This report will summarize water quality data and pollutant loading estimates from key stream monitoring stations in the Rice Creek Watershed.
2009 STREAM MONITORING REPORT

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Cover Photo: Anoka County Ditch 25 at Blackduck Road in Lino Lakes (“ACD25”). Unless otherwise noted, all photos by RCWD.
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Executive Summary

Water quality and flow data have been collected in the Rice Creek Watershed for decades. The methods by which the data have been collected have changed over the years, but the basic formula remains unchanged: measure (either directly, or though laboratory analysis) concentrations of various constituents at fixed points, and estimate volumes of water moving past those points.

With the exception of several cases on Hardwood Creek, measured concentrations of pollutants at primary Rice Creek Watershed District monitoring sites indicate support of Minnesota water quality standards. However, impairments exist on each of the main streams within the watershed. Other, more complex factors, such as stream instability and lack of habitat, may play a role in these impairments.

Load estimates for both Hardwood and Clearwater Creek watersheds are highly variable, and most dependent on precipitation and runoff. Goals set in the Peltier Lake TMDL for water pollution loading are not being met. In recent years, loading estimates seem to be reduced. Below average precipitation may play the largest role in the lower load estimates. A number of restoration projects aimed at reducing watershed loading are upcoming – most notably, the Lower Hardwood Creek Restoration Project.
Ramsey County Ditch 4 at Lydia Avenue ("RCD4.1")
I. Purpose

Water quality and flow data provide the foundation on which water resource management decisions are made. Informed management decisions are made possible by high quality and comprehensive datasets. Are we meeting state water quality standards in our streams? Is Rice Creek “healthy”? What changes have we seen in our streams following restoration projects? What is the pollution load being delivered to our lakes through streams and ditches? These questions can be answered in many ways, but water quality and flow monitoring data provide basis for quantitative answers.

The purpose of this document is to summarize water quality data collected on primary streams in the Rice Creek Watershed. Estimates of pollutant loads will also be provided for selected sites. Whenever possible, results of past and ongoing studies (e.g. Total Maximum Daily Load, Diagnostic Studies, special investigations) will be included. This information will support management decisions, track long-term changes in water quality and flow trends over time, and provide a summary document for the public. Data will be presented in relation to various goals for that stream system and its watershed.

Rice Creek below Highway 65 in Fridley (“R1”)
Figure 1. Stream and ditch monitoring sites in the Rice Creek Watershed, 2009. The red circles show the long-term, primary “trunk system” monitoring sites.
II. Introduction

Streams and ditches can serve many functions. They serve as a home to indigenous fish and invertebrates. In order to support a healthy and diverse population of fish and invertebrates, streams must provide clean water, habitat, and food sources. Pollution can limit the availability of each of these resources. Streams provide recreational opportunities for residents (e.g. the Rice Creek Water Trail). Residents will not recreate in degraded stream systems. Perhaps most importantly, streams transport pollutants into downstream lakes – most notably, phosphorus and sediment. These pollutants cause a cascade of effects on lakes – together referred to as eutrophication. The Rice Creek Watershed District maintains a monitoring network on streams to assess each of the stream functions listed above.

Monitoring data are used in many different ways. First and foremost, monitoring data tell us about the condition of the resource. Are we meeting various state standards for water quality? Are streams in the Rice Creek Watershed ‘healthy’? Secondly, monitoring data assist in indentifying sources of pollutants – this is especially true when a network of monitoring sites is used. Determining the source of pollutants guides management activities and improvement projects. Next, the data assist in project design. For example, when designing a sediment basin, a good estimate of sediment load will guide engineering specifications. Also, once a project is designed and implemented, monitoring data will be used to set maintenance frequency (i.e. how fast is sediment accumulating). Lastly, a long-term stream monitoring dataset will allow for trend analysis, and provide the basis for adaptive management. Are things getting better over time? Has the last restoration project resulted in lower loading, or improved stream condition?

In any given year, the RCWD operates anywhere from 5 to 15 continuous monitoring sites. In general, these sites are located at or near the bottom of subwatersheds. Data collected at these sites provides an indication of the overall health of the watershed above that point, and provide data to compute pollutant load estimates from the entire subwatershed.
New in 2009, the RCWD stream monitoring program is guided by a comprehensive plan. The *Rice Creek Watershed District Monitoring Program Plan*, done as part of the RCWD District-Wide Modeling Initiative, provides guidance for sample collection, timing, data management, and quality assurance / quality control. The Plan also provided a clear structure for different types of monitoring sites. Table 1 provides an overview of the different monitoring sites types.

<table>
<thead>
<tr>
<th>Monitoring Site Type</th>
<th>Goal / Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-Term Permanent</td>
<td>Long-Term Condition Monitoring; Trend Assessment</td>
</tr>
<tr>
<td>Synoptic</td>
<td>Detecting Short-Term Changes, usually &quot;project specific&quot;</td>
</tr>
<tr>
<td>Investigative</td>
<td>Acute Pollution Assessment (i.e. &quot;spike&quot; detection)</td>
</tr>
</tbody>
</table>

Table 1. RCWD monitoring site types

The timing of data collection throughout a season depends on the type of monitoring. Flow monitoring is continuous. Equipment used to measure flow is installed each spring, typically as close to ice-out as possible. This equipment runs throughout the course of the summer; staff time is required to maintain batteries and calibrate instrumentation. Water quality samples are collected based on flow, the goal being to collect samples across the range of flow conditions that each stream or ditch undergoes throughout the season. Runoff samples are targeted to aid in the development of pollutant loading estimates.

**State Standards and Goals**
There are a number of ubiquitous goals for streams in the Rice Creek Watershed; typically these are Minnesota State Water Quality Standards. These vary based on designated “beneficial use classes for surface waters”, set by the Minnesota Pollution Control Agency. The MPCA beneficial use classes are shown in Table 2.
### Use Class (and Sub Class) | Beneficial Use Description
---|---
1 | Drinking Water
2 | Aquatic Life and Recreation
2A | Cold water fisheries (trout fisheries)
2Bd | Cool and warm water fisheries & drinking water
2B | **Cool and warm water fisheries**
2C | Indigenous fish and associated aquatic community
2D | Wetlands
3 | Industrial Use and Cooling
4 | Agricultural Use
4A | Irrigation
4B | Livestock and wildlife watering
5 | Aesthetics and Navigation
6 | Other Uses
7 | Limited Resource Value (not fully protected)

*Table 2. MPCA Beneficial Use Classes*

Somewhat by default, many of flowing waterbodies in the Rice Creek Watershed (and many flowing waterbodies throughout the State, for that matter), are designated as **Class 2B waters**. Class 2B waters are expected to meet the beneficial use of supporting a native cool or warm water fishery. Assessing attainment of this beneficial use can be done by measuring several different parameters, including dissolved oxygen, chloride, pH, turbidity, and temperature. Attainment can also be assessed by directly assessing the biological community; both fish and invertebrate communities are assessed. This report will review data applicable to standards for dissolved oxygen, turbidity, and chloride.

**Dissolved Oxygen**
Dissolved oxygen (DO) is required for nearly every aquatic organism living in a stream. Several factors affect DO concentrations. First, DO concentrations are dependent on water temperature; colder water has a higher capacity to hold DO, while warm water has a lower capacity. Also, DO concentrations are naturally variable temporally (seasonal and daily), as well as spatially. Spatial variability is more of a factor in large rivers; since all of the streams in the Rice Creek Watershed are fairly well mixed, spatial variability is not a factor. However, temporal variability, especially in the warm summer months, can be significant. Photosynthetic activity during daylight hours can produce very high (supersaturated) DO concentrations, while nighttime plant respiration and microbial decomposition can lead to drops in DO.

The Minnesota State Standard for dissolved oxygen in Class 2B streams is **“Not less than 5 mg/L as a daily minimum”**. The standard must be met at least 90% of the time in order to be considered “fully supporting” for aquatic life.
Turbidity
Turbidity is a measure of the amount of light that can be passed through solution – basically a measure of the cloudiness or haziness of water. Turbidity can be measured directly using a turbidimeter (Nephelometric Turbidity Units, or NTUs). Since there is a strong relationship between turbidity and total suspended solids and transparency, these measures can be used as surrogates. High turbidity can be attributed to a number of factors. Suspended sediment particles from agricultural or stormwater runoff, high amounts of algae, or naturally occurring staining of the water from wetlands can all affect turbidity measurements. High turbidity resulting from suspended sediment can be harmful to stream life for many reasons. High suspended sediment concentrations can alter food webs by hindering visual-based hunters, and can lead to reproductive failure if course stream substrates are filled by fine sediment (a process known as sedimentation). High suspended sediment can also interfere directly with an organism’s ability to respire by clogging gill structures. In addition to the ecological effects of high turbidity, there are also ramifications for humans. Excess turbidity can degrade the aesthetics of a waterbody, making people less likely to recreate. Highly turbid water is also more expensive to treat for drinking water.

The Minnesota State Standard for turbidity in Class 2B streams is 25 NTUs. Surrogates for direct measurements of turbidity include total suspended solids and transparency. The turbidity equivalent standard for TSS is 100. The turbidity equivalent standard for transparency is 20 cm.

Chloride
Chloride is an ionic element. Often forming a bond with sodium (sodium chloride), the most significant source of chloride in stream is road salt. High levels of chloride can be toxic to fish and invertebrates. Chloride concentrations in stream are typically highest in spring months, as road salt is being washed into streams through stormwater conveyances.

There are two Minnesota State Standards for chloride: chronic and acute. The acute standard is 860 mg/L, while the chronic standard is 230 mg/L. A stream is considered impaired for chloride if it exceeds the chronic standard at least twice times in three years, or if it exceeds the acute standard once at any time.

Specific Goals
Site specific goals are usually the result of a completed lake water quality study, such as a Diagnostic Study or a TMDL, and are generally focused on “eutrophication” pollutants (i.e. nutrients). Water quality modeling done as part of the study (often times the BATHTUB model is used) can provide an estimate of a lake’s assimilative capacity for nutrients. Also provided is an estimate of current pollution loading from various sources. Pollution sources can be both internal and external. Often times, the majority of the external pollution is delivered to the lake through a stream or ditch. From this information, a nutrient reduction goal is applied to the specific stream or ditch flowing into a lake.

The lone specific goal presented in this report is associated with the Hardwood Creek TMDL. The TMDL identified a specific goal for average total suspended solids concentrations in Hardwood Creek. As more
TMDLs are completed, additional specific goals will be identified. These goals will be addressed in future RCWD Stream Monitoring Reports.

Pollutant Loads
Estimating pollutant loads is a critical step of any lake diagnostic study. By determining the amount (mass) of a given pollutant entering a lake, modelers can estimate a lake’s assimilative capacity - the amount of a specific pollutant that a lake can process, while still meeting state standards.

The data quantity requirements for producing estimates of pollutant loading are significant. Both water quality samples and continuous flow measurement are needed. Data quality requirements are also significant. This report will summarize recent load estimates for both Clearwater and Hardwood Creeks, and present the data in terms of goals identified in the Peltier Lake TMDL study. Future RCWD Stream Monitoring Reports will present additional load estimates, usually in relation to goals identified by either a Diagnostic Study or TMDL.

State standards do not exist for pollutant loads. Each waterbody has a different assimilative capacity for different pollutants.

III. Methods

Physical stream parameters, including temperature, pH, dissolved oxygen, and specific conductance, are collected directly by RCWD staff using YSI (“Sonde”) equipment (models 600 XLM and 600 XLM V2). Most dissolved oxygen readings are collected using an optical DO meter (600 XLM V2). The instruments are calibrated regularly, following protocols from the manufacturer.

Turbidity data are rarely collected by RCWD staff. There are several reasons for this. First, measures of turbidity can be influenced by factors that may not be detrimental to stream health, or linked to anthropogenic causes. For example, high tannin concentrations from decaying vegetation can lead to higher turbidity readings. This is a naturally occurring process that is not detrimental to stream health, as opposed to high turbidity as a result of high sediment concentrations. Second, RCWD staff measure two other parameters – transparency tube and total suspended solids - that are related to turbidity, but are easier to measure and more indicative of detrimental stream health factors. Lastly, the MPCA is planning to slowly phase out its turbidity standards, to be replaced with standards for total suspended solids.

Phosphorus, total suspended solids, chloride, and other water quality parameters are collected in one of two ways. First, grab water quality samples are collected directly by RCWD staff when visiting stream monitoring sites. Samples are collected while wading, or, when flows are too high for wading, with the use of a swing sampler from a bridge or culvert. Samples are collected in sterile Whirl-Pak bags.
Second, storm composite samples are collected using automated samplers. Auto-samplers can be programmed to automatically pump water samples out of a stream or ditch, based on flow conditions being monitored by a separate sensor – typically during a storm event. After an auto-sampler collected a sample, RCWD staff must visit the site to retrieve the sample. The downside to auto-samplers: significant staff time is required to program, maintain clean bottles, and otherwise “babysit” the sampler. After either a grab sample or storm composite sample is collected, the sample is delivered to the Ramsey County Environmental Services Laboratory in Arden Hills.

Flow data are collected using many different types of equipment. However, the process for collecting and converting the data is consistent. The first step in collecting flow data is to measure stream stage, or height (in feet). This number is typically arbitrary, and only represents the relative depth of the stream. Stage is recorded by automated equipment using various technologies. Submerged probes and bubblers, both mounted in the bed of the stream, measure the pressure of water being exerted on the probe – as water gets deeper, more pressure is exerted on the instrument. Ultrasonic sensors are mounted above a stream, looking down. The sensor sends an ultrasonic beam down to the surface of the water and measures the return time – as water gets deeper (and closer to the probe), the return time gets smaller. After stage is collected, it is converted to flow (in cubic feet/second) using a rating curve. A rating curve is a relationship between the stage of the stream and the amount of flow running through at a given stage. This requires a number of direct flow measurements to be made at each monitoring site. The rating curve should have flow measurements throughout the range of stream stages.

Pollutant loads are estimated using both flow and water quality concentration data. Once the concentration of a pollutant is measured (in mg/L), and we know the amount of water (in cubic feet /
second), a mass of pollutant can be estimated. Estimates are produced using the computer program FLUX.

IV. Results and Discussion
The results section will present data collected from all of the main stream sites ("trunk systems"), and several other key subwatershed outlets. Data will be presented in terms of existing standards and goals for that particular stream or subwatershed. As described in the RCWD Monitoring Program Plan, these sites are fixed, long-term monitoring sites.

Rice Creek at State Highway 65 ("R1")

<table>
<thead>
<tr>
<th>Total Length (mi.)</th>
<th>Drainage Area (sq. mi.)</th>
<th>Impairment Status¹</th>
<th>TMDL Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.2</td>
<td>186</td>
<td>Upper: Not Listed</td>
<td>None Started / None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Middle: Impaired - Biota</td>
<td>Planned</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower: Impaired - Biota</td>
<td></td>
</tr>
</tbody>
</table>

Site Description
This monitoring site is located on Rice Creek immediately downstream of Minnesota State Highway 65 in the City of Fridley. The site, known as “R1”, is the lower-most stream monitoring site in the Rice Creek Watershed, and acts as an aggregator site. As such, it provides an indication of the overall health of the watershed, as well as estimates of pollution loading for the urban area below Long Lake in New Brighton. Water quality data have been collected (non-continuously) at this site since 1977. Flow data have been collected continuously since 1996.

Standards/Goals for Rice Creek

Dissolved Oxygen
Dissolved oxygen data for site R1 is shown in Figure 2. Data are available as far back as 1978. As is common when assessing state standards compliance, only the most recent 10 years of data are presented here. As a Minnesota Class 2B stream, Rice Creek is held to a standard of 5mg/L of dissolved

¹ “Impairment Status refers to the State of Minnesota’s most current List of Impaired Waters (303D List)
oxygen, as indicated by the red line in Figure 2. According to the standard, DO concentrations should be above this line at least 90% of the time. The data indicate that dissolved oxygen concentrations are meeting state standards. Very few measurements below the standard have been collected in the last 10 years – less than 10%. In 2009, the lowest DO measurement collected was 6.5 mg/L.

The lower section of Rice Creek (Long Lake to Locke Lake) is represented by the dataset shown in Figure 2. This section of Rice Creek has higher stream slope and more course substrates (rock), in comparison to other reaches of Rice Creek, providing more areas of turbulence in the water, and therefore more aeration. In addition, much of Lower Rice Creek is shaded with riparian tree cover, mitigating high water temperatures that can limit DO concentrations. In summary, the data indicate that dissolved oxygen concentrations are meeting state standards. Natural factors (topological, geological, and vegetative) provide opportunities for dissolved oxygen concentrations to remain relatively high.

**Turbidity**
Turbidity is not measured directly in Rice Creek (see Methods section for explanation). However, two surrogates, transparency and total suspended solids are measured regularly. Transparency data for Rice Creek is shown in Figure 3. Data are available from 2004. The turbidity equivalent standard for transparency is 20 cm, as indicated by the red line in Figure 3. Greater than 20 cm of transparency should be maintained at least 90% of the time, and at least 3 measurements below the line are required to be listed as impaired. The data indicate that transparency is meeting the turbidity equivalent standard the majority of time. “By-the-book” interpretation of the data indicates violations of the standard – 11% of the readings, and four readings total, are below 20 cm. However, since the sampling
program targets high-flow events, the sampling distribution, based on flow, is skewed. Therefore, more low-transparency readings should be expected based on the sampling schedule.

Green points in Figure 3 indicate readings that are above the detection limit of the transparency tube (>60 or >120) – i.e. the water was too clear to be measured.

![Transparency in Rice Creek ("R1")](image)

Figure 3. Transparency tube data from Rice Creek ("R1"). The red line indicates the state standard equivalent for turbidity. THE GREEN POINTS INDICATE CLARITY READINGS ABOVE DETECTION LIMITS (I.E. >60 OR >120).

Total suspended solids (TSS) data is shown in Figure 4. TSS data are available from 1977. Since only the most recent ten year period of data is examined for standards compliance, data are shown from 2000. The turbidity-equivalent standard for TSS is 100 mg/L. Like transparency, a stream is considered impaired if at least 10 observations are collected, and at least 10% of the observations indicate violation of the standard. The data indicate that Rice Creek is meeting the turbidity-equivalent standard for TSS; less than 10% of the samples exceed the state standard.
Figure 4. Total suspended solids data from Rice Creek ("R1"). The red line indicates the state standard.

Taken as a whole, the transparency and TSS data indicate that Rice Creek is meeting the state standard for turbidity. Although transparency data show that Rice Creek does exceed the standard slightly more than 10% of the time, TSS data show very few exceedances of the state standard. The data presented above fit with observations noted by RCWD staff during monitoring visits: Although this section of Rice Creek carries significant stormwater and associated organic material (grass clippings, leaves, and other detritus), it is rarely described as “turbid” in notes.

Chloride
Chloride has been monitored in Rice Creek since 2007. Chloride data are shown in Figure 5. All of the data indicate that Rice Creek is meeting the state standard for chloride. There have not been exceedances of the chronic or acute standards since monitoring began.
Figure 5. Chloride concentrations in Rice Creek ("R1"). The red line indicates the state standard.

Given the high amount of impervious area in the surrounding watershed, it is somewhat surprising to measure such low concentrations in Rice Creek. The RCWD staff is vigilant about collecting samples in early spring, during snowmelt runoff events – the dataset does not reflect “missed” samples during critical periods. Nevertheless, RCWD will evaluate their chloride sampling protocol to ensure proper timing for samples.

**Hardwood Creek at 20th Avenue (“H2”)**

<table>
<thead>
<tr>
<th>Total Length (including JD2) (mi.)</th>
<th>Drainage Area (sq. mi.)</th>
<th>Impairment Status</th>
<th>TMDL Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.2</td>
<td>25</td>
<td>Impaired - Biota and Dissolved Oxygen</td>
<td>Completed and Approved, June 2009</td>
</tr>
</tbody>
</table>

**Site Description**

This monitoring site is located on the downstream side of Hardwood Creek and 20th Avenue Lino Lakes. The site, known as “H2”, is the lowermost stream monitoring site in the Hardwood Creek watershed, and act as an aggregator site. As such, it provides an indication of the overall health of Hardwood Creek and Anoka Washington Judicial Ditch 2, as well as estimates of pollutant loading for the entire
watershed. Water quality data have been collected (non-continuously) since 1977. Flow data have been collected continuously since 1999.

**Standards / Goals for Hardwood Creek**

**Dissolved Oxygen**

Dissolved oxygen data for Hardwood Creek are shown in Figure 6. Data have been collected since 1979. As is common when evaluating data against standards, only the last 10 years of data are shown. Hardwood Creek is listed as *impaired* for low dissolved oxygen; a Total Maximum Daily Load (TMDL) study was completed in 2009 to address the impairment. The data below show that DO is not meeting state standards; more than 10% of the samples were below the 5 mg/L standard (indicated by the red line).

![Dissolved Oxygen in Hardwood Creek ("H2")](image)

Figure 6. Dissolved Oxygen data for Hardwood Creek ("H2"). The red line indicates the state standard.

To further investigate the low dissolved oxygen concentrations, RCWD staff deployed continuous dissolved oxygen meters in Hardwood Creek for a number of days. The purpose of collecting these data is to examine the daily flux of dissolved oxygen; higher daily flux indicates a high degree of primary productivity and microbial breakdown, often associated with agricultural or stormwater pollution. Figure 7 shows continuous DO concentrations collected over a 4-day period in 2009. The data were collected from two different sites along Hardwood Creek – H2 and H1.3 (H1.3 is located at Harrow Ave).
These data indicate several things: First, DO concentrations are generally lower in the upper reaches of Hardwood Creek – a phenomenon described in the Hardwood Creek TMDL as ‘naturally occurring’ due to groundwater inputs. Second, the daily swing of DO is not significant. In comparison, data collected in other parts of the Rice Creek Watershed show daily swings of 4-6 mg/L, where Hardwood Creek only shown swings of 1-3 mg/L. This indicates a lower level of primary productivity. However, continuous organic inputs may be limiting DO concentrations overall. Also, low gradient and lack of course material limit the amount of aeration.

![Hardwood Creek Continuous Dissolved Oxygen (uncorrected data)](image)

Figure 7. Continuous DO data collected at 2 sites in Hardwood Creek (“H2” and “H1.3”). The red line indicates the state standard.

Upcoming stream restoration and cattle exclusion projects are expected to boost dissolved oxygen levels in the long-run by reducing organic inputs.

**Turbidity**

Turbidity is not measured directly in Hardwood Creek (see *Methods* section for explanation). However, two surrogates, transparency and total suspended solids are measured regularly. Transparency data collected in Hardwood Creek are shown in Figure 8. Data are available from 2004. The turbidity equivalent standard for transparency is 20 cm, as indicated by the red line in Figure 8. Greater than 20 cm of transparency should be maintained at least 90% of the time. The data show that transparency is meeting the turbidity equivalent standard approximately 92% of the time, indicating that Hardwood Creek is meeting the turbidity-equivalent standard for transparency.
Green points in Figure 8 indicate readings that are above the detection limit of the transparency tube (>60 or >120) – i.e. the water was too clear to be measured.

**Figure 8.** Transparency data from Hardwood Creek ("H2"). The red line indicates the state standard. THE GREEN POINTS INDICATE NON-DETECT READINGS - I.E. WATER WAS TOO CLEAR FOR MEASUREMENT (>60 OR >120).

Total suspended solids data for Hardwood Creek are shown in Figure 9. TSS data have been collected since 1977; only the last 10 years are shown here, as is common when assessing standards compliance. During the Hardwood Creek TMDL, the “Stressor Identification” process was utilized (as prescribed by the U. S. EPA) to determine the probable causes of poor biotic integrity. The process identified loss of habitat due to sedimentation as one of the primary causes (along with low DO). Since the TMDL documents needed to identify a “pollutant” associated with this stressor, TSS was used as a surrogate for loss of habitat due to sedimentation. Therefore, the completion of the Hardwood Creek TMDL created a specific goal for TSS on Hardwood Creek: annual average concentration of 19mg/L or less – the orange line in Figure 9 reflects this goal. As this is more stringent than the state standard, the data in Figure 9 are shown in relation to the TMDL goal. The data fluctuate over the past 10 years, with no clear trend evident. Encouragingly, the last two years have had relatively low average TSS concentrations; this may be a function of several years of relatively mild spring runoffs and below average precipitation.
Figure 9. Average total suspended solids in Hardwood Creek. The orange line indicates a TMDL-specific goal for Hardwood Creek.

Upcoming stream stabilization and restoration projects are expected to decrease TSS concentrations over the long-term.

Chloride
Chloride data have been collected in Hardwood Creek since 2004. Chloride data are shown in Figure 10. The data indicate that Hardwood Creek is meeting the state standard for chloride; exceedances of either of the chronic (230 mg/L, as indicated by the red line in Figure 10) or acute standard have not been measured. Hardwood Creek is meeting the state standard for chloride.
The percent impervious surface in the Hardwood Creek watershed is low – approximately 4.5%. Given this, it’s not entirely unexpected to find low chloride concentrations in Hardwood Creek.

**Phosphorus Loading**

The Peltier Lake TMDL has produced specific phosphorus loading goals for the Hardwood Creek Watershed. Based on current (2001) loading estimates, and the lake’s modeled assimilative capacity, the phosphorus loading goal for the Hardwood Creek watershed is 862 pounds\(^2\) per growing season (June-Sept). Growing season phosphorus loading estimates for the Hardwood Creek watershed are presented in Figure 11. The data do not show any trend. Data from recent years indicate reduced loading,, although still not meeting the goals set in the TMDL.

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\(^2\) The 862 pound goal is based on a proposed *Natural Background Condition* water quality standard for Peltier Lake. The proposed standard has not been approved by EPA as of June 2010.
Figure 11. Growing season phosphorus loads for the Hardwood Creek watershed. The orange line indicates the TMDL phosphorus loading goal.

Based on the 2001 modeled year, a 55% reduction in phosphorus loading in Hardwood Creek is required to meet the goals of the TMDL. Obviously, loading varies greatly from year to year. Variability is introduced into these estimates by the environment, the raw data, and the model used to predict the loads. Some of this variation can be attributed to precipitation – more specifically, precipitation intensity, frequency, and total amount. Variability is introduced when water quality measurements are analyzed, and when flow is measured. Variability is also added from the model. Even if every effort is made to ensure data quality, attention to detail, and “apples to apples” comparisons, the model ultimately relies on relationships between variables to predict loads. These relationships contain variability. Despite this variability, estimating loads is the most direct way to assess progress toward meeting water quality goals.

Upcoming restoration work on Hardwood Creek, as well as cattle exclusions, should help reduce phosphorus loading over the long run.
Clearwater Creek in Centerville ("C2")

<table>
<thead>
<tr>
<th>Total Length (including JD3) (mi.)</th>
<th>Drainage Area (sq. mi.)</th>
<th>Impairment Status</th>
<th>TMDL Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5</td>
<td>43³</td>
<td>Impaired - Biota</td>
<td>Not Started / Not Planned</td>
</tr>
</tbody>
</table>

**Site Description**

The Clearwater Creek monitoring station is located just south of Main Street in Centerville, and is known as “C2”. The site is located not far upstream of the outlet into Peltier Lake. It is considered an “aggregator” site for the Clearwater Creek / Anoka Washington Judicial Ditch 3 watershed, and is used to estimate loads of pollutants entering Peltier Lake. Water quality data have been collected (non-continuously) since 1977; flow data have been collected continuously since 1998.

**Standards/Goals for Clearwater Creek**

**Dissolved Oxygen**

Dissolved oxygen data for Clearwater Creek are shown in Figure 12. The state standard for dissolved oxygen is 5 mg/L, and is indicated by the red line in Figure 12. The data indicate that Clearwater Creek is meeting the state standard for dissolved oxygen; fewer than 10% of the samples were below 5 mg/L.

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³ Some of the total watershed is non-contributing. Most of the watershed passes through Bald Eagle Lake.
Figure 12. Dissolved oxygen in Clearwater Creek ("C2"). The red line indicates the state standard.

Although the data indicate support of the state standard, very few of the DO samples were collected early in the morning, when daily DO values should be at their lowest. Since Clearwater Creek is listed as impaired for biota and the low slope of the stream and lack of course substrate provides little opportunity for aeration, continuous DO data will be collected on Clearwater Creek in the near future. These data will be used to evaluate low DO as a possible stressor to biota.

Turbidity
Turbidity is not measured directly in Clearwater Creek (see Methods section for explanation). However, two surrogates, transparency and total suspended solids are measured regularly. Transparency data collected in Clearwater Creek is shown in Figure 12. Data are available from 2004. The turbidity equivalent standard for transparency is 20 cm, as indicated by the red line in Figure 13. Greater than 20 cm of transparency should be maintained at least 90% of the time. The data show that transparency is meeting the turbidity equivalent standard in every measurement, indicating full support of the standard.

Green points in Figure 13 indicate readings that are above the detection limit of the transparency tube (>/60 or >120) – i.e. the water was too clear to be measured.
Figure 13. Transparency data from Clearwater Creek ("C2"). The red line indicates the state standard. THE GREEN POINTS INDICATE NON-DETECT READINGS - I.E. WATER WAS TOO CLEAR FOR MEASUREMENT (>60 OR >120).

Total suspended solids data from Clearwater Creek are shown in Figure 14. Data have been collected since 1978, but only the past ten years are presented here, as is common when assessing against standards. To meet the turbidity-equivalent state standard for TSS, no more than 10% of samples should be above the standard. In Clearwater Creek, 9% of samples are above the standard. In the spring of 2009, Clearwater Creek was nearly listed as impaired for turbidity based on TSS data; in-depth analysis and of the dataset eventually resulted in Clearwater Creek NOT being listed. Continuing to monitor TSS, and adding more transparency tube data, should shed light on the possible turbidity issue in Clearwater Creek in upcoming MPCA assessment cycles. Additional data will also provide a basis for evaluating whether turbidity is a stressor on the impaired biota.
Figure 14. Total suspended solids data for Clearwater Creek ("C2"). The red line indicates the state standard.

As expected, the very high TSS values were associated with significant runoff events, usually during periods of above average precipitation. Transparency tube data were not collected during many of these periods (late-2000, mid-2002, late-2006, late-2007). Additional transparency tube data will be collected in the future, especially targeting high runoff events.

**Chloride**
Chloride data collected in Clearwater Creek are shown in Figure 15. Data have been collected since 2007. With zero exceedances of either the acute or chronic standard, the data indicate that Clearwater Creek is meeting state standards for chloride.
Although the Clearwater Creek watershed contains some developed areas and a number of major roadways, chloride values remain low. RCWD staff collected samples during spring runoff periods, so “missed” samples are not likely. Even so, additional snowmelt runoff samples would help verify that Clearwater Creek meets the chloride standard.

**Phosphorus Loading**

The Peltier Lake TMDL has produced specific phosphorus loading goals for the Clearwater Creek Watershed. Based on current (2001) loading estimates, and the lake’s modeled assimilative capacity, the phosphorus loading goal for the Hardwood Creek watershed is **678 pounds** per growing season (June-Sept). Growing season phosphorus loading estimates for the Clearwater Creek watershed are presented in Figure 16. The data do not show any trend. Data from recent years indicate reduced loading, although still not meeting the goals set in the TMDL.

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4 The 678 pound goal is based on a proposed *Natural Background Condition* water quality standard for Peltier Lake. The proposed standard has not been approved by EPA as of June 2010.
Based on the 2001 modeled year, a 29% reduction in phosphorus loading in Hardwood Creek is required to meet the goals of the TMDL. Obviously, loading varies greatly from year to year. Variability is introduced into these estimates by the environment, the raw data, and the model used to predict the loads. Some of this variation can be attributed to precipitation – more specifically, precipitation intensity, frequency, and total amount. Variability is introduced when water quality measurements are analyzed, and when way flow is measured. Variability is also added from the model. Even if every effort is made to ensure data quality, attention to detail, and “apples to apples” comparisons, the model ultimately relies on relationships between variables to predict loads. These relationships contain variability. Despite this variability, estimating loads is the most direct way to assess progress toward meeting water quality goals.

V. Summary

Although impairments have been identified on each of the trunk streams in the Rice Creek Watershed, data indicate that numeric water quality standards are rarely violated. The Hardwood Creek TMDL and Stressor Identification Process indicated that the probable stressors to that stream ecosystem were more complex than single numeric standards. In that case, “loss of habitat due to sedimentation” was identified as one of the primary stressors. This type of problem requires more specialized assessments
of the stream system, including assessment of stream stability and habitat quality. Some of these assessments have been done by RCWD; more will be done in the future, and will be presented in future RCWD Stream Monitoring Reports. These assessments will contribute to the overall understanding of these stream ecosystems, and help guide management decisions and restoration work in the future.

This is NOT to say that monitoring conventional parameters (i.e. those parameters presented here) lack value. Assessing the concentrations and loads of standard parameters is absolutely essential for addressing lake water quality problems. Every lake’s pollution budget includes sources from the watershed; quantifying the amount of pollution coming from each watershed, and monitoring changes over time will provide the basis for answering the more important questions – “As we apply RCWD rules and install improvement projects, are pollutant loads decreasing over time?”

Data collected in each of the trunk streams indicate that chloride is not much of a problem. Acute and chronic standards for chloride have not been violated. As the Rice Creek Watershed has a number of “fully built-out” and developed areas, all of which have contain a higher density of road networks, this finding is somewhat surprising. Additional snowmelt runoff sampling will be conducted to verify this finding. In addition, the 2010/2011 RCWD Lake Monitoring Report will assess available chloride data for a number of lakes. Many of the smaller streams and ditches in the Rice Creek Watershed have shown elevated levels of chloride; these data are shown in Figure 17. As expected, the watersheds of the sites presented below are fully developed and contain a high density of road networks. All three sites are in the SW quadrant of the RCWD. Although supporting the Minnesota Class 2B Standards in these small ditches and tributaries may be unrealistic⁵, these ditches drain to lakes – the monitoring sites shown in Figure 17 drain to either Little Johanna or Long Lake. High chloride levels in lakes, as in streams, can be toxic to biota. Continued high loading of chloride over time can lead to physical changes in the way lakes stratify. Many lakes stratify every summer based on water temperature – colder, denser water gets trapped at the bottom of a lake, while warmer, lighter water rests on top. Lakes with high chloride concentrations can develop a halocline, where they stratify based on salinity instead of temperature. This can inhibit spring and fall turnover, drastically altering the ecology of a lake.

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⁵ Meeting Class 2B standards in ditches will also likely be unnecessary in the future. The MPCA is developing new standards for “altered” stream systems as part of the Tiered Aquatic Life Uses (TALU) program.
Guidance for addressing high chloride concentrations will need to come from the MPCA. The Minnesota Department of Transportation and county road authorities will need to play a large role in changing current practices related to road salt application. The RCWD’s role will be supporting through data collection and dissemination.

This report provides phosphorus loading estimates for both Hardwood and Clearwater Creeks. Sufficient data exist to estimate loads at additional monitoring sites; future RCWD Stream Monitoring Reports will present this. Loading estimates from both Hardwood and Clearwater Creek watersheds highlight an important point: runoff, driven by precipitation, is the primary driver of watershed pollutant loading to lakes. During “dry” years, meeting pollutant loading goals may be achievable. Meeting those goals during wetter years will be the ongoing battle. Because loads are so heavily dependent on precipitation and runoff, detecting trends over time may be impossible, and more importantly, inappropriate. Future RCWD Stream Monitoring Reports will provide estimates of pollutant yields from subwatersheds. Also included will be flow-weighted mean concentrations of pollutants. Detecting changes over time in this metric may be possible, and evaluating these changes may be an appropriate way of assessing possible improvement.

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**Figure 17.** High chloride concentrations in the Rice Creek Watershed – Sites “CD2”, “D2”, and “RCD4.1”, respectively. The red line indicates the state standard.
Long Lake tributary in New Brighton (monitoring site “D2”)