Brown's Creek TMDL Implementation Plan

February 6, 2012

wq-iw6-05c

Prepared by
Emmons & Olivier Resources, Inc.
for the Brown's Creek Watershed District

BROWN'S CREEK WATERSHED DISTRICT

EOR water ecology community

Document Component Specs
Text: Staples • multipurpose paper, 24 lb. text – 50% post-consumer fibers, FSC Certified
Back Cover: Neenah Paper • Esse • Texture, Sapphire • 100 lb. cover • 30% post-consumer fibers, Green Seal® Certified
Wire Binding: Manufactured using recycled high carbon steel

BROWN'S CREEK WATERSHED DISTRICT

February 6, 2012

Letter of Submittal for the Brown's Creek Watershed District TMDL Implementation Plan

As we consider watershed management, management of ground water and surface water resources and the associated costs of either doing or not doing something within our power, I'd like to share the words of Louis L'Amour, a best selling Western author.

> "...we must never forget that the land and the water are ours for the moment only, that generations will follow who must themselves live from the land and drink that water. It would not be enough to leave something for them. We must leave it a little better than we found it." *-L. L'Amour*

That comment is a very succinct message that Watershed Boards, Department of Natural Resources personnel, Pollution Control Agency personnel and all elected or appointed officials with authority of water resources should keep in their mind at all times.

Thus, with pride in the state of our endeavors to date the Brown's Creek Watershed District submits the attached TMDL Implementation Plan. We have diligently tried to measure and identify pollutants and other materials detrimental to the health of our Brown's Creek. We tried to determine where specific problems are initiating. And, we recognize we are attempting to hit a moving target from a moving base, an exercise in periodic frustration. None the less, we are committed and dedicated toward continuing our efforts directed at improving water quality in Brown's Creek using an adaptive management style to develop and implement positive actions that will benefit our water resources.

Respectfully submitted,

Craig F. Leiser, President
Brown's Creek Watershed District
Washington County, Minnesota

Acknowledgments

The Brown's Creek TMDL Implementation Plan was developed with the participation of numerous people. The Board of Managers wishes to acknowledge the following groups and individuals for their involvement in the planning process. Without their hard work and dedication this plan would not have been possible and the Managers thank them for their effort.

Brown's Creek Watershed District Board Members

Craig Leiser	Board President
Rick Vanzwol	Vice President, CAC Liason
Gail Pundsack	Vice President
Connie Taillon	Treasurer
Gerald Johnson	Secretary

Brown's Creek Watershed District Staff

Karen Kill	District Administrator

Consulting Resource – Emmons & Olivier Resources, Inc.

Camilla Correll	Project Manager
Patrick Conrad	
Andrea Plevan	
Tom Miller	
Kevin Biehn	

Technical Advisory Committee

The following individuals participated in the Stakeholder Meeting for the Brown's Creek TMDL Implementation Plan:

Shawn Sanders	City of Stillwater
Sherri Buss	Stillwater TWP
Phil Olson	City of Grant
Cory Slagle	Washington County
Anna Kerr	MPCA
Melissa Lewis	BWSR
Brian Nerbonne	MnDNR
Molly Shodeen	MnDNR

Community Advisory Group

The following individuals attended the Open House Meeting for the Brown's Creek TMDL Implementation Plan:

Barbara & Jerry Holland	Toni Meglitsch	Connie Taillon
David & Ranae Majeski	Colin Kelly	Rick Vanzwol
Peggy Van DeRiet	Rob McKim	Ken Taillon
Nancy Brown	Tom Hendrson	Laurie Windisch
Molly Shodeen	David Johnson	Sheila-Marie Untiedt
Dave Junker	Paulette Jones	Richard Schubert
Amy Goetzel	Mark Owens	Tony Scherl

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1 EXECUTIVE SUMMARY

The Clean Water Act (CWA) Section 303 (d) mandates that the Minnesota Pollution Control Agency (MPCA) assess the condition of their aquatic resources to ensure the maintenance of both aquatic life and beneficial uses. Specific water bodies that fail to meet the aquatic life and beneficial uses criteria developed by states (in CWA 303 (d)) are submitted to the United States Environmental Protection Agency (U.S. EPA) under CWA Section 305 (b). Once water bodies are listed as impaired, stressors causing impairment must be identified, and remediation efforts, including development of total maximum daily loads (TMDLs) for identified pollutants, need to be initiated.

Brown's Creek is located in the Brown's Creek Watershed District (BCWD) in the St. Croix River basin in eastern Minnesota. Brown's Creek has an approximate 19,000-acre watershed that includes a significant portion of rural and agricultural areas. The watershed includes portions of the City of Stillwater, City of Oak Park Heights, City of Lake Elmo, City of Grant, City of Hugo, May Township, Stillwater Township and Baytown Township.

This TMDL report addresses two impairments on the stretch of Brown's Creek from Highway 15 to the St. Croix River (river ID 07030005-520); the reach is impaired for aquatic life due to a lack of a cold water fish assemblage and due to high turbidity. This reach is classified as a Class 2A stream. The TMDL study entailed analysis of existing data, intensive water quality and biological surveys of the creek, completion of the stressor identification process, watershed modeling, and the development of implementation strategies to meet the goals of the TMDLs.

Through the stressor identification process, the primary stressors to the biota in the impaired reach of Brown's Creek were identified as high suspended solids, high temperatures, and high copper concentrations. The TMDL is based on total suspended solids, which also serves as the surrogate measure for the turbidity impairment, and thermal load, which addresses the temperature stressor. Due to uncertainties related to the reliability of the copper monitoring data, copper loading allocations were not developed. The water quality targets for the TMDL are 23 mg/L TSS and 18.3°C (65°F).

Because Brown's Creek is a stream system individual wasteload allocations (WLAs) and load allocations (LAs) were established for TSS and thermal loads for five different flow regimes. Individual WLAs are provided for the City of Stillwater and the City of Lake Elmo. An individual WLA is also provided for the City of Oak Park Heights. While not currently regulated through the MS4 permit, the City of Oak Park Heights will likely come under regulation by the Phase II MS4 permit in the future; its WLA will only be in effect if and when it comes under MS4 regulation. Runoff from the unregulated portion of the watershed falls under the LA. This document presents the Implementation Plan (Table 11) for the Brown's Creek Impaired Biota Total Maximum Daily Load (TMDL) and is intended to assist member communities in meeting to goals for WLAs and LAs.

A series of stakeholder meetings were held during the plan development process. Cities, Washington County, agencies, and residents of the watershed were invited to provide input into the project approach and to weigh in on proposed implementation activities.

The BCWD has committed to taking an adaptive management decision-making approach to the implementation of this Plan and to meeting the goals of the Brown's Creek TMDL. Given uncertainties in the identification of pollutant loads and the quantification of improvements associated with implementation activities designed to address thermal loads, the goal will be to reduce the uncertainty over the course of the project by monitoring the system while implementing the projects recommended here and assessing the need to implement additional projects in the future. This process will provide the

BCWD and its member communities with a means of continually tracking progress and informing subsequent implementation projects.

Implementation of this Plan will be a joint effort among those entities contributing to the health of Brown’s Creek. These entities include, but are not limited to, the Brown’s Creek Watershed District, City of Stillwater, City of Oak Park Heights, City of Lake Elmo, City of Grant, City of Hugo, May Township, Stillwater Township, Baytown Township, Washington County, Minnesota Department of Transportation, Minnesota Department of Natural Resources and the Citizens of the Brown’s Creek Watershed District.

Given the Brown’s Creek Watershed District’s role in surface water management, the development of the TMDL Report and Implementation Plan, and watershed wide monitoring and evaluation activities, the BCWD will coordinate BMP implementation tracking and report progress towards meeting the TMDL requirements.

2 INTRODUCTION

This document presents the Implementation Plan for the Brown’s Creek Impaired Biota Total Maximum Daily Load (TMDL). This TMDL Implementation Plan addresses two impairments on the stretch of Brown’s Creek from Highway 15 to the St. Croix River (river ID 07030005-520); the reach is impaired for aquatic life due to a lack of a cold water fish assemblage (referred to often as a biotic or a fish impairment) and due to high turbidity. This reach is currently classified as a Class 2A stream. Class 2A waters are protected to permit the propagation and maintenance of a healthy community of cold water sport or commercial fish and associated aquatic life, and their habitats (MN Rule 7050.0222, Subp. 2).

Brown trout, a cold water fish species, have been stocked yearly since 1958. Stocking is set between 800 and 1,000 individuals, sometimes including several size classes but generally limited to fingerlings. Fish surveys do not report many trout, sometimes fewer than 20 individuals, and the trout are primarily young of the year (indicating trout have not established a permanent population in Brown’s Creek). Low temperatures from 1998 to 2004 co-occurred with improvements to the stream habitat, leading to higher trout populations in this period.

Recent surveys show a decline from 2004-2007. Long term data show that trout are not establishing well in Brown’s Creek. Natural reproduction is confirmed sporadically (1966, 1976, 1989, and 1998-2001) but not consistently enough to establish a permanent population. Native brook trout were not found in recent DNR surveys (2000, 2005, and 2008). These trout issues, combined with the presence of warm water tolerant species and the lack of established cold water fish populations, are the basis for the fish impairment designation.

This reach of Brown’s Creek will be removed from the impaired waters list for these impairments when the following occurs:

- The cold water fish community across multiple Brown’s Creek sites downstream of Highway 15 must meet the MPCA’s threshold for the index of biotic integrity (IBI). The IBI threshold for southern coldwater streams is 45, with the confidence interval ranging from 32-58[1].
- The instream turbidity at the existing monitoring sites must meet the state’s numeric standard (10 NTU). At least 20 new observations from the last five years are needed, and fewer than 10% of

[1] MPCA staff, personal communication

the samples may exceed the standard (10 NTU). A demonstration must be made of the changes in the watershed that led to the water quality improvements[2].

2.1 303d Listings

Table 1. Listing Information

Name	Description	River ID	Pollutant or Stressor	Affected Use	Year First Listed	Target Start/Completion (reflects priority ranking)
Brown's Creek	T30 R20W S18, west line to St. Croix River	07030005-520	Lack of a coldwater assemblage	Aquatic life	2008	2007/2009
Brown's Creek	T30 R20W S18, west line to St. Croix River	07030005-520	Turbidity	Aquatic life	2010	2010/2012

The Brown's Creek watershed is within the watershed of Lake St. Croix and Lake Pepin, which are both on the 303(d) waters list for an aquatic life impairment due to excessive nutrients. Although the Brown's Creek TMDL Implementation Plan does not directly address nutrients, practices implemented to address the Brown's Creek TMDL will be aimed at reducing suspended sediment and reducing the volume of runoff delivered to the creek. These practices will also reduce nutrients delivered to downstream water bodies, thus making progress towards meeting the Lake St. Croix[3] and Lake Pepin nutrient loading goals.

The Brown's Creek Impaired Biota TMDL sets loading limits for suspended sediment (measured as total suspended solids [TSS]) and for thermal loads. The TSS loading limits address the biotic impairment and the turbidity impairment. The thermal loading limits address the biotic impairment only.

2.2 Watershed Description

Brown's Creek has an approximate 19,000-acre watershed that includes a significant portion of rural and agricultural areas. The watershed includes portions of the City of Stillwater, City of Oak Park Heights, City of Lake Elmo, City of Grant, City of Hugo, May Township, and Stillwater Township (Table 2). The lakes in Hugo and May Township form the headwaters of Brown's Creek (Figure 1). The creek begins in May Township and flows south through the City of Grant, with much of this portion of the drainage-way consisting of broad, low-lying wetlands. Brown's Creek continues through Stillwater Township and the City of Stillwater as a narrow meandering flowage with gentle side slopes transitioning to steep bluffs as it continues to the St. Croix River.

Approximately 28 percent of the Brown's Creek watershed flows regularly overland or is semi-landlocked. The remaining 72 percent is composed of landlocked basins producing no regular overland flow to Brown's Creek (Figure 1). The landlocked portion of the watershed can be divided into two categories: subwatersheds that are landlocked up to the 100-year 24-hour rainfall event, and subwatersheds that are landlocked up to the 5-year 24-hour rainfall event. As Figure 1 illustrates, the subwatersheds that are considered landlocked up to the 100-year 24-hour rainfall event are located predominantly along the western edge of the watershed with additional subwatersheds located along the

[2] MPCA (Minnesota Pollution Control Agency). 2009. Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment. wq-iw1-04.

[3]The Lake St. Croix draft TMDL states that Brown's Creek needs to reduce its phosphorus load from 5,904 lb/yr to 3,957 lb/yr, for a load reduction of 1,947 lb/year of phosphorus.

northern edge of the watershed (51 percent of the watershed). The subwatersheds that are landlocked up to the 5-year 24-hour rainfall event are located in the southern portion of the watershed and drain to the City of Stillwater’s Diversion Structure (21 percent of the watershed).

The City of Stillwater completed an Alternative Urban Areawide Review (AUAR) in August 1997. The AUAR evaluated potential environmental impacts from development of the Annexation Area on the west side of the City, and proposed a mitigation plan to avoid, minimize or mitigate for these impacts. The cornerstone of the mitigation plan is the diversion of stormwater flowing from Long Lake and other portions of the annexation area to McKusick Lake. The McKusick Lake diversion structure was designed to allow for the following: to preserve and enhance the integrity of Brown’s Creek; to improve the water quality and quantity conditions in McKusick Lake; and to allow the City of Stillwater to proceed with development as proposed in the City’s comprehensive plan.

The diversion structure is located on the channel from Long Lake, immediately south of the Minnesota Zephyr railroad track. The diversion pipe, which is 36-inches in diameter, diverts storm events up to a 3-inch rainfall event (approximately equivalent to a 3-year 24-hour rainfall event) to McKusick Lake. During larger storm events, the flow is split between the low flow diversion pipe flowing under full pressure and a secondary outlet to Brown’s Creek. In addition to the construction of the diversion structure, the City of Stillwater installed an earthen berm along the northern side of McKusick wetland to prevent discharge from entering Brown’s Creek up to a specified elevation. To maintain a portion of the cold groundwater baseflow to Brown’s Creek originating in McKusick wetland, a 12-inch diameter weep hole (orifice) was installed at the base of the diversion structure.

Since the installation of the diversion structure in 2003, all stormwater flow from the Long Lake drainage area has been diverted from Brown’s Creek. As a result, the contributing drainage area for this Plan excludes that portion of the watershed draining to the Diversion Structure as well as the landlocked portions described previously (Figure 1).

Table 2. Municipality areas within the Brown’s Creek watershed (based on hydrologic boundary)

Municipality	Area [Acres]	Percent Area
City of Stillwater	2,387	12.9%
City of Oak Park Heights	384	2.1%
City of Lake Elmo	260	1.4%
City of Grant	9,218	49.8%
City of Hugo	2,251	12.2%
May Township	2,082	11.2%
Stillwater Township	1,924	10.4%
Baytown Township	1	0.0%
TOTAL	18,507	100%

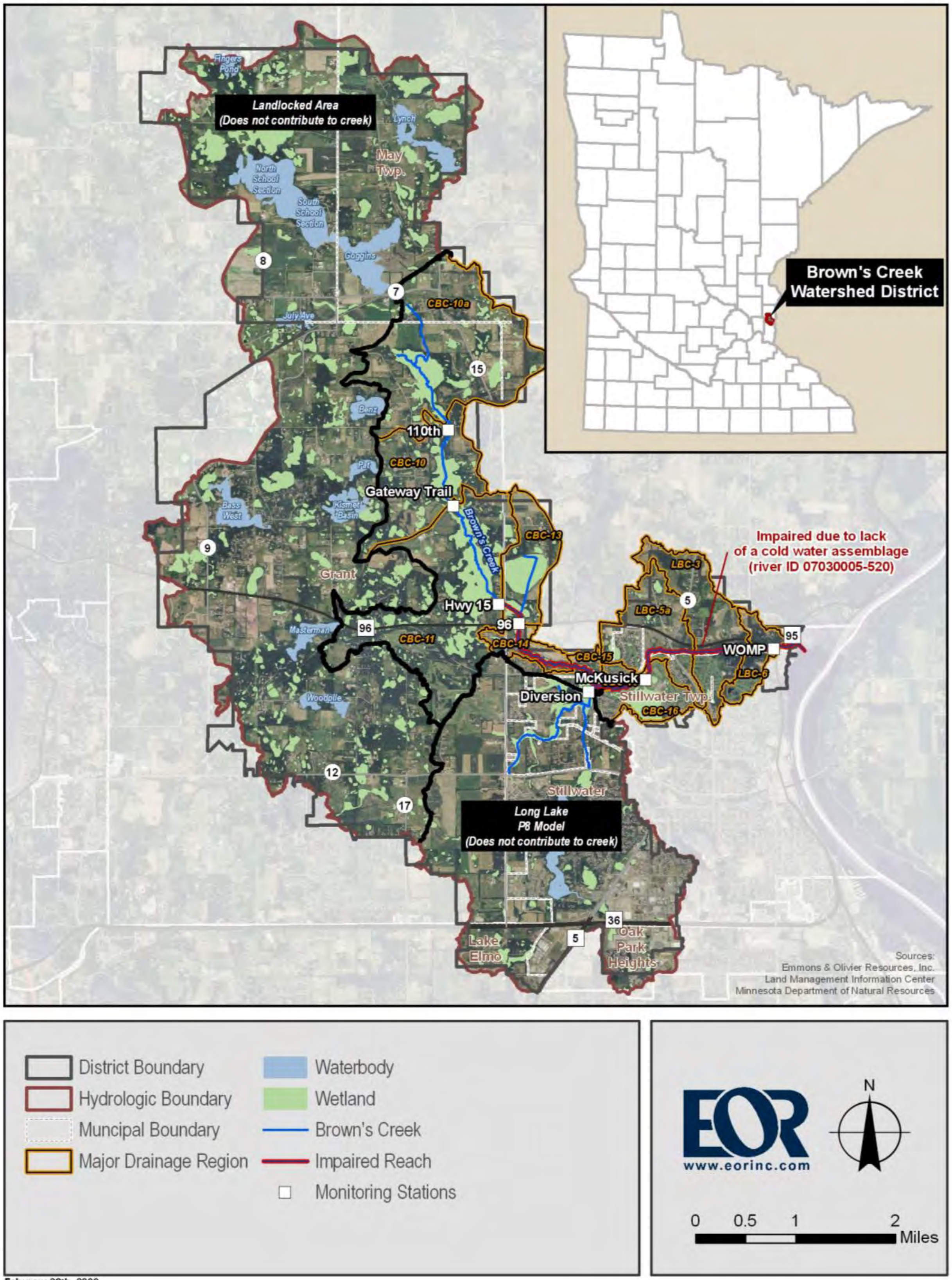

Figure 1. Area of focus for the Brown's Creek TMDL Implementation Plan

2.3 Adaptive Management Approach to Plan Implementation

As section 6.1 of this Plan describes, the BCWD is committed to taking an adaptive management decision-making approach to plan implementation. This approach uses scientific evidence and current information to drive a cyclical (iterative) process that further informs the next steps of plan implementation. This iterative process will include:

- On-going monitoring to inform performance assessment and additional source identification (see Section 10 Monitoring Plan)
- Outreach and technical assistance to promote stewardship of the District's resources and drive demand for implementation of practices (see Section 8.16 Education and Outreach)
- Identification of additional implementation activities to address the total TSS loads to the creek
- Prioritization of existing and new implementation activities (see Section 8.11 Schedule of Implementation)
- Implementation of the activities identified in the Plan (see Section 8 Overall Implementation Plan)

This Implementation Plan is based on the evaluation of monitoring data collected since the development of the TMDL report. It includes implementation activities that address known sources of TSS and thermal loads to the creek. As the adaptive management decision-making approach is applied to plan implementation, new information will drive revisions to the Implementation Plan as described in Section 8.11 Schedule of Implementation and in Table 10.

3 TEMPERATURE

3.1 TMDL Summary: Sources, Standards, and Allocations

The thermal TMDL is based on thermal loading at the WOMP monitoring site, using monitoring data from 2000 through 2007. The TMDL report focused on the data at the WOMP site since it was the only site with a long-term flow and temperature data record. The TMDL analysis concluded that temperature exceedances occur during baseflow and storm events. The highest instream temperatures occur in the hours following brief afternoon thunderstorms on a hot sunny day when runoff from impervious surfaces reaches the stream. During the storm, stream temperatures decrease (as a result of decreasing air temperatures during the storm).

There is no numeric temperature standard for streams. Water temperature goals were developed to protect the long-term survival of cold-water species in Brown's Creek. The analysis of biological impact of temperature in Brown's Creek relies most heavily on the brown trout threat temperature (18.3°C or 65°F), which is defined as the point of physiological stress, reduced growth, and egg mortality. The failure of trout to establish a breeding population taken together with the absence of cold water fish and invertebrate species are evidence that the temperature impact has sustained effects on the biota, best captured through evaluation against the threat temperature (as opposed to the critical temperature, which is defined as the point at which direct mortality can be expected). The TMDL and allocations were developed with the threat temperature of 18.3°C as the water quality goal.

Because temperature cannot directly be described as a load, the TMDL was calculated by using the amount of energy in the water at specific temperatures and flows. The TMDL and allocations were calculated in terms of the kilojoules (KJ) per day that the stream can assimilate and maintain water temperatures below the brown trout threat temperature. These energy-based allocations are provided in order to express temperature as a load-based TMDL. The allocations themselves are difficult to directly translate into implementation actions. This implementation plan prescribes implementation actions that target the sources of high temperatures identified through the data analyses.

The summary of allocations (Table 3) shows the load allocation (LA) and the individual waste load allocations (WLAs) for the five different flow regimes. The two LA categories are presented separately in order to provide information on the magnitude of LA available for each source. Individual WLAs are provided for the City of Stillwater and the City of Lake Elmo. An individual WLA is also provided for the City of Oak Park Heights. While not currently regulated through the MS4 permit, the City of Oak Park Heights will likely come under regulation by the Phase II MS4 permit in the future; its WLA will only be in effect if and when it comes under MS4 regulation. The Cities of Grant and Hugo, while they *are* currently regulated through the MS4 permit, are not given WLAs because they do not have any land uses regulated by the MS4 permit within the Brown's Creek watershed. Runoff from the unregulated portion of the watershed falls under the LA.

A reduction of 6% in thermal loading is needed across the entire watershed (and across all thermal sources). This is based on the difference between the allowed heat input (based on the threat temperature) and the average heat input observed during the 198 days when the threat temperature was exceeded (2000-2007). This needed reduction provides an estimate of the overall magnitude of the heat reductions needed. Since Lake Elmo and Oak Park Heights are located in the landlocked and/or semi-landlocked subwatersheds, they are assigned a 0% reduction (Table 4). Loads from these areas are not allowed to increase.

Table 3. Heat load and Wasteload Allocation Summary

Source		TMDL (Million KJ/day)				
		High Flows	**Moist Conditions**	**Mid-Range Flows**	**Dry Conditions**	**Low Flows**
		81.3 - 17.5 cfs	**17.5 - 9.7 cfs**	**9.7 - 7.6 cfs**	**7.6-5.9 cfs**	**5.9 - 0.0 cfs**
LA - Watershed		2,732	517	223	108	59
LA - Baseflow		1,668	1,630	1,342	1,150	970
WLA – Permitted stormwater						
MS4 or other source	Permit #					
Lake Elmo	MS400098	1.1	0.20	0.09	0.04	0.023
Oak Park Heights	Future	6.8	1.3	0.55	0.27	0.15
Stillwater	MS400259	289	55	23.6	11.4	6.2
Construction stormwater	Various	0.3	0.05	0.02	0.01	0.006
Industrial stormwater	No current permitted sources	0.3	0.05	0.02	0.01	0.006
Total		4,697	2,203	1,589	1,270	1,036

Table 4. Thermal Load Percent Reductions by Regulated Municipality

Municipality	Thermal Load Percent Reduction to Meet Allocations
Lake Elmo	0%
Oak Park Heights	0%
Stillwater	6%

3.2 Additional Data Analysis

The stressor identification process of the TMDL identified that temperature is a primary stressor to the biota of Brown's Creek. Additional data analysis was conducted during the development of this Implementation Plan to better understand under what conditions temperature exceedances occur so that implementation practices could be better targeted. The focus was on Brown's Creek downstream of Highway 15 because 1) naturally occurring factors (such as the low-gradient and the naturally open wetlands) are the main causes of higher temperatures upstream of Highway 15, and 2) cold-water biotic communities are more likely to have naturally occurred downstream of Highway 15. The following topics were investigated to better understand under what conditions temperature exceedances occur and to better inform the implementation plan.

Flow and water temperature on days when the threat temperature was exceeded; and factors that influence the number and magnitude of exceedances.

The daily average temperatures at three sites (WOMP, McKusick, and Highway 15) were compared to the brown trout threat temperature of 18.3°C. An exceedance was noted if the daily average temperature was greater than 18.3°C.

In 2001 and 2002 at the WOMP site, there were more exceedances, they occurred during a higher range of flows, and they were of greater magnitude (i.e. the daily average water temperature was higher) than in years after 2002 (Figure 2). In the last two years of monitoring, there were considerably fewer exceedances than in previous years; at the WOMP site, the daily average temperature exceeded 18.3˚C only twice in 2008 and four times in 2009 (Table 5, Figure 2).

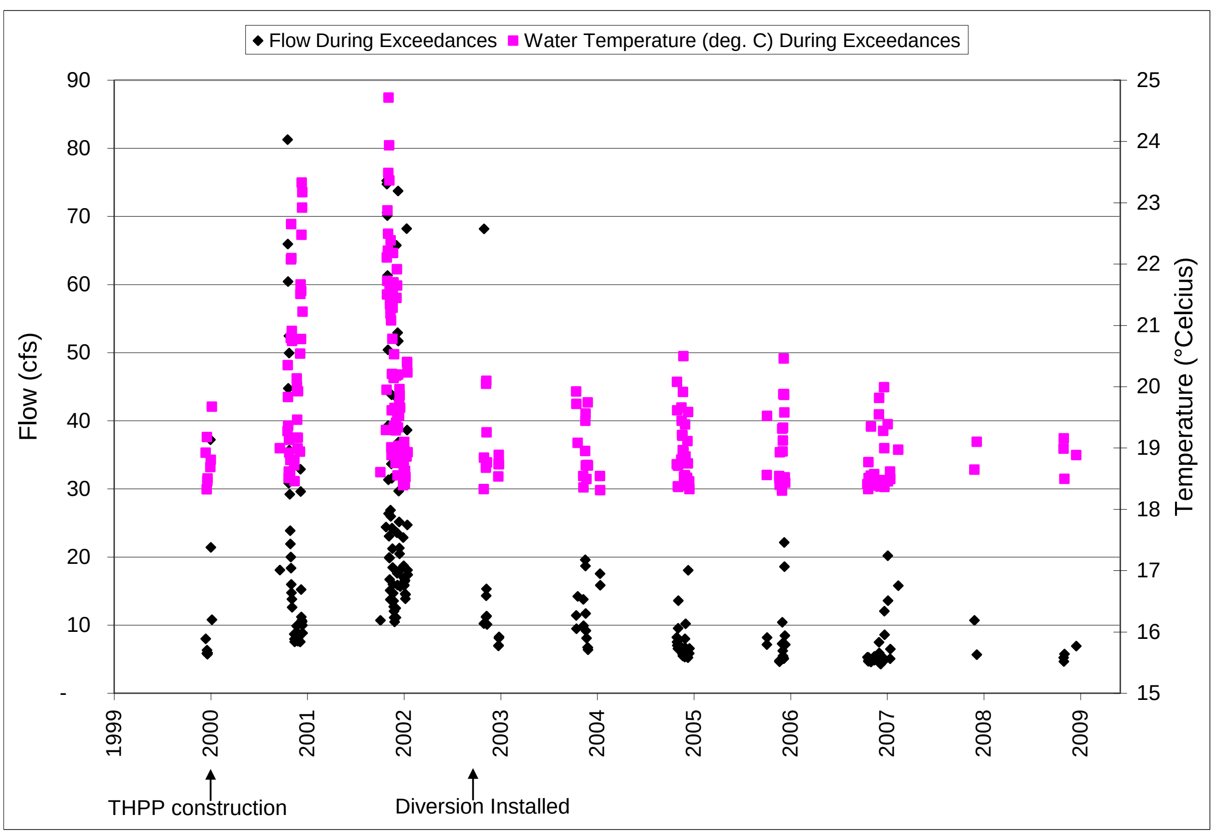

Figure 2. Daily average flow and temperature during days when the daily average temperature exceeded 18ºC at the WOMP site.

Each point represents one day.

Table 5. Number of instances that the daily average temperature exceeds 18.3˚C, by year for the period of record

Year	Exceedances at WOMP Station	Exceedances at McKusick	Exceedances at Hwy 15
2000	8	18	No Data
2001	39	60	No Data
2002	66	60	No Data
2003	11	36	No Data
2004	15	32	No Data
2005	29	43	42
2006	18	48	48
2007	23	54	57
2008	2	35	40
2009	4	26	41

Note: Shaded cells indicate exceedances that occurred after construction of the Diversion Structure

The lower flows and lower temperatures after 2002 could be due to multiple factors, including construction of the Long Lake Diversion Structure (and corresponding reductions in groundwater contributions to the creek), projects implemented in the watershed, changes in precipitation (and corresponding stormwater runoff contributions), and changes in air temperature as well as other climatological parameters. As described in Section 2.2 Watershed Description, the Diversion Structure was designed and constructed to divert stormwater runoff generated from rainfall events up to a 3-inch rainfall event (approximately equivalent to a 3-year 24-hour rainfall event) from Brown's Creek to McKusick Lake. As a result, it is assumed that the stormwater runoff from the drainage area to the Diversion Structure is not contributing to the high water temperatures within Brown's Creek.

The large drop in the flow and the magnitude of the temperature exceedances occurred after the Diversion Structure was constructed. However, the years before the diversion project (2001 and 2002) were also years with high precipitation, which is significantly correlated with the number of exceedances ($R^2 = 0.77$, $p < 0.001$; (Figure 3)). There is only one year (2005) after the diversion was constructed that experienced high precipitation. Without more points that represent time periods of high precipitation after the diversion project, it is difficult to separate the effects of the diversion project from the influence of precipitation on temperature exceedances. The expected relationship between precipitation and temperature exceedances is that higher precipitation yields more stormwater runoff, which can increase the temperature of water in Brown's Creek.

The lowest numbers of exceedances per year were observed in 2008 and 2009 (two and four, respectively); these are likely due to lower precipitation (Figure 3) and resulting lower volumes of stormwater runoff, since those years do not co-occur with a change in the Diversion Structure. Further evaluation of these years of data with respect to climatological data was not completed due to a lack of detailed, location-specific climatological data, such as relative humidity, soil and air temperature, and wind speed.

It is also difficult to separate the effects of the Diversion Structure from the influence of air temperature on water temperature exceedances, since 2001 and 2002 were also years of high average daily air temperature (Figure 4).

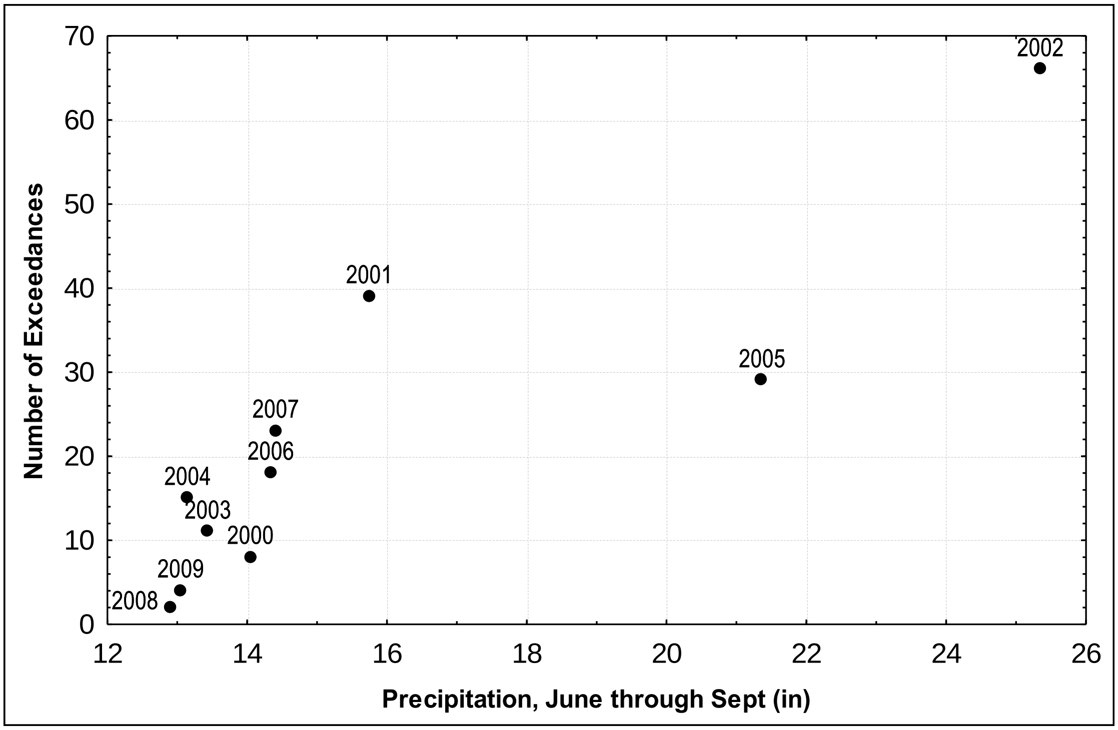

Figure 3. Impact of precipitation on number of temperature exceedances (June-September)

Long-term average June-September precipitation in Stillwater is 18.0 inches.

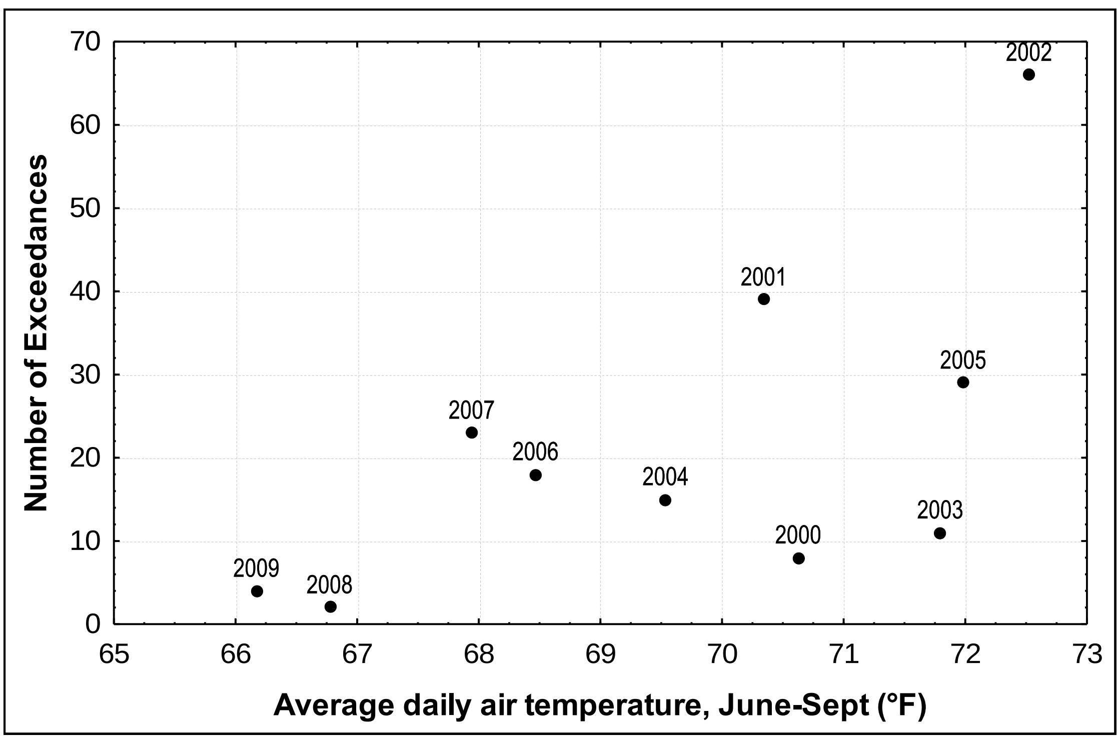

Figure 4. Impact of air temperature on annual number of temperature exceedances (June-September)

In summary, the lower flows and lower water temperatures after 2002 are due to multiple factors, some of which include construction of the Long Lake Diversion Structure, precipitation, and air temperature. Due to the major changes that the Diversion Structure brought to the flows in Brown's Creek, the rest of the data analysis focuses on the time period after 2002.

The distribution of exceedances, in terms of stormflow vs. baseflow, for those exceedances that happened after the Diversion Structure was constructed.

The streamflow conditions at the time of each exceedance were examined to determine the distribution of exceedances, in terms of whether they occur under stormflow or baseflow conditions. Using a daily time-step, the flow was divided into baseflow and stormflow using the sliding interval method from the USGS program HYSEP (Hydrograph Separation). Because very few flow conditions occur that are 100% baseflow or stormflow, this method assigns a percent of the daily flow as baseflow and stormflow. Exceedances were characterized as occurring during stormflow when greater than 50% of the flow was stormflow, and they were characterized as occurring during baseflow when greater than 50% of the flow was baseflow. For example, if the average daily flow rate on July 1 was 13.3 cfs and the HYSEP analysis showed that 8.4 cfs were baseflow, that day would be characterized as a baseflow day since more than half of the flow was baseflow.

Over the years 2003 through 2009, approximately 80% of the exceedances occurred during baseflow conditions, due to factors such as lack of riparian shading, changes in stream geomorphology, decreases in baseflow, and changes in climatic conditions. Approximately 20% of the exceedances occurred during stormflow conditions, due to the thermal load from stormwater, either from direct runoff or through ponds.

To address the exceedances that occur under baseflow conditions, solutions that should be evaluated include increased/improved shading through vegetative buffers, in-stream morphological improvements, and increasing the groundwater contribution to the stream (i.e. re-establishing groundwater connections lost as a result of the Diversion Structure and/or evaluating the impacts that groundwater appropriations for irrigation on golf courses have on the stream). To address the exceedances that occur under stormflow conditions, solutions that should be evaluated include addressing the thermal loads from irrigation ponds and stormwater ponds, retrofitting neighborhoods that currently have little or no stormwater management, and treating areas of direct discharge to the creek (e.g. roads).

Decreasing groundwater contribution

Baseflow was determined using the Sliding Interval (SI) method described in the USGS program Hydrograph Separation (HYSEP). The Sliding Interval (SI) method is a numerical method to evaluate baseflow using monitored flow data. The method finds the lowest flow within a specified time period and assigns that value as the baseflow value over the same time period. Review of ten years of annual baseflow volume determined through hydrograph separation analysis for the WOMP station shows a steady decline in baseflow to Brown's Creek since 2001. The baseflow calculated at the WOMP site decreased from 9 cfs in 2001 to approximately 4.5 cfs in 2009.

During the time frame with decreasing baseflow, annual appropriations located within the Prairie du Chien-Jordan groundwatershed have stayed flat for sole groundwater appropriation, and have slightly increased when including pond appropriations. Determination of the source of the surface water in the appropriation permits should be determined to verify that these waters don't begin as groundwater. From 2000-2009 there was a deficit in precipitation (relative to the 30-year running average) of roughly 8.7 inches. While dryer conditions are likely the primary reason for decreases in baseflow over the 2000-2009 period, additional flow that was once counted as a portion of Brown's Creek annual flow volume is now routed through the Diversion Structure and also contributes to the current trend in baseflow reduction.

Additional analysis is needed to quantify the relative impact of these factors (precipitation, Diversion Structure, and appropriations).[4]

Use of stream temperature models to quantify thermal reductions associated with buffer restoration projects

During the course of the project a simplified thermal model was evaluated to determine whether or not it could be used to quantify the temperature reductions associated with buffer improvement projects proposed in the Implementation Plan Table. The model used for this evaluation is the Stream Segment Temperature Model (SSTEMP) developed by the United States Geological Survey (USGS). SSTEMP may be used to analyze the effects of changing riparian shade or the physical features of a stream. This program handles only single stream segments for a single time period (e.g. month, week, day) for any given model run. The program requires inputs describing the average stream geometry, as well as (steady-state) hydrology and meteorology, and stream shading. It then predicts the mean daily water temperatures at specified distances downstream. It also estimates the daily maximum and minimum temperatures.

The buffer restoration project evaluated using the SSTEMP model is the Oak Glen Golf Course buffer and in-stream restoration project. Given the current state of the stream cross section through this portion of the golf course (turf grass mowed to the edge of the streambank), this project has been targeted by the BCWD as one of the highest priorities for thermal reductions and streambank stabilization. This project would involve the installation of 2.25 acres of buffer and the restoration of 1,300 feet of streambank.

After modeling the proposed project using SSTEMP it was found that the additional shading and in-stream restoration would reduce the predicted daily mean temperature by 2.8 degrees C (5 degrees F) and the maximum daily temperature by 3.3 degrees C (6 degrees F). While these results are useful in quantifying the potential temperature reductions associated with buffer restoration projects, it was decided that the collection of local climatological data would strengthen future modeling efforts. As a result, the SSTEMP model was not used to quantify the potential thermal reductions associated with the rest of the thermal reduction projects identified in the Implementation Plan Table. Instead, the BCWD is committed to monitoring the thermal impacts of this project that is being constructed in 2011-2012. The monitoring will be conducted to assess the performance of the project and to determine how well the actual temperature reductions match the modeled or predicted reductions.

The influence of directly connected ponds and wetlands on the in-stream temperatures during exceedances that happen during a stormflow event

Water temperature in Brown's Creek and in nearby stormwater and irrigation ponds was monitored in 2010 and 2011 to further evaluate the conditions under which the threat temperature was exceeded. A full evaluation of the data can be found in Appendix A; the following is a summary of the conclusions.

[4] Emmons & Olivier Resources, Inc. (2011). Groundwater State of Knowledge Report prepared for the Brown's Creek Watershed District.

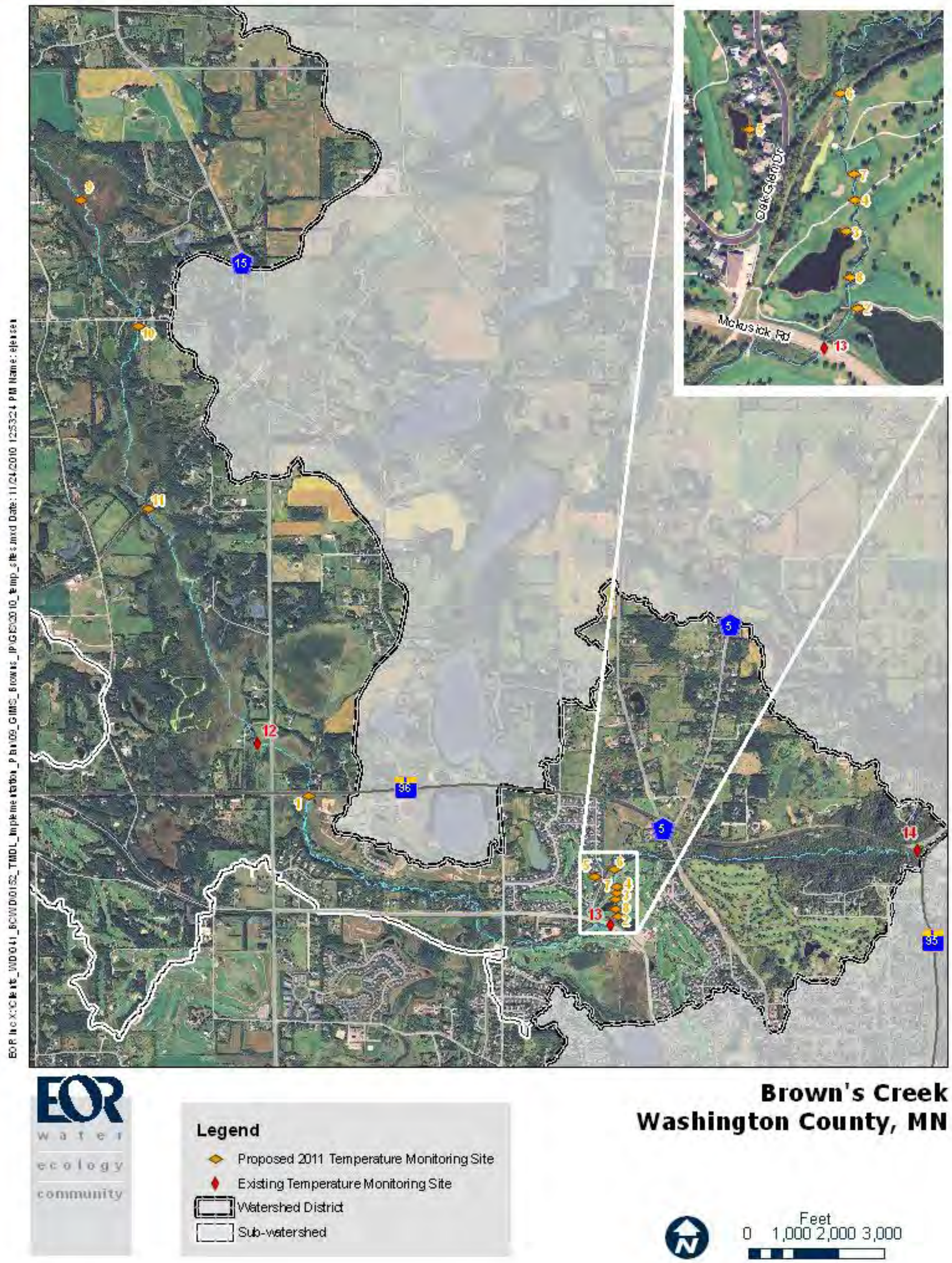

Figure 5. 2011 Additional Thermal Monitoring Sites

The data indicate that the irrigation ponds and the stormwater pond together have a thermal impact to the creek. Whether or not that impact translates into an impact to the biota depends on the amount of precipitation and the air temperature, which in turn impact the magnitude and length of time of the instream temperature increase. For storm events that occurred on days with a maximum air temperature of over 30°C and precipitation over 0.2 inches, an increase in instream temperature was observed. For events with less than 0.2 inches of precipitation on days with less than 22°C for a maximum high, the event did not lead to an increase in temperature. For events that fell in between these two groups, the predictability of whether or not the event leads to an increase in temperature is less certain.

The irrigation ponds and the stormwater pond appear to have similar impacts on the water temperature of Brown's Creek; after some storm events the irrigation ponds increase the temperature more and after other events the stormwater pond does.

The increases in water temperatures observed during this monitoring period in Brown's Creek are typically 1 to 2°C, and last for approximately 2 hours. Since these temperature increases are of a relatively short duration, data were also evaluated with respect to the critical temperature of 23.9°C instead of the threat temperature of 18.3°C. During 2010, instream temperatures of 21.9°C (2°C below the critical temperature) occurred periodically between May 24 and August 31 at the McKusick monitoring site (just upstream of the irrigation ponds); it is during these times that, if a temperature increase of 2°C were to occur, the instream critical temperature could be exceeded for 2 or more hours. If this increase occurs when temperatures are already at the critical temperature, it has the potential to lead to direct fish mortality, and more likely causes physiological stress to the fish. The incremental stress caused by these events can in the long run impact the trout population.

While the data do not suggest that the Mendel Wetland, upstream of Dellwood Road, has more of a thermal impact than the other wetlands along Brown's Creek, there are implementation options (i.e. restoration of the original channel/connection to Brown's Creek) that could cool the water from Mendel Wetland before it reaches the creek given that the current connection to Brown's Creek is a man-made ditch section constructed prior to the 1930's.

This thermal monitoring data was used to better understand the thermal loads associated with existing stormwater management facilities discharging to the creek and to validate the prioritization of retrofitting these ponds for the Implementation Plan Table.

Summary of data analyses

- The Long Lake Diversion Structure rerouted larger flows from Brown's Creek. As a result, the number and magnitude of the exceedances of the threat temperature by the daily average temperature within Brown's Creek decreased. This suggests that storm flows from the Long Lake drainage area contributed to temperature exceedances; these storm flows are no longer contributing to the problem. Analysis of this data led to the decision to use the 2003-2009 data set for future evaluation of exceedances, since these data represent existing conditions.

- Approximately 80% of the temperature exceedances occurred during baseflow conditions, as a result of a lack of riparian shading, changes to stream morphology, decreasing baseflow contributions, and changes in climatic conditions; and approximately 20% occurred during stormflow conditions, due to the thermal load from stormwater, either from direct runoff or through ponds. The development of this 80:20 distribution was used to guide the development of activities in the Implementation Plan.

- Review of annual baseflow volume determined through hydrograph separation analysis for the WOMP station shows a steady decline in baseflow to Brown's Creek since 2001. The baseflow calculated at the WOMP site decreased from 9 cfs in 2001 to approximately 4.5 cfs in 2009. Decreases in baseflow contribution to the creek influence the water temperature in Brown's Creek, since a lower baseflow provides less cooler water to dilute the thermal loads in the summer.

- An SSTEMP model was used to quantify the potential thermal reductions of a buffer and stream restoration project on the Oak Glen Golf Course: additional shading and in-stream restoration would reduce the daily mean temperature by 0.3 degrees C and the maximum daily temperature by 3 degrees C. Upon completion of this exercise, it was determined that the collection of local climatological data would strengthen the results of future thermal modeling work. As a result, this model was not used to quantify the potential thermal reductions associated with the other activities identified in the Implementation Plan.
- The irrigation ponds and the stormwater pond together have a thermal impact to the creek, at times the impact of one is greater and at times the impact of the other is greater. This information was used to prioritize activities identified in the Implementation Plan.

4 SUSPENDED SEDIMENT

4.1 TMDL Summary: Sources, Standards, and Allocations

The Brown's Creek Stressor ID indicated that TSS is a primary stressor to the coldwater fish species in Brown's Creek. The stressor ID concluded that the TSS is mostly generated in the watershed. The most likely causes of high TSS in watershed runoff are landscape alterations in the watershed including a high percentage of impervious surfaces and decreased bank vegetation that does not adequately filter the runoff.

Numeric state standards for TSS in streams do not exist in Minnesota. To translate the narrative standard into a numeric goal, a TSS equivalent of the turbidity standard was used. The Class 2A water quality standard for turbidity set by the State of Minnesota is 10 NTU, which corresponds to approximately 23 mg/L TSS in Brown's Creek. The TSS goal for the Brown's Creek Biotic TMDL was set at 23 mg/l TSS.

The summary of TSS TMDL allocations in Table 6 shows the LA and the individual WLAs for the five different flow regimes in Brown's Creek. These allocations represent loading limits for different TSS sources. TSS loads within the contributing drainage area, which includes both the regulated and non-regulated portions of municipalities, need to be reduced by 74% on average in order to meet these loading limits. This reduction was based on the average monitored TSS loading rate at the downstream monitoring site (285 lb/ac-yr) relative to the TSS loading rate goal (74 lbs/ac-yr).

To take into account variable loading rates across the direct drainage area to Brown's Creek and to provide more focused guidance as to where the reductions are needed in order to meet the TSS goal, *subwatershed reduction goals* were developed through the use of a P8 model, which was calibrated to Brown's Creek monitoring data.

Table 6. TSS Load and Wasteload Allocation Summary

Source		TMDL (lbs/day)				
		High Flows	Moist Conditions	Mid-Range Flows	Dry Conditions	Low Flows
		81.3 - 17.5 cfs	17.5 - 9.7 cfs	9.7 - 7.6 cfs	7.6-5.9 cfs	5.9 - 0.0 cfs
LA		2,800	1,313	946	757	617
WLA – Permitted stormwater						
MS4 or other source	Permit #					
Lake Elmo	MS400098	1.1	0.5	0.4	0.3	0.2
Oak Park Heights	Future	7.0	3.3	2.4	1.9	1.5
Stillwater	MS400259	296	139	100	80	65
Construction stormwater	Various	0.3	0.1	0.1	0.1	0.1
Industrial stormwater	No current permitted sources	0.3	0.1	0.1	0.1	0.1
Total		**3,105**	**1,456**	**1,049**	**839**	**684**

4.2 Additional Data Analysis

While investigating options for decreasing TSS loads to Brown's Creek, a discrepancy was found between the TSS load monitored at the WOMP site and visible TSS sources in the watershed. Visible sources of TSS in the watershed were evaluated using the District's history of known instabilities along the creek, sediment and erosion control inventories conducted along the creek, previous site visits, a review of the aerial photography in conjunction with the District's H/H model and the City of Stillwater's Local Surface Water Management Plan (to identify areas in need of stormwater treatment and areas suitable for retrofits), a windshield survey of the entire contributing drainage area, and input received at the Stakeholder Meeting and the Open House. While TSS sources were identified in the landscape and in-stream, they were not enough to account for the high concentrations that were monitored. In addition, a field survey showed several subwatersheds that are landlocked that had not been considered landlocked during the development of the subwatershed loading goals in the TMDL. As a result, an evaluation of the monitoring protocol was conducted and the subwatershed loading goals presented in the TMDL were re-calculated for the Implementation Plan.

TSS monitoring data

TSS monitoring data were further evaluated to investigate the discrepancy of monitored loads vs. observed sources. TSS is sampled in Brown's Creek with two different methods – the use of an automated sampler and manual grab sampling. Since suspended solids concentration is strongly influenced by the location of the intake within the depth of the flow[5], results from the two different methods were compared. The TSS concentrations in the samples taken through the automated sampler were on average higher than the samples taken as manual grab samples. Some of these differences were

[5] Mohseni, O., J.S. Gulliver, and P.T. Weiss. (2010). Automatic sampling of water containing suspended solids. In J.S. Gulliver, A.J. Erickson, and P.T. Weiss (Eds.), *Stormwater Treatment: Assessment and Maintenance.* University of Minnesota, St. Anthony Falls Laboratory. Minneapolis, MN.
http://stormwaterbook.safl.umn.edu/content/automatic-sampling-water-containing-suspended-solids

attributed to the fact that baseflow had in the past been sampled using an automated sampler. This practice was discontinued in 2007 because the intake from the sampler can take in small amounts of sediment from the stream bed. Under high flow conditions, this amount of sediment is negligible compared to the total amount of sediment in the flow due to the turbulence from the high flow. However, under baseflow conditions the sediment taken in can artificially elevate the amount of sediment measured in the sample.

Some of the differences were attributed to the types of storms that were captured with the automatic sampling equipment as compared to those captured through manual grab samples. The automatic samplers are triggered at a certain flow. If a small storm event does not trigger the samplers, then a manual grab sample is taken. Since the manual grab samples are often from smaller storms, which on average have lower concentrations of total suspended solids than the larger storms have, the pattern seen with lower sediment concentrations from the manual grab samples is expected.

The existing data on Brown’s Creek are currently the most accurate data available and remain as the basis of the TMDL and Implementation Plan.

Update of subwatershed loading goals

The subwatershed loading goals provided in the TMDL were updated to 1) account for the newly identified landlocked subwatersheds, and 2) distribute the loading goals by community within each subwatershed. Figure 6 identifies the updated subwatershed loading goals, and each community’s individual loading goals are listed in Table 12 (page 59).

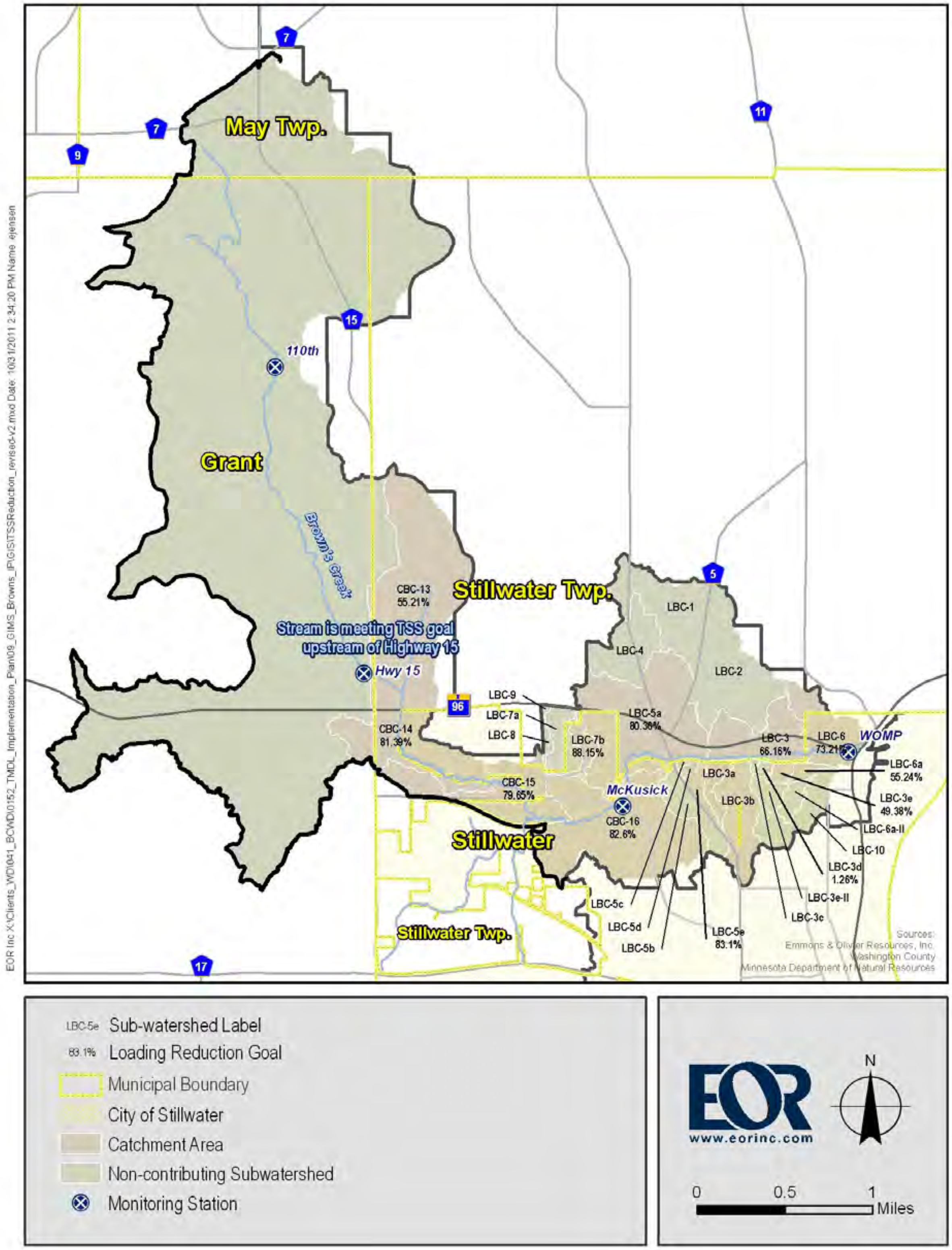

Figure 6. Revised Subwatershed Loading Goals

Summary of Data Analysis

- TSS sources were identified in the landscape and in the stream corridor, but they were not enough to account for the high concentrations that were monitored.
- Sampling suspended solids concentration is strongly influenced by the location of the intake within the depth of the flow. The existing data on Brown's Creek are currently the most accurate data available and remain as the basis of the TMDL and Implementation Plan. The District will evaluate options for new sampling equipment as research makes it available.
- A field survey showed several additional subwatersheds that are landlocked that had not been considered landlocked during the development of the subwatershed loading goals in the TMDL. The subwatershed loading goals were updated to account for this.

5 COPPER

5.1 Summary of TMDL Analysis

Copper was identified as one of the primary stressors, along with suspended solids and high temperatures, in the stressor identification report as part of the TMDL study. After completion of the stressor identification report, it came to the attention of project staff that the copper monitoring data were not collected and analyzed according to approved EPA methods that the Minnesota Pollution Control Agency (MPCA) requires for assessment of impaired waters (EPA 1638 for sample collection and EPA 1669 for sample analysis). While copper still may be a stressor on the creek's biota, TMDL allocations were not set for copper since monitoring data using approved methods are needed before it is confirmed as a primary stressor and allocations are set.

The assessment of Brown's Creek used the maximum standard value as the primary standard. The maximum standard is evaluated by the MPCA as a one-day average. Available copper monitoring points were sparse and not continuous. The chronic standard was exceeded most often (it is the lowest level) but requires continuous data for proper assessment. The final acute value was reached in a few monitoring cases, but is also inappropriate as a standard for Brown's Creek because no large scale die-offs were observed. The nature of the data (short spikes of copper) and observed effects (inability of trout to establish) make the maximum standard value the most fitting value at this point.

5.2 Additional Analysis

Source analysis

In an effort to identify the sources of copper to Brown's Creek, a set of questions was developed to identify the application of copper-containing products including algaecides, herbicides, pesticides, and fungicides. Questions were posed to the Oak Glen Golf Club, Stillwater Country Club, the City of Stillwater, and Grant Township, either during in-person meetings or over the phone. None of the entities stated that they used copper-containing products in their maintenance program.

Data analysis

Review of the 2008 through 2010 copper data showed exceedances of the maximum standard at the Diversion monitoring site (Figure 7). The drainage area to the Diversion structure will only contribute to the creek for events greater than the 1.5-year event (under fully developed conditions) and therefore is not a focus for this implementation plan. However, data from the Diversion site are included here because these copper concentrations could reach Brown's Creek in the future or for larger storm events (i.e. events exceeding the 5-year 24-hour rainfall event under current development conditions). All of the exceedances were either from grab snowmelt samples or composite stormwater samples from the following dates: 3-17-09, 8-19-09, 6-22-10, 6-24-10, 6-25-10, and 8-10-10. None were taken during baseflow.

However, since the data were not collected and analyzed according to approved EPA methods that the MPCA requires for assessment of impaired waters, there are no management recommendations for copper load reductions at this time.

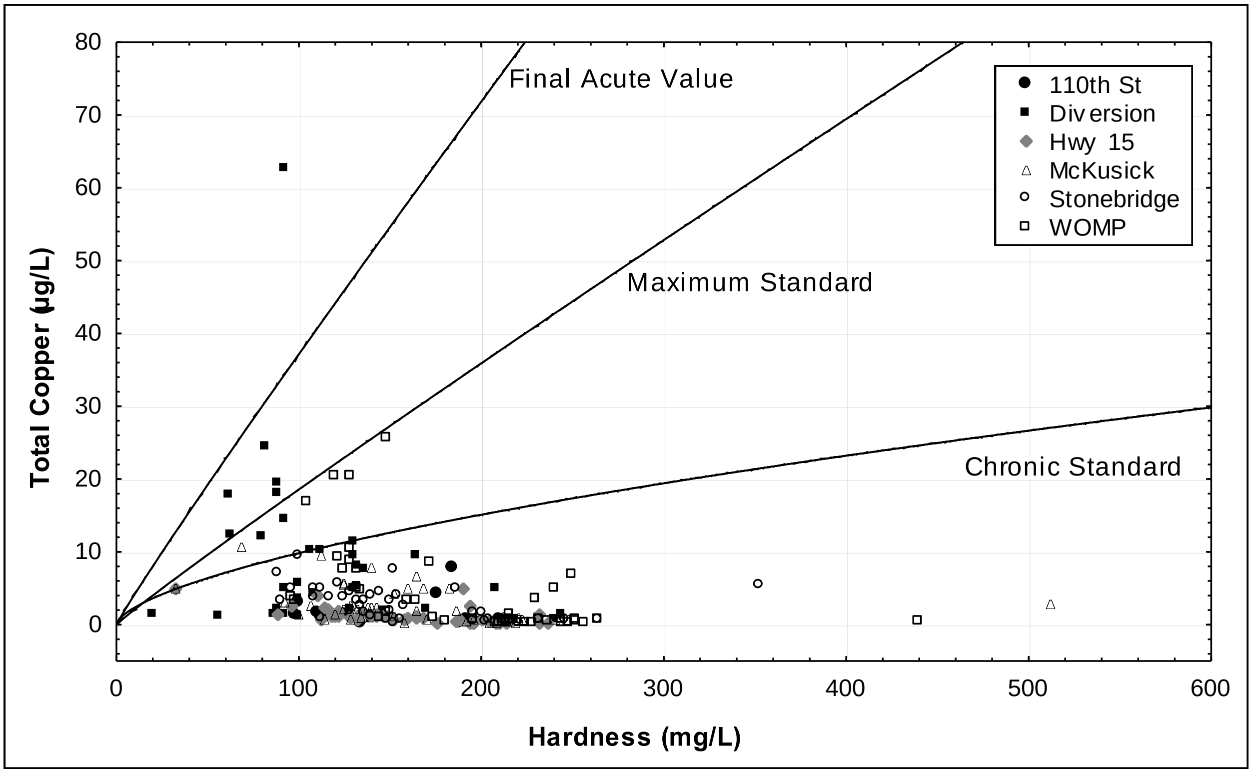

Figure 7. Copper concentrations monitored in Brown's Creek, 2008 through 2010

Summary of data analysis

- None of the entities interviewed in the Brown's Creek watershed said that they used copper-containing products in their maintenance program.
- The maximum copper standard was exceeded at the Diversion monitoring site multiple times from 2008 through 2010. However, since the data were not collected and analyzed according to approved EPA methods that the MPCA requires for assessment of impaired waters, there are no management recommendations for copper load reductions at this time.

6 IMPLEMENTATION APPROACH

The loading goals presented in this implementation plan are designed such that, if achieved, the cold water assemblage would be restored in Brown's Creek. However, achieving these load reduction goals does not necessarily guarantee restoration of the cold water assemblage. If the loading goals are achieved and the cold water assemblage is not restored, the relationship between the loading goals, the biota, and habitat in Brown's Creek will be re-examined to determine the feasibility of restoration of the cold water assemblage and the classification of Brown's Creek as a Class 2A water.

6.1 Adaptive Management

The BCWD has committed to taking an adaptive management decision-making approach to the Brown's Creek TMDL. The BCWD will adopt an iterative process as it implements the Brown's Creek TMDL Implementation Plan. This iterative process will include on-going monitoring (to inform performance assessment and additional source identification), outreach and technical assistance, identification of additional implementation activities, prioritization, and implementation. Given the uncertainty in the identification of TSS loads to the creek and in quantifying thermal reductions associated with recommended implementation activities, the goal will be to reduce the uncertainty over the course of the project by monitoring the system while implementing the projects recommended here. This process will provide the BCWD and its member communities with a means of continually tracking progress and informing subsequent implementation projects. The result of the adaptive management process will either be that new sources of TSS are identified and additional management practices will be recommended to address those sources, and/or that the TMDL overestimated the load reductions needed. In the latter case, the TMDL (including WLAs and LAs) can be updated to reflect the new findings.

As a result, it will be important that all activities or projects in the contributing drainage area that reduce TSS or thermal loads to the creek be documented and tracked. Annual monitoring of in-stream water quality, temperature, and biota will be continued while a thorough evaluation of the monitoring data will be conducted every five years. Annual variability in climatic conditions and potential lag time for BMPs to achieve full load reduction potential will need to be considered in assessing the data.

6.2 Summary of Regulatory and Non-Regulatory Goals

There are eight communities in the Brown's Creek Watershed District. In addition, Washington County and the Minnesota Department of Transportation have infrastructure located in the watershed. Each of these entities plays a role in the health of Brown's Creek and as a result each of these entities will have a role in the implementation of this Plan. Table 7 summarizes what each of these entities' roles will be in achieving the goals for TSS and thermal load to Brown's Creek by identifying whether or not the entity is a regulated Municipal Separate Storm Sewer System (MS4), has a wasteload allocation (WLA), load allocation (LA), or no net pollutant increase (0% reduction) requirement. Subsequent sections of the Plan will describe the specific WLAs in more detail.

Table 7. Summary of Regulatory and Non-regulatory Goals for each LGU/agency

LGU/Agency	Regulated MS4	WLA in TMDL	TSS Load Reduction Goals	Thermal Load Reduction Goals
City of Stillwater	Y	Y	> 0%[4]	6%
City of Oak Park Heights	N	Y[1]	0%	0%
City of Lake Elmo	Y	Y	0%	0%
City of Grant	Y	N[2]	> 0%[4]	0%
City of Hugo	Y	N[2]	0%	0%
May Township	N	N	0%	0%
Stillwater Township	N	N	> 0%[4]	6%
Baytown Township	N	N	0%	0%
Washington County	Y	N[3]	> 0%[4]	6%
MnDOT	Y	N[3]	> 0%[4]	6%

[1] The City of Oak Park Heights, while not currently a regulated MS4 community, may come under permit coverage in the near future and was provided a WLA in the TMDL. The WLA will be in effect only after the city comes under coverage of the MS4 permit.

[2] Whereas the City of Grant and the City of Hugo are regulated MS4 communities, they were not assigned a WLA for this TMDL since they do not have any regulated stormwater conveyances within the watershed. While they still have loading goals in the TMDL Implementation Plan, these loading goals will not be enforceable through the MS4 permit, and the city will not have to report on achievement towards those goals in their MS4 reporting to MPCA.

[3] The MS4 permit for Washington County and MnDOT applies to areas within the U.S. Census Urban Area, and the Brown's Creek watershed falls outside of the U.S. Census Urban Area.

[4] see Figure 6 for load reduction goals by subwatershed

While the MS4 entities will be required to meet the WLA established in this Plan (as described in the following section), it is the BCWD's expectation that the other communities will do their share in addressing the TSS and thermal loads coming from within their municipal boundaries.

6.3 MS4 Tracking and Meeting WLAs

MS4s are defined by the MPCA as conveyance systems owned or operated by an entity such as a state, city, town, county, district, or other public body having jurisdiction over disposal of stormwater or other wastes. A conveyance system includes ditches, roads, storm sewers, stormwater ponds, etc. Certain MS4 discharges are regulated by NPDES/SDS permits administered by the MPCA. The most current MS4 permit is expired, but the regulated communities will continue to operate under the conditions of the expired permit until a new permit is approved. The current (expired) MS4 permit requires regulated communities to review the adequacy of their Storm Water Pollution Prevention Program (SWPPP) to meet a TMDL's WLA for stormwater sources. If the SWPPP does not meet the applicable requirements, schedules, and objectives of the TMDL the SWPPP must be modified within 18 months after the TMDL is approved.

In May 2011, the MPCA released the draft permit, "General permit authorization to discharge stormwater associated with small municipal separate storm sewer systems under the National Pollutant Discharge Elimination System / State Disposal System (NPDES / SDS) permit program." Once approved, the new permit will serve as the regulatory link between a TMDL WLA and a regulated MS4 community.

The TMDL was based on data through 2007; therefore any activities implemented after 2007 that lead to a reduction in sediment or thermal loads to Brown's Creek may be considered as progress towards meeting a WLA or LA.

The Implementation Plan Table (Table 11) details the projects, activities, and programs that the regulated communities will complete in order to reduce suspended sediment and thermal loading to Brown's Creek. The table identifies which projects, activities, and programs apply to regulated sources (WLA) and which applied to non-regulated sources (LA). The regulated communities will likely need to document progress being made within their jurisdiction towards meeting the WLAs. More information regarding expectations for regulated MS4s will be included in the new MS4 permit.

6.4 Watershed Management Plan, WD Rules, and Cooperative Agreements

The Brown's Creek Watershed District's 3rd Generation Watershed Management Plan was adopted by the Board on January 27, 2007. This Plan will be in effect until the 4th Generation Watershed Management Plan is developed for adoption in 2016. In the interim the BCWD intends to conduct a major plan amendment to incorporate the findings of the TMDL report and the TMDL Implementation Plan so that the District can begin implementing the specific projects identified in the Implementation Plan Table.

The Brown's Creek Watershed District Rules (May 1, 2007) contain stormwater management, erosion and sediment control, and buffer standards that will provide the controls needed to meet the no net increase requirements of the TMDL (see Table 4 and Figure 6) for most new development and re-development activity. These standards include:

- No increase in annual phosphorus loading from pre-development conditions
- Volume control for the 2-year 24-hour rainfall event as compared to pre-settlement conditions
- Stormwater temperature discharge requirements for facilities proposed within the contributing drainage area to a groundwater-dependent natural resource (e.g. Brown's Creek)
- Buffer zone widths for Brown's Creek of 50 feet for the streamside zone, 100 feet for the middle zone and an outer zone corresponding to the upland edge of the idle zone to the structure setback line under the applicable shoreland ordinance
- Erosion and sediment control standards. Construction stormwater BMPs will be an important component of the BCWD TSS implementation plan. Currently, the BCWD issues permits and conducts inspections on all major construction within the district. The District's permitting program ensures that erosion and sediment control BMPs are in place and functioning properly, thus reducing the potential for sediment loading to the creek.
- There is a provision in the Applicability Requirements stating that the stormwater management requirements apply to "land disturbance of 5,000 square feet or more within the surface water contributing area of a groundwater dependent natural resource".

The communities with a no-net increase goal for TSS and thermal load include the cities of Oak Park Heights, Lake Elmo, Grant, and Hugo, May Township, and Baytown Township (Table 7). The types of activities that are not regulated under the BCWD's rules in these areas include:

- Residential subdivision or development under four lots
- Non-residential development creating less than an acre of impervious surface
- Redevelopment on a site less than 5 acres in size
- Creation of less than 5,000 square feet of additional impervious surface appurtenant to existing non-residential development
- Linear projects that are less than one acre in size

It is assumed that these exemptions will be a minimal issue for these areas because there is little developable land left in some of these communities; some of these communities drain to the Diversion Structure (and are therefore non-contributing up to the 5-year 24-hour rainfall event); and rural (single-family) residential development requires one unit per ten acres of land which could potentially have a minimal effect on downstream water quality. In any case, the BCWD will work with the communities to mitigate any additional contributions in TSS and thermal loads as a result of unpermitted development and/or re-development activity.

An additional factor to consider while discussing the BCWD’s Rules and Regulations is the *Revised Cooperative Agreement for a Project to Manage Stormwater and Protect Water Quality in the Brown’s Creek Watershed, Washington County, Minnesota.* This Revised Cooperative Agreement between the City of Stillwater, the City of Oak Park Heights, and the Brown’s Creek Watershed District went into effect on August 7, 2003. In summary, this agreement states that portions of the City of Stillwater and Oak Park Heights are exempt from the District’s volume control standards since is has been agreed that the “Trout Stream Mitigation Project (TSMP) as designed will manage surface water flows…so as to protect Brown’s Creek, its tributaries and the other water resources within the watershed.” For the reasons stated above it is assumed that the exception provided by this Cooperative Agreement will have a minimal impact on the water quality of Brown’s Creek. While there are three areas in the City of Stillwater that do not drain to the Diversion Structure but are exempt from the volume control requirement under the Cooperative Agreement, these too will have minimal impact on the quality of Brown’s Creek because they were either developed prior to execution of the Cooperative Agreement or, as in the case of the Millbrook Development, ended up complying with the District’s volume control standard.

7 IMPLEMENTATION PARTNERS, ROLES & RESPONSIBILITIES

Implementation of this Plan will be a joint effort among those entities contributing to the health of Brown’s Creek. The Implementation Plan identifies those project partners that have a WLA or LA assigned to them and/or own property that currently contributes to the impairment and are expected to participate in the implementation of activities identified in the Plan. These project partners are described below. In addition to the partners listed below there are numerous others that the BCWD intends to reach out to during implementation of the Plan including homeowners associations, Trout Unlimited, the St. Croix River Association, the Washington Conservation District, the Natural Resources Conservation Service, the Board of Water and Soil Resources and the Minnesota Pollution Control Agency. These partners may provide technical assistance in meeting load reductions, provide additional education and outreach, and/or provide sources of funding for implementation.

- **Brown’s Creek Watershed District** – Responsible for the management of surface and groundwater resources in the District
- **City of Stillwater** – Currently the City of Stillwater contributes approximately half of the TSS load to Brown’s Creek. As a result, the City’s role in implementation of this Plan will be to implement and/or partner in the implementation of activities identified in this Plan (as well as future Plan amendments) and provide information to the BCWD annually to track performance towards meeting the loading goals. Member communities will be responsible for tracking TSS and thermal impacts of all development activity occurring within their municipal boundary. In addition, the City’s role may increase as portions of Stillwater Township are annexed into the City of Stillwater.
- **City of Oak Park Heights** – This community has a 0% reduction goal. While it is anticipated that the District’s Rules and Regulations will facilitate meeting this goal, the City of Oak Park Heights may be requested to partner in the implementation of activities identified in subsequent

versions of the Implementation Plan. Member communities will be responsible for tracking TSS and thermal impacts of all development activity occurring within their municipal boundary.

- **City of Lake Elmo -** This community has a 0% reduction goal. While it is anticipated that the District's Rules and Regulations will facilitate meeting this goal, the City of Lake Elmo may be requested to partner in the implementation of activities identified in subsequent versions of the Implementation Plan. Member communities will be responsible for tracking TSS and thermal impacts of all development activity occurring within their municipal boundary.
- **City of Grant** – While the City of Grant is not currently contributing to the TSS and thermal loads, it is required to meet a no net increase in TSS and thermal contributions to the creek. Member communities will be responsible for tracking TSS and thermal impacts of all development activity occurring within their municipal boundary.
- **City of Hugo -** This community has a 0% reduction goal. While it is anticipated that the District's Rules and Regulations will facilitate meeting this goal, the City of Hugo may be requested to partner in the implementation of activities identified in subsequent versions of the Implementation Plan. Member communities will be responsible for tracking TSS and thermal impacts of all development activity occurring within their municipal boundary.
- **May Township -** This community has a 0% reduction goal. While it is anticipated that the District's Rules and Regulations will facilitate meeting this goal, May Township may be requested to partner in the implementation of activities identified in subsequent versions of the Implementation Plan. Member communities will be responsible for tracking TSS and thermal impacts of all development activity occurring within their municipal boundary.
- **Stillwater Township** – Currently Stillwater Township contributes approximately half of the TSS load to Brown's Creek. As a result, the Township's role in implementation of this Plan will be to implement and/or partner in the implementation of activities identified in this Plan (as well as future Plan amendments) and provide information to the BCWD annually to track performance towards meeting the loading goals. Member communities will be responsible for tracking TSS and thermal impacts of all development activity occurring within their municipal boundary. In the future, as more of Stillwater Township is annexed by the City of Stillwater, its role in implementation of the Plan may decrease (as these responsibilities shift to the City of Stillwater).
- **Baytown Township** – With only one acre of the township located in the BCWD, this community will play a very minor role in the implementation of the Plan.
- **Washington County** – Contains infrastructure in the area of focus for the Brown's Creek Implementation Plan
- **Minnesota Department of Transportation** - Contains infrastructure in the area of focus for the Brown's Creek Implementation Plan
- **Minnesota Department of Natural Resources** – Owns land adjacent to the creek which may or may not contribute to TSS and thermal loads. These public lands may also be the site of future implementation activities.
- **Citizens of the Brown's Creek Watershed District** – Conduct activities that may or may not contribute to the TSS and thermal loads in the creek.

Given the Brown's Creek Watershed District's role in surface water management, the development of the TMDL Report and Implementation Plan, and watershed wide monitoring and evaluation activities, the BCWD will coordinate BMP implementation tracking and report progress towards meeting the TMDL requirements.

Each year the BCWD will invite all of the Implementation Partners to a TMDL Implementation meeting. It is expected that member communities, Washington County, and MnDOT will submit a summary of BMP projects/initiatives completed in the previous year and the anticipated TSS reductions to the creek. (Thermal load reductions will not be tracked quantitatively.) Using the Implementation Plan Table (Table 11), BMPs will be catalogued to track progress toward the individual wasteload and load reduction goals. These annual meetings will also be used to discuss progress towards achieving the goals of the TMDL Implementation Plan, discuss TSS and thermal load source evaluations, and discuss additional opportunities for load reductions that may not have been previously identified.

8 OVERALL IMPLEMENTATION PLAN

The focus of the Brown's Creek Implementation Plan is on reducing TSS and thermal loads to Brown's Creek through structural BMPs, non-structural BMPs, and education and outreach. The overall goals of the Brown's Creek TMDL Implementation Plan are as follows:

1. Restore biological integrity
2. Control external load (TSS and thermal)
3. Control internal load (TSS and thermal)
4. Retrofit BMPs in the watershed as opportunities arise
5. Foster stewardship
6. Communicate with the public

Implementation will be a joint effort, with the BCWD taking responsibility for on-going coordination, general monitoring, and education activities. In addition, the BCWD will take the lead on the implementation of all of the activities identified in the current draft of the Implementation Plan with the exception of a couple of projects that for a variety of reasons make more sense for the Local Units of Government (LGUs) to conduct (e.g. projects previously identified by the city for implementation, or projects that are exclusively within the city or county's existing infrastructure system). The Cities of Stillwater and Lake Elmo will incorporate these BMPs into their Storm Water Pollution Prevention Programs (SWPPP), which will include meeting the six Minimum Control Measures, and will work with the BCWD to periodically assess progress toward advancing the overall goals of the Implementation Plan detailed above.

There were a number of challenges to the development of this Implementation Plan: the inability to identify all of the sources of TSS to Brown's Creek and the inability to quantify the thermal load reductions associated with the proposed BMPs. It is anticipated that implementation of the projects in the Implementation Plan will achieve 25% of TSS reductions needed. Until the biotic community in Brown's Creek is restored, the BCWD, in partnership with its member communities, Washington County, and MnDOT, will implement an adaptive management decision-making approach to address the impairments in Brown's Creek.

8.1 Implementation Plan Layout

The Implementation Plan Table (Table 11) contains the following information:

- Proposed Projects
- Project Description
- Subwatershed ID
- Community
- Estimated Load Reductions: TSS
- Estimated Load Reductions: Thermal
- Estimated Volume Reduction
- Estimated Costs: Engineering, Construction and Operation & Maintenance
- Schedule of Implementation
- Allocation Tracking
- Applicability to Stillwater's ORVW Requirements
- Responsible Parties: Implementation, O&M and Monitoring
- Project Partners

The following sections describe these Implementation Plan components in greater detail.

8.2 Accounting for Existing BMPs

The TMDL report was based on data through 2007; therefore any activities implemented after 2007 that lead to a reduction in sediment or thermal loads to Brown's Creek may be considered as progress towards meeting a WLA or LA.

The following structural BMPs have been constructed in the watershed district since 2007. The estimated load reductions associated with each of these projects is included in the Implementation Plan Table (Table 11).

- **Stillwater Country Club (SCC) BMPs –** The Stillwater Country Club, in conjunction with the BCWD, installed several stormwater BMPs in their golf course. The BMPs include native plantings and raingardens.
- **City of Stillwater 2010 Street Improvement Raingardens –** A total of 21 residential raingardens were recently installed by the City of Stillwater in the neighborhood west of the Oak Glen golf course.
- **BCWD Permit Program** – Since 2007 there have been seven permits issued by the Brown's Creek Watershed District that triggered Rule 2.0 Stormwater Management. Of these seven permits, two expired or did not complete the permitting process. The remaining permits met the District's Rules and Regulations and should result (post-construction) in a no net increase in TSS and thermal loads to the creek. In one case, Millbrook Development, the stormwater management plan exceeded the District's Rules and Regulations as stated in the description below.
    - **Millbrook Development** –Development located on the south side of Dellwood Avenue North, just east of Manning Avenue North. The site is in the City of Stillwater as part of Phase 3 of the Stillwater Orderly Annexation. The 140-acre site straddles the watershed

boundary dividing the Carnelian Marine St. Croix Watershed District (48 acres) and the Brown's Creek Watershed District (92 acres). The proposed project entailed development of both single and multi-family residential houses totaling 270 units. With the exception of the multi-family homes, the majority of the lots in this development will average about ¼ acre. The project directed 11.8 acres of drainage from CMSCWD into BCWD. The stormwater management plan exceeded the Districts (2000) Stormwater Rules and Regulations by providing volume reduction up to the 10-year 24-hour rainfall event.

- **BCWD BMP Cost-Share Incentive Program** – The following residents have installed stormwater BMPs on their properties since 2007:
  - **Windisch Residence** (8991 Oakhill Avenue North, Stillwater, MN) installed a raingarden that captures the 1-inch 24-hour rainfall event from 2,400 sq ft of impervious surface and two rain barrels in 2011.
  - **Wilson Residence** (2355 Walnut Creek Drive, Stillwater, MN) installed a raingarden that captures the runoff from the house generated for the 1-inch 24-hour rainfall event and a 2,765 sq ft native planting bed in 2011.
  - **Gartner Residence** (12670 McKusick Road North, Stillwater, MN) conducted a prairie restoration project totaling 0.69 acres in size in 2011.
- **Stormwater Pond Excavation on Oak Glen Golf Course -** The City of Stillwater excavated an existing pond located off Oak Glen Drive about 800 feet north of McKusick Road in 2008. The pond is about ¾ acre in size and collects drainage from the residential area along Oak Glen Drive. The project included dewatering of the pond, excavation of accumulated material, and restoration of the site. Outflow from the pond drains through an approximately 400 foot long wetland/ditch complex prior to entering Brown's Creek. This excavation was not included in the accounting of TSS reductions as this activity is a standard maintenance practice and was already assumed in the water quality model.

The following non-structural activities have taken place in the watershed district since 2007. These activities were not included in the TMDL Implementation Plan accounting to date as additional information is required from the City of Stillwater and Stillwater Township in order to quantify corresponding reductions. These activities can be used to document progress toward meeting a WLA or LA.

- **Street Sweeping –** Street sweeping occurs twice a year (spring after snowmelt and autumn after tree leaf-off) on the City of Stillwater streets within the watershed. The City of Stillwater has a process in which areas can be classified as Storm Water Quality areas and will be swept every two weeks. The City of Stillwater acquired a vacuum sweeper in 2008/2009 to improve street sweeping efficiencies. Sweeping of Washington County roads within the watershed is done at least one time a year.
- **Sand Application** – Since 2008, Stillwater Township has reduced the amount of sand applied to the streets. The City of Stillwater and MnDOT do not apply sand for winter road conditions. **Education and Outreach** – As Section 8.16 Education and Outreach indicates, the BCWD has been a partner of the East Metro Water Resource Education Program (EMWREP) since its inception. Program activities include efforts such as community events, student programs, mailings, newspaper columns, press releases, city newsletter articles, websites and social media. While it is difficult if not impossible to measure the estimated load reductions associated with these activities it is clear that there will be some reduction in TSS loads to the creek as a result of this program. Future rsearch or monitoring efforts may be conducted to more specifically assign load reductions to these activities.

8.3 Selection of Load Reduction Activities

The selection of load reduction activities in the contributing drainage area to Brown's Creek was based on the District's history of known instabilities along the creek, sediment and erosion control inventories conducted along the creek, previous site visits, a review of the aerial photography in conjunction with the District's H/H model and the City of Stillwater's Local Surface Water Management Plan (to identify areas in need of stormwater treatment and areas suitable for retrofits), a windshield survey of the entire contributing drainage area, and input received at the Stakeholder Meeting and the Open House. In addition, it included a review of the literature for BMPs used to address thermal loads to cold water fisheries and from stormwater management facilities (Appendix B). The overall goal for the selection of load reduction activities was to control external and internal loads to the creek, including the identification of retrofit opportunities in the watershed.

This section of the Plan describes the structural and non-structural load reduction activities identified in the Implementation Plan Table to address the internal and external TSS and thermal loads to Brown's Creek.

Structural TSS Load Reduction Activities:

The focus of TSS load reductions will be on known sources of TSS. Given that it was difficult to find sources in the watershed, greater emphasis has been placed on sources in or near the creek than what was previously identified in the TMDL report. For example, TSS implementation activities have been identified to address in-stream erosion, bluff and ravine instabilities and untreated direct drainage areas. Per the adaptvie management approach, the BCWD will continue to look for additional sources of TSS in the watershed and develop implementation activities to address these loads. Figure 8 identifies the locations of the implementation activities which are further described below. The estimated load reductions associated with each of these projects is included in the Implementation Plan Table (Table 11).

- **Water Quality Practices:** Water quality practices should be located in untreated catchments to remove sediment prior to runoff reaching the creek. These practices will be designed to maximize settling of sediment particles and to limit the thermal impact on the creek (e.g. by infiltrating stormwater runoff, and/or designing with bottom outlets and shading vegetation). There are three proposed stormwater BMP projects identified in the Implementation Plan:
  - **Countryside Repair -** One of the proposed new ponds is located behind Countryside Repair which is just upstream of McKusick Road. The site contains approximately 2 acres of gravel parking surface that contributes loads to the creek. Buffers, raingardens, or wetlands could be used on this site to minimize the impact of runoff from this site. A strategically positioned BMP near the creek could treat additional runoff from McKusick Road as well.
  - **Oakhill Avenue BMPs** – It is proposed that one or more stormwater BMPs (e.g. pond, raingarden, sediment trap) be located at both the northwest corner and the northeast corner of the intersection of Hwy 96 and Oakhill Avenue. Both of these areas receive drainage from the large lot development via a gravel road before sending the runoff to Brown's Creek via two separate culverts under Hwy 96.
  - **Neal Avenue Stormwater Area -** An untreated residential development exists on Neal Avenue south of the creek. The eastern right-of-way provides area to install infiltration trenches that can be sized to capture the 1-inch of runoff from the impervious surfaces within the drainage area. Estimated load reductions provided in the Implementation Plan Table assume the construction of four infiltration trenches.
- **Pond Retrofits:** Existing water quality ponds within the watershed will be evaluated to determine if their residence time and sediment settling function can be increased. Pond outlet configurations will

potentially be modified to further trap sediment within the ponds. These retrofits may include the addition of a filtration/infiltration ring around the perimeter of the pond to benefit both temperature and promote sediment capture. There are eight pond retrofit projects identified in the Implementation Plan:

- P1065 – Pond located on the Oak Glen Golf Course to the east of McKusick Road, P1045 and P1044.
- P1045 – Pond located on the Oak Glen Golf Course to the east of McKusick Road and east of P1044.
- P1044 – Pond located on the Oak Glen Golf Course to the east of McKusick and west of P1045.
- P1043 – Pond located on the Oak Glen Golf Course to the south of McKusick Road and Brown's Creek.
- P1042 – Irrigation pond located on the Oak Glen Golf Course to the northeast of McKusick Road and east of Brown's Creek. This 2.7 acre pond has a surface water level that is typically at or above its outlet elevation. As a result, it appears that the pond is routinely discharging to the creek. This has been observed on multiple site visits and the BCWD has measured a thermal signature from this pond. According to the golf course grounds keepers, the Oak Glen Golf Course pumps groundwater into the pond which is used to irrigate the golf course. Given the small drainage area to the pond, the recent lack of rainfall data, and the visual observations of water discharging from the ponds to the creek, it appears that pumping from the groundwater system to the pond occurs constantly.
- P1184 – Stormwater pond on the Oak Glen Golf Course is approximately ¾ acre in size and collects drainage from the residential area along Oak Glen Drive.
- P1217 – Stormwater pond located on the western edge of the Millbrook Development.
- P1048 – Pond located on the Oak Glen Golf Course to the north of McKusick Road and west of Brown's Creek. This pond has a surface water level that is typically at or above its outlet elevation. As a result, it appears that the pond is routinely discharging to the creek. This has been observed on multiple site visits and the BCWD has measured a thermal signature from this pond. According to the golf course grounds keepers this pond has a number of seeps (into the pond) which provide a steady flow of groundwater into the pond.

- **McKusick Road Improvements -** A large section of McKusick Road discharges to the creek untreated. This 5,900 linear foot section of McKusick Road extends from 3,000 feet west of Neal Avenue to near the parking lot of the Oak Glen Golf Course. A mix of raingardens, infiltration trenches, and proprietary settling devices are proposed for this stretch of road to remove sediment from the stormwater prior to discharging to the creek. There are a total of eight BMPs proposed in the Implementation Plan for this stretch of McKusick Road (see Figure 8).

- **Bluff stabilization -** Bluff erosion is occurring in areas within the gorge portion of Brown's Creek. Steep slopes and a bedrock valley expose soils to erosive stream forces. Bedrock protects steep slopes within the valley in many locations, but a bedrock valley occurs in the gorge along approximately 2,000 feet of channel starting roughly 900 feet upstream of the Highway 96 crossing. Four specific bluff stabilization areas were identified after conducting field surveys (see Figure 8).

- **Ravine Stabilization –** Ravine erosion is occurring in areas within the gorge portion of Brown's Creek. Ravine erosion occurs where concentrated flow and steep slopes exist on erodible soils. Twelve specific ravine stabilization areas were identified after conducting field surveys and examining concentrated flow points on steep slopes as identified on 2-foot topography maps (see Figure 8).

- **Stonebridge Stabilization Project –** The project involves the construction of various stabilization techniques to prevent the deterioration of the Stone Arch Bridge due to lateral migration of the stream. Project would include installing in-stream devices to reduce and deflect sheer stress as well as soil bioengineering elements.
- **Catch basin retrofits** – Existing catch basins can be retrofitted with separation devices such as sumped manholes or sediment capturing structures commonly referred to as stormwater proprietary devices. The Implementation Plan identifies four catch basin retrofit projects along McKusick Road near the Neal Avenue intersection and two catch basin retrofits along County Road 5 north of the Brown's Creek crossing (see Figure 8).
- **McKusick Wetland Restoration –** The outlet structure from McKusick wetland to Brown's Creek could be modified to increase detention time or provide filtering prior to discharge to the creek. Modifications made to increase detention time should take into consideration the thermal impacts of heated stormwater runoff being discharged to the creek (e.g. by conveying the discharge underground in an effort to cool it before discharging to the creek).
- **Oak Glen Stream Buffers –** There is currently a ¼ mile stretch of Brown's Creek to the northeast of McKusick Road that has no buffer protecting the creek from pollutant loads. The BCWD and the Oak Glen Golf Course are currently constructing a project to stabilize the banks, increase floodplain storage, and establish a more effective riparian buffer along this ¼ mile stretch of Brown's Creek.
- **Brown's Creek Realignment –** One of the projects identified under the Structural Load Reduction Activities (2) Stream Geomorphology and Thermal Buffer Improvements (Table 9) will also provide TSS load reductions. As a result, a mode detailed description of this project is provded in this section. This project corresponds to Reach ID 3 in Table 9.

  The Watershed District is considering a channel improvement project for a ditched section of the creek immediately upstream of the historic Stone Arch Bridge. This section accounts for roughly 275' of stream which runs parallel to the proposed trail: from 290' upstream of Stonebridge Trail to 565' upstream of Stonebridge Trail. The encroachment of the rail line fill section and past alteration of stream alignment within this reach has created geomorphic instabilities, which have resulted in bank erosion throughout this reach. Upon preliminary review two feasible restoration options exist: 1) pull the trail center-line away from Brown's Creek, thus providing an opportunity to restore the floodplain and increase sinuosity, (channel length), which will improve the over-all stability of this reach; 2) pull the trail center-line away from Brown's Creek enough to create a floodplain bench within current stream alignment. This project would resolve one of the most degraded reaches of Brown's Creek, reduce TSS and thermal loads to the creek and provide trail character.

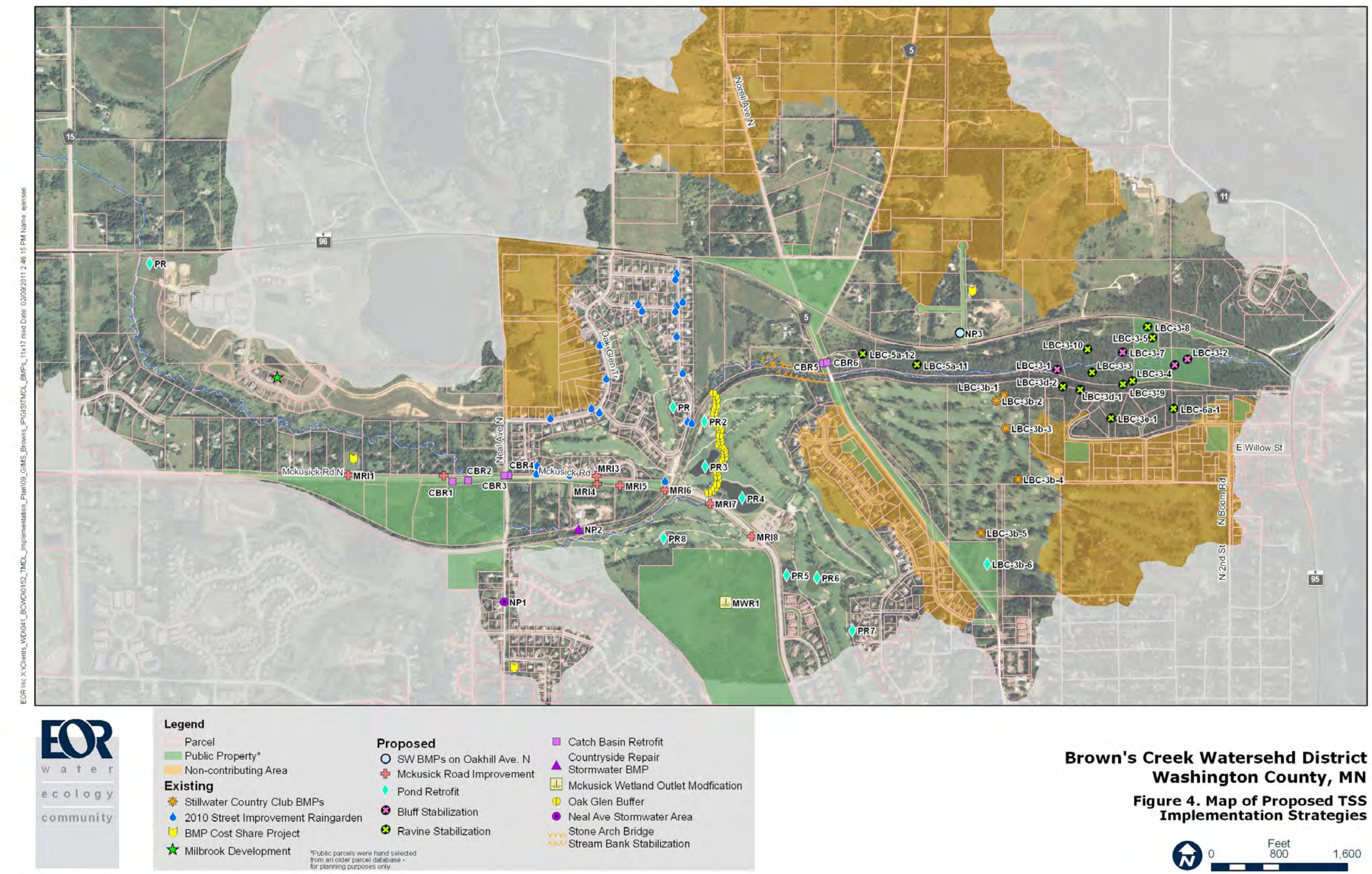

Figure 8. Map illustrating the locations of existing and proposed BMPs to address TSS loads to Brown’s Creek.

Non-Structural TSS Load Reduction Activities:

The following non-structural implementation activities are recommended as part of the long-term TSS management strategy. The estimated load reductions associated with each of these activities are not included in the Implementation Plan Table as more specific information is required from the implementing communities or entities. These activities can be used to document progress toward meeting a WLA or LA.

- **Improved Street sweeping** – Street sweeping frequency should be increased to 10 sweepings per year to prevent solids from reaching the stream.
- **Road Sand Management –** Application of road sand within the watershed should be reviewed to verify that the recommended rates are being observed. Recommended sanding rates vary from 400 – 750 lbs/2 lane mile for particular road conditions[6].
- **Pond Maintenance –** Existing ponds should be surveyed and maintained per an operation and maintenance plan providing 3-4 feet of permanent pool storage.
- **Education and Outreach** – As Section 8.16 Education and Outreach indicates, the BCWD has been a partner of the East Metro Water Resource Education Program (EMWREP) since its inception. Program activities include efforts such as community events, student programs, mailings, newspaper columns, press releases, city newsletter articles, websites and social media. While it is difficult if not impossible to measure the estimated load reductions associated with these activities it is clear that there will be some reduction in TSS loads to the creek as a result of this program. Future rsearch or monitoring efforts may be conducted to more specifically assign load reductions to these activities.

Structural Thermal Load Reduction Activities:

The Implementation Plan for the thermal load reductions consists of multiple components:

1. Stormwater BMP Projects (designed to address exceedances associated with stormflow conditions)
2. Stream Geomorphology and Thermal Buffer Improvements (designed to address exceedances associated with baseflow conditions)
3. Feasibility Studies

Figure 9 through Figure 10 identify the locations of the implementation activities described below. Given the limitations of the thermal model (as described in Section 3.2) it was not possible to quantify the thermal load reductions associated with each of these implementation activities. As a result, the Implementation Plan Table assigns a priority to each of the implementation activities under the Estimated Load Reductions: Thermal column.

1. <u>Stormwater BMP Projects</u>

The first step in identifying potential stormwater pond retrofit projects was to conduct an inventory of the stormwater best management practices (BMPs) in the drainage area to Brown's Creek. Figure 8 illustrates the stormwater BMPs identified during this inventory. After identifying the locations of all of the stormwater BMPs, the next step was to evaluate whether or not the BMPs have a thermal contribution to the creek (do they discharge to the creek). Of the BMPs that discharge to the creek, it

[6] University of Minnesota Center for Transportation Studies. 2005. Minnesota Snow and Ice Control: Field Handbook for Snowplow Operators. Manual Number 2005-01. Prepared for Minnesota Department of Transportation and the Minnesota Local Road Research Board.

was important to determine if they were constructed prior to the District's Rules and Regulations (no volume control, thermal design considerations) or after (varying levels of volume control and thermal design considerations depending upon which rules the BMPs were designed to meet). Of the 36 stormwater BMPs identified in this portion of the BCWD, 18 discharge to Brown's Creek directly or via McKusick Wetland (Table 8). Of the 18 ponds that discharge to the creek, ten were constructed prior to the District's Rules and Regulations, and the other eight ponds were constructed as part of the Millbrook Development and met or exceeded the District's old rules.

After identifying the ponds that have a thermal impact on the system (i.e. discharge directly to the creek) an evaluation of the potential retrofits that could reduce thermal loads was made. Retrofits recommended to address thermal loads to the creek are the same retrofits recommended for the TSS loads described previously:

- **McKusick Wetland Restoration** – Currently the outlet structure from McKusick Wetland consists of a 36-inch half moon riser that discharges to a 30-inch HDPE pipe. The riser establishes the normal water level (NWL) for McKusick Wetland. This outlet structure is located on the north end of McKusick Wetland, and runs under the Oak Glen Golf Course, where it discharges to the creek to the west of McKusick Road. In an effort to cool what is likely warmer runoff (as a result of longer residence time in the wetland) it is proposed that the outlet structure be modified so that low flows are routed underground through a rock trench (running parallel to the existing HDPE pipe), allowing the discharge to cool as it comes in contact with the cooler rocks and in situ subsurface materials.
- **Infiltration/Filtration Perimeter Ring** – This retrofit consists of the construction of an infiltration/filtration trench along a portion of the perimeter of existing stormwater ponds. In most cases (e.g. NURP ponds), this trench may be located along the bench of the facility. In other cases (e.g. irrigation ponds on Oak Glen Golf Course) these trenches will be located adjacent to the ponds at or near ground level. The objective will be to facilitate the discharge of stormwater runoff through the trench allowing it to infiltrate and/or cool as the stormwater is then conveyed to the original outlet via a drain tile system.

Implementation activities recommended to address TSS loads to the creek may have a thermal benefit as well depending upon what types of BMPs are designed and constructed to treat the runoff: Neal Avenue Stormwater Area, McKusick Road Improvements, and Countryside Repair.

Table 8. Stormwater Pond Inventory and Implementation Plan – Thermal Control

#	City of Stillwater Pond I.D.	BCWD TMDL Report Subwatershed I.D.	Pond Location	Pond Constructed Prior to BCWD Rules	Pond Constructed After BCWD Rules		Thermal Contribution to Brown's Creek [Y/N]		Potential Retrofit Project	Estimated Cost	Responsible Parties
					New Rules	Old Rules					
1	P1147	LBC-10	Stillwater Country Club	Natural Pond			N		*NA*	*NA*	
2	P1148	LBC-10	Stillwater Country Club	Natural Pond			N		*NA*	*NA*	
3	P1149	LBC-10	Stillwater Country Club	Natural Pond			N		*NA*	*NA*	
4	P1150	LBC-10	Stillwater Country Club	Natural Pond			N		*NA*	*NA*	
5	P1088	LBC-10	Stillwater Country Club	√			N		*NA*	*NA*	
6	P1085	LBC-10	City of Stillwater	√			N		*NA*	*NA*	
7	P1064	LBC-3b	Stillwater Country Club	Natural Pond			N		*NA*	*NA*	
8	P1046	LBC-3b	Stillwater Country Club	Natural Pond			N		*NA*	*NA*	
9	P1062	LBC-5b	Mark and Amy Enter	Natural Pond			N		*NA*	*NA*	
10	P1063	LBC-5b	Laura Westphal	Natural Pond			N		*NA*	*NA*	
11	P1061	LBC-5b	City of Stillwater	Natural Pond			N		*NA*	*NA*	
12	P1065	CBC-16	Oak Glen Golf Course	√			Y	*via McKusick Wetland*	1	$15,399	L
13	P1045	CBC-16	Oak Glen Golf Course	Natural Pond			Y	*via McKusick Wetland*	1	$37,066	L
14	P1044	CBC-16	Oak Glen Golf Course	Natural Pond			Y	*via McKusick Wetland*	1	$31,559	L
15	P1186	CBC-16	McKusick Wetland	Natural Pond			Y	*via McKusick Wetland*	1	$188,500	M
16	P1040	CBC-16	Oak Glen Golf Course	Natural Pond			N		*NA*	*NA*	
17	P1041	CBC-16	Oak Glen Golf Course	Natural Pond			N		*NA*	*NA*	
18	P1043	CBC-16	Oak Glen Golf Course	Natural Pond			Y	*via McKusick Wetland*	1	$6,888	L
19	P1049	CBC-15	Brown's Creek Reserve	√			Y		*Brown's Creek reserve - No need for retrofit*		
20	P1042	CBC-16	Oak Glen Golf Course	Natural Pond			Y		2	$106,952	H
21	P1048	CBC-16	Oak Glen Golf Course	Natural Pond			Y		2, 3, 4	$55,463	H
22	P1050	LBC-7b	Oak Glen Golf Course	Natural Pond			N		*NA*	*NA*	
23	P1184	LBC-5a	Oak Glen Golf Course	Natural Pond			Y		2	$73,914	H
24	P1185	LBC-5a	Oak Glen Golf Course	Natural Pond			Y		2	$80,475	H
25	P1047	LBC-7a	Private – Mult. Owners	Natural Pond			N		*NA*	*NA*	
26	P1051	LBC-8	Marie Heifort	Natural Pond			N		*NA*	*NA*	
27	P1221	CBC-15	C3 Land Development				Y		*No indication of ponding on contour data*		
28	P1211	CBC-15	Millbrook Development			√	□		*NA*	*NA*	
29	P1212	CBC-15	Millbrook Development			√	□		*NA*	*NA*	
30	P1216	CBC-14	Millbrook Development			√	□		*NA*	*NA*	
31	P1214	CBC-14	Millbrook Development			√	□		*NA*	*NA*	
32	P1213	CBC-14	Millbrook Development			√	□		*NA*	*NA*	
33	P0	CBC-14	Millbrook Development			√	□		*NA*	*NA*	
34	P1215	CBC-14	Millbrook Development			√	□		*NA*	*NA*	
35	P1014	CBC-14	Millbrook Development			Natural Pond	□		*NA*	*NA*	
36	*P1217*	*CBC-14*	Millbrook Development			√	*Y*		1	$41,688	M

□ Stormwater ponds on Millbrook Development do not discharge to Brown's Creek until the 5-year 24-hour rainfall event.

NA (shaded) These stormwater ponds to not discharge to Brown's Creek

NA These stormwater ponds were designed and constructed to meet (or exceed in the case of Millbrook Development) the BCWD's Rules and Regulations. It is assumed that these facilities will provide adequate thermal protection to Brown's Creek.

1 McKusick Wetland Improvement/Outlet Modification
2 Infiltration /Filtration Perimeter Ring
3 Infiltration Trench
4 Re-directing Discharge

2. **Stream Geomorphology and Thermal Buffer Improvements**
In an effort to identify areas in need of stream geomorphology improvements and/or thermal buffer creation/restoration EOR reviewed the following:

- 2007 and 2008 geomorphic assessment of Brown's Creek – authored by Emmons & Olivier Resources, Inc.
- Minnesota Land Cover Classification System (MLCCS)
- Soil Survey of Washington County, Minnesota
- Land Imagery - current and historic aerial photography
- National Wetlands Inventory
- Original Land Survey Bearing Trees
- Public Land Survey Corners with Presettlement Vegetation Information

In addition, BCWD Staff applied its knowledge of the system (e.g. visual observations and field work) to this evaluation.

An evaluation of Brown's Creek was made from the confluence with the St. Croix River to the Manning Avenue crossing. Unique reaches were identified and evaluated from the perspective of having instream cooling potential and deficiencies. Identified activities were categorized into three related but separate categories: morphology (M), vegetation (V) and/or buffer width (W). These three categories are illustrated on Figure 9 and Figure 10 and are defined as follows:

Morphology – Without identifying specific projects, reaches of the creek categorized as having degraded stream channel geomorphology (from a thermal stand-point) could be improved by addressing:

Stream Width – Due to former ditching and/or land cover manipulation certain stretches have become over-widened. It is commonly understood that stream channels that have excessive width to depth ratios have more potential for heat gain than the system did in its natural state. Reducing the stream channel width reduces heat gain from solar radiation.

Over-Hanging Banks – Due to watershed and/or channel manipulations, particular reaches of Brown's Creek have lost any signature over-hanging banks and the associated shading cutbank. Restoring stream cross-section and thereby reducing the gradual sloping banks restores shading that was once a factor in the thermal regime of the system.

Profile and Alignment - Restoring or improving the pool-riffle sequence and sinuosity to ditched segments of Brown's Creek will cool instream temperatures via the following restored characteristics: greater water depths, less exposed water surface, decreased stagnant waters, alteration of solar orientation, etc.

Further Classification: For each of the reaches identified as being in need of stream channel geomorphic improvements, they were further classified as being "Substantial," "Moderate," or "Minimal" restoration efforts. While this designation was based on familiarity with the system and engineering judgment, the differences can be described as follows: "Substantial" projects will require more inputs for implementation (e.g. more construction equipment, more erosion and sediment control, different vegetation needs, soil import requirements, etc.) whereas "Minimal" projects will require fewer inputs of costly materials and will involve more hand labor.

Vegetation – This component of the thermal buffer evaluation looked at existing vegetation composition along the creek and assessed limitations in terms of cooling the system: what is the structure, quality, age class and diversity of the land cover. Soils and hydrology were also evaluated to determine the feasibility and appropriateness of altering land cover from its current state.

Buffer Width – Buffer width evaluation is a physical measurement of adequate width for instream cooling. A fifty foot buffer from stream centerline on both sides, totaling 100 feet, was considered adequate for cooling purposes for a stream of this size. If a reach contained turf grass and/or impervious surfaces within this buffer zone it was considered to be deficient.

While buffer width is clearly related to the quality of vegetation within the thermal buffer a distinction was made to reflect the fact that in some cases additional width will need to be provided in areas where there are conflicting land uses. For example, the Oak Glen Golf Course currently uses the land the District would like to see restored to buffer along the creek for play. In these instances, there will be an additional cost to either restore or create the requisite buffer width (which in these cases is less than the 50 feet from the centerline of the stream being recommended for other areas where conflicting land use is not an issue). These additional costs reflect the fact that buffer re-establishment is beginning with a lower starting point (currently turf grass with irrigation versus vegetated system where reed canary grass is the predominant species) and there are higher expectations for what the buffer will look like after the project is implemented (may include costs associated with demolition, earth moving, hardscaping, higher vegetation inputs, etc.).

Table 9. Stream Geomorphology and Thermal Buffer Implementation Plan

BUFFER ANALYSIS					(V) VEGETATION COMPOSITION IMPROVEMENTS		(W) ADDITIONAL INPUTS AND BUFFER WIDTH		STREAM ANALYSIS		(M) MORPHOLOGY IMPROVEMENTS		SUBTOTAL	PRIORITIZATION
Potential Buffer Width In Feet	% of Area Insuf-ficient	% of Area To Be Improved	Acreage To Be Improved	Pre-dominate Cover To Be Restored	Acreage To Be Improved	Unit Cost $64,000	Acreage Requiring Additional Inputs	Unit Cost $58,000	Reach Stream Length	Potential Steam Legnth	Unit Cost in Feet Substantial - $250 Moderate - $120 Minimal - $80 None - $0	Subtotal		
100.0	80%	20%	0.1	Tree	0.1	$6,400	0.0	$0	306	306	$0	$0	$6,400	L
100.0	100%	0%	0.0	N/A	0.0	$0	0.0	$0	6023	6023	$0	$0	$0	ADEQUATE
100.0	100%	0%	0.0	Tree	0.0	$0	0.0	$0	366	440	$250	$110,000	$110,000	L
100.0	80%	20%	0.4	Tree	0.6	$38,400	0.0	$0	1230	1230	$0	$0	$38,400	L
50.0	0%	100%	1.4	Herb.	1.4	$89,600	1.4	$81,200	1368	1368	$80	$109,440	$280,240	H
75.0	90%	10%	0.3	Tree	0.3	$19,200	0.0	$0	2217	2217	$0	$0	$19,200	M
100.0	100%	0%	0.0	N/A	0.0	$0	0.0	$0	976	976	$0	$0	$0	ADEQUATE
100.0	100%	0%	0.0	N/A	0.0	$0	0.0	$0	651	780	$120	$93,600	$93,600	L
100.0	95%	5%	0.1	Tree	0.1	$6,400	0.1	$5,800	612	612	$0	$0	$12,200	L
100.0	95%	5%	0.4	Tree	0.4	$25,600	0.0	$0	6241	6241	$0	$0	$25,600	L
100.0	50%	50%	1.0	Herb.	1.0	$64,000	0.0	$0	1227	1227	$0	$0	$64,000	L
50.0	25%	75%	0.5	Herb.	0.5	$32,000	0.5	$29,000	600	600	$80	$48,000	$109,000	M
100.0	0%	100%	2.2	Herb.	0.0	$0	0.0	$0	967	1550	$120	$186,000	$186,000	H
100.0	90%	10%	0.2	Shrub	0.2	$12,800	0.0	$0	800	800	$0	$0	$12,800	L
			6.5			$294,400		$116,000				$547,040	$957,440	

also known as Brown's Creek Re-alignment Project

also known as Oak Glen Stream Buffers/Streambank Stabilization Project

PRIORITY	
HIGH subtotal	$466,240
MEDIUM subtotal	$128,200
LOWER subtotal	$363,000
ADEQUATE	$0
	$957,440

3. Additional Data Collection / Feasibility Studies

- **Re-establish Groundwater Inputs from McKusick Wetland to Brown’s Creek** - While the data suggest that the Diversion Structure reduced the thermal loads to Brown’s Creek by diverting stormwater runoff to McKusick Lake, the Diversion Structure also diverts a portion of the cold groundwater that once discharged to the creek. The wetland system just upstream of the Diversion Structure as well as McKusick Wetland can be considered a groundwater recharge area as there are a number of seeps and sand boils that contributed a steady source of cold water to the creek at one point in time. While there is a seepage hole at the base of the Diversion Structure to allow for a portion of this groundwater to feed Brown’s Creek, there is some question regarding its capacity. In addition, there are a number of sand boils downstream of the Diversion Structure that are generating a significant amount of groundwater. This groundwater contribution has been completely cut off from Brown’s Creek.

  This feasibility study would assess how much of the original groundwater contribution is being lost due to the Diversion Structure and explore options for (1) increasing the capacity to restore the groundwater connection at the Diversion Structure and (2) re-establishing a connection with the groundwater within McKusick Wetland (e.g. via a drain tile network).

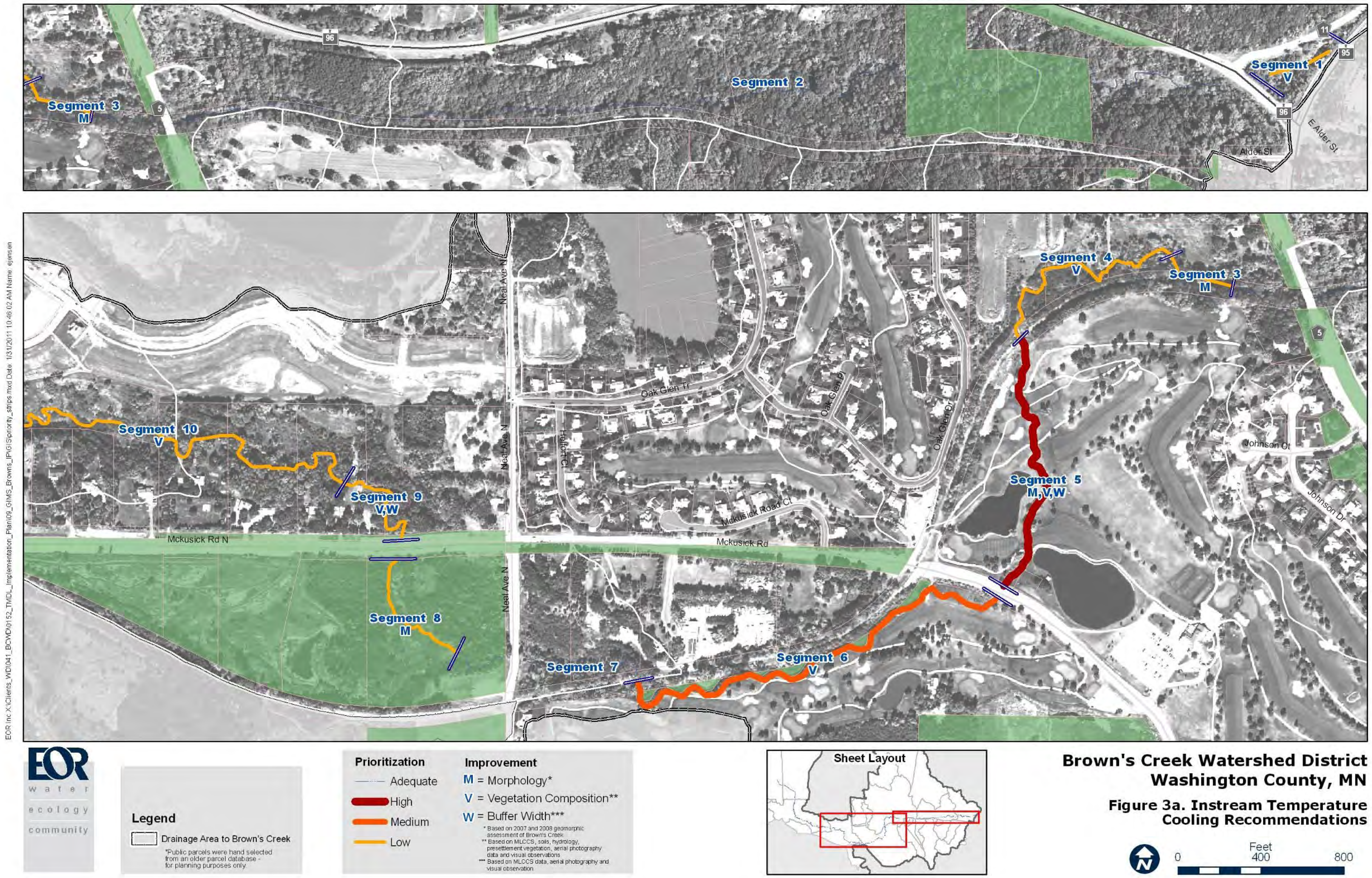

Figure 9. Stream geomorphology and thermal buffer improvements (Figure 1 of 2)

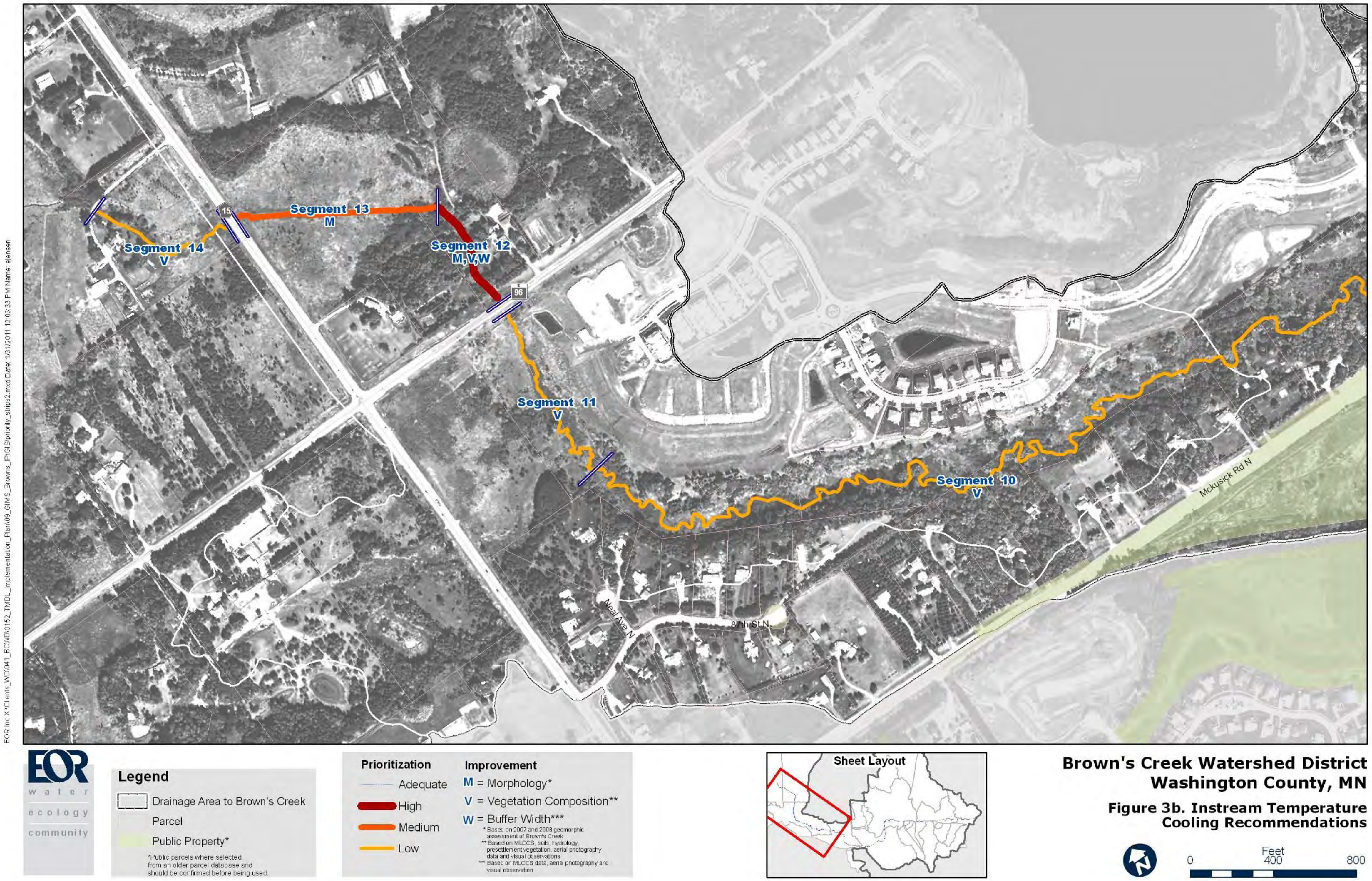

Figure 10. Stream geomorphology and thermal buffer improvements (Figure 2 of 2).

Non-Structural Thermal Load Reduction Activities:

Non-structural BMPs that the BCWD will promote in an effort to reduce thermal loads to Brown's Creek include:

- Minimizing impervious areas
- Disconnecting impervious surfaces
- Achieving additional volume control through rainwater harvesting

8.4 Subwatershed ID

The subwatershed the implementation activity is located in is identified in the Implementation Plan Table. This will assist all entities in determining how much of the WLA and LA for the particular subwatershed is being addressed by the implementation activity.

8.5 Community

The community the implementation activity is located in is identified in the Implementation Plan Table. This will assist the MS4 regulated communities (the City of Stillwater) in determining whether or not a particular implementation activity will count towards their WLA.

8.6 Estimated Load Reductions: TSS

The calibrated water quality (P8) model developed for the TMDL was used to estimate load reductions of existing and proposed Best Management Practices (BMPs). Since the results from different water quality models can vary greatly (i.e. due to differences in modeling equations, input parameters, modeling assumptions, etc.), it is important for consistency to use the same model to track progress during implementation that was used during TMDL development. This information was provided in the Implementation Plan Table to quantify the load reductions expected as a result of implementation of these activities for prioritization purposes.

8.7 Estimated Load Reductions: Thermal

As stated in Section 3.2 it was decided that use of a thermal model to estimate load reductions associated with buffer improvement projects and/or stormwater retrofit projects should wait until the collection of local climatological data. In the interim, thermal load reduction implementation activities were assigned a high (H), medium (M) or low (L) classification based on the following characteristics:

High = Little to no buffer on the creek; stormwater management practice (i.e. pond) located adjacent to the creek with a clear thermal signature

Medium = Untreated stormwater runoff from neighborhoods, streets, etc. some distance from the creek

Low = Stormwater retrofits with little potential for volume control; minor buffer modifications; proximity to the creek

Note that the assignment of H, M and L classifications included the prioritization of the stream geomorphology, vegetation improvement and buffer width projects (Table 9). This prioritization was based on a cost-benefit analysis where the estimated costs provided were weighed against the perceived thermal benefits afforded by the project. The District is using the word “perceived” to reflect the fact that individual projects were not modeled to quantify their thermal impact to the system. Rather, the benefits are based on the modeling results obtained for the Oak Glen Golf Course (SSTEMP Model) and best professional judgment.

8.8 Estimated Volume Reduction

The calibrated water quality (P8) model developed for the TMDL was used to estimate volume reductions of existing and proposed Best Management Practices (BMPs). The estimated volume reduction provided by each implementation activity was provided to highlight the projects that may assist the City of Stillwater in meeting its Outstanding Resource Value Waters (ORVW) requirements.

8.9 Estimated TP Reduction

The estimated total phosphorous (TP) reduction provided by each implementation activity was provided to quantify reductions that may assist the watershed and member communities in meeting the goals of the Lake St. Croix Nutrient Impairment.

8.10 Estimated Costs

The Implementation Plan Table includes the following estimated costs: Engineering; Construction; and Operation & Maintenance (O&M). These costs are for estimating purposes only: actual costs for design, construction and O&M shall be scoped out at the time of project implementation. In addition, costs provided in the Implementation Plan Table reflect the estimated cost of implementing the project today and have not been adjusted to account for the actual date of implementation.

Short term Operation and Maintenance (O&M) costs are included in the construction cost estimates as these activities are typically accounted for in the construction bidding process. Long term O&M costs were assumed to be approximately 30 percent of the estimated construction costs.

The following information further describes the assumptions that went into the development of the stream geomorphology and thermal buffer improvement costs:

Morphology Cost Estimate: The unit costs assigned to these potential projects are based on industry standard costs and have been adjusted to reflect the stream size. Estimated costs reflect construction costs only and do not include the costs associated with project administration, engineering design and land acquisition.

Vegetation Cost Estimate: Units costs utilized for these activities are industry standards for riparian vegetation restoration. Cost for herbaceous, woody and combinations of cover types were normalized.

Buffer Width Cost Estimate: Units costs utilized for these activities are industry standards for riparian vegetation restoration plus the assumed cost for additional inputs to alter the landscape and/or satisfy stakeholders.

8.11 Schedule of Implementation

The Implementation Plan Table includes a schedule that assumes that all identified activities will be completed within a 10 year time frame. Implementation of activities is scheduled to be completed within the following time periods:

- 2012 – 2013 These activities correspond with the design and construction of the Brown's Creek Trail which is scheduled to be completed by the Minnesota Department of Natural Resources in 2012
- 2014 – 2015 Activities identified as being a high (H) priority to be implemented in this time frame
- 2016 – 2018 Activities identified as being a medium (M) priority to be implemented in this time frame
- 2019 – 2021 Activities identified as being a low (L) priority to be implemented in this time frame

One of the immediate drivers for implementation of certain activities identified in the Implementation Plan is the acquisition of the Minnesota Zephyr railroad tracks by the MNDNR and the subsequent conversion of the railroad bed to an extension of the Gateway Trail. The MNDNR is currently in the process of aquiring the railroad from the owner of the Minnesota Zephyr and intends to initiate trail development plans, deconstruction of the railroad tracks and construction of portions or all of the trail in 2012. Given the proximity of this trail to Brown's Creek, the BCWD is very concerned about any activity that has the potential to directly impact Brown's Creek thereby indirectly impacting the St. Croix River. In addition, the BCWD sees the value of this trail as an education and outreach opportunity. The BCWD would like to partner with the MNDNR in the development of the plans for the Brown's Creek Trail in an effort to ensure that all aspects of the deconstruction, design and construction process meet the District's Rules and Regulations as well as the goals of the TMDL Implementation Plan. Appendix C contains the memorandum the BCWD submitted to the MNDNR stating it's intent to partner in this project. In addition, the BCWD has included the funds in its 2012 budget to design, permit and implement the three projects identified in the Implementation Plan that should be conducted in conjunction with development of the Brown's Creek Trail: Ravine and Bluff Stabilization Projects; Brown's Creek Rehabilitation (Section 3 of Stream Geomorphology and Thermal Buffer Improvements Table 9); and Countryside Auto Repair Stormwater BMP.

As stated previously, the BCWD is committed to taking an adaptive management approach to Plan implementation for the following reasons: implementation activities addressing TSS loads achieve only 25 percent of the total goal; unable to identify all sources of TSS to the creek; and unable to quantify the thermal benefits of implementation activities addressing thermal loads. As a result, the BCWD will conduct a thorough evaluation of the monitoring data in 2015 (five years after the last analysis of the entire data set) and will evaluate the need for additional implementation activities on an annual basis. A schedule clarifying when components of the adaptive management decision-making approach will take place and how future revisions of the Implementation Plan may occur is provided in Table 10. Future Implementation Plan revisions will address the expected time it will take to meet the allocations. It is anticipated that the TMDL allocations will be met in 25 years. While this is the long term goal, through the adaptive management process this date could be adjusted depending on the data available at that time.

Table 10. Schedule reflecting adaptive management decision-making approach on future plan revisions

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Monitoring and Evaluation										
- Implement baseline monitoring program	√	√	√	√	√	√	√	√	√	√
- Additional monitoring activities	Synoptic survey	Intensive thermal McKusick Wetland overflow	Macro-invertebrate survey					Macroinvertebrate survey (as part of MPCA's watershed assessment)		
- Evaluation of complete data set collected since last evaluation				√					√	
Education and Technical Assistance										
- EMWREP activities	√	√	√	√	√	√	√	√	√	√
Meetings with Project Partners										
- Annual meetings	√	√	√	√	√	√	√	√	√	√
Revisions to Implementation Plan										
- Minor revisions	√	√	√		√	√	√	√		√
- Major revisions				√					√	

<u>Minor revisions</u> – These revisions may include updating the table to reflect assumed removal rates associated with existing implementation projects/activities, the addition of implementation activities (with corresponding assignment of estimated reductions, costs, allocation tracking, responsible parties and project partners) and potential changes in schedule of implementation.

<u>Major revisions</u> – In addition to the revisions noted above (minor revisios) these revisions may include reassessing estimated load reductions (based on analysis of monitoring data), reassessing the schedule of implementation, extending the implementation schedule (beyond 2021 as needed), and identifying when the impairment is expected to be met.

8.12 Allocation Tracking

The implementation plan table (Table 11) can be used to identify the type of allocation that each recommended project falls under, in the “allocation tracking” columns. The columns identify if a project can be used to show progress towards meeting a WLA, an LA, and for which community.

Table 12 is provided for tracking of TSS load reductions and progress made towards meeting the allocations. The table presents the TSS load reductions needed for each municipality and township within each subwatershed. The BCWD will use this table to track overall progress made towards the TMDL. Individual municipalities and townships can use this table to track their progress towards meeting loading goals (WLA or LA). This includes regulated MS4 communities, who can use the table for reporting required for the MS4 permit.

8.13 Applicability to Stillwater’s ORVW Requirements

The entire length of the St Croix River was designated as a wild and scenic river in the original Wild and Scenic Rivers Act in1968. Due to this designation, the State of Minnesota declared the entire length of the river an Outstanding Resource Value Water (ORVW) on November 5, 1984 (Minn. Rule 7050.047).

The Minnesota nondegradation rule (Minn. Rule Ch. 7050.0180) protects ORVW’s from degradation by prohibiting or restricting new and expanded discharges to these waters so as to maintain their “function as exceptional recreational, cultural, aesthetic, or scientific resources”, according to the provisions of the rules. These state rules were put in place in order to comply with the “antidegradation” part of the federal Clean Water Act passed in 1972.

Since 2003, most municipalities with a population between 10,000 and 100,000 have been required to secure coverage under the general permit from the Minnesota Pollution Control Agency (MPCA) that authorizes storm water discharges from their municipal storm drainage system to waters of the state under the National Pollutant Discharge Elimination System (NPDES) program. These systems are known as Municipal Separate Storm Sewer Systems or MS4’s. The general permit does not authorize new and expanded discharges to ORVW’s such as the St. Croix River. For ORVW’s, a new discharge means one that was not in existence on the effective date the ORVW was designated, while an expanded discharge refers to any change in volume, quality, location, or other aspect of discharge such that the loading of one or more pollutants increases over the applicable values at the time the St. Croix River was designated.

Under Minn. Rule Ch. 7050.0180, subpart 6, the St Croix River is defined as a “restricted discharge” ORVW. The City’s MS4 general permit does not authorize new or expanded discharges to restricted discharge waters unless the discharges are in accordance with Minnesota Rule Chapter 7050.0180, subpart 6, 6a, and other applicable rules, and specific requirements given in the MS4 general permit.

The City’s MS4 general permit gives specific requirements that the City must follow to bring discharges to the St. Croix River into compliance. Stillwater is generally required to:

1. List the waters with restricted discharges to which it discharges,
2. Map with a minimum resolution of 1:24,000 the areas within Stillwater’s jurisdiction that discharge to the ORVW, and provide an estimate of the percent impervious based on current and future land use plans,
3. Assess whether its Stormwater Pollution Prevention Program (SWPPP) can reasonably be altered to eliminate the new and expanded discharge, including zoning and ordinance changes and implementation of Best Management Practices (BMPs) to existing and future development areas, and

4. Submit its assessment for public comment, respond to these public comments, and submit these responses and its proposed SWPPP modifications to the MPCA.

The MPCA will consider a permittee to be in compliance with the nondegradation rules if Baseline (1985) pollutant loading levels can be achieved, either through existing facilities, programs, and policies or through proposed modifications to these. Permit language allows a range of years around the 1985 Baseline. The City of Stillwater has selected 1985 due to the available data for that year. In other words, the Baseline condition is used as the "yardstick" to measure changes in pollutant loads over time. Permittees are considered to be in compliance with the Nondegradation rules when pollutant loads calculated for 2030 conditions meet or are less than the Baseline loads, unless mitigating environmental, economic, and social factors make additional control measures imprudent or infeasible.[7]

According to the City of Stillwater's general NPDES Permit, loading calculations for total phosphorus, total suspended solids and runoff volume were calculated for three time frames: 1985, 2007 (current), and 2030 (ultimate). In general, all three constituents increase as development occurs when considering the unimproved scenario with no BMP's.

Taking into consideration sedimentation BMP's installed since 1985 (NURP ponds) and the various water management organization rules (BCWD and MSCWMO), both TP and TSS are shown to be reduced to just below the baseline condition.

Volume of runoff is shown to have increased approximately 332 acre feet between 1985 and 2007 (annual discharge from approximately 133 acres of impervious). This was computed using volumetric runoff coefficients and annual precipitation depth for the area of each type of land use. To mitigate for this increase in volume the City of Stillwater proposes to abstract 0.5 inches of volume from 177 acres of impervious surface, targeting 75% volume reduction to achieve 332 acre feet.

As a result of the ORVW requirements, a column has been added to the Implementation Plan Table indicating the reduction in stormwater runoff associated with those BMPs that provide volume control. Implementation of these activities will benefit the City of Stillwater by meeting its TMDL requirements as well as its ORVW requirements.

8.14 Responsible Parties

Entities identified under the Responsible Parties column signify those who will have the primary responsibility for implementing the corresponding activity. The responsible party may call on other project partners to assist in funding of the project or other activities related to project implementation.

8.15 Project Partners

Project partners should at a minimum be notified when implementation activities are initiated and they may be involved in cost-sharing on implementation of the project or applying for grant funding.

[7] City of Stillwater, Part IX. Appendix C Submittal. St Croix Rover ORVW Restricted Discharge Water. Stillwater, MN. January 2009.

8.16 Education and Outreach

Continued public education and technical assistance will be beneficial throughout the implementation of management measures. These activities may include:

- Annual reporting of in-stream TSS and copper concentrations and temperature
- Annual reporting of management measures implemented and expected reductions
- Updates on the BCWD and municipalities websites, newsletters, and public meetings
- Research new developments in street sweeper technology and pollutant removal rates to assist the member communities, Washington County and MnDOT with the quantification of system improvements
- Continue to utilize the East Metro Water Resource Education Program (EMWREP) to promote stewardship of the District's water resources and to educate the public about the TMDL goals
- Individual property owner education and outreach to teach residents of the watershed what they can do to be better stewards of the creek (i.e. education and outreach on fertilizer use to address copper loads, low-impact lawn care practices to address TSS loads and rain garden installation and maintenance to address both TSS and thermal loads to the creek)
- Continue to sponsor macroinvertebrate survey work conducted by Stillwater Highschool students and utilize the Brown's Creek Citizens Advisory Committee (CAC) when conducting monitoring activities if feasible (e.g. to conduct the synoptic monitoring work described in Section 10.2)

8.17 Stakeholder Input Process

The activities and Best Management Practices (BMPs) identified in the Implementation Plan were reviewed and discussed by a Technical Advisory Committee (TAC) as well as the public at two meetings led by the Brown's Creek Watershed District (BCWD).

The TAC included stakeholder representatives from local cities (City of Stillwater, Stillwater TWP, and City of Grant), Washington County, the Board of Water and Soil Resources, the Minnesota Department of Natural Resources, and the Minnesota Pollution Control Agency. The TAC meeting, which was held on September 1, 2011 at the Washington Conservation District's Office, covered the following topics: TMDL Summary; Permitting Requirements; TMDL Implementation Plan; and Next Steps (for completion of the Implementation Plan). The minutes from this meeting can be found in the appendices.

The meeting for the public was held on September 21, 2011 at the Family Means facility in Stillwater, MN. The meeting, which was held in an Open House format, was intended to educate the public about the Brown's Creek Biotic impairment, describe the Implementation Plan, discuss proposed projects with potentially affected landowners and instill a sense of responsibility in addressing the issues. A summary of this meeting can be found in the appendices.

Table 11. Implementation Plan Table

Implementation Categories/Proposed Projects	Project Description	Subwatershed	Community	Estimated Load Reduction: TSS (lb/yr)		***Estimated Load Reduction: Total Phosphorus	Estimated Load Reduction: Thermal (L/M/H)	Estimated Volume Reduction [AF]	Estimated Costs			Schedule of Implementation	Allocation Tracking			Applicability to Stillwater's ORVW Requirements	Responsible Parties			Project Partners
				[tons/year]	[lbs/year]				Engineering	Construction	Operation & Maintenance*		WLA - MS4: Stillwater	WLA - MS4: Lake Elmo, OPH	LA: Stillwater TWP, Grant		Implementation	O&M	Monitoring	
REGULATION																				
ORVW Requirements	Restricting discharge to November 5, 1984 levels. Achieve this by abstracting 0.5 inches of runoff from 177 acres of impervious surface (targeting 75% volume reduction to achieve 332 acre feet).	NA	City of Stillwater	TBD	TBD	TBD	TBD	maximum 332 AF	TBD	TBD	TBD	On-going	X			X	City of Stillwater	City of Stillwater	City of Stillwater	BCWD
NEW DEVELOPMENT & REDEVELOPMENT STANDARDS																				
Stormwater Management	BCWD standards address potential impacts of most new development and redevelopment above a certain threshold. These will address new thermal and TSS loads and will not improve the current situation (i.e. no net increase).	NA	ALL														Permit Applicant	Permit Applicant	Permit Applicant	*NA*
Rate Control		NA	ALL	No net increase	No net increase	No net increase	--	--	TBD	TBD	TBD	On-going					Permit Applicant	Permit Applicant	Permit Applicant	*NA*
Volume Control		NA	ALL	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	On-going	X	X			Permit Applicant	Permit Applicant	Permit Applicant	*NA*
Water Quality		NA	ALL	No net increase	No net increase	No net increase	--	--	TBD	TBD	TBD	On-going					Permit Applicant	Permit Applicant	Permit Applicant	*NA*
Erosion and Sediment Control Standard		NA	ALL	No net increase	No net increase	No net increase	--	--	TBD	TBD	TBD	On-going	X	X			Permit Applicant	Permit Applicant	Permit Applicant	*NA*
Lake, Stream and Wetland Buffers		NA	ALL	No net increase	No net increase	No net increase	--	--	TBD	TBD	TBD	On-going	X	X			Permit Applicant	Permit Applicant	Permit Applicant	*NA*
Stream and Lake Crossings		NA	ALL	No net increase	No net increase	No net increase	--	--	TBD	TBD	TBD	On-going	X	X			Permit Applicant	Permit Applicant	Permit Applicant	*NA*

Implementation Categories/Proposed Projects	Project Description	Subwatershed	Community	Estimated Load Reduction: TSS (lb/yr) [tons/year]	Estimated Load Reduction: TSS (lb/yr) [lbs/year]	***Estimated Load Reduction: Total Phosphorus	Estimated Load Reduction: Thermal (L/M/H)	Estimated Volume Reduction [AF]	Estimated Costs: Engineering	Estimated Costs: Construction	Estimated Costs: Operation & Maintenance*	Schedule of Implementation	Allocation Tracking: WLA - MS4: Stillwater	Allocation Tracking: WLA - MS4: Lake Elmo, OPH	Allocation Tracking: LA: Stillwater TWP, Grant	Applicability to Stillwater's ORVW Requirements	Responsible Parties: Implementation	Responsible Parties: O&M	Responsible Parties: Monitoring	Project Partners
PUBLIC PROJECTS																				
Stormwater BMPs - 96 and Oakhill Avenue N	Install one or more stormwater BMPs (e.g. pond, raingarden, sediment trap) at both northwest corner and northeast corner of intersection of Hwy 96 and Oakhill Avenue. Both areas receive drainage from the large lot development via a gravel road before sending runoff to Brown's Creek via two separate culverts under Hwy 96.	LBC-3	Stillwater TWP	2.6	5,200	25	L	7	$2,400	$23,800	$7,140	2016-2018			X		Stillwater TWP	Stillwater TWP	Stillwater TWP	BCWD, Mn/DOT
Pond Retrofit - P1065	Evaluate (1) residence time and sediment settling function to determine if they can be increased, (2) pond outlet configurations for modifications to further trap sediment within the ponds, (3) addition of a filtration/infiltration ring around the perimeter to benefit both temperature and promote sediment capture.	CBC-16	City of Stillwater	0.67	1,340	6	L	5	$4,750	$10,750	$3,225	2016-2018	X			X	City of Stillwater	City of Stillwater	City of Stillwater	BCWD, Oak Glen Golf Course
Pond Retrofit - P1045		CBC-16	City of Stillwater	2.02	4,040	19	L	--	$11,500	$25,500	$7,650	2019-2021	X				BCWD	BCWD	BCWD	Oak Glen Golf Course
Pond Retrofit - P1044		CBC-16	City of Stillwater	0.44	880	4	L	--	$10,000	$21,750	$6,525	2019-2021	X				BCWD	BCWD	BCWD	Oak Glen Golf Course
Pond Retrofit - P1043		CBC-16	City of Stillwater	0.3	600	3	L	--	$2,250	$4,750	$1,425	2019-2021	X				BCWD	BCWD	BCWD	Oak Glen Golf Course
Pond Retrofit - P1042	Evaluate construction of a filtration/infiltration ring around the perimeter to benefit both temperature and promote sediment capture.	CBC-16	City of Stillwater	1.16	2,320	11	H	5	$33,000	$73,760	$22,128	2016-2018	X			X	City of Stillwater	City of Stillwater	City of Stillwater	BCWD, Oak Glen Golf Course
Pond Retrofit - P1184		LBC-5a	City of Stillwater	2.61	5,220	25	H	--	$23,000	$51,000	$15,300	2019-2021	X				BCWD	BCWD	BCWD	Oak Glen Golf Course
Pond Retrofit - P1217		CBC-14	City of Stillwater	0.58	1,160	5	M	1.6	$13,000	$28,750	$8,625	2014-2015	X			X	City of Stillwater	City of Stillwater	City of Stillwater	BCWD, Millbrook Development
Pond Retrofit - P1048	Construction of a filtration/infiltration ring around the perimeter to benefit both temperature and promote sediment capture	CBC-16	City of Stillwater	0.25	500	2	H	--	$6,000	$13,250	$3,975	2019-2021	X				BCWD	BCWD	BCWD	Oak Glen Golf Course

Implementation Categories/Proposed Projects	Project Description	Subwatershed	Community	Estimated Load Reduction: TSS (lb/yr) [tons/year]	Estimated Load Reduction: TSS (lb/yr) [lbs/year]	***Estimated Load Reduction: Total Phosphorus	Estimated Load Reduction: Thermal (L/M/H)	Estimated Volume Reduction [AF]	Estimated Costs: Engineering	Estimated Costs: Construction	Estimated Costs: Operation & Maintenance*	Schedule of Implementation	Allocation Tracking: WLA - MS4: Stillwater	Allocation Tracking: WLA - MS4: Lake Elmo, OPH	Allocation Tracking: LA: Stillwater TWP, Grant	Applicability to Stillwater's ORVW Requirements	Responsible Parties: Implementation	Responsible Parties: O&M	Responsible Parties: Monitoring	Project Partners
Bluff Stabilization	Bluff erosionidentified in 4 areas within the gorge portion of Brown's Creek. Steep slopes and a bedrock valley expose soils to erosive stream forces. Bedrock protects steep slopes within the valley in many locations, but a bedrock valley occurs in the gorge along approximately 2,000' of channel starting roughly 900' upstream of the Highway 96 crossing.	LBC-3	City of Stillwater, Stillwater TWP	68	136,000	643	--	--	$52,000	$250,000	--	2012 - 2013	X		X		BCWD	BCWD	BCWD	Private landowners, MNDNR, Washington County, City of Stillwater, Stillwater TWP
Ravine Stabilization	Ravine erosion is occurring in 12 areas within the gorge portion of Brown's Creek. Ravine erosion occurs where concentrated flow and steep slopes exist on erodible soils.	LBC-3, LBC-6a, LBC-3e, LBC-3d, LBC-5a	City of Stillwater, Stillwater TWP				--	--					X		X					
Catch Basin Retrofits: McKusick Road (4)	Four (4) existing catch basins can be retrofitted with separation devices such as sumped manholes or sediment capturing structures commonly referred to as stormwater proprietary devices.	CBC-15	Stillwater TWP	0.08	160	1	--	--	$800	$7,500	$2,250	2019-2021	X				Washington County	Washington County	Washington County	BCWD
				0.11	220	1	--	--	$800	$7,500	$2,250	2019-2021	X				Washington County	Washington County	Washington County	BCWD, Stillwater TWP
				0.22	440	2	--	--	$300	$3,400	$1,020	2019-2021	X				Washington County	Washington County	Washington County	BCWD
				0.23	460	2	--	--	$300	$3,400	$1,020	2019-2021	X				Washington County	Washington County	Washington County	BCWD
Catch Basin Retrofits: Stonebridge Trail	Two (2) existing catch basins can be retrofitted with separation devices such as sumped manholes or sediment capturing structures commonly referred to as stormwater proprietary devices.	LBC-5a	Stillwater TWP	1.54	3,080	15	--	--	$300	$3,200	$960	2016-2018	X				Washington County, MNDOT	Washington County, MNDOT	Washington County, MNDOT	BCWD, City of Stillwater
				0.46	920	4	--	--	$800	$8,300	$2,490	2019-2021	X							
McKusick Wetland Outlet Modification	Increase outlet elevation 0.5 feet	CBC-16	City of Stillwater, Stillwater TWP	0.3	600	3	M	--	$5,000	$10,000	--	2019-2021	X				BCWD	BCWD	BCWD	City of Stillwater, MNDNR, Oak Glen Golf Course
	Underground outlet for low flows	CBC-16		0.3	600	3	M	--	$58,500	$130,000	--	2019-2021	X				BCWD	BCWD	BCWD	City of Stillwater, MNDNR, Oak Glen Golf Course

Implementation Categories/Proposed Projects	Project Description	Subwatershed	Community	Estimated Load Reduction: TSS (lb/yr)		***Estimated Load Reduction: Total Phosphorus	Estimated Load Reduction: Thermal (L/M/H)	Estimated Volume Reduction [AF]	Estimated Costs			Schedule of Implementation	Allocation Tracking			Applicability to Stillwater's ORVW Requirements	Responsible Parties			Project Partners
				[tons/year]	[lbs/year]				Engineering	Construction	Operation & Maintenance*		WLA - MS4: Stillwater	WLA - MS4: Lake Elmo, OPH	LA: Stillwater TWP, Grant		Implementation	O&M	Monitoring	
Neal Avenue Stormwater Area	An untreated residential development exists on Neal Avenue south of the creek. The eastern right of way provides area to install infiltration trenches that can be sized to capture 1" off of impervious surfaces within the drainage area (4 BMPs).	CBC-16	City of Stillwater	7	14,000	66	M	13.7	$19,900	$199,300	$59,790	2014-2015	X			X	City of Stillwater	City of Stillwater	City of Stillwater	BCWD
Stone Arch Bridge Streambank Stabilization	Construction of various stabilization techniques to prevent deterioration of Stone Arch Bridge due to lateral migration of the stream includes installing in-stream devices to reduce and deflect sheer stress as well as soil bioengineering elements.	LBC-5a	City of Stillwater	0.45	900	4	L	--	Complete	$10,000	$3,000	2019-2021	X				BCWD	BCWD	BCWD	Stillwater TWP
McKusick Road Improvements	Large section of Mckusick Road discharges to creek untreated: 5,900 linear foot section of Mckusick extends from 3,000' west of Neal Avenue to near the parking lot of Oak Glen Golf Course. There is the potential to construct approximaely 8 BMPs along this stretch including a mix of raingardens, infiltration trenches and proprietary settling devices.	CBC-16	City of Stillwater, Stillwater TWP	11.9	23,800	113	M	8.2	$7,600	$76,000	$22,800	2014-2015	X			X	Washington County	Washington County	Washington County	BCWD, City of Stillwater, Stillwater TWP, Oak Glen Golf Course
2010 Street Improvement Raingardens	In 2010 a total of 20 raingardens were installed in the neighborhood located to the north east of the Oak Glen Golf Course.	LBC-7b, LBC-5a, CBC-16	City of Stillwater	1.95	3,891	18	M	5.4	--	--	--	Completed	X			X	City of Stillwater	City of Stillwater	City of Stillwater	BCWD
Oak Glen Stream Buffers/Streambank Stabilization	Project intent is to stabilize creek banks, increase floodplain storage, and establish a more effective riparian buffer along Brown's Creek through the Oak Glen Golf Course. The goal is to lessen instream erosion and provide additional creek shading to reduce thermal loading.	CBC-16, LBC-5a	City of Stillwater	13.35	26,700	126	H	--	$70,000	$520,000	--	2011 - 2012	X				BCWD	BCWD	BCWD	Oak Glen Golf Course

Implementation Categories/Proposed Projects	Project Description	Subwatershed	Community	Estimated Load Reduction: TSS (lb/yr) [tons/year]	Estimated Load Reduction: TSS (lb/yr) [lbs/year]	***Estimated Load Reduction: Total Phosphorus	Estimated Load Reduction: Thermal (L/M/H)	Estimated Volume Reduction [AF]	Estimated Costs: Engineering	Estimated Costs: Construction	Estimated Costs: Operation & Maintenance*	Schedule of Implementation	Allocation Tracking: WLA - MS4: Stillwater	Allocation Tracking: WLA - MS4: Lake Elmo, OPH	Allocation Tracking: LA: Stillwater TWP, Grant	Applicability to Stillwater's ORVW Requirements	Responsible Parties: Implementation	Responsible Parties: O&M	Responsible Parties: Monitoring	Project Partners
Stream Geomorphology + Thermal Buffer Improvements																				
Reach 1	Brown's Creek evaluated from confluence with St. Croix River to Manning Avenue crossing. Unique reaches identified and evaluated from the perspective of having instream cooling potential and deficiencies. Identified activities categorized into three categories: morphology; vegetation; and buffer width. **Morphology** - Reaches of creek categorized as having degraded stream channel geomorphology (from a thermal stand-point) could be improved by addressing stream width, over-hanging banks, and/or profile and alignment. **Vegetation** - Evaluated existing vegetation composition along the creek and assessed limitations in terms of cooling the system: what is structure, quality, age class and diversity of landcover? Soils and hydrology also evaluated to determine feasibility and appropriateness of altering landcover from its current state. **Buffer Width** - 50' buffer from stream centerline on both sides (total 100') considered adequate for cooling purposes. If reach contained turf grass and/or impervious surfaces within this buffer zone it was considered to be deficient.	LBC-6, LBC-5a, CBC-16, CBC-15, CBC-14, CBC-13, CBC-11	City of Stillwater, Stillwater TWP	--	--	--	L	--		$6,400**	--	2019-2021	X				BCWD	BCWD	BCWD	City of Stillwater, MNDNR, MNDOT
Reach 3				4.5	9,000	43	L	--	$40,000	$120,000**	--	2012-2013			X		BCWD, MNDNR	BCWD, MNDNR	BCWD, MNDNR	Private landowners, Washington County, City of Stillwater
Reach 4				--	--	--	L	--		$38,400**	--	2019-2021			X		BCWD	BCWD	BCWD	Stillwater TWP
Reach 6				7.7	--	--	M	--		$19,200**	--	2016-2018	X				BCWD	BCWD	BCWD	City of Stillwater, MNDNR, Oak Glen Golf Course
Reach 8				4.3	--	--	L	--		$93,600**	--	2019-2021	X				BCWD	BCWD	BCWD	City of Stillwater
Reach 9				--	3,200	15	L	--		$12,200**	--	2016-2018	X				BCWD	BCWD	BCWD	City of Stillwater
Reach 10				--	--	--	L	--		$25,600**	--	2019-2021	X				BCWD	BCWD	BCWD	City of Stillwater
Reach 11				--	9,200	44	L	--		$64,000**	--	2016-2018	X				BCWD	BCWD	BCWD	City of Stillwater
Reach 12				3.4	11,200	53	M	--		$109,000**	--	2016-2018			X		BCWD	BCWD	BCWD	Stillwater TWP
Reach 13				8.5	--	--	H	--		$186,000**	--	2014-2015			X		BCWD	BCWD	BCWD	Stillwater TWP
Reach 14				--	--	--	L	--		$12,000**	--	2019-2021			X		BCWD	BCWD	BCWD	City of Grant

Implementation Categories/Proposed Projects	Project Description	Subwatershed	Community	Estimated Load Reduction: TSS (lb/yr) [tons/year]	Estimated Load Reduction: TSS (lb/yr) [lbs/year]	***Estimated Load Reduction: Total Phosphorus	Estimated Load Reduction: Thermal (L/M/H)	Estimated Volume Reduction [AF]	Estimated Costs: Engineering	Estimated Costs: Construction	Estimated Costs: Operation & Maintenance*	Schedule of Implementation	Allocation Tracking: WLA - MS4: Stillwater	Allocation Tracking: WLA - MS4: Lake Elmo, OPH	Allocation Tracking: LA: Stillwater TWP, Grant	Applicability to Stillwater's ORVW Requirements	Responsible Parties: Implementation	Responsible Parties: O&M	Responsible Parties: Monitoring	Project Partners
Diversion Structure Project	This project would entail the installation of nested piezometers in the wetland at the Diversion Structure to determine groundwater contributions, flows in the area and assess the amount of groundwater that could potentially be "harvested" from the area and re-directed to Brown's Creek via a drain-tile type system. Project includes feasibility study, design and construction costs.	CBC-16	City of Stillwater	--	--	--	H	--	$25,000	$100,000	--	2014-2015	X				BCWD	BCWD	BCWD	City of Stillwater
PRIVATE PROJECTS																				
Stillwater Country Club BMPs	Project involved the installation of 8 raingardens, 2 native planting areas and numerous other stormwater management features.	LBC-3b	City of Stillwater	2.6	5,130	24	L	16.8	*NA*	*NA*	--	Completed	X			X	BCWD	BCWD	BCWD	Stillwater Country Club
Countryside Repair Stormwater BMP	Countryside Repair is an automobile repair shop located upstream of McKusick Road. The site contains approximately 2 acres of gravel parking surface that contributes loads to the creek. Buffers, raingardens and wetlands could be utilized on this site to minimize the impact of runoff from this site. A strategically positioned BMP near the creek could treat additional runoff from McKusick Road as well.	CBC-15	City of Stillwater	2.3	4,600	22	M	4.5	$1,700	$16,700	$5,010	2012 - 2013	X			X	BCWD, MNDNR	BCWD, MNDNR	BCWD, MNDNR	Private landowners, Washington County, City of Stillwater
Millbrook Development	140-acre development site straddles the watershed boundary dividing the CMSCWD and the BCWD. Proposed project entails development of both single family and multi-family residential housing totaling 270 units. Project directed 11.8 acres of drainge from CMSCWD to the BCWD. The stormwater management plan exceeds the District's 2000 Rules and Regulations by providing volume control up to the 10-year 24-hour rainfall event.	CBC-14	City of Stillwater	12.2	24,443	116	--	???	*NA*	*NA*	--	Completed	X			X	Permit Applicant	Permit Applicant	Permit Applicant	*NA*

Implementation Categories/Proposed Projects	Project Description	Subwatershed	Community	Estimated Load Reduction: TSS (lb/yr)		***Estimated Load Reduction: Total Phosphorus	Estimated Load Reduction: Thermal (L/M/H)	Estimated Volume Reduction [AF]	Estimated Costs			Schedule of Implementation	Allocation Tracking			Applicability to Stillwater's ORVW Requirements	Responsible Parties			Project Partners
													WLA - MS4		LA					
				[tons/year]	[lbs/year]				Engineering	Construction	Operation & Maintenance*		Stillwater	Lake Elmo, OPH	Stillwater TWP, Grant		Implementation	O&M	Monitoring	
Windisch Residence (BCWD Homeowner BMP Program)	Installed a raingarden that captures the 1-inch 24-hour rainfall event from 2,400 sq/ft of impervious surfaces and two rain barrels.	LBC-3	City of Stillwater	0.03	53	0	--	???	*NA*	*NA*	--	Completed	X			X	BCWD and Homeowner	Homeowner	BCWD	*NA*
Wilson Residence (BCWD Homeowner BMP Program)	Installed a raingarden that captures the runoff from the house generated for the 1-inch 24-hour rainfall event and a 2, 765 sq/ft planting bed	CBC-16	City of Stillwater	0.03	67	0	--	???	*NA*	*NA*	--	Completed	X			X	BCWD and Homeowner	Homeowner	BCWD	*NA*
Gartner Residence (BCWD Homeowner BMP Program)	Conducted a prairie restoration project totaling 0.69 acres in size	CBC-15	City of Stillwater	0.06	128	1	--	???	*NA*	*NA*	--	Completed	X			X	BCWD and Homeowner	Homeowner	BCWD	*NA*
MUNICIPAL OPERATION AND MAINTENANCE																				
Improved Street Sweeping	Street sweeping frequency should be increased to 10 sweepings per year to prevent solids from reaching the stream	ALL	ALL	TBD	TBD	TBD	--	--	TBD	TBD	TBD	On-going	X		X		City of Stillwater, Stillwater TWP	City of Stillwater, Stillwater TWP	City of Stillwater, Stillwater TWP	BCWD
Road Sand Management	Application of road sand within the watershed should be reviewed to verify that the recommended rates are being observed. Recommended sanding rates vary from 400 – 750 lbs/2 lane mile (LTAP et al. 2005) for particular road conditions.	ALL	ALL	TBD	TBD	TBD	--	--	TBD	TBD	TBD	On-going	X		X		City of Stillwater, Stillwater TWP	City of Stillwater, Stillwater TWP	*NA*	BCWD

Implementation Categories/Proposed Projects	Project Description	Subwatershed	Community	Estimated Load Reduction: TSS (lb/yr) [tons/year]	Estimated Load Reduction: TSS (lb/yr) [lbs/year]	***Estimated Load Reduction: Total Phosphorus	Estimated Load Reduction: Thermal (L/M/H)	Estimated Volume Reduction [AF]	Estimated Costs: Engineering	Estimated Costs: Construction	Estimated Costs: Operation & Maintenance*	Schedule of Implementation	Allocation Tracking: WLA - MS4: Stillwater	Allocation Tracking: WLA - MS4: Lake Elmo, OPH	Allocation Tracking: LA: Stillwater TWP, Grant	Applicability to Stillwater's ORVW Requirements	Responsible Parties: Implementation	Responsible Parties: O&M	Responsible Parties: Monitoring	Project Partners
Pond Maintenance	Municipalities regulated under the National Pollutant Discharge Elimination System/State Disposal System (NPDES/SDS) Municipal Separate Storm Sewer System (MS4) Permit Program are required to annually inspect all structural pollution control devices and 20 percent of all stormwater ponds they operate. Pond design should incorporate maintenance requirements, allowing easy access for the removal of sediment that accumulates in the basin. Regular inspections will determine when it is necessary to dredge the pond and remove excess sediment accumulation, but generally ponds should be evaluated to determine the need for dredging every five years.	ALL	ALL	No net increase	No net increase	No net increase	--	--	TBD	TBD	TBD	On-going					City of Stillwater, Stillwater TWP	City of Stillwater, Stillwater TWP	*NA*	BCWD
Yard Waste	The City of Stillwater allows residents to place ward waste curbside for collection on trash day from April 1 - November 1. Stillwater TWP ???	ALL	ALL	TBD	TBD	TBD	--	--	TBD	TBD	TBD	On-going	X		X		City of Stillwater, Stillwater TWP	City of Stillwater, Stillwater TWP	*NA*	BCWD
COUNTY OPERATION AND MAINTENANCE																				
Improved Street Sweeping	Street sweeping frequency should be increased to 10 sweepings per year to prevent solids from reaching the stream	CBC-13, CBC-14, CBC-15, CBC-16, LBC-1, LBC-2, LBC-4, LBC-5a, LBC-5e, LBC-3b	City of Stillwater, Stillwater TWP, City of Grant, Oak Park Heights, Lake Elmo	TBD	TBD	TBD	--	--	TBD	TBD	TBD	On-going	X		X		Washington County	*NA*	*NA*	BCWD
Road Sand Management	Application of road sand within the watershed should be reviewed to verify that the recommended rates are being observed. Recommended sanding rates vary from 400 – 750 lbs/2 lane mile (LTAP et al. 2005) for particular road conditions.			TBD	TBD	TBD	--	--	TBD	TBD	TBD	On-going	X		X		Washington County	*NA*	*NA*	BCWD

Implementation Categories/Proposed Projects	Project Description	Subwatershed	Community	Estimated Load Reduction: TSS (lb/yr)		***Estimated Load Reduction: Total Phosphorus	Estimated Load Reduction: Thermal (L/M/H)	Estimated Volume Reduction [AF]	Estimated Costs			Schedule of Implementation	Allocation Tracking			Applicability to Stillwater's ORVW Requirements	Responsible Parties			Project Partners
													WLA - MS4		LA					
				[tons/year]	[lbs/year]				Engineering	Construction	Operation & Maintenance*		Stillwater	Lake Elmo, OPH	Stillwater TWP, Grant		Implementation	O&M	Monitoring	
STATE OPERATION AND MAINTENANCE																				
Improved Street Sweeping	Street sweeping frequency should be increased to 10 sweepings per year to prevent solids from reaching the stream	CBC-13, LBC-5a, LBC-3, LBC-6	Stillwater TWP, City of Grant	TBD	TBD	TBD	--	--	TBD	TBD	TBD	On-going			X		MNDOT	*NA*	*NA*	BCWD
Road Sand Management	Application of road sand within the watershed should be reviewed to verify that the recommended rates are being observed. Recommended sanding rates vary from 400 – 750 lbs/2 lane mile (LTAP et al. 2005) for particular road conditions.			TBD	TBD	TBD	--	--	TBD	TBD	TBD	On-going			X		MNDOT	*NA*	*NA*	BCWD
EDUCATION																				
Pond Managament: Golf Course	Pond management plans should be developed for Oak Glen Golf Course and Stillwater Country Club to ensure that irrigation operations are not inadvertently leading to an increase in sediment load or thermal load to the creek.	CBC-16, LBC-7b, LBC-5a, LBC-5b, LBC-5c, LBC-5d, LBC-5e, LBC-3a, LBC-3b, LBC-10, LBC-6a, LBC-3e	City of Stillwater	TBD	TBD	TBD	--	--	TBD	TBD	TBD	On-going	X				BCWD	*NA*	*NA*	Golf Courses

Implementation Categories/Proposed Projects	Project Description	Subwatershed	Community	Estimated Load Reduction: TSS (lb/yr)		***Estimated Load Reduction: Total Phosphorus	Estimated Load Reduction: Thermal (L/M/H)	Estimated Volume Reduction [AF]	Estimated Costs			Schedule of Implementation	Allocation Tracking			Applicability to Stillwater's ORVW Requirements	Responsible Parties			Project Partners
				[tons/year]	[lbs/year]				Engineering	Construction	Operation & Maintenance*		WLA - MS4 Stillwater	WLA - MS4 Lake Elmo, OPH	LA Stillwater TWP, Grant		Implementation	O&M	Monitoring	
Stormwater Management - Golf Course	Develop management plan to promote water conservation, preserve or improve water quality and protect water resources. Environmental concern of golf courses is the degradation of water quality as a result of the use of high rates of fertilizers, pesticides and fungicides on managed turf that makes up the courses. Other practices that have the potential to produce stormwater pollutants to contribute to increased stormwater runoff include: equipment and parts washing; fuel storage; irrigation of golf course grounds.	CBC-16, LBC-7b, LBC-5a, LBC-5b, LBC-5c, LBC-5d, LBC-5e, LBC-3a, LBC-3b, LBC-10, LBC-6a, LBC-3e	City of Stillwater	TBD	TBD	TBD	--	--	TBD	TBD	TBD	On-going	X				BCWD	*NA*	*NA*	Golf Courses
Stormwater Management - Homeowners	Develop management plan to assist homeowners with proper use of fertilizer or pesticides on lawns, gardens, shrubs and trees. Improperly storing and applying these products may result in fertilizer or pesticides moving through the soil into the groundwater or washing off into surface waters. It is important for homeowners to know how to maintain their yard while still protecting surface water and groundwater. Proper application of fertilizers and pesticides, safe storage practices, and correct watering are all part of the overall protection plan.	ALL	ALL	TBD	TBD	TBD	--	--	TBD	TBD	TBD	On-going	X				City of Stillwater, City of Oak Park Heights, City of Lake Elmo, BCWD	*NA*	*NA*	
East Metro Water Resource Education Program (EMWREP)	A partnership formed in 2006 to develop and implement a comprehensive water resource education and outreach program for the east metro area of St. Paul, MN. Program activities include efforts such as community events, student programs, mailings, newspaper columns, press releases, city newsletter articles, websites and social media.	ALL	NA	TBD	TBD	TBD	--	--	TBD	TBD	TBD	On-going	X				EMWREP	EMWREP	EMWREP	EMWREP, BCWD, City of Stillwater, City of Lake Elmo, City of Oak Park Heights, City of Grant, Stillwater TWP

Table 12. TSS Accounting

Subwatershed	% TSS reduction needed	Existing load (lbs/yr)	Goal load (lbs/yr)	Total reduction needed (lbs/yr)	Stillwater Township (LA*)		City of Stillwater (WLA*)		City of Grant (LA*)		Lake Elmo, OPH WLA		May TWP LA	
					Reduction needed (lbs/yr)	Reductions provided by IP (lbs/yr)	Reduction needed (lbs/yr)	Reductions provided by IP (lbs/yr)	Reduction needed (lbs/yr)	Reductions provided by IP (lbs/yr)	Reduction needed (lbs/yr)	Reductions provided by IP (lbs/yr)	Reduction needed (lbs/yr)	Reductions provided by IP (lbs/yr)
Subwatersheds upstream of Hwy 15	0%	36,258	36,258	-	*NA*	*NA*	*NA*	*NA*	0		*NA*	*NA*	0	
CBC-13	55%	189,515	84,883	104,633	-		104,633		*NA*	*NA*	0		*NA*	*NA*
CBC-14	81%	190,652	35,477	155,175	64,829		52,139	24,443	*38,208*		0		*NA*	*NA*
CBC-15	80%	155,412	31,630	123,783	30,503		93,280	128	*NA*	*NA*	0		*NA*	*NA*
CBC-16	83%	342,843	59,639	283,204	283,204		-	808	*NA*	*NA*	0		*NA*	*NA*
LBC-1	0%	-	-	-	-		-		*NA*	*NA*	0		*NA*	*NA*
LBC-10	0%	-	-	-	-		-		*NA*	*NA*	0		*NA*	*NA*
LBC-2	0%	-	-	-	-		-		*NA*	*NA*	0		*NA*	*NA*
LBC-3	66%	67,531	22,855	44,676	1,966		42,710	53	*NA*	*NA*	0		*NA*	*NA*
LBC-3a	0%	305	305	-	-		-		*NA*	*NA*	0		*NA*	*NA*
LBC-3b	0%	13,039	13,039	-	-		-	5,130	*NA*	*NA*	0		*NA*	*NA*
LBC-3c	0%	3	3	-	-		-		*NA*	*NA*	0		*NA*	*NA*
LBC-3d	1%	1,197	1,182	15	15		-		*NA*	*NA*	0		*NA*	*NA*
LBC-3e	49%	4,570	2,313	2,257	2,250		6		*NA*	*NA*	0		*NA*	*NA*
LBC-4	0%	-	-	-	-		-		*NA*	*NA*	0		*NA*	*NA*
LBC-5a	80%	326,380	64,090	262,291	62,769		199,522	2,038	*NA*	*NA*	0		*NA*	*NA*
LBC-5b	0%	-	-	-	-		-		*NA*	*NA*	0		*NA*	*NA*
LBC-5c	0%	168	168	-	-		-		*NA*	*NA*	0		*NA*	*NA*
LBC-5d	0%	110	110	-	-		-		*NA*	*NA*	0		*NA*	*NA*
LBC-5e	83%	25,285	4,274	21,011	21,011		-		*NA*	*NA*	0		*NA*	*NA*
LBC-6	73%	73,490	19,687	53,803	39,167		14,636		*NA*	*NA*	0		*NA*	*NA*
LBC-6a	55%	5,786	2,590	3,196	3,196		-		*NA*	*NA*	0		*NA*	*NA*
LBC-7a	0%	-	-	-	-		-		*NA*	*NA*	0		*NA*	*NA*
LBC-7b	88%	40,749	4,827	35,922	33,677		2,245	1,112	*NA*	*NA*	0		*NA*	*NA*
LBC-8	0%	-	-	-	-		-		*NA*	*NA*	0		*NA*	*NA*
LBC-9	0%	-	-	-	-		-		*NA*	*NA*	0		*NA*	*NA*
Totals**	74%	1,473,292	383,328	1,089,965	542,587		509,170		*38,208*	*NA*	0		*NA*	*NA*

*The portion of the City of Stillwater that is in the direct drainage area of Brown's Creek represents the WLA for the TMDL except for an insignificant area that was categorized as unregulated in the TMDL. For simplification, this area is included in the WLA loading goals in this implementation plan.

9 FUNDING SOURCES

The Brown's Creek Watershed District has a number of programs in its annual budget that it can use to fund the implementation of this plan. These programs include:

- Monitoring Program
- Groundwater Monitoring Program
- Homeowner BMP Program
- BMP Program – LGU/Community Demonstration Projects
- Land Conservation Program
- Shared Educator Position
- Education and Outreach Program

The BCWD has also committed to including a standing line item in its annual budget for implementing the Brown's Creek TMDL. In 2012, the BCWD budgeted $5,000 for the meetings and coordination of the Implementation Plan in addition to separate budgets for the following implementation activities: Buffer/Instream Restoration at the Oak Glen Golf Course ($7,500); Oak Glen Pond Modifications/Float ($5,000); Ravine Stabilization ($52,000); Brown's Creek Trail Improvements ($210,000 a portion of which is for the implementation of activities such as the stormwater BMPs designed to address direct runoff from Countryside Repair); and Brown's Creek Re-meander Project.

In addition, the BCWD will explore and pursue a number of outside funding sources for the implementation of this plan including: State and Federal Grant Programs (e.g. Clean Water Funds); Washington County Land and Water Legacy Program; and funding provided from stakeholder groups such as Trout Unlimited; among others.

Member communities, Washington County, the Minnesota Department of Transportation, and potentially the Minnesota Department of Natural Resources will also be expected to participate in the implementation of this Plan as articulated in the Implementation Plan Table and as planned in subsequent Implementation Plan updates.

10 MONITORING PLAN

In order to evaluate the effectiveness of the Brown's Creek TMDL Implementation Plan and to apply adaptive management decision-making throughout the process, ongoing monitoring will need to be conducted. This monitoring plan will also serve to aid the communities in assessing whether progress toward the TMDL is being made. Monitoring will assess in-stream conditions, BMP effectiveness, and watershed loading.

As stated previously, annual monitoring of in-stream water quality and temperature will be continued while a thorough evaluation of the monitoring data will be conducted every five years. Annual variability in climatic conditions and potential lag time for BMPs to achieve full load reduction potential will need to be considered in assessing the data and developing conclusions.

This monitoring plan includes multiple components and identifies the entities responsible for completing the monitoring activities. Monitoring sites are identified in Figure 11.

10.1 Biota

Current: DNR monitors the fishery at multiple sites on an annual basis.

Goal: Evaluate biological integrity of the creek to determine if cold water species assemblage is restored.

Table 13. Biota Monitoring Plan

Monitoring Activity	Responsible Entity
Annual fish survey at multiple locations	DNR and BCWD
Macroinvertebrate survey as part of 10-yr MPCA watershed assessment	MPCA
Macroinvertebrate survey every 5 years minimum	BCWD

The fish community should be monitored annually to evaluate the impact of management practices that are implemented to address the impairment. Since the trout population can vary annually, mostly due to the success of natural reproduction, annual monitoring is needed to fully capture the condition of the fish community. The DNR and BCWD will cooperatively assess the fish community at multiple sites along Brown's Creek. The focus of the monitoring will be the lower reach, where the natural habitat is more conducive to supporting trout. Since fish sampling can be somewhat disruptive to the fish community, attention will be paid to sampling timing and location. For example, if it is found that there is a breeding trout population in portions of the creek, disruption in this area would be minimized.

The invertebrate community is a good indicator of the thermal environment and can be used to evaluate the habitat and food availability of cold water fish species. Basic invertebrate community monitoring is an important early warning system for detecting unanticipated impacts or changes to the biotic integrity of the stream. In addition to the invertebrate monitoring that will be conducted by the MPCA on a ten-year cycle (next assessment for Brown's Creek is scheduled for 2019), more intensive invertebrate monitoring should occur approximately every five years. The following are options for invertebrate monitoring in Brown's Creek:

- Intensive year-round monitoring of the invertebrate community, and more specifically the chironomid community, was conducted during 2008 to evaluate the distribution of invertebrates that have different tolerances to low DO, high temperature, and poor habitat quality. This type of monitoring can be used to track changes in the invertebrate community after the implementation of management activities. This type of monitoring is highly specific and requires individuals that can complete the chironomid analyses.

- If resources are not available for the highly specific chironomid monitoring, more traditional invertebrate monitoring should be completed. Monitoring should occur at several sites along Brown's Creek and at least seasonally (once each during spring, summer, winter, and fall). The next invertebrate monitoring should take place in 2014 so the data is available for the BCWD's thorough evaluation of the creek.

10.2 TSS

Current monitoring activities include TSS monitoring in conjunction with flow at WOMP, McKusick, Highway 96, Highway 15, and Stonebridge. Monitoring was conducted at the Gateway Trail, and 110th Street for the Stressor ID. Monitoring is targeted to capture flow after storm events and during baseflow conditions.

Goal:

1. Identify additional sources of TSS to the creek.
2. Assess performance of existing and future stormwater management practices.

Table 14. TSS Monitoring Plan

Monitoring Activity	Responsible Entity
Continue baseline monitoring at the Brown's Creek monitoring sites already established by the BCWD	BCWD
Synoptic monitoring during storm events – monitor TSS and turbidity at multiple sites along the creek simultaneously (as close in time as possible) to evaluate TSS sources. Data will be used to inform follow-up monitoring.	BCWD
Analysis for automatic vs. manual sampling	BCWD
Existing pond performance	Municipalities
BMP performance assurance	BCWD permit applicants

10.3 Copper

Current monitoring activities include total copper monitoring in conjunction with flow at WOMP, McKusick, Highway 96, Highway 15, Gateway Trail, and 110th Street.

Goal: Collect monitoring data according to acceptable protocols and evaluate compliance with copper standard.

Table 15. Copper Monitoring Plan

Monitoring Activity	Responsible Entity
Continue baseline monitoring at the WOMP, McKusick, Stonebridge, Highway 15, and Diversion monitoring sites for three years; analyze dissolved copper, total copper, hardness, pH; collection methods should follow EPA method 1669, and analytical methods should follow EPA method 1638	BCWD

Since copper toxicity varies with both hardness and pH, all three measures should be taken simultaneously. Data collection should involve collecting both total and dissolved copper ambient data. Having both fractions may provide confirmation regarding the source of the copper. The dissolved fraction should be taken so that the data can be compared to the appropriate dissolved copper standard conversion. Collection methods for copper sampling should follow EPA method 1669, and analytical methods should follow EPA method 1638.

If high copper concentrations are found, the watershed district should resume the investigation into copper sources and implementation activities. The MPCA will not consider the copper data valid unless the data are collected and analyzed with state-approved methods.

10.4 Thermal

Current monitoring activities include temperature monitoring in conjunction with flow at WOMP, McKusick, Highway 96, Highway 15, and Stonebridge. The Gateway Trail and 110th Street were monitored for the Stressor ID. In 2011 targeted thermal monitoring was collected at the following sites: the creek headwaters; the Gateway Trail; 110th Street; Dellwood Road; west and east (irrigation) ponds at Oak Glen Golf Course; downstream of the irrigation ponds on the Oak Glen Golf Course; stormwater pond in the Oak Glen Golf Course development; and downstream of the stormwater pond outfall.

Goal:

1. Create more comprehensive thermal monitoring network for Brown's Creek.
2. Assess the thermal benefits of stormwater management retrofits and BMPs

Table 16. Thermal Monitoring Plan

Monitoring Activity	Responsible Entity
Continue water temperature monitoring at the existing in-stream monitoring stations: Highway 96, Highway 15, McKusick, Stonebridge and WOMP.	BCWD
Add additional temperature probes (type) along the creek; locations should be selected to ensure that multiple conditions are covered, including the following: shaded and non-shaded areas; locations of direct discharges to the creek; locations of groundwater contributions; developments adjacent to the creek (i.e. Millbrook)	BCWD
Install temperature probes in and downstream of pond retrofits to assess the thermal benefit.	BCWD

10.5 Climatological Data

Current monitoring activities include the collection of the following parameters at the Stillwater Public Works Facility with an Onset® Brand Hobo U30-NRC Weather Station: temperature, relative humidity, wind speed, wind direction, solar radiation and precipitation.

Goal: Collect local climatological data for data analysis and/or thermal modeling efforts to better understand all thermal contributions to creek.

Table 17. Climatology Monitoring Plan

Monitoring Activity	Responsible Entity
Continue baseline program	BCWD

10.6 Stream Flow

Current monitoring activities include continuous flow monitoring at WOMP, McKusick, Highway 96, Highway 15, Stonebridge and the Diversion area.

Goal:

1. Collect continuous stream flow data to calculate pollutant loads and to evaluate water quality data with respect to hydrologic regime.
2. Confirm assumptions regarding flow from area draining to Diversion Structure

Table 18. Stream Flow Monitoring Plan

Monitoring Activity	Responsible Entity
Continue baseline program	BCWD
Install monitoring station at overflow from McKusick wetland to Brown's Creek	BCWD

10.7 Other Recommendations from TMDL Report

Unionized ammonia (NH_3) is the form of ammonia that, in high concentrations, can be directly toxic to fish. The concentration of unionized ammonia can be calculated from total ammonia concentration if both temperature and pH from the same sample are available. The TMDL stressor ID showed a few points of unionized ammonia in excess of the water quality standard. However, there was not enough temperature and pH data to convert many of the total ammonia samples to unionized ammonia concentration in order to fully evaluate the impact of unionized ammonia on the biota.

Current monitoring activities include ammonia monitoring in conjunction with flow at WOMP, McKusick, Highway 96, Highway 15, Gateway Trail, and 110th Street.

Goal:
Evaluate compliance with unionized ammonia standard in the creek.

Table 19. Ammonia Monitoring Plan

Monitoring Activity	Responsible Entity
Monitor total ammonia, pH, and temperature simultaneously at baseline monitoring sites.	BCWD

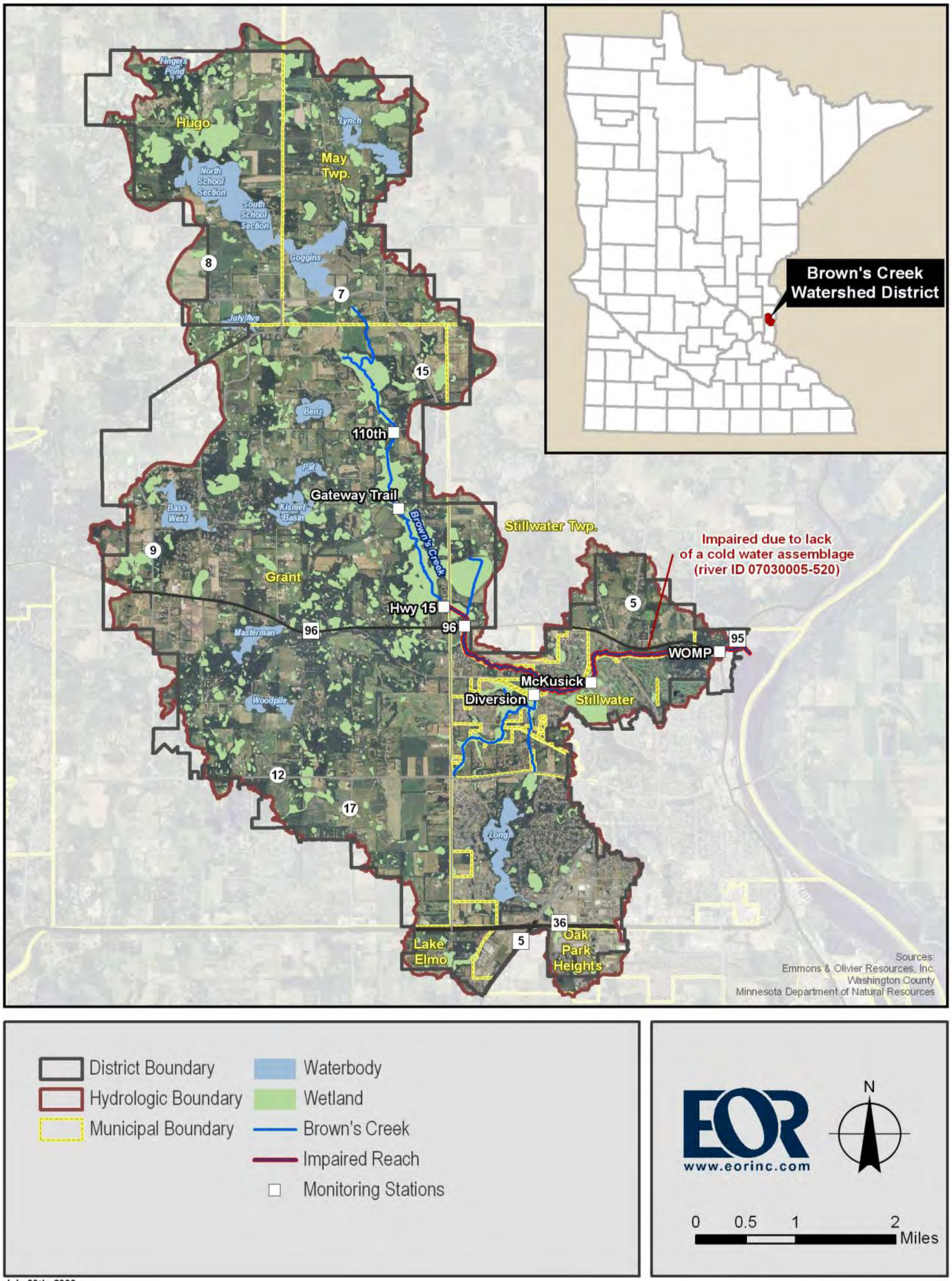

Figure 11. Location of Brown’s Creek Watershed District Monitoring Sites

APPENDIX A:

Temperature Data Analysis Memos

memo

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Date | December 7, 2010

To | BCWD Board of Managers

cc | Karen Kill, BCWD Administrator

From | Andrea Plevan, Tom Miller, and Camilla Correll

Regarding | Temperature data collected in Brown's Creek, August through November 2010

As the first phases of the Brown's Creek TMDL Implementation Plan were completed it became apparent that additional temperature monitoring data would be useful to evaluate the potential impacts of wetlands and stormwater BMPs on the thermal loads to Brown's Creek. At the August 2010 Board Meeting the Managers approved a scope to install the five temperature probes acquired for the Springshed investigation to collect additional data for the TMDL Thermal Implementation Plan. This memorandum summarizes the findings of this additional thermal monitoring work.

Approach

A total of six temperature probes were installed at the locations identified in Table 1 and Figure 1. One of the temperature probes that was installed for this data collection effort belongs to the Minnesota Department of Natural Resources and was installed by Brian Nerbonne.

Table 1. Temperature monitoring sites

Site #	Location	Dates of Monitoring	Monitoring Entity	Purpose
1	Brown's Ck, Dellwood Rd N	Aug 5 - Oct 8	DNR	Impact of Mendel Wetland
		Oct 19 - Nov 15	EOR	
2	W Pond, Oak Glen	Aug 5 - Nov 15	EOR	Impact of irrigation ponds
3	E Pond, Oak Glen	Aug 5 - Nov 15	EOR	Impact of irrigation ponds
4	Brown's Ck, Oak Glen	Oct 19 - Nov 15	EOR	Impact of irrigation ponds
5	Stormwater pond, E of Oak Glen Drive	Aug 5 - Nov 15	EOR	Impact of stormwater pond serving the residential development and part of the golf course
6	Brown's Creek, dwnstrm of stormwater pond outfall to creek	Aug 5 - Nov 15	EOR	Impact of stormwater pond serving the residential development and part of the golf course

Instream temperatures at Sites 2, 3, 5, and 6 were recorded using HOBO Water Temp Pro v2 loggers. Site 1 was monitored using a Water Temp Pro v2 logger for the period of August 5 through October 8. Loggers were affixed to the streambed and pond bottoms using spiral stakes that are typically used as pet restraints. Spiral stakes function well in this manner as they firmly hold the temperature logger in place and at a height of roughly five inches above the bed bottom. Having the logger situated above the bed bottom helps eliminate cooling of the logger by groundwater input through the streambed. Dataloggers were launched with a logging interval of fifteen minutes.

Solinst Levelloggers, Model 3001, were also used to monitor temperature at two locations. One of these loggers was used to replace the Dellwood Road logger that had been loaned by the DNR (Site 1), and the other was used to monitor the instream location on Oak Glen Golf Course (Site 4). Solinst dataloggers were launched with a logging interval of fifteen minutes.

Precipitation data (15-minute interval) from the monitoring station at Highway 15 were used.

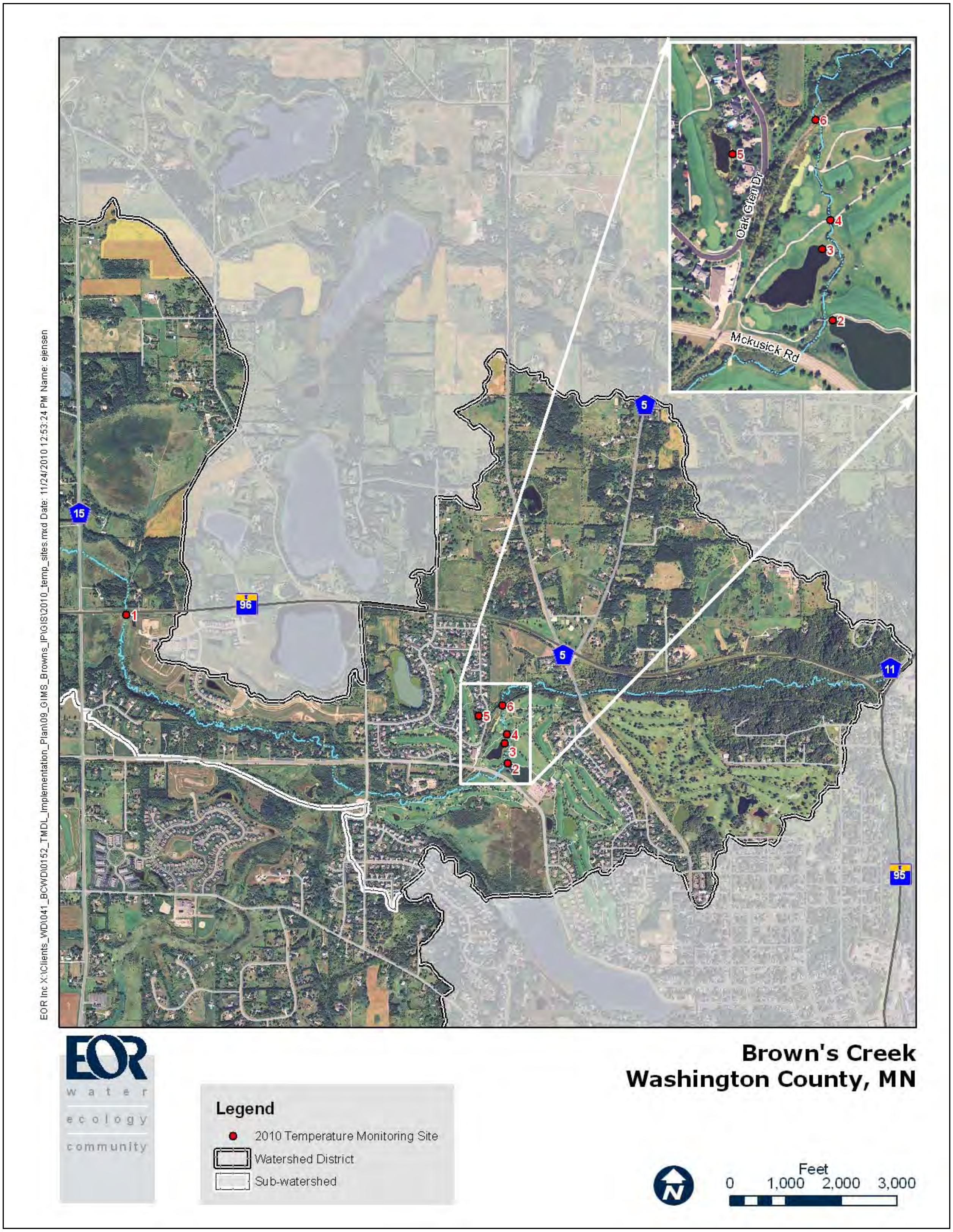

Figure 1. Monitoring sites

Results

The following observations were made:

- Temperature generally follows a diurnal cycle, with cooler temperatures at night and warmer temperatures during the day (Figure 2).
- The temperatures in the irrigation ponds and in the stormwater pond are generally higher than the Brown's Creek instream temperature (Figure 2).
- The temperatures in the two Brown's Creek monitoring sites (Site 1 at Dellwood and Site 6 downstream of the stormwater pond) are similar, but the Dellwood site is typically slightly higher than the downstream site (Figure 2). This is likely due to the cooler groundwater inputs that occur between the two sites (approximately 1 to 2 cfs of groundwater flow enters the stream between the two sites). Note that there is noise in the data from the east irrigation pond site; this was due to the monitoring equipment and does not represent true changes in temperature. When the data are shown closer up in Figure 3, a running average is used to somewhat smooth out the data.
- Temperatures in the stormwater pond (Site 5) are similar to temperatures in the west irrigation pond (Site 3). Temperatures in the east irrigation pond (Site 2) are generally cooler (Figure 2), but still higher than the stream water. The lower temperatures in Site 2 could be due to a number of factors, including groundwater augmentation, pond depth, and pond surface area.
- After a precipitation event, the three ponds all discharge into Brown's Creek, indicated in the data by an abrupt drop in pond temperature as cooler precipitation and runoff displaces the water that had been in the ponds. Immediately after the ponds discharge into the creek, the instream temperature downstream of the ponds (Site 6) increases.
    - This phenomenon is represented by a storm event on August 8 (Figure 3). The total precipitation on August 8 was 1.3 inches, with 0.8 inches falling within 30 minutes at approximately 7:00 PM. The temperature in the ponds dropped (indicated by the red asterisk in Figure 3), after which the instream temperature increased by approximately 2°C for approximately two hours. Note also in Figure 3 the temperature at the McKusick monitoring site in Brown's Creek. This site is located immediately upstream of the irrigation ponds and receives untreated runoff from a nearby residential development. After a precipitation event, the temperature increases briefly, then decreases again. A comparison of this signal with the temperature at Brown's Creek Site 6 confirms that the increase in temperature at Site 6 is due to the ponds and not to runoff from direct impervious areas.
    - This phenomenon is observed, in addition to the August 8 occurrence described above, after precipitation events on August 10, 13, 24, and 31, and September 2, 15, and 23. During the September events (Figure 4), daily maximum air temperatures drop to approximately 18-19°C and the instream water temperature is not as high as it had been in August. Therefore, even though the magnitude of the increase in water temperature is similar to the increases that occur in August, the temperatures are not as high and therefore the increase likely does not have as much of an impact on the instream biota.
    - These occurrences suggest that the ponds (irrigation ponds and stormwater ponds together) are a source of thermal pollution to Brown's Creek when they discharge.
- Data at Brown's Creek Sites 4 and 6 were used to separate the impact of the irrigation ponds from the impact of the stormwater pond (Figure 5). Data at Site 4 (Brown's Creek, downstream of Oak Glen irrigation ponds) were collected only from October 19 through November 15. Instream temperatures at the site downstream of the irrigation ponds (Site 4) and at the site downstream of the stormwater pond (Site 6) generally track one another closely. The only precipitation that fell during the period in which both sites were monitored was from October 23 through October 27; during this time period there were four instances during which the temperature at Site 6 increased when the temperature at

Site 4 did not increase (numbered in Figure 5). Events #2 and #4 occurred after precipitation events, presumably after the ponds discharged into the creek. (When air temperatures are cooler, there is not as clear of a temperature signal in the ponds when they discharge to the creek as there is during hotter weather when precipitation and runoff are usually cooler than the water in the ponds.) These occurrences suggest that the stormwater pond may have more of a thermal impact on instream temperatures than the irrigation ponds do likely because the larger drainage area and impervious area contributing to the stormwater pond. The magnitude of the difference illustrated with these data is quite small; however the difference might be larger during the hotter summer months. This observation is from only two occurrences. It is not apparent what led to the differences in temperature at events #1 and #3 in Figure 5.

- There is not a clear thermal signal from the wetland that enters the creek at the Dellwood monitoring site (Site 1). Monitoring data at Dellwood were compared to monitoring data collected by the Washington Conservation District at the Highway 15 monitoring site, located 0.3 miles upstream of the Dellwood site, and upstream of where discharge from the wetland, known as the Mendel Wetland, enters the creek. The temperature at both sites cycles diurnally, but the relative temperature at each site also cycles diurnally, as illustrated by a graph of the temperature difference between the two sites (Figure 6). During the day, the temperature at the Highway 15 site is usually higher than the temperature at Dellwood. At night it reverses and the Dellwood temperature is higher. The temperature logger at Dellwood was flush with the streambed, whereas the logger at Highway 15 was approximately two inches above the streambed. If there are groundwater inputs where the Dellwood site is located, the temperature could have been influenced by the groundwater temperature. It is not clear what led to changes in the cycling of the temperature differences (such as an abrupt shift that occurred on August 26). These changes could be caused by a disruption to surrounding vegetation caused by humans or wildlife. Overall, the data indicate that the water from the Mendel Wetland has similar temperatures as the wetlands upstream of Highway 15 along the creek.

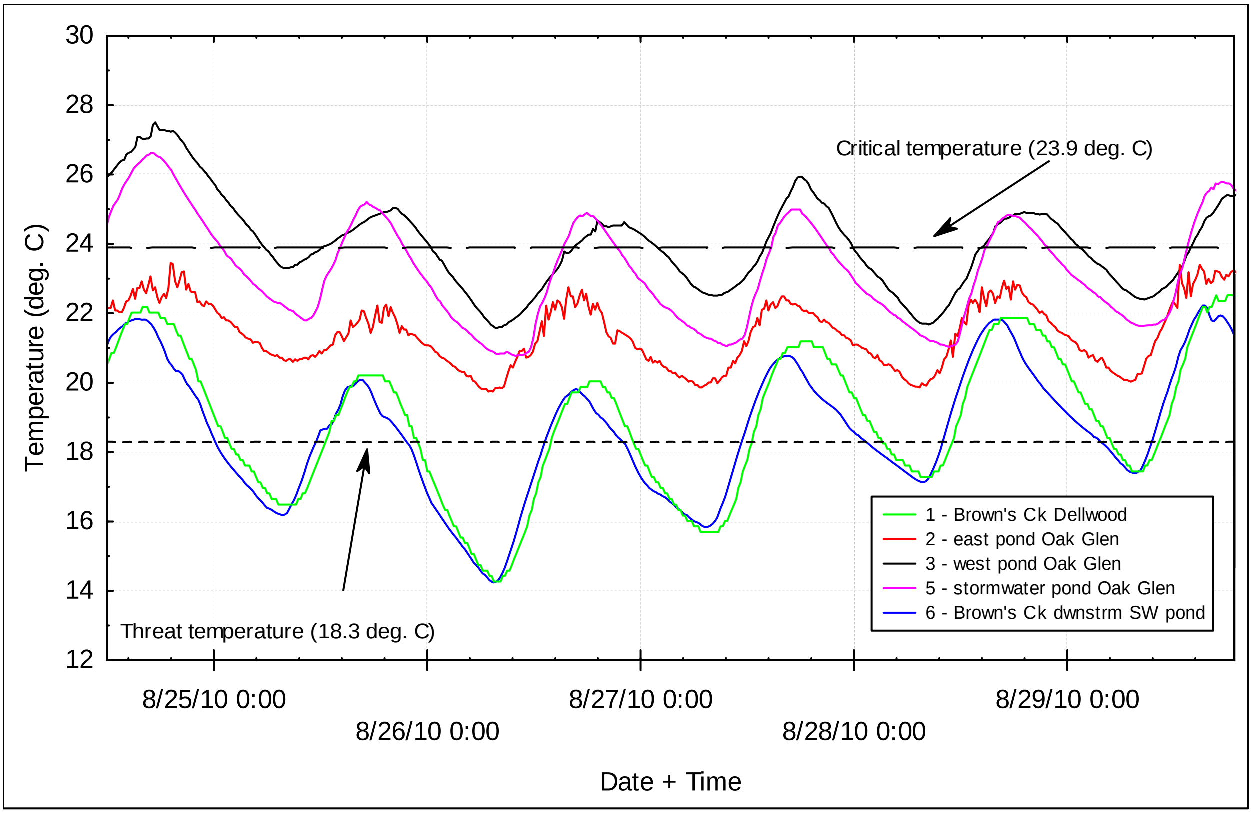

Figure 2. Brown's Creek water temperature, Aug 25 - Aug 29 (period of no precipitation)

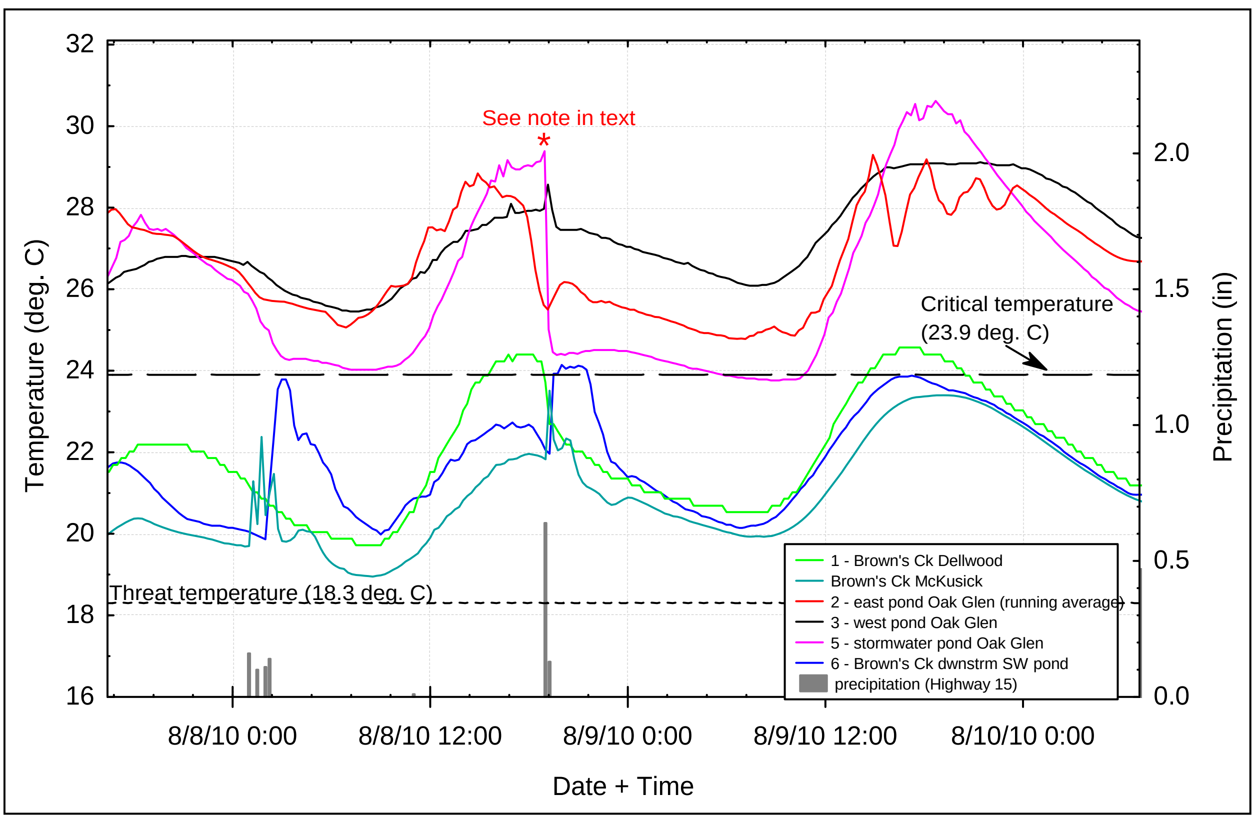

Figure 3. Brown's Creek water temperature, Aug 8 - Aug 10: summer precipitation events

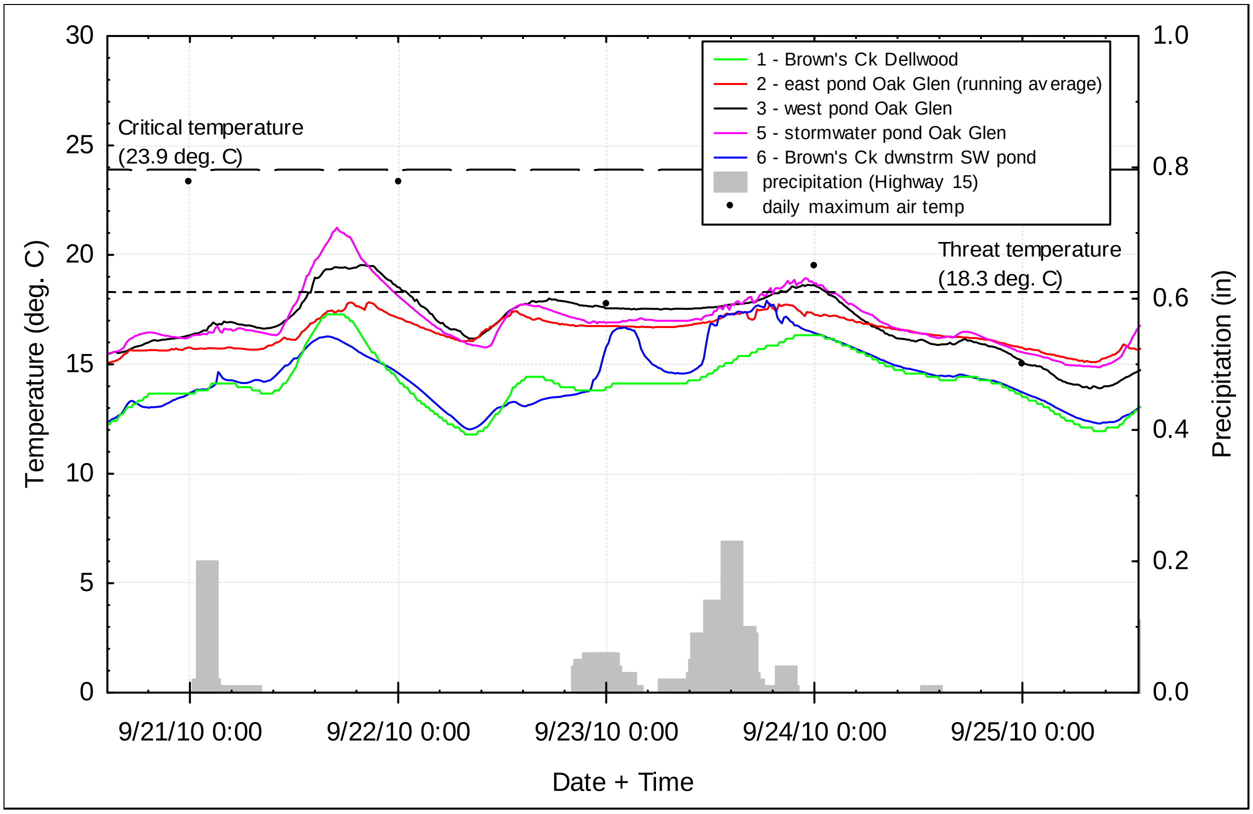

Figure 4. Brown's Creek water temperature, Sept 21 – Sept 25

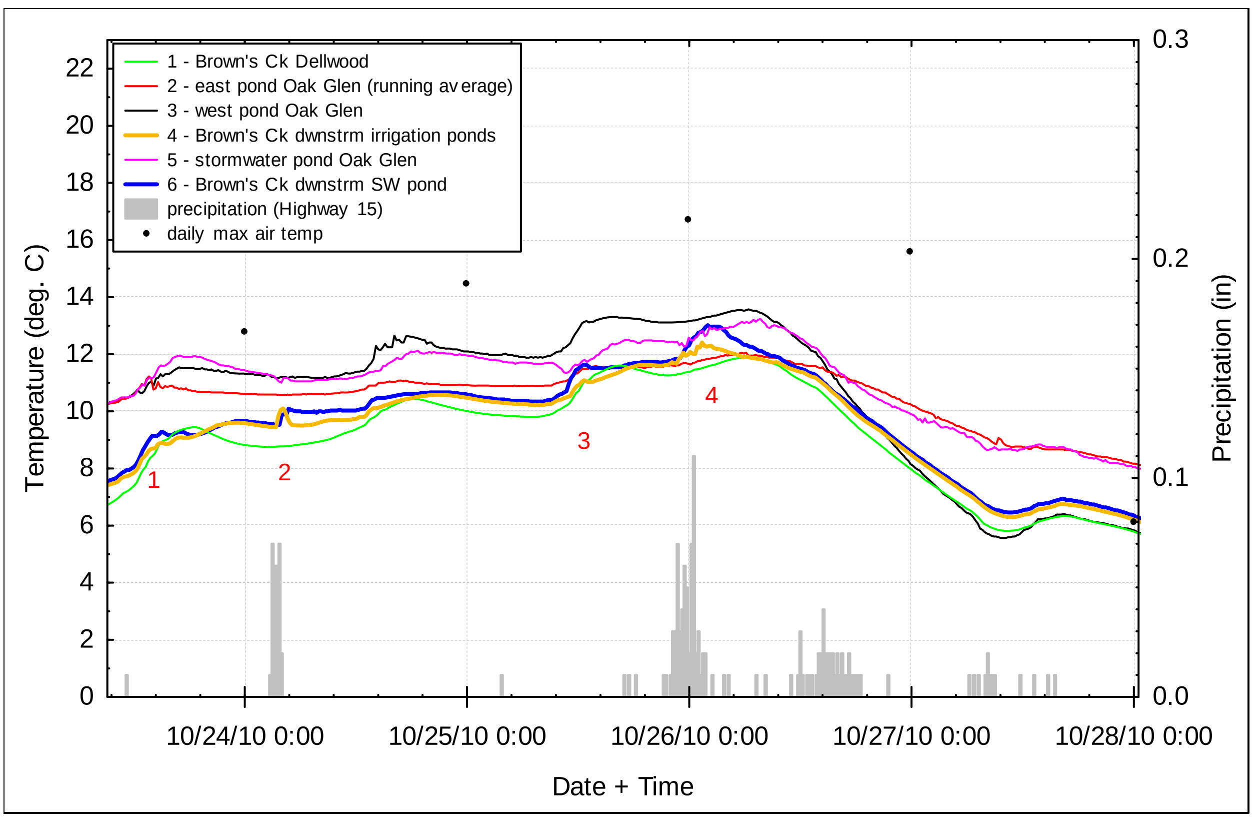

Figure 5. Brown's Creek water temperature, Oct 24 - Oct 28: October precipitation events
The instream sites compared in the text are the blue and orange lines, which are thicker than the others.

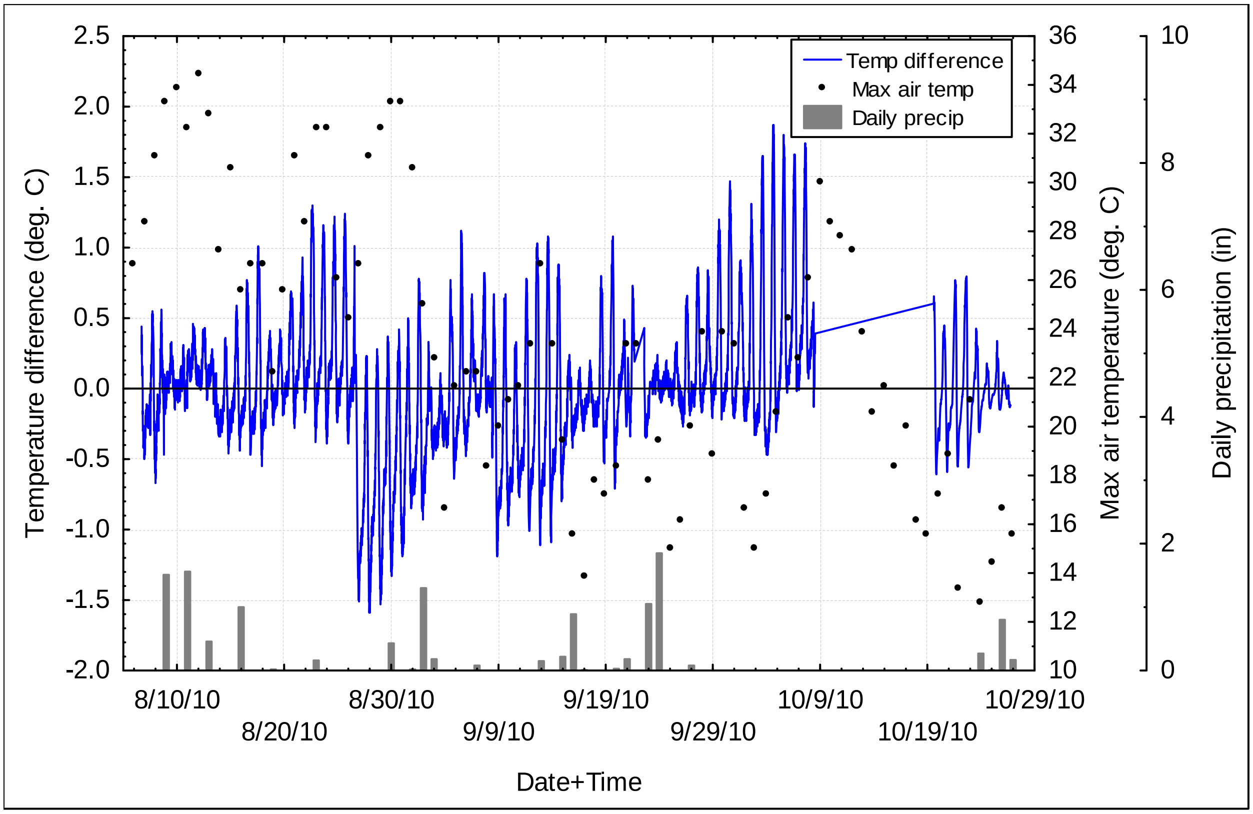

Figure 6. Difference in temperature at the Highway 15 monitoring site relative to the Dellwood site. Values with a temperature difference greater than zero indicate that temperature was higher at the Highway 15 site (upstream of the Mendel Wetland), and values lower than zero indicate that temperature was higher at the Dellwood site (downstream of where the Mendel Wetland discharge enters the creek).

Discussion

The data indicate that the irrigation ponds and the stormwater pond together have a thermal impact to the creek. Whether or not that impact translates into an impact to the biota depends on the amount of precipitation and the air temperature (Figure 7), which in turn impact the magnitude and length of time of the instream temperature increase. For storm events that occurred on days with a maximum air temperature of over 30°C and precipitation over 0.2 inches, an increase in instream temperature was observed (Figure 7). For events with less than 0.2 inches of precipitation on days with less than 22°C for a maximum high, the event did not lead to an increase in temperature. For events that fell in between these two groups, the predictability of whether or not the event leads to an increase in temperature is less certain.

The increases in water temperatures observed during this monitoring period in Brown's Creek are typically 1 to 2°C, and last for approximately 2 hours. Since these temperature increases are of a relatively short duration, data should be evaluated with respect to the critical temperature of 23.9°C instead of the threat temperature of 18.3°C. During 2010, instream temperatures of 21.9°C (2°C below the critical temperature) occurred periodically between May 24 and August 31 at the McKusick monitoring site (just upstream of the irrigation ponds); it is during these times that, if a temperature increase of 2°C were to occur, the instream critical temperature could be exceeded for 2 or more hours. If this increase occurs when temperatures are already at the critical temperature, it has the potential to lead to direct fish mortality, and more likely causes physiological stress to the fish. The incremental stress caused by these events can in the long run impact the trout population.

The Brown's Creek TMDL identified the lack of riparian cover and the impact of warm stormwater as the two main causes of the high temperatures within Brown's Creek. Work completed for the implementation plan suggests that approximately 80% of the temperature exceedances occur during baseflow conditions, as a result of a lack of riparian shading, and 20% of the exceedances occur during stormflow, due to the thermal load from stormwater, either from direct runoff or through ponds. This percent distribution of exceedances will be used to guide the relative amount of effort put towards restoring riparian cover and reducing the thermal load from stormwater. The thermal load from the irrigation ponds and the stormwater pond should be addressed as a component of the thermal load from stormwater.

While the data do not suggest that the Mendel Wetland has more of a thermal impact than the other wetlands along Brown's Creek, there are implementation options that could cool the water from Mendel Wetland before it reaches the creek. These options should be further investigated.

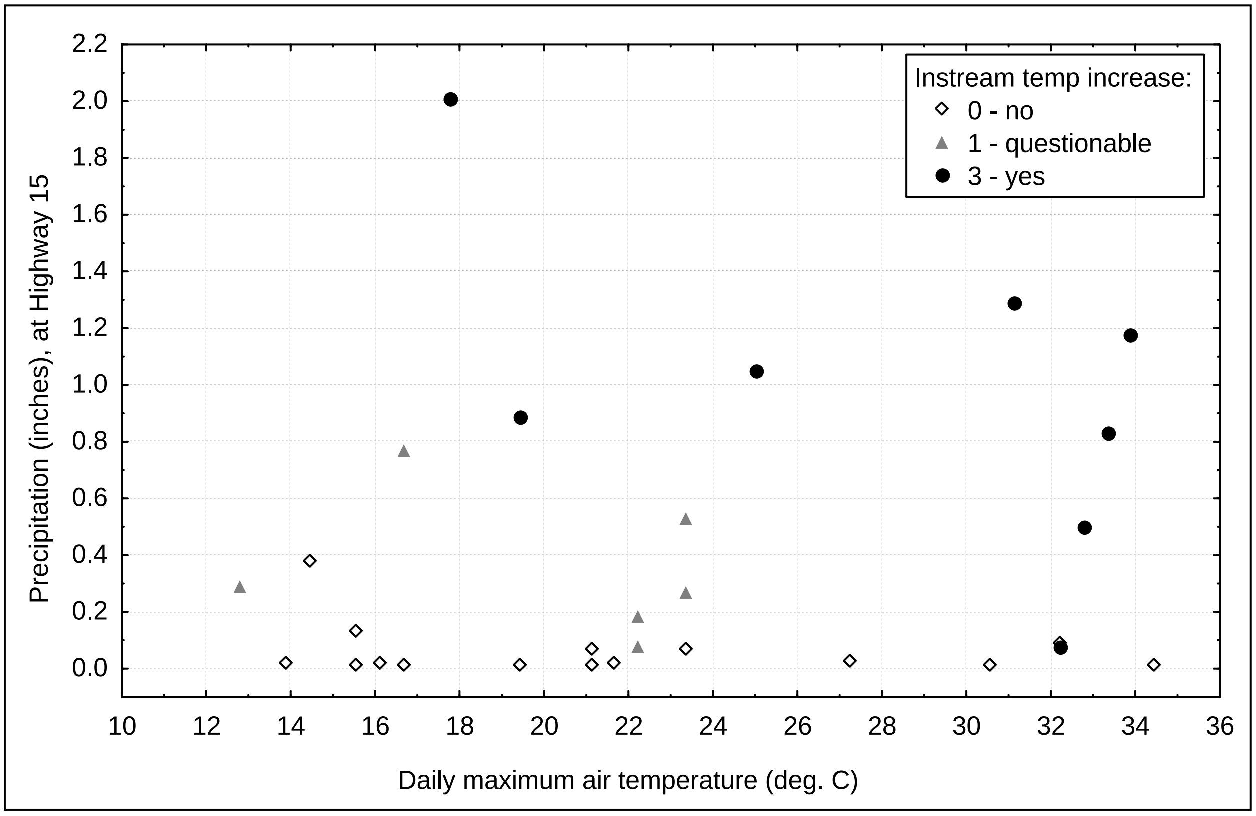

Figure 7. Relationship between air temperature, precipitation, and changes to instream temperature
"Questionable" indicates that there was a slight impact on temperature after the event, but the change was too small to be certain.

Recommendations

- Begin data collection to determine feasibility of pond retrofit(s), including a survey of pond outlet structures and pond depth. Options for pond retrofit include reconfiguring the outlet structure so that it releases bottom water from the pond instead of surface water. Additional issues to consider are monitoring the temperature of pond bottom water and evaluating pond volume and water residence time during runoff events.
- Collect a full season of monitoring data in 2011 to better understand temperature fluctuations at these sites over multiple summer months. The existing data set has limited summer temperature information, and, at Site 4, no summer temperature data. Additional data will strengthen the conclusions and will help quantify the thermal improvements expected from implementation projects. Quantification of these benefits will strengthen the District's applications for grants for implementation funds.
    - The following Brown's Creek sites should be monitored: Highway 15, Dellwood, McKusick, downstream of the irrigation ponds (Site 4 in this memo), downstream of the stormwater pond outfall (Site 6), and WOMP.
    - The following pond sites should be monitored: west and east ponds at Oak Glen (Sites 2 and 3), and the stormwater pond (Site 5).
    - Monitoring should be coordinated between EOR and the WCD to ensure consistency of logger placement; the microclimate should be evaluated to take into consideration the height of the logger with respect to the stream bottom, its location along the riffle-pool sequence, and riparian cover.

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Date | October 11, 2011

To | Andrea Plevan

From | Meghan Jacobson

Regarding | Thermal influences of stormwater versus irrigation ponds on Brown's Creek

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Continuous water temperature data were collected in 2011 in the east and west Oak Glen irrigation ponds (Sites 2 and 3[1]), in the stormwater pond east of Oak Glen Drive (Site 5), in Brown's Creek downstream of the irrigation ponds (Site 4), and in Brown's Creek downstream of both the irrigation ponds and the stormwater pond (Site 6).

These data were plotted with time around two summer precipitation events: a 1.12 inch rainfall with a duration of 1 hour beginning at 22:00 on July 30 (Figure 1 and Figure 2), and a 2.62 inch rainfall with a duration of 3 hours beginning at 18:30 on August 17 (Figure 3 and Figure 4). The first key result was that the water temperature in Brown's Creek downstream of the irrigation ponds and the stormwater pond increased while the water temperature in the irrigation ponds and the stormwater pond decreased following the precipitation event. This suggests that the pond water is temporarily increasing the temperature of Brown's Creek following large precipitation events. The second key result was that the increase in water temperature in Brown's Creek was larger downstream of the stormwater pond than downstream of the irrigation ponds. However, the corresponding decrease in water temperature in the stormwater pond was also larger than the decrease in water temperature in the irrigation ponds. This suggests that the magnitude of temperature change is related to the volume of water discharging from the pond.

Minimum and maximum daily temperatures (14:00 – 14:00) were calculated for the air, Brown's Creek downstream of the irrigation ponds (Site 4), and Brown's Creek downstream of the stormwater pond (Site 6). There were 7 rain events (> 0.01 inches / 15 minutes) between July 22 and August 22 in 2011. Initial water temperature and degree change in water temperature were calculated for each rain event and are summarized in Table 1. The effect of the stormwater pond on Brown's Creek water temperature was calculated as the change in water temperature in Brown's Creek downstream of the irrigation ponds and the stormwater pond less the change in water temperature in Brown's Creek downstream of the irrigation ponds but upstream of the stormwater pond.

The largest increase in water temperature in Brown's Creek due to a rainfall event occurred after the August 16 event. The increase in water temperature in Brown's Creek downstream of the irrigation ponds was 2.1 deg. C, and the increase in temperature downstream of the stormwater pond was 2.4 deg. C, indicating that the increase due to the stormwater pond alone was 0.3 deg. C (Table 1). The irrigation ponds and the stormwater pond appear to have similar impacts on the water temperature of Brown's Creek; after some storm events the irrigation ponds increase the temperature more and after other events the stormwater pond does.

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[1] Site number references are from the Dec 7, 2010 memo to the BCWD Board, "Temperature data collected in Brown's Creek, August through November 2010."

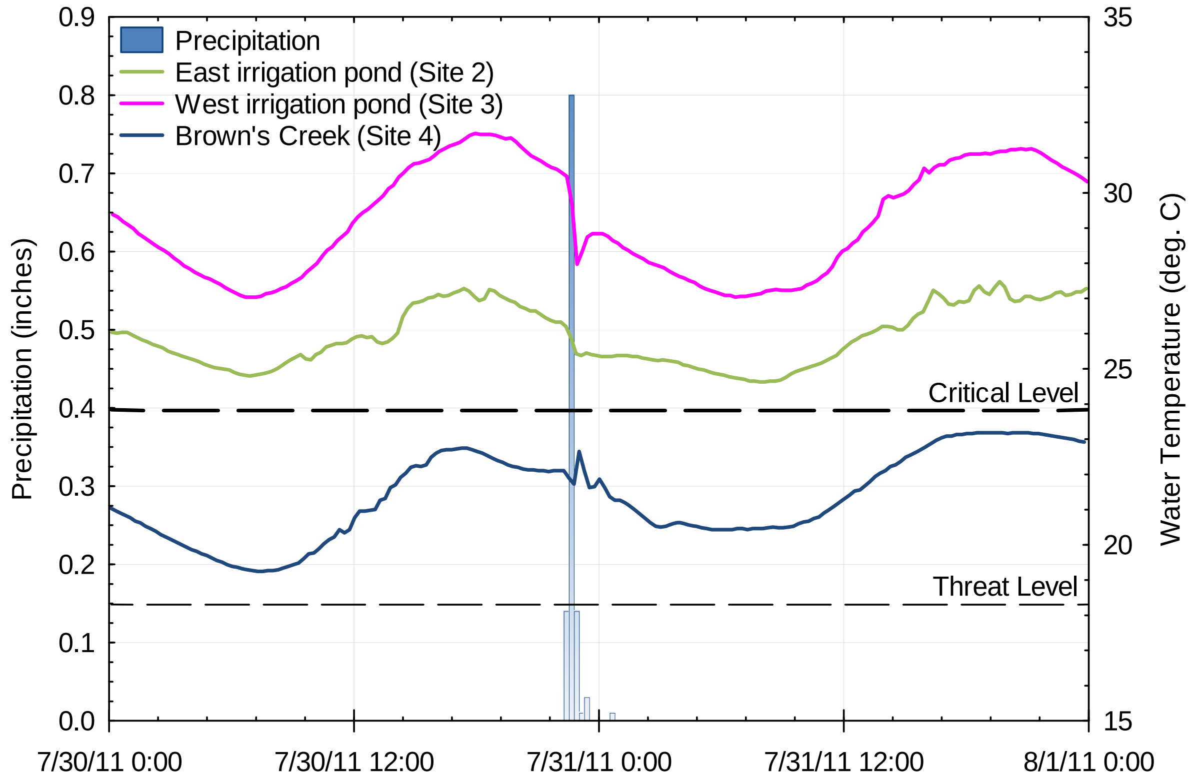

Figure 1. Irrigation pond and Brown's Creek water temperature, summer nighttime precipitation event.

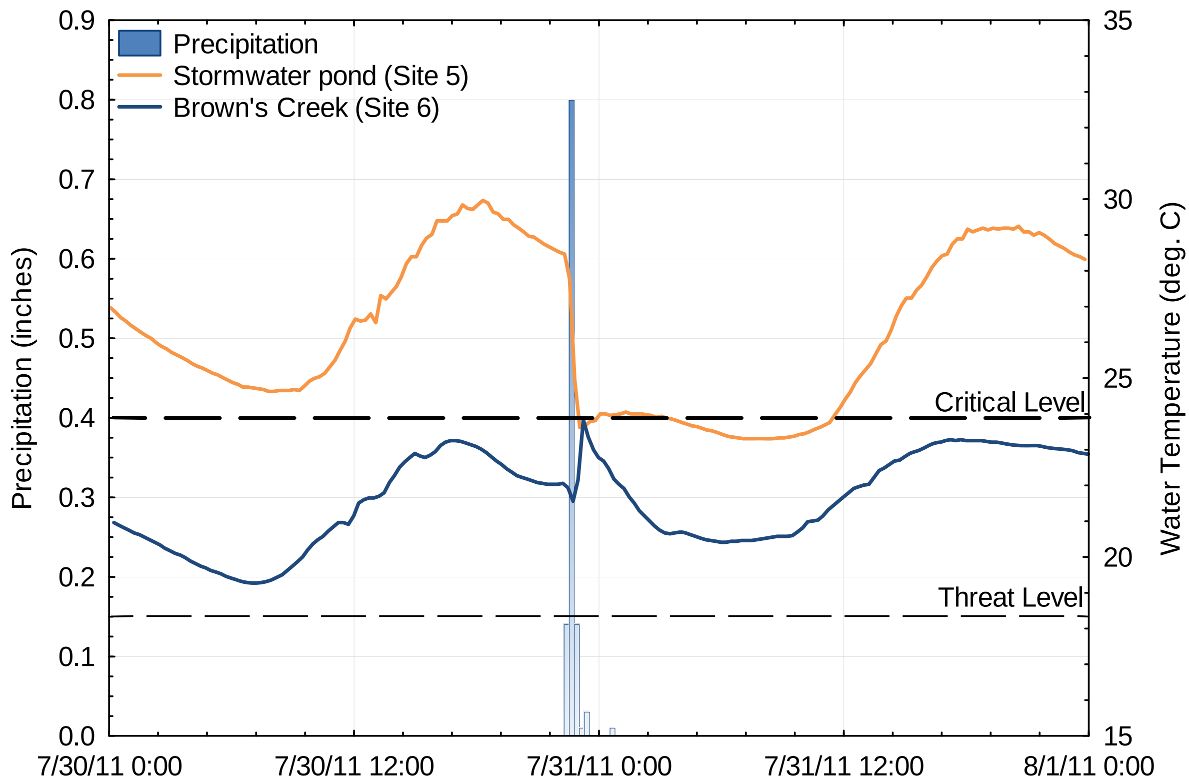

Figure 2. Stormwater pond and Brown's Creek water temperature, summer nighttime precipitation event.

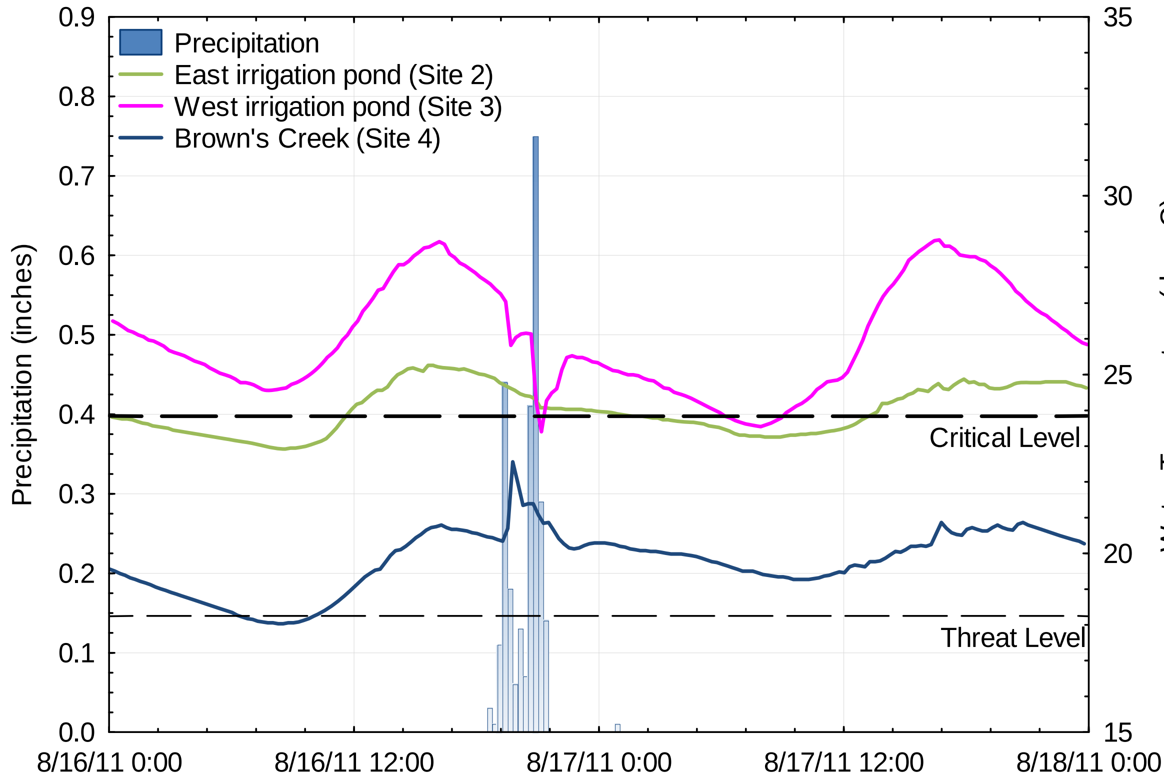

Figure 3. Irrigation ponds and Brown's Creek water temperature, summer daytime precipitation event.

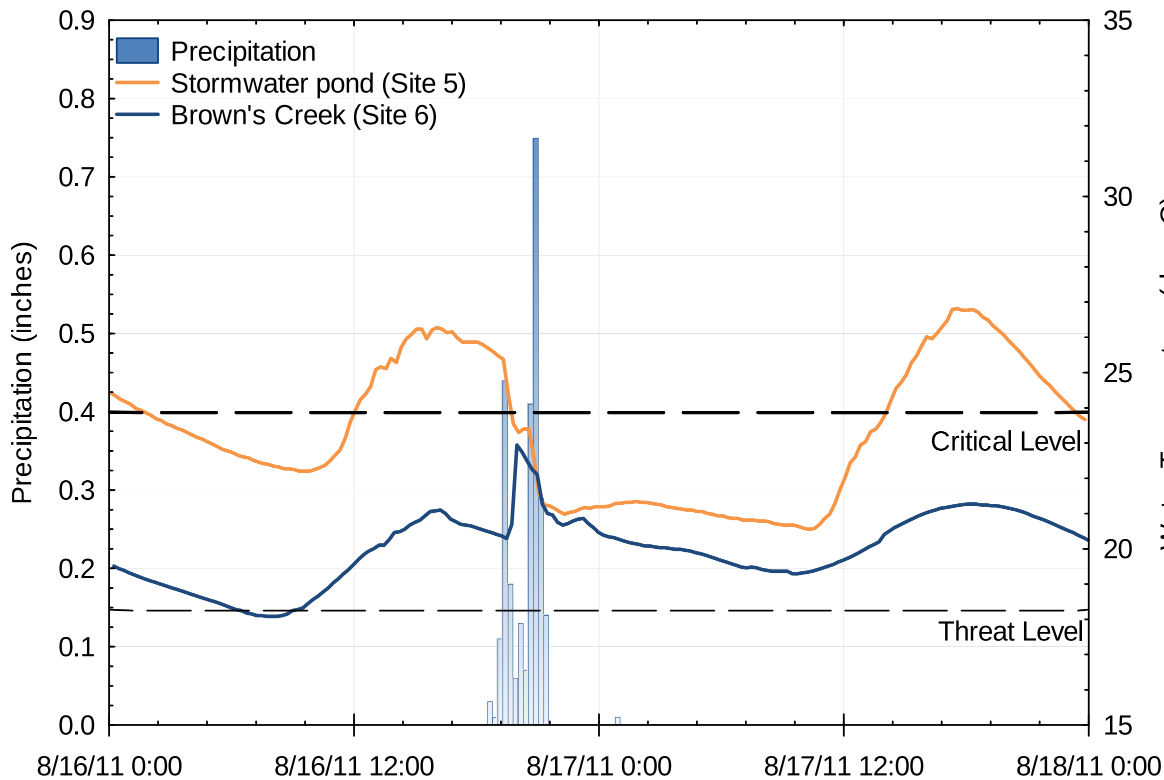

Figure 4. Stormwater pond and Brown's Creek water temperature, summer daytime precipitation event.

Table 1. Effect of rainfall event on change in water temperature in Brown's Creek.

Rain Event	Rainfall, inches	Change in water temperature, degrees C				
		Brown's Creek downstream of irrigation ponds		Brown's Creek downstream of stormwater pond		Effect of stormwater pond only
		Initial	Change	*Initial*	Change	
23-July	0.29	*21.5*	– 0.3	*21.6*	– 0.4	– 0.1
27-July	0.50	*20.4*	+ 1.1	*20.3*	+ 1.8	+ 0.7
30-July	1.12	*22.1*	+ 0.6	*21.9*	+ 1.9	+ 1.3
1-August	0.19 0.41	*21.3* *21.3*	+ 0.5 + 0.8	*21.3* *21.8*	+ 1.1 + 1.2	+ 0.6 + 0.4
6-August	0.32	*22.0*	+ 1.7	*21.8*	+ 2.8	+ 1.1
13-August	0.95	*17.6*	+ 0.6	*17.6*	+ 1.4	+ 0.8
16-August	0.83 1.79	*20.5* *22.6*	+ 2.1 – 1.8	*20.5* *22.9*	+ 2.4 – 1.9	+ 0.3 – 0.1

APPENDIX B:

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APPENDIX C:

BCWD Memorandum to MNDNR regarding the Brown's Creek Trail

651 Hale Avenue North Oakdale, Minnesota 55128 telephone: 651.770.8448 facsimile: 651.770.2552 www.eorinc.com

Date | November 16, 2011

To | Kent Skaar, MNDNR Acquisition and Development Section Leader
Colin Kelly, MNDNR Parks and Trails Planner

cc | BCWD Board of Managers
Karen Kill, BCWD Administrator

From | Camilla Correll, EOR
Pat Conrad, EOR
Ryan Fleming, EOR
Kevin Biehn, EOR

Regarding | Brown's Creek Watershed District Official Comment on Brown's Creek Trail Development Process

Background

On October 6, 2011 Karen Kill, BCWD Administrator and Camilla Correll, BCWD Engineering Consultant met with Kent Skaar, MNDNR Acquisition and Development Section leader and Colin Kelly, MNDNR Parks and Trails Planner to discuss the MNDNR's plans for the Brown's Creek Trail and the BCWD's interest in partnering with the MNDNR on the trail development process. During this meeting it was requested that the BCWD provide the MNDNR with a statement of intent as well as a list of activities that the BCWD would like the MNDNR to consider as it moves forward with the trail development process.

Statement of Intent

The Brown's Creek Watershed District (BCWD) is very concerned about any activity that has the potential to directly impact Brown's Creek thereby indirectly impacting the St. Croix River. Brown's Creek is one of the few remaining naturally producing trout streams in the Twin Cities Metropolitan Area and the BCWD (as well as the City of Stillwater, Washington County and the State Agencies) have gone to great lengths to protect this sensitive and unique resource for future generations to come.

The BCWD is currently in the process of developing a TMDL Implementation Plan to address a biotic impairment on Brown's Creek. Given that the primary stressors to the biota in the impaired reach of Brown's Creek were identified as high suspended solids, high temperatures and high copper concentrations, coupled with the fact that the proposed trail is adjacent to the impaired reach of Brown's Creek, there is concern with the deconstruction of the railroad and trail construction as well as long-term impacts of the trail on the creek.

The BCWD would like to partner with the MNDNR in the development of the plans for the Brown's Creek Trail in an effort to ensure that all aspects of the deconstruction, design and construction process meet the District's Rules and Regulations as well as the goals of the TMDL Implementation Plan. In addition, it would like to evaluate opportunities to partner on projects that the BCWD has already identified as high-priority projects through the TMDL Implementation Planning Process. The following list of activities specifically addresses the BCWD's areas of concern as well as opportunities for partnership in the development of the Brown's Creek Trail.

Compliance with the District Rules and Regulations

It is our understanding that MNDNR does not intend to apply for a BCWD Permit. While the DNR has indicated they do not intend to apply for a permit you have indicated your willingness to meet the intent and/or objectives of the District's Rules and Regulations. The following section articulates the rule, how the proposed Trail project would trigger the rule and our recommendations for design considerations which should address the standard.

Rule 2.0 – Stormwater Management

Conversion of the railroad into a bituminous trail prompts rule 2.0 in that the proposed project will create greater than one acre of impervious surface (2.2.e) as well as land disturbance of 5,000 square feet or more within the surface water contributing area of a groundwater-dependent natural resource (2.2.f). Based on available railroad GIS line work, approximately 5 miles of the proposed trail is in the District hydrologic boundary. According to preliminary calculations, 3.7 acres of additional impervious surface will be created along this length of the trail. This was calculated assuming the railroad tie area as the existing impervious footprint and an average proposed trail width of 10 feet. Based on an average tie dimension of 8.5 by 0.75 feet (LxW) and spaced at a one foot interval, the existing impervious footprint is about 45 percent.

The most important Best Management Practice (BMP) for this project from a stormwater management and erosion and sediment control perspective will be vigorous and substantial shoulders: "vigorous" meaning that the shoulders are densely vegetated and "substantial" meaning that the shoulders are substantial in size. The use of native vegetation for planting of shoulders and other restoration work is a high priority for the District. Where there is room for additional stormwater treatment, consideration should be given to the following:

Rate control for stormwater reaching resources along the trail will likely not be of great concern given the incremental increase in impervious spread across the entire trail length and the number of resources receiving stormwater runoff. Stormwater runoff rate can be reduced by incorporating a periodic pitch across the trail so as to avoid long runs where runoff can concentrate.

Volume control should be provided to mitigate for the additional impervious area as described above. Low profile, minimal maintenance volume control facilities (biofiltration swales and depressions) at low collection points should be provided to meet the 2-year volume control standard for the net additional impervious surface. These practices will also address the thermal impacts of creating bituminous surfaces where gravel ballast used to exist. The western portion of the trail may drain to landlocked basins which are very sensitive to increases in stormwater volume. Incorporation of these features will also attenuate any increase in runoff flow or pollutant loading due to the trail construction.

Specific recommendations for stormwater management along the Trail will be easier to identify once the survey of the culverts has been completed and the drainage areas delineated. Based on the District's site visit, BCWD staff has preliminarily characterized four typical settings along the trail (see Figure 1). Recommendations for stormwater management in these settings are provided below for MN DNR's consideration as preliminary plans for the Trail are developed.

Setting #1 – Gorge

This area is characterized by a narrow bed with limited space for an expanded trail cross-section. Given the proximity of the existing railroad bed to the creek and steep slopes, this is also one of the most critical sections from a stormwater management and erosion and sediment control stand point. Limitations in space within this stretch of the trail make the application of stormwater management difficult. One of the few options for the MNDNR to consider would be the use of pervious pavement for this stretch of the trail.

Setting #2 – Brown's Creek Meander

The portion of the trail that runs along the Oak Glen Golf Course and dips south of McKusick road drains directly to Brown's Creek and the adjacent wetlands as it meanders north of Lake McKusick.

Recommendations for stormwater management along this portion of the trail corridor consist of pitching the trail away from the creek (to the south between Manning Avenue and where Brown's Creek crosses the railroad, and to the north between the two creek crossings through the Oak Glen Golf Course). Grassed swales on the edge of the shoulder can be incorporated where space allows such as approximately 1,200 feet west of Stonebridge Trail. The curved alignment in this area will lend itself well to banking runoff into this infiltration feature.

Setting #3 – Open Space

The portion of the trail that runs adjacent McKusick Road North is characterized by very slight grade and windrows of trees running alongside of it.

Recommendations for stormwater management in this portion of the trail corridor consist of utilizing the flat, grassy areas within the right of way for infiltration. These areas can be enhanced with low maintenance native plantings. A relatively highly visible location for a stormwater BMP is near the Gasthaus restaurant, just east of the driveway. The few culvert crossings in this stretch of the trail corridor could be retrofitted with infiltration areas on the upstream end prior to discharge at driveway culverts and at Manning Avenue, and the downstream end at the two centerline crossing culverts approximately 300 and 2,000 feet east of Manning that convey flow to the south.

Setting #4 – Wetland/Pothole Landscape

The western portion of the trail, extending from approximately 1,500 feet west of Manning Avenue to the Gateway Trail, is characterized by a landscape of potholes and wetlands on either side of the railroad.

Recommendations for stormwater management in this portion of the trail consist of pitching the trail within the existing culvert catchment areas to the upstream end of the culvert (typically south side). A retrofit to the culvert to encourage storage with infiltration areas at the upstream end will assist in achieving volume control. Pretreatment prior to infiltration and site appropriate plantings will need to be incorporated into the design.

Rule 3.0 – Erosion Control

This project will likely involve the movement of more than fifty (50) cubic yards (1,350 cubic feet) of earth and/or disturb greater than 5,000 square feet of vegetation. Deconstruction of the railroad and subsequent trail grading to achieve desired vertical curve and slope will require disturbance immediately adjacent to Brown's Creek, wetlands, and groundwater recharge areas.

A detailed erosion and sediment control plan with attentive site inspection at all times during construction will be necessary to protect the vitality of the surrounding natural resources.

Causality of existing mass slumping should be studied along with the potential implications of trail redevelopment. The trail redevelopment plan should include attentive detail to local and regional drainage and slope stability.

Slope disturbance should be minimized. Trail redevelopment proposals should maintain or lessen slope steepness. Increase in slope severity should not be allowed. Existing and disturbed slopes should be stabilized with BMP's such as live cuttings, wattles, hydro-seeding and native plantings.

Additionally, opportunities exist to lessen the rail line's side slope severity. In some reaches there is adequate room to pull the proposed trail center-line toward the bluff, while maintaining appropriate horizontal alignment, thus reducing the slope towards Brown's Creek.

A restoration plan including rapid stabilization methods should be provided due to the steep slopes and sensitive nature of resources adjacent the trail. This plan should demonstrate what vegetation establishment and restoration entails, articulate the timing of this work and provide maintenance and site stabilization/restoration assurances.

The BCWD would like to see the development of a response-action plan in the event of a failure during or post-construction so there is a point-of-contact and a plan for stabilizing the site as quickly and effectively as possible.

Rule 5.0 - Shoreline & Streambank Alterations

The shoreline and streambank alteration standard applies where there will be disturbance partially or wholly below the ordinary high water mark of a waterbody, such as work performed in conjunction with bridge crossings.

If a Permit Applicant were required to obtain a permit for this rule, it would be on the premise that erosion is occurring or is likely to occur, which may or may not apply in the areas of existing bridges or where cutting of the existing railroad bed is necessary to achieve the desired slopes. In any case of shoreline or streambank alteration, it is the policy of the District to preserve and enhance the ecological integrity of the resource by adhering to the criteria laid out in the District Rules.

Rule 6.0 – Watercourse and Basin Crossings

This rule applies if there is use of the beds of any waterbody within the District for the placement of roads, highways and utilities. This may be triggered if the MNDNR replaces or makes modifications to bridge crossings along the railroad: where Brown's Creek crosses the railroad west of McKusick Road or where the railroad crosses Brown's Creek on the Oak Glen Golf Course. This may also be triggered if the cross section of the railroad bed needs to be modified thereby impacting adjacent wetlands. The District is eager to partner with the MNDNR in assessing and assuring appropriate hydraulic capacity in these instances.

Rule 7.0 – Floodplain and Drainage Alterations

Avoidance or minimization of floodplain filling in adjacent resources should be considered during the planning stage.

Implementation Plan Activities (Proposed Projects)

During development of the Brown's Creek TMDL Implementation Plan, the BCWD identified a number of implementation activities to address TSS and thermal loads to the creek. The following projects are located in close proximity to the Zephyr Railroad and should probably be timed with construction of the trail to minimize impacts to the District's water resources and project inefficiencies. The approximate locations of these projects are included in Figure 1.

<u>Ravine & Bluff Stabilization Projects</u>

The Watershed District is considering stabilizing a number of bluff and ravine instabilities within the "gorge".

Collaboration considerations:

- Stage trail construction to accommodate ravine and bluff stabilization. The BCWD is interested in completing this work without impacting work related to the Brown's Creek Trail and would like to identify opportunities to trade materials or share other project related resources (if feasible).

<u>Brown's Creek Rehabilitation</u>

The Watershed District is considering a channel improvement project for a ditched section of the creek immediately upstream of the historic Stone Arch Bridge. This section accounts for roughly 275' of stream which runs parallel to the proposed trail: from 290' upstream of Stonebridge Trail to 565' upstream of Stonebridge Trail. The encroachment of the rail line fill section and past alteration of stream alignment within this reach has created geomorphic instabilities, which have resulted in bank erosion throughout this reach. Upon preliminary review two feasible restoration options exist: 1) pull the trail center-line away from Brown's Creek, thus providing an opportunity to restore the floodplain and increase sinuosity, (channel length), which will improve the over-all stability of this reach; 2) pull the trail center-line away from Brown's Creek enough to create a floodplain bench within current stream alignment. This project would resolve one of the most degraded reaches of Brown's Creek, reduce TSS and thermal loads to the creek and provide trail character.

Collaboration considerations:

- Extend survey extent within this reach to cover stream rehabilitation and associate trail alignment; BCWD to cover cost;
- Consider realigning trail within this reach to accommodate stream rehabilitation;
- If stream project advances pair and/or stage construction so that one project does not encumber the other and so both parties can maximize on returns (materials, mobilization costs, etc).

<u>Countryside Auto Repair</u>

Currently the Countryside Auto Repair operation utilizes a portion of the DNR trail property, generally for roadway and parking. The BCWD has identified the Countryside Auto Repair Property as a potential opportunity for reducing sediment and nutrient loads to Brown's Creek (see Figure 2). Drainage from the largely graveled area, as well as from what appears to be a landscape material storage area, flows along the DNR Property and heads to the west into a wooded ravine before entering the creek. The point at which the drainage enters the creek is immediately upstream of the creek's crossing of the DNR property (the Countryside Auto Repair property drains upstream in relation to the flow of the creek). There is a catch basin within the driveway area immediately upstream of where the wooded ravine begins that presumably drains directly to the creek. The catch basin location is within the DNR parcel as indicated in the figure at right.

The District encourages the DNR to work with the owners of Countryside Auto Repair and the District engineers to work on water quality improvements in this area. At a minimum it is hoped that an appropriate buffer can be established as the area is restored. The District would like to investigate ways in which to store and infiltrate water in this area rather than allowing it to discharge directly to the Creek and would like to see the DNR cooperate in this effort. The logical location for stormwater treatment on the site would be at the existing catch basin location.

Additional Issues & Opportunities

- A significant amount of household garbage (appliances, tires, cans, etc.) can be found along the rail right-of-way. Garbage is specifically concentrated along the first 2,000 feet east of the Hazel Street crossing. Consider partnering with BCWD to remove garbage and debris. The BCWD sees this type of activity as an excellent opportunity to engage 4-H club members, the Boy Scouts of America or a service club (e.g. Rotary or Trout Unlimited).

- Many of the stormwater conveyances, some of which could be considered historic, are in need of repair or replacement.

- Erosion adjacent to the Stone Arch Bridge is jeopardizing this historic structure. One can assume that redevelopment of the rail line into a trail corridor will draw more attention to the Stone Arch Bridge. If not appropriately planned and designed for, this curiosity could result in trespass and damaging foot traffic conflicts.

- Damaging foot traffic disturbance is extensive below Stonebridge Trail. Recommendation: Controlled access should be granted, designed and implemented at this and other future critical locations to minimize damage caused by excessive foot traffic. Stairs are necessary at this location to minimize traffic on the sensitive slope below the Stonebridge Trail Bridge. A combination of fencing, railings and vegetation will be necessary to exclude users.

- The BCWD would appreciate being afforded the opportunity to review the final plans and the DNR's work schedule before the DNR undertakes the work. If the DNR intends to hire a contractor for rail deconstruction or trail construction, the BCWD would urge that the DNR use its procurement discretion to ensure that the selected contractor(s) have the experience and capacity to perform this very sensitive work without damage to Brown's Creek or any disturbance of the riparian corridor beyond what is absolutely necessary. This would include using best value procurement or otherwise incorporating criteria in its contractor selection so that it can carefully consider the diligence and capability of potential contractors and not be bound to accept the low bidder. Finally, the BCWD also would urge that the contract documents require a work schedule that minimizes the risk of having to overwinter any part of the trail in a disturbed and unstabilized condition.

BCWD's 2012 Budget Allocations to Brown's Creek Trail Related Activities

The BCWD has included the following items in its 2012 budget in an effort to assist the MnDNR in this effort and to dovetail projects the BCWD has already identified as high priority projects with construction of the trail.

- Permit and/or plan review and coordination
- Inspections
- Surveying existing culverts/structures
- Field locate existing areas of erosion

- Design of smaller scale stormwater BMPs (suite of BMPs + identification of suitable installation sites) and a couple of larger stormwater management facilities
- Stream re-alignment feasibility study, design/permitting/coordination and construction
- Ravine and bluff stabilization projects design/permitting/coordination and construction
- Countryside Auto Repair design

Contact Information

Questions regarding the content of this memorandum or the BCWD's participation in this project should be directed to Karen Kill, BCWD Administrator at (651) 275-1136 (ext. 26) or klkill@mnwcd.org.

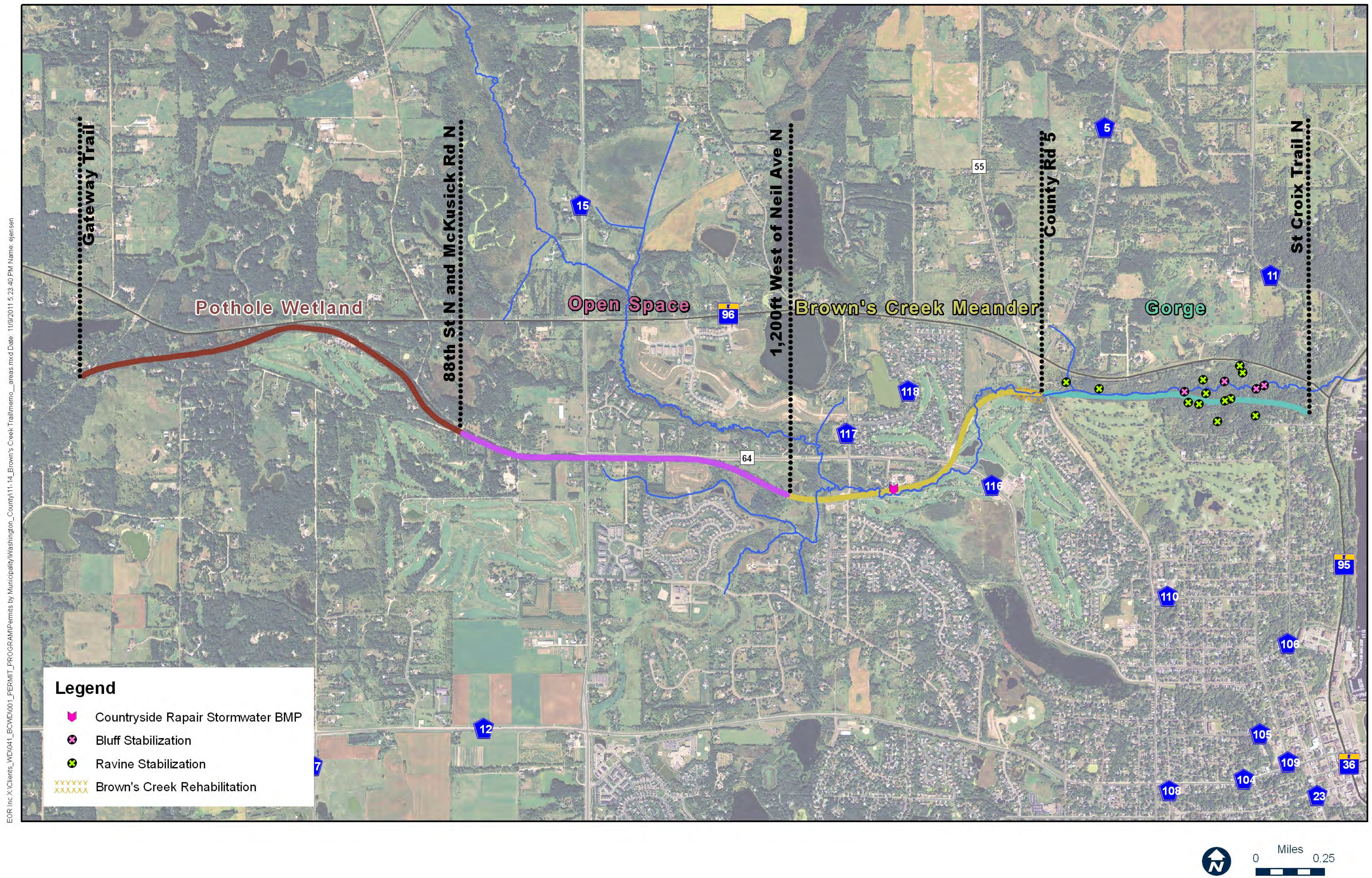

Figure 1. Locations of Trail Setting and Proposed TMDL Implementation Plan Activities

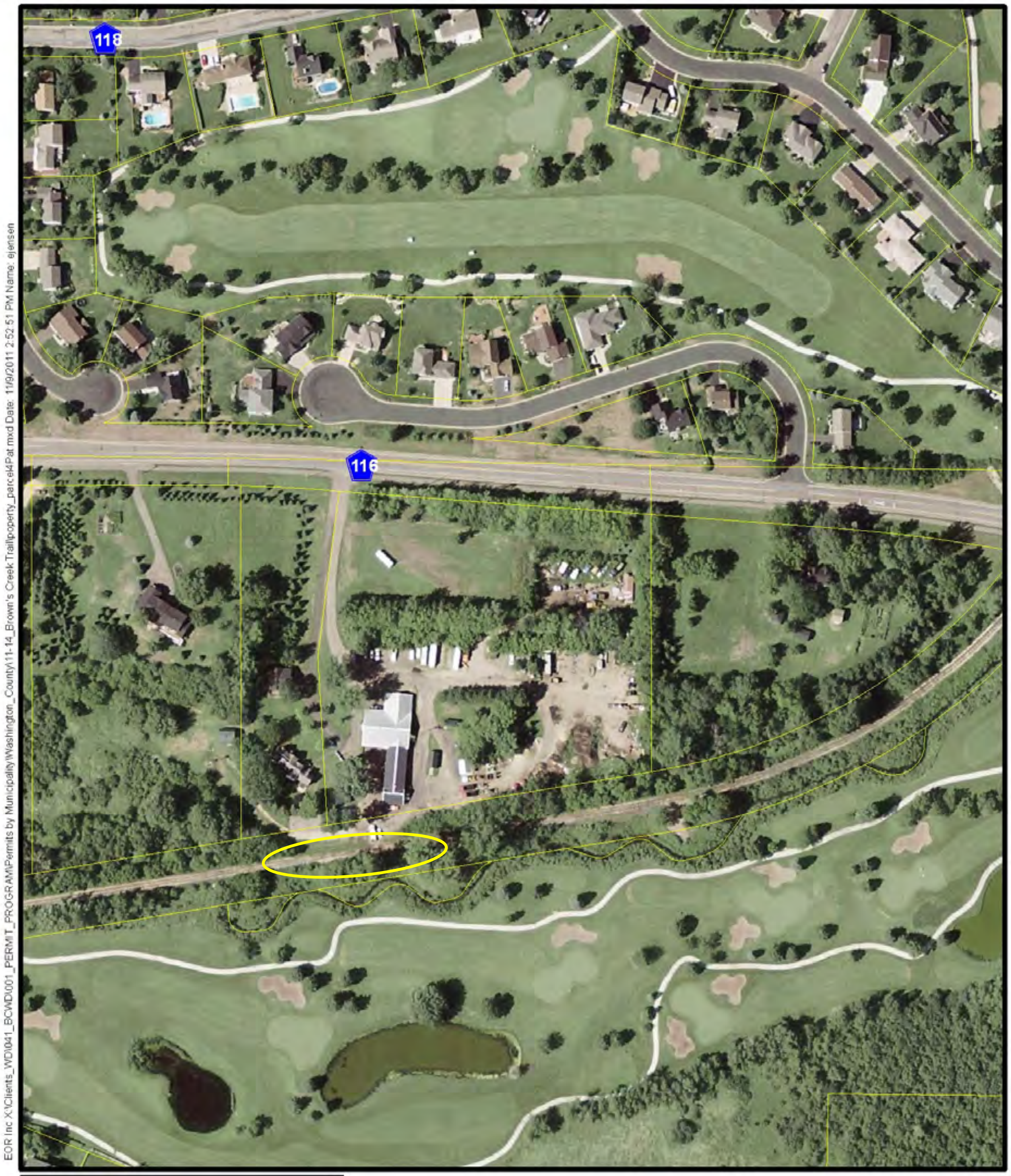

Figure 2. Location Map for Countryside Auto Repair