Barr Engineering Company
4700 West 77th Street • Minneapolis, MN 55435-4803
Phone: 952-832-2600 • Fax: 952-832-2601 • www.barr.com *An EEO Employer*

Minneapolis, MN • Hibbing, MN • Duluth, MN • Ann Arbor, MI • Jefferson City, MO • Bismarck, ND

Memorandum

To: Northfield Technical Steering Committee
From: Barr Engineering Company
Subject: City of Northfield Regulation Development Project
Technical Assessment Report: Coldwater Stream Watershed Management
Date: April 20, 2010
Project: 23661006.00 100 001

Executive Summary

This is one of four "technical assessment reports" intended to support the development of a new stormwater management ordinance and the Rice Creek policy document. This report provides information about coldwater fishery stream watershed management.

The following watershed management aspects are discussed in this report:

a. Coldwater fishery needs and issues—what coldwater fish, such as trout, need to survive, what can endanger their survival

b. Protection tools—what regulations, in-stream improvements, education programs, cooperative efforts with other agencies, and monitoring programs can be used to protect coldwater fish and their habitat

c. Monitoring tools—what type of monitoring can be done to collect baseline information and determine if protection tools are successfully managing the resource

d. In-stream improvement methods

e. Education and partnering with agencies and individuals to protect and improve streams

Based on the needs, issues, and protection tools, this report then makes recommendations for developing a Rice Creek policy document and the stormwater ordinance, including revising some policies of the Northfield Surface Water Management Plan (SWMP) for the stormwater ordinance.

Table of Contents

Introduction

The City of Northfield and Bridgewater Township have signed an agreement to allow the City of Northfield to annex portions of Bridgewater Township under certain conditions. One area proposed to be annexed to the City of Northfield includes Rice Creek, which has been designated as a trout stream by the Minnesota Department of Natural Resources (DNR). Specifically, the DNR has designated that portion of Rice Creek (also known as Spring Brook) within Sections 2-4 of Township 111 North, Range 20 West as a trout stream. Table 1 lists the designated trout stream length and watershed of Rice Creek by the local government unit. The DNR designates a stream as a trout stream if it currently has conditions to support trout, which includes an analysis of several factors including whether trout are present (although some streams can be designated trout streams without trout), water temperature, dissolved oxygen, habitat, and invertebrates. The DNR does not differentiate between trout streams and coldwater streams.

Because of the special nature of trout streams, this technical assessment report is meant to assist the City of Northfield in understanding coldwater streams (trout streams) and various protections tools for the City to considering in preparing a Rice Creek Policy Manual and stormwater ordinances.

Table 1 Rice Creek Stream Length and Watershed

	Before Annexation				After Annexation			
	Area (sq. mi.)	Area (acres)	Length (ft)	Length (mi)	Area (sq. mi.)	Area (acres)	Length (ft)	Length (mi)
City of Northfield	0.0004	0.3	226	0.04	0.44	281.0	5,087	0.96
City of Dundas	0.15	93.4	0	0.00	0.15	93.4	0	0.00
Bridgewater Township	6.28	4,017.7	10829	2.05	5.84	3,737.0	5,968	1.13
Forest Township	0.03	17.7	0	0.00	0.03	17.7	0	0.00
Total	6.45	4,129.0	11,055	2.09	6.45	4,129.0	11,055	2.09

Note:
- Length is measured along the centerline of only the main channel, not the tributaries.

Background

Rice Creek is the home of naturally-reproducing brook trout.[1] Brook trout are often viewed as an indicator species of clean coldwater with good ecological integrity. The Minnesota Pollution Control Agency (MPCA) uses the brook trout and their need for cold, clear waters with silt-free bottoms, as a sign of good water quality. Brook trout are the only native species of trout in Minnesota streams and are more sensitive to temperature than other trout species.

Coldwater Stream Fishery Needs

Trout need cold, clean, oxygenated water that is rich in aquatic life in order to survive and thrive. Their preferred habitat includes streams with gravel and rock/rubble bottoms, a variety of deep pools and shallow riffles, and overhead cover. Trout eat a wide variety of benthic invertebrates, primarily aquatic insects, but also crayfish, minnows and terrestrial insects that fall into the streams.

Temperature

Water temperature is one the most important factors in the health of a coldwater stream. Water temperature's relationship with dissolved oxygen influences living organisms. As the water gets warmer, an aquatic organism's metabolism speeds up, increasing its need for oxygen, but the warmer the water gets, the less oxygen it can hold. Aquatic organisms are adaptive to a variety of water temperatures, but each species has its own optimum for growth and reproduction. The optimum water temperature for brook trout is between 55 degrees Fahrenheit and 65 degrees Fahrenheit[2]. As shown in Figure 1, once water temperatures exceed 68 degrees Fahrenheit, trout survival rapidly decreases.[3] Trout can tolerate brief periods of water temperatures up to 72 degrees Fahrenheit[4], but exposure to temperatures of 75 degrees Fahrenheit for only a few hours is usually lethal[5].

---

1 Personal communication with Jeff Weiss (Minnesota Department of Natural Resources) and Cathy Larson and Steve Albers (Bridgewater Township residents)

2 Raleigh, R. F. 1982. Habitat suitability index models: brook trout. U.S. Department of the Interior, Fish and Wildlife Service, FWS/OBS-82/10.24

3 Wehrly, Kevin E., L. Wang and M. Mitro, "Field-Based Estimates of Thermal Tolerance Limits for Trout: Incorporating Exposure Time and Temperature Fluctuation" *Transactions of the American Fisheries Society* 2007, 136, 365-374.

4 Conservation Strategy Work Group, Eastern Brook Trout Joint Venture. December 2005. Conserving the Eastern Brook Trout: An Overview of Status, Threats, and Trends.

5 Flick, W. A. 1991. Brook trout. Pages 196-207 in J. Stohlz and J. Schnell, editors. The wildlife series: Trout. Stackpole Books. Harrisburg, Pennsylvania.

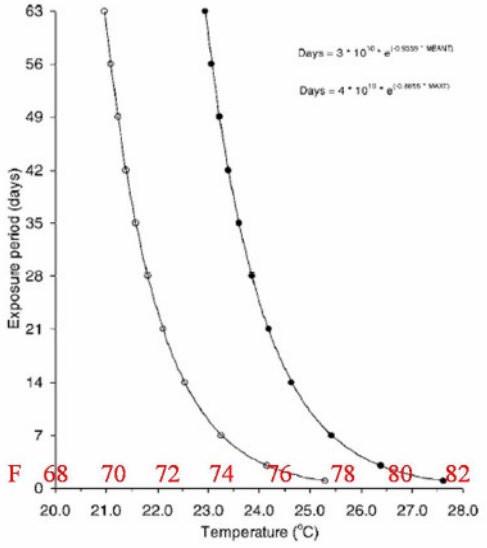

Figure 1. Estimates of the maximum daily mean temperatures (open circles) and the maximum daily maximum temperatures (closed circles) of brook and brown trout as functions of exposure period (Wehrley, 2007)

Dissolved Oxygen

Dissolved oxygen is a measure of the amount of oxygen that is dissolved in the water and available for aquatic organisms to use. The capacity for water to hold oxygen in dissolved form decreases as water temperature increases. Trout require a minimum of about 5 mg/l to survive, and the MPCA has established a minimum of 5 mg/l as a water quality standard for the state.

Coldwater Stream Issues

Coldwater streams can be negatively affected by several human activities. Reducing the amount of coldwater entering the stream, polluting the stream's water, changing a stream's hydrology, and removing the stream's inhabitants can have negatively consequences on the stream's health.

Many of the issues identified in this memorandum report are inter-jurisdictional issues. If the City of Northfield annexes more of the Rice Creek watershed, it will need to work with landowners and other jurisdictions to address these issues to protect and improve Rice Creek.

Reduction in Groundwater

The water source of most cold water streams in Minnesota is groundwater. Seeps and springs convey the cold groundwater to ground surface. If the groundwater table drops, because of climatic conditions, the lack of surface water replenishing it, or from over-pumping, less groundwater will feed a coldwater stream. Less groundwater can lead to less water in the stream and warmer water temperatures; either of which can cause the stream's inhabitants to become stressed. For trout, groundwater within a stream's gravel beds is also critical for egg circulation and successful reproduction.

The DNR does not allow any changes to the "course, current, or cross-section" of a trout stream that could negatively affect it. And, the DNR has been unwilling to establish any measurement standard for how much change in current is acceptable. For example, modeling indicates that proposed Woodbury drinking water wells could cause a slight reduction in the baseflow of Valley Creek, a trout stream within Afton, but the DNR has not stated if a reduction of the baseflow by even a 0.1 foot drop in water level is acceptable.

Pollution

Thermal

During the growing season, surface water runoff is warmer than groundwater. Excessive warm inputs from urban and agricultural runoff lead to thermal pollution of coldwater streams. Thermal pollution could also be caused by the lack of shading vegetation.

Some stormwater management practices can cause more thermal pollution than others. For example, the water in stormwater rate control wet detention ponds heats up with sunlight and can become approximately the same temperature as the air. When a storm occurs, the heated water in the pond discharges into the coldwater stream. Therefore, many organizations who manage coldwater streams prohibit wet ponds as stormwater management features and instead require practices that will infiltrate or filter runoff

However, even the implementation of infiltration practices can have negative thermal affects. In 2000, the City of Lakeville commissioned a technical study to examine the temperature impact of a single infiltration pond versus its proximity to a trout stream. Although many uncertainties exist in the Lakeville modeling used to quantify this effect, the modeling suggests some temperature influence in downstream groundwater due to concentrated infiltration pond. As summarized in Figure 2, the City of Lakeville determined thermal affects from a stormwater detention/infiltration basin were strongest in the first 150 feet downgradient of the basin. Smaller temperature increases were predicted in the direction that is side-gradient to the groundwater flow. Furthermore, the model predicted continual warming of groundwater downgradient and sidegradient to the basin for approximately five years, until a steady-state condition was reached. This is shown on Figure 2 with the lines which represent various years after the construction of the basin.

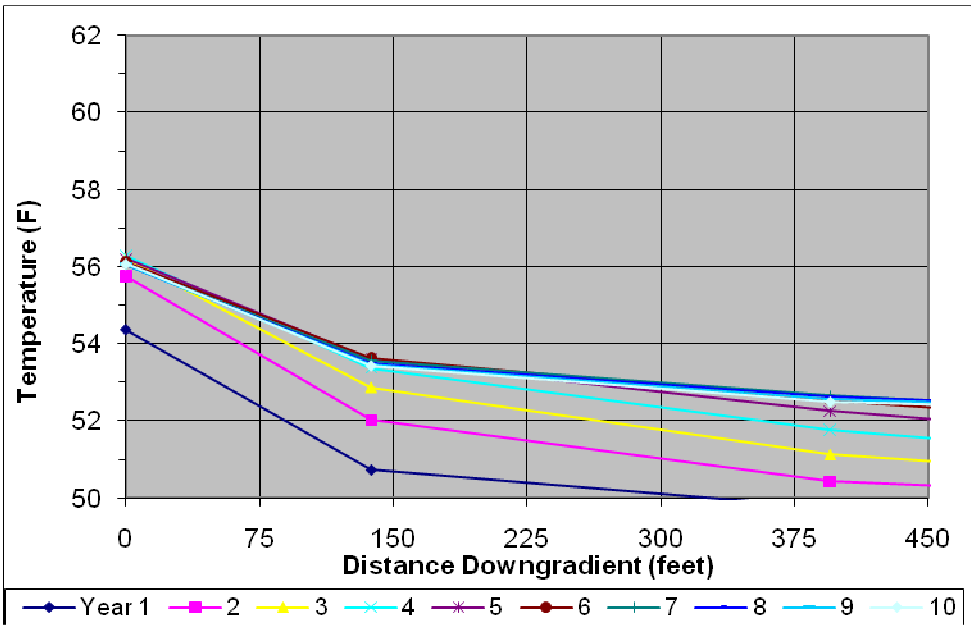

Figure 2. Thermal Impacts to Groundwater Downgradient from an Infiltration Basin. City of Lakeville South Creek Management Plan, Appendix B, Figure 2, July 17, 2000.

Siltation

Siltation destroys trout spawning habitat. Brook trout spawn from October to December, congregating in shallow riffles over gravel and rubble bottoms. The female constructs a nest, or redd, by sweeping out a depression in the gravel with her anal and tail fins. Fertilized eggs settle to the bottom into crevices between the gravel and rubble. Siltation prevents the eggs from successfully developing because it reduces the available oxygen—smothering of eggs and embryos in the redd. Siltation also reduces the embryos ability to escape the redd.

In addition, siltation can negatively affect the food source for trout by accumulating over materials needed to support the aquatic insects. Sediment also acts as an abrasive on small organisms, which reduces the food source of aquatic insects and in turn reduces the food source for trout.

Siltation in streams typically occurs as a result of five major watershed factors: sheet erosion from agricultural practices on uplands, gully erosion, runoff from developments, construction site erosion in and near the stream, and erosion in the stream itself.

Rice Creek is the MPCA's draft 2010 impaired waters list for turbidity (e.g. suspended sediment) because its water exceeded the 10 NTU MPCA turbidity standard.

Other Pollutants

In addition to sediment, runoff can carry other pollutants with it, which can harm a coldwater stream. Rice Creek is the MPCA's draft 2010 impaired waters list for Escherichia (E.)

coli/fecal coliform. High E. coli concentrations are mainly due to livestock manure and nonconforming separate sewage treatment systems, but tend to not impact trout directly.

Nitrogen from fertilizer as well as from other sources can have a direct impact on water quality of rivers and lakes. Nitrogen can move either through direct runoff, by means of erosion, via tile line drainage, subsurface flow, and shallow groundwater flow. Rice Creek is on the MPCA's draft 2010 impaired water list for nitrates, apparently because the creek's water has nitrate concentrations exceeding 10 mg/L.

Relatively low concentrations of nitrates may be harmful to fish. Grabda et al.[6] reported that fry of rainbow trout, exposed to 5–6 mg NO3-N/l for several days affected blood chemistry and caused liver damage. Kincheloe et al. [7] concluded that a nitrate level as low as 2.0 mg NO3- N/l in surface waters of low total hardness (<40 mg CaCO3/l) would be expected to limit survival of some salmonid fish populations because of impaired reproductive success.

Because excessive nitrate concentrations in water are typically because of agriculture fertilizer use, better fertilizer management is needed to reduce nitrate concentrations. Some practices suggested by the Nitrogen Fertilizer Task Force to prevent degradation of Minnesota water resources while maintaining farm profitability include:

- Adjusting nitrogen rates according to soil organic matter content, previous crop, and manure application,
- Using a deep soil test to measure residual soil nitrate in the root zone,
- Using prudent manure management,
- Timing nitrogen application for better crop uptake

Other Factors

Reducing overhead cover along the stream margin can be a major factor limiting brook trout abundance[8]. Eliminating inputs of large woody debris into streams can have a negative effect on trout habitat by decreasing pool areas and volumes, increasing riffle lengths, increasing vulnerability to predation[9]. In addition to impacts on stream temperatures and riparian cover, any land use activity

6 Grabda, E., Einszporn-Orecka, T., Felinska, C., Zbanysek, R., 1974. Experimental methemoglobinemia in trout. Acta Ichthyol. Piscat. 4, 43–71.

7 Kincheloe, J.W., Wedemeyer, G.A., Koch, D.L., 1979. Tolerance of developing salmonid eggs and fry to nitrate exposure. Bull. Environ. Contam. Toxicol. 23, 575–578.

8 Enk, M. D. 1977. Instream overhead bank cover and trout abundance in two Michigan streams. M.S. Thesis, Michigan State University, East Lansing.

9 Hicks, B. J., J. D. Hall, P. A. Bisson, and J. R. Sedell. 1991. Responses of salmonid populations to habitat changes caused by timber harvests. Pages 483-518 in W. R. Meehan, ed. Influence of forest and rangeland

that removes vegetative cover, disturbs the soil mantle, reduces infiltration rates, decreases soil moisture storage, or increases overland flow has the potential to negatively affect streams by causing higher peak stream flows and more rapid attainment of peaks[10]. Stream manipulation (culverts, dams, etc.) can affect fish passage. Over-fishing can decrease trout's ability to naturally reproduce.

Coldwater Stream Watershed Protection Tools

This section provides a summary of the protection tools that are most applicable to, or have/could have the most impact on, protecting Rice Creek.

Regulations

Land Use Planning

Land use planning can be used to protect coldwater streams by guiding high-impervious land uses away from the stream and possibly outside of its watershed. Research in recent years has consistently shown a strong relationship between the percentage of impervious cover in a watershed and the health of the receiving stream. Scientists generally agree that stream degradation consistently occurs at relatively low levels of imperviousness (10 - 15%) where there is minimal or inadequate treatment of stormwater runoff. Increased impervious surfaces alter stream hydrology resulting in lower flows during droughts and higher peak flows during floods. With advanced planning and identification of at-risk watersheds, total impervious cover can be reduced during development within a watershed and engineering steps taken to mitigate the impacts of added impervious cover with appropriate volume control and infiltration practices.[11]

Other land use planning and zoning-type tools that can preserve undeveloped land include:

- Natural resource conservation plans,
- Official maps,
- Donated conservation easements,
- Purchase of development rights,
- Transfer of development rights (density transfer),
- Land acquisition,
- Overlay districts,
- Conservation subdivision design (also known as clustering)

---

10 Hibbert, A. R. 1967. Forest treatment effects on water yield. Pages 527-543 in W.E. Supper and H.W. Lull, eds. Forest hydrology. Pergamon Press, Oxford.

11 Kauffman, G. (2000). The role of impervious cover as a watershed-based zoning tool to protect water quality in the Christina River Basin of Delaware, Pennsylvania and Maryland. *Watershed Management Conference* (pp. 1-10). Water Environment Federation

Groundwater Management

As discussed in the regulatory framework technical report, the DNR regulates groundwater usage rate and volume as part of its charge to conserve and use the waters of the state. The City will need to consider the groundwater impacts and effects on Rice Creek's base flow when locating future wells or planning increases in pumping volumes of existing wells. The City of Woodbury has been working with the DNR and several other stakeholders for over five years on locating future wells so they will not negatively impact a trout stream.

While developing more stringent groundwater appropriation rules than the DNR might be feasible depending on legal interpretations of Minnesota Statute and Minnesota Rule, enforcement of more stringent rules isn't very practical. However, the City might want to consider regulations prohibiting practices like open-ended geothermal systems which waste groundwater by using it and discharging it to the ground surface.

Municipal Stormwater Management

Regulated Activities

Table 2 summarizes the activities that require stormwater management by a sampling of area organizations with jurisdiction over trout stream watersheds.

Table 2. Activities Requiring Stormwater Permits by Area Local Government Units[12]

General Activity	Permit Triggers of Area Local Government Units with Trout Streams				
	Browns Creek Watershed District	City of River Falls	Valley Branch Watershed District	Vermillion River Joint Powers Organization	City of Winona
Disturbing Land	5,000 square feet or more within the surface water contributing area of a groundwater-dependent natural resource Movement of more than 50 cubic yards of earth or removal of vegetative cover on 5,000 square feet or	Any land development or land disturbing activity of any size, with several exemptions	One acre or more	One acre or more outside of the Shoreland District or 10,000 square feet or more or 100 linear feet or more of shoreline in a Shoreline District	Greater than 4000 square feet for commercial and industrial land uses and one acre or more for residential uses, and excavation or fill of greater than 1,000 cubic yards of material

12 Summaries have not been reviewed and verified by each organization.

General Activity	Permit Triggers of Area Local Government Units with Trout Streams				
	Browns Creek Watershed District	**City of River Falls**	**Valley Branch Watershed District**	**Vermillion River Joint Powers Organization**	**City of Winona**
	more of land				
Subdivisions	Residential subdivision or development of four or more lots		All subdivisions, plats, and developments		Subdivisions that create more than four lots or require drives or road improvements
Creating impervious surfaces	5,000 square feet or more of additional impervious surface appurtenant to existing non-residential development Road, bikeway, sidewalk or other linear impervious surface of one acre or more Non-residential development creating impervious surface that, in the aggregate, exceeds either one acre or 5% of a site Redevelopment on a site of five acres or more, where pervious surface is disturbed and final impervious surface, in the aggregate, exceeds one acre or 5% of a site		6,000 square feet or more of new impervious		

General Activity	Permit Triggers of Area Local Government Units with Trout Streams				
	Browns Creek Watershed District	**City of River Falls**	**Valley Branch Watershed District**	**Vermillion River Joint Powers Organization**	**City of Winona**
Floodplain Work	Alterations or fill below the 100-year flood elevation of any waterbody		All work below a 100-year flood level of a water	Alter or fill land, or build a structure or infrastructure below the 100-year critical flood elevation of any major waterway, public waters, public waters wetland, or other wetland	
Wetland/ Shoreline/ Streamline Work	Disturbance of the natural shoreline or streambank partially or wholly below the ordinary high water mark of a waterbody		Any work within a wetland	Any work within a wetland	Any work, including cutting vegetation, grading or filling, installing and maintaining water supply and wastewater systems, or subdivision within a shoreland
Miscellaneous			Lake augmentation projects Projects that will discharge municipal or industrial water or wastewater to a surface water drainage system	Activities that alter artificially drain surface water, or obstruct or divert the natural flow of runoff	

Specific Parameters and Standards

Table 3 summarizes various parameters regulated by a sampling of area organizations with jurisdiction over trout stream watersheds.

Table 3. Parameters and General Standards of Area Local Government Units[13]

Parameters	Standards of Area Local Government Units with Trout Streams				
	Browns Creek Watershed District	**City of River Falls**	**Valley Branch Watershed District**	**Vermillion River Joint Powers Organization**	**City of Winona**
Stormwater Runoff Rate Control	No increase from pre-settlement rates for the 2, 10-, and 100-year 24-hour events	No increase from existing rates for the 1.5-, 2-, 10-, and 100-year rainfall events	No increase from existing rates for the 2, 10-, and 100-year 24-hour events and 10-day 100-year snowmelt event	No increase from existing runoff rates for the 1-year and 10-year critical duration storm events (also 100-year event, but implemented by cities)	No change in the runoff rate from the 1-year, and 2-year, 10-year, and 100-year 24-hour precipitation events from existing conditions
Stormwater Runoff Volume Control and Quality Treatment	Trout stream watersheds: No increase for the 2-year 24-hour event from pre-settlement conditions Landlocked basins: No increase for the 5-year 24-hour event from pre-settlement conditions	No increase for the 1.5-year rainfall event Prior to infiltration, reduce the TSS load by 85% for new development and 40% for redevelopment	Dependent on location: • Non-trout stream: No increase for the 1-inch 24-hour event and treat ½ inch off impervious surfaces • Trout stream watersheds: No increase for the 2-year 24-hour event and treat 1 inch off impervious surfaces	No increase for 2-year 24-hour storm above pre-development conditions. Credits given for rooftop disconnections, disconnected impervious surfaces, buffers, grassed channels, soil amendments, forest/prairie restorations, natural area conservation, green rooftop, permeable paver/pavement, and irrigation	No change in the runoff volume from the 1-year, and 2-year, 24-hour precipitation events from existing conditions

13 Summaries have not been reviewed and verified by each organization.

Parameters	Standards of Area Local Government Units with Trout Streams				
	Browns Creek Watershed District	**City of River Falls**	**Valley Branch Watershed District**	**Vermillion River Joint Powers Organization**	**City of Winona**
				reuse.	
Erosion and Sediment Control	Standards similar to those required by other agencies	Standards similar to those required by other agencies	Standards similar to those required by other agencies	Standards similar to those required by other agencies	Standards similar to those required by other agencies
Wetland Management	Hydrologic standards	No standards found	Wetland Conservation Act requirements and hydrologic standards	Wetland Conservation Act requirements	Wetland Conservation Act requirements
Vegetative Buffers	Varies by resource, 100 feet for Brown's Creek (trout stream)	No standards found	Varies by resource: • 100 foot minimum for Valley Creek (trout stream portion) • 50 feet for other streams (and intermittent reaches of Valley Creek)	150 foot average and 100 foot minimum for trout stream designated area, less for other areas	100 foot minimum stream buffer

Parameters	Standards of Area Local Government Units with Trout Streams				
	Browns Creek Watershed District	**City of River Falls**	**Valley Branch Watershed District**	**Vermillion River Joint Powers Organization**	**City of Winona**
Floodplain Management/ Minimum Floor Elevations	Fill requires replacement of flood volume No specific standard for crossings <u>Minimum floor elevations:</u> 2 feet above the 100-year flood level (3 feet for landlocked basins) or 1 foot above the emergency overflow	No standards found	<u>Lakes, ponds and storage sites:</u> Cumulative effect of all possible filling will not raise the 100-year flood level more than 0.1 foot <u>Waterways</u>: Cumulative effect of all possible alterations will not increase the 100-year flood level more than 0.5 foot <u>Minimum building elevation (basement floor elevation):</u> Must be at two feet above the adjacent water body's 100-year flood elevation	Fill apparently requires replacement of flood volume No specific standard for crossings Minimum floor rule refers to other state and county rules	Minimum floor required to be two feet above 100-year flood level

Agricultural Lands

Agricultural lands are typically exempt from stormwater ordinances. However, agencies such as the Natural Resources Conservation Service and the County Soil and Water Conservation District are usually available to work with landowners to help design, implement, and maintain stormwater practices on their land. Typical agricultural stormwater management practices include

- Filter strips

- Farm ponds (wet ponds should be discouraged in coldwater watersheds because of thermal affects; dry ponds should be encouraged)
- Strip cropping/contour farming
- Grassed waterways
- Diversion structure
- Crop residue management

As compared to urban development, the DNR views agriculture land use a temporary land use when managing trout stream Watersheds.

Stream Use

Currently, there are DNR stream fishing easements in place along Rice Creek. Typically, the DNR plans parking and access so that streams are not negatively affected by overuse.

Monitoring

Collecting baseline data is important to understand the current health of Rice Creek. Future monitoring can then be used to determine if protection tools have been successful. Types of monitoring include water quality, water quantity, invertebrate, fish, and physical.

Water Quality and Quantity

Collecting discrete and continuous water quality data is useful. Typical parameters to monitor include

- Stage
- Discharge
- Precipitation
- Conductivity
- Temperature
- Dissolved Oxygen
- Total Solids
- Total Suspended Solids
- Volatile Suspended Solids
- Total Phosphorus
- Dissolved Phosphorus
- Total Nitrate Nitrogen
- Total Nitrogen
- Major Ions (hardness and alkalinity)

Invertebrates

While water samples provide an assessment of stream water quality at the time of sample collection, benthic invertebrates provide a long-term assessment of water quality. They live on the bottom and in the vegetation of a stream as long as water quality conditions permit. As attached organisms, benthic aquatic invertebrates are exposed to all the temporal variations in stream quality and "integrate" the quality of passing water. Each type of benthic invertebrate has a different tolerance for pollution; studying the numbers and types of benthic invertebrates can indicate pollution in a stream. When sufficient pollutants enter the stream to prevent their survival, they are eliminated. Monitoring the presence or absence of biological indicator organisms provides indirect evidence of the effects of transitory changes in stream water quality related to stormwater runoff.

Samples are typically collected from a riffle location with a D-frame aquatic net. The substrate is disturbed with the sampler's feet, allowing dislodged invertebrate to drift into the net downstream. Samplers also pass the D-frame net through debris and vegetation near the banks. Rocks are examined, too. All the invertebrate samples are preserved in 80 percent alcohol and later identified.

Once individual invertebrates are identified, a biotic index, such as the Hilsenhoff's Biotic Index is used to further analyze the data. The index uses invertebrate data to rank a stream according to its water quality. Water quality categories include excellent, very good, good, fair, poor, and very poor.

Fish

With the proper permits, routine fish shocking can be done to determine the type and quantity of fish within a stream.

Physical

Physical monitoring to assess stream degradation, including the identification and progress of streambank and gully erosion sites can be useful.

In-Stream Improvements

There are various methods for stabilizing streams, including

- Constructed riffles for grade control
- Rock vanes for bank protection
- Stone toe protection for bank protection
- Root wads for bank protection
- Soil pillows for bank protection
- Bank grading and revegetation for bank protection
- Vegetated reinforced soil slope technique for steep bank protection
- Vegetation management for bank protection
- Culvert stabilization for bank protection

These methods are described in more detail in Appendix A.

Education and Partnering with other Agencies and Individuals

Regulations cannot solve all coldwater stream issues. Sometimes public education is needed as well as work on private lands outside of regulation program. For this type of work, partnering with another agency, such as the Soil and Water Conservation District, the DNR, and Trout Unlimited, can reduce the City's time commitment and costs and can improve the City's chances of obtaining grants. More discussion on education—building on policies 4-8 of the City's education strategy included in the Surface Water Management Plan—can be explored in the Rice Creek Policy Document.

Preliminary Recommendations of Coldwater Stream Protection Tools

A monitoring plan and education plan should be developed in the Rice Creek policy document and the stormwater ordinance should include runoff rate and volume controls and vegetative buffer requirements.

Monitoring Plan Suggestions

Continuous water quantity and quality monitoring, coupled with precipitation monitoring, should be considered near the outlet of Rice Creek. The City might be able to partner with the Soil and Water Conservation District or another entity to conduct the monitoring. If monitoring is done, protocols need to be adopted and followed to assure the data are accurate. There might be grant dollars available through the MPCA (e.g. 319 Grant) to reduce the costs of the monitoring and data analysis. While Rice Creek is outside of the jurisdiction of the Metropolitan Council, the Metropolitan Council has indicated it is willing to analyze the samples (which would be at a lower cost than a private laboratory) and provide some technical assistance.

The invertebrates of the stream could be monitored annually at the same location. The City could work with the Soil and Water Conservation District, a school, or a college to collect and analyze the samples.

The City could request that the DNR continue to conduct routine (approximately every couple of years) fish surveys at a specific location within the area consider to be annexed to the City on Rice Creek. The DNR could also analyze the data with a biotic index.

Overall, the City might want to consider completing a stream inventory that the Cannon River Watershed Partnership has apparently started. The inventory could identify and map features such as the centerline of the stream, sediment delivery sites, sediment sites, stream widths, streambank erosion, plant populations, human-made structures, tree downfalls, seeps, and springs. Grants might be available for this work.

Education and Partnership Program Suggestions

Once the problem areas (e.g. sediment delivery sites, streambank erosion sites, areas lacking buffers, human-made structures blocking fish passage, etc.) of the creek have been identified, the City could partner with other agencies or the Rice Creek Concerned Citizens Group to work with individual landowners to implement improvement and protection measures. Typically, one-on-one conversations and site visits are more productive than mass mailings. Because the City of Northfield will not have jurisdiction over the entire Rice Creek watershed, working with Bridgewater Township, the City of Dundas, and Rice County will be needed to protect and improve Rice Creek.

Regulations

Developing a stormwater ordinance that will prevent major changes to the hydrology of the Rice Creek watershed should be considered. Establishing stormwater rate and volume controls is needed and revisions to the policies listed in the City's SWMP should be considered.

Most entities involved in trout stream management have rules that do not allow increases in the peak stormwater runoff rate from existing conditions for the 2-, 10-, and 100-year events. For new development within the Rice Creek watershed, the City's SWMP suggests stormwater runoff rate control limited to "a maximum for 0.1 cfs per acre for the 100-year critical storm event." This policy encourages large ponds, which likely will cause thermal pollution unless somehow mitigated (which is difficult). Furthermore, this highly restrictive rate will reduce the natural stream flush and sediment removal that occurs during/following periodic large storms (e.g. the 100-year event). Periodic sediment removal is an important natural condition to conserve trout habitat. Applying the rate control policy listed the SWMP for non-Rice Creek watersheds would be more appropriate.

For volume control, most entities with jurisdiction over trout streams have rules consistent with the MPCA's NPDES rule, which allows no increase in runoff volume for the 2-year 24-hour event. Low-impact design concepts can be used to accomplish these controls. The City should consider revising the policy included in the SWMP to conform to the MPCA rule. Currently, the SWMP policy states that infiltration systems within the Rice Creek watershed "will be sized to infiltrate runoff from impervious surface area from a 1-inch rainfall event in 72 hours." The SWMP volume control policy also prescribes infiltrate rates for soils based on the soil's hydrologic group. The City should consider encouraging or requiring developers, especially developers of large impervious surfaces, to conduct on-site infiltration testing to design and construct systems that are more likely to be successful.

Most entities who manage trout streams have stormwater rules that compare the proposed condition to the existing condition; however, some, like the City's SWMP rate control policy, compare the proposed condition to the pre-settlement condition. Using the pre-settlement condition might be advantageous to restore the creek's hydrology, but it also might mean reducing the runoff to upstream wetlands—essentially draining them—and reducing the natural flushing of sediment through a creek.

Establishing a vegetative buffer ordinance is needed to protect the stream and its habitat. Most entities with trout streams require a 100-foot minimum buffer width and prohibit impervious surfaces within the buffer. Based on a City of Lakeville study, the City could consider requiring a 150-foot wide buffer. Rather than the City's SWMP policy that "promotes and encourages the establishment of wetland buffers," a specific standard should be developed in the City's stormwater ordinance.

Regulating groundwater uses is typically best handled by the DNR. However, the City should work with the DNR to ensure any future significant increases in groundwater appropriations do not negatively affect the baseflow of Rice Creek. Likewise, the City should work with others to ensure septic systems are functioning properly and agricultural lands are managed properly.

Appendix A

In-Stream Improvement Methods