAMM).

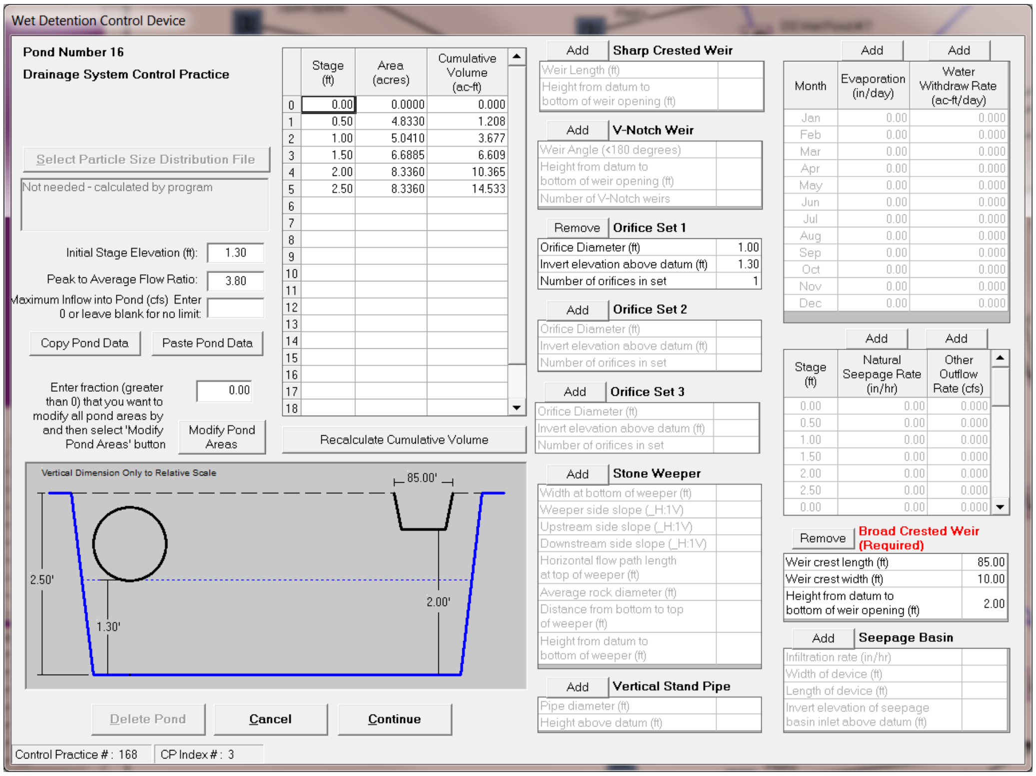


Figure 39: Stormwater Pond SWP73, SWP74, SWP75, SWP91 in SF-8 (WinSLAMM).

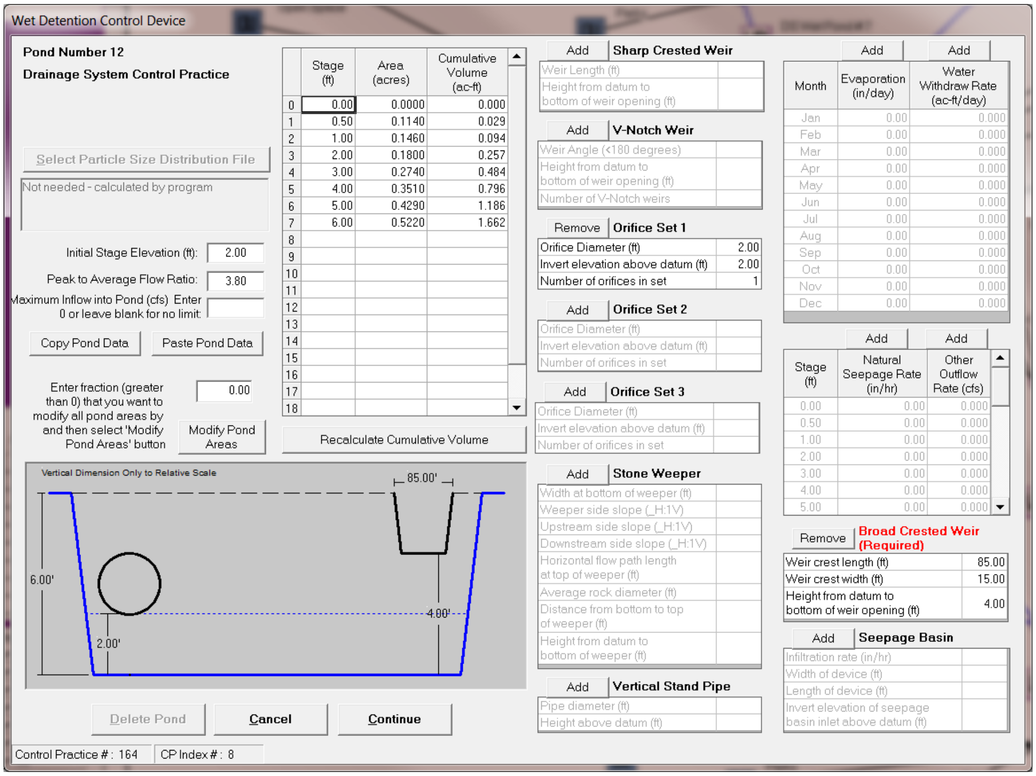


Figure 40: Stormwater Pond SWP88 in SF-8 (WinSLAMM).

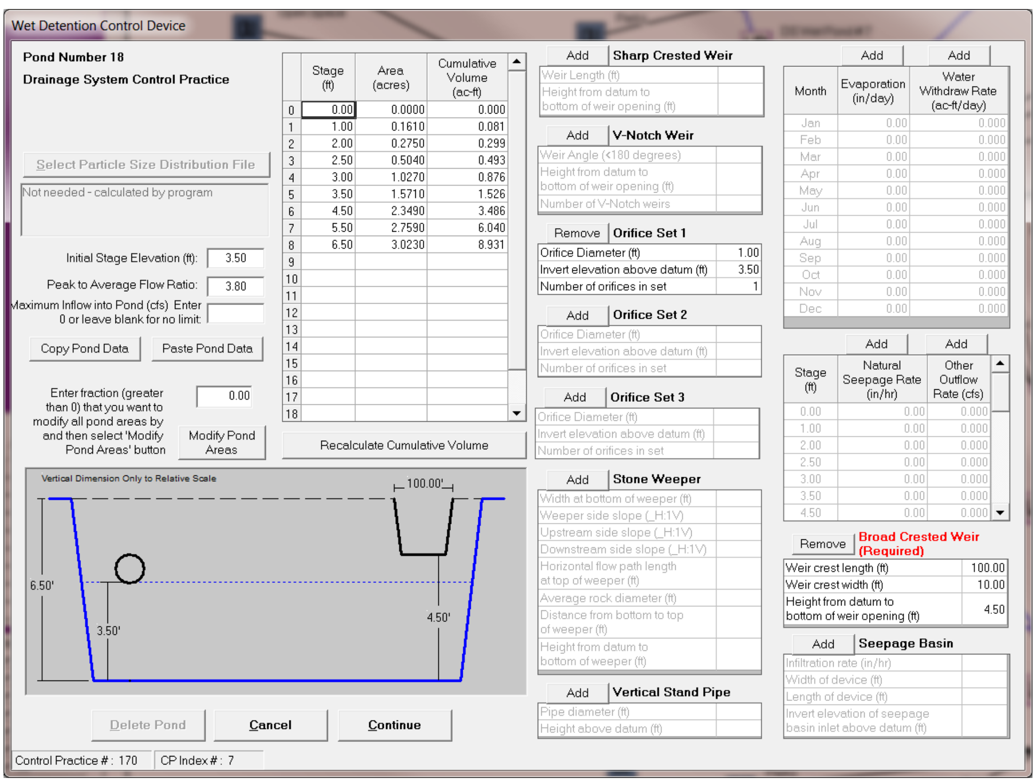


Figure 41: Stormwater Pond SWP86, SWP87 in SF-8 (WinSLAMM).

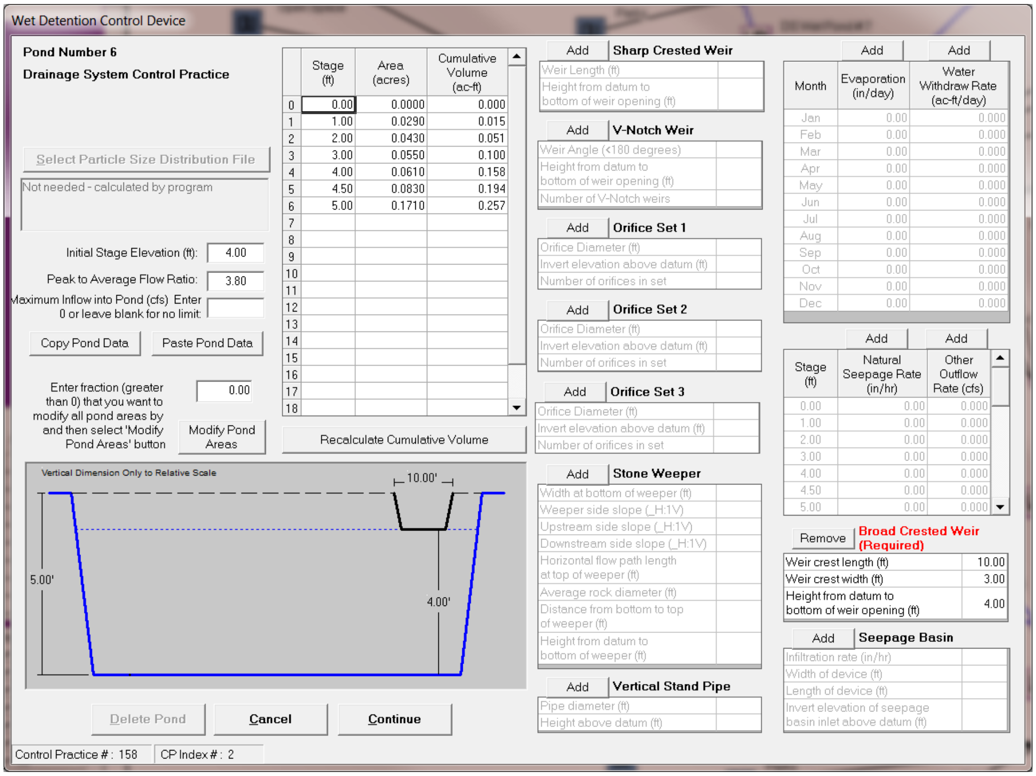


Figure 42: Stormwater Pond SWP101 in SF-8 (WinSLAMM).

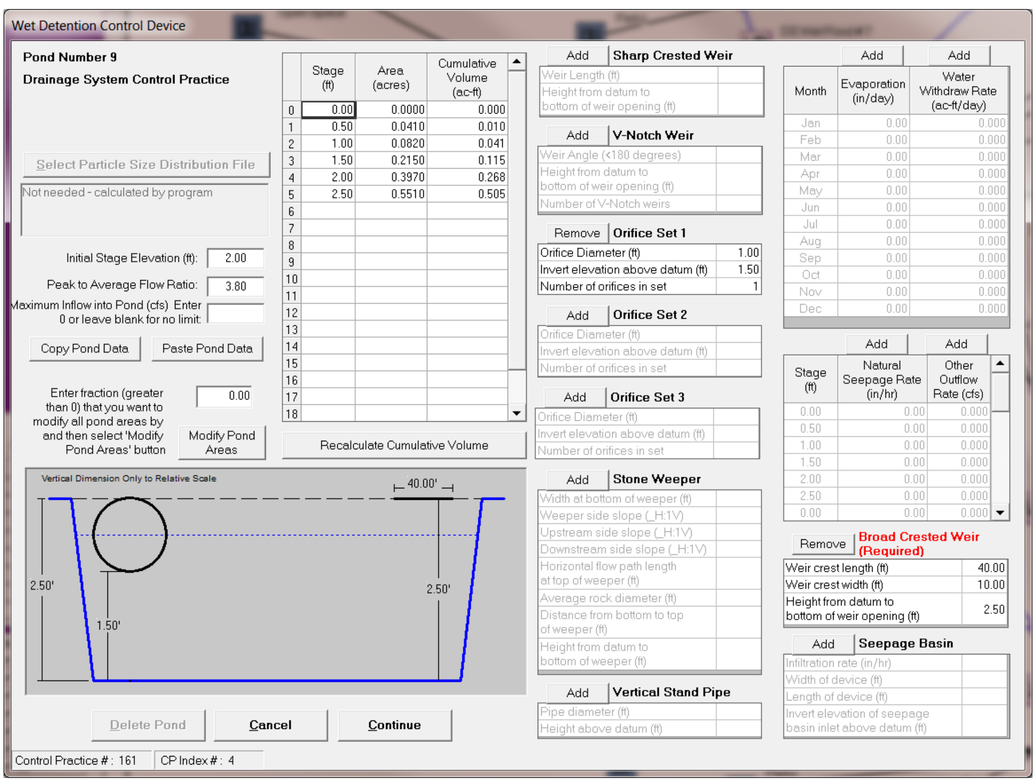


Figure 43: Stormwater Pond SWP23 in SF-8 (WinSLAMM).

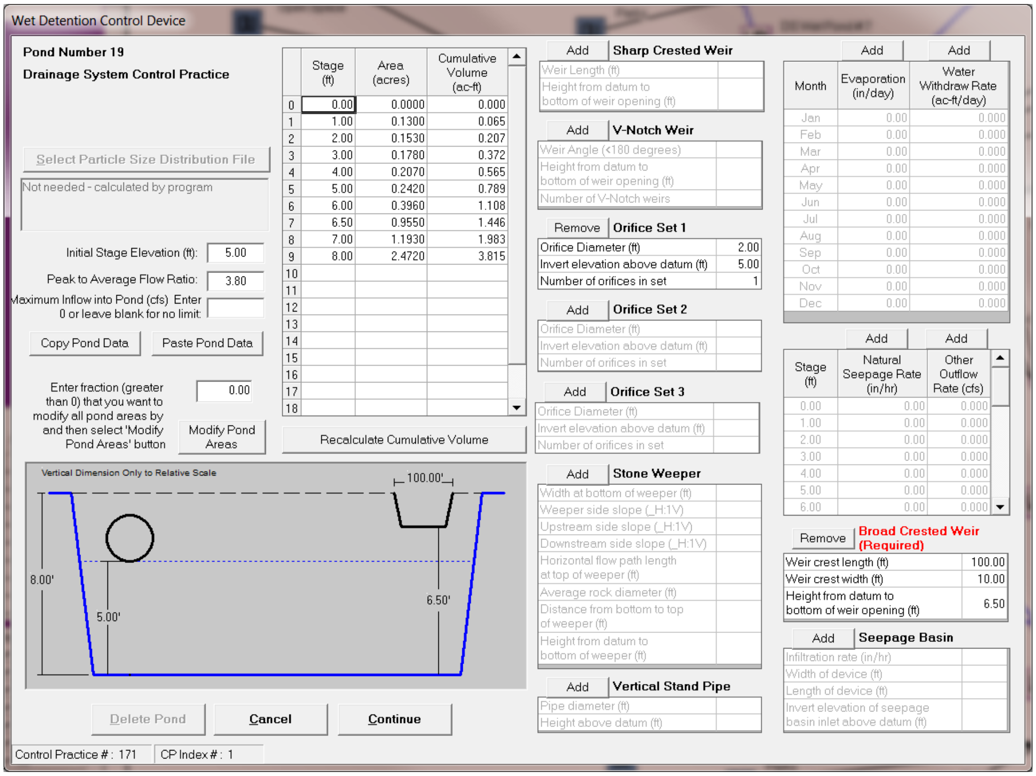


Figure 44: Stormwater Pond SWP85 in SF-8 (WinSLAMM).

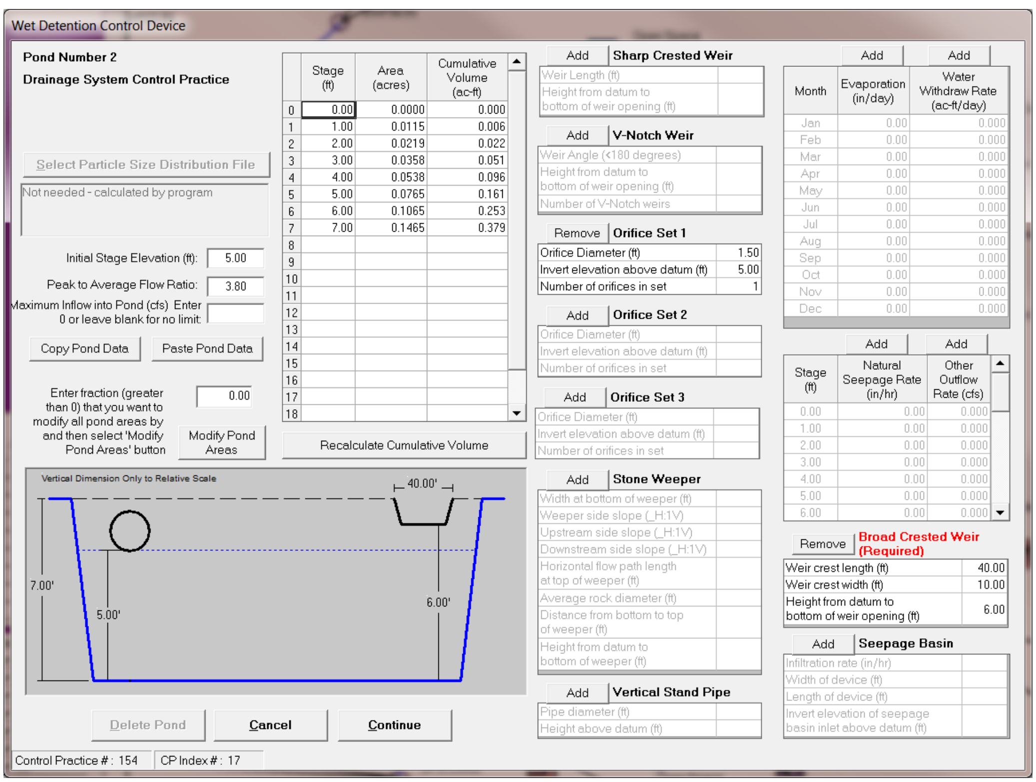


Figure 45: Stormwater Pond SWP119 in SF-8 (WinSLAMM).

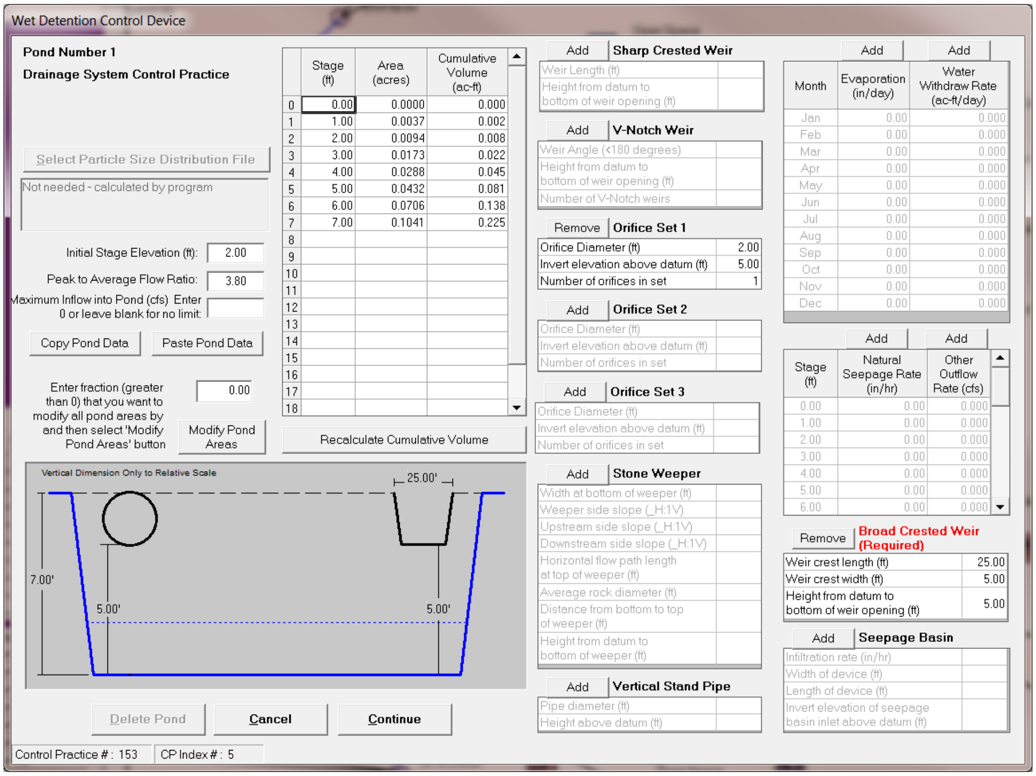


Figure 46: Stormwater Pond NW114 in SF-8 (WinSLAMM).

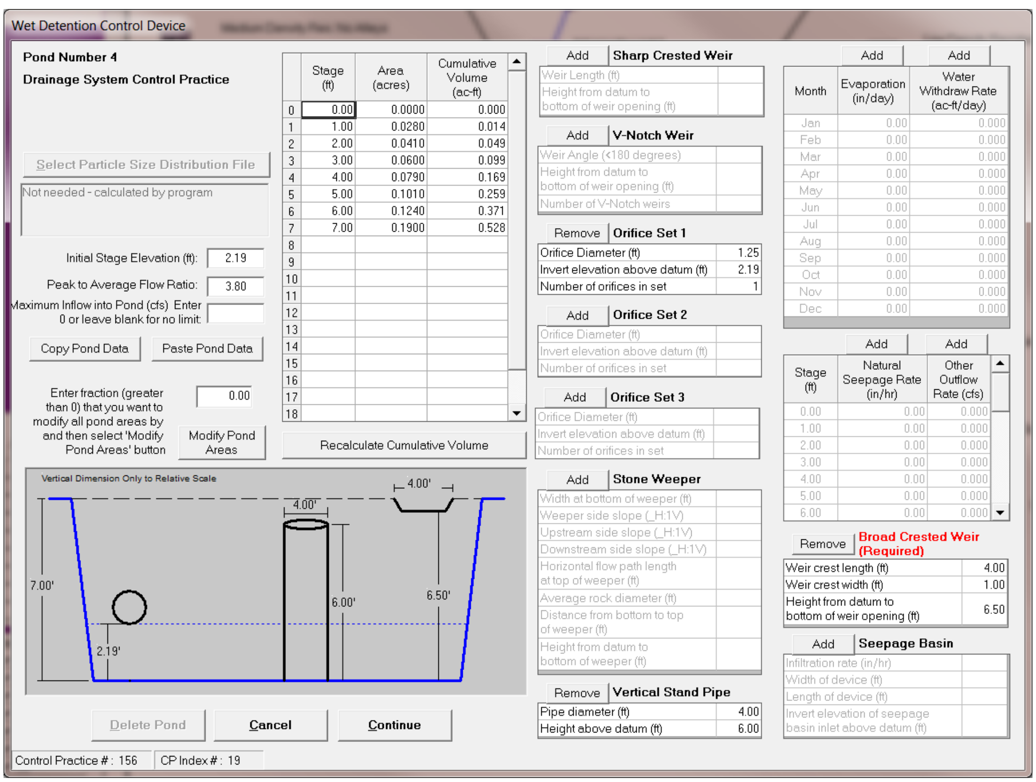


Figure 47: Stormwater Pond SWP122 in SF-8 (WinSLAMM).

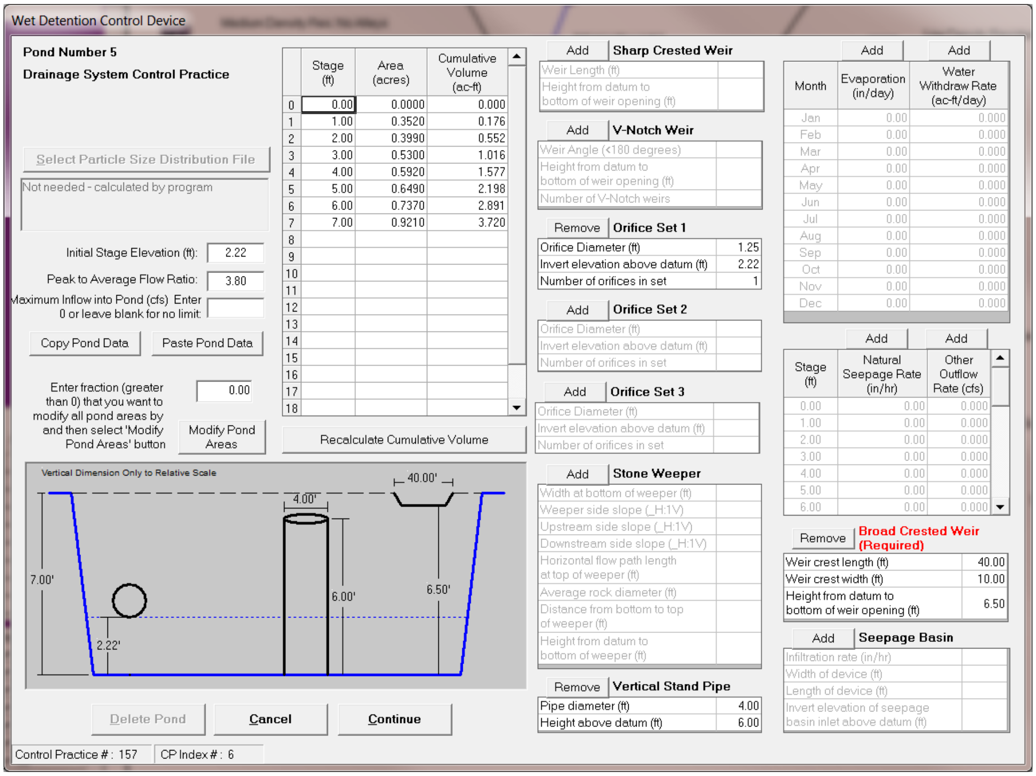


Figure 48: Stormwater Pond SWP123 in SF-8 (WinSLAMM).

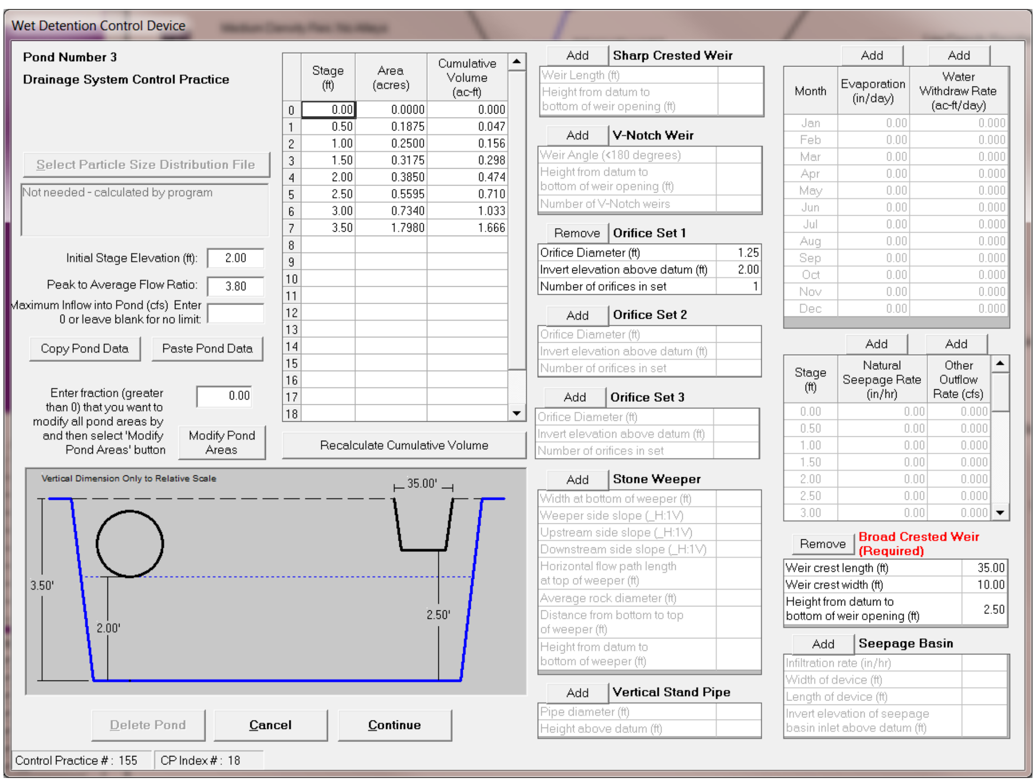


Figure 49: Stormwater Pond SWP100 in SF-8 (WinSLAMM).

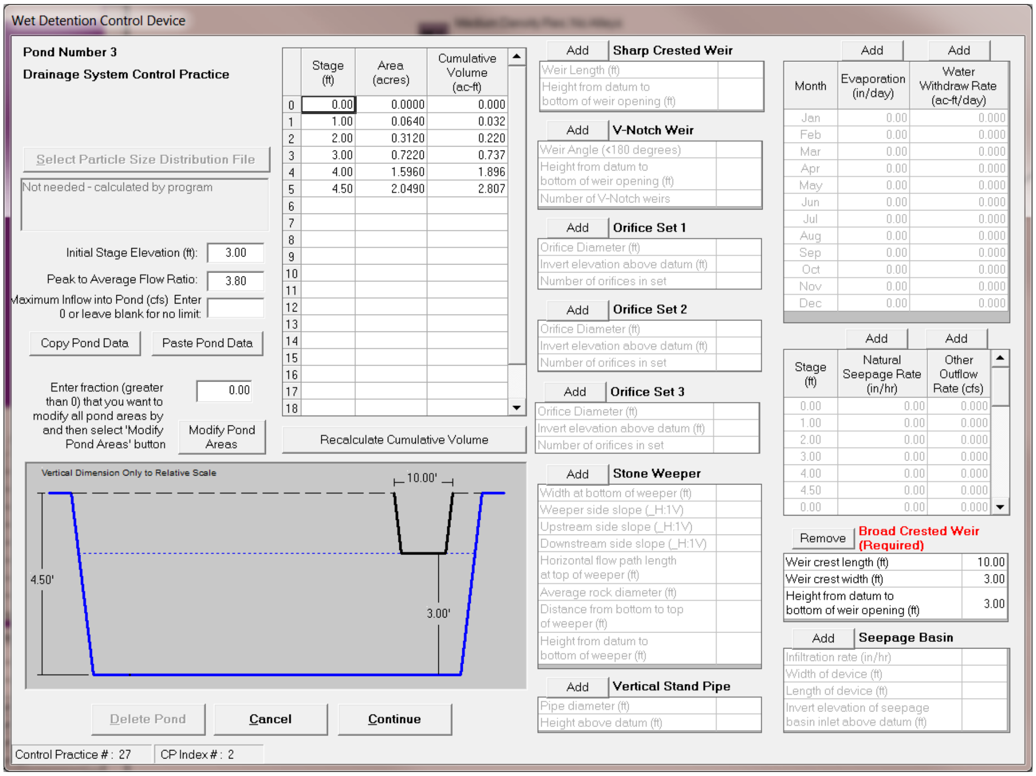


Figure 50: Stormwater Pond SWP12, SWP61 in SF-10 (WinSLAMM).

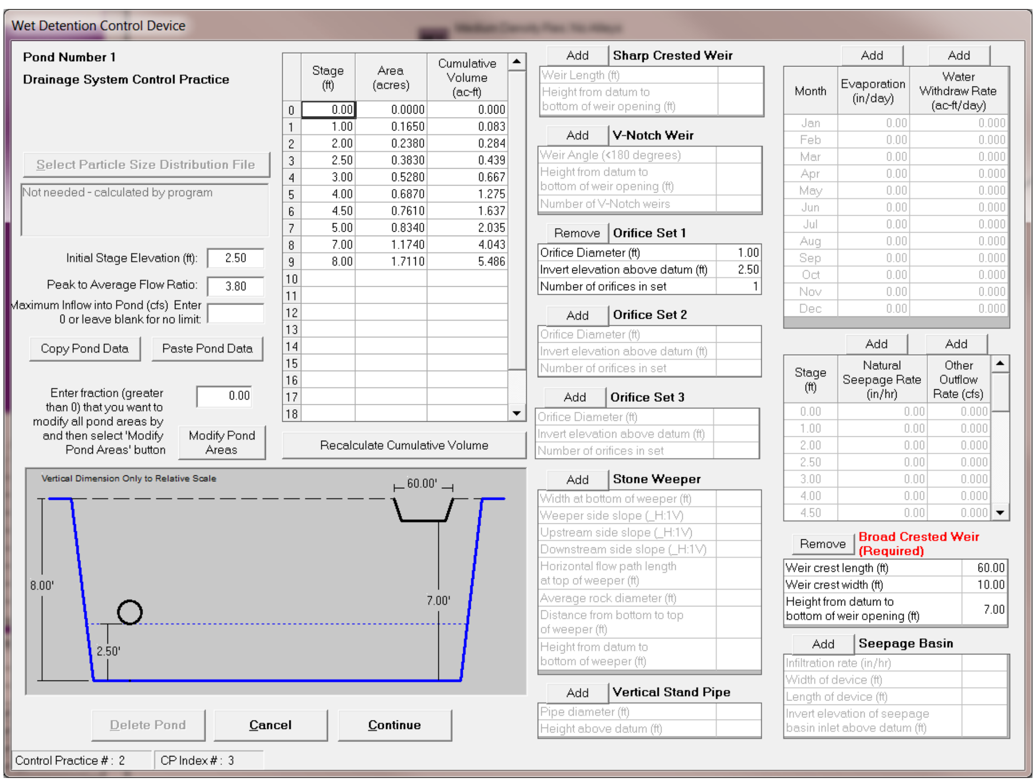


Figure 51: Stormwater Pond SWP7 in SF-10 (WinSLAMM).

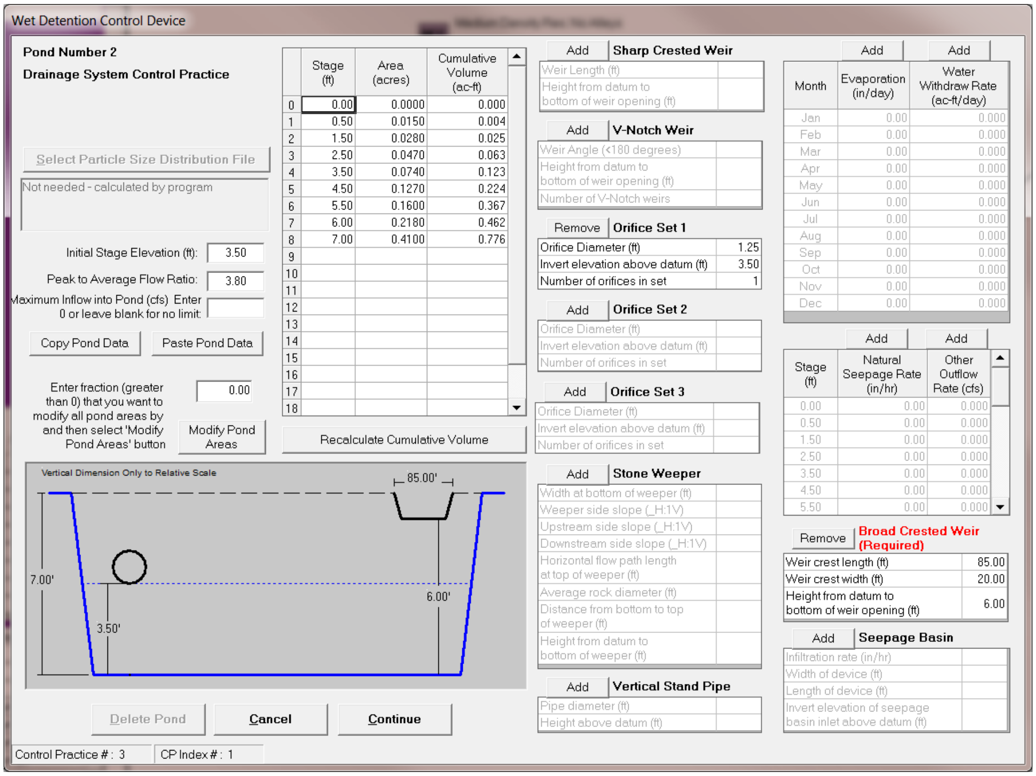


Figure 52: Stormwater Pond SWP6 in SF-10 (WinSLAMM).

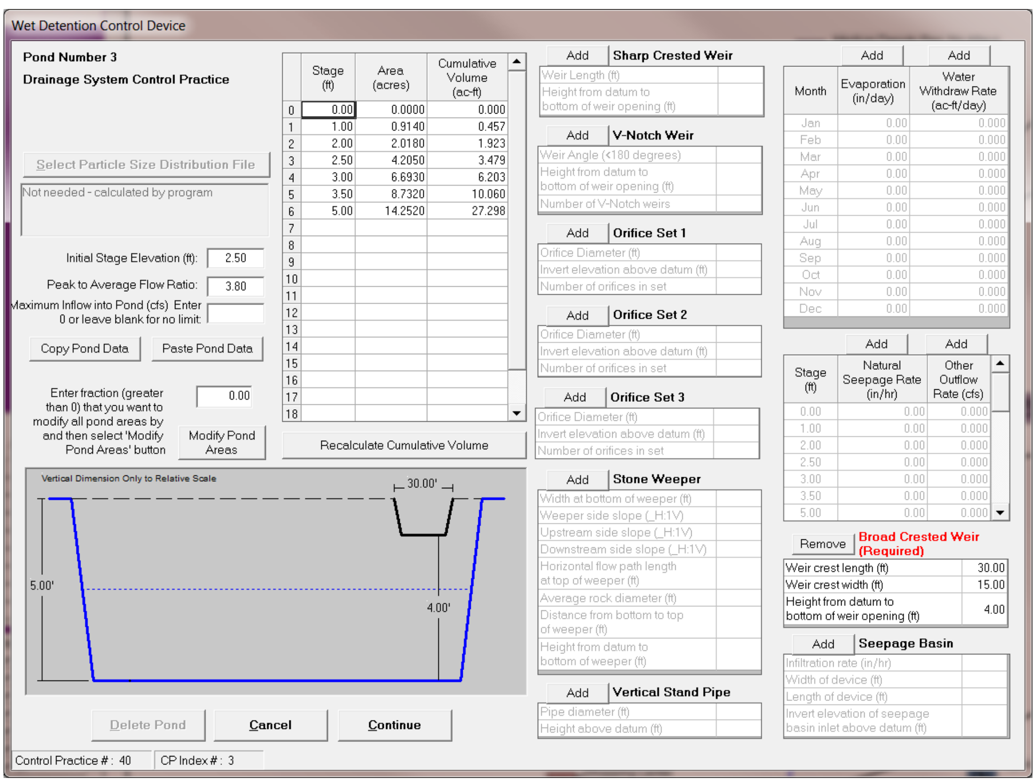


Figure 53: Stormwater Pond NW109, NW110, NW111, NW113 in SF-11 (WinSLAMM).

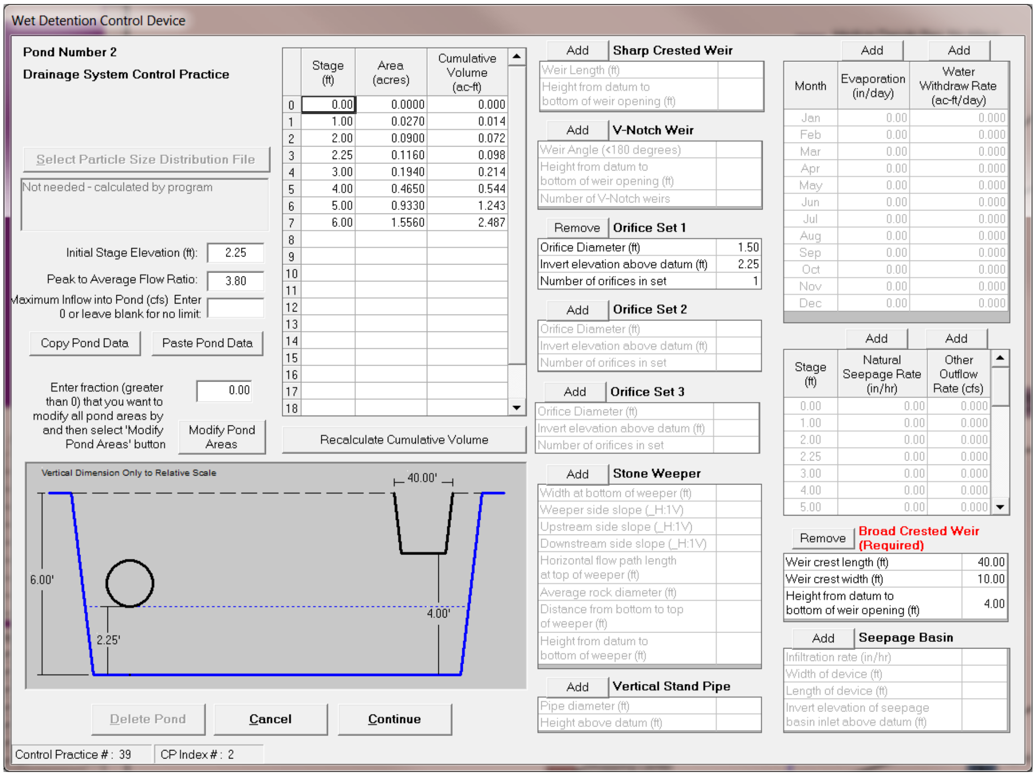


Figure 54: Stormwater Pond SWP9 in SF-11 (WinSLAMM).

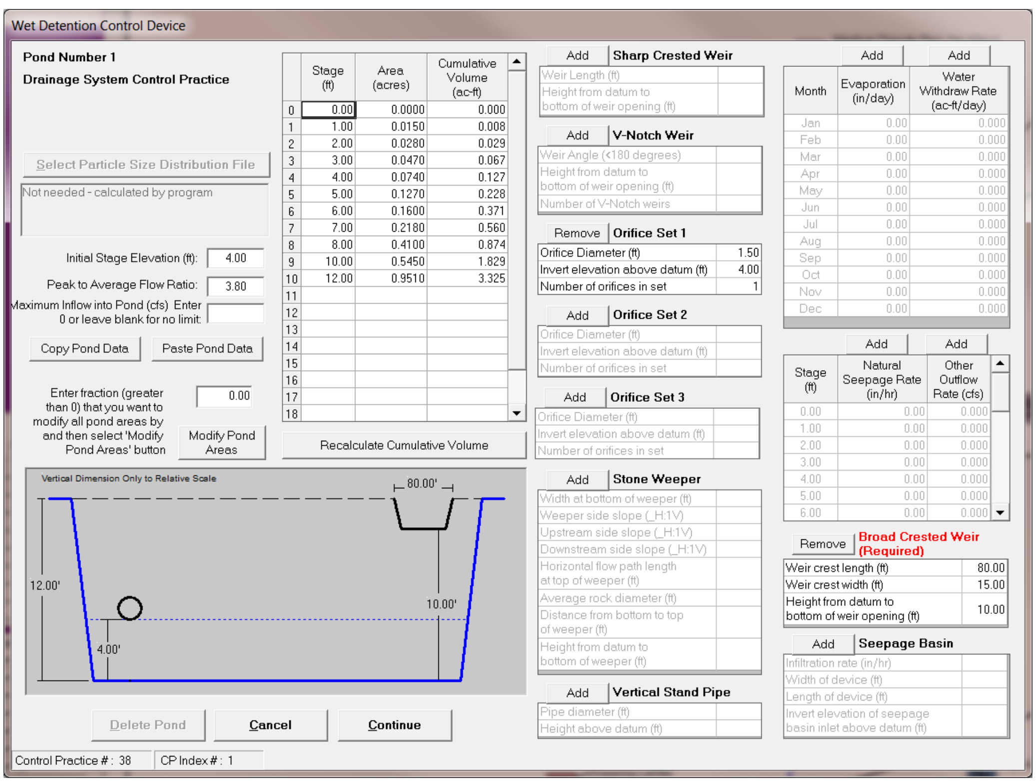


Figure 55: Stormwater Pond SWP8 in SF-11 (WinSLAMM).

Street Cleaning

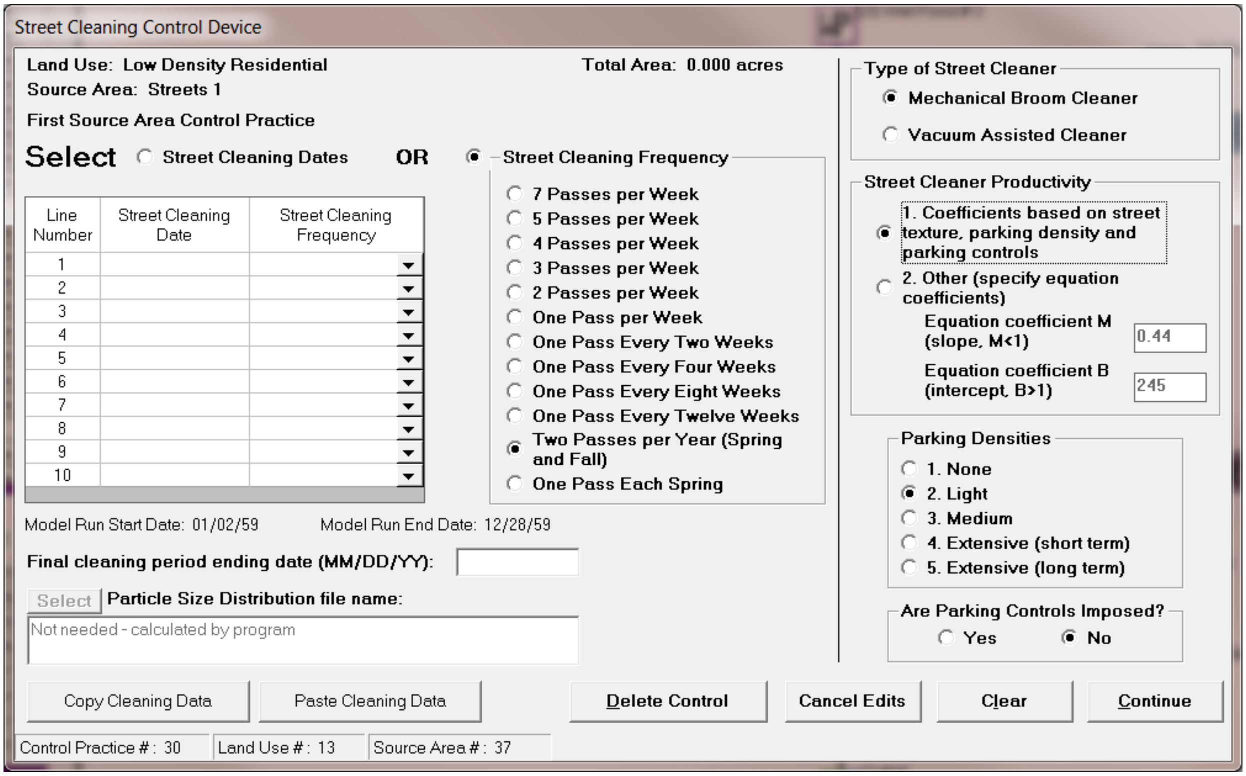


Figure 56: Street cleaning parameters used in all the catchments (SF-1 to SF-11) (WinSLAMM).

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.

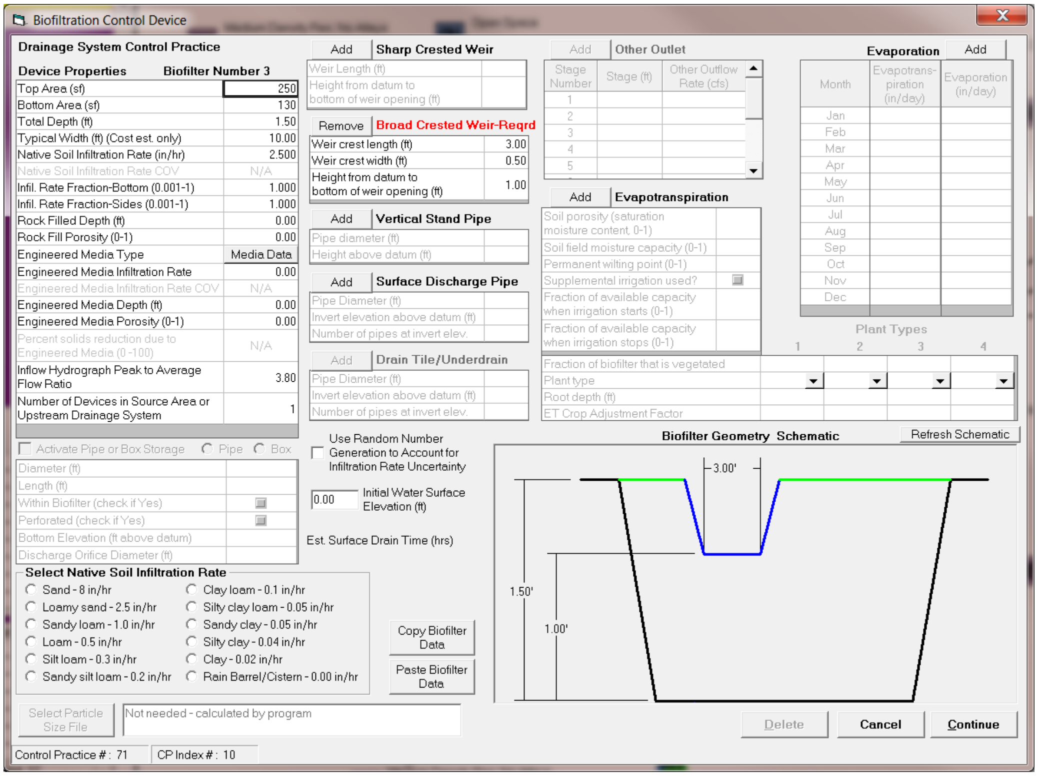


Figure 57: Curb-Cut Rain Garden (WinSLAMM).

Hydrodynamic Device

Table 6: 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

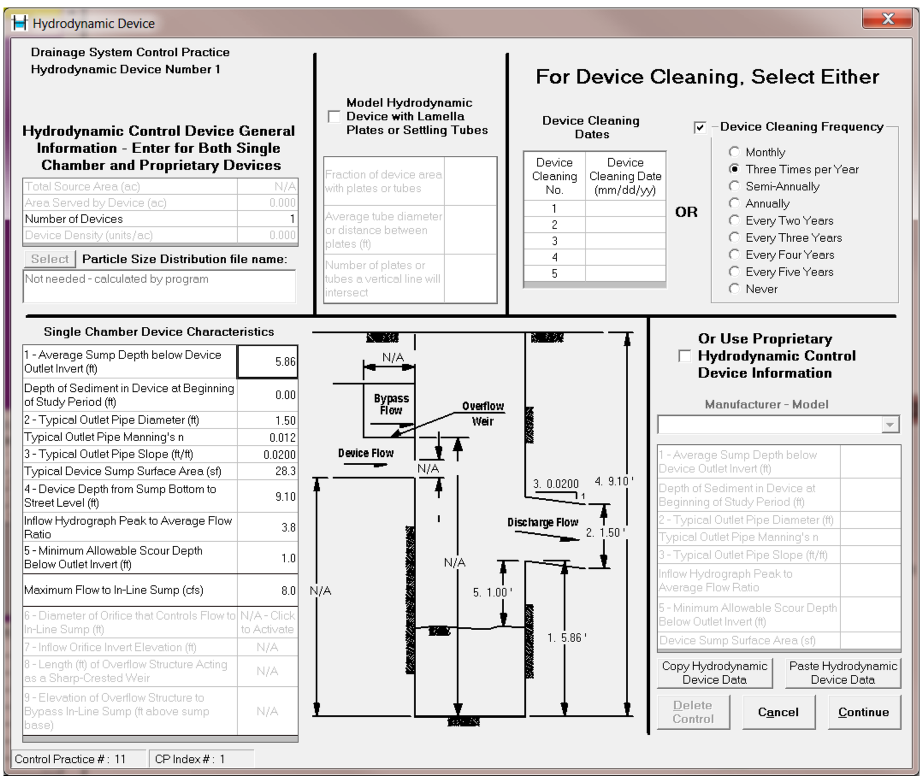


Figure 58: Hydrodynamic Device - 6' diameter modeled in SF-9 (WinSLAMM).

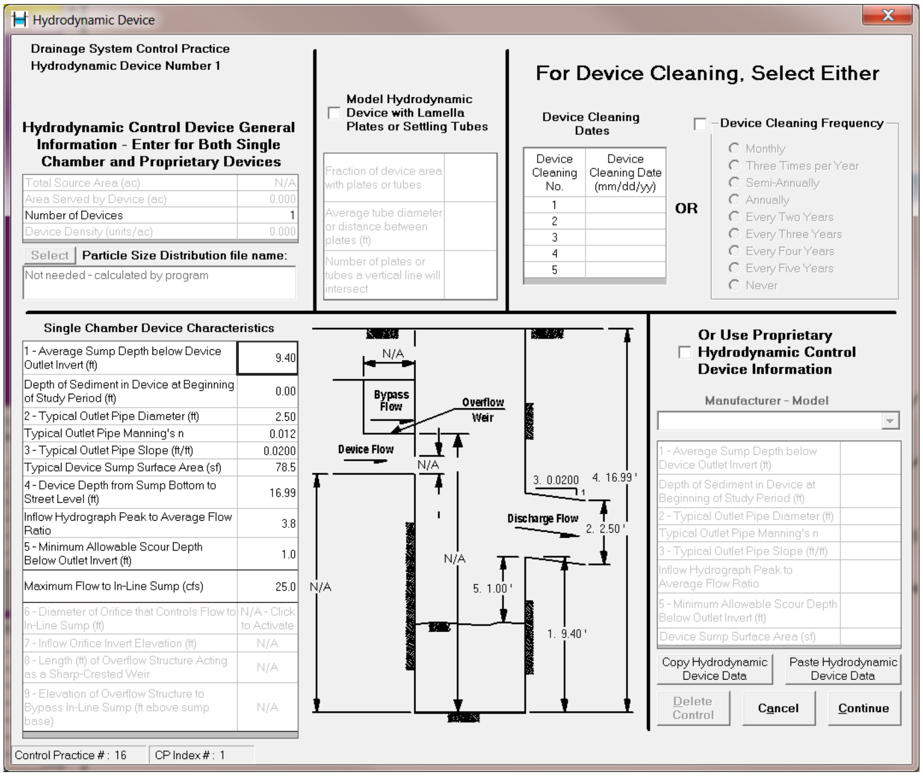


Figure 59: Hydrodynamic Device - 10' diameter modeled in SF-3 and SF-6 (WinSLAMM).

BMP Modification

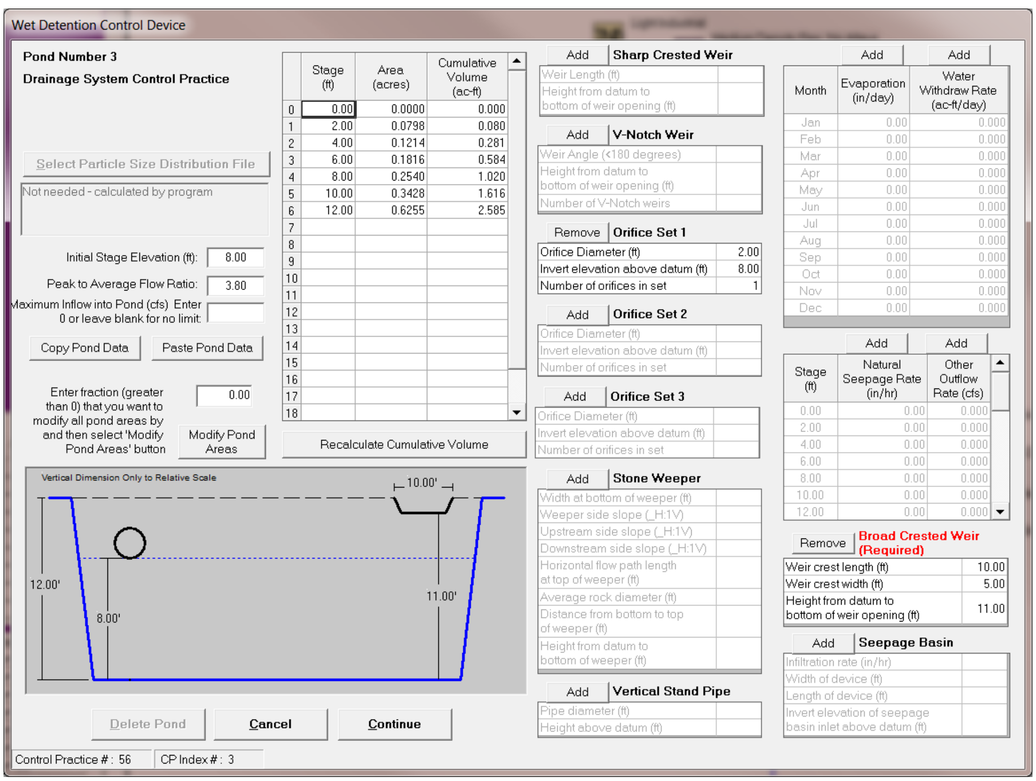


Figure 60: Stormwater pond modification at SWP 50 in SF-1 (WinSLAMM).

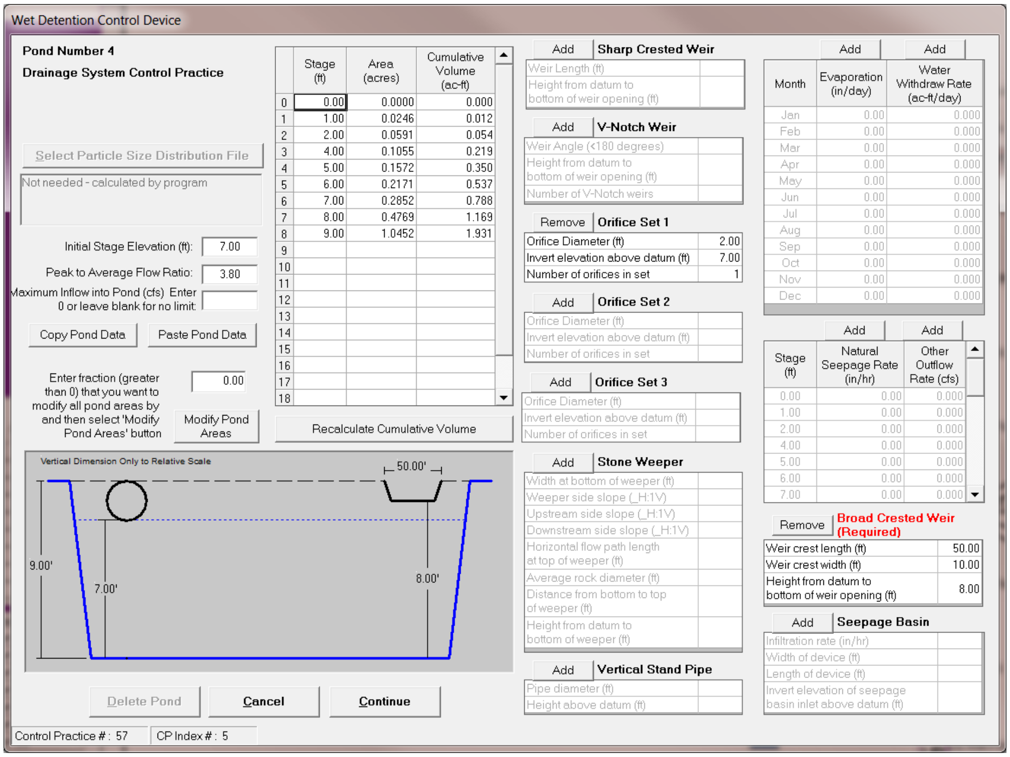


Figure 61: Stormwater pond modification at SWP116 in SF-1 (WinSLAMM).

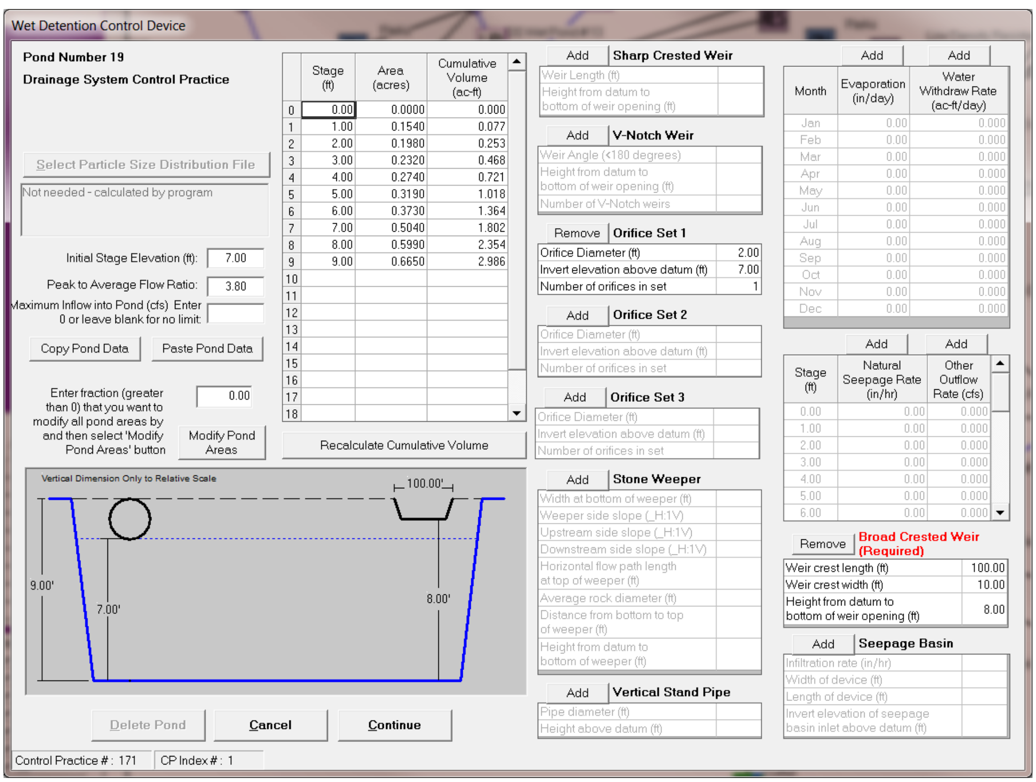


Figure 62: Stormwater pond modification at SWP85 in SF-8 (WinSLAMM).

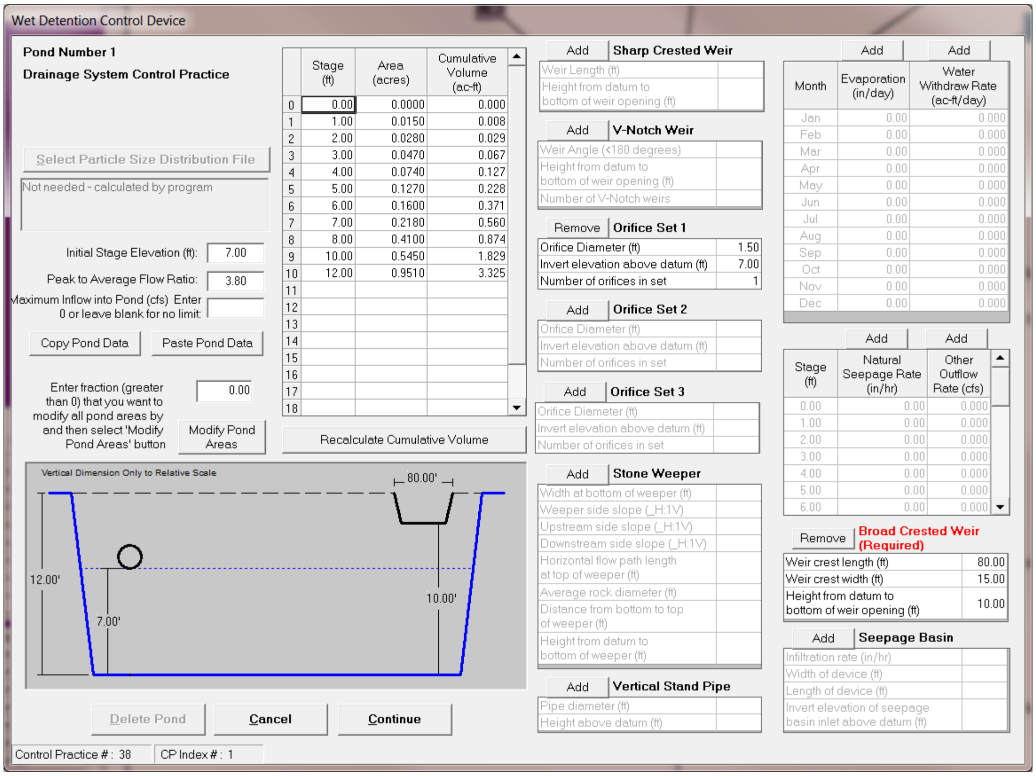


Figure 63: Stormwater pond modification at SWP8 in SF-11 (WinSLAMM).

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 challenging. 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.

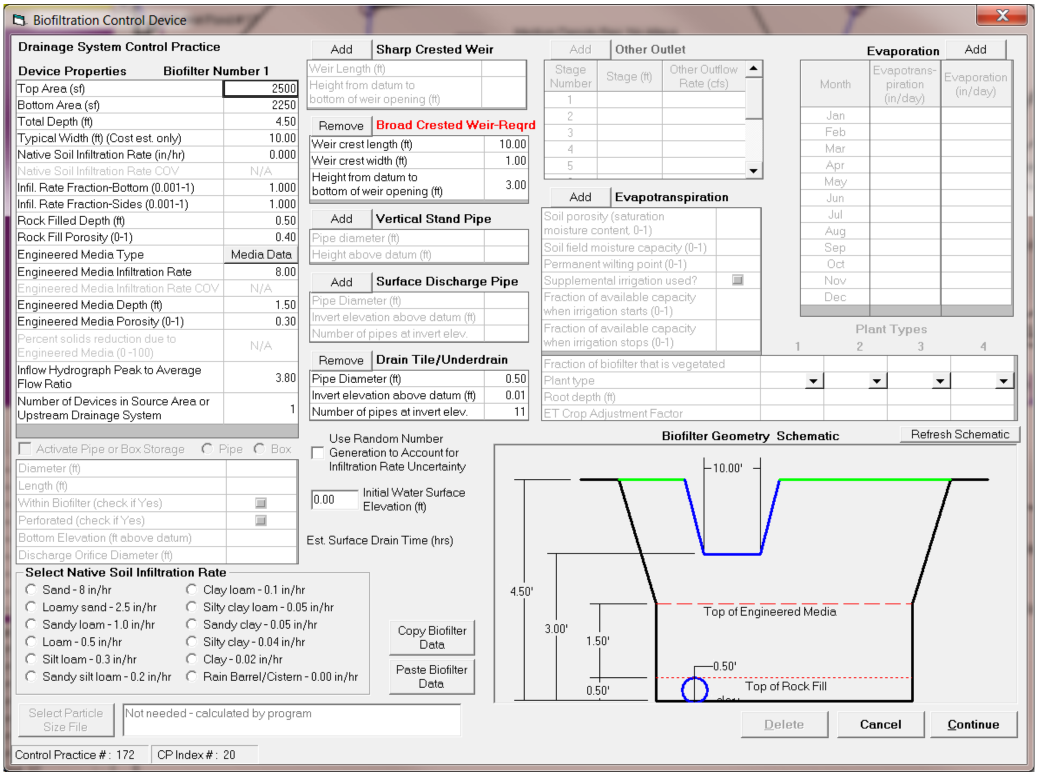


Figure 64: Iron enhanced sand filter pond bench at SWP123 in SF-8 (WinSLAMM).

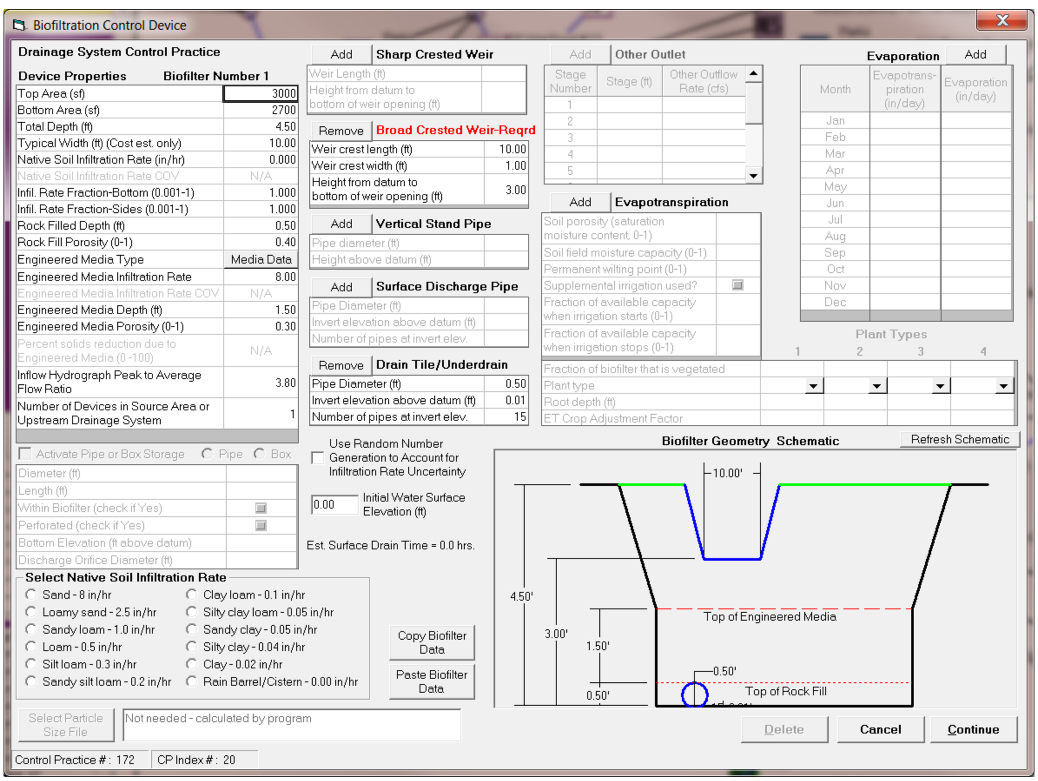


Figure 65: Iron enhanced sand filter pond bench at SWP85 in SF-8 (WinSLAMM).

Iron-enhanced Sand Filter Check Dam

With this BMP there are two processes that drive pollutant retention within the practice. First, the practice detains stormwater behind the dam, dropping particulate pollutants out of suspension. Secondly, any water that has been impounded by the dam can either pass through the dam (and its IESF) or be evapotranspired prior to passing through the dam. To mimic these processes within WinSLAMM two different models were created, each with the same land use, soil, and existing stormwater infrastructure conditions. Within both models a biofiltration drainage area control practice was installed.

To model the effect of detaining water behind the dam, a biofiltration control practice with the same ponding storage as the check dams was modeled. This practice did not have an underdrain and assumed very silty soils with no infiltration (Figure 66). Volume, TSS, and particulate phosphorus retention were determined from this model. For water passing through the filter, a similarly sized biofiltration control practice was modeled, but in this case was modeled with an underdrain (Figure 67). Dissolved phosphorus retention was determined from this model assuming that 80% of dissolved phosphorus flowing through the dam was retained (Erickson & Gulliver, 2010). Total phosphorus reduction was the summation of particulate and dissolved phosphorus reductions between the two models.

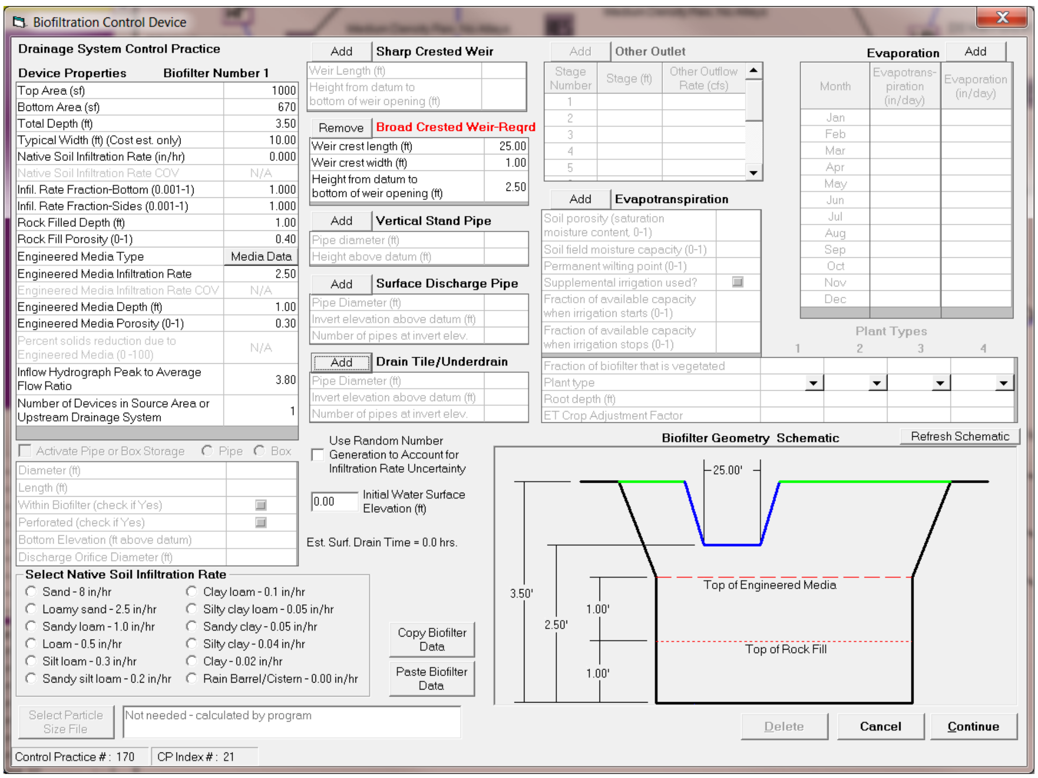


Figure 66: Iron-enhanced sand filter check dam in SF-8. Parameters model dam behind the iron-enhanced sand filter (WinSLAMM).

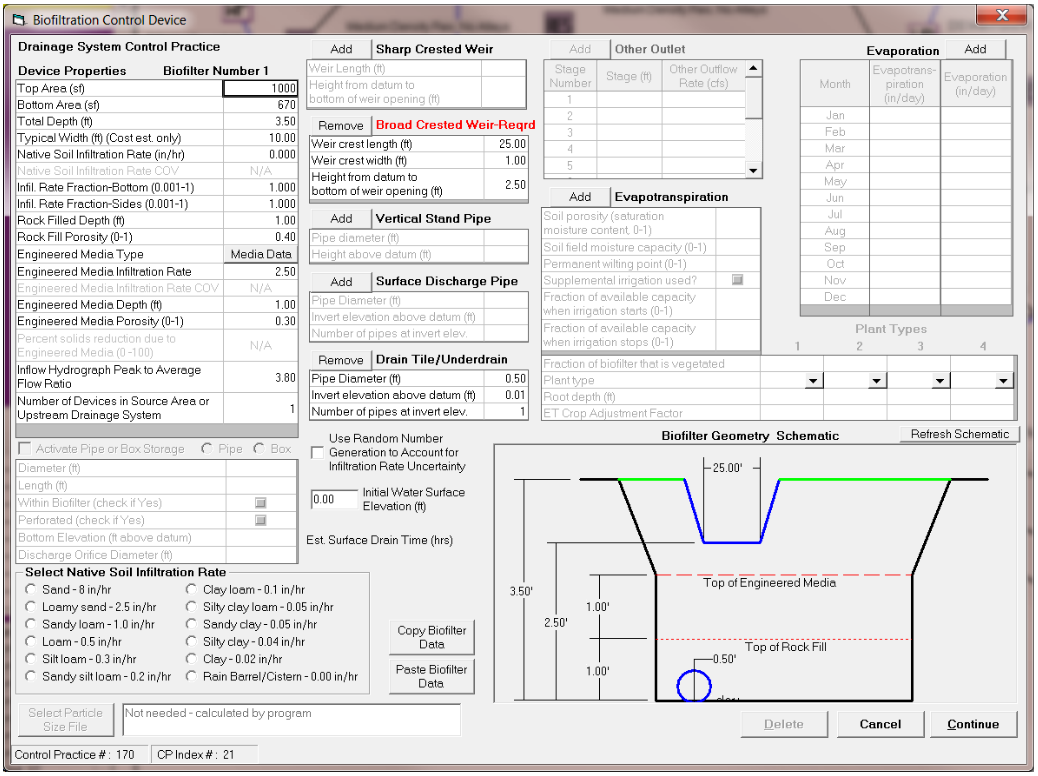


Figure 67: Iron-enhanced sand filter check dam in SF-8. Parameters model the iron-enhanced sand filter (WinSLAMM).

Permeable Pavement

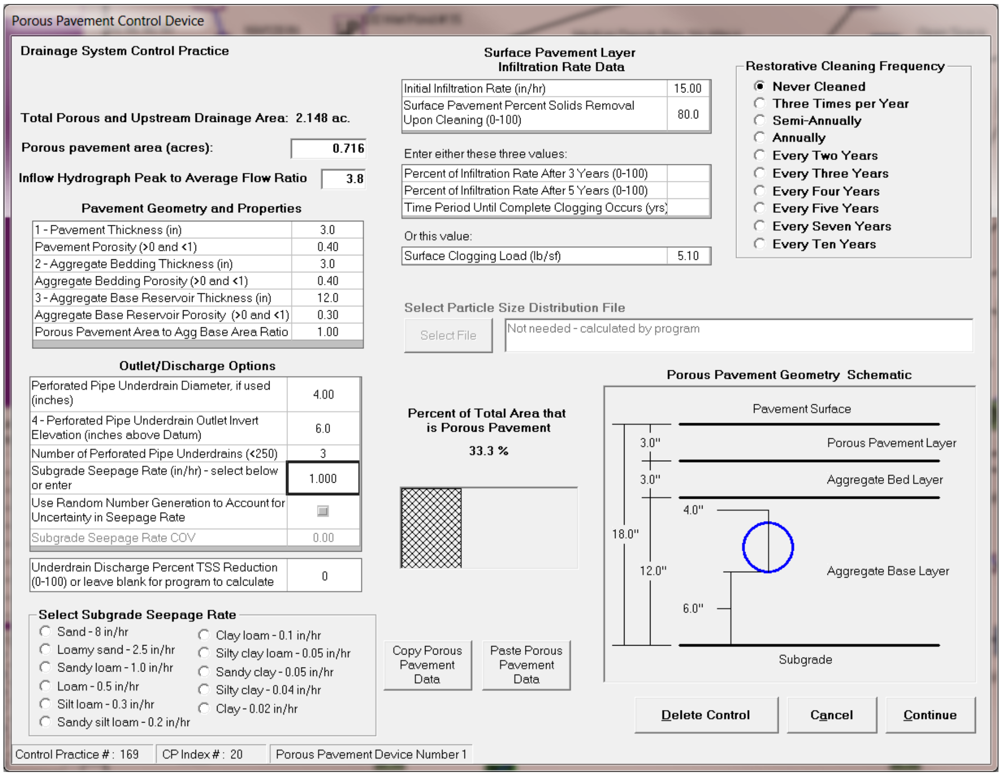


Figure 68: Permeable pavement at St. Francis High School, side parking lot in SF-8 (WinSLAMM).

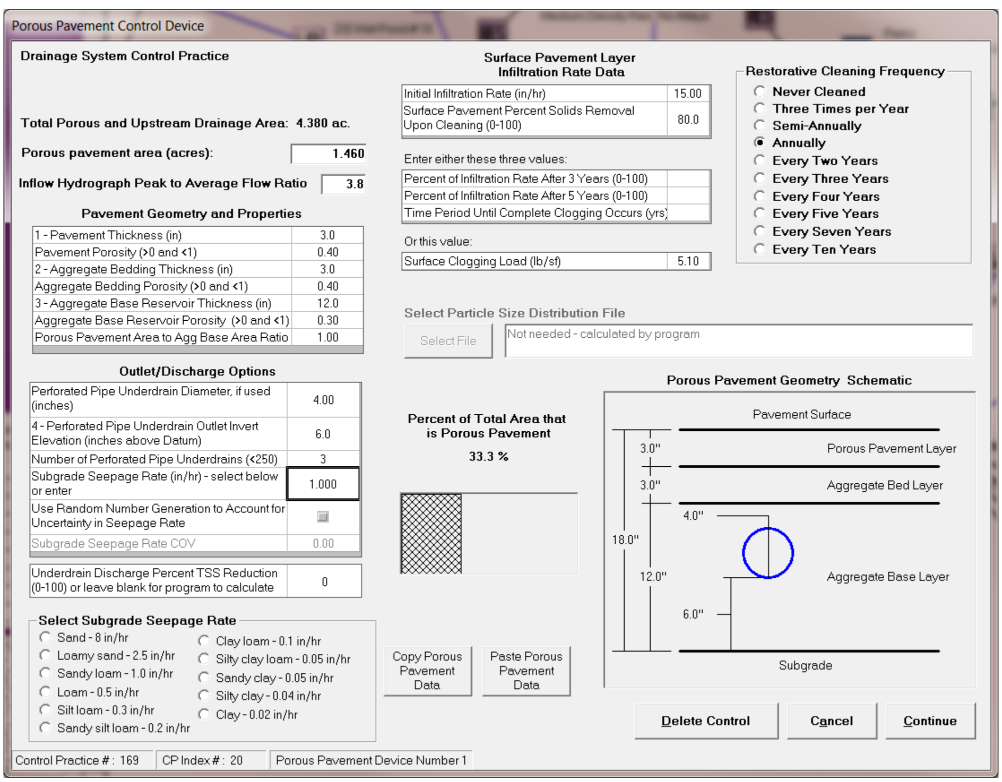


Figure 69: Permeable pavement at St. Francis High School, main parking lot in SF-8 (WinSLAMM).

Stormwater Reuse

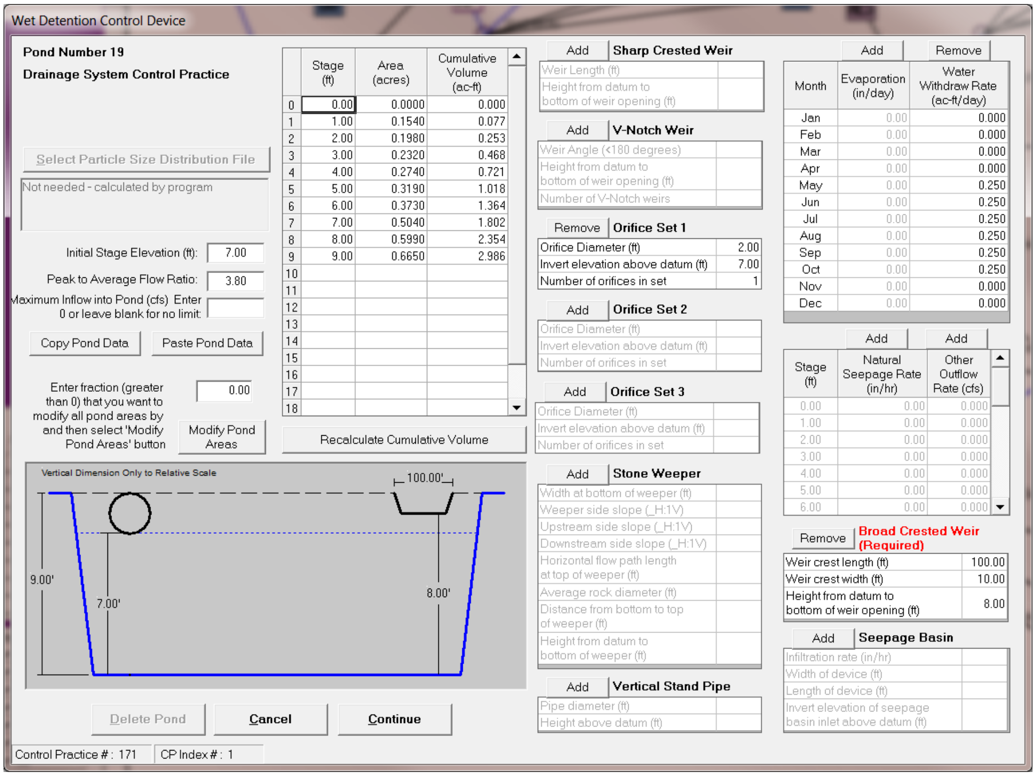


Figure 70: Stormwater Reuse at SWP85 in SF-8 (WinSLAMM).

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.

BMP Modification

Table 7: Catchment SF-1 – Pond Modification at SWP50.

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)	1,600	1,600	1,600
Cost To Excavate ($/cu-yd)	$20	$35	$50
Cost To Excavate (Total $)	$32,000	$56,000	$80,000
Other Construction Costs ($)	$85,000	$85,000	$85,000
Total Project Cost ($)	$117,000	$141,000	$165,000

Table 8: Catchment SF-1 – Pond Modification at SWP116.

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)	1,300	1,300	1,300
Cost To Excavate ($/cu-yd)	$20	$35	$50
Cost To Excavate (Total $)	$26,000	$45,500	$65,000
Other Construction Costs ($)	$85,000	$85,000	$85,000
Total Project Cost ($)	$111,000	$130,500	$150,000

Table 9: Catchment SF-8 – Pond Modification at SWP85.

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)	1,600	1,600	1,600
Cost To Excavate ($/cu-yd)	$20	$35	$50
Cost To Excavate (Total $)	$32,000	$56,000	$80,000
Other Construction Costs ($)	$85,000	$85,000	$85,000
Total Project Cost ($)	$117,000	$141,000	$165,000

Table 10: Catchment SF-11 – Pond Modification at SWP8.

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)	700	700	700
Cost To Excavate ($/cu-yd)	$20	$35	$50
Cost To Excavate (Total $)	$14,000	$24,500	$35,000
Other Construction Costs ($)	$85,000	$85,000	$85,000
Total Project Cost ($)	$99,000	$109,500	$120,000

Iron Enhanced Sand Filters

Table 11: Catchment SF- 8 – IESF Pond Bench at SWP85.

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
Clearing, Removal of Existing Infrastructure, and Pond Dewatering	Each	$ 12,000.00	1	$ 12,000.00
Common Excavation & Disposal	cu-yards	$ 40.00	440	$ 17,600.00
IESF Materials and Installation	sq-ft	$ 17.00	3,000	$ 51,000.00
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 =		$ 185,600.00

Table 12: Catchment SF-8 – IESF Pond Bench at SWP123.

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
Clearing, Removal of Existing Infrastructure, and Pond Dewatering	Each	$ 12,000.00	1	$ 12,000.00
Common Excavation & Disposal	cu-yards	$ 40.00	370	$ 14,800.00
IESF Materials and Installation	sq-ft	$ 17.00	2,500	$ 42,500.00
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 =		$ 174,300.00

Iron Enhanced Sand Filter Check Dams

Table 13: Catchment SF-8 – IESF Check Dam.

Activity	Units	Unit Price	Quantity	Unit Price
Design	each	$3,000.00	1	$3,000.00
Mobilization and Site Preparation	each	$3,000.00	1	$3,000.00
Engineered Soil Mix (5% iron by weight)	cu-yards	$275.00	3.1	$852.50
Rocks	cu-yards	$125.00	4.6	$575.00
Permeable Liner	per dam	$100.00	1	$100.00
Installation	per dam	$5,000.00	1	$5,000.00
Total for Project =				$12,527.50

Stormwater Reuse

Table 14: Catchment SF-8 –Stormwater Reuse at SWP85.

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

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 15: Cost-effectiveness of retrofits with respect to volume reduction. Projects 1 - 17. 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	6-A	54	Curb-Cut Rain Garden	Various locations in catchment	6	0.9-7.4	223-1,906	0.9-4.5	$15,844-$90,112	$225-$2,250	$837-$1,298
4	5-A	50	Curb-Cut Rain Garden	227th Ct. & 227th Ave.	5	0.4-1.6	56-358	0.5-1.7	$8,982-$35,928	$225-$900	$1,077-$1,250
2	8-G	68	Stormwater Reuse	St. Francis High School	8	12.3	2,434	20.7	$608,760	$3,000	$1,125
3	8-A	62	Curb-Cut Rain Garden	Various locations in catchment	8	0.5-3.7	82-659	1.1-3.8	$32,348-$81,860	$675-$2,025	$1,240-$1,558
5	2-A	39	Curb-Cut Rain Garden	Woodbine St. & 232nd Ave.	2	0.3-1.1	69-270	0.4-1.5	$15,844-$40,600	$225-$900	$1,512-$1,931
6	8-B	63	Permeable Pavement	St. Francis High School	8	5.3	1,586	4.1	$643,796	$48,000	$17,096
7	8-C	64	Permeable Pavement	St. Francis High School	8	1.4	420	1.9	$313,796	$23,250	$18,124
17	1-A	34	Pond Modification	St. Francis Blvd. & Stark Dr.	1	3.1	1,760	0	$122,840-$170,840	$1,300	N/A
17	1-B	35	Pond Modification	St. Francis Blvd. & 233rd Ave.	1	1.9	782	0	$116,840-$155,840	$1,300	N/A
17	3-A	43	Hydrodynamic Device	Bridge St. & Rum River Blvd.	3	0.7	374	0	$109,752	$630	N/A
17	6-B	55	Hydrodynamic Device	225th Lane	6	1.2	433	0	$109,752	$630	N/A
17	8-D	65	Pond Modification	St. Francis High School	8	3.1	1,760	0	$122,840-$170,840	$1,300	N/A
17	8-E	66	IESF Bench	St. Francis High School	8	8.5	0	0	$191,075	$689	N/A
17	8-F	67	IESF Bench	St. Francis High School	8	1.8	0	0	$179,775	$574	N/A
17	8-H	69	IESF Check Dam	Rum River Blvd. & Park Rd.	8	1.8	459	0	$15,448	$365	N/A
17	9-A	72	Hydrodynamic Device	Bridge Street	9	0.2	103	0	$28,752	$630	N/A
17	11-A	79	Pond Modification	227th Ave. & Poppy St.	11	0.9	343	0	$104,840-$125,840	$1,300	N/A

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

Appendix D – Soil Information

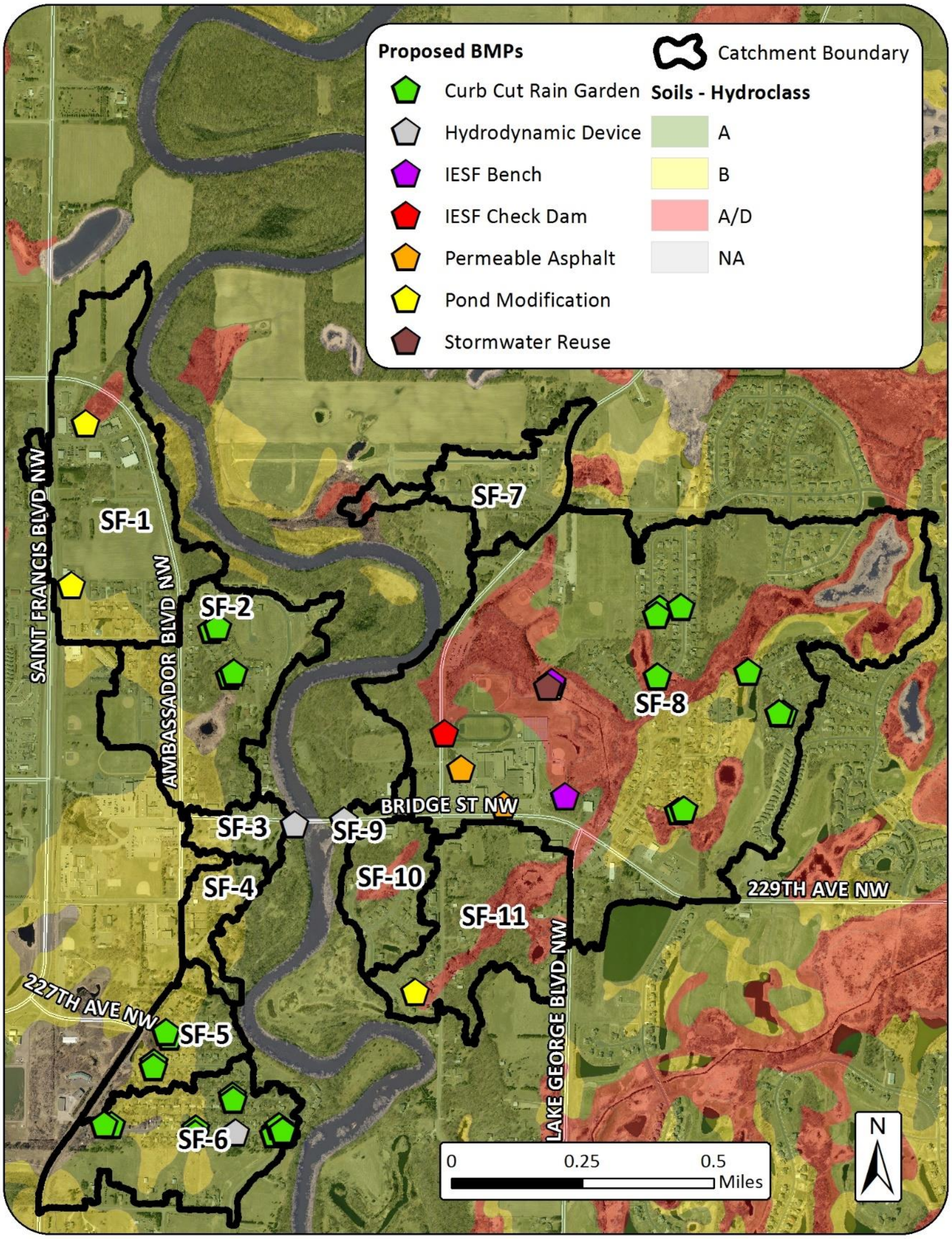


Figure 71: Soil hydroclass and proposed retrofit locations in the City of St. Francis.

Appendix E –Wellhead Protection Areas

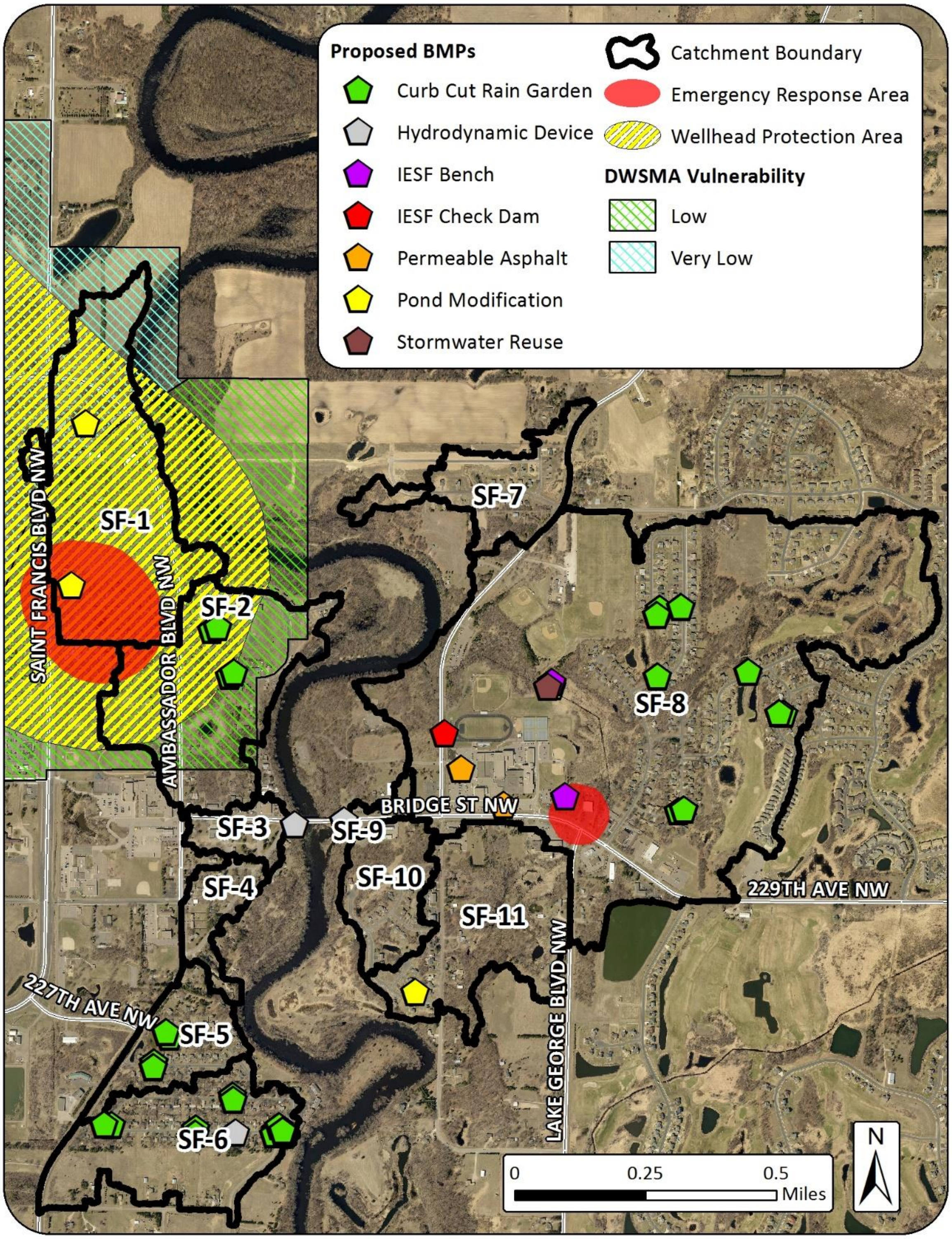


Figure 72: Wellhead protection areas and proposed retrofit locations in the City of St. Francis.