Ditch 14 Hydraulic and Water Quality Study

Pelican River Watershed District

Detroit Lakes, Minnesota

Prepared for

Pelican River Watershed District

April 2006

Wenck

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Prepared for:

PELICAN RIVER WATERSHED DISTRICT
Detroit Lakes, Minnesota

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April 2006

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1.0 Introduction

1.1 INTRODUCTION

The Detroit Lakes-Becker County Airport has identified two expansion alternatives that result in the filling of 24 or 27 acres of wetland adjacent to Ditch 14 in the city of Detroit Lakes, MN (Figure 1). The Pelican River Watershed District (PRWD) authorized Wenck Associates, Inc. to conduct a hydrologic and water quality study on the affect of the proposed airport expansion and wetland fill. The PRWD is concerned that the proposed fill may impact the water quality of downstream waterbodies such as Lake St. Clair and the Pelican River. The following report describes the methods, results and analysis. The report does not consider wetland mitigation requirements under the Minnesota Wetland Conservation Act or the Federal Clean Water Act.

1.2 BACKGROUND

The Detroit Lakes-Becker County Airport Commission proposed improvements to the Detroit Lakes-Becker County Airport (Wething Field) as presented in the *Final Draft Federal Environmental Assessment and Final State Environmental Impact Statement* (SEH, September 2005). The proposed expansion includes the extension of the primary runway, installation of a precision approach, completion of the full-length parallel taxiway, improvements in the terminal area, and land acquisition to accomplish the proposed improvements. The document details five runway alignment alternatives, of which one is "no-action." The preferred alternatives, as identified in the document, propose wetland fill of 24 or 27 acres (Appendix A). The proposed fill is located adjacent to Becker County Ditch 14 between Long Lake Road and US Highway 10 and immediately west of US Highway 59.

2.0 Methods

2.1 SUBWATERSHEDS

The study area includes all areas tributary to the Ditch 14-Airport wetland and the downstream extent of Ditch 14 where any noticeable impacts from the proposed filling may occur. USGS quadrangle maps and the Detroit Lakes *Stormwater Drainage Plan* (Larson-Peterson & Associates, Inc., 2001) were used to delineate subwatersheds within the study area. Figure 2 shows the subwatershed boundaries located within the study area.

2.2 HYDRAULIC INFORMATION

Minnesota DNR, City and MnDOT staff provided hydraulic information for all crossings and hydraulic structures within the study area. Three crossings were not shown on the USGS quadrangle map or the Larson-Peterson study. Therefore, the subwatershed map was updated with hydraulic information provided by each agency.

Wetland and lake storage-area relationships were determined based on DNR lake data and with a Planix digital planimeter using the USGS quadrangle maps – more accurate topographic maps were not available. Open channel dimensions were estimated based on field inspection and personal experience of PRWD and DNR staff. All hydraulic information is summarized in Appendix B.

The Detroit Lake peak discharge was obtained from the FEMA Flood Insurance Study (1986) for the 2-, 10-, 50-, and 100-year events. A discharge hydrograph was not available for each of the events.

2.3 G.I.S. LAND USE INFORMATION

After finalizing the subwatershed boundaries, Wenck contacted City staff to obtain a future land use plan. After review of the future land use plan, it was determined that much of the study area

was located out of the legal boundary of the city. The city land use plan, therefore, is not included in this analysis.

Wenck staff also obtained land use data from the DNR. The DNR data includes the entire state of Minnesota, so it provided land use data for the balance of the study area not included in the City's land use plan. The City and DNR data sources, however, do not contain comparable land use categories. For example, much of the area within the airport subwatershed (Subwatershed 12 on Figure 2) is defined as "government facilities" on the City's land use plan. Within this one category, however, there are several land uses with different runoff characteristics: MnDOT facilities, the airport and wetlands. The DNR appropriately separated these land use categories into wetlands, urban and industrial, and "transitional use." Therefore, Wenck staff decided to use only the land use data from the DNR in order to be consistent throughout the study area (Figure 3).

2.4 SUBWATERSHED CURVE NUMBERS

Using the DNR land use data and an electronic copy of the Becker County Soil Survey (Figure 4), Wenck calculated curve numbers based on land use and soil types. Composite curve numbers were calculated for each subwatershed. A curve number indicates the potential for runoff from a specific land use. Higher curve numbers indicate higher runoff potential. Subwatershed curve number calculations are provided in Appendix C.

2.5 EXISTING CONDITION COMPUTER MODEL

Wenck used the XP-SWMM computer model for hydraulic and hydrologic modeling. XP-SWMM is a dynamic, unsteady flow model that simulates the effect of storage and backwater in conduits and floodplains and accounts for the timing of multiple hydrographs to yield a true representation of the water elevation at any point in space and time. The model simulates the complete hydrologic cycle in rural and urban watersheds.

The data was entered into the computer program for the existing condition and executed. Similar models were built for the two airport alternatives. The difference between the existing and the

"Alt 1" model was that 24 acres were removed from the stage-area relationship for the Ditch 14-Airport wetland in Subwatershed 12. Similarly, the second model, titled "Alt 2," removed 27 acres from the stage-area relationship of Subwatershed 12. All other hydrologic and hydraulic information was not changed.

3.0 Analysis & Results

3.1 ANALYSIS

The Ditch 14-Airport wetland is a Type 3 (shallow marsh) wetland area and approximately 110 acres in size. Review of the 2003 Farm Service Agency aerial photo (Figure 1) indicates the wetland has very little open water with the majority of the wetland covered by emergent vegetation (i.e. cattails). Ditch 14 flows through the center of the entire wetland and continues south under Long Lake Road to Lake St. Clair.

Activities at the airport will result in the filling of some wetland acres and the potential loss of wetland habitat. The loss of wetland area could result in a loss or decline in wetland functions. One area of concern is a potential change in wetland bounce. Large fluctuations in wetland bounce can stress wetland vegetation, which can lead to a decline in water quality. Significant changes in wetland bounce can also affect the mineralization of wetland soils, ultimately increasing the rate of soil breakdown and increasing the associated phosphorus release. Another area of concern would be a decrease in wetland storage capacity, which would be seen as an increase in discharge volume. A large increase in discharge volume may include a large export of phosphorus from the wetland that could in turn have negative impacts to other lakes and wetlands downstream in the watershed.

To evaluate potential changes in wetland function, recommended management strategies from the Minnesota Routine Assessment Method for Evaluating Wetland Functions (MnRAM) were used. There are four different wetland management classifications listed in conjunction with MnRAM. The four classes are: Preserve, Manage 1, Manage 2, and Manage 3 (Appendix D). A wetland classified in the Preserve category would have a very high vegetation diversity, provide exceptional habitat for wildlife, fish and amphibians and not be significantly impacted by invasive species or human-alterations. Wetlands in the preserve category may also demonstrate unique features or would be considered outstanding resource waters. The Ditch 14-Airport

wetland already has been impacted through the creation of the Ditch 14 and therefore the Preserve management class is not applicable. The Manage 1 guidelines are established to preserve current wetland functions and values as well as habitat conditions.

The Manage 1 guidelines for hydrology recommend no more than a 0.5 ft change in wetland bounce for the 10-yr storm event. The Manage 1 guidelines for stormwater treatment recommend pretreatment of flow to the wetland and recommend a 35-50 foot buffer to protect the functionality remaining wetland from the loss of habitat due to fill. Manage 2 and 3 classifications are described in Appendix D.

3.2 RESULTS

3.2.1 Wetland Bounce

The XP-SWMM model results for discharge rate and bounce are presented in Table 1. The model results from both alternatives predict that the change in wetland bounce will be 0.1 feet for the 10-year storm, which is within the Mange 1 hydrologic guidelines. The model results show that the change in bounce under both alternatives will not change the functions and values of the wetland. Additionally, it is unlikely that the change in bounce will significantly change the soil mineralization dynamics in the wetland.

Note that there was no change in bounce downstream of Lake St. Clair where Ditch 14 crosses County Highway 6. Therefore, analysis for potential impacts to waterbodies downstream of Lake St. Clair is not necessary.

3.2.2 Water Quality

To estimate the impacts to water quality, changes in volume were examined for each airport alternative. Review of the District water quality monitoring data indicated no monitoring sites within the Ditch 14-Airport wetland. However, we can estimate a total phosphorus (TP) concentration based on typical concentrations measured in other wetlands in the watershed. If the management strategies discussed in the preceding section are followed, it is reasonable to assume that the TP concentrations will remain constant after wetland alterations. Using the assumption that the pre- and post-impact TP concentration will remain constant, changes in TP load can be

l from increases in runoff volume due to impacts to the Ditch 14-Airport wetland from
lel alternative.

)f 2005 water quality monitoring data from wetland sampling stations throughout the
d reveals that TP concentrations range from a 20 to 192 mg/L. For our calculations we
oncentration of 105 mg/L, which is a mid-point value in the range. Using 105 mg/L for
and both alternative conditions, the total increase in TP load will be less than 1 lb for
e four different storm type events at each of the three locations noted (Table 2). A less
increase in overall TP load is not considered significant and overall impacts to water
'ill be minimal.

'THER CONSIDERATIONS

roundwater

not included in the scope of this study, Wenck staff considered potential impacts to
ater flow as a result of the proposed airport alternatives. The Barr 1998 analysis *A Study*
ntribution of Groundwater to Phosphorus Loadings for Selected Lakes in the Pelican
tershed reports the Ditch 14-Airport wetland as a discharge wetland. Barr reported the
of groundwater flow was generally from Long Lake southeastward to Detroit Lake. A
f the flow was found to discharge to the Ditch 14 wetland complex. Wenck believes
roposed alternatives may impact groundwater discharge at localized areas, but that the
ng groundwater discharge to the Ditch 14 wetland complex will be maintained. It is
t any groundwater flows impeded by wetland fill will be redirected around the
:e and continue to discharge within the wetland complex.

/WTP Discharge

of Detroit Lakes discharges treated effluent from the wastewater treatment plant
to Ditch 14 just north of Long Lake Road (immediately downstream of the airport and
of Lake St. Clair, Figure 1). As a result, the plant is a significant source of phosphorus
) Lake St. Clair. Any increase in discharge from the WWTP would obviously have an

impact on downstream water quality and would require a completely separate analysis apart from this study.

4.0 Conclusion & Recommendations

4.1 CONCLUSION

Due to the proposed activities at the airport, slightly more than 20% of the 110-wetland acres of the Ditch 14-Airport wetland will be filled under either alternative. However, even with the loss of wetland acres, review of the model results suggests that there will not be a loss of wetland functions related to water quality. The change in bounce of the Ditch 14-Airport wetland will be within the recommended management guidelines and the overall increase in TP load will be minimal and not pose a threat to water quality.

4.2 RECOMMENDATIONS

4.2.1 Compensatory Storage

Model results indicate the existing 100-year floodplain elevation of the Ditch 14-Airport wetland is 1340.5. Wenck recommends that compensatory storage at a 1:1 ratio be required for any fill placed below this elevation. This study has demonstrated that the proposed airport expansion alone will not increase the wetland 100-year elevation by more than 0.3 feet nor degrade downstream water quality. However, because there are several property owners adjacent to this wetland, cumulative impacts due to many property owners filling parts of the wetland are a concern. For example, if two or three property owners are initially allowed to fill part of the wetland, the result may increase flood elevations to a level where fill by the rest of the adjacent property owners is not allowed. Creation of compensatory storage by each property owner will allow all property owners equal opportunity to fill and replace lost floodplain storage within the subwatershed of the Ditch 14-Airport wetland.

4.2.2 Low Floor Elevations

The model shows that the 100-year floodplain elevation will increase approximately 0.3 feet as a result of the proposed fill. This increase in elevation may impact existing homes and/or businesses that surround the wetland. Creation of compensatory storage will alleviate this

concern, as it will maintain the existing 100-year floodplain elevation. If compensatory storage is not required, a survey should be conducted to ensure that the proposed 0.3-foot elevation increase will not impact adjacent existing low floor elevations.

4.2.3 Best Management Practices

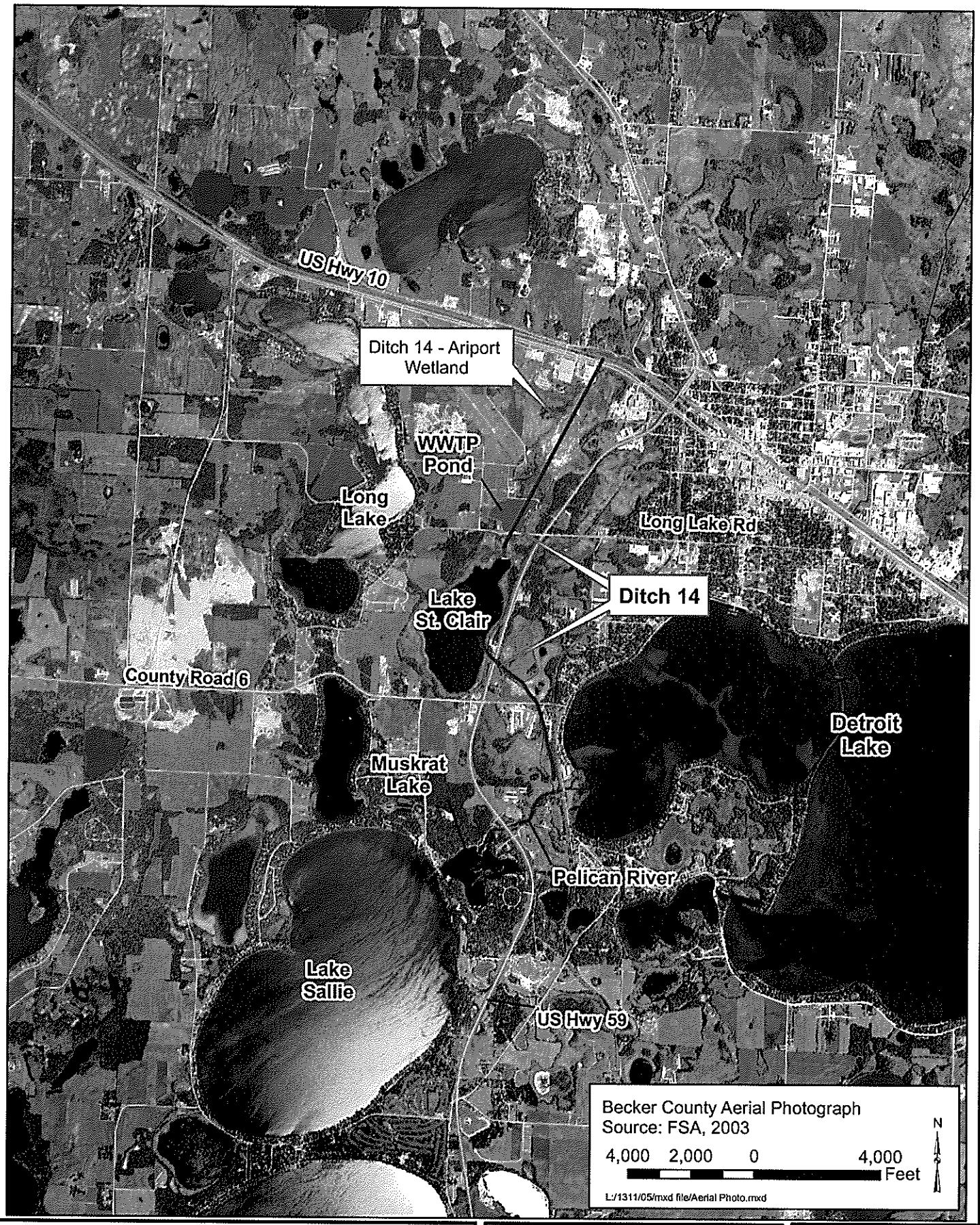
Finally, while the overall function and treatment capacity of the wetland will not be significantly affected by the filling of wetland acres, it is still recommended that BMPs be implemented to pre-treat runoff to the wetland complex. This is expected to occur according to PRWD permit requirements. Additionally, the creation of 35-50-foot buffer strips is also recommended to protect the wetland.

4.2.4 Summary

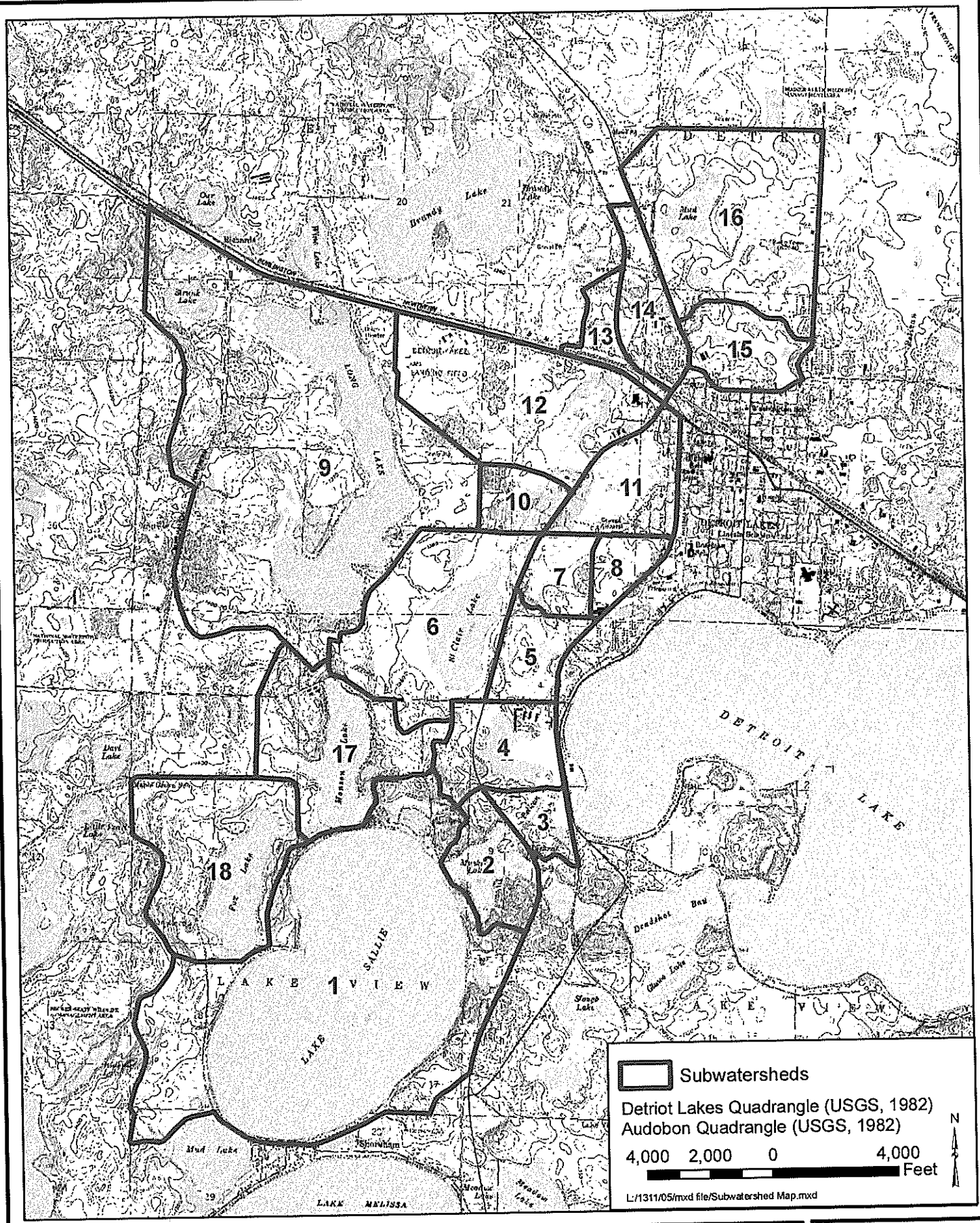
Wenck recommends the following actions to mitigate effects of the proposed wetland fill:

1. Require 1:1 compensatory storage for all fill below elevation 1340.5.
2. Require a minimum 35-foot buffer setback from the delineated wetland boundary, as future properties surrounding the wetland are platted.
3. Require that a MnRAM 3.0 evaluation be conducted on the wetland before and after airport expansion to ensure that all existing wetland functions and values are maintained.

Figures



PELICAN RIVER WATERSHED DISTRICT	Wenck Wenck Associates, Inc. 1800 Pioneer Creek Center Environmental Engineers Maple Plain, MN 55359-0429	APR 2006
Location Map		Figure 1



PELICAN RIVER WATERSHED DISTRICT

Subwatershed Map

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Wenck Associates, Inc. 1800 Pioneer Creek Center
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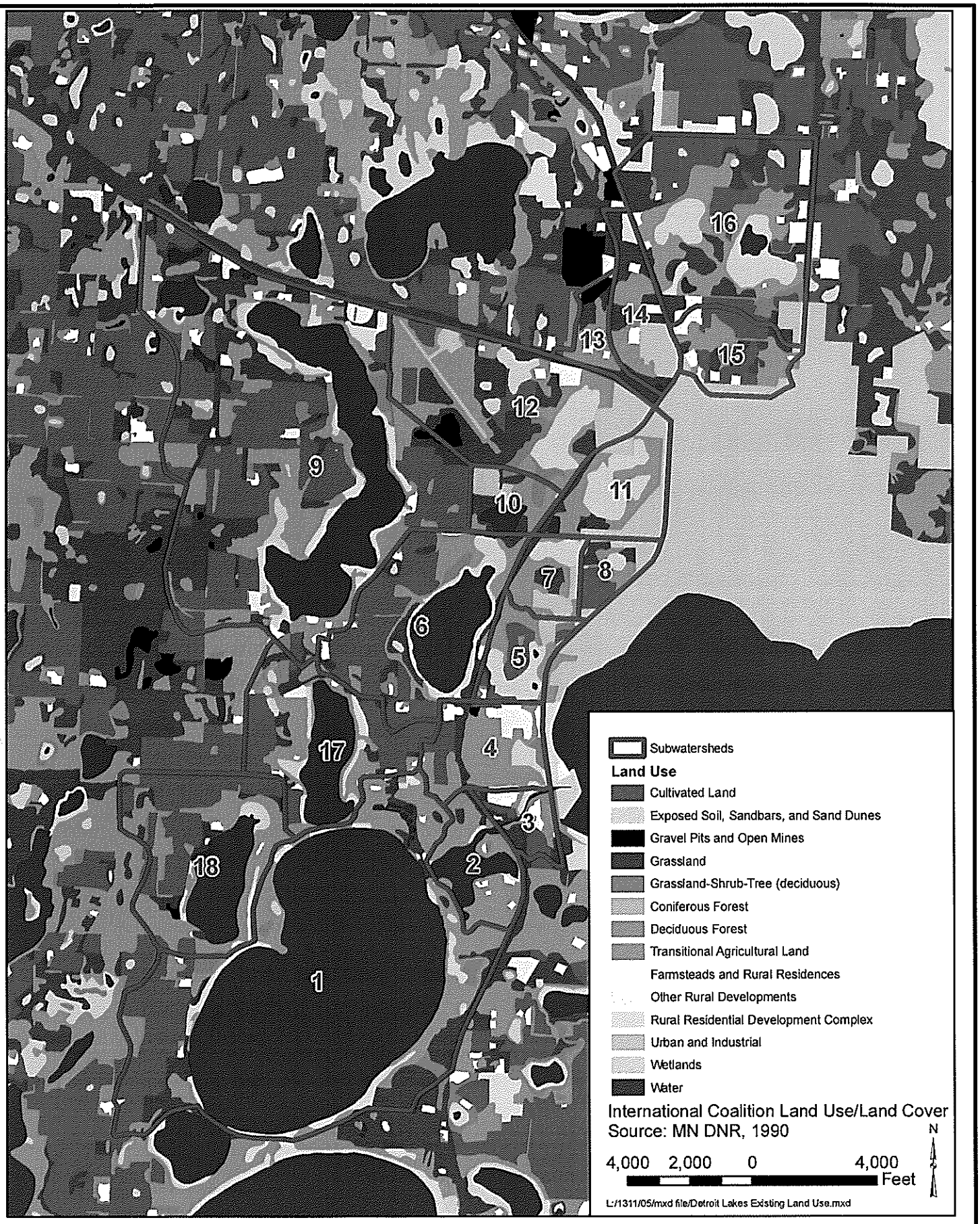
APR 2006

Figure 2



PELICAN RIVER WATERSHED DISTRICT

DNR Land Use with Subwatershed Boundaries

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Figure 3

PELICAN RIVER WATERSHED DISTRICT

Becker County Soil Survey with Subwatershed Boundaries

Wenck

Wenck Associates, Inc. 1800 Pioneer Creek Center
Environmental Engineers Maple Plain, MN 55359-0429

APR 2006

Figure 4

Table 1: Ditch 14 XP-SWMM model results to evaluate bounce of waterbodies.

2-year, 24-hour event

Location	Existing Discharge (cfs)	Existing Bounce (ft)	Alt #1 Discharge (cfs)	Alt #1 Bounce (ft)	Alt #2 Discharge (cfs)	Alt #2 Bounce (ft)
Airport	19.5	2	19.6	2	19.6	2
St. Clair	0.9	0.6	0.9	0.6	0.9	0.6
N Hwy 6	23.9	1.9	23.9	1.9	23.9	1.9

10-year, 24-hour event

Location	Existing Discharge (cfs)	Existing Bounce (ft)	Alt #1 Discharge (cfs)	Alt #1 Bounce (ft)	Alt #2 Discharge (cfs)	Alt #2 Bounce (ft)
Airport	30.5	2.7	31.6	2.8	31.8	2.8
St. Clair	6.7	1.2	6.7	1.2	6.7	1.2
N Hwy 6	74.5	3.6	74.5	3.6	74.5	3.6

50-year, 24-hour event

Location	Existing Discharge (cfs)	Existing Bounce (ft)	Alt #1 Discharge (cfs)	Alt #1 Bounce (ft)	Alt #2 Discharge (cfs)	Alt #2 Bounce (ft)
Airport	36.4	3.2	38.4	3.4	38.6	3.5
St. Clair	21.4	2.3	21.4	2.3	21.5	2.3
N Hwy 6	125.2	4.9	125.2	4.9	125.2	4.9

100-year, 24-hour event

Location	Existing Discharge (cfs)	Existing Bounce (ft)	Alt #1 Discharge (cfs)	Alt #1 Bounce (ft)	Alt #2 Discharge (cfs)	Alt #2 Bounce (ft)
Airport	39.4	3.5	42.4	3.8	42.9	3.8
St. Clair	26.8	2.8	27.1	2.8	27.1	2.8
N Hwy 6	146.9	5.6	146.9	5.6	146.9	5.6

Alt. #1: Wetland fill of 24 acres in Ditch 14 wetland (Airport).
Alt. #2: Wetland fill of 27 acres in Ditch 14 wetland (Airport).
Airport = Wetland to be filled adjacent to Ditch 14
St. Clair = Lake St. Clair, downstream of Ditch 14 wetland to be filled
N Hwy 6 = Wetland downstream of Lake St. Clair - east of Hwy 59 and north of Hwy 6

Table 2: Estimates of changes in Total Phosporus load for each wetland impact alternative

2-year, 24-hour event									
Location	Estimated TP Concentration (mg/L)	Existing Vol (ac-ft)	Predicted TP Load (lbs)		Alt #1 Vol (ac-ft)	Predicted TP Load (lbs)		Alt #2 Vol (ac-ft)	Predicted TP Load (lbs)
Airport	0.105	28.46	8.13		28.46	8.13		28.46	8.13
St. Clair	0.105	33.04	9.44		33.04	9.44		33.04	9.44
N Hwy 6	0.105	38.35	10.95		38.35	10.95		38.35	10.95
10-year, 24-hour event									
Location	Estimated TP Concentration (mg/L)	Existing Vol (ac-ft)	Predicted TP Load (lbs)		Alt #1 Vol (ac-ft)	Predicted TP Load (lbs)		Alt #2 Vol (ac-ft)	Predicted TP Load (lbs)
Airport	0.105	94.64	27.03		94.82	27.08		94.84	27.09
St. Clair	0.105	45.17	12.90		45.28	12.93		45.30	12.94
N Hwy 6	0.105	59.67	17.04		59.78	17.07		59.79	17.08
50-year, 24-hour event									
Location	Estimated TP Concentration (mg/L)	Existing Vol (ac-ft)	Predicted TP Load (lbs)		Alt #1 Vol (ac-ft)	Predicted TP Load (lbs)		Alt #2 Vol (ac-ft)	Predicted TP Load (lbs)
Airport	0.105	185.70	53.04		185.93	53.10		185.97	53.11
St. Clair	0.105	167.05	47.71		167.29	47.78		167.34	47.79
N Hwy 6	0.105	190.47	54.40		190.71	54.47		190.75	54.48
100-year, 24-hour event									
Location	Estimated TP Concentration (mg/L)	Existing Vol (ac-ft)	Predicted TP Load (lbs)		Alt #1 Vol (ac-ft)	Predicted TP Load (lbs)		Alt #2 Vol (ac-ft)	Predicted TP Load (lbs)
Airport	0.105	247.38	70.65		247.37	70.65		247.37	70.65
St. Clair	0.105	265.66	75.87		266.24	76.04		266.32	76.06
N Hwy 6	0.105	294.48	84.10		295.06	84.27		295.14	84.29

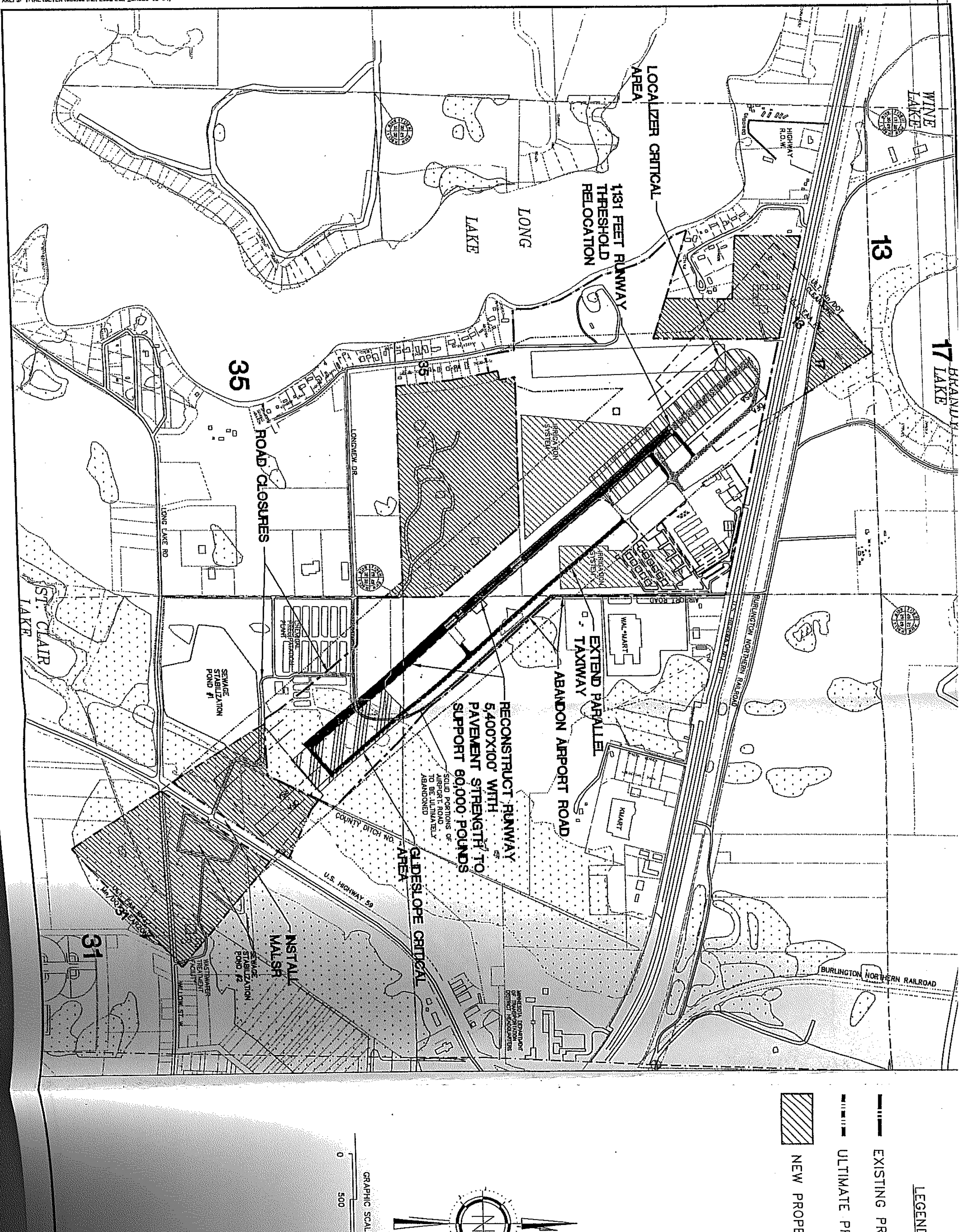
Alt. #1: Wetland fill of 24 acres in Ditch 14 wetland (Airport).
Alt. #2: Wetland fill of 27 acres in Ditch 14 wetland (Airport).
Airport = Wetland to be filled adjacent to Ditch 14
St. Clair = Lake St. Clair, downstream of Ditch 14 wetland to be filled
N Hwy 6 = Wetland downstream of Lake St. Clair - east of Hwy 59 and north of Hwy 6

Appendix A

Airport Alternatives

Y:\AE\DETLK\030100\ALP2002\FIGURES-9-2004\FIG15.DWG
DATE: 09-20-05 TIME: 1:17 pm USER: MUNDERWOOD
XREFS: Y:\AE\DETLK\030100\ALP2002\ALP_BASE9-16-04,

PLOTTED: 09-20-05 @ 1:18 PM

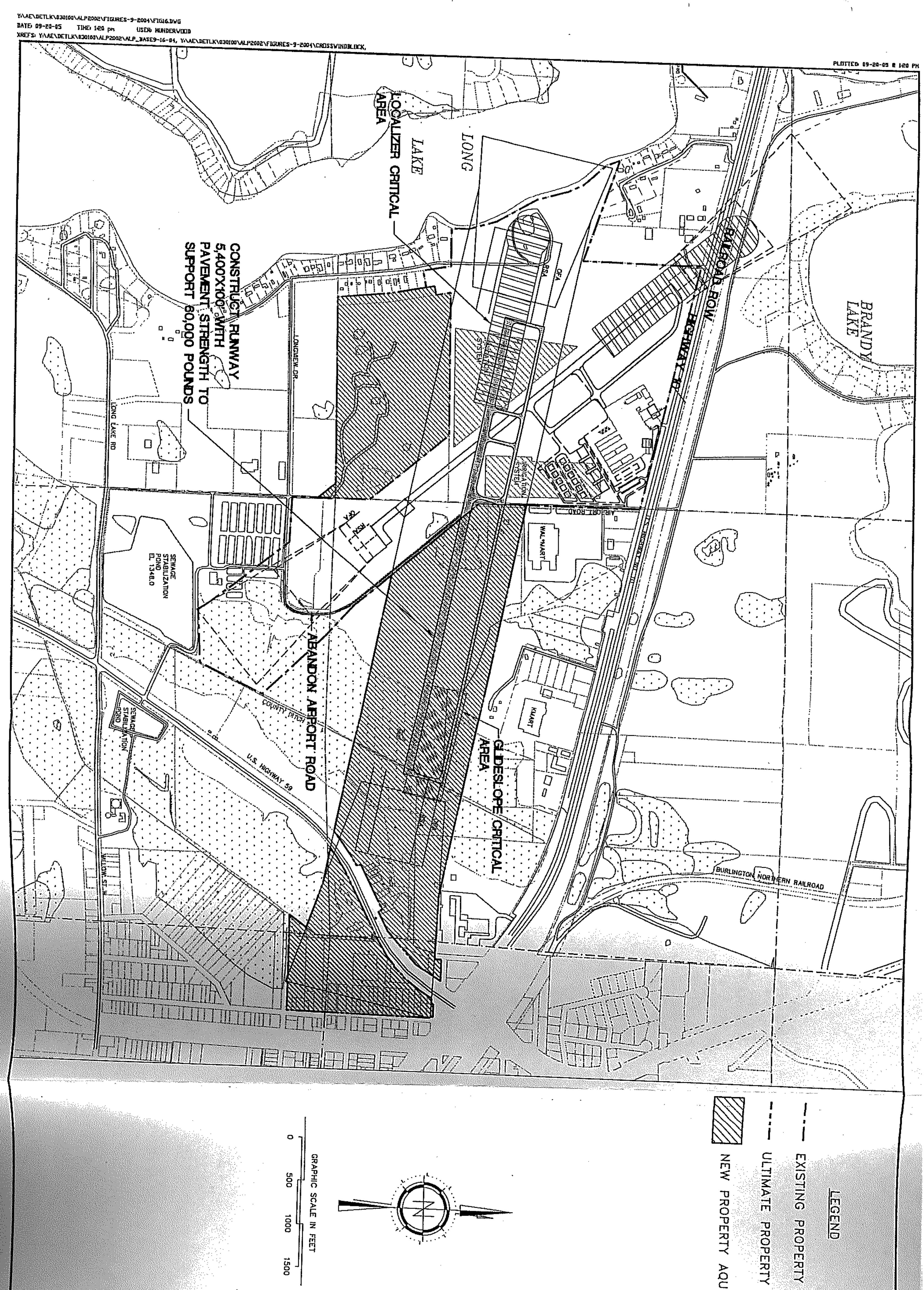


ALTERNATIVE #4 - 5,400 FOOT RUNWAY

DETROIT LAKES-BECKER COUNTY AIRPORT ENVIRONMENTAL ASSESSMENT

SEH

FIGURE 15



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ALTERNATIVE #5 CROSSWIND RUNWAY ALTERNATIVE

DETROIT LAKES-BECKER COUNTY AIRPORT ENVIRONMENTAL ASSESSMENT

FIGURE 16

Appendix B

Hydraulic Information

Pond number	2	Sallie

Contour	Area (in^2)	Area (acres)
1329		1246 (DNR)
1330		1300
1335		1325

Outlet structure: Rating Curve?
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Pond number	17	Munson

Contour	Area (in^2)	Area (acres)
		123 DNR
1332		133 USGS
1340		165

Outlet structure: 18" CMP
Crown elevation
Invert elevation 1333.2
Slope 1332.61
n 0.024 25'

Outlet structure: Road
Crown elevation
Invert elevation 1337.0
Slope
n

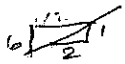
Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Hwy 59

Pond number	3	Pelican River @ [redacted]

Contour	Area (in^2)	Area (acres)
Natural Channel		
50' top		
2:1 slopes		
6' deep		
26' bottom		



Outlet structure: Rating Curve?
Crown elevation
Invert elevation
Slope
n

Outlet structure: 12'x12' box (?)
Crown elevation
Invert elevation
Slope 1329.54
n 1329.20

NWL = 1333.17

Outlet structure: Top Road 25'
Crown elevation
Invert elevation
Slope 1350.64
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Pond number	2	Muskrat

Contour	Area (in^2)	Area (acres)
1332		67 (DNR)
1340		87

Outlet structure: Rating Curve
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Pond number	5	Hwy 6

Contour	Area (in^2)	Area (acres)
1332.5	10' bottom x 2150 =	0.49
1337.5	5' deep	1.5
1340		66

Outlet structure: 60" RCP - 74'
Crown elevation
Invert elevation 1332.54
Slope 1332.20
n 0.013

Outlet structure: Road - 25' wide
Crown elevation
Invert elevation 1347.06
Slope
n

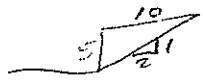
Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Pond number	4	Monitoring Station

RC →

Contour	Area (in^2)	Area (acres)
	10' bottom	
Natural Channel	2:1 slopes	
	5' deep	
	30' top	



Outlet structure Rating Curve
Crown elevation
Invert elevation
Slope
n

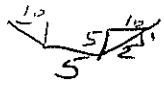
Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Pond number	7	Hwy 59

Contour	Area (in²)	Area (acres)
1330	5' bottom x 1600' =	0.18
1338	5' deep x	0.92
1340		39



Outlet structure: 60" RCP - 96'
Crown elevation
Invert elevation 1333.00
Slope 1332.50
n 0.013

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Pond number	6	St. Clair

RC → USGS

Contour	Area (in²)	Area (acres)
~~1340~~		140 (DNR)
		250

Outlet structure: Rating Curve?
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

(OR)

Outlet structure: 60" RCP, 166'
Crown elevation
Invert elevation 1333.00
Slope 1332.75
n 0.013

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Pond number	9	Long Lake

Contour	Area (in^2)	Area (acres)
Outlet from RC →		357 (DNR)
USGS → 1350		413

Outlet structure: Rating Curve ?
Crown elevation
Invert elevation
Slope
n

Outlet structure: Dam - 3 bays
Crown elevation
Invert elevation assume 5' wide
Slope 1349.45 1349.38 1349.32
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation 1348.53
Slope
n 48" x 36" CMPA 30' long pipe DS of dam

Pond number	8	Cheryl

Contour	Area (in^2)	Area (acres)
1337		9.6
1340		31

Outlet structure: 42" ECP
Crown elevation
Invert elevation 1337.03
Slope 1336.72
n 0.013

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Pond number	10 b	Ditch 14 @ Long Lake Rd

Contour	Area (in^2)	Area (acres)
Natural Channel		
5' wide bottom		
5' deep		
2:1 side slopes		
850'		
25' top		

Outlet structure:	
Crown elevation	
Invert elevation	1336.67
Slope	36" RCP
n	88'

Outlet structure:	
Crown elevation	
Invert elevation	
Slope	
n	

Outlet structure:	
Crown elevation	
Invert elevation	
Slope	
n	

Outlet structure:	
Crown elevation	
Invert elevation	
Slope	
n	

Pond number	//	Willow Rd

Contour	Area (in^2)	Area (acres)
Outlet Invert	5' wide bottom x 3500 =	0.38
Top ditch	5' deep ditch (2:1) =	1.9
1340		130 ac
1345		148 ac

Outlet structure:	
Crown elevation	
Invert elevation	1332.69
Slope	36" CMP
n	

Outlet structure:	
Crown elevation	
Invert elevation	1336.34
Slope	15" CMP
n	

Outlet structure:	
Crown elevation	
Invert elevation	
Slope	
n	

Outlet structure:	
Crown elevation	
Invert elevation	
Slope	
n	

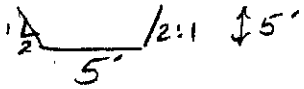
Pond number	12	Ditch 14 @ Airport Rd

Contour	Area (in^2)	Area (acres)
Outlet invert = 5' deep	5' wide bottom x 3800' =	0.44 ac
	2:1 slopes (9' wide) =	2.2
1340		99 ac
1345		130 ac

2' deep?

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n



Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Pond number	10 a	Ditch 14 @ Sludge Pond RD

Contour	Area (in^2)	Area (acres)
Natural Channel		
5 wide bottom	800' long	
2:1 sideslopes		
5' deep		
25' top		

Outlet structure:
Crown elevation
Invert elevation 1337.12
Slope 24" CMP
n

Outlet structure:
Crown elevation
Invert elevation 1336.23
Slope 36" CMP
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Pond number	14	Rail road N

Contour	Area (in^2)	Area (acres)

Outlet structure: 60" CMP

Crown elevation 54'

Invert elevation

Slope

n Not shown on plans- ~~interpolate~~

Outlet structure:

Crown elevation

Invert elevation

Slope

n

Outlet structure:

Crown elevation

Invert elevation

Slope

n

Outlet structure:

Crown elevation

Invert elevation

Slope

n

Pond number	13	Hwy 10 + RR

Contour	Area (in^2)	Area (acres)

Outlet structure: 60" CMP - 54'

Crown elevation

Invert elevation →

Slope

n 0.024

~~Not~~ Shown on plans - interpolate

Outlet structure: 36" CMP, 188'

Crown elevation

Invert elevation 1341.65

~~Slope~~ out 1342.23

~~n~~ 0.024

Outlet structure: 18", 74' CMP

Crown elevation

Invert elevation 1344.68 assumed inverts

Slope 1344.66

n 0.024

↓

Outlet structure: 18", 76' CMP

Crown elevation

Invert elevation

Slope in 1344.68

n out 1344.66

Pond number	16-	Mud Lake

Contour	Area (in^2)	Area (acres)
1348	Mud Lake	27.0
1350	Wetland	302.0
1355	Interpolated	367.3

Outlet structure: 36" RCP
Crown elevation
Invert elevation 1348.26
~~Slope~~ out = 1347.54
n 0.013

← 130' →

Outlet structure: 36" RCP
Crown elevation
Invert elevation 1348.26
~~Slope~~ out 1347.54
n 0.013

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Pond number	15	

Contour	Area (in^2)	Area (acres)
1350	Wetland	~~67~~ 69
1355	Interpolated	90

50'
Outlet structure: Berm
Crown elevation
Invert elevation 1351.0
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Pond number	18	Fox

Contour	Area (in^2)	Area (acres)
1332		135 DNR
1340		181 4565

Outlet structure: Channel (DNR)
Crown elevation
Invert elevation 1333.2
Slope
n 15' wide (assumed) 10' long

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure: 2.4' x 1.6' CMPA
Crown elevation
Invert elevation 1331.98
Slope
n 0.024 1331.90 25' long

Outlet structure: Road
Crown elevation
Invert elevation 1335.6
Slope
n

Pond number		

Contour	Area (in^2)	Area (acres)

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

Outlet structure:
Crown elevation
Invert elevation
Slope
n

NA-02630-01
(W-84)

AUG 12 1985

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATERS

PROJECT: Long Lake LAKE NO. 3-383

AT/~~NEAR~~ Detroit Lakes - Becker COUNTY REQ. NO. 85-105

PURPOSE: SURVEY [X] INVESTIGATION [X] MAINTENANCE [ ]

TYPE: LEVELS [X] TOPOGRAPHY [ ] NOHW/OHW [X] RECONNAISSANCE [ ]

HYDROGRAPHIC WORK REPORT

Survey date: July 17, 1985
Survey crew: Scherek, Potocnik, Scott
Datum: NGVD 1929
Vertical control: By water transfer and double turn levels from B.M. at the fish hatchery at Sallie Lake - brass disk on right downstream corner of left of 2 structures between Muskrat and Sallie Lakes; Elevation = 1334.33

Long Lake is located in Section 5 - T138 and Sections 29-32, T139, R41; in the Ottertail River Watershed Unit. It is 434 acresplanimetered and 485 acres meandered. It outlets on the east side (in the SE-NE-SW of Sec. 32); Southeasterly to St. Clair Lake. There is a 3 bay old type "C" concrete dam located approx. 330' downstream from the present waters edge. No previous survey work has been done by the Hydrographic Unit concerning this lake.

Our survey work at this time included an outlet profile downstream to the dam and pertinent elevations on the dam. We also completed an O.H.W. - N.O.H.W. investigation. We found the following:

	" At the outlet"
Water surface, Long Lake	1350.46
Present runout (℄ outlet channel on sand, 39' downstream from beginning of channel)	1349.6
℄ channel at upstream side of dam	1349.2
Headwater at dam	1349.95
Tailwater at dam	1349.91
Top left end left abutment of dam	1356.10
Top right end left abutment of dam	1355.48
Sill, Bay 1	1349.45
Top of pier between Bays 1 & 2	1354.24
Sill, Bay 2	1349.38
Top of pier between Bays 2 & 3	1354.17
Sill, Bay 3	1349.32
Top left end right abutment	1355.32
Top right end right abutment	1355.36
0⁰⁰ of HW gage	1349.61
0⁰⁰ of TW gage	1345.80

John M. Scherek

July 18, 1985 — DATE
John M. Scherek — SIGNED
Survey Crew Supervisor — TITLE

Note: There are no stoplogs in the dam. The entire outlet channel upstream of the dam has a sandy bottom and there are presently several spots within 0.1' - 0.3' of the runout elevation. Consequently the runout elevation and the location could vary somewhat from time to time.

" O.H.W. - N.O.H.W. evidence"

Toe of berm in lake	1349.9
Toe of lake bank	1351.0
Recent washline	1351.2
Top of lake bank	1352.4
Toe of steep bank	1353.2
HWM's (stains on boulder)	1351.0 & 1351.3
O.H.W.	1351.2

Note: We also found evidence indicating a N.O.H.W. of 1353.2

In conjunction with our levels we set the following B.M. at Ridgewood Resort on the south end of the lake:

- Bent 60d spike in the east base of a 2.1' oak, 42' east of NE corner of red cabin (6th cabin south of main office), 29' NW of ℄ of gravel road nearest the lake, and at the NW corner of the easterly trailer parking area: Elev.=1356.20.

Minnesota DNR Waters
Field Survey Report

Project MUNSON LAKE **Lake No.** 3-357

City NR. DETROIT LAKES **County** BECKER **Req. No.** 2003-72

Sec. 5, 8 **Twp.** 138 **Rng.** 41 **Watershed** OTTER TAIL RIVER

SURVEY DATE: 4/2/03

SURVEY CREW: Scherek, Schaffer

LAKE SIZE

Meandered Area 132 Acres ☐ Non-meandered

Planimetered Area 139 Acres ☐ Unknown

DATUM ADJUSTMENT

☐ Assumed ☐ 1912 ☒ 1929 ☐ 1988 Source: DNR Waters B.M. at Sallie Lake

CONTROL BENCHMARK

Location: at inlet to Sallie Lake from Muskrat Lake (center of E ½ of E ½ of Sec. 8)

Elevation: 1337.42

Description: round brass disk in left upstream abutment of new bridge over inlet from Muskrat Lake

SURVEY WORK COMPLETED

☒ levels ☐ topography ☐ cross sections ☒ profiles ☒ OHW

☒ establish benchmarks ☒ outlet elevations ☒ other: photographs

WATER LEVELS

Highest Recorded: Water Surface: 1333.99, 4/2/03

Lowest Recorded: OHW Elev: 1333.9

Range: Highest Known: 1333.99

OUTLET

General Description: on SE side of lake (SE-NE-NW, Sec.8), via a culvet under Woodland Lane, thence southerly to Sallie Lake

Runout Elevation and Description: 1333.2, on solid sediment (sand & gravel) at upstream end of an 18" C.M.P. under Woodland Lane

BENCHMARKS SET

Location: at the public access (SE-NE-NW, Sec. 8-138-41)

Elevation: 1337.47

Description: vertical 3/8" x 8" spike in the west root of a leaning 1.7' basswood, 18' lakeward (NW) of the edge of the bituminous surface of Woodland Lane and 64' S-SW of the access path (gravel)

Location:

Elevation:

Description:

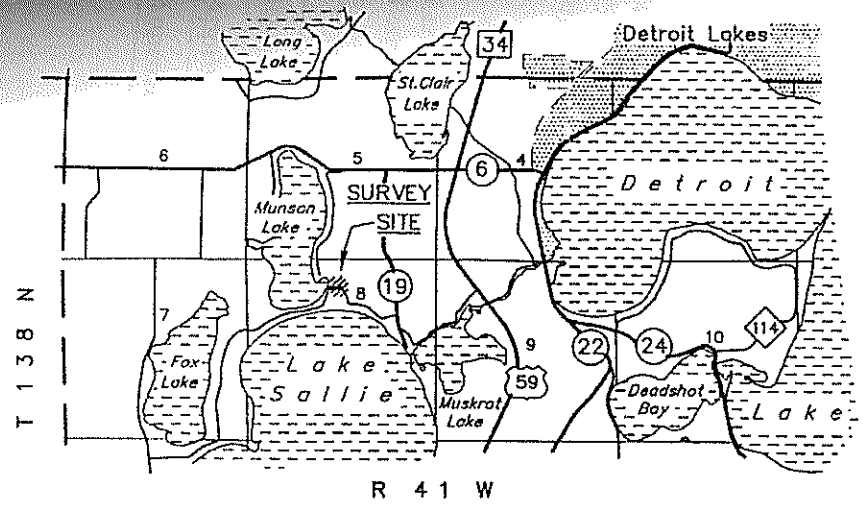
Prepared By	Title	Date
John M. Scherek JMS	S.C.S.	4/10/2003

Due to the nature of the shoreline around most of this lake (steeper and/or abrupt banks at the waters edge), suitable tree evidence was limited. The O.H.W. level is based on the average reduced elevation of the 12 best trees of the 16 which we documented (elm, ash, basswood & cottonwood). No stainlines or washlines were observed. The water level of the lake is shown at 1332 on the 1959 (photorevised 1982) USGS quadrangle.

Following are the elevations we found at the outlet:

Water level, Munson Lake	1333.99
0+00 Bottom at beginning of outlet channel	1332.0
Note: There is some loose bog accumulated at the beginning of the channel, but it does not act as a restriction.	
0+24 Channel bottom	1332.1
0+48 Channel bottom	1331.8
0+68 Channel bottom at upstream side of a wooden bridge	1332.9
0+73 Top center of wooden bridge	1335.5
0+78 Channel bottom at downstream side of bridge	1332.7
0+99 Flowline on solid sediment (sand & gravel) at upstream end of 18" C.M.P. under Woodland Lane - present runout	1333.2
Top bent upstream end of culvert	1334.71
Headwater at culvert	1333.99
1+21 Centerline of road over culvert	1337.0
1+39 Top downstream end of 18" C.M.P.	1334.11
Downstream invert	1332.61
Channel bottom below culvert	1331.6
Tailwater at culvert	1332.38
1+64 Channel bottom	1331.9
1+89 Channel bottom	1331.9
2+89 Channel bottom	1331.5
Water level at same location	1332.36

Three photographs were taken at the outlet, one looking at the upstream end of the culvert, one looking upstream at the wooden bridge and one looking at the downstream channel. We also searched for, but could not locate, either of the 8/12/65 Game and Fish benchmarks.



N

LOCATION MAP

Scale 1" = 1 Mile

3-357

MUNSON LAKE

NEAR DETROIT LAKES-BECKER COUNTY

OUTLET PROFILE

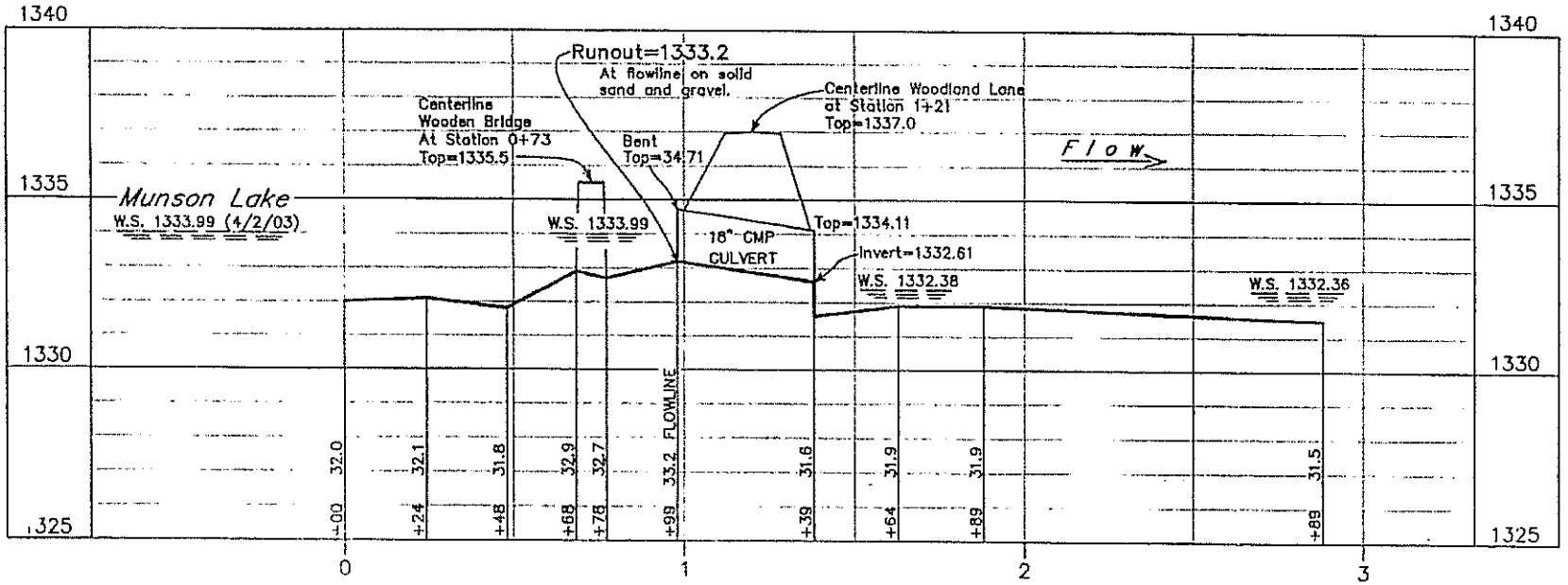
Sec. 8 T. 138 N. R. 41 W.

Req. 2003-72

Survey: JMS 4/2/03 Datum: NGVD-1929

Drawn: DDS 6/24/03 Checked: GY

DNR Waters



OUTLET PROFILE

Scale: Horizontal 1" = 50'

Vertical 1" = 5'

DRAWING NO.

A-976

NA-02684-03
Rev. 8/90

Department of MINNESOTA Natural Resources Waters

REQUISITION FOR SURFACE WATER/HYDROGRAPHIC SERVICES

RECEIVED
APR 1 2003
DIVISION OF WATERS
DETROIT LAKES, MN

Project FOX LAKE			**Lake No.** 3-358
City NR. DETROIT LAKES	**County** BECKER		**Req. No.** 2003-71
Sec. 7, 18	**Twp.** 138	**Rng.** 41	**Quad No.** K-6c

Statement of Problem/Situation (Provide detailed information)

This lake is in close proximity to Detroit Lakes and has been gauged since 1992. An O.H.W. level would be beneficial for future shoreland management of the lake.

Services Requested (Attach map as necessary)

1) O.H.W.L. determination.
2) Pertinent outlet elevations.
3) Photographs.
4) Tie survey to NGVD - 1929 as per lake gauge R.M.
5) Establish additional B.M.(s) as necessary.
6) Tie in 8/12/65 Game & Fish B.M. if possible.

Landowner(s):
Permission obtained for access: ☐Yes ☐ No

Requested By John Scherek for Bob Merritt	**Date** 3/28/03	**Phone No.**
Approved by		**Date**
Approved Glen Yakel		**Date** 3/28/2003

Minnesota DNR Waters
Field Survey Report

Project FOX LAKE | **Lake No.** 3-358

City NR. DETROIT LAKES | **County** BECKER | **Req. No.** 2003-71

Sec. 7, 18 | **Twp.** 138 | **Rng.** 41 | **Watershed** OTTER TAIL RIVER

SURVEY DATE: 4/1/03

SURVEY CREW: Scherek, Schaffer

LAKE SIZE
Meandered Area 155 Acres ☐ Non-meandered
Planimetered Area 149 Acres ☐ Unknown

DATUM ADJUSTMENT
☐ Assumed ☐ 1912 ☒ 1929 ☐ 1988 Source: DNR Waters lake gauge R.M.

CONTROL BENCHMARK
Location: on east side of lake (SE-SE-NW-SE, Sec. 7-138-41)
Elevation: 1341.83
Description: NW corner of concrete slab for hot tub on lakeside of Brad Green (gauge reader) home, address # 14358 E. Fox Lake Road

SURVEY WORK COMPLETED
☒ levels ☐ topography ☐ cross sections ☒ profiles ☒ OHW
☒ stablish benchmarks ☒ outlet elevations ☒ other: photographs

WATER LEVELS
Highest Recorded: 1334.17, 7/7/98
Lowest Recorded: 1333.38, 9/6/92
Range: 0.79' (period of record, 5/6/92 to present)
Water Surface: 1333.87, 4/1/03
OHW Elev: 1334.0
Highest Known: 1334.17

OUTLET
General Description: on south side of lake (NW-NW-NE, Sec. 18-138-41), southerly via a channel to Sallie Lake
Runout Elevation and Description: 1333.2, channel bottom 14' downstream from beginning; also at a sediment accumulation 98' downstream

BENCHMARKS SET
Location: on west side of lake (SE-SE-SE-NW, Sec. 7-138-41)
Elevation: 1337.62
Description: horizontal 3/8" x 8" spike 1.3' above ground in the N-NE side of a 1.5' ash, 11' from waters edge, 52' E-SE of edge of bituminous surface of W. Sallie Lake Drive and 64' south of driveway to address # 14539

Location:
Elevation:
Description:

Prepared By	Title	Date
John M. Scherek JMS BH	S.C.S.	4/11/2003

Due to the nature of the shoreline around most of this lake, suitable tree evidence was limited. The O.H.W. level is based on the average reduced elevation of the 7 best trees of the 10 which we documented (elm, ash, cottonwood & aspen). No stainlines or washlines were observed. The water level of the lake is shown at 1332 on the 1959 (photorevised 1982) USGS quadrangle.

Following are the elevations we found at the outlet:

Water level, Fox Lake	1333.87
0+00 Bottom in lake	1332.5
0+12 Bottom in lake	1332.1
0+19 Bottom at beginning of outlet channel	1332.7
0+28 Channel bottom at remnants of a beaver dam	1333.0
0+33 Channel bottom (very solid) - present runout	1333.2
0+43 Channel bottom	1333.0
0+55 Channel bottom	1333.1
0+70 Channel bottom	1332.8
0+82 Channel bottom	1332.9
0+96 Channel bottom	1332.8
1+17 Channel bottom (at an accumulation of sediment and debris)	1333.2
Headwater at accumulation	1333.82
Tailwater at accumulation	1333.59
1+24 Channel bottom	1332.5
1+36 Channel bottom	1333.0
1+48 Channel bottom	1332.4
1+60 Channel bottom	1332.2
1+72 Channel bottom	1332.6
1+84 Channel bottom	1332.6
1+96 Channel bottom	1332.3
2+08 Channel bottom where it enters a small ponded area	1331.6
Water level of ponded area	1333.39

Note: No distance was measured, but the channel leaves the ponded area approximately 50' from the above shot. As such, the stationing is approximate from that point on.

≈2+58 Channel bottom where it leaves the ponded area	
≈2+74 Bottom in a breach in a beaver dam	1332.7
Top of dam at left side of breach	1333.5
Top of dam at right side of breach	1333.5
Headwater at beaver dam	1333.30
Tailwater at beaver dam	1333.04
≈3+24 Channel bottom	1332.0
≈3+74 Channel bottom	1331.7
≈4+24 Channel bottom	1331.7
≈4+99 End of upstream apron of a 2.4' x 1.6' metal arch culvert under Pebble Beach Lane	1332.07
Invert at upstream culvert opening	1331.98
Top upstream end	1333.68
Headwater at culvert	1332.61

≈5+15 Centerline of road over culvert	1335.6
≈5+30 Top downstream end of culvert	1333.49
Downstream invert	1331.90
End of downstream apron	1331.94
Channel bottom below apron	1331.2
Tailwater at culvert	1332.13

Note: The entire channel between the lake and the culvert has a very irregular bottom

Two photographs were taken, one looking downstream at the beginning of the outlet channel and one looking at the beaver dam downstream of the ponded area. We searched for, but could not definitely locate, either of the 8/12/65 Game and Fish benchmarks.

Appendix C

Subwatershed Areas

Soil Type A Land Use (Acres)

Land Use Curve Number	65	30	30	59	46	76	46	30	65	81	77
Subwatershed ID	Cultivated Land	Grassland	Deciduous Forest	Farmsteads and Rural Residences	Other Rural Developments	Gravel Pits and Open Mines	Rural Residential Development Complex	Grassland-Shrub-Tree (deciduous)	Transitional Agricultural Land	Urban and Industrial	Exposed Soil, Sandbars, and Sand Dunes
1	1.2	77.7	142.9	2.1	0.0	0.0	29.1	15.5	0.9	0.0	5.2
2	0.0	2.2	41.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.6	6.1	8.9	0.6	1.0	0.0	0.0	0.0	5.4	0.0	0.0
4	4.3	4.6	61.1	2.7	2.0	1.7	0.0	7.6	0.5	0.0	0.0
5	12.3	0.8	14.9	0.0	0.0	0.0	0.0	3.1	0.0	4.9	0.0
6	8.4	23.8	17.9	1.1	1.1	0.0	0.0	1.7	0.0	0.0	0.0
7	1.3	12.2	27.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0
8	3.7	0.1	9.7	0.0	0.0	0.0	0.0	0.0	0.0	11.8	0.0
9	12.0	20.4	67.0	3.5	0.5	0.0	6.3	9.7	0.3	0.0	0.0
10	0.0	13.9	13.7	0.0	0.0	0.0	0.0	7.4	0.0	17.1	0.0
11	0.0	3.7	39.1	0.0	0.0	0.0	0.0	0.0	0.0	10.3	0.0
12	4.7	41.8	43.0	0.9	2.9	0.0	0.0	18.8	57.9	38.8	0.0
13	0.0	18.5	34.4	0.4	0.9	3.9	0.0	0.0	0.0	0.0	0.0
14	0.0	34.3	27.6	4.7	0.0	0.0	0.0	0.0	3.5	15.1	0.0
15	15.2	5.9	44.2	0.6	3.8	0.0	0.0	0.0	0.0	6.6	0.0
16	20.7	68.0	124.8	4.1	4.3	0.0	0.1	8.0	0.0	6.3	0.0
17	1.8	9.8	39.7	2.7	0.0	0.0	10.2	3.2	0.0	0.0	0.0
18	1.7	3.8	49.1	0.0	0.0	0.0	4.4	1.8	0.0	0.0	0.0

Soil Type B Land Use (Acres)

Land Use Curve Number	75	58	55	74	65	85	65	48	75	88	86
Subwatershed Id	Cultivated Land	Grassland	Deciduous Forest	Farmsteads and Rural Residences	Other Rural Developments	Gravel Pits and Open Mines	Rural Residential Development Complex	Grassland-Shrub-Tree (deciduous)	Transitional Agricultural Land	Urban and Industrial	Exposed Soil, Sandbars, and Sand Dunes
1	163.4	75.8	142.2	6.7	0.0	0.0	26.0	10.5	0.4	0.0	3.4
2	1.0	8.2	59.3	4.0	0.8	0.0	0.0	1.4	3.8	0.0	0.0
3	23.3	19.1	8.5	5.1	9.5	0.0	0.0	0.0	0.7	0.0	0.0
4	27.9	14.5	46.3	4.9	7.1	0.0	0.0	0.0	10.5	0.0	0.0
5	5.0	3.3	16.3	0.3	0.0	0.0	0.0	0.1	0.0	9.3	0.0
6	199.9	39.9	65.7	12.0	0.3	0.0	0.8	12.1	0.0	0.0	0.0
7	1.0	9.1	20.8	0.0	0.0	0.0	0.0	0.0	0.0	21.3	0.0
8	24.1	12.8	7.4	0.0	0.0	0.0	0.0	0.0	0.0	18.8	0.0
9	553.6	319.7	334.2	24.4	32.3	3.8	77.4	13.1	57.9	0.0	0.0
10	0.9	11.0	20.6	0.7	0.0	0.0	0.0	2.3	0.0	6.9	0.0
11	0.0	15.1	33.0	0.1	0.0	0.0	0.0	0.0	0.0	66.7	0.0
12	38.1	115.1	23.2	2.5	9.0	14.3	0.0	3.4	60.9	32.1	2.2
13	1.2	15.6	8.1	0.8	1.9	6.0	0.0	0.0	0.0	0.0	0.0
14	0.0	33.9	12.2	4.7	0.0	0.0	7.1	0.0	7.6	25.1	0.0
15	40.9	15.6	24.0	4.3	11.2	0.0	0.0	0.0	0.0	23.5	0.0
16	169.7	96.4	55.6	11.3	14.6	0.0	17.5	4.7	0.0	13.6	0.0
17	125.0	27.4	69.4	4.6	4.4	0.0	7.8	8.9	0.6	0.0	0.0
18	179.7	29.0	131.2	4.7	0.0	2.7	7.0	2.5	0.0	0.0	0.0

Soil Type C Land Use (Acres)

Land Use Curve Number	80	71	70	82	77	89	77	65	85	91	91
Subwatershed Id	Cultivated Land	Grassland	Deciduous Forest	Farmsteads and Rural Residences	Other Rural Developments	Gravel Pits and Open Mines	Rural Residential Development Complex	Grassland-Shrub-Tree (deciduous)	Transitional Agricultural Land	Urban and Industrial	Exposed Soil, Sandbars, and Sand Dunes
1	0.0	0.0	3.9	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	3.3	0.0	6.9	7.1	13.9	0.0	0.5	0.0	0.0	0.0	0.0
5	25.8	3.1	11.6	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.1	2.9	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	7.9	15.3	3.2	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Soil Type D Land Use (Acres)

Land Use Curve Number			77	100	85	98
Subwatershed Id			Deciduous Forest	Water	Wetland	Roads
1			0.0	1269.0	9.6	19.3
2			0.0	70.8	4.1	5.7
3			0.0	4.2	6.4	0.1
4			0.0	0.0	18.0	1.6
5			0.0	1.6	40.9	2.6
6			0.0	151.5	54.2	6.9
7			0.0	0.0	24.6	1.8
8			0.0	0.0	7.4	0.8
9			0.6	457.9	53.1	29.8
10			0.0	22.8	0.0	0.8
11			0.0	6.2	66.6	10.3
12			0.0	0.0	90.1	12.9
13			0.0	0.0	0.0	3.8
14			0.0	1.4	0.0	7.5
15			0.0	0.2	0.0	5.1
16			0.0	17.0	104.0	11.2
17			0.0	129.1	19.6	8.9
18			0.0	131.9	11.9	9.2

Percent Water Area, Composite Curve Number, and Time of Concentration Calculation

Subwatershed Id	% Water	Composite Curve Number	Travel Length (ft)	Average Subwatershed slope (ft/ft)	Tc (min, Lag/CN method)
1	63	54	3100	0.022	107
2	35	51	1800	0.057	46
3	4	61	2300	0.042	51
4	0	57	3600	0.006	213
5	1	71	1200	0.067	18
6	25	67	3000	0.020	78
7	0	61	1700	0.014	69
8	0	70	2000	0.020	52
9	22	64	6000	0.018	155
10	19	54	2000	0.008	124.6
11	2	71	1500	0.025	36
12	0	66	7000	0.008	250
13	0	47	1700	0.020	83
14	1	58	3000	0.010	139
15	0	60	1000	0.033	30
16	2	60	2500	0.014	97
17	27	62	2600	0.030	65
18	23	62	3500	0.111	43

Appendix D

MnRAM Management Classification

Table 1.1
Recommended Wetland Management Standards
Minnesota Routine Assessment Method for Evaluating Wetland Functions, Version 3.0

Management Class	Management Strategy	Stormwater Treatment	Buffer[1]	Mitigation Standard	Hydrologic Guidelines
A—Preserve	Maintain wetland and existing functions, values and wildlife habitat. Possible need for active management of wetland to protect unique features. Apply strict avoidance standards. May be appropriate to develop a conservation easement.	Avoid conveyed flows where prudent and feasible. Upstream sediment and nutrient pretreatment required to maintain background loading rates. Maintain existing hydrology—divert increased flows. Avoid concentrating flows.	≥50 feet for water quality ≥100 feet for wildlife habitat.[2] Require monuments to mark buffer edge.	WCA minimum or greater replacement ratio with documented replacement of functions/values. Consider requiring buffer replacement.	*Bounce (10 yr):* Existing *Inundation (1 & 2 yr):* Existing *(10 yr):* Existing *Runout Control:*[3] No Change Maintain existing hydrology. Encourage infiltration and reduced impervious BMPs. Conduct water budget analysis.
B—Manage 1	Maintain wetland without degrading existing functions, values and wildlife habitat. Apply WCA sequencing process.	Pretreat conveyed flows to maintain background loading rates.	35-50 feet Require monuments to mark buffer edge.	WCA minimum or greater replacement ratio. Replacement of functions and values on site or in location specified in plan for drain/fill/excavation impacts. In compliance with Ch. 7050 the entire area affected by storm water or other wastewater flows must be avoided, minimized and replaced at a replacement ratio of 1:1 for all changes in wetland type.	*Bounce (10 yr):* Existing + 0.5 ft *Inundation (1 & 2 yr):* Existing plus 1 day *(10 yr):* Existing + 7 days *Runout Control:*[2] No Change Maintain existing hydrology. Encourage infiltration and reduced impervious BMPs.
C—Manage 2	Maintain wetland footprint. Improve wetland biological and plant community diversity/integrity or enhance other functions if possible. Apply WCA sequencing process. Consider for restoration.	Pretreat all conveyed discharges to remove all heavy particles and maximize removal of fine grained sediment prior to discharging to the wetland	25-35 feet Require monuments to mark buffer edge.	WCA minimum replacement of acreage and functions/values on site or in location specified in plan for drain/fill/excavation impacts In compliance with Ch. 7050 the entire area affected by storm water or other wastewater flows must be avoided, minimized and replaced at a replacement ratio of 1:1 for all changes in wetland type.	*Bounce (10 yr):* Existing + 1.0 ft *Inundation (1& 2 yr):* Existing plus 2 days *(10 yr):* Existing + 14 days *Runout Control:*[2] 0 to 1.0 ft above existing runout
D—Manage 3	Allow for relaxed sequencing and replacement plan flexibility. Consider for restoration/enhancement.	Pretreat all conveyed flows to remove all medium grained and larger sediments.	25 feet	WCA allows mitigation flexibility with minimum standards required in the plan area, see M.R. 8420.0650. In compliance with Ch. 7050 the entire area affected by storm water or other wastewater flows must be avoided, minimized and replaced at a replacement ratio of 1:1 for all changes in wetland type.	*Bounce (10 yr):* No Limit *Inundation (1 & 2 yr):* Existing plus 7 days *(10 yr):* Existing + 21 days *Runout Control:*[2] 0 to 4.0 ft above existing runout

[1] Buffers are unmowed, naturalized strips of vegetation around the wetland perimeter. Buffers would be provided during development or redevelopment
[2] Where possible, use 300-foot buffers as per MnRAM (Question #23).
[3] If currently landlocked, new outlet should be above delineated wetland elevation.

Management Classification