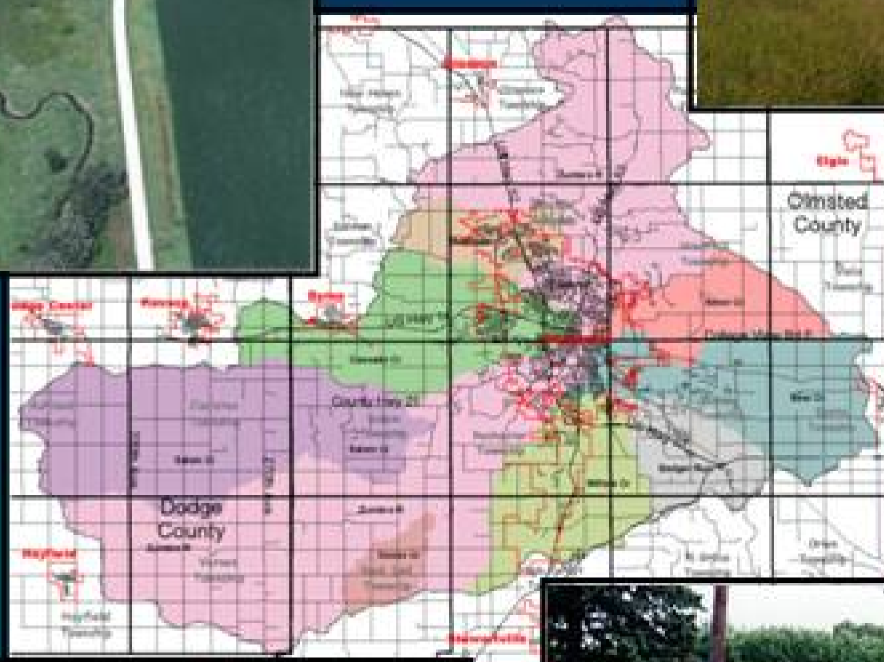
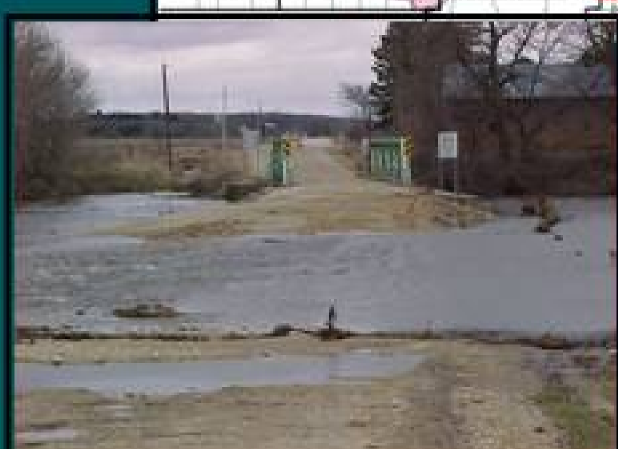
South Zumbro Watershed

Storm Water & Capital Improvement Plan

September 2003





Bonestroo Rosene Anderlik & Associates

South Zumbro Watershed
Storm Water and Capital Improvement Plan
Olmsted and Dodge Counties

September 2003

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Abbreviations

ADT	Average Daily Traffic
BALMM	Basin Alliance for the Lower Mississippi in Minnesota
BMP	Best Management Practice
BWSR	Board of Water and Soil Resources
CIP	Capital Improvement Program
CN	Curve Number (used for hydrologic modeling)
CR	County Road
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CSAH	County State Aid Highway
DNR	Department of Natural Resources
EQIP	Environmental Quality Incentives Program
FEMA	Federal Emergency Management Agency
FSA	USDA Farm Service Agency
GIS	Geographic Information System
LCMR	Legislative Commission on Minnesota Resources
LMC	League of Minnesota Cities
MEP	Maximum Extent Practicable
Mn/DOT	Minnesota Department of Transportation
MPCA	Minnesota Pollution Control Agency
MS4	Municipal Separate Storm Sewer System
MSP	Minneapolis-St. Paul International Airport
NO_3	Nitrate-Nitrogen
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NWI	National Wetland Inventory
OWML	Occoquan Watershed Monitoring Laboratory
PAC	Policy Advisory Committee
SCS	Soil Conservation Service
SWCD	Soil and Water Conservation District
SWMP	Storm Water Management Plan
SWPPP	Storm Water Pollution Prevention Plan
SZWSCIP	South Zumbro Watershed Storm Water and Capital Improvement Plan
TAC	Technical Advisory Committee
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSS	Total Suspended Solids
UA	Urbanized Area
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
WHIP	Wildlife Habitat Incentives Program
WRP	Wetlands Reserve Program

Glossary

Aggradation:	The process by which a river or stream raises the bed elevation from sediment deposition.
Attenuation:	The process by which a peak flow is reduced by using storage to delay the release of flows. Also used for a compound as the process by which its concentration is reduced over time, through absorption, adsorption, degradation, dilution, and/or transformation.
Base flow:	Low flow in rivers and streams that is usually maintained by ground water contribution and not by direct surface runoff or storm water.
Down-cutting:	The process by which a channel, river or stream erodes and lowers its bed elevation.
Drainageway:	Area of the landscape that conveys surface waters from rain storms, usually dry between storms.
Channelization:	Straightening and deepening streams so water will move faster, a marsh-drainage tactic that can interfere with waste assimilation capacity, disturb fish and wildlife habitats, and aggravate flooding.
Check dam:	A low structure (dam or weir, usually of rock) across a channel or stream to stabilize its slope and reduce erosion.
Depressional areas:	Areas with low elevations that retain water and sediments due to lack of surface drainage. Surface drainage can become active when water surface elevations exceed the lowest, controlling land surface elevation.
Eutrophication:	The slow aging process during which a lake, estuary, or bay evolves into a bog or marsh and eventually disappears. During the later stages of eutrophication the water body is choked by abundant plant life due to higher levels of nutritive compounds such as nitrogen and phosphorus. Human activities can accelerate the process.
Hydric soil:	A soil formed under conditions of water saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part of the soil.
Hydrograph:	The graph of flow against time at a specific location.
Overbank:	Area outside the main channel of a stream or river that conveys water flows during large rain storms.

Plug flow: Type of flow that occurs in tanks, basins, or ponds when a slug of water moves through without ever dispersing or mixing with the rest of the water flowing through.

Riparian: Refers to habitats, areas, lands or other features adjacent to rivers and streams. Riparian habitats have differing density, diversity, and productivity of plant and animal species relative to nearby uplands.

Sheet flow: Flow where the water depth is much smaller than the water width. Water molecules move parallel to each other without mixing (turbulent flow) or concentrating (concentrated flow).

Sheet-piling: Metal sheets that are joined to create weirs or walls, such as to hold water or soil to stabilize sloped lands.

Temporal variability: Variations in a parameter (such as rainfall) that occur as a function of time.

Waterway: Area of the landscape that conveys surface waters, usually without running dry.

Weir: A structure placed in a channel or stream, or at the outlet of a pond, dam or lake to measure and/or control flow.

South Zumbro Watershed

Storm Water and Capital Improvement Plan

Olmsted and Dodge Counties

Executive Summary

In the South Zumbro Watershed the alteration of the natural hydrology by roadways is now so extensive that the distinction between transportation and water management has become blurred.

As is the case in many rural and suburban areas across the country, road ditches in the watershed now function as the headwaters of the tributary streams—intersecting and redirecting upland drainages. The natural drainage system is bisected and influenced by culverts and bridges. These are also the points at which roadways are at the greatest risk of flooding and where road safety is the most compromised. To address these concerns, Olmsted and Dodge Counties decided to examine an approach that integrates storm water management with transportation planning design principals. *The South Zumbro Watershed Storm Water and Capital Improvement Plan* determined that implementing a watershed-based bridge replacement approach would:

- Reduce runoff flow volumes and velocities
- Improve water quality
- Lower transportation and maintenance costs
- Improve road safety
- And perhaps most importantly of all, provide enough cost savings to pay for the installation of upstream storm water management systems

The Minnesota Board of Water and Soil Resources (BWSR), Olmsted County, Dodge County, and the City of Rochester financed this study.

The Problem

Bridges and culverts have dramatically altered the landscape of the South Zumbro Watershed, specifically the drainage characteristics of our local waterways. Historically, bridges were not constructed with storm water (runoff) rate control in mind, but were designed to pass flows quickly downstream—a practice that results in hydraulic overloading, channel instability, degradation of recreational waters, and diminished wildlife habitat. These downstream problems are compounded because the stream corridors become isolated from the riparian wetlands and their floodplains that would, under natural conditions, help slow and temporarily store floodwaters. Without these critical storage areas, a cascading effect took place in the watershed; storm water flows increased as stream corridors were progressively degraded, resulting in undue stress on transportation infrastructure and a need for larger and larger bridges downstream.

The Solution

A big-picture, watershed-based approach that integrates storm water management with transportation planning can solve these problems. Rather than reactively designing individual bridges, this approach advocates installing strategically placed upstream flow-control structures to offset peak flows from different subwatersheds. By simply retaining water longer in the watershed's upper reaches, "flashy" storm water flows are attenuated and downstream bridge crossings can be reduced in size. Downsizing of the transportation infrastructure provides an overall costs savings compared to the traditional construction approach, and the installation of the upstream storm water management structures provide an added water quality benefit to downstream receiving waters.

The basic concept is to use riparian overflow areas for temporary water storage, and to create low berms and flow structures that provide rate control near the priority bridge crossings. When designed in conjunction with each other, these ecologically sensitive improvements can attenuate flows, stabilize streams, and improve water quality. Ultimately, Dodge and Olmsted Counties will be able to replace downstream bridges with less expensive, lower capacity culverts (or appropriately sized bridges), resulting in significant cost savings to their bridge replacement programs.

Benefits of a Watershed-Wide Approach

Economic Benefits – Improved upstream water management means bridges can be replaced with less costly, less maintenance-intensive culverts. The ultimate goal is to use funds from the Counties' bridge replacement programs, and other sources, to build upstream structures that allow smaller, less expensive stream crossings. Potential savings-to-cost ratios can be greater than 1.2 (savings is 1.2 times the cost) just by constructing the upstream improvements in the watershed.

Environmental Benefits – Temporarily storing water in natural upstream riparian areas gives pollutants an opportunity to settle rather than being immediately transported downstream. Ponding helps remove phosphorus and total suspended solids, improving water quality in the stream corridor. Reduced pollutant loads benefit downstream waterbodies such as Cascade Lake and Lake Zumbro. Also, because flow rates are decreased, channel erosion and bank sloughing decreases.

In summary, integrating storm water management and transportation efforts delivers the following benefits:

- Reduced runoff flow volumes and velocities, resulting in greater flood protection for bridges, roads, and property owners
- Improved water quality
- Stabilized drainage and stream systems
- Reduced sediment and streambank erosion
- Enhanced wildlife habitats
- Protected groundwater recharge areas
- Lower transportation construction and maintenance costs
- Increased connectivity between streams, wetlands and uplands
- Restored wetlands

The Process

Several different types of analytical tools were used in this study to evaluate the watershed conditions. Site assessments were conducted at priority bridge crossing locations to determine the hydrologically important characteristics of the drainage area. Hydrologic modeling was performed to identify potential locations for upstream flow control structures. Wetland assessments were conducted to determine where water storage could potentially impact each wetland basin, and where creating berms or flow control structures could enhance and/or restore historic water regimes. Finally, topographic data was analyzed with geographical information system (GIS) software to explore storage opportunities near each priority bridge crossing.

At the beginning of the study, a Technical Advisory Committee (TAC) and Policy Advisory Committee (PAC) were established to oversee the project. The TAC included land and water resource managers, technicians, and educators, as well as transportation engineers. This committee guided the development of the study and reviewed technical aspects of the project. The PAC included elected officials from the Dodge and Olmsted County Boards of Commissioners, Rochester City Council, Olmsted County Township Representatives, and the Olmsted Soil and Water Conservation District (see Appendix A). The core members of this committee represented the South Zumbro Watershed Joint Powers Board. The PAC provided support in analyzing specific policy initiatives and their implications, and with facilitating contact with local landowners.

As the study progressed, the Counties worked closely with individual stakeholders and riparian landowners to identify problem areas, priority locations for farm ponds, wetland restoration opportunities, and potential sites for the installation of the flow control structures. Based on their input and review of the data, an ordered ranking system was established to identify optimal locations for flow control structures, wetland restoration, upland restoration, and rural section rain gardens.

Implementation

The main source of financing for this watershed-based approach is expected to come from the savings in the Counties' bridge replacement programs. However, to demonstrate these savings, an initial investment from other sources (governmental programs and private grants) will be needed to kick-off the project. The Minnesota Department of Transportation (MnDOT) could facilitate this financing by recognizing the benefits of this integrated approach to bridge construction.

In addition, the new National Pollutant Discharge Elimination System (NPDES) Phase II Municipal Separate Storm Sewer Systems (MS4s) program provides an opportunity for local governmental units to work together to implement watershed-wide storm water management approaches. The MS4 program currently regulates storm water activities in a significant portion of the South Zumbro Watershed, including Olmsted County, the City of Rochester, Cascade Township, Haverhill Township, Marion Township, and Rochester Township. Cooperation is essential among these regulated communities. Working jointly on developing storm water best management practices (BMPs) can reduce storm water management costs, meet established water quantity and quality goals for recreational waterbodies, and improve the overall water quality of the entire watershed.

Costs

The study's financial analysis found that the savings achieved by using smaller bridges/culverts, while providing similar flood protection, could pay for the upstream improvement measures. The benefit/cost ratio is expected to be greater than 1.2 for the entire watershed, as estimated by the hydrologic and hydraulic study for the Cascade Creek Subwatershed (see Appendix C). The benefits could be even greater if environmental enhancements (sediment deposition and streambank erosion) were considered in the analysis.

A financing strategy must be established to implement this study's recommendations, particularly the storm water components that would be integrated with the Counties' road and bridge replacement programs. In addition to capturing other funding sources, Olmsted and Dodge Counties should integrate relevant storm water projects into their transportation improvement funding, as the program will generate immediate and direct savings and other benefits to their transportation system, among them, reduced construction and maintenance costs.

South Zumbro Watershed

Storm Water and Capital Improvement Plan

Olmsted and Dodge Counties

1 Introduction

This *South Zumbro Watershed Storm Water and Capital Improvement Plan* is a result of a collaborative effort among Olmsted and Dodge Counties, the City of Rochester and several Townships to address storm water management concerns and the high cost of building and maintaining bridges. This plan studied a new approach to transportation planning that integrates storm water management with innovative bridge design principals. “Flashy” floods or peak flows have had a major impact on infrastructure and the environmental quality of the stream corridors. County Comprehensive Water Management Plans (Dodge, 1995 and Olmsted, 1998) and many other studies have documented these storm water concerns.

Olmsted and Dodge counties expend significant resources on bridge capital improvements. For example, Olmsted County’s 2001-2005 Capital Improvement Program estimates expenditures of $13,395,000 to preserve and improve its bridges. Maintenance and inspection efforts increase operating costs. Combining transportation planning with water resources planning can help reduce costs, improve flood protection, and avoid the domino effect that can lead to bigger and bigger bridge structures.

This study’s purpose was to develop a plan that identifies opportunities to downsize bridges and improve water quality and wildlife habitat by using riparian buffers, installing rural section rain gardens, restoring wetlands, controlling stream bank erosion, and managing storm water. This plan elaborates on the virtues of a watershed-wide approach to generate cost savings in the bridge replacement and maintenance program.

This study was financed by:

- The Minnesota Future Resources Fund, administered by the Legislative Commission on Minnesota Resources (LCMR), through the Board of Water and Soil Resources’ (BWSR) Local Water Planning Challenge Grant Program;
- Olmsted County;
- Dodge County; and
- The City of Rochester

The geographic extent of this plan’s study area is illustrated in Figure 1.

1.1 Background—Historical Storm Water Planning Efforts

The well-drained terrain of the South Zumbro Watershed predisposes the area to flash flooding. In response to a series of record floods that occurred in the area from 1951 to 1978, the South Zumbro Flood Control Project was initiated to reduce watershed flooding. The Project included channelizing the riverbanks in the City of Rochester and constructing seven flood control reservoirs in the upper reaches of the watershed: Silver Creek (SR-2), Chester Woods Lake on Bear Creek (BR-1), Willow Creek (WR-4 and WR-6A), and North Fork of Cascade Creek (KR-3, KR-6 and KR-7).

This reservoir was built for Silver Creek (SR-2). With a wet pool area of about 98 acres serving a 9.90 square mile drainage area, the reservoir attenuates flows to a maximum of 135 cubic feet per second for greater than 100-year storms.

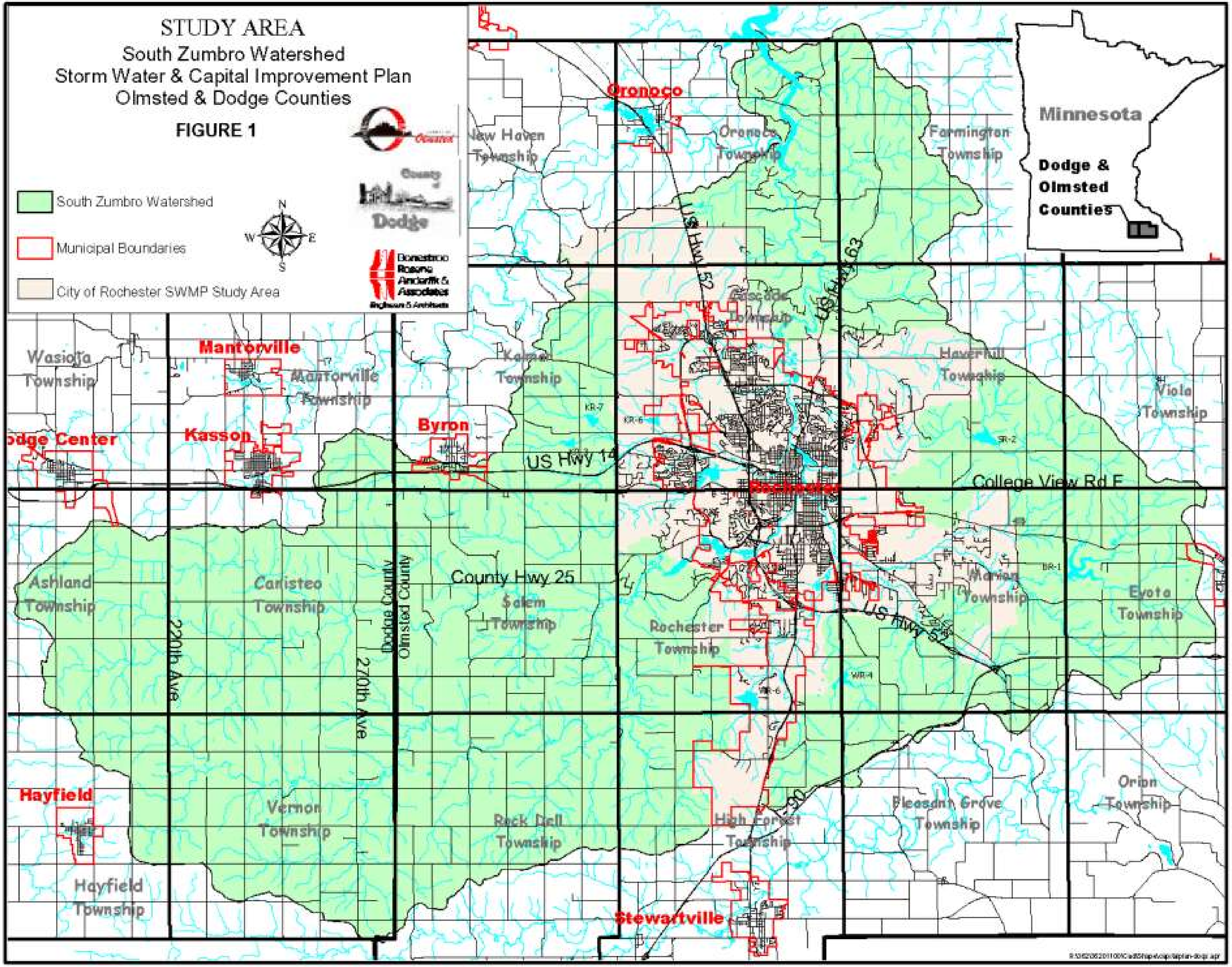
Olmsted County's updated Comprehensive Water Management Plan (1998) identified numerous issues and specified priority action items, including:

- Supporting the development of a surface water runoff management plan for the South Zumbro Watershed area within Olmsted County to identify priority areas for implementing water and soil conservation practices
- Establishing landscape management strategies that preserve, restore, and enhance natural systems to provide retention, nutrient recycling, pollutant degradation, biological diversity, and recreation

In 1995, the City of Rochester started a storm water management planning process that culminated in the preparation of its Storm Water Management Plan (SWMP 1997, revised 1999) to address storm water impacts from urban development. Some of the plan's relevant storm water management goals include:

- Improving water quality in all protected waterbodies by treating runoff from upstream drainage areas
- Protecting groundwater quality and quantity by allowing for passive treatment and storm water infiltration
- Promoting groundwater recharge by creating additional ponding areas
- Reducing to the greatest practical extent the capital expenditures necessary to upgrade the storm water system to meet water quantity and quality standards

(Opposite page, Figure 1)



STUDY AREA
South Zumbro Watershed
Storm Water & Capital Improvement Plan
Olmsted & Dodge Counties
FIGURE 1
South Zumbro Watershed
Municipal Boundaries
City of Rochester SWMP Study Area
N
S
E
W
County of Dodge
Bonestroo Rosene Anderlik & Associates
Minnesota
Dodge & Olmsted Counties
Oronoco
New Haven Township
Oronoco Township
Farmington Township
US Hwy 52
US Hwy 63
Cascade Township
Mantorville
Wasioja Township
Mantorville Township
Kalmar Township
Haverhill Township
Viola Township
Kasson
Byron
Dodge Center
US Hwy 14
Rochester
College View Rd E
Ashland Township
Canisteo Township
County Hwy 25
Salem Township
Marion Township
Eyota Township
220th Ave
270th Ave
Dodge County
Olmsted County
Rochester Township
US Hwy 52
Hayfield
Vernon Township
Rock Dell Township
High Forest Township
Pleasant Grove Township
Orion Township
I-90
Hayfield Township
Stewartville

In 1996, Dodge County's Comprehensive Water Management Plan identified priority actions to:

- Inventory, study, and protect wetlands that provide significant recharge to groundwater, reduce flooding, and reduce soil transport
- Provide incentives to landowners to implement best management practices for storm water management

In 2001, the Southeast Minnesota Water Resources Board and the Basin Alliance for the Lower Mississippi in Minnesota (BALMM) addressed storm water-related problems associated with changes in land use since pre-European settlement. BALMM published the *Lower Mississippi River 2001 Basin Plan Scoping Document* that identifies storm water-related problems in southeastern Minnesota. The BALMM document addresses the goals and objectives of the Total Maximum Daily Loads (TMDL) established for fecal coliform in the Lower Mississippi River Basin.

Led by Olmsted and Dodge Counties, the *South Zumbro Watershed Storm Water and Capital Improvement Plan* (SZWSCIP) efforts began in 2001. This document provides a strategy for building flow control structures to downsize bridge crossings while improving wildlife habitat. It also identifies opportunities for establishing rural rain garden demonstration projects to enhance water quality protection. As illustrated in Figure 1, it concentrates on areas not already studied in the City of Rochester's Storm Water Management Plan.

1.2 Objective

In the South Zumbro Watershed (see Map 1, large format, in pocket at end of document) roadways have altered natural hydrology so extensively that the distinction between transportation and water management has become blurred. In many rural and suburban areas of the country, road ditches now function as the headwaters of the tributary streams—intersecting and redirecting upland drainages. The natural drainage systems have become dissected and influenced by culverts and bridges. These are also the points at which roadways are at the greatest risk for flooding and where road safety is most compromised.

A unique strategy for the South Zumbro Watershed is to integrate storm water management and transportation planning, specifically, the bridge replacement program. Done effectively, this approach will reduce runoff flow volumes and velocities, improve water quality, stabilize drainage and stream systems, reduce sediment and downstream flooding damage, enhance wildlife habitat, lower transportation construction and maintenance costs, and improve road safety.

Implementation strategies include protecting and restoring sensitive areas such as wetlands, floodplains, groundwater recharge areas, steep slopes, wildlife habitats, and natural communities. The project focuses on providing demonstration sites for ecologically compatible flow management facilities to reduce flooding, prevent sediment damage, reduce bridge-crossing capacities, and enhance storm water quality in the watershed.

Watershed-Based Approach

A watershed-based approach is proposed as a basis for appropriately sizing bridges, taking into account the natural flow attenuation (slowing and reducing) function of the existing floodplain areas in the stream corridor (illustrated in the photo on the right). This plan focuses on the bridges listed in the Capital Improvement Plans of Olmsted and Dodge Counties to:

- Identify ponding and flow attenuation potential
- Assess environmental impacts and potential benefits
- Select high priority improvements
- Assess priority wetlands and uplands for enhancement or restoration potential
- Estimate water quality benefits

Low berm flow-control structures that optimize the use of existing natural storage are proposed to attenuate peak flows. This allows a) the downsizing of current bridges, and/or b) achievement of a higher level of service at the bridge crossing (greater flood protection). For illustrations and more details on the attenuation concept refer to Section 3.2.1 on page 17, or Section 3.2.2 on page 20 for the flow control structures.

In addition, the use of rain gardens for rural applications was explored to identify demonstration project opportunities. Rain gardens are starting to show great potential as a storm water best management practice (BMP) for improving surface water quality and promoting ground water recharge. For more details refer to Rural Section Rain Gardens Section 4.3 (page 44).

The Problem

Bridges, channelization, drain tile, and wetland drainage are examples of watershed alterations that accelerate runoff and speed the delivery of sediment to downstream receiving waters. Over the years, bridges in agricultural areas have been built to maximize row crop production, minimize localized flooding, and provide safe transportation routes during flood-events. The bridge designer's main goal was to provide a large enough span so as not to interfere with the channel's ability to rapidly convey water downstream. Little if any rate control was considered. On the contrary, bridge crossings were often designed to pass flows quickly downstream, even flows resulting from large rain events.

Once the first bridges in the watershed were built, a cascading effect took place, forcing the conveyance capacity of downstream bridges to increase over time. As the bridges were replaced and their capacities further increased, the cascading effect was further compounded. Today's transportation and highway engineers replace bridges the same way they have for the last two centuries—they evaluate the existing capacity of the structure and either maintain or enlarge it, contributing to the cascading effect and causing channel instability, flooding problems, and downstream water quality degradation.

Often, channel down-cutting due to hydraulic overloading isolates creek channels from riparian wetlands and floodplains. Under natural conditions, these riparian wetlands lie within the floodplain that would slow and temporarily store floodwaters, allowing pollutants like sediments, particle-bound nutrients, and bacteria to settle in a lower-energy environment outside the main channel. The floodplains in these altered watersheds now rarely receive the overbank discharge from the frequent small and moderate-sized runoff events that are responsible for the majority of watershed pollutant loading.

The Solution

A proactive watershed-wide approach should replace the reactive practice of designing individual bridges. Through a systematic hydrologic analysis, opportunities have been identified to control storm water flows and replace bridges and culverts at lower capacity levels. The Counties worked closely with stakeholders and riparian landowners to identify high-priority locations where ecologically sensitive flow control structures could be built to attenuate flows and stabilize streams.

Strategies to slow flow in main channels during runoff events will cause the water to backup into upstream overbank areas dominated by riparian wetlands, where floodwaters can be temporarily stored. Such flow control would be provided by berms and a stable control structures that blend with stream bottomland settings. This approach will allow the Counties to replace downstream bridges with less expensive, lower capacity culverts, or more appropriately sized bridges.

Other BMPs can be implemented to improve water quality. These include installation of rural section rain gardens for treating runoff, such as sand and salt, along the roadways.

Benefits of a Watershed-Based Approach

Cost Savings – The long-term maintenance and replacement costs associated with bridges spanning small- and medium-sized waterways is a substantial burden to local governments, driven largely by the legitimate concern for public safety.

The watershed approach helps local governments determine where bridges can be replaced with less maintenance-intensive, and less costly, culverts by taking advantage of opportunities for better water management upstream. The ultimate goal is to invest funds saved from the bridge replacement program to build upstream structures that improve conditions in the stream corridor and result in smaller, less expensive stream crossings.

Environmental Benefits –The natural weirs and berms that slow water and reduce downstream discharge rates will also cause runoff to backup into, and be temporarily stored in, upstream riparian areas. In this lower-energy environment, sediments, particle-bound nutrients, and bacteria can settle out and be trapped before the water passes through the structure.

Natural vegetation in the riparian overbank area traps much of this material. Further, by decreasing channel flow rates, channel stability should increase and channel erosion/bank-sloughing should decrease. The resulting decrease in sediment loads will benefit downstream waterbodies such as Rochester's Cascade Lake, which has been identified as a high priority recreational resource in both the City and County water management plans.

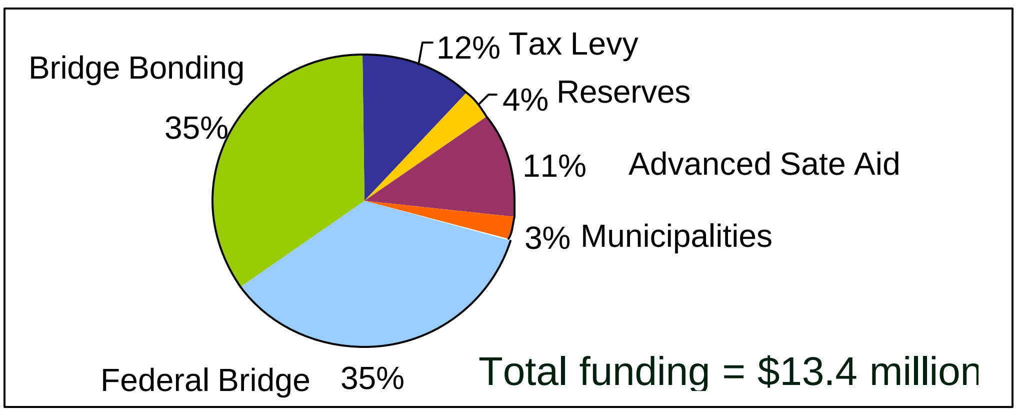
The weirs will be compatible with the existing stream biota. For example, a low-flow "notch" in the weir will let fish and other mobile organisms in the stream environment pass freely (see more detail and photos in Section 3.2.2, page 20). Finally, to improve the social acceptability of the projects to riparian landowners (virtually all of whom are farmers), deeper "farm ponds" could be built in parts of the riparian overbank areas. These farm ponds would provide a non-potable water supply, wildlife habitat, and a recreational amenity for the landowners. Farm pond Illustrations are presented in Section 3.2.2, page 21.

The watershed-based approach provides a new beginning to restoring natural stream corridors and enhancing environmental features, and provides connectivity between streams, wetlands, and uplands for wildlife use.

1.3 Bridge Replacement and Capital Improvement Programs

Olmsted County's Capital Improvement Program addresses road improvements and bridge replacements with a 5- and 20-year plan. The five-year plan includes an estimated $72,211,700 for road and bridge projects. Of this amount, $13,395,000 is for preservation and system improvement/upgrade projects for bridges. An additional $11,460,000 (for bridges only) is estimated in the 20-year plan.

Funding for bridge projects comes from several sources, which include tax levy dollars, State Aid, Federal Bridge, and Bridge Bonding. The chart below shows the estimated source distribution for the five-year Olmsted County plan.



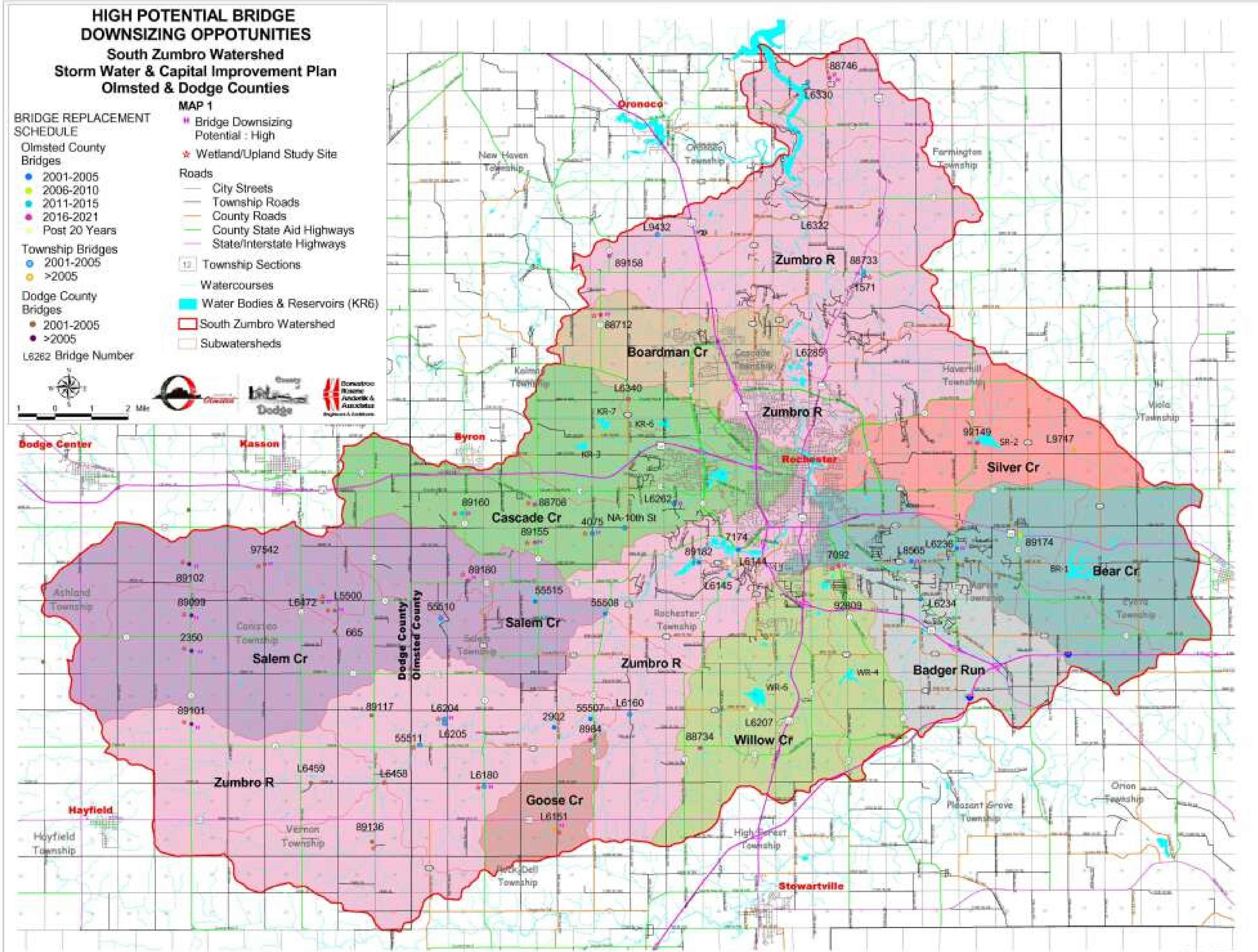
Dodge County also has a Capital Improvement Program, concentrating on a five-year plan. Improvements are planned based on financial availability, and depend mainly on State Aid resources.

The order in which bridges are replaced usually depends on factors such as sufficiency rating, average daily traffic (ADT), safety, frequency of flooding, and access. Fund availability is often the most critical factor in the replacement/improvement of bridges and roads.

Map 1 illustrates the bridges that are part of the Counties' improvement programs. In Olmsted County it also includes Township bridges.

1.4 Stakeholders and Technical and Multi-County Policy Advisory Committees

Stakeholder involvement is the key to the development and implementation of a successful storm water management program. Stakeholders include community leaders, residents, and


HIGH POTENTIAL BRIDGE
DOWNSIZING OPPOTUNITIES
South Zumbro Watershed
Storm Water & Capital Improvement Plan
Olmsted & Dodge Counties
MAP 1
BRIDGE REPLACEMENT SCHEDULE
Olmsted County Bridges
2001-2005
2006-2010
2011-2015
2016-2021
Post 20 Years
Township Bridges
2001-2005
>2005
Dodge County Bridges
2001-2005
>2005
L6262 Bridge Number
Bridge Downsizing Potential : High
Wetland/Upland Study Site
Roads
City Streets
Township Roads
County Roads
County State Aid Highways
State/Interstate Highways
Township Sections
Watercourses
Water Bodies & Reservoirs (KR6)
South Zumbro Watershed
Subwatersheds
Dodge
Oronoco
Dodge Center
Kasson
Byron
Rochester
Hayfield
Stowartville
Zumbro R
Boardman Cr
Cascade Cr
Salem Cr
Silver Cr
Bear Cr
Badger Run
Willow Cr
Goose Cr
Dodge County
Olmsted County
New Haven Township
Farmington Township
Haverhill Township
Viola Township
Rochester Township
Hayfield Township
Vernon Township
Pleasant Grove Township
Orion Township
High Forest Township
88746
L6330
L9432
L6322
89158
88733
1571
88712
L6285
L6340
KR-7
KR-6
KR-3
92149
SR-2
L9747
89160
88706
L6262
89155
4075
NA-10th St
97542
89180
89102
89099
L6472
L5500
665
2350
55515
55510
55508
7174
89182
L6144
L6145
7092
L6236
L6565
89174
BR-1
L6234
92809
WR-4
WR-5
L6207
88734
89101
89117
L6204
L6205
55511
2902
55507
8984
L6160
L6459
L6458
L6180
L6151
89136

property owners, along with elected officials or representatives. Their participation in the planning process helps identify critical issues and effective solutions.

The stakeholders participated directly in this project through a Technical Advisory Committee (TAC) and a Multi-County Policy Advisory Committee (PAC). (A list of members is included in Appendix A.) The TAC included land and water resource managers, technicians, and educators, as well as transportation engineers from various agencies and departments. The PAC included elected officials from the Dodge and Olmsted County Board of Commissioners, Rochester City Council, Olmsted County Township Representatives, and the Olmsted Soil and Water Conservation District.

The PAC provided support in analyzing policy implications and offering perspectives, approaches, and guidelines for implementing the plan. PAC members also facilitated contacts with local landowners interested in the project.

The TAC guided and reviewed the technical aspects of the project. The members of the committee contributed valuable information and were instrumental in reaching general stakeholders, particularly those interested in developing demonstration sites on their property.

2 South Zumbro Watershed General Description

2.1 Watershed Description

A tributary to the Mississippi River, the Zumbro River drains a mostly agricultural watershed dominated by row crops. This river as had moderate to severe water quality problems, including high suspended sediment concentrations, fecal coliform, and nutrients such as nitrates and phosphorous (BALMM 2001). Rapid urbanization, suburban development, and agricultural land use have impacted water quality of the river and the stream corridors.

The South Fork of the Zumbro River drains approximately a 297,000-acre watershed in Olmsted and Dodge Counties. It includes the following Townships (see Figure 1, opposite to page 2):

Dodge County

- Ashland
- Hayfield
- Mantorville
- Canisteo
- Vernon

Olmsted County

- Kalmar
- Salem
- Rock Dell

Olmsted County (continued)

- Oronoco
- Cascade
- Rochester
- High Forest
- Farmington
- Haverhill
- Marion
- Pleasant Grove
- Viola
- Eyota

The South Zumbro Watershed is located in a karst geologic region, with features that promote high infiltration of surface waters into ground water. As a result, surface water flows can be lower than in other geologic settings. Fractured limestone and sinkholes create conduits that increase the surface water recharge into the region's aquifers, which increases the risk of ground water pollution.

This mature landscape setting has a well-developed, intricate drainage system, with wetlands located in the headwaters and along floodplains. However, current land use changes have reduced the watershed's natural water storage and retention capacity. As a result, stream flows are more "flashy" and have lower base flows. The combination accelerates stream bank erosion and degrades land and aquatic ecosystems that harbor wildlife.

Flashy storm water flows result from degraded stream corridors and wetlands, and decreased water retention in fields. In the South Zumbro Watershed, this occurs even for rainfall events that occur frequently, such as less than 2.5 inches of precipitation in 24 hours. Flashy flows severely hinder stream stability and aquatic habitat. Historically, wetlands helped regulate these flows. Although many wetlands remain, streambed undercutting has degraded their ability to control storm water flows. Implementing minor flow control improvements can restore or even enhance the wetland's natural function to retain and treat storm water.

Table 2-1 shows the 24-hour precipitation for different storm frequencies (and probability of occurrence in a year) for Rochester, which are valid for the South Zumbro Watershed. These values result from precipitation statistics and are used for hydrologic/hydraulic design of bridges and storm water infrastructure. For example, 6.2 inches is the 24-hour precipitation associated with the 100-year storm, which has a one percent probability of occurring in a given year.

Table 2-1 – 24-hour precipitation frequency/probability for Rochester, MN

Storm frequency (years)	1	2	5	10	25	50	100
Probability of Occurrence in a year (%)	100	50	20	10	4	2	1
24-hr Precipitation (inches)	2.5	3.0	3.8	4.3	4.8	5.5	6.2

Monthly and annual normal precipitation averages for the Rochester and Minneapolis Airports are presented in Table 2-2; the Minneapolis station is often used for reference. Statistically, July is the wettest month in Rochester. While normal precipitation may show some variation within the South Zumbro Watershed, individual storms are highly variable spatially. As a result, daily rainfall can differ by several inches between two sub-areas in the watershed.

Table 2-2 – Normal precipitations for Rochester and Minneapolis Airports

Normal Precipitation in inches

Station	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Rochester Airport	0.94	0.75	1.88	3.01	3.53	4.00	4.61	4.33	3.12	2.2	2.01	1.02	31.4
Minneapolis Airport	1.04	0.79	1.86	2.31	3.24	4.34	4.04	4.05	2.69	2.11	1.94	1.00	29.41

Source: Midwest Regional Climate Center-Illinois State Water Survey and National Climate Data Center (http://mcc.sws.uiuc.edu/Precip/MN) Data: 1971-2000 NCDC Normals

To illustrate the high temporal variability in precipitation, Table 2-3 shows the precipitation extremes for the Rochester Airport. Notice that July 1978 was when the worst flood was recorded in the South Zumbro River at Rochester.

Table 2-3 – Precipitation extremes for Rochester Airport (MN)

Period of Record for Precipitation Extremes: 1893-2001						
Month	**High (in)**	**Year**	**Low (in)**	**Year**	**1-Day Max (in)**	**Date**
JAN	2.53	1967	0.07	1961	1.42	1/24/1967
FEB	2.3	1915	0.04	1964	1.09	2/27/1948
MAR	4.01	1951	0	1910	1.9	3/14/1918
APR	7.3	2001	0.46	1946	3.81	4/23/1990
MAY	8.41	1982	0.4	1934	4.02	5/17/2000
JUN	12.51	2000	0	1910	4.8	6/1/2000
JUL	12.33	1978	0.41	1946	7.47	7/11/1981
AUG	9.52	1979	0.31	1941	3.27	8/1/1931
SEP	10.5	1986	0.33	1953	5.98	9/12/1978
OCT	9.11	1911	0.01	1952	2.85	10/6/1911
NOV	5.91	1909	0.01	1917	2.3	11/1/1991
DEC	2.83	1982	0	1943	1.19	12/9/1911
Annual	43.94	1990	11.65	1910	7.47	7/11/1981
Winter	4.92	1983	0.69	1958	1.42	1/24/1967
Spring	15.87	2001	3.12	1910	4.02	5/17/2000
Summer	23.34	2000	3.78	1910	7.47	7/11/1981
Fall	14.91	1986	1.49	1976	5.98	9/12/1978
Source: Midwest Regional Climate Center-Illinois State Water Survey and National Climate Data Center (http://mcc.sws.uiuc.edu/Precip/MN/217004_psum.html)						

2.2 Land Use and Soils

2.2.1 Land Use

Land use in the South Zumbro Watershed is 74% agricultural (177,390 acres), 15% urban/suburban (65,000 acres), 8% forest, 2% water, and 1% wetland. However, the watershed is experiencing a rapid change due to urban and suburban growth, and the transformation of agricultural practices (such as higher acreage of row crops in areas traditionally used for grazing). Much of the urbanization is taking place in and around the Rochester and Byron.

Urban and suburban dwellings have changed the areas' hydrologic characteristics, often reducing infiltration and on-site water retention. Where storm water BMPs are not implemented, storm water flows have become flashier, resulting in higher peak flows that destabilize streams and accelerate stream bank erosion.

In agricultural areas, the Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service, SCS) promotes the following conservation practices to farmers and rural landowners: grassed swales, contour plowing, strip cropping, and buffers on stream corridors. These practices help reduce erosion in agricultural fields and waterways, which can assist in reducing sediment loading to streams.

In general, changes in agricultural practices have impacted many wetlands or natural flow-attenuating floodplains in the watershed. For example, row crop agriculture in floodways (illustrated in the photo on the right) and its associated tile lines, has increased wetland draining. As a result, water retention (sponge benefit of wetlands) in the watershed has decreased, increasing waterway peak flows.

2.2.2 Soils

Several types of soils are found throughout the watershed. The mild to gently rolling, steep-sloped landscape of the area has formed through different geologic processes, such as glaciation and wind and water erosion/deposition. About nine soil associations are present in Olmsted County and seven in Dodge County. For more information and maps refer to the County Soil Surveys: USDA-SCS 1980 for Olmsted County and USDA-SCS 1961 for Dodge County.

In general, loamy and silty soils dominate the watershed landscape. Coarser sandy soils are found along the outwash terraces and floodplains. Finer soils are typically found along the broad uplands and near drainageways. These soils tend to have higher clay content, which reduces water infiltration. Soils generally drain well through the subsoil towards waterways or bedrock. Areas with fractured limestone, for example, facilitate the flow of surface water to ground water aquifers. However, areas with underlying impermeable layers such as the Decorah shale and glacial till can retain water on-site to create wetland hydrologic conditions.

Wetlands are usually present in areas with hydric soils—those that contain higher silt and clay content. These soils also have higher organic content, particularly compared to cultivated upland soils. Upland soils vary significantly, but generally have coarser textures than depressional areas. They have higher contents of silt and sand, and low clay content. However, soils with higher clay content are also found, such as those associated with the Decorah shale and glacial till.

Changes in soil cover that increase soil exposure (such as row crop agriculture) accelerate upland erosion. The eroded soils then become deposited in depressional areas or watercourses, reshaping-stream morphology. Sediments deposited along the stream and at road crossings increase 1) the risk of downstream flooding, 2) road maintenance costs, and 3) downstream economic losses.

Floodplain soils present an opportunity to promote infiltration and/or water retention. The opportunity is particularly high to restore hydrologic conditions in areas where floodplain still exists, but is hydraulically disconnected from the stream channel during frequent storms.

2.3 Drainage and Stream Corridors

2.3.1 Drainage

Originating in Dodge County, the South Zumbro River flows east into Olmsted County through Rochester. As the river travels through the channelized portion of the City, it begins to flow north to its confluences with the Middle and North Fork of the Zumbro River near the Olmsted-Wabasha County line. The river flows through broadleaf forest and farmland across the Rochester Plateau, a rolling, high upland of windblown silt over glacial till in the west, and Paleozoic sedimentary bedrock strata in the east.

The South Zumbro has several major tributaries or subwatersheds (see Map 1), which include:

- Cascade Creek
- Salem Creek
- Willow Creek
- Goose Creek
- Boardman Creek
- Bear Creek
- Badger Run
- Silver Creek

The subwatersheds illustrated in Map 1 were grouped using Minnesota Department of Natural Resource's (DNR) geographic information system (GIS) coverages that join the unnamed watersheds to their regional subwatersheds. For example, the unnamed subwatersheds that flow into Salem Creek from the north were included in the Salem Creek Subwatershed.

Overall, the transportation network has altered the native landscape and its drainage characteristics. Several watercourses have been straightened or ditched to accommodate road alignments. Two major railroads were built through the watershed, reshaping the drainage landscape. One is now the Douglas Trail, which is used for recreation between Rochester and Pine Island. The other railroad (Dakota, Minnesota & Eastern) runs east-west towards Winona through Dodge Center, Kasson, Byron, Rochester, and Eyota.

Numerous watercourses in the region have areas of high infiltration due to coarse soils and the karst geology. Fractured bedrock and conduits dissolved by water increase groundwater recharge, which reduces surface water flows. In addition, significant sand and gravel resources have been found along stream corridors (see geologic County Atlas Series maps by the Minnesota Geologic Survey). These areas also facilitate recharge of surface waters to ground water.

As stated earlier, seven flood control reservoirs were constructed in the upper reaches of the watershed to reduce downstream flooding. These reservoirs have reduced flooding potential and altered the area's hydrology. Bridges immediately downstream of these reservoirs experience much lower flows, such as bridge 92149 by reservoir SR-2. See Map 1 for the location of these reservoirs.

2.3.2 Stream Corridors

Stream corridors were evaluated using a variety of techniques. US Geological Survey (USGS) topographic maps and aerial photographs were studied to determine locations of existing stream channels. Infrared aerial photographs were used to assess natural communities and wetland sites within and adjacent to stream corridors. Site visits were conducted to better understand existing conditions and verify slope and conveyance capacities. In some cases, residents were interviewed for historic accounts of peak water levels observed within, or extending beyond existing channels.

For consistency and to provide a uniform watershed-wide approach, the methodology and criteria used for the City of Rochester's Storm Water Management Plan was considered to define the stream corridors for this study. The elements that were considered included:

- Hydric soils
- Wetlands
- Forested land
- Steep slopes, 18% or greater
- 100-year high water levels (base flood)
- Minimum riparian buffers
- Reservoirs and ponds
- Designated parks
- Significant communities from the County Biological Survey (Natural Heritage)

Stream corridors are shown in Map 2. This map also displays National Wetland Inventory (NWI) wetlands and DNR Natural Heritage significant community locations available from Olmsted County's Biological Survey. Stream corridors are shown wider where base flooding data is available from the Federal Emergency Management Agency (FEMA), mostly within the City of Rochester and the South Zumbro River downstream of the City. For more detailed information on the stream corridors within the City of Rochester, please refer to the City's SWMP. The County will maintain an updated database as base flooding data becomes available.

Recognizing the function of stream corridors is vital to promote healthy environmental habitats and water quality while protecting rural and urban infrastructure (roads, houses, farmlands, etc.). Stream corridors not only serve as waterways to convey the flows experienced throughout the seasons, they also function as waterways for the less frequent flows, such as the 100-year flows that have a one percent probability of occurring in a given year.

Stream corridors are pathways for wildlife (fish, mammals, birds). They provide aesthetic value, serve as oxygen sources, and offer recreational opportunities (walking, biking, birding, hunting, fishing). Wetlands play a special role in stream corridors—they help regulate flows and serve as habitats for plants and animals.

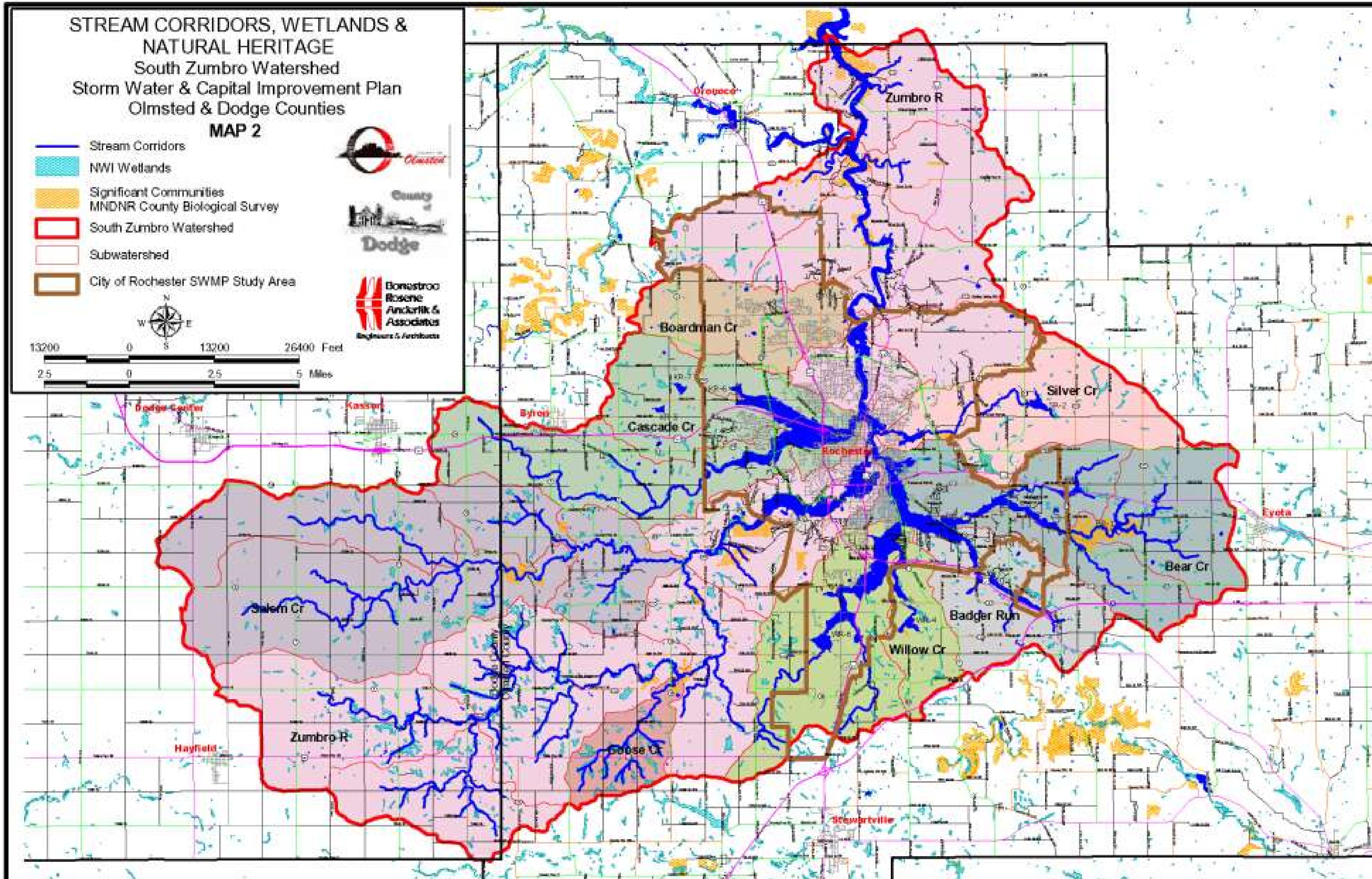
Other biological communities, such as upland woodlands and prairies, are also very important to water quantity and quality within the watershed. Along with land use, these communities shape stream corridors, affecting their stability and dynamics. Providing buffers between channels and cultivated/urban land can improve the environmental quality of streams and reduce costs associated with impacts from erosion and sediment deposits. Preserving stream corridors by maintaining vegetated waterways and perennial vegetation also benefits agriculture by reducing gully erosion that affects farm fields. Perennial vegetation buffers can retain ambient moisture, creating microclimate conditions that are beneficial to crops. Buffers with a diversity of plant species can also help prevent the spread of plant pests and diseases.

These features and functions lend themselves to the idea of designating, for planning purposes, multifunctional “stream corridors” that extend beyond their channel banks. Identifying stream corridors is essential to promote good land stewardship.

Reports from land owners and site inspections of existing stream channels and roadside ditches confirm that infiltration is high in many floodplain areas, as well as other drainageways where steep slopes transition into milder slopes. While some stream corridors are relatively stable, others suffer from moderate to severe degradation.

Specific features of interest of each subwatershed (Maps 1 and 2) are described in Appendix B. The purpose of this characterization is to illustrate land uses, flora and fauna species, and other natural landscape features. However, it does not represent a full inventory of all the important resources in the South Zumbro Watershed.

(Opposite page, Map 2)


STREAM CORRIDORS, WETLANDS & NATURAL HERITAGE
South Zumbro Watershed
Storm Water & Capital Improvement Plan
Olmsted & Dodge Counties
MAP 2
Stream Corridors
NWI Wetlands
Significant Communities
MNDNR County Biological Survey
South Zumbro Watershed
Subwatershed
City of Rochester SWMP Study Area
N
W
E
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13200
0
13200
26400 Feet
2.5
0
2.5
5 Miles
Olmsted
County of Dodge
Bonestroo Rosene Anderlik & Associates
Engineers & Architects
Oronoco
Zumbro R
Boardman Cr
Silver Cr
Cascade Cr
Dodge Center
Kasson
Byron
Rochester
Eyota
Bear Cr
Salem Cr
Badger Run
Willow Cr
Zumbro R
Goose Cr
Hayfield
Stewartville

3 Watershed Analysis and Priority Bridges

3.1 CIP Bridges

This watershed-based analysis focuses on bridges likely to be replaced over the next 20 years, as identified by Olmsted and Dodge Counties in their capital improvement programs (CIPs). These bridges include culvert structures classified as bridges based on criteria from the Minnesota Department of Transportation (Mn/DOT).

Map 1 shows the locations of the capital improvement program bridges in the South Zumbro Watershed, identifying their planned replacement schedule and the Mn/DOT bridge number (for example, L6262). This map also illustrates the major road network, including Highway 52 (north-south), Highway 63 (north-south), Highway 14 (east-west), and Highway 30 (east-west). These and other County and Township roads provide good connectivity and access to the transportation network. Jurisdiction for construction and maintenance responsibilities for these roads is assigned by agency: Federal/State, County State Aid Highway (CSAH), Municipal State Aid, County Road (CR), Municipal Street, and Township.

Structural characteristics and traffic intensity are the main factors considered for setting bridge replacement priorities, with safety being the most important consideration. Accessibility and flood protection are also important in specific cases. For example, bridge L-6262, located on 45th Avenue Southwest, serves as the only access to local residences.

Bridge replacement programs are highly dependent on funding. Table 3-1 lists bridges that both Counties plan to replace within the South Zumbro Watershed. The bridge locations are identified in this table by road, Township, and section number(s). Tables appearing later in this document identify sites using just the bridge number identifier. Bridge data used for the hydraulic analysis is found in Table D-1 of Appendix D.

Table 3-1 – CIP Bridges

No.	Subwatershed	Bridge No.	Location (road, Township-Section)	Drain-age Area (acres)
	OLMSTED COUNTY:			
1	Cascade Creek	89160	County Hwy 5, Salem-5	4507
2	Cascade Creek	89155	County Hwy 3, Salem-10	6823
3	Cascade Creek	88708	County Hwy 3, Salem-3	595
4	Cascade Creek	4075	70th Ave SW, Salem-11/12	9306
5	Cascade Creek	L6262	45th Ave SW, Rochester-5	11526
6	Salem Creek	89180	County Hwy 25, Salem-17	3798
7	Salem Creek	55510	110th Ave SW, Salem-19	28842
8	Salem Creek	55515	County Hwy 3, Salem-15	35895
9	Salem Creek	55508	County Hwy 15, Salem-24	39841
10	South Zumbro	L6180	County Hwy 5, Rock Dell-17/16	1920
11	South Zumbro	55511	County Hwy 26, Rock Dell-6	23017
12	South Zumbro	L6204 L6205	110th Ave SW, Rock Dell-6/5	26872
12	South Zumbro	L6205	110th Ave SW, Rock Dell-6/5	
13	South Zumbro	2902	County Rd 126 (80th Ave SW), Rock Dell-3/2	34132
14	South Zumbro	55507	County Hwy 15, Rock Dell-2/1	35661
15	SZ-Goose Creek	L6151	80th Ave SW, Rock Dell-22/23	180
16	SZ-Goose Creek	8984	County Hwy 15, Rock Dell-2/1	4410
17	South Zumbro	L6160	60th Ave SW, Rock Dell-1/High Forest-6	40855
18	South Zumbro	55J36		1400
19	South Zumbro	89182	County Rd 125 (Mayowood Rd SW), Rochester-8	94459
20	South Zumbro	L6145	County Hwy 8 (Bamber Valley Rd SW), Rochester-16	1443
21	South Zumbro	7174	County Hwy 8 (Bamber Valley Rd SW), Rochester-10	97342
22	Willow Creek	88734	County Hwy 16, High Forest-4/9	2100
23	Willow Creek	92809	County Hwy 1, Marion-19	275
24	Willow Creek	7092	County Hwy 1, Rochester-13	18728
25	Badger Run	L6234	30th St SE-Marion-20/21/16/17	9116
26	Bear Creek	89174	County Hwy 19 (Chester Rd SE), Marion-11	1836
27	Bear Creek	L6236	County Hwy 11 (50th Ave SE), Marion-9/10	17871
28	Bear Creek	L8565	County Rd 143 (20th St SE), Marion-8/17	19025
29	Silver Creek	L9747	Silver Creek Rd NE, Viola-30/31	1172
30	Silver Creek	92149	County Hwy 11 (55th Ave NE), Haverhill-27	6198
31	Northeast area	L6285	East River Rd NE, Cascade-14/13	5358
32	Northeast area	1571	Dresser Dr NE, Haverhill-6	860
33	Northwest area	88712	County Hwy 3, Kalmar 12	719
34	Northwest area	89158	County Hwy 3, New Haven-36	884
35	Northwest area	L9432	85th St NW, Oronoco-29/30/31/32	2047
36	North	88746	County Rd 114 (11th Ave NE), Oronoco-1	671
37	North	L6330	Shorewood Circle NE, Oronoco-1	935

Table continues in next page

No.	Subwatershed	Bridge No.	Location (road, Township-Section)	Drain-age Area (acres)
	DODGE COUNTY:			
38	Salem Creek	97542	240th Ave, Canisteo-17/16	6458
39	Salem Creek	L6472	670th St, Canisteo-15/22	8680
40	Salem Creek	L5500	260th Ave, Canisteo-22/23	9094
41	Salem Creek	665	260th Ave, Canisteo-22	14657
42	South Zumbro	L6459	720th St, Vernon-10/15	728
43	South Zumbro	89117	County Hwy 15, Vernon-2/1	920
44	South Zumbro	89136	270th Ave, Vernon-23/24	2585
45	South Zumbro	L6458	720th St, Vernon-12/13	8367

3.2 Identifying Potential Improvement Sites

3.2.1 Concept

This study identifies feasible and effective practices within the stream corridor that can improve water quantity and quality. These practices complement other measures being implemented in the upstream agricultural areas of the watershed.

Some of the watershed's original flow-regulating capacity can be restored using existing degraded wetlands or floodplains inundated by the 100-year flows (1% probability of occurrence in a given year, which is considered the base flood by the Federal Emergency Management Agency, FEMA). Regulating or controlling storm water flows can reduce peak flows, making the flows less "flashy." This is achieved by temporarily storing the storm water during peak conditions, and releasing it gradually, at lower flow rates. Peak flows from more frequent storms (1 to 50-year storms) can be attenuated using the existing floodplain (storage available for the 100-year storm, the base flood).

Longer runoff water retention in the upper reaches of a watershed can attenuate peak flows and reduce their destructive force. The South Zumbro Watershed and subwatersheds offer many opportunities to achieve this goal.

A watershed hydrologic analysis is a crucial first step. For example, available floodplain storage can be used to offset peak flows from different runoff-contributing areas of the watershed for the frequent storms (those from 1 to 3 inches, up to the two-year storm). As a result, peak flows can be further reduced. However, the key is to implement site specific BMPs that do not cause peak flows to overlap, which would increase downstream flooding.

The traditional approach for bridge/culvert design usually:

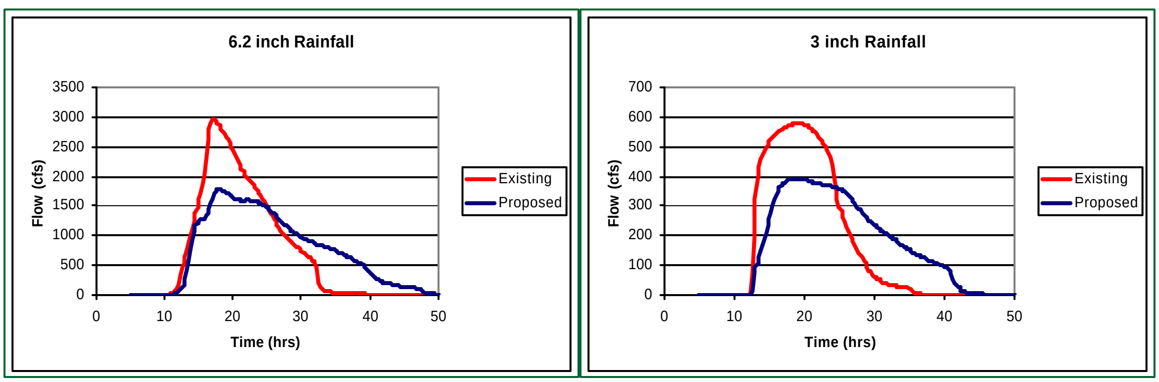
- Considers each road bridge/culvert crossing individually
- Does not provide much peak flow attenuation for frequent rainfalls (such as the two-year storm or lower), since they are designed for the high, overtopping flow events
- Tends to yield oversized upstream culverts where temporary storage is available
- Contributes to "flashy" peak flows, particularly for the frequent rainfall events

Compared to the traditional approach, the watershed approach of installing small upstream flow control structures (detailed in Section 3.2.2, page 20) with or without wetland restoration has the following benefits:

- Peak flows are offset from the different subwatersheds, using hydrographs to optimize road improvements and flood protection
- The potential to attenuate frequently occurring peak flows, which cause most streambank degradation/erosion, is increased
- Peak flows are delayed and reduced because floodplain areas are used for a few more hours than existing conditions provide
- Water velocities are reduced, thus reducing erosion

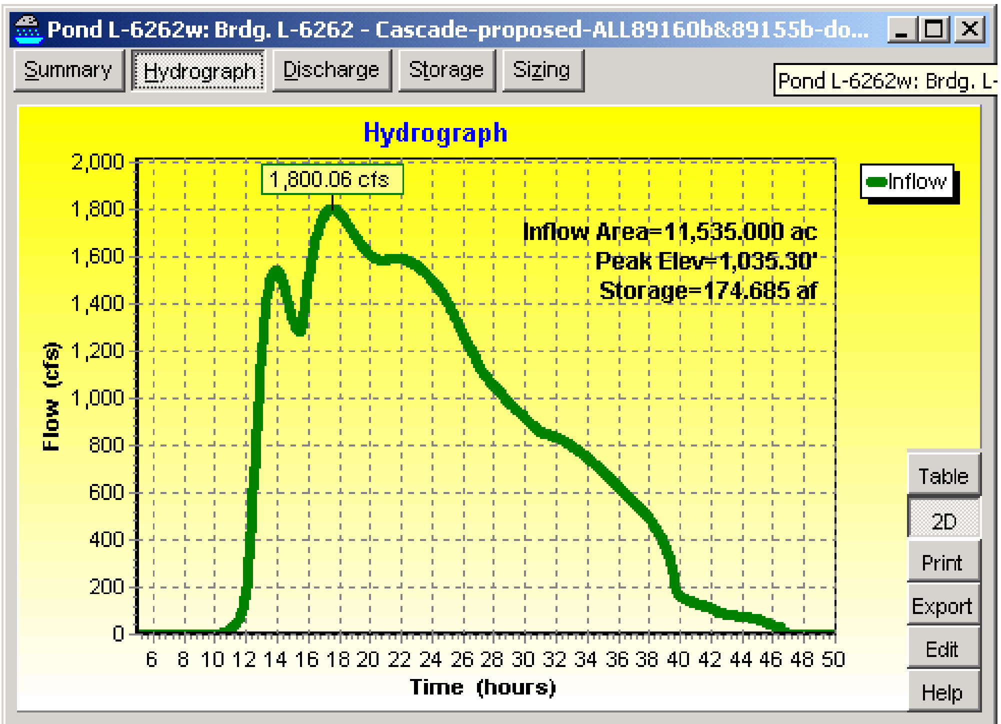
A hydrograph is a tool to analyze flow distribution in time. The benefit of controlling flows can be illustrated by comparing a proposed condition hydrograph with the hydrograph for existing conditions. Figure 3-1 illustrates these hydrographs for bridge L-6262 (45th Avenue SW, Rochester), with one graph for the 6.2-inch rainfall (100-year frequency) and the other for the 3-inch rainfall (two-year frequency) [note the difference in the scales for flow]. These hydrographs illustrate the peak flow reduction, and the reduction in the rate of change in flow with time (flashiness). A 100-year peak flow reduction of 40% to 50% was achieved by controlling/regulating the flows.

Figure 3-1 – Existing and proposed hydrographs at bridge L-6262



The significant peak flow reduction illustrated in Figure 3-1 is possible because the temporary ponding from the proposed flow control structures offsets the runoff contributions from the subwatersheds (see Appendix C for the detailed study of Cascade Creek). Figure 3-2 illustrates two defined peaks that are offset in the hydrograph for flows into L-6262.

Figure 3-2 – Example of offsetting peak flows with ponding: inflow at bridge L-6262



As a result, the improvements yield hydrographs with economically and environmentally beneficial hydrologic characteristics. Economic benefits include cost-savings in bridge replacements with downsized structures, and reduced flood damage to roads, bridges, and other infrastructure. Environmental benefits include improved aquatic and riparian habitat, reduced erosion-sedimentation problems, and a more stable stream.

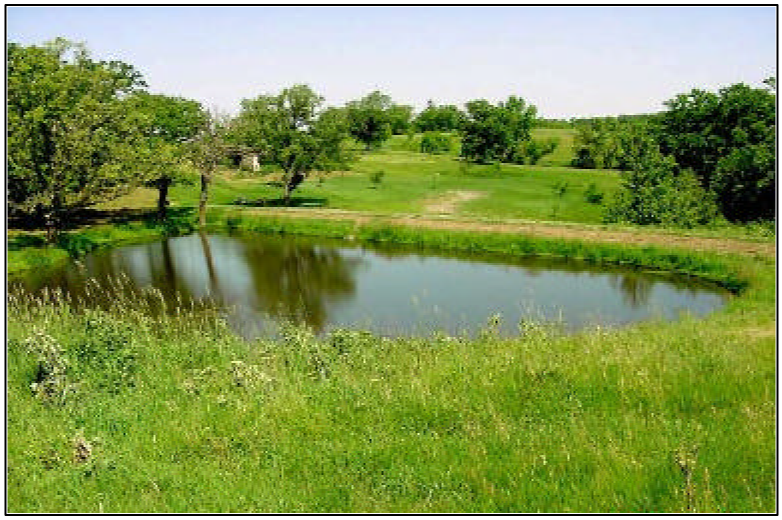
3.2.2 Flow Control Structures

The flow control structures envisioned to attenuate flashy storm peak flows have low berms with an average height of only six feet. These structures include flow control weirs that maintain fish passage, as illustrated in the photo on the right. This photo is during construction (without the riprap that covers the sheet-piling that makes the weir.) Notice the low cut on the weir designed to facilitate fish passage and aquatic habitat connectivity during low flows.

The photo at left illustrates how this type of structure operates after a storm. Notice that the sheet-piling is almost completely covered by the riprap used to stabilize the weir structure. Furthermore, the structure blends into the natural environment, as illustrated in the photo on the right.

These flow control structures are designed to use the existing floodplain to attenuate the frequent 1 to 3 inch storms. After the storm runoff recedes, the area does not maintain a water pool and returns to dry or base flow conditions. These high water and normally non-ponded conditions are illustrated in the photos below.

These flow control structures were discussed with the DNR area hydrologist, who recommended paying special attention to fisheries and berm heights in the feasibility phase.



The flow control structures can be associated with the establishment of farm ponds, as illustrated in these photos: an NRCS pond in Elmira Township (*right*); ponding associated with wetland restoration in Kalmar Township (*bottom left*); and a NRCS pond in Haverhill Township (*bottom right*). When a farm pond is desired, it becomes a by-product of the borrow pit for the material to construct the berm. Otherwise, this material can be obtained from areas that will not result in open water.

Farm ponds and wetland restorations/enhancements are improvements that can be associated with flow control projects; they are part of the integrated watershed-based approach. Farm ponds would generally be built off-line from the stream. However, in some cases, the objective could be to reduce sediment loading to areas downstream of the pond (such as to a road crossing). In these cases, an on-line pond may be preferred. For example, if maintaining the pond would be less expensive than cleaning excess sediments from a road crossing, then an on-line pond may be the best sediment control solution.

Farm ponds can be a source of water during dry periods and provide wildlife with critical habitat. These ponds can also provide recreational benefits and aesthetic value to the landowner. During this study, some landowners expressed interest in developing fish habitat within their ponds. The value as fish habitat would depend on the overall design of the pond, connectivity with the stream, the presence of existing fisheries in the stream, and its management (such as stocking). The design of each pond can have a major role in the characteristics of the habitat and its ability to sustain aquatic life.

Flow control structures can also help enhance and restore wetlands in the South Zumbro Watershed. Restoration potential is site specific and covered by the wetland assessment (see Section 3.5, page 36) for high priority sites. The opportunity for these structures to enhance or restore the hydrology of a wetland is usually higher when the stream channel and the wetland have become hydrologically disconnected for frequently occurring storms. Degrading, deepening stream channels can reduce storm water availability to wetlands, and can further induce wetland drainage. Building the flow control structures in these cases can restore or enhance the flooding frequency to the wetland, to restore or improve its quality.

Reconnecting a stream channel with its floodplain can also occur in areas without wetlands. Reconnection can increase the temporary storage available to reduce runoff peak flows. Where the floodplain is currently cultivated, flow control structure design can be based on tolerable flooding characteristics for the given land use. These characteristics include the depth, frequency and duration of flooding.

For example, inundating a cornfield a few feet, a few times a year for less than 24 hours would not significantly affect crop production. Therefore, a structure that allows drainage within the crop tolerance would be acceptable. This practice is even beneficial, since floodwaters usually contain nutrients that increase crop production; a nutrient management technique used in many alluvial floodplains in the world.

Temporary ponding upstream enables peak flow reduction. This increases the ponding duration, or the time it takes for runoff flows to pass a given point. Table 3-2 illustrates the extended duration at the L-6262 location with high potential improvements and the downsizing of the bridge structure (see Appendix C for more details). The additional duration is estimated to be about 9 to 13 hours of ponding time on the landscape, compared to existing conditions for different rainfall events. Note that the negative change in time of ponding for the one-inch rainfall means that ponding time at L-6262 is lowered by water retention in the upstream areas.

Table 3-2 – Change in time of ponding at L-6262 with high potential improvements and downsizing of structures

Location	24-hr Rainfall Event (inches)	Change in Time of Ponding (hrs)
L-6262	1	-16.3
	2	9.5
	3	10.7
	4	11.4
	5	12.2
	6	12.5

Ponding duration is not considered an issue for agricultural land use in these floodplain areas.

In addition, several wetland restoration/enhancement opportunities were observed in the watershed. Wetland restoration/enhancement projects could provide economic benefits to farmers and landowners interested in participating in available agriculture programs or other financing sources (see Table 5-4 and Table 5-5 in the financing section, page 68). Section 3.5 (page 36) presents the methodology used for the wetland assessment and the findings for high priority sites that were identified.

3.2.3 Site Assessment

Conditions at each bridge location were evaluated to determine their potential for downsizing opportunities. Potential ponding improvement sites were primarily assessed for their ability to reduce peak flows. Factors that were considered included:

- Flow control structure height and cost
- Presence of buildings or other structures that could be impacted
- Topographic characteristics and availability of larger temporary storage volumes
- Stream morphology, drainage area and flow regime
- Strategically located sites to increase hydrologic travel time
- Location close to bridge structures
- Interest of landowner in having a ponding improvement site
- Wetland and upland enhancement potential (details in Section 3.5 and Appendix F)
- Water quality treatment potential
- Soil and vegetation attributes indicative of floodplain characteristics

Areas with houses, farm buildings, industrial facilities, or other structures in the vicinity of bridge crossings were eliminated from consideration because of their limited storage potential.

To assist with the site assessments, digital data was analyzed using GIS. Topographic data was used to explore site-specific initial water storage opportunities, and hydrologic modeling was used to estimate upstream storage capacity.

Changes in land use and agricultural practices were observed during the site assessment portion of this study. Impacts noted included:

- Changes in land use in floodplain areas, often affecting or degrading wetlands with natural flow-attenuation capacity
- A regional trend toward increasing row-crop acreage, compared to permanent vegetative cover such as pasture
- Urban and suburban development

Landowners in the watershed corroborate several of these impacts, which include higher peak flows, increased streambank erosion, and increased sediment deposition in mildly sloped stream reaches and lakes.

Areas from the City of Byron draining into Cascade Creek merit special attention. Rapid urbanization combined with inadequate storm water management practices have resulted in impacts to downstream residents. Higher runoff volumes and peak flows have caused increased bank erosion and sediment deposition along Cascade Creek. Field assessments and interviews with landowners verified these downstream conditions.

Higher peak flows, streambank erosion, and sediment deposition have degraded water quality and aquatic habitat, and destabilized stream morphology throughout the watershed. These impacts have also increased infrastructure maintenance costs and caused other economic losses to individual landowners. For example, many streams have been widening and changing course as a result of increased sediment deposition, affecting cropland and other riparian lands.

3.2.4 Priority Crossings

The priority bridge crossing analysis focused on those road crossings and bridges identified by Olmsted and Dodge Counties' Capital Improvement Programs (CIPs). Priority crossings were identified based on the potential for downsizing bridge structures by using existing temporary storage capacities available in the floodplain. The crossings are downsized compared to the traditional approach to bridge design, which does not take into account the natural upstream storage capacity.

Temporary storage can be used in the area immediately upstream from a bridge, or at a more appropriate upstream location. These locations are also referenced in this document as *potential ponding improvement sites*.

Potential ponding improvement sites were priority-ranked based on their ability to reduce peak flows, as well as practical economic and environmental considerations:

- Flow control structure height and cost
- Absence of buildings or other structures that could be impacted
- Availability of larger temporary storage volumes
- Strategically located sites to increase hydrologic travel time
- Location close to bridge structures
- Landowner interest in having a ponding improvement site
- Wetland enhancement potential
- Water quality treatment potential
- Soil and vegetation attributes indicative of floodplain characteristics

3.3 Water Quantity

3.3.1 Ponding Opportunities and Flow Rate Control

Based on the site assessment and the hydrologic modeling, bridges were ranked according to their ponding potential. Sites with bridge-downsizing/ponding potential immediately upstream of the bridge, or further upstream, are identified in Table 3-3. This table includes the number of bridge improvements planned downstream and the number of road crossings down to a particular bridge location. The larger these numbers, the greater the benefit of implementing a flow control structure at the referenced site.

The watershed-based assessment identified many potential ponding improvement sites to control runoff flows based on the characteristics of rural land use stream corridors. Most road-stream crossings had good characteristics for ponding or controlling flows. Crossings with smaller watersheds (upstream contributing areas) generally offer greater flow attenuation potential.

Using hydrologic and hydrograph modeling techniques, the overall assessment determined that greater flood protection for bridges and roads could be attained with storm water improvements in the South Zumbro Watershed. Merely delaying peak flows from upstream areas significantly reduced peak flows to downstream bridges. This reduction became more significant for larger rainfall events as available storage increased. This was particularly evident in elongated subwatersheds, such as in Cascade Creek, where bridges L-6262 and 4075 could have 40% or greater peak flow reduction if high priority flow control measures were implemented (see Appendix C for details).

Table 3-3 – Bridge Downsizing Opportunities

No.	Subwatershed	Bridge No.	Drainage Area (acres) from GIS	Area Between Bridge Improvements (acres) from GIS	No. of Bridge Improvements Planned Downstream	Downstream Reference Bridge [A] No.	No. of Road Crossings Down to Reference Bridge [A]	No. of Road Crossings Down to [A] with Potential New Roads	Down-sizing Potential at bridge location	Down-sizing Potential UPSTREAM of bridge location	Upstream Crossings Required and/or number potential ones	Comments	Opportunities	In FEMA Floodway
	OLMSTED COUNTY:													
1	Cascade Creek	89160	4507	4507	3	L-6262	6	8	High	High	>1 preferable	Demonstration site upstream 89160b.	Pond/wetland & upstream by Frontier Rd.	
2	Cascade Creek	89155	6823	2316	2	L-6262	4	5	High	High	89160	Medium priority if demonstration site upstream 89155b is built		
3	Cascade Creek	88708	595	595	2	L-6262	5	6	High	Low	2 preferable			
4	Cascade Creek	4075	9306	1888	1	L-6262	3	3	High	High	89160, 89155, 88708			
5	Cascade Creek	L6262	11526	2220	0	L-6262	1	1	High	High	89160, 89155, 88708			yes
6	Salem Creek	89180	3798	3798	4	7174	4	5	High		L-9963 & 2 crossings		Wetlands upstream? By 109 Av. SW	
7	Salem Creek	55510	28842	5091	4	7174	4	5	Medium	High	4 to 7 crossings			
8	Salem Creek	55515	35895	3255	3	7174	3	4	Medium	High	L-9963 and/or 89180 & 4 to 7 crossings			
9	Salem Creek	55508	39841	3946	2	7174	3	4	Medium	High	L-9963 and/or 89180 & 4 to 8 crossings			
10	South Zumbro	L6180	1920	1920	5	7174	6	11	High	High	1 crossing by Hwy 30			
11	South Zumbro	55511	23017	13922	6	7174	6	10	Medium	Medium	>4 crossings	State Wildlife Area	Upstream dependent!	
12	South Zumbro	L6204 L6205	26872	2935	5	7174	6	10	High	Medium	>5 crossings	Raise road 2 to 3 ft		
12	South Zumbro	L6205							See L6204					
13	South Zumbro	2902	34132	5340	4	7174	5	9	Medium	Medium	>6 crossings	Has staff gage. High water in 1978		
14	South Zumbro	55507	35661	1529	3	7174	5	9	Medium	Medium	>7 crossings			
15	SZ-Goose Creek	L6151	180	180	4	7174	8	10	High					
16	SZ-Goose Creek	8984	4410	4230	3	7174	5	9	Medium	Medium	2 to 3 crossings			
17	South Zumbro	L6160	40855	784	2	7174	5	9	Low	Medium	>8 crossings		Upstream by Hwy 30	
18	South Zumbro	55J36	1400	1400	2	7174	5	10	Medium			May have potential		
19	South Zumbro	89182	94459	12363	1	7174	2	2	Low		L-9963 and/or 89180 & 4 to >10 crossings		Upstream dependent!	yes, downstream side
20	South Zumbro	L6145	1443	1443	1	7174	2	2	Low					
21	South Zumbro	7174	97342	1440	0	7174	1	1	Low	Medium	L-9963 and/or 89180 & 4 to >11 crossings		Upstream dependent!	yes
22	Willow Creek	88734	2100	2100	1	7092	9	12	Low		1 crossing	WR-6A Dam downstream. 3 crossings down to WR-6A	Investigate upstream	
23	Willow Creek	92809	275	275	1	7092	3	4	Medium			WR-4 Dam upstream		
24	Willow Creek	7092	18728	16353	0	7092	1	1	Medium		1 crossing	WR-6A & WR-4 Dams upstream		yes
25	Badger Run	L6234	9116	9116	0	L-6234	1	1	Low		>2 crossings		Investigate upstream	yes
26	Bear Creek	89174	1836	1836	2	L-8565	3	3	Medium		>1 crossing			yes
27	Bear Creek	L6236	17871	16035	1	L-8565	1	2	High			Chester Woods Park Dam (SR-1) upstream	Downsize crossing	yes
28	Bear Creek	L8565	19025	1154	0	L-8565	1	1	High			Chester Woods Park Dam (SR-1) upstream	Downsize crossing	yes
29	Silver Creek	L9747	1172	1172	1	92149	5	5	Low		1 crossing	SR-2 Dam downstream		
30	Silver Creek	92149	6198	5026	0	92149	1	1	High			SR-2 Dam just upstream	Downsize crossing	
31	Northeast area	L6285	5358	5358	0	L-6285	1	1	Low	Medium	>3 crossings	Upstream dependent. Debris problems!		
32	Northeast area	1571	860	860	0	1571	1	1	High			Hwy 63 crossing before Zumbro river	Swale for pond	
33	Northwest area	88712	719	719	0	88712	1	1	High			Flows to Kings Run, White Oaks. More than 9 crossings to Zumbro river	Downsize crossing using existing storage & road elevation	
34	Northwest area	89158	884	884	1		2	2	Medium		1 crossing			
35	Northwest area	L9432	2047	1163	0	L-9432	1	1	Medium		89158 & 1 crossing			
36	North	88746	671	671	1	L-6330	2	2	High				Ponding	
37	North	L6330	935	264	0	L-6330	1	1	Low	High	88746		Depends on Bridge 88746	
	DODGE COUNTY:													
38	Salem Creek	97542	6458	6458	6				High	High	>5 crossings	Raise road about 2 ft?	Ponding with some excavation; also upstream	
39	Salem Creek	L6472	8680	2222	5				High	High	97542 & >6 crossings	Bridge being designed; to be done by April 15 2002		
40	Salem Creek	L5500	9094	414	4				High	High	97542, L-6472 & >6 crossings	Ideal for ponding	Ponding/wetland	
41	Salem Creek	665	14657	14657	4				Low	High	>4 crossings	home back yard is restriction for ponding		
42	South Zumbro	L6459	728	728	7				Low	Low	1 crossing		Wetlands upstream?	
43	South Zumbro	89117	920	920	6				Medium			Steeper area	Downstream?	
44	South Zumbro	89136	2585	2585	8				Medium		2 crossings		Upstream?	
45	South Zumbro	L6458	8367	5782	7				Medium	High	1 to 4 crossings		Upstream?	
A1	Salem Creek	89102	4400		7				High			Not in 5-yr bridge replacement plans		
A2	Salem Creek	89099	1800		5				High			Not in 5-yr bridge replacement plans		
A3	Salem Creek	2350	4000		5				High			Not in 5-yr bridge replacement plans		
A4	South Zumbro	89101	1500		7				High			Not in 5-yr bridge replacement plans		

Note: [A] is the Downstream Reference Bridge for counting the number of road crossings.

Table 3-4 – Ponding Characteristics

No.	Subwatershed	Bridge No.	Location (road, Township-Section)	Drainage Area (acres)	Ponding Area at NWL[1] (acres)	Ponding Area at HWL[2] (acres)	Storage Volume (acre-feet)	Existing Peak Flow for 2 yr (cfs)	Peak Flow for 2 yr (cfs)	Flow Reduction for 2 yr (%)	Comments
	OLMSTED COUNTY:										
1	Cascade Creek	89160	County Hwy 5, Salem-5	4507	0.01	16	36	205	191	7	
2	Cascade Creek	89155	County Hwy 3, Salem-10	6823	0.01	35	61	304	231	24	
3	Cascade Creek	88708	County Hwy 3, Salem-3	595	0.01	2.7	8	77	49	36	
4	Cascade Creek	4075	70th Ave SW, Salem-11/12	9306	0.01	35	44	419	268	36	
5	Cascade Creek	L6262	45th Ave SW, Rochester-5	11526	0.01	20	62	595	332	44	
6	Salem Creek	89180	County Hwy 25, Salem-17	3798	0.01	13	50	229	197	14	
10	South Zumbro	L6180	County Hwy 5, Rock Dell-17/16	1920	0.01	6	27	197	158	20	Consider upstream sites
12	South Zumbro	L6204 L6205	110th Ave SW, Rock Dell-6/5	13535	0.01	40	131	1013	959	5	
15	SZ-Goose Creek	L6151	80th Ave SW, Rock Dell-22/23	180	0.01	2.1	8	50	11	78	
27	Bear Creek	L6236	County Hwy 11 (50th Ave SE), Marion-9/10	16215	0.01	n/a	n/a				Bridge could be sized to reflect flow attenuation from Chester Woods Park Dam (SR-1)
28	Bear Creek	L8565	County Rd 143 (20th St SE), Marion-8/17	17369	0.01	n/a	n/a				Bridge could be sized to reflect flow attenuation from Chester Woods Park Dam (SR-1)
30	Silver Creek	92149	County Hwy 11 (55th Ave NE), Haverhill-27	22395	0.01	n/a	n/a				Bridge could be sized to reflect flow attenuation from adjacent SR-2 Dam
32	Northeast area	1571	Dresser Dr NE, Haverhill-6	860	0.01	3.8	17	196	123	37	
33	Northwest area	88712	County Hwy 3, Kalmar 12	719	0.01	3	18	76	28	63	
36	North	88746	County Rd 114 (11th Ave NE), Oronoco-1	671	0.01	2	12	131	87	34	
	DODGE COUNTY:										
38	Salem Creek	97542	240th Ave, Canisteo-17/16	6458	0.01	4.8	12	357	308	14	
39	Salem Creek	L6472	670th St, Canisteo-15/22	8680	0.01	2	10	510	426	16	
40	Salem Creek	L5500	260th Ave, Canisteo-22/23	9094	0.01	3.3	17	526	442	16	
A1	Salem Creek	89102	County Hwy 9 (220th Ave), Ashland-12/13/Canisteo-7/18	4400	0.01	8	29	248	230	7	
A2	Salem Creek	89099	County Hwy 9 (220th Ave), Ashland-24/Canisteo-19	1800	0.01	2.3	9	152	147	3	
A3	Salem Creek	2350	County Hwy 9 (220th Ave), Ashland-25/Canisteo-30	4000	0.01	1.9	5	241	240	0	
A4	South Zumbro	89101	County Hwy 9 (220th Ave), Hayfield-1/Vernon-6	1500	0.01	2.2	8	111	109	2	

Notes: [1] NWL is Normal Water Level
[2] HWL is High Water Level
n/a means that flow control structures are not needed at these bridge locations because flows are regulated by upstream reservoirs.

Table 3-4 shows the ponding characteristics for the high priority sites in the South Zumbro Watershed. These results are based on the hydrologic modeling using 10-foot contour topographic data. The flows were estimated to assess the relative benefit of the flow control structures. Flow reductions greater than 60% are achievable with these structures for the two-year storm (3 inches). Even cases with reductions lower than 20% achieved significant delay in peak flows, often greater than an hour. The benefits could be greater and need to be analyzed in the future with a feasibility study that uses more detailed topographic information to optimize the design of the flow control structure in relation to the natural storage.

A listing of the high priority ponding sites is included in Table 5-2. Cost estimates are included in Table 5-3.

3.4 Water Quality Benefits From Ponding Improvements

Ponding improvements achieved with the flow control structures can enhance the water quality treatment function of wetlands and riparian lands. These stream corridor improvements promote stream channel/floodplain connectivity, and as a result, can provide water quality benefits. These benefits are estimated in this section.

3.4.1 Background

Runoff from agricultural areas can generate significant loads of a variety of pollutants. Table 3-5 shows some of the more common pollutants found in agricultural watersheds dominated by row crops, and the range of export coefficients (pounds/acre/year) found in the literature for those pollutants. Values presented below are for the Minnesota River Basin, but are not expected to differ significantly for other row-crop dominated landscapes in southern Minnesota.

Table 3-5 – Typical Export Rates for Common Pollutants in Agricultural Watersheds

Pollutant	Export Rate Range (lbs./ac./yr.)
Total Suspended Solids (TSS)	100-1000 lbs./ac./yr.
Total Phosphorus (TP)	**0.1 – 0.8 lbs./ac./yr.**
Nitrate-Nitrogen (NO_3)	5-30 lbs./ac./yr.

Source: Dr. David Mulla, ADAPTS Model, University of Minnesota

Most of these loads are exported to surface waters when nutrients and sediments are carried off agricultural fields during runoff events. Export rates vary widely with the time of year, the crop, and the intensity and depth of the precipitation event. Other significant sources of pollutants in agricultural watersheds include livestock feedlots, which can generate extremely high bacteria and nutrient loads to nearby receiving waters; and tile drains, which can be a large source of dissolved nutrients like phosphorus and nitrogen.

A less obvious impact that certain types of agricultural practices have on water quality is decreased streambank stability. With extensive tile drains, ditching, and loss of wetlands, greater quantities of runoff reach a stream or river more quickly than under natural conditions. This "hydraulic overloading" can de-stabilize the channel, causing streambanks to erode and generating very high sediment loads.

3.4.2 Water Quality Analysis for Cascade Creek

As mention earlier, flow control structures reduce peak flows downstream, which allows transportation design engineers to reduce the size of bridge channel crossings and specifically increase flood protection to 45th Avenue SW. In addition to providing rate control, these structures have the ability to provide downstream water quality benefits. As part of the Cascade Creek Hydrology and Hydraulic Study (Appendix C) an effort was made to quantify the potential water quality benefits of the flow control structures. These results can be extrapolated to other improvements in the watershed.

The primary water quality treatment mechanism on which this analysis is based includes the physical settling and entrapment of soil particles by vegetation in the overbank areas located upstream of the structures. It is important to note that this analysis did not attempt to account for the benefits of the flow control structures in reducing streambank erosion, since it was beyond the scope of the study.

The analysis focused on two parameters, total suspended solids (TSS) and total phosphorus (TP). Total suspended solids is a measure of the amount of material (mostly sediment) carried by and suspended in water. Sediment adversely affects aquatic environments in many ways.

- It acts as a vehicle to transport other pollutants frequently attached to it, including heavy metals, herbicides/pesticides, hydrocarbons, and the plant nutrient phosphorus
- It fills in lakes, wetlands, and stream channels
- It smothers fish eggs, beneficial aquatic insects, and desirable rooted aquatic plants
- It causes water to become turbid, decreasing light penetration, increasing water temperature, reducing transparency, impairing fish sight (many of which are gamefish), and has the ability to damage fish gills

Phosphorus is a concern because of its role in lake, river, and stream eutrophication, or nutrient enrichment. While eutrophication can affect moving water in severe cases, its effects are most often seen in lakes and reservoirs. When a stream carries nutrient-enriched water to a lake or reservoir, it can cause populations of certain types of algae to explode during the summer season. The most common nuisance types are bluegreen algae. They are particularly problematic for several reasons:

- They decrease water clarity, which affects the perceived suitability of the water body for recreation
- They form objectionable surface scum that often generate strong odors
- They often die-off seasonally, decreasing the oxygen content of the water and threatening the survival of game fish, making the water body more desirable for rough fish, and causing other undesirable conditions
- On occasion, they can secrete toxins poisonous to warm-blooded animals, including livestock, pets, and humans

Controlling these pollutants is desirable to reduce negative impacts to the stream channel as well as downstream lakes/impoundments, such as Cascade Lake and Lake Zumbro.

3.4.3 Methodology and Results

The dominant water quality treatment mechanism associated with each of the flow control structures is likely to be physical settling and entrapment of particles by vegetation in overbank areas. As runoff from precipitation events occurs, the flow control structures across the stream channel cause the water elevations in the creek channel upstream to increase and overtop the channel banks above the structure. As water spreads out across these overbank storage areas, flow velocity decreases, as does the flow's ability to carry suspended particles. Settling of some of the particles carried in the stream flow then occurs.

To quantify this effect, a simple method was developed using the following information:

- The frequency of certain benchmark precipitation events (in this case, the 1", 2", and 3" rainfall events) occurring during the open water season between April and November
- Runoff depths generated by precipitation events in the Cascade Creek Subwatershed
- Magnitude of the flows at each structure generated by those events
- The plug-flow (see glossary for definition) detention time of each structure for each event
- An empirical relationship between TSS (total suspended solids) and TP (total phosphorus) removal and detention time

Table E-1 in Appendix E shows the 24-hour rainfall depth frequency distribution in 0.5-inch increments for the open water period of April through November, based on 40 years of data for the Minneapolis-St. Paul International Airport (MSP). The average total depth of rainfall for this period is presented for each 0.5-inch increment near the bottom of the table. Since this distribution is not available for Rochester, and monthly rainfall depths in the April/November period at Rochester are within 9% of those recorded over a similar period of record for the MSP area (see Table 3-6), the rainfall depth and distribution for MSP are considered statistically similar to that of Rochester for the purposes of this analysis. For more information on Rochester's precipitation and its variability see Section 2.1 (page 8).

Rainfall depths were converted to inches of runoff for a watershed hydrologic curve number (CN) of 68, which reflects the average CN value (parameter used to estimate runoff based on land use, conditions and soils) for the Cascade Creek Subwatershed. Based on this information, rainfall depths less than 1 inch were removed from the summarized distribution.

Table 3-6 – Normal April-November and Annual Precipitations for Rochester and Minneapolis

	Precipitation in inches	
Station	**APRIL-NOVEMBER**	**ANNUAL**
Rochester Airport	26.81	31.4
Minneapolis Airport	24.72	29.41
Difference between Rochester and Minneapolis (inches)	2.09	1.99
Difference between Rochester and Minneapolis (%)	8.5	6.8

Source: Midwest Regional Climate Center-Illinois State Water Survey and National Climate Data Center (http://mcc.sws.uiuc.edu/Precip/MN) Data: 1971-2000 NCDC Normals

While these small events are very frequent, they do not appear to generate significant runoff in the Cascade Creek system and consequently are expected to contribute only a minor portion of the average annual runoff volume and pollutant load. The remaining average runoff depths for each rainfall depth increment were expressed as a percent of the total cumulative runoff depth over all depth increments above 1 inch.

The results of the analysis for both rainfall depth and runoff depth for the Cascade Creek Subwatershed are shown in Table 3-7.

Table 3-7 – Rainfall/Runoff Depth Analysis – Based on Precipitation Records 1960-1999 (April – November)

	0"-0.5"	0.5"-1"	1"-1.5"	1.5"-2"	2"-2.5"	2.5"-3"	3"-3.5"	>3.5"	Total April-November
Rainfall depth	9.2"	7.11"	3.58"	1.80"	1.11"	.75"	.08"	.5"	24.13"
% Rainfall[1]	38%	29%	15% (47%)	7% (22%)	5% (16%)	3% (9%)	0% (0%)	2% (6%)	– – –
Mean runoff depth[2]	0	0	0.03"	0.13"	0.3"	0.52"	0.77"	0.91"	2.66"
% Runoff depth	<1%	<1%	5%	16%	26%	26%	<1%	26%	– – –

[1]Numbers in parenthesis are re-calculated percentages based only on rainfall depths greater than or equal to 1"

[2]Runoff depth in inches based on CN of 68 for Cascade Creek Subwatershed. The runoff depth for the precipitation interval is the average of the runoff depths estimated for the rainfall amounts bounding the interval.

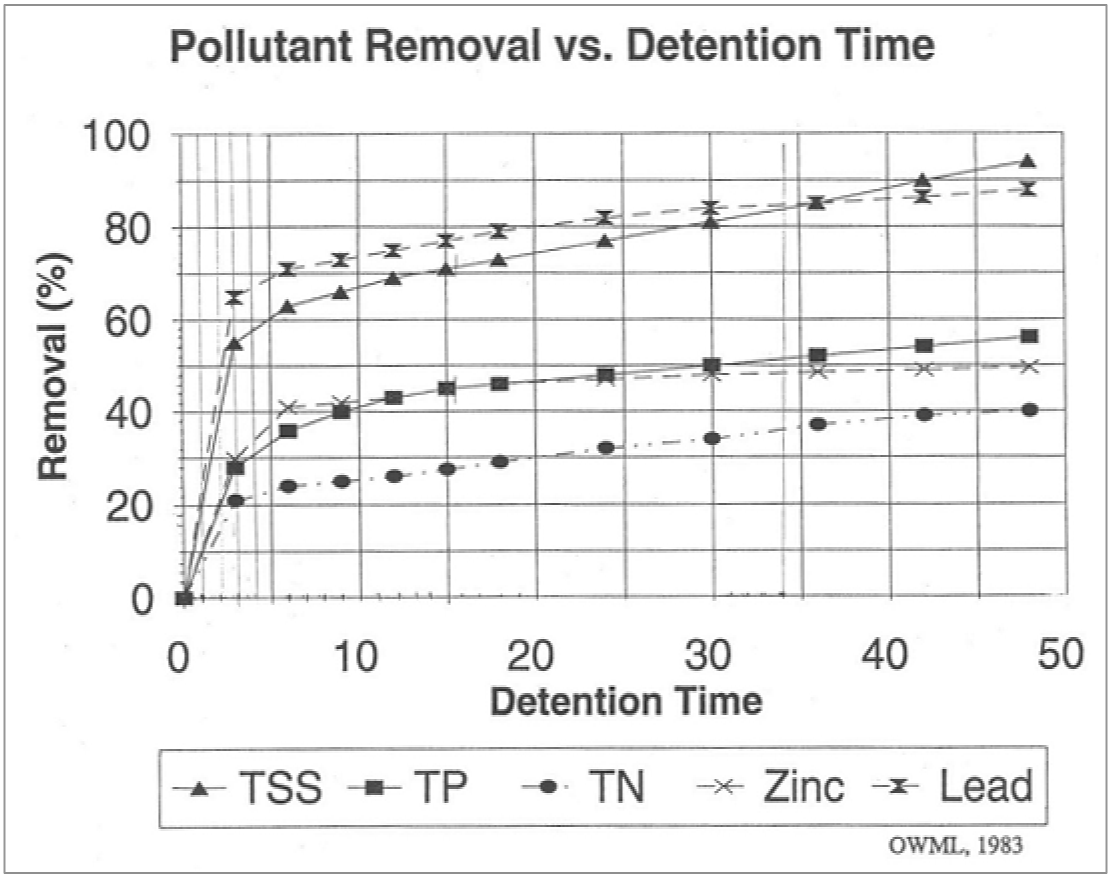
The values in Table 3-7 show that about 21% of average annual runoff depth for the April-November period comes from events in the 1 to 2 inch rainfall depth interval, and 53% of the average annual runoff depth comes from events in the 2 to 3 inch rainfall depth interval. The remaining runoff depth (about 26%) comes from 24-hour rainfalls over 3 inches.

The structures' pollutant removal efficiency estimates are based only on removal rates for runoff generated by rainfall events between 1 inch and 3 inches during April through November during an average year. Thus, the removal efficiencies do not incorporate rainfall events over 3 inches and precipitation/runoff that occur outside the April-November period (i.e., snowmelt).

Table E-2 in Appendix E shows information on the flow rate, runoff volumes and estimated detention times for the 1 inch, 2 inch, and 3 inch rainfall events at each of the seven structures proposed in the Cascade Creek Subwatershed study.

Figure 3-3 shows a graph based on empirical data from the Nationwide Urban Runoff Program (NURP) that relates the water detention time to pollutant removal (expressed as percent of total load). This figure is used to estimate percent removal of pollutants as a function of the time it takes the water to traverse the ponded area. This time is known as detention time. For example, a 10-hour detention time would remove about 67% of total suspended solids.

Figure 3-3 – Pollutant Removal versus Water Detention Time – for Total Suspended Solids (TSS), Total Phosphorus (TP), Total Nitrogen (TN), Zinc and Lead



Source: Results from the Nationwide Urban Runoff Program (NURP) by Occoquan Watershed Monitoring Laboratory (OWML)

At each site, the detention times for runoff events associated with the 1 inch, 2 inch and 3 inch rainfalls were used to provide a percent removal for total suspended solids (TSS) and total phosphorus (TP) respectively, based on the graphical relationship shown in Figure 3-3. Average removal for the rainfall/runoff interval was estimated by averaging the percent removal for the pollutant based on the plug flow detention times for the rainfall depth bounding each interval. These figures were then weighted based on the runoff depth frequency associated with each of the rainfall intervals between 1 inch and 3 inches shown in Table 3-7.

Table 3-8 summarizes the average removal efficiencies for total phosphorus and total suspended solids for precipitation events during the April-November period at each of the seven structures in Cascade Creek (locations are illustrated in Figure 1 of Appendix C). The data show the estimated removal efficiency ranges from 2% to 20% for TP, and 5% to 37% for TSS. The mean removal efficiency estimates for all structures on the Cascade Creek drainage are approximately 11% for TP and 22% for TSS. It is important to note that these removal efficiencies are based on the natural contours of the overbank areas upstream of each structure. These removals could be improved by increasing the dead storage volume of the overbank areas, such as through the excavation of ponds in those riparian areas. Increasing the storage volume would increase plug flow detention time, and increase removal efficiency.

3.4.4 Extrapolation to Remainder of the South Zumbro

Using the information generated above for Cascade Creek, TP and TSS removal efficiencies were estimated for the 16 other structures proposed for the South Zumbro Watershed. To approximate these removal efficiencies, the ratio between the total watershed and the pool surface area for the 2 inch rainfall event was regressed against the calculated removal for efficiency for TP and TSS for the seven structures analyzed in the Cascade Creek drainage. The regression relationships are shown in Figure 3-4 for TP and in Figure 3-5 for TSS.

Figure 3-4 – Total Phosphorus Removal Efficiency Regression

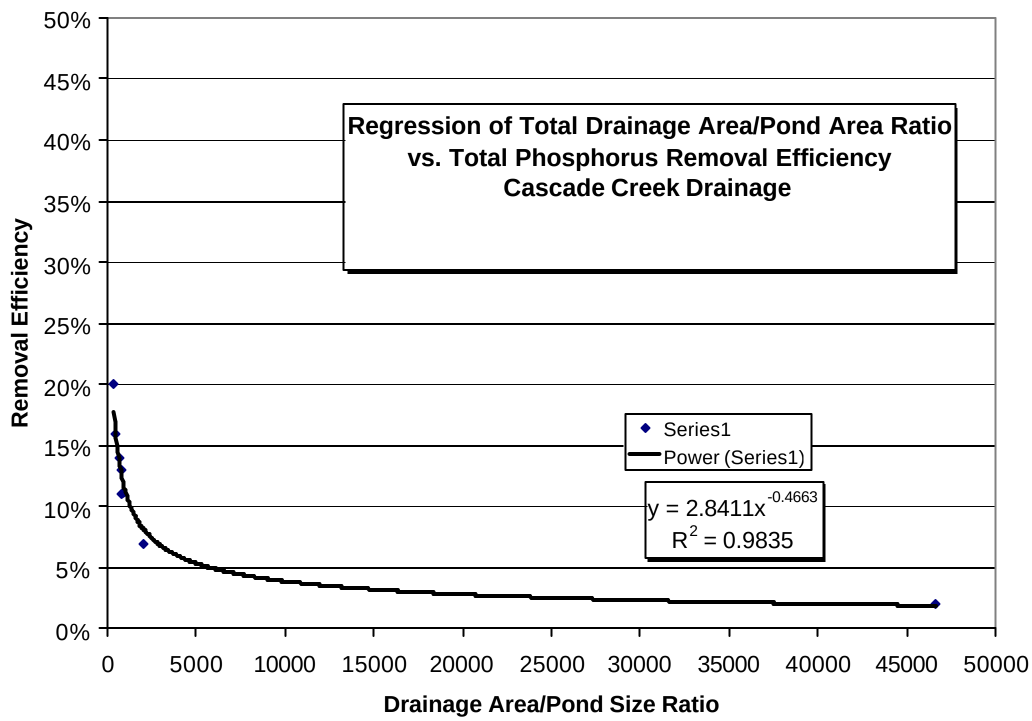
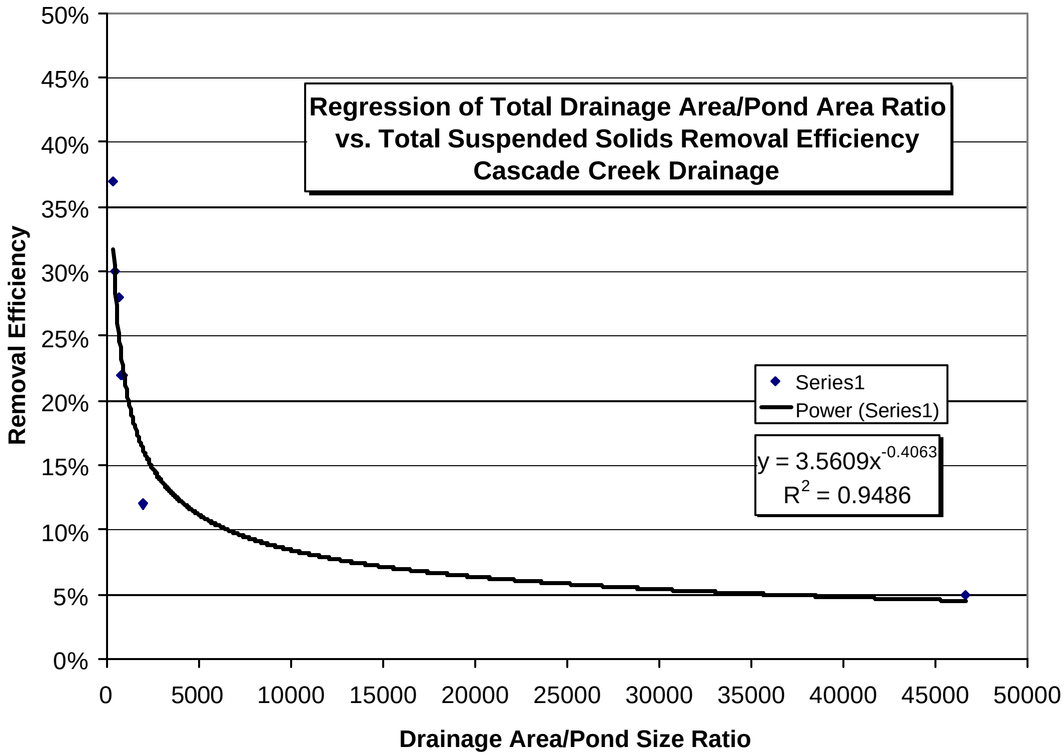


Table 3-8 – Estimated TP and TSS Removal Efficiencies by Structure – Cascade Creek Subwatershed

						1"-2" Rainfall		2"-3" Rainfall			
Site	Location	Rainfall	Detention	TP Removal	TSS Removal	Mean Removal Efficiency TP	Mean Removal Efficiency TSS	Mean Removal Eficiency TP	Mean Removal Eficiency TSS	Aggregate TP Removal	Aggregate TSS Removal
		(inches)	(hrs)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	L-2380	1"	2.0	20	40						
		2"	2.8	26	50						
		3"	3.6	30	55	23	45	28	52.5	20	37
2	89160b	1"	15.1	44	82						
		2"	0.3	3	6						
		3"	0.3	3	6	23.5	44	3	6	7	12
3	89160	1"	0.2	3	5						
		2"	2.7	26	48						
		3"	2.4	24	44	14.5	26.5	25	46	16	30
4	89155b	1"[a]	34.0	52	84						
		2"	1.1	12	22						
		3"	1.0	10	20	32	53	11	21	13	22
5	89155	1"	0.4	4	8						
		2"	1.0	10	20						
		3"	2.8	26	50	7	14	18	35	11	21
6	4075	1"	0.6	6	12						
		2"	0.1	2	4						
		3"	0.4	4	8	4	8	3	6	2	5
7	L-6262	1"	5.1	32	60						
		2"	1.6	14	28						
		3"	2.2	22	42	23	44	18	35	14	28
								Overall Mean		**12**	**22**
								Area Weighted Mean		**11.93**	**22.45**

[a] 0.1 cfs outflow assumption

Figure 3-5 – Total Suspended Solids Removal Efficiency Regression



The basin pool area and total drainage area were then estimated for each of the 16 structures proposed for the remainder of the South Zumbro Watershed. The regression relationship developed with the Cascade Creek data was used to estimate the TP and TSS removal efficiencies, respectively. Table 3-9 summarizes the estimated removal efficiencies for TP and TSS during the April-November period at each of the 16 structures. The data show that the estimated removal efficiency ranges from 6% to 35% for TP, and 11% to 57% for TSS. The mean removal efficiency estimates for all structures in the South Zumbro Waterhsed are approximately 13.6% for TP and 24.9% for TSS.

Building water quality ponds and instituting other BMPs in the watershed can increase removal efficiencies. The water quality benefits estimated in this section are a secondary benefit from the peak flow reduction objective of this study. However, the reduction in streambank erosion from attenuating the peak flows can be substantial; significantly reducing sediment transport (bedload and suspended sediments) to downstream waterbodies.

Table 3-9 – Estimated Removal Efficiencies for Flow Control Structures – South Zumbro Watershed

Watershed	BridgeNo	Total drainage Area (DA) (acres)	Basin Pool Area (PA) (acres)	DA/PA Ratio	TP Removal (%)	TSS Removal (%)
Bear Creek	L-6236	17871	4	4468	5.6%	11.7%
Bear Creek	L-8565	19025	6	3171	6.6%	13.5%
Cascade Creek	4075	9306	8	1163	10.6%	20.2%
Cascade Creek	88708	595	0.5	1190	10.5%	20.0%
Cascade Creek	89160	4507	10	451	16.4%	29.7%
Cascade Creek	L-6262	11526	16	720	13.2%	24.6%
North	88746	671	2	336	18.9%	33.5%
Northeast area	1571	860	1	860	12.2%	22.9%
Northwest area	88712	719	4	180	25.2%	43.2%
Salem Creek	89180	3798	8	475	16.0%	29.1%
Salem Creek	97542	6458	5	1292	10.1%	19.4%
Salem Creek	L-5500	9094	10	909	11.9%	22.4%
Salem Creek	L-6472	8680	5	1736	8.8%	17.2%
SZ-Goose Creek	L-6151	180	2	90	34.9%	57.2%
South Zumbro	L-6180	1920	1	1920	8.4%	16.5%
South Zumbro	L-6204 L-6205	26872	15	1791	8.6%	17.0%
				Overall Mean	13.6%	24.9%

3.5 Wetland and Upland Assessment of Restoration Potential

The wetland and upland assessment was done mainly to identify restoration or enhancement opportunities near the high potential ponding sites (considered for establishing flow control structures for temporary ponding of water). The assessment included an evaluation of wetland susceptibility to storm water. The upland areas assessed were those associated with the wetland areas in the stream corridor, mostly in areas that could be temporarily ponded if flow control structures were built.

Section 3.5.1 presents the methodology and ranking criteria and Section 3.5.2 presents a summary of the assessment by sites in Table 3-11 (page 40).

3.5.1 Methodology and Ranking Criteria

As part of this study, site assessments were conducted to review opportunities to enhance water storage within the upstream wetlands at the bridge downsizing locations. The wetland assessment completed as part of this study reviewed the wetland's community type and vegetative component, as well as hydrologic alterations (tiling, ditching, channel downcutting, etc.) taking place in the drainage area. This was done to determine where water storage could potentially impact the wetland basin, and where creating berms or water control structures might restore the wetland's historic water regime. Wetlands were ranked for storm water susceptibility, wetland restoration potential, and flood storage capacity.

3.5.1.1 Storm Water Susceptibility

Two factors determine a wetland's susceptibility to storm water damage: community type, and community quality (as measured by floral diversity). For example, sedge meadows are highly susceptible to damage and degradation when they are exposed to repeated and/or extreme fluctuations in water levels (bounce). Native species in these communities can quickly die if runoff impacts their basin, leaving opportunities for disturbance-adapted exotic or aggressive species to invade. Other community types, such as floodplain forests, contain species that have adapted to this type of "bounce" in water levels, and can tolerate storm water impacts with fewer negative effects.

Similarly, the overall quality of the community affects how susceptible an area is to storm water impacts. Because a high quality area is more diverse, it is likely to contain species somewhat conservative in habitat. These conservative species have a lower tolerance for disturbance, and usually drop out of a community as disturbance pressures increase. Thus, storm water impacts can reduce diversity at a site and alter the condition of good quality areas. Since low quality areas, by definition, have reduced species diversity and tend to be dominated by disturbance-adapted species, storm water impacts are unlikely to further degrade these sites.

The State of Minnesota Storm Water Advisory Group has prepared a technical paper, *Storm Water and Wetlands: Planning and Evaluation Guidelines for Addressing Potential Impacts of Urban Storm-Water and Snow-Melt Runoff on Wetlands,* that divides wetland communities into the categories of highly susceptible, moderately susceptible, slightly susceptible, and least susceptible. Wetland susceptibility is based on the community type, vegetative disturbance, and overall floral diversity. Table 3-10 summarizes how susceptibility was determined for each wetland.

Table 3-10 – Wetland Community Susceptibility Ratings

Susceptibility Rating	Highly Susceptible*	Moderately Susceptible	Slightly Susceptible	Least Susceptible**
Wetland Community	Sedge Meadow	Shrub Carr[1]	Floodplain Forest[4]	Gravel Pit
	Bog	Alder Thicket[1]	Wet Meadow[5]	Cultivated Hydric Soil
	Calcareous Fen	Wet Meadow[1,2]	Shallow Marsh[5]	Dredge/Fill Disposal Site
	Low Prairie	Shallow Marsh[2, 3]	Deep Marsh[5]	Low Floral Diversity
	Coniferous Swamp	Deep Marsh[2,3]		
	Lowland Hardwood			
	Seasonally Flooded Basin			

Notes: A) All scientific and natural areas, and pristine wetlands should be considered highly susceptible; **B)** There will always be exceptions to the general categories listed above.

[1] These can tolerate inundation of 6-12” for short periods; may be completely dry in drought or late summer conditions.
[2] These can tolerate inundation of >12 “, and are adversely affected by sediment and/or nutrient loading and prolonged high water level
[3] There are some exceptions to wet meadow and marsh communities
[4] These communities can tolerate inundation of 1-6+ feet, possibly more than once per year
[5] Wet meadows that are dominated by reed canary grass
[6] Marshes dominated by reed canary grass, cattail, giant reed or purple loosestrife.

* Special consideration must be given to avoid altering these wetland types. Inundation must be avoided. Water chemistry changes due to alteration by storm water impact can also cause adverse impacts.
** These wetlands are usually so degraded that input of urban storm water may not have adverse impacts.

3.5.1.2 Wetland Restoration Ranking

Wetland restoration efforts strive to return the ecosystem to its pre-degradation condition. Restoration potential depends on ease of reestablishing the original aquatic functions and their related physical, chemical and biological characteristics. A summary of the wetland restoration ranking criteria is listed below:

Restoration Potential	**Description**
High	These wetlands are partially or fully drained by hydrologic alterations such as tile lines and ditches. With a high rank, restoration would enable previous water regimes that existed prior to the alteration. These wetlands are typically easy to restore and do not have any issues (such as homes or roads at low elevations, etc.) that would limit the restoration.
Medium	Wetlands ranked with medium restoration potential are partially or fully drained. Typically, restoration would restore their historic hydrologic regime or enhance the wetland basin’s plant community. They are not ranked as “high” because some of the restorations would be enhancements and/or there was an issue (low home or road elevation, etc.) that limited the restoration.

Low	Wetlands are ranked low if there is little or no alteration that would make hydrologic restoration necessary. In some cases, raising water levels would have an adverse impact on these communities.

3.5.1.3 Flood Storage Ranking

Wetlands were also evaluated for their ability to provide floodwater storage. Below is a summary of how flood storage was ranked.

Flood Storage	**Description**
High	Wetlands were ranked as having high flood storage potential if they were large, relatively flat basins where constructing a control structure would result in significant water storage. Consideration was also given to whether the water storage could be contained within the wetlands, or if adjacent land would be flooded. When floodwater storage could be maintained predominately within the wetland, the ranking would be higher then a wetland where a water control structure would result in extensive flooding of land outside the wetland basin. Consideration was also given to the potential impact on a plant community. If flooding would not impact the plant community, and the wetland met the other criteria for a ranking of high flood storage, then the basin was ranked high. If it met the other criteria for flood storage but would result in an impact to a sensitive plant community the wetland ranking would drop to medium/high or medium.
Medium	Wetlands ranked with medium flood storage potential provide floodwater storage, but not to the same degree as the high-ranking wetlands. Other factors, such as recent bridge replacement limiting the need for storage, or impact on plant communities, also resulted in a shift from high to medium.
Low	Wetlands were ranked low if deep ditches limited flooding potential and/or if, even with a water control structure, storage would be limited due to the existing topography.

3.5.1.4 Upland Restoration Ranking Criteria

The upland restoration ranking criteria, listed below, was used to evaluate the high priority bridge crossing locations identified in each County's CIP. Each site was given a restoration potential or ranking based on its proximity to other natural communities and ease of restoration within the stream corridor. A summary of the upland restoration ranking criteria follows:

Restoration Potential	**Description**
High	These upland areas exhibit one of several conditions including a high quality natural area, close proximity to a natural area, immediately adjacent to a wetland restoration site, and/or possibility of an inexpensive restoration project.
Medium	These areas may be in close proximity to a natural area, located near a potential wetland restoration site, able to support native vegetation, or may present some challenges if managed to improve their quality.
Low	These areas generally do not occur within ¼ - ½ mile of another natural community, do not occur near a site with wetland restoration potential, have little or no existing native vegetation (e.g., cornfield), or present significant long-term challenges to restore the natural communities.

3.5.2 Wetland and Upland Restoration Opportunities by Sites

Table 3-11 summarizes the wetland susceptibility to storm water, the wetland restoration opportunities, the flood storage functions, and the upland restoration opportunities for each priority bridge crossing location. Wetland and upland restoration locations are shown on Map 1. For a summary of observations by site refer to Appendix F.

Table 3-11 – Summary of Wetland and Upland Assessment

Crossing (by bridge #)	Wetland Susceptibility to Storm Water	Wetland Restoration Opportunity	Flood Storage Functions	Upland Restoration Opportunity
2350	Least	Medium	Medium/High	High
4075	Least	Medium/High	High	High
7092	Least	Low	Medium/High	Low
55511	Highly	Medium	Medium/Low	Low
88708	Least	Low	Moderate/Low	Medium
88712	Least	High	High	Medium
88733	Least	Medium	Medium/High	
89099	Least	High	High – with restoration	Low
89101	Least	Medium/Low	High – with restoration	Medium
89102	Least	High	High	High
89136	Slightly	Medium/Low	Medium/Low	
89155	Least	Medium/High	High	
89160	Least	Medium/Low	Medium/Low	Low
89180	Slightly	Low	Medium/High	Medium
97542	Highly	High	Medium/Low	Medium
L5500	Slightly	Medium	Medium/Low	Low
L6151	Highly	High	Medium/Low	High
L6180	Least	Medium	Low – High with restoration	High
L6204-L6205	Highly	Medium	Medium/Low	Medium
L6472	Slightly	Low	Low	Low

4 Public Involvement and Demonstration Projects

4.1 Public Involvement and Voluntary Program

Community leaders, farmers, landowners, and residents of the watershed participated in this study. They provided valuable input into the current storm water management issues and problems in the watershed. Their involvement was facilitated by County staff and staff of other institutions that participated in the Technical Advisory Committee (TAC). Public officials in the Policy Advisory Committee (PAC) helped identify issues and develop methods for involving future stakeholders. Staff members working in the area, such as members of the Dodge and Olmsted Soil and Water Conservation Districts (SWCDs), have been playing a major role in promoting BMPs in agricultural activities as well as in stream corridor environmental enhancement.

For high priority ponding sites, personal contact and public meetings were used to seek volunteers willing to enlist their property as demonstration projects for this watershed-based CIP approach. A public meeting was held at the Salem Township Hall on March 13, 2002, to inform watershed residents, farmers, and landowners about the study and to obtain feedback from the potential beneficiaries and participants of the project.

Participants had the opportunity to ask questions and express interest in having a farm pond, flow control structure, and/or other improvements on their property. Because it is an ongoing project, they were also invited to express future interest. In Olmsted County, four landowners expressed interest in developing upstream storage sites on their property. Two sites were selected as priority demonstration sites for the project. In Dodge County, two landowners volunteered to participate in the project.

The Counties envisioned implementing ponding improvement sites on a voluntary basis to promote watershed BMPs. The flow control structures are designed to reduce transportation maintenance costs, manage storm water, and improve the stream corridor environment. If desired, farm ponds, wildlife habitat, wetland restoration, or other improvements can be integrated with the structure project. Implementing the ponding improvement demonstration projects is very important to help promote the idea, secure support, and encourage education on the value of the stream corridors in the South Zumbro Watershed.

4.2 The Cascade Creek Experience, Cost-Benefit Considerations, and Ponding Demonstration Projects

The more detailed study of the Cascade Creek Subwatershed focused on bridges L-6262 and 4075 (Appendix C). Many high potential ponding improvement sites were identified in the subwatershed. The benefits and costs analysis results are summarized here to illustrate the potential of this watershed ponding approach.

The direct benefits from ponding improvements can be measured as:

1. Increased flood protection to roads and bridges.

2. Savings in bridge replacement costs using a watershed-based approach (with ponding improvements) versus the traditional approach to achieve the same flood protection.

In addition to direct cost savings, indirect benefits would include reduced road repairs and maintenance after flooding; reduced cost from removing sediments where aggradation occurs; and reduced flooding damage to crops or other infrastructure. Environmental benefits are harder to value, but can be measured indirectly, such as through indicators of aquatic and riparian quality.

4.2.1 Increased flood protection to roads and bridges

One way to consider the economic benefit is to evaluate how the improvements increase flood protection to bridge L-6262. Table 4-1 illustrates how flood protection is increased from existing conditions as improvements are made. Note that:

- Protection can be raised from about the 15-year flood to the 65-year flood with the proposed improvements
- Implementing high potential ponding improvements helps ensure 50-year flood protection to bridge
- Higher protection could be possible by optimizing improvements during the design stage
- Additional flood protection could be achieved with other medium and low potential improvements when opportunities arise
- A 100-year flood protection could potentially be achieved if economically feasible

Table 4-1 – L-6262 flood protection for existing conditions and different improvements

Case Description	Approximate Flood Protection (years)	Comments
1) Existing conditions	15	With road low point at 1,031 ft
2) Implementing ponding improvement sites 89160b and 89155b	35	With road low point at 1,034.9 ft
3) Implementing high potential ponding improvement sites	50	With road low point at 1,034.9 ft
4) Implementing high potential ponding improvement sites and downsizing bridge structures	65	With road low point at 1,034.9 ft

4.2.2 Savings in bridge replacement costs

Downsizing bridge structures is possible when ponding improvements are made. The cost of the high potential improvements was estimated at $556,000 for the Cascade Creek Subwatershed. This includes the construction of weirs, and berms with a six-foot average height, and the associated excavation and protection of the construction-affected area. Adding the cost for the lower potential ponding improvements would increase that amount to $1,434,000. This would further reduce peak flows.

The economic benefit can be estimated as the potential savings in replacing the bridges using a traditional method, versus a watershed-ponding approach that allows bridge downsizing. The cost savings depend on the desired flood protection to be achieved at the different bridge locations.

To estimate the savings from downsizing bridges we compared:

A) The traditional approach where culverts are sized to meet the target flood protection

B) The upstream temporary ponding approach (watershed approach) with downsizing of culverts, which was used to define the possible target flood protection achievable

Both approaches were used to achieve a similar flood protection and allow a cost comparison.

A savings of $653,280 was estimated for replacing the high-ranked bridges. These savings are possible due to ponding improvements at high potential sites, which cost $556,000. This results in an overall savings of $97,280 (benefit to cost ratio of 1.2; that is, savings is 1.2 times the cost), as presented in Table 4-2.

> *This means that the overall savings can pay for the upstream storm water improvement projects and that the Counties can reduce the sizing of the bridges/culverts in the watershed, while achieving similar road flood protection as a traditional design approach.*

Table 4-2 – Net savings from high potential improvements in Cascade Creek

Description	Amount
Cost of Temporary-Ponding Improvements	$556,000
Potential Savings From Downsizing Bridge Structures	653,280
Net Savings	$ 97,280

Implementing the high potential ponding improvements yields additional savings when other downstream bridges/culverts are replaced (beyond those scheduled in the current CIP). That is, once the ponding improvements are made, other downstream bridges benefit from the reduced peak runoff flows. For example, additionally replacing culverts at the two low-ranked sites yields a total potential savings of $834,720 (see Table 7 in Appendix C for more details). Subtracting the total ponding improvement cost of $556,000 yields an overall savings of $278,720 (benefit to cost ratio of 1.5). This is a positive balance that can be used for other transportation or ponding improvement projects in the watershed.

4.2.3 Ponding Demonstration Projects

Based on the results from the Cascade Creek Subwatershed study and the interest of two landowners in having ponding demonstration projects, the two selected projects should be implemented as soon as financing becomes available. These two projects will provide direct benefits to high priority bridges L-6262 and 4075. These possible ponding demonstration projects are located upstream of bridges 89160 and 89155. Other projects could also be implemented when a funding source is established.

4.3 Rural Section Rain Gardens

Rural section rain gardens are considered in this plan as one tool for treating and controlling storm water along the roadways. Their main function is to capture pollutants and promote infiltration of runoff generated “on-site.” For other best management practices that apply to road waterways refer to Section 4.4.2.2 (page 59).

Rural section rain gardens are landscaped areas located in the road drainageways. They are planted with native and/or locally adapted vegetation for the purpose of retaining and treating storm water. The plants used in these gardens are able to tolerate dry to wet conditions and even prosper when they are regularly flooded. Figure 4-1 illustrates the concept of the rain garden, which is designed for each specific site. If impermeable soils are present, an underdrain system can be constructed to allow infiltration into the soil bed. Figure 4-2 illustrates a surface sand filter design for clayey soils.

Figure 4-1 – Rain Garden Diagram

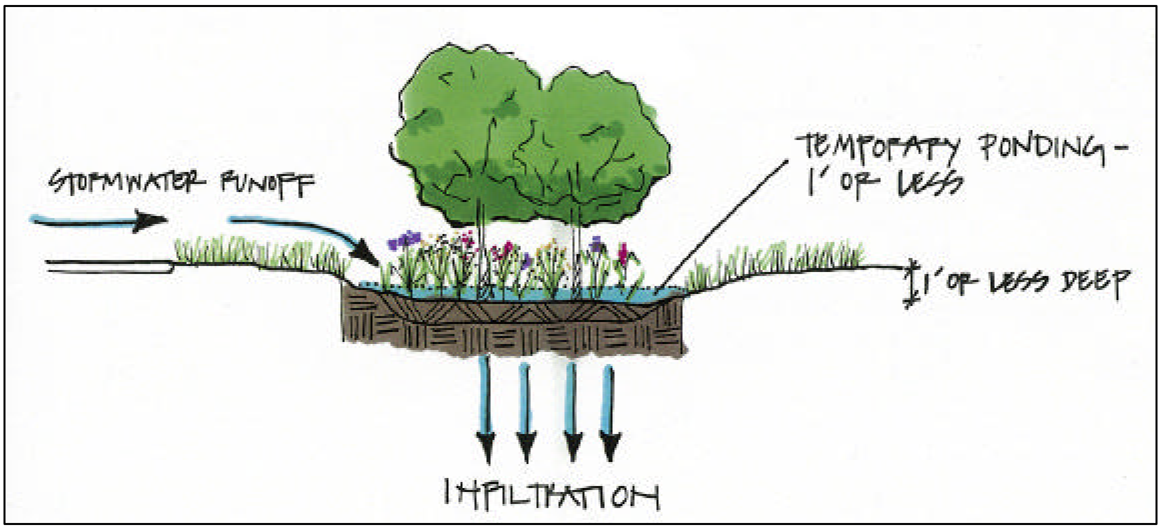
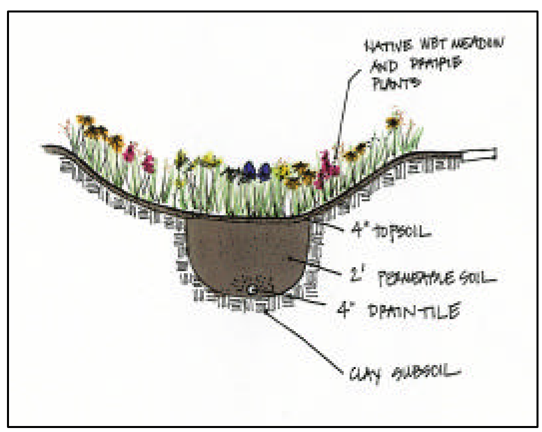


Figure 4-2 – Rain Garden with permeable soil added



A rural section rain garden:

- Is also known as rainwater garden
- Is a special type of biofiltration, bioretention, or bioswale device
- Is an infiltration type of storm water best management practice
- Is a shallow depression or “strategic puddle”
- Holds and infiltrates runoff from rainwater close to where it falls
- Is usually planted with native plants or hardy perennials

4.3.1 What is a Rain Garden?

Figure 4-3 illustrates the construction and development of a rain garden servicing a road section and parking street extension in Wayzata (Minnesota). Notice how this area was both aesthetically and environmentally improved.


Before

Figure 4-3 – Lake Street extension rain garden before, during, and after construction

During construction

After construction

After one year

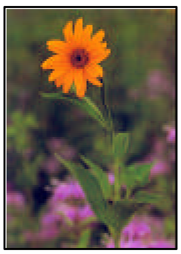
4.3.1.1 Rain Garden Requirements

- Appropriate soil conditions and/or filtration material
- Water and drought tolerant plants
- A site-specific design
- Low water flow velocities
- Appropriate design for overflows
- Special considerations during construction to avoid compaction
- Maintenance to ensure long-term performance

Rain Gardens give best results:

- In sandy to sandy/loam soils
- When plants are carefully selected for specific site conditions
- In relatively flat areas
- When separation from groundwater is four feet or greater
- With pretreated sediments
- For small drainage areas
- Where residents participate actively and maintain garden
- When water enters garden as sheet flow

A rain garden will work best when sheet flows from impervious surfaces (such as roads or parking lots) are directed into the garden areas.



Plant selection is critical for a successful rain garden. Many alternative plants can be chosen to adapt to water, soil, temperature, and sun conditions. Trees and shrubs can also be included. Native flowers can be added to give the garden more color and planting a variety of species can provide the area with a continuous bloom throughout the growing season. The plant composition is selected during the design and can include plants such as the Black-Eyed Susan, Blue Flag Iris, Purple Coneflower, and Little Bluestem.

Rain Gardens are primarily used for water quality treatment:

- Often designed to handle first inch to inch-and-a-half of runoff
- Most (75%) rainfall events are in this category
- Capture "first flush" of pollutants
- Can also infiltrate runoff from small storms
- Pollutant removal efficiency varies based on conditions and runoff volumes

At left: Photo taken after 3.5 inches of rain fell in less than an hour late one afternoon.

At right: The morning after the storm, all water has been infiltrated.

4.3.1.2 Rain Garden Limitations

- Cannot usually infiltrate large storm events
- Sediment overloading can impact vegetation, the garden's life and its infiltration capacity
- Concentrated loading of pollutants
- Availability of space to meet design requirements
- Vulnerable to "disappear" or be impacted with changes in land ownership

4.3.1.3 Opportunities for Rural Section Rain Gardens

- Ditches with small runoff contributing areas can provide great opportunities for establishing rain gardens
- Space availability is generally greater in rural than in urban settings
- Can establish alternative plants in areas with cattails
- Can be designed in conjunction with check dams or other best management practices.

4.3.2 Benefits of Rain Gardens

- Aesthetically pleasing
- Promote infiltration, which:
  - Reduces peak runoff flows
  - Reduces total runoff volume
  - Recharges ground water
  - Enhances base flow in streams
  - Reduces streambank erosion
- Enhance water quality in receiving water bodies
- Filter/treat pollutants
- Reduce thermal impacts on receiving surface waters
- Reduce water stagnation and mosquito breeding

The benefits are generally for the small storms. Benefits decrease as rainfall volume and intensity increases.

4.3.3 Costs of Rain Gardens

The average cost of building a rain garden ranges from $3,200 to $5,000 for an area about 10 feet wide and 30 feet long, if built by the County; this cost could be $12,000 to $16,000 using a contractor. Site characteristics significantly influence the cost. The cost also depends on whether one or several are built together to reduce the unit cost.

4.3.4 Rural Section Rain Garden Demonstration Sites

The following criteria were used for the selection of the rain garden demonstration sites within the watershed:

- Geographic distribution in several Townships
- Access and visibility to promote the concept
- Areas with water problems reported by residents or County staff
- Potential for water quality treatment of road-side pollutants (such as salts and sand)
- Areas with undesirable cattails
- Technical feasibility
- Areas with small drainage areas contributing flow

Numerous sites in the watershed showed a high potential for rural section rain gardens. The development of rain gardens along the roadways would contribute to improved downstream water quantity and quality characteristics, reduced runoff peaks and flows (mainly for small storms), and increased groundwater infiltration. In addition, rain gardens can also be combined with other BMPs, such as check dams, to further control and treat storm water runoff.

Potential rain garden demonstration sites are located on Map 3. The numbers are provided for reference and do not indicate their priority (e.g., RDS-04). Once funding becomes available, an implementation strategy can be established for developing the rain garden demonstration projects. In order to spread out cost and workload for developing the sites, one possible strategy is the goal of establishing two rain gardens per year in the watershed. The locations could be chosen based on a detailed site assessment at the implementation stage of the project. While the sites are generally envisioned within the road right-of-way, they can include other appropriate areas if easements or joint ventures are pursued with the property owners.

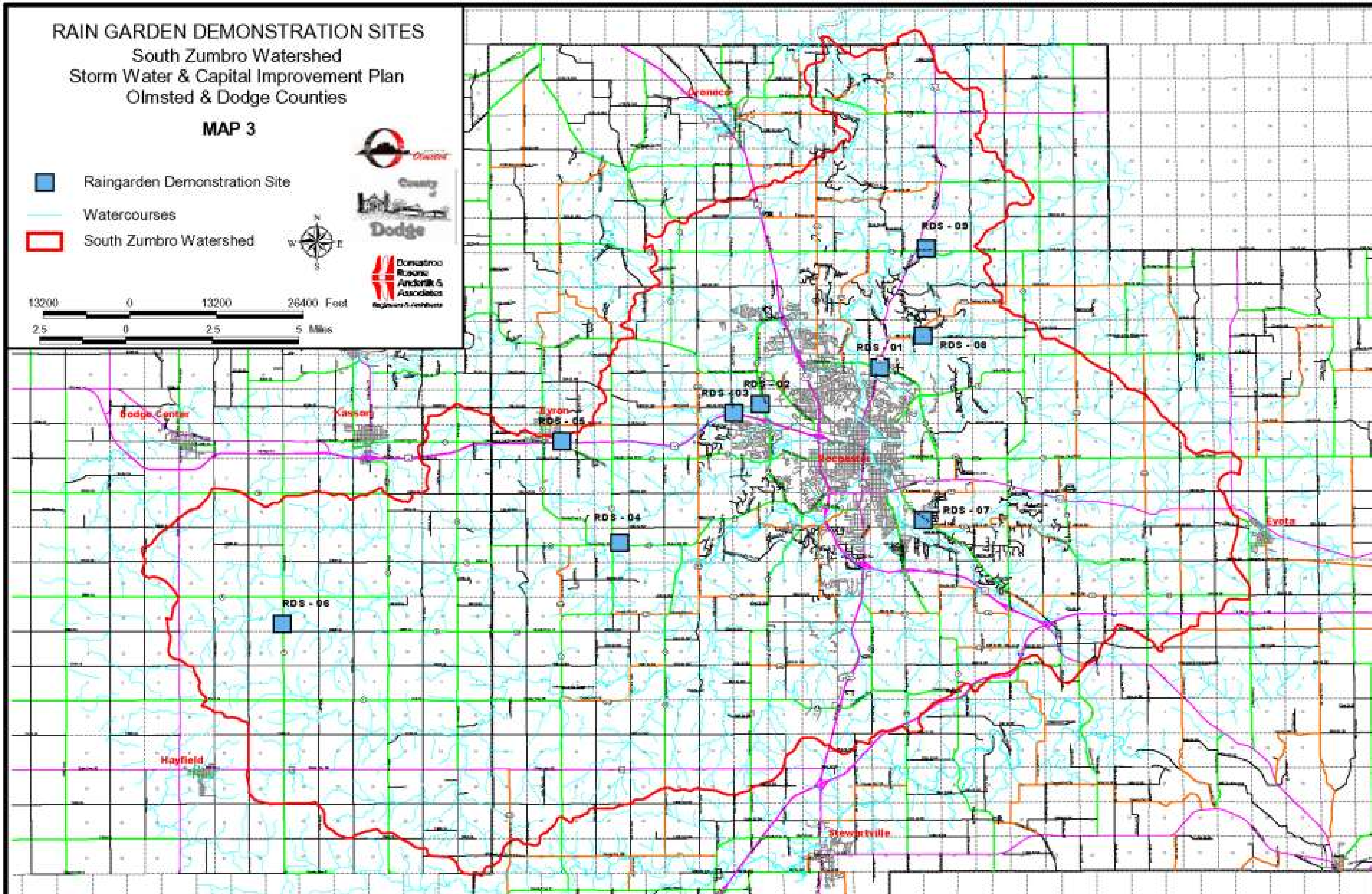
Site RDS-01
Location: Intersection of Hwy 63 and CSAH 22 (north side of CSAH 22 and south of ShopKo North parking lot), Olmsted County.

Comments: A highly visible site that is prone to localized flooding. Large amounts of sand and salt applied to the intersection as well as parking lots serving ShopKo North and the Chateau Theaters. Severe erosion problems are experienced downstream near Domaille Auto Dealership. Waterway flows directly to the South Zumbro River.

Site RDS-02
Location: Near intersection of CSAH 22 and 19th Street NW (west side of CSAH 22 and about 200' north of 19th Street), Olmsted County.

Comments: A highly visible site near Cinemagic Stadium 12 Theaters in Rochester. Large amounts of sand and salt applied to intersection as well as parking lots serving the industrial area to the north. Area is prone to localized flooding. Space along the roadway can be used to create a series of rain garden demonstrations on the west side of CSAH 22 leading to the culvert at the intersection of 19th Street. Concentration of flows may require the use of other BMPs. Waterway flows to Cascade Lake.

(Opposite page, Map 3)


RAIN GARDEN DEMONSTRATION SITES
South Zumbro Watershed
Storm Water & Capital Improvement Plan
Olmsted & Dodge Counties
MAP 3
Raingarden Demonstration Site
Watercourses
South Zumbro Watershed
N
S
E
W
13200
0
13200
26400 Feet
2.5
0
2.5
5 Miles
RDS - 01
RDS - 02
RDS - 03
RDS - 04
RDS - 05
RDS - 06
RDS - 07
RDS - 08
RDS - 09
Oronoco
Byron
Kasson
Dodge Center
Rochester
Eyota
Hayfield
Stewartville

Site RDS-03
Location: Highway 14 east of County Road 104, Olmsted County.

Comments: Highly visible with potential aesthetic value. Large amounts of sand and salt are applied along the roadway. Flows drain to Cascade Lake. It is recommended that Olmsted County contact Mn/DOT about establishing a joint demonstration project.

Site RDS-04
Location: Salem Corners area by County Road 25 and County Road 3.

Comments: Highly visible area by the Salem Town Hall, very accessible for educational purposes. Rain garden would have a high aesthetic value. Large amounts of sand and salt are applied along the roadway. Waterway flows to Salem Creek.

Site RDS-05
Location: Frontage road area north of Highway 14 between County Road 5 and 10 Avenue SE in Byron.

Comments: Highly visible with potential aesthetic value. Large amounts of sand and salt are applied along the roadway. Drainageway flows to Cascade Creek. It is recommended that Olmsted County contact Mn/DOT about establishing a joint demonstration project.

Photo 3 -- Dodge County Road 9

Site RDS-06
Location: County Road 9, south of County Road 6 (see Photo 3 or RDS-06 in Map 3), Dodge County.

Comments: Cattails are a nuisance to nearby residents, sometimes even affecting visibility of oncoming vehicles. Long swale can provide effective treatment of road salts and other pollutants.

Site RDS-07
Location: CSAH 36 and 20th Street SE (1900 Block in Marion Township)(see Photo 1), Olmsted County.

Comments: A highly visible residential area in Marion Township along CSAH 36 (Marion Road). Large amounts of sand and salt are applied along the roadway. Residential complaints about localized flooding of property; may require additional BMPs. Rain garden would be an aesthetically pleasing solution that residents would likely accept. Waterway flows to Bear Creek.


Photo 1 -- CSAH 36 and 20th Street SE (1900 Block in Marion Township)

Site RDS-08
Location: County Road 124 and 48th Street NW (East side of CR 124 in Haverhill Township) (see Photo 2). County Road 124 is also known as Hadley Valley Road NE.

Photo 2 -- CR 124 and 48th Street NW

Comments: A well-traveled and highly visible location in Haverhill Township. Site has localized flooding with numerous landowner complaints. Rain gardens have the potential to remove some sediments and nutrients that enter drainageway from adjoining properties; may require additional BMPs. Flows drain to an unnamed tributary of the South Zumbro River along the Hadley Valley. Erosion and sedimentation along this creek have created maintenance problems at the intersection with County Road 124 (Hadley Valley Road).

Site RDS-09
Location: County Road 14 (75th Street NE) and Highway 63

Comments: High visibility with aesthetic value. Large amounts of sand and salt are applied along the roadway. Waterway flows to a small tributary of the Zumbro River.

4.4 Regulations: NPDES Phase II

4.4.1 NPDES Storm Water Program Background

The National Pollutant Discharge Elimination System (NPDES) program represents the United States Environmental Protection Agency's (USEPA) effort to control water pollution from non-point source storm water runoff. After the Clean Water Act was passed in 1972, point sources were the major focus of pollution control efforts—single-pipe pollution discharges from municipal wastewater treatment plants, industrial facilities, and other sources. Significant progress was made, but water pollution remained a serious problem.

In 1990, the USEPA promulgated Phase I of NPDES. Phase I established a system of permit coverages to address storm water runoff from certain types of facilities and activities that threaten surface waters:

- Municipal Separate Storm Sewer Systems (MS4s) of cities with populations of 100,000 or more (Minneapolis and St. Paul in Minnesota)
- Construction activities disturbing five acres of land or greater
- Ten categories of industrial activities

In 1996, the National Water Quality Inventory found that approximately 40% of the surveyed water bodies in the U.S. were still impaired by pollution and did not meet water quality standards. As a result, NPDES Phase II was created.

NPDES Phase II is intended to further reduce adverse impacts to water quality and aquatic habitat by instituting controls on unregulated sources of storm water discharges that have the greatest likelihood of causing continued environmental degradation.

Like Phase I, NPDES Phase II consists of three major programs:

- Industrial Activities
- Construction Activities
- MS4 Storm Water Program

Table 4-3 describes the NPDES storm water program and the criteria for determining if an activity is regulated under the program.

Table 4-3 – Criteria for Determining if an Activity is Regulated

Program Category	Under Phase I	Under Phase II
Industrial Permit	Required at USEPA-defined industrial facilities – publicly owned facilities were exempt	Required at USEPA-defined industrial facilities – regardless of ownership
Construction Permit	Required at construction sites disturbing 5 acres or more	Required at construction sites disturbing 1 acre or more
MS4 Permit	Applied to MS4s servicing populations > 100,000 – Minneapolis and St. Paul	Applies to much larger group of MS4s (cities, Townships, counties) within the Urbanized Areas (Twin Cities, Rochester, St. Cloud, Duluth, Grand Forks, Fargo/Moorhead, La Crosse, WI) and other cities determined using criteria defined by the MPCA

4.4.1.1 Industrial Activities

Under Phase I of the NPDES Storm Water Program, 10 categories of industrial activities were required to apply to the Minnesota Pollution Control Agency (MPCA) for a permit to discharge storm water runoff. At that time, industrial facilities owned by municipalities and other governmental entities were exempt. **Under Phase II, publicly owned facilities are no longer exempt. In addition, Phase II allows a facility to claim "No-Exposure" as a substitute for the permit.**

This program includes industrial facilities throughout the state. All facilities within the regulated categories must apply to the MPCA for permit coverage every five years. The primary permit requirement is to develop and implement a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP must be tailored to site-specific conditions and designed to eliminate or minimize storm water contact with pollutants through the use of BMPs. The SWPPP is not submitted to the MPCA but is kept at the permitted facility at all times.

The SWPPP must contain the following:

- Drainage map for the facility or site
- Inventory of exposed significant materials
- Evaluation of facility areas where significant materials are exposed
- Description of structural and non-structural BMPs that will be used at the facility
- Evaluation of all non-storm water discharge conveyances (i.e. floor drains)
- Preventative maintenance program
- Spill prevention and response program
- Employee training program
- Identity of personnel responsible for managing SWPPP

4.4.1.2 Construction Activities

Uncontrolled runoff from construction sites is a water quality concern because sedimentation can have devastating effects on local waterbodies, particularly small streams. Numerous studies have shown the amount of sediment transported by storm water runoff from construction sites with no controls is significantly greater than from sites with controls. In addition to sediment, construction activities yield pollutants such as pesticides, petroleum products, construction chemicals, solvents, asphalts, and acids that can contaminate storm water runoff.

During storms, construction sites may be the source of sediment-laden runoff, which can overwhelm a small stream channel's capacity, resulting in streambed scour, streambank erosion, and destruction of nearstream vegetative cover. Where left uncontrolled, sediment-laden runoff has been shown to result in the loss of in-stream habitats for fish and other aquatic species, an increased difficulty in filtering drinking water, the loss of drinking water reservoir storage capacity, and negative impacts on the navigational capacity of waterways.

This program regulates construction sites throughout the state. Under Phase I, operators of construction sites disturbing five or more acres were required to obtain NPDES permit coverage. **Under NPDES Phase II, owners and operators of construction sites disturbing one acre or more must obtain permit coverage.**

The Construction Activities Permit requirements include:

- Storm Water Pollution Prevention Plan (SWPPP)
- Permanent storm water management system
- Best Management Practices (BMPs)
  - Sediment control practices
  - Dewatering and basin draining
  - Inspections and maintenance
  - Pollution prevention management measures
  - Final stabilization
- Special provisions for discharges to special waters
- Special provisions for discharges to wetlands

Permits for construction activities are issued by the MPCA. The owner and/or operator of each construction site are responsible to apply for the permit and meet the permit requirements. Where a construction site is owned by a private party, the public entity with jurisdiction (city, County, etc.) has no direct role in the permit process. Where the construction project is owned or operated by the public entity, this entity will have all the responsibilities for the site under the permit requirements.

It should be noted that, under the MS4 Permit requirements, each regulated MS4 is required to develop, implement, and enforce a construction runoff control program independent of the MPCA's Construction Activities Permit program.

4.4.1.3 MS4 Storm Water Program

Another significant source of water pollution is urban storm water runoff. Under Phase I, Minneapolis and St. Paul were the only regulated MS4s in Minnesota. **Under Phase II, the number of regulated MS4s expanded by 146 Cities and Townships and 15 counties**. These regulated entities are wholly or partially within the Urbanized Areas in Minnesota as defined by the U.S. Census Bureau (see Figure 2 for the Rochester Urbanized Area). Additional cities will be designated by the MPCA under new criteria to be determined later in 2003.

Every regulated MS4 is required to submit a Notice of Intent (NOI) to comply with the General NPDES Phase II MS4 General Permit for the State of Minnesota. This NOI must include a Permit Application Form and a Storm Water Pollution Prevention Program (SWPPP).

The SWPPP is a unique document written by each MS4 based on the characteristics of their storm water system. Each SWPPP must:

- Reduce the discharge of pollutants to the “maximum extent practicable” (MEP)
- Protect water quality
- Satisfy the water quality requirements of the Clean Water Act

Implementing the MEP standard typically requires developing and implementing BMPs, and listing and achieving measurable goals to satisfy each of six Minimum Control Measures:

- Public education and outreach
- Public participation and involvement
- Illicit discharge detection and elimination
- Construction site runoff control
- Post-construction runoff control
- Pollution prevention/municipal good housekeeping

The requirements of the MS4 General Permit fall into two major categories: specific and non-specific. The legal standard for meeting all the requirements is the Maximum Extent Practicable. Table 4-4 lists some of the Permit requirements.

(Opposite page, Figure 2)

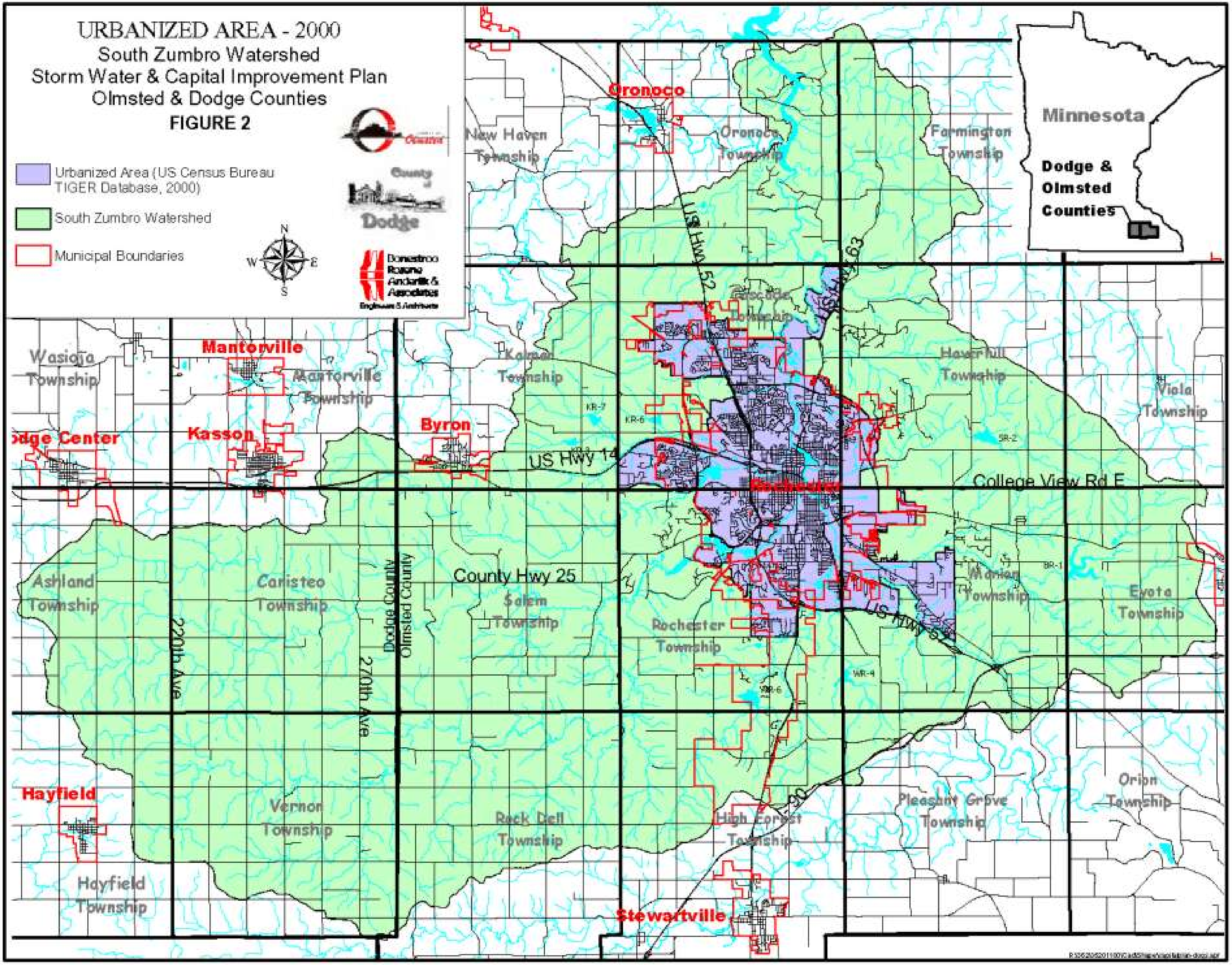

URBANIZED AREA - 2000
South Zumbro Watershed
Storm Water & Capital Improvement Plan
Olmsted & Dodge Counties
FIGURE 2
Urbanized Area (US Census Bureau TIGER Database, 2000)
South Zumbro Watershed
Municipal Boundaries
N
S
E
W
County of Dodge
Bonestroo Rosene Anderlik & Associates
Engineers & Architects
Minnesota
Dodge & Olmsted Counties
Oronoco
New Haven Township
Oronoco Township
Farmington Township
US Hwy 52
US Hwy 63
Cascade Township
Mantorville
Mantorville Township
Wasioja Township
Kalmar Township
Haverhill Township
Viola Township
Kasson
Byron
Dodge Center
US Hwy 14
KR-7
KR-6
SR-2
Rochester
College View Rd E
SR-1
Ashland Township
Canisteo Township
County Hwy 25
Salem Township
Rochester Township
Marion Township
Eyota Township
US Hwy 52
220th Ave
270th Ave
Dodge County
Olmsted County
WR-4
WR-6
I-90
Hayfield
Vernon Township
Rock Dell Township
High Forest Township
Pleasant Grove Township
Orion Township
Hayfield Township
Stewartville

Table 4-4 – NPDES specific permit requirements

SPECIFIC PERMIT REQUIREMENTS	
Public Education & Outreach	
	One public meeting per year • Public notice • Receive & consider written and oral comments from the public
Public Participation & Involvement	
	One public meeting per year • Public notice • Receive & consider written and oral comments from the public
Illicit Discharge Detection & Elimination	
	Storm sewer map • Ponds, streams, lakes and wetlands that are part of your system • Structural pollution control devices • Pipes and conveyances – min. 24" diameter • Outfalls
Pollution Prevention/Municipal Good Housekeeping	
	Inspect annually all structural pollution control devices
	Inspect, at minimum, 20% of the outfalls, sediment basins, and ponds
	Summarize the results of the inspections in the Annual Report
	Keep inspection records
Annual Report	
	Public meeting
	Status of compliance • Assessment of BMPs • Progress toward achieving measurable goals • Changes to BMPs • Reliance upon other entities • Reporting submittals

***NON-SPECIFIC* PERMIT REQUIREMENTS**	
Public Education & Outreach	
	Select and implement a program of appropriate BMPs
	Distribute educational materials to the community or conduct outreach activities about the impacts of storm water discharges on water bodies and the steps that the public can take to reduce pollutants in storm water runoff
	Implement an education program that individually addresses each Minimum Control Measure
	Your education program must identify: • Audience • Educational goals for each audience • Activities used to reach goals • Activity implementation plans • Available performance measures
	Describe how your educational program is coordinated with and makes effective use of other storm water education programs from other entities
Public Participation & Involvement	
	Select and implement a program of appropriate BMPs and measurable goals
	Consider the public input from the Annual Meetings and make adjustments to the SWPP
Illicit Discharge Detection & Elimination	
	Develop, implement, and enforce a program to detect and eliminate illicit discharges
	Select and implement a program of appropriate BMPs
	Effectively prohibit, through ordinance or other regulatory mechanism, non-storm water discharges into your storm sewer system
	Develop and implement a program to detect and address non-storm water discharges, including illegal dumping, to your system
	Inform employees, businesses, and the general public of hazards associated with illegal discharges and improper disposal of waste
Construction Site Storm Water Runoff Control	
	Develop, implement, and enforce a program to reduce pollutants in storm water runoff from construction activities
	Select and implement a program of appropriate BMPs
	Ordinance or other regulatory mechanism to require erosion and sediment controls
	Requirements for construction site operators to implement appropriate erosion and sediment controls
	Requirements for construction site operators to control waste
	Procedures for site plan review
	Procedures for receipt and consideration of complaints from the public
	Procedures for site inspection and enforcement

Post-construction Storm Water Management	
	Develop, implement, and enforce a program to address storm water runoff from new development and redevelopment projects
	Ensure that controls are in place Select and implement a program of BMPs
	Ordinance or other regulatory mechanism to address post-construction runoff
	Ensure adequate long-term operation and maintenance of BMPs
Pollution Prevention/Municipal Good Housekeeping	
	Select and implement a program of appropriate BMPs
	Training component for municipal employees
	Operate and maintain your storm water sewer system in a manner so as to minimize the discharge of pollutants
General	
	Change the SWPPP in response to the requirements of a TMDL implementation plan
	Special measures for discharges to Outstanding Resource Value Waters
	Special measures for discharges to Trout Waters
	Special measures for discharges to Wetlands

4.4.2 NPDES Implications to the South Zumbro Watershed

Of NPDES Phase II, the MS4 program is the most relevant for the South Zumbro Watershed Storm Water and Capital Improvement Plan. Figure 2 shows the Urbanized Area (UA) in this watershed, which is the area regulated by the MS4 program. The MS4 program currently regulates storm water activities in a significant portion of the South Zumbro Watershed. The regulated communities include those listed on Table 4-5.

Table 4-5 – Regulated MS4s within the South Zumbro Watershed

- Olmsted County
- City of Rochester
- Cascade Township
- Haverhill Township
- Marion Township
- Rochester Township

Olmsted County, the City of Rochester, and the four townships have submitted SWPPPs to the MPCA. These SWPPPs, in conjunction with other planning and policy documents, represent the definition of the storm water programs for these entities. As the UA (urbanized area) around Rochester expands and the NPDES program develops over time, more of the land area of the South Zumbro Watershed will be regulated under this program. Currently, Olmsted County has a very limited scope with regard to MS4 permit coverage (see Section 4.4.2.1in page 59).

Many of the BMPs that these regulated communities institute under their Phase II SWPPPs are appropriate for voluntary application elsewhere in the watershed. Coordination between all the public entities within the watershed will result in increased effectiveness for all the BMPs.

To meet the requirements of the MS4 General Permit, Olmsted County has committed to new and expanded BMPs, revisions to their ordinances and regulatory mechanisms, and extensive inspection and maintenance programs.

Cooperation between the regulated MS4s is essential because:

- NPDES Phase II is a significant new regulation and its implementation is a real opportunity to improve water quality in the South Zumbro River and other waterbodies
- The Minnesota MS4 General Permit recommends that regulated MS4s coordinate their programs with other entities
- The implementation options under this program are intended to promote a regional approach to storm water management coordinated on a watershed basis
- This Plan represents an important opportunity to develop and coordinate programs and practices throughout the South Zumbro Watershed within the framework of NPDES Phase II

Olmsted County can play a very important lead role in promoting cooperation among cities, townships and counties. Table 4-6 includes recommendations formulated in partnership with the Technical and Policy Advisory Committees (TAC and PAC).

Table 4-6 – Recommendations formulated with the TAC and PAC

- Set up an NPDES Working Committee led by Olmsted County to advise and support implementation programs.
- Establish formal agreements to cooperate in storm water programs and other environmental and infrastructure programs as appropriate, to use existing programs, information, capabilities and resources.
- Follow the recommendations of the NPDES Phase II Guide Plan prepared by the League of Minnesota Cities.
- Identify opportunities to use economies of scale to prepare information and overlapping CIP activities.
  - Identify common programs and joint efforts to prepare SWPPP considering the Six Minimum Control Measures.
  - Organize a resource center.
  - Share educational and outreach programs.
- Research the development of a countywide storm water management program to proactively improve environmental quality and infrastructure.
  - Promote environmental corridor improvements to restore temporary storage of runoff and enhance wetlands/floodplains.
  - Develop countywide storm water and water resources management requirements for new development.
- Revise and complement existing ordinances and other tools at the County, Township and City levels to provide the same level of protection.

4.4.2.1 Counties' NPDES MS4 Program Scope

Of the two counties involved in this study, the NPDES MS4 program does not regulate Dodge County. Therefore, the regulatory requirements of MS4s only apply to the identified jurisdictions within Olmsted County. However, Dodge County can also improve water quality by implementing appropriate storm water BMPs, such as temporary-ponding improvements and rainwater gardens.

Olmsted County has a very limited scope with regard to MS4 permit coverage as part of the NPDES Phase II Program. The MPCA has determined that the County is only required to obtain MS4 permit coverage for the conveyance system owned by the County in the Rochester Urbanized Area (UA). This equates to about 80 lineal miles of ditch along County roadways.

Olmsted County's MS4 permit application follows the Guide Plan model developed by the League of Minnesota Cities (LMC). The Guide Plan provided coordination and continuity to participating MS4 communities on a statewide basis, and helped the County develop its permit application and storm water pollution prevention program (SWPPP).

4.4.2.2 BMPs Recommended for Road Waterways

BMPs need to be selected and designed for specific site conditions and flow characteristics during the implementation stage. The design of the BMPs will depend on what is regulated. For example, when the County is only regulated for storm water runoff from roads, the BMPs would be sized to treat this water and not the runoff from an urban/suburban development. However, the latter runoff will reduce the treatment efficiency of the BMP designed only for road runoff, unless those flows can be bypassed.

BMPs that are appropriate for the area include but are not limited to:

- Rainwater gardens
- Check dams
- Road sweeping
- Flow control – level spreaders
- Low-flow control weirs
- Bioengineered waterways or swales
- Infiltration or bioretention basins
- Water quality ponds
- Appropriate sizing of replacement culverts and associated improvements

For illustrations and details of these and other BMPs refer to available information, such as the Minnesota Pollution Control Agency's BMP manual (MPCA, 2000).

BMPs can be combined to enhance water quality treatment. For example, using check dams with grassed or bioengineered swales can improve infiltration and biological treatment. Soil and subsoil characteristics are critical in selecting and designing the BMPs.

Pollutant loading is also critical in assessing the feasibility of BMPs and their maintenance requirements. For example, high loadings of silt and clay can reduce infiltration capacity of infiltration basins, making water quality ponds more appropriate.

Sizing replacement culverts on roads merits special attention. This can prevent major problems later, such as severe erosion of adjacent soils that deposit downstream and increase maintenance of downstream road crossings. Particularly vulnerable are areas with non-cohesive soils with weak soil aggregate structure.

4.4.2.3 MS4 Requirements for the City of Rochester and Regulated Townships

The City of Rochester and the regulated Townships (Cascade Township, Haverhill Township, Marion Township, and Rochester Township) have authority over land development and construction activities within their jurisdiction. As MS4s they are required (among many requirements) to have ordinances or other regulatory mechanisms to address post-construction runoff. Therefore, BMPs are required to address the impact of changes in land use to waterbodies and the environment.

Olmsted County may be affected by storm water from City or Township developments that discharge to the County's conveyance system, and vice versa. As a consequence, the MS4s have a vested interest in storm water entering their systems. Mutual cooperation is necessary between the County, the City and the Townships to tackle this water quality challenge in a cost-effective way.

4.4.2.4 Filling the Voids – A Countywide Storm Water Management Program

Since the NPDES regulated local governments include thus far only those within the UA in the South Zumbro Watershed, it does not include some areas experiencing storm water problems from urban/suburban development. An example is the growth and storm water issues around the City of Byron. For the health of the watershed, its stream corridors and the infrastructure along these corridors (bridges, roads, houses, agricultural investments, and others), all local governments (Cities, Townships and Counties) should be involved in active storm water management and erosion and sediment control.

One way to provide regulatory fairness and consistency to developers, builders, landowners, and residents is to develop a countywide storm water management program. A countywide ordinance linked to the current permitting process is likely to be the most appropriate mechanism at present. The potential benefits would be significant (including savings in implementation costs) if all the local governments cooperate and participate actively, such as through policy advisory boards. It is important to be sensitive to each government’s interest and limitations (such as budgets).

Success could depend on setting storm water standards that evolve over time, starting with basic standards acceptable to Townships, Cities and the County. Each government can set more stringent standards than the countywide standards, but as they are closer to each other the playing field will be more leveled. As a result, environmental degradation would be reduced and could even improve our stream corridors.

Countywide storm water management offers opportunities and benefits:

- Provides a level playing field for development
- Promotes cooperation and coordination
- Facilitates sound watershed management
- Can reduce duplication of efforts, such as in developing and adopting ordinances
- Involves key players in storm water management that are not presently regulated MS4s
- Promotes system compatibility and consistency

- Can increase BMPs lifetime

For an example, Dane County (Wisconsin) has adopted a countywide storm water management approach for all municipalities within its jurisdiction. The countywide standard provides consistency and predictability to landowners and developers and provides site planners with the flexibility to choose the best practices for a particular site or project. Dane County staff administers the ordinance in the unincorporated areas while each City is expected to meet specific provisions of the countywide erosion control and storm water management program. Each City develops and administers its own ordinance and creates its own fee structure for the program. They are promoting integration and compatibility of erosion control and storm water management ordinances to meet NPDES regulation requirements.

Any countywide ordinance or regulatory instrument must be developed carefully assessing the economic feasibility of what will be required. While stringent requirements may be appropriate for new urban/suburban developments, gradual approaches may be necessary to bring existing sources into compliance.

5 Implementation

5.1 Integrating Transportation and Storm Water Planning

The concept and importance of integrating transportation and storm water planning are discussed in Section 3 (page 15). This section deals with implementation of the proposed improvements, starting with stream corridor management guidelines to preserve and enhance their hydrologic and environmental function, in relation to the benefit to bridges and other infrastructure.

5.1.1 Stream Corridor Management

Effective management of the stream corridors is essential to preserve and/or enhance the South Zumbro Watershed's environmental quality. Especially critical are forests, wetlands, and riparian lands that provide connectivity between these resources. Efforts need to continue in protecting, preserving, and enhancing:

- The floodway and the immediately adjacent natural resources
- The upland and wetland areas that support the stream ecosystem
- Steep slopes, highly erodible soils, and other areas highly prone to erosion
- Areas with high infiltration or groundwater contamination potential

It is important to promote strategies and practices to preserve and improve stream corridors in the South Zumbro Watershed, such as those outlined in Table 5-1.

Table 5-1 – Strategies and practices for Stream Corridors

Strategies	Practices
Floodway Preservation	Minimize filling and disturbance within the floodway to maintain stream capacity, preserve ecosystem and reduce impacts to infrastructure.
Stream Bank Stability	Promote best management and conservation practices, such as flow control structures, and buffers from agricultural and urban/suburban land uses.
Wetlands	Promote wetland restoration/enhancement and minimize wetland impacts to the extent possible. Enhance their water-regulating function.
Corridor Connectivity and Wildlife Habitat	Promote the connection of natural vegetation areas. Preserve existing trees and sensitive plant communities. Promote perennial vegetation growth. Minimize actions that break corridors into segments. Promote the establishment of buffer areas to enhance environmental quality and biodiversity.
Steep Slopes	Minimize removal of trees and disturbance of steep slopes.
Storm Water Runoff	Promote storm water best management practices (BMPs), such as rain gardens, check dams, farm ponds. Promote regulating flows from frequent storms.
Education	Educate citizens on the value and functions of the corridor for a healthy environment that protects infrastructure. Emphasize the impact of activities on water quality, storm water peak flows and infrastructure protection from flooding.

5.1.2 Priorities

Implementing the high potential improvements is dependent on the schedule of the bridge replacement program. Ideally, flow control improvements should be implemented before downstream bridges are replaced. A feasibility study should precede the replacement so the bridge (major culverts included) can be appropriately sized when considering upcoming flow control improvements.

Improvements in the upper reaches of the watershed are of the highest priority, since they will benefit the greatest number of bridge-stream crossings. However, the implementation schedule depends on available funding.

Of these high priority sites, those that are downstream of the flood reservoirs would not necessarily require a flow control structure. The appropriate size bridge could be replaced considering the attenuation provided by the reservoirs. Bridge 92149, immediately downstream of reservoir SR-2 (Silver Creek), would not require a berm and could easily be downsized. Other bridges that could be downsized are Bridges L6236 and L8565 below reservoir BR-1 (Chester Woods Park Dam on the Bear Creek), and Bridge 7092 below reservoirs WR-6A & WR-4 in Willow Creek. However, these sites will require a more detailed study.

The flow-control improvements for the high priority are listed in Table 5-2.

Table 5-2 – High Priority Flow-Control Improvements

No	Sub-watershed	Bridge No.	Location (road, Township-Section)	Down-sizing Potential at bridge location	Down-sizing Potential Upstream of bridge location	Comments
	OLMSTED COUNTY:					
1	Cascade Creek	89160	County Hwy 5, Salem-5	High	High	Demonstration site upstream 89160b (Tvedt's).
2	Cascade Creek	89155	County Hwy 3, Salem-10	High	High	Medium priority if demonstration site upstream 89155b (Stork's) is built
3	Cascade Creek	88708	County Hwy 3, Salem-3	High	Low	
4	Cascade Creek	4075	70th Ave SW, Salem-11/12	High	High	
5	Cascade Creek	L6262	45th Ave SW, Rochester-5	High	High	
6	Salem Creek	89180	County Hwy 25, Salem-17	High		
10	South Zumbro	L6180	County Hwy 5, Rock Dell-17/16	High	High	
12	South Zumbro	L6204 L6205	110th Ave SW, Rock Dell-6/5	High	Medium	Raise road 2 to 3 ft
15	SZ-Goose Creek	L6151	80th Ave SW, Rock Dell-22/23	High		
27	Bear Creek	L6236	County Hwy 11 (50th Ave SE), Marion-9/10	High		Chester Woods Park Dam (SR-1) upstream
28	Bear Creek	L8565	County Rd 143 (20th St SE), Marion-8/17	High		Chester Woods Park Dam (SR-1) upstream
30	Silver Creek	92149	County Hwy 11 (55th Ave NE), Haverhill-27	High		SR-2 Dam just upstream
32	Northeast area	1571	Dresser Dr NE, Haverhill-6	High		Hwy 63 crossing before Zumbro river
33	Northwest area	88712	County Hwy 3, Kalmar 12	High		Flows to Kings Run. More than 9 crossings to Zumbro R.
36	North	88746	County Rd 114 (11th Ave NE), Oronoco-1	High		
	DODGE COUNTY:					
38	Salem Creek	97542	240th Ave, Canisteo-17/16	High	High	Raise road about 2 ft?
39	Salem Creek	L6472	670th St, Canisteo-15/22	High	High	Bridge being designed; to be done by April 15 2002
40	Salem Creek	L5500	260th Ave, Canisteo-22/23	High	High	Ideal for ponding
A1	Salem Creek	89102	County Hwy 9 (220th Ave), Ashland-12/13/Canisteo-7/18	High		Not in 5-yr bridge replacement plans
A2	Salem Creek	89099	County Hwy 9 (220th Ave), Ashland-24/Canisteo-19	High		Not in 5-yr bridge replacement plans
A3	Salem Creek	2350	County Hwy 9 (220th Ave), Ashland-25/Canisteo-30	High		Not in 5-yr bridge replacement plans
A4	South Zumbro	89101	County Hwy 9 (220th Ave), Hayfield-1/Vernon-6	High		Not in 5-yr bridge replacement plans

5.1.3 Cost and Benefits

The benefit/cost ratio is expected to be greater than 1.2 (benefit is greater than 1.2 times the improvement cost), as estimated in the more detailed study for Cascade Creek (see 4.2.2 in page 42, or for more details Appendix C). This ratio indicates the direct savings to the bridge replacement program from downsizing structures. The benefit would be greater if environmental enhancements are considered, such as reduced streambank erosion and sediment deposition.

The costs of building the flow control structures (ponding improvements) are presented in this section for planning purposes only. The main assumption is that berm construction material is available on site. The cost includes construction of the berm and a flow control structure of sheet-pile and rip rap protection (see Section 3.2.2 in page 20).

Figure 5-1 shows the estimated flow-control structure cost for six-foot high berms as a function of the berm length. This relationship was derived from estimates for structures in Cascade Creek (triangles) and was used to estimate the cost of the flow-control structures for the South Zumbro watershed in Table 5-3. The high priority projects add up to approximately $1.0 million for Olmsted County and $371,000 for Dodge County. These cost estimates assume construction of three or more structures in one contract to benefit from economies of scale. These costs will vary and should be more accurately estimated with a feasibility study.

Figure 5-1 – Estimated Cost of Flow Control Structures by Berm Length

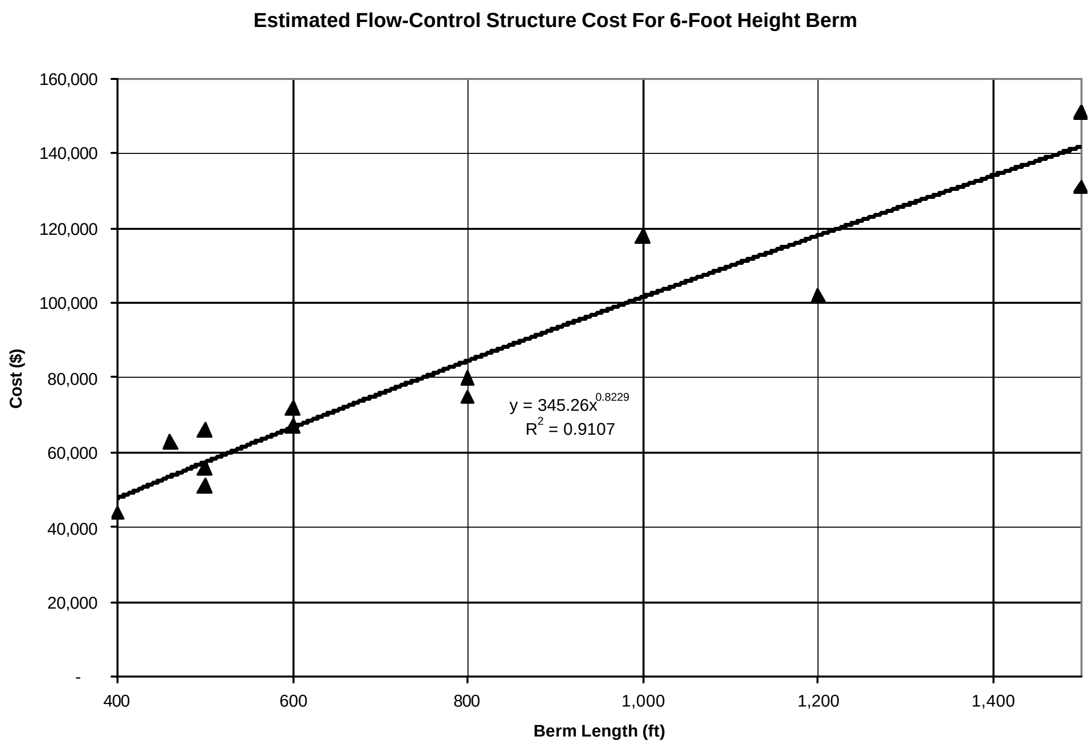


Table 5-3 – Estimated Flow Control Structure Cost

No.	Sub-watershed	Bridge No.	Location (road, Township-Section)	Esti-mated berm length (ft)	Estimated Flow Control Structure Cost ($)	Comments
OLMSTED COUNTY:					$995,000	**SUBTOTAL**
1	Cascade Creek	89160	County Hwy 5, Salem-5	500	$66,000	Cost from Cascade study. For potential demonstration site 89160b cost is $63,000.
2	Cascade Creek	89155	County Hwy 3, Salem-10	1000	$118,000	Cost from Cascade study. For potential demonstration site 89155b cost is $118,000.
3	Cascade Creek	88708	County Hwy 3, Salem-3	600	$67,000	Cost from Cascade study.
4	Cascade Creek	4075	70th Ave SW, Salem-11/12	1500	$151,000	Cost from Cascade study.
5	Cascade Creek	L6262	45th Ave SW, Rochester-5	1500	$102,000	Cost from Cascade study.
6	Salem Creek	89180	County Hwy 25, Salem-17	1200	$119,000	
10	South Zumbro	L6180	County Hwy 5, Rock Dell-17/16	500	$58,000	
12	South Zumbro	L6204 L6205	110th Ave SW, Rock Dell-6/5	1200	$119,000	
15	SZ-Goose Creek	L6151	80th Ave SW, Rock Dell-22/23	300	$38,000	
27	Bear Creek	L6236	County Hwy 11 (50th Ave SE), Marion-9/10		$0	Downsizing bridge is possible due to reservoir BR-1
28	Bear Creek	L8565	County Rd 143 (20th St SE), Marion-8/17		$0	Downsizing bridge is possible due to reservoir BR-1
30	Silver Creek	92149	County Hwy 11 (55th Ave NE), Haverhill-27		$0	Downsizing bridge is possible due to reservoir SR-1
32	Northeast	1571	Dresser Dr NE, Haverhill-6	400	$48,000	
33	Northwest	88712	County Hwy 3, Kalmar 12	700	$76,000	
36	North	88746	County Rd 114 (11th Ave NE), Oronoco-1	250	$33,000	
DODGE COUNTY:					$371,000	**SUBTOTAL**
38	Salem Creek	97542	240th Ave, Canisteo-17/16	300	$38,000	
39	Salem Creek	L6472	670th St, Canisteo-15/22	100	$16,000	
40	Salem Creek	L5500	260th Ave, Canisteo-22/23	600	$67,000	
A1	Salem Creek	89102	County Hwy 9 (220th Ave), Ashland-12/13/Canisteo-7/18	500	$58,000	Not in 5-yr bridge replacement plans
A2	Salem Creek	89099	County Hwy 9 (220th Ave), Ashland-24/Canisteo-19	700	$76,000	Not in 5-yr bridge replacement plans
A3	Salem Creek	2350	County Hwy 9 (220th Ave), Ashland-25/Canisteo-30	500	$58,000	Not in 5-yr bridge replacement plans
A4	South Zumbro	89101	County Hwy 9 (220th Ave), Hayfield-1/Vernon-6	500	$58,000	Not in 5-yr bridge replacement plans

The primary benefits of the watershed approach with stream corridor improvements are:

- Reduced runoff flow volumes and velocities
- Lower transportation construction and maintenance costs
- Improved road safety (reduce flood risk)
- Improved downstream water quality
- Stabilized drainage and stream corridors
- Reduced sediment and flooding damage

While the secondary benefits are:

- Reduced streambank erosion
- Restored/created wetlands
- Improved fish and wildlife habitat
- Connected wildlife corridors

One of the major benefits is that bridges can be appropriately sized (*downsized*) using existing opportunities for temporary storage available in the floodplain. This available storage helps reduce (attenuate) peak flows when small-scale improvements are made.

The flow control structures have a relatively low cost associated with the low berms, particularly when compared to the flood control reservoirs built in the 1990s. These low berms would be built with an average height of only six feet, and would include flow control weirs that maintain fish passage (for more details see Section 3.2.2, page 20).

The Cascade Creek study (Appendix C) illustrated the benefits that result from implementing a watershed approach to the bridge replacement program using ponding improvements in the Cascade Creek Subwatershed:

- Direct economic benefits result from building flow control structures (temporary ponding). These include:
    - ◊ Bridge downsizing savings enabled by reducing peak flows
    - ◊ Reduced road maintenance costs and reduced property damage resulting from higher levels of flood protection

- Ponding improvements can be paid for through the savings achieved by being able to use smaller culverts to provide similar road flood protection. Implementing only the high priority ponding improvements in the Cascade Creek Subwatershed could save an estimated $97,280. Savings could increase if the flow control structures and bridge replacements are built from upstream to downstream (not always possible due to bridge conditions and priorities).

- Potential savings-to-cost ratios can be greater than 1.2 in the bridge replacement program that incorporates the construction of ponding improvements. If other benefits are included, the benefit to cost ratio is definitely larger than 1.2, without even estimating the value of the environmental benefits.

Similar benefits are expected for other bridge replacements in the South Zumbro Watershed. Table 3-3 displayed the number of bridge crossings downstream of each potential ponding site as a qualitative indicator of benefit. Greater benefits are expected as the number of bridges increases downstream of the ponding improvement sites. Controlling flows further upstream benefits more road crossings and more miles of stream corridors.

5.1.4 Financing

The main source of financing is expected to come from the savings in the bridge replacement fund by implementing a watershed-based approach. To experience these savings requires initial investment that should also seek financing from other grants or programs. Bridge bonding appears to be a promising source. The Minnesota Department of Transportation could facilitate the financing by recognizing the benefits of this approach.

Table 5-4 shows a list of pertinent potential funding sources by funding agency. Table 5-5 shows agriculture conservation programs that could also be explored to finance the stream corridor improvements. These and other financing sources need to be explored to coincide with the availability of funds.

Table 5-4 – Potential Funding Sources of Stream Corridor Improvements

Funding Agency	Program Name	Description/Comments[1]
BWSR	Flood Storage Easements Pilot Program	Promotes flood storage on agricultural lands using easements that allow haying, grazing or other activities. No deadline. (BWSR is the MN Board of Water & Soil Resources)
MN DNR	Stream Bank Maintenance Grant	Bank stabilization and debris removal from stream channels and floodplains. Offered to County Governmental agencies. (DNR is the Department of Natural Resources)
LCMR	Legislative Commission on MN Resources (LCMR)	Due in February: Special natural resource projects that help maintain and enhance Minnesota's natural resources.
NRCS	Watershed Protection and Flood Prevention	Watershed Protection, flood prevention, water supply and quality, erosion, wetlands, habitat enhancement and recreation projections in watersheds less than 250,000 acres. $3.5 to $5 million, cost share. (NRCS is the Natural Resources Conservation Service)
Pheasants Forever	Pheasants Forever	Generally to provide habitat for ringneck pheasants with private landowners for native grass/forb plantings in old fields and areas to be retired from agriculture. County Chapter may help with seeding cost for land enrolled in CRP or other programs.
Wild Turkey Federation	Wild Turkey Federation	WTF is focused on providing habitat for a specific game species. Potential partnering might include the planting of mast-bearing native trees, such as oaks, in old field areas or native grasses, forbs, or shrubs.

Notes:
[1] Funding availability and programs can change frequently, contact agency for updates.

Table 5-5 – Agriculture Conservation Programs – Potential Funding Sources

<u>Environmental Quality Incentives Program (EQIP)</u>

- **Purpose:** To provide technical and financial help to landowners for conservation practices that protects soil and water quality.
- **Practices:** Grassed waterways, stream fencing, critical area planting, terraces, manure management systems including storage structures and barnyard runoff protection, and many other conservation practices.
- **Eligibility:** Agricultural producers on agricultural land are eligible. Projects are selected based on environmental value.
- **Contract:** 5-10 year contracts. Ag producers may be eligible for up to 75% cost-share, up to $10,000 per year, and $450,000 thru year 2007.
- **Public Access:** Not required.
- **Contact:** USDA-Natural Resource Conservation Service (NRCS), Dodge or Olmsted Soil and Water Conservation District (SWCD), USDA-Farm Service Agency (FSA).

<u>Wildlife Habitat Incentives Program (WHIP)</u>

- **Purpose:** To develop or improve fish and wildlife habitat on privately owned land.
- **Practices:** Seeding, fencing, in-stream structures, and other conservation practices.
- **Eligibility:** Almost any type of land is eligible, including agricultural and non-agricultural land, woodlots, pastures, and streambanks.
- **Contract:** Normally 10 year contract to maintain habitat. Up to 75% of restoration costs, to a maximum of $10,000. Other organizations may provide the remaining 25% cost-share.
- **Public Access:** Not required.
- **Contact:** NRCS, SWCD

<u>Wetlands Reserve Program (WRP)</u>

- **Purpose:** To restore wetlands previously altered for agricultural use.
- **Practices:** Wetland restoration and wildlife habitat establishment.
- **Eligibility:** Land which has been owned for one year and can be restored to wetland conditions.
- **Contract:** Landowners may restore wetlands with permanent or 30-year easements or 10-year contracts. Permanent easements pay 100% of the agricultural value of the land and 100% cost-sharing; 30-year easements pay 75% of the agricultural value and 75% cost-sharing; 10-year contract pays 75% cost-share only. Permanent or 30-year easements recorded with property deed. 10-year contract is not recorded with deed.
- **Public Access**: Not required.

Contact: NRCS

<u>Conservation Reserve Program (CRP)</u>

- **Purpose:** To reduce erosion, increase wildlife habitat, improve water quality, and increase forestland.
- **Description:** Landowner sets aside cropland with annual rental payments based on amount bid.
- **Practices:** Tree planting, wildlife ponds, grass cover, and others environmental practices.
- **Eligibility:** Varies by soil type and crop history. Land is accepted into program if bid qualifies. Continuous signup open for buffers, waterways and environmental practices. Periodic signups announced throughout the year for other practices.
- **Contract:** 10 years, 15 years if planting hardwood trees. Transferable with change in ownership.
- **Public Access**: Not required.
- **Contact:** NRCS, FSA, SWCD

<u>Conservation Reserve Enhancement Program (CREP)*</u>

- **Purpose:** To provide flexible and cost effective means to address agriculture resource problems by targeting specific geographic regions of particular environmental sensitivity.
- **Practices:** Improve water quality, erosion control, and wildlife habitat in specific geographic areas, which have been adversely impacted by agricultural activities, with emphasis on addressing non-point source water pollution and habitat restoration in a cost-effective manner.
- **Eligibility:** Private landowner
- **Contract:** A 10 to 15 year CRP contract plus a long-term easement with the State of Minnesota RIM Program is required.
- **Public Access**: Not required.
- **Contact:** FSA, NRCS, SWCD, Minnesota Board of Water and Soil Resources (BWSR)

* Not currently available to landowners in the South Zumbro Watershed; however the State is submitting an application to the USDA in September 2003 seeking to make the program available after January 1, 2004.

Wetland banking can also be explored as a potential funding source. Institutions that could contribute to fund these storm water and environmental projects include, but are not limited to NRCS, DNR, Ducks Unlimited, Pheasants Forever, and BWSR. As stated throughout this document, stream corridor improvement projects such as flow control structures, wetland and upland restorations, farm ponds, rain gardens, and other BMPs also improve wildlife habitats. Hence, financing that targets this goal can also be explored.

DNR flood control program funding is currently limited. However, this source could be explored in the future, as well as other funding that targets flood control objectives.

In addition to capturing government funding and private financing, Olmsted and Dodge Counties should integrate relevant storm water projects into their transportation improvement programs. This will generate direct savings and other benefits to the transportation program (construction and maintenance).

A financing strategy must be established for implementing this *Storm Water and Capital Improvement Plan*, particularly as related to the storm water components that need to be integrated with the Counties and Townships road and bridge programs.

6 Conclusions and Recommendations

6.1 Conclusions

- Stakeholders' involvement in watershed projects is critical to identify issues and propose solutions that are technically, socially, economically, and politically feasible.
- Public participation is vital to the success of flow control/ponding improvement projects, potentially increasing local and downstream benefits.
- Property owners become interested in corridor improvement projects when they clearly understand the objectives and potential impacts, such as of the small scale flow control structures that use mostly the floodplain for temporary ponding.
- A watershed approach to bridge replacement programs can reduce construction and maintenance costs, while enhancing the environmental quality of stream and riparian habitats. This approach enables appropriate sizing of bridge structures using the opportunities for temporary storage within the floodplain.
- Sizing bridges independently can yield oversized structures and/or loss of flood protection to roads and other downstream infrastructure.
- Storm water management planning can help identify opportunities to restore wetlands or use existing floodplain with minimal adverse impacts (such as a few more hours of temporary ponding).
- Retaining water temporarily in upstream watershed areas can significantly reduce downstream peak flows.
- Taking advantage of ponding opportunities can result in a significant peak flow reduction by offsetting the runoff contributions from the different subwatersheds or regions.
- Flow control structures enable use of available floodplain storage for frequent storms, particularly in areas where stream degradation has occurred.
- The implementation of rain garden demonstration projects can promote the adoption of this best management practice to enhance water quality, create aesthetic environments, and potentially reduce maintenance costs.
- A proactive participation of the stakeholders can facilitate meeting NPDES Phase II and other regulations.
- Lack of appropriate storm water management practices can reduce flood protection levels (for example, to roads and bridges) and accelerate streambank erosion. Sediment is then deposited in protected streams, or other downstream water bodies such as Cascade Lake and the Zumbro River, degrading their water quality and the stream morphology's stability. Poor storm water management also affects farmers when sediment-clogged streams change/widen their course and overflow their banks causing increased flooding and reducing access. Some residents are already affected by runoff problems caused by rapid land use changes without storm water management BMPs in place; the City of Byron in an example.

6.2 Recommendations for Action

Stakeholders in the South Zumbro Watershed:

- ✓ Continue to promote cooperation and coordination between local governments and other local and State institutions that work to benefit the region, especially to pursue joint funding opportunities.
- ✓ Continue to have active Technical Advisory and Policy Advisory Committees to guide and proactively establish storm water programs that enhance the watershed's environmental quality, with priority on the stream corridors.
- ✓ As appropriate, establish a more permanent entity to provide stewardship in storm water management for the South Zumbro Watershed, or incorporate specific responsibilities into an existing entity or entities.

Financing storm water improvements:

- ✓ Establish a financing mechanism to implement this plan, in particular to build high priority flow control structures, establish rain garden demonstration sites, and support the NPDES Phase II efforts.

High priority improvements:

- ✓ Construct the flow control structures (temporary ponding) identified with the Cascade Creek Subwatershed complementary study as soon as feasible; particularly implement projects 89155b and 89160b to serve as demonstration projects to promote the concept for the rest of the South Zumbro Watershed.
- ✓ Implement other high potential flow control projects in the South Zumbro Watershed before, or in conjunction with other road and bridge improvements. This would require specific assessments, such as the one done for the Cascade Creek Subwatershed.

Rain gardens:

- ✓ Secure the financing, study the feasibility, and implement the rain garden demonstration projects.
- ✓ Promote the implementation of rain gardens to enhance water treatment of contaminants from roads and other impervious areas (such as parking lots).
- ✓ Target the implementation of two rain gardens a year, or what is financially reasonable for the local government, to establish a budget that initiates a sustainable program.

Voluntary program:

- ✓ Continue to promote the voluntary program to implement improvement projects to support the interest and enthusiasm of residents in building flow control structures and associated improvements.
- ✓ Support community leaders and volunteers interested in having stream corridor improvement projects, and aggressively seek financing of at least two flow control/wetland restoration demonstration projects.

Watershed approach to bridge replacement program:

- ✓ Use a watershed approach when implementing the bridge replacement program, considering upstream downsizing opportunities and downstream benefits whenever a bridge is being replaced.
- ✓ Promote the construction of flow control structures, since they will also increase the level of service of the road (greater flood protection).

Storm water cooperation efforts:

- ✓ Dodge and Olmsted counties should continue cooperating and coordinating efforts to implement storm water management strategies beneficial to both counties and the whole watershed's stream corridors and road/bridge infrastructure.
- ✓ Strongly promote storm water best management practices, particularly flow control structures and wetland restorations in Dodge County, since numerous potential sites were observed as having natural opportunities.
- ✓ Strongly promote storm water best management practices, particularly flow control structures and wetland restorations, in the upper reaches of the watershed in Olmsted County that have natural opportunities and offer high potential.
- ✓ Promote the storm water management concepts presented in this study to the farming community to unite efforts in the stewardship of the land and its stream corridors.
- ✓ Coordinate with and encourage the City of Byron, and other small Cities and Townships in the watershed, to implement appropriate storm water management practices to address changes in land use, mainly to avoid reducing current flood protection to existing roads and bridges, and to help prevent degradation of the stream corridor (such as streambank erosion).

Stream corridors and wetland/upland restoration:

- ✓ Promote strategies and practices to preserve and improve stream corridors in the South Zumbro Watershed, such as those outlined in Table 6-1.
- ✓ Implement wetland and upland restoration projects in conjunction with the flow control structures (temporary ponding improvements) as part of an integrated approach stream corridor management to enhance environmental quality.

Storm water incentives:

- ✓ Study the feasibility of establishing a countywide erosion control and storm water management ordinance or other legal instruments to promote environmentally sound and infrastructure-protecting measures. In addition, the development of a countywide set of standards would provide consistency, predictability, and a level playing field for developers, builders, landowners and residents on land development and land disturbance projects. A countywide program that is applied in a consistent manner is more likely to improve water quality and reduce localized flooding in the watershed.
- ✓ Study and promote economic incentives to enhance stream corridors, such as through the Conservation Reserve Enhancement Program (CREP), other Federal or State programs, or locally established programs.

Downsizing bridges below existing flood control reservoirs:

- ✓ Explore the feasibility of downsizing bridges when they are replaced to reflect current flow characteristics downstream of these reservoirs. Particularly, start with the bridge immediately below the Silver Creek Reservoir.

NPDES Phase II:

As summarized in the NPDES section of this document, each local government is responsible for its own program. The NPDES Phase II regulated local governments (MS4s) in the South Zumbro Watershed include Olmsted County, the City of Rochester, Cascade Township, Haverhill Township, Marion Township, and Rochester Township.

- ✓ Each regulated local government should follow the NPDES requirements with its own Storm Water Pollution Prevention Plan (SWPPP), establishing appropriate measurable goals (for more details see the NPDES section in this document).
- ✓ NPDES Phase II regulated local governments (MS4s) in the South Zumbro Watershed should cooperate and work jointly in this effort, as pertinent, to be more effective at improving water quality and to reduce costs.

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Appendices

Appendix A	South Zumbro Watershed SW&CIP Policy Advisory Committee and Technical Advisory Committee
Appendix B	Description of Subwatersheds of the South Zumbro Watershed
Appendix C	Hydrologic and Hydraulic Study of Cascade District Major Road Crossings
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Appendix E	Water Quality
Appendix F	Wetland and Upland Assessment
Appendix G	Olmsted County - Storm Water Pollution Prevention Program

Appendix A

South Zumbro Watershed

SW&CIP Policy Advisory Committee

and Technical Advisory Committee

Appendix A

South Zumbro Watershed SW&CIP – Policy Advisory Committee (PAC)

1. Dodge County Board - David Erickson
2. Olmsted County Board – Jim Bier*
3. Olmsted County Board – Matt Flynn*
4. Olmsted County Board – Jeff Thompson*
5. Rochester City Council – John Hunziker*
6. Rochester City Council – Jean McConnell*
7. Rochester City Council – Walter Stobaugh*
8. Olmsted Soil and Water Conservation District Board – Paul Uecker*
9. Salem Township Board – John Connelly
10. Rock Dell Township Board – Terry King
11. Rochester Township Board – Gene Peters

* Member of the South Zumbro Watershed Joint Powers Board

Appendix A

South Zumbro Watershed SW&CIP – Technical Advisory Committee (TAC)

1. Dodge County Public Works Department – Guy Kohlnhofer
2. Dodge County Water Planner – Mark Gamm
3. Dodge County SWCD – Jim Hruska
4. Olmsted County Public Works Department – Mike Cousino
5. Olmsted County Public Works Department – Mike Sheehan
6. Olmsted County Public Works Department – Tony Hill
7. Olmsted County Water Planner – Terry Lee
8. Olmsted County SWCD – Floyd Whitaker
9. City of Rochester Public Works Department – Barb Huberty
10. Rochester/Olmsted Planning Department – John Harford
11. Township Cooperative Planning Association – Roger Ihrke
12. University of Minnesota Extension Service – Lisa Behnken
13. Minnesota Board of Water & Soil Resources – Mary Kells
14. Minnesota Department of Natural Resources – Bob Bezek
15. Minnesota Pollution Control Agency – Dave Morrison
16. Minnesota Department of Transportation – Kjersti Anderson
17. U.S.D.A. – Natural Resources Conservation Service – Dave Copeland

Appendix B

Description of Subwatersheds of the South Zumbro Watershed

Description of Subwatersheds

of the

South Zumbro Watershed

Specific features of interest of the South Zumbro Watershed are described in this appendix by subwatershed (illustrated in Map 1 at the end of the report and in Map 2 in Section 2). The purpose of this characterization is to illustrate land uses, the flora and fauna species it supports, and other particular features. However, it does not represent an inventory of all the important features.

The South Zumbro subwatersheds (see Map 1) that are described are located in Dodge and Olmsted Counties and include:

- Goose Creek
- South Zumbro upstream of 720th Street – Dodge County
- South Zumbro (areas not included in others)
- Salem Creek
- Cascade Creek
- Boardman Creek
- Willow Creek
- Badger Run
- Bear Creek
- Silver Creek

The **Goose Creek Subwatershed** occurs on the south side of the study area and is surrounded on the east, west and north sides by the Zumbro River Subwatershed. Despite its small size, the Goose Creek Subwatershed supports a significant amount of rare plant populations and quality plant communities. These include the DNR-owned Nelson Fen and Suess Wildlife Management Areas, as well as several small calcareous fens and a wet meadow, all in Rock Dell Township. At least 7 rare plant populations have been recorded at the calcareous fens in Sections 16 and 23 of Rock Dell Township. Interestingly, the upstream area from crossing L6151 in this study may also support a seepage meadow or fen, representing a unique potential of opportunity for management of this rare wetland type. The watershed itself is dominated by rowcrops, although some pastures and fallow ground are locally common.

The **South Zumbro Subwatershed upstream of 720th Street** (Bridge L6458 in Map 1, by 270th Avenue) is a relatively small watershed that originates in southeastern Dodge and southwest Olmsted County. It flows through a landscape that is moderately to somewhat steeply rolling with rowcrop agriculture and permanent landcover such as pastures, trees, and grass plantings most common. It flows north into the South Fork Zumbro River one mile north of Highway 30 in Dodge County. Permanent cover in the form of pastures and set aside acreage are perhaps the most prominent natural features here, along with a respectable amount of moderate to good quality prairie in roadsides in Dodge County.

The **South Zumbro River Subwatershed** includes areas of the watershed not included in other subwatersheds, as illustrated in Maps 1 and 2. The South Zumbro River originates just east of Hayfield in Dodge County and flows through downtown Rochester, extending north, to the east side of Oronoco. In the western portion of the watershed in Dodge County, it is characterized by gently to moderately rolling hills with a floodplain that varies from moderately narrow to broad. Land use in the western portion of the watershed is a mix of row crop agriculture, and permanent herbaceous land cover such as pastures. Forest cover is generally confined to the river floodplain, lateral stream valleys, and steeper slopes. Land cover in the center portion of the watershed is dominated by the City of Rochester itself. North of the City of Rochester the watershed becomes more steeply rolling, with some forest areas in the predominating rowcrop agricultural land use in milder slopes.

The Dodge County portion of the watershed supports a number of prairie roadsides and pastures with some native species. Notable natural areas and rare species are more numerous in Olmsted County and include several wet meadows, as well as several rare plant and animal populations in the upper portions of lateral watersheds in Salem Townships. The Zumbro River corridor itself supports several good quality lowland hardwood, floodplain, and oak forests upstream from the city limits of Rochester. More than 12 rare animal and 5 rare plant populations are documented, including two new records for the State-threatened glade mallow (*Napaea dioica*) found during this study.

The City of Rochester, although not documented to support significant natural communities along the Zumbro, has approximately 20 rare animal documentations, primarily within the stream itself. The area north of the City of Rochester hosts several dry prairies in the rolling hills along lateral stream valleys, including a significant concentration of 5 rare plant species at Oronoco Prairie Scientific & Natural Area. The shallow soils on the limestone-ridden hills harbor valerian, white wild indigo, tuberous Indian plantain, rattlesnake master, and Hill's thistle. The intermittent stream corridor along which this prairie lies is significant for the Rochester area and perhaps southeast MN because of the concentration of rare plants found on the dry to dry-mesic prairies. Within the stream corridor itself, there are a number of sizeable tracts of Oak, Lowland Hardwood, Floodplain, and Maple-basswood forests supporting at least 3 rare plant and 2 rare animal populations.

The **Salem Creek Subwatershed** is characterized by gently to moderately rolling landscape. The vast majority of the land cover here is dominated by agriculture, particularly row crop production. Permanent vegetative cover is generally confined to the stream corridor of Salem Creek, its immediate environs, and steeper slopes. Many of the remaining grassland and woodland areas are either active or retired pastures. In the Dodge County portion of this watershed, there are several nice quality prairie remnants, including several retired pastures with a remarkably large amount of quality remnant prairie in the vicinity of Section 30 of Canisteo Township. A roadside in Section 14 of Ashland Township also hosts a significant population of the State-threatened Sullivant's milkweed. In Olmsted County, the MN DNR County Biological Survey noted a nice complex of natural areas along a lateral stream of Salem Creek in Section 19 of Salem Township, as well as smaller parcels of quality oak woodland and dry prairie in Sections 18 and 14, respectively. Additionally, 9 rare animal and 4 rare plant records are known for this watershed in Olmsted County.

The northern area of Salem Creek Subwatershed includes two unnamed subwatersheds in the MN DNR GIS. These originate in Dodge County to the north of Salem Creek. The westernmost of these empties into Salem Creek in Canisteo Township of Dodge County, while the other meets Salem Creek near the center of Salem Township in Olmsted County. Similar to surrounding watersheds, the landscape is characterized by gently to moderately rolling hills with row crop agriculture as the predominant land cover type. Permanent pastures and wooded waterways and steep slopes, as well as some minor rural development comprise the majority of the remaining area. Within Dodge County there are several moderate quality prairie roadsides, including one length in Ashland Township that supports a sizeable population of the State-threatened Sullivant's milkweed. Within Olmsted County, the MN DNR documented one oak woodland-brushland and an associated dry prairie in Section 17 of Salem Township.

The **Cascade Creek Subwatershed** main creek lies mostly south of, and roughly parallels Highway 14, straddling both sides of the highway in the upper reaches where it extends two miles into Dodge County, just past Byron. This is a somewhat broad and moderately rolling landscape. It includes a mix of row crop agriculture, permanent cover such as Conservation Reserve Program ground and pastures, as well as the commercial and residential developments associated with Highway 14. No rare species or significant natural communities were noted by the DNR in Olmsted County, or during a Roadside Prairie Inventory conducted for Dodge County in 2002. Despite this, some hillsides, stream corridors, and other areas support vegetation that can be maintained or improved for the benefit of wildlife corridors and habitat. Significantly, a wetland restoration and ponding project was done north of Highway 14 and west of County Road 104 (60^{th} Avenue NW), which is already providing multiple benefits for wildlife and surface water management.

The **Boardman Creek Subwatershed** is a relatively small subwatershed found on the northwest area of the South Zumbro Watershed; it is also referred to as Kings Run in the City of Rochester's Storm Water Management Plan. It has approximately two thirds of its land area west of Highway 52 and one third east of Highway 52. It flows from west to east, emptying into the South Fork Zumbro River in Section 11 of Cascade Township. Although the eastern two thirds of the watershed have experienced substantial residential and commercial development, the upper reaches are more open. Here, agriculture is more common, although a significant portion of the stream corridors have been ditched and/or channelized. Despite this, there still exists some opportunities for managing and restoring natural areas.

The **Willow Creek Subwatershed** is located in the south-central portion of the South Zumbro Watershed. It will be described in three sections: Willow Creek - West Fork, Willow Creek - East Fork and Willow Creek - Lower Reach. The West Fork extends from County Road 16 just north of the Rochester Municipal Airport, downstream to Trunk Highway 63. The East Fork extends from just north of 60th Street SE, between Simpson Road and 20th Avenue SE, downstream to Trunk Highway 52. The Lower Reach includes those sections of both the east and west branches from the lower boundaries described above, downstream to the confluence of Willow Creek and Bear Creek.

Willow Creek - West Fork contains two valleys: the western-most valley containing the main stem of Willow Creek; and the other one a small perennial stream. The stream channel in the upper reaches is narrow, often flowing over bedrock at a moderate to high gradient. Cattle graze on much of the land adjoining the western-most valley. The other valley is much more remote and contains several areas of good-quality forested natural communities. These two upper valleys drain to the Willow Creek Reservoir (WR-6, approximately 70 acres in size and with a maximum depth of 22 feet). Most of the land area around the reservoir consists of old farm fields and woodland. These areas were previously used for row crops and grazing, but are now slowly reverting to woodland-brushland and forest. Downstream from Willow Creek Reservoir, the West Fork of Willow Creek flows through the Willow Creek Golf Course. Within this reach, an additional tributary joins Willow Creek from the west. After flowing through the golf course, Willow Creek flows through a narrow band of floodplain forest before passing under Trunk Highway 63.

The dominant pre-European settlement vegetation consisted of oak savanna with scattered pockets of mesic oak forest and lowland hardwood forest occurring on moister sites in the bottom of stream valleys or on north facing slopes. Dry prairies also occurred on steep southwest facing slopes where frequent fires prevented the establishment of woody vegetation. At present, dry to mesic oak forest and oak woodland dominate the upper reaches of Willow Creek. Most of these oak forest and woodlands have succeeded from the oak savanna which dominated this area prior to European settlement. The conversion of oak savanna and prairie to agricultural land uses and the effective suppression of wild fires are largely responsible for this succession.

The type of natural community present is largely a function of soil type, slope and aspect. Dry oak forest occurs along south and west facing hillsides and where soils are better drained. The dominant tree species in these areas include bur oak, black oak, pin oak, white oak, black cherry and trembling aspen. On the more moist, mesic sites, red oak, bur oak, basswood, sugar maple and iron wood are dominant. Along the creek itself, lowland hardwood forest, dominated by boxelder, eastern cottonwood, american elm, green ash and basswood, occurs. The quality of these forested natural communities in terms of species diversity and lack of invasive species such as buckthorn and boxelder is generally the highest in the eastern valley. The western valley is lower quality due to recent grazing and logging.

Around the Willow Creek Reservoir (WR6), the primary natural communities include oak savanna, oak woodland, lowland hardwood forest and wet meadow wetland. In addition to these communities, there are several areas along steep south-southwest facing hillsides that contain small remnants of native prairie. Shoreline areas of Willow Creek Reservoir contain scattered areas of emergent marsh. The quality of natural communities in this segment is low due to past farming and more recent disturbances resulting from the construction of Willow Creek Reservoir.

Below Willow Creek Reservoir, much of the riparian vegetation has been removed as Willow Creek flows through the golf course. Downstream from the golf course, however, the creek enters a floodplain forest dominated by boxelder, black willow, bur oak and green ash. This floodplain forest community is poor quality due to high flow, sediment deposits from flooding, and logging and grazing. Invasive species such as boxelder and buckthorn are common within this natural community.

Plunkett (1992) listed 205 documented species of birds in the vicinity of Willow Creek Reservoir including such rare species as peregrine falcon and bald eagle, along with a host of resident and migratory songbirds, shorebirds, waterfowl and raptors. According to Plunkett, the main reasons for such high numbers of avians is the presence of a large body of water (in a county practically devoid of lakes) and that much of the area surrounding the reservoir is off limits to the public. Additional species noted in this section of the Willow Creek Corridor include: deer, turkey, pheasant, cottontail rabbit, grey squirrel, fox, coyote, mink, beaver and muskrat. The primary habitat for fish is the Willow Creek Reservoir. Fish that have either been stocked or are proposed to be stocked in the reservoir include bluegill, largemouth bass, yellow bullhead, channel catfish, yellow perch, black crappie and small mouth bass. Fish present in both the reservoir and upstream reaches of Willow Creek include white sucker, common shiner, creek chub and green sunfish.

Records of the Minnesota Department of Natural Resources Natural Heritage Program documented a fox snake (special concern) north of Willow Creek Reservoir. Unofficial records include peregrine falcon (endangered), bald eagle (threatened), and common tern and caspian tern (both special concern).

Willow Creek - East Fork is similar to the West Fork in terms of land uses, although a greater proportion of the land adjacent to the creek consists of grassland, often no longer used for pasture or cropland. The riparian fringe, immediately adjacent to Willow Creek is a mixture of wetlands and narrow strips of lowland hardwood forest. A flood control reservoir (WR-4, about 40 acres in size with a maximum depth of 24 feet) is located just west of Highway 1 and south of County Road 101 (45th Street SE); land adjacent to this reservoir is owned by the Gamehaven Boy Scout Reservation. The pre-European settlement dominant vegetation consisted of oak savanna with scattered pockets of mesic oak forest and lowland hardwood forest in the south portion of the corridor, near the reservoir; while prairies dominated the area north of the reservoir.

At present, the East Fork contains a number of good-quality natural communities including bluff prairie, wet meadow and some sizable tracts of forest land. The forest land contains dry to mesic oak forest, oak woodland and lowland hardwood forest natural communities. As in the West Fork, the presence of natural communities is largely a function of slope, aspect and soil types. The bluff prairie is of moderate to good quality and dominated by native grasses, including side oats gramma, indian grass, little blue stem, big blue stem and prairie dropseed. Many of the wetland natural communities are wet meadow-seepage fens occurring at the base of hillsides along the creek. Common plant species include hummock sedge, prairie cordgrass, blue joint grass and shrubs such as pussy willow and red oiser dogwood. The forest communities contain many of the species listed for the same forest communities found in the West Fork portion of the corridor.

The highest quality wildlife habitat is located in the vicinity of the reservoir, where the largest blocks of good-quality forest natural communities remain. In addition, species with specialized habitat requirements, such as those requiring native prairie or high-quality wetlands, may be present in this area due to the presence of these rare natural communities. Although not as rich in avian diversity as the West Fork of the Willow Creek, a total of 97 species of birds were documented near the WR-4 reservoir (Plunkett, 1992). Wildlife habitat in the northern portion of the East Fork is not as high in quality due to a lack of continuous vegetation along the creek. In some areas of the north portion of this corridor, the creek flows through pasture with little in the way of natural vegetation along the creek.

The DNR Lake Management Plan for reservoir WR4 calls for stocking bluegill, largemouth bass, channel catfish, yellow bullhead, yellow perch, black crappie and small mouth bass. No other fisheries survey information was available to indicate what fish species are native to the East Fork of Willow Creek, although other species of fish common to small, warm water streams such as fathead minnows, shiners and suckers were probably present before the reservoir was constructed and are likely present today.

Two rare natural communities are listed by the DNR Natural Heritage Program including dry prairie (bedrock bluff subtype) and wet meadow. The dry prairie is located in the Gamehaven Boy Scout Reservation on several steep bluffs above the reservoir. The wet meadow is located downstream from the reservoir between the creek and railroad grade. The plants *Valeriana edulis ssp.* (threatened), located in the dry prairie and wet meadow natural communities; and *Oxypolis rigidior* (cowbane), considered rare by the DNR and found in the wet meadow.

Willow Creek - Lower Reach occupies a floodplain area dominated by wetlands, where the East Fork and West Fork of Willow Creek converge. Shortly downstream from this point, Willow Creek discharges into Bear Creek. Because much of the Lower Reach of the Willow Creek lies within the floodplain, agricultural land use is very limited. Most of the Lower Reach is currently in parks and open space with some areas along Willow Creek featuring walking/biking trails. Along the Highway 63 corridor, industrial/commercial uses are present within floodplain fringe areas.

Natural communities include such wetlands communities as sedge meadow, wet meadow, shrub swamp, emergent marsh and flood plain forest. Species common to the sedge meadow communities include hummock sedge, lake sedge, blue vervain, giant goldenrod and water hemlock. Several of the sedge meadow communities in this reach are among the better quality wetlands in the City of Rochester. Wet meadows are generally of poor quality and occur where drainage from ditching and/or tiling has occurred. These sites are dominated by reed canary grass, an aggressive, nonnative grass species. Within shrub swamp natural communities, reed canary grass is also a dominant species, along with shrubs such as red oiser dogwood, pussy willow, sandbar willow, black willow and a low diversity of wetland forbs including some of those found in sedge meadow wetlands. Many of the sedge meadow and wet meadow wetlands appear to be succeeding to shrub swamp, possibly due to hydrologic alterations in the watershed and lack of fires to kill back the woody vegetation.

Floodplain forest natural communities occur almost continuously along the creek where sediment deposits create a linear fringe of slightly higher (and dryer) land where trees grow. Dominant trees include boxelder, green ash, american elm and black willow. Buckthorn, a non-native, invasive shrub generally dominates the understory, along with occasional clumps of native dogwoods, willows and currents.

The diversity of different wetland natural communities, coupled with the meandering channel of Willow Creek, provides for high-quality wildlife habitat. The Lower Reach of Willow Creek is considerably deeper and flows are more permanent. As a result, aquatic invertebrates, fish, turtles, amphibians, waterfowl, shorebirds, and aquatic fur bearing mammals are all present. Some of the more common species noted include mink, muskrat, beaver, raccoon, coyote, grey squirrel, white-tail deer, pheasant, roughlegged hawk (late fall migrant) and a variety of songbirds. Although the floodplain forests generally have a low diversity of tree, shrub and ground cover plant species, many large trees containing cavities provide shelter and food for many species of birds and mammals. Perhaps the biggest impediment to wildlife in this section of the corridor is the presence of highways 63 and 52, both of which act as potential barriers to wildlife movement up and down the stream corridor. Wildlife is also affected by expanding urban/suburban development.

Because the lower reach of Willow Creek is contiguous with Bear Creek and the South Fork Zumbro River, it is likely that many of the fish species present in these waters are also found in Willow Creek. No records exist for rare features in this section of the corridor; however, the presence of good-quality wetlands suggests that some rare plant species may be present, which are found in other nearby wetlands.

The **Badger Run Subwatershed** is located in the southeast area of the South Zumbro Watershed and drains to Bear Creek near its confluence with Willow Creek. The upper portion of Badger Run, just downstream from County Road 11, flows through, or adjacent to, a series of wet meadow/sedge meadow wetlands. The wetlands and the slightly higher land adjacent to them are presently used for pasture. The lower portion of Badger Run flows through pastured areas of hobby farms and residential areas. Much of the riparian fringe in this reach of Badger Run is affected by debris and fill dumped in the floodplain. Runoff from residential septic systems (outlet pipes from drain fields) and livestock is evident in places along this reach. The pre-European settlement dominant vegetation was oak savanna and oak woodland-brushland. Along the creek itself, wet prairie and wet meadow wetlands would have also been present.

The upper portion of Badger Run just below County Road 11 contains numerous wet meadow wetlands. Because of drainage and cattle grazing, most of these wetlands are degraded and are dominated by reed canary grass with scattered pockets of hummock sedge and blue vervain. The surrounding pastures are grazed heavily and generally contain a mixture of brome and blue grass. The lower portion of Badger Run (downstream from 30th Avenue, SE) is characterized by a narrow riparian fringe of low-quality floodplain forest dominated by boxelder and eastern cottonwood or shrub swamp dominated by willow, dogwood and reed canary grass. Along Pinewood Road, several tracts of oak forest and oak woodland-brushland are present. The more moist, mesic forested natural communities occur on north facing slopes and are dominated by bur oak, basswood, red oak, white oak and american elm.

Wildlife habitat quality is moderate within Badger Run. The quality of wildlife habitat is reduced due to the poor overall quality of natural communities in this corridor and the lack of a connection between Badger Run and upland wildlife habitat. Many of the fish species found in the lower portions of Bear Creek (such as the special concern fish black redhorse) are likely present in, or would migrate into, Badger Run. Beaver dams (which were present in several locations) and low water levels may act as a barrier to upstream fish migration during some years. One record of a blandings turtle (threatened) is shown for the upper portion of this reach. The occurrence of blandings turtles is possible along much of Badger Run due to the number of wetlands along the creek.

The **Bear Creek Subwatershed** is located in the southeast area of the South Zumbro Watershed. Willow Creek and Badger Run flow into Bear Creek, which flows into the Zumbro within the City of Rochester just north of 4th Street SE. The Bear Creek is here described in two reaches, Upper and Lower, separated by Marion Road.

Bear Creek - Upper Reach starts as a mildly rolling landscape dominated in the uplands by agricultural land use. The creeks meander through narrow forested floodplains, with adjacent upland forest that widens going downstream. About 8,400 acres (13.1 square miles) of the upper reach flow into the Bear Creek Reservoir (BR-1) built by late 1994 for flood control. This reservoir and its surrounding area became part of the recreational area now known as Chester Woods Park, administered by Olmsted County. It is located just south of Highway 14 about a mile and a half east of County Road 19 (Chester Road). This area has a high recreational value for area residents for swimming, fishing, picnicking, camping, and hiking. Regulated flows from the reservoir have been promoting streambank stability, for example, compared to the tributary flowing from the southeast into Bear Creek on the upstream side of County Road 19 that transports large volumes of sediments. Just downstream from County Road 11 (50th Avenue SE), an unnamed tributary joins Bear Creek from the north, which experiences substantial flows. A narrow strip of floodplain forest runs along this tributary for much of its length, making it a significant component of the Bear Creek Corridor, with some sections severely degraded by agricultural activities.

The pre-European settlement vegetation of the Upper Reach of Bear Creek consisted mostly of forest and woodland natural communities. Near Bear Creek, floodplain and lowland hardwood forest was present. Farther back from the creek, on higher ground, oak forest, oak woodland-brushland and oak savanna were found. On ridge tops, above the creek valley, scattered patches of prairie were present. At present, lowland hardwood forest, floodplain forest and oak woodland-brushland are the dominant natural communities in the Upper Reach of the Bear Creek. Groundwater, including seepage as influenced by shallow bedrock and impervious Decorah Shale, seems to be the primary source of water, not inundation from the nearby creek. Dominant tree species include green ash, eastern cottonwood, bur oak, american elm, silver maple and boxelder. Native shrubs such as american hazel, speckled alder and chokecherry were present in this lowland hardwood forest. Ground cover species were not surveyed.

Upland forest communities in the Upper Reach of the Bear Creek are generally mesic oak forest on north and east facing slopes and oak woodland - brushland on dry, well-drained areas adjacent to the creek floodplain. Within mesic oak forest natural communities, red oak, bur oak, basswood, black cherry and green ash are the common tree species. In oak woodland-brushland areas bur oak, pin oak, black oak, trembling aspen and black cherry are the dominant tree species. In general, the shrub layer is dominated by such species as buckthorn, prickly gooseberry, black current, prickly ash and raspberry. The overall quality as measured by species diversity and impacts from human disturbances (logging and grazing) is moderate to high in these upland forested natural communities.

Several significant wetlands occur in the Upper Reach of the Bear Creek. Their species composition is similar to the wetland by County Road 11, just north of creek. This wetland is a seepage meadow with old creek oxbows bisecting it in several places. Small areas of emergent marsh occur in these oxbows. The wet meadow seepage areas are dominated by sedges and wool grass; the emergent areas by river bullrush, cattail, wild mint and reed canary grass. Although exotic species such as reed canary grass are present, and grazing continues to occur in this wetland, the overall quality of this wetland is good.

Due to the high quality and good diversity of natural communities and the connectivity of these natural communities to Bear Creek, wildlife habitat values in the Upper Reach are high. The DNR classifies this creek as rough fish-forge fisheries. Some of the more common fishes include white sucker, creek chub, fathead minnow, black redhorse and golden redhorse. The DNR maintained a marginal fishery for brown, rainbow and brook trout through stocking up until 1975. Stocking was discontinued after it was determined that suitable habitat for trout in Bear Creek is very limited for two primary reasons: Suitable trout habitat is scarce in Bear Creek; and low productivity due to fine sand substrates and warm water temperatures. In some portions of Bear Creek where springs provide cold water sources, the potential for future trout establishment exists. Reestablishment of trout in Bear Creek, however, does not appear to be a high priority of the DNR. The main fisheries in Bear Creek will likely be a children's fishery for suckers and chubs. A number of rare and endangered animals are documented from the Upper Reach of Bear Creek. Two records of blandings turtle (threatened) and two records of blue racer snakes (special concern) are shown for this area. The black redhorse is a special concern fish species found only in a few drainage areas of southeast Minnesota. This species has been documented during fishery surveys of Bear Creek.

Bear Creek - Lower Reach lies within a level floodplain. Within this reach, Willow Creek and Badger Run discharge into Bear Creek. Floodplain forest runs continuously along Bear Creek and its tributaries in this reach. Because most of this area lies within the floodplain, land uses are mostly limited to agricultural fields and city parks. Within this reach, Bear Creek is a sizable stream, averaging 37 feet wide and more than 3 feet deep. The banks of Bear Creek in this lower reach are generally quite high (8-10 feet) due to the sediment deposits and creek channel downcutting.

The pre-European settlement vegetation in this section of the Bear Creek Corridor consisted of oak savanna, oak woodland-brushland and oak forest. Oak forest occurred in areas protected by fires (such as areas adjacent to the creek). Oak savanna occurred on well-drained alluvial soils where fires and activities of large grazing animals, such as bison, prevented the establishment of woody vegetation. Some parts of the lower reach of the Bear Creek still superficially resemble oak savanna. These areas contain the original bur oak trees but have largely lost their native assemblages of grasses and forbs. Presently, the dominant natural community along Bear Creek is floodplain forest. Dominant tree species include box elder, silver maple, green ash, american elm and willow. The shrub layer is generally open and is dominated by buckthorn, an exotic shrub. Where the elevation is somewhat higher and flooding is not as frequent, dry oak forest dominated by bur oak, white oak, pin oak, black oak, black cherry and trembling aspen is found. These areas have probably succeeded from a more open oak woodland-brushland due to the lack of fires. Forested natural communities in the Lower Reach of Bear Creek contain large numbers of exotic and/or weedy species such as boxelder and buckthorn and, therefore, are of low to moderate quality. In addition to forested natural communities, wet meadows and scrub shrub wetlands are scattered throughout this reach in depressional areas. These wetlands are generally of low to moderate quality and are dominated by reed canary grass, red oiser dogwood, willows and buckthorn.

The Lower Reach of Bear Creek provides significant wildlife habitat in spite of the generally low quality of natural communities. The forested communities typically contain many large trees with numerous cavities. Many of these dead trees, referred to as snags, are still standing. The snags provide habitat for many species of wildlife that use tree cavities for nesting and as a food source (dead trees typically contain a lot of insects). In addition to the numerous snag trees, large white and bur oaks common to this area provide food for a host of different wildlife species. The creek also contains food items such as fish and crayfish and other aquatic invertebrates important to species such as herons, mink and raccoons. Perhaps the most important factor, though, is that this area serves as a link among other areas of significant wildlife habitat including: Willow Creek, Badger Run and the Upper Reach of Bear Creek, linking all of these corridors to allow for the movement of birds, mammals, reptiles and amphibians. A major threat to the corridor links is fragmentation from road crossings and urban development. These physical barriers limit the movement of wildlife between different areas. Road crossings in particular should be designed to provide for the safe movement of wildlife. Fisheries found in the upper reach are also found in the lower reaches. However, some fish connectivity with the Zumbro River has been lost due to the drop structures built as part of the flood control channel improvements. The black redhorse (fish species of special concern) has been collected from this reach of Bear Creek.

The **Silver Creek Subwatershed** is located in the eastern portion of the South Zumbro Watershed, draining to the Zumbro River at Silver Lake in the City of Rochester. The Silver Creek Reservoir (SR-2) was built just east of County Road 11, serving a 6,336 acre (9.90 square mile) drainage area. This reservoir has a wet area of about 98 acres and was designed to never overtop (contain the probable maximum precipitation). It has a 30-inch diameter reinforced concrete pipe principal spillway, designed for a 135 cfs maximum capacity, which also is used for the channel design between the reservoir outlet and County Road 11. As a result, the reservoir controls flows for events greater than the 100-year rainfall; the freeboard was designed using the 6-hour probable maximum precipitation of 24.5 inches. Base flows are now more continuous, compared to the more intermittent flows before the reservoir was built.

The mildly sloping land dominated by cropland and pasture drains through a deep valley with a mixture of forest, pasture and cropland. About a mile downstream from County Road 11, the channel of Silver Creek widens and the gradient increases with sections of the creek flowing over boulders and rubble. The scenery is outstanding with the creek flowing through a broad, sweeping valley with a mixture of forest, pasture and row crops. Below Silver Creek Road, the creek enters into a broad floodplain, passes by the Quarry Hill area, and flows through urban land use towards Silver Lake.

The pre-European settlement vegetation of the Silver Creek area was dominated by prairie and oak savanna. At present, the prairies have mostly been converted to cropland and the oak savanna has either succeeded to oak woodland/forest or is used for pasture. The upper and middle portion of the Silver Creek Corridor contains a mixture of forest, wet meadow and pasture. Oak forest and oak woodland - brushland is found on south and west facing slopes. Mesic oak and maple-basswood forest is found on north and east facing slopes. Wet meadow and small areas of lowland hardwood forest are characteristic of the low areas adjacent to Silver Creek. Generally, the natural communities in the upper to middle reaches of the Silver Creek Corridor are of moderate quality. Although the diversity of trees is good in many of the forest communities, the shrub layer is almost completely dominated by exotic and/or weedy native shrubs. In addition, many of the native ground cover grasses and forbs are absent from these areas due to grazing.

Below Silver Creek Road, Silver Creek flows through moderate to poor quality floodplain forest dominated by black willow, eastern cottonwood and boxelder. Like the upper reach, the shrub layer of these forests is almost completely dominated by exotic shrubs such as buckthorn. A high quality sedge meadow/emergent marsh wetland is located along the tributary entering Silver Creek from the southeast. It is dominated by such species as lake sedge, hummock sedge, cattail, with scattered willow and meadowsweet shrubs. To the north of Silver Creek, dry oak forest and oak woodland-brushland are dominant within the Quarry Hill Nature Center. These oak forest and woodlands are generally of low quality due to invasion by buckthorn and past logging and grazing activities.

The Silver Creek Corridor contains good quality wildlife habitat along most of its length, including the reservoir pool and surrounding habitat. Some of the species observed include deer, turkeys, pheasant, beaver, mink, raccoon, blue heron and wood ducks. The upper portion of the corridor is generally remote and contains forest communities with large wildlife snag trees, which provide good habitat for wildlife. In contrast to the other corridors, the upper portion of Silver Creek Corridor contained several active beaver ponds which provide habitat for other furbearers and water fowl such as wood ducks. According to the DNR, river otter, a species rare to Southeast Minnesota, have been sighted in the 1990s in Silver Creek. Silver Creek is classed as rough fish/forge fish fisheries by the DNR. The upper and middle portion of the creek contains such species as the central stoneroller, common shinner, fathead minnow, blacknose dace and johnny darter. The lower portion of Silver Creek may provide spawning and nursery habitat for smallmouth bass and black redhorse. Other species of fish in Silver Lake may use the small minnow-like fish found in Silver Creek as a forage base.

Two significant natural communities are listed by the DNR for this corridor: the wet meadow wetland described for the southeast tributary and a bedrock bluff prairie on a west facing bluff within Quarry Hill Nature Center. An additional remnant of bedrock bluff prairie is located west of the intersection of County Road 11 and County Road 50. This site contains rattlesnake master, a special concern plant species. A wood turtle (threatened) was observed west of Quarry Hill Nature Center.

Appendix C

Hydrologic and Hydraulic Study

of

Cascade District Major Road Crossings

Technical Memo

Bonestroo Rosene Anderlik & Associates
Engineers & Architects

Project Name: Hydrologic and Hydraulic Study of Cascade District Major Road Crossings

Client: Olmsted County

File No: 362-02-101

To: Mike Sheehan, Dept. Public Works, Olmsted County

Date: April 11, 2003

From: Ivo López / Ismael Martínez, Bonestroo Rosene Anderlik & Associates

Re: Report

Contents

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1 Introduction

Olmsted County expends significant resources on bridge capital improvements. The 2001-2005 Capital Improvement Program estimates a cost of $13,395,000 for preservation and system improvement/upgrade projects. In addition, bridge maintenance and inspection increase operating costs. Combining transportation planning with water resources planning can help reduce County costs while improving flood protection and avoiding the domino effect that can lead to bigger and bigger bridge structures.

The South Zumbro Watershed Stormwater and Capital Improvement Plan (SZWSCIP) project, which began in 2001, identified several bridge-downsizing opportunities just upstream of existing bridges in the Cascade Creek subwatershed. This *Cascade District Hydrologic and Hydraulic Study of Major Road Crossings* provides a more in-depth analysis to explore the feasibility of reducing peak flows and downsizing those bridges.

Bridges 4075 and L-6262, built in 1923 and 1953, respectively, are of primary interest because of their high priority for replacement in 2002-2003 (see their characteristics in the attached photographs). Bridge L-6262 is particularly important because 45th Avenue SW is the only access available to residences in the area and it has only 15-year flood protection (Mn/DOT Structure Inventory March 18, 1999).

Requested by the Olmsted County Public Works Department, this study's goal is to take a watershed-approach to bridge replacement and improvement to:

- Downsize bridges
- Increase flood protection
- Reduce storm water volumes and improve water quality
- Reduce construction and road maintenance costs

The specific purpose is to analyze the feasibility of some of the potential improvements to provide greater levels of flood protection/service to bridges, particularly for bridge L-6262. In this study, *downsizing bridges* refers to appropriately sizing bridges using existing temporary storage available in the floodplain through storm water management.

The primary benefits of the watershed-approach are to:

- Reduce runoff flow volumes and velocities
- Lower transportation and maintenance costs
- Improve road safety
- Improve downstream water quality
- Stabilize drainage and stream system
- Reduce sediment and flooding damage

While the secondary benefits are to:

- Reduce streambank erosion
- Restore/create wetlands
- Improve fish and wildlife habitat
- Connect wildlife corridors

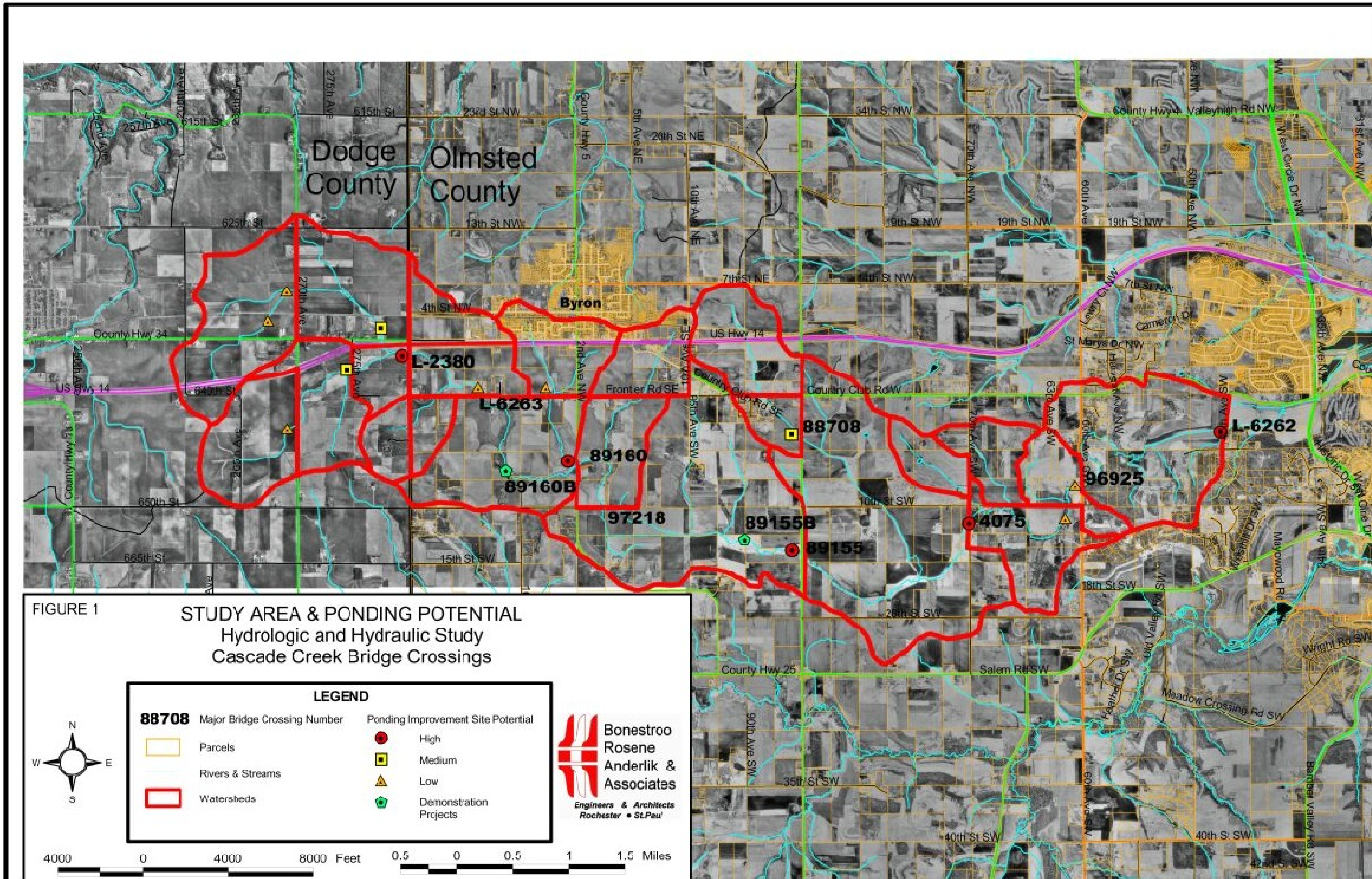

FIGURE 1
STUDY AREA & PONDING POTENTIAL
Hydrologic and Hydraulic Study
Cascade Creek Bridge Crossings

The study approach is based on building flow control structures to provide temporary ponding to attenuate peak runoff flows. These improvements provide some water retention for agricultural purposes ("farm ponds"), if desired. The ponding improvements seek to maintain similar or reduced high water elevations than for the existing conditions' 100-year flood, considered the base flood for floodplain mapping by the Federal Emergency Management Agency (FEMA).

Olmsted and Dodge Counties were interested in evaluating the benefits and costs associated with ponding improvements and bridge downsizing. The effort included an analysis of how to improve road/bridge flood protection, considering downsizing upstream bridges/culverts and incorporating flow control structures that distribute the flows and reduce their peaks.

The study area's topographic boundary and some of the major road crossings are shown on Figure 1. The area includes the Cascade Watershed upstream of 45th Avenue SW (Bridge L-6262).

2 Watershed Description and Data Collection

The Cascade watershed tributary to bridge L-6262 (45th Avenue SW) is approximately 11,540 acres (18 square miles) of predominantly agricultural land. The watershed is elongated, about five times longer than it is wide, with a dendritic (tree-like) drainage pattern flowing east towards the South Zumbro River. Upstream high elevations are between 1310 and 1330 feet. The stream invert elevation at L-6262 is approximately 1,024 feet; representing a drop of about 300 feet. Table 1 presents a watershed description by county.

Table 1 – Watershed Description by County

County	Area in acres (% of watershed in parenthesis)	General Characteristics
Dodge	2,500 (22%)	Western, upper portion of the watershed; a gently rolling landscape with predominantly mild slopes (1% to 2%).
Olmsted	9,040 (78%)	Eastern, central and lower portion of the watershed. In the central portion of the watershed, Cascade stream runs closer to the southern watershed boundary, with most drainage flowing from north to south/southwest in the central area. Land slopes gradually increase going east (downstream), with an average slope of about 4% in the eastern region and localized slopes greater than 18%.

Available data collected for this study included:

- County soil survey
- Land use county map
- Infrared color aerial photography (MNDNR)
- Topographic information
- Flood Insurance Studies (FIS for 1987, 1995 and 1998, MNDNR, USACE, FEMA)

The 1987, 1995 and 1998 versions of the Flood Insurance Studies (FIS) were obtained from the Rochester/Olmsted Planning Department. Hydraulic results for the area upstream of L-6262 did not change between 1987 and 1995.

The Department of Natural Resources and the U.S. Army Corps of Engineers (USACE) provided the HEC-2 models for the Flood Insurance Studies of 1987 and 1995. These models included OLMST14, OLMST15, OLMST16, OLMST17, ROCHE19, casc95, and cascf95. The 1995 version did not update the area upstream of County Road 22 (West Circle Drive). The 1998 report also suggested that the 1998 model was not up-to-date with the current bridge crossing improvements.

Table 2 displays the estimated existing flood protection for the two study bridges and the one in between, as reported in the Mn/DOT bridge inventory data.

Table 2 – Existing Flood Protection

Bridge No.	Existing Opening (square feet)	Existing Flood Protection (yrs)
L-6262	210	15
96925	188	25
4075	125	15

The Hydraulic Analyses and Risk Assessments to replace Bridges 4075 and L-6262 (Hancock Concrete Products Co., Inc., July 26, 2001 and September 27, 2001, respectively) were also reviewed for this study. These assessments estimated the overtopping flood frequency at 15 years and 10 years, respectively. Note the following observations:

- For Bridge 4075:
  - o Since 4075 is being replaced with a road realignment that raises the inverts, a larger opening was proposed in the risk assessment to have similar protection (traditional approach). Alternative approaches to reduce the culvert sizes and/or increase flood protection are to a) raise the road a couple feet as part of the road realignment, and/or b) reduce peak flows with upstream structures.
- For Bridge L-6262:
  - o The Hydraulic Analysis and Risk Assessment (September 27, 2001) proposed replacement structures that include a center culvert box of 14 ft by 8 ft and two outside box culverts of 12 ft by 7 ft (280 ft^2), to provide a 10-year flood protection. The Mn/DOT Structure Inventory (March 18, 1999) reported a 15-year flood protection with a waterway opening of 210 ft^2. The difference in protection is probably due to the estimation method and can be considered of similar magnitude. However, the 2001 study uses the 1998 Flood Insurance Study flows (1,700 and 3,650 cfs for the 10- and 100-year events) that are for 20.4 square miles. Since only 18 square miles drain to L-6262, the 2001 study used higher flows that resulted in a lower flood protection (10-year) than that reported in the inventory data (15-year).

Hand-level topographic information was collected to obtain approximate stream cross-sections to complement the existing FIS data and collect other hydrologically important characteristics. Other pertinent data was obtained for hydraulic modeling of the bridge crossings. Surveying data was obtained from Olmsted County for potential sites where owners expressed interest in the project.

We observed the impact of land-use changes on stream stability. Landowners corroborated these impacts. The impacts include higher peak flows, increased streambank erosion, and increased sediment deposition in mild-sloped stream reaches and lakes. These impacts affect Cascade

Creek, as well as Cascade Lake and the Zumbro River, degrading their water quality and the stream morphology's stability. They also increase maintenance costs and cause other economic losses to land owners and the County.

These impacts are a result of:

- Changes in land use in floodplain areas, often wetlands with natural flow-attenuation capacity
- A regional trend toward increasing row-crop acreage, compared to permanent vegetative cover such as pasture
- Urban and suburban developments in the Byron area. Downstream residents are already being affected by higher runoff volumes and peak flows due to the lack of appropriate storm water management practices.

Based on stream indicators of bank erosion, the rapid development of Byron merits special attention due to its potential impact on downstream infrastructure. For example, it can potentially reduce the flood protection level and increase maintenance costs to bridges and roads.

3 Hydrologic/Hydraulic Modeling

We performed a watershed evaluation to quantify hydrologic parameters based on topographic information, existing models and site visits. The modeling effort's main objective was to improve the existing flow regime while maximizing local and downstream benefits. These benefits include lower flows and velocities, which reduce erosion and enhance stream stability and water quality. Lower flows also provide greater flood protection to roads and bridges.

As part of this study, the 1987 HEC-2 model was converted to HEC-RAS (the current and FEMA preferred version). The model was adjusted to achieve the 1998 FIS water surface profiles up to the FIS study limit (bridge 96925, or 60th Avenue SW). These were used to help us understand the system behavior, the floodplain, and the bridge overtopping conditions.

To complement the steady-state modeling in HEC-RAS, hydrologic/hydraulic modeling was performed using HydroCAD to evaluate the watershed behavior and assess opportunities for ponding and/or downsizing bridge structures. The HydroCAD model was calibrated to obtain the flows used for the 1998 FIS. A base flood flow (100-yr event) of 3,830 cfs was used in the 1987 and 1995 FIS reports for the 20.4 square miles drainage area to the confluence with the South Run of the North Fork of Cascade Creek. This flow was reduced to 3,650 cfs in the 1998 FIS update. The flows to bridge L-6262 were adjusted proportionally using its 18 square mile drainage area. The 100-yr flow was estimated at about 3,460 cfs for bridge L-6262. This was used for model calibration and then adjusted with site observations and high water information from area residents. Additional bridge and storage data was also obtained, to accurately reflect existing field conditions and available storage. As a result, the 100-year flow at L-6262 was estimated to be around 3,000 cfs, which was used as the existing condition to compare with the alternatives for ponding and downsizing of bridges.

4 Priority Ranking

Potential ponding improvement sites were priority-ranked based on their ability to reduce peak flows, as well as practical economic and environmental considerations:

- Flow control structure height and cost

- Absence of buildings or other structures that could be impacted
- Availability of larger storage volumes
- Strategically located sites to increase the hydrologic travel time
- Location close to bridge structures
- Interest of landowner to have a ponding improvement site
- Wetland enhancement potential
- Water quality treatment potential
- Soil and vegetation attributes indicative of floodplain characteristics

Table 3 presents the potential ponding ranking by location (see Figure 1).

Table 3 – Potential Ponding Ranking

Bridge Number/Location (downstream to upstream)	**Location Description**	**Ponding Potential**
L-6262	45th Avenue SW	High
96925	60th Avenue SW (County Road 104)	Low
4075	70th Avenue SW	High
89155	Olmsted County Highway 3	High
88708	Olmsted County Highway 3	Medium
97218	10th Street SW	Low
89160	Olmsted County Highway 5	High
L-6263	Frontier Road SE	Medium
L-2380	19th Avenue SW (Dodge-Olmsted Counties boundary)	High
Hwy 14 N	North of US Highway 14 and about 1500 ft west of the Dodge-Olmsted Counties boundary	Medium
275th Ave	275th Avenue (Dodge County)	Medium
270th Ave – North Site	270th Avenue (Dodge County) Site north of US Highway 14	Low
270th Ave – South Site	270th Avenue (Dodge County) Site south of US Highway 14	Low
Frontier Rd – West of CR 5	Frontier Road west of County Road 5	Low
10th St - West of 60th Ave	10th Street SW about 600 ft west of 60th Avenue SW	Low

Note: Other ponding sites with potential were not ranked, but could be evaluated based on priorities and the sequencing of bridge replacements or road improvements.

An estimated 80% of road crossings showed a potential to attenuate peak flows. Those offering more temporary storage opportunities were ranked higher in ponding potential.

5 Demonstration Projects

Olmsted County envisioned implementing ponding improvement sites on a voluntary basis to promote watershed best management practices. The flow-control structures are designed to reduce transportation maintenance costs, manage storm water, and improve the stream corridor environment. If desired, farm ponds, wildlife habitat, wetland restoration, or other improvements can be integrated with the structure project.

A public meeting was held at Salem Township Hall on March 13, 2002 to inform watershed residents about the study findings and get feedback from the potential beneficiaries and participants. Participants had the opportunity to ask questions and express interest in having a farm pond, flow-control structure and/or other improvements on their property. They were also invited to express future interest, since it is an on-going project.

Three landowners expressed interest. Two sites were selected as demonstration sites; David Stork's property near bridge 89160, and Denis Tvedt's property near bridge 89155. These two sites are identified on Figure 1 as 89160b and 89155b, respectively.

6 Benefits and Cost

6.1 Benefits

The traditional approach for bridge/culvert design usually:

- Considers each road bridge/culvert crossing individually.
- Does not provide much peak flow attenuation for the frequent rainfalls (such as the 2-year storms or lower), since they are designed for the high, overtopping flow events.
- Tends to yield oversized upstream culverts where temporary storage is available.
- Contributes to have "flashy" peak flows, particularly for the frequent rainfall events.

Compared to the traditional approach, installing upstream flow control structures (watershed approach) with or without wetland restoration has the following benefits:

- Allows offsetting peak flows from the different subwatersheds, using hydrographs to optimize road improvements and flood protection
- Has great potential for attenuating the frequently occurring peak flows, which cause most of the streambank degradation/erosion
- Delays and reduces peak flows using floodplain areas for a few more hours than existing conditions
- Reduces water velocities, thus reducing erosion potential

Findings based on the site visits and the hydrologic/hydraulic modeling include:

- Bridges L-6262 and 4075 could have a higher level of flood protection if watershed management measures are implemented.
- Many potential ponding improvement sites were identified (see Figure 1); most road-stream crossings showed good characteristics for ponding or controlling flows.
- The benefit to bridge L-6262 of implementing the high potential improvements (ponding and downsizing of bridges) can be seen in Figure 2. The hydrographs are presented for the existing (highest curve) and proposed conditions. One graph is for the 6.2-inch rainfall (100-year frequency) and the other for the 3-inch rainfall (2-year frequency). These hydrographs

illustrate the peak flow reduction, and the reduction in the rate of change in flow with time (flashiness).

- A 100-year peak flow reduction of 40% to 50%, from 3,000 cfs to about 1,800 cfs, at bridge L-6262 can be achieved if high potential ponding and downsizing are implemented.
- Depending on the improvement characteristics and the storage volumes available, more peak attenuation could be achieved for the 3-inch rainfall.

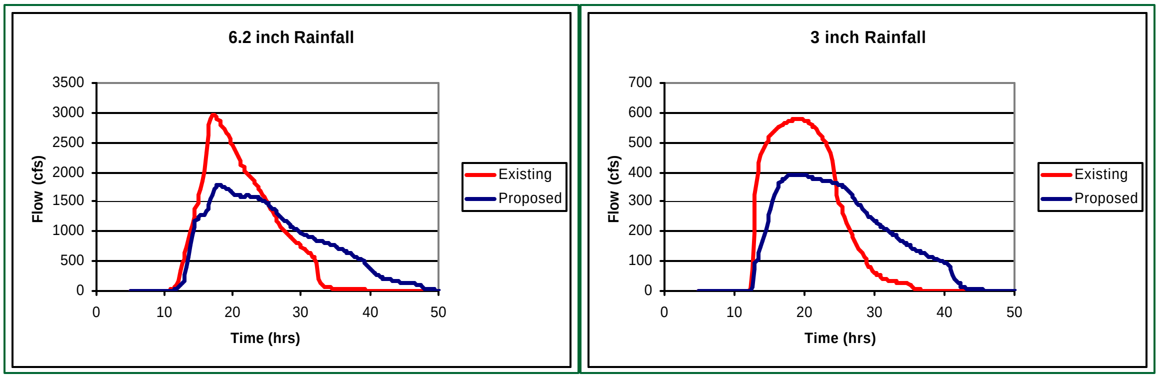

Figure 2 – Existing and proposed hydrographs at bridge L-6262

The significant peak flow reduction illustrated in Figure 2 was possible because the temporary ponding offsets the runoff contributions from the different subwatersheds. Figure 3 illustrates this point, showing how two defined peaks are offset in the hydrograph for flows into L-6262. This was achieved by incorporating high potential ponding improvements and downsizing bridge structures.

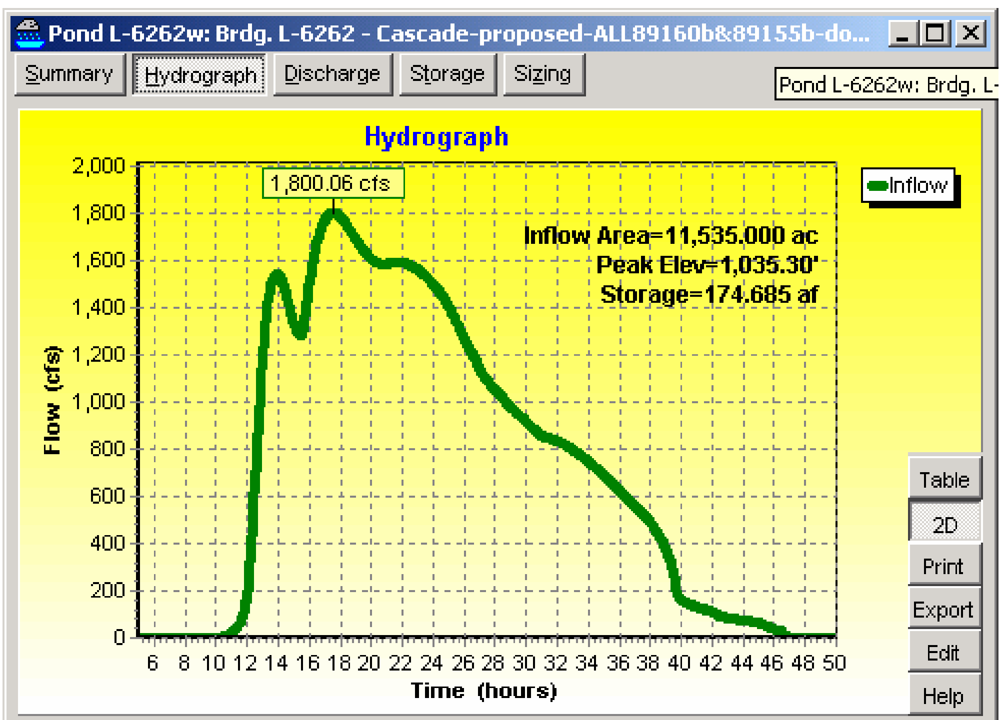

Figure 3 – Example of offsetting peak flows with ponding: inflow at bridge L-6262

As a result, the improvements make it possible to have hydrographs with characteristics that yield many economic and environmental benefits. As previously mentioned the environmental benefits include an improvement in the aquatic and riparian habitat, reducing erosion-sedimentation problems, and promoting a more stable stream.

Temporary ponding upstream enables the peak flow reduction (attenuation), which increases the ponding duration, or time that it takes for the runoff flows to pass. Table 4 illustrates the extended duration at the L-6262 location with high potential improvements. The important point is that the impact is only of nine to 13 hours of additional ponding time, compared to existing conditions for different rainfall events. Note that the negative change in time of ponding for the one-inch rainfall means that ponding time at L-6262 is lowered by the water retention in the upstream areas.

Table 4 – Change in time of ponding at L-6262 with high potential improvements and downsizing of structures

Location	24-hr Rainfall Event (inches)	Change in Time of Ponding (hrs)
L-6262	1	-16.3
	2	9.5
	3	10.7
	4	11.4
	5	12.2
	6	12.5

The ponding time duration is not considered an issue for agricultural land use in these floodplain areas. The benefit of ponding is a significant increase in flood protection to infrastructure (such as roads and bridges).

One way to consider the economic benefit is to evaluate how the improvements increase the flood protection to bridge L-6262. Table 5 illustrates how the flood protection is increased from existing conditions as improvements are made. Note that:

- Protection can be raised from about the 15-year flood to the 65-year flood with the proposed improvements.
- Implementing the high potential ponding improvements ensures a 50-year flood protection to bridge L-6262.
- Higher protection could be possible when optimizing the improvements during the design stage.
- Additional flood protection could be achieved with other medium and low potential improvements when opportunities arise.
- A 100-year flood protection to L-6262 could potentially be achieved if economically feasible.

Table 5 – L-6262 flood protection for existing conditions and different improvements

Case Description	Approximate Flood Protection (years)	Comments
1) Existing conditions	15	With road low point at 1,031 ft
2) Implementing ponding improvement sites 89160b and 89155b	35	With road low point at 1,034.9 ft
3) Implementing high potential ponding improvement sites	50	With road low point at 1,034.9 ft
4) Implementing high potential ponding improvement sites and downsizing bridge structures	65	With road low point at 1,034.9 ft

6.2 Cost of temporary-ponding improvements

Table 6 (next page) presents the estimated temporary-ponding improvement cost by location (see Figure 1) and includes the two demonstration sites. The cost of the high potential improvements is estimated at $556,000. The costs include the construction of weirs and berms with a 6-ft average height, and the associated excavation and protection of the construction-affected area.

The cost for all the ponding improvements would be approximately $1,434,000. All these would reduce peak flows further than those illustrated for the high potential improvements.

Table 6 – Ponding Improvement Costs and Adjusted Potential Ponding Ranking

No.	Bridge Number/ Location (listed downstream to upstream)	Location Description	Ponding Potential	Estimated Ponding Improvement Cost
1	L-6262	45th Avenue SW	High	$ 102,000
2	96925	60th Avenue SW (County Road 104)	Low	87,000
3	10th St - West of 60th Ave	10th Street SW about 600 ft west of 60th Avenue SW	Low	72,000
4	4075	70th Avenue SW	High	151,000
5a	89155	Olmsted County Highway 3	High (Low if 89155b is done)	118,000
5b	89155b	Stork's Site	High (Low if 89155 is done)	118,000
6	88708	Olmsted County Highway 3	Medium	67,000
7	97218	10th Street SW	Low	131,000
8	89160	Olmsted County Highway 5	High	66,000
9	89160b	Tvedt's Site	High	63,000
10	L-6263	Frontier Road SE	Medium	80,000
11	L-2380	19th Avenue SW (Dodge-Olmsted Counties boundary)	High	56,000
12	Hwy 14 N	north of US Highway 14 and about 1500 ft west of the Dodge-Olmsted Counties boundary	Medium	75,000
13	275th Ave	275th Avenue (Dodge County)	Medium	102,000
14	270th Ave – North Site	270th Avenue (Dodge County) Site north of US Highway 14	Low	51,000
15	270th Ave – South Site	270th Avenue (Dodge County) Site south of US Highway 14	Low	51,000
16	Frontier Rd – West of CR 5	Frontier Road west of County Road 5	Low	44,000

	Total		All	$1,434,000
	Total		High	$ 556,000

6.3 Savings from downsizing bridge structures

Downsizing the bridge structures is possible when ponding improvements are made. The economic benefit can be estimated as the potential savings in downsizing the culverts. The cost savings depend on the desired flood protection to be achieved at the different bridge locations.

Table 7 shows the results of comparing:

A) The traditional approach where culverts are sized to meet the target flood protection; and

B) The upstream temporary ponding approach with downsizing of culverts, which was used to define the possible target flood protection achievable.

Both approaches were used to achieve a similar flood protection.

The $653,280 savings with the high-ranked crossings (Table 7) are possible due to ponding improvements, which cost $556,000 for the high potential ponding sites. This results in an overall savings of $97,280 (Table 8). This means that the ponding improvements can be paid for by the savings possible from being able to use smaller culverts, while achieving similar road flood protection.

Table 7 also illustrates that implementing the high potential ponding improvements results in more savings when other bridges/culverts are replaced. For example, additionally replacing culverts at the two low-ranked sites yields a total potential savings of $834,720. Subtracting the total ponding improvement cost of $556,000 yields an overall saving of $278,720. This is a positive balance that can be used for other transportation or ponding improvement projects.

In addition to the direct cost savings, other indirect benefits would be obtained, including reduced road repairs/maintenance after flooding; reduced cost from removing sediments where aggradation occurs; reduced flooding damage to crops or other infrastructure.

Environmental benefits are harder to value, but can be measured indirectly, such as through indicators of aquatic and riparian quality.

Table 7 – Potential savings from downsizing culverts to achieve similar flood protection

No.	Bridge Number/Location (down-stream to up-stream)	Location Description	Ponding Potential	Estimated Rainfall Flood Protection	Culvert Length	A) Traditional Approach: Required Number and Size Culverts	A) Traditional Approach: Culvert Replacement Cost	B) Upstream Ponding With Downsizing of Culverts: Required Number and Size Culvert	B) Upstream Ponding With Downsizing of Culverts: Culvert Replacement Cost	Potential Culvert Replacement Savings (A - B)
1	L-6262	45th Avenue SW	High	5.7 inches	60 ft	5-12'x7'	$385,800	2-12'x7'	$154,320	$231,480
2	96925	60th Avenue SW (County Road 104)	Low		70 ft	2-12'x8'	182,980	no change	182,980	0
3	10th St - West of 60th Ave	10th Street SW about 600 ft west of 60th Avenue SW	Low			assume 4075 sizes	297,120	assume 4075 sizes	148,560	148,560
4	4075	70th Avenue SW	High	4.2 inches	60 ft	4-12'x6'	297,120	2-12'x6'	148,560	148,560
5a	89155	Olmsted County Highway 3	High	5.8 inches	60 ft	3-10'x8'	202,860	1-10'x8'	67,620	135,240
7	97218	10th Street SW	Low	5.3 inches	60 ft	2-12'x6'	148,560	2-10'x6'	115,680	32,880
8	89160	Olmsted County Highway 5	High	6.2 inches	120 ft	2-10'x8'	270,480	1-10'x8'	135,240	135,240
11	L-2380	19th Avenue SW (Dodge-Olmsted Counties boundary)	High	4.6 inches	60 ft	1-96"	46,920	1-90"	44,160	2,760

	Total		All				$1,831,840		$997,120	$834,720
	Total		High				$1,203,180		$549,900	$653,280

Table 8 – Net savings from high potential improvements

Description	Amount
Cost of Temporary-Ponding Improvements	$556,000
Potential Savings From Downsizing Bridge Structures	653,280
Net Savings	$ 97,280

7 Conclusions and Recommendations

Based on this hydrologic and hydraulic study for the Cascade Creek Watershed, we conclude:

- Direct economic benefits result from building flow-control structures (temporary ponding). These include:
  - ◊ Bridge downsizing savings enabled by reducing peak flows
  - ◊ Reduced road maintenance costs and reduced property damage resulting from higher levels of flood protection
- Ponding improvements can be paid for through the savings achieved by being able to use smaller culverts to provide similar road flood protection. Implementing only the high priority ponding improvements in the Cascade Creek Watershed could save an estimated $97,280. Savings could increase if the flow-control structures and bridge replacements are built from upstream to downstream (Not always possible due to bridge conditions and priorities).
- High potential ponding improvement sites can be enhanced to improve environmental conditions and provide local and downstream benefits including road/bridge protection (infrastructure), and reduced peak flows and more stable flows to enhance the stream's flora and fauna habitat.
- Implementing the high potential ponding improvements protects 45th Avenue SW (bridge L-6262) up to approximately a 50-year flood. Further improvements would result in a higher level of flood protection.
- Farm ponds and other improvements should be encouraged and implemented to regulate flows and make flow variations more gradual (better hydrologic characteristics). Other improvements can include the enhancement, restoration, or creation of wetlands and wildlife habitats.
- The flow-control structures envisioned in this study are composed of low berms, generally with a maximum height of six feet. Furthermore, the structures are considered environmentally friendly and enhance the "natural" stream habitats for aquatic species. This approach of low-risk structures at several locations can also provide the additional benefits of establishing farm-ponds and wildlife habitats, enhancing the stream corridor quality.
- Some landowners have expressed interest in having ponding improvements located on their property. These should be implemented to serve as demonstration projects through which other residents will be able to see the improvements being made.
- Several wetland restoration/enhancement opportunities were observed, which could provide economic benefits to farmers interested in participating in programs such as the Conservation Reserve Enhancement Program, or others.

- Lack of appropriate storm water management practices can reduce flood protection levels (for example, to roads and bridges) and accelerate streambank erosion. Sediment is then deposited in protected streams, or other downstream water bodies such as Cascade Lake and the Zumbro River, degrading their water quality and the stream morphology's stability. Poor storm water management also affects farmers when sediment clogged streams overflow their banks causing increased flooding and reducing access. Some residents are already being affected by runoff problems caused by rapid land use changes in Byron.

What was learned from this study?

- ✓ Public participation is vital to the success of ponding improvement projects, potentially increasing local and downstream benefits.
- ✓ Sizing bridges independently can yield oversized structures and/or loss of flood protection to roads and other downstream infrastructure.
- ✓ A watershed-approach to bridge replacement programs can reduce construction and maintenance costs, while enhancing the environmental quality of the stream and riparian habitats. This approach enables appropriate sizing of bridge structures using the opportunities for temporary storage within the floodplain.
- ✓ Storm water management planning can help identify opportunities to restore wetlands or use existing floodplain with minimal adverse impacts (such as a few more hours of temporary ponding).
- ✓ Flow-control structures are very important to enable use of available floodplain storage for frequent storms, particularly in areas where stream degradation has occurred.
- ✓ Retaining water temporarily in upstream watershed areas can significantly reduce downstream peak flows.
- ✓ Using ponding opportunities can result in a significant peak flow reduction by offsetting the runoff contributions from the different sub-watersheds.

We recommend:

- ✓ Constructing the flow-control structures (temporary ponding) as soon as feasible. The County could accomplish this using the following phased-in approach:
  1. Immediately implement the two demonstration projects identified in Figure 1 as 89155b and 89160b.
  2. Implement the other high priority flow-control projects as financing becomes available.
  3. Implement other flow-control projects as necessary, in conjunction with other road and bridge improvements. This would require a specific assessment.
- ✓ Exploring wetland banking for potential funding, as well as other financing mechanisms or sources (such as, NRCS, DNR, Ducks Unlimited, Pheasants Forever, BWSR).
- ✓ Continuing to coordinate efforts with Dodge County to implement storm water management strategies that are beneficial to both counties.
- ✓ Coordinating with and encouraging Byron to implement appropriate storm water management practices for changes in land use, mainly to avoid reducing current flood protection to existing roads and bridges.

List of Figures

List of Tables

Photographs

Source of photographs: Olmsted Public Works

Bridge No. 4075

August 2001

Salem Township
TWN 199 Cascade Creek (70th Avenue SW)

East to west

West to east

Looking downstream

Looking upstream

Downstream of bridge

Upstream of bridge

Bridge No. L-6262

Rochester Township
TWN 222 Cascade Creek (45th Avenue SW)

North to south

South to north

Looking downstream

Looking upstream

Downstream from bridge

Upstream from bridge

Appendix D

Bridge Data

Table D-1 - Bridge Data

South Zumbro Watershed Storm Water and Capital Improvement Plan (362-01-100)
Olmsted and Dodge Counties
Bonestroo Rosene Anderlik and Associates/ILL

No.	Subwatershed	Bridge No.	Drainage Area (acres) from GIS	Area Between Bridge Improvements (acres) from GIS	Type Main Span*	Year Built*	No. of Span/barrels *	Main Span (ft)*	Culvert Rise or approx. rise (ft)	Culvert ID*	Description	Culvert barrel length (ft)*	Waterway Openning (sq.ft.)*	Drainage Area (MnDOT database) (sq.mile)*	Suffi-ciency*	Deck width (ft)*
	OLMSTED COUNTY:															
1	Cascade Creek	89160	4507	4507	13	1938	2	10	8	W108D	Box culvert	72	160		97.3	
2	Cascade Creek	89155	6823	2316	13	1938	3	10	8	W108T	Box culvert	39	240		87.4	
3	Cascade Creek	88708	595	595	13	1938	1	10	6	W106	Box culvert	44	60		98.4	
4	Cascade Creek	4075	9306	1888	01	1923	1	31.2	4.0		Beam span		125		51.6	18.2
5	Cascade Creek	L6262	11526	2220	09	1953	2	15	7.0		Slab span		210		67.7	22
6	Salem Creek	89180	3798	3798	13	1964	2	10	8	C108D	Box culvert	43	160		98.8	
7	Salem Creek	55510	28842	5091	02	1920	1	78	12.0		Low truss		936		47.2	22.2
8	Salem Creek	55515	35895	3255	01	1967	3	51.7	9.2		Beam span		1430		68.1	34.7
9	Salem Creek	55508	39841	3946	01	1962	3	60.3	6.9		Beam span		1250		73.5	32.7
10	South Zumbro	L6180	1920	1920	13	1939	1	10	8	W108	Box culvert	20	80		94	
11	South Zumbro	55511	23017	13922	01	1964	3	60	8.3		Beam span		1500		81.2	32.7
12	South Zumbro	L6204 L6205	26872	2935	13	1936	1	10	6	W106	Box culvert	26	60	41.8	94	
12	South Zumbro	L6205			01	1915	1	15	3.7		Beam span		56	41.8	36	25
13	South Zumbro	2902	34132	5340	02	1918	1	68	12.0		Low truss		816		25.3	18
14	South Zumbro	55507	35661	1529	01	1962	3	61.5	5.4		Beam span		1000	56	63.1	32.7
15	SZ-Goose Creek	L6151	180	180	01	1940	1	12	6.0		Beam span		72		96	22
16	SZ-Goose Creek	8984	4410	4230	13	1960	2	12	10	W1210D	Box culvert	52	240		96.9	
17	South Zumbro	L6160	40855	784	13	1940	1	12	6	W126	Box culvert	22	72		77.9	
18	South Zumbro	55J36	1400	1400				3.5			CMP	30				
19	South Zumbro	89182	94459	12363	01	1934	7	20	5.4		Beam span		762		12.5	23
20	South Zumbro	L6145	1443	1443	15	1947	5	6.1	4.6	6'1"X4'7"	CMP Arch	92	110		64.1	
21	South Zumbro	7174	97342	1440	01	1958	3	72	11.9		Beam span		2580		43.8	30.6
22	Willow Creek	88734	2100	2100	13	1958	1	10	8	W108	Box culvert	62	80		96.9	
23	Willow Creek	92809	275	275	13	1958	1	12	6	W106 CM EXT	Box culvert	111	38		98.2	
24	Willow Creek	7092	18728	16353	01	1952	2	45	9.0		Beam span		810	28.4	53.3	64.3
25	Badger Run	L6234	9116	9116	09	1952	2	14	6.0		Slab span		168		66.9	21.3
26	Bear Creek	89174	1836	1836	13	1940	2	10.6	6.0	W88D	Box culvert	54	128		98.7	
27	Bear Creek	L6236	17871	16035	01	1933	2	20.6	8.3		Beam span		340		36.2	32.5
28	Bear Creek	L8565	19025	1154	01	1966	2	21.2	8.9		Beam span		378	32.3	10.4	28
29	Silver Creek	L9747	1172	1172	15	1977	1	11.6	5.5	11'5"X7'3"	CMP Arch	36	64		91.6	
30	Silver Creek	92149	6198	5026	13	1965	3	14	10.3	C(111411)12T	Box culvert	82	432		87.3	
31	Northeast area	L6285	5358	5358	14	1940	4	6		6' DIA	Round pipe culvert	50	90		64	
32	Northeast area	1571	860	860	01	1914	1	12	5.5		Beam span		66		49.6	23.5
33	Northwest area	88712	719	719	13	1940	2	7	5	C75D	Box culvert	58	70		97.1	
34	Northwest area	89158	884	884	13	1938	2	10	4	W104D	Box culvert	48	80		98.8	
35	Northwest area	L9432	2047	1163	15	1940	1	11.8	7.58333	11'10"X7'7"	CMP Arch	43	61		92.6	
36	North	88746	671	671	13	1946	1	10	10	C1010	Box culvert	52	100		97	
37	North	L6330	935	264	09	1932	1	20	5.0		Slab span		100		75.1	22
	DODGE COUNTY:															
38	Salem Creek	97542	6458	6458	12	1976	1	16.5	5.0	16.5'X5.0'	CMP Arch	55	60		40	
39	Salem Creek	L6472	8680	2222	01	1950	1	27.4	10.5		Beam span		270		52.3	17.3
40	Salem Creek	L5500	9094	414	01	1908	1	23.6	8.8		Beam span		207		70.5	18
41	Salem Creek	665	14657	14657	02	1914	1	57	16.0		Low truss		912	23	25	20
42	South Zumbro	L6459	728	728	01	1915	1	11.5	4.8		Beam span		55		39.9	32
43	South Zumbro	89117	920	920	13	1951	3	4	6.0	W46T TIM	Timber box culv	36	72		89.1	
44	South Zumbro	89136	2585	2585	01	1941	1	14.1	13.6		Beam span		192	3.9	58.1	24
45	South Zumbro	L6458	8367	5782	01	1945	2	33.2	9.0		Beam span		600		42.8	19.2
A1	Salem Creek	89102	4400		13	1938	2	10.5	6.7	W107D	Timber box culv	26	140	7.2	82.5	
A2	Salem Creek	89099	1800		09	1955	1	18	9.0		Slab span		162		81.6	28
A3	Salem Creek	2350	4000		09	1954	1	24	6.0		Slab span		144		75.2	26.3
A4	South Zumbro	89101	1500		14	1935	2	7	5.4	7' DIA	Round pipe culvert	80	76		93.5	

Notes:
* Data from Mn/DOT bridge database (April 2001)

Appendix E

Water Quality

Table E-1- Minneapolis/St. Paul International Airport 24-hour Rainfall Depth Frequency Distribution

Between April Through November and Entire Year

Rain Year	Apr - Nov. 24-hour Total Rainfall in 0.5" Increments								Total Precip. Apr - Nov.	% Precip Apr - Nov.	Total Precip. Year
	0.0" - 0.5"	0.5" - 1"	1" - 1.5"	1.5" - 2"	2" - 2.5"	2.5" - 3"	3" - 3.5"	> 3.5"			
1960	7.1	9.41	1.18	1.51	0	0	0	0	19.2	89%	21.46
1961	8.94	6.05	3.47	1.7	0	0	0	0	20.16	78%	25.74
1962	10.67	7.12	6.29	0	0	0	0	0	24.08	84%	28.83
1963	8.51	5.52	1.24	1.62	0	3	0	0	19.89	88%	22.54
1964	10.08	6.68	2.04	0	4.21	0	0	0	23.01	89%	25.97
1965	10.02	10.83	3.92	4.74	2.39	0	0	0	31.9	80%	39.94
1966	7.4	4.31	4.74	1.89	0	0	0	0	18.34	75%	24.34
1967	6.33	6.38	6.1	0	0	0	0	0	18.81	74%	25.44
1968	7.93	10.73	7.21	7.12	0	0	0	0	32.99	87%	37.93
1969	8.19	5.88	0	0	0	0	0	0	14.07	73%	19.39
1970	10.56	9.65	7.21	0	0	0	0	0	27.42	90%	30.53
1971	10	6.35	3.61	0	4.61	0	0	0	24.57	83%	29.44
1972	8.65	8.37	1.03	1.57	0	0	0	0	19.62	83%	23.77
1973	6.81	5.55	3.15	1.64	0	0	0	0	17.15	81%	21.13
1974	8.02	4.59	2.33	1.59	0	0	0	0	16.53	86%	19.11
1975	8.3	3.55	6.83	1.56	6.26	2.58	0	0	29.08	83%	34.85
1976	6.62	3.63	1.45	0	0	0	0	0	11.7	71%	16.5
1977	12.54	6.04	3.63	0	0	0	0	7.28	29.49	85%	34.88
1978	8.93	8.04	0	3.15	2.17	5.68	0	0	27.97	92%	30.26
1979	10.36	6.75	3.18	3.13	2.29	0	0	0	25.71	83%	31.07
1980	6.8	4.08	3.74	1.65	0	2.53	0	0	18.8	86%	21.77
1981	9.76	8.89	1.23	1.64	2.38	0	0	0	23.9	85%	27.97
1982	9.96	8.18	1.13	1.72	0	0	0	0	20.99	69%	30.23
1983	10.25	12.53	6.47	3.21	0	0	0	0	32.46	83%	39.07
1984	9.11	5.57	6.94	1.8	4.39	2.91	0	0	30.72	83%	36.94
1985	10.85	6.98	2.59	1.83	2.42	0	0	0	24.67	78%	31.72
1986	9.1	12.12	3.59	3.37	4.36	0	0	0	32.54	89%	36.62
1987	7.48	5.78	2.13	0	2.22	2.75	0	9.15	29.51	92%	32.16
1988	9.22	3.64	2.5	0	0	0	0	0	15.36	81%	19.03
1989	8.9	6.14	2.39	1.72	0	0	0	0	19.15	82%	23.32
1990	9.9	5.04	8.6	1.54	2.44	0	0	0	27.52	83%	33.06
1991	11.45	10.94	4.16	5.27	0	0	0	0	31.82	87%	36.68
1992	7.39	5.26	4.95	3.46	2.18	2.59	0	0	25.83	87%	29.67
1993	11.67	9.54	7.56	0	0	0	0	0	28.77	89%	32.21
1994	12.01	9.09	2.25	3.22	0	0	0	0	26.57	90%	29.37
1995	10.06	9.05	1.01	1.67	0	0	0	0	21.79	85%	25.66
1996	9.64	5.97	3.8	1.58	0	0	0	0	20.99	80%	26.24
1997	9.52	3.34	3.68	1.97	0	5.54	3.19	3.71	30.95	90%	34.45
1998	9.17	7.36	3.49	3.42	0	2.54	0	0	25.98	78%	33.44
1999	9.83	9.39	2.37	1.53	2.16	0	0	0	25.28	83%	30.54
1960 -1999 Averages	**9.20**	**7.11**	**3.58**	**1.80**	**1.11**	**0.75**	**0.08**	**0.50**	**24.13**	**83%**	**28.83**
% of Apr - Nov Avg. Rainfall	**38%**	**29%**	**15%**	**7%**	**5%**	**3%**	**0%**	**2%**			
% of Yearly Precip. Average	**32%**	**25%**	**12%**	**6%**	**4%**	**3%**	**0%**	**2%**			

Note: Rainfall depths greater than 2" are infrequent on an annual basis allowing storm events > 3" to be neglected on an annual basis.

Table E-2 - Discharge/Stage Calculations and Detention Times At Proposed Structures

No.	Bridge Number/ Location	Location Description	Total Drainage Area (ac)	Drainage Area between Improvements (ac)	Rainfall (inches)	Q in (cfs)	Q out (cfs)	NWL (ft)	HWL (ft)	Water Level Fluctuation (ft)	Storage Volume (AF)	High Water Area (ac)	Runoff Volume (AF)	Plug-Flow Detention Time (min)
1a	L-2380	19th Avenue SW (Dodge-Olmsted Counties boundary)	2500	2500	1.00	0.3	0.2	1216.0	1216.2	0.2	0.03	0.05	0.2	119
1b					2.00	45.2	31.9	1216.0	1219.0	3.0	8.83	6.5	41	168
1c					3.00	175.8	117.0	1216.0	1221.8	5.8	36.7	12	131	218
2a	89160b	Tvedt's Site	3620	1120	1.00	0.3	0.1	1171.0	1172.0	1.0	0.13	0.14	0.2	906
2b					2.00	47.4	47.2	1171.0	1174.3	3.3	1.18	1	59	20
2c					3.00	155.9	155.2	1171.0	1176.1	5.1	3.6	1.8	189	18
3a	89160	Olmsted County Highway 5	4525	905	1.00	0.2	0.2	1163.0	1163.1	0.1	0.003	0.015	0.2	13
3b					2.00	67.8	54.3	1163.0	1166.7	3.7	12.98	10	73	160
3c					3.00	245.4	191.7	1163.0	1168.8	5.8	36	16	236	143
4a	89155b	Stork's Site	6535	2010	1.00	0.4	0.0	1113.0	1114.5	1.5	0.28	0.25	0.3	large b/c Qout=0
4b					2.00	83.8	82.1	1113.0	1117.6	4.6	7.91	7	107	65
4c					3.00	323.4	315.7	1113.0	1119.0	6.0	22.3	13	345	59
5a	89155	Olmsted County Highway 3	6845	310	1.00	0.1	0.1	1105.0	1105.0	0.0	0.001	0.06	0.01	23
5b					2.00	84.4	76.5	1105.0	1109.2	4.2	9.09	8	110	60
5c					3.00	324.1	247.3	1105.0	1111.6	6.6	67	35	357	167
6a	4075	70th Avenue SW	9330	2485	1.00	0.4	0.4	1075.4	1075.6	0.2	0.02	0.1	0.2	38
6b					2.00	108.8	108.3	1075.4	1080.0	4.6	0.61	0.2	151	5
6c					3.00	331.3	321.6	1075.4	1082.2	6.8	13.8	8	486	23
7a	L-6262	45th Avenue SW	11540	2210	1.00	0.8	0.4	1023.7	1023.9	0.2	0.15	0.1	0.3	305
7b					2.00	149.6	126.2	1023.7	1028.6	4.9	19.83	16	186	93
7c					3.00	455.9	389.2	1023.7	1030.8	7.1	69.7	21	602	131

Appendix F

Wetland and Upland Assessment

Wetland and Upland Assessment

This wetland and upland assessment was done mainly to identify restoration or enhancement opportunities in high ponding potential sites, considered for establishing flow control structures for temporary ponding of water. First, the ranking methodology presented in the main document is repeated. Then, the observations for each site are summarized. The sites are mostly referred by the bridge number or crossing located immediately downstream; that is, the areas assessed are those adjacent to the upstream side of each bridge crossing.

The assessment included an evaluation of the wetland susceptibility to storm water. The upland areas assessed were those associated with the wetland areas in the stream corridor, mostly in areas that could be temporarily ponded if flow control structures were built.

1.1 Wetland Assessment of Restoration Potential

1.1.1 Methodology

As part of this study, we reviewed opportunities to enhance water storage within wetlands to determine whether bridge downsizing could occur. The wetland assessment completed as part of this study reviewed the wetlands community type and vegetative component as well as hydrologic alterations (tiling, ditching, channel downcutting, etc.). This was done to determine where storage could potentially impact the wetland basin, and where creating berms or water control structures to enhance water storage could benefit the wetland by restoring the historic water regime. Wetlands were ranked for stormwater susceptibility, wetland restoration potential and flood storage.

1.1.1.1 Stormwater Susceptibility

Two factors determine a wetland's susceptibility to stormwater damage: community type and community quality (as measured by floral diversity). Some community types, such as sedge meadows, are highly susceptible to damage and degradation if exposed to repeated and/or extreme fluctuations in water levels (bounce). Native species in these communities can quickly die if runoff impacts their basin, leaving opportunities for disturbance-adapted exotic or aggressive species to invade. Other community types, such as floodplain forests, contain species that have adapted to this type of "bounce" in water levels, and can tolerate stormwater impacts with fewer negative effects on vegetation.

Similarly, the overall quality of the community affects how susceptible an area is to stormwater impacts. Because a high quality area is more diverse, it is likely to contain species somewhat conservative in habitat. These conservative species have a lower tolerance for disturbance, and usually drop out of a community as disturbance pressures increase. Thus, stormwater impacts can reduce diversity at a site and alter the condition of good quality areas. Since low quality areas, by definition, have reduced species diversity and tend to be dominated by disturbance-adapted species, stormwater impacts are unlikely to further degrade the site.

The State of Minnesota Stormwater Advisory Group has prepared a technical paper *Stormwater and Wetlands: Planning and Evaluation Guidelines for Addressing Potential Impacts of Urban Storm-Water and Snow-Melt Runoff on Wetlands* that divides wetland communities into the categories of highly susceptible, moderately susceptible, slightly susceptible, and least susceptible. Wetland susceptibility is based on the community type, vegetative disturbance, and overall floral diversity. Table 1 summarizes how susceptibility was determined for each wetland.

Table 1 – Wetland Community Susceptibility Ratings

Susceptibility Rating	Highly Susceptible*	Moderately Susceptible	Slightly Susceptible	Least Susceptible**
Wetland Community	Sedge Meadow	Shrub Carr[1]	Floodplain Forest[4]	Gravel Pit
	Bog	Alder Thicket[1]	Wet Meadow[5]	Cultivated Hydric Soil
	Calcareous Fen	Wet Meadow[1, 2]	Shallow Marsh[5]	Dredge/Fill Disposal Site
	Low Prairie	Shallow Marsh[2, 3]	Deep Marsh[5]	Low Floral Diversity
	Coniferous Swamp	Deep Marsh[2, 3]		
	Lowland Hardwood			
	Seasonally Flooded Basin			

Notes: A) All scientific and natural areas, and pristine wetlands should be considered highly susceptible; **B)** There will always be exceptions to the general categories listed above.

1 These can tolerate inundation of 6-12" for short periods; may be completely dry in drought or late summer conditions.
2 These can tolerate inundation of >12 ", and are adversely affected by sediment and/or nutrient loading and prolonged high water level
3 There are some exceptions to wet meadow and marsh communities
4 These communities can tolerate inundation of 1-6+ feet, possibly more than once per year
5 Wet meadows that are dominated by reed canary grass
6 Marshes dominated by reed canary grass, cattail, giant reed or purple loosestrife.

* Special consideration must be given to avoid altering these wetland types. Inundation must be avoided. Water chemistry changes due to alteration by storm water impact can also cause adverse impacts.
** These wetlands are usually so degraded that input of urban storm water may not have adverse impacts.

1.1.1.2 Wetland Restoration Ranking

Wetland restoration efforts strive to reestablish the historic wetland type. The restoration potential depends on ease of restoration and its potential impact on adjacent land uses. A summary of the wetland restoration ranking criteria is given below:

Restoration Potential	**Description**
High	These wetlands are partially or fully drained by hydrologic alterations such as tile lines and ditches. With a high rank, restoration would enable previous water regimes that existed prior to the alteration. These wetlands are typically easy to restore and do not have any issues (low home or road elevations, etc.) that would limit the restoration.

Medium	Wetlands ranked with medium restoration potential are partially or fully drained. Typically, restoration would restore their historic hydrologic regime or enhance the wetland basins plant community. They are not ranked as “high” because some of the restorations would be enhancements and/or there was an issue (low home, road elevation, etc.) that limited the restoration.
Low	Wetlands are ranked low if there is little or no alteration that would make hydrologic restoration necessary. In some cases, raising water levels would have an adverse impact on these communities.

1.1.1.3 Flood Storage Ranking

Wetlands were also evaluated for their ability to provide floodwater storage. Below is a summary of how flood storage was ranked.

Flood Storage	**Description**
High	Wetlands were ranked with high flood storage potential if they were large, relatively flat basins where constructing a water control structure would result in significant water storage. Considerations were also given to whether the water storage could be contained within the wetlands or if adjacent land use would be flooded. When floodwater storage could predominately be maintained within the wetland without extensive flooding of adjacent land, the ranking would be higher then a wetland where a water control structure would result in extensive flooding of land outside the wetland basin. Consideration was also given to the potential impact to a plant community. If flooding would not impact the plant community and the wetland met the other criteria for a ranking of high flood storage, then the basin was ranked high. If it met the other criteria for flood storage but would result in an impact to a sensitive plant community the wetland ranking would drop to medium/high or medium.
Medium	Wetlands ranked with medium flood storage potential provide floodwater storage, but not to the same degree as the high-ranking wetlands. Other factors, such as recent bridge replacement limiting the need for storage or plant communities potentially being impacted by storage, also resulted in a shift from high to medium.
Low	Wetlands were ranked low if deep ditches limited flooding potential and/or, even with a water control structure, storage would be limited due to existing topography.

1.1.2 Summary of Wetland Restoration Opportunities by Sites

Map 1 shows the location of the sites (referred to by bridge number) described below as part of the wetland assessment.

Crossing: **7092 (**County Hwy 1, Olmsted Co., Rochester Township Section 13, Willow Creek Subwatershed)
Floodplain Forest Susceptibility: Slightly
Wetland Restoration Opportunity: Low
Flood Storage Functions: Medium/High Existing Conditions

This wetland supports a floodplain forest community directly upstream from Highway 1. The floodplain forest has moderate quality for the study area and was dominated by species such as black willow, green ash, boxelder and reed canary grass. The stream was in a natural state and did not show evidence of downcutting that would limit natural flooding of the adjacent floodplain.

Wet Meadow Susceptibility: Least
Restoration Opportunity: Medium
Flood Storage Functions: High with Restoration

It is recommended that any rate control or raising of the normal water level be focused upstream of the floodplain forest in the wet meadow community. The wet meadow community located upstream of the floodplain forest is dominated by reed canary which is an aggressive invasive that is not impacted by flooding. Permanently raising the water levels to inundate the wet meadow 1+ feet would enhance the basin by flooding out reed canary grass and allowing other emergent to establish. Restoration opportunity for this site was ranked as medium due to the low elevations of the homes that surround this basin likely limiting the permanent raising of the water levels.

Crossing: **L6151** (80th Ave SW, Olmsted Co., Rock Dell Township Sections 22/23, Goose Creek Subwatershed)
Susceptibility: Highly
Wetland Restoration Opportunity: High
Flood Storage Functions: Medium/Low

This wetland is a fen and that had good diversity compared to others in the study area. The wetland plant species included: cattail, green bulrush, softstem bulrush, saw toothed sunflower and a variety of sedges. The active discharge of groundwater allows this fen to occur on the top of a slope and has also limited the affect of an adjacent ditch located along the road. Due to the extremely low culvert, when compared to the adjacent landscape, there is active downcutting within the ditch that runs north south along the road. This downcutting has the potential to impact the wetland if not corrected.

Recommendations at the culvert would include raising it approximately 6 feet to inundate the ditch and eliminate downcutting. Other options to control downcutting would include a gabion drop structure located near the outlet structure to artificially raise the water level just upstream of the outlet. To determine the exact elevation of a proposed culvert or gabion structure, considerations will need to be made to help ensure the fen is not periodically or permanently flooded or inundated beyond what currently exists. Due to the existing wetland community type and plant composition, it has a high potential to be impacted by bounce and inundation.

The best potential for floodwater storage occurs upstream of the fen community within a swale that flows from west to east. A series of check dams or other rate control structures could be located along the swale and would have no impact to wetlands. Additional benefit to the farm operators could involve impoundment of the swale at several locations to provide a potential water source for cattle.

Crossing: **L6180** (County Hwy 5, Olmsted Co., Rock Dell Township Sections 17/16, South Zumbro River Subwatershed)
Susceptibility: Least
Wetland Restoration Opportunity: Medium
Flood Storage Functions: Currently Low - High with Restoration

This is wet meadow basin that has been ditched. The depth to water in the ditch is approximately 3+ feet deeper that the adjacent landscape. The depth of the ditch limits inundation of the adjacent wetland as a result the wetland shows disturbance indicators such as a dominance of reed canary grass. Raising the normal water elevation approximately 4+ feet would provide vegetative enhancement to the wetland basin by flooding out reed canary grass, and would also enhance the wetland's flood storage.

Crossing: **L6204-L6205** (110th Ave SW, Olmsted Co., Rock Dell Township Sections 6/5, South Zumbro River Subwatershed)
Susceptibility: Highly (Due to proximity of State-listed (Threatened) plant glade mallow – Slightly if threatened plant outside proposed flooding
Wetland Restoration Opportunity: Medium
Flood Storage Functions: Existing Medium

This bridge crossing has a wide floodplain that supports a population of the State-listed (threatened) plant glade mallow (Napaea dioica). As such, it should have a more thorough ecological study completed before any kind of water management is employed that would change the floodplain's hydrology. The wetland is dominated by willow, box elder, stinging nettle, and angelica. The stream has downcut slightly, and this may limit the utilization of the floodplain to larger storm events. The water elevation in the stream is approximately 4+ feet lower then the adjacent landscape. If it is determined no glade mallow exists within the floodplain area, rate control that focuses on temporary inundation could be done without impacting this wetland basin. It is recommended that no permanent inundation be completed at this site.

Crossing: **55511** (County Hwy 26, Olmsted Co., Rock Dell Township Section 6, South Zumbro River Subwatershed)
Susceptibility: Adjacent Wet Meadow Highly Susceptible, Floodplain Forest Highly (Due to proximity of State-listed (threatened) plant glade mallow – Slightly if threatened plant outside proposed flooding
Wetland Restoration Opportunity: Medium
Flood Storage Functions: Medium/Low

The wetland directly adjacent to the stream was predominately wet meadow and floodplain forest. The floodplain forest community showed some disturbance indicators from grazing. The predominate species found in the floodplain included box elder, green ash, willow and reed canary grass. A side hill seep wet meadow is located west of the stream and contained a more diverse assemblage of plants that included: smartweed, sedge, swamp milkweed, amorpha fruticosa, green bulrush, angelica, prairie cordgrass, cup plant. The State-listed (threatened) plant glade mallow (Napaea dioica) was also found in this area. A more thorough ecological study should be completed before any kind of water management occurs that would change the floodplain. Due to a new bridge, it is anticipated this site will be a low priority for floodplain storage.

Crossing: **89136** (270th Ave, Dodge Co., Vernon Township Sections 23/24, South Zumbro River Subwatershed)
Susceptibility: Slightly Susceptible
Wetland Restoration Opportunity: Medium/Low
Flood Storage Functions: Medium/Low

This meandering creek has some erosion on the outside bends. Downcutting combined with flows may have contributed to bank sloughing. Wetland adjacent to the creek is marginal and may not have sufficient hydrology to be classified as wetland due to infrequent and minimal duration of flooding that likely occurs. There is a new bridge at this site, so this may be a low priority. Restoring the floodplain would involve raising the stream elevation 1 – 2 feet at the outlet, or a series of rock weirs to allow sediment to build back to historic levels prior to downcutting. The steeper topography will likely limit flooding to inside bends of the river.

Crossing: **89101** (County Hwy 9 (220th Ave), Dodge Co., Hayfield Township Section 1/Vernon Township Section 6, South Zumbro River Subwatershed)
Susceptibility: Least Susceptible
Wetland Restoration Opportunity: Medium/Low
Flood Storage Functions: High with Restoration

This meandering creak has a difference in water elevation to adjacent land surface that may be sufficient enough to limit inundation time and flooding. The vegetation was cut the day of the visit. There were no indications that flooding outside the stream channel had occurred this growing season. Since the vegetation was cut, it was difficult to determine if there is adjacent wetland. The ranking for wetland restoration was lowered due the deep ditch, sloping topography toward the ditch, and low adjacent road. This site is better suited to provide floodplain storage then wetland restoration.

Crossing: **2350** (County Hwy 9 (220th Ave), Dodge Co., Ashland Township Section 25/Canisteo Township Section 30, Salem Creek Subwatershed)
Susceptibility: Least
Wetland Restoration Opportunity: Medium
Flood Storage Functions: Medium/High

The adjacent wetland is predominately (70%) wet meadow dominated by reed canary grass. Floodplain forest represents the remaining 30% of the wetland, and contains predominately black willow and reed canary grass. A natural creek has been downcut 3 – 4 feet from the wetland service. This site would be a candidate for wetland enhancement but not restoration because its hydrologic regime may not be adversely impacted. Flood storage was ranked as medium/high because of the storage area that could be utilized adjacent to the creek.

Crossing: **89099** (County Hwy 9 (220th Ave), Dodge Co., Ashland Township Section 24/Canisteo Township Section 19, Salem Creek Subwatershed)
<u>Susceptibility</u>: Least
<u>Wetland Restoration Opportunity</u>: High
<u>Flood Storage Functions</u>: High with Restoration

There currently is no wetland at this site, but historically, this had the potential to be a large (20 + acres) wetland basin. This will need to be researched further to determine if the soils will support a wetland at this site. Drainage has occurred by a combination of deep ditches (6+feet), tile lines and swales that allow the water to drain of the site quickly and eliminates wetland hydrology. Wetland restoration has the potential to provide a substantial increase in flood storage, wildlife habitat and wetland mitigation/bank. This site has the best potential for the study area of being a true wetland restoration.

Crossing: **89102** (County Hwy 9 (220th Ave), Dodge Co., Ashland Township Sections 12/13/Canisteo Township Sections 7/18, Salem Creek Subwatershed)
<u>Susceptibility</u>: Least
<u>Wetland Restoration Opportunity</u>: High
<u>Flood Storage Functions</u>: High

This site has an excellent potential to enhance the wetland and floodplain storage because it is a large (40+ acre), flat, wet meadow currently dominated by reed canary grass, making it least susceptible to storm water bounce and inundation. Enhancement to the wetland could be realized if a permanent pool was provided to inundate the reed canary grass by approximately 1 foot or more. Due to the distinct topographic break between the wetland and adjacent agricultural fields, wetland enhancement could be realized without impacting adjacent agricultural fields if planned properly. If a permanent pool to flood out the reed canary grass could not be accomplished this would still be a good site for storage.

Crossing: **97542** (240th Ave, Dodge Co., Canisteo Township Sections 17/16, Salem Creek Subwatershed)
<u>Susceptibility</u>: Highly
<u>Wetland Restoration Opportunity</u>: High
<u>Flood Storage Functions</u>: Medium/Low
<u>Upland Restoration Opportunity</u>: Medium

The wetland area upstream of this crossing is ditched with rowcrop fields immediately adjacent to the ditch. Restoring upland areas here would require removing land from crop production and planting of native grasses and forbs appropriate for the site. This site would require more effort to manage the uplands than some of the others in this study. The wetland/ditch system is dominated by reed canary grass, stinging nettle, willow, boxelder, and sourdock, together these indicate a low quality plant community.

Crossing: **L6472** (670th St, Dodge Co., Canisteo Township Sections 15/22, Salem Creek Subwatershed)
<u>Susceptibility</u>: Slightly
<u>Wetland Restoration Opportunity</u>: Low
<u>Flood Storage Functions</u>: Low

The stream immediately upstream from the crossing contained a stable bottom and did not appear to be downcut. The sloping down to the stream was natural and was not conducive to providing substantial storage. This is one of the few natural, stable stream sections that should be preserved if possible. Investigation further upstream should be conducted to determine if a better site exists.

Crossing: **L5500** (260th Ave, Dodge Co., Canisteo Township Sections 22/23, Salem Creek Subwatershed)
<u>Susceptibility</u>: Slightly
<u>Wetland Restoration Opportunity</u>: Medium
<u>Flood Storage Functions</u>: Medium
<u>Wetland Restoration Opportunity</u>: Medium/Low

This wetland is a wet meadow that contains predominately reed canary grass with thistle and some elm. The elevation to water in the stream is approximately 3+ feet from the adjacent landscape. Floodwater storage could be enhanced with a structure and may provide some minor benefit to the adjacent wetland by creating more frequent flooding of the wet meadow.

Crossing: **89180** (County Hwy 25, Olmsted Co., Salem Township Section 17, Salem Creek Subwatershed)
Susceptibility: Slightly
Wetland Restoration Opportunity: Low
Flood Storage Functions: Medium/High

This wetland contains a stable stream with a natural floodplain. Enhancing the floodplain and increasing storage could be accomplished with a structure, however it may provide good storage naturally. The wetland areas include reed canary grass, stinging nettle, angelica, common elder, wild grape, sedge, and others.

Crossing: **89155** (County Hwy 3, Olmsted Co., Salem Township Section 10, Cascade Creek Subwatershed)
<u>Susceptibility</u>: Least
<u>Wetland Restoration Opportunity</u>: Medium/High
<u>Flood Storage Functions</u>: High

This wet meadow is dominated by reed canary—an aggressive invasive not impacted by flooding. Permanently raising the water levels to inundate the wet meadow 1+ feet would enhance the basin by flooding out reed canary grass and allowing other emergent species to establish. The wetland restoration opportunity was ranked as medium/high rather than high due to property ownership limiting the berm placement. The berm to restore the basin is proposed at a wider portion of the wetland and, as a result, more fill impact to the wetland will occur. Placement of the berm downstream closer to County Road 103 would minimize the fill necessary for the berm.

Crossing: **89160** (County Hwy 5, Olmsted Co., Salem Township Section 5, Cascade Creek Subwatershed)
<u>Susceptibility</u>: Least
<u>Wetland Restoration Opportunity</u>: Medium/Low
<u>Flood Storage Functions</u>: Medium/Low

This wetland was a mixture of wet meadow and floodplain forest. The creek was downcut and limited flooding of the adjacent wetland. Wetland restoration was medium/low due to the adjacent wetland area that potential could be restored being relatively small and the level of effort to restore the adjacent wetland being significant. The low plant diversity within the wetland would allow storage to occur without impacting the plant diversity. However, due to topography, significant storage would not be realized. Because the property owner is willing to allow storage within his property, the flood storage function was not ranked as low.

Crossing: **88708** (County Hwy 3, Olmsted Co., Salem Township Section 3, Cascade Creek Subwatershed)
<u>Susceptibility</u>: Least
<u>Wetland Restoration Opportunity</u>: Low
<u>Flood Storage Functions</u>: Moderate/Low

This crossing has a ditch approximately 6 feet deep with an adjacent slope dominated by reed canary grass. The slope to the ditch limits the storage capacity and wetland enhancement potential to a narrow area directly adjacent to the stream.

Crossing: **4075** (70th Ave SW, Olmsted Co., Salem Township Sections 11/12, Cascade Creek Subwatershed)
<u>Susceptibility</u>: Least
<u>Wetland Restoration Opportunity</u>: Medium/High
<u>Flood Storage Functions</u>: High

Although this broad, intermittently wet area is dominated by the nonnative reed canary grass, there is reasonable potential that wetland restoration would help increase the amount of native vegetation found at this site by stabilizing water regimes and reducing the frequency of disturbance from flashy flows. From the water level in the ditch to the top of bank it is approximately 4 feet deep, so any restoration of water regimes would need to involve some permanent raising of the ditch bottom.

Crossing: **88712** (County Hwy 3, Olmsted Co., Kalmar Township Section 12, Boardman Creek Subwatershed)
<u>Susceptibility</u>: Least
<u>Wetland Restoration Opportunity</u>: High
<u>Flood Storage Functions</u>: High

This is a wet meadow dominated by reed canary grass. It provides excellent potential for wetland enhancement by providing a permanent pool that inundates the reed canary grass by 1 foot. From the water level in the ditch to the top of bank was 3-5 feet. A berm of approximately 4-6 feet would be required to enhance the wetland. Even if enhancement is not possible this site provides an excellent opportunity for floodwater storage with a structure.

Crossing: **88733** (County Hwy 14 (75th St NE), Olmsted Co., Farmington Township Section 31/Haverhill Township Section 6, South Zumbro River Subwatershed)
Susceptibility: Least
Wetland Restoration Opportunity: Medium
Flood Storage Functions: Medium/High

This wet meadow is dominated by reed canary grass and has low floral diversity. The wetland is confined to a wide drainage swale. Permanently raising the water levels to inundate the wet meadow 1+ feet would enhance the basin by flooding out reed canary grass and allowing other emergent species to establish. Due to the potential flooding of adjacent fields in agricultural production the wetland was ranked as medium for restoration potential.

1.2 Upland Assessment of Restoration Potential

The upland areas assessed were those associated with the wetland areas, mostly in areas that could be temporarily ponded if flow control structures were built. We evaluated each of the high priority crossing locations visited for several criteria. Each was given a restoration potential or ranking based on its proximity to other natural communities and ease of restoration.

1.2.1 Upland Restoration Ranking Criteria

A summary of the upland restoration ranking criteria is given below:

Restoration Potential	**Description**
High	These upland areas exhibit one of several conditions including current high quality natural area, close proximity to other natural areas, immediately adjacent to a wetland restoration site, and/or easy/inexpensive restoration.
Medium	These areas may have been within sight of another natural area, occur near a potential wetland restoration site, support some native vegetation, or may present some challenges if managed to improve their quality.
Low	These areas generally do not occur within ¼ - ½ mile of another natural community, do not occur near a site with wetland restoration potential, have little or no existing native vegetation (e.g., cornfield), or present significant long-term challenges to restore or reconstruct natural communities.

1.2.2 Summary of Upland Restoration Opportunities by Sites

Crossing: **L6151** (80th Ave SW, Olmsted Co., Rock Dell Township Sections 22/23, Goose Creek Subwatershed)
Upland Restoration Opportunity: High
This wetland supports a small fen and should be investigated further by a trained ecologist if any wetland restoration work is planned here. The wetland is surrounded by pasture in good condition. Additional benefit could be provided to both the water quality

and the farm operator's pasture forage quantity and quality by investigating the idea of breaking the pasture into paddocks. Native warm season grasses and flowers could be planted to provide season-long forage. Impounding the small intermittent stream could provide a potential water source for cattle grasses. Pasture and wetland restoration planning services could be provided free to the landowner through the Prairie Stewardship Planning Assistance program. Overall, active management at this crossing provides a very good opportunity to provide a win-win situation for the County and the farm operator.

Crossing: **L6180** (County Hwy 5, Olmsted Co., Rock Dell Township Sections 17/16, South Zumbro River Subwatershed)
Upland Restoration Opportunity: High
The area immediately upstream from this crossing is used as pasture. It is largely dominated by nonnative, cool season grasses such as Kentucky bluegrass, but does host some native plant species tolerant of regular grazing. A portion of this pasture is also wooded. This pasture is a potential candidate for adjustments in grazing practices, including the integration of native warm season grasses/forbs, and moveable fencing systems to provide better water quality buffering for the stream and increased forage production for the farm operator. Although it does not have existing quality natural communities, it is thought to have good potential for improving natural community function, water quality, and farm operator income.

Crossing: **L6204-L6205** (110th Ave SW, Olmsted Co., Rock Dell Township Sections 6/5, South Zumbro River Subwatershed)
Upland Restoration Opportunity: Medium
This bridge crossing has a wide floodplain that supports a population of the State-listed (threatened) plant glade mallow (Napaea dioica). As such, it should have a more thorough ecological study completed before any kind of water management occurs that would change the hydrology of the floodplain. Overall, the adjacent floodplain and low meadows would benefit from some types of natural resource management.

Crossing: **89101** (County Hwy 9 (220th Ave), Dodge Co., Hayfield Township Section 1/Vernon Township Section 6, South Zumbro River Subwatershed)
Upland Restoration Opportunity: Medium
The vast majority of the existing perennial vegetation at this site occurs within the wetland. The upland areas are predominantly crop ground. Planting upland buffer for any wetland restoration would be beneficial.

Crossing: **2350** (County Hwy 9 (220th Ave), Dodge Co., Ashland Township Section 25/Canisteo Township Section 30, Salem Creek Subwatershed)
Upland Restoration Opportunity: High
The area upstream of this crossing is a retired pasture and supports a mix of nonnative, cool season grasses and species such as wild parsnip. Currently, the overall quality, from a natural community standpoint, is poor. Active management and planting of native species would help improve the buffering capacity and increase overall natural resource quality. The wetland area supports scattered floodplain forest tree species such as boxelder and willow, with reed canary grass, stinging nettle the most common ground cover. Also found were the natives arrowhead, cattail, and several species of sedge.

Crossing: **89102** (County Hwy 9 (220th Ave), Dodge Co., Ashland Township Sections 12/13/Canisteo Township Sections 7/18, Salem Creek Subwatershed)

Upland Restoration Opportunity: High

This old pasture provides a very good opportunity to restore upland areas adjacent to a wetland restoration. The site is a candidate for a wet prairie restoration and currently supports Kentucky bluegrass, ragweed, stinging nettle and others. The wetland areas support reed canary grass, foxtail sedge, ironweed, the native purple loosestrife, water smartweed, manna grass, and water smartweed. Overall, this site appears to be a good candidate for natural areas and surface water management.

Crossing: **97542** (240th Ave, Dodge Co., Canisteo Township Sections 17/16, Salem Creek Subwatershed)

Upland Restoration Opportunity: Medium

The wetland area upstream of this crossing is ditched with row crop fields immediately adjacent to the ditch. Restoring upland areas here would require removing land from crop production and planting native grasses and forbs appropriate for the site. This site would require more effort to manage the uplands than some of the others in this study. The wetland/ditch system is dominated by reed canary grass, stinging nettle, willow, boxelder, and sourdock. Together these indicate a low quality plant community.

Crossing: **89180** (County Hwy 25, Olmsted Co., Salem Township Section 17, Salem Creek Subwatershed)

Upland Restoration Opportunity: Medium

The upland areas found immediately upstream of this crossing are generally small with a patchy canopy of lowland trees including green ash, boxelder and willow. Overall, this may be a more difficult site to restore than some of the others in this study area. As such, it received a fair rank. The wetland areas include reed canary grass, stinging nettle, angelica, common elder, wild grape, sedge, and others.

Crossing: **88708** (County Hwy 3, Olmsted Co., Salem Township Section 3, Cascade Creek Subwatershed)

Upland Restoration Opportunity: Medium

This crossing has a ditched swale dominated by reed canary grass upstream. Restoring an upland buffer at this location would likely entail retiring some ground from row crops and planting native grasses/forbs. This may require more effort than some of the other areas in the study (e.g., modifying grazing regimes).

Crossing: **4075** (70th Ave SW, Olmsted Co., Salem Township Sections 11/12, Cascade Creek Subwatershed)

Upland Restoration Opportunity: High

Although this broad, intermittently wet area is dominated by the nonnative reed canary grass, there is reasonable potential that a wetland restoration would help increase the amount of native vegetation found at this site by stabilizing water regimes and reducing the frequency of disturbance from flashy flows. The most common native plants found across the site are angelica, tall meadow rue, water smartweed, Canada goldenrod, and turtlehead. Additional non-natives include stinging nettle and wild parsnip.

Crossing: **88712** (County Hwy 3, Olmsted Co., Kalmar Township Section 12, Boardman Creek Subwatershed)

Upland Restoration Opportunity: Medium

Potential restoration activities for this site include planting native vegetation in the waterway to provide better filtering capacity than the existing smooth brome. Additional buffering capacity could be gained by widening the waterway/buffer to decrease the amount of sediment reaching the crossing.

Crossings: 89160, 7092, 89099, 55511, L6472, L5500

These sites have Low Upland Restoration Opportunity Rank. Several of these low-rank sites do support moderate to poor quality natural communities. However, they are found at crossing sites that have medium to low potential for wetland restoration or quantity storage. For this reason, they were included in areas with low upland restoration potential.

Appendix G

Olmsted County –

Storm Water

Pollution Prevention Program

OLMSTED COUNTY
STORM WATER POLLUTION PREVENTION PROGRAM

May 2003

Olmsted County Public Works Department
2122 Campus Drive SE, Suite 200
Rochester, MN 55904

BMP Description Sheet

MS4 Name: Olmsted County

Unique Identifying Number: 1.A

Minimum Control Measures Addressed by This BMP

x	Public education & outreach		Construction site runoff controls
x	Public participation & involvement		Post-construction stormwater management
	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: 2003-2004 Education Activity Implementation Program	
BMP Description: Olmsted County will establish a basic Education Activity Implementation Program for 2003-2004 reporting cycle. The first year strategy is to use existing public education and outreach programs developed and implemented by the various County departments. After the first year reporting cycle, Olmsted County will evaluate and assess the 2003-2004 programs to determine the effectiveness in educating the general public about storm water and potential runoff impacts to surface waters. Based on the evaluation and assessment measures of the 2003-2004 Education Activity Implementation Program, updates and revisions could be made to the plan for incorporation into the 2004-2008 Education Activity Implementation Program.	
Measurable Goals: • Completed 2003-2004 Education Activity Implementation Program.	**Timeline / Implementation Schedule:** • Year 1 (May 2003 thru March 2004) – Completed meetings, presentations and newspaper articles, participation in field tours and public events, and website development.
Specific Components & Notes (optional):	
Responsible Person for this BMP	**Responsible Department or Organization**
Name: Floyd Whitaker	Dept. or Org.: Olmsted County Public Works
Title: SWCD District Coordinator	Dept. Head: Mike Cousino
Phone:507-280-2850	Phone: 507-285-8231
E-mail: floyd.whitaker@mn.nrcs.usda.gov	E-mail: cousino.mike@co.olmsted.mn.us

Educational components related to this BMP (description or number – optional):

- Newspaper Articles on Lawn Care Pollution Prevention Measures and Good Housekeeping Practices (1.A.1)
- K-8 Educational Classes (1.A.2)
- Storm Water Website (1.A.3)
- Road & Storm Water Field Tour (1.A.4)
- Targeted Residential Wastewater Treatment Project (1.A.5)
- Pesticide/Herbicide and Fertilizer Applicator Training (1.A.6)
- Meetings with County Staff (1.A.7)

BMP Description Sheet

MS4 Name: Olmsted County

Unique Identifying Number: 1.A.1

Minimum Control Measures Addressed by This BMP

X	Public education & outreach		Construction site runoff controls
	Public participation & involvement		Post-construction stormwater management
	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Newspaper Articles on Lawn Care Pollution Prevention Measures and Good Housekeeping Practices

BMP Description: The Olmsted County Extension Service will develop and publish news articles in the "Buds and Blooms" newspaper column, in the Rochester Post Bulletin (regional newspaper), focusing on lawn care and storm water best management practices. The purpose of the articles will be to inform county residents on lawn care pollution prevention techniques and good housekeeping measures related to minimizing the impacts to storm water.

Measurable Goals:	**Timeline / Implementation Schedule:**
• Number of articles. • Number of households served by the publication.	• December 2003 – spring and fall newspaper columns.

Specific Components & Notes (optional):

Responsible Person for this BMP	Responsible Department or Organization
Name: Doug Courneya	Dept. or Org. Olmsted County Extension Service
Title: Extension Educator	Dept. Head: Kay Lovett
Phone: 507-287-7902	Phone: 507-287-7903
E-mail: courneya.douglas@co.olmsted.mn.us	E-mail: lovett.kathleen@co.olmsted.mn.us

Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County

Unique Identifying Number: 1.A.2

Minimum Control Measures Addressed by This BMP

X	Public education & outreach		Construction site runoff controls
	Public participation & involvement		Post-construction stormwater management
	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Elementary Education Classes

BMP Description: Olmsted County staff will develop and present a water quality and storm water management program to elementary students as part of the Olmsted County Extension Service's Ag-in-the-Class Program. The goal is to educate elementary students in the County's jurisdictional boundary on urban, suburban, and rural water quality and storm water management issues.

Measurable Goals:	**Timeline / Implementation Schedule:**
• Number of presentations. • Number of classrooms participating. • Teacher surveys completed. • Completed analysis of returned surveys.	• March 2003 – Development of storm water education program for elementary students. • March thru May 2003 – Participate in Ag-in-the-Classroom programs. • June 2003 – Evaluation of surveys and revisions made to the program, if necessary.

Specific Components & Notes (optional):

Responsible Person for this BMP	**Responsible Department or Organization**
Name: Lisa Behnken	Dept. or Org.: Olmsted County Extension Service
Title: Extension Educator	Dept. Head: Kay Lovett
Phone: 507-287-7144	Phone: 507-287-7903
E-mail: behnken.lisa@co.olmsted.mn.us	E-mail: lovett.kathleen@co.olmsted.mn.us

Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 1.A.3

Minimum Control Measures Addressed by This BMP

x	Public education & outreach		Construction site runoff controls
x	Public participation & involvement		Post-construction stormwater management
	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Storm Water Website

BMP Description: Olmsted County will develop a website to provide citizens with an understanding of the NPDES Phase II Storm Water regulations, County related programs, and links to volunteer opportunities.

Measurable Goals:	Timeline / Implementation Schedule:
• Date website developed and posted for public access. • Number of website "hits".	• September 2003 – Begin design layout and development process. • February 2004 – Public access to website.

Specific Components & Notes (optional):

Responsible Person for this BMP	Responsible Department or Organization
Name: John Orris	Dept. or Org.: Olmsted County Public Works
Title: Education Resource Specialist	Dept. Head: Mike Cousino
Phone: 507-285-8231	Phone: 507-285-8231
E-mail: orris.john@co.olmsted.mn.us	E-mail: cousino.mike@co.olmsted.mn.us

Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 1.A.4

Minimum Control Measures Addressed by This BMP

x	Public education & outreach	x	Construction site runoff controls
x	Public participation & involvement	x	Post-construction stormwater management
	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Road and Storm Water Field Tour

BMP Description: Olmsted County Public Works Department will conduct a field tour for elected officials (e.g., County Board, Township Representatives, and SWCD Board), construction industry representatives, and the general public on road and storm water management activities. The field tour will be used to discuss: 1) the County's Storm Water Pollution Prevention Program (SWPPP), 2) construction site runoff control practices, 3) post-construction runoff control measures, and 4) review storm water management projects. The field tour will increase public awareness of storm water runoff issues and the importance of implementing the SWPPP provisions.

Measurable Goals:	**Timeline / Implementation Schedule:**
• Number of attendees.	• June 2003 – Completed field tour agenda, attendees list, and finalize site locations. • July 2003 – Completed Tour.

Specific Components & Notes (optional):

Responsible Person for this BMP	**Responsible Department or Organization**
Name: Mike Sheehan	Dept. or Org.: Olmsted County Public Works
Title: County Engineer	Dept. Head: Mike Cousino
Phone: 507-285-8231	Phone: 507-285-8231
E-mail: sheehan.michael@co.olmsted.mn.us	E-mail: cousino.mike@co.olmsted.mn.us

Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 1.A.5

Minimum Control Measures Addressed by This BMP

x	Public education & outreach		Construction site runoff controls
	Public participation & involvement		Post-construction stormwater management
x	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Targeted Residential Wastewater Treatment Project

BMP Description: Staff from the University of Minnesota Extension Service, with assistance from Olmsted County personal, will provide educational and technical assistance to owners of Individual Sewage Treatment Systems (ISTS) focusing on preventing failures through proper Operation and Maintenance (O&M) of their systems. Workshops will be developed for educating ISTS owners and elected officials in proper O&M practices and the problems associated with illicit discharges from ISTS.

Measurable Goals:	**Timeline / Implementation Schedule:**
• Number of events. • Number of attendees.	• April 2003 – Begin conducting workshops.

Specific Components & Notes (optional):

Responsible Person for this BMP	**Responsible Department or Organization**
Name: Terry Lee	Dept. or Org.: Olmsted County Administration
Title: Environmental Resources Coordinator	Dept. Head: Richard Devlin
Phone: 507-285-8339	Phone: 507-285-8115
E-mail: lee.terry@co.olmsted.mn.us	E-mail: devlin.richard@co.olmsted.mn.us

Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 1.A.6

Minimum Control Measures Addressed by This BMP

X	Public education & outreach		Construction site runoff controls
	Public participation & involvement		Post-construction stormwater management
	Illicit discharge detection & elimination	X	Pollution prevention/Good housekeeping

BMP Title: Pesticide/Herbicide and Fertilizer Applicator Training

BMP Description: Olmsted County Extension Service will develop and implement a training program for County staff and the general public that will focus on pesticide/herbicide and fertilizer applicator training.

Measurable Goals:	**Timeline / Implementation Schedule:**
• Number of training sessions per year. • Number of employees attending the training sessions per year.	• December 2003 – Program development and implementation.

Specific Components & Notes (optional):

Responsible Person for this BMP	**Responsible Department or Organization**
Name: Doug Courneya	Dept. or Org.: Olmsted County Extension Service
Title: Extension Educator	Dept. Head: Kay Lovett
Phone: 507-287-7902	Phone: 507-287-7903
E-mail: courneya.douglas@co.olmsted.mn.us	E-mail: lovett.kathleen@co.olmsted.mn.us

Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 1.A.7

Minimum Control Measures Addressed by This BMP

x	Public education & outreach	x	Construction site runoff controls
x	Public participation & involvement	x	Post-construction stormwater management
x	Illicit discharge detection & elimination	x	Pollution prevention/Good housekeeping

BMP Title: Meetings with County Staff

BMP Description: Olmsted County's Storm Water Coordinator will meet with all County staff listed in the storm water pollution prevention plan, the City of Rochester's Storm Water Coordinator, and township personal that deal with storm water management issues. Meetings will be held on an annual basis to discuss the components of the Storm Water Pollution Prevention Program (SWPPP), progress of the plan's implementation, and collaboration activities with neighboring Municipal Separate Storm Water Sewer System (MS4) communities. Additional meetings might be necessary as implementation of the plan proceeds.

Measurable Goals:	Timeline / Implementation Schedule:
• Number of meetings. • Number of attendees.	• May thru December 2003 – Meetings for 2003 Permit Cycle. • Annual Meeting (May 2003).

Specific Components & Notes (optional):

Responsible Person for this BMP	Responsible Department or Organization
Name: Floyd Whitaker	Dept. or Org.: Olmsted County Public Works
Title: SWCD District Coordinator	Dept. Head: Mike Cousino
Phone: 507-280-2850	Phone: 507-285-8231
E-mail: floyd.whitaker@mn.nrcs.usda.gov	E-mail: cousino.mike@co.olmsted.mn.us

Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 1.B

Minimum Control Measures Addressed by This BMP

x	Public education & outreach	x	Construction site runoff controls
x	Public participation & involvement	x	Post-construction stormwater management
x	Illicit discharge detection & elimination	x	Pollution prevention/Good housekeeping

BMP Title: 2004-2008 Education Activity Implementation Program

BMP Description: Olmsted County will establish a 2004-2008 Education Activity Implementation Program after the first year of the reporting cycle. Decisions on the program will be determined by examining the basic 2003-2004 Education Activity Implementation Program (1.A) and evaluating the specific components listed below.

Measurable Goals:	Timeline / Implementation Schedule:
• Completion of the 2004-2008 Education Activity Implementation Program.	• Year 1 (March 2003 thru March 2004) – Conduct the 2003-2004 Education Activity Implementation Program (1.A) and evaluate components. • Year 2 (March 2004) – Completed outline of 2004-2008 Education Activity Implementation Program and implementation schedule.

Specific Components & Notes (optional):

Responsible Person for this BMP	Responsible Department or Organization
Name: Floyd Whitaker	Dept. or Org.: Olmsted County Public Works
Title: SWCD District Coordinator	Dept. Head: Mike Cousino
Phone: 507-280-2850	Phone: 507-285-8231
E-mail: floyd.whitaker@mn.nrcs.usda.gov	E-mail: cousino.mike@co.olmsted.mn.us

Educational components related to this BMP (description or number – optional):

- Newspaper Articles on Lawn Care Pollution Prevention Measures and Good Housekeeping Practices (1.A.1)
- K-8 Educational Classes (1.A.2)
- Storm Water Website (1.A.3)
- Road & Storm Water Field Tour (1.A.4)
- Targeted Residential Wastewater Treatment Project (1.A.5)
- Pesticide/Herbicide & Fertilizer Applicator Training (1.A.6)
- Meetings with County Staff (1.A.7)

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 2.A

Minimum Control Measures Addressed by This BMP

X	Public education & outreach		Construction site runoff controls
X	Public participation & involvement		Post-construction stormwater management
	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Public Notice Requirements

BMP Description: Olmsted County will provide a notice to the general public 10-days prior to the annual storm water pollution prevention program informational meeting with the County Board. The public notices will be distributed to areas that best notify a diverse group of citizens within the County's jurisdiction.

Measurable Goals:	Timeline / Implementation Schedule:
• Completed Public Notice.	• The first 10-day public notice will be for the April 2003 annual public meeting and continued on an annual basis. If additional meetings become necessary, the 10-day public notice requirement will be executed to notify the general public.

Specific Components & Notes (optional):

- Date
- Time
- Location
- Description of how the meeting will be conducted
- Location of the SWPPP for review prior to the meeting
- Locations of notice
  - Rochester Post Bulletin (Regional Newspaper)
  - County Website

Responsible Person for this BMP	Responsible Department or Organization
Name: Floyd Whitaker	Dept. or Org.: Olmsted County Public Works
Title: SWCD District Coordinator	Dept. Head: Mike Cousino
Phone: 507-280-2850	Phone: 507-285-8231
E-mail: floyd.whitaker@mn.nrcs.usda.gov	E-mail: cousino.mike@co.olmsted.mn.us

Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 2.B

Minimum Control Measures Addressed by This BMP

x	Public education & outreach		Construction site runoff controls
x	Public participation & involvement		Post-construction stormwater management
	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Annual Public Meeting	
BMP Description: Olmsted County staff will conduct an annual public meeting with the County Board to solicit public opinion on the adequacy and effectiveness of the County's Storm Water Pollution Prevention Program (SWPPP).	
Measurable Goals: • Completed public meetings.	**Timeline / Implementation Schedule:** • April 2003 - First annual. • Annual meeting in each year of the Permit cycle (March 2004 – 2008).
Specific Components & Notes (optional):	
Responsible Person for this BMP	**Responsible Department or Organization**
Name: Mike Cousino	Dept. or Org.: Olmsted County Public Works
Title: Public Works Director	Dept. Head: Mike Cousino
Phone: 507-285-8231	Phone: 507-285-8231
E-mail: cousino.mike@co.olmsted.mn.us	E-mail: cousino.mike@co.olmsted.mn.us
Educational components related to this BMP (description or number – optional):	

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 2.C

Minimum Control Measures Addressed by This BMP

	Public education & outreach		Construction site runoff controls
x	Public participation & involvement		Post-construction stormwater management
x	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Olmsted County Adopt-a-Highway Program

BMP Description: Olmsted County will continue to implement the volunteer Adopt-a-Highway Program along County roadsides. Volunteers cleanup the roadsides and ditches along County roadways. In many areas of the County, road ditches now function as the headwaters of the tributary stream system. Removing trash and debris from the roadsides eliminates illicit discharges to the County's storm water conveyance system.

Measurable Goals:	Timeline / Implementation Schedule:
• Number of miles cleaned up each year. • Number of groups/organizations participating in cleanup activities.	• Year 1 (May 2003 thru March 2004) – Implement Program. Continue to implement program for the entire permit cycle.

Specific Components & Notes (optional):
The County provides volunteers with trash bags, protective vests, and garbage pickup and disposal. Volunteer groups receive a sign identifying their service along the stretch of roadside they adopt.

Responsible Person for this BMP	Responsible Department or Organization
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Title: Senior Construction Inspector	Dept. Head: Mike Cousino
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Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 3.A

Minimum Control Measures Addressed by This BMP

	Public education & outreach		Construction site runoff controls
	Public participation & involvement		Post-construction stormwater management
x	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Storm Water Conveyance System Map

BMP Description: Olmsted County has completed a storm water map for the conveyance system owned by the County within the Rochester 2000 Census Urbanized Area (UA). The County will continue to update the map on an annual basis, if necessary.

Measurable Goals:	Timeline / Implementation Schedule:
• Annual updating of the County's storm water system map for the conveyance system within the UA.	• Year 1 (May 2003 thru March 2004) – Implement Program. • At the end of each reporting year (March), the storm water system map will be updated, when necessary, to reflect any structural changes to the system and components listed below.

Specific Components & Notes (optional):

Responsible Person for this BMP	Responsible Department or Organization
Name: Mike Sheehan	Dept. or Org.: Olmsted County Public Works
Title: County Engineer	Dept. Head: Mike Cousino
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Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 3.B

Minimum Control Measures Addressed by This BMP

	Public education & outreach		Construction site runoff controls
	Public participation & involvement		Post-construction stormwater management
x	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Illicit Discharge, Detection, and Enforcement Ordinance

BMP Description: Olmsted County will develop an ordinance to prohibit non-storm water discharges into the storm water conveyance system by March 10, 2008.

Measurable Goals:	**Timeline / Implementation Schedule:**
• Adoption of an Illicit Discharge, Detection, and Enforcement Ordinance by the County Board by March 10, 2008.	• Year 1 (March 2004) – Review League of Minnesota Cities (LMC) guidance documents and draft ordinances. Compare ordinances with existing County requirements, other community ordinances, and Minnesota Pollution Control Agency (MPCA) regulatory requirements. • Year 2 (March 2005) – Collaborate with neighboring MS4 communities to standardize ordinance. • Year 3 (March 2006) – Completed illicit discharge, detection, and elimination ordinance. • Year 4 (March 2007) – Adoption of Ordinance by County Board.

Specific Components & Notes (optional):

Responsible Person for this BMP	**Responsible Department or Organization**
Name: John Harford	Dept. or Org.: Rochester-Olmsted Planning Department
Title: Senior Planner	Dept. Head: Phil Wheeler
Phone: 507-285-8232	Phone: 507-285-8232
E-mail: harford.john@co.olmsted.mn.us	E-mail: wheeler.phil@co.olmsted.mn.us

Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 3.C

Minimum Control Measures Addressed by This BMP

	Public education & outreach		Construction site runoff controls
	Public participation & involvement		Post-construction stormwater management
x	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Program for Detecting and Addressing Failing Septic Systems

BMP Description: Olmsted County will implement an inspection program to detect failing septic systems and illicit connections to the storm water conveyance system in the County's jurisdiction of the Rochester 2000 Census Urbanized Area (UA).

Measurable Goals:

- Number of septic system inspections in the County's jurisdiction of the UA.
- Number of septic system upgrades in the County's jurisdiction of the UA.
- Number of illicit connections to the storm water conveyance system identified in County's jurisdiction of the UA.

Timeline / Implementation Schedule:

- Year 1 (December 2003) – Gather existing information on number of septic systems and illicit connection complaints within the County's jurisdiction of the UA.
- Year 2 (December 2004) – Begin conducting field investigations in the County's jurisdiction of the UA for identifying septic system discharges into the existing storm water conveyance system for the entire permit cycle.

Specific Components & Notes (optional):

Responsible Person for this BMP	Responsible Department or Organization
Name: Dennis Manning	Dept. or Org.: Rochester-Olmsted Planning Department
Title: Inspections Unit Supervisor	Dept. Head: Phil Wheeler
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E-mail: manning.dennis@co.olmsted.mn.us	E-mail: wheeler.phil@co.olmsted.mn.us

Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 3.D

Minimum Control Measures Addressed by This BMP

x	Public education & outreach		Construction site runoff controls
	Public participation & involvement		Post-construction stormwater management
x	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Illegal Dumping and Assessment Program	
BMP Description: Olmsted County will prioritize the assessment and detection of illegal dumping in the County's jurisdiction of the Rochester 2000 Census Urbanized Area (UA).	
Measurable Goals: • Number of sites identified within the County's jurisdiction of the UA. • Number of actions initiated within the County's jurisdiction of the UA.	**Timeline / Implementation Schedule:** • Year 1 (December 2003) – Review existing assessment of illegal dumpsites for the County's jurisdiction of the UA and identifying any new sites. • Year 2 (December 2004) – Development of an adequate response program.
Specific Components & Notes (optional):	
Responsible Person for this BMP	**Responsible Department or Organization**
Name: Tony Hill	Dept. or Org.: Olmsted County Public Works
Title: Environmental Analyst	Dept. Head: Mike Cousino
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Educational components related to this BMP (description or number – optional):	

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 4.A

Minimum Control Measures Addressed by This BMP

	Public education & outreach	X	Construction site runoff controls
	Public participation & involvement		Post-construction stormwater management
	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Construction Site Storm Water Runoff Ordinance	
BMP Description: Olmsted County will amend the current Soil Erosion, Sedimentation, Runoff, and Slope Stability Ordinance (Olmsted County Zoning Ordinance 10.20) to meet the minimum control standards established by the permitting authority by March 10, 2005.	
Measurable Goals: • Adoption of the revised Ordinance by the County Board by March 10, 2005.	**Timeline / Implementation Schedule:** • Year 1 (December 2003) – Evaluate existing ordinance by comparing it to Minnesota Pollution Control Agency (MPCA) minimum standards and review requirements enlisted by other communities. • Year 2 (December (December 2004) – Collaborate with neighboring MS4 communities to establish a standardize ordinance. • Year 3 (March 2005) – Implementation of the amended construction site erosion and sedimentation ordinance with enforcement procedures.
Specific Components & Notes (optional):	
Responsible Person for this BMP	**Responsible Department or Organization**
Name: John Harford	Dept. or Org.: Rochester-Olmsted Planning Department
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Educational components related to this BMP (description or number – optional):	

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 4.B

Minimum Control Measures Addressed by This BMP

	Public education & outreach	X	Construction site runoff controls
	Public participation & involvement		Post-construction stormwater management
	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Construction Site Inspection and Enforcement Program	
BMP Description: Olmsted County will refer erosion and sediment control inspections and enforcement activities to the neighboring Municipal Separate Storm Water Sewer System (MS4) communities (*Cascade Township, Haverhill Township, Marion Township, Cascade Township, and City of Rochester*) responsible for land development activities and construction site practices in the Rochester 2000 Census Urbanized Area (UA).	
Measurable Goals: • Number of Calls referred to neighboring MS4s.	**Timeline / Implementation Schedule:** • Year 1 (March 2003) - Implement Program.
Specific Components & Notes (optional):	
Responsible Person for this BMP	**Responsible Department or Organization**
Name: Floyd Whitaker	Dept. or Org.: Olmsted County Public Works
Title: SWCD District Coordinator	Dept. Head: Mike Cousino
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Educational components related to this BMP (description or number – optional):	

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 5.A

Minimum Control Measures Addressed by This BMP

	Public education & outreach	X	Construction site runoff controls
	Public participation & involvement	X	Post-construction stormwater management
	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Surface Water Management Plan for the South Zumbro Watershed

BMP Description: Olmsted County will develop a comprehensive surface water management plan for the watershed encompassing the Rochester 2000 Census Urbanized Area (UA). The plan will identify areas for possible storm water wetland detention ponds and rain garden infiltration sites in the South Zumbro Watershed. The plan will provide a comprehensive transportation and storm water management strategy for the watershed.

Measurable Goals:	**Timeline / Implementation Schedule:**
• Date Plan Developed • Number of BMPs installed over permit period.	• Year 1 (June 2003) – Completion of the Plan. • Year 2 (March 2004) – Plan review with staff and public officials. Year 3 (March 2005) – Begin Plan Implemented.

Specific Components & Notes (optional):

Responsible Person for this BMP	**Responsible Department or Organization**
Name: Mike Cousino	Dept. or Org.: Olmsted County Public Works
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Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 5.B

Minimum Control Measures Addressed by This BMP

	Public education & outreach		Construction site runoff controls
	Public participation & involvement	X	Post-construction stormwater management
	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Development and Redevelopment Post-Construction Ordinance

BMP Description: Olmsted County will amend the current Soil Erosion, Sedimentation, Runoff, and Slope Stability Ordinance (Olmsted County Zoning Ordinance 10.20) to further address post-construction runoff from new development and redevelopment projects by March 10, 2008.

Measurable Goals:	Timeline / Implementation Schedule:
• Adoption of the revised Ordinance by the County Board by March 10, 2008.	• Year 1 (May 2004) – Review League of Minnesota Cities (LMC) guidance documents and draft ordinances. Compare ordinances with existing County requirements, other communities ordinances, and MPCA regulatory requirements. • Year 2 (March 2005) – Collaborate with neighboring MS4 communities to standardize ordinance. • Year 3 (March 2006) – Completed Development and Redevelopment Post-Construction. • Year 4 (March 2007) – Adoption of Ordinance by County Board.

Specific Components & Notes (optional):

Responsible Person for this BMP	Responsible Department or Organization
Name: John Harford	Dept. or Org.: Rochester-Olmsted Planning Department
Title: Senior Planner	Dept. Head: Phil Wheeler
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Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 5.C

Minimum Control Measures Addressed by This BMP

	Public education & outreach		Construction site runoff controls
	Public participation & involvement	x	Post-construction stormwater management
x	Illicit discharge detection & elimination		Pollution prevention/Good housekeeping

BMP Title: Ditch Inspection and Maintenance Program

BMP Description: Olmsted County will implement a ditch inspection and maintenance program to minimize the impact of development and redevelopment activities to the conveyance system in the County's jurisdiction of the Rochester 2000 Census Urbanized Area (UA).

Measurable Goals:	Timeline / Implementation Schedule:
• Number of Physical Inspections. • Number of Complaints. • Number of Ditches Cleaned and Maintenance Activities Conducted in the UA.	• Year 1 (May 2003 thru December 2003) – Gather existing information on ditch and storm water conveyance system within the County's jurisdiction of the Rochester 2000 Census Urban Area (UA). Develop procedures for conducting inspections and recording complaints. Coordinate with adjacent MS4 communities to address discharges to the County storm water conveyance system. • Year 2 (March 2004) – Begin program implementation.

Specific Components & Notes (optional):

Responsible Person for this BMP	Responsible Department or Organization
Name: Kevin Harms	Dept. or Org.: Olmsted County Public Works
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Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 6.A

Minimum Control Measures Addressed by This BMP

	Public education & outreach		Construction site runoff controls
	Public participation & involvement		Post-construction stormwater management
	Illicit discharge detection & elimination	x	Pollution prevention/Good housekeeping

BMP Title: New Construction and Land Disturbance Training

BMP Description: Olmsted County Public Works Department currently incorporates new construction and land disturbance training to highway employees responsible for road construction projects. The County will continue to train employees on best management practices related to new construction and land disturbance activities.

Measurable Goals:	**Timeline / Implementation Schedule:**
• Number of Training Programs. • Number of employees trained per year.	• Year 1 (May 2003) – Implement program

Specific Components & Notes (optional):

- Silt Fence Installation Training
- Disturbed Soil Protection Training
- MS4 Inlet Protection Training

Responsible Person for this BMP	**Responsible Department or Organization**
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Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 6.B

Minimum Control Measures Addressed by This BMP

	Public education & outreach		Construction site runoff controls
	Public participation & involvement		Post-construction stormwater management
x	Illicit discharge detection & elimination	x	Pollution prevention/Good housekeeping

BMP Title: Parking Lot and Street Cleaning

BMP Description: Olmsted County Public Works Department owns one mechanical street sweeper for the purpose of removing sediment, grit, and debris from County owned roadways and parking lots. The County will continue to use the current system of street and parking lot cleaning that involves employee training, storage, refuse disposal, and sweeping schedules.

Measurable Goals:
- Total length of pavement swept per year in the County's jurisdiction of the UA.
- Number of road cleanings in County's jurisdiction of the UA.
- Estimated amount of debris removed per year.

Timeline / Implementation Schedule:
- Year 1 (May 2003) - Implemented program.

Specific Components & Notes (optional):

Responsible Person for this BMP	Responsible Department or Organization
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Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 6.C

Minimum Control Measures Addressed by This BMP

	Public education & outreach		Construction site runoff controls
	Public participation & involvement		Post-construction stormwater management
x	Illicit discharge detection & elimination	x	Pollution prevention/Good housekeeping

BMP Title: Road Salt Materials Management Program

BMP Description: Olmsted County Public Works Department will develop a program to track the amount of road salt applied to the roadways during the annual reporting cycle. After reviewing the first three years of information, the County will reevaluate application rates and compare them to industry standards and adjust the application accordingly. The County Public Works Department will continue to use and evaluate alternative de-icing products on County roadways and parking areas.

Measurable Goals:
- Amount of road salt applied each year.
- Number of alternative products used.

Timeline / Implementation Schedule:
- Year 1 (November 2003) - Implement program.

Specific Components & Notes (optional):

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Phone: 507-285-8231	Phone: 507-285-8231
E-mail: harms.kevin@co.olmsted.mn.us	E-mail: cousino.mike@co.olmsted.mn.us

Educational components related to this BMP (description or number – optional):

BMP Description Sheet

MS4 Name: Olmsted County
Unique Identifying Number: 6.D

Minimum Control Measures Addressed by This BMP

	Public education & outreach		Construction site runoff controls
	Public participation & involvement		Post-construction stormwater management
x	Illicit discharge detection & elimination	x	Pollution prevention/Good housekeeping

BMP Title: Storm Water Conveyance System Inspection Program	
BMP Description: Olmsted County will inspect at least 20% of the outfalls, sediment basins, and ponds within the County's jurisdiction of the Rochester 2000 Census Urbanized Area (UA) for each reporting cycle.	
Measurable Goals: • Inspection of 20% of the MS4 outfalls, sediment basins and ponds each year in the County's jurisdiction of the UA.	**Timeline / Implementation Schedule:** • Year 1 (May 2003) - Implement program.
Specific Components & Notes (optional):	
Responsible Person for this BMP	**Responsible Department or Organization**
Name: Kevin Harms	Dept. or Org.: Olmsted County Public Works
Title: Maintenance Engineer	Dept. Head: Mike Cousino
Phone: 507-285-8231	Phone: 507-285-8231
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Educational components related to this BMP (description or number – optional):	