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MARCH 2013

IMPROVEMENTS TO CEDAR, ALBION, HENSHAW, SWARTOUT IMPROVEMENT PROJECT #06-1

Prepared for:

CLEARWATER RIVER WATERSHED DISTRICT
75 Elm Street East, Box 481
Annandale, Minnesota 55302

Prepared by:

WENCK ASSOCIATES, INC.
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Technical and Cost Specifications

Improvements to
Cedar, Albion,
Henshaw, Swartout
Improvement Project #06-1

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I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineering under the laws of the State of Minnesota.

3-22-13

Norman C. Wenck   Registration No. 8946

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<u>APPENDICES</u>

1.0 Purpose

On March 13, 2013, the Board of Managers of the Clearwater River Watershed District (District) at their regular meeting ordered the District Engineer to prepare Technical and Cost Specifications for the improvements to Project #06-1, the Cedar, Albion, Swartout, and Henshaw Improvement Project (Project #06-1).

This document is intended to fulfill the requirements of Minnesota Statutes Section 103D.635, Subdivision 1, and 103D.605 for improvements to a project.

The District applied for and was awarded a Minnesota BWSR Clean Water Assistance (CWA) Grant (see Appendix A for grant application) for a project titled Cedar Lake Watershed Protection and Improvement Project.

2.0 Introduction

Project #06-1 was ordered and implemented to improve the water quality for the four lakes of Cedar, Albion, Swartout, and Henshaw. The Engineer's Report dated August 2006 considered 16 activities to reduce the phosphorus loading to the lakes (see Appendix B). Ultimately, a scaled-down version of the recommended project was approved. Six of the projects were chosen to be implemented, plus three years of evaluation to determine if more activities were required to meet the project goals. A November 11, 2009, Technical Memorandum indicates that further activities are required to fully meet project goals (Appendix C).

TMDL studies for Albion, Swartout and Henshaw Lakes were completed as part of the Five Lakes TMDL project started in 2008 and submitted to the EPA in a report dated November 2009, Wenck Associates, Inc. (2009).

Excerpts from the TMDL report dated 2009 (Appendix D) describe the condition of Albion Lake, Henshaw Lake and Swartout Lake and present the following information:

- The existing lake nutrient loadings
- The nutrient load allocation for each lake and subsequent nutrient load reduction required for each lake to reach its in-lake water quality goal and
- A conceptual implementation plan to reach the water quality goals for these lakes.

Fourteen of these activities apply to these lakes and were recommended to be considered for implementation.

Technical Specifications dated November 24, 2009, described potential improvements to Project #06-1 that could be implemented to achieve the purposes of the project (see Appendix E). A Technical Memorandum dated July 3, 2012, (see Appendix F) recommended the installation of a project upstream of Old Highway 55 to target load reduction direction to Cedar Lake, and a project at the outlet of the wetland complex east of Swartout Lake which drains to Swartout Lake (monitoring station SSW02) and Cedar Lake which is downstream of Swartout Lake. The grant application (Appendix A) requested funds to implement these recommendations.

Project #06-1 identified the goal for total phosphorus loading to Cedar Lake of 1,000 pounds per year. Monitoring during the period of 2009 through 2012 (Appendix G) shows an average loading for site SSW04 (taken as the input to Cedar Lake) of 2,017 pounds per year over the period.

3.0 Technical Specifications

The proposed improvement to Project #06, a 480 pound-per-year total phosphorus reduction to Cedar Lake, is required as a step to reach the load reduction goal to 1,000 pounds per year. The current loading rate is approximately 2,000 pounds per year based on data collected during the past four years. Progress monitoring to determine progress towards attaining the water quality goals to Cedar Lake will continue and additional activities identified may need to be implemented in the future.

The estimation of total project cost is $554,200, of which $277,900 is funded with a CWA Grant. The remainder is local cash and in-kind match of $276,300. The estimated project cost has evolved and been developed over the past several months as the proposed project has moved from a conceptual basis to a defined project.

The Appraiser’s Report for Project #06-1 (Appendix H) indicated a benefit per unit of $7,182. The assessment of Project #06-1 in 2006 was $979.34 per unit. The estimated levy for this improvement is approximately $785 per unit. This estimated levy could be reduced by whatever amount the District decides to contribute to this proposed project.

4.0 Recommendations

It is recommended that Project #06-1 be improved, as described in Section 3.0 of these Technical and Cost Specifications. The improvements must be implemented to attain the level of operating efficiency contemplated at the time of implementation of Project #06-1.

5.0 Certification

Additional activities as described in Section 3.0 are required to be implemented to fully achieve the purposes of Project #06-1.The exact nature of additional activities will be determined from the ongoing monitoring and evaluation of the project.

Appendix A

Clean Water Assistance (CWA) Grant Application
Submitted September 2012

FY 2013 Clean Water Fund
Clean Water Assistance
Project Description
Form FY13-A

The entire project description portion of the application should be no more than 6 pages in length, use no less than 10 point font, and must include the following topics as section headings. Applications containing a project description longer than 6 pages (page number does not include a map or photos) will not be accepted by BWSR.

1. Project Description

a. Title (10 words or less):

Cedar Lake Watershed Protection and Improvement Project

b. Project Abstract (300 words or less): What are you trying to achieve and how do you intend to achieve those results? Keep this brief and high level – *imagine a paragraph on the BWSR website describing your project to members of the public*.

In 2002 citizens began to notice severe algal blooms in Cedar Lake, a high value recreational lake with exceptional clarity and fisheries habitat. Those observations, coupled with a sharp rise in average summer phosphorus and chlorophyll-a raised a red flag over the future of the lake. Clearwater River Watershed District began an intensive monitoring program in 2003 to identify nutrient sources and protect Cedar Lake. Through intensive lake and watershed monitoring, CRWD identified the major source of nutrients to the lake: three nutrient impaired shallow lakes (Swartout, Albion and Henshaw Lakes) in the upper watershed and impaired wetlands discharged excess amounts of soluble phosphorus. CRWD also identified a suite of in-lake and watershed BMPs to improve water quality in the impaired shallow lakes to protect Cedar Lake. Implementation of these projects began in 2007. A TMDL for the three upstream lakes was approved by EPA in 2009 and MPCA approved a Watershed Wide Implementation plan also in 2009. Since 2007, CRWD has implemented as many capital and programmatic BMPs as possible with current funding and landowner participation, but additional load reductions are needed to meet water quality goals in all the lakes. The project targets reductions to the largest watershed sources of nutrient to Cedar and Swartout Lakes by installing iron sand filters to remove soluble phosphorus currently exported from degraded wetlands and lakes. The target is to size sand filters to treat baseflow and the 1.25-inch event to provide the maximum cost/ benefit while preserving upstream hydrology. The projects target reductions from the largest watershed sources of nutrients to each lake providing 80% of the necessary watershed load reductions to Swartout Lake (800 lbs/yr), and 40% of the necessary watershed load reductions to Cedar Lake (480 lbs/ yr).

2. Water Plan and/or Completed TMDL Relationship and Prioritization

a. Identify the specific comprehensive local water management plan reference by title, section and page number.

These implementation activities are associated with the "Clearwater River Watershed District's (CRWD) 2010 Watershed Management Plan", Section 2.2.4 (page 2-2 and 2-3); Section 4.14 (page 4-3) and Section 9.1.1 (Page 9-1) and Section 11.2.5 (pages 11-5 and 11-6). They are also associated with the 2009 "CRWD TMDL Implementation and Watershed Protection Plan" and the "Technical Specifications for Alterations to Cedar, Albion, Henshaw, Swartout Improvement Project #06-01". The implementation activities were those identified through the Engineer's Report, and TMDL process and subsequent research and refining of potential projects.

b. Based on the State approved and locally adopted comprehensive local water plan referenced above, explain why this project is a priority for your organization.

Cedar Lake is a 783-acre high value recreational lake with a maximum depth of 108 feet. Residents became alarmed when severe algal blooms began in 2002 and average summer surface TP concentrations skyrocketed to as high as 58 ug/L between 2003 and 2006 compared with historic conditions ranging between 20 and 30 ug/L TP. The District conducted an intensive study of the Cedar Lake sub-watershed. The biggest source of pollution to Cedar Lake was found to be the tributary watershed that drains to Cedar at the south end of the lake. This tributary is fed by three nutrient impaired shallow lakes for which TMDLs have been approved by EPA. The District, petitioned by residents, implemented a project consisting of capital and programmatic BMPs as well as monitoring to protect and improve the water quality in Cedar Lake and in the tributary lakes. Monitoring of project results has documented improvement in average summer surface TP concentrations in Cedar Lake as well as achievment of a clear lake state from time to time in the upper watershed impaired lakes. However, severe algal blooms persist in Cedar Lake, as does District and resident concern over the degradation of this lake. The CRWD is approaching the limit of what load reductions can be achieved with existing budgets and landowner cooperation in the upper watershed. The monitoring and modeling done suggested that Cedar Lake was possibly at a "tipping point" having been historically loaded with nutrients, and that continued high nutrient loading might cause rapid and severe degradation. It is the District's perspective that protecting high quality lakes is more cost effective than restoring them. Additionally, the CRWD's first goal listed in their Comprehensive Plan is reduction of external nutrient loads to surface water. Implementing the TMDL load reductions has also been a high priority for the CRWD, and the proposed project allows for both progress towards achieving a TMDL (in Swartout Lake) and protection of a high value recreation lake which may be at a tipping point in terms of water qualtiy. These elements make this a high priority project for the District.

c. Is the water resource identified in this application of regional or State significance? If yes, briefly describe that significance; including identification in basin-level, regional or statewide conservation and/or water quality plans.

Cedar Lake is a 783-acre high value recreational lake with a maximum depth of 108 feet with historically low TP concentrations (20-30 ug/L TP). Currently, this deep high quality lake hosts a population of tullibees, this is the southernmost edge of the range for tulibiees in the state. Few lakes in this area of the state enjoy such water quatliy and there is a state interest in preventing further degradation.

d. Describe the methods and results of inventory and source targeting done to date to identify the most critical pollution sources within the project area that are responsible for causing impairments or threats to surface and/or ground water quality.

The CRWD undertook a study of this sub-watershed in 2003, collecting both in-lake samples and tributary drainage area water quality samples. Hydrology was also monitored and analyzed. The Canfield-Bachmann lake response model was applied to Cedar Lake, and a more detailed lake response modeling was conducted for the TMDLs for Swartout, Albion and Henshaw Lakes (these are the three upstream impaired lakes). Watershed loading was determined from hydrologic and water qualtiy data collected in the watershed. The biggest source of pollution to Cedar Lake was found to be the tributary on the south end of the lake which is fed by three nutrient impaired shallow lakes (Swartout, Albion and Henshaw). Drainage areas to Swartout, Albion and Henshaw Lakes are small and dominated by agriculture and wetlands. Carp infestations, internal loading and soluble phosphorus loading from upstream wetlands seem to be driving the poor water qualtiy. The historically degraded wetland upstream of Swartout was determined to be the largest watershed source of phosphorus to Swartout Lake.

Carp migration management, carp harvesting, capital projects and agricultural BMPs to target these sources have been implemented in this sub-watershed and will continue. The results have improved water quality in Cedar Lake. Further, clear lake state has been achieved from time to time in the three impaired shallow upstream lakes (Swartout, Albion and Henshaw). However, TP concentrations in these lakes remain high despite a clear lake state- and therefore the loading to Cedar Lake remains high. Reducing the loading to Cedar Lake is critical to protect it from further degradation.

The CRWD has also conducted, in partnership with DNR and others, water fowl surveys, rough fish surveys, and macroinvertebrate surveys. CRWD will continue to track the efficacy of projects based on the outcome, not only of water quality samples but on ecological health of the lakes.

The proposed project targets the largest two concentrated loading sites in the subwatershed as identified by sampling and models.

e. Describe additional inventory and source targeting that is needed, including qualitative and quantitative tools you will use to identify the most critical pollution sources within the project area.

Critical pollution sources have already been identified. What is needed now is to further reduce loads which will require additional targeting of soluble phosphorus from the upstream lakes and wetland. Tracking progress towards load reductions will be needed; this will be accomplished through ongoing monitoring which is part of the CRWDs budget though the original project and through our annual water quality monitoring program.

3. Integrated Water Resource Management

a. Explain the importance of the outcomes identified in the spreadsheet and how they will protect the identified water resource(s) from future water quality impairments or help restore the identified water resource(s) to State water quality standards.

Reducing the pollutant loading to Cedar Lake will protect it from future degradation and should keep it off the state's 303d list. Historic concentrations in Cedar Lake were about 20-30 ug/L, but for a time increased to well above the state standard. The on-going work should keep this lake off the states 303d list. The work also targets the largest watershed source to Swartout Lake, an impaired lake. This work is necessary to take Swarout Lake off the states impaired waters list.

b. Describe any hydrologic benefits of this project. If your project intends to keep water on the land by infiltrating runoff, describe why this activity will not be a threat to groundwater quality.

The upper watershed has been ditched and connections between lakes and wetlands established through agricultural and civil development. The project as proposed requires intalling a filter berm which will allow some water to filter through sand-iron systems. In simply slowing this water down, infiltration as well as filtration is encouraged. However, since the work is near existing wetlands, the work will avoid hydrolgoic impacts to these wetlands including changes to the hydroperiod and OHWs unless such changes can be shown to be beneficial to habitat and the quality of the wetland. The infiltration is into the surficial aquifer which is not the source of regional drinking water.

c. **Will the overall project have additional secondary benefits, including those that enhance aquatic and terrestrial wildlife, improve native habitats, or protect rare and native species? If so, please specifically describe what will be done.**
The project is both protective and resotrative, it will protect and preserve the already high quality ecosystem of Cedar Lake while improving water quality in the currently impaired Swartout Lake. Currently, Cedar Lake is a deep high quality lake which hosts a population of tullibees, this is the southernmost edge of the range for tulibiees in the state. Few lakes in this area of the state enjoy such water quatliy and there is a state interest in preventing further degradation. Swartout Lake is an impaired lake in which CRWD has invested several dollars and from time to time has achieved a clear state shallow lake. However, soluble phosphorus exports remain high, continuing to threaten water qualtiy in downstream Cedar Lake.

4. Project Management, Partnerships, and Readiness

a. **Describe the strength of staff qualifications and other collaborating organizations, including the participation of appropriate local, state, or federal government, to the success of this project.**
The CRWD has successfully leveraged existing funding and programs towards achieving 13 EPA-approved TMDLs, implementation of the TMDL Watershed Restoration and Protection Plan and improving water quality in the past. The District was awarded the DNR's Watershed District of the Year in 2004. District staff members are experts at fostering public involvement and working with other groups to gain participation and buy-in. Assistant District Administrator Dennis Loewen worked to implement Phase I of this stormwater management project in Kimball. Phase I of the project was completed last year. Phase II of the Kimball project is underway: the project is on track to begin construction in 2013. District Engineers Norm Wenck and Rebecca Kluckhohn have 65 years (combined) of experience in environmental and water resources engineering and they are supported by a staff of water resource professionals at Wenck Associates.

The Lake Association and residents have been successful partners with the CRWD in the implmenetation of the original suite of projects identified for this area and are geared up to implement these additional projects.

b. **Will construction start by the end of calendar year 2013? Provide an anticipated timeline when implementation activities are to begin, including project development and construction.**
Yes. Concept design for this project is complete. The CRWD will convene a Technical Advisory Committee (TAC) of local stakeholders including the Township, Wright County, MPCA, BWSR, and DNR to detail project elements and finalize design in the early spring of 2012 as soon as the grant is received. Final design, permitting and bidding will be conducted in the fall of 2013. The Notice to Proceed with construction will be issued in fall. Construction will proceed over the winter as conditions allow with final site restorations and plantings installed in the spring of 2014. The project will be featured in the 2014 CRWD District-wide tours. The project will be inspected annually through the project life cycle through the Districts Operation and Maintenance Program to determine maintenance needs thereafter for the life of the project. The District will also conduct follow-up monitoring to gauge system effectiveness and report annually in the CRWD's Annual Water Quality Monitoring and Implementation Progress Report. Based on other similar projects in the watershed already constructed, this timeline is reasonable with respect to permitting and construction. Our expertise and recent experience with this type of project elsewhere in the watershed ensure that the projects can be constructed per the schedule above.

c. Identify how this project provides assurance that the practice(s) will remain in place for practice(s) effective life.

The CRWD will secure perpetual easements over the necessary lands to maintain and operate the project. Further, the project will be inspected annually through the project life cycle through the District's Operation and Maintenance Program to determine maintenance needs thereafter for the life of the project. The District will also conduct follow-up monitoring of the lakes and watershed to gauge system effectiveness and report annually in the CRWD's Annual Water Quality Monitoring and Implementation Progress Report.

d. List and provide the status of any permits (federal, state, or local) that may be required for this project (for example, NPDES construction permit applied for on January 1, 2010, etc.).

The project will require an NPDES construction permit, a DNR Waters permit, a BWSR WCA permit and a USACE Section 404 permit. These permit applications will be made following review of the final project by the project TAC, which will include participants from the county, BWSR, DNR, and MPCA. None of these permits has yet been secured. However, we have ongoing technical advisory committees with representatives of these agencies.

e. If the project participants choose to consider the conservation value of land where Clean Water Fund conservation practices will be installed as local match, please describe the valuation methods of the land and how this value will be applied as match (answer if applicable).

The value of the land was determined on a cost per acre basis based on recent sales in the area. A formal appraisal will be conducted by a certified party as the project progresses.

5. Supplementing Traditional Funding

The Constitutional Amendment requires that Amendment funding must not substitute traditional funding. Briefly describe how this project will provide water quality benefits to the State of Minnesota without substituting existing funding.

The proposed project will supplement traditional funding, not substitute it. If the project were built using existing CRWD funds, it would not be built at all due to the burden of the existing TMDLs that CRWD needs to meet. Without supplemental grant funding, the CRWD will not be able to further protect Cedar Lake.

Project Location Map and Photos

- **Required:** Attach an 8.5” x 11” map (required) in image (jpg, gif, tiff, bmp, png) or pdf formats showing both the specific project location and the general location in the State. **Optional:** Applicants may attach a photo of the project area in <u>ONLY</u> image (jpg, gif, tiff, bmp, png) format.

Appendix B

Excerpts from Engineer's Report on Project #06-1
Dated August 2006

3.0 Alternative Solutions Considered

3.1 GENERAL

The CRWD conducted a special monitoring project from 2004 to 2005 to study the potential causes for increasing nutrient levels in Cedar Lake observed starting in Fall 2003, and persisting high nutrient levels in Swartout, Albion and Henshaw Lakes. Available data was analyzed, including data collected during the scope of the study, historical lake data, and data available from other sources such as the MPCA, the Minnesota DNR and the University of Minnesota.

The District identified the specific cause and identified feasible methods to reduce nutrient loading to Cedar Lake and reduce phosphorus concentrations in upper watershed lakes through the data collection, data analysis, and a nutrient balance.

In-lake water quality was used to predict the total annual phosphorus load to Cedar Lake. Based on characteristics of the lake and surrounding watershed, a total phosphorus load of 1,000 pounds per year is predicted to yield in-lake phosphorus concentrations observed prior to 2003 and thus maintain water quality in Cedar Lake. This information, coupled with supplemental monitoring data collected in 2004 and 2005, indicated that presently 2,000 to 3,000 pounds of phosphorus per year were entering Cedar Lake through the southeast inlet alone, about 96 % of the total phosphorus load to Cedar Lake under current conditions.

The primary phosphorus source to Cedar Lake is caused by high phosphorus concentrations in upper watershed lakes. To reduce the phosphorus concentrations in Cedar Lake it will be necessary to reduce the nutrient load from upper watershed lakes. This finding also rules out other causes for the increasing nutrient levels in Cedar Lake such as individual septic systems for lakeshore homes, internal loading in Cedar Lake exacerbated by carp or curly leaf pondweed within the lake, or other point sources.

The nutrient balance in Swartout Lake showed a small amount of phosphorus and sediment coming into the lake from the outside watershed relative to the internal loading in Swartout Lake. Internal loading to Swartout Lake is about 76% of the load to the lake. Internal loading for Albion and Henshaw Lakes represent about 91% and 95% respectively of the phosphorus loads to each lake. A reduction of in-lake phosphorus concentrations in Swartout Lake will require addressing both internal and external phosphorus loading.

3.2 ALTERNATIVES CONSIDERED

Sixteen alternatives were evaluated to reduce phosphorus loading to Cedar Lake, and reduce phosphorus concentrations in the upper watershed lakes:

1. Eliminate ISTS discharges to Cedar Lake through grants to homeowners or installation of a regional treatment facility.

   Data showed that potential point source loading to Cedar Lake from ISTS was low, while the cost of implementing this option was high.

2. Aggressive curly leaf pondweed control in the southern portion of Cedar Lake.

   Data showed that internal loading to Cedar Lake though exacerbated by curly leaf pond weed, was not a significant portion of the nutrient load to Cedar Lake. Further, a 2005 macrophyte study by the Minnesota DNR showed that the extent of curly leaf pond weed in Cedar Lake is small. (Figure 3)

3. Removal of Cormorants on Swartout Lake

   Based on a water foul survey conducted by the University of Minnesota in 2004, removing the cormorants from Swarout Lake would result in only a maximum of 1% phosphorus load reduction to Swartout Lake.

4. Carp population reduction through Rotenone, physical harvesting

   Carp population reduction in the upper watershed lakes would reduce the internal loading in Swartout Lake between 15 and 40 %, which in turn would likely reduce the phosphorus loading to Cedar Lake as well.

   Management of the carp population would be an ongoing task with annual activities necessary to maintain reduced loads and would require installation of migration barriers to prevent repopulation of upstream lakes by the carp that over winter in Cedar Lake.

   However, there was no interest by residents in actively managing the carp populations in any of the upstream lakes through chemical means, or through lake draw downs.

5. Fish migration barriers between Albion and Swartout, and Henshaw and Swartout Lakes

   Fish migration barriers used in conjunction with fish population management techniques such as lake drawdown to induce winter kill, harvesting, or chemical treatment, will likely result in a significant reduction in the internal loading in upstream watershed lakes, and a decrease in nutrient loading to watershed lakes.

   Short of active management of carp populations, the shallow upstream lakes will likely experience a winter fish kill at some point in the future given their depth. The installation of fish migration barriers coupled with a natural winter fish kill would likely have a positive effect on in lake water quality. Figures 4 through 8 show the results of a survey of channel elevations between Henshaw, Swartout, and Cedar Lakes. This survey was conducted to determine the feasibility of physical barriers.

6. Install fish barriers between Hwy 55 and Cedar Lake, and Swartout Lake outlet at CR 6 to prevent upstream migration.

   This option would prevent carp repopulation of upper watershed lakes, and in conjunction with natural or aided carp population management would reduce nutrient loadings in Swartout Lake. Figures 4 through 8 show the results of the survey conducted to ascertain the feasibility of fish barriers at these locations.

7. Treat Swartout wetland outlet to remove phosphorus from the water before it enters Cedar Lake.

   Directly treating the primary source of nutrients to Cedar Lake would dramatically reduce phosphorus loading to Cedar Lake and improve water quality therein. It is the surest and the quickest way to return Cedar Lake to its pre 2004 water quality of 0.23 mg/ L average summer total phosphorus. This solution, however, does not address the cause of the high nutrient loading in the upper watershed.

8. Increase residence time on wetland between Swartout and Highway 55 to increase sediment removal and reduce nutrient loads to Cedar Lake.

   This option would raise the outlet elevation of the Highway 55 wetland, and allow for greater suspended nutrient settling. It might also allow for greater uptake of nutrients in the wetland. However, the size of the wetland and the high dissolved component to the phosphorus load indicate this option has a low probability of success, a high level of uncertainty, and a high cost.

9. Watershed best management practices.

A reduction in the external and internal phosphorus load to Swartout Lake is necessary to reduce in-lake phosphorus concentrations. Watershed best management practices can be implemented on the portion of the upper watershed that is a direct tributary to Swartout Lake and costs are generally low. Figure 9 shows the recommended extent for initial implementation of watershed BMPs.

10. Buffer tile lines, ditches and streams in upper watershed.

A reduction in the external and internal phosphorus load to Swartout Lake is necessary to reduce in-lake phosphorus concentrations. Buffer strips can be easily and cost effectively implemented on the portion of the upper watershed that is a direct tributary to Swartout Lake. Figure 9 shows the recommended extent for initial implementation of ditch and tile line buffer strips.

11. Lake shore management in Cedar, Swartout, Albion and Henshaw Lakes

Managing lakeshore plants and habitat can have a positive ecological impact on lakes that will work synergistically with other measures to reduce phosphorus concentrations. This option will have a greater impact on shallow lakes where lakeshore habitat plays a larger role in water quality. This option is best implemented by lake associations. The Minnesota DNR's manual *Lakescaping for Wildlife and Water Quality* should be used as a guide for residents.

12. Ecological management of Henshaw, Albion and Swartout Lakes to induce a shift in lake ecosystems from algal/ carp dominance to macrophyte dominance

This option would entail reducing carp populations in upper watershed lakes, and preventing future upstream migration of carp from Cedar Lake to the shallow upstream lakes. Temporary lake drawdowns would be used to induce winter fish kills and stimulate submergent and emergent plant communities in the lakes.

13. Isolate Swartout Lake and redirect outflow downstream of Cedar Lake

    This option was rejected due to potential impacts to downstream water bodies.

14. Isolate wetland between Highway 55 and Swartout Lake and re-direct outflow downstream

    This option was rejected due to potential impacts to downstream water bodies.

15. Install wetland treatment system in the Highway 55 Wetland.

    This option might have allowed for more residence time and greater settling for suspended nutrients, and perhaps greater uptake of nutrients in the wetland. However, the size of the wetland and the high dissolved component to the phosphorus load showed this option to be less effective with a high cost.

16. Install sedimentation basins to reduce external nutrient and sediment load to Swartout Lake.

    Installing sediment basins in the watershed that is a direct tributary to Swartout Lake is an important component of addressing nutrient concentrations in Swartout Lake. This option has the potential to reduce the loading to Swartout Lake by 1 to 10%.

Appendix C

Technical Memorandum
Dated November 11, 2009

TECHNICAL MEMORANDUM

TO: Marvin Brunsell, Chairperson, Clearwater River Watershed District

FROM: Norman Wenck, District Engineer

DATE: November 11, 2009

SUBJECT: Evaluation of Cedar Lake Project #06-1

INTRODUCTION

This memorandum is prepared to assess Cedar Lake Project #06-1. Project #06-1 was initiated in 2007 in response to a petition by lake shore residents to address the declining water quality and severe algae blooms in Cedar Lake.

The anticipated goals of the project were to reduce phosphorus concentrations in Cedar Lake and the accompanying nuisance algae blooms. More specifically, the goal of the project was to reduce the phosphorus load to Cedar Lake to 1,000 lbs and the in-lake summer average phosphorus concentration in Cedar Lake to 20 µg/l. An additional goal of the project was to further reduce phosphorus loading from upstream lakes through a reduction in the carp population of the lakes.

The recommended solution for reducing the phosphorus loading and carp population in Cedar, Albion, Henshaw, and Swartout Lakes consisted of carp barriers, sedimentation basins, watershed best management practices (BMPs), and a phosphorus removal treatment system. However, the phosphorus removal treatment system was deleted and a three year evaluation task was added. This memorandum presents our evaluation of Project 06-1 as of this date.

Several measures were implemented to reduce in lake phosphorus concentrations in Swartout, Albion, and Henshaw Lakes, thereby reducing the phosphorus load to Cedar Lake and improving lake water quality in Cedar, Swartout, Albion, and Henshaw Lakes. The projects that were implemented are described below and their locations are shown on Figure 1.

Ultimately, the plan that was implemented was a portion of the original plan. When addressing impairments in shallow lakes it is also necessary to address the health of biological communities. To improve the quality of shallow lakes, it is beneficial to restore the health of biological communities in the lake, including fish, plants, and zooplankton. Ideally, shallow lake management plans incorporating water level management to promote vegetation growth, and fish community management strategies, such as lake drawdowns or the application of Rotenone to promote rough fish kills, would be implemented. However, efforts to implement these strategies have been met with limited success with landowners so the implementation strategies were limited to rough fish barriers and harvesting, and watershed BMPs.

Best Management Practices (BMPs)
The Project recommended the implementation of watershed BMPs, including drain tile inlet replacement, buffering of tile inlets, and ditch and stream buffer strips.

Watershed BMPs that were implemented in 2007 included the buffering of five tile intakes for a three year period, 14 acres of alfalfa buffer for one year, and 132 acres of soybean stubble buffer for one year. The one year cropland buffers were not renewed and were planted into corn in 2008. There were no additional buffers implemented in 2008 or 2009.

Rough Fish Management
Rough fish management activities including the construction of carp barriers and rough fish harvesting were recommended and implemented as part of the Project to help control rough fish populations in the upstream lakes.

The Project recommended the construction of four carp barriers on Cedar Lake tributary streams. The fish barriers are intended to impede upstream migration of carp, which prevents adult carp from reaching their preferred spawning grounds in the wetlands adjacent to the lakes. This can help keep carp populations in check and also reduces carp damage to shallow upstream lakes. Carp can cause problems in shallow lakes by stirring up bottom sediments through their feeding activities. This makes the waters turbid which typically does not allow submerged aquatic vegetation to grow in the lake. The disturbance of the nutrient rich bottom sediments can also lead to an increase in internal cycling of nutrients from the bottom sediments, exacerbating the impairment of upstream lakes and therefore adding higher phosphorus loads to Cedar Lake.

Three fish barriers were installed during early spring 2007 on the Cedar Lake inlet upstream of Highway 55, and at the Swartout Lake and Henshaw Lake outlets. In 2008, carp barriers were installed at two inlets to Swartout Lake and in the diversion channel upstream of Segner Pond. Based on observations made during 2008 and 2009, the barriers appear to be effectively restricting the upstream migration of carp from Cedar Lake to the upstream lakes.

In addition to the installation of fish barriers, rough fish harvesting was conducted in the upstream lakes in 2008. Approximately 57,000 lbs of carp were removed from Swartout Lake by two nettings performed by a commercial fishing operation in February 2008. An additional 4,760 lbs of rough fish were removed from Swartout Lake in December 2008. Netting was also performed on Henshaw Lake in 2008, removing 220 lbs of bullheads from the lake.

While it is difficult to completely eradicate carp from lakes, effective rough fish population management would likely result in a significant reduction in the internal loading in upstream watershed lakes, and a decrease in nutrient loading to waters downstream. A reduction in the carp population in the lakes together with improved water clarity may allow aquatic vegetation to grow in the lake, which would provide more suitable habitat for waterfowl and other wildlife.

It is difficult to determine with certainty the impact that the rough fish management practices that have been implemented have had on carp populations. However, observations made in 2008 and 2009, coupled with the significant decrease in the amount of carp harvested from the lake in

December 2008, indicate that the implemented practices have been effective in reducing carp populations.

Sedimentation Basins

The Project recommended the construction of three sedimentation basins. However, one larger basin was constructed.

Construction of the Segner Pond treatment wetland on the Cedar Lake inlet just upstream of Cedar Lake was completed in 2008. Construction of the treatment wetland began in December 2007, and the grading and placement of the limestone treatment filter was completed in January 2008. Flow from the inlet to Cedar Lake was not diverted into Segner Pond until September 2008 to allow vegetation to become established on the slopes of the pond and in the mitigation wetland.

The treatment wetland consists of a 2.9 acre sedimentation basin with a limestone treatment filter. A diversion constructed in the stream channel upstream of the treatment wetland routes stream flow into the sedimentation basin to remove particulate phosphorus from the inflow to Cedar Lake. The limestone treatment filter further reduces the phosphorus load to Cedar Lake by removing dissolved phosphorus from the inflow. The limestone filter targets the soluble portion of the phosphorus load to Cedar Lake.

RESULTS

Water quality monitoring was conducted for the past three years to track the progress of the Project. The results of the monitoring are described in the following section. Samples were collected from four lakes, including Albion Lake, Cedar Lake, Henshaw Lake, and Swartout Lake. Samples were also collected from eight locations in tributary streams in the subwatershed during the time period that the tributary streams were flowing.

Stream Loads

The tributary streams that were monitored typically started flowing in early spring after snow melt and flowed until early summer, depending on precipitation conditions. Since precipitation was near or below normal in 2007-2009 (See Table 1), most of the streams were not flowing after early summer during each year in which they were monitored.

Table 1: Annandale Precipitation, 2007-2009

	2007 Annandale/ Corinna (Wright)	2008 Annandale/ Corinna (Wright)	2009 Annandale/ Corinna (Wright)	1971-2000 Normal (Cokato)
January	0.39	0.34	0.66	0.93
February	0.69	0.40	0.76	0.70
March	2.29	0.83	2.93	1.69
April	1.78	3.31	0.97	2.33
May	2.37	5.21	0.88	3.30
June	2.29	4.12	5.49	4.62
July	1.84	1.61	1.45	4.04
August	4.97	1.95	5.90	4.00
September	5.20	2.46	1.06	2.78
October	4.79	2.39	6.32	2.23
November	0.02	1.31	--	1.73
December	1.19	1.07	--	0.71
Total	27.82	25.00	26.42*	29.06

*Total through October (Normal through October is 26.62 inches)

The calculated phosphorus loads at each stream location monitored from 2007-2009 are shown below in Table 2 and on Figure 2. Runoff and phosphorus loads were highest in 2008 due to increased precipitation during the early summer period when the streams were flowing. Overall, the external phosphorus load to Cedar Lake, as measured at monitoring site SSW04 ranged from approximately 500 lbs to 1000 lbs with an average of 797 lbs compared to the project goal of 1000 lbs.

The phosphorus load calculated for monitoring site SSW02 indicates that a large load of phosphorus enters Swartout Lake from the watershed east of the lake.

Table 2: Tributary Stream 2007-2009 Data

	Mean TP Concentration (ug/L)			TP Load (lbs)			Runoff (in)		
Site	2007	2008	2009	2007	2008	2009	2007	2008	2009
SCE01	38	28	34	121	199	136	1.6	3.6	2
SCE03	186	49	*	136	8	*	*	*	*
SDD01	352	165	178	163	120	10	3.1	4.8	0.4
SHE01	283	222	195	81	247	61	1.2	4.5	1.3
SSW01	232	159	276	98	698	602	0.7	7	3.5
SSW02	96	301	345	292	858	739	0.5	4.7	3.5
SSW03	257	71	*	102	39	*	1.6	2.2	*
SSW04	58	201	265	870	1011	512	1.2	4	1.5

*Site not monitored

In-Lake Water Quality

Summer average phosphorus and chlorophyll-a concentrations and Secchi depth from the four lakes monitored from 2007-2009 is shown below in Table 3. Data from the closest year in which each lake was monitored prior to the start of the Project is also included in Table 3 for comparison. These summer average values are compared to past concentrations from all monitoring conducted prior to 2007 in Appendix A.

Table 3: Summer Average Monitoring Data

Lake	Year	Summer Average (June-Sept)		
		Phosphorus (ug/L)	Chlor-a (ug/L)	Secchi Depth (m)
Albion	2006	296	203	1.2
	2007	186	79	1.1
	2008	188	97	1.1
	2009	173	38	1.4
Cedar	2006	58	20	2.6
	2007	29	11	1.7
	2008	19	9	1.8
	2009	32	12	1.9
Henshaw	2005	281	144	0.5
	2007	390	278	0.2
	2008	266	121	0.7
	2009	90	25	0.7
Swartout	2006	372	207	0.9
	2007	262	168	0.2
	2008	401	832	0.6
	2009	299	152	0.2

Overall, summer average phosphorus and chlorophyll-a concentrations in Albion and Henshaw Lakes have decreased since the start of the Project. Similarly, water clarity in the two lakes has improved. Abundance of submerged aquatic vegetation was noted to be improved in Albion and Henshaw Lakes in 2009. The suspected cause of the improvement in water quality in these two lakes is the improved ecological health of the two lakes resulting from natural fish kills due to freeze out and lower water levels due to below normal precipitation allowing for an increase in aquatic vegetation growth.

Summer average total phosphorus and chlorophyll-a concentrations in Swartout Lake have remained high but relatively stable since 2006. Water clarity remains low in the lake due primarily to severe algae blooms throughout the summer.

Monitoring data from events conducted from 2007 to 2009 in Cedar Lake is found in Appendix B. Overall, summer average in-lake phosphorus concentrations ranged from 19 to 32 µg/l during that time period. From 2007 to 2009, Cedar Lake was also sampled by a lake resident as part of a volunteer lake monitoring program. As demonstrated in Appendix B, data from the two monitoring programs was found to be similar.

While in-lake summer average phosphorus concentrations have decreased in Cedar Lake since 2006, they remain above the Project goal of 20 µg/l.

Although internal loading of phosphorus is not suspected to make up a significant portion of the phosphorus load in Cedar Lake, it is likely that there is some internal loading of phosphorus in the lake. This is evidenced by increased concentrations of phosphorus in the lake in 2009, even though the external load to the lake was relatively low. Samples were collected near the bottom of the lake in 2007 and 2009 (See Table 4). Elevated concentrations of phosphorus near the lake bottom indicates potential internal loading. Temperature and dissolved oxygen profile data indicates that the lake is stratified during most of the time period from June to September.

Table 4: Cedar Lake Near Bottom Monitoring Data

Site ID	Date	TP (µg/L)	OrthoPhos (µg/L)	Total Fe (mg/L)
LCE01B	5/25/2007	56	39	0.14
LCE 01B	6/29/2007	158	121	0.08
LCE01B	7/27/2007	150	129	0.12
LCE01B	8/24/2007	159	139	0.04
LCE01B	6/11/2009	212	166	< 0.015
LCE01B	7/13/2009	279	179	0.015
LCE01B	8/6/2009	272	254	0.036
LCE01B	9/14/2009	365	263	0.135

It is suspected that curly leaf pondweed, which is present in small areas of the lake, may contribute to internal loading in the lake by making phosphorus from buried lake sediment available in the water column during the growing season.

Although the summer average Secchi depth has not shown an improvement since 2006, at times, water clarity in Cedar Lake has been very good. In 2007, although the average Secchi depth was 1.7 meters, the observed range of Secchi depth was 0.9 to 5.2 meters. In 2008, Secchi depth ranged from 1.4 to 5.5 meters with an average of 1.8 meters, and in 2009 Secchi depth ranged from 1.1 to 9.4 meters with an average of 1.9 meters.

CONCLUSIONS

1. The external phosphorus load to Cedar Lake from the upstream watershed for 2007 to 2009 was between approximately 500 lbs and 1000 lbs with an average of 798 lbs/year compared to the project goal of 1000 lbs.

2. Precipitation during 2007 to 2009 was below average overall, and thus lower than average annual runoff.

3. The in-lake phosphorus concentration in Cedar Lake was between 19 and 32 µg/l compared to a goal of 20 µg/l.

4. Three years of reduced external phosphorus loading has not resulted in meeting the Cedar Lake in-lake phosphorus concentration goal.

5. Fewer BMPs were implemented than planned.

6. Rough fish harvesting in conjunction with the installation of carp barriers was effective in reducing carp populations in Swartout Lake.

7. Curly leaf pondweed appears to be contributing to the internal phosphorus loading of Cedar Lake.

RECOMMENDATIONS

1. Continue funding additional BMPs (especially in the watershed tributary to Swartout Lake to the southeast) and maintain existing BMPs.

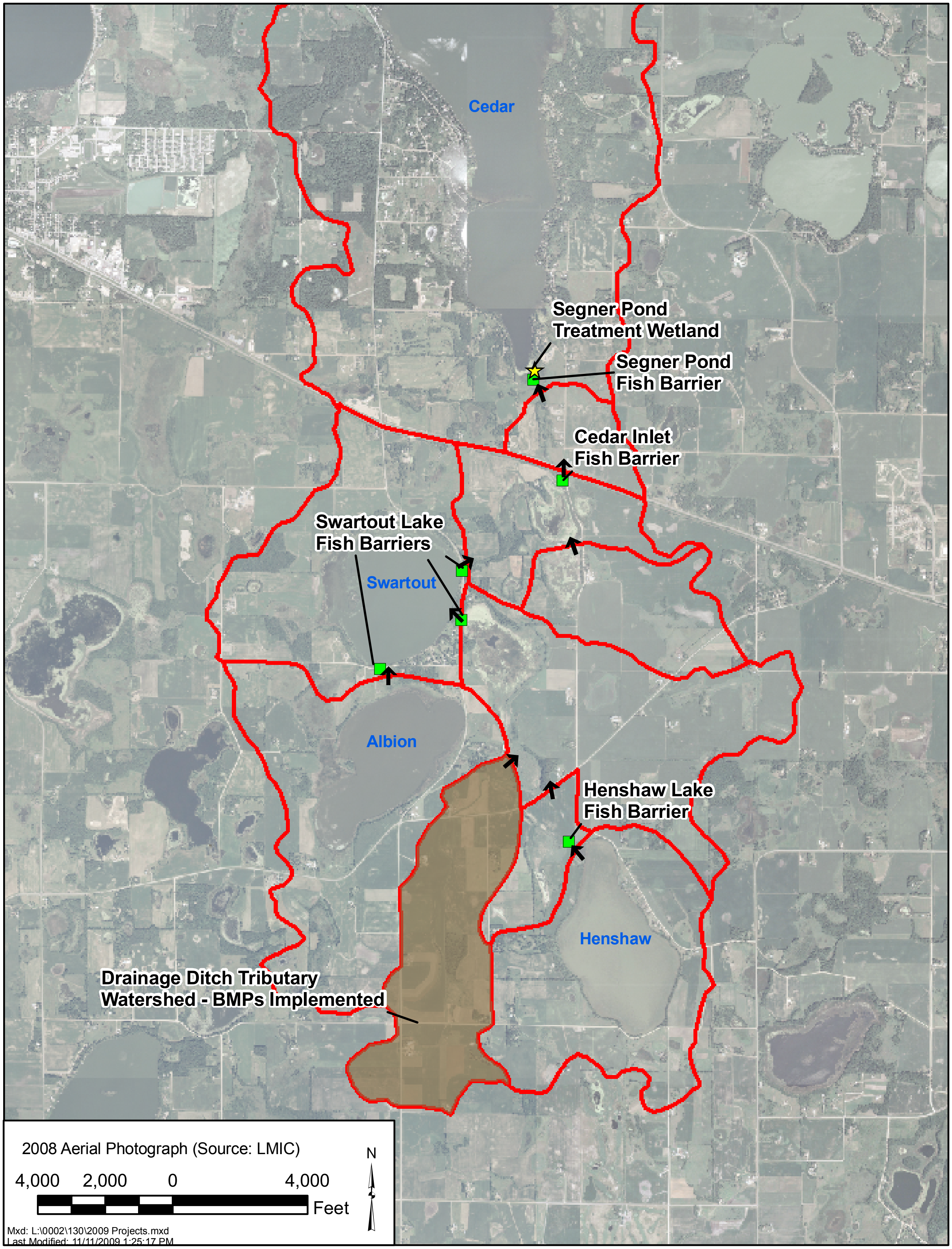
2. Continue maintaining carp barriers and continue with rough fish harvesting from Swartout Lake.

3. Continue the project evaluation monitoring program.

4. Consider curly leaf pondweed management in Cedar Lake, which may include vegetation inventories and chemical treatment.

5. Continue maintenance of Segner Pond.

Figures



CRWD

Implementation Location Map

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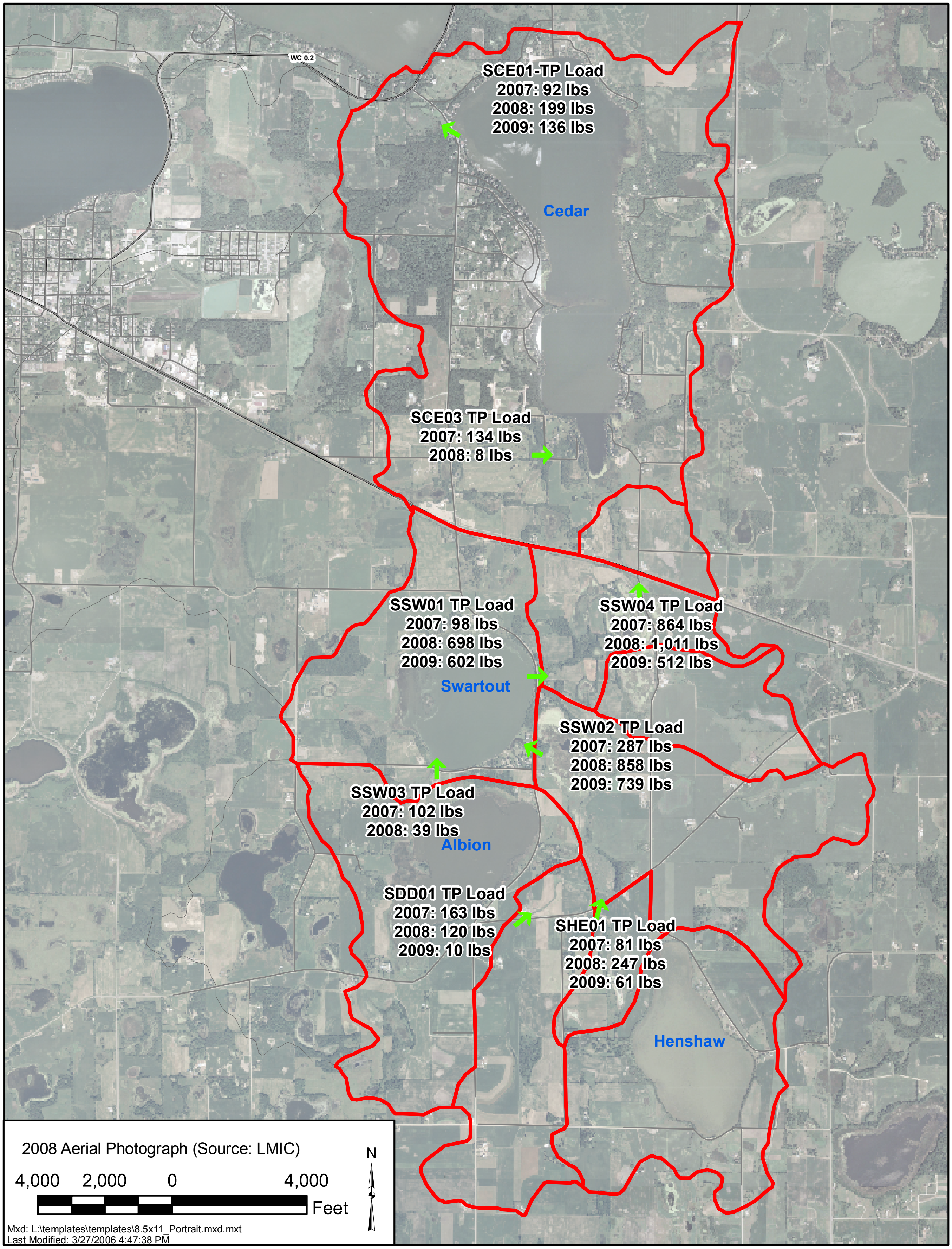
Wenck Associates, Inc. Environmental Engineers

1800 Pioneer Creek Center Maple Plain, MN 55359-0429

NOV 2009

Figure 1



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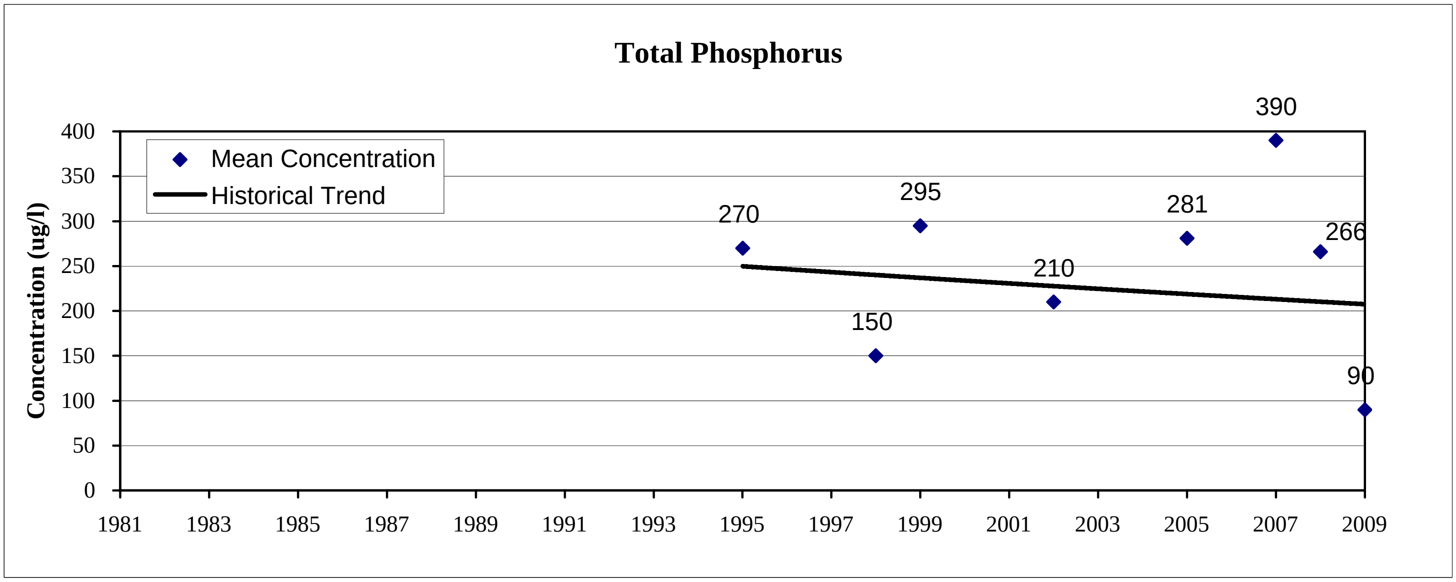
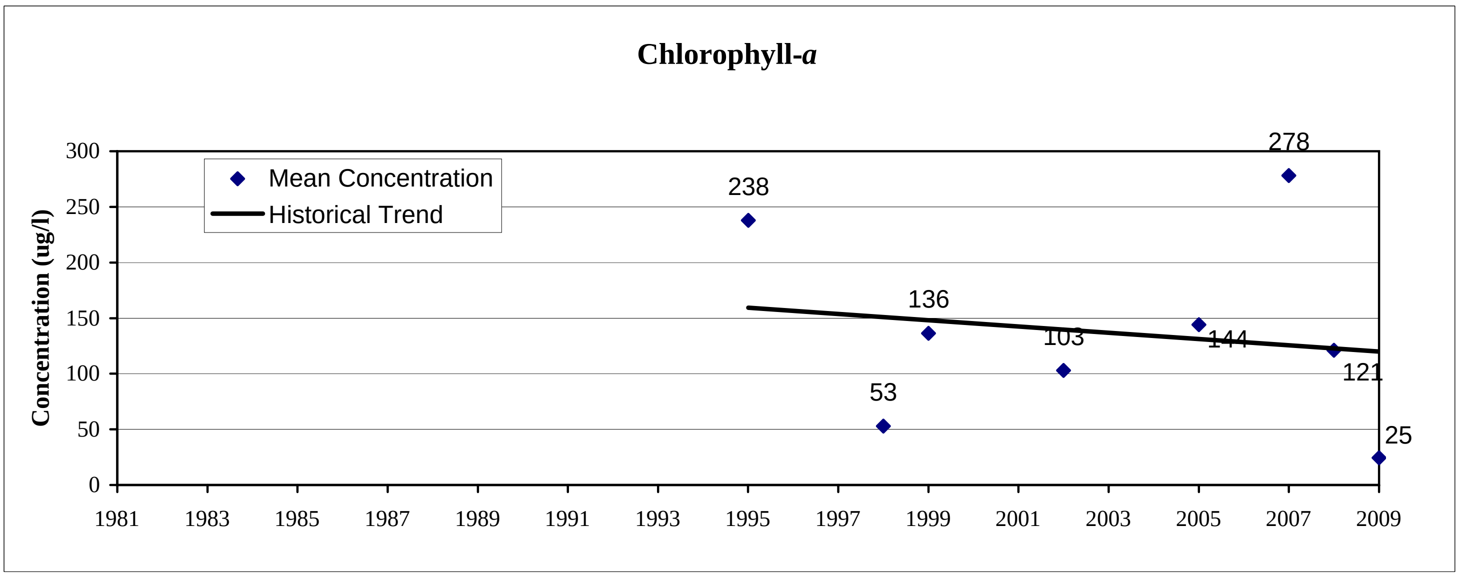
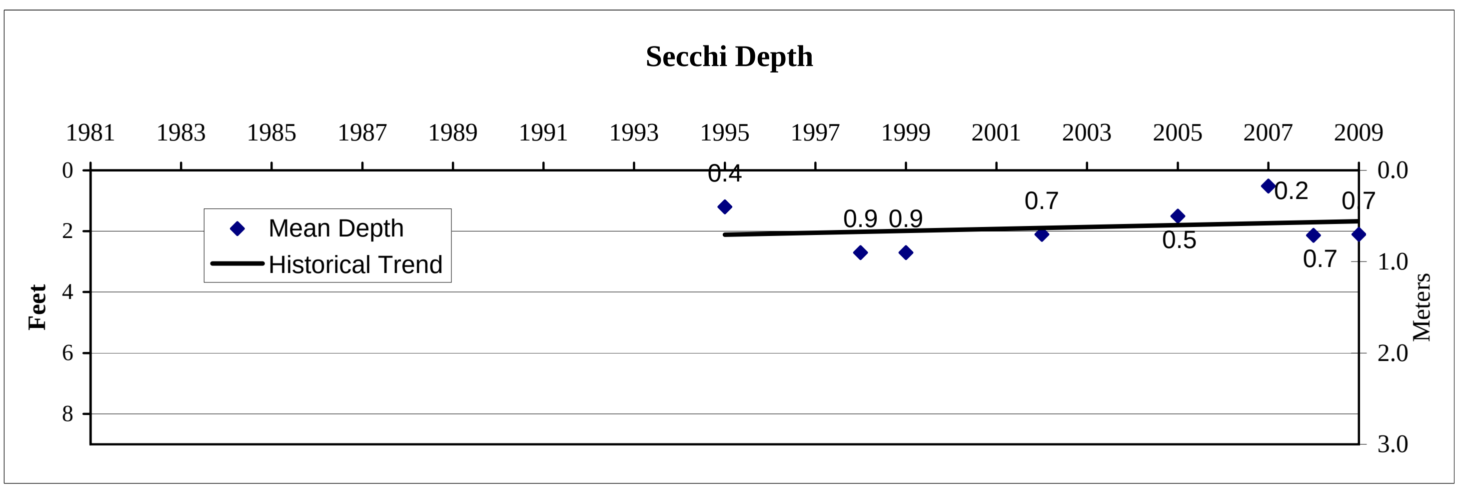
CRWD	Wenck	NOV 2009
Tributary Stream Phosphorus Loads	Wenck Associates, Inc. Environmental Engineers 1800 Pioneer Creek Center Maple Plain, MN 55359-0429	Figure 2

Appendix A

Historical In-Lake Water Quality

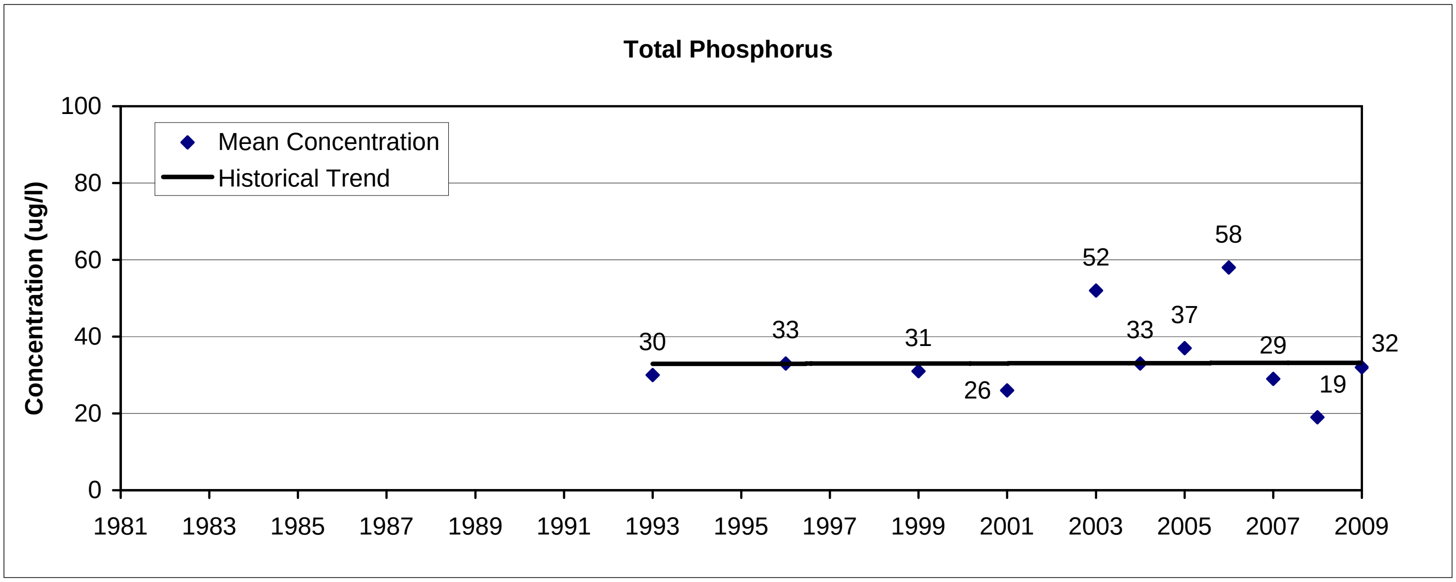


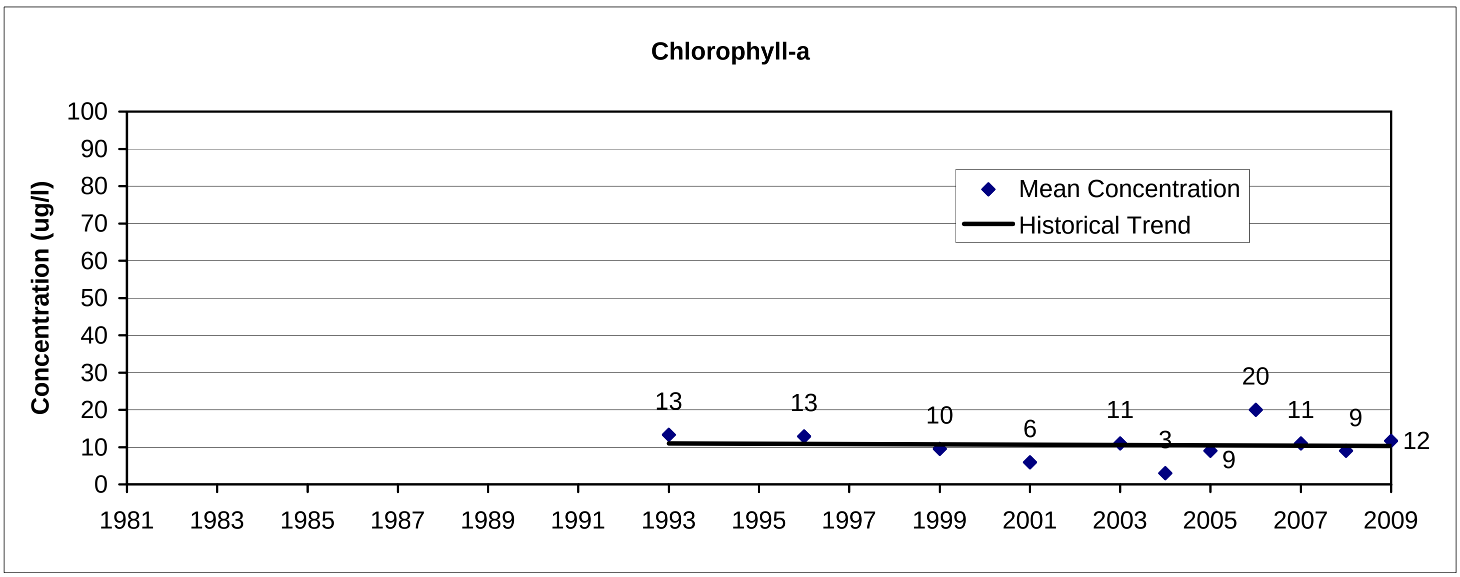


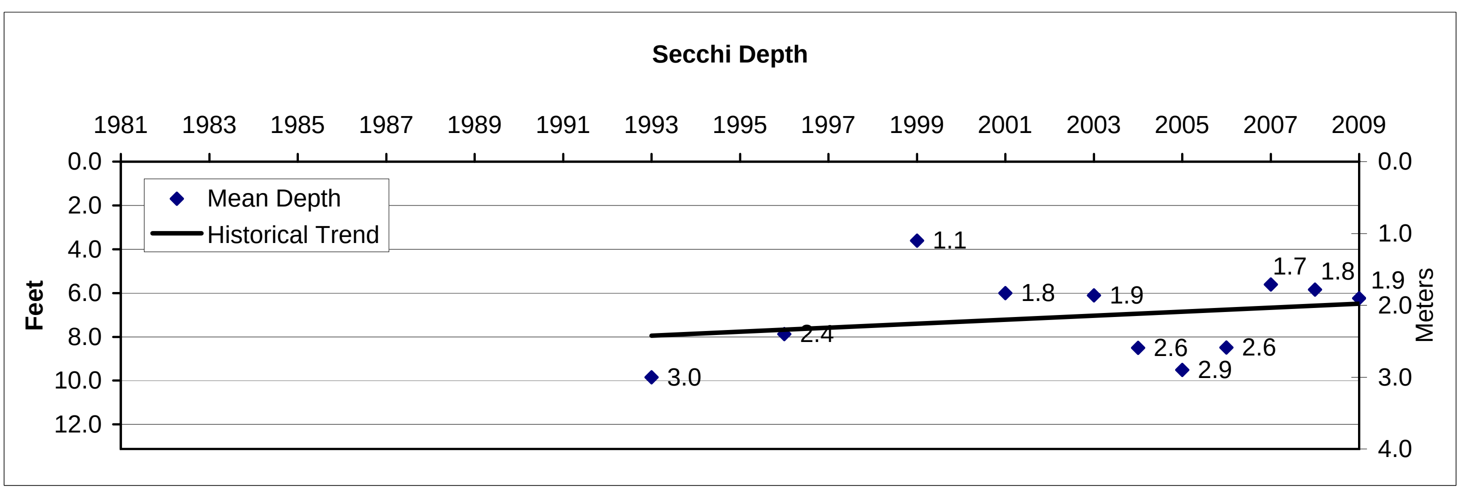


Clearwater River Watershed District	Wenck	Jan 2009
Henshaw Lake Historical Data	Wenck Associates, Inc. Environmental Engineers 1800 Pioneer Creek Center Maple Plain, MN 55359	Appendix A-1

T:\0002\130\Cedar Chain_WQ_ 2009Henshaw Lake

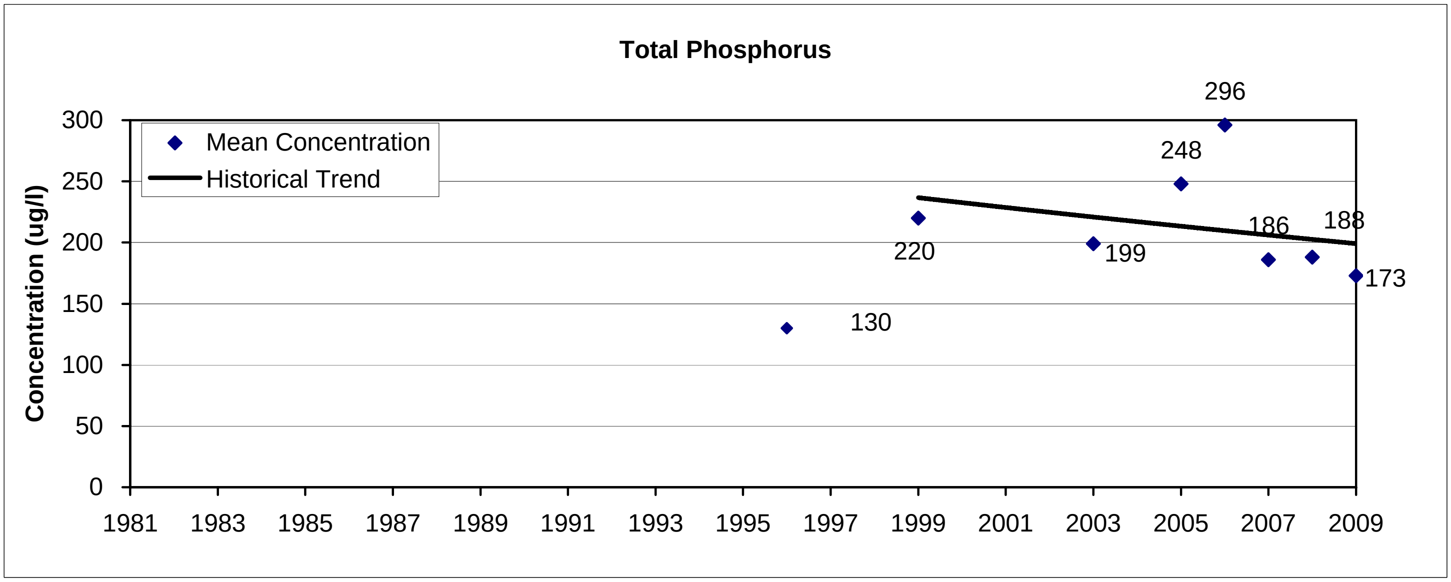


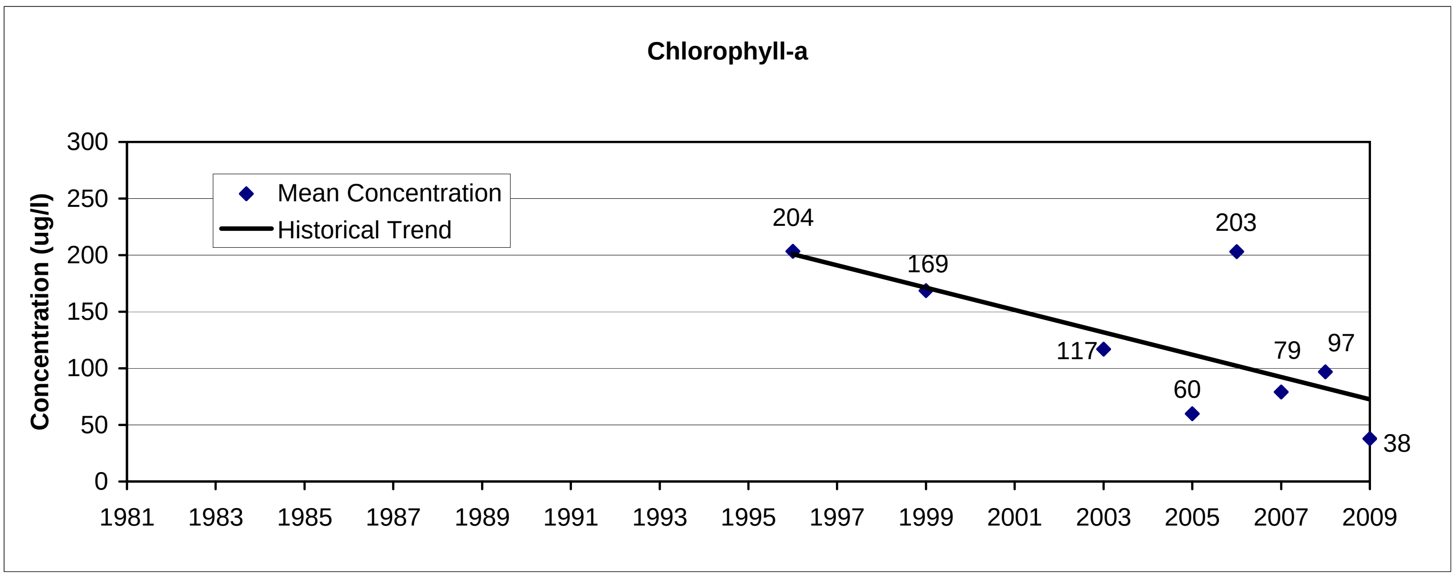


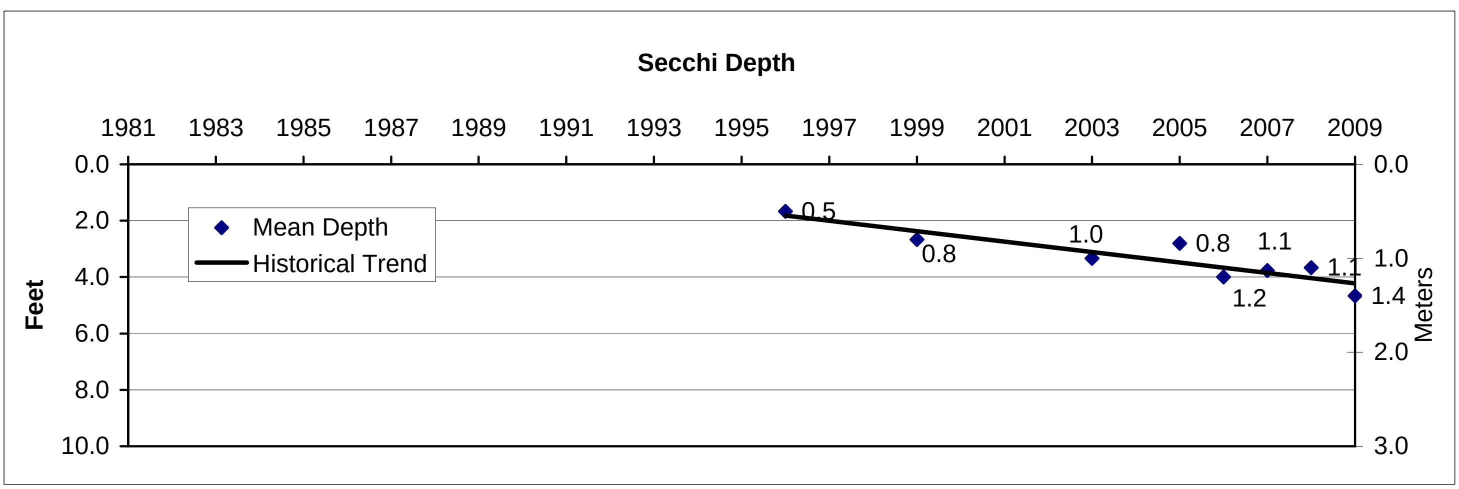


Clearwater River Watershed District	Wenck	Jan 2009
Cedar Lake Historical Data	Wenck Associates, Inc. Environmental Engineers 1800 Pioneer Creek Center Maple Plain, MN 55359	Appendix A-2

T:\0002\130\Cedar Chain_WQ_ 2009Cedar Lake







Clearwater River Watershed District	Wenck	Jan 2009
Lake Albion Historical Data	Wenck Associates, Inc. 1800 Pioneer Creek Center Environmental Engineers Maple Plain, MN 55359	Appendix A-3

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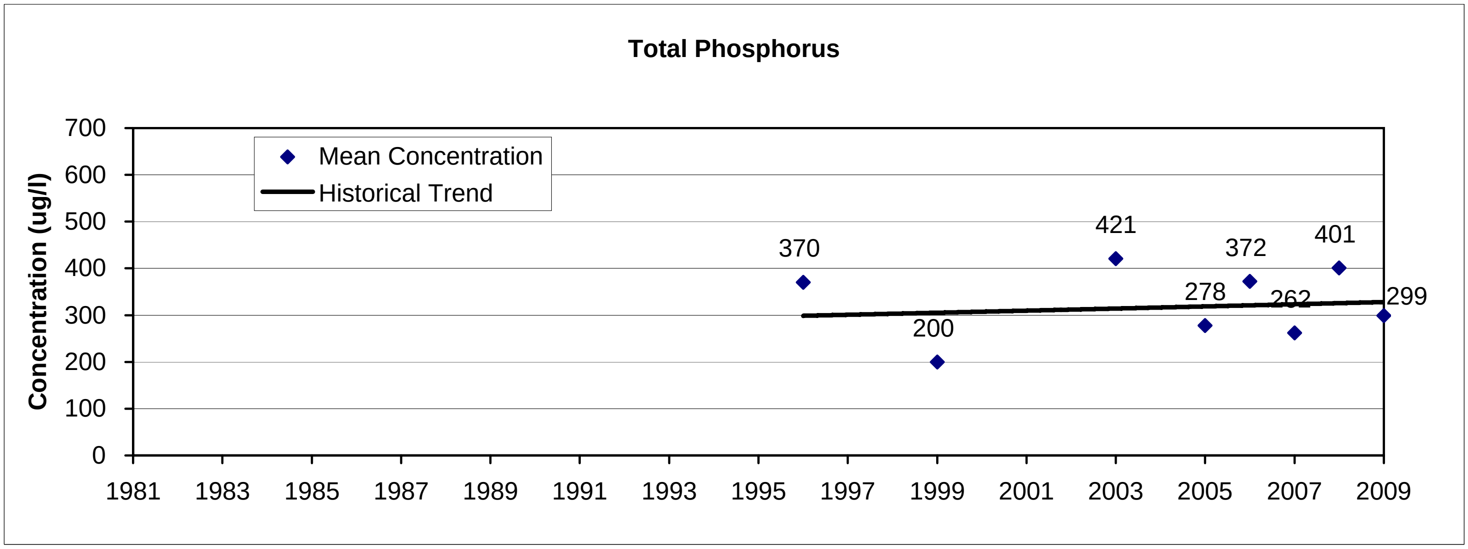

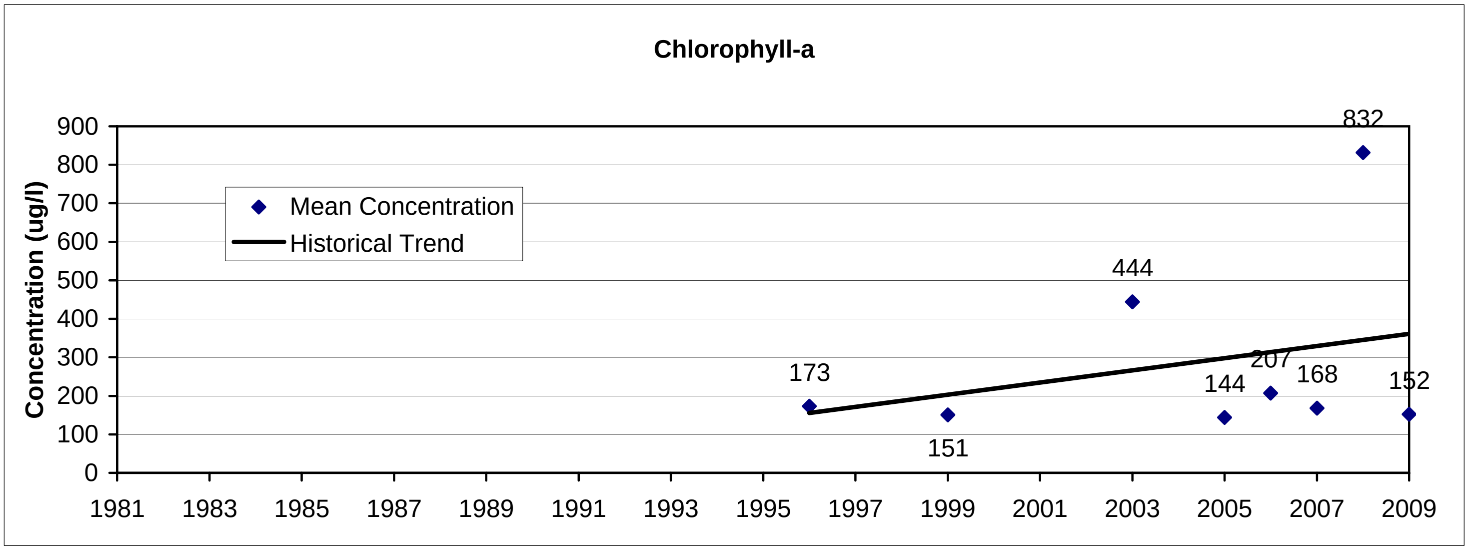

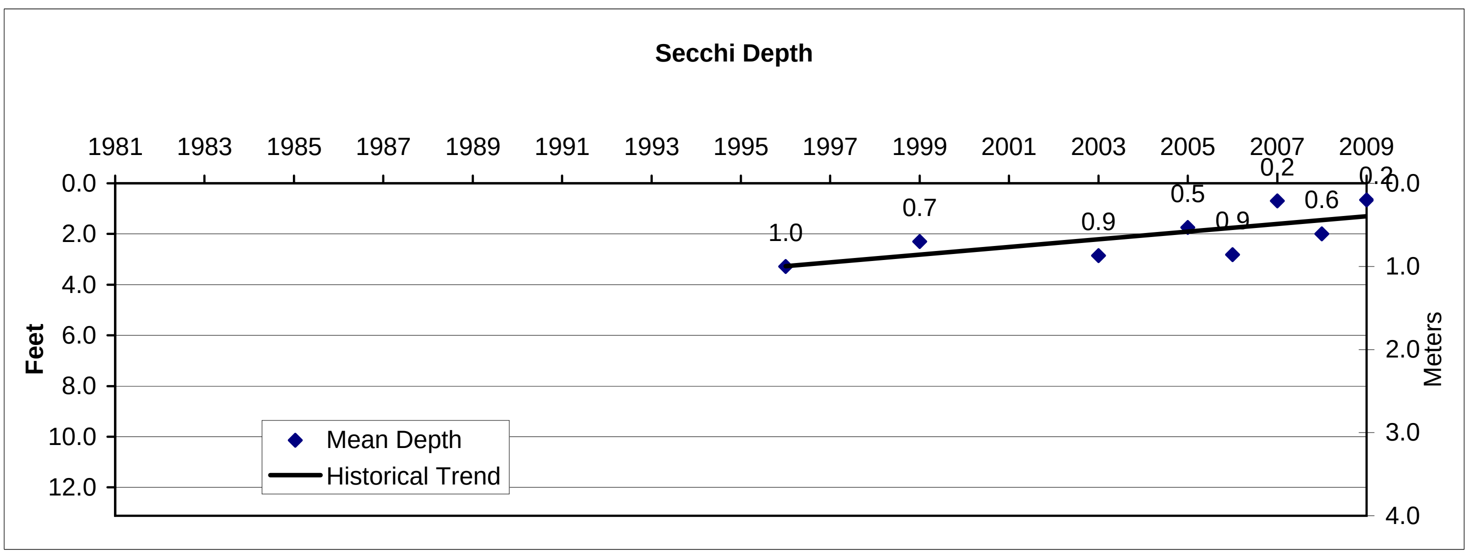

Clearwater River Watershed District

Swartout Lake Historical Data

Wenck Associates, Inc. Environmental Engineers
1800 Pioneer Creek Center Maple Plain, MN 55359

Jan 2009

Appendix A-4

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Appendix B

Cedar Lake Monitoring Data

Appendix B: Cedar Lake 2007-2009 Water Quality Data

	Date	Total Phosphorus (ug/L)	Chlorophyll-a (ug/L)	Secchi Depth (m)
CRWD Sampling Results	5/25/2007	18		3.5
	6/29/2007	45	11	0.9
	7/27/2007	20	9	0.9
	8/24/2007	31	14	1.5
	2007 Summer (June-Sept) Average	32	11	1.1
Volunteer Lake Sampling Results	5/19/2007	26	6	5.2
	6/3/2007	37	21	2.1
	6/17/2007	28	16	1.4
	7/1/2007	34	9	1.1
	7/15/2007	20	4	1.7
	8/19/2007	20	14	1.4
	9/4/2007	19	8	1.4
	9/16/2007	21	8	2.0
	2007 Summer (June-Sept) Average	26	11	1.6
CRWD Sampling Results	5/8/2008	38	17	3.1
	7/7/2008	18	9.2	1.8
	8/6/2008	20		1.8
	9/30/2008			1.7
	10/21/2008	70	17	1.7
	2008 Summer (June-Sept) Average	19	9	1.8
Volunteer Lake Sampling Results	5/18/2008	37	4	4.7
	6/16/2008	24	3	5.5
	7/20/2008	39	14	2.0
	8/17/2008	24	8	1.4
	9/14/2008	20	9	2.4
	2008 Summer (June-Sept) Average	27	9	2.8
CRWD Sampling Results	6/11/2009	26	13.8	3.5
	7/13/2009	42	16.3	1.1
	8/6/2009	32	9.2	1.4
	9/14/2009	26	7.4	1.8
	2009 Summer (June-Sept) Average	32	12	1.9
Volunteer Lake Sampling Results	5/17/2009	44	1	9.4
	6/14/2009	34	23	2.1
	7/19/2009	42	22	1.4
	8/23/2009	27	9	1.5
	9/20/2009	36	5	1.7
	2009 Summer (June-Sept) Average	35	15	1.7

Appendix D

Excerpts from
Five Lakes TMDL Report
Dated May 2009 (Revised September 2009)

Clearwater River Watershed District

Five Lakes Nutrient TMDL
for:
Lake Caroline
Lake Augusta
Albion Lake
Henshaw Lake
Swartout Lake

DRAFT

Wenck File #. 0002-127

Prepared by:

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May 2009
(Revised September 2009)

Wenck

maximum depth of eight feet (Table 3.1). The littoral zone covers the entire 270-acres of the basin due to the maximum depth being less than 15 feet. As a result of Henshaw Lake having a littoral area greater than 80 percent of the basin, the lake meets the MPCA definition of a shallow lake. There are no defined inflow or outlet tributaries for Henshaw Lake. A wetland complex at the northwest corner of the basin serves as the lake outlet as it flows north toward Swartout Lake.

3.1.5 Swartout Lake

Swartout Lake is not located along the main stem of the Clearwater River, but instead is part of a chain of three lakes that is tributary to Cedar Lake in the southeast-most corner of the Clearwater River watershed. Swartout Lake is located downstream of Albion and Henshaw Lakes and upstream of Cedar Lake. The Swartout Lake watershed covers 4,768 acres including approximately 2,771 acres of direct sub-watershed and the upstream watersheds of Albion and Henshaw Lakes. The Swartout Lake watershed is located within Albion Township in Wright County, Minnesota. There are no municipalities located within the Swartout Lake watershed. Swartout Lake is a 296-acre basin with an average depth of seven feet and a maximum depth of 12 feet (Table 3.1). The littoral zone covers the entire 296-acres of the basin due to the maximum depth being less than 15 feet. As a result of Swartout Lake having a littoral area greater than 80 percent of the basin, the lake meets the MPCA definition of a shallow lake. There are two unnamed tributaries that flow into Swartout Lake. One tributary flows from Albion Lake and enters the southwest corner of the basin and the second flows from a wetland complex that is part of the Swartout State Wildlife Management area and enters at the southeast corner of the basin. The outlet of Swartout Lake is a perennial stream that exits the northeast corner of the lake and flows north to Cedar Lake.

Table 3.1 Morphometric characteristics for the five lakes in the Clearwater River Chain of Lakes

Parameter	Lake Caroline	Lake Augusta	Albion Lake	Henshaw Lake	Swartout Lake
Surface Area (ac)	125	169	251	271	296
Average Depth (ft)	15	25	6	4	7
Maximum Depth (ft)	44.5	82	9	8	12
Volume (ac-ft)	1,923	4,269	1,508	1,904	2,105
Average Residence Time (days)	0.07	0.15	4.80	4.65	1.26
Littoral Area (ac)	59	55	251	270	293
Watershed (ac)	61,975	64,779	1,094	903	4,768

3.2 LAND USE

The Clearwater River watershed is composed mainly of agricultural land uses. The National Agriculture Statistics Services (NASS) 2007 cropland data layer was used to determine land use within the sub-watersheds of the five lakes in this TMDL study. This data is an appropriate data set for large agricultural watersheds as the use categories within the data set are more specific in

Figure 5.2 Average In-lake TP Concentrations for Deep Impaired Lakes

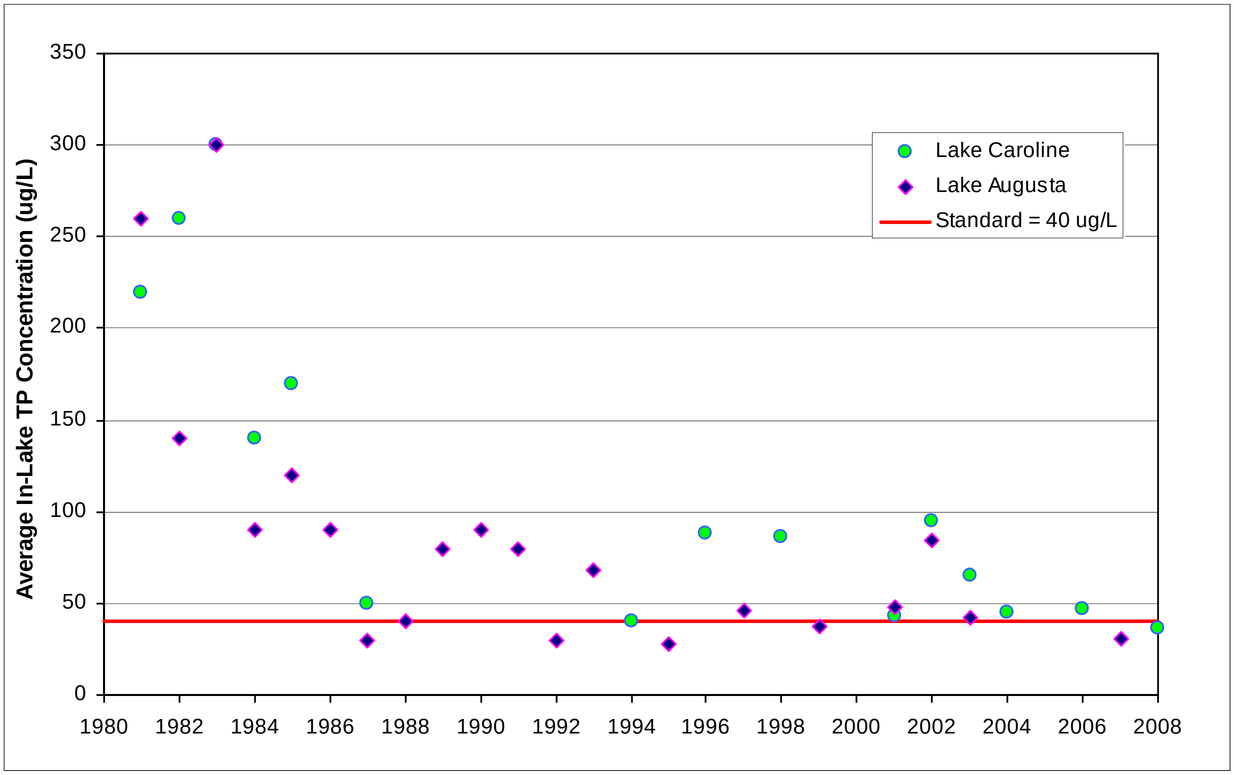

Table 5.1 Recent Typical Annual Average TP Concentrations Compared to Numeric Standard

Lake	TP (µg/L)		Chlorophyll-a (µg/L)		Secchi Depth (ft)	
	Standard	Recent	Standard	Recent	Standard	Recent
Lake Caroline	40	36 – 95	14	12 - 55	4.6	4.2 - 7.2
Lake Augusta	40	31 - 84	14	6 – 29	4.6	5.7 - 7.2
Albion Lake	60	130 - 296	20	60 - 204	3.3	1.6 - 5.2
Henshaw Lake	60	150 - 390	20	53 - 278	3.3	0.7 - 2.9
Swartout Lake	60	200 - 421	20	144 - 832	3.3	0.7 - 3.3

5.1 LAKE CAROLINE

District monitoring for Lake Caroline began in 1981 with the Clearwater Chain of Lakes Restoration Project. Summer average total phosphorus concentrations in Lake Caroline ranged from 36 in 2008 to 300 µg/L in 1983. With the exception of 2008, average in-lake concentrations exceed the state standard of 40 µg/L during all monitoring years. Since 1998, recent typical in-lake average summer surface TP concentrations have averaged about 60 µg/L. Summer average chlorophyll-a concentrations ranged from 3 µg/L in 1983 to 55 µg/L in 1998. Since 1998, typical recent chlorophyll-a concentrations have averaged about 32 µg/L. Observed Secchi-depth readings have ranged from just over 2.5 feet in 1994 to greater than 6 feet in 2006. Since 1998 the recent average Secchi depth is approximately 5 feet. In-lake water quality in Lake Caroline has improved significantly relative to monitoring conducted in the early 1980s.

5.2 LAKE AUGUSTA

District water quality monitoring in Lake Augusta began in 1981. Summer average total phosphorus concentrations in Lake Augusta have exhibited a wide range of variation, ranging from 28 µg/L in 1995 to 300 µg/L in 1983. Average in-lake concentrations exceed the state standard of 40 µg/L during 14 of 20 monitoring years. Since 1997, recent typical in-lake average summer surface TP concentrations have averaged about 50 µg/L.

Observed in lake chlorophyll-a concentrations have varied widely in Lake Augusta with some years below the State standard of 14 µg/L and other years greatly exceeding the standard. Summer average chlorophyll-a concentrations ranged from 4 µg/L in 1983 to 73 µg/L in 1990. Since 1997, typical recent chlorophyll-a concentrations have averaged about 16 µg/L. Secchi depth has varied from 3.5 feet in 1991 to a high of 6.2 feet in 2002. Since 1997, recent typical Secchi depth values have averaged about 5.5 feet. In-lake water quality in Lake Augusta has improved significantly relative to monitoring conducted in the early 1980s; however, the lake remains impaired.

5.3 ALBION LAKE

District monitoring in Albion Lake began in 1996. Summer average total phosphorus concentrations in Albion Lake have ranged from 130 to 296 µg/L during that time. Average in-lake concentrations have exceeded the State standard for shallow lakes of 60 µg/L during all monitoring years. Recent typical in-lake P concentrations have average about 230 µg/L. Albion Lake is located in the southeast-most corner of the Clearwater River watershed. It has no contributing upstream lakes and a relatively small contributing watershed. The outlet to Albion Lake is a tributary stream that flows north into Swartout Lake.

Chlorophyll-a values observed in Albion Lake have ranged from 60 µg/L in 2005 to 203 µg/L in 2006, with recent values averaging approximately 120 µg/L. The Secchi depth readings have ranged from 1.6 to 5.2 feet, averaging 3.6 feet. Secchi values have been equal to or better than the State standard during each of the past three monitoring years.

5.4 HENSHAW LAKE

District monitoring for Henshaw Lake began in 1995. Summer average total phosphorus concentrations in Henshaw Lake ranged from 150 µg/L in 1998 to 390 µg/L in 2007. Average in-lake concentrations have exceeded the state standard for shallow lakes of 60 µg/L during all monitoring years. Recent typical in-lake P concentrations have averaged about 270 µg/L.

Henshaw Lake is located in the southeastern corner of the Clearwater River watershed. It has a very small drainage area with a 2.3:1 ratio and no upstream lakes. An outlet structure for Henshaw Lake installed at an unknown time artificially maintains lake elevations compared to native conditions. The native condition of Henshaw Lake was likely waterfowl habitat instead of its current state as fish habitat. The combination of artificially maintained hydrology in Henshaw Lake and the introduction of carp likely led to the current level of degradation in vegetative habitat and the resulting water quality.

Chlorophyll-a concentrations in Henshaw Lake have varied from a low of 53 µg/L in 1998 to a high of 278 µg/L in 2007. Recent chlorophyll-a concentrations have averaged approximately 150 µg/L. Water clarity is very poor in Henshaw Lake. The Secchi depth readings have ranged from 0.7 to 2.95 feet due primarily to high non-algal turbidity, though algal turbidity is also an issue. Non-algal turbidity is driven by wind suspension and the lack of aquatic macrophytes. The water clarity values have been less than the State standard for shallow lakes (>3.2 ft) during all monitoring years. Recent Secchi values have averaged slightly less than 2 feet.

The CRWD has worked unsuccessfully with Ducks Unlimited and land owners to implement a shallow lakes management plan that includes drawdown of the lake and rough fish management. The lake shore residents have been unreceptive to such plans citing an unwillingness to manipulate lake levels or to treat the lake with pesticide to eradicate rough fish.

5.5 SWARTOUT LAKE

District monitoring for Swartout Lake began in 1996. Water quality is very poor in Swartout Lake with observed total phosphorus and chlorophyll-a concentrations exceeding State standards during all monitoring years. Summer average total phosphorus concentrations in Swartout Lake ranged from 200 µg/L in 1999 to 421 µg/L in 2003. Recent typical in-lake P concentrations have averaged about 300 µg/L.

Observed chlorophyll-a concentrations have ranged from 144 µg/L in 2005 to 444 µg/L in 2003. Recent typical chlorophyll-a concentrations have averaged about 220 µg/L. Water clarity is very low in Swartout Lake, with Secchi depth values ranging from 0.7 to 3.2 feet. Recent Secchi values have averaged approximately 2 feet.

Rough fish migration control and removal is an important element of past and current lake management. The District has worked in recent years with the Swartout Lake residents in an attempt to control populations and movements of rough fish, specifically carp, in Swartout Lake. Fish barriers to prevent carp from migrating into wetlands adjacent to Swartout Lake have been installed. Additionally, commercial fishermen were hired during the winter of 2007/2008 and again during the winter to 2008/2009 to net and remove rough fish from Swartout Lake. Table 5.2 shows the pounds of fish removed during recent commercial fishing efforts.

Table 5.2 Rough Fish Removal from Swartout Lake

Year	Rough Fish Removed (lbs)
February 2008	57,000
December 2008	5,000

Lake Augusta:

- Water quality in Lake Augusta is dominated by loads from the Clearwater River and Lake Caroline. The short residence time of this lake means that water quality in the lake during the early spring and summer months is essentially the same as in the river.
- Based on the model results, it appears that water quality goals can be met through a combination of watershed and internal load reductions and management.

Albion Lake:

- Lake Albion is much closer to a clear state shallow lake than are either Swartout or Henshaw. Management strategies for this lake should be taken very carefully given the lake's current state of ecological integrity.
- Albion Lake has a small tributary watershed. As a result, while a reduction of watershed loads will be important, reducing watershed loads alone will not be sufficient to achieve water quality targets for the lake.
- Internal loads in Albion Lake are the major nutrient source to the lake. A significant reduction in this internal nutrient source will be required to meet water quality targets; however, care must be taken to maintain high ecological integrity.

Henshaw Lake:

- Henshaw Lake has a small tributary watershed. As a result, while a reduction of watershed loads will be important, reducing watershed loads alone will not be sufficient to achieve water quality targets for the lake.
- The tributary watershed alone is unlikely to have caused the impairment of the lake itself. Artificial maintenance of lake level through installation of an outlet, coupled with the introduction of rough fish, has likely resulted in the turbid water conditions observed on Henshaw Lake. As phosphorus loading alone did not impair the lake, hydrologic and ecological restorations will also be required to return the lake to a more clear state. To date, however, residents have been unwilling to implement recommended strategies outside of watershed load reduction.
- Internal loads in Henshaw Lake are the major nutrient source to the lake. A significant reduction in this internal nutrient source will be required to meet water quality targets

Swartout Lake:

- Internal loads in Swartout Lake are the major nutrient source to the lake. A significant reduction in this internal nutrient source will be required to meet water quality targets
- Swartout Lake receives significant nutrient loads from both the lake direct subwatershed and the upstream lakes, Albion and Henshaw.
- Management of both internal and external loads to Swartout Lake will be critical in achieving water quality goals.

Table 7.1 WWTPs in the Clearwater River Watershed District Tributary to Listed Waters Addressed in this Report.

Permit Holder/ System	Waste Water Treatment Method
City of Fairhaven	SSTS (Potential future)
City of Kimball	Land Application (SDS Permit)
City of Watkins	Land Application (SDS Permit)
City of South Haven	Land Application (SDS Permit)
CRWD- Regional	Master System (Potential)
CRWD- Rest-a-While Shores	Cluster System
CRWD- Wandering Ponds	Cluster System
CRWD- Lake Louisa Hills	Pending Cluster System

The load allocation must be divided among existing sources, save those that are not permitted under state law. Discharge from septic systems, for example, is not allowed by law and therefore the load allocation for septic systems is zero. Relative proportions allocated to each source are based on reductions that can reasonably be achieved through best management practices as discussed in the implementation section of the report.

7.1.2 Critical Conditions

The critical period for lakes is the summer growing season. Minnesota lakes typically demonstrate the impacts of excessive nutrients during the summer recreation season (June 1 to September 30) including excessive algal blooms and fish kills. Lake goals have focused on summer-mean total phosphorus, Secchi transparency and chlorophyll-a concentrations. These parameters have been linked to user perception of water quality (Heiskary and Wilson 2005). Consequently, the lake response models have focused on the summer growing season as the critical condition.

7.1.3 Allocations

The loading capacity is the total maximum daily load. The daily load and wasteload allocations for the average conditions for each lake are shown in Table 7.2

Table 7.2 Total Phosphorus TMDL Allocations Expressed as Daily Loads

Lake	Total Phosphorus TMDL (lbs/day)	Waste Load Allocation (lbs/day)	Load Allocation (lbs/day)	Margin of Safety
Lake Caroline	10.14	0.10	10.04	Implicit
Lake Augusta	11.36	0.11	11.25	Implicit
Albion Lake	0.98	0.01	0.97	Implicit
Henshaw Lake	0.73	0.01	0.72	Implicit
Swartout Lake	2.22	0.02	2.20	Implicit

T:\0002\127\models and data\Goal LRM (Marie-Caroline-Augusta).xls – TMDL Tables

Load allocations by source for each lake are provided in Table 7.3. No reduction in atmospheric loading is targeted because this source is impossible to control on a local basis. The remaining load reductions were applied based on our understanding of the lakes and efficacy of proposed implementation strategies, as well as the model fit.

Table 7.3 Total Phosphorus Partitioned Load Allocation Expressed as Daily Load

Lake	Load Allocation (lbs/day)	Direct Watershed	Upstream Lakes	Septic Systems	Atmospheric + Groundwater	Internal
Lake Caroline	10.04	0.59	6.41	0.00	2.23	0.82
Lake Augusta	11.25	0.76	6.65	0.00	1.93	1.91
Albion Lake	0.97	0.34	0.00	0.00	0.16	0.47
Henshaw Lake	0.72	0.08	0.00	0.00	0.18	0.46
Swartout Lake	2.20	0.82	0.33	0.00	0.19	0.86

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Annual total maximum loads are provided in Tables 7.4 and 7.5. The values in Tables 7.2 and 7.3 are calculated from annual loads dividing by 365.25 days per year (to account for leap year). The loading capacity provided in Tables 7.4 and 7.5 are based on average model predicted results for the years in which lake water quality data was available during the recent seven-year period, which represents both wet and dry conditions.

Table 7.4 Total Phosphorus TMDL Allocations Expressed as Annual Loads

Lake	Total Phosphorus TMDL (lbs/yr)	Waste Load Allocation (lbs/yr)	Load Allocation (lbs/yr)	Margin of Safety
Lake Caroline	3,705	37.05	3,668	Implicit
Lake Augusta	4,150	41.5	4,109	Implicit
Albion Lake	359	3.59	355	Implicit
Henshaw Lake	265	2.65	262	Implicit
Swartout Lake	812	8.12	804	Implicit

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Table 7.5 Total Phosphorus Partitioned Load Allocation Expressed as Annual Load

Lake	Load Allocation (lbs/yr)	Direct Watershed	Upstream Lakes	Septic Systems	Atmospheric + Groundwater	Internal
Lake Caroline	3,668	214	2,342	0	814	298
Lake Augusta	4,109	279	2,429	0	704	697
Albion Lake	355	125	0	0	59	171
Henshaw Lake	262	30.1	0	0	64.8	167.5
Swartout Lake	804	300	120	0	70.5	314

T:\0002\127\models and data\Goal LRM (Marie-Caroline-Augusta).xls – TMDL Tables

9.0 Implementation

9.1 IMPLEMENTATION FRAMEWORK

Implementing TMDLs within the CRWD will be a collaborative effort between state and local government, and individuals led by the CRWD. To meet water quality standards, CRWD will leverage existing regulatory framework, and relationships to generate support for TMDL implementation efforts. CRWD will provide technical support, funding, coordination and facilitation to other cooperating LGUs when needed. For example, the CRWD has funded stormwater studies for the cities of Kimball, Annandale and Watkins though which several opportunities to retrofit BMPs to existing development were identified as well as opportunities for BMPs for future development. Efficiency and cost savings are realized by using existing governmental programs and services for TMDL implementation to the maximum extent possible.

Second, the CRWD is committed to identifying new technologies and new methods for reducing nutrient loads to lakes. For example, the CRWD achieved their in lake water quality goal in Clearwater Lake by identifying watershed sources and designing cutting edge projects that reduced watershed P through the Chain of Lakes Restoration in the 1980s.

9.1.1 Clearwater River Watershed District

The mission of the Clearwater River Watershed District is to promote, preserve and protect water resources within the boundaries of the District in order to maintain property values and quality of life as authorized by MS103D. To this end, the District's Comprehensive Plan approved July 23, 2003, documents the District's goals, existing policies and proposed actions. One of the District's stated goals is to bring all of CRWD surface water into compliance with state water quality standards through the TMDL process.

Because the primary goal and mission of the CRWD is in line with the goal of TMDL implementation, many of the implementation strategies are extensions of existing CRWD programs and projects and can be funded using existing CRWD budgets. However, additional implementation funding will be necessary. The recommended implementation plan to meet lake water quality goals and associated cost is described in the following section.

9.1.2 Counties, Cities, Townships, Lake Associations

Partnerships with counties, cities, townships and lake associations are one mechanism through which the CRWD protects and improves water quality. The CRWD will continue its strong tradition of partnering with state and local government to protect and improve water resources and to bring waters within the CRWD into compliance with State standards.

9.1.3 Board of Water and Soil Resources

The CRWD recognizes that public funding to set and implement TMDLs is limited, and therefore understands that leveraging matching funds as well as utilizing existing programs will be the most cost efficient and effective way to implement TMDLs within the CRWD. The CRWD does project a potential need for about 50% cost-share support from the Board of Water and Soil Resources, MPCA or other sources in the implementation phase of the TMDL process.

9.2 REDUCTION STRATEGIES

9.2.1 Annual Load Reductions

The focus in implementation will be on reducing the annual phosphorus loads to the lakes through structural and non-structural Best Management Practices. The TMDL established for each lake is shown in Section 7 of this report (Table 7.2 and allocated among sources in Table 7.3). Table 9.1 shows load reductions by source for each lake.

Table 9.1 Load Reductions by Source

Lake	Total	Direct Watershed	Upstream Lakes	Septic Systems	Atmospheric + Groundwater	Internal
Lake Caroline	35%	31%	43%	100%	0%	26%
Lake Augusta	27%	31%	33%	100%	0%	21%
Albion Lake	91%	63%	NA	100%	0%	95%
Henshaw Lake	93%	88%	NA	100%	0%	95%
Swartout Lake	90%	70%	77%	100%	0%	95%

No reductions in atmospheric or groundwater loading are targeted because these sources are not readily controllable. The remaining load reductions were applied based on our understanding of the lakes and surrounding watersheds as well as output from the model.

9.2.2 Actions

A conceptual implementation plan for reducing phosphorus loads to the six impaired lakes is presented below (Table 9.2). Strategies are recommended based on their relative cost and effectiveness given the current level of understanding of the sources and in-lake processes. Recommendations take into account findings from stakeholder participation. Cost share breakdown is expected to be 50% from the state and federal funds, 25% from the individual, and 25% from watershed budgets.

The implementation plan pulls from existing CRWD studies and project proposals to reduce watershed phosphorus loads.

Table 9.2 Conceptual Implementation Plan and Costs

Practice	TMDL	Unit Cost	Units	Note	Qty	Cost
Promote Ag BMPs (P Testing and fertilizer application)	Nutrient, DO	$75,000	ls		1	$75,000
Replace Tile Intakes w/ Filters	Nutrient, DO, Bacteria	$500	per intake	*evaluate limestone/steel wool filter intakes to increase P removal	400	$200,000
Tile Intake Buffers	Nutrient, DO, Bacteria	$100	per intake		300	$30,000
Buffer Tributaries	Nutrient, DO, Bacteria	$350	ac		300	$105,000
Buffer Stream Banks	Nutrient, DO, Bacteria	$350	ac		200	$70,000
DO Augmentation for Clearwater River	DO		lf	*design and construct, operation		$500,000
Tile Discharge Management	Nutrient, DO, Bacteria	$130,000	ls	* Inventory, FS, design construct	1	$130,000
Riparian Pasture/ Grazing Management Grants	Nutrient, DO, Bacteria	$10,000	ea		10	$100,000
Street Sweeping: Kimball, Southaven, Fairhaven & Watkins	Nutrient, DO, Bacteria	$40	per curb mile	* high efficiency, 55 curb miles for 15 years		1,125,000
Lakeshore Septic Upgrade Grants	Nutrient	$7,500	ea	All Impaired Lakes	130	$975,000
Lake shore restoration grants (Shore land Erosion)	Nutrient	$300	ea	*grants	300	$90,000
Shallow Lakes Management Plans for Marie, Clear, Swartout, Albion & Henshaw Lakes	Nutrient	$15,000	ea		5	$75,000
Carp Control	Nutrient	$25,000	average per year per lake	*Fish trap already installed at Louisa, harvesting under way in several impaired lakes (5 lakes, 6 yrs)	30	$750,000
Curly Leaf Pondweed Control	Nutrient			*Lake association cost, some cost share		$100,000
Lake Aeration	Nutrient			2 Existing aerators re-installed		$600,000
Alum dosing of Cleawater River upstream of Kingston	Nutrient, DO					$600,000
Hypolimnetic withdrawl (Betsy)	Nutrient					$350,000
Kingston Wetland Maintenance / Enhancement	Nutrient, DO					$250,000
South Haven Stormwater Enhancement	Nutrient, DO, Bacteria					$75,000
City of Kimball Stormwater Enhancement Per 2004 Kimball Area Stormwater Management Study	Nutrient, DO, Bacteria					$500,000
City of Watkins Stormwater Enhancement per 2006 Watkins Area Stormwater Management Study	Nutrient, DO, Bacteria					$800,000
Public Outreach	Nutrient, DO, Bacteria	$10,000	per year		10	$100,000
Implementation Project Management and Administration	Nutrient, DO, Bacteria	$30,000	per year		10	$300,000
Implementation Performance Monitoring, Recommendations for Adaptive Management	Nutrient, DO, Bacteria	$25,000	per year		10	$250,000
Implementation Engineering	Nutrient, DO, Bacteria	$15,000	per year		10	$150,000
T:\0002\127\[TMDL Implementation_FINAL.xls]August 08					**TOTAL:**	**$8,300,000**

Appendix E

Excerpts from
Technical Specifications for
Alterations to Cedar, Albion, Henshaw, Swartout
Improvement Project #06-1
Dated November 2009

Technical Specifications

Alterations to Cedar, Albion, Henshaw, Swartout Improvement Project #06-1

Wenck File #0002-130

Prepared for:

CLEARWATER RIVER WATERSHED DISTRICT
PO Box 481
Annandale, MN 55302

Prepared by:

WENCK ASSOCIATES, INC.
1800 Pioneer Creek Center
P.O. Box 249
Maple Plain, Minnesota 55359-0249
(763) 479-4200

November 2009

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineering under the laws of the State of Minnesota.

Norman C. Wenck   Registration No. 8946

Table of Contents

1.0 Purpose

On November 11, 2009, the Board of Managers of the Clearwater River Watershed District (CRWD) at their regular meeting received and reviewed a Technical Memorandum from Wenck Associates, Inc., The District Engineer, evaluating Project #06-1, the Cedar, Albion, Swartout, Henshaw Improvement Project (Appendix A). The Board of Managers also reviewed procedures outlined by CRWD's attorney, Mr. Stanley J. Weinberger, Jr., in a memorandum dated November 9 2009 (Appendix B). At the meeting, the Board ordered the District Engineer to prepare Technical Specifications for the alterations to the project. This document is intended to fulfill the requirements of Minnesota Statutes Section 103D.635, Subdivision 1, for an alterations to a project.

2.0 Introduction

Project #06-1 was ordered and implemented to improve the water quality for the four lakes of Cedar, Albion, Swartout and Henshaw. The Engineer's Report dated August 2006 considered 16 activities to reduce the phosphorus loading to the lakes (see Appendix C). Ultimately, six of the alternatives were chosen to be implemented, plus three years of evaluation to determine if more activities were required to meet the project goals. The November 11, 2009, Technical Memorandum indicates that further activities are required to fully meet project goals.

TMDL studies for Albion, Swartout and Henshaw Lakes were completed as part of the Five Lakes TMDL project started in 2008 and submitted to the EPA in a report dated November 2009, Wenck Associates, Inc. (2009).

Excerpts from the TMDL report dated November 2009 (Appendix D) describes the condition of Albion Lake, Henshaw Lake and Swartout Lake, presents the existing loadings to the lakes, presents the load allocation for each lake to reach it's in-lake water quality goal and presents a conceptual implementation plan to reach the water quality goals for these lakes. Fourteen of these activities apply to these lakes and need to be considered for implementation.

3.0 Technical Specifications

In order to fully meet the goals of Project #06-1, further activities are required as listed in Appendix A, C and D. The following activities and others to be identified through further evaluation may be required:

- Eliminate ISTS discharges;
- Aggressive curly leaf pondweed control;
- Removal of cormorants on Swartout Lake;
- Carp population reduction;
- Fish migration barriers between Albion and Swartout, and Henshaw and Swartout Lakes;
- Install fish barriers between Highway 55 and Cedar Lake, and Swartout Lake outlet at CR 6 to prevent upstream migration;
- Treat Swartout wetland outlet to remove phosphorus;
- Increase residence time on wetland between Swartout and Highway 55;
- Watershed best management practices;
- Buffer tile lines, ditches and streams;
- Lake shore management in Cedar, Swartout, Albion and Henshaw Lakes
- Ecological management of Henshaw, Albion and Swartout Lakes;
- Isolate Swartout Lake;
- Isolate wetland treatment system in the Highway 55 wetland;
- Install sedimentation basins;
- Promote Ag BMPS (P Testing and fertilizer application);
- Replace tile intakes with filters;
- Tile intake buffers;
- Buffer tributaries;
- Buffer stream banks

- Tile discharge management;
- Riparian pasture/grazing management;
- Lakeshore septic upgrade;
- Lakeshore restoration (shore land erosion);
- Shallow Lakes Management Plans;
- Public outreach; and
- Other activities as indicated by future project monitoring and evaluation.

4.0 Recommendations

It is recommended that Project #06-1 be altered, as described in Appendix A, C and D, and Section 3.0 Technical Specifications. The alterations will be specifically identified by future project monitoring and evaluation.

5.0 Certification

Additional activities as described in Appendices A, C and D (as summarized in Section 3.0) and others, are required to be implemented to fully achieve the purposes of Project #06-1. The exact nature of additional activities will be determined from the on-going monitoring and evaluation of the project.

Appendix F

Technical Memorandum
Status of Cedar, Albion, Swartout, and Henshaw
Improvement Project #06
Dated July 3, 2012

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TECHNICAL MEMORANDUM (Revised 7-3-12)

TO: Mr. Robert Schiefelbein, Chairperson, Board of Managers
Clearwater River Watershed District

FROM: Norman C. Wenck, P.E. - Wenck Associates, Inc.**,** Engineers for the District

DATE: July 3, 2012

SUBJECT: Status of Cedar, Albion, Swartout, and Henshaw Improvement Project #06

---

1. Background

A. The Engineers Report on the subject project dated August 9, 2006 recommended five activities for the water quality improvement of the four lakes. Ultimately four of the activities were approved for the Project. The Phosphorous Removal System was removed and a continuing monitoring program was substituted.

B. Technical Specifications were prepared in a report dated November 24, 2009 and examined additional alternatives for the project. The report stated that "further activities are required to fully meet the goals of the project". See Attachment 1 for the list of potential additional activities. The Clearwater River Watershed District (CRWD) Board of Managers amended the project to include "Aggressive Curly Leaf Pondweed Control".

C. The Five Lakes Nutrient TMDL Report dated August 2010 includes the establishment of the TMDL for Albion Lake, Henshaw Lake and Swartout Lake. Table 1 shows the phosphorous budget for these lakes.

Table 1 Current Annual Phosphorous Budget (lbs/yr)

Lake	Total	Direct Watershed	Upstream Lakes	Septic Systems	Atmospheric + Groundwater	Internal
Albion Lake	3,865	342	-	14	60.3	3,449
Henshaw Lake	3,723	256	-	16	65.1	3,386
Swartout Lake	7,982	1,011	533	34	71	6,333

Table 2 shows the required load reduction to reach the TMDL. It can be seen that reductions range from 70% to 95%, except that all septic systems must be in compliance. If and when these TMDL's are achieved it is likely that the 1000 pound per year goal to Cedar Lake should be achieved. However, achieving the TMDL's will be difficult and take many years.

Table 2 Load Reductions by Source

Lake	Total	Direct Watershed	Upstream Lakes	Septic Systems	Atmospheric + Groundwater	Internal
Albion Lake	91%	63%	NA	100%	0%	95%
Henshaw Lake	93%	88%	NA	100%	0%	95%
Swartout Lake	90%	70%	77%	100%	0%	95%

D. The 2011 Water Quality Monitoring and TMDL Implementation Status Report dated January 2012 presents the stream flow and total phosphorus data from 2007 – 2011 in the Cedar Lake watershed. See Attachment 2.

Site SSW04 represents most of the upstream watershed of Cedar Lake. The upstream total phosphorous load to Segner Pond and then to Cedar Lake ranged from 512 to 3866 pounds for the year, and averaged about 1500 pounds per year.

Segner Pond is located downstream of Site SSW04 and before Cedar Lake. This treatment unit has an expected phosphorous removal efficiency of 50%, while the estimated total phosphorous load to Cedar Lake in 2011 was over 1900 pounds. This exceeds the 1000 pound per year goal, however, the five year average loading was less than the goal.

For the years since 2007, total phosphorous loads to Cedar Lake were below or nearly at goal for four of the five years. It is clear from this data that the loading is closely related to the run off volume.

2. Recent events:

An intense algae bloom on Cedar Lake of Aphanizomenon flos – aquae occurred on June 1, 2012. The Cedar Lake Conservation Club (CLCC) made a presentation to the CRWD on June 13, 2012 requesting continued conversation for the improvement of Cedar Lake.

3. Recent Monitoring Results

The phosphorous concentrations in Cedar Lake are near 20 ug/L, which is quite low for the lake. The high water may have flushed the lake and we expect to see improved water clarity in the lake over the next few weeks.

Phosphorous concentrations appear on the lower end of the normal ranges in Swartout and Henshaw. The total phosphorous concentrations have remained stable in Henshaw. There is extremely low orthophosphorous and high TSS that is coming out of Henshaw this year. It is suspected that the high TSS and particulate phosphorous may be a result of rough fish stirring up the bottom sediments in the lake.

Phosphorous concentrations on Albion are very low. We assume there is good aquatic vegetation cover in the lake this year.

The flows appear quite high during June across the watershed, but phosphorous concentrations appear to be in the normal ranges at most sites.

Orthophosphorous concentrations appear high at sites downstream of large wetlands. This data, paired with the very low DO concentrations at some of these same sites (CLN, SSWO4) may be an indication of orthophosphorous export from these wetlands.

4. Potential Future Activities:

The CRWD requested an evaluation of the activities presented in Attachment 1. Table 3 presents the scope of various activities, together with a conceptual cost estimate and potential total phosphorous removal rates. Please note the cost per pound has not been determined pending further definition of O & M expenses and project life expectancy.

5. Recommended Actions

a. Continue operating the present project, including rough fish management, expanding the buffer program with producers in the watershed, maintaining Segner Pond, and continuing the monitoring program.
b. Develop Ecological Management Plans for the three upstream lakes, including consideration of alum treatment of the three lakes.
c. Installation of a Wetland Treatment project in the wetland above old Highway 55.
d. Consider a V-notch weir and sand/iron filter at the outlet of the SSWO2 wetland with an enhanced fish barrier.

6. Next Steps:

If the CRWD wishes to proceed to further consider amending the project, a Public Hearing could be called to reconsider activities defined in the Technical Specifications dated November 24, 2009.

Following the Public Hearing, the project could be further amended to include activities deemed to be necessary to meet the project's goals.

Table 3: Summary of Cost Effectiveness of Potential Activities

Activity	Conceptual Scope	Conceptual Cost Estimate	Potential Total Phosphorous Removal
Eliminate ISTS discharges	Assumptions: Cedar - 120 Failing units Albion – 3 Failing Units Swartout – 8 Failing Units Henshaw – 4 Failing Units	$1,100,000	Up to 1,365 lbs/yr
Curly Leaf Pond Weed Control	Project amended to include this in 2009	N/A	N/A
Removal of Comorants on Swartout Lake	Est. Total Phosphorous load to Swartout Lake estimated to be 9.5 lbs/year in 2010 Water Quality Report, therefore not considered to be significant	N/A	N/A
Carp Population Reduction	Already part of project, should be continued	N/A	N/A
Install fish barriers	Already implemented	N/A	N/A
Treat Swartout Lake Wetland Outlet to remove Phosphorous	Ferric Chloride or Alum Treatment of Wetland discharge	Orig. 2006: Cost Updated to $600,000	200 to 2000 lbs/yr depending on runoff
Increase Residence Time	V-notch Weir on Wetland and acquire easements	$200,000	80 to 600 lbs/yr
Watershed Best Management Practices	Apply to Cropland and Developed areas	$270,000	115 lbs/yr
Buffer tile lines	Apply to cropland	$20,000	10 lbs/yr
Buffer ditches, streams	50 foot buffer on both sides	$600,000	120 lbs/yr
Lake Shore Management in CASH lakes	Assume 50% participation	$750,000	75 lbs/yr
Ecological Management of Henshaw, Albion and Swartout Lakes	Develop plan only, no implementation	$75,000	0
Isolate Swartout Lake	Possible diversion to Crow River Watershed – very unlikely to be allowed	$25,000,000	500 to 4000 lbs/yr
Install Wetland Treatment System in Hwy 55 Wetland	Use old Hwy 55 as berm	$350,000	50 – 400 lbs/yr
Install Sedimentation basins	Already implemented		
Promote Ag BMPS	Apply to cropland	$400,000	115 lbs/yr
Replace Tile Intake with Filters	Apply to cropland areas	$200,000	50 lbs/yr
Riparian Pasture/Grazing Management	Apply to grasslands	$200,000	20 lbs/yr
Alum Treatment of Swartout Lake Alum Treatment of Henshaw Lake Alum Treatment of Albion Lake	Removes phosphorous from water column and reduces internal loading	$300,000/lake	Up to 4000 lbs/yr For 4 years
V-Notch Weir with sand/iron filter on SSWO2 Wetland into Swartout Lake	Removes phosphorous from largest input to Swartout Lake	$150,000	800 lbs/yr
Others are repeats or variations of above items			

Attachment 1

From Section 3.0 of Technical Specifications
Alterations to Cedar, Albion, Henshaw, Swartout
Improvement Project #06-1
Dated November 2009
For Clearwater River Watershed District
PO Box 481, Annandale, MN 55302

Wenck File #0002-130

3.0 Technical Specifications

In order to fully meet the goals of Project #06-1, further activities are required as listed in Appendix A, C and D. The following activities and others to be identified through further evaluation may be required:

- Eliminate ISTS discharges;
- Aggressive curly leaf pondweed control;
- Removal of cormorants on Swartout Lake;
- Carp population reduction;
- Fish migration barriers between Albion and Swartout, and Henshaw and Swartout Lakes;
- Install fish barriers between Highway 55 and Cedar Lake, and Swartout Lake outlet at CR 6 to prevent upstream migration;
- Treat Swartout wetland outlet to remove phosphorus;
- Increase residence time on wetland between Swartout and Highway 55;
- Watershed best management practices;
- Buffer tile lines, ditches and streams;
- Lake shore management in Cedar, Swartout, Albion and Henshaw Lakes
- Ecological management of Henshaw, Albion and Swartout Lakes;
- Isolate Swartout Lake;
- Isolate wetland treatment system in the Highway 55 wetland;
- Install sedimentation basins;
- Promote Ag BMPS (P Testing and fertilizer application);
- Replace tile intakes with filters;
- Tile intake buffers;
- Buffer tributaries;
- Buffer stream banks

- Tile discharge management;
- Riparian pasture/grazing management;
- Lakeshore septic upgrade;
- Lakeshore restoration (shore land erosion);
- Shallow Lakes Management Plans;
- Public outreach; and
- Other activities as indicated by future project monitoring and evaluation.

Attachment 2

From Section 4.0 Cedar Lake Project #06-1
of 2011 Water Quality Monitoring and
TMDL Implementation Status Report
Dated January 2012
For Clearwater River Watershed District
PO Box 481, Annandale, MN 55302

Wenck File #0002-164

Table 4.3 Tributary Stream Flow Data 2007-2010

	Runoff (in)				
Site	2007	2008	2009	2010	2011
SCE01	1.6	3.6	2	2.5	12.3
SHE01	1.2	4.5	1.3	5.3	14.2
SSW01	0.7	7	3.5	6.0	14.8
SSW02	0.5	4.7	3.5	3.8	7.4
SSW04	1.2	4	1.5	3.7	10.8

Table 4.4 Tributary Stream Total Phosphorus Data 2007-2011

	Mean TP Concentration (ug/L)					TP Load (lbs)					
Site	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011	TP Load Goal
SCE01	38	28	34	32	33	121	199	136	160	791	
SHE01	283	222	195	153	122	81	247	61	198	424	
SSW01	232	159	276	225	261	98	698	602	839	4164	
SSW02	96	301	345	267	522	292	858	739	624	2358	
SSW04	58	201	265	251	313	870	1011	512	1149	3866	1000

Overall, total phosphorus concentrations were comparable to previous years at most monitoring locations with the exception of SSWO2, the outlet of a major wetland complex. The increase in concentration at this site is likely due to a significantly larger portion of the wetland inundated with spring melt and runoff for longer in the season and a potential release of soluble phosphorus from this wetland.

As a result of the significantly higher runoff at each of the sites throughout the season, total external phosphorus loading to Cedar Lake and the other upper watershed lakes was two to nearly five times higher in 2011 than in 2010.

Appendix G

Excerpts from
2012 Water Quality Monitoring and TMDL
Implementation Status Report
Dated January 2013

to a lack of runoff from snowmelt and below normal precipitation in late summer. Annual runoff at each monitoring site from 2007 to 2012 is shown in Table 4.1 below. The calculated phosphorus loads from 2007 to 2012 are shown in Table 4.2 below. Phosphorus loading rates at each monitoring location are shown on Figure 4.4.

Table 4.1 Tributary Stream Flow Data 2007-2012

	Runoff (in)					
Site	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
SCE01	1.6	3.6	2	2.47	12.26	6.49
SHE01	1.2	4.5	1.3	5.27	14.17	5.85
SSW01	0.7	7	3.5	5.95	14.78	3.68
SSW02	0.5	4.7	3.5	3.83	7.41	6.13
SSW04	1.2	4	1.5	3.66	10.76	5.49

Table 4.2 Tributary Stream Total Phosphorus Data 2007-2012

	TP Load (lbs)						
Site	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**TP Load Goal**
SCE01	121	199	136	160	791	395	
SHE01	81	247	61	198	424	272	
SSW01	98	698	602	839	4164	1121	
SSW02	292	858	739	624	2358	1342	
SSW04	870	1011	512	1149	3866	2543	1000

Runoff was higher downstream of Swartout Lake in 2012 due to vandals removing stoplogs at the Swartout Lake outlet control structure in early June which lead to a large flush of water out of Swartout and down into Cedar Lake. Phosphorus loads were larger than normal as a result of high phosphorus concentrations and the period of high flow in early June.

As demonstrated in Table 4.3, ortho-phosphorus made up a large proportion ofthe total phosphorus at SSW04, SSW02, and SSW01 in 2012. This is an indication that the export of soluble phosphorus from wetlands and lakes in the sub-watersheds upstream of Cedar Lake is a significant contributor to the phosphorus load to Cedar Lake.

Table 4.3 Mean Phosphorus Concentrations and %TP as Ortho-P in Cedar Lake Sub-watershed

Site	Mean TP Concentration (µg/L)	Mean Ortho-P Concentration (µg/L)	%TP as Ortho-P
SHE01	174	8	4%
SCE01	28	5	18%
SSW04	420	227	54%
SSW02	334	190	57%
SSW01	277	162	58%

Appendix H

Excerpts from Appraiser's Report
Dated October 4, 2006

GRANITE CITY APPRAISAL
Ronald C. Zitzow
Certified General Appraiser
Lic. State of MN #4000345

22 Wilson Avenue NE, P.O. Box 6121, St. Cloud, MN 56302
Bus: (320) 251-3648 . Res: (320) 253-0903

October 4, 2006

Clearwater River Watershed Board
C/O Mr. Merle Anderson - Chairman
3147 South 15th Avenue
St. Cloud, MN 56301

Dear Mr. Anderson:

Please find attached the appraisal panels consulting report regarding Cedar, Albion, Swartout, Henshaw Improvement Project #06-01.

Per your request and the request of the Watershed Board, we have completed our consulting report regarding the above project.

The appraisal panel viewed all parcels to be assessed on September 21, 2006. The following is our scope of work completed. All sales were viewed by Granite City Appraisal staff and Ronald C. Zitzow, appraiser.

- 29-Lakeshore properties were analyzed on Sugar, Clearwater, Pleasant, Sylvia, John and Albion/Swartout Lakes.
- 10-Lakeshore properties were analyzed on Cedar Lake.
- 8-Tier 1 sales were analyzed, four with deeded lake access.
- 5-Tier 2 & 3 sales were analyzed.
- 12-Agricultural properties were analyzed 10+ Acres in size(includes one wetland sale #12, $1,925.00/Acre, Stearns County).

The Wright County Assessor, IT, Zoning and Treasure-Auditor Offices were contacted. All sales were confirmed by CRV, buyer, seller or "MLS". All lot and building sizes were confirmed by County Records. Wenck Associates and the Clearwater River Watershed Board were consulted. DNR Lake profile maps were obtained for all lakes in the study. The Marshall Swift Cost Guides and local Contractors were consulted for building and site development costs. The "USDA" Soils and Map Services Data was obtained from the Map Surety Program, Grand Forks, ND. The final conclusions of benefits are the results of the appraisal panel as of October 3, 2006.

The conclusions stated in this report are in a consulting format. This is not a restricted, summary or self-contained appraisal report and is for the sole use of the Clearwater River Watershed Board. The intended use is to determine the assessments for Improvement Project #06-01.

Definition of Market Value:

MARKET VALUE is defined as "the most probable price which a property should bring in a competitive and open market under all conditions requisite to a fair sale, the buyer and seller, each acting prudently and knowledgeably, and assuming the price is not affected by undue stimulus". Implicit in this definition is the consummation of a sale as of a specified date the passing of title from seller to buyer under conditions whereby:

- The buyer and seller are typically motivated.
- Both parties are well informed or well advised, and acting in what they consider their own best interest.
- A reasonable time is allowed for exposure in the open market.
- Payment is made in terms of cash in U.S. dollars or in terms of financial arrangements comparable thereto.
- Financing, if any, is on terms generally available in the community At the specified date and typical for property type in its locals.
- The price represents the normal consideration for the property sold unaffected by special or creative financing or sales concessions granted by anyone associated with the sale.

Source: Office of the Comptroller of the Currency under 12CFR. Part 34 Subpart C-Appraisals 34.42 Definitions(F).

If you have any questions about this consulting report, please call Ronald Zitzow at (320)-251-3648.

Sincerely yours,

Ronald C. Zitzow
Cert. General Real Prop.
MN Lic. #4000345
"Granite City Appraisal"
(320)-251-3648

RCZ/jmz

CEDAR, ALBION, SWARTOUT, HENSHAW
Improvement Project Number 06-1

Clearwater River Watershed District
Water Clarity and Benefits Report

- Buyers of lakeshore properties pay more for Lake Lots with higher water clarity. (See study attached)

  A) Lakeshore properties with higher water quality enhance swimming and all round recreational use.

  B) Water quality is directly effected by nutrient runoff primarily phosphate, potassium and nitrogen. Higher concentrations of these nutrients promote weed and algae growth in lakes and significantly reduces lake quality.

- Other Contributing Factors

  A) Failing septic systems are one of several contributors to lowering a lakes water quality.

  B) Failing septic systems can be a direct contributor to well pollutants.

  C) Sandy soils like Esterville, Hawick and Dorset are droughty and are poor filters for septic tank drainage fields.

  D) Many lake front property owners are not well versed in "on site septic systems, its operation and maintenance".

  E) Higher lake water quality and a central septic or sewer system will enhance local property values and will permit new or replacement permanent housing construction in the neighborhood.

  F) High - density housing requires a central sewage collector system to maintain the public's health and improve the living standard in the area.

- Benefit Statement

  A) It's the conclusion of the appraisal panel that in reviewing Tier 1, 2-3 lots with deeded lake access that their benefit is increased by 20% over those parcels with out access. This conclusion is supported by comparing sales with deeded lake access vs. no deeded access.

  B) In all cases when the home owners septic system must be extended into an adjacent parcel (with separate parcel number), that owner will be assessed at the higher benefit unit only.

  Example: A lakeshore property owner with a septic on a Tier 1 parcel lot. This owner's property shall be Assessed as lakeshore with 1 unit of benefit.

C) Agricultural, Tier 1, 2-3, Commercial & Public Ownership parcels.

1) Local sales indicate that agricultural parcels within close proximity to Cedar, Swartout Albion and Henshaw lakes will benefit from increased water quality and clarity.

2) Agricultural, Tier 1, 2-3 commercial, public ownership and non-profit parcels will benefit from the improved water quality because of enhanced recreational use of these lakes. In addition demand will increase for rural building sites in these neighborhoods as the lake water quality improves.

3) Improved and/or higher water quality on local lakes has increased property values in the Clearwater and neighboring watershed districts. This conclusion is supported by 2004-2006 sales data and the respective lot values and/or component values found within these sales.

4) It is the conclusion of the appraiser panel after reviewing the sales data from Wright County that the following assessment shall be placed on the Lakeshore properties.

   A) The shoreland class with 1 Unit of Benefit is the base for all assessments. The assessment be prorated to the other class of owners according to the Wenck Legend found on the August 2006 Appendix 1 & 2 map.

   B) The FGR Addition 1-5 and Sunrise Bay 2nd Addition with lake access respective tier assessments should be increased by 20%. The public land, Commercial property and Non Profit be assessed on the Benefit schedule outlined in the attachment schedule A.

LAKE	ACRES	CLARITY	$/FF 50' - 99'	$/FF 100' - 200'	MEAN
Cedar	837	7.2'	$3,025	$2,212	$2,900
Sylvia	1524	17.0'	$3,878	$3,112	$3,495
Sugar	1015	9.3'	$3,867	$2,305	$3,500
Pleasant	509	11.5'	$2,792	$2,866	$2,800
Lake John	411	7.3'	N/A	$1,900	$1,900
Clearwater	4296	7.4'	$4,296	$2,457	$3,500
Swartout/Albion	171	N/A	N/A	N/A	$467

Lake By Class Size:

Lake	$/FF	Clarity	$/FT Clarity
#1 - Pleasant	$2,706	11.5'	
John	$1,900	7.3'	
Difference	$ 806	4.2'	+$192/FT
#2 - Sugar	$3,500	9.6'	
Cedar	$2,900	7.2'	
Difference	$ 600	2.4'	+$250/FT
#3 - Sylvia	$3,878	17.0'	
Cedar.	$2,900	7.2'	
Difference	$ 978	9.8'	+$100/FT
		MEAN:	+$180/Foot Clarity

Secchi Disk Cedar Lake Clarity "Starting Point". . . 7.2'

Secchi Disk Cedar Lake Clarity "Ending Point". . . . 10.2'

- The Appraisal Panel using the Wenck study which states 2'-4' of increased clarity after 10 years on Cedar Lake used +3' of increased clarity as our measure.

Mean of $/FT clarity: $180/FT
X 100' (average lot)
$18,000/FT x 3'= $54,000

There is a $54,000 Benefit to the Cedar lakeshore parcels at the end of 10 years.

The average 2005-2006 Cedar Lake home sale price:	$352,000
Benefit:	$ 54,000
	$406,000

$406,000 Base Value divided by $54,000 = 13.3%

$54,000 x 13.3% = $7,182 Assessment for 1 Unit of Benefit.

This represents a 22.3% return on their investment over 10 years.

- Permanent Easement for holding ponds.

  1) The Appraisal Panel has determined from local and regional sales of wetland acres that these Acres plus the Ingress & Egress Easement, land owners be compensated as follows:

  Base Wetland Market Value $1,950/Acre x 85% Permanent Easement = $1,658/Acre. The recommended land owner compensation is $1,658/Acre. For the Permanent Easement Area.

Appraisal Panel Members:

Ronald C. Zitzow - Granite City Appraisal (320)251-3648

Bob Markstrom - (320)274-3276

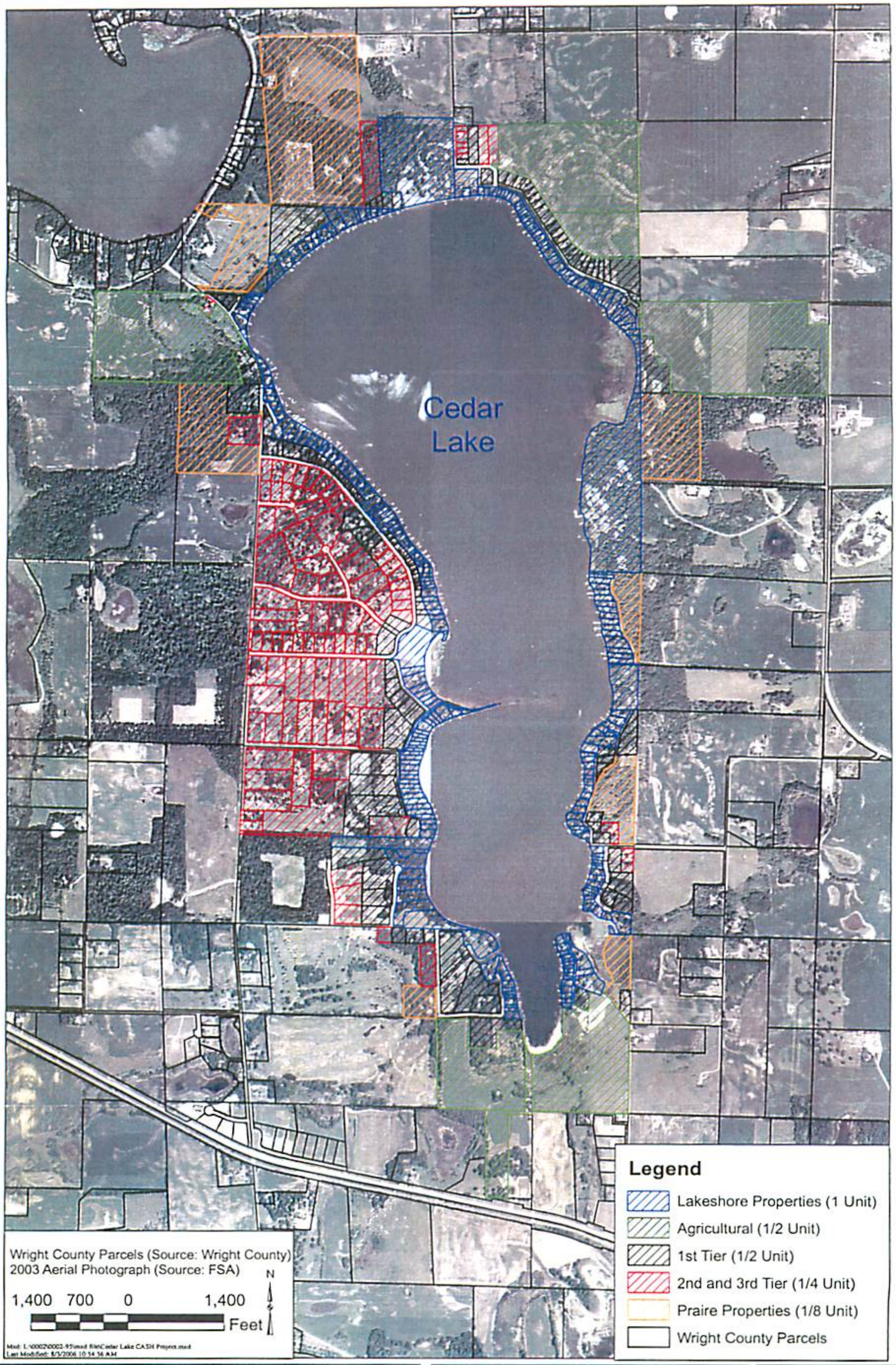
Ken Heimenz - (320)363-8803

Other Consulting Members and Participants:

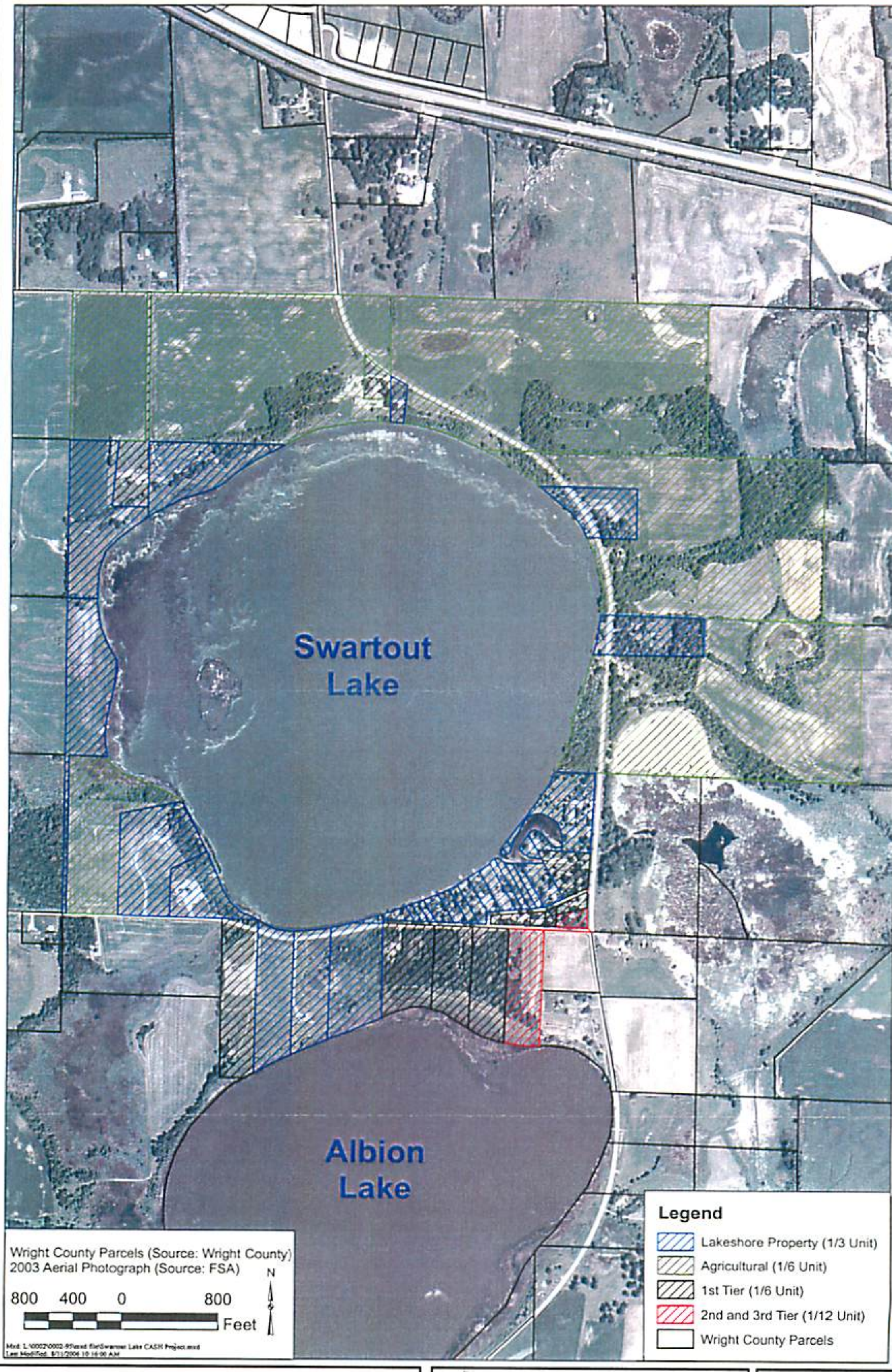
Bonnie Doemel & Michelle Hinnenkamp

Resource material:

** Research Document "Lakeshore Property Values and Water Quality" June 2003 - Web Page http://info.bemidjistate.edu/news/currentnews/lakestudy



CLEARWATER RIVER WATERSHED DISTRICT	Wenck	AUG 2006
Potentially Benefited Property Owners	Wenck Associates, Inc. 1800 Pioneer Creek Center Environmental Engineers Maple Plain, MN 55359-0429	Appendix I Figure 1



CLEARWATER RIVER WATERSHED DISTRICT	Wenck	AUG 2006
Potentially Benefited Property Owners	Wenck Associates, Inc. 1800 Pioneer Creek Center Environmental Engineers Maple Plain, MN 55359-0429	Appendix I Figure 2

EXHIBIT "A"

Assessment Formula
Project 06-1
September 6, 2006

PUBLIC LAND

Wright County Schroeder Park

51 total sites

6 full season sites @ .5 units = 3 units of benefit

45 two-week maximum sites @ .25 units = 11.25 units of benefit

TOTAL UNITS OF BENEFIT = 14.25

State of Minnesota Public Access

10 all-season parking spaces @ .25 units = 2.5 units of benefit

TOTAL UNITS OF BENEFIT = 2.5

Corinna Township Public Access

1 parking space @ .25 units = .25 units of benefit

TOTAL UNITS OF BENEFIT = .25

COMMERCIAL PROPERTY

Cedar Park Apartments

8 units @ .25 units = 2 units of benefit

TOTAL UNITS OF BENEFIT = 2.

Gerdink Resort

4 units @ .25 units = 1 unit of benefit

TOTAL UNITS OF BENEFIT = 1.

NON-PROFIT PROPERTY

Courage Center

Parcels 1400, 4100, 2030, 2040, 2060, 2070, and 2080 @ 1 unit = 7 units of benefit

Parcel 232300 @ .5 units = .5 units of benefit (contiguous behind 1400)

Parcel 233200 @ 1/8 unit = 1/8 units of benefit (contiguous behind 4100)

TOTAL 9 PARCELS UNIT OF BENEFIT = 7.6

ROUND TO 8 UNITS OF BENEFIT

Cedar Lake

Tier: Lake Front

Lake area: 837 Acres **Maximum Depth: 108'** **Water Clarity: 7.2'**

Parcel Number	Sale Date	Sale Price	Lot Value	FF / Cost Per FF	SF / Cost Per SF
#1 - 206-077-001060 &					
206-076-0001000	7/25/2005	$275,000	$208,000	60 FF / $3,466 FF	12,792 SF / $16.26 SF
#2 - 206-025-000050	5/26/2005	$575,000	$344,000	322 FF / $1,068 FF	57,908 SF / $5.94 SF
#3 - 206-025-000020	2/8/2006	$409,900	$249,000	93 FF / $2,677 FF	10,460 SF / $23.80 SF
#4 - 206-070-001040	9/29/2005	$264,000	$149,000	87 FF / $1,712 FF	22,704 SF / $6.56 SF
#5 - 206-022-000220	6/30/2005	$218,000	$166,000	50 FF / $3,320 FF	8,900 SF / $18.65 SF
#6 - 206-022-000130	6/27/2006	$336,960	$231,000	75 FF / $3,080 FF	13,350 SF / $17.30 SF
#7 - 206-000-272405	2/25/2005	$343,000	$250,000	80 FF / $3,125 FF	24,805 SF / $10.08 SF
#8 - 206-035-001020	6/27/2005	$280,000	$260,000	81 FF / $3,210 FF	25,428 SF / $10.22 SF
#9 - 206-061-000010	5/26/2006	$327,900	$184,000	80 FF / $2,300 FF	18,948 Sf / $9.71 SF
#10 - 206-065-000110	6/9/2005	$490,000	$392,000	177.2 FF / $2,212 FF	28,086 Sf / $13.96 SF
Mean of comps #1, 3, 5, 7-10:		$335,000	$243,000	$2,923 ~ $2,900 FF	$14.99 ~ $15.00 SF
* Home located on South end of Cedar Lake/Channel					

West Lake Sylvia & Sylvia

Tier: Lake Front

Lake area: 1,524 Acres   Maximum Depth: 97'   Water Clarity: 17'

Parcel Number	Sale Date	Sale Price	Lot Value	FF / Cost Per FF	SF / Cost Per SF
#1 - 217-000-281204 land only	10/10/2005	$272,000	$272,000	100 FF / $2,720 FF	26.572 SF / $10.24 SF
#2 - 217-067-000120 land only	7/27/2006	$450,000	$450,000	495 FF / $909 FF	133,010 SF / $3.38 SF
#3 - 209-000-051204	3/24/2006	$475,000	$300,000	89 FF / $3,371 FF	20,038 SF / $14.97 SF
#4 - 217-028-000110 &					
217-029-001011 &					
217-029-002010	4/28/2006	$415,000	$282,000	130 FF / $2,169 FF	38,422 SF / $7.34 SF
#5 - 217-000-291404	6/26/2006	$368,500	$211,000	93 FF / $2,269 FF	99,274 Sf / $2.13 SF
#6 - 217-022-000090	3/29/2006	$400,000	$295,000	280 FF / $1,054 FF	42,987 SF / $6.86 SF
#7 - 217-026-000050	4/28/2006	$480,000	$359,000	60 FF / $5,993 FF	8,246 SF / $43.61 SF
#8 - 209-033-001030	4/27/2006	$685,000	$556,000	125 FF / $4,448 FF	24,133 SF / $23.04 SF
	Mean:	$443,000	$341,000	$2,866 ~ $2,900 FF	$13.95 ~ $14.00 SF

Sugar Lake

Tier: Lake Front

Lake area: 1,015 Acres **Maximum Depth: 69'** **Water Clarity: 8'**

Parcel Number	Sale Date	Sale Price	Lot Value	FF / Cost Per FF	SF / Cost Per SF
#1 - 206-080-001130	5/26/2006	$725,000	$488,000	86 FF / $5,674 FF	13,397 SF / $36.43 SF
#2 - 206-000-113207 &					
206-088-002050 &					
206-120-001120	1/16/2006	$598,000	$387,000	75 FF / $5,160 FF	55,761 Sf / $6.94 SF
#3 - 206-086-002070	5/27/2005	$370,000	$296,000	75 FF / $3,947 FF	12,525 SF / $23.63 SF
#4 - 206-091-000200	5/5/2006	$385,000	$262,000	69 FF / $3,797 FF	17,138 SF / $15.29 SF
#5 - 206-066-000250	7/11/2005	$235,000	$235,000	92 FF / $2,554 FF	16,560 SF / $14.19 SF
#6 - 206-000-021102	3/3/2005	$310,000	$244,000	100 FF / $2.440 FF	5,648 SF / $43.20 SF
#7 - 206-000-021101	6/1/2005	$275,000	$217,000	100 FF / $2,170 FF	5,530 SF / $39.24 SF
#8 - 206-091-000210	2/23/2006	$250,000	$143,000	69 FF / $2,068 FF	16,919 SF / $8.45 SF
	Mean:	$393,500	$284,000	$3,476.25 ~ $3,500 FF	$23.42 ~ $23.00 SF

Pleasant Lake

Tier: Lake Front

Lake area: 509 Acres　　**Maximum Depth: 74'**　　**Water Clarity: 11.5'**

Parcel Number	Sale Date	Sale Price	Lot Value	FF / Cost Per FF	SF / Cost Per SF
102-011-000020	6/15/2006	$215,000	$170,000	56 FF / $3,036 FF	6,014 SF / $28.27 SF
206-067-001040	5/26/2006	$609,000	$407,000	142 FF / $2,866 FF	39,475 SF / $10.31 SF
206-062-000030	3/24/2006	$295,000	$191,000	75 FF / $2,547 FF	18,555 SF / $10.29 SF
	Mean:	$373,000	$256,000	$2,816.33 ~ $2,800 FF	$16.29 SF ~ $16.00 SF

Lake John

Tier: Lake Front

Lake area: 411 Acres   Maximum Depth: 28'   Water Clarity: 7.3'

Parcel Number	Sale Date	Sale Price	Lot Value	FF / Cost Per FF	SF / Cost Per SF
217-057-000130	6/30/2006	$490,000	$252,000	134.4 FF / $1,875 FF	32,885 SF / $7.66 SF
217-013-000210 land only	6/23/2006	$270,000	$270,000	137.4 FF / $1,965 FF	35,773 SF / $7.55 SF
	Mean:	$380,000	$261,000	$1,920 ~ $1,900 FF	$7.60 SF

Clearwater Lake

Tier: Lake Front

Lake area: 3,158 Acres   Maximum Depth: 73'   Water Clarity: 7.4'

Parcel Number	Sale Date	Sale Price	Lot Value	FF / Cost Per FF	SF / Cost Per SF
#1 - 206-000-164205 &					
206-031-000351	7/22/2005	$502,200	$357,000	51 FF / $7,000 FF	31,793 SF / $11.23 SF
#2 - 206-031-000260	5/25/2005	$277,000	$215,000	60 FF / $3,583 FF	12,427 SF / $17.30 SF
#3 - 206-073-001040	5/24/2005	$237,500	$175,000	50 FF / $3,500 FF	9,642 SF / $18.15 SF
#4 - 206-093-000221	5/19/2006	$497,000	$339,000	100 FF / $3,390 FF	25,247 Sf / $13.43 SF
#5 - 206-019-000041	7/12/2005	$203,900	$155,000	50 FF / $3,100 FF	4,500 SF / $34.44 SF
#6 - 206-019-000050	1/13/2005	$220,000	$138,000	100 FF / $1,380 FF	10,432 SF / $13.23 SF
#7 - 206-000-064405 &					
206-019-000201 &					
206-034-000361	10/28/2005	$385,000	$260,000	100 FF / $2,600 FF	14,887 SF / $17.46 SF
	Mean:	$332,000	$234,000	$3,507 ~ $3,500 FF	$17.89 ~ $18.00 SF

Albion & Swartout Lakes

Tier: Lake Front

Lake area: 171 Acres **Maximum Depth: 12.5'** **Water Clarity: N/A**

Parcel Number	Sale Date	Sale Price	Lot Value	FF / Cost Per FF	SF / Cost Per SF
201-000-091102	10/4/2005	$140,000	$140,000	300 FF / $467 FF	341,815 SF / $.41 SF

TIER 1

Parcel Number	Sale Date	Sale Price	Lot Value	FF / Cost Per FF	SF / Cost Per SF
Cedar Lake:					
#1 - 206-023-001050	5/26/2006	$175,000	$69,000	N/A	20,986 Sf / $3.29 SF
#2 - 206-036-001070	12/19/2005	$277,000	$82,000	w/ easement to lake	41,663 Sf / $1.97 Sf
#3 - 206-023-001190 land only	9/20/2005	$65,000	$65,000	N/A	20,000 SF / $3.25 Sf
Clearwater:					
#4 - 206-031-000502	10/31/2005	$186,000	$136,000	N/A	86,528 SF / $1.57 SF
#5 - 206-031-000480 &					
206-031-000491	5/5/2006	$175,000	$175,000	w/ easement to lake	338,026 SF / $.52
#6 - 206-030-001200 &					
206-030-001231 &					
206-030-001240	6/30/2006	$324,000	$178,000	w/easement to lake	104,170 SF / $1.71 SF
#7 - 206-000-052316	12/28/2005	$205,000	$58,000	N/A	68,834 SF / $.85 SF
Lake John:					
#8 - 217-014-000162	5/30/2006	$221,000	$115,000	w/easement to lake	13,927 SF / $8.26 SF

CLEARWATER RIVER WATERSHED DISTRICT	Wenck	AUG 2006
F G R Additions (1-5) and Sunrise Bay 2nd Addition	Wenck Associates, Inc. Environmental Engineers 1800 Pioneer Creek Center Maple Plain, MN 55359-0429	Appendix I Figure 1

PARCEL	TPSORTNAME	TPHOUSE	TPSTR	TPADDR1	TPCITY	TPZIP	PROPCITY	PROPSTR	PROPHOUSE	PROPZIP
F G R 1st Addition										
206035000010	REZNECHEK,DUANE A & J C	8300	ISAAK	8300 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8300	55302
206035000011	CLEVELAND,RANDALL A &SHELBY	8294	ISAAK	8294 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8294	55302
206035000020	CEDAR ACRES ASSOC INC	8041	ISAAK	8041 ISAAK AVE NW	ANNANDALE	55302				
206035001010	GUNNERSON,CURTIS V &JULIE A	8152	ISAAK	8152 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8152	55302
206035001020	ALTMAN,GERALD W REV TRUST U/A	18100	39TH	18100 39TH AVE N	PLYMOUTH	55446				
206035001030	BLAINE,STEVEN & SUSAN	8130	ISAAK	8130 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8130	55302
206035001040	JACOBSON,JOHN R & CHERYL L	8120	ISAAK	8120 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8120	55302
206035001050	JACOBSON,JAMES A	8110	ISAAK	8110 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8110	55302
206035001060	ABDELLA,WAYNE J & DARLENE J	8102	ISAAK	8102 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8102	55302
206035001061	PALMQUIST,JAMES R &BONITA K	8100	IRVINE	8100 IRVINE AVE NW	ANNANDALE	55302				
F G R 2nd Addition										
206036001010	RAPINAC,BRANDON S & TRACY L	8109	ISAAK	8109 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8109	55302
206036001020	HOWARD,VIRGINIA C	8083	ISAAK	8083 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8083	55302
206036001030	ROLFHUS,KENNETH M & B J	8063	ISAAK	8063 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8063	55302
206036001040	WALBURN,LLOYD D & R A	8041	ISAAK	8041 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8041	55302
206036001050	MARQUETTE,ROBERT L & ANGELA M	8019	ISAAK	8019 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8019	55302
206036001060	KITTOK,VINCENT F	7991	ISAAK	7991 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	7991	55302
206036001070	DAMMANN,KATHLEEN KITTOK	7969	ISAAK	7969 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	7969	55302
206036001080	STILES,MARY A REV TRUST AGREE	7927	ISAAK	7927 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	7927	55302
206036002030	NEUENFELDT,HENRY W&PATRICIA	8930	78TH	8930 78TH ST NW	ANNANDALE	55302	ANNANDALE	78TH	8930	55302
206036002040	MANUEL,PAUL J & ANGIE	8908	78TH	8908 78TH ST NW	ANNANDALE	55302	ANNANDALE	78TH	8908	55302
206036002050	VOGELER,STEPHEN L	6638	COUNTY ROAD 3	6638 COUNTY ROAD 35 W	MAPLE LAKE	55358				
206036002060	LARSON,ROBERT & SANDRA	8838	78TH	8838 78TH ST NW	ANNANDALE	55302	ANNANDALE	78TH	8838	55302
206036002070	ILSTRUP,JOSHUA A	8820	78TH	8820 78TH ST NW	ANNANDALE	55302	ANNANDALE	78TH	8820	55302
206036002080	SCHMITZ,JOHN S & SHARON	8800	78TH	8800 78TH ST NW	ANNANDALE	55302	ANNANDALE	78TH	8800	55302
206036002090	SJODAHL,RICHARD D & CAROL A	8768	78TH	8768 78TH ST NW	ANNANDALE	55302	ANNANDALE	78TH	8768	55302
206036002100	ALBACHTEN,DUANE A & LAURIE J	8744	78TH	8744 78TH ST NW	ANNANDALE	55302	ANNANDALE	78TH	8744	55302
206036002110	LEE,ARLAN E	8720	78TH	8720 78TH ST NW	ANNANDALE	55302	ANNANDALE	78TH	8720	55302
206036002120	DIRCKS,DENNIS R &JEANNINE G	8660	78TH	8660 78TH ST NW	ANNANDALE	55302				
F G R 3rd Addition										
206037001010	DAUBANTON,RANDY A & LINDA A	8223	ISAAK	8223 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8223	55302
206037001020	O'REILLEY,JAMES L & BARBARA L	8201	ISAAK	8201 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8201	55302
206037001030	ARENDT,WILLIAM &MARY E WELLS	8178	ISAAK	8178 ISAAK AVE NW	ANNANDALE	55302				
206037002010	STILES,MARY A REV TRUST AGREE	7927	ISAAK	7927 ISAAK AVE NW	ANNANDALE	55302				
206037002020	WESTHOFF,WILLIAM N & RUTH M	16050	38TH	16050 38TH AVE N	PLYMOUTH	55446				
206037002030	DALE,GERALD L & JOANN M	8640	79TH	8640 79TH ST	ANNANDALE	55302	ANNANDALE	79TH	8640	55302
206037003020	DIRCKS,DENNIS R &JEANNINE G	8660	78TH	8660 78TH ST NW	ANNANDALE	55302	ANNANDALE	78TH	8660	55302

PARCEL	TPSORTNAME	TPHOUSE	TPSTR	TPADDR1	TPCITY	TPZIP	PROPCITY	PROPSTR	PROPHOUSE	PROPZIP
F G R 4th Addition										
206038001010	FERNANDEZ,JOSEPH R	8251	ISAAK	8251 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8251	55302
206038001020	ANDERSON,THOMAS J	8275	ISAAK	8275 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8275	55302
206038001030	MATTILA,JUNE H	8283	ISAAK	8283 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8283	55302
206038001040	CLARK,WAYNE K	8289	ISAAK	8289 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8289	55302
206038001051	MILLER,THOMAS D &	8299	ISAAK	8299 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8299	55302
206038001060	MOONEY,JEFF T & PATTY	8305	ISAAK	8305 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	8305	55302
206038001070	TUCHTENHAGEN,CHRISTOPHER&	8972	81ST	8972 81ST ST NW	ANNANDALE	55302	ANNANDALE	81ST	8972	55302
206038001080	ERICKSON,WILLIAM K &DEBRA J	8946	81ST	8946 81ST ST NW	ANNANDALE	55302	ANNANDALE	81ST	8946	55302
206038001090	ADAMS,TOM & PAULA	8930	81ST	8930 81ST ST NW	ANNANDALE	55302	ANNANDALE	81ST	8930	55302
206038001100	MARX,BRIAN J & REBECCA L	8900	81ST	8900 81ST ST NW	ANNANDALE	55302	ANNANDALE	81ST	8900	55302
206038001110	GARTHE,DEBRA A				ANNANDALE	55302	ANNANDALE	81ST	8909	55302
206038001120	JACOBSON,DREW S & DONNA M	8132	COUNTY ROAD 6	8132 COUNTY ROAD 6 NW	ANNANDALE	55302				
206038001130	NYSTROM,RODNEY D&MARJORIE M	8926	79TH	8926 79TH ST NW	ANNANDALE	55302	ANNANDALE	79TH	8926	55302
206038001140	MARSNIK,PAUL A & JAMIE B	8858	79TH	8858 79TH ST NW	ANNANDALE	55302	ANNANDALE	79TH	8858	55302
206038001150	ANNANDALE COUNTRYSIDE TRUST	1744	AVOCET	1744 AVOCET LN	MOUND	55364	ANNANDALE	ITEN	7963	55302
206038001160	BOWERS,JAY W & JILL A	8029	ITEN	8029 ITEN AVE NW	ANNANDALE	55302	ANNANDALE	ITEN	8029	55302
206038001170	CONDON,THOMAS W & RHONDA M	8045	ITEN	8045 ITEN AVE NW	ANNANDALE	55302	ANNANDALE	ITEN	8045	55302
206038001180	LAMBERGER,RICHARD A & EVELYN G	8056	ITEN	8056 ITEN AVE NW	ANNANDALE	55302	ANNANDALE	ITEN	8056	55302
206038001190	BRUTGER,CATHERINE M	8028	ITEN	8028 ITEN AVE NW	ANNANDALE	55302	ANNANDALE	ITEN	8028	55302
206038001200	BALL,HARLAN W & MARY K	7974	ITEN	7974 ITEN AVE NW	ANNANDALE	55302	ANNANDALE	ITEN	7974	55302
206038001210	BITZER,ROBERT E & BARBARA A	7944	ITEN	7944 ITEN AVE NW	ANNANDALE	55302	ANNANDALE	ITEN	7944	55302
206038001220	WUOLLET,STEVEN J & TERRI L	8716	79TH	8716 79TH ST NW	ANNANDALE	55302	ANNANDALE	79TH	8716	55302
206038002010	NELSON,STEVEN R & SHELLY A	8957	79TH	8957 79TH ST NW	ANNANDALE	55302	ANNANDALE	79TH	8957	55302
206038002020	NORGREN,PETER J & JODI M	8877	79TH	8877 79TH ST NW	ANNANDALE	55302	ANNANDALE	79TH	8877	55302
206038002030	THOMPSON,KEITH A & LORI L	8833	79TH	8833 79TH ST NW	ANNANDALE	55302	ANNANDALE	79TH	8833	55302
206038002040	POWELL,KENT	8787	79TH	8787 79TH ST NW	ANNANDALE	55302	ANNANDALE	79TH	8787	55302
206038002050	FOBBE,JAMES T & ADELE A	8741	79TH	8741 79TH ST NW	ANNANDALE	55302	ANNANDALE	79TH	8741	55302
206038002060	ADAMS,JAMES P & DEBRA L	8685	79TH	8685 79TH ST NW	ANNANDALE	55302	ANNANDALE	79TH	8685	55302
F G R 5th Addition										
206101001010	PROVO,GARY A	8773	78TH	8773 78TH ST NW	ANNANDALE	55302	ANNANDALE	78TH	8773	55302
206101001020	ADAMS,JOSEPH P & MICHELLE L	8795	78TH	8795 78TH ST NW	ANNANDALE	55302	ANNANDALE	78TH	8795	55302
206101001030	RUPRECHT,ROBIN R	8843	78TH	8843 78TH ST NE	ANNANDALE	55302	ANNANDALE	78TH	8843	55302
206101001040	GELDERT,CHRISTOPHER G &MARY	8897	78TH	8897 78TH ST NW	ANNANDALE	55302	ANNANDALE	78TH	8897	55302
206101001050	FLOISTAD,JOHN A & NANCY A	7606	COUNTY ROAD 6	7606 COUNTY ROAD 6 NW	ANNANDALE	55302	ANNANDALE	COUNTY ROAD 6	7606	55302
206101001060	SMITH,STEVEN J&	8966	75TH	8966 75TH ST NW	ANNANDALE	55302	ANNANDALE	75TH	8966	55302
206101001070	PETROSKI,JAMES A & ANN L	8946	75TH	8946 75TH ST NW	ANNANDALE	55302	ANNANDALE	75TH	8946	55302

PARCEL	TPSORTNAME	TPHOUSE	TPSTR	TPADDR1	TPCITY	TPZIP	PROPCITY	PROPSTR	PROPHOUSE	PROPZIP
206101001080	WARNER,KEVIN S	8896	75TH	8896 75TH ST NW	ANNANDALE	55302	ANNANDALE	75TH	8896	55302
206101001090	ELDRED,RUSSELL A & DOLORES D	8858	75TH	8858 75TH ST NW	ANNANDALE	55302	ANNANDALE	75TH	8858	55302
206101001100	KATKA,JEROME P	8818	75TH	8818 75TH ST NW	ANNANDALE	55302	ANNANDALE	75TH	8818	55302
206101001110	MANSK,DAVID R & JULIE A	8786	75TH	8786 75TH ST NW	ANNANDALE	55302	ANNANDALE	75TH	8786	55302
206101001120	HERRMANN,STEVEN L &SU LEE L	8744	75TH	8744 75TH ST NW	ANNANDALE	55302	ANNANDALE	75TH	8744	55302

Sunrise Bay 2nd Addition										
206082001010	GEARDINK,ELLA M	9013	IRESFELD	9013 IRESFELD AVE NW	ANNANDALE	55302				
206082001020	FLEMMING,MITCHELL E &DENISE	7685	ISAAK	7685 ISAAK AVE NW	ANNANDALE	55302	ANNANDALE	ISAAK	7685	55302
206082001030	DIRCKS,RONALD M & LINDA R	7602	ISAAK	7602 ISAAK AVE NW	ANNANDALE	55302				
206082001040	DIRCKS,RONALD M & LINDA R	7602	ISAAK	7602 ISAAK AVE NW	ANNANDALE	55302				
206082001050	DIRCKS,RONALD M & LINDA R	7602	ISAAK	7602 ISAAK AVE NW	ANNANDALE	55302				

TIER 2 – 3

Parcel Number	Sale Date	Sale Price	Lot Value	FF / Cost Per FF	SF / Cost Per SF
Cedar:					
#1 - 206-113-001050	3/1/2006	$313,000	$89,000	N/A	69,172 Sf / $1.29 SF
#2 - 206-123-002090	2/2/2006	$291,555	$51,000	N/A	90,858 Sf / $.56 SF
#3 - 206-123-001020 &					
206-123-001030 &					
206-123-001040 &					
206-123-002010	2/2/2006	$248,400	$248,400	N/A	416,869.2 SF / $.60 SF
Sugar:					
#4 - 206-078-001080	12/28/2005	$371,000	$108,000	N/A	43,560 SF / $2.46 SF
Clearwater:					
#5 - 206-030-001160	6/30/2005	$179,000	$66,000	N/A	46,008 SF / $1.43 SF

TIER – AGRICULTURAL

Number	Sale Date	Sale Price	Lot Value	Acres / Cost Per Acre
#1 -	2/25/2005	$290,500	$137,293	21.05 Acres / $6,522 per acre
#2 -	6/24/2005	$427,000	$427,000	74.13 Acres / $5,760 per acre
#3 -	7/15/2005	$2,850,000	$2,646,620	80 Acres / $33,083 per acre
#4 -	12/21/2004	$385,000	$385,000	80 Acres / $4,813 per acre
#5 -	6/1/2005	$360,400	$360,400	74.5 Acres / $4,838 per acre
#6 -	5/1/2005	$581,461.27	$581,461.27	152.26 Acres / $3,819 per acre
#7 -	8/11/2004	$1,150,000	$863,876	75.36 Acres / $11,463 per acre
#8 -	4/14/2004	$1,100,000	$1,100,000	105.77 Acres / $10,400 per acre
#9 -	1/26/2006	$194,000	$194,000	15.55 Acres / $12,476 per acre
#10 -	9/9/2005	$195,000	$195,000	19.52 Acres / $9,990 per acre
#11 -	1/12/2006	$642,000	$482,000	80 Acres / $6,025 per acre
#12 -	5/26/2006	$31,839.50	$31,839.50	16.54 Acres / $1,925 per Acre
	Mean:	$683,933 ~ $684,000	$317,041 ~ $317,000	$9,260 per Acre

Number	Cropland - $ / Acre	Woodland - $ / Acre	Pasture - $ / Acre	Wetland - $ / Acre & Road Acreage
#1 -	20 Acres - $6,865 / A			1.05 Acres of Road
#2 -	46.5 Acres - $7,117 / A		27 Acres - $3,558 / A	.63 Acres of Road
#3 -	56 Acres - $30,650 /A	20 Acres - $45,377 /A	3 Acres - $7,563 / A	1 Acre of Road
#4 -	73 Acres - $5,168 / A		6 Acres - $1,292 / A	1 Acre of Road
#5 -	60.4 Acres - $4,412 / A	12.6 Acres - $7,454 / A		1.5 Acres of Road
#6 -	132 Acres - $4,283 / A			17 Acres -$1,070/ A , 3.26 Acres of Road
#7 -	54 Acres - $12,107 / A		21 Acres - $10,000 / A	.36 Acres of Road
#8 -	70 Acres - $13,784 / A	7 Acres - $13,784 / A		28 Acres - $1,378 / A , .77 Acres of Road
#9 -	10.6 Acres - $16,943 / A			3.4 Acres - $4,235 / A ,1.55 Acres of Road
#10 -	8.7 Acres - $20,103 / A			10 Acres - $2,010 / A , .82 Acres of Road
#11 -	74 Acres - $6,916 / A		5 Acres - $3,239 / A	1 Acre of Road
#12 -				16.54 Acres - $1,925 / A , 0 Acres of Road
Mean:	$11,668 ~ $11,700 / A	$22,205 ~ $22,200 / A	$5,130 ~ $5,100 / A	$2,124 ~ $2,100 / A