2005
Emergency Management
Plan Revision

Chisago Lakes Outlet Project

Chisago Lakes Lake Improvement District
Chisago County Board

Final

September 8, 2005

Prepared by:

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Executive Summary

The Emergency Management Plan for the Chisago Lakes Outlet Projects describes the critical infrastructure, maintenance requirements, and operating rules for continued operation of the system. The plan is organized starting with Section 1.0: Introduction, which describes the history and current condition of the outlet system, and goals and policies. The Introduction is followed by Section 2.0, which details the Operating Procedures, and Section 3.0, which describes Monitoring and Inspection efforts to be followed for operating the outlet system. Section 4.0 describes required Documentation and Reporting procedures, while Section 5.0 describes procedures for amending the Plan. Appendices to the Plan include:

- Appendix A: Technical Memorandum: Modeling Work for Areas Downstream of CR 80 and Bloomquist Creek, which describes the hydrologic modeling on which the outlet structure changes are based.

- Appendix B: Winter Outflow Safety Plan, which describes safety procedures for operation of the outlet system during the winter.

SECTION 1.0: INTRODUCTION

1.1 BACKGROUND AND PURPOSE

The Chisago Lakes Lake Improvement District (CLLID) was legally designated as a lake improvement district under Minnesota State Statute and established on April 21, 1976 by resolution of the Chisago County Board. The CLLID then remained dormant until August 21, 1984 at which time the CLLID was reactivated by resolution of the County Board. The CLLID consists of an eight member Board of Directors and their purpose to make recommendations to the County Board on matters pertaining to the CLLID.

The CLLID encompasses nearly 24 sq. miles and encompasses all or part of four cities and four townships. Of the area within the CLLID, nearly 7 sq. miles is lake surface area.

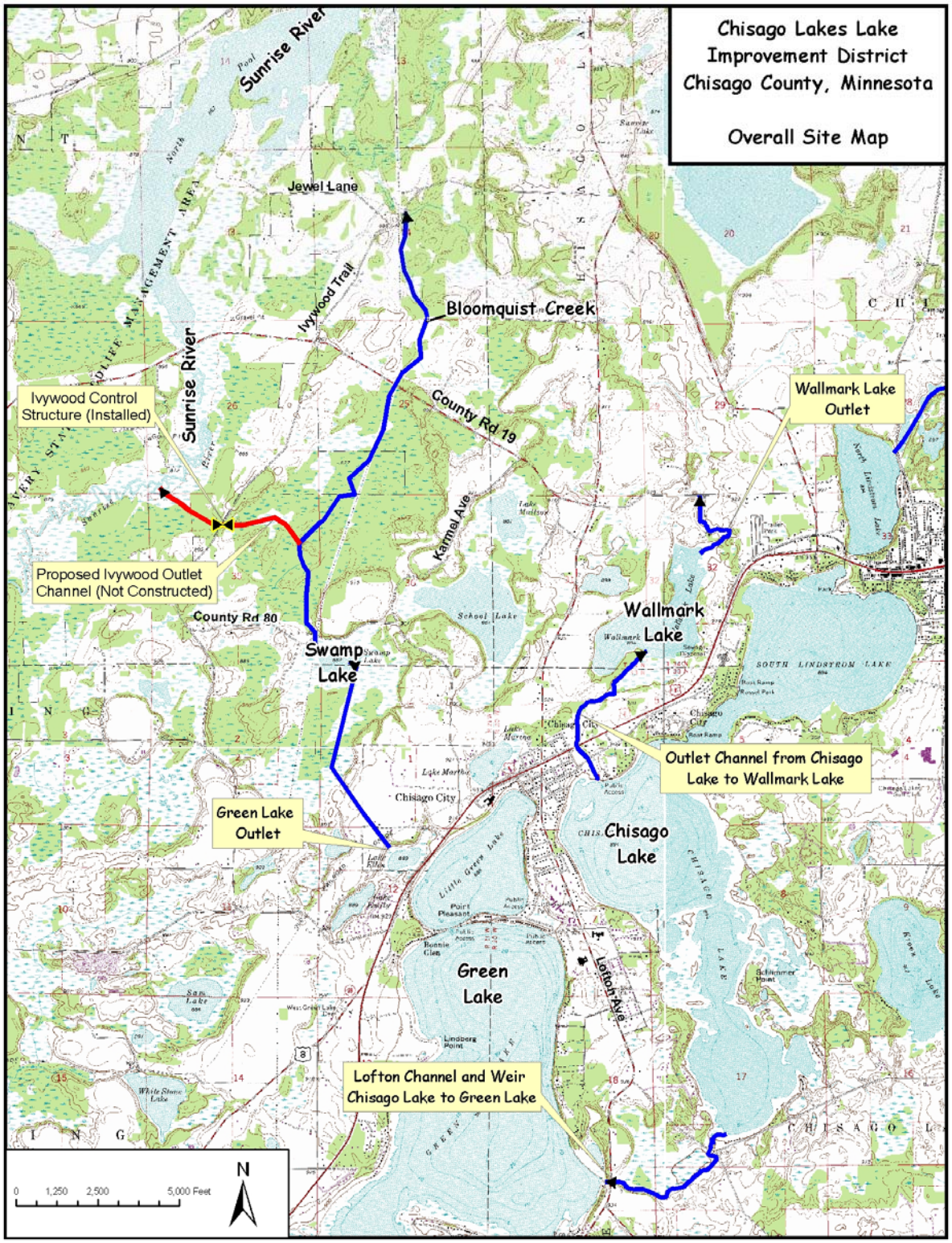
The purpose of this plan is to describe the operating procedures, and the monitoring, documentation and reporting requirements for the Chisago Lakes Outlet Project. The Chisago Lakes Outlet Project was undertaken in 1986 to provide an outlet from the Chisago Chain of Lakes to Green Lake, and from Green Lake to the Sunrise River (Figure 1). The purpose of the project was to alleviate extremely high lake levels. In the past Green Lake was landlocked, and the Chisago Chain of Lakes was virtually landlocked. A separate project in 1986 improved an existing outlet from the Chisago Chain through Wallmark Lake. Previously this outlet barely functioned. An Emergency Management Plan was completed for the Outlet Project in 1987 (Wenck Associates, 1987, 1987 Emergency Management Plan: Chisago Lakes Outlet Project). However, portions of the plan have not been completed, and some of the improvements have not operated as expected. The CLLID has experienced recurring high water levels since the original outlet project was constructed, and improvements are needed to the outlet system. This current document revises the previous 1987 Emergency Management Plan to reflect these improvements.

1.1.1 Changes to Existing Plan

The portion of the plan that has not been completed is the Ivywood Outlet Channel that goes from Swamp Lake to the Carlos Avery Wildlife Management Area and the Sunrise River. An outlet has been constructed at Ivywood Trail, but not the channel. The channel has not been completed because of federal permitting requirements and concerns regarding the introduction of exotic plant species into the refuge from the lakes through the outlet system. Changes to the outlet system to address these concerns include elimination of the Ivywood channel. Instead, it is the intent of the Chisago LID to acquire the necessary easements to allow flow to proceed north by natural pathways to Bloomquist Creek. The hydrologic analysis documenting the anticipated water level impacts and flowage easement needs is presented as Appendix A.

Other changes covered by this revised plan include lowering the low elevation of the Lofton Avenue weir, and channel maintenance and repairs for the outlet between Chisago and Green Lakes.

Figure 1
Overall Site Map



Investigations have shown how sensitive the system is to even minor lapses in maintenance of the outlet systems, particularly the outlet between Chisago and Green Lakes. Problems have occurred such as fallen trees, unexpected growth of aquatic plants or debris blocking culverts along the outlet. The very low hydraulic gradients out of both the Chisago-to-Green Outlet and the Chisago-to-Wallmark Outlet make them susceptible to even small increases in channel roughness or blockages. There are no proposals to change the maximum flows allowed at the Chisago and Green Lake Outlets.

1.1.2 System Description

Table 1 presents the basic elevation and outflow data for the Chisago Lakes Outlet System.

Table 1
Basic Elevations and Outflow Data Chisago Lakes Outlet Project

	Chisago to Green	Chisago to Wallmark	Green
Ordinary High Water	900.2	--	892.5
Permanent Outlet (High Weir) Elevation	899.2	899.2	891.0
Low Weir Elevation**	895.2	--	--
Design Outflow Rate	48cfs*	--	78cfs

***** cfs = cubic feet per second
** Revised (3 feet lower than initially construction as approved by MnDNR permit # 85-3331).

Historic lake levels for Chisago and Green Lakes are presented in Figures 2 and 3, respectively. Damage to property surrounding the Chisago Lakes starts at an elevation of 898.0 Comparison of the historic lakes levels with the level of 898 for Chisago Lake, shows that the lakes frequently exceeds this level. Damages to surrounding property were estimated in 1998 dollars as part of the 1999 Watershed Management Study by HDR. These results are summarized in Table 2.

The Chisago Lakes Outlet Project includes several control gates. These gates are described in Table 3. A drawing of the County Road 24 (known as the Lofton Avenue Weir) drop structure showing the proposed revision (i.e., the Chisago Low Weir and the Chisago Permanent Weir Outlet) is presented as Figure 4. This structure has a pair of gates that control the activation of both the low weir and the permanent outlet weir. Revisions include lowering the crest of the low weir from 898.2 to 895.2 along with lowering the baffle. The permanent weir outlet elevation will remain unchanged.

The Lake Ellen drop structure has a gate and controls the water level in both Lake Ellen and Green Lake. There are no revisions to this structure.

The Chisago-Wallmark Outlet weir elevation is the same as the permanent weir elevation at the Lofton Avenue Weir/County Road 24 Outlet. This outlet carries about 10 percent of the outflow from the Chisago Chain of Lakes during high water events. The Chisago-Wallmark Outlet has no control gates and flows freely whenever the lake exceeds the weir level. There are no proposed revisions to this structure.

Figure 2
Green Lake Levels

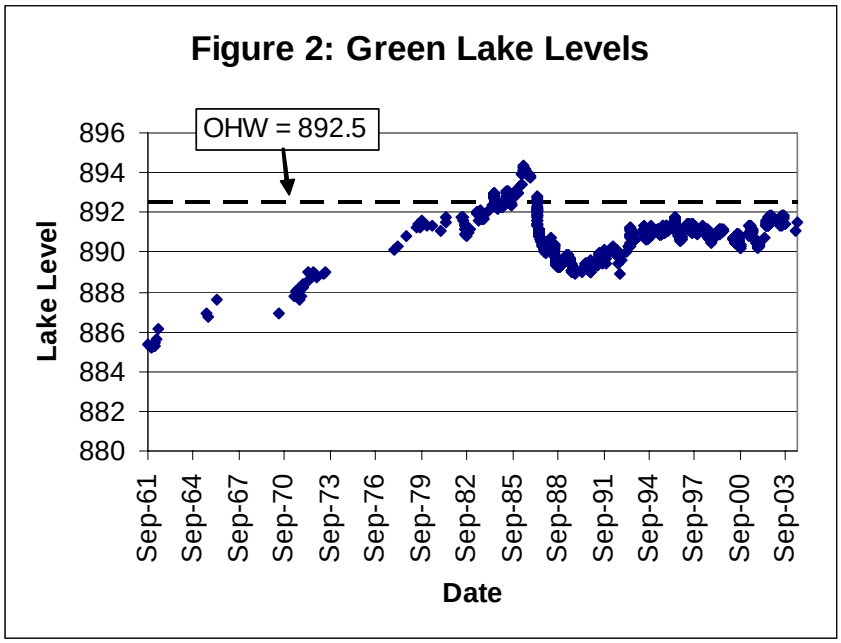


Figure 3
Chisago Lake Levels

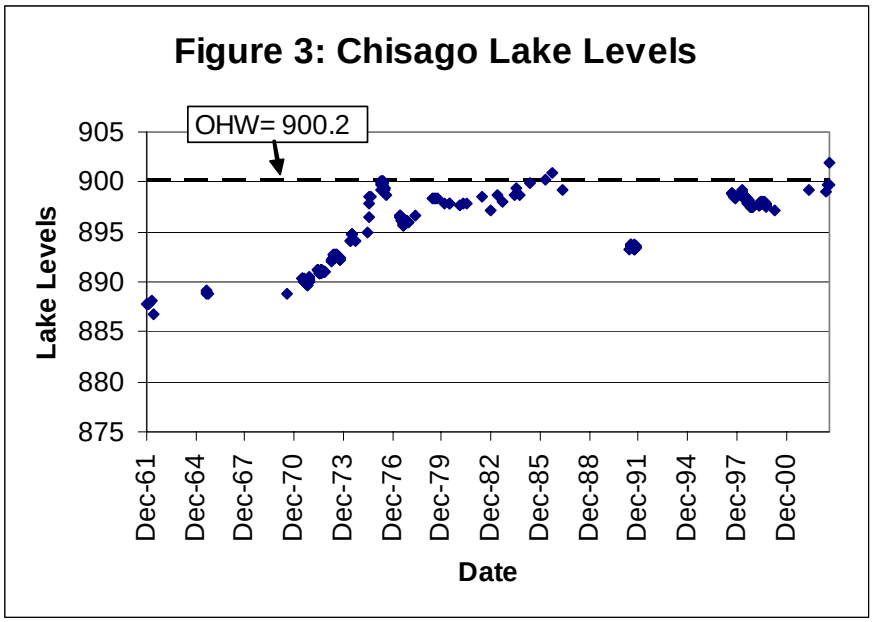


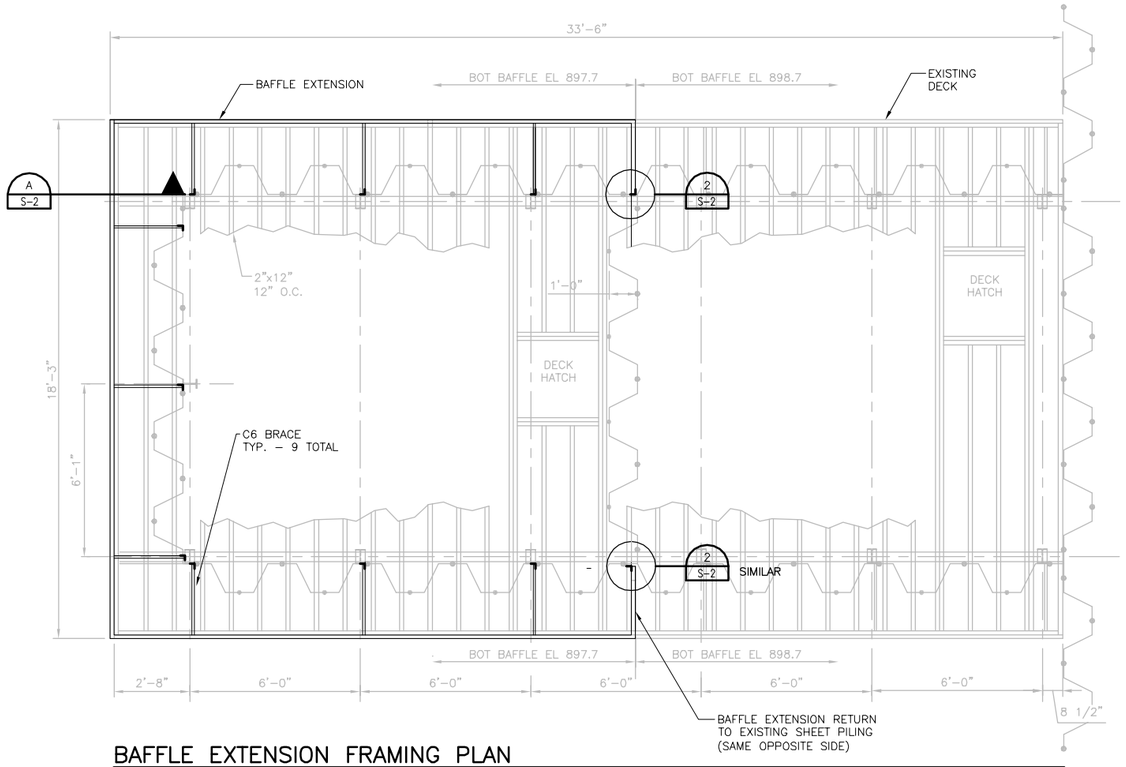
Table 2
Chisago Lakes Lake Improvement District Damage Curves – 1998 Dollars*

Elevation (ft)	North Center Lake	South Center Lake	North Lindstrom Lake	South Lindstrom and Chisago Lakes	Total Damage
898	$0	$13,930	$0	$334,316	$348,245
898.2	$13,930	$20,895	$0	$367,747	$402,572
898.4	$19,502	$33,432	$0	$409,537	$462,470
898.6	$27,860	$45,968	$0	$442,968	$516,796
898.8	$41,789	$61,291	$0	$484,757	$587,838
899	$55,719	$78,007	$0	$520,975	$654,701
899.2	$61,291	$98,902	$27,860	$568,336	$756,389
899.4	$69,649	$125,368	$44,575	$618,484	$858,076
899.6	$75,221	$157,407	$66,863	$668,631	$968,122
899.8	$83,579	$188,052	$89,151	$718,778	$1,079,561
900	$125,368	$211,733	$107,260	$777,284	$1,221,645
900.2	$153,228	$250,737	$108,653	$835,789	$1,348,406
900.4	$195,017	$300,884	$108,653	$902,652	$1,507,206

* Source: Watershed Management Study Final Report: HDR Project No. 08385-003-164, 1999. Table 11.

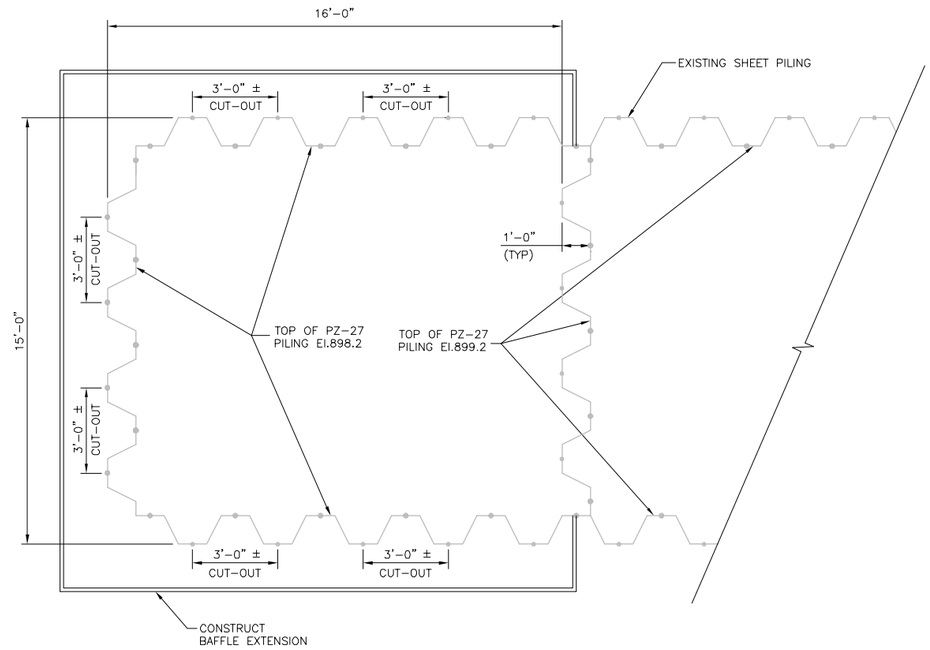
Table 3
Control Gates Chisago Lakes Outlet System

Control Gate	Location	Description	Purpose
Chisago Low Weir	Lofton Avenue County Rd. 24 Drop Structure	2 gates, each 4 ft x 4 ft	To activate low weir to effect drawdown
Chisago Permanent Outlet	County Rd. 24 Drop Structure	1 gate< 3 ft x 3 ft	To ensure against downstream damage by limiting outlet to design rates and, if ever necessary by stopping outflow
Green Outlet	Lake Ellen Drop Structure	1 gate, 4 ft x 4 ft	To ensure against downstream damage by limiting outlet to design rate and, if even necessary, by stopping flow
Ivywood Outlet	Ivywood Trail	Flashboard riser	To regulate flow from the Ivywood wetland area west to the Sunrise River Carlos Avery Wildlife Refuge
Chisago to Wallmark Weir	Lindquist Park	CableCrete Weir	To allow weir flow to Wallmark Lake



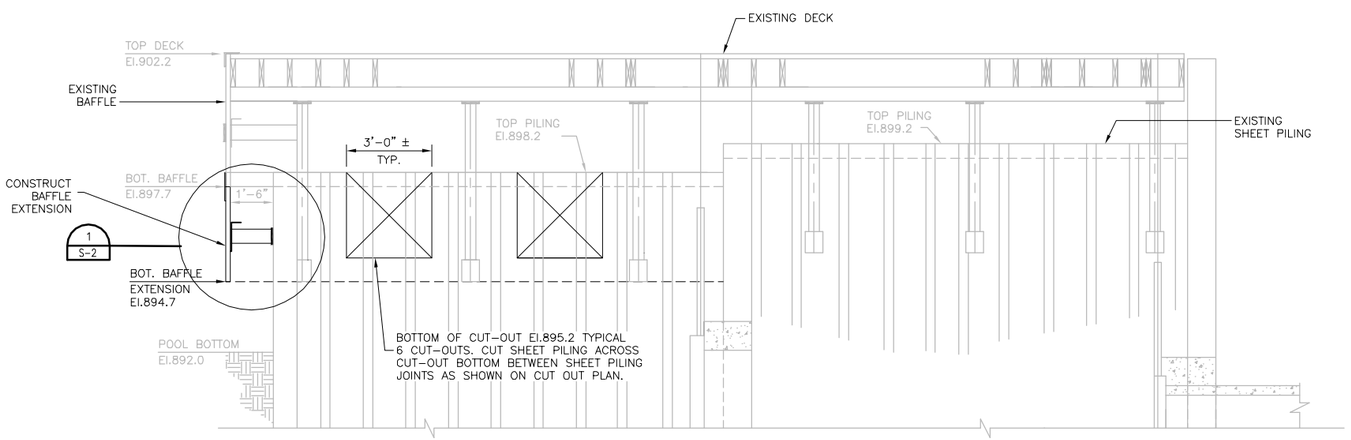
BAFFLE EXTENSION FRAMING PLAN

3/8" = 1'-0"



SHEET PILING CUT-OUT PLAN

3/8" = 1'-0"



NORTH ELEVATION (SOUTH & WEST ELEVATIONS SIMILAR)

3/8" = 1'-0" SEE SHEET PILING CUT-OUT PLAN

GENERAL NOTES :

1. WOOD: SOUTHERN YELLOW PINE PRESSURE TREATED TO 0.4 POUNDS PER CUBIC FOOT RETENTION OF ALKALINE COPPER QUAT (ACQ) PER AWPA STANDARDS OR EQUIVALENT
2. STEEL: ASTM A36
3. BOLTS, NUTS, WASHERS: ASTM A307 GRADE A, ZINC PLATED. UPSET THREADS OR DOUBLE NUT TO PREVENT NUTS FROM BACKING OFF.
4. WELDING: ACCORDING TO AWS D1.1 USING E70 SERIES ELECTRODES
5. GALVANIZING: HOT-DIP GALVANIZING PER ASTM A123 OR A153 WITH A MINIMUM COATING OF 2.0 OUNCES OF ZINC PER SQUARE FOOT OF METAL UNLESS OTHERWISE DICTATED BY STANDARD.
6. ALL STEEL SHALL BE GALVANIZED AFTER FABRICATION.
7. ALTERNATIVE CONNECTION DETAILS MAY BE CONSIDERED TO FACILITATE UNDERWATER CONSTRUCTION.

HDR

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
A	7/8/04	FOR CLLID REVIEW

PROJECT MANAGER	J. CHRISTOPHERSON
PROJECT NUMBER	15090-001-164

CHISAGO LAKES LAKE IMPROVMENT DISTRICT LOFTEN AVENUE WEIR MODIFICATION

BAFFLE EXTENSION FRAMING PLAN SHEET PILING CUT - OUT PLAN, AND ELEVATIONS

0 1" 2"

FILENAME

SCALE AS SHOWN

SHEET **Fig. 4**

C:\WINDM\15090001.164\00S-01.DWG, Plot, 11/09/2004 03:09:10 PM, mhenkel

It is the existence of the control gates at the Chisago and Green Outlets that made the initial 1987 Emergency Management Plan necessary. This current plan updates the 1987 plan to reflect changes to the outlet system. Section 2.0 presents the Operating Procedures for the various outlets. Section 3.0 describes monitoring and inspection procedures. Documentation and reporting requirements are presented in Section 4.0. Procedures for amending this plan are presented in Section 5.0, while a Winter Outflow Safety Plan is included as Appendix B. Appendix A includes supporting hydrologic and hydraulic documentation for the revisions.

1.2 GOALS AND POLICIES

In 1992, the CLLID developed a mission statement and adopted the following goals and objectives:

Mission Statement

> "The mission of the Chisago Lakes Improvement District is to make recommendations to the Chisago County Board of Commissioners, appropriate local units of government, state agencies and the general public on all matters pertaining to the management of the land and water resources in order to maintain the quality of the Chisago Lakes watershed."

Specific goals and objectives of the Chisago LID include:

- Preserve, protect and enhance water quality and quantity levels within the Lake Improvement District
- Maximize the aesthetic, cultural and financial benefit of living in Chisago County
- Maximize the value of land in an environmentally sound manner
- Encourage environmentally sound agricultural practices to ensure water quality within the Lake Improvement District

Goals and objectives for the Chisago Lakes Outlet management efforts include:

- Minimizing property damage to landowners along the outlet route, while minimizing Chisago and Green lake water level fluctuations and damage to lakeshore properties
- Securing maintenance access throughout the outlet system
- Minimizing long term maintenance needs and capital expenditures for the outlet system

SECTION 2.0: OPERATING PROCEDURES

This section discusses specific procedures, and notification requirements for operation of the control gates at the Chisago low weir, the Chisago permanent outlet, the Green (Ellen Lake) Outlet and the Ivywood Outlet structure.

2.1 CHISAGO LOW WEIR

The usual position of the low weir control gates is fully closed.

The MnDNR Area Hydrologist shall be notified prior to opening or closing the low weir gate. The low weir control gates may be opened if:

- Chisago Lake's level is projected to rise above the Ordinary High Water Level of 900.2
- Any time the actual level exceeds elevation 899.2

The gates must be closed:

- If inspections find downstream damage, obstructions that could lead to damage, or water levels outside of easements
- When the lake is lowered to an elevation of 898.7

Reproducible hydrologic methods will be used to project summer lake levels. The following snow pack formula will be used to make winter/snow melt projections.

"Projected Level" – L + f x S

Where L = the actual lake level measured in late winter, f = 0.18, and S = the water equivalent in inches of accumulated snow. The factor f in this definition is the ratio of the watershed area to lake area, the ratio then being divided by 12 to convert inches to feet. The water equivalent of accumulated snow, factor S, shall be obtained from the National Weather Service.

2.2 CHISAGO OUTLET

The usual position of the Chisago Outlet control gate varies seasonally as follows:

<u>During Late Winter Through Fall.</u> During late winter through fall (that is from March 1 until the formation of ice on the lakes), the usual position of the Chisago Outlet control gate is fully open when the lake level is below 900.0; for higher lake levels the discharge from the gate will be limited to the

available capacity of the outlet systems as defined by the easements. However, the gate may be maintained closed if desired when the lake level is below 899.2.

During Early and Mid-Winter. During early and mid-winter (that is, the period from ice formation until the end of February), the usual position of the Chisago Outlet control gate is fully closed.

Closing of the Chisago Outlet Control Gate. The Chisago Outlet control gate must be closed if Green Lake exceeds its OHW (892.5). The gate must also be partially or fully closed if inspections find that significant downstream damages, or obstructions, or if the downstream capacity is consumed as defined by easements. Once damages are repaired or obstructions removed the gate can be opened provided there is capacity within the easements.

2.3 GREEN OUTLET

The usual position of the Green Lake Outlet varies by season as follows:

During Late Winter Through Fall. During late winter (i.e., from March 1 until the formation of ice on the lakes), the usual position of the Green Outlet control gate is fully open when the lake level is 891.5; for high lake levels the position in set for up to the design outflow rate. However, the gate may be maintained closed if desired when the lake level is below 891.0.

During Early and Mid-Winter. During early and mid-winter (i.e., the period from ice formation until the end of February), the usual position of the Green Outlet control gate is fully closed.

Closing of the Green Outlet Control Gate. If Swamp Lake reaches a “high” level (defined as 882.7), then the Green Outlet control gate must be closed until both of the following occur: (1) the County investigates whether any flow obstructions exist at County Road 80 or downstream, and if so, removes them, and (ii) the level of Swamp Lake retreats to 881.6. After (i) and (ii) occur, the gate may be opened again to its usual position.

The gate must also be partially or fully closed if inspections find that significant downstream damages, or obstructions, or if the downstream capacity is consumed as defined by easements. Once damages are repaired or obstructions removed the gate can be opened provided there is capacity within the easements.

Ivywood Outlet Structure. The normal position of the Ivywood structure is to have all of the flashboard risers in place. Risers can be removed when the Green Outlet gate is open provided inspections show no potential for downstream damage.

SECTION 3.0: MONITORING AND INSPECTION

Monitoring and inspection will be completed to document flow conditions, assure the adequacy of natural flowage paths downstream from Swamp Lake and to assist with determining control gate settings for the Chisago and Green Outlets. The Wallmark Outlet will also be routinely inspected to identify maintenance needs.

3.1 MONITORING

Monitoring will consist of weekly lake level readings by the County, or through the Minnesota Department of Natural Resources (MnDNR) volunteer-based Lake Hydrology program. Lakes monitored by this effort include Green, Chisago Lake, North Center, North Lindstrom, South Lindstrom, Ellen, Swamp and Wallmark Lakes. In addition, when the lower weir is in operation, water level measurements will also be collected weekly at a representative locations established near each outlet structure, the Swamp Lake Outlet at County Road 80, the Ivywood Outlet structure at Ivywood Trail and at Highway 19. The water level stations will be surveyed, so that all measurements can be conveniently made from a bench mark of known elevation above sea level.

If it is desired to exercise the late-winter drawdown option with the Chisago Outlet, then the level of Chisago Lake must be monitored during the drawdown period.

3.2 INSPECTIONS

Monthly inspections of the outlet system will be completed when the system is operating and at least quarterly when the system is not operating. Inspections shall focus on whether or not there is erosion, or whether the capacity of the outlet system in adequate to handle flows released from adjusting the gates. Inspections shall include the outlet channel from Chisago to Green Lake, the Chisago Lake Outlet, the culvert at Highway 8, the Ellen Lake Outlet, the Swamp Lake Outlet at County Road 80, the Ivywood Outlet Structure, the Chisago to Wallmark Outlet weir and the channel at Highway 19. Inspections shall document water levels, erosion, obstructions to flow, ice conditions, the presence of nuisance aquatic vegetation and any other condition that may lead to damage along the outlet route. If obstructions, erosion, or problems are identified they must be corrected or repaired.

SECTION 4.0: DOCUMENTATION AND REPORTING

Weekly water levels reports will be prepared by the County and forwarded to MnDNR. An annual report will also be produced that provides a summary of outlet operations, water levels and maintenance activities for the previous year. This report will also be provided to the MnDNR.

SECTION 5.0: AMENDMENT PROCEDURES

Amendments to the plan will be completed as follows:

1. The County, in consultation with the Lake Improvement District and others as appropriate, will develop the proposed revision.
2. The County will submit the proposed revision to the MnDNR for review, and possibly, for permit revisions; and
3. The County will address MnDNR comments as necessary for approval.

Following MnDNR approval, the revision would become part of the plan.

Appendix A

Technical Memorandum:

Modeling Analysis for the Areas Downstream of CR 80 and Bloomquist Creek

HDR | ONE COMPANY *Many Solutions*℠

Memo

To:	Chisago Lakes Lake Improvement District		
From:	Suresh Hettiarachchi / Jeff Christopherson	Project:	Chisago Lakes
CC:			
Date:	9/8/2004	Job No:	13820

RE: Technical Memorandum: Modeling Analysis for Areas Downstream of CR 80 and Bloomquist Creek

1.0 Introduction

This memorandum proposes an alternative to the Ivywood Outlet to provide a secure outlet to the Chisago LLID (CLLID) water. The original plan approved by the DNR for the outlet from Green Lake to the Sunrise River called for construction of an outlet channel to convey CLLID water into Carlos Avery WMA. The principal outlet for the system, known as the Ivywood Outlet, has never been constructed. There have been numerous attempts to gain permit approvals for the Ivywood Outlet to no avail. Federal permit requirements have prevented project completion due to the required excavation of a Type 6 tamarack wetland and increased risk of exotic species transfer across watershed divides. The alternate plan would abandon the construction of the Ivywood Outlet and instead acquire flowage easements along the existing discharge route. In addition to acquiring easements, improvements to private access road culverts are recommended. This newly proposed alternative plan results in only minor wetland disturbance and creates a significant greenway buffer adjacent to Carlos Avery WMA.

Hydrologic and hydraulic modeling was conducted to determine easement needs along the outlet route. The proposed outlet route is downstream of Swamp Lake through the wetland area bordered by County Road 80 on the south, County Road 19 on the north, Ivywood Trail on the west, Karmel Avenue on the east, and then along Bloomquist Creek north of County Road 19, as shown in Figure 2. Seven parallel 24-inch culverts pass under County Road 80, separating Swamp Lake from the wetland area, and a single 36-inch culvert passes under County Road 19, separating the wetland area from Bloomquist Creek. The hydrologic and hydraulic modeling results are used to estimate the extent of impact caused by the addition of CLLID water through the wetland area and along Bloomquist Creek.

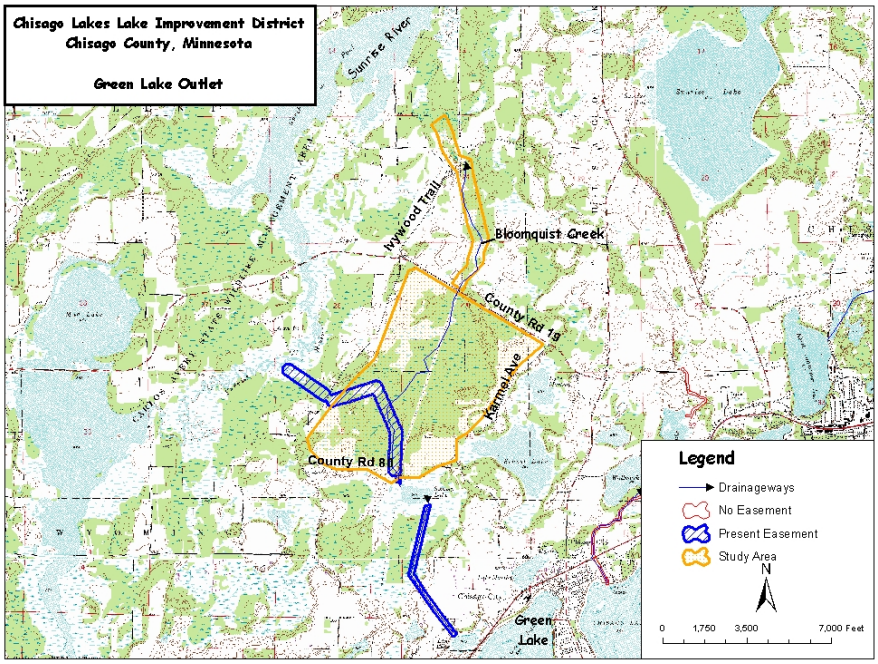


Figure 1 – Project area for the Green Lake Outlet

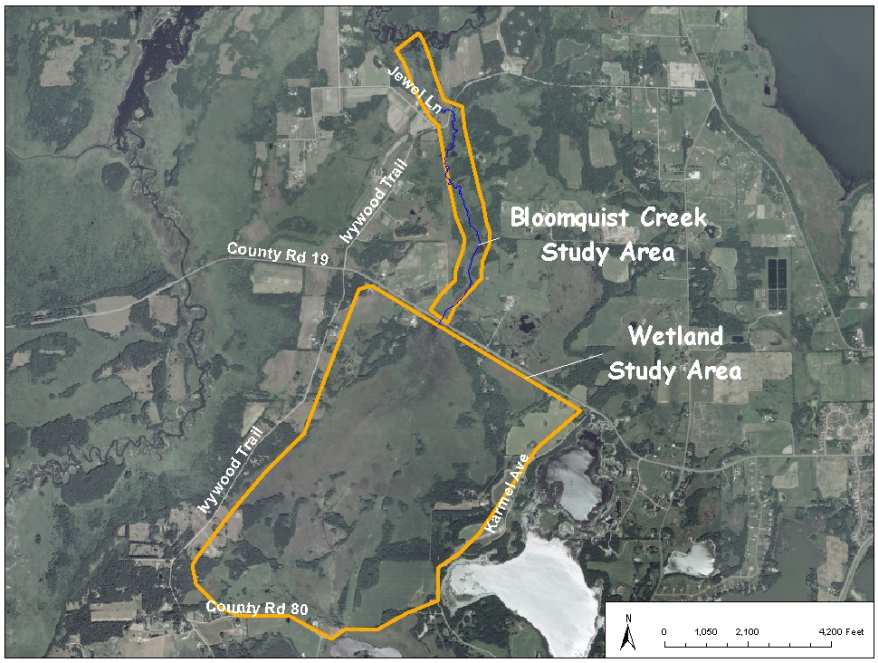


Figure 2 – Outlet and modeling area north of Swamp Lake ***(2003 FSA aerial photo)***

2.0 Modeling Approach

The modeling approach is based on determining the runoff volume and rate for the surrounding watershed and adding the additional maximum CLLID water flow from the Lakes as a constant rate flow. The maximum CLLID water flow from the Lakes is permitted to be 78 cubic feet per second (cfs) and is added upstream of County Road 80. Model runs were completed to estimate the extent of high-water caused by the local watershed and with and without 78 cfs from the CLLID. The runoff from the local watershed is based on a 100-year 24 hour rainfall event (5.9 inches in 24 hours).

2.1 Modeling the area between County Road 80 to County Road 19

The County Road 80 to County Road 19 subwatershed area (Figure 1) is approximately 816 acres. The wetland slopes seven feet from County Road 80 (elevation 881) to County Road 19 (elevation 874), which allows for a small but positive flow gradient (approximately 0.0007 ft/ft) towards Bloomquist Creek. Due to this slight gradient, a large volume of water can be stored within the area. The wetland area was modeled as three separate storage areas (Figure 3) to approximate the above mentioned flow path. The storage rating curves for the three areas were determined based on the 1-ft contours and are listed in Table 1. The local runoff rate and runoff volume contributing to the wetland area was determined using the SCS Curve Number Method which utilizes sub-watershed area, sub-watershed curve number, time of concentration, and initial abstraction. The resulting values for each parameter are listed in Table 2. Two model runs were completed for the local runoff only condition and with the added 78-cfs.

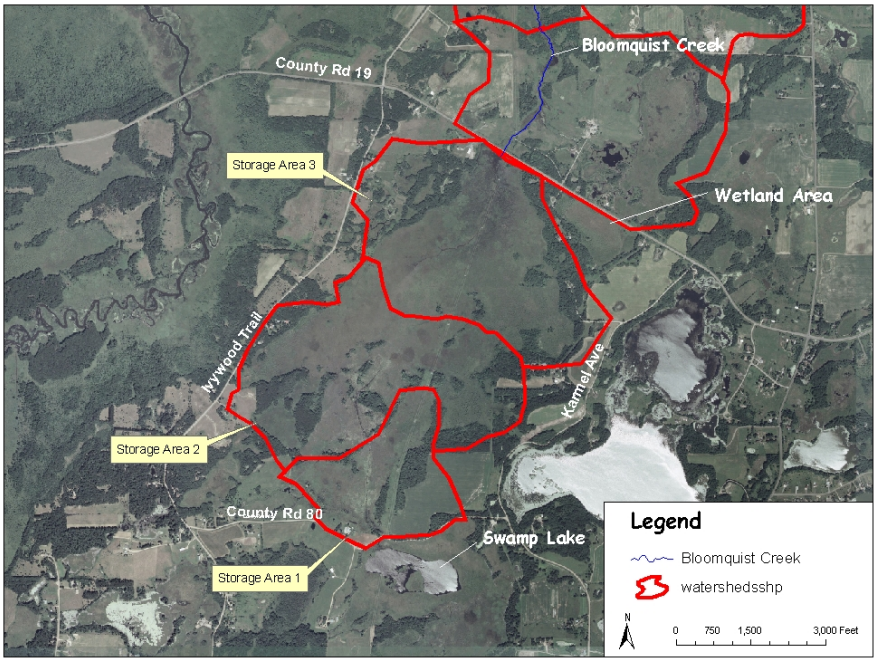


Figure 3 – Three separate storage areas for the wetland area model ***(2003 FSA aerial photo)***

The storage and hydrologic information was used as input into the XP-SWMM modeling software package. XP-SWMM was selected due to its capability to simulate backwater effects that would govern the flow during high water levels.

Table 1 – Stage information for the wetland area

	Elevation (ft)	Area (acres)	Volume (ac-ft)
Storage Area 1	879	0.2	0
	880	52.5	26
	881	56.1	81
	882	57.7	137
	883	60.6	197
	884	60.9	257
Storage Area 2	877	0.5	0
	879	133.0	134
	880	229.9	315
	881	238.6	549
	882	246.7	792
	883	256.9	1044
	884	261.3	1303
	885	301.6	1584
Storage Area 3	872	0.2	0
	874	0.9	1
	875	16.3	10
	876	49.7	43
	877	95.3	115
	878	210.4	268
	879	237.7	492
	880	248.8	735
	881	269.0	994
	882	271.1	1264
	883	277.9	1539
	884	282.8	1819
	885	296.1	2109

Table 2 – Hydrologic information for the County Road 80 to County Road 19 area

	Watershed Area (acres)	Curve Number	Time of Concentration (min)
Storage Area 1	144	76	58
Storage Area 2	328	84	54
Storage Area 3	344	82	57

2.2 Modeling Bloomquist Creek

Bloomquist Creek was set up as a separate model. The areas are connected by a 36-inch diameter corrugated metal pipe (CMP) and the inflow to Bloomquist Creek is calculated as the outflow hydrograph from the County Road 80 to County Road 19 XP-SWMM model. Since Bloomquist Creek is a distinct channel, HEC-RAS was selected as the most appropriate modeling software for modeling open channel flow.

Figure 4 displays the locations of the cross-sections used to develop the geometry of the HEC-RAS model. The cross-sections and the hydraulic structures were surveyed on June 16, 2004. The roughness coefficients for the Creek were estimated based on field observations, survey notes and aerial photographs.

To estimate the peak flow contributed from the Creek's local watershed, the USGS regression equation for that area was used. The basis for selecting USGS regression equations is that the USGS regression equations provide a simple and direct approach to account for the flow attenuation and storage of swamps and wetlands.

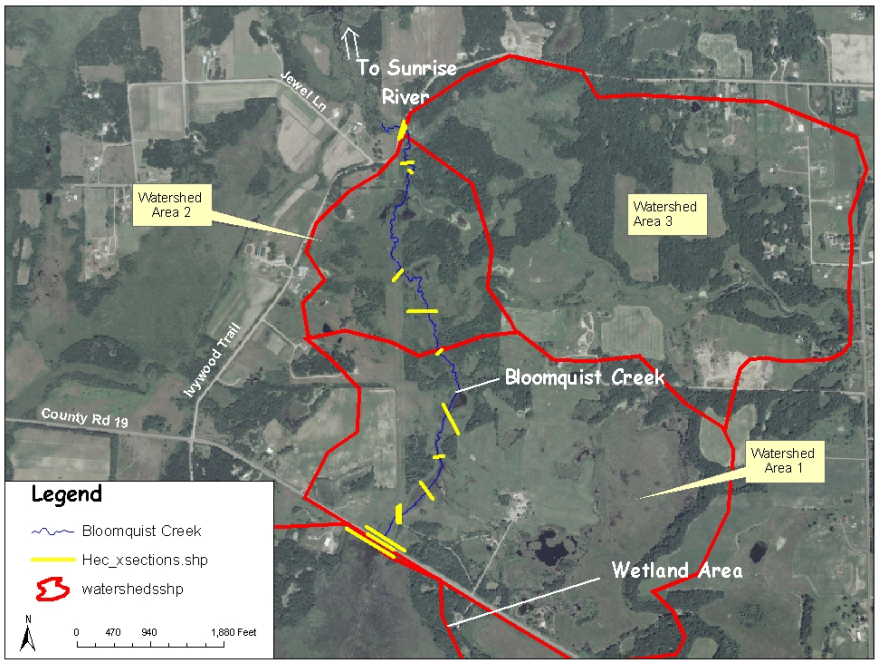


Figure 4 – HEC-RAS cross section locations and watershed boundaries for Bloomquist Creek. ***(2003 FSA aerial photo)***

The watershed areas for the regression equations were divided as shown in Figure 4 with the input and results listed in Table 3. The estimated error for the regression equation as listed in the guide is 54%. Hence the peak flows were increased by 54% in order to be conservative. The peak flow from the wetland area across County Road 19, as modeled in XPSWMM, was added to the upstream of the HECRAS model. As seen in the results section, the outflow across County Road 19 did not change due to the addition of 78-cfs.

Table 3 – Hydrologic information for the Bloomquist Creek model

	Watershed Area 1	Watershed Area 1 + Area 2	Watershed Area 1 + Area 2 + Area 3
Area (acres)	364	476	876
Slope (ft/ft)	0.0058	0.00515	0.003375
Lake Area (acres)	150	160	253
Peak Flow for 100-Yr Event from Regression Equation (cfs)	38	43	46
Local Flow Only with 54% Error (cfs)	58	66	71
Peak flow rate including flow across County Road 19 from wetland area	137	145	150

3.0 Results

Figure 5 shows the extent of water coverage based on the modeling effort. Table 4 lists the results from the HEC-RAS model along with the results from the XP-SWMM model for the upstream portion. As shown in Table 4, the peak water surface elevation (WSE) changed minimally due to the additional lake flows upstream of County Road 80. The storage volume available within the wetland area is able to attenuate the effects of the added flow at County Road 80. The outflow across County Road 19 to Blooquist Creek remains unchanged, resulting in no change in the water surface elevations.

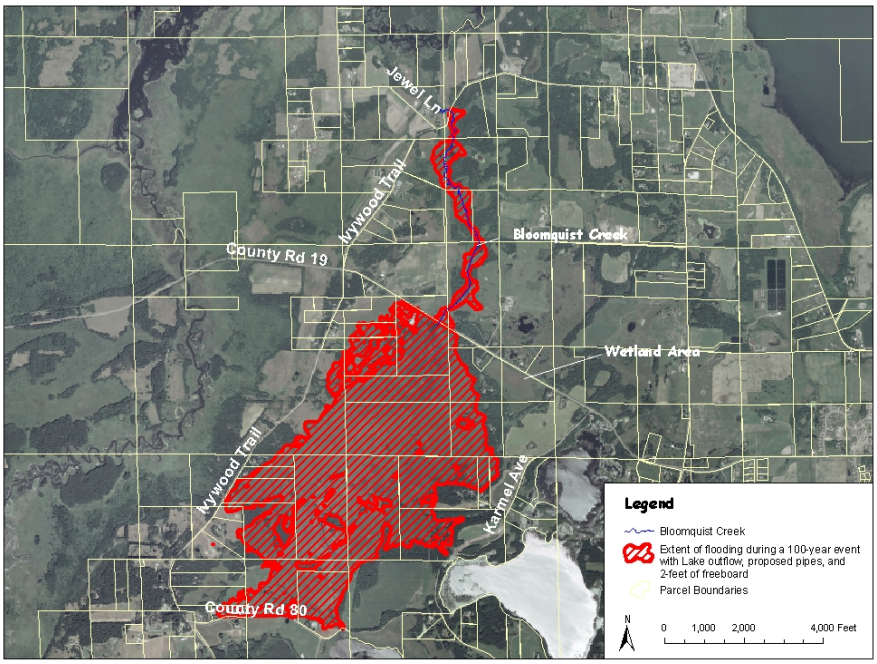


Figure 5 – Extents of water coverage based upon modeling ***(2003 FSA aerial photo)***

Table 4 – Modeling Results

		Outflow before additional flow (cfs)	Outflow after additional flow (cfs)	Elevation before additional flow (ft)	Elevation after additional flow (ft)	Elevation with 2-feet of freeboard (ft)
Area between County Road 80 and County Road 19 (XP-SWMM Results)	**Storage Area 1**	74	82	881.3	881.3	883.3
	Storage Area 2	227	227	880.8	880.8	882.8
	Storage Area 3	79	79	880.7	880.7	882.7
Bloomquist Creek (HEC-RAS Results)	**Watershed Area 1**	137.5	137.5	872.9	872.9	874.9
	Watershed Area 2	145	145	865.9	865.9	867.9
	Watershed Area 3	150	150	865.1	865.1	867.1
	Outlet	150	150	860.4	860.4	862.4

4.0 Summary

The CLLID board has determined that it is no longer feasible to construct the Ivywood Outlet. An alternate plan is proposed that results in acquisition of flowage easements in two areas. These two areas are between CR 80 and County Road 19, and north of County Road 19 along Bloomquist Creek.

The required easement area was determined by running hydrologic and hydraulic models for two cases. The first case was under pre-CLLID outlet conditions using a 100-year peak flow event to establish pre-CLLID outlet project high water levels. The CLLID peak outlet flow of 78 cfs was then added to the model to evaluate the impact of the CLLID water on the study area. The model results indicate that peak surface water elevations are not significantly impacted, however duration of highwater events is increased. Practical experience with CLLID outflow has shown that longer duration flows can cause maintenance issues that result in temporary episodes of highwater in localized areas. Therefore, a two foot freeboard has been factored into the analysis to account for these temporary episodes.

The easement requirements are listed in Table 5

Table 5 – Easement Requirements

Area	Number of Parcels affected	Existing Flooding Area (acres)	Area with 2-ft Freeboard Area (acres)	Flood Easement Required (acres)
Bloomquist Creek	7	24.1	38.3	14.2
Area between County Road 80 and County Road 19	28	582.4	631.4	49.0

Appendix B

Winter Outflow Safety Plan

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES

BOX , 500 LAFAYETTE ROAD • ST. PAUL, MINNESOTA • 55146

DNR INFORMATION
(612) 296-6157

RECEIVED BY
WENCK ASSOCIATES INC.
DEC 29 1986

December 23, 1986

Mr. John B. Erdmann, P.E.
Wenck Associates, Inc.
832 Twelve Oaks Center
Wayzata, MN 55391

Dear Mr. Erdmann:

It appears that your Winter Outflow Safety Plan meets the minimum marking standards set forth in the Commissioner's Order on aeration systems. The Chisago County Sheriff's Department has picked up 25 - "Thin Ice" signs from us for use on the project.

Sincerely,

Kim A. Elverum
Boat and Water Safery Coordinator

KAE/de

Cc: Dave Leuthe, DNR/Cambridge-Waters
Dave Ford, DNR/St. Paul-Waters
Chisago Co. Sheriff's Department

AN EQUAL OPPORTUNITY EMPLOYER

Wenck Associates, Inc.

Consulting Engineers
(612) 475-0858

December 16, 1986

Mr. Douglas J. Weiszhaar, P.E.
Chisago County Engineer
Chisago County Highway Department
Box 326
Center City, Minnesota 55012

Re: Winter Outflow Safety Plan
Chisago Lakes Outlet Project

Dear Doug:

Enclosed is the Winter Outflow Safety Plan as requested. As I explained on the telephone, copies are also being transmitted directly to the DNR to expedite review and approval.

Let me know if you have any questions on this.

Respectfully submitted,

WENCK ASSOCIATES, INC.

John B. Erdmann

John B. Erdmann, P.E.

JBE/msw

Enclosure

cc: David Leuthe, DNR (Cambridge)
David Ford, DNR (St. Paul)
Kim Elverum, DNR (St. Paul)

832 Twelve Oaks Center
15500 Wayzata Blvd.
Wayzata, MN 55391

WINTER OUTFLOW SAFETY PLAN
CHISAGO LAKES OUTLET PROJECT
DECEMBER 1986

A. Purpose

The purpose of the Winter Outflow Safety plan is to prevent accidents which could potentially occur as a result of open water created by flow through the Chisago Lakes Outlet Project during its first winter of operation. There are four particular areas of concern: (1) the outfall vicinity in Green Lake from the Chisago-Green outlet, (2) the narrows between Green and Little Green Lakes, (3) the area in Little Green Lake near the Highway 8 crossing into Lake Ellen, and (4) all of Lake Ellen itself. Figure 1 shows the location of the outfall in Green Lake from the Chisago-Green outlet. Figure 2 shows the other three locations. In all of these areas there will most likely be a region of open water and/or thin ice. This poses a potential hazard to snowmobilers, ice fishermen, children and others who venture onto the lake ice for any purpose.

B. Guidelines

The Minnesota Department of Natural Resources has official safety requirements for lake aeration systems, which also may create open water or thin ice. The DNR transmitted these safety requirements to Chisago County to be used as guidelines for the Winter Outflow Safety Plan. The DNR requirements are contained in Commissioner's Order 2194 and related sign specifications.

C. Marking

As outlined below, Green Lake, Little Green Lake and Lake Ellen will be marked with specified signs at public access and other commonly used access locations and at the four particular areas of concern.

1. Public Access Locations

Figure 3 shows the typical sign which will be posted on the shorelines of Green Lake, Little Green Lake and Lake Ellen at each public access point and other areas commonly used by the public for access to the lake.

2. Particular Areas of Concern

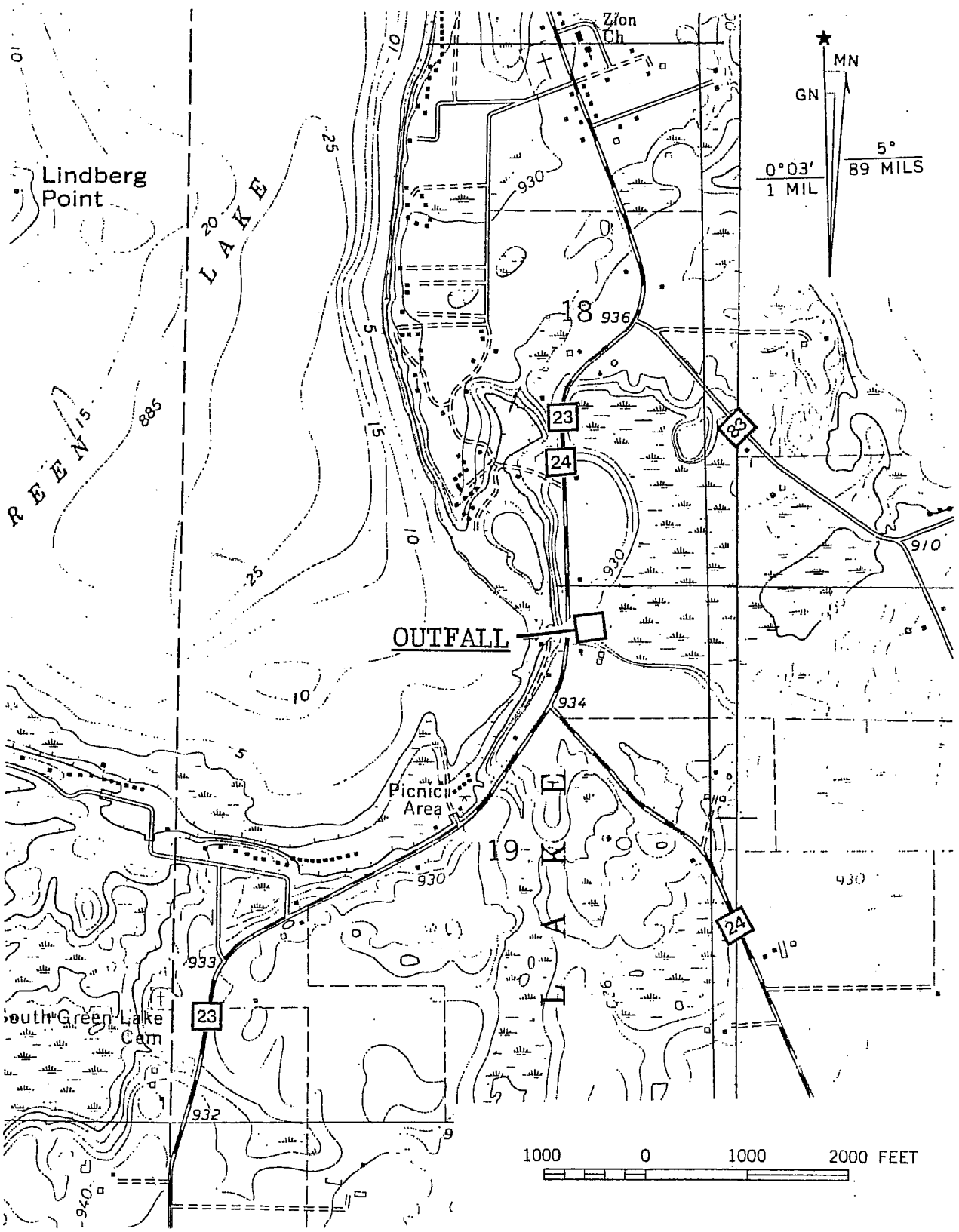
Figure 4 shows the typical "thin ice" sign which will be posted around the perimeter of the four particular areas of concern where the flowing water significantly affects the ice. For each area, the signs will be installed at a height of from four to six feet in a rectangular pattern at each corner of the area. At least two additional signs will be posted between the corner signs on any side exceeding 100 feet in length.

To the extent that the County deems it prudent and feasible, fencing will be placed around the affected areas.

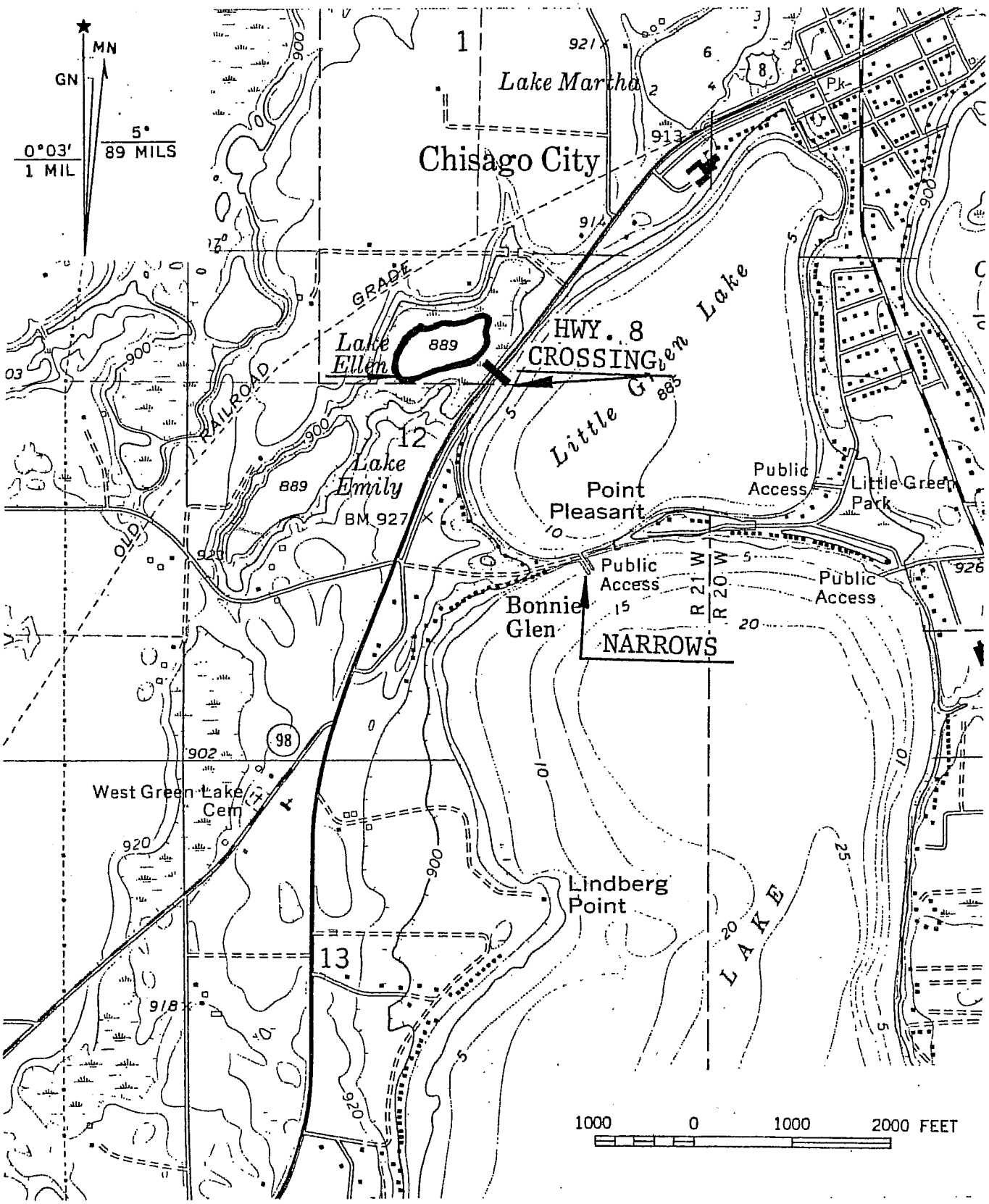
In order to facilitate retrieval of signs and any fencing used on the lake, these may be installed using wooden posts set into the ice.

D. Publication of Notice

Between 5 and 20 days prior to commencement of winter flow through the Chisago Lakes Outlet Project, notice will be published at least two times in area newspapers including the Chisago County Press, Lindstrom and the East Central Minnesota Post Review, North Branch. The notice will include the locations of the outfall in Green Lake, the narrows, the Highway 8 crossing, and Lake Ellen, and the date of commencement of operation.



CHISAGO COUNTY BOARD	Consulting Engineers	DEC. '86
Location of Chisago-Green Outfall in Green Lake	Twelve Oaks Center 15500 Wayzata Blvd.	1



CHISAGO COUNTY BOARD	Consulting Engineers	Dec. 86
Location of Ellen, Hwy. 8 Crossing & Narrows	Twelve Oaks Center 15500 Wayzata Blvd	2

Minnesota Department of Natural Resources

Sign Typical
Bureau of Engineering

WARNING

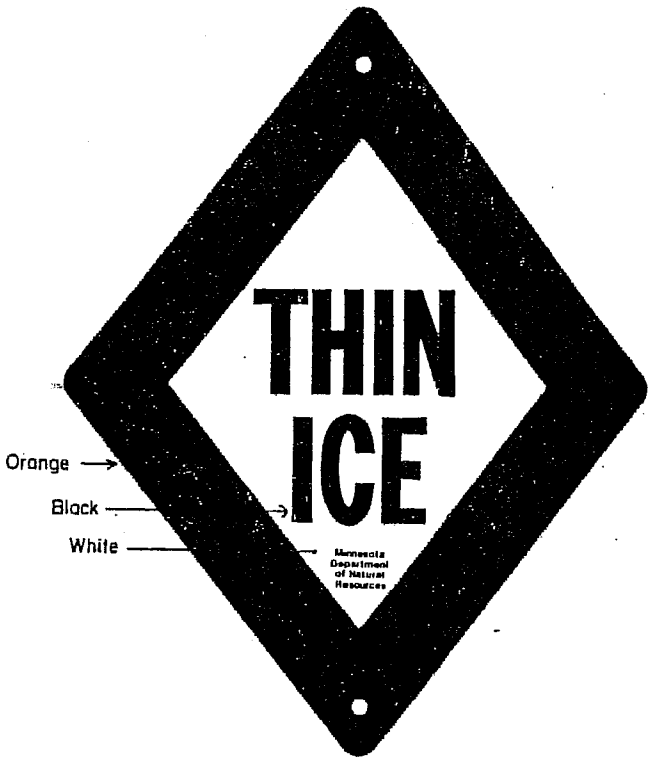
Inflowing water is creating open water and thin ice on this lake.

USE EXTREME CAUTION

Sign: WARNING	Notes:
Color. BL./OR.	Wording modified for lake outlet system.
Material: ■ Al. ☐ W.R. ☐ Cd.Bd. ☐ Decal	
Size: ☐ 12"x 18" ■ other 18" x 24"	
Mounting Post: ☐ metal ■ wood	
Reflectorized: ☐ no ■ yes	
File/ID. no NR 8-348 Date 5/84	

Minnesota Department of Natural Resources

Sign Typical
Bureau of Engineering



Sign: Thin Ice	Notes: To be used on all Fisheries operations where open water may be created. Sign can be applied to a wood support.
Color: BL., OR. / WH.	
Material: ■ Al. ☐ W.R. ☐ Cd.Bd. ☐ Decal	
Size: ☐ 12"x18" ■ other 14"x 18"	
Mounting Post: ☐ metal ■ wood	
Reflectorized. ☐ no ■ yes	Specified by Minn. Water Safety Law NR 204 (a) (6) (8)
File/ID. no. NR 8-345 Date 5/84	