A long-range reservoir operating plan study.

Mississippi River Headwaters
Reservoir Operating Plan Evaluation (ROPE)

Minnesota

UPPER MISSISSIPPI RIVER HEADWATERS
BEMIDJI TO ST. PAUL, MINNESOTA

DRAFT INTEGRATED RESERVOIR OPERATING PLAN EVALUATION AND ENVIRONMENTAL IMPACT STATEMENT

August 2008

LEAD AGENCY:

U.S. ARMY CORPS OF ENGINEERS, ST. PAUL DISTRICT, ST. PAUL, MINNESOTA

COOPERATING AGENCY:

U.S. FOREST SERVICE, CHIPPEWA NATIONAL FOREST, CASS LAKE, MINNESOTA

US Army Corps of Engineers
St. Paul District

FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE

This page intentionally left blank.

UPPER MISSISSIPPI RIVER HEADWATERS
BEMIDJI TO ST. PAUL, MINNESOTA

DRAFT INTEGRATED RESERVOIR OPERATING PLAN EVALUATION AND ENVIRONMENTAL IMPACT STATEMENT

The responsible lead agency is the U.S. Army Corps of Engineers; the St. Paul District has the lead in preparation of this Integrated Reservoir Operating Plan Evaluation and Environmental Impact Statement. The U.S. Forest Service is a cooperating agency.

This Draft Integrated Reevaluation Report and Environmental Impact Statement will be announced in the Federal Register for agency and public review on September 19, 2008. The end of the comment period will be November 3, 2008. **Please provide written comments by November 3, 2008,** to the St. Paul District, U.S. Army Corps of Engineers, ATTN: Mr. Steven Clark, CEMVP-PM-A, 190 Fifth Street East, Suite 401, St. Paul, Minnesota 55101, or by email: Steven.J.Clark@usace.army.mil .

The St. Paul District will compile the comments, prepare written responses, seriously consider changes to this draft report, and will prepare a final report and Environmental Impact Statement (EIS). The final report and EIS will be provided for agency and public review. We will compile comments received and transmit them along with the final Reservoir Operating Plan Evaluation and EIS to the St. Paul District Commander, U.S. Army Corps of Engineers in St. Paul Minnesota. Upon approval of the report, the St. Paul District Commander and Forest Supervisor of the U.S. Forest Service, Chippewa National Forest will take the recommendations in this report under consideration and will issue separate Records of Decision. The St. Paul District Commander will issue a Record of Decision for the Corps reservoirs and the Forest Supervisor will issue a Record of Decision for Knutson Dam on Cass Lake.

This page intentionally left blank.

DRAFT INTEGRATED RESERVOIR OPERATING PLAN EVALUATION AND ENVIRONMENTAL IMPACT STATEMENT

TABLE OF CONTENTS

SUMMARY S-1
- Purpose S-1
- Need for Action S-1
- Study Process S-1
- Proposed Actions S-4
- Major Conclusions and Findings S-28
- Areas of Controversy S-29
- Unresolved Issues S-29
- Relationship to Environmental Laws and Regulations S-29
- Participating Agencies and Organizations S-29

CHAPTER 1. BACKGROUND 1
- 1.1 Introduction 1
- 1.2 Terminology Used in This Document 2
- 1.3 Study Purpose 2
- 1.4 Study Area 3
- 1.5 Need for Action 5
- 1.6 Authorities 5
- 1.7 Prior Studies, Reports, and Existing Water Resource Projects 6

CHAPTER 2. PLANNING PROCESS 10
- 2.1 Study Management 11
- 2.2 Study Participants 11
- 2.3 Study Schedule and Cost 11
- 2.4 Coordination and Public Involvement 11
- 2.5 Scoping Process 13
- 2.6 Study Scope 14
- 2.7 Significant Resources 14
- 2.8 Planning Objectives 15
- 2.9 Planning Assumptions 16
- 2.10 Planning Constraints 17

CHAPTER 3. PROBLEMS AND OPPORTUNITIES 18
- 3.1 Problems 18
- 3.2 Opportunities 19

CHAPTER 4. AFFECTED ENVIRONMENT 20
- 4.1 Study Reservoirs And Rivers 20
- 4.2 Social and Economic Conditions 32
- 4.3 Cultural Resources 57
- 4.4 Natural Resources 60

CHAPTER 5. PLAN FORMULATION 81
- 5.1 Formulation of Alternative Plans 81
- 5.2 Identification and Screening of Alternative Measures 83
- 5.3 Alternative Measures/Plan Components 83
- 5.4 Alternatives and Measures Eliminated From Consideration 101

5.5 Alternative Plans Considered in Detail 108
5.6 Evaluation and comparison of Alternative Plans 142
5.7 Plan Selection 142
CHAPTER 6. RECOMMENDED PLAN 143
6.1 Recommended Plan 143
6.2 Implementation 143
6.3 Monitoring, Evaluation, and Adaptive Management 143
CHAPTER 7. ENVIRONMENTAL EFFECTS 146
7.1 Environmental effects summary matrix 146
7.2 No Action Alternative 148
7.3 Alternative Operating Plan R 165
7.4 Alternative Operating Plan E 175
7.5 Alternative Operating Plan T 191
7.6 Alternative Operating Plan P 205
7.7 Cumulative Effects 222
CHAPTER 8. ENVIRONMENTAL COMPLIANCE AND REVIEW 225
8.1 Applicable Environmental Laws and Executive Orders 225
8.2 Comments on the Draft Report and EIS 225
8.3 Required Coordination 225
8.4 Distribution of Draft Report/EIS and Statement of Recipients 227
CHAPTER 9. COST SHARING 228
CHAPTER 10. CONCLUSIONS AND RECOMMENDATIONS 229
10.1 Conclusions 229
10.2 Recommendation 229
CHAPTER 11. LIST OF PREPARERS 230
CHAPTER 12. REFERENCES 232
CHAPTER 13. APPENDICES 236

SUMMARY

PURPOSE

This Draft Integrated Reservoir Operating Plan Evaluation (ROPE) Report and Environmental Impact Statement (EIS) is about a review of water control operations at the Mississippi River Headwaters federal reservoirs in north-central Minnesota. This report integrates the U.S. Army Corps of Engineers (hereafter also referred to as the "Corps") and U.S. Forest Service decision document and the National Environmental Policy Act (NEPA) documents to avoid duplication and to consolidate information for reviewers.

The primary purpose of the ROPE study is to evaluate alternative plans for these reservoirs and to improve the operation of the system to balance benefits in consideration of tribal trust, flood control, environmental, water quality, water supply, recreation, navigation, hydropower, and other public interests. A secondary purpose of the study is to facilitate better understanding of the system regarding reservoir management, water levels, and the related and interconnected impacts throughout the system.

NEED FOR ACTION

The current operating plans for the Federal dams in the headwaters of the Mississippi River (hereafter referred to as the "Headwaters"), were developed in most part during the period from the 1930s to the 1960s. Since then, only minor modifications have been made to the plans. However, there have been changes to the environment of the Headwaters, most noticeably through increased human development. These changes in the human use of the reservoirs, the age of the current operating plans, and an increasing awareness of the interactions between competing uses of the Headwaters resources led to the need to reevaluate and possibly modify the current operating plans.

STUDY PROCESS

This reevaluation study of an existing Corps project followed the standard Corps of Engineers six-step planning process:

1. Identify problems, needs, opportunities and constraints.
2. Inventory and forecast future conditions.
3. Formulate alternatives.
4. Evaluate alternatives.
5. Compare alternatives.
6. Select a recommended plan.

This study has also followed the substantive and procedural requirements of the NEPA guidelines for an EIS.

This draft report and EIS is being released for public review and comment. Following the review period, each comment will be reviewed and carefully considered for potential modifications to the draft report and EIS prior to the completion of the final report and EIS. The final report and EIS will then be released for another public review and comment period prior to the final selection of an alternative operating plan. This selection will be made through the public release of a Record of Decision (ROD). The U.S. Forest Service and the Corps of Engineers will each release separate RODs. The Forest Service will be selecting an operating plan for Knutson Dam, whereas the Corps will select an operating plan for Lake Winnibigoshish, Leech Lake, Pokegama Lake, Sandy Lake, Cross Lake (also referred to as the Whitefish Chain of Lakes), and Gull Lake.

The effects of each alternative considered in detail, including the proposed plan are summarized in Table 1.

Table 1. Comparative Direct Short-Term Effects of Operating Plan Alternatives Generalized for the Project Area.

	Current Plan - Existing Condition Compared to Future	R Plan	E Plan	T Plan	Proposed Plan (P)
Air Quality	0	-1	+1	+1	+1
Terrestrial Habitat	-1	-1	+1	+2	+1
Sedimentation and Bank Erosion	-1	-1	+1	+3	+1
Wetlands	-1	-1	+1	+1	+1
Aquatic Habitat	-1	-1	+1	+3	+1
Fishery	-1	-1	+1	+3	+1
Biological Productivity	-1	-1	+1	+2	+1
Biological Diversity	-1	-1	+1	+2	+1
Water Quality	-1	-1	+1	+2	+1
Threatened & Endangered Species	0	0	0	0	0
Recreational Opportunities	0	+1	-2	-3	-1
Public Health/Safety	0	0	-1	-1	0
Community Cohesion	0	0	-1	-2	0
Community Growth and Development	0	+1	-1	-1	0
Controversy	0	-1	-2	-3	-1
Property Values	0	+1	-1	-2	0
Regional Growth	0	0	0	0	0
Employment	0	0	-1	-1	0
Business Activity	0	+1	-1	-2	0
Flooding Effects	0	-1	+1	+2	+1
Historic Architectural	0	0	0	0	0
Archeological	-1	-1	+1	+1	+1

Key:

+3 = Significant Beneficial

+2 = Substantial Beneficial

+1 = Minor Beneficial

0 = No Effect

-1 = Minor Adverse

-2 = Substantial Adverse

-3 = Significant Adverse

PROPOSED ACTIONS

The recommended plan is to implement Plan P (also listed as the Proposed Plan) as described throughout this report. A detailed description of the proposed plan can be found in Section 5.5.5. A summary of the primary aspects of the proposed and current operating plans is provided below for each reservoir.

Implementation of the proposed plan would occur following the release of the Record of Decision (ROD). The ROD will be released following the public review of the final report. After release of the ROD, the Corps and Forest Service will each update their Water Control Manuals for the reservoirs. The revised operating plans are expected to remain in place over the next 25 years, with the potential for modifications as described in Section 6.2.

Implementation costs of the recommended plan are expected to be minor and will be included in the operation and maintenance budget for the reservoirs. Minor increased costs over the existing budget would be expected for additional coordination and monitoring of water levels.

Costs for updating the Water Control Manuals would also be included in operation and maintenance costs and are expected to be minor relative to study costs.

A benefit-cost ratio was not calculated for this study because there would be no construction costs. The adverse and beneficial effects as described in Section 7 and summarized in the Major Conclusions and Findings below were used in the plan selection process in place of a benefit-cost ratio.

Following the implementation of a new operating plan, an adaptive management process will be initiated to monitor and revise the new plan as needed into the future (see Section 6.2). Because of this, the risk of negative effects due to unforeseen performance deficiencies in the new operating plan is greatly reduced.

Cass Lake Proposed Plan

Major components of the current and proposed operating plans for Cass Lake are summarized in the tables and figure below. The most significant changes to the current operating plan are the lower water elevations in early summer and the increase in minimum releases. However, the proposed increases in minimum releases would not be implemented on Cass Lake until modifications are made to Knutson Dam to improve outflow adjustability. More specific information regarding the proposed plan rules can be found in Section 5.5.

The effects of the proposed plan are discussed in detail in Section 7.6 and are summarized in Major Conclusions and Findings below. In general, the proposed plan is judged to have a minor beneficial effect on numerous natural resources on Cass Lake and a minor beneficial effect on boat access during the last half of summer most years in areas of shallow water. The table below shows the differences between water levels under the current and proposed plan in inches to better help describe expected water levels under the proposed plan.

Under the proposed operating plan, a late summer decline would begin on July 15. However, the water levels would not drop drastically on that date. Instead, water levels would gradually decline on Cass after July 15, less dramatically than what is prescribed by the existing operating plan. Water levels would not be held as high during the early spring to help reduce shoreline erosion on the lake.

It is important to note that during the summers of 2006 and 2007 water levels on Cass Lake were about 6 inches lower than the targeted water levels under the proposed plan. Also, if water levels are below the target in the proposed plan, the goal would be to raise water levels; in other words, we would not continue drawing water levels down if we are already low on July 15.

One common misconception is that the proposed decline in lake levels is being done to increase downstream flows to increase the water supply for municipalities such as Minneapolis, Minnesota. This is not the purpose for any proposed changes in the operating plan.

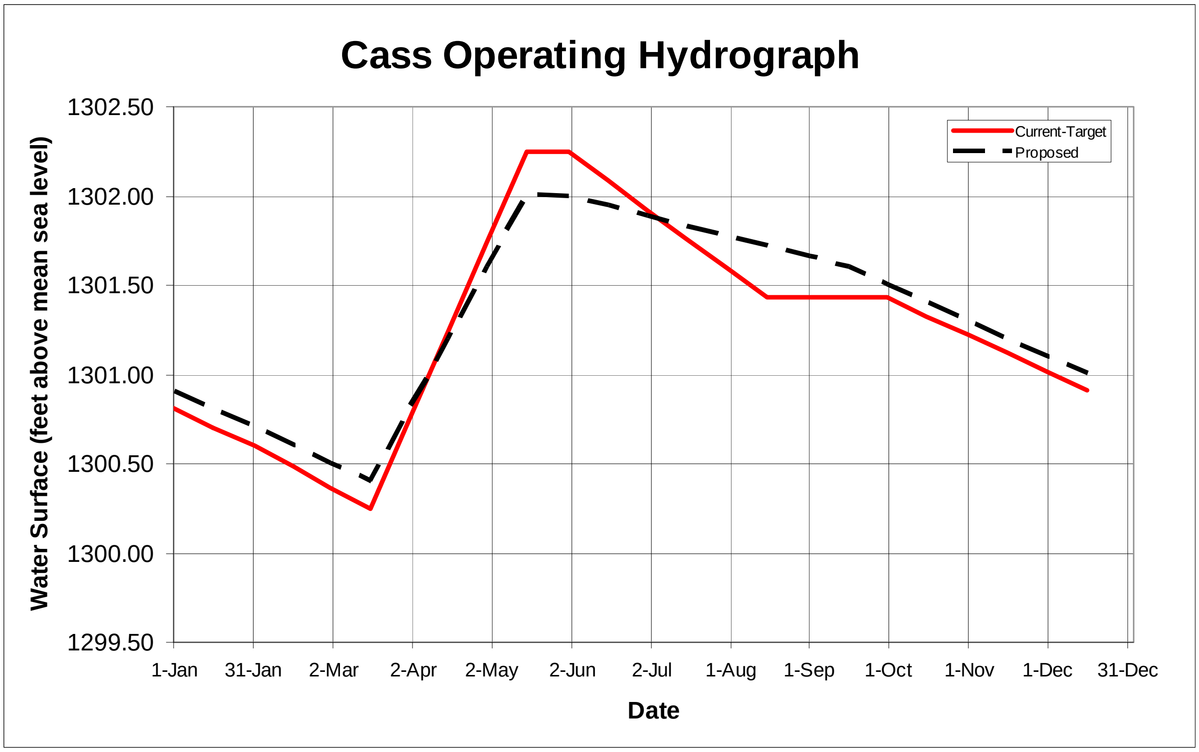
It is our assessment that boat access would be improved in late summer under this plan on Cass Lake. We also believe that environmental resources will benefit through lower spring water levels and the maintenance of a gradual decline similar to those proposed for the other study reservoirs.

If a new operating plan is implemented, we will still be open to modifying it quickly if we determine that it is not working as intended. We have described a process that will be implemented with a new operating plan that will enable us to easily modify the plan in the future if needed.

Finally, it is important to reiterate that the intent of the proposed plan is not to significantly impact one user group for the benefit of another; the intent is to balance the benefits and impacts for the improvement of the whole system for all current and future users. We believe that these reservoirs are valuable resources, and we wish to protect and enhance their health for future generations.

CASS LAKE OPERATING RULES		
	CURRENT	**PROPOSED**
Summer Band (elev. - feet)	1301.4 - 1301.7	1302.25 - 1301.35
Summer Target (elev. - feet)	1301.43-1302.25	1301.6 -1302.0 (May 15- Sep 15)
Band Width (feet)	0.3	0.5
Normal Drawdown (elev. - feet)	1300.25	1300.4
Maximum Drawdown (elev. - feet)	1300.25	1300.25
Rate of Release (change/day)	20-30%	20-30%
Spring Pulse	NA	840 cfs
Minimum Flow Requirements April through September	all water levels: 100 cfs	>= (bottom of band): 130 cfs
		< (bottom of band) >= (bottom of band – 15"): 80 cfs
		< (bottom of band – 15"): 40 cfs
Minimum Flow Requirements October through March	all water levels: 100 cfs	>= (target - 6"): 80 cfs
		< (target - 6"): 40 cfs

Cass Lake Late Summer Elevations			
	Current (feet)	**Proposed (feet)**	**Difference (inches)**
August 1	1301.70	1301.77	+0.84
September 1	1301.43	1301.66	+2.76
October 1	1301.43	1301.50	+0.84


Cass Operating Hydrograph
Water Surface (feet above mean sea level)
1302.50
1302.00
1301.50
1301.00
1300.50
1300.00
1299.50
1-Jan
31-Jan
2-Mar
2-Apr
2-May
2-Jun
2-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
31-Dec
Date
Current-Target
Proposed

Lake Winnibigoshish Proposed Operating Plan

Major components of the current and proposed operating plans for Winnibigoshish are summarized in the tables and figure below. The most significant changes to the current operating plan are the late summer decline in reservoir water levels and the increase in minimum releases. More specific information regarding the proposed plan rules can be found in Section 5.5.

The effects of the proposed plan are discussed in detail in Section 7.6 and are summarized in Major Conclusions and Findings below. In general, the proposed plan is judged to have a minor positive effect on numerous natural resources on Lake Winnibigoshish but a minor adverse effect on boat access during the last half of summer in areas of shallow water. The table below shows the differences between water levels under the current and proposed plan in inches to better help describe expected water levels under the proposed plan.

Under the proposed operating plan, a late summer decline would begin on July 15. However, the water level would not drop drastically on that date. Instead, water levels would gradually decline on Winnibigoshish after July 15 so that they would be about 1 inch lower than normal on August 1, 3 inches lower than normal on September 1, and just over 2 inches lower than normal on October 1. It is important to note that during the summers of 2006 and 2007 water levels on Winnibigoshish were about 6 inches lower than the targeted water levels under the proposed plan. Also, if water levels are below the target in the proposed plan, we would attempt to raise water levels; in other words, we would not continue drawing water levels down if we are already low on July 15.

One common misconception is that the proposed decline in lake levels is being done to increase downstream flows to increase the water supply for municipalities such as Minneapolis. This is not the purpose for any proposed changes in the operating plan.

The primary purpose of lowering the lake beginning in mid-July is to benefit the aquatic plants and animals on Winnibigoshish. Operating the lake in this manner would better approximate water levels that occur on a natural lake, which is beneficial to the lake's environment in general because the plants and animals evolved around a natural rise and fall of water levels. A couple of the more specific benefits are that the gradual decline is favorable to near-shore emergent vegetation such as cattail and bulrush, which benefits fish and birds by providing cover for nesting and rearing of young. More importantly, vegetation can help stabilize eroding banks, for which Winnibigoshish is known. Furthermore, vegetation helps trap eroding sediment and keeps it from covering deeper spawning habitat for fish such as walleye. This gradual decline will not cause fish kills and, in general, will benefit the lake's fishery. It is our assessment that the proposed plan will not harm, but could benefit, stands of wild rice, although it may slightly impede harvest in some years. It is also our assessment that the proposed plan will benefit wetland habitat and the animals that inhabit them. Drawing down wetlands by a few inches late in summer mirrors a natural process and likely encourages reptiles, amphibians, and wetland mammals to overwinter in more stable areas, where winter freeze-out is less likely.

We do realize that this plan has a "cost," in that a decline in water levels does reduce accessibility for boaters. However, it is our assessment that this cost is outweighed by the long-term environmental benefits that will enhance all uses of Winnibigoshish into the future.

The proposed plan also includes increases in the minimum flow requirements for the benefit of downstream aquatic habitat. It is our assessment that these increases would not impact reservoir water levels, even in dry years such as 2006 and 2007.

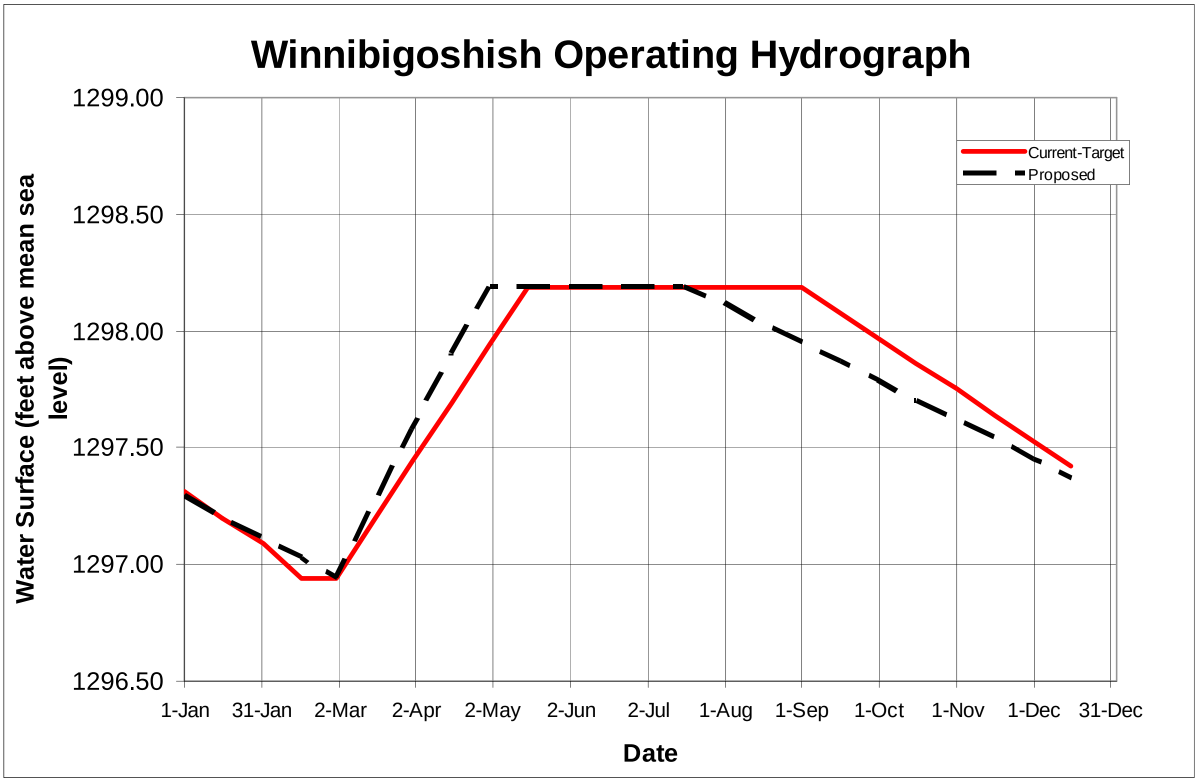
If a new operating plan is implemented, we will still be open to modifying it quickly if we determine that it is not working as intended. We have described a process that will be implemented with a new operating plan that will enable us to easily modify the plan in the future if needed.

Finally, it is important to reiterate that the intent of the proposed plan is not to significantly impact one user group for the benefit of another; the intent is to balance the benefits and impacts for the improvement of the whole system for all current and future users. We believe that these reservoirs are valuable resources, and we wish to protect and enhance their health for future generations.

**LAKE WINNIBIGOSHISH
OPERATING RULES**

	CURRENT	PROPOSED
Summer Band (elev. - feet)	1297.94 -1298.44	1297.94 -1298.44
Summer Target (elev. - feet)	1298.19	1298.19 (May 1 – Jul 15)
Band Width (feet)	0.5	0.5
Normal Drawdown (elev. - feet)	1296.94	1296.94
Maximum Drawdown (elev. - feet)	1294.94	1294.94
Rate of Release (change/day)	200 cfs or 0.5 ft. of TW change	20-30%
Spring Pulse	NA	1060 cfs
Minimum Flow Requirements April through September	>=(1294.94): 100 cfs	(>= bottom of band): 160 cfs
		< (bottom of band) >= (bottom of band – 15"): 110 cfs
	<(1294.94): 50 cfs	< (bottom of band – 15"): 50 cfs
Minimum Flow Requirements October through March	>=(1294.94): 100 cfs	>= (target - 6"): 110 cfs
	<(1294.94): 50 cfs	< (target - 6"): 50 cfs

Winnibigoshish Late Summer Elevations			
	Current (feet)	Proposed (feet)	Difference (inches)
August 1	1298.19	1298.12	-0.84
September 1	1298.19	1297.95	-2.88
October 1	1297.97	1297.79	-2.16



Leech Lake Proposed Operating Plan

Major components of the current and proposed operating plans for Leech Lake are summarized in the tables and figure below. The most significant changes to the current operating plan are the late summer decline in reservoir water levels and the increase in minimum releases. More specific information regarding the proposed plan rules can be found in Section 5.5.

The effects of the proposed plan are discussed in detail in Section 7.6 and are summarized in Major Conclusions and Findings below. In general, the proposed plan is judged to have a minor positive effect on numerous natural resources on Leech Lake but a minor adverse effect on boat access during the last half of summer in areas of shallow water. The table below shows the differences between water levels under the current and proposed plan in inches to better help describe expected water levels under the proposed plan.

Under the proposed operating plan, a late summer decline would begin on July 15. However, the water level would not drop drastically on that date. Instead, water levels would gradually decline on Leech after July 15 so that they would be about 1 inch lower than normal on August 1, just over 2 inches lower than normal on September 1, and about 1.5 inches lower than normal on October 1. It is important to note that during the summers of 2006 and 2007 water levels on Leech were about 6 inches lower than the targeted water levels under the proposed plan. Also, if water levels are below the target in the proposed plan, we would attempt to raise water levels; in other words, we would not continue drawing water levels down if we are already low on July 15.

One common misconception is that the proposed decline in lake levels is being done to increase downstream flows to increase the water supply for municipalities such as Minneapolis. This is not the purpose for any proposed changes in the operating plan.

The primary purpose of lowering the lake beginning in mid-July is to benefit the aquatic plants and animals on Leech Lake. Operating the lake in this manner would better approximate water levels that occur on a natural lake, which is beneficial to the lake's environment in general because the plants and animals evolved around a natural rise and fall of water levels. A couple of the more specific benefits are that the gradual decline is favorable to near-shore emergent vegetation such as cattail and bulrush, which benefits fish and birds by providing cover for nesting and rearing of young. More importantly, vegetation can help stabilize eroding banks. Furthermore, vegetation helps trap eroding sediment and keeps it from covering deeper spawning habitat for fish such as walleye. This gradual decline will not cause fish kills and, in general, will benefit Leech Lake’s fishery. It is our assessment that the proposed plan will not harm, but could benefit, stands of wild rice, although it may slightly impede harvest in some years. It is also our assessment that the proposed plan will benefit wetland habitat and the animals that inhabit them. Drawing down wetlands by a few inches late in summer mirrors a natural process and likely encourages reptiles, amphibians, and wetland mammals to overwinter in more stable areas, where winter freeze-out is less likely.

We do realize that this plan has a "cost," in that a decline in water levels does reduce accessibility for boaters. However, it is our assessment that this cost is outweighed by the long-term environmental benefits that will enhance all uses of Leech Lake into the future.

The proposed plan also includes increases in the minimum flow requirements for the benefit of downstream aquatic habitat. It is our assessment that these increases would not impact reservoir water levels, even in dry years such as 2006 and 2007.

If a new operating plan is implemented, we will still be open to modifying it quickly if we determine that it is not working as intended. We have described a process that will be implemented with a new operating plan that will enable us to easily modify the plan in the future if needed.

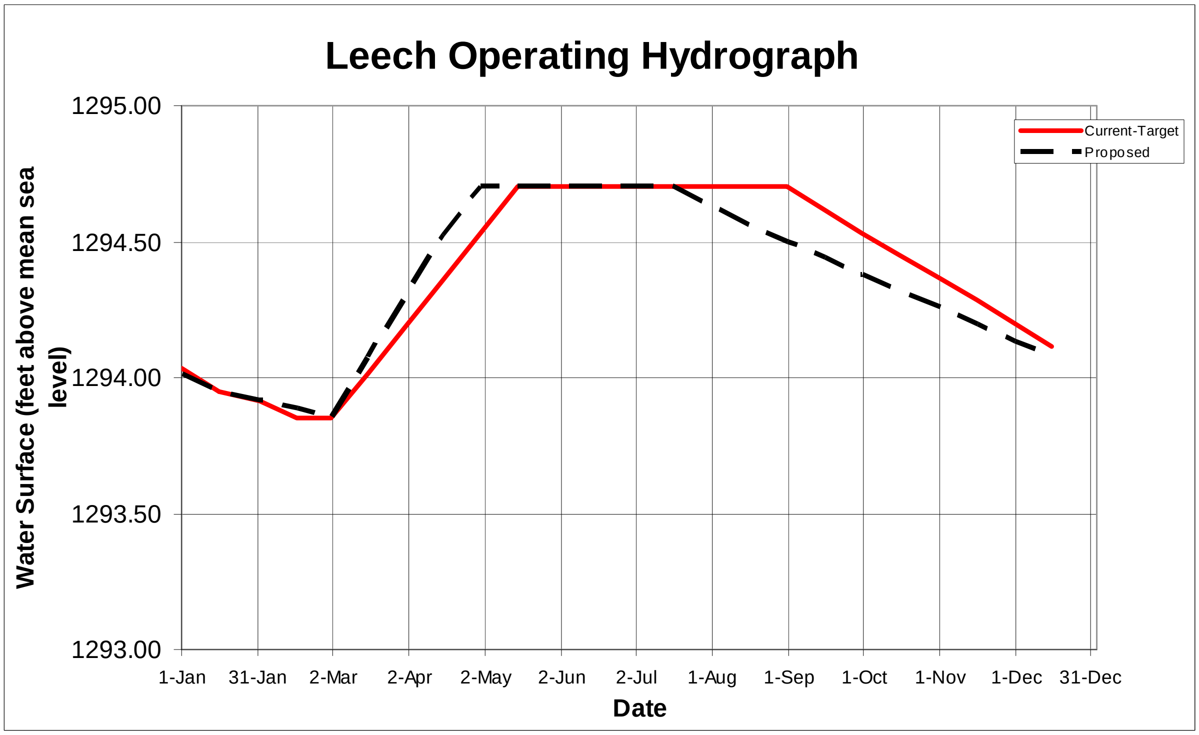
Finally, it is important to reiterate that the intent of the proposed plan is not to significantly impact one user group for the benefit of another; the intent is to balance the benefits and impacts for the improvement of the whole system for all current and future users. We believe that these reservoirs are valuable resources, and we wish to protect and enhance their health for future generations.

LEECH LAKE
OPERATING RULES

	CURRENT	PROPOSED
Summer Band (elev. - feet)	1294.50-1294.90	1294.45-1294.95
Summer Target (elev. - feet)	1294.70	1294.70 (May 1 – Jul 15)
Band Width (feet)	0.4	0.5
Normal Drawdown (elev. - feet)	1293.80	1293.80
Maximum Drawdown (elev. - feet)	1292.70	1292.70
Rate of Release (change/day)	100 cfs or 0.25 ft. of TW change	20-30%
Spring Pulse	NA	790 cfs
Minimum Flow Requirements April through September	>=(1292.70): 100 cfs	(>= bottom of band): 120 cfs
		< (bottom of band) >= (bottom of band – 15”): 80 cfs
	<(1292.70): 50 cfs	< (bottom of band – 15”): 40 cfs
Minimum Flow Requirements October through March	>=(1292.70): 100 cfs	>= (target - 6”): 80 cfs
	<(1292.70): 50 cfs	< (target - 6”): 40 cfs

Leech Lake
Late Summer Elevations

	Current (feet)	Proposed (feet)	Difference (inches)
August 1	1294.70	1294.63	-0.84
September 1	1294.70	1294.50	-2.4
October 1	1294.53	1294.40	-1.56



Pokegama Lake Proposed Operating Plan

Major components of the current and proposed operating plans for Pokegama Lake are summarized in the tables and figure below. The most significant changes to the current operating plan are the late summer decline in reservoir water levels and the increase in minimum releases. More specific information regarding the proposed plan rules can be found in Section 5.5.

The effects of the proposed plan are discussed in detail in Section 7.6 and are summarized in Major Conclusions and Findings below. In general, the proposed plan is judged to have a minor positive effect on numerous natural resources on Pokegama Lake but a minor adverse effect on boat access during the last half of summer in areas of shallow water. The table below shows the differences between water levels under the current and proposed plan in inches to better help describe expected water levels under the proposed plan.

Under the proposed operating plan, a late summer decline would begin on July 15. However, the water level would not drop drastically on that date. Instead, water levels would gradually decline on Pokegama after July 15 so that they would be 1 inch lower than normal on August 1, 3 inches lower than normal on September 1, and just over 2 inches lower than normal on October 1. Also, if water levels are below the target in the proposed plan, we would attempt to raise water levels; in other words, we would not continue drawing water levels down if we are already low on July 15.

One common misconception is that the proposed decline in lake levels is being done to increase downstream flows to increase the water supply for municipalities such as Minneapolis. This is not the purpose for any proposed changes in the operating plan.

The primary purpose of lowering the lake beginning in mid-July is to benefit the aquatic plants and animals on Pokegama. Operating the lake in this manner would better approximate water levels that occur on a natural lake, which is beneficial to the lake's environment in general because the plants and animals evolved around a natural rise and fall of water levels. A couple of the more specific benefits are that the gradual decline is favorable to near-shore emergent vegetation such as cattail and bulrush, which benefits fish and birds by providing cover for nesting and rearing of young. More importantly, vegetation can help stabilize eroding banks. Furthermore, vegetation helps trap eroding sediment and keeps it from covering deeper spawning habitat for fish such as walleye. This gradual decline will not cause fish kills and, in general, will benefit Pokegama’s fishery. It is our assessment that the proposed plan will not harm, but could benefit, stands of wild rice, although it may slightly impede harvest in some years. It is also our assessment that the proposed plan will benefit wetland habitat and the animals that inhabit them. Drawing down wetlands by a few inches late in summer mirrors a natural process and likely encourages reptiles, amphibians, and wetland mammals to overwinter in more stable areas, where winter freeze-out is less likely.

We do realize that this plan has a "cost," in that a decline in water levels does reduce accessibility for boaters. However, it is our assessment that this cost is outweighed by the long-term environmental benefits that will enhance all uses of Pokegama into the future.

The proposed plan also includes increases in the minimum flow requirements for the benefit of downstream aquatic habitat. It is our assessment that during years with normal precipitation, these increases would not impact reservoir water levels. During drought years such as 2006 and 2007, it is our assessment that these increased minimums would further reduce lake levels by less than 2 inches.

If a new operating plan is implemented, we will still be open to modifying it quickly if we determine that it is not working as intended. We have described a process that will be implemented with a new operating plan that will enable us to easily modify the plan in the future if needed.

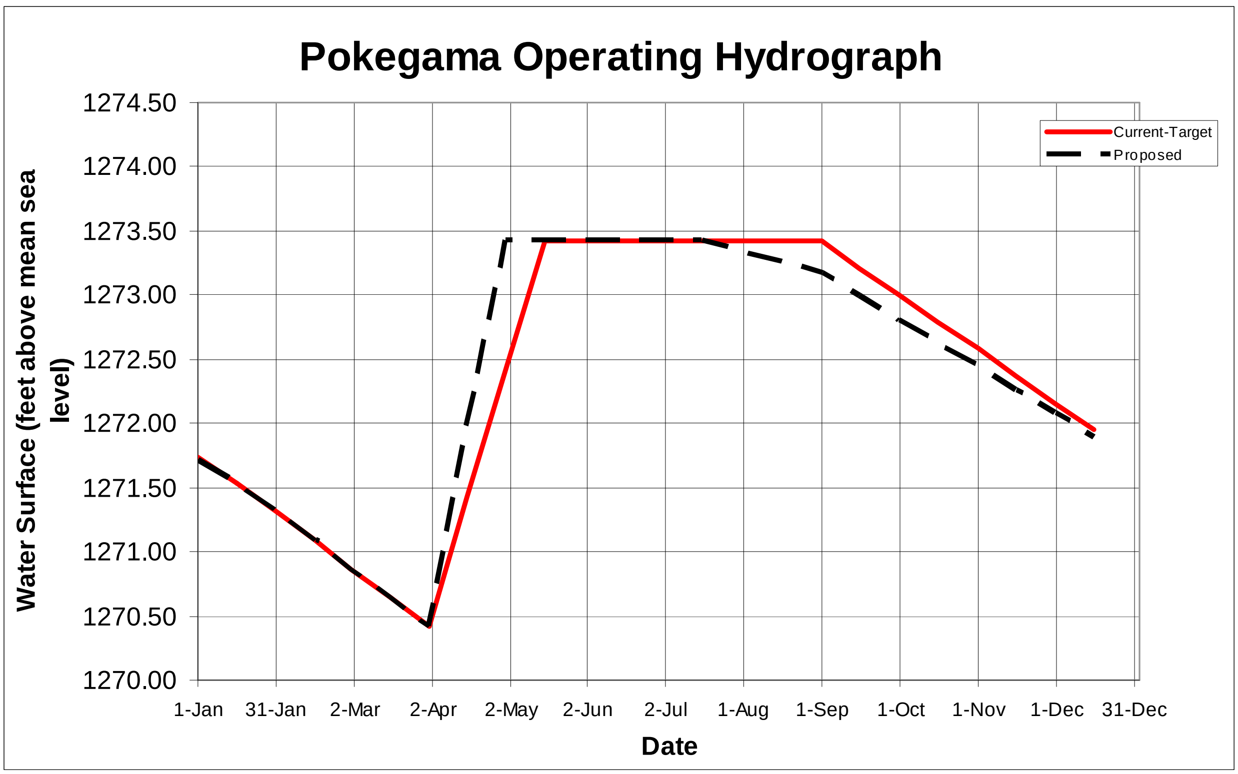
Finally, it is important to reiterate that the intent of the proposed plan is not to significantly impact one user group for the benefit of another; the intent is to balance the benefits and impacts for the improvement of the whole system for all current and future users. We believe that these reservoirs are valuable resources, and we wish to protect and enhance their health for future generations.

POKEGAMA LAKE
OPERATING RULES

	CURRENT	PROPOSED
Summer Band (elev. - feet)	1273.17-1273.67	1273.17-1273.67
Summer Target (elev. - feet)	1273.42	1273.42 (May 1 – Jul 15)
Band Width (feet)	0.5	0.5
Normal Drawdown (elev. - feet)	1270.42	1270.42
Maximum Drawdown (elev. - feet)	1270.42	1270.42
Rate of Release (change/day)	20-30%	20-30%
Spring Pulse	NA	2410 cfs
Minimum Flow Requirements April through September	>=(1273.17): 200 cfs	(>= bottom of band): W+L+50 or 240 cfs
		< (bottom of band) >= (bottom of band – 15"): W+L+10 or 200 cfs
	<(1273.17): Winni + Leech	< (bottom of band – 15"): 120 cfs
Minimum Flow Requirements October through March	>=(1273.17): 200 cfs	>= (target - 6"): W+L+10 or 200 cfs
	<(1273.17): Winni + Leech	< (target - 6"): 120 cfs

Note: For proposed minimum releases, "W+L+10 or 200 cfs", for example, is interpreted as the lesser of the combined outflow from Winnibigoshish and Leech, or 200 cfs.

Pokegama Late Summer Elevations			
	Current (feet)	**Proposed (feet)**	**Difference (inches)**
August 1	1273.42	1273.34	-0.96
September 1	1273.42	1273.17	-3
October 1	1273.0	1272.81	-2.28



Sandy Lake Proposed Operating Plan

Major components of the current and proposed operating plans for Sandy Lake are summarized in the tables and figure below. The most significant changes to the current operating plan are the late summer decline in reservoir water levels and the increase in minimum releases. More specific information regarding the proposed plan rules can be found in Section 5.5.

The effects of the proposed plan are discussed in detail in Section 7.6 and are summarized in Major Conclusions and Findings below. In general, the proposed plan is judged to have a minor positive effect on numerous natural resources on Sandy Lake but a minor adverse effect on boat access during the last half of summer in areas of shallow water. The table below shows the differences between water levels under the current and proposed plan in inches to better help describe expected water levels under the proposed plan.

Under the proposed operating plan, a late summer decline would begin on July 15. However, the water level would not drop drastically on that date. Instead, water levels would gradually decline on Big Sandy after July 15 so that they would be 1 inch lower than normal on August 1, 3 inches lower than normal on September 1, and 5 inches lower than normal on October 1. It is important to note that during the summers of 2006 and 2007 water levels on Big Sandy were about 6 inches lower than the targeted water levels under the proposed plan. Also, if water levels are below the target in the proposed plan, we would attempt to raise water levels; in other words, we would not continue drawing water levels down if we are already low on July 15.

One common misconception is that the proposed decline in lake levels is being done to increase downstream flows to increase the water supply for municipalities such as Minneapolis. This is not the purpose for any proposed changes in the operating plan.

The primary purpose of lowering the lake beginning in mid-July is to benefit the aquatic plants and animals on Big Sandy. Operating the lake in this manner would better approximate water levels that occur on a natural lake, which is beneficial to the lake's environment in general because the plants and animals evolved around a natural rise and fall of water levels. A couple of the more specific benefits are that the gradual decline is favorable to near-shore emergent vegetation such as cattail and bulrush, which benefits fish and birds by providing cover for nesting and rearing of young. More importantly, vegetation can help stabilize eroding banks, for which Big Sandy is known. Furthermore, vegetation helps trap eroding sediment and keeps it from covering deeper spawning habitat for fish such as walleye. This gradual decline will not cause fish kills and, in general, will benefit Big Sandy's fishery. It is our assessment that the proposed plan will not harm, but could benefit, stands of wild rice, although it may slightly impede harvest in some years. It is also our assessment that the proposed plan will benefit wetland habitat and the animals that inhabit them. Drawing down wetlands by a few inches late in summer mirrors a natural process and likely encourages reptiles, amphibians, and wetland mammals to overwinter in more stable areas, where winter freeze-out is less likely.

We do realize that this plan has a "cost," in that a decline in water levels does reduce accessibility for boaters. However, it is our assessment that this cost is outweighed by the long-term environmental benefits that will enhance all uses of Big Sandy into the future.

The proposed plan also includes increases in the minimum flow requirements for the benefit of downstream aquatic habitat. It is our assessment that during years with normal precipitation, these increases would not impact reservoir water levels. During drought years such as 2006 and 2007, it is our assessment that these increased minimums would further reduce lake levels by less than 2 inches.

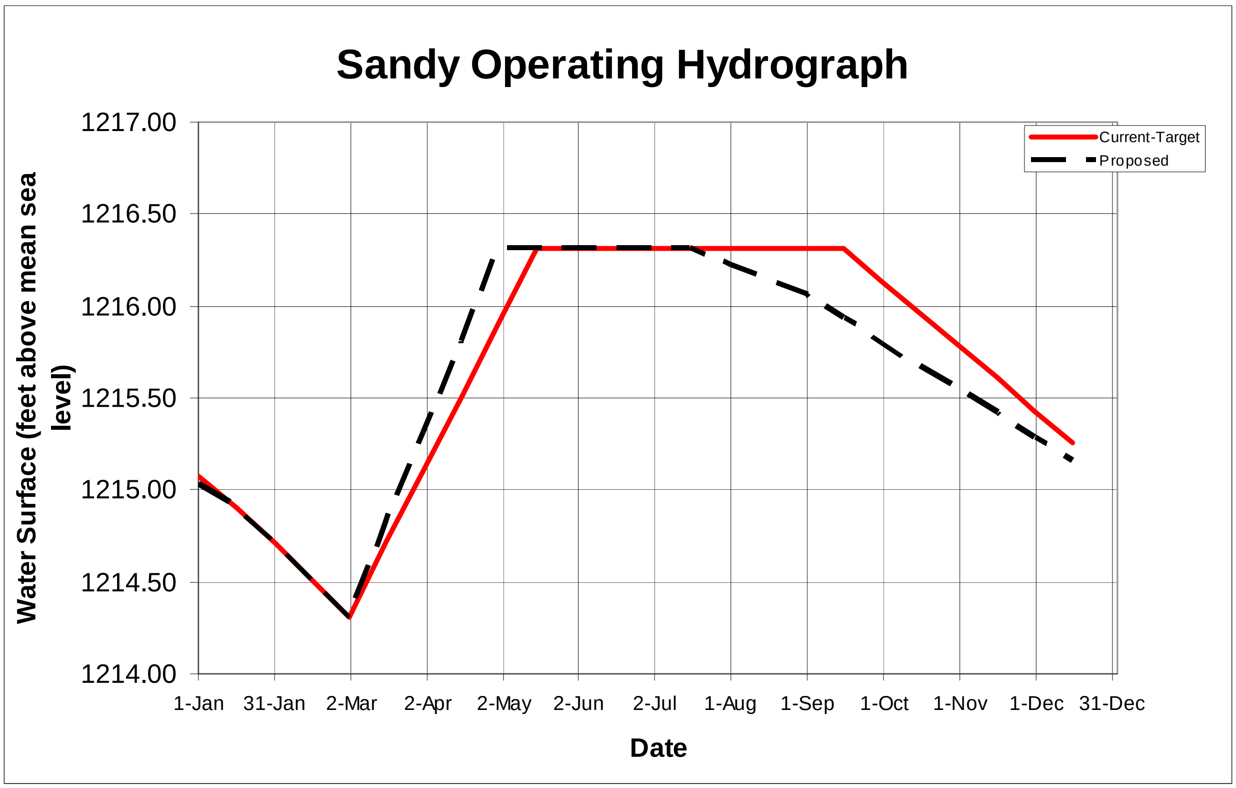
If a new operating plan is implemented, we will still be open to modifying it quickly if we determine that it is not working as intended. We have described a process that will be implemented with a new operating plan that will enable us to easily modify the plan in the future if needed.

Finally, it is important to reiterate that the intent of the proposed plan is not to significantly impact one user group for the benefit of another; the intent is to balance the benefits and impacts for the improvement of the whole system for all current and future users. We believe that these reservoirs are valuable resources, and we wish to protect and enhance their health for future generations.

**SANDY LAKE
OPERATING RULES**

	CURRENT	PROPOSED
Summer Band (elev. - feet)	1216.06-1216.56	1216.06-1216.56
Summer Target (elev. - feet)	1216.31	1216.31 (May 1 – Jul 15)
Band Width (ft.)	0.5	0.5
Normal Drawdown (elev. - feet)	1214.31	1214.31
Maximum Drawdown (elev. - feet)	1214.31	1214.31
Rate of Release (change/day)	20-30%	20-30%
Spring Pulse	NA	490 cfs
Minimum Flow Requirements April through September	>=(1214.31): 20 cfs	(>= bottom of band): 40 cfs
		< (bottom of band) >= (bottom of band – 15”): 20 cfs
	<(1214.31): 10 cfs	< (bottom of band – 15”): 10 cfs
Minimum Flow Requirements October through March	>=(1214.31): 20 cfs	>= (target - 6”): 20 cfs
	<(1214.31): 10 cfs	< (target - 6”): 10 cfs

Sandy Lake Late Summer Elevations			
	Current (feet)	**Proposed (feet)**	**Difference (inches)**
August 1	1216.31	1216.23	-0.96
September 1	1216.31	1216.06	-3
October 1	1216.13	1215.80	-3.96



Cross Lake Proposed Operating Plan

Major components of the current and proposed operating plans for Cross Lake and the Whitefish Chain of Lakes are summarized in the tables and figure below. The most significant changes to the current operating plan are the late summer decline in reservoir water levels and the increase in minimum releases. More specific information regarding the proposed plan rules can be found in Section 5.5.

The effects of the proposed plan are discussed in detail in Section 7.6 and are summarized in Major Conclusions and Findings below. In general, the proposed plan is judged to have a minor positive effect on numerous natural resources on Cross Lake and the Whitefish Chain but a minor adverse effect on boat access during the last half of summer in areas of shallow water. The table below shows the differences between water levels under the current and proposed plan in inches to better help describe expected water levels under the proposed plan.

Under the proposed operating plan, a late summer decline would begin on July 15. However, the water level would not drop drastically on that date. Instead, water levels would gradually decline after July 15 so that they would be 1 inch lower than normal on August 1, 3 inches lower than normal on September 1, and just over 3 inches lower than normal on October 1. Also, if water levels are below the target in the proposed plan, we would attempt to raise water levels; in other words, we would not continue drawing water levels down if we are already low on July 15.

One common misconception is that the proposed decline in lake levels is being done to increase downstream flows to increase the water supply for municipalities such as Minneapolis. This is not the purpose for any proposed changes in the operating plan.

The primary purpose of lowering the lake beginning in mid-July is to benefit the aquatic plants and animals on the Whitefish Chain. Operating the lake in this manner would better approximate water levels that occur on a natural lake, which is beneficial to the lake's environment in general because the plants and animals evolved around a natural rise and fall of water levels. A couple of the more specific benefits are that the gradual decline is favorable to near-shore emergent vegetation such as cattail and bulrush, which benefits fish and birds by providing cover for nesting and rearing of young. More importantly, vegetation can help stabilize eroding banks, for which the Whitefish Chain is known. Furthermore, vegetation helps trap eroding sediment and keeps it from covering deeper spawning habitat for fish such as walleye. This gradual decline will not cause fish kills and, in general, will benefit the lake’s fishery. It is our assessment that the proposed plan will not harm, but could benefit, stands of wild rice, although it may slightly impede harvest in some years. It is also our assessment that the proposed plan will benefit wetland habitat and the animals that inhabit them. Drawing down wetlands by a few inches late in summer mirrors a natural process and likely encourages reptiles, amphibians, and wetland mammals to overwinter in more stable areas, where winter freeze-out is less likely.

We do realize that this plan has a "cost," in that a decline in water levels does reduce accessibility for boaters. However, it is our assessment that this cost is outweighed by the long-term environmental benefits that will enhance all uses of the lake into the future.

The proposed plan also includes increases in the minimum flow requirements for the benefit of downstream aquatic habitat. It is our assessment that during years with normal precipitation, these increases would not impact reservoir water levels. During drought years such as 2006 and 2007, it is our assessment that these increased minimums would further reduce lake levels by less than 2 inches.

If a new operating plan is implemented, we will still be open to modifying it quickly if we determine that it is not working as intended. We have described a process that will be implemented with a new operating plan that will enable us to easily modify the plan in the future if needed.

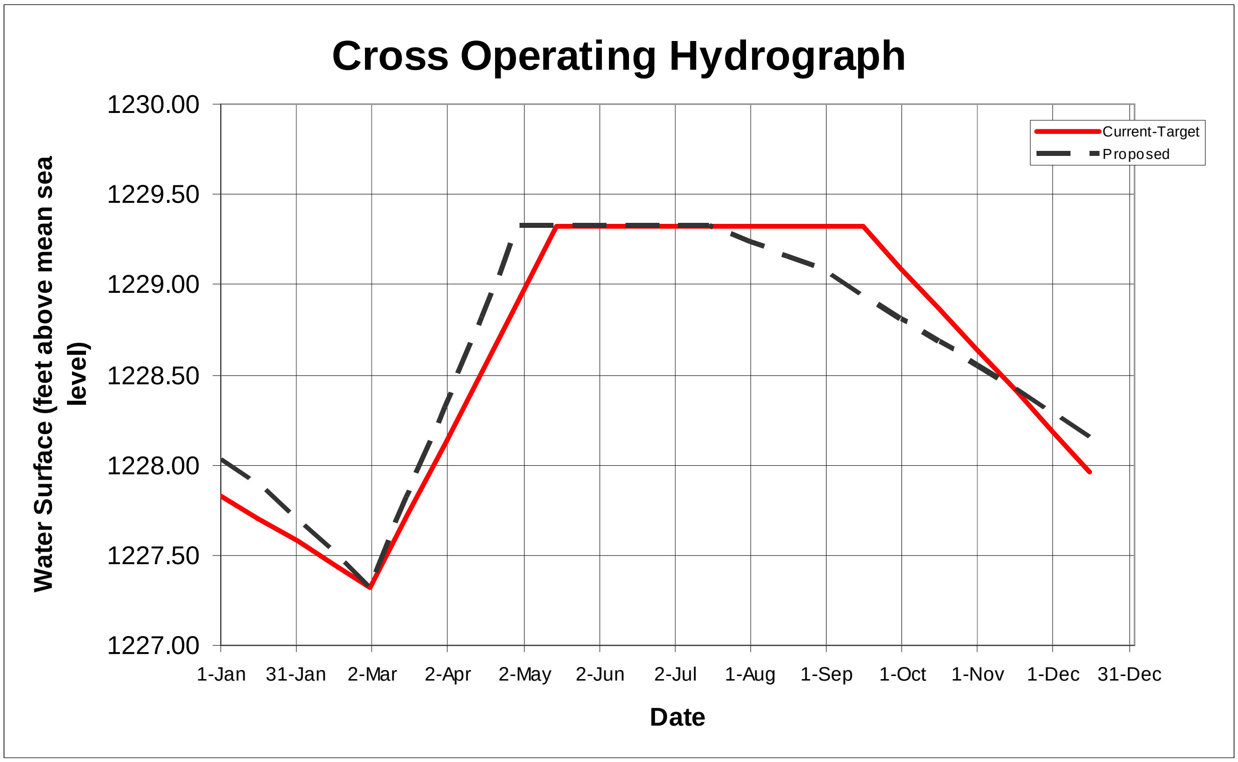
Finally, it is important to reiterate that the intent of the proposed plan is not to significantly impact one user group for the benefit of another; the intent is to balance the benefits and impacts for the improvement of the whole system for all current and future users. We believe that these reservoirs are valuable resources, and we wish to protect and enhance their health for future generations.

CROSS LAKE OPERATING RULES

	CURRENT	PROPOSED
Summer Band (elev. - feet)	1229.07-1229.57	1229.07-1229.57
Summer Target (elev. - feet)	1229.32	1229.32 (May 1 – Jul 15)
Band Width (feet)	0.5	0.5
Normal Drawdown (elev. - feet)	1227.32	1227.32
Maximum Drawdown (elev. - feet)	1225.32	1225.32
Rate of Release (change/day)	60 cfs or 0.25 ft. of TW change	20-30%
Spring Pulse	NA	500 cfs
Minimum Flow Requirements April through September	>=(1225.32): 30 cfs	(>= bottom of band): 50 cfs
		< (bottom of band) >= (bottom of band – 15”): 30 cfs
	<(1225.32): 15 cfs	< (bottom of band – 15”): 20 cfs
Minimum Flow Requirements October through March	>=(1225.32): 30 cfs	>= (target - 6”): 30 cfs
	<(1225.32): 15 cfs	< (target - 6”): 20 cfs

Cross
Late Summer Elevations

	Current (ft.)	Proposed (ft.)	Difference (in.)
August 1	1229.32	1229.24	-0.96
September 1	1229.32	1229.07	-3
October 1	1229.09	1228.81	-3.36



Gull Lake Proposed Operating Plan

Major components of the current and proposed operating plans for Gull Lake are summarized in the tables and figure below. The most significant changes to the current operating plan are the increase in summer water levels, early fall/late summer decline in reservoir water levels, and the increase in minimum releases. More specific information regarding the proposed plan rules can be found in Section 5.5.

The effects of the proposed plan are discussed in detail in Section 7.6 and are summarized in Major Conclusions and Findings below. In general, the proposed plan is judged to have a minor positive effect on numerous natural resources on Gull Lake and a very minor positive effect on boat access. The table below shows the differences between water levels under the current and proposed plan to better help describe expected water levels under the proposed plan.

Under the proposed plan the summer water level target would be raised to 1194.0. Most will not notice much change as water levels have been very near this level during the summer since about the mid-1980's. The proposed plan would also include a late summer decline that would begin on September 1. It is important to note that during the summers of 2006 and 2007 late summer water levels on Gull were about 6 inches lower than the targeted water levels under the proposed plan.

The proposed plan also includes increases in the minimum flow requirements for the benefit of downstream aquatic habitat. It is our assessment that during years with normal precipitation, these increases would not impact reservoir water levels. During drought years such as 2006 and 2007, it is our assessment that these increased minimums would further reduce lake levels by less than 2 inches.

One common misconception is that the proposed decline in lake levels is being done to increase downstream flows to increase the water supply for municipalities such as Minneapolis. This is not the purpose for any proposed changes in the operating plan.

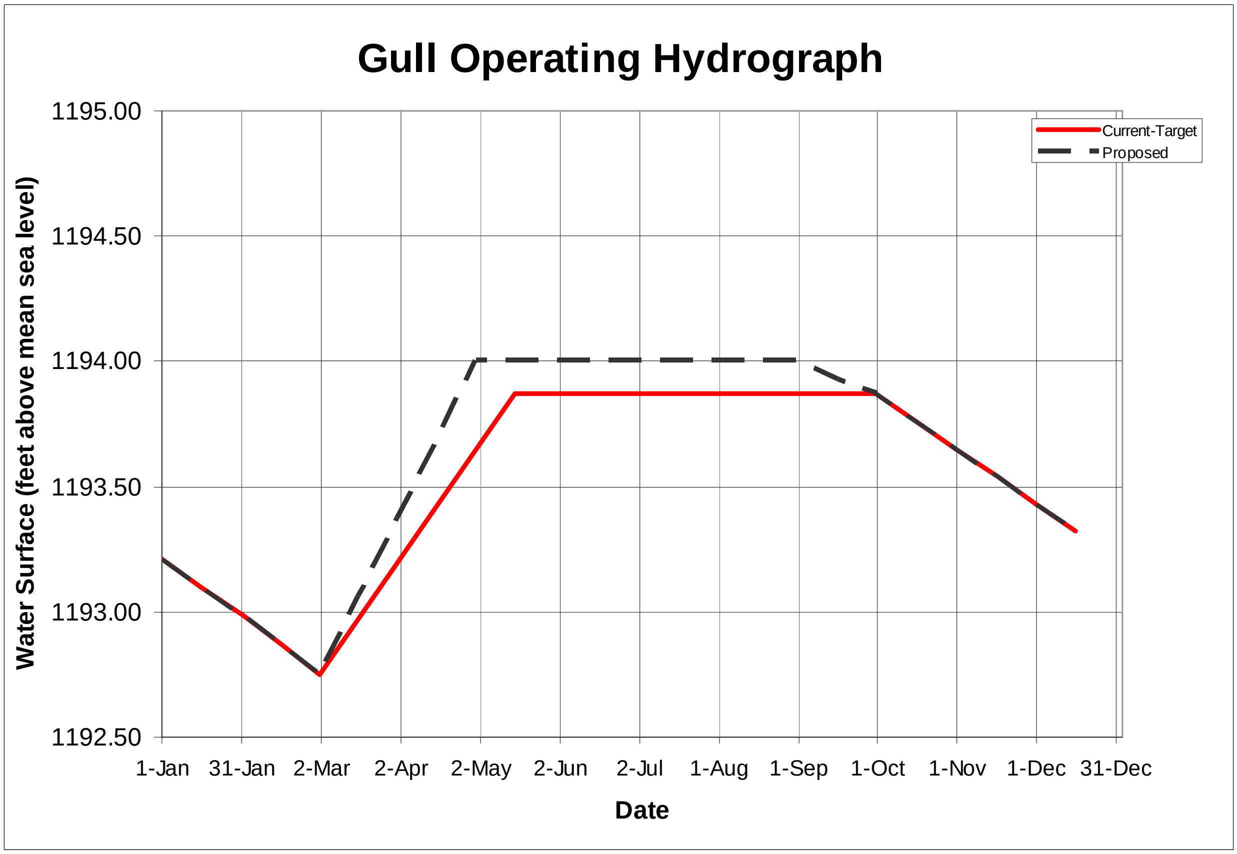
If a new operating plan is implemented, we will still be open to modifying it quickly if we determine that it is not working as intended. We have described a process that will be implemented with a new operating plan that will enable us to easily modify the plan in the future if needed.

Finally, it is important to reiterate that the intent of the proposed plan is not to significantly impact one user group for the benefit of another; the intent is to balance the benefits and impacts for the improvement of the whole system for all current and future users. We believe that these reservoirs are valuable resources, and we wish to protect and enhance their health for future generations.

GULL LAKE OPERATING RULES		
	CURRENT	**PROPOSED**
Summer Band (elev. - feet)	1193.75-1194.0	1193.85-1194.15
Summer Target (elev. - feet)	1193.87	1194.0 (May 1 – Sep 1)
Band Width (feet)	0.25	0.3
Normal Drawdown (elev. - feet)	1192.75	1192.75
Maximum Drawdown (elev. - feet)	1192.75	1192.75
Rate of Release (change/day)	20-30%	20-30%
Spring Pulse	NA	250 cfs
Minimum Flow Requirements April through September	>=(1192.75): 20 cfs	(>= bottom of band): 40 cfs
		< (bottom of band) >= (bottom of band – 15"): 20 cfs
	<(1192.75): 10 cfs	< (bottom of band – 15"): 10 cfs
Minimum Flow Requirements October through March	>=(1192.75): 20 cfs	>= (target - 6"): 20 cfs
	<(1192.75): 10 cfs	< (target - 6"): 10 cfs

Gull Late Summer Elevations			
	Current (feet)	**Proposed (feet)**	**Difference (inches)**
August 1	1193.87	1194.0	+1.56
September 1	1193.87	1194.0	+1.56
October 1	1193.87	1193.87	0

Note: The difference was calculated from the target in the current operating plan (1193.87), rather than the top of the band (1194).


Gull Operating Hydrograph
Water Surface (feet above mean sea level)
1195.00
1194.50
1194.00
1193.50
1193.00
1192.50
1-Jan
31-Jan
2-Mar
2-Apr
2-May
2-Jun
2-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
31-Dec
Date
Current-Target
Proposed

Flood Operating Rules Under the Proposed Plan

The proposed plan includes minor revisions to the flood operating rules that are expected to have very little to a minor beneficial effect of reducing flooding impacts over the impacts experienced under the current plan. Details regarding the proposed flood operating rules can be found in Section 5.3.6.

Flood damage curves are used in the current and proposed plans to help guide operations during a flood. The curves are graphical relationships showing the water stages at chosen locations that would result in equal flood damages and are used to guide reservoir regulation decisions during floods. The proposed rules retain the basic flood damage curve relationships that are found in the existing plan with the exception that Big Sandy Lake will no longer be included in the curves. As a result, under any given flood, the relative targeted water levels between the city of Aitkin, Minnesota, and Pokegama would remain the same as under the existing plan. Flood levels experienced at Pokegama and Aitkin are expected to be about the same for most events under the proposed plan. Even though Sandy Lake would be removed from the flood curves, flood levels on Sandy Lake are also expected to remain the same under the proposed rules.

Since the guide curves were published in 1956, it has proven very difficult if not impossible to operate Big Sandy Lake Dam in accordance with its water elevations required by the guide curves. This is due to the fact that the Big Sandy Lake Dam tailwater is affected by backwater from the Mississippi River up to the dam. During flood events, it submerges the Big Sandy Lake Dam gates, restricting the outflow due to reduced head across the dam. As a result, for a large portion of the existing guide curves for Aitkin stages above the13-foot flood elevation at Aitkin, a water control regulator cannot proactively operate Big Sandy Dam for flood control because the Mississippi River controls the dam's outflow.

Following the spring drawdown, the Corps releases inflow from Big Sandy Lake Dam to maintain the target drawdown level. Experience has shown that, as the snow melts and stages at Aitkin rise, the maximum flood damage reduction benefit for both Big Sandy Lake and Aitkin is obtained by releasing as much water as possible through the dam prior to the backwater effect from the Mississippi River restricting the outflow through the gates. Even though the gates are often wide open by this time, the outflow approaches zero as the tailwater level below the dam rises with very little flow from the Sandy River making its way to Aitkin. By releasing as much water as possible early on, Big Sandy Lake retains as much storage as possible to assist Aitkin while keeping its ultimate peak lake elevation as low as possible. In summary, the flood control operation at Big Sandy Lake Dam is driven by the characteristics of the runoff and geomorphology of the river and its watershed. The Corps does not have enough control to actively follow the Sandy Lake portion of a guide curve.

However, Pokegama Lake, with the assistance of Lake Winnibigoshish and Leech Lake, can provide flood damage reduction for Aitkin for a wide range of flood events. As a result, curves were developed that retain the existing relationship between Pokegama's reservoir levels and Aitkin's stages while eliminating Big Sandy Lake from the curves. Additionally, guidance has been added to the proposed plan to help the Corps regulator better understand the capabilities and limitations of the system in the event of a flood.

These proposed changes to the flood operating rules will enhance the clarity of flood operating procedures for the Corps regulator and for the general public. They will also provide a minor benefit by enhancing the consistent and efficient management of flood waters.

MAJOR CONCLUSIONS AND FINDINGS

Overall, the proposed plan would have a beneficial effect on the human environment in the project area. The majority of this effect would occur in the upper half of the project area from approximately Little Falls, Minnesota, upstream to Lake Bemidji.

In general, the proposed plan is expected to have a minor negative short-term and a minor beneficial long-term effect on socioeconomic resources in the study area. No serious long-term negative economic impacts are expected as a result of the implementation of the proposed plan. Instead, long-term overall positive socioeconomic impacts of the plan should result from a healthier lake and river ecosystems that both residents and visitors can use and enjoy now and into the future. The primary contributing factor to these effects is the proposed late summer decline in water levels on the reservoirs. Starting on July 15 on all reservoirs but Gull, water levels would be allowed to fall at a rate of about 2 inches per month. This decline would make navigation through some connecting channels more difficult for larger boats in late summer and early fall. In most cases, this decline in water levels is not expected to have a substantial impact on recreation on the reservoirs.

The proposed plan would have a minor beneficial effect on natural resources in the project area in the short-term and long-term caused by hydrologic conditions that more closely resemble natural conditions relative to the existing operating plan. The beneficial effects to natural resources would be the result of seasonal changes in reservoir levels and river flows that better coincide with those experienced in unregulated (without dams) systems. The native plants, reptiles, amphibians, fish, insects, birds, and mammals that use aquatic habitats in the headwaters evolved over time to match their life histories and seasonal movements to the natural rise and fall of water levels. Disruptions, or variability, in water levels are common in natural systems, but on average the basic rise and fall of water levels follow a predictable seasonal pattern that begins with high water levels immediately after snowmelt in the spring, gradually declining water levels through the summer, and steady low water levels and flows in the winter. While the proposed operating plan would not result in seasonal water level changes identical to those that would occur without the dams in place, it would produce seasonal changes that are more similar to a natural pattern and, therefore, would be beneficial to a variety of species. This improvement and protection of aquatic plants and animals would help ensure that the natural qualities for which the Headwaters are appreciated will be protected into the future more so than which they would under the existing operating plan. A secondary minor beneficial effect of this change in hydrology would be a minor reduction in shoreline erosion due to increased emergent vegetation and a reduction in the length of time water is held high and eroding shorelines.

The proposed plan would have no measurable effect on flooding over the existing plan because proposed changes in the flood operating rules are minor, are being proposed to better reflect the existing physical constraints of the system, and would provide more clarity and detail for future operation.

The proposed plan would have minimal effects on air quality, hydropower production, property values, employment, public health and safety, community growth and development, archeological resources, and threatened and endangered species.

AREAS OF CONTROVERSY

There is controversy regarding the gradual summer decline in reservoir water levels in the proposed plan. Most members of the public who have commented on changes to the existing operating plan question whether the tradeoff between the recreational effects and the natural resource benefits is worthwhile.

There is also controversy regarding the operation of Stump Lake Dam by Otter Tail Power. While the operation of this dam was reviewed in the ROPE, the Corps and the Forest Service do not have authority over the operation of the dam; therefore, a new operation plan for the Stump Lake Dam is not presented in, nor will the operation of Stump Lake Dam be modified as a direct result of, the ROPE Study. If the operation of the dam is modified, a separate review process would be completed by Otter Tail Power and the Minnesota Department of Natural Resources.

There is controversy regarding the regulation of the reservoirs for “recreational” purposes in opposition to tribal uses of the reservoirs. The tribes feel that recreational uses should be secondary to regulation for tribal purposes. Nontribal reservoir users feel that recreational interests should be paramount.

There is controversy regarding the perceived conflicting interests in flood operations between residents of Pokegama Lake, Sandy Lake and Aitkin. All groups tend to believe that the other groups are benefiting at their expense.

There in controversy in that most Headwaters residents tend to believe that during drought conditions the minimum releases are being provided to maintain a water supply to Minneapolis. Furthermore, they also tend to believe that the increases in the revised plan are being included for this same reason; however, this is not the case.

UNRESOLVED ISSUES

There are no unresolved issues at this time related to the environmental effects of the proposed plan.

RELATIONSHIP TO ENVIRONMENTAL LAWS AND REGULATIONS

This reevaluation of an existing project has been conducted according to Corps of Engineers planning guidance (ER 1105-2-100) and NEPA regulation (ER 200-2-2) in compliance with applicable Federal and State laws and regulations. Section 7 of this report and EIS provides a detailed description of the relationship of the planning process and proposed action to environmental protection laws and regulations.

PARTICIPATING AGENCIES AND ORGANIZATIONS

A number of agencies and organizations have participated in the reevaluation study, including:

Minnesota Department of Natural Resources (MDNR)
Minnesota Pollution Control Agency (MPCA)
U.S. Forest Service (UWFS)
U.S. Geological Survey (USGS)
Mille Lacs Band of Ojibwe
Leech Lake Band of Ojibwe
Mississippi Headwaters Board

The U.S. Forest Service is an official cooperating agency in preparing this report and EIS.

CHAPTER 1. BACKGROUND

1.1 INTRODUCTION

The Mississippi River is one of the most commonly known geographic features of the world, and it has played a prominent role in the shaping of our country. From its start at Itasca State Park, the Mississippi River flows south 2,350 miles to the Gulf of Mexico.

The Mississippi River headwaters reservoirs are a set of impounded natural lakes in north-central Minnesota. The current operating plans for the Headwaters reservoirs of the Mississippi River were developed in most part during the 1960's. Since then, only minor modifications have been made to the plans. However, there have been dramatic changes to environment of the Headwaters, most noticeably through increased human development.

In 1998, the Mississippi Headwaters Board sent a letter to the Corps' St. Paul District of requesting a review of the Headwaters reservoirs operating plans to "evaluate the effects of the current reservoir operations to people and nature" and to revise them if necessary (see Appendix B, Correspondence). U.S. Representative James L. Oberstar of Minnesota sponsored a resolution that authorized a reconnaissance study that was completed in 2001 (US Army Corps of Engineers 2001). The study was used to evaluate the water resource problems, needs, and Federal interest in the Mississippi River from its headwaters at Lake Itasca to Lock and Dam 2 in Hastings, Minnesota. The reconnaissance study concluded that:

> "The study area is faced with many land and water use development pressures that jeopardize the quality of land and water resources. Population increases projected in the study area, expanded urbanization, lakeshore and riverine developments, and increases in industrial and agricultural land uses are key factors that could significantly degrade water quality in the Upper Mississippi River. There is growing consensus at all levels of government and in the private sector that "smart growth" is needed to accommodate the growing future population and related development, and yet protect the health of the natural and man-made environments. Coordination with non-Federal sponsors has led to identification of potential cost-shared feasibility studies, which are documented in this Reconnaissance Study. These needed studies include: Basin-scale Planning for Watershed Management; Optimization of Headwaters Reservoir Regulation; Watershed-scale Planning for Water Quality; and Water Supply Protection, Surface Water Use Management and River Corridor Restoration for the Twin Cities/Metro Area."

The next step beyond the reconnaissance study would have been a comprehensive study as listed above; however, such a study would have required a non-Federal cost-share sponsor. A willing sponsor could not be identified. Therefore, the Corps instead initiated the ROPE study, which has been funded federally, but was limited to a review of current reservoir operating procedures.

The ROPE study was initiated in 2001. In April 2003, the U.S. Forest Service agreed to participate in the study so that an analysis of the operation of the Forest Service-owned

Knutson Dam on Cass Lake could be included. The Forest Service agreed to fund 15 percent of study costs from that date forth and to assist with alternative development and evaluation for all reservoirs. They also agreed to assist with the completion of this EIS in the capacity of a cooperating agency. At the completion of the study, the Corps and the Forest Service will sign separate Records of Decision.

Two other entities have expressed an interest in cooperating with the Corps in the ROPE study. Otter Tail Power owns Stump Lake Dam in Bemidji, Minnesota. Stump Lake Dam controls water levels on Lake Bemidji. Also, the Minnesota Department of Natural Resources (MDNR) operates a dam on Mud Lake on the Leech Lake River downstream of the Corps-owned Leech Lake Dam. The Corps of Engineers has considered operating plans for these non-Federal dams and may assist with the revision of their operating plans in the future if requested. However, the ROPE process will not directly result in a change in the operating plans of these two reservoirs because the Corps and the Forest Service do not have authority over these reservoirs. Furthermore, funding restrictions limited the ability of the Corps to include modifications to the operating plans for these dams in the study.

1.2 TERMINOLOGY USED IN THIS DOCUMENT

A variety of terms, references, and abbreviations are used in this document. Those that are most critical or complex are described here briefly to facilitate understanding.

ROPE – Reservoir Operating Plan Evaluation. This is the study process used by the St. Paul District to evaluate and modify reservoir operating plans.

Operating plan – The set of procedures used for dam operation in the regulation of reservoir water elevations and river discharges.

Dam operation – The operation of moveable dam gates, affecting river discharge downstream and reservoir water levels.

River and reservoir regulation – The process of controlling river flow and reservoir water levels according to an operating plan.

Cross Lake/Pine River Dam and the Whitefish Chain of Lakes – Cross Lake is a part of the Whitefish Chain of Lakes, which is controlled by the Cross Lake/Pine River Dam. Cross Lake and the Whitefish Chain of Lakes are used interchangeably in this document to refer to the body of water regulated by this dam.

Stage – Water level measured against a reference elevation. In the Mississippi River Headwaters, the reference elevation used by the Corps is 1929 NGVD (mean sea level 1929 National Geodetic Vertical Datum).

Discharge – Water flow in rivers. The Corps measures releases from dams and flow in rivers in cubic feet per second (cfs).

1.3 STUDY PURPOSE

The primary purpose of the ROPE study was to evaluate alternative plans for the Mississippi River Headwaters reservoirs and to improve the operation of the system to balance benefits in consideration of tribal trust, flood control, environmental concerns, water quality, water supply, recreation, navigation, hydropower, and other public interests. A secondary purpose of the study is to facilitate better understanding of the system regarding reservoir management, water levels, and the related and interconnected impacts throughout the system.

This report integrates the Corps and Forest Service decision document and the NEPA and Clean Water Act documents to avoid duplication and to consolidate information for reviewers.

1.4 STUDY AREA

The study area is the Upper Mississippi River basin in Minnesota, defined as the river basin upriver from Lock and Dam 2 near Hastings, Minnesota, extending north to the river source at Lake Itasca (see Plate 1). This area includes about 19,400 square miles of land area. The focus of this study is primarily on the portions of the Upper Mississippi River basin affected by the operation of eight Headwaters reservoirs. Lake Bemidji is the first reservoir on the system and is controlled at Stump Lake Dam, which is owned and operated by Otter Tail Power. Cass Lake is controlled at Knutson Dam, which is owned and operated by the U.S. Forest Service. Lake Winnibigoshish, Leech Lake, Pokegama Lake, Sandy Lake, the Whitefish Chain of Lakes (Pine River Dam), and Gull Lake are all owned and operated by the Corps. Pine, Gull, and Sandy Rivers, the receiving rivers for the Whitefish Chain of Lakes, Gull Lake, and Sandy Lake, respectively, are also included as part of the study area.

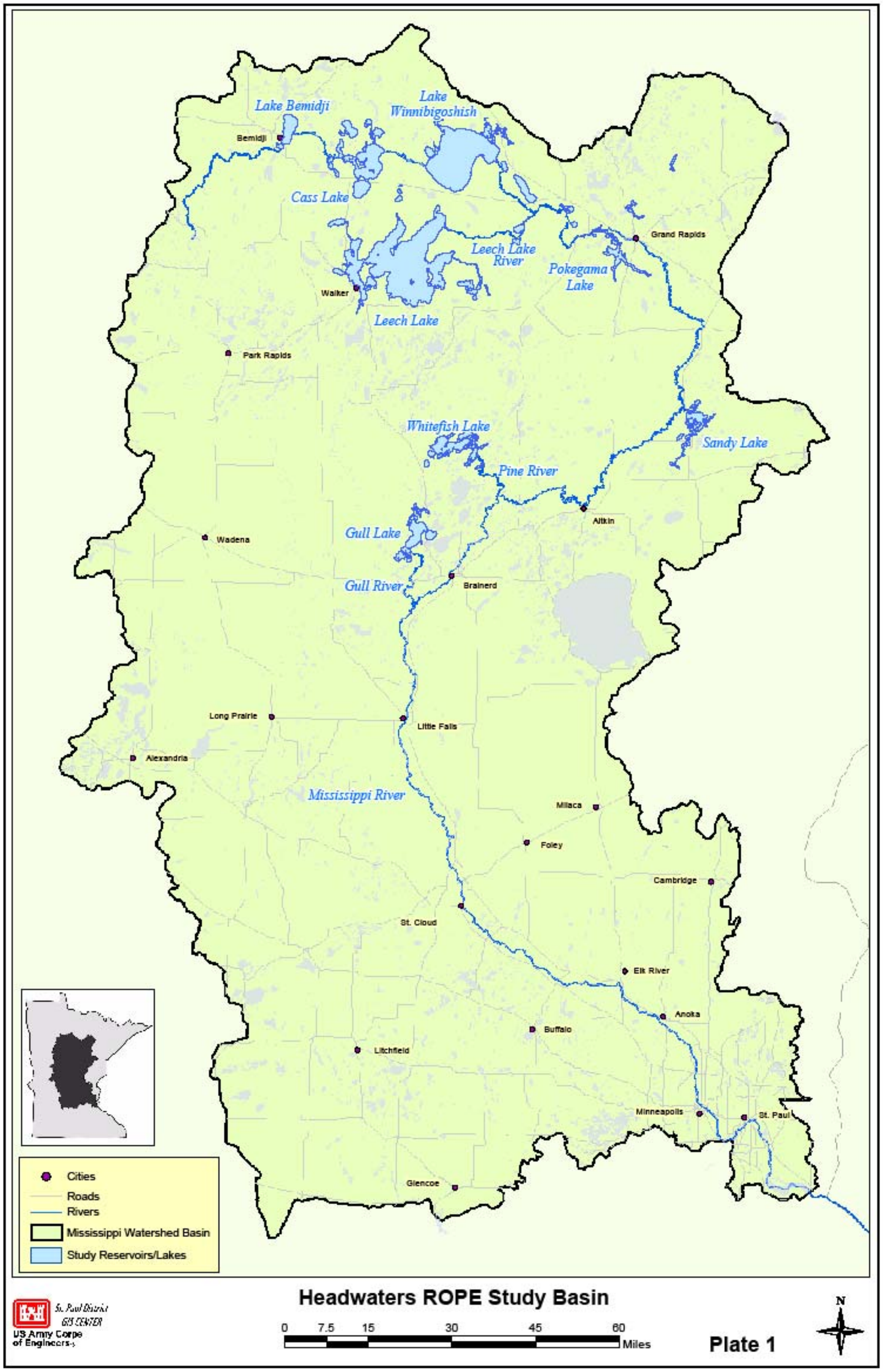


Plate 1. Mississippi River Headwaters Basin.

1.5 NEED FOR ACTION

The current operating plans for the Federal dams in the Headwaters were developed in most part during the period from the 1930s to the 1960s. Since then, only minor modifications have been made to the plans. However, there have been dramatic changes to the environment of the Headwaters, most noticeably through increased human development. In this document, the term “operating plan” refers to the Water Control Plan for the Headwaters Reservoirs, which implies gates are adjusted at a dam to regulate water levels/discharges. The current published Water Control Plans for the reservoirs are dated January 2003.

The Rope Study was initiated in 2001. In April 2003, the U.S. Forest Service signed an agreement to participate in the study so that an analysis of operations of the Forest Service-owned Knutson Dam on Cass Lake could be included. The Forest Service agreed to fund 15 percent of the study costs from that date forth and to assist with alternative development and evaluation for all reservoirs. They also agreed to assist with the completion of this EIS, in the capacity of a cooperating agency. The Corps and the Service will sign separate Records of Decision.

1.6 AUTHORITIES

The River and Harbors Acts of June 14, 1880 and August 2, 1882 authorized the construction of dams at each of the six Mississippi River Headwaters lakes for the purpose of forming reservoirs. The lakes affected by these acts include Winnibigoshish, Leech, Pokegama, Sandy, Cross (Pine River), and Gull. Following authorization of the reservoirs, Congress directed the Secretary of War to establish regulations governing their operation through the River and Harbor Act of August 11, 1888.

Knuston Dam was purchased by the Forest Service through authorization granted in 1926 under Public Law 270.

Corps regulation ER-1165-2-119 states that it is the general policy of the Chief of Engineers that completed Corps projects be observed and monitored by the Corps to ascertain whether they continue to function in a satisfactory manner and whether potential exists for better serving the public interest…”Whenever reporting officers find that changes in a completed project may be desirable, investigations should be undertaken to document the need for and feasibility of project modification. To the extent possible, modifications to completed projects should be accomplished under existing authorities.”

Section 216 of the Flood Control Act of 1970 (Public Law 91-611) states:

> "The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to significantly changed physical or economic conditions, and to report thereon to

Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest."

Corps of Engineers regulation ER 1105-2-100, Appendix G, Amendment No.1, June 30, 2004, defines the project approval authority delegated to the Division Commander. The St. Paul District is in the Mississippi Valley Division of the Corps. The Division office is in Vicksburg, Mississippi. Division commanders may approve changes to authorized projects, or elements thereof, if such changes meet certain criteria. The modifications recommended for the Mississippi River Headwaters projects would be done under the original project authorization and Section 216 of the Flood Control Act of 1970. The recommended modifications would not increase or decrease the scope of the project (for example, storage capacity, outputs, environmental impacts) originally authorized by Congress. The recommended modifications would not change the location or substantially change the design of the project. The environmental impacts of the recommended modifications would be minor in comparison to the impacts of original project construction, and the recommended modifications would not add or delete a project purpose.

1.7 PRIOR STUDIES, REPORTS, AND EXISTING WATER RESOURCE PROJECTS

State, Federal, and local agencies and academic institutions have prepared hundreds of land and water related studies about land and water management of the study area. These include studies to evaluate and design municipal water supplies, steam-electric and hydropower plants, park and recreation areas, fish and wildlife conservation areas, commercial navigation, flood protection projects, wastewater treatment plants, cleanup projects to restore polluted lands, spill response, and projects to improve/protect water quality or restoration of habitat.

1.7.1 Corps of Engineers Studies and Reports of the Mississippi River Headwaters

Important Corps plans and reports relevant to land and water resources management in the study area include:

“Master Reservoir Regulation Manual, Headwaters Dams and Reservoirs,” U.S. Army Engineer District, St. Paul, Corps of Engineers, St. Paul, Minnesota, April 1963 (revised February 1968).

“Multiple Use Survey, Winnibigoshish and Leech Lake Reservoirs,” Chippewa National Forest, Minnesota Forest Service, U.S. Department of Agriculture, undated (approximately mid-1960's).

“Environmental Review of the Headwaters of the Mississippi River Reservoir Projects,” Bemidji College, 1973.

“Review of Design Features of Existing Dams at Mississippi River Headwaters Reservoirs,” RCA ENGCW-(OT)761, St. Paul District, Corps of Engineers, March 1974.

“Mississippi River Headwaters - Master Plan for Public Use Development,” St. Paul District, Corps of Engineers, August 1977.

“Effect of Different Operating Plans for the Six Mississippi River Headwaters Dams, Saint Anthony Falls Hydraulic Laboratory Project Report No. 184,” University of Minnesota, 1979.

“Limnological Study of Reservoirs in Minnesota, North Dakota and Wisconsin Operated by the St. Paul District, U.S. Army Corps of Engineers,” Robert O. Megard, Department of Ecology and Behavioral Biology, University of Minnesota, November 1980.

“Mississippi River Headwaters Lakes Feasibility Study, Main Report and Appendixes, Two Volumes,” St. Paul District, Army Corps of Engineers, 1982.

“Computer Operations Study of Reservoir Operations for Six Mississippi River Headwaters Dams, Final Report and Appendixes, Three Volumes,” St. Paul District, Corps of Engineers, 1982.

“Area-Ccapacity Table Reevaluation for the Mississippi River Headwaters Study,” St. Paul District, Corps of Engineers, August 1983.

“Mississippi River Headwaters Lakes in Minnesota - Low Flow Review,” St. Paul District, Corps of Engineers, October 1990.

“Drought Contingency Plan, Appendix DCP to the Lake Winnibigoshish Dam and Reservoir Regulation Manual, Mississippi River Headwaters,” Corps of Engineers, St. Paul District, September 1992 (Draft).

“Emergency Plan, Winnibigoshish Dam,” Corps of Engineers, St. Paul District, September 1994.

“Water Available from the Mississippi River at Minneapolis and Other Upstream Minnesota Locations During Low Flow Conditions, Section 22 Report,” Corps of Engineers, St. Paul District, September 1994.

“Reconnaissance Study, Upper Mississippi River, Lake Itasca to Lock and Dam 2,” Corps of Engineers, St. Paul District, June 2001.

1.7.2 Studies and Reports of the Mississippi River Headwaters by Others

A number of recent studies have recommended coordinated basin-scale/watershed management planning for the Upper Mississippi River.

- “The Mississippi River in the Upper Midwest, Its Economy, Ecology, and Management,” The McKnight Foundation, 1996.

- "Five Year Strategic Plan FY2001-2005," Minnesota Pollution Control Agency, November 2000.

- "Minnesota Environment 2000," Minnesota Pollution Control Agency, 2000.

- "A River That Works and A Working River," The Audubon Society and the Upper Mississippi River Conservation Committee, January 2000.

- "Comprehensive Management Plan - Mississippi National River and Recreation Area," National Park Service, September 1994.

1.7.3 Existing Projects

Congress has recognized the Federal interest in the region through authorization of a number of water resources related projects.

Mississippi River Nine-Foot Channel Navigation Project - Congress authorized construction in the River and Harbor Act of July 3, 1930. This major commercial navigation project consisted of a system of 29 locks and dams from Alton, Illinois, to St. Anthony Falls in Minneapolis, Minnesota. This navigation project was constructed and is maintained by the Corps of Engineers. Congress recognized the Upper Mississippi River System as a nationally significant navigation system and a nationally significant river ecosystem in the Water Resources Development Act of 1986. The Upper Mississippi River System is a destination for tourism and supports over 3 million visitor days each year.

Mississippi River Headwater Reservoirs Project - The Corps of Engineers completed the Mississippi River Headwaters Dams in 1911 to augment flows in the Mississippi River for navigation. This project consists of six dams that regulate reservoirs at Gull, Leech, Sandy, Pokegama, and Winnibigoshish Lakes and on the Pine River (often referred to as the Pine River Dam, Cross Lake Reservoir). Although these dams were constructed to aid in commercial navigation, they are currently operated for the general public good and tribal trust requirements, which include flood control, recreation, and fish and wildlife considerations.

Mississippi National River and Recreation Area (MNRRA) - In 1988, Public Law 100-696 established the MNRRA as a unit of the National Park System. The system is composed of about 370 areas administered by the National Park Service. The MNRRA was established by Congress to protect, preserve, and enhance the significant values of the Mississippi River corridor through the Twin Cities metropolitan area; encourage coordination of Federal, State, and local programs; and provide a management framework to assist the State of Minnesota and units of local government in the development and implementation of integrated resource management programs and to ensure orderly public and private development in the area. The MNRRA Comprehensive Management Plan was completed in May 1995.

Chippewa National Forest - This national forest is managed by the U.S. Forest Service for timber production, public use, and fish and wildlife management. The Chippewa Forest is a large forest but it is also a water world of wetlands and more than 1,300 lakes and nearly 1,000 miles of trout stream that attracts more than a million visitors annually. The Chippewa Forest, located in north-central Minnesota in the upper reach of the study area, was the first national forest established east of the Mississippi River. Created in 1908, it was initially known as the Minnesota National Forest. The forest's name was changed in 1928 to honor the Chippewa Indians who inhabited the forest. The Knutson Dam, located on Cass Lake in this forest, is owned and operated by the Forest Service.

A detailed description of the existing Mississippi River Headwaters projects being studied here is provided in Chapter 4.

CHAPTER 2. PLANNING PROCESS

This report and EIS documents a planning process that began in 2001 to address problems with operation of the Headwaters reservoirs. The planning process has six steps and follows Corps planning guidance:

1. Identify problems, needs, opportunities and constraints.
2. Inventory existing conditions and forecast future conditions.
3. Formulate alternative plans.
4. Evaluate alternative plans.
5. Compare alternative plans.
6. Select the recommended plan.

This report is organized around these steps of the planning process.

A reservoir operating plan consists of various parts, or “components,” such as summer water elevation targets, flood damage reduction procedures, and minimum release requirements, just to name a few. The vast number of possible combinations of such components in the development of an operating plan complicates the process. Alternatives development for the ROPE was further complicated by the number of individual dams where an operating plan is needed (seven Federal dams). The study intent was to develop new operating plans for each of these reservoirs while treating the Headwaters as a system; therefore, in theory, the study intent is to develop a single “plan” that is the interconnected collection of the individual reservoir operating plans. Therefore, hereafter, the singular “plan” or “alternative” will refer to a collection of individual reservoir operating plans unless stated otherwise. Individual reservoir operating plans are collections of operating components.

Because of the large number of possible combinations of components for alternative development, it was necessary to simplify the development and evaluation of alternatives by reasonably limiting the number of combinations. It is also necessary to evaluate a full range of potential alternatives to ensure an informed decision can be made during alternative selection. Each of these goals was achieved through a multistep process.

First, potential components and alternative concepts were discussed. Those that were clearly unacceptable were eliminated from consideration early.

Second, alternatives were developed that were focused toward different system goals but still attempted some balance to limit the “cost” to other system goals. These multiobjective alternatives were evaluated in more detail to better evaluate their effects.

Finally, effects at this second tier of analysis were used to develop a “balanced” alternative that attempts to provide the most benefit and least “cost” to each interest in the system. The balanced alternative is also better adjusted for unique characteristics at each reservoir in the system. This alternative was evaluated in even more detail to ensure that plan effects can be fully described and compared. The balanced plan was chosen as the preferred alternative and, therefore, is also referred to as the proposed plan.

2.1 STUDY MANAGEMENT

This study is being managed by the St. Paul District, U.S. Army Corps of Engineers, with funding and policy guidance through the Mississippi Valley Division, U.S. Army Corps of Engineers, Vicksburg, Mississippi.

The project delivery team (PDT) is an experienced and interdisciplinary group of St. Paul District and Forest Service engineers, scientists, economists, real estate and public affairs specialists, and attorneys (see list of preparers in Section 11 below).

2.2 STUDY PARTICIPANTS

This study has been conducted with considerable input from interested agencies, conservation organizations, the resort industry, the Leech Lake Band of Ojibwe, the Mille Lacs Band of Ojibwe, and the public. At the outset of the study in 2001, the St. Paul District invited interested stakeholders to participate with the Corps PDT in the planning process. A series of planning workshops was held. A number of agencies and organizations have participated in the planning process, including the following:

Minnesota Department of Natural Resources (MDNR)
Minnesota Pollution Control Agency (MPCA)
U.S. Forest Service (USFS)
U.S. Geological Survey (USGS)
Mille Lacs Band of Ojibwe
Leech Lake Band of Ojibwe
Mississippi Headwaters Board (MHB)

2.3 STUDY SCHEDULE AND COST

The study began in 2001. Funding constraints delayed study progress. The study is expected to be completed by December 2008 if study funding is available in early fiscal year 2009. The combined Forest Service and Corps study costs to date total about $4.4 million.

2.4 COORDINATION AND PUBLIC INVOLVEMENT

In January 1999, the St. Paul District, Corps of Engineers, in close cooperation with the Mississippi Headwaters Board (MHB), conducted a series of scoping meetings with the public, interested agencies, and Native American Indian Tribes/Bands in an effort to identify water resource problems and opportunities in the Mississippi River Headwaters area. The study area for that effort was essentially the same as that of the current ROPE. The public involvement and interagency coordination accomplished in 1999 was intended to be a catalyst for leveraging funding and fostering future collaborative planning and implementation efforts. This goal was not met because no cost-share sponsor was identified to assist in the implementation of a comprehensive basin-wide study. Results of the 1999 scoping effort were summarized in a letter report (Letter Report, Upper Mississippi River Watershed, Minnesota). Information from the letter report pertinent to the ROPE scoping process has been included here.

In 2002, ROPE study "task forces" were assembled to represent different resource/user groups within the Headwaters and to provide technical expertise to help guide the direction of the ROPE. The groups are comprised mostly of resource agency personnel from the Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, Minnesota State Historic Preservation Office, The Nature Conservancy, public utilities, U.S. Forest Service, and the Corps of Engineers. These task force groups have met numerous times throughout the study process and have provided valuable assistance in study formulation. The following is a list of the task force groups:

- Downstream Interest Group
- Environmental/Natural Resources Task Force Group
- Flood Control/Erosion Control Task Force
- Public Involvement/Education Task Force Group
- Hydropower and Downstream Uses Task Force Group
- Cultural Resources/Historic Preservation Task Force Group
- Recreation and Tourism Task Force Group

Lake groups, also known as "citizen/stakeholder workgroups" were formed for each of the major reservoirs by inviting all citizens and members of preexisting lake groups to participate in meetings. These lake groups were formed to solicit nontechnical public input and to serve as a vehicle for communicating information to the public. Numerous lake group meetings have been held to meet these objectives.

A Partner Group comprised of high-level officials and stakeholder representatives was also convened and briefed at strategic times to solicit ideas, communicate on study related problems and opportunities, and generate understanding and consensus of key managers within key water resource managing agencies.

A ROPE newsletter was developed, named "Around the ROPE"; four issues have been released since November 2003. The newsletter is used to update readers on ROPE events and information and to solicit comments. Currently, the newsletter has a distribution of about 632 individuals.

Public scoping meetings were held for the ROPE during the week of June 7, 2004. The Corps and the Forest Service hosted these meetings to gather input on the potential effects of new reservoir operation plan alternatives that would be studied under the ROPE. These meetings were used to express what potential impacts would be studied in detail within the ROPE and to obtain additional public input regarding possible alternative plans and associated impacts that should be studied but were not previously identified. These meetings consisted of a presentation of current information on the ROPE followed by a session for gathering public input. The problems and opportunities identified and documented during the meetings in 1999 were summarized in handout materials presented at each of the EIS scoping meetings. These handouts and summaries of the existing condition and future conditions under the current operating plan (i.e., future without project) were provided to agency representatives at each meeting. The results of these meetings were summarized in the Final Scoping Document (Appendix B).

Additional scoping meetings were held in August 2006 to present the progress of the study and gain input for the alternatives analysis, list future actions for modeling revisions, data generation, report formulation, and continued public involvement strategy development. The results of these meetings were recorded in a memorandum that can be found in Appendix B. The meetings were held at the following dates and locations:

Cass Lake (Public): Monday, Aug. 21, 6:30-8:30 p.m., Pike Bay Town Hall, 15514 State Highway 371 NW

Aitkin (Public): Tuesday, Aug. 22, 1-3 p.m., at Aitkin City Hall, 109 1st Ave. NW

Grand Rapids (Public): Tuesday, August 22, 6:30-8:30 p.m., at the Grand Rapids City Hall, 420 Pokegema Ave.

Walker (Agency): Wednesday, Aug. 23, 1-3 p.m., at the Walker AmericInn, 907 Highway 371 N.

Walker (Public): Wednesday, Aug. 23, 5-8 p.m., at the Walker AmericInn, 907 Highway 371 N.

Brainerd (Agency): Thursday, Aug. 24, 1-3 p.m., Administration Building of the Gull Lake Recreation Area, 100867 E. Gull Lake Dr.

Brainerd (Public): Thursday, Aug. 24, 5-7:30 p.m., Administration Building of the Gull Lake Recreation Area, 100867 E. Gull Lake Dr.

2.5 SCOPING PROCESS

Scoping is a process conducted at the outset of preparing a Federal EIS. An EIS was determined to be necessary to document the planning and decision process for modifications to the Headwaters reservoirs operation. Scoping is required by NEPA, Regulations for Implementing the Procedural Provisions of NEPA (Council of Environmental Quality guidelines, 40 CFR Parts 1500 – 1508), and by Corps regulation ER200-2-2, Procedures for Implementing NEPA. Scoping is primarily intended to focus the EIS, determine the study area, identify the issues to be addressed and identify the significant resources that might be affected by a proposed action. The NEPA scoping document is based on discussions by the Corps PDT and stakeholders.

A Notice of Intent to Publish a Draft EIS was published in the Federal Register on December 12, 2003. The scope of the EIS was determined by soliciting public, agency, and tribal comment on the preliminary scope through various meetings. Comments received were incorporated into a draft scoping document that was released for further public review and comment in February 2005. The availability of the draft scoping document was announced through a news release and the ROPE email list. The comments received were incorporated in the final scoping document, which was posted on the ROPE website. The comments received throughout the scoping process have been used in the development of the draft EIS.

2.6 STUDY SCOPE

The study area includes the area and resources that may be affected by modifications to Mississippi River Headwaters reservoirs operation. It includes the main stem Mississippi River and regulated tributaries and the floodplains, wetlands and riparian zones affected by river regulation.

The study is about an existing project and is limited to improvements to water control operations.

The temporal scope of the study is 25 years. We anticipate that the Headwaters Reservoirs Operating Plan will be reviewed and fully modified again within 25 years. However, it is the policy of the Corps that water control plans be continually reviewed, updated, and adjusted as needed to ensure the best use is made of available water resources, which is consistent with the proposed adaptive management plan found in Section 6.2.

2.7 SIGNIFICANT RESOURCES

Significant resources in the study area include socioeconomic, natural and cultural resources that are recognized as significant by institutions and the public. The significance of resources is based on both monetary and nonmonetary values. Monetary value is based on the contribution of the resources to the Nation’s economy. Nonmonetary value is based on technical, institutional or public recognition of the ecological, cultural, and aesthetic attributes of resources in the study area. The scientific community and natural resources management agencies recognize the technical significance of resources.   Through discussion with stakeholders and study participants, numerous significant resources in the study area were identified. Table 2.7 is a list of the primary significant resources being studied here for impacts related to the regulation of the Headwaters reservoirs.

Table 2.7 Significant Resources of the Headwaters Potentially Affected by Reservoir Regulation

Resource	Significance	Relationship to Reservoir Regulation
Fish	Ecological health Sport fishing Tribal resource	Hydrologic alteration in the form of modified seasonal and yearly variation leads to disruptions in life cycles and habitat degradation. Dams impose barriers to fish migrations and limit access to needed habitats.
Wild Rice	Ecological health Harvest Tribal resource	Altered hydrology affects the seasonal and long-term abundance of wild rice. High water levels early in the summer can limit survival, and low water levels late in the summer can limit harvest

Table 2.7 Significant Resources of the Headwaters Potentially Affected by Reservoir Regulation

Resource	Significance	Relationship to Reservoir Regulation
Waterfowl	Ecological health Hunting Tribal resource	Altered hydrology can lead to nest flooding in the spring, and habitat can be reduced through decreased abundance and diversity of emergent and submersed vegetation.
Water Quality	Ecological health, Recreation, Property values	Altered hydrology can lead to indirect effects to water quality through sedimentation caused by bank erosion, algal growth from reduced macrophyte growth, and dissolved oxygen depletion in rivers during low flow periods.
Wetlands	Ecological Health Tribal resource	Altered hydrology can lead to decreased vegetation diversity and abundance. Decreased seasonal and yearly variability in water levels reduces the disturbance required to enhance a naturally diverse and resilient wetland community.
Private Property	Economic Value Social value	Private property has been positively affected by the regulation of the study reservoirs. It can be adversely affected by flooding. Property value can be impacted by changes in recreational opportunities.
Recreational Opportunity	Economic Value Social value	Reservoir regulation has positively affected recreational opportunities. Low water levels have the potential to limit boating access in shallow water areas.
Farmland	Economic Value Social value	Flooding has the potential to adversely affect farmland in the study area.
Hydropower Production	Economic Value	River flows dictate hydropower production capacity. Low flows have the potential to limit hydropower production.

2.8 PLANNING OBJECTIVES

The primary purpose of the ROPE study is to develop a system-wide operating plan that improves stewardship of the Headwaters reservoirs, sustains and improves the natural environment, fully considers tribal interests, fairly balances public use of resources, and fully considers all impacts associated with changes in operations. A secondary purpose is to improve the understanding of the system by all regarding the aspects of reservoir management techniques, physical system constraints, and associated water level impacts throughout the system.

Study participants provided input on objectives for future conditions. In summary, the planning objectives for this study are as follows:

- Maintain or improve aquatic, wetland, and terrestrial habitat in and around the Headwaters reservoirs and receiving rivers.
- Increase the abundance and diversity of all aquatic and semi-aquatic native species and communities in the Headwaters reservoirs and receiving rivers.
- Reduce bank erosion and sedimentation in the Headwaters reservoirs.
- Protect and improve water quality in the Headwaters reservoirs and receiving rivers.
- Protect and improve the productivity, extent, and harvest of wild rice beds in the Headwaters.
- Maintain current recreational use types and quality of the Headwaters reservoirs and receiving rivers.
- Maintain navigation on the Headwaters reservoirs and rivers and between associated lakes through connecting channels.
- Maintain the use of existing boat docks, ramps, and lifts on the Headwaters reservoirs.
- Maintain property values directly and indirectly affected by water levels.
- Maintain businesses and employment dependent on the use of Headwaters reservoirs and rivers.
- Manage floodwaters to balance, and if possible reduce, flooding damage to property and agricultural crops in the system.
- Manage and reduce controversy that may result in the implementation of a revised operating plan.
- Maintain or improve hydropower production capacity for facilities on the receiving rivers.
- Reduce damages to archeological resources around the Headwaters reservoirs and receiving rivers.
- Protect and enhance tribal resources that are dependant on water levels in the Headwaters reservoirs and receiving rivers.

2.9 PLANNING ASSUMPTIONS

Planning assumptions underlie the logic of the planning process. Although these states of nature and anticipated human activities are not certain, they are assumed to apply in the future:

The Headwaters reservoirs will continue to operate into the foreseeable future. We assume that the plan developed here will be fully reevaluated in 25 years. Therefore, this report and EIS addresses the effects of changes in the operation plan for 25 years into the future.

For purposes of the analyses in this study, we assume that climactic conditions will remain unchanged over the next 25 years. While there is evidence for near-term climactic fluctuations, some of which may includes predictions for more extreme events such as droughts and rainfall events, the likelihood and magnitude of these changes is uncertain. Even more importantly, it would be difficult to predict future hydrologic conditions as affected by climate change to the level of detail required for informed decision-making regarding operating plan alternatives. Therefore, as in most studies of this nature, historic hydrologic conditions will be used as a surrogate to best represent potential future conditions for informed decision-making.

2.10 PLANNING CONSTRAINTS

Planning constraints are temporary or permanent limits imposed on the scope of the planning process and choice of solutions and include ecological, economic, engineering, legal, and administrative constraints. Some are states of nature; some are based on the design of built structures and other engineering considerations. Legislation and policy-making impose other constraints. The human-imposed constraints are possible to change. Following are the planning constraints identified in this study:

1. The planning process must be consistent with all applicable Federal, State, and local laws, regulations, and policy.

2. Planning for this study will be limited to water and related land resources in the vicinity of Mississippi River Headwaters project.

3. The existing population, land uses, communities, and economy of the northern Minnesota in the vicinity of the Headwaters project impose constraints.

4. The existing design and condition of the built water resources infrastructure, including the Mississippi River Headwaters dams and related embankments, impose constraints.

5. The climate, hydrology, hydraulic conditions, geology, soils, and native biota of the Upper Mississippi River in the study area impose constraints.

CHAPTER 3. PROBLEMS AND OPPORTUNITIES

Through previous efforts a great deal of information has been gathered regarding resources and how they are being affected by current reservoir operation. Specifically, information on current problems and opportunities for improving conditions has been collected as a way to focus the study. Below is a summarized list of many of the problems and opportunities that are found through the study basin.

3.1 PROBLEMS

- There has been a loss of habitat diversity and littoral vegetation in the system including a loss in wild rice.
- There is a reduction in channel complexity and a loss of functioning floodplain as a result of channel modifications downstream of Leech Lake in the Leech Lake River.
- Due to raised water levels and an unnatural flow regime, there is an increased amount of lakeshore and riverbank erosion and sedimentation in the system.
- The unnatural flow regime impedes the restoration of aquatic fish and wildlife habitat, these impediments point to a need to assess the overall ecosystem restoration needs of the headwaters area.
- The hydrologic cycle of the reservoirs impacts fish spawning, rearing, and overwintering; semi-aquatic mammals; waterfowl; and wetland habitat, while the dams act as barriers to movement for aquatic species.
- There are many land and water use development pressures that can lead to increased levels of pollutants.
- The headwaters reservoirs and the Mississippi River face degradation of water quality and supply, possibly linked to population growth and how the dams on the system are operated.
- Minneapolis and St. Cloud, Minnesota, are dependent on the Mississippi River for water supply and do not have alternative sources of supply in the event of drought or a spill of contaminants into the river. St. Paul and Brooklyn Center also use the Mississippi River for water supply but have alternate sources in the event of drought or contamination of the river.
- Increases in water levels in the Headwaters lakes could flood septic systems and destroy some infrastructure that are located within the areas where the Corps has flowage rights.
- It is not known if the Flood Control Guide Curves used to manage flooding, which were last updated in the 1950's, are a good representation of current conditions. However, because of significant changes in population distribution in the study area and greater public uses of the lake areas, it is likely that the guide curves need some revision.
- It is not known how the economic impact of storing water in the reservoirs compares to the damages prevented in Aitkin for flood events.
- It is not known how the effects (economic and environmental) of releasing water in the fall and winter (drawing down the Headwaters reservoirs) compare to the economic value of damages prevented in Aitkin.

- Steam generation and nuclear power plants use the river water for cooling purposes. Low flows and high water temperatures can limit the amount of power that can be generated, posing a potential problem for electrical generation capacity for the Twin Cities metropolitan area.
- Changes to the drawdown plan may affect hydropower. The potential changes to flow duration (high and low) at particular locations will need to be evaluated, as well as the economic impacts on the hydropower plants.
- Obstructions and/or low water in connecting channels and at boat ramps and docks in the reservoirs can make navigation difficult.
- Ice damage is a common problem on reservoirs.

3.2 OPPORTUNITIES

- Because of the willingness of the Corps, the Forest Service, the Minnesota Department of Natural Resources, Minnesota Power, and the Otter Tail Power Company to work together to implement system-wide operational improvements, there is an opportunity to operate all the dams in the Headwaters as a system to more effectively manage water resources. There is an opportunity to improve the communication between Corps and non-Corps dam operators. These communications could be used to operate the system in a way that can better address and solve water resources problems.
- There is an opportunity to work with the Leech Lake and Mille Lacs Bands to clarify how the Government can meet its Tribal Trust responsibilities and where possible to identify tribal interests that can be enhanced as part of reservoir operation.
- There is an opportunity to develop operating plans that could achieve more natural flows and flux of water levels, to improve both lake and river habitats (i.e., restoration of ecosystem function, structure, and dynamics could restore a more naturalistic, functioning, and self-regulating system that would protect critical resources from degradation).
- Current understanding of instream low flow requirements and rate of change flow rates is now better than when they were last established by the managing agencies in the 1960’s. As a result, improvements to the low flow and rate of change rules are possible.
- There is a better understanding of how reservoir drawdowns affect shoreline ice damage, and this current understanding will be valuable in assessing drawdown requirements.
- If this study does recommend actions that would return the flow regime to a more natural condition, there is an opportunity to monitor the effects of such an operating plan in such a way as to research, demonstrate, and document effectiveness of such restoration actions.
- There is an opportunity to coordinate and institutionalize an adaptive management approach to water management and restoration efforts. This approach would monitor project performance and fully network adaptive operational measures to help attain desired operational outputs recommended by the ROPE study.
- There is an opportunity for improved public input and public education on issues related to how the reservoirs are operated including: best land management practices and water resource stewardship.

CHAPTER 4. AFFECTED ENVIRONMENT

The affected environment is the area and resources that might be affected by modifications to Headwaters reservoirs operation. This chapter also serves to describe the existing and future "without-project" conditions.

The study area is the Upper Mississippi River basin upstream of St. Paul (Pate 1). The potential effects of reservoir operations under review here cover a much smaller area, depending on the category or effect.

A forecast of future without-project conditions is used as a baseline to evaluate alternative plans. The without-project conditions are the conditions that would be most likely to occur in the future in the absence of any change in project operations or any change in public law or policy. The without-project conditions include practices likely to be adopted by the public sector under existing law and policy as well as actions that are part of broader public and private initiatives for management of the Headwaters area.

From a Federal perspective, the without-project condition includes all actions that are currently authorized and foreseeable under existing programs for management of navigation and the river ecosystem. From a non-Federal perspective, the without-project condition includes any actions that may be taken by the State, local governments, organizations, or individuals to improve condition of the Headwaters resources and to reduce flooding damages.

The Mississippi River Headwaters Project will continue to be operated and maintained for the foreseeable future. River regulation, reservoir operation and maintenance of the dams are expected to continue.

4.1 STUDY RESERVOIRS AND RIVERS

Desirous of improving navigation on the Mississippi River through the Twin Cities, Congress authorized the Corps of Engineers to construct six dams in the headwaters between 1880 and 1907. Congress initially refused the project, but in 1880 it authorized an experimental dam for Lake Winnibigoshish and authorized the remaining dams shortly afterwards. The Headwaters project provided for construction of the Winnibigoshish Dam in 1883 to 1884 and the completion of dams at Leech Lake (1884), Pokegama Falls (1884), Pine River (1886), Sandy Lake (1895), and Gull Lake (1912). In its 1895 Annual Report, the Corps reported that releasing the water from the Headwaters reservoirs had successfully raised the water level in the Twin Cities by 12 to 18 inches, helping navigation interests and the millers. Within the Headwaters, though, the impoundment of large volumes of water and subsequent controlled fluctuations of water levels had a profound -- and almost entirely negative -- impact on tribal lands adjacent to the region. Table 4.1 below shows the area flooded by the construction of each reservoir.

Table 4.1 Reservoir area flooded.

Reservoir	Original Lake Area (sq. mi.)	Current Lake Area (sq. mi.)	Area Flooded (sq. mi.)	Year Built
Winnibigoshish	117	179	62	1881
Leech Lake	173	251	78	1882
Pokegama	24	35	11	1882
Sandy Lake	8	17	9	1891
Pine River	18	24	6	1883
Gull Lake	20	21	1	1911

4.1.1 Lake Bemidji

Lake Bemidji, the northernmost lake feeding the Mississippi River, is a glacially-formed lake approximately 11 square miles in area (6,420 acres) with a maximum depth of 76 feet. It is located less than 50 miles downstream from the source of the Mississippi River and both receives and is drained by the Mississippi River. More than 396,000 acres of the Upper Mississippi River watershed drain into Lake Bemidji. The city of Bemidji sits on its southwestern shore. Bemidji's population was 11,917 at the 2000 Census.

Stump Lake Hydropower Dam is on the Mississippi River upstream from Knutson Dam and 5 miles below Lake Bemidji. It impounds a small lake, Stump Lake, but has the effect of regulating the water level on the much larger Lake Bemidji.

The dam was built in 1907 by the Warfield Electric Company to provide electricity to the city of Bemidji. At that time, the average electrical customer used the equivalent of one light bulb worth of power. Today, the dam represents less than 1 percent of the electrical power used in the service area. The original customers were a group of 14 wood product factories located in Bemidji. The dam was purchased in 1944 from the Interstate Power Company by the Otter Tail Power Company. As a result, this dam is often called the Otter Tail Power Dam.

This hydropower dam does not fall under the jurisdiction of the Federal Energy Regulatory Commission (FERC). It was constructed and is operated based on an act of Congress. The act can be found in the Laws of the United States, 62nd Congress, 3rd Session, House of Representatives, Document No. 1491, Chapter 1474. The Corps had approval authority over the plans for the dam. The coordination of operations between Lake Winnibigoshish Dam and Stump Lake Dam is done on an as needed basis.

4.1.2 Cass Lake

Cass Lake is located in Beltrami County. The lake is over 15,000 acres; over 3,000 acres of the lake are less than 15 feet deep while the deepest part of the lake is 120 feet. There are nine lakes on the Cass Lake Chain that are connected by the Mississippi River. The lakes in the chain include Big Wolf Lake, Lake Andrusia, Cass Lake, Pike Bay, Buck Lake, Kitchi Lake, Anderson Lake, Little Rice Lake and Big Rice Lake. The lake water levels are affected by the operation of two dams on the Mississippi River. Otter Tail Power Company operates a dam upstream, just below Stump Lake. At the Cass Lake outlet is Knutson Dam.

Knutson Dam was built as a logging dam in the 1890's and was rebuilt by the Corps in 1928. The dam was then turned over to the Forest Service. It is one of very few dams that are managed by the Forest Service. The city of Cass Lake sits on its southern shore. Cass Lake's population was 860 at the 2000 Census.

Knutson Dam is owned and operated by the Forest Service. It is located above Winnibigoshish reservoir at the outlet of Cass Lake. This dam is normally operated to keep levels in Cass Lake and its tributaries at a higher elevation than levels in Lake Winnibigoshish. The gate sill at Knutson Dam is at approximately elevation 1297.0 feet (+ 0.2 foot) which compares to a normal pool elevation on Winnibigoshish of 1298.19 feet. So, water levels in Lake Winnibigoshish always influence Knutson Dam discharges to some degree. The crest of the overflow spillways at Knutson Dam are at approximately elevation 1301.5 feet (+ 0.2 foot). When the Winnibigoshish pool approaches this elevation, Knutson Dam becomes submerged, and Cass Lake levels are controlled to a greater degree by Lake Winnibigoshish Dam. The upper and lower operating elevations at Knutson Dam are 1302.25 feet and 1300.25 feet, respectively. Normal summer pool is between elevation 1301.43 and 1302.25 feet. The coordination of operations between Lake Winnibigoshish Dam and Knutson Dam is done on an as needed basis.

Table 4.1.2
Lakes Affected by Knutson Dam Operation

1. Cass Lake 2. Big Wolf Lake (1) 3. Lake Andrusia (1) 4. Pike Bay 5. Buck Lake	6. Kitchi Lake 7. Anderson Lake 8. Little Rice Lake 9. Big Rice Lake

1. These lakes can be impacted significantly by outflows from Stump Lake Dam. Water surface elevations can rise dramatically if the gates of Stump Lake Dam are opened to pass high flows from Lake Bemidji. Stump Lake Dam is operated to keep Lake Bemidji from rising more than 0.5 feet for large inflow events.

NOTE: Names of all lakes in this list were taken from the original flowage system survey maps. Changes in name and spelling may have occurred over the years.

4.1.3 <u>Lake Winnibigoshish</u>

The original wooden Lake Winnibigoshish Dam was started in 1881 and finished in 1884 to regulate the flow of water on the Upper Mississippi River. A constant flow was desired by loggers, fur traders, and millers downstream at St. Anthony Falls. It was replaced with a concrete dam in 1899 to 1900. This was the first major reservoir built on the Mississippi River.

At the time of the construction of the original dam, the region was inhabited almost exclusively by Ojibwe Indians, who lived on the shores of this part of the river for at least several generations, as documented by the explorer, Henry Schoolcraft.

Lake Winnibigoshish is 67,000 acres in size, with about 140 miles of shoreline. It was formed by a huge ice block left behind by a receding glacier. Unlike lakes in the Brainerd Lakes area, Winnibigoshish remains mostly undeveloped. As the fifth largest lake in Minnesota, it is considered to be a crown jewel for fishing and some of the best walleye fishing in the world.

The watershed above Lake Winnibigoshish Dam includes the southern portion of Beltrami County; the southwest portion of Itasca County; and parts of Cass, Hubbard, and Clearwater Counties, Minnesota. Winnibigoshish Dam is situated on the Mississippi River at the outlet of Lake Winnibigoshish, 1247.9 river miles above the mouth of the Ohio River and approximately 14 miles northwest of Deer River, Minnesota. The dam is approximately 170 river miles downstream from the source of the Mississippi River in Lake Itasca and 408 river miles above St. Paul, Minnesota.

Lake Winnibigoshish Reservoir controls the runoff from 1,442 square miles. The basin is located 160 miles northwest of Minneapolis and 30 miles northwest of Grand Rapids, Minnesota. The watershed is bounded by the Leech Lake Reservoir basin to the south, Rainy River basin to the north, and Pokegama Lake Reservoir basin to the east. Storage in the reservoir affects 16 lakes, including Lake Winnibigoshish. When the maximum operating elevation is exceeded, a total of 30 lakes are affected by reservoir storage (Table 4.1.3).

Table 4.1.3 Lakes Affected by Lake Winnibigoshish Dam Operation	
1. Lake Winnibigoshish	16. Sugar Lake
2. Cutfoot Sioux Lake	17. Cass Lake (1)
3. Little Cutfoot Sioux Lake	18. Rice Lake
4. Sunken Lake	19. Popple Lake (2)
5. Little Lake (2)	20. Little Wolf Lake (2)
6. Brauswah Lake (2)	21. Wolf Lake
7. Upper Pidgeon Lake (2)	22. Mud Lake
8. Middle Pidgeon Lake (2)	23. Buck Lake (2)
9. Lower Pidgeon Lake	24. Kitchi Lake
10. Dixon Lake (2)	25. Long Lake
11. Little Dixon Lake (2)	26. Big Lake
12. Sioux Lake (2)	27. Burns Lake (2)
13. Kenogama Lake (2)	28. Moose Lake (2)
14. Raven Lake	29. Andrusia
15. Rabbits Lake (2)	30. Pike Bay
(1) At high water, when Knutson Dam is submerged by Lake Winnibigoshish. (2) These lakes are not affected unless maximum operating limits are exceeded. Note: The names of all lakes in this list were taken from the original flowage survey maps. A change in name or spelling may have occurred over the years.	

4.1.4 Leech Lake

Begun in 1882, Leech Lake Dam was the second to be constructed in the Headwaters Reservoir system. Leech Lake is the third largest in Minnesota; it covers 111,527 acres and has a maximum depth of 150 feet. It is a popular sport fishing hotspot and is fished for walleye, largemouth bass, smallmouth bass, panfish, northern pike and muskellunge.

Leech Lake Dam and Reservoir is located in north-central Minnesota, approximately 100 miles west of Duluth, Minnesota. Leech Lake Dam is at the outlet of the reservoir on the Leech Lake River, 27 miles above the junction with the Mississippi River. The confluence of the Leech and Mississippi Rivers is approximately 1,244 river miles above the mouth of the Ohio River. Leech Lake Dam is at the northwest edge of the town of Federal Dam in Cass County, Minnesota, 410 river miles above St. Paul, Minnesota, and 60 river miles above Pokegama Dam.

Leech Lake Reservoir controls the runoff from 1,163 square miles. The basin is located 140 miles northwest of Minneapolis and 30 miles west of Grand Rapids. The watershed is bounded by Lake Winnibigoshish Reservoir basin to the north, Pine River reservoir basin to the south, and Pokegama Lake Reservoir basin to the east. The watershed occupies most of the northern part of Cass County and much of Hubbard County. Walker, Minnesota, the largest community in the watershed area, has a population of

1,069. Leech Lake is approximately 17 miles long from north to south and 20 miles wide from east to west.

At normal pool, the backwater effect from the dam affects eight lakes that are connected to the reservoir. When the maximum operating limit is exceeded, 14 lakes (including Leech) are affected by backwater (see Table 4.1.4).

Table 4.1.4
Lakes Affected by Leech Lake Dam Operation

1. Leech Lake	8. Three Lake[1]
2. Steamboat Lake	9. Sucker Lake
3. Little Steamboat Lake	10. Swamp Lake[1]
4. Boy Lake	11. Kabekona Lake
5. Portage Lake[1]	12. Benedict Lake[1]
6. Lomish Lake	13. Horseshoe Lake[1]
7. Swift Lake	14. Garfield Lake[1]

1. Lakes not affected unless maximum operating stage is exceeded.
Note: The names of all lakes in this list were taken from the original flowage survey maps.
A change in name or spelling may have occurred over the years.

4.1.5 Pokegama Lake

Construction of the Pokegama Dam started in 1882, with the dam going into operation in 1885. The wooden structure was replaced with concrete in 1904. The main reservoir behind Pokegama Dam is to the south of the main Mississippi River channel. The Ojibwe coined the name Pokegama to mean the water that juts off from another water. Prior to the dam, Pokegama Lake was mostly wetland described by locals as a vast region of wild rice. Below the lake was a series of falls. The Pokegama dam was built in the narrows just above a smaller falls. A larger 10-foot drop was covered with water when the paper mill dam opened just down stream. This area of rough water was known as the Grand Rapids of the Mississippi River.

Pokegama Lake and Reservoir is in north-central Minnesota. Pokegama Dam lies on the Mississippi River in Itasca County approximately 3 miles upstream of the city of Grand Rapids. The dam is 3.5 river miles below the outlet of Pokegama Lake and 344.5 river miles above St. Paul.

Pokegama Lake Reservoir controls the runoff from 3,265 square miles. The basin is located 150 miles northwest of Minneapolis. The Pokegama Reservoir watershed is bounded by Lake Winnibigoshish Reservoir basin to the northwest and Leech Lake Reservoir basin to the west. The area of the local portion of the drainage basin above Pokegama Dam (below Winnibigoshish and Leech Dams) is 660 square miles. Grand Rapids is the largest community in this area with a population of 7,764 (2000 statistics).

The operation of Pokegama Reservoir affects 17 lakes in addition to Pokegama Lake. The affected lakes are listed in Table 4.1.5.

Table 4.1.5 Lakes Affected by Pokegama Lake Dam Operation	
1. Pokegama	10. Gould Lake
2. Ball Club Lake (1)	11. Siseebakwet Lake (1)
3. White Oak Lake	12. Little Sissebakwet (1)
4. Little White Oak Lake	13. Long Lake
5. Rice Lake (1)	14. Snells Lake
6. Little Rice Lake (1)	15. Leighton Lake
7. Loon Lake	16. Blackwater Lake
8. Vermillion Lake (1)	17. Cutoff Lake (1)
9. Little Vermillion Lake (1)	18. Little Drum Lake
(1) These lakes not affected unless maximum operating stage is exceeded. Nos. 11 and 12 are sometimes referred to as Sugar Lake and Little Sugar Lake. The creek connecting them to Pokegama is named Sugar Brook. Note: Names of all lakes in this list were taken from the original flowage system survey maps. Changes in name and spelling may have occurred over the years.	

4.1.6 Sandy Lake

Sandy Lake Dam and Reservoir is located in Aitkin County, Minnesota, on the Sandy River, 1.25 miles upstream of the junction of the Sandy and Mississippi Rivers, 264.2 Mississippi River miles above St. Paul, Minnesota, 50.2 Mississippi River miles above Aitkin and 77.7 Mississippi River miles below Pokegama Dam. The Sandy Lake watershed includes small portions of St. Louis and Carlton Counties, Minnesota, to the east, but primarily is in Aitkin County. The town of Aitkin is the largest community in the county, with 1,984 people in 2000.

The original timber dam dates from 1892 to 1895. In 1896, a navigation lock, the only one in the Headwaters reservoir system, was completed. This damsite was near the terminus of the Savanna Portage, which connected Sandy Lake and the Upper Mississippi River with the St. Louis River and Lake Superior. Explorers, fur traders and missionaries used the portage between 1755 and 1855. In 1794, to the south of the damsite at Brown's Point on Big Sandy Lake, the Northwest Company established a fur trading post. In 1830, the American Fur Company established a post at Sandy Lake at the junction of the Mississippi and Sandy Rivers, just to the west of the present dam.

Sandy Lake Reservoir controls the runoff from 421 square miles. The basin is located 70 miles west of Duluth and 120 miles north of Minneapolis and is the most easterly watershed of the six Corps Headwaters basins. It is the only Corps Headwaters reservoir basin not sharing a common boundary with another Corps Headwaters reservoir watershed. The basin extends eastward from the Mississippi River approximately 26 miles and is about 18 miles wide in the north to south direction. The backwater effect from the dam affects eight lakes that are connected to the reservoir (see Table 4.1.6).

Table 4.1.6 Lakes Affected by Sandy Lake Dam Operation	
1. Sandy Lake 2. Aitkin Lake 3. Sandy River Flowage 4. Davis	5. Round 6. Tiesen 7. Sandy River 8. Rat

4.1.7 Aitkin Area

Aitkin is located in Aitkin County in northern Minnesota approximately 125 miles north of Minneapolis/St. Paul and 80 miles west of Duluth. It is on the banks of the Mississippi River. Aitkin had a 2000 population of 1,984, an increase of 16.8 percent from 1990. Aitkin is in the heart of a beautiful lakes and woods area and can be described as a full service community with educational and medical facilities, as well as financial, legal and professional services. Aitkin County had a 2000 population of 15,301.

The Aitkin area is a frequently flooded reach of the Mississippi River. Aitkin is located on a slight rise of land on a broad, flat, swampy plain which was once the bottom of glacial Lake Aitkin. Both agricultural (livestock and crop) and urban flood damages are common in this river segment. Rapid snowmelt, combined with spring rains and prolonged periods of above normal summer rainfall, are major causes of flooding on the Mississippi River near Aitkin.

Major flooding occurred in 1950, 1965, 1969, 1975, and as recently as 2001. Nearly 200 homes and 44 business establishments in Aitkin were flooded in 1950. In 1965, 16 homes experienced first floor flooding and an additional 45 homes had basement flooding.

The Corps constructed a congressionally-authorized flood control project at Aitkin during 1952 to 1957. The project consists of approximately 6 miles of diversion channel and related structures just north of Aitkin and two additional cutoffs downstream of that community. The channel is capable of carrying 6,000 cfs, which is about 50 percent of a 16-year frequency flood event, with a maximum velocity of 2.5 feet per second.

The Corps constructed an 8,290-foot emergency levee at Aitkin in 1969 under the Public Law 84-99 program. This dike requires emergency dike closures, sandbagging in low areas, and emergency pumping to function properly. The dike system has no interior drainage facilities and was constructed to an average height of 8.5 feet above ground, with a 10-foot top width, and with 1- to 1 ½-foot side slopes. These levees were constructed under emergency conditions and do not meet acceptable design standards. They could be breached by floods of less than 1-percent (100-year) flood frequency.

Discharges on the Mississippi River in the Aitkin area have been reduced by the operation of four federally controlled headwater reservoirs upstream of Aitkin: Leech Lake, Winnibigoshish Lake, Pokegama Lake, and Big Sandy Lake. Leech Lake and

Winnibigoshish Lake provide the primary flood storage of the four reservoirs, but their effectiveness in reducing flood discharges is limited by their distance from Aitkin.

4.1.8 Whitefish Chain of Lakes and the Pine River

The Whitefish Chain of Lakes is controlled by the Pine River Dam, Cross Lake Reservoir Project. The Whitefish Chain of Lakes is a commonly used term because the water in the reservoir includes 15 natural lakes and originates from three main rivers. It covers 13,660 acres and has 119 miles of shoreline.

The dam is located in Cross Lake, Crow Wing County, Minnesota, 22 miles north of Brainerd, Minnesota. As of the 2000 census, there were 1,893 people in Cross Lake. The dam is on the Pine River at the outlet of Cross Lake, 14.5 river miles above the junction of the Pine and Mississippi Rivers, 199.0 Mississippi river miles above St. Paul. The lakes that form Cross Lake reservoir (Pine River Dam) are completely within the Crow Wing County boundaries. The outermost portions of the Pine River Watershed are located in Cass County. Crow Wing County includes the city of Brainerd (2000 population 13,178).

Pine River was the fourth Headwaters reservoir to be constructed. The original timber dam dates from 1884 and was put into operation in 1886. The dam was reconstructed to its present appearance between 1905 and 1907. The control structure is 233 feet in length and consists of reinforced concrete supported on timber piles. There are 13 sluiceways. A log sluice and fishway are no longer in use. A series of perimeter dikes built around the dam, between 1899 and 1914, allowed it to be filled to capacity.

The Pine River Dam controls the runoff from a 562-square-mile basin. The basin is located 90 miles west of Duluth and 120 miles north-northwest of Minneapolis. The watershed shares a common boundary with the Leech Lake Reservoir basin to the north and the Gull Lake Reservoir to the south. Its extent is about 20 miles north to south and 30 miles east to west. The backwater effect from the dam affects 15 lakes that are connected to the reservoir (see Table 4.1.8).

Table 4.1.8
Lakes Affected by Pine River Dam Operation in the Whitefish Chain of Lakes

1. Cross	9. Big Trout
2. Daggett	10. Arrowhead
3. Little Pine	11. Pig
4. Rush	12. Clamshell
5. Island	13. Bertha
6. Ox	14. Upper Hay
7. Upper Whitefish	15. Lower Hay
8. Lower Whitefish	

4.1.9 Gull Lake and the Gull River

Gull Lake Reservoir is located in the extreme southern portion of Cass County, 8 miles northwest of Brainerd. The dam is on the Gull River about 1/2 river mile below the outlet of Gull Lake, 11 river miles upstream of the junction with the Crow Wing River, 16 river miles upstream of the junction of the Crow Wing and the Mississippi Rivers, and approximately 167.1 river miles upstream of St. Paul. It was put into service in 1912, the last of the Headwaters reservoir dams constructed. A timber dam preceded the current structure.

The lakes that form Gull Lake Reservoir are mostly within the Cass County boundaries. Eastern portions of the Gull Lake basin are located in Crow Wing County. Crow Wing County includes the city of Brainerd (2000 census population 13,178). The northern half of Cass County consists of the sparsely populated Chippewa National Forest and part of the Leech Lake Indian Reservation.

Gull Lake Reservoir controls the runoff from 287 square miles. The backwater effect from the dam affects eight natural lakes that are connected to the reservoir (see Table 4.1.9). The basin is located 100 miles northwest of Minneapolis and the same distance west of Duluth. The watershed shares a common boundary with the Cross Lake Reservoir basin to the north and the Crow Wing River basin to the south. Its extent in both the north to south and east to west directions is about 20 miles.

Gull Lake Reservoir is actually a chain of lakes. It includes the following eight natural lakes: Nisswa, Roy, Spider, Bass, Upper Gull, Margaret, Gull and Round Lakes.

Table 4.1.9

Lakes Affected by Gull Lake Dam Operation

1. Gull	6. Spider
2. Upper Gull	7. Bass
3. Roy	8. Margaret
4. Nisswa	9. Love
5. Round	10. Hole-In-The Day

4.1.10 Mississippi River

The study area encompasses the Upper Mississippi River drainage basin above the confluence with the Minnesota River in the vicinity of St. Paul and Minneapolis, which includes about 19,400 square miles of land area.

The Mississippi River is about 680 miles long in Minnesota and about 580 miles from Lake Itasca through St. Paul; the whole river is about 2,350 miles long. Lake Itasca in

Itasca State Park in Clearwater County is the source of the Mississippi River. Lake Itasca has a surface area of 1077 acres and maximum depth of 40 feet.

An average annual runoff of about 4.5 inches occurs for both the 19,400-square-mile Mississippi River Headwaters drainage area upstream of the Twin Cities and the portion of the drainage basin upstream of Grand Rapids. The 3,370 square miles upstream of Grand Rapids includes Cass, Winnibigoshish, Leech, and Pokegama Lakes.

The many lakes and wetlands in the basin combined with the controlled headwaters lakes provide a large amount of storage, a factor that prohibits rapid runoff. Runoff extremes ranging from approximately 1.1 to 11.7 inches have been recorded. The months with the highest rates of runoff are usually March through June. The average slope of the river upstream of Minneapolis is about 2.5 feet per mile.

Above St. Paul, the Mississippi River region contains many lakes, most of which are water table lakes hydraulically connected to aquifers. Nearby wells can induce water to move from the lakes or streams, increasing well yields, particularly in sandy counties like Anoka, Isanti, and Sherburne. However, the overall effect of wells on water surfaces in adjoining lakes or streams is insignificant in the upper basin Headwaters lakes area.

There are eight significant dams that were considered in this study on the main stem of the Mississippi River that control outflows from the headwaters lakes. Stump Lake Dam between Lake Bemidji and Cass Lake is owned by Otter Tail Power Company. This dam has some control over the water surface elevation of Lake Bemidji and it is operated to prevent increases over 0.5 foot on the lake. Knutson Dam controls the outflow of Cass Lake unless the pool elevation from Lake Winnibigoshish is high enough to submerge the dam. Knutson Dam is owned and operated by the Forest Service. Operation of these dams is coordinated with the Corps when required.

The other six dams are owned and operated by the Corps. The next main stem dam downstream from Cass Lake is Winnibigoshish. It is operated in concert with the Leech Lake Dam on the Leech Lake River so that the combined outflows do not exceed 2,200 cfs to avoid flooding problems upstream of Pokegama Dam. Downstream from the Leech Lake Dam on the Leech Lake River is the Mud Lake Dam, owned and operated by the Minnesota Department of Natural Resources. The operation of this dam has a very minor effect on the overall system and is influenced greatly by the operation of Leech Lake Dam. Pokegama Dam is in the vicinity of Grand Rapids and receives the combined outflow from Winnibigoshish and Leech. It controls runoff from the upper 3,265 square miles of the Mississippi River drainage basin. Lake Winnibigoshish and Leech Lake are regulated to assist Pokegama Lake during flood reduction operations. Sandy Lake Dam and Reservoir is located in Aitkin Countyon the Sandy River, 1.25 miles upstream of the junction of the Sandy and Mississippi Rivers, at Mississippi River mile 1106.85 above the Ohio River.

The Aitkin Diversion is a channel that intercepts flows from the Mississippi River upstream of Aitkin and joins the river again downstream of town. It plays a large role in the reduction of flood damages in the city of Aitkin. The diversion is a channel having a general east-west alignment between river miles 1064 and 1040.4 on the Mississippi River. The channel is about 6 miles long with a bottom width of 90 feet and 1 on 3 side slopes except for a contracted section at each end of the main diversion channel. Also included were a channel about 1,100 feet in length leading the Little Willow River into the main diversion channel, a 2,800-foot-long channel diverting Wakefield Creek into the main diversion channel, and erosion control structures at the mouth of the Little Willow and Wakefield Creek diversions and at one other point.

In addition, two supplementary cutoff channels are located downstream, the 800-foot Pine Knoll cutoff between miles 1040.9 and 1040.1 and the 1,300-foot Tow Head Rapids cutoff located between miles 1031.4 and 1030.5. The project was completed in June 1956. The responsibility for local cooperation was assumed by the Aitkin Drainage and Conservancy District, which furnished assurances and provided necessary rights-of-entry to lands required for construction. The project was transferred to local interests on December 24, 1956.

The Pine River Dam, Cross Lake Reservoir Project, is located in Crow Wing County, 22 miles north of Brainerd. The dam is on the Pine River at the outlet of Cross Lake, 14.5 river miles above the junction of the Pine and Mississippi Rivers, 199.0 Mississippi river miles above St. Paul, at Mississippi river mile 1038.3 above the Ohio River. The dam is at the town of Cross Lake and is sometimes referred to as the Cross Lake Dam. Gull Lake Reservoir is located in the extreme southern portion of Cass County, 8 miles northwest of Brainerd. The dam is on the Gull River about 1/2 river mile below the outlet of Gull Lake, 11 river miles upstream of the junction with the Crow Wing River, 16 river miles upstream of the junction of the Crow Wing and Mississippi Rivers, approximately 167.1 river miles upstream of St. Paul, and at river mile 1006.4 above the mouth of the Ohio River.

Other non-Federal are dams built across the Mississippi River main stem. These include the Blandin Paper Mill Dam at Grand Rapids downstream from Pokegama Dam, the Northwest Paper Company Dam (Rice Lake) in Brainerd, the Minnesota Power and Light Company Dam at Little Falls, the Blanchard Dam near Royalton (Zebulon Pike Lake), the St. Regis Paper Company Dam at Sartell, the old Whitney hydroelectric dam at St. Cloud, now operated by Minnesota Power, and the Coon Rapids Dam just above the Twin Cities between Hennepin and Anoka Counties. These dams do not function to impound large volumes of water and were not directly evaluated in the ROPE study.

Table 4.1.10 Rivers Impacted by Reservoir Operations
1. Mississippi River – Lake Bemidji/Stump Lake Dam - Schoolcraft River 2. Mississippi River – Cass Lake/Knutson Dam - Turtle River 3. Mississippi River - Lake Winnibigoshish and Dam 4. Leech Lake River - Leech Lake and Dam 5. Mississippi River - Pokegama Lake and Dam 6. Sandy River - Big Sandy Lake and Dam 7. Mississippi River – Aitkin Diversion 8. Pine River – Cross Lake Dam 9. Gull River - Gull Lake Dam - Mayo Creek - Stony Brook - Home Brook
NOTE: There are other non-federal dams built across the Mississippi River main stem. These include the Blandin Paper Mill dam at Grand Rapids downstream from Pokegama Dam, the Northwest Paper Company Dam (Rice Lake) in Brainerd, the Minnesota Power and Light Company dam at Little Falls, the Blanchard Dam near Royalton (Zebulon Pike Lake), the St. Regis Paper Company dam at Sartell, the old Whiney hydroelectric dam at St. Cloud, now operated by Minnesota Power and Light, and the Coon Rapids dam just above the Twin Cities.

4.2 SOCIAL AND ECONOMIC CONDITIONS

The analysis area for potential socioeconomic effects consists of all or portions of 31 Minnesota counties contained within the Upper Mississippi River basin. Six Mississippi Headwaters lakes are located within this area. These lakes were natural lakes that were raised by the construction of dams and containment levees. The lakes support commercial navigation on the Upper Mississippi River, flood control, Indian Treaty Trust resources, sport and commercial fisheries, wild rice, fish and wildlife, and low flows that contribute to instream uses and water supply for municipal, industrial, and agricultural uses as far downstream as the Minneapolis/St. Paul Metropolitan area.

4.2.1 Historical Background

The Minnesota landscape is characterized by countless lakes, ponds, and bogs that feed into three major North American watersheds and give rise to the "Mighty Mississippi" River, the nation's most important natural highway. However, the Headwaters region of north-central Minnesota no longer constitutes a natural river system.

Congress authorized the Corps to construct six dams in the headwaters between 1880 and 1907 to improve navigation. The dams allowed for the regulation of downstream flows, providing more constant flows during low water periods enabling flour mills and other waterpower users to operating longer and more consistently. Communities along the river supported the proposal to boost navigation and restore competition to the region's transportation industry, which had been virtually monopolized by the railroads. Mississippi River water and hydropower fostered a paper and wood products industry. High-grade iron ore and later taconite transported from the Iron Range have fed the blast furnaces of the Great Lakes industrial cities since the late 1800's, producing most of the steel that this country has used. Wheat from the Minnesota and Dakota prairies was milled by Mississippi River hydropower at Minneapolis and shipped downriver in barrels to New Orleans and overseas.

Despite the benefits experienced by European residents of the area as a result of the dam projects, Native American residents experienced severe adverse impacts to their economy, culture, and way of life. The major lakes that comprised the headwaters of the Mississippi, Winnibigoshish, Leech, Pokegama, Sandy, and Gull, had been the sites of Ojibwe villages since the early 1700s. These lakes had provided the primary means of subsistence for the headwaters bands. Ojibwe culture was intimately bound to the lakes and their associated resources. The reservoirs created by the Federal Government submerged an estimated 167 square miles of land, permanently altering the landscape, destroying a significant portion of the bands' means of subsistence, and undermining their traditional way of life.

During and after the first third of the 1900s, as the number of homes and recreation on the reservoirs increased and agriculture and urban development downstream began to occur, local landowner interests became more important in governing reservoir management. Resort owners and local residents organized and demanded the establishment of minimum operating levels to provide for more reliable conditions. As a result, on February 11, 1931, the Secretary of War issued an order that included both high and low reservoir operating limits, minimum outflows, minimum summer flows, and other rules for the management of the headwaters reservoir system. Additional regulations have been issued over time as new issues surfaced.

4.2.2 <u>Social Values</u>

As one of the most commonly known geographic features of the world, the Mississippi River has played a prominent role in the shaping of our country. It flows from Itasca State Park in Minnesota to the Gulf of Mexico, draining 33 states. Its watershed covers one-half of the nation. It fosters cities and commerce; transports people and goods; and provides habitat for fish, plants, and wildlife. The river enriches human life with natural and recreational opportunities.

The headwaters area is predominately rural in nature with small towns. Generally, area farms are small and often only marginally productive. The majority of residents are classified as rural nonfarm because they do not reside on farms but live in small towns of less than 2,500 persons or in homes in the country. The natural beauty and amenities of the area appeal to hunters, fishermen, snowmobilers, skiers, and other outdoor enthusiasts. These features draw both residents and visitors to the area (U.S. Army Corps of Engineers 1982).

A survey of residents in Minnesota, Illinois, Iowa, Missouri, and Wisconsin was conducted as part of the Environmental Management Program for the Upper Mississippi

River (Carlson 1990) to assess views regarding river resource values and expectations. Respondents expressed nearly unanimous agreement that it is important to take care of the river system so that it can be passed along to future generations. A majority of respondents (80 percent) also agreed that the river is important for environmental, commercial and economic, recreational, historical, and aesthetic reasons.

When respondents to the above referenced survey were asked to identify the most important management efforts for the river system, efforts aimed at reducing pollution were most commonly identified (62 percent). Efforts to improve and increase habitat and the aesthetic quality of the river ranked next highest (15 percent) followed by recreation (9 percent), flood protection (7 percent), reducing barge traffic(5 percent), and increasing lock size or efficiency (3 percent).

Many residents are concerned about the effect that changes in lake levels may have on the value and use of lake shore properties. The maintenance of recreational uses is important to some residents for both lifestyle and economic reasons. However, others believe that management decisions should not favor recreation over environmental concerns.

4.2.3 Population

The heaviest concentration of development along the river is centered in the Twin Cities metropolitan area between Hastings and St. Cloud. The region surrounding the Upper Mississippi River retains much of its pristine beauty and good water quality. The river winds it way through forests, wetlands, and lakes supporting recreational activities popular with residents of the state and visitors from across the nation. The river provides drinking water to an estimated 1.5 million people in the cities of St. Cloud, Minneapolis, and St. Paul.

Table 4.2.3.a. Upper Mississippi Basin Population by County.

County	1980	1990	2000	2006 (Estimate)	% Change 2000-2006
Aitkin	13,404	12,425	15,301	16,198	5.9 %
Anoka	195,998	243,641	298,084	328,614	10.2 %
Becker	29,336	27,881	30,000	32,256	7.5 %
Beltrami	30,982	34,384	39,650	43,094	8.7 %
Benton	25,187	30,185	34,226	38,774	13.3 %
Carver	37,046	47,915	70,205	86,236	22.8 %
Cass	21,050	21,791	27,150	28,949	6.6 %
Clearwater	8,791	8,309	8,423	8,453	0.4 %
Crow Wing	41,722	44,249	55,099	61,038	10.8 %
Douglas	27,839	28,674	32,821	35,477	8.1 %
Hennepin	941,411	1,032,431	1,116,200	1,152,508	3.3 %
Hubbard	14,098	14,939	18,376	18,925	3.0 %
Isanti	23,600	25,921	31,287	38,436	22.9 %
Itasca	43,069	40,863	43,992	44,347	0.8 %

Table 4.2.3.a. Upper Mississippi Basin Population by County.

County	1980	1990	2000	2006 (Estimate)	% Change 2000-2006
Kanabec	12,161	12,802	14,996	16,279	8.6 %
Kandiyohi	36,763	38,761	41,203	41,689	1.2 %
McLeod	29,657	32,030	34,898	37,042	6.1 %
Meeker	20,594	20,846	22,644	23,418	3.4 %
Mille Lacs	18,430	18,670	22,330	26,057	16.7 %
Morrison	29,311	29,604	31,712	32,997	4.1 %
Otter Tail	51,937	50,714	57,159	58,552	2.4 %
Pine	19,871	21,264	26,530	28,355	6.9 %
Pope	11,657	10,745	11,236	11,211	-0.2 %
Ramsey	459,784	485,765	511,035	515,059	0.8 %
Renville	20,401	17,673	17,154	16,613	-3.2 %
Sherburne	29,908	41,945	64,417	85,025	32.0 %
Sterns	108,161	118,791	133,166	144,443	8.5 %
Todd	24,991	23,363	24,426	24,469	0.2 %
Wadena	14,192	13,154	13,713	13,615	-0.7 %
Washington	113,571	145,896	201,130	228,103	13.4 %
Wright	58,681	68,710	89,986	114,806	27.6 %
Analysis Area Total Population	2,513,603	2,764,341	3,138,549	3,351,038	**6.8 %**
State of Minnesota	4,075,970	4,375,099	4,919,479	5,231,106	6.3 %

Sources: U.S. Bureau of Census, Census of Population and Housing 1980, 1990, and 2000 and Minesota State Demographic Center, Post-2000 Population and Household Estimates.

As displayed in Table 4.2.3.a. the overall population within the analysis area grew by and estimated 6.8 percent, slightly higher than the State average of 6.2 percent from 2000 to 2006. Generally, the greatest growth occurred in counties adjacent to the Twin Cities Metropolitan area and in counties located closest to the river. Sherburne County experienced the greatest growth from 2000 through 2006 at 32 percent followed by Wright County with 27.6 percent.

Projections for future population growth by county are displayed in Table 4.2.3.b

Table 4.2.3.b. Upper Mississippi Basin Population for 2000 and Projections by County through 2035.

County	2000	2010	2020	2030	2035	% Change 2000-2035
Aitkin	15,301	17,050	18,700	19,370	19,630	28.3 %
Anoka	298,084	352,080	393,470	411,600	421,060	41.3 %

Table 4.2.3.b. Upper Mississippi Basin Population for 2000 and Projections by County through 2035.

County	2000	2010	2020	2030	2035	% Change 2000-2035
Becker	30,000	34,300	38,210	39,860	40,790	36.0 %
Beltrami	39,650	46,590	52,380	56,430	57,900	46.0 %
Benton	34,226	43,730	51,490	56,970	59,150	72.8 %
Carver	70,205	100,830	127,270	149,400	160,050	128.0 %
Cass	27,150	31,040	34,500	36,250	36,600	34.8 %
Clearwater	8,423	8,790	9,270	9,470	9,530	13.1 %
Crow Wing	55,099	65,220	73,960	79,750	81,610	48.1 %
Douglas	32,821	37,890	42,750	45,920	46,960	43.1 %
Hennepin	1,116,200	1,149,290	1,178,170	1,190,240	1,192,760	6.9 %
Hubbard	18,376	19,560	20,840	21,430	21,480	16.9 %
Isanti	31,287	45,080	57,710	68,770	74,250	137.3 %
Itasca	43,992	45,610	47,630	48,470	48,590	10.5 %
Kanabec	14,996	17,560	19,710	20,970	21,360	42.4 %
Kandiyohi	41,203	42,000	43,320	44,080	44,180	7.2 %
McLeod	34,898	38,930	42,230	44,660	45,610	30.7 %
Meeker	22,644	24,470	26,250	27,200	27,510	21.5 %
Mille Lacs	22,330	29,620	35,970	40,630	42,390	89.8 %
Morrison	31,712	34,480	37,470	39,450	40,110	26.5 %
Otter Tail	57,159	59,040	61,930	63,700	64,040	12.0 %
Pine	26,530	30,660	34,320	36,450	37,030	39.6 %
Pope	11,236	11,560	12,270	12,670	12,760	13.6 %
Ramsey	511,035	494,710	489,130	482,490	479,060	-6.3 %
Renville	17,154	16,860	17,300	17,590	17,660	2.9 %
Sherburne	64,417	101,560	134,390	161,990	175,410	172.3 %

Table 4.2.3.b. Upper Mississippi Basin Population for 2000 and Projections by County through 2035.

County	2000	2010	2020	2030	2035	% Change 2000-2035
Sterns	133,166	154,220	173,520	188,760	194,490	46.1 %
Todd	24,426	25,200	26,230	26,630	26,660	9.1 %
Wadena	13,713	14,110	14,830	15,300	15,440	12.6%
Washington	201,130	240,990	272,280	297,550	308,370	53.3%
Wright	89,986	136,110	181,240	221,480	241,850	168.8%
Analysis Area Total Population	3,138,549	3,469,140	3,768,740	3,975,530	4,064,290	29.4%
State of Minnesota	**4,919,479**	**5,446,530**	**5,943,240**	**6,297,950**	**6,446,270**	**31.0%**

Source: Population projections for Minnesota counties, 2005 to 2030, Minnesota State Demographic Center, April 2007.

The total population within the analysis area is expected to grow by approximately 29.4 percent between 2000 and 2035, very similar to the projection for the State of 31 percent. The greatest rate of growth is expected in Sherburne County at 172.3 percent followed by Wright County with 168.8 percent. Projected growth in the analysis area counties as a whole represents a somewhat slower rate of growth than the 32.5 percent experienced in the 25 years from 1980 to 2005. Minnesota's growth during the same period was 27.7 percent compared to projected growth of 31. percent over the next 25 years (Minnesota State Demographic Center 2007).

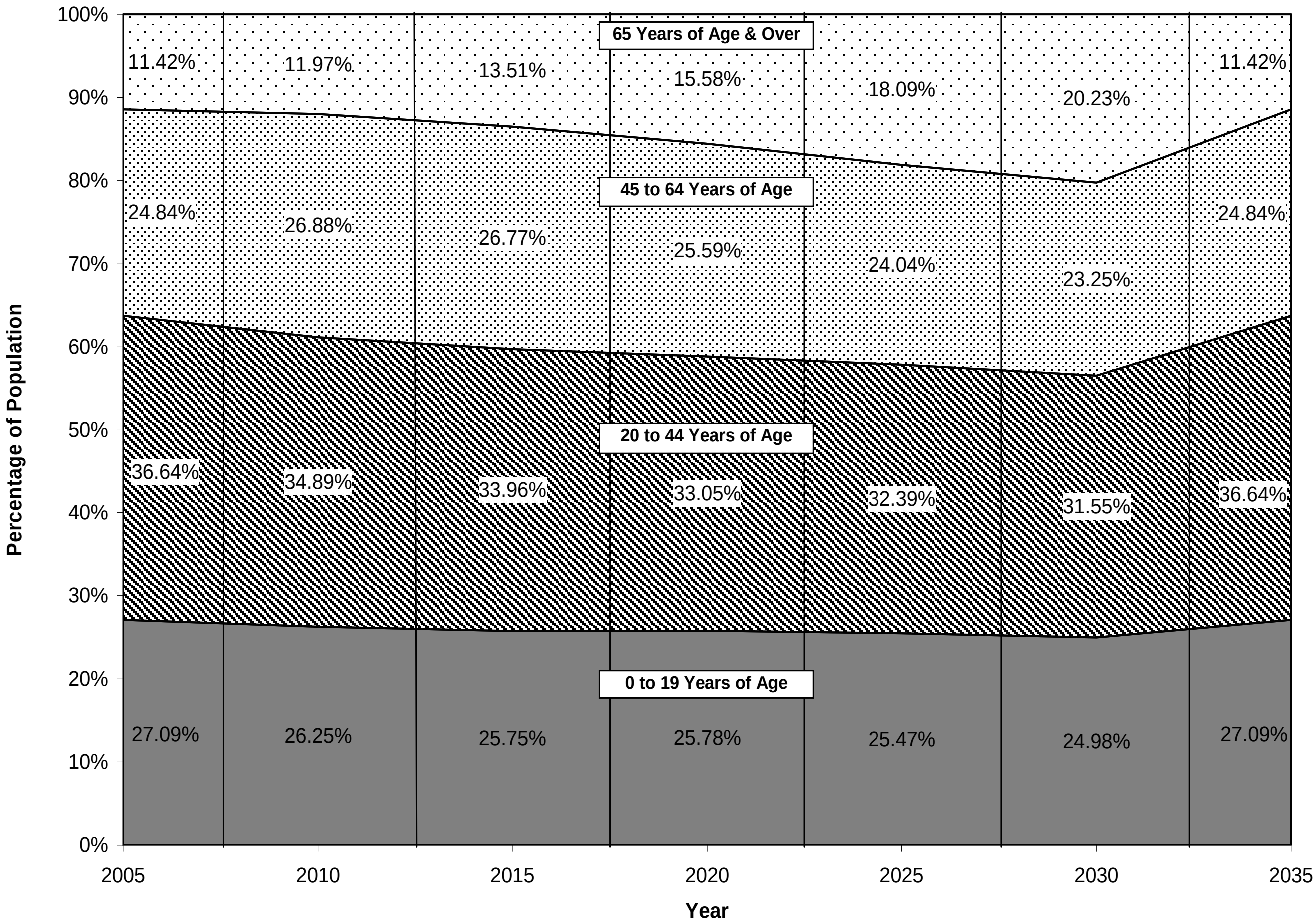


Figure 4.2.3.a. Projected Age Distribution for Analysis Population, 2000 – 2035.

Recreational uses of central Minnesota are changing from a region of family resorts and vacation cottages into an area popular for retirement homes, large-scale resorts, and year-round residences. This trend is expected to continue. The proportion of the analysis area population from ages 0 to 44 is projected to decrease over the 25 year period from 2005 to 2030. The percentage of persons age 44 to 64 is also expected to gradually decrease during the same time frame. However, the greatest change is expected to occur in percentage of the population age 65 and over. This segment of the population is projected to increase from 11.4 percent in 2005 to 20.2 percent in 2030. The proportion of the population over the age of 65 is projected to begin to decrease after 2030. Projected changes in the age distribution of the analysis population are displayed in Figure 4.2.3.a (Minnesota State Demographic Center 2007).

Table 4.2.3.c. Analysis Area Racial and Ethnic Population Distribution by County, 2000 Census.

Geographic Area	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian & Other Pacific Islander	Some Other Race	Two or More Races	Hispanic or Latino (of any race)
Aitkin	96.4%	0.2%	2.3%	0.2%	0.0%	0.2%	0.7%	0.6%
Anoka	93.6%	1.6%	0.7%	1.7%	0.0%	0.6%	1.7%	1.7%
Becker	89.4%	0.2%	7.5%	0.4%	0.0%	0.2%	2.3%	0.8%
Beltrami	76.7%	0.4%	20.4%	0.6%	0.0%	0.2%	1.8%	1.0%
Benton	96.2%	0.8%	0.5%	1.1%	0.0%	0.4%	0.9%	0.9%
Carver	95.9%	0.6%	0.2%	1.6%	0.0%	0.9%	0.8%	2.6%
Cass	86.5%	0.1%	11.5%	0.3%	0.0%	0.1%	1.5%	0.8%
Clearwater	89.3%	0.2%	8.6%	0.2%	0.0%	0.2%	1.5%	0.8%
Crow Wing	97.6%	0.3%	0.8%	0.3%	0.0%	0.2%	0.8%	0.7%
Douglas	98.5%	0.2%	0.2%	0.4%	0.0%	0.2%	0.5%	0.6%
Hennepin	80.5%	9.0%	1.0%	4.8%	0.0%	2.1%	2.6%	4.1%
Hubbard	96.3%	0.2%	2.1%	0.3%	0.0%	0.2%	0.9%	0.7%
Isanti	97.6%	0.3%	0.6%	0.4%	0.0%	0.2%	0.9%	0.8%
Itasca	94.6%	0.2%	3.4%	0.3%	0.0%	0.2%	1.3%	0.6%
Kanabec	97.3%	0.2%	0.8%	0.4%	0.0%	0.2%	1.1%	0.9%
Kandiyohi	93.6%	0.5%	0.3%	0.4%	0.1%	4.2%	0.9%	8.0%
McLeod	96.6%	0.2%	0.2%	0.6%	0.1%	1.8%	0.6%	3.6%
Meeker	97.3%	0.2%	0.2%	0.4%	0.0%	1.4%	0.5%	2.2%
Mille Lacs	93.6%	0.3%	4.7%	0.2%	0.0%	0.2%	1.1%	1.0%
Morrison	98.5%	0.2%	0.3%	0.3%	0.0%	0.2%	0.5%	0.6%
Otter Tail	97.1%	0.3%	0.5%	0.4%	0.0%	0.8%	0.8%	1.7%
Pine	94.4%	1.3%	2.7%	0.3%	0.0%	0.3%	1.0%	1.8%
Pope	98.9%	0.2%	0.2%	0.1%	0.0%	0.2%	0.5%	0.5%
Ramsey	77.4%	7.6%	0.8%	8.8%	0.1%	2.5%	2.9%	5.3%
Renville	95.7%	0.1%	0.5%	0.2%	0.0%	2.8%	0.7%	5.1%
Sherburne	96.7%	0.9%	0.4%	0.6%	0.0%	0.4%	0.9%	1.1%
Stearns	96.0%	0.8%	0.3%	1.6%	0.0%	0.5%	0.8%	1.4%
Todd	97.5%	0.1%	0.5%	0.3%	0.0%	0.7%	0.8%	1.9%
Wadena	97.9%	0.5%	0.6%	0.2%	0.0%	0.3%	0.6%	0.9%
Washington	93.6%	1.8%	0.4%	2.1%	0.0%	0.6%	1.4%	1.9%
Wright	97.9%	0.3%	0.3%	0.4%	0.0%	0.4%	0.8%	1.1%
Analysis Area Totals	**86.8%**	**4.8%**	**1.3%**	**3.6%**	**0.0%**	**1.4%**	**1.9%**	**3.1%**
Minnesota	89.4%	3.5%	1.1%	2.9%	0.0%	1.3%	1.7%	2.9%

Table 4.2.3.c displays the racial and ethnic distribution of the analysis area population by county.

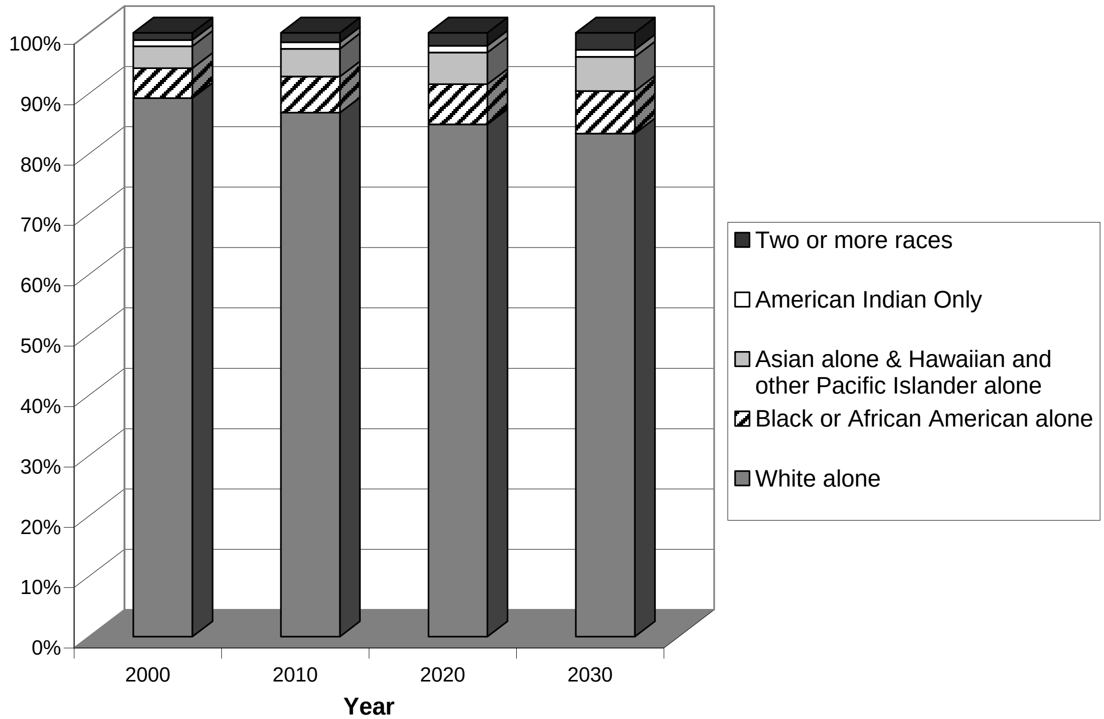


Figure 4.2.3.b. Projected Distribution by Race for Analysis Population, 2000 – 2030.

Figure 4.2.3.b displays the projected distribution of the analysis area population by race. Overall, the population of nonwhite and Latino residents in Minnesota is younger than the white population and is projected to grow at a much faster rate through a combination of in-migration and natural increase (the excess of births over deaths). Minnesota's future growth will rely increasingly on the contribution of nonwhites and Latinos as the white population is projected to have the slowest rate of growth. Within the analysis area, whites represented approximately 88.4 percent of the population in 2000. By the year 2030, whites will represent only 81.4 percent (Minnesota State Demographic Center 2005).

The black or African-American population is Minnesota's largest nonwhite racial group. Growth within this group is expected to be among the fastest. Statewide, the population of those who consider themselves black or African-American alone is expected to more than double by 2030 with an increase of approximately 115 percent. Hennepin and Ramsey counties within the analysis area are projected to add the largest number of new African-American residents; however, the rate of growth is projected to be higher in some of the suburban counties. Across the analysis area as a whole, the population of African-Americans is expected to grow from 4.9 percent in 2000 to an estimated 6.9 percent in 2030 (Minnesota State Demographic Center 2005).

The population of Asian alone and Hawaiian and other Pacific Islander alone was approximately 3.6 percent in 2000. The size of this segment is expected to increase to approximately 5.6 percent by 2030. The greatest number of persons in this group will be added in the State's two most populous counties, Hennepin and Ramsey (Minnesota State Demographic Center 2005).

The American Indian population was approximately 1 percent in 2000. This group will grow more slowly than other nonwhite populations, primarily because there tends to be little net in-migration among American Indians. The primary source of growth is natural increase. The American Indian population is expected to grow substantially in most areas, with the exception of Hennepin County, which trend data indicate has a net out-migration. Within the analysis area, the American Indian population is expected to grow to 1.1 percent by 2030 (Minnesota State Demographic Center 2005).
The greatest rate of growth is expected in the segment of the population who consider themselves to be of two or more races in both the State and within the analysis area. This group represented 1.2 percent of the population in 2000 within the analysis area and is expected to more than double to 2.7 percent in 2030 (Minnesota State Demographic Center 2005).

Across the State as a whole, the Hispanic population is expected to increase by approximately 184 percent from 2000 to 2030. This growth is attributed to international in-migration, net in-migration from other states, and natural increase. Within the analysis area, the population of Hispanics or Latinos is currently an estimated 2.7 percent. This is projected to increase to 5.5 percent by 2030 (Minnesota State Demographic Center 2005).

4.2.4 Income

Median Household Income. With the ninth highest estimated median household income in the nation in 2005, Minnesota ranks among the national income leaders. Minnesota's median household income was $52,048, substantially above the national average of $46,242 (US Census 2008). Inflation adjusted income increased by 17.4 percent between 1989 and 1999, the fifth highest rate of increase in the country. Within the analysis area, the highest rate of growth occurred in Cass County with a 41 percent increase over the same period (McMurry 2002).

Median household income is the midpoint at which one half of the households earn higher and one half earn less. Fourteen of the thirty-one counties in the analysis area had median household incomes that were lower than the national average as displayed in Figure 4.2.4.a. Carver and Washington Counties had the highest median incomes at $74,493 and $73,976, respectively, which were 43 and 42 percent higher than the State average (U.S. Census 2008).

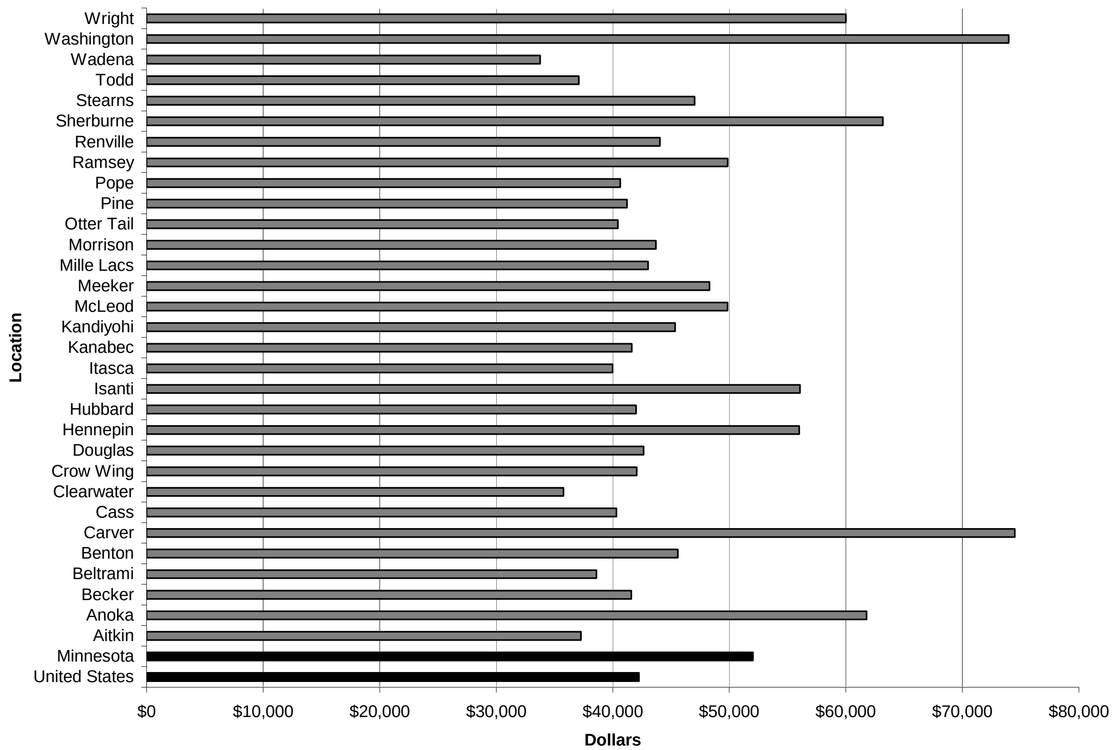


Figure 4.2.4.a. Estimated Median Household Income by County, 2005 (90% Confidence Interval).

Per Capita Income. Per capita income represents total income divided by the population to derive a per person income estimate. At $37,290, the estimated per capita income in Minnesota surpassed the national average by over 8 percent in 2005. The majority of counties within the analysis area had per capita incomes that were less than the national average as displayed in Figure 4.2.4.b. The exceptions were Carver, Hennepin, Ramsey, and Washington Counties, which exceeded the State average and Anoka County which exceeded the national average (BEA 2008).

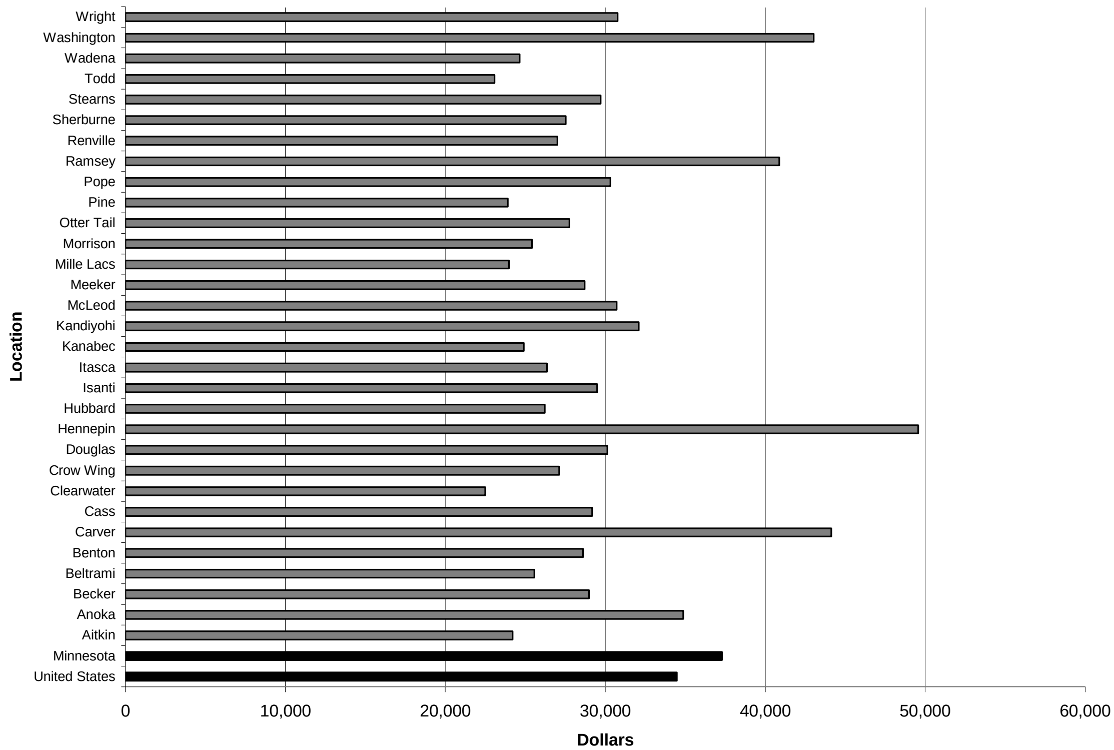


Figure 4.2.4.b. Per Capita Personal Income by County, 1999.

Persons Below Poverty Level. Following the Office of Management and Budget's (OMB) Statistical Policy Directive 14, the Census Bureau uses a set of money income thresholds that vary by family size and composition to determine who is in poverty. If a family's total income is less than the family's threshold, then that family and every individual in it is considered in poverty. The official poverty thresholds do not vary geographically, but they are updated for inflation using Consumer Price Index (CPI-U). The official poverty definition uses money income before taxes and does not include capital gains or noncash benefits (such as public housing, Medicaid, and food stamps) (U.S. Census 2008a). The poverty threshold for a family of four in 2005 was $19,806 (Census Bureau 2008b)

As displayed in Figure 4.2.4.c, the county with the highest percentage of persons classified as below poverty level was Beltrami with 13.3 percent, and the State average is 9.2 percent. Carver County had the lowest percentage of persons below poverty level with 3.5 percent.

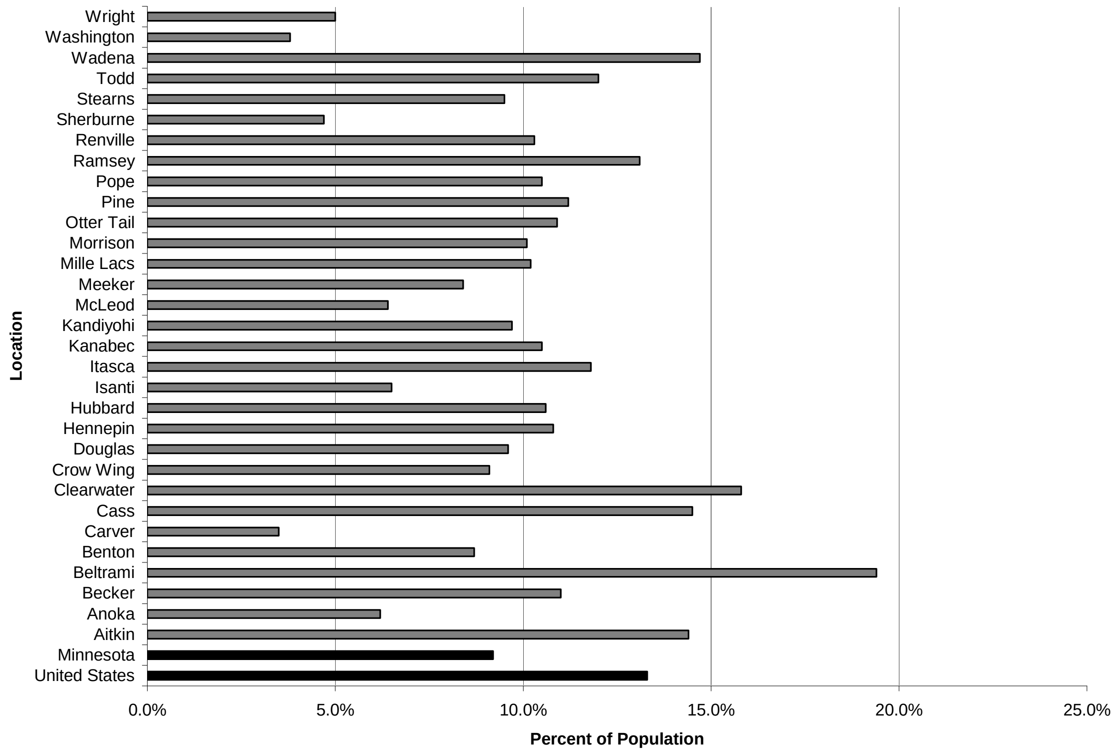


Figure 4.2.4.c. Estimated Percentage of Population Below Poverty Level, 2005 (90% Confidence Interval).

The 2000 Census provides the most recent data regarding poverty levels by race and is displayed in Table 4.2.4.a. Poverty levels were most elevated among minority populations.

Table 4.2.4.a. Percentage of the Analysis Area Population Below Poverty Level by Race or Ethnicity, 1999.

Race/Ethnicity	Percentage of Population Below Poverty Level
White alone	**5.7 %**
Black or African American alone	**27.2 %**
Asian alone	**20.3 %**
American Indian and Alaska Native alone	**29.1 %**
Native Hawaiian and other Pacific Islander alone	**13.9 %**
Two or More Races	**19.4 %**
Hispanic or Latino	**19.3 %**
Source: (Minnesota Department of Administration 2006)	

On average, in 1999, approximately 3.4 percent of Minnesota households received public assistance, identical to the national average. A slightly higher percentage of households in the analysis area received public assistance in the same year at 3.7

percent. The county with the highest percentage of households receiving public assistance was Beltrami County at 8 percent. The lowest was Carver County with 1.2 percent (U.S. Census Bureau 1999).

Nationally, an average of 16.7 percent of households received retirement income in 1999. On average, 13.7 percent of Minnesota households received retirement income. Within the analysis area, the average was very close to that of the State with 13.6 percent. The counties with the highest percentage of households receiving retirement income were Aikin, Itasca, Hubbard, and Cass with 23.5, 22.5, 22.1, and 21.5 percent respectively (U.S. Census Bureau 1999).

4.2.5 Education

The Upper Mississippi River basin is home to many universities, State universities, private liberal arts colleges, community colleges, and technical and business colleges. The University of Minnesota, located in Minneapolis, is one of the most comprehensive public universities in the United States and ranks among the most prestigious. State Universities are also located in St. Cloud and Bemidji.

Nationally, 80.4 percent of the population over age 25 had achieved a high school degree or higher in 2000. It was estimated that 87.9 percent of the Minnesota population had accomplished this level of education.

On average across the analysis area, 88.6 percent of the population had achieved a high school degree or higher and 29.7 had achieved a bachelor's degree or higher in 2000. The county with the highest percentage of persons achieving a high school degree or higher was Washington County at 94 percent. The county with the lowest percentage of the population with a high school degree or higher was Clearwater County at 76.4 percent (U.S. Census Bureau 2000).

The State of Minnesota also had a higher percentage of the population that had completed a bachelor's degree or higher at 27.4 percent compared to 24.4 percent nationally. The average across the analysis area was also higher at 29.7 percent. The county with the highest percentage of the population with a bachelor's degree or higher was Hennepin County with 39.1 percent. The county with the lowest percentage of residents with this level of education was Todd County at 10 percent (U.S. Census Bureau 2000).

Table 4.2.5.a. Educational Attainment by County as a Percentage of the Population Age 25 and Over, 2000.

Location	Percentage of Population to Achieve a High School Degree (or equivalent) or Higher	Percentage of Population to Achieve a Bachelor's Degree or Higher
United States	**80.4 %**	**24.4 %**
Minnesota	**87.9 %**	**27.4 %**
Aikin	**80.4 %**	**11.3 %**
Anoka	**91.0 %**	**21.3 %**
Becker	**82.9 %**	**16.7 %**
Beltrami	**83.4 %**	**23.5 %**

Table 4.2.5.a. Educational Attainment by County as a Percentage of the Population Age 25 and Over, 2000.

Location	Percentage of Population to Achieve a High School Degree (or equivalent) or Higher	Percentage of Population to Achieve a Bachelor's Degree or Higher
Benton	**84.9 %**	**17.2 %**
Carver	**91.4 %**	**34.3 %**
Cass	**83.9 %**	**16.6 %**
Clearwater	**76.4 %**	**14.7 %**
Crow Wing	**86.3 %**	**18.4 %**
Douglas	**85.6 %**	**17.3 %**
Hennepin	**90.6 %**	**39.1 %**
Hubbard	**86.1 %**	**20.2 %**
Isanti	**86.6 %**	**14.5 %**
Itasca	**85.6 %**	**17.6 %**
Kanabec	**80.6 %**	**10.5 %**
Kandiyohi	**83.5 %**	**18.3 %**
McLeod	**84.7 %**	**15.4 %**
Meeker	**81.5 %**	**13.9 %**
Mille Lac	**81.3 %**	**12.2 %**
Morrison	**79.7 %**	**12.6 %**
Otter Tail	**81.4 %**	**17.2 %**
Pine	**79.0 %**	**10.3 %**
Pope	**81.8 5**	**14.7 %**
Ramsey	**87.6 %**	**34.3 %**
Renville	**80.9 %**	**12.6 %**
Sherburne	**89.9 %**	**19.4 %**
Stearns	**86.2 %**	**22.0 %**
Todd	**79.3 %**	**10.0 %**
Wadena	**79.5 %**	**13.4 %**
Washington	**94.0 %**	**33.9 %**
Wright	**88.1 %**	**17.9 %**
Analysis Area Average	86.6 %	29.7 %

Source: (U.S. Census Bureau 2000)

Educational attainment within the analysis area was generally lower among minority residents as displayed in Table 4.2.5.b. An exception is that 35 percent of the Asian population had a bachelor's degree or higher, more than any other group (U.S. Census Bureau 2000).

Table 4.2.5.b. Analysis Area Educational Attainment by Race or Ethnicity as a Percentage of the Population Age 25 and Over, 2000.

Race/Ethnicity	Percentage of Population to Achieve a High School Degree (or equivalent) or Higher	Percentage of Population to Achieve a Bachelor's Degree or Higher
White alone	**90.2 %**	**30.6 %**
Black or African American alone	**79.2 %**	**18.3 %**
American Indian or Alaska Native	**73.2 %**	**8.8 %**

Table 4.2.5.b. Analysis Area Educational Attainment by Race or Ethnicity as a Percentage of the Population Age 25 and Over, 2000.

Race/Ethnicity	Percentage of Population to Achieve a High School Degree (or equivalent) or Higher	Percentage of Population to Achieve a Bachelor's Degree or Higher
alone		
Asian	**69.9 %**	**35.6 %**
Native Hawaiian and other Pacific Islanders alone	**80.4 %**	**21.1 %**
Two or More Races	**79.2 %**	**20.4 %**
Hispanic	**59.4 %**	**16.1 %**

Source: (U.S. Census Bureau 2000)

4.2.6 Employment

Minnesota's labor force grew by 16 percent from 1990 to 2000. Almost all of that growth was due to population increase. The participation of men actually fell from 77.4 to 76.6 percent of the population of males age 16 and over. The main reason was a decline in participation for men in the 25 to 54 year age group, which fell from 93.9 to 91.3 percent. Even so, participation rates in Minnesota exceed the national average of 85.6 percent. The reason for this trend is not clear, but may be the result of increased use of disability, greater reliance on working wives, more people living off of investments, and increased rates of incarceration. Female participation in the Minnesota work force rose from 62.5 percent of women age 16 and over to 66 percent from 1990 to 2000 in contrast to the national average which remained steady (McMurry 2002).

Among the States, Minnesota has the fourth highest rate of male participation in the labor force and the highest rate for women, resulting in the second highest rate of participation for all persons over the age of 16. The Minnesota labor force has become more racially and ethnically diverse, mirroring changes in the population as a whole. Participation rates for African-American alone, Latino, other race alone, and people who identify with two or more races are well above the national averages. The labor force is also becoming older with the proportion of those in the 45- to 64-year age group rising from 24.8 percent of the labor force in 1990 to 31.4 percent in 2000. Meanwhile, the percentage of workers age 25 to 44 dropped from 55.2 to 48.6 percent (McMurry 2002). Within the analysis area, the labor force grew by 15.5 percent from 1990 to 2000, a slightly lower rate than the State average. However, growth of the labor force in some counties exceeded the State average significantly. In total, 25 of the 31 counties in the analysis area had rates of growth that exceeded the State average. Rates of labor force growth ranged from a low of 4.3 percent in Ramsey County to a high of 62.8 percent in Sherburne County (McMurry 2002).

Total jobs by industry within the analysis area were estimated with 2003 data using IMPLAN modeling. IMPLAN is a computerized economic modeling program. IMPLAN uses a database of basic economic statistics constructed by the Minnesota IMPLAN Group (MIG). Information for this database was obtained from major government sources such as the Bureau of Economic Analysis, County Business Patterns, Regional

Economic Information System (REIS), Bureau of Labor Statistics, U.S. Census, etc., and converted to a consistent format using widely accepted methodologies.

The IMPLAN database breaks the economy down into 509 sectors, which are bridged to the 2002 North American Industrial Classification System (NAICS). These sectors were aggregated to summarize the data. The aggregation scheme that was used grouped sectors by the first two digits of the NAICS code.

In 2006, the economy within the 31 counties of the analysis area supported an estimated 2,384,995 jobs across 436 IMPLAN sectors. This number includes full-time, part-time, seasonal, and intermittent positions. One person who holds three part-time jobs would be counted three times in the data; therefore, these job estimates cannot be compared against population estimates. Table 4.2.6.a displays the distribution of jobs within 20 aggregated sectors.

Table 4.2.6.a. Analysis Area Employment, 2006.

Sector	Jobs	Percentage Jobs
Ag, Forestry, Fish & Hunting	**44,538**	**1.9%**
Mining	**1,109**	**0.0%**
Utilities	**8,642**	**0.4%**
Construction	**124,940**	**5.2%**
Manufacturing	**236,728**	**9.9%**
Wholesale Trade	**103,250**	**4.3%**
Transportation & Warehousing	**82,153**	**3.4%**
Retail Trade	**253,165**	**10.6%**
Information	**43,997**	**1.8%**
Finance & Insurance	**137,688**	**5.8%**
Real Estate & Rental	**93,389**	**3.9%**
Professional- Scientific & Tech Services	**167,492**	**7.0%**
Management of Companies	**59,261**	**2.5%**
Administrative & Waste Services	**137,764**	**5.8%**
Educational Services	**50,670**	**2.1%**
Health & Social Services	**261,489**	**11.0%**
Arts- Entertainment & Recreation	**57,788**	**2.4%**
Accommodation & Food Services	**146,351**	**6.1%**
Other Services	**119,573**	**5.0%**
Government & Non NAICs	**255,008**	**10.7%**
Total	**2,384,995**	**100.0 %**

Source: Ott 2008

Until recently, unemployment in Minnesota over the last 10 years has generally remained approximately 1 percent or more lower than the national average. In 2007, the unemployment rate for the analysis area, State, and nation were the same at 4.6 percent. Throughout the last 10 years the average unemployment rate within the analysis area has generally mirrored that of the State as displayed in Figure 4.2.6.a.

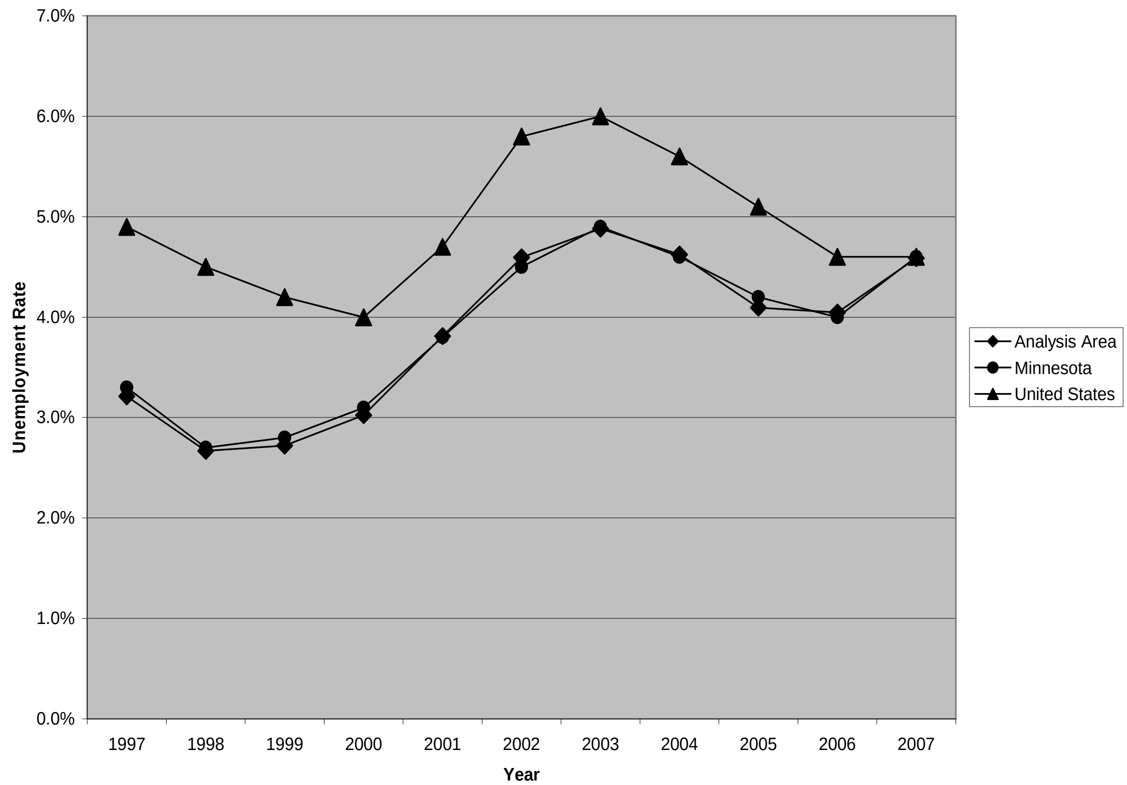


Figure 4.2.6.a. Average Annual Unemployment Rates, 1997-2007.

Average annual unemployment by county within the analysis area in 2007 varied from a low of 4 percent in Carver, Hennepin, and Washington Counties to a high of 10.4 percent in Clearwater County.

4.2.7 Flood Damages

Winnibigoshish, Leech, Pokegama and Sandy reservoirs are regulated for flood damage reduction at Aitkin. Pokegama and Sandy are operated according to Spring and Summer Flood Control Guide Curves. The need for separate curves is necessitated by the additional rural damages that would take place during a summer flood as compared to an early spring flood. However, this flood operation is accomplished with the assistance of Winnibigoshish and Leech (where the largest amount of storage resides).

The Pokegama/Sandy/Aitkin Flood Control Guide Curves were developed from an analysis of historic flood events at Aitkin when the river exceeded a certain stage. The relationship is affected by the area distribution and time-volume relationships of individual floods. The curves show the relation between reservoir elevations and the corresponding peak flood stage at Aitkin, which will result, on the average, in the minimum total flood damages to affected interests in the three principal damage areas: Pokegama Lake; Sandy Lake; and the rural/urban Aitkin area. Potential damages are considered for residential, farm, commercial, industrial, and public properties/structures. Also factored in is the acres flooded and damage per acre based on the various probable flood events and time of year of occurrence.

The Aitkin diversion channel was completed in 1957 and consists of a diversion channel about 6 miles long bypassing Aitkin to help alleviate flood conditions. The channel is capable of carrying approximately 6,000 cfs, which is about 50 percent of a 16-year frequency flood with a maximum velocity of 2.5 feet per second. The operations of the headwaters reservoirs have prevented an estimated $22 million in agricultural, residential, commercial, and industrial damages in the rural and urban Aitkin area. In addition, the Aitkin diversion channel has prevented an additional $11 million in damages. The Corps has initiated a reevaluation of potential Federal interest associated with a flood control project in the Aitkin area.

A new inventory of structures that could possibly be affected by high water as a result of the operation of the headwaters reservoirs has been undertaken as part of the ongoing ROPE study. The inventory also includes all the structures located in the floodplain in the urban and rural Aitkin area. This inventory will be used to reevaluate the current flood control operating procedures and to compare it with possible changes in operating procedures to minimize damages on an equitable system-wide basis.

4.2.8 Navigation

The Upper Mississippi River and Illinois Waterway Navigation System consists of about 1,250 miles of navigable rivers controlled by 36 locks and dams and plays a major role in the movement of bulk commodities to the nation's manufacturing centers. The Mississippi River and Illinois River are the major navigation arteries. The rivers and several thousand miles of tributaries are also available for recreational navigation and water-based recreation.

Within the Upper Mississippi River basin study area the Corps has constructed and operates the following locks and dams: Upper St. Anthony Falls, Lower St. Anthony Falls, and Lock and Dam No.1, all located in the Twin Cities.

While the Headwaters reservoirs owned and operated by the Corps were originally constructed to aid in navigation, they have not been operated for that purpose to a substantial degree since the construction of the aforementioned locks and dams in the 1930's.

4.2.9 Hydropower

There are nine hydropower dams that are affected by the operation of the six Corps Headwaters dams (see Table 4.2.9). Two additional hydropower facilities downstream of the Corps' dams are in the planning stages (at Coon Rapids and Upper St. Anthony). Two dams (Stump Lake and Prairie) are not affected by the operation of the Corps' dams; however, their operation impacts the system's water control plan.

Water is released from the six Corps reservoirs in the fall and winter to draw down the water levels to create room to store the spring runoff. The total combined drawdown flow from all six dams varies each year depending on the hydrologic conditions (inflows, snowpack, etc.). In a typical year, the combined increment of flow needed above the inflow to accomplish the drawdown is approximately 1,000 cfs. However, this value can vary from 500 to approximately 2,000 cfs depending on when the drawdown is started versus the progression of the snowpack during the winter. These releases occur during what would, under natural conditions, be a low-flow period. The increase in flow provides an economic benefit to the hydropower dams through increased power generation. The Forest Service dam on Cass Lake (Knutson Dam, upstream of Lake Winnibigoshish) also contributes to the downstream flow duration. Knutson Dam's drawdown flows all pass through Winnibigoshish Dam.

Under Section 10f of the Federal Power Act, an owner of a hydropower plant is required to reimburse upstream owners of dams/reservoirs for an equitable part of the benefits it receives from the flow duration above the natural condition. The act requires FERC to determine the benefits received by downstream hydropower project owners who have an installed generating capacity of greater than 1.5 megawatts (MW). The charges assessed by FERC to the hydropower owners are called "Headwaters Benefits Assessments," and the money collected is returned to the U.S. Treasury.

Table 4.2.9. Hydropower dams.

Selected Hydropower Dams Upstream of Lock and Dam No. 2 Mississippi River Watershed (listed in downstream order)			
Dam Name and Location (1.)	**Dam Operator**	**MW Capacity**	**Notes**
1. Stump Lake Dam Bemidji, MN	Otter Tail Power Co.	0.8	Stump L. Dam is upstream of the all Corps' dams. Otter Tail Power is a partner in the Corps' ROPE study.
2. Blandin Dam Grand Rapids, MN	Minnesota Power Co.	2.1	Affected by discharges from Winn, Leech and Pokegama Dam.
3. Prairie River Dam NE of Grand Rapids, MN	Minnesota Power Co.	1.1	On the Prairie River. Not affected by Corps dam operations.
4. Potlatch Dam Brainerd, MN	Missota Paper Co.	3.3	Affected by discharges from Winni, Leech, Pokegama, Sandy and Pine Dam.
5, Little Falls Dam Little Falls, MN	Minnesota Power Co	4.9	Downstream of all the Corps Headwaters Dams.
6. Sylvan Dam SE of Pillager, MN	Minnesota Power Co	1.8	On the Crow Wing River. Affected by discharges from Gull Lake Dam.
7. Blanchard Dam Near Royalton, MN	Minnesota Power Co	18.0	Downstream of all the Corps Headwaters Dams.
8. Champion Dam Sartell, MN	Champion Intl. Paper Co.	9.5	Downstream of all the Corps Headwaters Dams.
9. St. Cloud Dam St. Cloud, MN	City of St. Cloud	8.8	Downstream of all the Corps Headwaters Dams.
10. Coon Rapids Dam Coon Rapids, MN	*Three Rivers Park Dist.*	*NA*	*Reactivating hydropower in the dam is in the planning stages.*
11. Upper St. Anthony Falls Minneapolis, MN	XCEL Energy	12.0	Downstream of all the Corps Headwaters Dams.
12. Upper St. Anthony Falls Minneapolis, MN	*Crown Hydropower*	*NA*	*Still in the planning stages.*
13. Lock and Dam No. 1	Ford Motor Co.	14.4	Downstream of all the Corps Headwaters dams.
1. All the dams are on the Mississippi River unless otherwise noted.			

4.2.10 Agriculture

In 1992, the State of Minnesota had a total of 75,079 farms totaling 25,666,944 acres. The average farm size was 342 acres. In 2001, total cash receipts were over $9.5 billion.

The changing pattern of the farm industry in the basin corresponds to that of the nation in that the number of farms is decreasing and the average farm size is increasing, employing more capital and less labor.

Agricultural land in the Aitkin area is vulnerable to flooding. Cropping practices are about half mixed hay and half corn silage. There are also sod-growing operations. Flooding occurs such that for 2-year, 10-year, and 100-year events, about 600, 12,000, and 18,000 acres, respectively, are flooded during events of those magnitudes.

4.2.11 Recreation

Historically, the lands and waters provided food and shelter for the Native Americans and early explorers in the region. As settlement advanced into the region, much of the forested lands in Minnesota were cleared for agriculture and/or timber in the late 1800's and early 1900's. While the lands and waters still provided food, there was a shift in utilization from subsistence to supplemental, with the establishment of hunting and fishing camps. With the growth of recreation, the taking of game and fish, harvesting wild rice, and gathering of fruits, berries, mushrooms, has for many become a recreational experience. For Native Americans, these activities form an important part of their culture and heritage and, for many people, continue to be subsistence activities.

In the earlier years of the 20th century, before the widespread use of the automobile, taking vacations "up north at the lake" meant taking the train. Resort owners would meet the trains at various stations and take their guests to the resorts by wagon. As roads improved and the use of automobiles increased, families would buy lakeshore property and build cabins for use during the summer months.

The recreational use and development of the region expanded greatly in the years following World War II. At the same time, other industries, such as farming and timber harvesting were declining. As a result, the economy began to shift towards more dependence on summer residents and tourism. In Minnesota, water-oriented recreation has traditionally focused on lakes. During the middle of the 20th century, most of the resorts were small "ma and pa" operations. They were very lake dependent, advertising fishing, boating, and swimming activities, primarily summer activities. Private development around the lakes increased as more people wanted a cabin by the lake to go to during the summer. With most of the activity occurring during the summer, many of the recreation-related/dependent businesses would close during the winter months.

During the latter part of the century, the development of the snowmobile and the rediscovery of cross-county skiing and snowshoeing resulted in the development of trail networks and increasing winter recreational use of the region. Cabin and resort owners began to winterize so they could use their property year-round. Cabin owners began to think of their cabins as a retirement home. Cabins that were once used only during the summer were remodeled or replaced by year-round residences. Resorts began to cater to the winter recreationists. Businesses began staying open year-round in response to the increasing recreational activity in the region.

Over the years, many of the smaller resorts are no longer operating, with many of the properties being sold for private developments. A number of the larger resorts have changed their focus from water-based recreation to multiple recreational opportunities combined with conference centers. A large number of golf courses have been developed in the region. Summer use of the trail systems by mountain bikers and all-terrain vehicle (ATV) riders also is increasing. Hunting and fishing activities within the region has remained relatively stable and still accounts for sizeable portion of the overall recreational use of the area

The increased economic activity and number of year-round residences have attracted new business, primarily service and retail sales, into the region. These, in turn have attracted people to live and work in the region. Improved highways have increased accessibility to and within the region for those seeking the recreational opportunities offered. The result is an increasing demand on the recreational resources, primarily the lakes in the region.

Recreation uses in the area are many and varied including fishing, recreational boating, canoeing, birding, nature walking, snowmobiling, all terrain vehicle riding, etc.

Minnesota's lakes are essential to the ecological, economic and cultural health and well being of the State of Minnesota. The more than 10,000 freshwater lakes that the State of Minnesota is known for provides essential benefits that must be wisely managed if they are to be sustained. Aside from their ecological importance, Minnesota's lakes are extremely important to the state's recreation and tourism industry, as well as to many local economies.

Tourism plays a critical role in Minnesota - providing jobs and income in many communities. The total economic impact of tourism is more than just the dollars a visitor spends in a community. Tourism contributes to sales, income, jobs, and tax revenues. Tourists spend money on a variety of things in a community – lodging, attractions, food and other services - creating a direct effect on the businesses and economy in the form of income that pays wages and taxes. The tourism businesses in turn are buyers of goods and services required to meet the needs of the visitors, and the direct tourism business receipts are then spent on investments or purchase of goods and services. This spending by tourism businesses as a result of increased tourist visits creates indirect effects by contributing to wages and employment in other local businesses that supply the goods and services to the tourism business.

Davidson-Peterson Associates was hired to conduct a "bottom up" analysis of traveler expenditures in Minnesota and their impact on the economy of the state during the period June 2005 through May 2006 (Davidson-Peterson 2006). The study was a joint project with Explore Minnesota Tourism, the University of Minnesota Tourism Center and the Minnesota Arrowhead, Minnesota Heartland and Southern Minnesota Tourism Associations and the Metro Tourism Committee.

The purpose of this study was to measure the economic benefits the residents and governments derive from the dollars spent by travelers in the state.

The study found that in total, travelers in Minnesota spent $11.786 billion in the state. More than half of the state's traveler expenditures were spent by travelers staying overnight in hotels/motels/B&Bs. Half of the state's traveler expenditures were spent in the Metro Region and more than a third of total traveler expenditures were spent in the summer season.

The $11.786 billion spent in Minnesota from June 2005 through May 2006 supported 286,000 full-time-equivalent jobs, $6.9 billion in resident income (wages, salaries and proprietary income), $1.5 billion in state government revenues and $0.5 billion in local government revenues.

Minnesota received 41 million person-visits during the period June 2005 through May 2006. Some 9.3 million person-visits were by travelers on day trips and the balance were made by travelers staying overnight in Minnesota (31.6 million). One third of all visits were by travelers staying in hotels/motels/B&Bs (33%) with nearly as many staying with friends and relatives (31%). Campgrounds (9%) and resorts (3%) accommodated the balance.

Some 1,119 hotels/motels/B&Bs with 64,919 rooms offered 23 million roomnights and sold 14.8 million during the period June 2005 through May 2006. As noted, travelers staying in these rooms made the largest contribution to the traveler expenditures in Minnesota.

A total of 899 resorts with 9,440 units made 2.26 million unitnights available and sold 1.27 million of them during the 12-month period.

A total of 725 campgrounds on both public and private lands have 32,496 sites, making those sites available for 6.48 million sitenights and sold 2.81 million.

Those numbers led to occupancy rates of 64% for hotels/motels, 56% for resorts and 43% for campgrounds.

According to managers' estimates, more than half of the guests who stayed in Minnesota properties were Minnesota residents – 54% in hotels; 68% in campgrounds and 76% in resorts.

Managers estimated that hotel/motel/B&B guests came on average in parties of two and stayed two nights; resort guests came in parties of four and stayed four nights, and campers came in parties of three and stayed three nights.

The controlled headwaters lakes of the Mississippi River are located in north central Minnesota. The drainage basins of these lakes are located principally in Aitkin, Beltrami, Cass, Crow Wing, Hubbard, and Itasca Counties. The following table displays total travel expenditures by county, its ranking among Minnesota's 87 counties, and its percentage of the total traveler expenditures statewide for the aforementioned counties.

Table 4.2.11.a Traveler Expenditures, June 2005 – May 2006

County	Total Expenditures	Rank	% of State
Crow Wing	314,604,714	6	2.67
Cass	314,512,248	7	2.67
Itasca	202,757,822	13	1.72
Beltrami	147,451,857	15	1.25
Hubbard	118,101,572	21	1.00
Aitkin	77,694,485	30	0.66

Source: Minnesota County Report: The Economic Impact of Expenditures By Travelers On Minnesota Counties and Regions June 2005 – May 2006

The Direct Economic Impacts of Expenditures by travelers are those economic benefits due directly to the traveler expenditures. For example, when traveler expenditures pay the salary and benefits for a hotel desk clerk, that amount would be considered in the direct impact for both jobs and wages. The following table displays the Direct Economic Impacts of Expenditures by travelers for the six counties.

Table 4.2.11.b. Direct Economic Impact of Expenditures by Travelers by County, June 2005 – May 2006

County	Traveler Expenditures $	Full-Time Equivalent Jobs	Resident Income $	State Revenue	Local Revenue $
Aitkin	77,694,485	1,410	21,380,948	6,532,907	2,110,982
Beltrami	147,451,857	2,532	40,217,161	12,399,582	3,837,504
Cass	314,512,248	5,397	85,782,508	26,448,096	8,185,332
Crow Wing	314,604,714	5,399	85,807,729	26,455,872	8,187,738
Hubbard	118,101,572	2,026	32,211,938	9,931,447	3,073,649
Itasca	202,745,822	3,682	55,794,144	17,047,802	5,508,655

Source: Minnesota County Report: The Economic Impact of Expenditures By Travelers On Minnesota Counties and Regions June 2005 – May 2006

The Total Economic Impacts of Expenditures by travelers include all of the direct impacts but also include the estimated indirect impacts. For example, the front desk clerk pays income tax and property tax which are an indirect result of tourist expenditures. The front desk clerk also pays her utility bills, buys food for her family, shops for gifts, etc. Those dollars create the indirect impact of the initial traveler expenditures through many additional rounds of spending in the economy. The following table displays the Total Economic Impacts of Expenditures by travelers.

Table 4.2.11.c. Total Economic Impact of Expenditures by Travelers by County, June 2005 – May 2006

County	Traveler Expenditures $	Full-Time Equivalent Jobs	Resident Income $	State Revenue	Local Revenue $
Aitkin	77,694,485	1,879	33,172,767	9,498,266	3,181,881
Beltrami	147,451,857	3,625	67,310,914	18,221,464	6,029,788
Cass	314,512,248	7,737	143,573,014	38,866,062	12,861,431
Crow Wing	314,604,714	7,738	143,615,220	38,877,489	12,865,213
Hubbard	118,101,572	2,904	53,912,681	14,594,482	4,829,558
Itasca	202,745,822	4,899	86,565,198	24,785,968	8,303,214

Source: Minnesota County Report: The Economic Impact of Expenditures By Travelers On Minnesota Counties and Regions June 2005 – May 2006

4.2.12 Tribal Interests in Socioeconomic Resources

The lakes and streams of the Mississippi Headwaters area, as well as the plants and animals associated with them hold great spiritual, economic, and subsistence value to Ojibwe people. Natural resources are a fundamental aspect of their cultural identity as American Indians. All waters and the species that utilize them are important to the members of the Tribe and cannot be individually ranked nor can uses be prioritized.

The plants and animals that inhabit the headwaters lakes and streams evolved in a system of fluctuating water levels. The Band and its members are concerned that the reservoir system and the maintenance of relatively high and stable water levels has been detrimental to many species and their habitats and has resulted in erosion and degraded water quality.

The Leech Lake Band of Ojibwe reports that of the approximately 860 plant species that have been located on reservation lands to date, over 500 are associated with the headwaters lakes or streams or inhabit areas that could be affected by water level manipulations. Similarly, of the approximately 350 vertebrate species found on the reservation, close to two thirds are associated with the headwaters lakes or streams or inhabit areas that could be affected by water levels.

The Mille Lacs and Leech Lake Bands have expressed several concerns regarding the impacts of reservoir management on native species and their habitats. The composition of aquatic vegetation communities has been negatively affected by high and stable water levels. Open sand beaches are being lost without naturally occurring fluctuations in water levels and wave action, this in turn adversely impacts species dependent on these areas. Increased accumulations of silt as a result of lake shore erosion and lowered stream velocities is contributing to the loss of spawning beds and aquatic vegetation required by some species. Increased displacement and mortality is occurring among aquatic mammals and invertebrates due to the lack of water level fluctuations.

One of the resources important to Native Americans for cultural, economic, and subsistence reasons is wild rice. Wild rice is an annual plant that benefits from periodic disturbance. The stable conditions arising from existing reservoir management are more beneficial to perennial plants such as water lilies. The perennial plants tend to grow faster in the spring, out-competing annuals such as wild rice. Additionally, increased turbidity resulting from lake shore erosion reduces the penetration of sunlight to the substrate, adversely impacting germination of annual plant seeds and the growth of young plants.

Although the Leech Lake Band of Ojibwe feel that it would be best to totally restore the natural water levels and flow to the headwaters streams, they recognize that due to the extent of alteration and current use patterns, such a change is unlikely. Additionally, they recognize that the reservoirs serve to slow the spread of non-native species to reservation lands. However, the Band favors adjustment to fluctuations and flow timing in order to restore at least part of the values that existed prior to the construction of the reservoir system.

4.3 CULTURAL RESOURCES

Cultural resources in the Headwaters region are a major component of our cultural heritage and are integral, nonrenewable elements of the physical landscape. Cultural resources include archaeological resources (e.g., sites, artifacts, plant and animal remains, habitation, cooking and storage signatures and other cultural phenomena), historic resources (e.g., fur posts, town sites, logging camps), historic structures (e.g., buildings, shipwrecks, dams, transportation features) as well as Traditional Cultural Properties and other historic properties (e.g., districts). The archaeological sites and many of the historic sites located in the region constitute an irreplaceable legacy that warrants preservation. The construction of dams at Winnibigoshish, Leech, Pokegama, Sandy and Gull Lakes, and along the Pine River (Whitefish Lake) during the late 19th and early 20th centuries and their continued operation and maintenance has negatively impacted numerous cultural resources (Carroll 1990; Gibbon and Leistman 1984; Johnson et. al 1977; Johnson and Schaaf 1978; Johnson 1979; LLBO 2005).

Shaped in the retreat of the last Ice Age through a complex sequence of climate, geomorphic, and vegetation changes during the Late Pleistocene and throughout the Holocene, the Headwaters region is marked by countless lakes, ponds, bogs and streams that feed into three major North American watersheds and give rise to the “Mighty Mississippi” River, the nation’s most important natural highway (Anfinson 2003; Bryson and Hare 1974; Webb et. al 1983; Wright 1971, 1972). Humans presumably arrived in the region shortly after the glacial ice retreated, approximately 12,000 years before present (Benchley et. al 1997; Fagan 1991; Johnson 1969). Archaeological and historic research of the ensuing cultural manifestations yields important knowledge for understanding past environments, human adaptations and social developments through time. Because of the region’s geographic position, reciprocal influences occurred between groups inhabiting the Headwaters region and the prairie-plains region to the west, the boreal forests to the north, the eastern woodlands and southern reaches of the

Mississippi River. With the arrival of Europeans into the area, profound effects occurred to the groups living in the region, as well as to the environment (Carroll 1990; Gibbon 2003; LLBO 2005; White 1991).

There has been very little systematic cultural resources work in the Headwaters, with the exception of work completed by the Chippewa National Forest and the Leech Lake Band of Ojibwe that centers on the Cass Lake, Leech Lake and Lake Winnibigoshish areas (Koenen 2001). Most of the ROPE study area outside of the National Forest boundary has not been systematically surveyed and large portions of the Corps' Headwaters Project as defined by flowage easement and fee-title lands has not been surveyed.

A variety of amateur antiquarians and professional archaeologists have examined a variety of material remains in the Headwaters region since the middle of the 19th century (Brower 1898; Winchell 1911). Some of these projects included delving into burial mounds, collecting artifacts from eroding shorelines, and mapping portages, village sites and earthworks. Many of these early investigations noted shoreline erosion throughout the region. More rigorous field investigations by the University of Minnesota commenced during the 1960s, concentrating on several sites around the reservoir lakes (Cooper and Johnson 1964; Johnson 1969). In the late 1970s the St. Paul District, Corps of Engineers (Corps) conducted a series of relatively comprehensive reservoir shoreline surveys at all six reservoirs (Gibbon and Leistman 1984; Johnson et. al. 1977; Johnson 1979). The surveys were successful in locating a considerable number of sites and providing recommendations for future work. Most of the recommendations concerned the evaluation of eroding archaeological sites that were identified during surveys. In very few instances has there been any follow-up on the recommendations from those surveys (Birk 1993; Johnson and Schaaf 1978; Mooers and Dobbs 1993).

In 2000, Leech Lake Heritage Sites Program and Chippewa National Forest completed a systematic assessment of damage to twenty-six archeological sites located on the shorelines of Cass, Winnibigoshish, and Leech Lakes (Kluth and Kluth 2000). The assessment was done as a result of concern over damage from unusually high water levels. All of the sites selected had prior documentation of damage from erosion, ice shove or other action, and most were recorded during the 1977 and 1979 reservoir surveys (Johnson 1977, Johnson and Schaaf 1979). Of the twenty-six sites, seventeen were reported to be actively eroding in 2000. Three sites were described as in “Poor” condition, with damage or deterioration affecting more than 25% of the property. Eleven sites were in “Fair” condition showing some signs of deterioration but generally stable. The remaining twelve sites were in “Good” condition with the majority of the property appearing intact and stable. However, the authors noted that in some cases, there was no indication that the archeological context still existed, only that erosion had stabilized. On at least eight sites, it was noted that a previously documented eroding beach or other feature had been totally removed or had been significantly altered.

Within a .25-mile buffer zone extending from current reservoir and river shorelines a total of 1,184 cultural resources have been recorded (PEC 2004; SHPO Files 2008). These historic properties include a variety of precontact and historic sites that range from ca. 12,000 year old projectile points to standing structures from the early 20th Century. Nearly all of these sites are located in part along current shorelines. Of these, 97 archaeological sites have been either listed on or determined eligible for listing on the National Register of Historic Places (NRHP).

Dams that cause fluctuation of water levels are particularly destructive to archeological sites located in shallow shoreline areas. Increased wave action causes erosion of archeological materials, ultimately damaging the archeological context of the site, and reducing or destroying the site's research potential. Movement of ice, sometimes called ice shove (Pomerleau, n.d.), can also uncover, remove, and redeposit archeological remains. At boat accesses and other intensive use areas, physical disturbance of the site by humans can be severe. Sites may also be affected by erosion that makes normally buried artifacts and features more visible to people who may remove or alter them.

The ROPE area has been occupied for at least the last 9,000 years by various densities of people. Their main impacts on the landscape were fire-related, with periodic intentionally-set burning. Aboriginal people used waterways as travel corridors, and riparian areas provided both terrestrial and aquatic subsistence resources. The greatest number of archeological remains are commonly found in current or relict shoreline areas. The larger populations of the last several centuries prior to the arrival of Europeans created greater impacts within the ecosystems than previous occupations. Through treaty and federal legislation most of the ancestral lands of the Ojibwe people were ceded and opened to logging, farming and permanent settlement by Euroamericans in the late 19^{th} century. This era of increased use, settlement, and fire suppression forever changed the character of the area in a number of ways, such as growth of fewer white pine, decline in fire dependent pine forests, increase in hardwoods, balsam fir, and shrubs. The practice of damming waterways to provide flow for floating logs during the early pine logging, also altered both terrestrial and aquatic habitats within the watersheds.

Investigations of cultural resources for this project follow the implementing regulations of Section 106 (36 CFR 800) of the National Historic Preservation Act (PL 89-665; 16USC470) as amended 1992, to fulfill National Environmental Policy Act requirements. Information concerning the location and nature of cultural resource sites is protected from public disclosure by the National Historic Preservation Act and the Archeological Resources Protection Act (PL 96-95), and is exempt from information requests under the Freedom of Information Act.

The St. Paul District Corps of Engineers has been and is consulting with the Minnesota State Historic Preservation Office, the U. S. Forest Service, Chippewa National Forest, the Mille Lacs Band of Ojibwe Tribal Historic Preservation Office, the Leech Lake Band of Ojibwe Tribal Historic Preservation Office, and the U.S.D.I. National Park Service, Mississippi National River and Recreation Area, regarding historic properties affected by reservoir operations. Once the proposed plan for reservoir operations under ROPE is selected, continued consultation between the Corps and these parties will result in a Memorandum of Agreement or Programmatic Agreement as to what actions the Corps will take to comply with Sections 106 and 110 of the National Historic Preservation Act. The agreement will cover the identification, evaluation, treatment and monitoring of historic properties and burial sites located in the reservoir operations area of potential effect. The agreement will be finalized and included in the final EIS.

4.3.1 <u>Tribal Interests in Cultural Resources</u>

The greatest density of culturally important archeological sites in the Headwaters area is normally found along the shorelines of lakes, rivers, and streams. These sites are located both above and below the current water level. The Tribe's primary goal with regard to these resources is to ensure that the cultural heritage of the Ojibwe be preserved as an integral part of community life, providing orientation to its people, their language, music, stories, and traditions. The preservation of these cultural sites is considered a vital legacy to be maintained for future generations. Damage to these shoreline resources has already been incurred as a result of artificially imposed water levels. There is concern about the potential effects that changes in reservoir management may have on these important sites.

4.4 NATURAL RESOURCES

4.4.1 Tribal Interests in Natural Resources

Natural resources in the Headwaters have been and continue to be vitally important to the well-being of the Americans Indians that live there. Natural resources hold spiritual, economic, and subsistence value to Tribal members and, therefore, are tied to every aspect of Tribal life.

The importance of natural resources to Tribal members was recognized early in the planning process for this study. To help better understand the significance and importance of these resources, the Leech Lake and Mille Lacs Bands of Ojibwe were contracted to provide a report describing their interests in natural resources and to prioritize them for purposes of developing operating plan alternatives. Information from the resulting reports was used in the discussion in this section and some passages from the report from the Leech Lake Band are quoted as well.

An important point made by the Bands was that specific natural resources in the Headwaters could not be prioritized by importance or use because "all waters and the species that use them are important" because they are all interconnected and bonded together. Indeed, all the organisms in an ecosystem are linked together through food webs and their interaction with the shared physical environment in such a way that an impact to one species will affect others. This position by the Bands emphasizes the importance of natural resources to their culture by not singling out a group of resources that hold more value and implying that those not listed do not.

The Bands also listed many aspects in which the dams have altered the physical environment through the flooding of thousands of acres of land and the hydrologic alternation caused by continued operation. Specific types of impacts listed include erosion, loss of fish spawning and foraging habitat, loss of wild rice beds, loss of aquatic vegetation, loss of open beach habitat, and the loss of wildlife due to winter drawdown. These effects are discussed in more detail throughout the EIS and the acres flooded after dam construction are shown in Table 4.1. It is important to note that the natural resource concerns of the Bands are the same basic concerns held by others interested in the ecological health of the system including the Corps and the Forest Service.

While the Bands have stated that the natural resources of the Headwaters cannot be prioritized, it is evident through communication with them that they have a special interest in wild rice. Wild rice has special cultural and environmental significance to the Ojibwe in the Headwaters. From an environmental perspective, it is an important habitat component and is often viewed as an indicator species. The following is an excerpt from the Leech Lake Band's report referenced above:

> Throughout the headwaters region there have been declines in the quantity and productivity of wild rice beds. Wild rice is an important cultural resource to Native Americans as well as an important food for wildlife, particularly waterfowl. Wild rice is an annual plant (grows from seed each year) so it is best adapted to conditions that include periodic disturbance, which results in old plant material being recycled back into the substrate. This can occur when water levels are low and wave action can penetrate deeper into the water, or as a result of ice action. In a stable situation most annual plants will be out-competed over time by perennial plants such as water lilies that store food materials in their roots and are able to grow much faster in the spring. Silt from erosion increases the turbidity in the water, which in turn reduces the ability of sunlight to penetrate to the substrate and stimulate germination of annual plant seeds or growth of young plants. Restoring some fluctuation to the water level should alleviate these problems.

The Bands support a modification of the operating plan that would result in hydrology more similar to that which would have been present prior to the construction of the dams. Such an operating plan would benefit natural resources in the Headwaters because these species evolved their life histories around an unregulated hydrologic regime. The following passages from the Leech Lake Band's report help describe their perspective on some negative aspects of the current operating plan and some ways in which it could be improved:

> Although it is felt that it would be best to totally restore the natural water levels and flows to the headwaters streams, it is recognized and has always been understood that due to the extent of alteration and current use patterns this is unlikely to happen. It is also understood that dams will slow the spread of some non-native invasive species into reservation lands. Even faced with these realities it is argued that fluctuations and flow timing can be adjusted to restore at least part of the values these conditions formerly provided for the numerous resources living in the headwaters reservoirs.
>
> Some examples of how this could be accomplished are outlined below:
>
> Establishing high flows in the spring would simulate snowmelt and provide good conditions for fish movement, spawning, and channel scouring. Currently spring flows out of the headwaters dams are kept very low in an effort to reduce downstream flooding. On a rotational basis flows could be increased out of one reservoir while holding water in another; this would result in no overall downstream effect.
>
> Similarly, in some years the water levels should be lower or higher to more closely mimic what would naturally occur. In a year when Lake Winnibigoshish water levels are lower, for example, the change could be offset by maintaining Cass, Leech, and some of the other downstream impoundments at a more normal elevation or even at a high level for that year. (Begin to operate seasonally to benefit and maintain established resources.)

It is realized that to some degree reservoir levels are dependent upon the amount of precipitation received, and that the suggested changes in dam operation would perhaps not work every year, but even so, it would be an improvement over current operation procedures.

4.4.2 Geology and Soils

The upper portion of the study area lies in a region of geologically young, gray, glacial drifts from the Keewatin Center, which, in the Grand Rapids, Minnesota, area, become a thin veneer over a rugged moraine of Patrician or young red drift. Sandy, Pine River, and Gull Lakes lie in the red drift region. The gray drift is generally more clayey and less stony than the red drift. The drifts vary in thickness from 300 to 400 feet at the head of the Mississippi River to about 200 feet near Gull Lake.

Cass County contains three of the Corps dams (Winnibigoshish, Leech, and Gull) and comprises 1,998 square miles of gently rolling upland surface and numerous lakes. This topography is the result of deposition of glacial drift during the Wisconsin Age. Three general types of deposition are found in Cass County. In the north, along the south shore of Lake Winnibigoshish, is a sandy outwash plain. South of this outwash, near Leech Lake, is a substantial zone of glacial till plain. The southwestern portion of the county, from Leech Lake to northern Gull Lake, is part of the St. Croix moraine system.

At least 16 distinct types of soil are recorded in Cass County. The outwash of the northern part of the county has developed a very light-colored, loamy sand with low inherent agricultural fertility. The soils in the remainder of the county are mixtures of sand, clay, and loam of fair to good fertility. Organic peat soils occur in numerous low-lying areas throughout the county. These soils have good fertility potential but present problems in physical structure and water holding capability.

Aitkin County, in which Sandy Lake is located, is predominantly glacial till plain with a large outwash area immediately to the northeast characterized by surface deposits of sand and gravel. The soil of the glacial till plain area is brownish and slightly acidic, with pebbles and boulders of granite and gneiss.

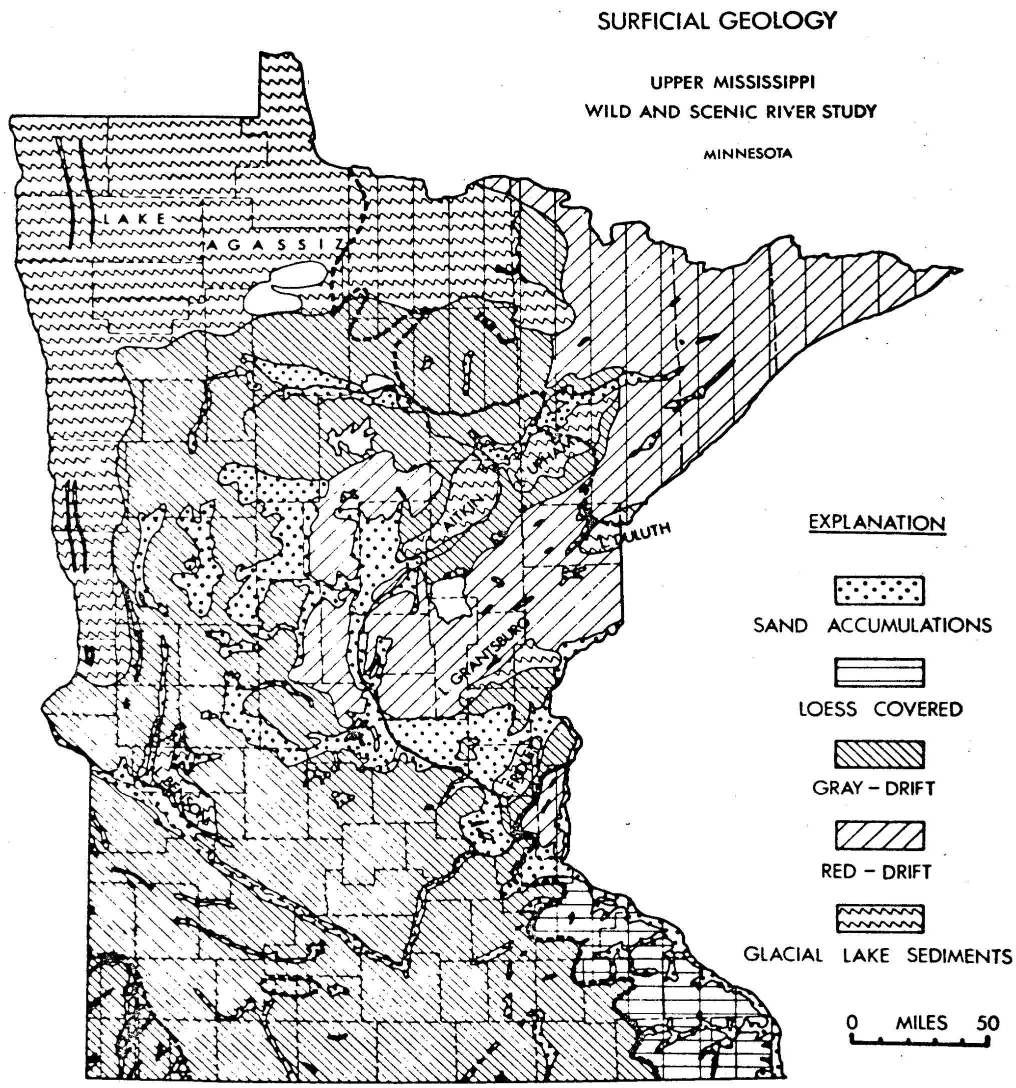
Crow Wing County, in which the Whitefish Lake chain is located, consists primarily of glacial outwash, with considerable moraine along the eastern border and till plain along the southern margin. Pine River Lake is located on outwash soils dominated by sand and clay with fair to poor fertility.

Itasca County, in which Pokegama Lake is located, is characterized by surface features resulting from the Wisconsin glaciation over 10,000 years ago. The soils are diverse. Loamy sands characterize the east central and west central portions of the county. Silty lake sediments occur in several townships. Erosion-prone sand and peat deposits of low fertility occur in the southeastern part of the county, and a belt of reddish clay loam extends from the southwest to the northeast.

Veins of gravel and sand are located throughout the Headwaters region, especially in the gray drift areas. These veins permit free interchange of water between the Headwaters lakes and the underground water table. Sand and gravel deposits are found extensively in Cass, Crow Wing, and Itasca Counties as well as in and around Minneapolis and St. Paul, Minnesota, at the southern extreme of the study area. Figure 1 shows the surface geology of Minnesota.

The Mississippi River basin contains two iron ore ranges, the Mesabi and Cuyuna. In Itasca County, the Mesabi Iron Range extends northeast to southwest across the prairie and the Mississippi River, passing through and terminating several miles southwest of Grand Rapids. The Cuyuna Iron Range runs parallel to the Mississippi River and then crosses it near the center part of the eastern border of Crow Wing County. Iron ore reserves in the Mesabi Range contain four major types: natural ore, nonmagnetic taconite, magnetic taconite, and semitaconite. The Cuyuna range has large reserves of nonmagnetic, low-grade ores.

Figure 4.4.2. Surface Geology of Minnesota



SOURCE: Minnesota Geological Survey

16

4.4.3 <u>Climate</u>

The climate found in this region is considered the continental type that does not benefit from the moderating influences of the earth's oceans. Large annual temperature ranges characterize this type. Winters are most often long and cold. The warmer summer months are generally mild, but may contain periods of excessive heat and humidity.

Freezing temperatures usually prevail from mid-October to mid-April. The mean annual precipitation including melting snow is approximately 28 inches. Approximately 18 inches of this occurs during April through September. This is summarized by Table 4.4.3, which shows the average maximum and minimum temperatures, and the average rainfall for every month of the year for Bemidji, Brainerd, and Minneapolis. These can be considered the northernmost, the middle, and the most southern zones of the study area. The growing season, or that length of time between the last frost in the spring and the first frost of the fall, over the region varies from 118 to 148 days. Crops are thus limited to those that can mature and be harvested during this period.

Precipitation is influenced by moisture from the Gulf of Mexico that combines with weather systems that generally come from the west since the prevailing winds are northwesterly. Precipitation occurs as rain, freezing rain, hail, and snow. Violent weather events often occur, but these are of short duration and affect relatively small areas. These events include tornadoes, severe thunderstorms, and hailstorms.

Table 4.4.3. Climate data for Bemidji, Brainerd, and Minneapolis

Weather station **BEMIDJI, BELTRAMI CTY.** is at 47.45°N 94.86°W. Height about 1338 feet above sea level. Averaging records from 1961 to 1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Max. Temp °F	13.6	21	33.8	50.5	64.8	73.9	79.3	76.5	64.9	53.2	34.3	18.9	48.7
Min. Temp. °F	-8.8	-3.7	10.8	28	40.5	51.3	56.5	53.8	43.2	32.4	17.2	-0.7	26.8
Rain fall inches	0.6	0.5	0.9	1.8	2.6	3.9	3.4	3.5	2.5	1.8	0.9	0.7	23.1

Weather station **BRAINERD, CROW WING CTY.** is at 46.36°N 94.20°W. Height about 1177 feet above sea level. Averaging records from 1961 to 1990

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Max. Temp °F	18.1	25.2	37	53.2	67.3	76.1	81.1	78.3	67.6	56.3	38.1	23	51.8
Min. Temp. °F	-5.5	-0.3	13.5	29.8	41.5	50.7	56.3	52.9	43.2	33.3	19.2	2.5	28.2
Rain fall inches	0.8	0.7	1.3	2.1	2.9	3.8	4.4	4.3	2.3	2.1	1.4	0.7	26.8

Weather station **MINNEAPOLIS INTL AP, HENNEPIN CTY.** is at 44.88°N 93.21°W. Height about 833 feet above sea level. Averaging records from 1950 to 1995.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Max. Temp °F	20.8	26.6	39.2	56.5	69.3	78.8	83.8	80.6	70.7	58.6	41	25.5	54.1
Min. Temp. °F	2.8	9.3	22.8	36.1	47.5	57.6	63	60.3	50.2	38.7	25.3	10.2	35.2
Rain fall inches	0.8	0.9	1.8	2.3	3.2	4.1	3.8	3.7	2.7	1.9	1.4	1	27.6

4.4.4 Hydrology

The construction and operation of the Headwaters reservoirs has impacted natural resources in the study area in numerous ways. The inundation of thousands of acres of terrestrial habitat and the subsequent hydrologic alteration are most notable. Now, over one hundred years after the construction of the dams, the natural resources of the region appear to be in a relatively "healthy" state at first glance; however, a closer examination shows that humans have had an influence on the system. Change will continue in the future as the Headwaters ecosystem is modified through human influence.

Unfortunately, many of the changes to natural systems brought about by human influence are undesirable.

A synthesis paper (Poff et al. 1997) provides an excellent summary of the topic of natural flow of rivers. Several other studies are relevant to the ecology of the Headwaters lakes, including some that compare Rainy Lake and Namakan Reservoir, a natural lake and an impounded reservoir, both in Voyageurs National Park. The purpose of examining the literature on the effects of impoundment and river regulation is to summarize the benefits of operating a river system with impoundments in a way that more closely follows the natural flow pattern, or hydrograph.

Chinese and Egyptians began modifying the flows of rivers thousands of years ago to provide drinking water supply and agricultural irrigation water. In the age of industrial development more drastic changes were made for transportation, energy generation, industrial waste disposal and recreation among others.

Prior to human intervention, plants and animals lived where their habitat requirements were met by local conditions. Not all plants and animals would thrive at the same time as some might be better suited to wet years and others to dry but in the long term the different species populated their habitats, interacting with other species and their environment.

Different habitats support different groups of species. Headwater streams support a different community of life than do larger floodplain rivers. In the Headwaters study area, the lakes range from nutrient-poor acid bogs with few fish species to nutrient-rich flowage lakes with many fish species.

Animal species tolerate certain ranges of conditions beyond which they cannot survive. Walleyes, for example, are river and lake species that are adapted to flowing water. They can survive cold water in rivers during winter near 0 ºC. Bluegills in contrast, are adapted to living in lakes and need somewhat warmer water in winter.

Where conditions are less ideal, species will have broader tolerances that allow them to live under a wide range of conditions and there will be many individuals of fewer species. Some riverine species have adapted to living in impoundments.

Alterations of natural habitats and other human actions have led to the introduction, either accidentally or intentionally, of exotic species of plants or animals which thrive in the absence of the predators, competition and diseases in their new habitat, imposing stress or outcompeting native species.

Streamflow quantity and timing are critical components of water supply, water quality, and the ecological integrity of river systems. Indeed, streamflow, which is strongly correlated with many critical physical and chemical characteristics of rivers, such as water temperature, channel geomorphology (shape and depth), and habitat diversity can be considered a “master variable” that limits the distribution and abundance of riverine species and regulates the ecological integrity of flowing water systems (Poff et al. 1997).

The natural flow regime organizes and defines river ecosystems. In rivers, the physical structure of the environment and, thus, of the habitat, is defined largely by physical processes, especially the movement of water and sediment within the channel and between the channel and floodplain (Poff et al. 1997).

To understand the biodiversity, production, and sustainability of river ecosystems, it is necessary to appreciate the central role played by a varying physical environment. Over periods of years to decades, a single river can consistently provide ephemeral, seasonal, and persistent types of habitat that range from free-flowing, to standing, to no water. This diversity of in-channel and floodplain habitat types has promoted the evolution of species that exploit the habitat created and maintained by hydrologic variability. For many riverine species, completion of the lifecycle requires an array of different habitat types, whose availability over time is regulated by the flow regime. Indeed, adaptation to this environmental variation allows aquatic and floodplain species to persist in the face of seemingly harsh conditions, such as floods and droughts, that regularly destroy and re-create habitat elements (Poff et al. 1997).

Five critical components of the flow regime regulate ecological processes in river ecosystems: the magnitude, frequency, duration, timing, and rate of change of hydrologic conditions. These components can be used to characterize the entire range of flows and specific hydrologic phenomena, such as floods or low flows, which are critical to the integrity of river ecosystems. Furthermore, by defining flow regimes in these terms, the ecological consequences of particular human activities (e.g., the management of reservoir operations) that modify one or more components of the flow regime can be considered explicitly (Poff et al. 1997).

A myriad of environmental attributes are known to shape the habitat characteristics that control aquatic and riparian species distributions including flow depth and velocity, temperature, substrate size distributions, oxygen content, turbidity, soil moisture/saturation, and other physical and chemical conditions and biotic influences. Hydrological variation plays a major part in structuring biotic diversity within river ecosystems as it controls key habitat conditions within the river channel, the floodplain, and hyporheic (stream-influenced groundwater) zones (Richter et al, 1997).

Human alteration of flow regime changes the established pattern of natural hydrologic variation and disturbance, thereby altering habitat dynamics and creating new conditions to which the native biota maybe poorly adapted. The magnitude and frequency of high and low flows regulate numerous ecological processes. Naturally variable flows create and maintain the dynamics of in-channel and floodplain conditions and habitats that are essential to aquatic and riparian species (Poff et al. 1997).

The changes made to water bodies and flows have altered the habitat available to support plants and animals. In many cases, the changes would favor the more adaptable species at the expense of the ones with narrow tolerances. While this shift may not be seen as detrimental, it does involve a reduction in diversity of plants and animals and a decline of habitat quality. Diversity is a key component that provides for the health of an ecosystem through resilience. Continued existence of large natural diversity in biological communities is the best insurance against catastrophic consequences of unplanned ecosystem alterations (Patrick, 1988) and perpetuation of native aquatic habitat diversity and ecosystem integrity depends on maintaining or restoring some semblance of natural flow variability" (Richter et al, 1997).

4.4.5 Aquatic Habitat

Table 4.4.5.a. shows some important statistics for the aquatic habitat of the eight primary study lakes. In general, the aquatic habitat of the Headwaters is of good quality, but dam operation and increasing development has and will continue to contribute to a gradual decline in habitat quality.

Given the inherently unstable nature of the glacially derived soils surrounding the reservoirs, increases in lake levels caused by the dams has resulted in significant shoreline erosion. This has in turn impacted the quality of near shore aquatic habitat on the reservoirs; including covering of spawning beds with fine sediment and reducing the quality and distribution of shoreline vegetation. Reservoir operation has also resulted in an unnatural flow pattern in downstream river channels. The flow pattern has been changed in the following ways;

- winter flows which would normally be low are increased in order to draw down lake levels
- spring flows, which are normally high are decreased to control flooding
- springtime floods are minimized and often eliminated
- low flows are lower at times than they would be
- lake levels are held steady throughout the summer.

These changes in flow patterns result in impacts to shoreline, aquatic habitat by affecting the ability of emergent plant species to germinate, inducing erosion on river banks during the winter, deceasing nutrient delivery to wetlands, decreasing spawning habitat suitability, increasing the potential for oxygen depletion in the rivers, and other numerous factors related to the general disruption of life history requirements for many species of aquatic animals.

Table 4.4.5.a. Characteristics of primary study lakes.

Lake Name	*Area (acres)*	*Littoral Area (acres)*	*Maximum Depth (ft)*
Bemidji	6,420	1,862	76
Cass	15,596	3,119	120
Winnibigoshish	58,544	18,904	70
Leech	111,527	57,994	150
Pokegama	6,612	1,978	112
Big Sandy	6,526	3,067	84
Cross/Whitefish	7,370	2,713	138
Gull	9,418	2,825	80

The project area also contains many miles of riverine aquatic habitat. Table 4.4.5.b lists the primary study rivers and the length of river in the study area.

Table 4.4.5.b. Potentially affected rivers in the study area.

River	*River Miles*
Leech Lake River	24
Sandy River	1
Pine River	28
Gull River	19
Mississippi River from Bemidji to Brainerd	292
Mississippi River from Brainerd to Hastings	186

4.4.6 Wetland Habitat

The Upper Mississippi River basin above Lock and Dam 2 is about 21 percent wetland. The Upper Mississippi River is bordered by floodplain wetlands in much of the Headwaters region. Floodplain wetlands along the river have been greatly affected by reservoir regulation and river channelization. Elevated water levels in wetlands due to lake level elevation results in fundamental changes to wetland hydrology and subsequently wetland vegetation. Forested wetlands for example, which are regarded as highly important in northern MN, convert to shrub scrub and emergent wetland types following prolonged flooding. In the absence of regular flooding, floodplain wetlands (meadow types) convert to shrub scrub types. These changes in wetland hydrology and vegetation have many impacts to numerous species. However, these wetlands are still highly valuable. The area between Leech Lake, Lake Winnibigoshish, and Pokegama Lake is a large and relatively high-quality wetland area. Many of the reservoirs are also fringed with wetlands. Much of the shorelines of Leech Lake and Lake Winnibigoshish are undefined and merge into large wetland areas. Also, there is an extensive wetland area east of Leech Lake and Lake Winnibigoshish between the Mississippi and Leech Lake Rivers. These wetlands are influenced greatly by lake water levels and would be affected by changes in reservoir operation.

Wild rice is a key wetland plant species that can be found throughout the Headwaters. Wild rice is used by humans and a number of waterfowl species as a food source. Wild rice requires rather specific water level conditions to prosper. It is considered an important resource in most areas upstream of Little Falls and is particularly important at Big Sandy, Leech Lake, Lake Winnibigoshish, and numerous smaller lakes.

4.4.7 Terrestrial Habitat

Terrestrial or upland habitat of the drainage of the Headwaters is characterized as 4% developed, 28% forested, 20% cropland, and 17% pasture/hay. Forested areas contain tree species such as sugar maple and basswood in the southern and western areas, and white spruce, balsam fir, and paper birch in the northeastern areas. The composition of individual forests is largely dependent on soil, as pines prefer lighter soils whereas hardwood species prefer heavier soils. Cropland is typically planted to row crops such as corn, but small grains can also be found.

4.4.8 Water Quality

Minnesota's lakes are essential to the ecological, economic and cultural health and well being of the State of Minnesota. The more than 10,000 freshwater lakes that the State of Minnesota is known for provide essential benefits that must be wisely managed if they are to be sustained. Aside from their ecological importance, Minnesota's lakes are extremely important to the state's recreation and tourism industry, as well as to many local economies. According to the Minnesota Department of Natural Resources (MDNR hereafter): "High-quality water is essential for a healthy state economy" (1998). Clearly, Minnesota lakes are an extremely valuable resource, assets worthy of protection if their benefits are to continue.

The challenge to maintain and protect lake water quality will become increasingly difficult if population and development trends continue at the present rate. In the last 50 years, lakeshore development on Minnesota's lakes has increased dramatically (Minnesota Planning 1998) and during the 1990's---in much of the area where the Mississippi Headwaters Board has jurisdiction---"growth has exploded…as demand for lakefront property has increased" (MPCA 2000). Lakeshore property is in demand because of the amenities or benefits they provide its owners, such as water-based recreation possibilities, an aesthetic setting for a home, tranquility away from urban and commercial life, and perhaps the privilege or esteem of owning an increasingly scare and valuable resource.

While the overall quality of Minnesota Lakes may be good, lakeshore development has and continues to degrade lake quality. In a recent DNR study, it was found that "developed shorelines have two-thirds less aquatic vegetation than undeveloped shorelines" (MDNR 2001). From an ecological and water quality perspective, this finding is startling and is even more alarming when we consider that about two-thirds of Minnesota's lakeshore is privately owned and not all of it is developed---yet.

Lakeshore development---in combination with other land-use activities and surface-water recreation---increases sediment, nutrient and other pollutant inputs. These inputs lead to unnatural eutrophication and reduce water quality. Other undesirable effects include the loss of native plants and animals, loss of littoral habitat and increases in invasive species, including exotics. The manifestation of reduced water quality results a reduction of a lake's aesthetic values. Decreased recreation benefits, and a lowering of the price of properties around the lake (Boyle, Lawson, Michael, Bouchard 1998).

Public policy and the activities of lakeshore property owners directly affect water quality. Protecting water quality through prudent policy and precautionary treatment of lakeshore property is more effective and less expensive than restoration of a degraded ecosystem.

(From "Lakeshore Property Values and Water Quality: Evidence from Property Sales in the Mississippi Headwaters Region." Submitted to the Legislative Commission on Minnesota Resources by the Mississippi Headwaters Board and Bemidji State University (May 14, 2003))

All of the Mississippi Headwaters dams affect water levels in numerous adjoining lakes whose water surface elevations are within the operating range of reservoir operations. It follows that, to whatever extent lake water quality may be related to dam operations, many of these lakes could be similarly affected. Presently, there are no data or site-specific studies in the region that can support general or specific conclusions relative to how the current operating plans are affecting water quality. The mechanisms by which water quality changes could be influenced by reservoir operation include:

- Higher or lower summer pool affecting the size and placement of littoral and riparian communities. Changes in lake nutrition (inflow and cycling of nutrients) and localized dissolved oxygen conditions could happen but would likely be minor.
- Changing the vertical operating range or changing the mode of the annual operating cycle could affect the size and placement of littoral and riparian communities and could modify the volume and seasonal timing of water movement into and out of riparian wetlands. Such water exchange could be a

- Shoreline erosion due to elevated lake levels can influence water quality by creating a source for sediment, mercury and phosphorus.

“Beneficial uses” are the uses that states decide to make of their water resources. The process for determining beneficial uses is prescribed in the federal rules implementing the Clean Water Act. Seven beneficial uses are defined in Minn. R. 7050.0200.

Drinking water – Class 1
Aquatic life and recreation – Class 2
Industrial use and cooling – Class 3
Agricultural use, irrigation – Class 4A
Agricultural use, livestock and wildlife watering – Class 4B
Aesthetics and navigation – Class 5
Other uses – Class 6
Limited Resource Value Waters – Class 7.

Ground water. Underground waters are protected for just one use, as an actual or potential source of drinking water. All ground water is designated as Class 1.

Surface water. All surface waters, lakes, rivers, streams and wetlands in Minnesota are either Class 2, protected for aquatic life and recreation, or Class 7, designated as Limited Resource Value Waters. In addition, all surface waters (i.e., both Class 2s and 7s) are protected for industrial use (Class 3), agricultural uses (Class 4A and 4B), aesthetics and navigation (Class 5), and other uses (Class 6). Thus, all surface waters are protected for multiple uses.

The vast majority of surface waters in Minnesota are Class 2, protected for aquatic life and recreation. Some Class 2 surface waters are also protected as drinking water sources and, in addition to the other uses, are designated Class 1 waters. All trout waters are protected for drinking (even though most are not used for this purpose), and some Class 2B waters are protected for drinking (designated as Class 2Bd waters). Examples of the latter include portions of the Mississippi River upstream of St. Anthony Falls, the Red River, and some mine-pit lakes.

The Clean Water Act requires States to publish, every 2 years, an updated list of streams and lakes that are not meeting their designated uses because of excess pollutants. The list, known as the 303(d) list, is based on violations of water quality standards and is organized by river basin. In Minnesota, the MPCA is tasked with compiling and updating this list.

4.4.9 <u>Contaminants</u>

Two toxic pollutants are of interest within the study area, mercury and PCB’s. The MPCA lists these as bioaccumulative toxics, which means they accumulate in organisms up the food chain. The MPCA has developed a map of the Headwaters basin (Figure 4.4.9.a) that shows impaired water bodies and the contaminant responsible for that listing. Most waters are listed as impaired for mercury and a few near the southern portion of the study area are listed for PCB's. Mercury is introduced to most aquatic habitats in the study area via atmospheric precipitation rather than through immediately adjacent industrial or geological sources. The occurrence of mercury in its toxic methyl-mercury form is generally associated with low dissolved oxygen and low Eh (redox potential) water in wetlands. PCB's have been used extensively in industry and were typically introduced into aquatic habitats via point sources. Therefore, aquatic habitats listed as impaired for PCB's in the study area typically are found in more industrial settings.

The MPCA has also developed a map of the Headwaters basin (Figure 4.4.9.b.) that shows waters impaired for aquatic life and/or aquatic restoration. The factor contributing to the impairment is also given for each impaired water. In the northern half of the study area, the typical factors listed for impairment are either turbidity or low dissolved oxygen. In the southern half of the study area, fecal coliform, biota, low dissolved oxygen, and turbidity are typical listed factors.

Changing the annual operating cycle could modify the volume and seasonal timing of water movement into and out of riparian wetlands. Such water exchange could be a significant factor in assessing potential methyl-mercury loading and bioaccumulation in fish. Scientific studies are needed to determine whether modifying the flow regime could improve fish habitat by eliminating stressful low dissolved oxygen conditions and reduce methyl-mercury loading.

Figure 4.4.9.a

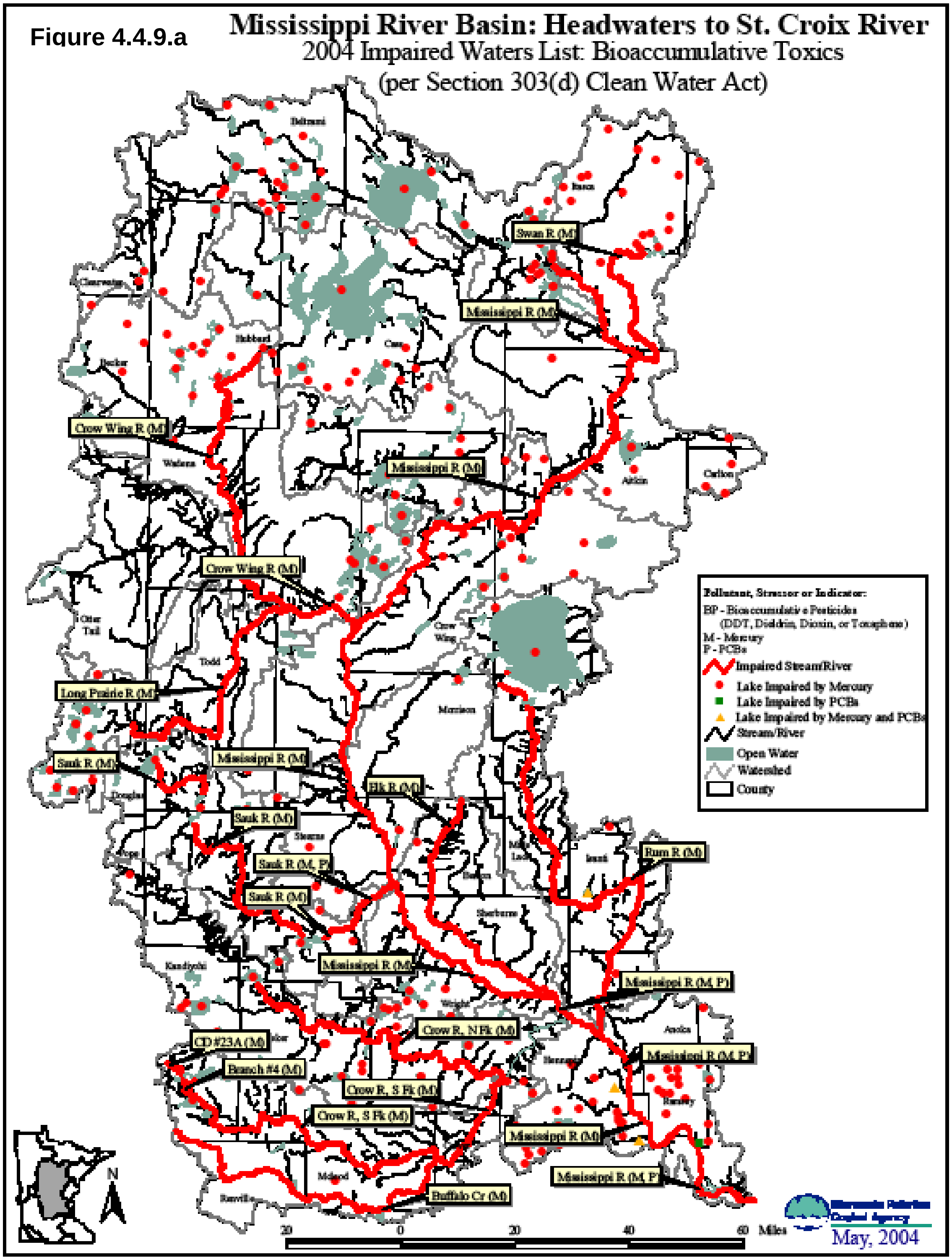
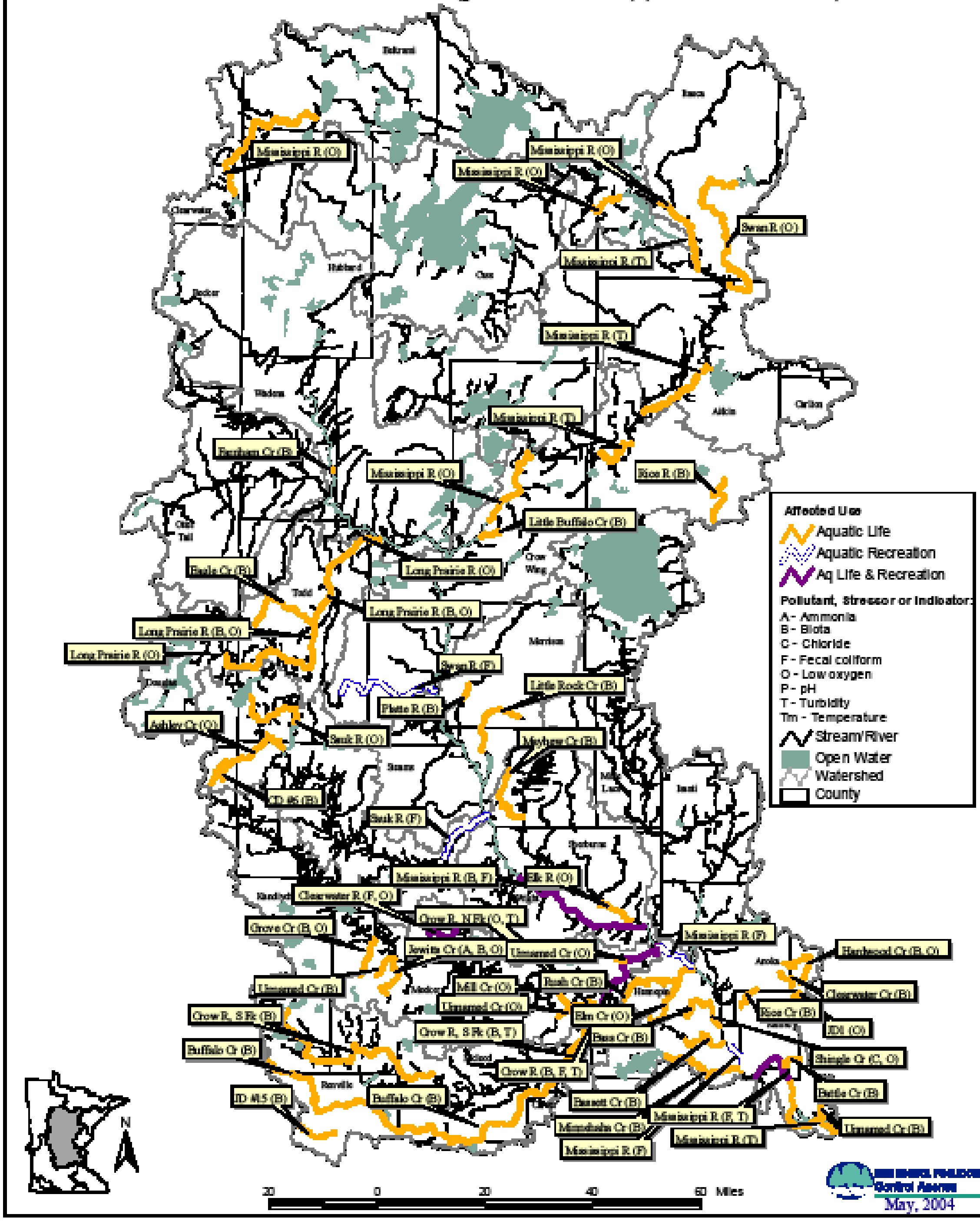

Mississippi River Basin: Headwaters to St. Croix River
2004 Impaired Waters List: Bioaccumulative Toxics
(per Section 303(d) Clean Water Act)
Swan R (M)
Mississippi R (M)
Crow Wing R (M)
Mississippi R (M)
Crow Wing R (M)
Long Prairie R (M)
Sauk R (M)
Mississippi R (M)
Elk R (M)
Sauk R (M)
Sauk R (M, P)
Sauk R (M)
Rum R (M)
Mississippi R (M)
Mississippi R (M, P)
CD #23A (M)
Crow R, N Fk (M)
Branch #4 (M)
Mississippi R (M, P)
Crow R, S Fk (M)
Crow R, S Fk (M)
Mississippi R (M)
Mississippi R (M, P)
Buffalo Cr (M)
Pollutant, Stressor or Indicator:
BP - Bioaccumulative Pesticides (DDT, Dieldrin, Dioxin, or Toxaphene)
M - Mercury
P - PCBs
Impaired Stream/River
Lake Impaired by Mercury
Lake Impaired by PCBs
Lake Impaired by Mercury and PCBs
Stream/River
Open Water
Watershed
County
N
20 0 20 40 60 Miles
May, 2004

Figure 4.4.9.b

Mississippi River Basin: Headwaters to St. Croix River
2004 Impaired Waters List: Conventional Parameters
(per Section 303(d) Clean Water Act)



4.4.10 Fish

The lakes and rivers of the Headwaters generally have healthy fisheries. Walleye, northern pike, muskellunge, yellow perch, largemouth bass, smallmouth bass, bluegill, and crappie are the most common species sought after by anglers. Walleye tend to be the most important game fish for most anglers. Some lakes are stocked with game fish species by the MDNR, but many are supported strictly by natural reproduction. In general, game fish populations are stable; however, increased fishing pressure has led to decreased individual fishing success. In some cases, this has led to the perception that the fishery is in decline. While in general fish populations are stable, the potential for future problems is increasing due to increasing human impacts.

Other common fish species that can be found in some or all areas of the Headwaters include rock bass, pumpkinseed sunfish, sauger, whitefish, tullibee (cicso), shorthead redhorse, bullheads, white sucker, burbot (eelpout), bowfin (dogfish), common carp, common shiner, and rainbow smelt.

A number of fish species are less common in the Headwaters and some are listed as species of special concern by the MDNR. The lake sturgeon, least darter, and pugnose shiner are three species found in the study area that are listed as species of special concern by the MDNR. The American eel, longear sunfish, greater redhorse, and weed shiner are four species being considered for listing by the MDNR. Impacts to these and other non-game fish species have been considered during the ROPE study. No federally listed threatened or endangered fish species are known to occur in the Headwaters.

4.4.11 Aquatic Macroinvertebrates

Benthic macroinvertebrates are small animals that live in lakes and streams. They form an important link in the food chain as they provide food for fish while feeding on algae and microscopic animals as well as contributing to the breakdown of plant and animal debris. They primarily consist of insects that live part or all of their lives in the water such as dragon flies, mayflies, black flies, whirligig beetles and various bugs like backswimmers and water boatmen. Benthic macroinvertebrates also include small crustaceans such as scuds and crayfish, leeches and other worms, snails and clams (discussed elsewhere).

Most benthic macroinvertebrates are mobile and can adjust to changing water levels by relocating. During the winter some may be frozen if the lake bottom is exposed to freezing.

4.4.12 Mussels

Historically, as many as 39 mussel species including three federally listed species – Higgins eye mussel (*Lampsilis higginsii*), winged mapleleaf *(Quadrula fragosa),* and fat pocketbook *(Potamilus capax)* – and most state listed species in Minnesota have been found within the Headwaters basin. The mussel fauna below the Falls of St. Anthony was historically and presently is far more diverse than the fauna above the Falls, a result of the Falls itself, which historically served as a faunal barrier to the post-glacial upstream migration of mussels. Nineteen of the 39 species either occurred historically or are present below the Falls of St. Anthony and exclusive to Pools 1 and 2 including several Minnesota state listed species and the three federally endangered species. No populations of the three federally listed endangered species currently exist in the Mississippi River Headwaters study basin.

Presently, 21 live species occur in Pools 1 and 2. Individuals from seven of these 15 historical species occurring below the Falls have been relocated from lower Mississippi River pools during 2000-01 to areas in Pool 2, including 371 of the federally-listed endangered *L. higginsii*. The mussel fauna within Pools 1 and 2 is dominated (in descending order) by three-horned wartyback (*Obliquaria reflexa*), threeridge (*Amblema plicata*), deertoe (*Truncilla truncata*), and mapleleaf (*Quadrula quadrula*). At least five state listed species are present, including two listed as endangered in Minnesota, rock pocketbook (*Arcidens confragosus)* and wartyback (*Quadrula nodulata). Quadrula nodulata* ranked fourth in abundance in Pools 1 and 2, and nowhere in the Upper Midwest has the species been reported in such high numbers.

It appears that mussels are expanding their range above St. Anthony Falls, now easily circumnavigated by mussels' obligatory host fish through the navigation locks. The Mississippi River St. Anthony Falls Pool (St. Anthony Falls to the Coon Rapids Dam) harbors 17 live species including 11 species previously not reported. Apparently, these species have arrived as larvae attached to fish that have used navigation locks to travel around the Falls of St. Anthony. The community is dominated by deertoe with three other species also abundant: mapleleaf, plain pocketbook (*L. cardium*), and pink heelsplitter (*Potamilus alatus*). Two Minnesota state listed species also occur: black sandshell (*Ligumia recta*) (special concern) and round pigtoe (*Pleurobema sintoxia*) (threatened).

It appears at present that the Coon Rapids Dam serves as a faunal barrier to upstream dispersal from the lower Mississippi River, much as the Falls of St. Anthony has done historically. The entire Mississippi River proper above the Coon Rapids Dam harbors only 11 live species and, cumulatively, the Mississippi River tributaries above the Coon Rapids Dam harbor the same 11 species plus an additional one, threeridge (*Amblema plicata)*. In addition to being less species rich, mussel community composition and species' relative abundance vary as well, as compared to the lower river. Generally, in riverine portions of these upper reaches of the Mississippi River and its tributaries, communities tend to be dominated by fatmucket (*Lampsilis siliquoidea*) and plain pocketbook, whereas in lakes and reservoirs, giant floater (*Pyganodon grandis*), a species more adapted to softer substrate and lentic conditions, tends to be dominant. Not surprisingly, two species present in these upper reaches and not found in the Mississippi River proper below the Coon Rapids Dam, creek heelsplitter (*Lasmigona compressa*) and paper pondshell (*Anodontoides ferussacianus*), are more typical of headwaters and smaller streams. Creek heelsplitter is generally found throughout these upper reaches, and although found in the Mississippi River proper, they tend to be more common in the smaller tributary streams. Cylindrical papershell (*Anodontoides ferussacianus)* typically occurs in small order tributary streams and the extreme Headwaters of the Mississippi River. Two state listed species present are the black sandshell and creek heelsplitter. Black sandshell populations appear healthy in many areas of the riverine portions of the Mississippi River.

Most mussels are adapted to riverine habitat with a few minor exceptions. Mussels that have adapted to lentic habitats or do survive in reservoirs typically reside in shallow areas where oxygen is available and wave action maintains a more consolidated silt-free substrate. The construction and operation of the Headwater dams no doubt had an initial impact on mussels. As natural reservoirs were enlarged, relatively non-motile mussels would have been further inundated by water, effectively distributing them in deeper water and exposing them to anoxic conditions and flocculent-laden substrate. The dewatering and the altered flow regime affected mussels immediately downstream of dams by the operation of the dams. Dams have impeded fish host passage, possibly isolating mussel populations from their obligate host fish and/or limiting the potential for mussel dispersal.

Zebra mussels have invaded the Great Lakes and the Mississippi River basin and recently have been discovered in Lake Ossawinnamakee near Cross Lake, which is drained by Pelican Brook, a tributary of the Mississippi River near Pine River. This species colonizes native mussels and impedes their movement, reduces their ability to feed and eliminate wastes, and competes for food and space, which often results in significant native mussel mortality. Zebra mussels are a lentic species that thrive in the lower pools of the Upper Mississippi River, the St. Louis River estuary, and many other reservoirs and lakes in midwestern and eastern North America. During the larval stage, zebra mussels are free floating and subject to dispersal by currents. It remains speculative as to the origin of the recent invasion in Headwaters drainage, but they are easily transported by live wells, bait buckets, etc. They tend to not survive in great numbers in lotic conditions, so the maintenance of the Headwater reservoirs may provide ideal zebra mussel habitat.

4.4.13 Wildlife

Approximately 240 species of birds can be found in the Headwaters. It would be impractical to discuss even a large portion of those species here. Furthermore, the significance of the occurrence of bird species is variable depending on a number of factors. Some species migrate through the area and are present for only short periods of time, breeding and over-wintering north and south of the Headwaters, respectively. Other species are summer residents that use the region only for reproduction. Still others are yearly residents that use the region to carry out their entire life cycles. Likely even more important than these factors for purposes here is the type of habitat used by a species while in the region. A resident common crow, while present year-round, would not be affected by changes in aquatic environments. On the other hand, a migrating shorebird, present in the region for only a few weeks during migration, could not complete its migration and life cycle if high water inundated feeding and resting habitat.

Some groups of birds are more likely to be affected by water level management than others. Surface-feeding ducks such as mallards and wood ducks depend on emergent and submersed vegetation for food and cover. Bay ducks, such as lesser scaup, depend on submersed vegetation and invertebrates for food. Marsh birds, such as yellow rail, depend on emergent vegetation for shelter and the invertebrates living there for food. Shorebirds such as spotted sandpiper require bare open areas such as mud flats for feeding. The common tern nests on Leech Lake and is listed as a threatened species by the MDNR. The common loon is found throughout the northern portion of the study area and nests on the water's edge, thus making it vulnerable to water level changes.

Many species of mammals inhabit the Headwaters; however, only those that prefer wet lowland areas or those dependent on aquatic systems and would possibly be affected by the outcome of the ROPE study are discussed here. Other species would possibly be affected indirectly; however, drawing conclusions as to the relative magnitude of effects would be difficult or impossible for the scope of this study.

Lowland mammals, or those that can be found near or seem to prefer wet areas, found in the Headwaters include arctic shrew, pygmy shrew, southern bog lemming, meadow vole, red-backed vole, meadow jumping mouse, woodland jumping mouse, raccoon, least weasel, long-tailed weasel, and white-tailed deer. These mammals are not necessarily dependent on wetland habitats and would likely be indirectly affected by the ROPE study outcomes. There is no evidence that the populations of these lowland mammals are in decline with the exception of the least weasel, which is listed as a species of special concern by the MDNR.

Aquatic species found in the Headwaters include water shrew, star-nosed mole, beaver, muskrat, mink, otter, and moose. These mammal species, with the possible exception of the moose, require access to open water as a source of food and in some cases as a source of shelter. Water-level management can have a major impact on aquatic mammals by inundating or exposing their shelters at times of the year when the animals are vulnerable to the elements or predators. Also, water-level management can influence the vegetation, which is needed for food and shelter. There is no evidence that populations of these aquatic mammals are in decline.

4.4.14 Federally Listed Threatened and Endangered Species

Three species found in the Headwaters are or have been on the Federal threatened and endangered species list. The Canada lynx (*Lynx canadensis*) is currently listed as a threatened species and may be found in the far northern portion of the study area. They prefer dense forests and prey on snowshoe hares. Lynx populations cycle with snowshoe hare populations, and at times when snowshoe hare numbers are low, it is likely that there are no lynx in Minnesota.

The gray wolf (*Canis lupus*), previously listed as a threatened species, can be found throughout the northern half of the study area. The gray wolf was delisted in Minnesota on August 08, 2007. There are about 2,500 gray wolves in Minnesota. They prefer forested areas and prey on deer, moose, beavers, and small mammals.

The bald eagle (*Haliaeetus leucocephalus*) was previously listed as threatened and is found throughout the project area. The bald eagle was delisted in March 12, 2007 but they are still protected. They feed primarily on fish and, therefore, are usually found near water. Eagle numbers have been steadily increasing since a ban on DDT was enacted in 1974.

4.4.15 Biological Productivity

Biological productivity is the quantity of living organisms supported by an ecosystem. High biological productivity is good in cases where desirable species are in abundance, but is not in cases where undesirable species replace desirable ones. In general, biological productivity in the study area is good. However, numbers of the common game fish and bird species are lower than desired in some areas. To help alleviate this, some species of fish such as walleye and musky are stocked in an effort to increase their numbers. Also, projects to improve waterfowl habitat are often implemented. In conjunction with methods to increase numbers, game regulations are set to limit harvest. This helps ensure that harvest does not exceed production.

However, biological productivity is too high in some lakes where excessive nutrient inputs result in algal blooms. Many lakes in the study area are oligotrophic (see water quality section below), and low biological productivity is desirable. An increase in primary production causes shifts in a lake's aquatic ecosystem that often result in increases in undesirable species and decreases in water clarity. Decreases in submersed vegetation can also result. Water level management may provide a means to alleviate some of the symptoms of excessive nutrient inputs, but solving the problem requires a broader watershed-scale approach.

4.4.16 Biological Diversity

Biological diversity is the variety of living organisms, their habitats, and the processes occurring there. In general, biodiversity is declining in freshwater environments all over the world. The numerous aquatic species on the threatened and endangered species list in the United States is evidence of this. Some of the known causes are pollution, sedimentation, nutrient runoff, and the introduction of exotic species. Another known cause is an unnatural hydrologic cycle. This factor is directly related to potential outcomes of the ROPE study.

While it is not possible to know the magnitude to which biological diversity in the Headwaters has decreased since European settlement, it is likely that there has been a decline. It is possible to argue that biological diversity in the Headwaters could have increased in certain habitats since European settlement. However, it is unknown as to whether or not this has been shown in the Headwaters. Also, in instances where this has been found, often the increase in biological diversity can be attributed to the expansion of higher numbers of more tolerant, less desirable species into a habitat that had been dominated by fewer and often more desirable but less tolerant species. A common example of this is a former high-quality trout stream that after watershed impacts became warmer and more turbid, and consequently supported a more diverse warm-water fish community. At the stream-reach or even the watershed scale, this example would have a higher biological diversity. However, at a larger scale, the likely cumulative effect would be lower diversity due to a loss in sensitive cold-water species that were not replaced by new species but simply forced out by existing warm-water ones.

In the Headwaters, changes in the hydrologic cycle subsequent to the construction and operation of the reservoir dams likely contributed to a decline in biological diversity.

Since the late 1930's, the operation of the Headwaters has been marked by increasingly stable water levels and a shift in the timing of events. Changes in the timing of peak spring reservoir levels and river flows upset fish spawning, bird nesting, and furbearer reproduction activities. Also, by holding water back in the spring, the river does not receive the high flows necessary for cleansing silt from the river bottom, which reduces habitat quality for benthic invertebrates. Furthermore, the winter drawdown, which lowers reservoir levels and raises river flows, can negatively affect whitefish spawning and winter habitat for aquatic mammals, turtles, frogs, and a variety of other lake and riverine organisms. These types of changes favor more adaptable species and can eliminate those that have more specific requirements.

Just as important as these effects, possibly more so, are changes in the vegetative community. Eliminating the larger periodic hydrologic events would have had a major influence on the aquatic vegetation. Under natural conditions, high water levels would have set back woody vegetation. High water levels would also have increased the extent of emergent vegetation, which is important to waterfowl, aquatic mammals, marsh birds, and some fish species. Low water levels, such as those that would occur during a drought, would increase the area over which emergent and submersed vegetation would grow, thereby increasing the amount of habitat available to fish and other aquatic species. Furthermore, natural variability in water levels would allow a wider variety of plant species to establish, and consequently animal species as well, thereby improving biological diversity.

CHAPTER 5. PLAN FORMULATION

5.1 FORMULATION OF ALTERNATIVE PLANS

Alternative plans are combinations of alternative measures, also called components, that would contribute to attaining the planning objectives. In addition to the no action plan, the combination plans that were considered are shown in the tables in Section 5.5.

Alternatives were formulated and reformulated throughout the study that would result in various levels of effect to all the resources of interest in the study area. Alternatives that would have significant effects to any resources were given very careful consideration and were often reformulated to reduce impacts. The alternatives evaluated in detail here represent a full range of possible plans that would be possible.

Public input regarding these alternatives was used continually during the plan formulation process. Alternative components that would lead to significant controversy were carefully considered prior to inclusion in any alternative.

5.1.1 SHARED VISION PLANNING

Shared Vision Planning is a technique that combines the best of traditional water resources analyses, effective public involvement techniques, and the use of easy to understand computer models to formulate and evaluate new ways of managing water. Shared Vision Planning is also a philosophy that supports the ROPE Study goal of getting all partners involved in the process to develop a plan that is most beneficial to all stakeholders. Therefore, the principles of Shared Vision Planning were employed early on in the study.

5.1.2 ROPE MODELS

Four modeling tools have been used during the course of the study: the Prescriptive Reservoir Model (PRM); the Structural Thinking Experimental Learning Laboratory with Animation (STELLA) model; the Decision Model; and the Daily Flow Model. All of these models have been used as planning tools to help inform alternatives development, analysis, and selection. PRM is an optimization model used to inform plan development and STELLA is a simulation model used for plan refinement and analysis. STELLA is the transparent Shared Vision Planning tool. Using an optimization and a simulation model alternately, each informing and updating the other, was intended to help participants better understand the system and the interaction between objectives, and allow them to develop a plan of operation that balances those objectives as effectively as possible. Due to the complexity of the system though, it was determined that another tool was needed to summarize the vast amount of information produced by the STELLA model; for that purpose, the Decision Model was developed. Finally, a daily flow model was developed to augment STELLA Model output due to the limitation that the STELLA model developed for this study operates at a two-week time step.

5.1.2.1 Optimization Model (PRM)

Prescriptive Reservoir Model or PRM is a reservoir-system modeling tool that uses optimization to determine system operations that maximize the stated goals of the system, subject to system constraints. Those stated goals are defined by the sometimes numerous objectives of the water system. The model distributes water (or operates the reservoirs) optimally by representing the system as a minimum cost flow network, and minimizing penalties that articulate the system goals and objectives. Optimization provides the ability to evaluate and quantify trade-offs between conflicting system objectives, and suggests new and perhaps not-yet-considered operating schemes for the reservoir system. A Period-of-Record analysis with PRM produces a series of optimal reservoir releases and storage levels over a historical period, from which efficient operating rules can be inferred. The "answer" provided by optimization is a time series of reservoir levels and releases. This is valuable information, but it is the "answer" only for the historic inflow dataset. To apply it in real life, operating rules are inferred from the results that produce similar levels and flows for the historic inflow data that can also be applied in practical circumstances with new inflows. A simulation model (in this case STELLA) is used to demonstrate and refine those operating rules.

5.1.2.2 Simulation Model (STELLA)

Structural Thinking Experimental Learning Laboratory with Animation or STELLA is a flexible generic systems analysis tool that can be configured to represent diverse systems ranging from river basins to high-speed data networks. Because STELLA is not specifically designed for river basin planning, the user is responsible for configuring generic objects in ways that capture the characteristic logic of the elements of the river system such as reservoirs, inflows, outflows, flood control operation, etc. The STELLA simulation model was customized for the river system under study. As a Shared Vision Planning tool, STELLA has been used successfully to model river systems and to build trust and a common "vision" across multiple stakeholder groups about how the reservoir/river system operates and the limits and possibilities of the system.

For the ROPE, physical characteristics of the study area are represented as nodes and river reaches as connecting pathways between nodes. Operating rules are assigned at each reservoir in the system and it is “operated” to move water through the system. This water is represented by actual reservoir inflows that occurred over the period of record from 1930 through 2002. Therefore, the STELLA model simulates what reservoir elevations and river flows may have been during the period of record under different operating plans.

5.1.2.3 Daily Mass-Balance Flood Model

This model is a tool that was used to help further aid in determining the potential effects the proposed plan. The STELLA model is a planning tool that operates at an averaged bi-monthly (nearly two-week) time interval, whereas, the Daily Mass-Balance Flood Model is a real-time daily model. Peak flood elevations which are short-duration occurrences are obscured when averaged over a two-week period. The Daily Mass-Balance Flood Model is used to more accurately simulate peaks during flood events, so they can be compared for different operating plans. This model also allows the simulation of daily decisions at each of the upstream reservoirs as would actually occur during a flood event. In application, the user (or the regulator) is given what happened the previous day and the current days predicted inflows (as would be available from weather forecasts and upstream water levels). From this information the user can make a decision as to what operations need to be performed at each of the reservoirs. The results from those operations are then used for the next day's decision. This is repeated throughout the flood. This model is also useful for assisting in predicting the effects of drought on the reservoirs under the proposed plan. In particular, the minimum release modifications in the proposed plan were formulated based on results from this model. Some example outputs from the daily mass-balance model are provided in Appendix E.

5.1.2.4 Decision Model

The Decision Model is simply a series of spreadsheets used to summarize reservoir water level elevations and river flows from the STELLA model for numerous locations throughout the study area. Decision Model outputs range from hydrographs showing water levels for a given period of time, to outputs representing hydropower electricity production.

5.2 IDENTIFICATION AND SCREENING OF ALTERNATIVE MEASURES

The ROPE study PDT and stakeholders identified alternative measures to improve various components of the existing operating plan to meet various planning objectives. The alternative measures were individually examined and screened to determine if they would be retained for further consideration. Screening criteria included the degree to which the alternative measures would contribute to attaining the planning objectives, environmental effects, compatibility with other measures, and institutional and public acceptance.

5.3 ALTERNATIVE MEASURES/PLAN COMPONENTS

Operating plan components are defined here as the basic operating procedures (such as summer reservoir elevations, or flood control operations) that are combined and coordinated to describe a complete operating plan. Because of the inherent complexity in operating plans, descriptions of basic operating plan components and their alternatives are provided here to further understanding. Some of the components will not be changed from the existing plan and are so noted. Some of them will only have two variations, including the existing one found in the current plan. The development of each alternative component, if applicable, is discussed as well. The combinations and specific values of these components will be clearly defined for each complete alternative operating plan. The terms reservoir "operation" and "regulation" are used interchangeably to refer to the procedures used to manage reservoir water elevations and discharges. All the elevations used in this document refer to the 1929 National Geodesic Vertical Datum (NGVD) which is currently in use at the Headwaters reservoirs.

5.3.1 Present/Total Operating Limits

These limits represent the absolute upper and lower limits within which the Corps is allowed to operate the reservoirs. The Total Operating Limits originated from regulations issued by the Secretary of War between 1931 and 1944. The upper limits at Pokegama, Sandy, and Cross Lake were modified in later years. The upper limits at Pokegama and Sandy were raised in the 1950's following the adoption of the spring and summer Aitkin Flood Control Guide curves to permit more storage for downstream flood control. Cross Lake's upper limit was raised in 2001 following the completion of the dam safety rehabilitation which raised the dam 4 feet. The lower limits represent the maximum winter drawdown levels, which can be used if the snowpack indicates that a drawdown to the normal “ordinary” levels will not be adequate.

The Present/Total Operating limits are not being revised as a part of the ROPE because a need to do so was not identified during the scoping process and the proposed changes to the operating plan fit within the existing limits. Any changes in these limits require Congressional approval.

5.3.2 Ordinary Operating Limits

In general, the Ordinary Operating Limits range from the normal winter drawdown level to the elevation above which erosion begins to accelerate in a particular reservoir. They are meant to be a range of elevations residents might expect to experience in an “ordinary” annual cycle. In actual practice, the lower elevations are reached in most years as part of the winter drawdown, however; depending on the reservoir, the upper limits are reached less frequently. The limits are a narrower range contained within the Present/Total Operating Limits.

These limits are not being revised as a part of the ROPE because a need to do so was not identified during the scoping process and the proposed changes to the operating plan fit within the existing limits.

5.3.3 Normal Summer Band and Target

The Summer Band represents the range of water levels that are the most beneficial to a majority of the users during the summer months. The summer bands resulted from an investigation of desirable summer water levels through public consultation in the late 1920’s or early 1930’s. Water elevations generally fluctuate within this band but the targeted elevation is normally the center of the band. The various summer target alternatives are presented in graphical form in Section 5.5. Summer operating band alternatives are described below.

5.3.3.1 Current Summer Bands

The current summer band elevations are shown in Table 5.5.1. The total widths (feet/inches) of the current bands are shown in table 5.3.3 below.

5.3.3.2 Wide Summer Bands

An alternative to the current summer bands was developed to provide greater flexibility in the operation of the reservoirs. Total band widths of 8 inches were developed and included in some of the operating plan alternatives for review. The operating target would fall in the center of the modified band.

5.3.3.3 Modified Summer Bands

A modified summer band width alternative was developed as a balance between wider operating bands and the current bands in order to impart as much consistency between reservoirs as possible in the proposed plan, while minimizing concerns for higher or lower water as a result of wider bands. The operating target would fall in the center of the modified band. This target is the desirable water level management goal for each reservoir. During periods when water levels may vary significantly from the desired target level (due to high or low inflow or authorized intentional water level deviation), reasonable efforts will be taken to bring the reservoir water elevation back to the target level, as soon as practicable and with due consideration for appropriate outflow ramping rates. These bands would be in effect from April 1st through September 30th. The modified bands are also shown in Table 5.3.3. Gull's modified operating band which is included in the proposed plan is narrower than those of the other reservoirs to help reduce the potential for high water impacts (a 2 inch rather than 3 inch upper band). The modified bands on Leech and Cass would be wider under the proposed plan to provide consistency with the other reservoirs. It is expected that these minor changes in band width would have a minimal impact on reservoir regulation.

Table 5.3.3. Summer Operating Bands (feet/inches)

Alternative Band	Cass	Winni	Leech	Pokegama	Sandy	Whitefish	Gull
Current	0.3/4	0.5/6	0.4/4.8	0.5/6	0.5/6	0.5/6	0.25/3
Wide	0.67/8	0.67/8	0.67/8	0.67/8	0.67/8	0.67/8	0.67/8
Modified	0.5/6	0.5/6	0.5/6	0.5/6	0.5/6	0.5/6	0.3/3.6

5.3.4 Minimum Releases

Minimum flows are normally set to protect aquatic habitat downstream of reservoirs from impacts caused by low or ceased flows. Therefore, minimum flows are reservoir releases that must be equaled or exceeded if possible. There are two minimum release components currently followed at the Corps' Headwaters reservoirs. The Federal Average Annual Flow/Minimum Flow and the Minnesota Department of Natural Resouces (MDNR) Low-Flow Guidelines are found in the existing operating plan and are outdated for a number of reasons. The Federal Average Annual Flow rarely impacts normal daily operation and it conflicts with the MDNR Guidelines. Since the MDNR Guidelines were adopted in the 1960s, observations of the affected downstream resources have indicated the guidelines may be too low for some dams (e.g. Leech). Sections below discuss proposed revisions.

5.3.4.1 Federal Average Annual Flow/Minimum Flow

This regulation stipulates that when the reservoirs are at or above the minimum Total Operating Limit, a specified minimum annual flow volume equivalent to an average annual discharge as listed in Table 5.5.1 must be released every year. This minimum volume is met most years during the spring runoff. However, when the reservoirs are below the minimum Total Operating Limit elevation, no discharge larger than the annual average value is allowed unless directed by the Chief of Engineers. This in effect stipulates a maximum average annual flow when reservoir levels are extremely low. It is important to note that under certain cases this regulation will conflict with the current Minnesota Department of Natural Resources low-flow guidelines. A consistent, single low-flow guideline is recommended in this report. If new minimum release rules are adopted, the Code of Federal Regulations will be revised to change the Federal Regulation. In the past, language in the Water Resources Development Act (WRDA) has been used to accomplish this.

5.3.4.2 Existing Minimum Release Guidelines

After taking measures to insure that the average annual Federal discharge/volume/minimum flow requirement can be satisfied, the Minnesota Department of Natural Resources (MDNR) guidelines are followed on the Corps' Reservoirs. The MDNR guidelines suggest minimum flow values if a reservoir is at or above the lower Federal elevation limits. These guidelines were developed in the 1960's for the protection of aquatic habitat. Furthermore, if a reservoir is below the lower limit, the minimum discharge is reduced by half. However, during an extreme dry period, over the span of many months or years, the MDNR guidelines could conflict with the Federal average annual discharge requirement. The Federal regulations are primary. A consistent, single low-flow guideline is recommended in this report.

The minimum release rule for Knutson Dam is one gate fully-open, which is about 100 cfs. This rule is in place as a safety precaution due to the swimming hazard to persons caused by a partially-opened gate. Table 5.3.4.2 show the existing low-flow guidelines. The division between normal and low conditions are defined by the reservoir elevations shown.

Table 5.3.4.2. Existing Low-Flow Guidelines

Condition	**Cass**	**Winni**	**Leech**	**Pokegama**	**Sandy**	**Whitefish**	**Gull**
Normal	**100 cfs**	≥1294.94 **100 cfs**	≥1292.70 **100 cfs**	≥1273.17 **200 cfs**	≥1214.31 **20 cfs**	≥1225.32 **30 cfs**	≥1192.75 **20 cfs**
Low	**100 cfs**	<1294.94 **50 cfs**	<1292.70 **50 cfs**	<1273.17 **Winni+Leech**	<1214.31 **10 cfs**	<1225.32 **15 cfs**	<1192.75 **10 cfs**

5.3.4.3 Revised Minimum Release Rules

These minimum release rules were developed through the ROPE and were based on a method developed by Tenant (1976). Details of the methods used can be found in the Minimum Release Review in Appendix G and actual values representing these rules can be found in Tables 5.3.4.3.a and 5.3.4.3.b below and in the E and T Plan details (Sections 5.5.3 and 5.5.4).

Table 5.3.4.3.a. Revised Summer Minimum Flow (cfs) Rules April 1st through Sept. 30th.

Reservoir Condition	*Reservoir Elevation*	Cass	Winni	Leech	Pokegama (lesser of)	Sandy	Whitefish	Gull
High	**>= Target**	170	210	160	Winni+Leech+110 or 480	100	100	50
Normal	**< Target to >= Target – 3"**	130	160	120	Winni+Leech+80 or 360	70	70	40
Low	**Target – 3" to >= Target – 18"**	80	110	80	Winni+Leech+50 or 240	50	50	20
Very Low	**< Target – 18"**	40	50	40	Winni+Leech+30 or 120	20	20	10

Table 5.3.4.3.b. Revised Winter Minimum Flow (cfs) Rules October 1st through March 31st

Reservoir Condition	*Reservoir Elevation*	Cass	Winni	Leech	Pokegama (lesser of)	Sandy	Whitefish	Gull
Normal	**>= Target – 6"**	80	110	80	Winni+Leech+50 or 240	50	50	20
Low	**< Target – 6"**	40	50	40	Winni+Leech+30 or 120	20	20	10

5.3.4.4 Proposed Minimum Release Rules

The Proposed Minimum Release Rules are the Revised Minimum Release Rules (above) with three basic modifications. These modifications include removing the high reservoir condition rules, referring the minimum releases to a band rather than a target for the summer months, and a reduction in the minimum release rules for selected reservoirs.

It was determined that the minimum release rules for "high" reservoir conditions would provide minimal benefits and would be removed to help improve simplicity. Benefits would be minimal because when the reservoirs are in this condition the receiving rivers are also normally experiencing higher flows. Furthermore, the spring pulse operating component (Section 5.3.10) would help provide much of the same intended benefit during springs with lower flow.

The minimum releases are related to operating bands under this component to help provide more consistent day-to-day operations. If they are tied to the targets, there would be frequent fluctuations in the minimum releases due to the fact that under normal conditions the reservoir water elevations would fluctuate above and below the target on a frequent basis.

These rules were further modified from those in Section 5.3.4.3 to reduce the required release for Pokegama, Sandy, and the Whitefish chain because it was determined that they would unacceptably impact water levels in dry years. An analysis was used that indicated that during years such as 1976, 1988, 2006, and 2007, the increased minimum on these reservoirs may lead to water levels dropping an additional 4 to 10 inches (depending on the reservoir and year) relative to the drop experienced under the existing plan. The increased minimum releases on the other reservoirs in these years may have further reduced water levels by just less than 2 inches, and in many cases, less than 1 inch. Under normal hydrologic conditions, the increased minimums presented in Section 5.3.4.3 had no measurable impact on water levels relative to the existing plan. This modification lowered the minimum releases for Cross (Whitefish chain) and Pokegama to 20% of their mean annual flow, while it lowered the minimum release for Sandy to below the 20% level and equal to Gull, as they are in the current plan. These releases are still higher than those in the existing plan, except during extreme low water conditions, and are expected to provide some environmental benefit over the existing guidelines while having a minor negative impact to recreational uses. The loss in environmental benefits over the plan in Section 5.3.4.3 is expected to be minimal, especially for Sandy and Pokegama. This is because the tailwater of Pokegama is raised and controlled to a great degree by the Blanding Dam, and because the Sandy River below Sandy dam is less than a mile long and fish would be able to move into the Mississippi River downstream during times of stress.

Tables 5.3.4.4.a and 5.3.4.4.b show the proposed minimum release rules which are included in the Proposed Plan.

It should be noted for Cass Lake that while this is the proposed plan, these minimum releases would not be implemented until structural modifications can be completed to rectify the current safety concern for swimmers with a partially open gate. Therefore, 100 cfs (one gate wide open) will remain in place as the minimum release rule for Knutson Dam for the foreseeable future.

Table 5.3.4.4.a. Proposed Summer Minimum Flow (cfs) Rules April 1st through Sept. 30th.

Reservoir Condition	*Reservoir Elevation*	Cass	Winni	Leech	Pokegama (lesser of)	Sandy	Whitefish	Gull
Normal	**Within summer band**	130	160	120	Winni+Leech+50 or 240	40	50	40
Low	**< band to >= band -15”**	80	110	80	Winni+Leech+10 or 200	20	30	20
Very Low	**< band - 15”**	40	50	40	120	10	20	10

Table 5.3.4.4.b. Proposed Winter Minimum Flow (cfs) Rules Oct.[st] through Mar. 31[st]

Condition	*Reservoir Elevation*	Cass	Winni	Leech	Pokegama (lesser of)	Sandy	Whitefish	Gull
Normal	**>= Target – 6”**	80	110	80	Winni+Leech+10 or 200	20	30	20
Low	**< Target – 6”**	40	50	40	120	10	20	10

5.3.5 <u>Congressional Notification Levels</u>

In 1988, Minnesota Governor Rudy Perpich asked the Corps of Engineers to make supplemental releases from the Headwaters reservoirs to meet downstream water use requirements. When rainfall returned to the region in early August 1988, the Corps denied the request. Congressman James Oberstar, however, determined that some Congressional oversight was needed related to the use of the water contained within the reservoirs for the benefit of upstream and downstream uses. As a result, the Congressman sponsored Section 21 of Public Law 100-676 (Water Resources Development Act of 1988). The law states that the Secretary of the Army must notify Congress 14 days in advance of any reservoir going outside the prescribed minimum and maximum operating limits. This law was later modified by Section 3175 of WRDA 2007. Specific information on the Congressional Notification Limits is listed later. These notification levels are not being changed as part of the ROPE because a need to do so was not identified during the scoping process.

5.3.6 <u>Operation for Flood Control</u>

Flood damage reduction is one of the main purposes for operating the Corps Headwaters reservoirs. Property along Corps reservoirs and the receiving rivers is protected from flood damages in a manner that attempts to minimize total damages for any given flood event. The system has been operated for flood damage reduction at many locations throughout the system. The city of Aitkin is the most flood-prone area affected by Headwaters reservoir operation, and as such, is the focal point for flood damage reduction during flooding events. Cass Lake and Lake Bemidji are not specifically operated for flood damage reduction. The basic flood operating procedures for the six Corps reservoirs is described below. Sections 5.3.6.2 thru 5.3.6.4 discuss proposed revisions.

5.3.6.1 Current Flood Operating Rules

Winnibigoshish, Leech, Pokegama, and Sandy: Winnibigoshish, Leech, Pokegama, and Sandy reservoirs are regulated for flood control at Aitkin, Minnesota. Pokegama and Sandy are operated according to Spring and Summer Flood Control Guide Curves for Aitkin (see Figures 5.3.6.1.a and 5.3.6.1.b). However, this flood control operation is accomplished with the assistance of Winnibigoshish and Leech (where the largest amount of storage resides), which are both upstream of Pokegama. The guide curves were developed in the 1950s from an analysis of 14 flood events at Aitkin when the river exceeded a 17-foot stage. The curves relate the maximum reservoir elevations and the corresponding peak flood stage at Aitkin which will result in, on average, the minimum total flood damages to the affected interests.

The curves take effect at Aitkin stages of 14 feet in the spring (Figure 5.3.6.1.a) and 12 feet in the summer (Figure 5.3.6.1.b) and extend to 19 feet (referenced to the USGS gage). These stages are near the respective levels where damages begin to occur at Aitkin, approximately 14 feet in the spring (structural damage) and about 13 feet in the summer (agricultural damage).

The summer guide curve differs from the spring guide curve due to the agricultural damages that occur during a summer event within the agricultural growing season. Thus the summer curve begins at a lower stage at Aitkin.

Most of the summer flood events at Aitkin are due to local area rainfall that falls below Pokegama Dam. The typical travel time for outflows from Pokegama to Aitkin is approximately 3 days. The runoff from high intensity, short duration local area rainfall events can reach Aitkin in less than 3 days. As a result, utilizing Winnibigoshish, Leech and Pokegama to aid in flood control at Aitkin is less effective than in the spring. However, for longer duration rainfall events where the outflow from Pokegama is a significant portion of the total flow at Aitkin prior to the event, cutting the outflows at the upstream reservoirs can provide some relief to Aitkin.

Winnibigoshish and Leech also store water to assist Pokegama in accomplishing its final winter drawdown.

Since the guide curves were adopted in the 1950s, experience has indicated that it is difficult to operate Big Sandy Dam for flood control at Aitkin while maintaining Sandy reservoir levels in compliance with the guide curve. Sections 5.3.6.3 and 5.3.6.4 discuss proposed revisions.

Cross Lake/Pine, Flood Control: The January 2003 Cross Lake/Pine Water Control Plan states: "Pine River Dam is operated, if necessary, for flood control to prevent damages on the Mississippi River from Fort Ripley to the Twin Cities and other areas downstream." Flood control operation for Cross Lake/Pine will not change as a result of the ROPE because a need to do so was not identified during the scoping process.

Gull, Flood Control: The January 2003 Cross Lake/Pine Water Control Plan states: "if conditions warrant, inflow can be stored for downstream protection up to the Upper Operating Limit (1194.75 ft.)." Flood control operation will not change at Gull Lake as a result of the ROPE because a need to do so was not identified during the scoping process.

Figure 5.3.6.1.a Current Spring Guide Curve

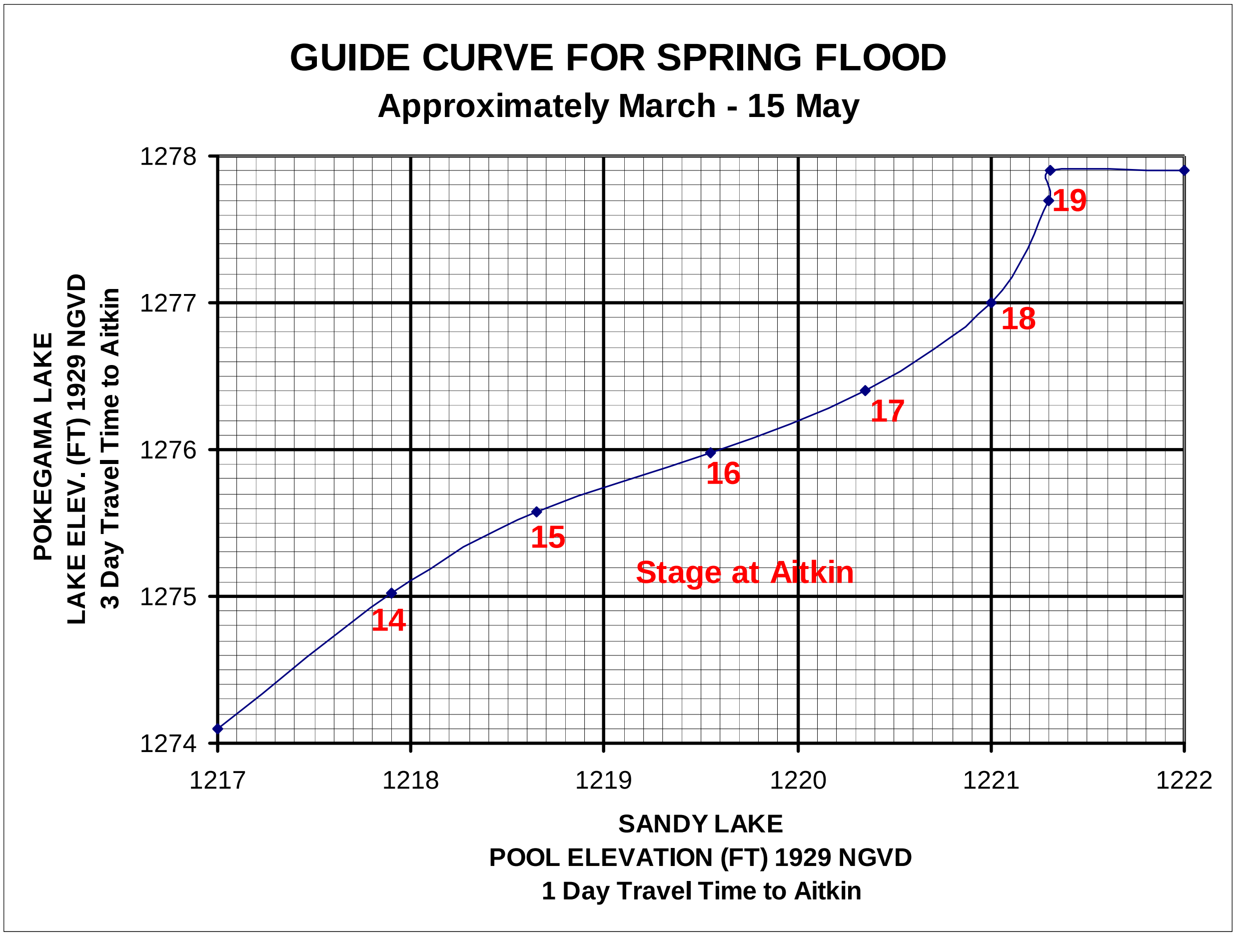
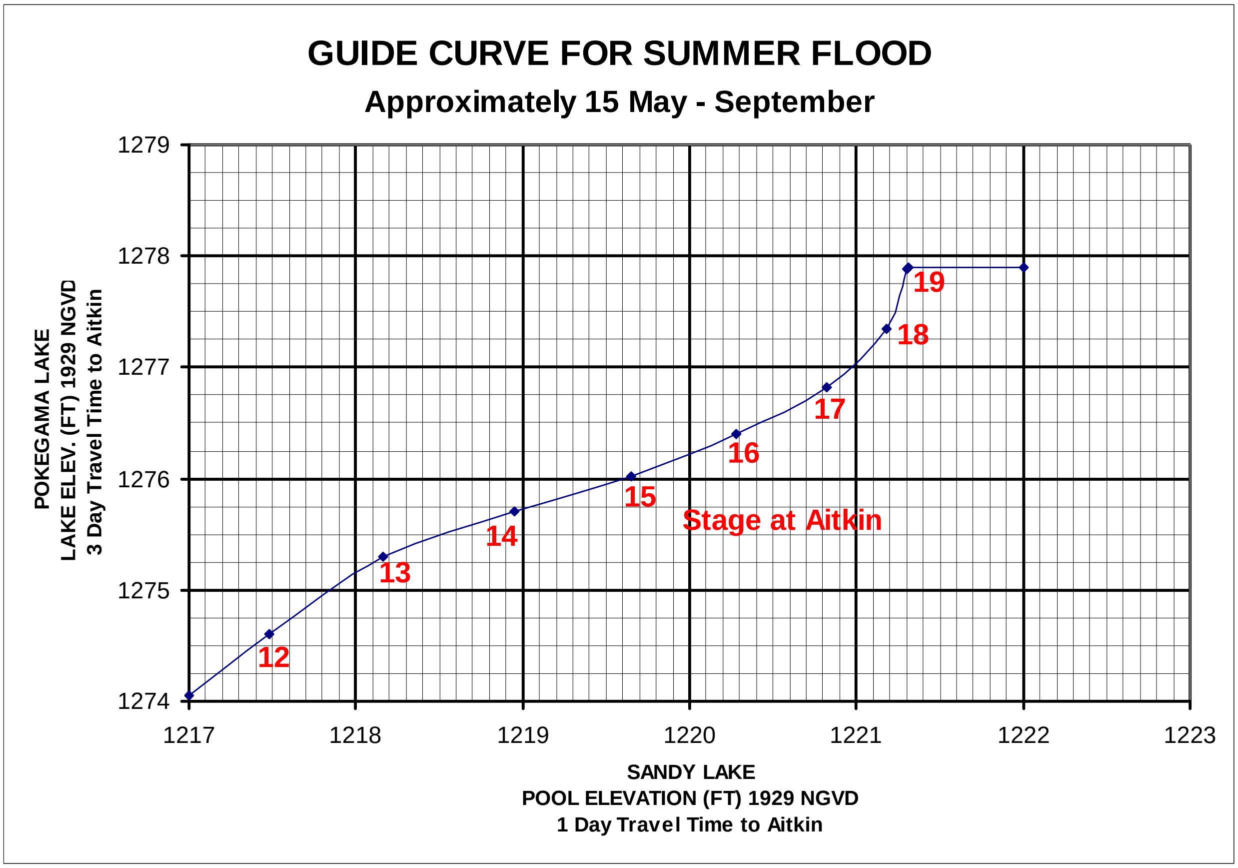


Figure 5.3.6.1.b Current Summer Guide Curve



5.3.6.2 Updated Structure Damage Guide Curves

Winnibigoshish, Leech, Pokegama, and Sandy Reservoirs are operated as a system in order to provide flood control for Aitkin (see Section 5.3.6.1). Updated Elevation-Damage (structural damage) relationships were developed for Winnibigoshish, Leech, Pokegama, and Sandy Lakes, as well as rural and urban Aitkin. These structure damage relationships were used to develop two guide curves (see Figures 5.3.6.2.a and 5.3.6.2.b) based on points of equal damage. These guide curves balance the structural damages at the 5 locations by providing water surface elevations of equal damage. As long as each of the locations is at the elevations specified at any given point on the curve, the structural damages experienced at those locations are the same. In practice, maintaining water levels at an exact balance along the curve is not possible and damages being experienced at a given location may be slightly higher or lower than the idealized relationship portrayed by the curves. These guide curves would allow the regulator of the system to monitor each location's current levels and associated damages.

This analysis was limited to structural damages (primarily residences) because it was determined that this would be the most equitable way to compare potential damages across the system. The analysis that was completed in the 1950's included agricultural damages. While agricultural damages are important, damages to business and other forms of private property around the reservoirs are also important and should be included as well. However, data is not available for these other categories of impacts, and therefore, a complete equable analysis could not be completed including them.

Guide Curve 1 relates the points of equal damages on Pokegama Lake to Lake Winnibigoshish and Leech Lake. For example, when Pokegama Lake is at 1276.8 feet, Leech Lake's corresponding elevation of equal damage is 1296.8 and Lake Winnibigoshish's is 1301.9 feet.

Guide Curve 2 relates the points of equal damages at Aitkin to Big Sandy Lake and Pokegama Lake. For example, when Aitkin is at 15.0 feet, Pokegama Lake's corresponding elevation of equal damage is 1277.1 and Big Sandy's is 1220.8 feet.

The two guide curves would be used together to operate the reservoirs to balance the damages at all 5 locations.

Following an evaluation of these curves, it was determined that they would not be included in any of the alternative operating plans (see Section 5.4.4).

Figure 5.3.6.2.a Updated Structure Damage Guide Curve

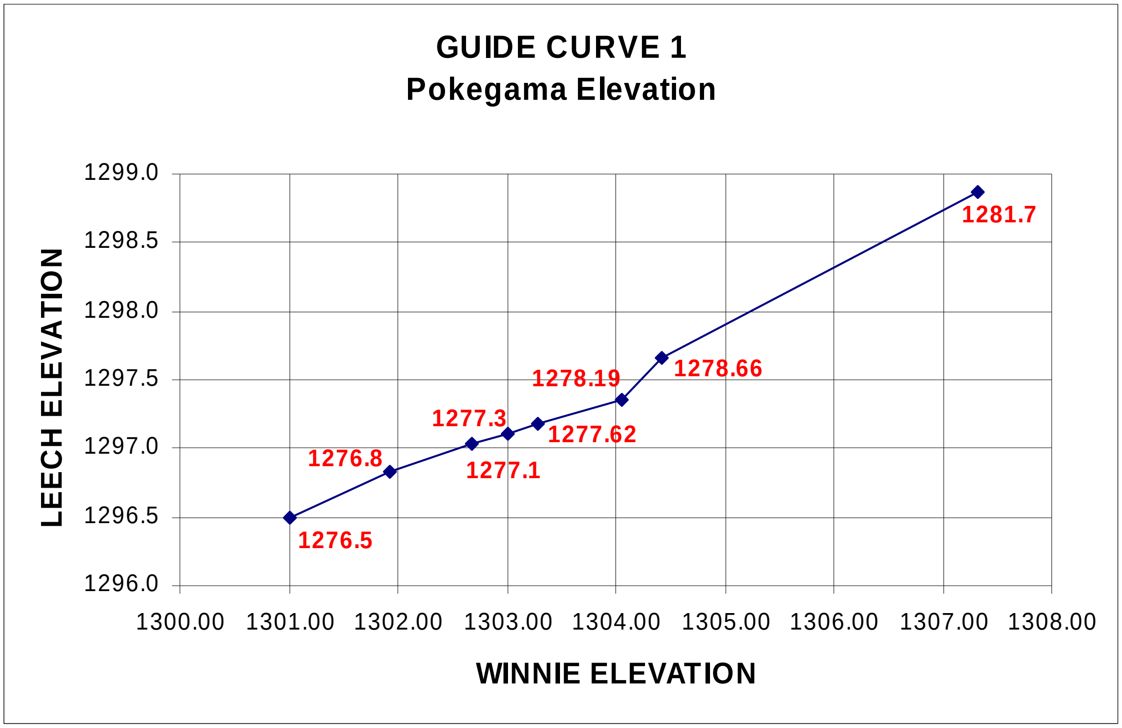
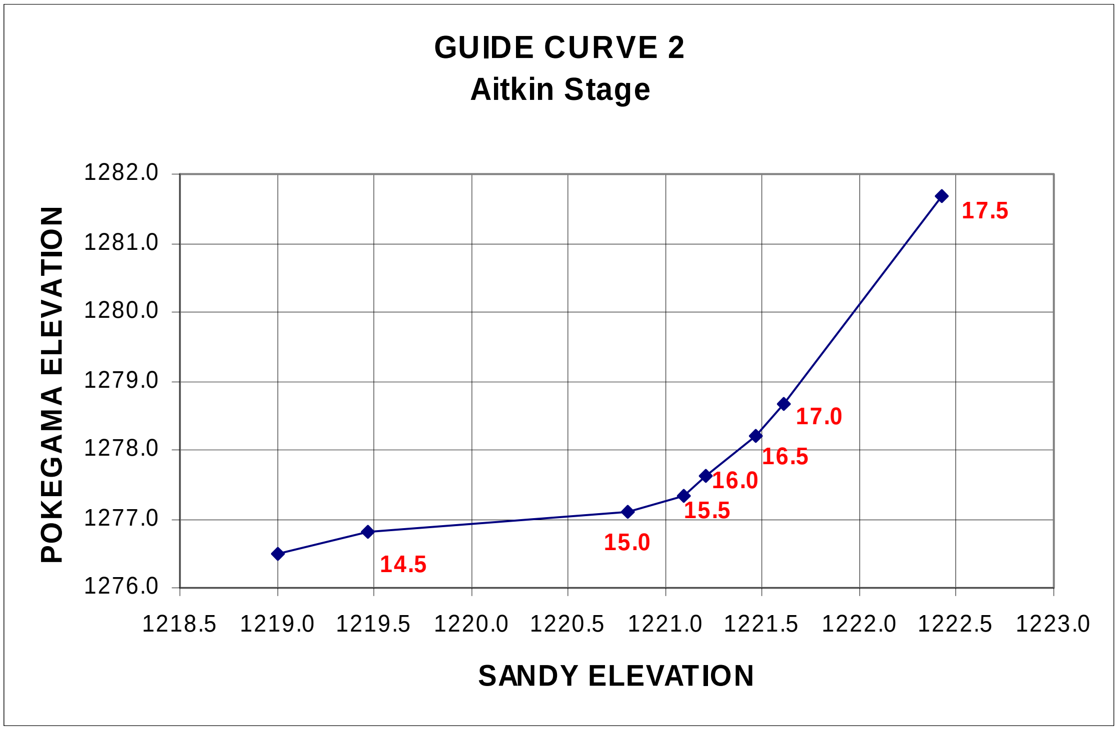


Figure 5.3.6.2.b Updated Structure Damage Guide Curve



5.3.6.3 Modified Guide Curves Without Big Sandy Lake

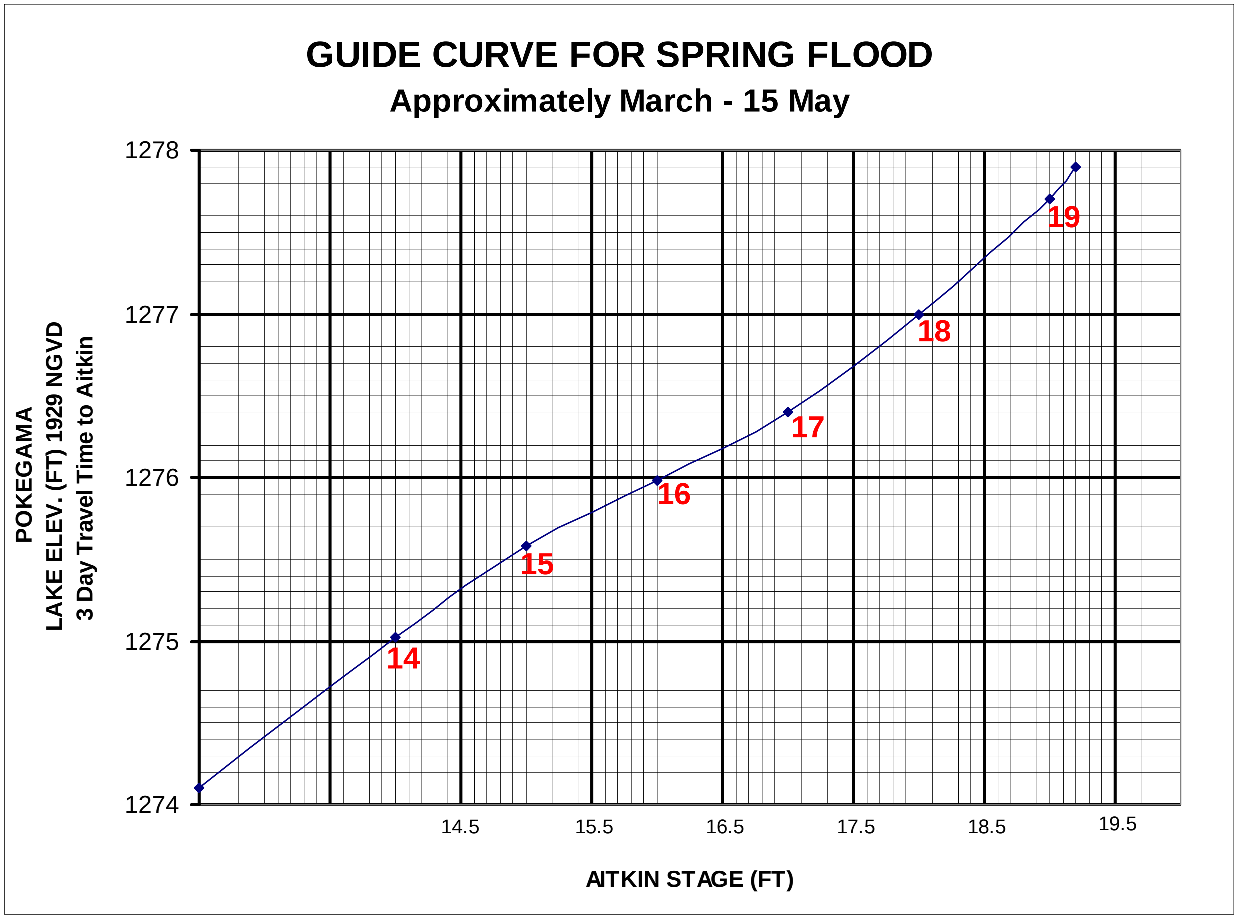
Under this proposed component, the existing guide curves were modified as discussed below. This is due to the fact that the ability to regulate Big Sandy Lake for flood control in compliance with the spring and summer guide curve relationships during flood events at Aitkin is limited. The modified curves are included as part of the Proposed Plan details (Section 5.5.5).

Since the original guide curves were published in 1956, it has proven very difficult if not impossible to operate Big Sandy Lake Dam in accordance with its water elevations required by the guide curves (on the X-axis). This is due to the fact that the Sandy tailwater is affected by backwater from the Mississippi River up to the dam. During flood events the Mississippi River submerges Sandy's gates, restricting the outflow (reduced head across the dam). An analysis of flood events from 1945 thru 2002 at Aitkin, that exceeded a stage of 12 feet (see Appendix F), indicates that submergence of Sandy outflow frequently occurs before Aitkin reaches a stage of approximately 13.5 to 14 feet. As a result, for a large range of the existing guide curves for Aitkin stages above 13 feet, a regulator cannot proactively operate Big Sandy Dam for flood control (i.e. the Miss. River controls the dam's outflow). Very little damage occurs in the Aitkin area below a stage of approximately 13 feet, particularly during the growing season.

Following the spring drawdown, Sandy releases inflow to maintain the target drawdown level. Experience has shown that, as the snow melts and stages at Aitkin rise, the maximum benefit for both Sandy Lake and Aitkin is obtained by releasing as much water as possible through the dam, prior to the backwater from the Mississippi River restricting the outflow through the gates. Even though the gates are often wide open by this time, the outflow approaches zero as the tailwater level below the dam rises with very little flow from the Sandy River making its way to Aitkin. By releasing as much water as possible early on, while Aitkin stages are non-damaging, Sandy retains as much storage as possible to assist in reducing peak Aitkin stages and keep its ultimate peak lake elevation as low as possible. In summary, the flood control operation at Sandy is driven by the characteristics of the runoff and geomorphology of the river/watershed. The regulator does not have enough control to actively follow the Sandy portion of a guide curve.

Unlike the more limited flood control protection provided to Aitkin by Sandy, Pokegama Lake with the assistance of Lake Winnibigoshish and Leech Lake, can provide flood control for Aitkin for a wide range of flood events. As a result, new spring and summer guide curves were developed that retain the existing relationship between Pokegama's reservoir levels and Aitkin's stages while eliminating Big Sandy Lake from the curves (see Figures 5.3.6.3.a and 5.3.6.3.b).

Figure 5.3.6.3.a Modified Spring Guide Curve Without Sandy Lake



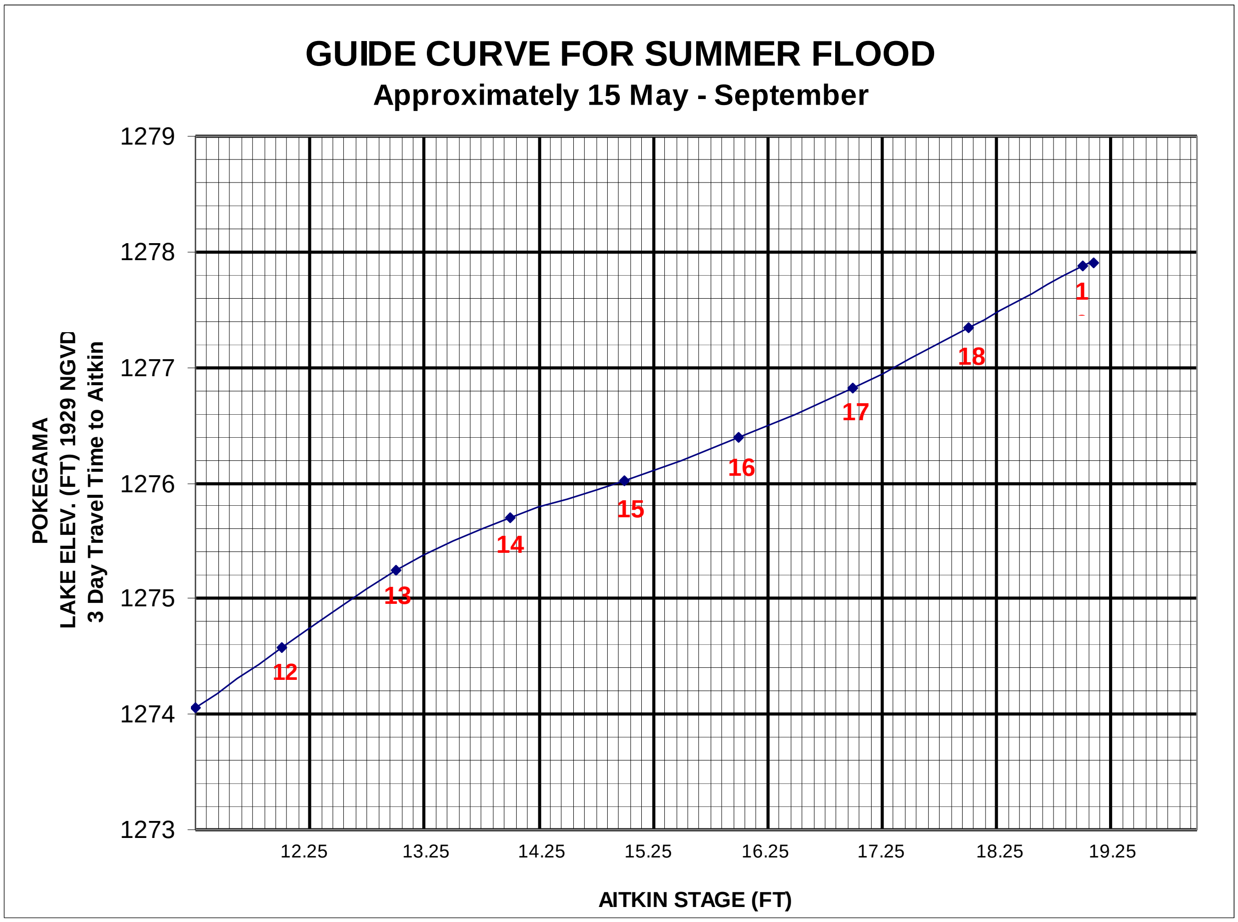
The modified spring guide curve (Figure 5.3.6.3.a) was developed from the existing curve (Figure 5.3.6.1.a.) as follows:

a) Big Sandy Lake was removed from the plot for reasons described at the beginning of this section;
b) Instructions on how to operate Pokegama Dam prior to Aitkin reaching a stage of 14 feet have been clarified as discussed below;
c) The relationship between Aitkin stages and Pokegama water levels remained the same as the 1956 relationship on Figure 5.3.6.1.a.

When it becomes clear for a spring event that the forecasted stage at Aitkin will approach or potentially exceed 14 feet, Pokegama's reservoir level must be increased to correspond, as closely as possible, to 1275.0 feet on the spring guide curve by the time Aitkin reaches a 14 foot stage. The guide curve should be followed, when possible, from that point forward. When Aitkin is below a stage of 14 feet the regulator has some flexibility in operating Pokegama Dam. Depending on the conditions in the basin, (snowpack etc.) and the forecasted stage at Aitkin, it may be prudent to begin following the curve from some distance below 14 feet. On the extreme lower part of the spring guide curve, during other less threatening conditions, the regulator has the flexibility to make informed decisions on an event by event basis as to how to operate Pokegama Dam for Aitkin Flood control. In any case, the regulator needs to insure that the reservoir elevations and Aitkin stages converge on the spring guide curve, as much as possible, by the time the structural damage elevation of 14 feet is reached at Aitkin.

The dams at Lake Winnibigoshish and Leech Lake will also assist in the flood control operation as they do under the current plan. These two dams will minimize their respective outflows in order to assist Pokegama Lake in following the guide curve.

Figure 5.3.6.3.b Modified Summer Guide Curve Without Sandy Lake



A modified summer guide curve (Figure 5.3.6.3.b) was developed from the existing curve (Figure 3.1.6.1.b) in a similar manner to the spring curve. Similarly, Big Sandy Lake was removed from the plot and instructions on how to operate Pokegama Dam prior to Aitkin reaching the summer/agricultural damage stage of approximately 13 feet were clarified as discussed below.

When it becomes clear for a summer event that the forecasted stage at Aitkin will approach or potentially exceed 13 feet, Pokegama's reservoir level must be increased to correspond, as closely as possible, to approximately 1275.2 feet on the summer guide curve by the time Aitkin reaches a 13 foot stage. The guide curve should be followed, when possible, from that point forward. Although the agricultural damage stage in the Aitkin area is approximately 13 feet, the reduced reaction time to a summer flood event (see Section 5.3.6.1) requires the operator to begin following the curve, as soon as possible, as stages at Aitkin rise. In most cases, the regulator will need to, when conditions allow, begin following the summer guide curve at Pokegama beginning at or below a 12 foot stage at Aitkin. In any case, the regulator needs to insure that the reservoir elevations and Aitkin stages converge on the summer guide curve, as much as possible, by the time the agricultural damage stage of 13 feet is reached.

Lake Winnibigoshish and Leech Lake will also assist in the summer flood control operation as they do under the current plan. These two dams will minimize their respective outflows in order to assist Pokegama in following the guide curve.

In both the spring and summer flood events, when the elevations on Pokegama reach the upper end of the curve(s), further adjustments will need to be made. As water elevations in the reservoir reach between 1277.92 and 1278.42 feet, the discharge from the control structure will, out of necessity for dam safety considerations, be ramped upwards until the dam is completely open by the time the reservoir reaches elevation 1278.42 feet (the top of the control structure). Open river conditions will then exist until the reservoir drops to elevation 1277.92 feet.

In addition to regulating Pokegama for a peak stages at Aitkin in the spring and summer, the dam must also be regulated on the recession. On the recession side of the inflow hydrograph, the water levels in Pokegama reservoir shall be governed by the guide curves, if possible, until the reservoir has returned to within the summer band. In some situations, if Sandy Lake is also high, caution must be exercised to not increase the discharge out of Pokegama too aggressively in an effort to follow the guide curve on the recession. This is due to the fact that the backwater from the Mississippi River can drown out Sandy's tailwater, which restricts the outflow. If the discharge from Pokegama, on the recession, is increased too soon it can delay the lowering of Sandy Lake reservoir.

5.3.6.4 Updated Aitkin Guide Curves: Truncating the Curves Below 14 ft.

Under this proposed component, in addition to removing Big Sandy from the guide curves (see Section 5.3.6.3), both the spring and summer guide curves would begin at an Aitkin stage of 14 feet. The purpose of this component is to allow the regulator the flexibility to release more water during smaller events and thus retain more storage in Pokegama for the larger damaging events.

An evaluation of this component was completed under the ROPE and it was determined that truncating the lower end of the curves did not provide significant addition storage capacity and had adverse impacts. For these reasons, this component was not carried forward for further analysis (see Section 5.4.5).

5.3.7 Winter Drawdown

Reservoir water levels are lowered every winter to create room for flood storage in the spring and to reduce shoreline ice damage in the winter. Currently, the drawdown begins in the fall (September or early October) and concludes prior to the spring breakup. The drawdown is targeted for completion by February 28 with the exception of Winnibigoshish, Leech and Pokegama. The drawdown of Winnibigoshish and Leech is often targeted for February 15 (but can be as late as the end of February) to allow time for reducing the outflows from the two dams in time to allow the final drawdown at Pokegama. The existing drawdown elevations listed in Section 5.5.1 are "targets". The actual drawdown elevation in any given year is adjusted as the extent of the snowpack reveals itself over the course of a winter. The final drawdown elevation can be higher, or in some cases lower, than the "Normal" drawdown target. For example, the "Maximum" drawdown elevation in Table 5.5.1 can be utilized for heavy snowpack conditions.

Operating for a winter drawdown is being maintained in all the plan alternatives, as are differing levels of drawdown based on snowpack as discussed below in Sections 5.3.7.1 and 5.3.7.2; however, there are differences in the drawdown under each alternative plan. In the alternatives, the starting date varies and in some cases the normal drawdown target varies as well. The details are presented in Section 5.5 and summarized in Tables 5.5.2 through 5.5.5.

5.3.7.1 Normal Drawdown ("normal snowpack")

The definition of a normal snowpack and the corresponding recommended "Normal" drawdown elevation varies at each reservoir and constitutes approximately 3 to 6 inches of snow water content. The normal drawdown target elevations are the lower elevations of the Ordinary Operating Limits. The exception is Leech, where a normal drawdown elevation of 1293.80 feet has been found to be adequate as opposed to the listed value of 1293.20 feet. In the case of Pokegama, Sandy, and Gull, the normal drawdown elevation is also the lower Total Operating Limit. The normal drawdown targets change under alternative plans as discussed in Section 5.5.

5.3.7.2 Extreme Drawdown (high snow water content)

If the water content of the snow is higher than normal, Winnibigoshish, Leech, and Cross Lake can be drawn down below the "Normal" drawdown to the lower Total Operating Limit (i.e. a "Maximum" drawdown). The "Normal" drawdown elevation and the "Maximum" drawdown elevation are equal for Pokegama, Big Sandy and Gull. This component of the winter drawdown will not change as a result of the ROPE because a need was not identified during the scoping process and a greater drawdown would exceed the authorized operating limits.

5.3.8 Winnibigoshish/Leech Outflow Restriction

The Corps has an agreement with local landowners and the MDNR that states we will limit the combined discharge from Winnibigoshish and Leech to 2,200 cfs to alleviate flooding problems along the river reaches upstream of Pokegama. Property damage can occur along these reaches as well on adjoining lakes/flowages like Little Winnibigoshish Lake, Ball Club Lake, White Oak Lake and Mud/Goose Lake. Water can sometimes back up to the city limits of Deer River, MN.

An evaluation of this restriction was completed under the ROPE and it was determined that the restriction should remain unchanged. This is described in more detail in Section 5.4.6.

5.3.9 Maximum Outflow Guideline, MDNR

The St. Paul District also has an informal agreement with the Minnesota Department of Natural Resources regarding maximum releases from the dams in relation to pool levels. Information on these guidelines can be found in Table 7-6 of the 2003 Water Control Manuals. The exception is Pokegama, which does not have a guideline. These guidelines give a recommended maximum discharge per pool elevation. Application of these guidelines has been difficult to impossible and therefore will not be used in any of the alternative operating plans (see Section 5.4.7).

5.3.10 Spring Pulse

An intentional spring pulse flow is not included in the existing operating plan but is included as an alternative operating component that is part of the E, T, and proposed plans. A spring pulse would be initiated immediately following ice-out, when doing so would not exceed channel capacities or induce downstream flooding. The duration of the peak would only be 1 to 3 days. The purpose of this component is to provide a spawning trigger for riverine fishes such as walleye and white sucker and to clean sediment from spawning beds below the dams. The pulsing flows identified are 200% of the mean annual flow. This is identified as a suitable pulsing flow by Tenant (1976). Specific discharges are discussed in Section 5.5.

5.3.11 Winnibigoshish Fish Spawning Guideline, MDNR

This guideline represents an informal agreement with the MDNR. When runoff conditions in the spring permit, Winnibigoshish reservoir is regulated to enhance walleye spawning. A difference in the water level between Lake Winnibigoshish and Little Cut Foot Sioux Lake creates a current, which induces a spawning run into Little Cut Foot. The target is a reservoir level of between elevation 1297.44 and 1297.75 feet by approximately April 25. An elevation of 1297.75 feet during the period 18 to 25 April is optimal as it coincides with the top of the walleye egg-stripping boards that are placed at the inlet to Little Cut Foot Sioux bay by the MDNR. Between 25 April and the first day of the fishing season (approximately mid-May), Lake Winnibigoshish is gradually raised to the Normal Summer Band (1297.94 to 1298.44 feet). Spring runoff conditions do not allow this plan to be implemented every year. This guideline was adopted after the 1963 (revised in 1968) Master Water Control Manual was published. The MDNR has stated that there is no longer a need to operate for this purpose. As a result, these guidelines will not be used in any of the alternative operating plans (see Section 5.4.8).

5.3.12 Cross Lake/Pine Fish Spawning Guideline, MDNR

This guideline represents an informal agreement with the Minnesota Department of Natural Resources. In past years (prior to 2002), the beginning of the Cross Lake drawdown has been delayed to as late as December 15. The start of the drawdown was delayed in the fall, relative to the other Headwaters reservoirs, to promote whitefish spawning. The whitefish are dependent on cool water temperatures, as well as an adequate depth of water, for successful spawning.

The proposed operating plan addresses the concerns with whitefish spawning by starting a gradual drawdown earlier in the season. Therefore, this specific component has not been carried forward in the alternatives (Section 5.4.9).

5.3.13 Reservoir Flowage Rights

Flowage rights establish a legal right to flood land around the reservoirs. In many cases, an exact elevation cannot be assigned to the flowage rights, as rights were obtained on: entire 40-acre parcels; by condemnation of entire strips of land; and by other means. In some cases, the records are simply not clear on the subject, or subsequent erosion has created problems. Flowage rights for the Cass Lake chain of lakes (upstream of Knutson Dam) are approximately 1 foot above the flowage rights on Winnibigoshish. Lake Winnibigoshish inundates Knutson Dam when the reservoir exceeds approximately elevation 1301.5 feet. The Corps also has flowage rights between Winnibigoshish/Leech and Pokegama as well as in other areas of the Headwaters. Flowage rights will not change as a result of the ROPE.

5.3.14 Channel Capacities

These are the approximate non-structural-damaging discharges in the river reaches below each dam. In general, they are the discharges that fill the river channel but do not overflow the top of the bank. These values can vary greatly depending on the situation during a particular flood due to backwater effects, floating bog, weed growth, ice conditions, and other factors. These values are based on physical characteristics and, therefore, will not change as a result of the ROPE study.

5.3.15 Rate-of-Release Guidelines, MDNR

Rate-of-Release guidelines are established to protect downstream aquatic habitat from drastic changes in flows. The Corps has its own guidelines as well as agreements with the Minnesota Department of Natural Resources regarding rate-of-release changes.

5.3.16 Routine Rate-of-Release Rule

The MDNR Guidelines can be found in Table 7.5 of the 2003 Water Control Manuals, which are available for review in the St. Paul District office. These guidelines have been evaluated and each plan alternative has a variation of the guidelines.

5.3.17 Low-Flow Rate-of-Release Rule

In addition, the Corps is a formal signatory to the Mississippi River Low-Flow Management Plan which indicates no more than a 10 percent change in outflow at Winnibigoshish and Pokegama in any 2-hour period when the U.S. Geological Survey gage at Grand Rapids reports an average daily flow of 400 cfs or less.

In all cases, a large percent increase or decrease in the total magnitude of the flow is not advisable (e.g., going from 300 to 100 cfs or 2,000 to 1,000 cfs in one gate move). The District's Environmental Resources Section is consulted when changes are being made during critical flow periods, particularly during low-flow conditions. Two or three gate changes per day are often necessary during critical flow periods to alleviate stress to fish and wildlife resources.

5.3.18 Wild Rice Operation

The current operating plan does not include an explicit component for the consideration of wild rice, even though impacts to wild rice are considered during the growing season. The regulation component below has been included in the proposed plan to clarify wild rice considerations.

Wild rice is a resource of particular interest to the Leech Lake and Mille Lacs Bands of Ojibwe. Wild rice is particularly sensitive to water level fluctuations during the floating leaf stage. Water level increases of 6 inches can uproot wild rice plants and reduce stand densities, and increases of a foot or more can lead to complete crop failures. The floating leaf stage typically occurs during late June. Annually, during the floating leaf stage of wild rice (or from the middle of June through the first week of July) reservoir water level increases will be minimized when practical such that the total water elevation increase during this timeframe does not exceed 6 inches.

5.4 ALTERNATIVES AND MEASURES ELIMINATED FROM CONSIDERATION

A number of alternatives and components were considered and eliminated with a limited analysis for a variety of reasons. Below are descriptions of each and justifications for exclusion.

5.4.1 Single-Purpose Alternatives

Single-purpose plans were briefly considered for recreation, flood damage reduction, hydropower, erosion control, archeological resources, and biological/environmental resources. A single-purpose operating plan would maximize benefits to only one interest and would only benefit other interests where it would not conflict with the primary interest. Single purpose plans were eliminated from consideration very early in the process; however, their development assisted in defining the components of an operating plan that are important in maximizing benefits to these interests. These key components were combined with others during the development of the multi-objective plans considered in detail later.

5.4.2 Dam Removal

In the long-term, dam removal would be beneficial to the native biological community of the reservoirs and rivers by restoring water elevations and hydrology to pre-dam levels. However, the negative social and economic impacts would be extreme and the short-term environmental impacts would be significant. For these reasons there would be minimal support for this alternative and it was eliminated from consideration early in the planning process. However, a hydrologic model run to simulate this alternative was used to better understand the system and aid in the formation of the multi-objective alternatives.

5.4.3 Summer Drawdown for Vegetation Management

A growing season drawdown is a management technique that is used to improve emergent aquatic vegetation beds in lakes and wetlands. To conduct such a drawdown, water levels are lowered 1 to 2 feet in spring and held low continuously for 1 or 2 years. Emergent plants such as cattail, bulrush, and arrowhead would germinate on the exposed sediment, thereby expanding these vegetation beds that were lost over time. Stands of perennial submerged vegetation would be reduced in shallow areas, thereby opening up substrate for colonization of annual plants such as wild rice. Emergent plant beds provide numerous environmental services such as spawning and nursery habitat for fish, nesting habitat for wetland birds, sediment stabilization and improved water clarity, and food for many species, just to name a few.

Negative social and economic impacts during a drawdown would likely be significant due to reduced boating access in shallow water areas, boat ramps and docks. In the long term however, it is reasonable that positive social and economic benefits would be realized due to improved environmental conditions and increased enjoyment of the reservoirs. However, during public meetings it was determined that there would be very little public support in favor of management drawdowns, and this component was eliminated from further consideration. It is recommended that management drawdowns be considered in the future, when or if public support for this measure increases.

5.4.4 Updated Structure Damage Guide Curves

The existing Pokegama/Sandy/Aitkin Flood Control Guide Curves were developed in the 1950's from an analysis of 14 historic flood events at Aitkin, when the river exceeded a 17-foot stage. The analysis, therefore, is based on a certain amount of hindsight. Actual operations in any particular year may result in the use of more or less reservoir storage than indicated by the curves to effect stage reductions at Aitkin. However, the curves are followed as closely as possible. The relationship is also affected by the areal distribution and time-volume relationships of individual floods. The curves show the relation between maximum Pokegama and Sandy reservoir elevations and the corresponding peak flood stage at Aitkin, which will on the average result in the minimum total flood damages to the affected interests in the three principal damage areas.

One objective of the ROPE was to evaluate the guide curves to determine whether or not they should be updated. It was recognized that development in the study area could have potentially changed the "balance" of damages that would occur by following the existing curves. Modifying the guide curves based on updated hydrologic and property damage information could result in more evenly balanced damages during future flood events. Therefore, modified curves based on new property value data were developed (Section 5.3.6.2) and are analyzed and discussed in this section.

A structure inventory was conducted as part of the ROPE study for areas that are affected by the operation of the Headwaters reservoirs during floods. This inventory included all of the reservoirs and connected water bodies, and the Aitkin area, both urban and rural. Pertinent information gathered during the survey included: ground elevation, first floor elevation, structure type, presence of a basement, address, X and Y coordinates, photograph, and depreciated replacement value. This information was used to update existing elevation-damage relationships for the study area, relating flood damages to varying flood elevations. Elevation acres flooded and damage per acre relationships were also developed to account for the agricultural damage potential in the rural Aitkin area.

The flood damage relationships were used to create an updated structure damage spring guide curve as shown in Section 5.3.6.2 and Figure 5.4.4. This draft was based only on damages to structures, primarily dwellings, and does not include damages to agricultural crops, boat docks, landscaping, septic systems, bank erosion, or other potential damages that can result from high water. Because they are based only on structures, the comparison of damages between the reservoirs and Aitkin is considered to be fair in that the types of damages being evaluated or "balanced" are the same. The available quantitative data for agricultural damage was not used because quantitative data for other potential impacts on the reservoirs were not collected. This was adequate for the initial review here because the potential for numerous other adverse impacts negated the need for a more in-depth analysis, because the updated structure damage guide curves were rejected as an alternative due to the adverse impacts as described below.

The current spring guide curve shown in section 5.3.6.1 and in Figure 5.4.4 below, targets water levels for events with stages between 14 and 19 feet at Aitkin. For all events lower than a 20 foot stage at Aitkin, target water levels on Sandy and Pokegama are below their total operating limits, shown as a dashed line labeled as the top of the control structure on the figure. When water levels are higher than the total operating limit, the dam gates must be wide open to protect the structural integrity of the dam. The current guide curve does in error show water levels being targeted above this level on Sandy. In general, the current guide curve can be applied for flood events that result in stages at Aitkin from 12 to 19.5 feet. Table 5.4.4 shows that Aitkin experiences a stage of 12 feet nearly every year and a stage of 16 feet once every ten years. Aside from some potential improvements to the current guide curve as discussed later, it is generally possible to follow the curve as shown for most events without approaching the physical limits of the dams.

The updated structures guide curve is shown in Figure 5.4.4. Notice that for any given event, it results in more water being held in Pokegama and Sandy than under the current curve. For example, if the stage at Aitkin is 14 feet, lake elevations should be 1275 and 1218 for Pokegama and Sandy, respectively, under the current curve. However for the same event water levels should be 1276.5 and 1219 on Pokegama and Sandy, respectively, under the updated guide curve. That is an additional 1.5 and 1 foot of water on Pokegama and Sandy respectively, for an event that has occurred 18 years in the last 56 years. There is an even greater difference for a 16 foot event, for which the updated curve would result in an additional 1.6 and 1.7 feet of water on Pokegama and Sandy, respectively.

The updated guide curve would result in more water being held in Pokegama and Sandy than under the existing curve because of increased development in the Aitkin area since the existing curves were developed. It could be argued from one perspective that modifying the curve in this manner would be appropriate for balancing damages in an equitable manner during a flood. However, actually doing so becomes problematic on further examination because of significant adverse impacts.

First of all, the updated curve shown here would result in reservoir water levels reaching their total operating limits more frequently than under the existing guide curve. In fact, the curve would drive both reservoirs to their total operating limit any time Aitkin reaches a stage of 17 feet; a level that was reached or exceeded eight times between 1945 and 2005. Once the total operating limit is reached, the gates on both dams must be fully open to maintain dam safety. This would have an adverse impact on dam operation flexibility and may result in the potential for problems related to dam safety.

Bank erosion and sedimentation are major problems on all of the Headwaters reservoirs except Gull. The primary contributing factor to these problems is unnaturally high water levels as a result of dam operation. Prior to impoundment, the Headwaters lakes would have had relatively stabile and gently-sloped banks that formed over thousands of years. When dams were built, water levels were raised up to steeper-sloped banks which are much more susceptible to erosion. Wave action easily erodes these steep banks and the sediment washes into the reservoirs.

The raise in water levels during relatively frequent flood events on Pokegama and/or Sandy under this updated curve would result in significant net adverse effects to natural and economic resources. There would be a beneficial impact on agricultural economics due to decreased crop damages in the Aitkin area. This would likely be a minor benefit because many of the floods that damage crops occur in summer and are local events, where storage in the reservoirs only provides a minimal benefit. However, there would be significant adverse economic effects on the reservoirs from bank erosion and related property loss, and damage to septic systems, landscaping, and boat docks. There would also be an adverse economic impact to resorts due to an increased frequency and height of high water in the spring which may reduce use. Significant environmental damages would occur, primarily related to shoreline erosion and sedimentation. Erosion and sedimentation affects wetland and aquatic communities by reducing habitat quantity and quality for numerous species. Furthermore, septic system flooding would result in additional nutrient and contaminant loading to the reservoirs.

Based on the reasoning above, it has been determined that the updated structural damage curve alternative will be eliminated from consideration and will not be evaluated further.

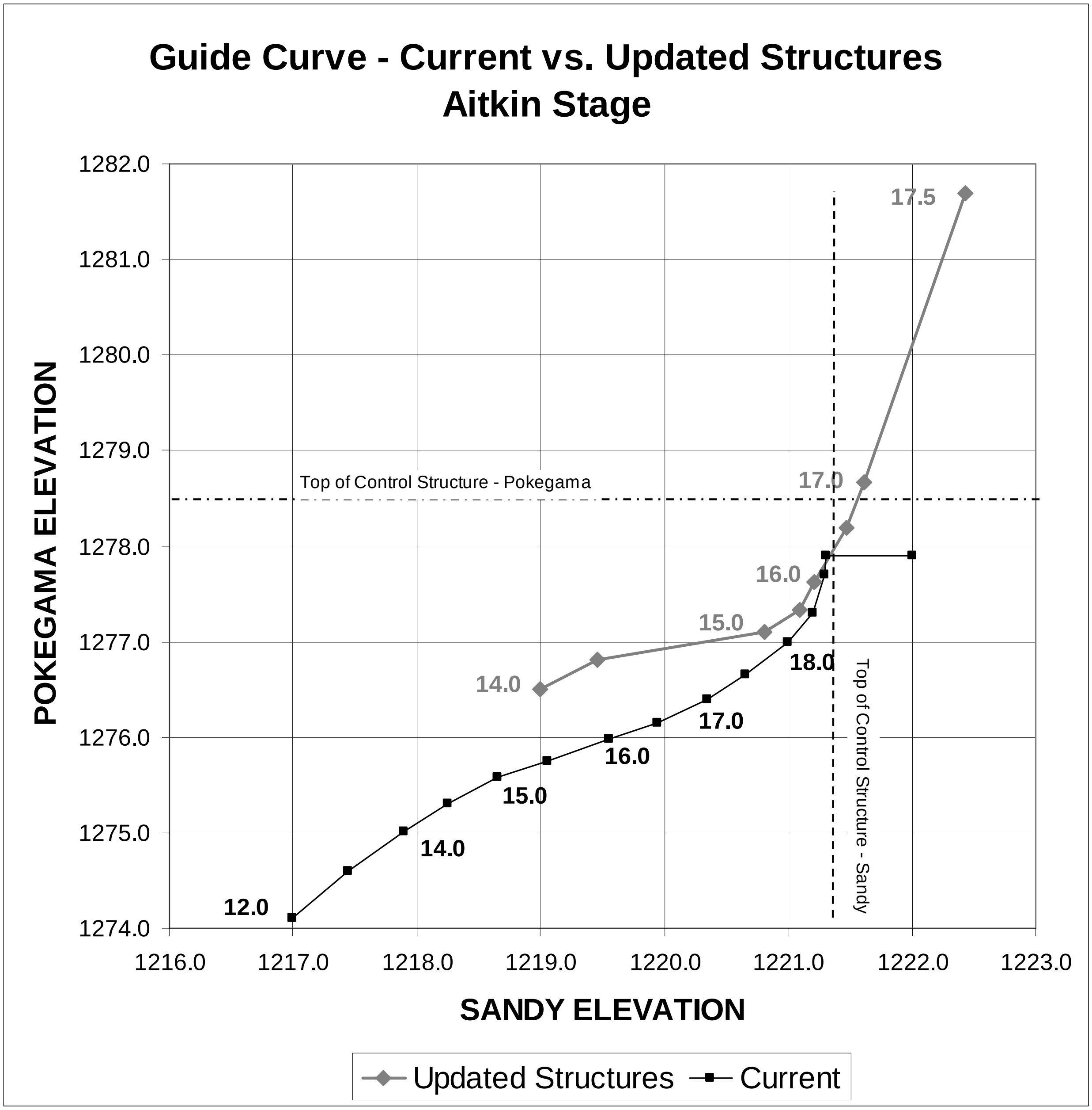
In addition to the basic determination above, it was also determined that any modification to the guide curve that would result in higher water levels on Pokegama or Sandy would not be developed. There are two basic reasons for this. One is that the resulting downstream benefits would continue to decline at lower levels of increased storage for any such alternative, and it is likely that the adverse effects would still greatly outweigh the benefits. Second is that in order to modify the curves further, a quantification of bank erosion and related adverse effects would be necessary. Doing this would be difficult, in that there would be a high potential for error in the results, and extremely expensive due to the amount of data collection and analysis necessary.

It has been determined that the existing guide curves could be improved. Some minor modifications, including the removal of Big Sandy, to the existing guide curves are presented in section 5.3.6.3. These will be included in the proposed plan. The modification presented there is only based on hydrologic factors, or basically improving the Corps' ability to follow the balance of damages found in the existing guide curves.

TABLE 5.4.4
Aitkin – Maximum Stage

Year	Max Stage	Year	Max Stage	Year	Max Stage	Year	Max Stage
1945	17.51	1961	10.47	1977	9.75	1993	14.30
1946	11.15	1962	16.65	1978	13.21	1994	12.67
1947	16.6	1963	12.37	1979	17.12	1995	12.19
1948	18.77	1964	13.78	1980	8.65	1996	15.8
1949	9.18	1965	14.53	1981	10.61	1997	16.3
1950	22.49	1966	13.58	1982	15.97	1998	10.7
1951	13.23	1967	13.00	1983	10.3	1999	14.1
1952	17.73	1968	10.47	1984	13.3	2000	11.16
1953	15.13	1969	17.28	1985	14.02	2001	17.7
1954	14.73	1970	13.39	1986	15.3	2002	12.3
1955	12.62	1971	15.92	1987	10.61	2003	8.39
1956	14.27	1972	14.70	1988	9.41	2004	9.16
1957	13.82	1973	12.19	1989	13.29	2005	13.1
1958	7.21	1974	15.57	1990	11.19		
1959	11.9	1975	17.95	1991	11.95		
1960	13.13	1976	12.72	1992	10.3		

Figure 5.4.4. Updated Structures and Current Guide Curves for Spring Flood Events



5.4.5 <u>Updated Aitkin Guide Curves: Truncated Curves Below 14 ft</u>

As discussed in Section 5.3.6.4, in addition to removing Big Sandy from the guide curves, an analysis was completed to evaluate the effects of beginning both the spring and summer guide curves at an Aitkin stage of 14 feet. This was suggested as way to allow the regulator the flexibility to release more water during smaller events without the requirement for higher reservoir levels that would be imposed by the guide curve, and thus retain more storage in Pokegama for the damaging events. An analysis of this revealed the following:

a) The lack of identified stages on the existing spring guide curve (Figure 3.1.6.1.a) and the proposed modified curve (Figure 5.3.6.3.a) below 14 feet allows for flexibility in this region of the curve.
b) During summer events, in most cases, the summer guide curve must be followed well before 14 feet due to the timing of rainfall events (see Section 5.3.6.1). In addition, agricultural damages begin at approximately 13 feet.
c) Minimal storage is preserved for larger events due to the fact that the regulator must follow the guide curves above 14 feet and often times before reaching that level.
d) Releasing more water from Pokegama earlier in an event places more water in the system down to Aitkin prior to damaging events. With a 3-day travel time from Pokegama to Aitkin, this increases the risk of higher stages at Aitkin. This is true for runoff events of short duration or the continuation of an existing event due to additional rainfall.

Based on the weight of the negative factors listed above, this component was eliminated from consideration and was not carried forward for further analysis.

5.4.6 Winnibigoshish/Leech Outflow Restriction Modification

As discussed in Section 5.3.8, the current plan includes a combined outflow restriction of 2,200 cfs for Lake Winnibigoshish and Leech Lake. At one time it was thought that this restriction could possibly be lifted if an evaluation determined that the impacts of doing so would be negligible. However, it was determined that in fact at 2,200 cfs the river is approximately bank full at the confluence of the Mississippi River and Leech River. At other places it is slightly lower than bank full. The HEC-RAS model was used to verify this as well. Additionally, in 2006 releases were approximately 2,200 cfs and the Corps rangers in the area noted the Hwy. 2 Bridge, which is located near the Mississippi and Leech river confluence was very close to overtopping. Therefore, it has been determined that the 2,200 cfs rule should remain in effect and its removal was not carried forward to operating plan alternatives.

5.4.7 Maximum Outflow Guideline, MDNR

This component is explained in Section 5.3.9. Application of these guidelines has been difficult to impossible, and therefore will not be used in any alternative operating plans.

5.4.8 Winnibigoshish Fish Spawning Guideline, MDNR

This component is discussed in section 5.3.11. The MDNR has stated that there is no longer a need to operate for this purpose, as the focus should be placed on providing high quality natural spawning habitat. Furthermore, it has been the experience of the Corps that operating in this fashion is difficult and unsuccessful in most years. Therefore this component has not been included in alternative plans.

5.4.9 Cross Lake/Pine Fish Spawning Guideline, MDNR

The proposed operating plan addresses the concerns with whitefish spawning by starting a gradual drawdown earlier in the season. Therefore, this specific component has not been carried forward in the alternatives. Effects on whitefish spawning are discussed in more detail later.

5.5 ALTERNATIVE PLANS CONSIDERED IN DETAIL

A number of multi-objective alternatives were considered in detail. Each of these alternative plans is a specific combination of the alternative components discussed in Section 3.1. Brief descriptions of each component of these plans are given below but more detailed descriptions can be found in Section 5.3. Reservoir water level targets are shown in graphical form for each reservoir and alternative.

5.5.1 No-Action Alternative or Current Plan

The no-action alternative is described in large part by the current plan components for the existing operating plan in Section 5.3. Tables 5.5.1 and 5.5.1.b, and Figures 5.5.1.a through 5.5.1.g below list the numerical values that are integral to describing this alternative. The no-action plan is the continued use of the existing operating plan throughout the study period with only very minor adjustments to assist in meeting operating objectives.

The no-action alternative focuses primarily on operation for flood damage reduction and benefits to recreational interests, primarily boaters. Some of the plan components are intended to prevent damages to natural resources, but targeted water levels on the reservoirs have been influenced mostly by boat access concerns and flood damage reduction.

Present/Total Operating Limits, Ordinary Operating Limits, Congressional Notification Levels, Reservoir Flowage Rights, and Channel Capacities are included in the no-action plan, are relatively simple, and will not be discussed further here. The Normal Summer Range/Band and Target are the reservoir water elevations that are maintained as much as possible, but vary due to weather conditions, minimum release rules, and other factors that influence water levels.

Under the no-action plan the Federal Average Annual Flow/Minimum Flow and the Low-Flow Guidelines from the Minnesota Department of Natural Resources (MDNR) would continue to be utilized. As mentioned earlier, the Federal rules do supersede the MDNR guidelines, but have not been utilized at least in the last 40 years. The minimum release rule for Knutson dam, which is one gate fully open, or about 100 cfs, would remain in place.

The no-action alternative includes the current flood operating rules as described in section 5.3.6.1. The primary consideration in flood operations is to balance flood damages between Aitkin, Sandy Lake, and Pokegama Lake by following the guide curves to the extent possible during a flood event.

The winter drawdown under the no-action alternative is described in Section 5.3.7. The normal starting dates for the drawdowns on each reservoir are depicted by the reservoir target elevations in Figures 5.5.1.a through 5.5.1.g. These are general target dates and roughly represent the median date for starting the drawdown; however, this date varies somewhat from year to year based on hydrologic conditions. Table 5.5.1.b. below represents current guidelines to assist the operator in determining draw down levels for each reservoir in any given year. The guidelines for Winnibigoshish, Leech, Cross Lake and Gull were developed after consultation with experienced regulators of the reservoir combined with the assumption of 30 percent runoff of the snowpack over their respective drainage areas. Consideration is given to the ability to reach summer water level targets in a timely manner. These guidelines are currently found in various locations in the existing operating manuals, but are summarized in table 5.5.1.b for clarity.

The no-action plan includes an outflow restriction for Lake Winnibigoshish and Leech Lake that limits their combined outflow to 2,200 cfs or less. It also includes a maximum outflow guideline provided by the MDNR; however, following this guideline has been difficult to achieve.

The no-action plan includes guidelines to assist with fish spawning on Lake Winnibigoshish and Cross Lake. These guidelines were developed at the request and with the assistance of the MDNR and would likely be modified as needed in the future. These guidelines have very little to no affect on the overall operation of the reservoirs.

The no-action plan also includes rate-of-release guidelines that were developed with the MDNR. These guidelines are implemented to protect downstream aquatic organisms from drastic changes in river flows caused by reservoir operation.

TABLE 5.5.1
BASIC PLAN COMPONENTS
CURRENT OPERATING PLAN

	Cass	Winnibigoshish	Leech	Pokegama	Sandy	Cross	Gull
Present/Total Operating Limit	NA	1294.94-1303.14	1292.70-1297.94	1270.42-1278.42	1214.31-1221.31	1225.32-1235.30	1192.75-1194.75
Ordinary Operating Limit	1300.25- 1302.25*	1296.94-1300.94	1293.20-1295.70	1270.42-1274.42	1214.31-1218.31	1227.32-1230.32	1192.75-1194.75
Normal Summer **Band Elevations (ft)** **Target** **Band Width (ft)**	1301.28-1302.4 1301.43-1302.25 0.3	1297.94-1298.44 1298.19 0.5	1294.50-1294.90 1294.70 0.4	1273.17-1273.67 1273.42 0.5	1216.06-1216.56 1216.31 0.5	1229.07-1229.57 1229.32 0.5	1193.75-1194.00 1193.87 0.25
Federal Minimum Average Annual Flow	NA	1294.94 150 cfs	1292.70 70 cfs	1270.42 200 cfs	1214.31 80 cfs	1225.32 90 cfs	1192.75 30 cfs
Low Flow Guidelines Minnesota DNR	NA	≥1294.94 100 cfs <1294.94 50 cfs	≥1292.70 100 cfs <1292.70 50 cfs	≥1273.17 200 cfs <1273.17 Winni+Leech	≥1214.31 20 cfs <1214.31 10 cfs	≥1225.32 30 cfs <1225.32 15 cfs	≥1192.75 20 cfs <1192.75 10 cfs
Congressional Notification Levels	NA	1296.94 1303.14	1293.20 1297.94	1270.42 1278.42	1214.31 1221.31	1227.32 1235.30	1192.75 1194.75
Spring Pulse (cfs)	NA	NA	NA	NA	NA	NA	NA
Winter Drawdown **Initial Drawdown, Target Date** **Normal Drawdown, Target Date** **(can vary based on Snow WC)**	NA 1300.25, Mar 15	1297.20, Jan 15 1296.94, Feb 15	1294.10, Dec 25 1293.80, Feb 15	1271.53, Jan 15 1270.42, Mar 31	1214.90, Jan 15 1214.31, Feb 28	1228.00, Dec 10 1227.32, Feb 28	1193.25, Dec 25 1192.75, Feb 28
Maximum Winter Drawdown	NA	1294.94	1292.70	1270.42	1214.31	1225.32	1192.75
Rate of Release (change/day) Insofar If Practicable	20-30%	200 cfs or 0.5 ft. of TW Change	100 cfs or 0.25 ft. of TW Change	20-30%	20-30%	60 cfs or 0.25 ft. of TW Change	20-30%

Rate of Release rules are not applicable when operating for flood control and/or to prevent property damage (particularly at Sandy and Gull). During other times, reasonable judgment must be exercised. For example, a large percent increase or decrease in the magnitude of the flow is not advisable (e.g. going from 300 cfs to 100 cfs in one gate move).
*For Cass Lake the Ordinary Operating Limits are defined differently than in the Corps' operating plan in that they are simply the total range of water elevations that could be expected in any given year as described in the Knutson Dam operating plan. Elev. 1293.80 feet is adequate for "normal" conditions at Leech (see Table 5.5.1.b).

Table 5.5.1.b. Existing Plan Winter Drawdown Summary
Miss. R. Headwater Reservoir System, Drawdown Information: Snow Water Content in Inches, Elev. in Feet

Drawdown Level	Winnibigoshish	Leech	Pokegama	Sandy	Cross L./Pine River	Gull
Initial	Less Than Approx. 3 to 4 Inches Elev. 1297.20 or Higher	Less Than Approx. 3 to 4 Inches Elev. 1294.10 or Higher			Less Than or Equal To Approx. 2 Inches Elev. 1228.00 or Higher	Less Than or Equal To Approx. 2 Inches Elev. 1193.25 or Higher
Typical		Approx. 4 to 6 Inches 1294.10 to *1293.80* See Notes Below				
		Approx. 6 to 8 Inches 1293.80 to 1293.50				Approx. 2 to 3 Inches 1193.25 to 1193.00
Normal	Approx. 4 to 5 Inches 1297.20 to **1296.94**	Approx. 8 to 10 Inches 1293.50 to **1293.20** See Notes Below	**1270.42** See Notes Below	**1214.31** See Notes Below	Approx. 2 to 4 Inches 1228.00 to **1227.32**	**1192.75** See Notes Below
	Approx. 5 to 7 Inches 1296.94 to 1296.20				Approx. 4 to 5 Inches 1227.32 to 1227.00	
	Approx. 7 to 9 Inches 1296.20 to 1295.40				Approx. 5 to 6 Inches 1227.00 to 1226.50	
Maximum	Extreme Conditions 1295.40 to **1294.94**	Extreme Conditions 1293.20 to **1292.70**	**1270.42** See Notes Below	**1214.31** See Notes Below	Greater Than Approx. 6 Inches 1226.50 to **1225.32**	Greater Than Approx. 3 Inches 1193.00 to **1192.75** See Notes Below

1. Winnibigoshish: Cass Lake is filled to elev. 1301.70 ft. after the spring runoff. The maximum drawdown level of Cass Lake is elevation 1300.25 ft. However, the U.S. Forest Service only draws down Cass Lake to elevation 1300.50 ft. (or higher) when the snow water content is less than or equal to 4 inches. The volume required to fill Cass L. from 1300.25 and 1300.50 ft. up to 1301.70 ft. is approx. 35,700 ac-ft and 30,400 ac-ft, respectively, which equals approx. 0.5 feet of elevation/storage on Winnibigoshish. This information, combined with the assumption of 30 percent runoff of the snowpack over the drainage area of 1,442 square miles, resulted in the above guidelines. However, close coordination with the U.S. Forest Service should occur every year.
2. Leech: Elevation 1293.20 is technically the "normal" drawdown level according to the regulations/guidelines. However, depending on the conditions, a drawdown to that level is not required very often. Experience has shown that elevation 1293.80 feet is adequate for "normal" or "typical" conditions. Leech's "normal" drawdown level (Lower Ordinary Limit) has been changed numerous times throughout the years (see **Table 3-1** in the Jan. 2003 Water Control Manual).
3. Pokegama, Sandy and Gull: At these locations, the normal and maximum drawdown elevations are equal. A maximum drawdown is necessary in most years at Pokegama and Sandy due to the relatively large drainages areas upstream of the reservoirs versus their storage capacity. Gull is also drawdown to the maximum most years although the above snow water content guidelines provide some flexibility.

4. General: The above guidelines for **Winnibigoshish, Leech, Cross Lake and Gull** were developed after consultation with experienced operators and regulators of the dam and reservoir combined with the assumption of 30 percent runoff of the snowpack over their respective drainage areas. The Ordinary and Total Operating Limits are in bold in the above table.

Figure 5.5.1.a Existing Operating Hydrograph, Cass Lake

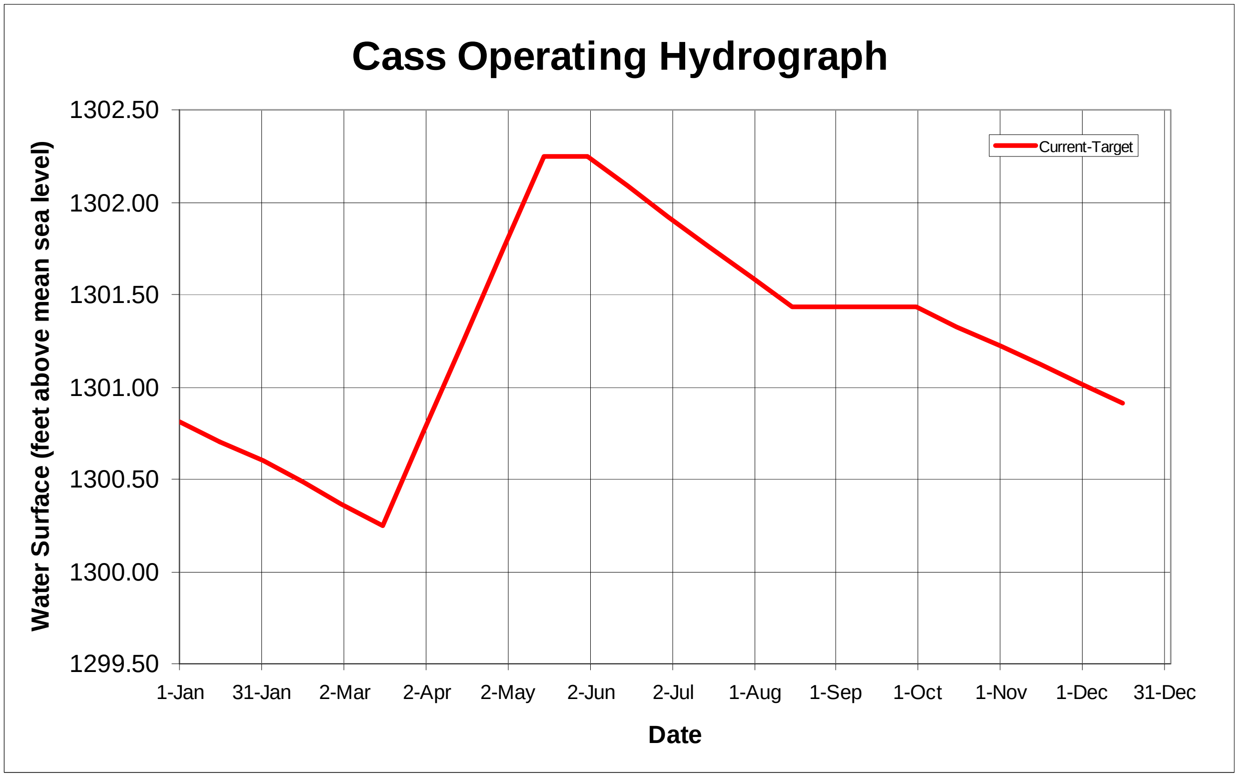


Figure 5.5.1.b Existing Operating Hydrograph, Lake Winnibigoshish

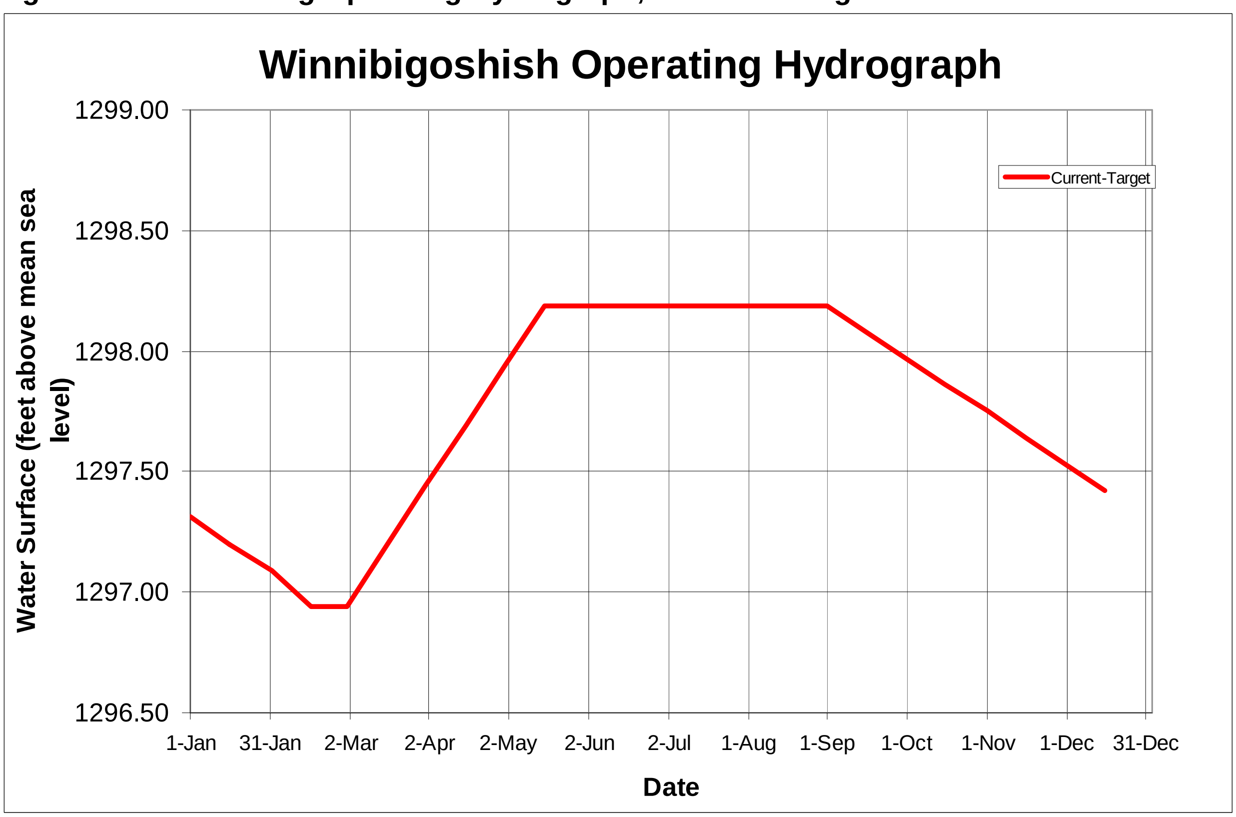


Figure 5.5.1.c Existing Operating Hydrograph, Leech Lake

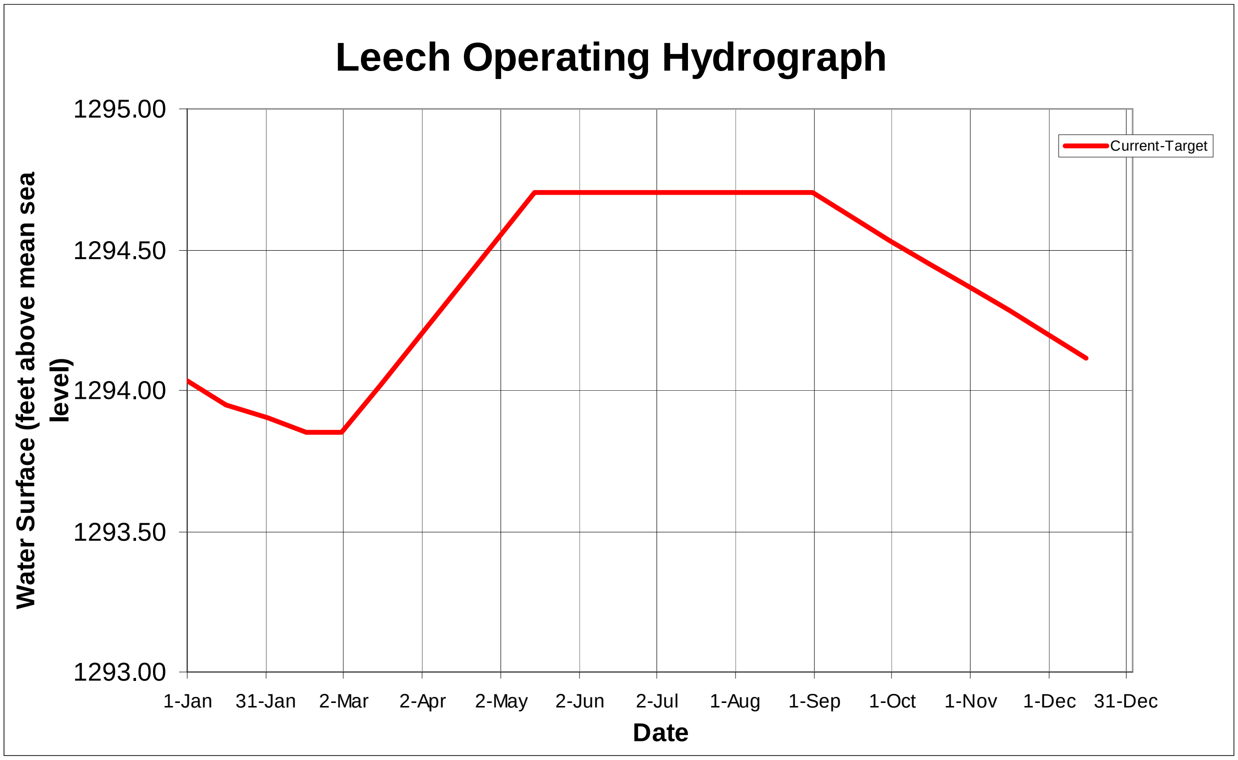


Figure 5.5.1.d Existing Operating Hydrograph, Pokegama Lake

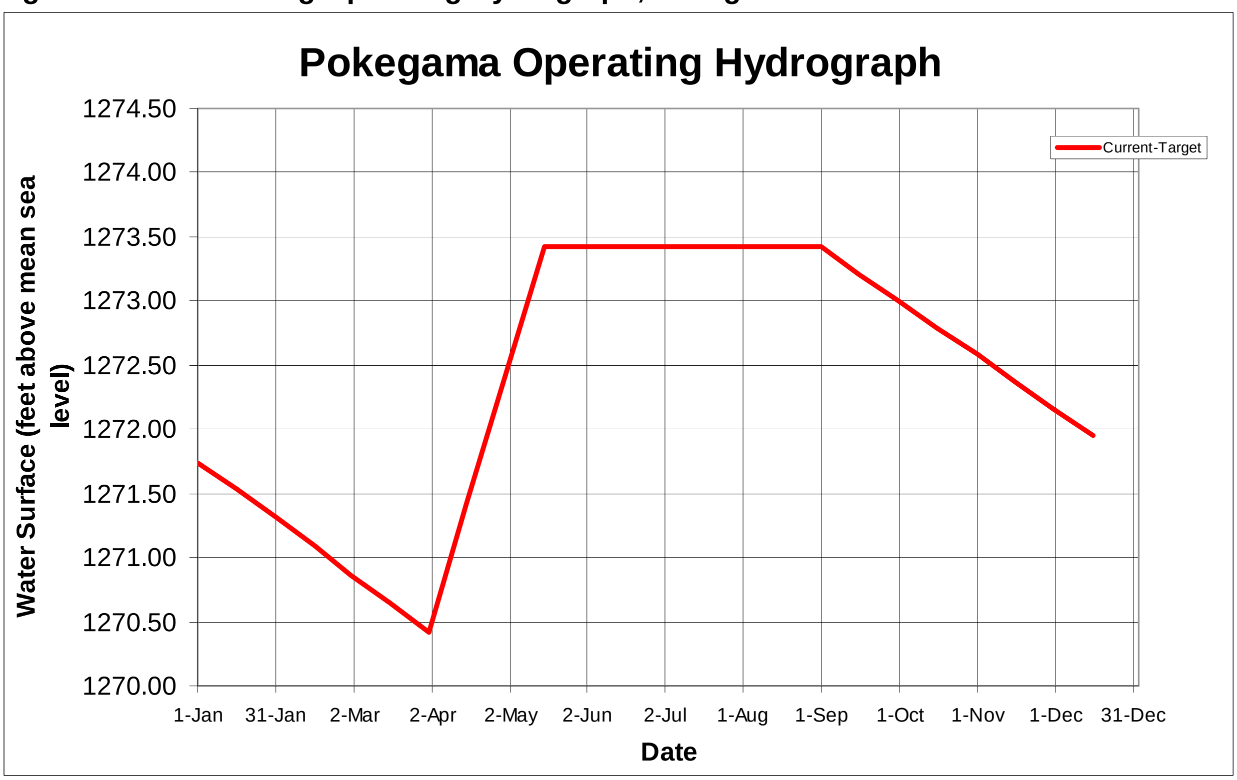


Figure 5.5.1.e Existing Operating Hydrograph, Sandy Lake

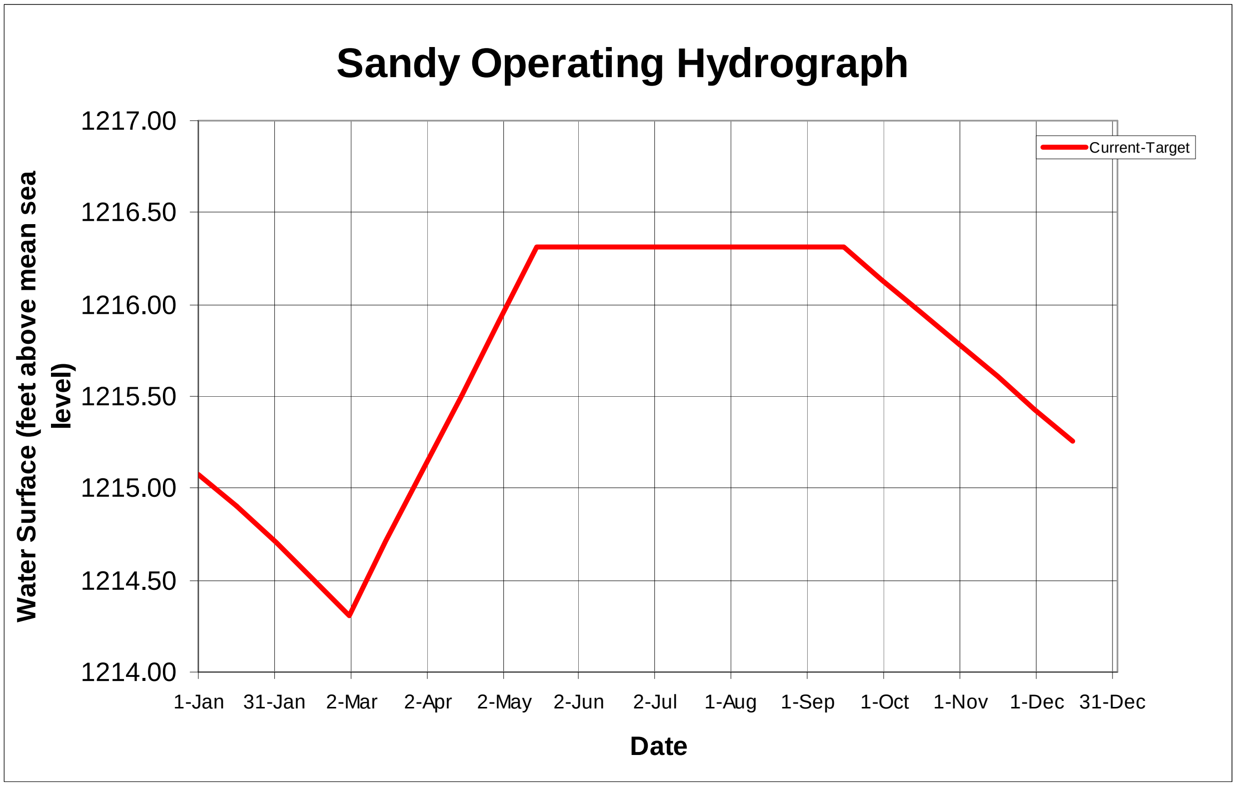


Figure 5.5.1.f Existing Operating Hydrograph, Whitefish Chain of Lakes

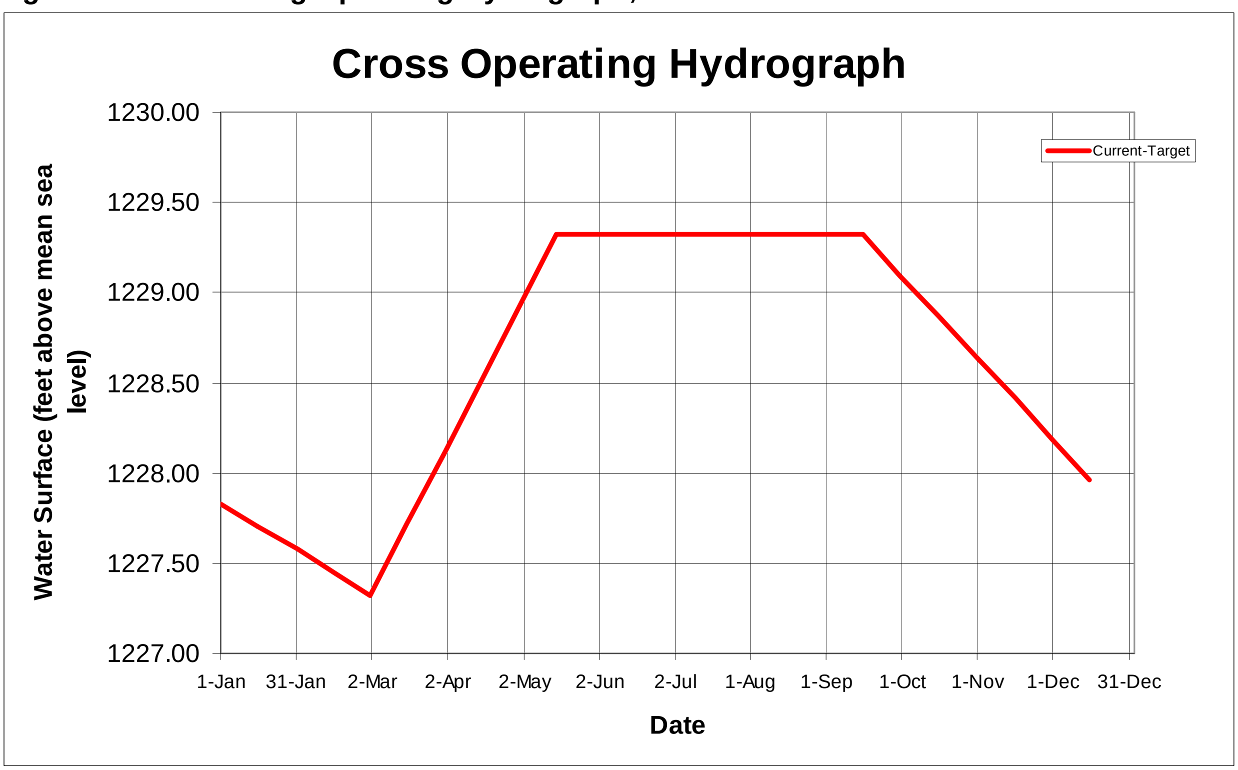
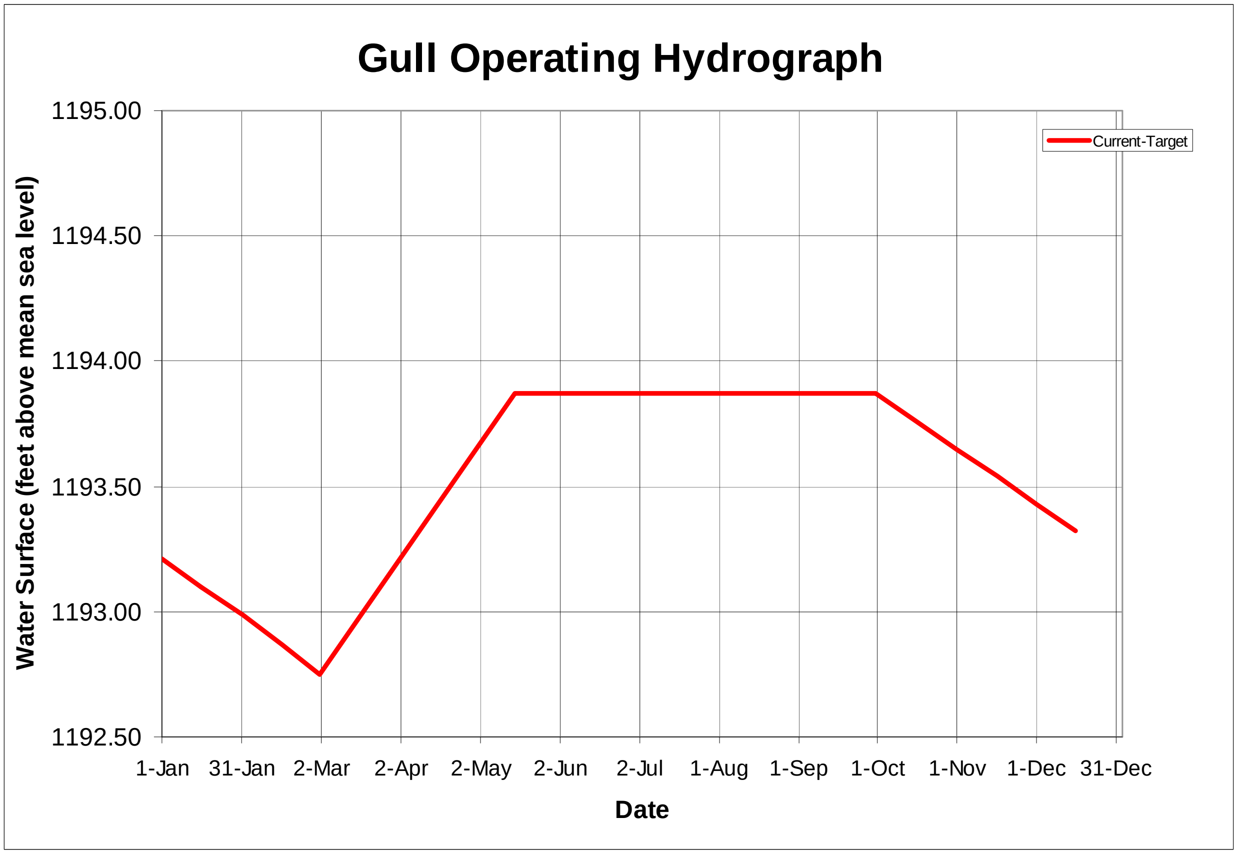


Figure 5.5.1.g Existing Operating Hydrograph, Gull Lake



5.5.2 R Plan

The R plan attempts to maximize direct economic benefits while not causing significant adverse effects to other resources. There are only two major plan components that are modified from the current plan in the R plan, the flood operating rules and the open-water season reservoir targets.

The reservoir water elevation targets would be modified to maintain high and stable water levels as long as possible through the open-water season from the beginning of May through the middle of October. Additionally, the summer target elevation would be raised a little over 5 inches on Gull (5.16 in. = 0.43 ft.) to further improve boat access. A raise such as this is not possible on the other reservoirs due to potential significant effects on shoreline erosion.

Around October 15th the winter drawdown would begin on all reservoirs. The existing final drawdown target levels as described in the no-action plan would be unchanged (as shown in Table 5.5.2), but the later start would require a more rapid decline and higher discharge rate than under the existing plan.

Flood operations under the R plan would follow the procedure discussed in Section 5.3.6.3, which includes the Modified Guide Curves without Big Sandy Lake.

For the individual reservoir details refer to Table 5.5.2 and Figures 5.5.2.a through 5.5.2.g below. Highlighted rows in the table are those that are substantially different from the no-action alternative.

TABLE 5.5.2
BASIC PLAN COMPONENTS
R OPERATING PLAN

	Cass	Winnibigoshish	Leech	Pokegama	Sandy	Cross	Gull
Present/Total Operating Limit	NA	1294.94-1303.14	1292.70-1297.94	1270.42-1278.42	1214.31-1221.31	1225.32-1235.30	1192.75-1194.75
Ordinary Operating Limit	1300.25- 1302.25*	1296.94-1300.94	1293.20-1295.70	1270.42-1274.42	1214.31-1218.31	1227.32-1230.32	1192.75-1194.75
Normal Summer **Band Elevations (ft)** **Target** **Band Width (ft)**	1301.85-1302.4 1302.0-1302.25 0.3	1297.94-1298.44 1298.19 0.5	1294.50-1294.90 1294.7 0.4	1273.17-1273.67 1273.42 0.5	1216.06-1216.56 1216.31 0.5	1229.07-1229.57 1229.32 0.5	1194.18-1194.43 1194.3 0.25
Federal Minimum Average Annual Flow	NA	1294.94 150 cfs	1292.70 70 cfs	1270.42 200 cfs	1214.31 80 cfs	1225.32 90 cfs	1192.75 30 cfs
Low Flow Limits (cfs) **<u>Min Flow Apr-Sep:</u>**	100	>1294.94 100 <1294.94 50	>1292.70 100 <1292.70 50	>1273.17 200 <1273.17 W+L	>1214.31 20 <1214.31 10	>1225.32 30 <1225.32 15	>1192.75 20 <1192.75 10
<u>Min Flow Oct-Mar:</u>	100	>1294.94 100 <1294.94 50	>1292.70 100 <1292.70 50	>1273.17 200 <1273.17 W+L	>1214.31 20 <1214.31 10	>1225.32 30 <1225.32 15	>1192.75 20 <1192.75 10
Congressional Notification Levels	NA	1296.94 1303.14	1293.20 1297.94	1270.42 1278.42	1214.31 1221.31	1227.32 1235.30	1192.75 1194.75
Spring Pulse (cfs)	NA	NA	NA	NA	NA	NA	NA
Winter Drawdown **Initial Drawdown, Target Date** **Normal Drawdown, Target Date** **(can vary based on Snow WC)**	1300.72, Jan 15 1300.25, Mar 15	1297.20, Jan 15 1296.94, Feb 15	1293.95, Jan 15 1293.80, Feb 15	1271.53, Jan 15 1270.42, Mar 31	1214.90, Jan 15 1214.31, Feb 28	1227.90, Jan 15 1227.32, Feb 28	1193.10, Jan 15 1192.75, Feb 28
Maximum Winter Drawdown	1300.25	1294.94	1292.70	1270.42	1214.31	1225.32	1192.75
Rate of Release (change/day) Insofar If Practicable	20-30%	200 cfs or 0.5 ft. of TW Change	100 cfs or 0.25 ft. of TW Change	20-30%	20-30%	60 cfs or 025 ft. of TW Change	20-30%

Rate of Release rules are not applicable when operating for flood control and/or to prevent property damage (particularly at Sandy and Gull). During other times, reasonable judgment must be exercised. For example, a large percent increase or decrease in the magnitude of the flow is not advisable (e.g. going from 300 cfs to 100 cfs in one gate move).

*For Cass Lake the Ordinary Operating Limits are defined differently than in the Corps' operating plan in that they are simply the total range of water elevations that could be expected in any given year as described in the Knutson Dam operating plan. Elev. 1293.80 feet is adequate for "normal" conditions at Leech (see Table5.5.1.b).

Figure 5.5.2.a. R Plan Operating Hydrograph, Cass Lake

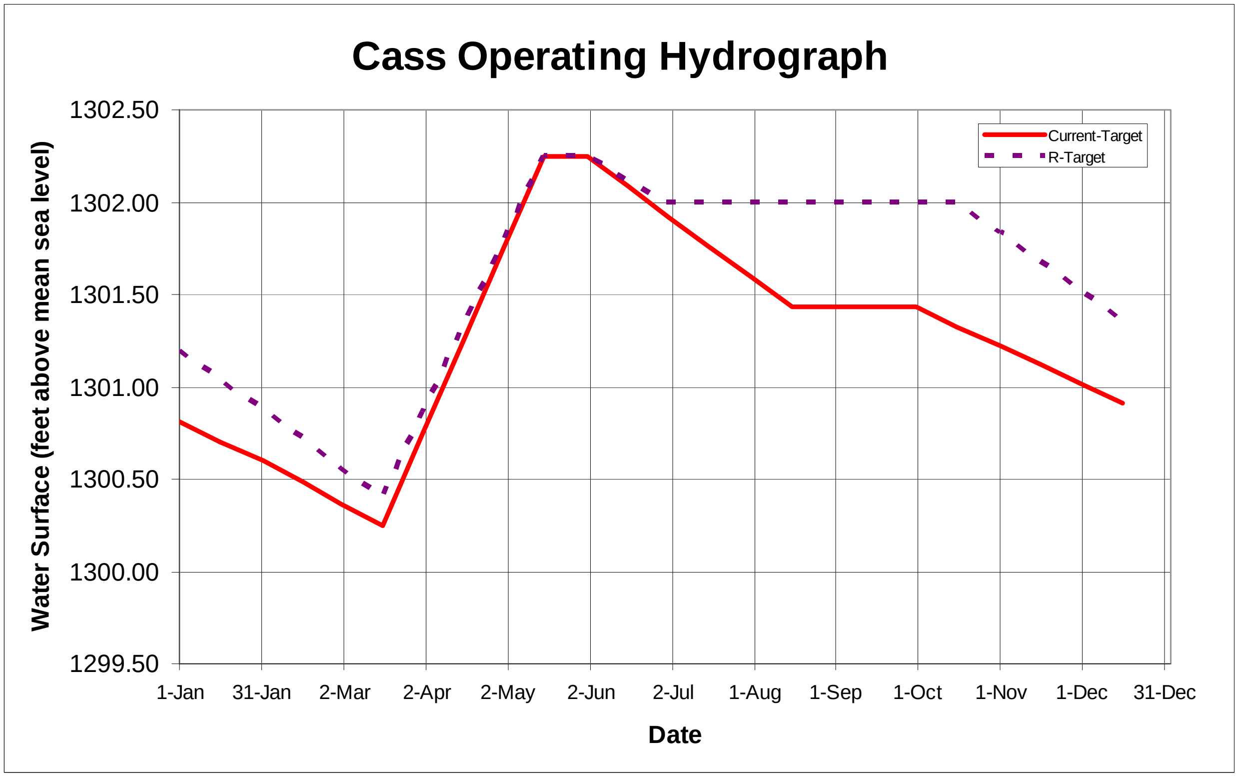


Figure 5.5.2.b. R Plan Operating Hydrograph, Lake Winnibigoshish

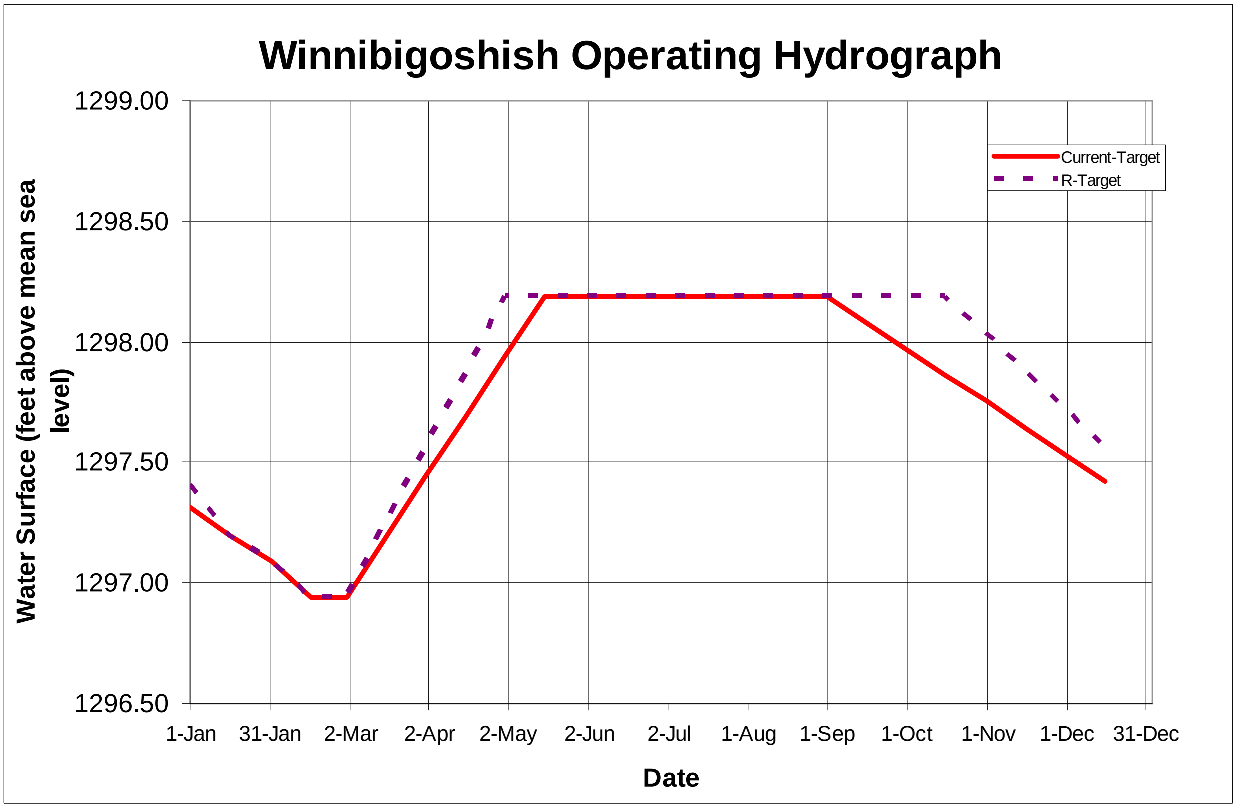


Figure 5.5.2.c. R Plan Operating Hydrograph, Leech Lake

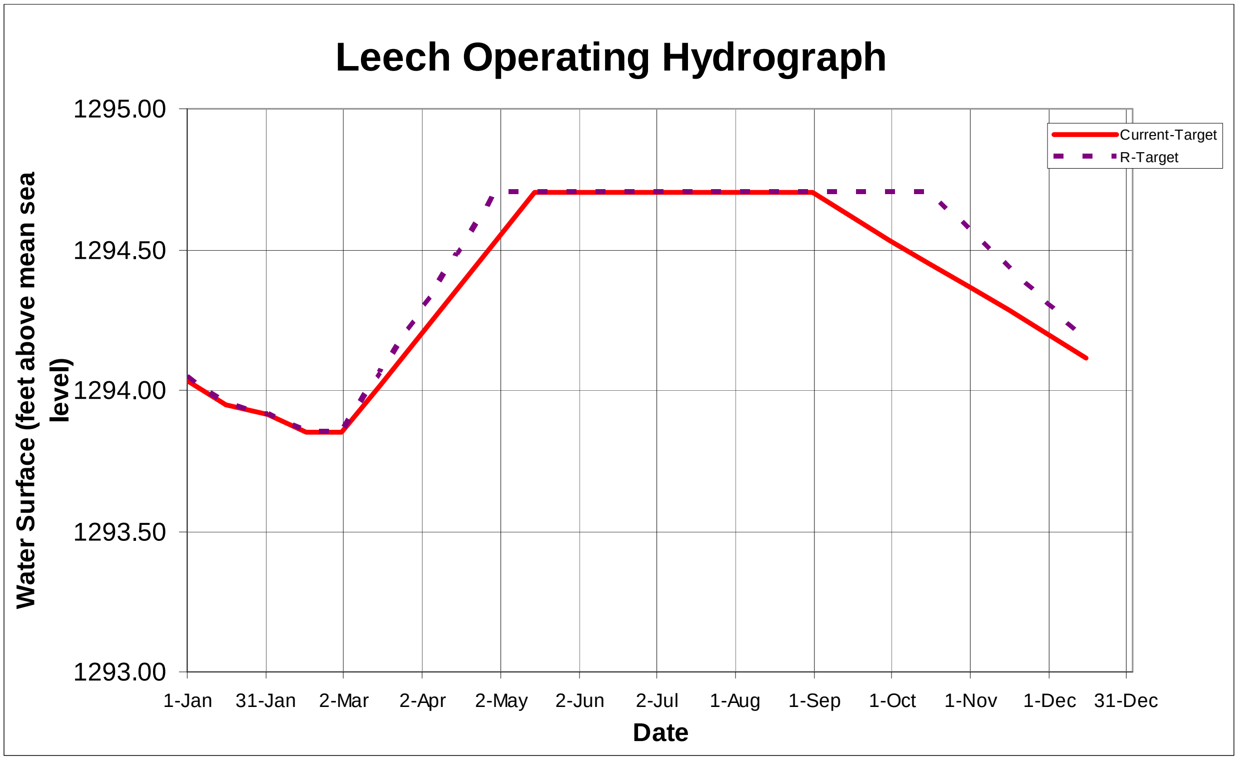


Figure 5.5.2.d. R Plan Operating Hydrograph, Pokegama Lake

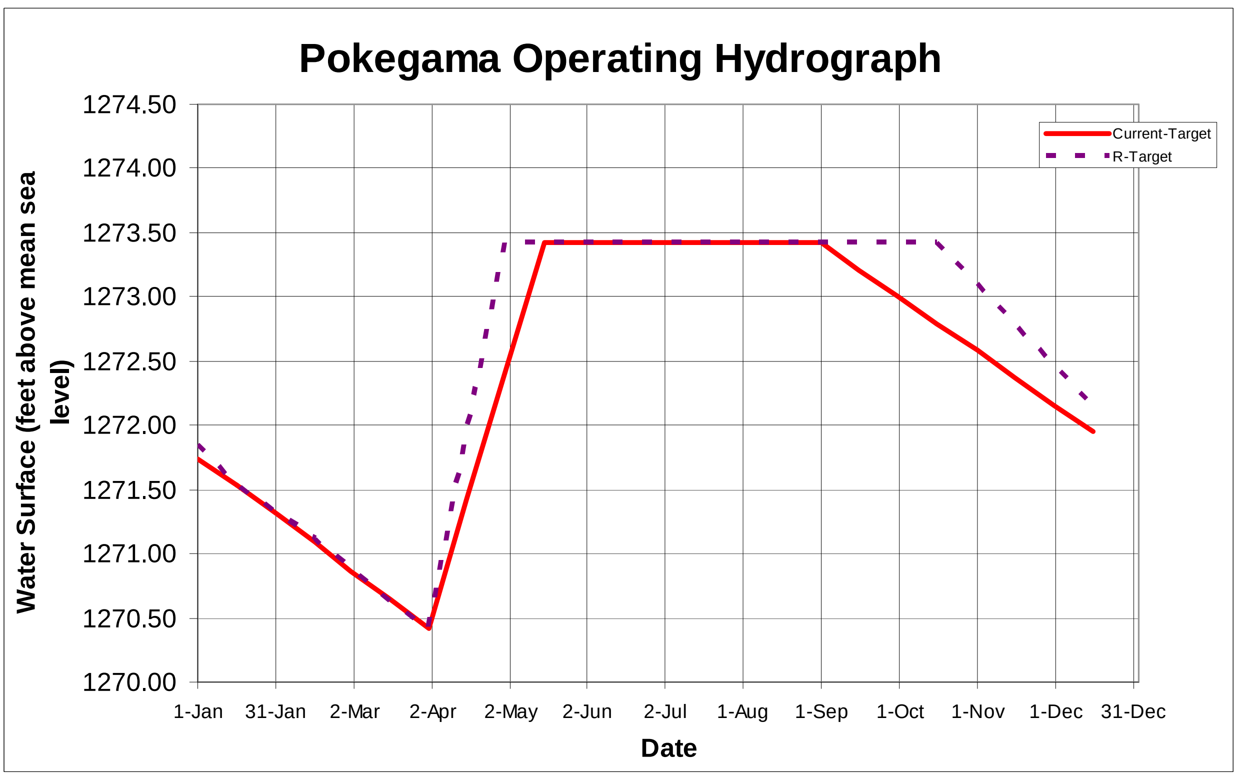


Figure 5.5.2.e. R Plan Operating Hydrograph, Sandy Lake

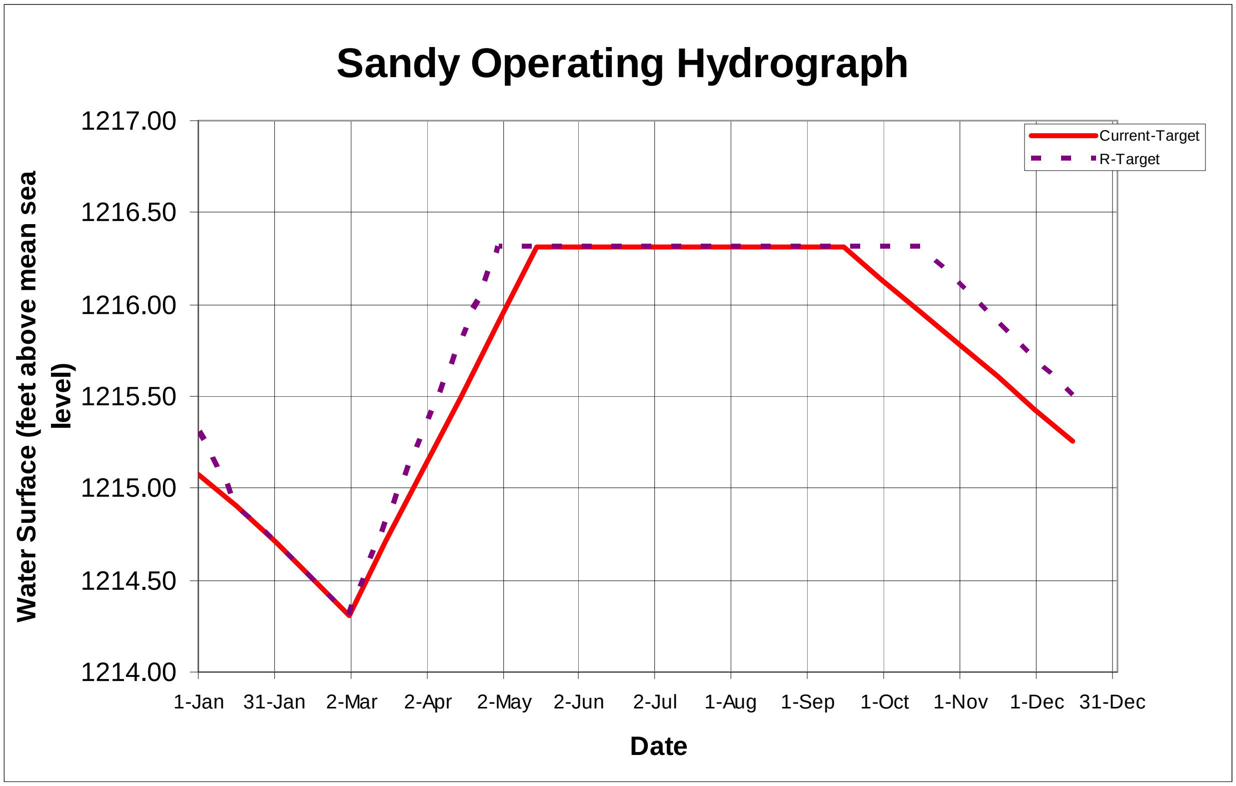


Figure 5.5.2.f. R Plan Operating Hydrograph, Whitefish Chain of Lakes

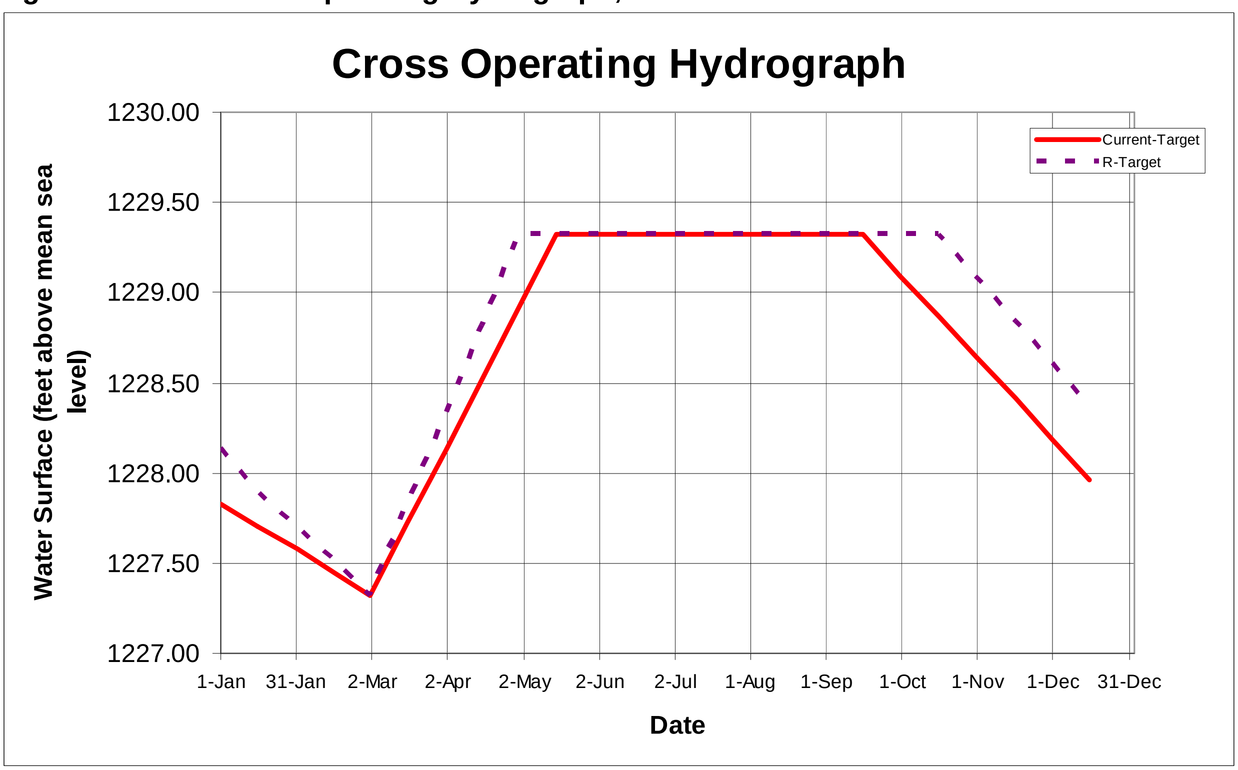
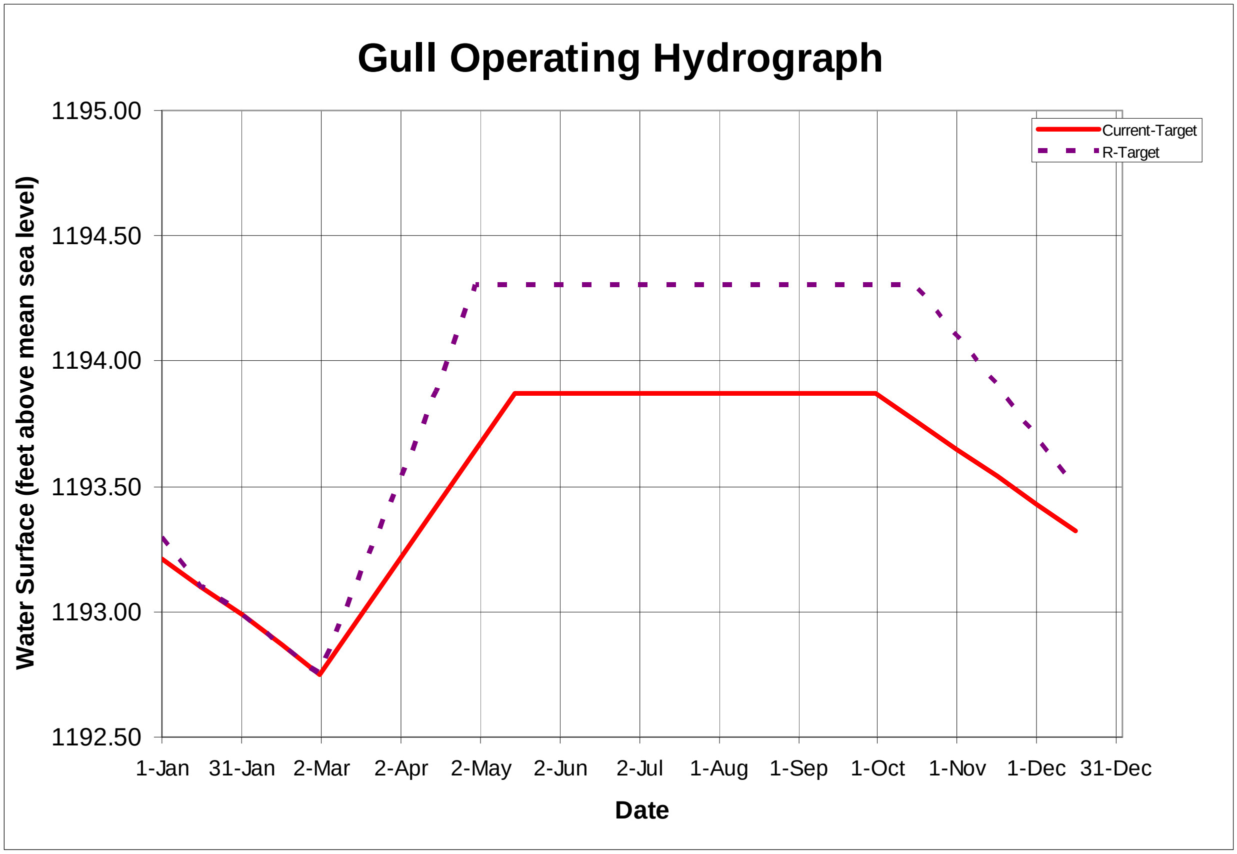


Figure 5.5.2.g. R Plan Operating Hydrograph, Gull Lake



5.5.3 E Plan

This plan attempts to provide maximum benefit to the aquatic ecosystem while maintaining water elevations on average at the levels experienced under the existing operating plan.

Flood operations under the E plan would follow the procedure discussed in section 5.3.6.3, which includes the Updated Guide Curves without Big Sandy Lake.

The water elevation targets were developed through a multi-step process. First, a hydrologic model was used to simulate elevations and flows throughout the system for the period of record (1930-2002) assuming each dam was replaced with a fixed-crest weir. The modeled weir elevation was adjusted through trial and error to result in median summer water elevations near to the existing summer water elevation targets. However, the summer elevation on Gull was adjusted higher because unlike the other reservoirs, there would be little impact to shoreline erosion. The simulated “unregulated” median water elevation was then plotted and manually readjusted for all reservoirs to incorporate the current drawdown targets. These adjusted water levels were used to represent an approximation of unregulated or “natural” reservoir water elevations with the dams in place and were used as the targeted water levels under the E plan as shown in the Figures 5.5.3.a through 5.5.3.g.

The wide summer operating band component as described in Section 5.3.3.2 would be included in the E plan. This component basically consists of an 8 inch wide operating band for each reservoir and would provide more flexibility to incorporate natural short-term variability in water levels.

Minimum release rules would be changed under this plan as listed in section 5.3.4.3 Revised Minimum Release Rules. The Federal Minimum Average Annual Flow would be withdrawn.

A spring pulse would be included as part of this plan as described in section 5.3.10.

The winter drawdown targets would be changed to reflect operating targets that would already be lower late in the summer than under the existing plan. On Gull the normal winter drawdown target elevation would be raised about 6 inches because there would be little impact due to shoreline erosion with spring high water on this reservoir, and there would be environmental benefits from the reduced drawdown in winter. The maximum drawdown target would not change on any reservoir and, therefore, they could be drawn down further in wet years. The winter drawdown completion dates for Winnibigoshish and Leech would be delayed two weeks (to the end of February) because the longer drawdown starting in mid summer would reduce the amount of water stored in the wetlands between these reservoirs and

Specific values for this operating plan can be found in Table 5.5.3 and Figures 5.5.3.a through 5.5.3.g. Highlighted rows in the table are those that are different from the no-action alternative.

TABLE 5.5.3 BASIC PLAN COMPONENTS E OPERATING PLAN							
	Cass	**Winnibigoshish**	**Leech**	**Pokegama**	**Sandy**	**Cross**	**Gull**
Present/Total Operating Limit	NA	1294.94-1303.14	1292.70-1297.94	1270.42-1278.42	1214.31-1221.31	1225.32-1235.30	1192.75-1194.75
Ordinary Operating Limit	1300.25- 1302.25*	1296.94-1300.94	1293.20-1295.70	1270.42-1274.42	1214.31-1218.31	1227.32-1230.32	1192.75-1194.75
Normal Summer **May 1 – Sep1 **(see note 1)** **Band Elevations (ft)** **Target** **Band Width (ft)**	target ± ½ width 1301.37-1302.0 0.67	target ± ½ width 1297.72-1298.14 0.67	target ± ½ width 1294.20-1294.72 0.67	target ± ½ width 1272.94-1273.54 0.67	target ± ½ width 1215.70-1216.31 0.67	target ± ½ width 1228.81-1229.32 0.67	target ± ½ width 1193.51-1194.14 0.67
Federal Minimum Average Annual Flow	NA	NA	NA	NA	NA	NA	NA
Low Flow Limits (cfs) **Min Flow Apr-Sep:** **>= target** **target to (target-3")** **target-3" to -18"** **< (target-18")** **Min Flow Oct-Mar** **>= (target-6")** **< (target-6")**	170 130 80 40 80 40	210 160 110 50 110 50	160 120 80 40 80 40	Lesser of: W+L+110 or 480 W+L+360 or 360 W+L+240 or 240 W+L+120 or 120 W+L+240 or 240 W+L+120 or 120	100 70 50 20 50 20	100 70 50 20 50 20	50 40 20 10 20 10
Congressional Notification Levels	NA	1296.94 1303.14	1293.20 1297.94	1270.42 1278.42	1214.31 1221.31	1227.32 1235.30	1192.75 1194.75
Spring Pulse (cfs)	840	1060	790	2410	490	500	250
Winter Drawdown **Initial Drawdown, Target Date** **Normal Drawdown, Target Date** **(can vary based on Snow WC)**	1300.39, Jan 15 1300.25, Mar 15	1297.20, Jan 15 1296.94, Feb 28	1293.95, Jan 15 1293.80, Feb 28	1271.53, Jan 15 1270.42, Mar 31	1214.90, Jan 15 1214.31, Feb 28	1227.90, Jan 15 1227.32, Feb 28	1193.34, Jan 15 1193.27, Feb 28
Maximum Winter Drawdown	1300.25	1294.94	1292.70	1270.42	1214.31	1225.32	1192.75
Rate of Release (change/day) Insofar If Practicable	20-30%	20-30%	20-30%	20-30%	20-30%	20-30%	20-30%

Rate of Release rules are not applicable when operating for flood control and/or to prevent property damage (particularly at Sandy and Gull). During other times, reasonable judgment must be exercised. For example, a large percent increase or decrease in the magnitude of the flow is not advisable (e.g. going from 300 cfs to 100 cfs in one gate move).
*For Cass Lake the Ordinary Operating Limits are defined differently than in the Corps' operating plan in that they are simply the total range of water elevations that could be expected in any given year as described in the Knutson Dam operating plan. Elev. 1293.80 feet is adequate for "normal" conditions at Leech (see Table 5.5.1.b).

**Note 1: The summer band and target for this plan vary throughout the summer season. These numbers are the average elevations. Further detail of the targeted elevations can be seen from the individual reservoir lake level plots in Figures 5.5.3.a through 5.5.3.g.

Figure 5.5.3.a. E Plan Operating Hydrograph, Cass Lake

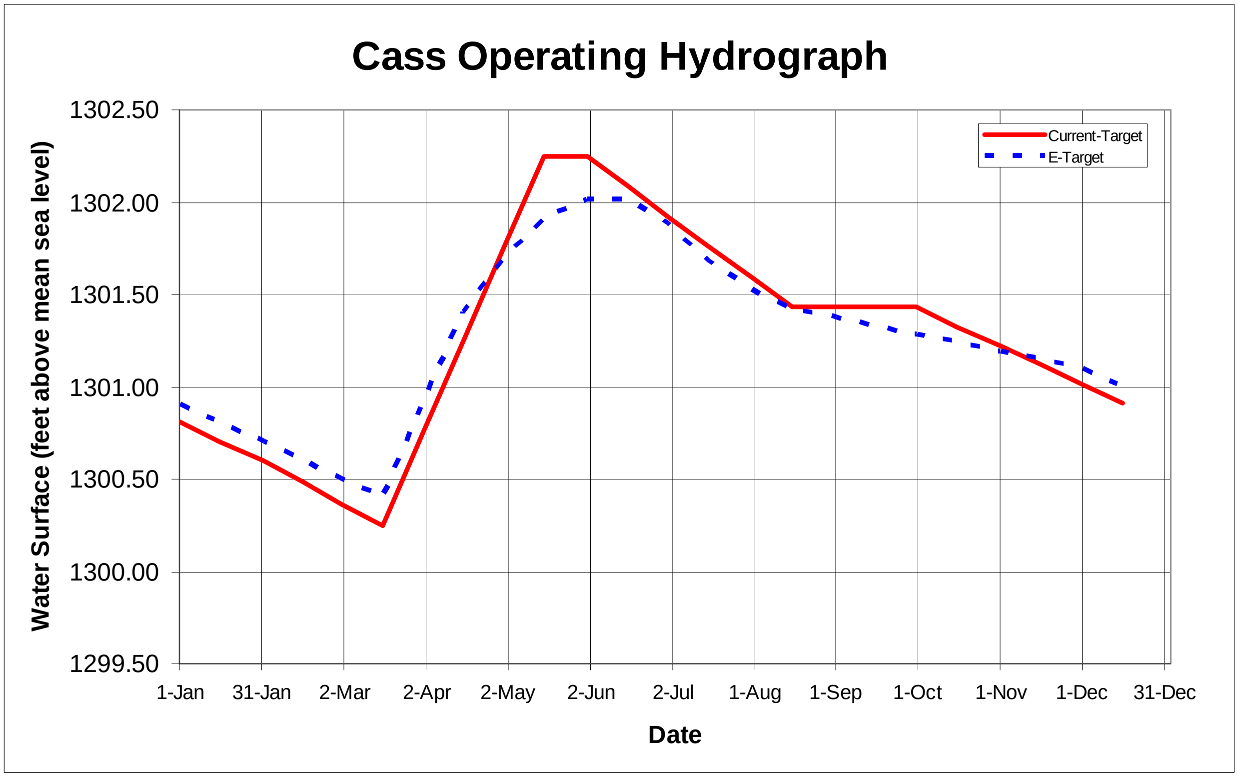


Figure 5.5.3.b. E Plan Operating Hydrograph, Lake Winnibigoshish

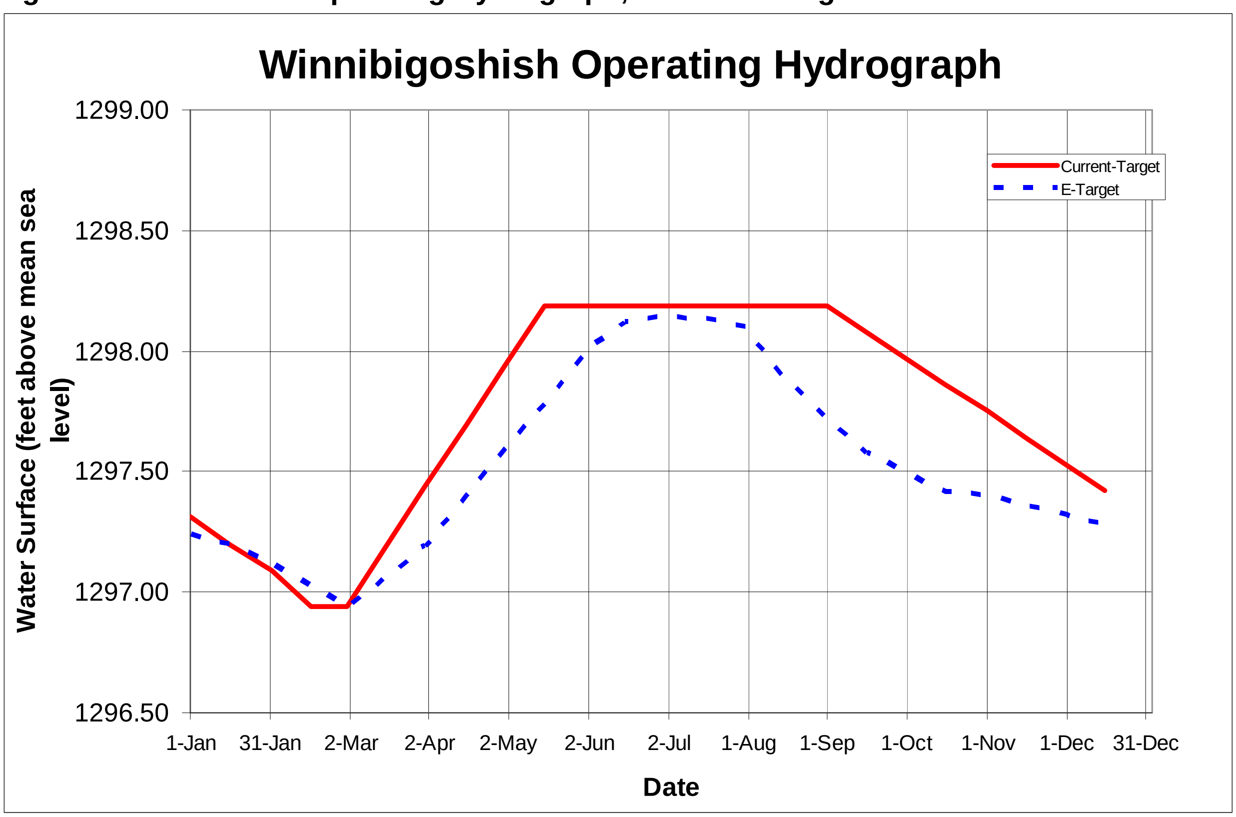


Figure 5.5.3.c. E Plan Operating Hydrograph, Leech Lake

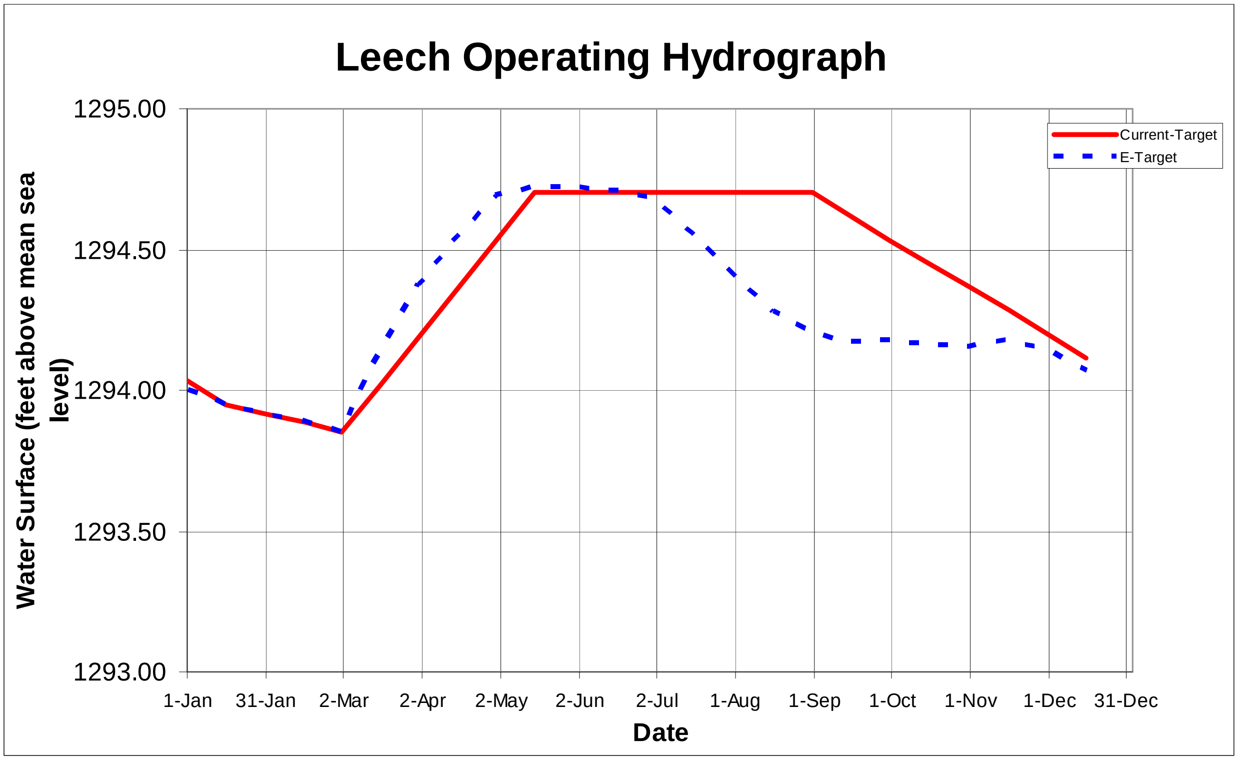


Figure 5.5.3.d. E Plan Operating Hydrograph, Pokegama Lake

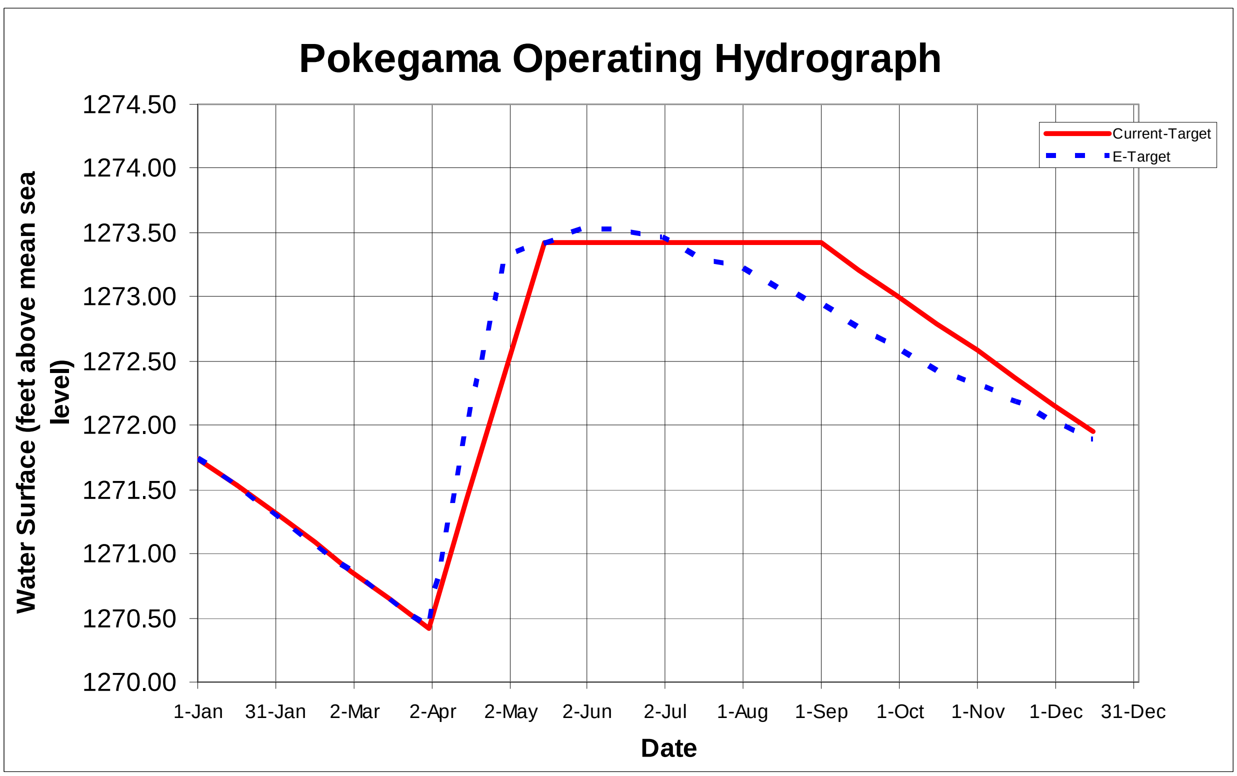


Figure 5.5.3.e. E Plan Operating Hydrograph, Sandy Lake

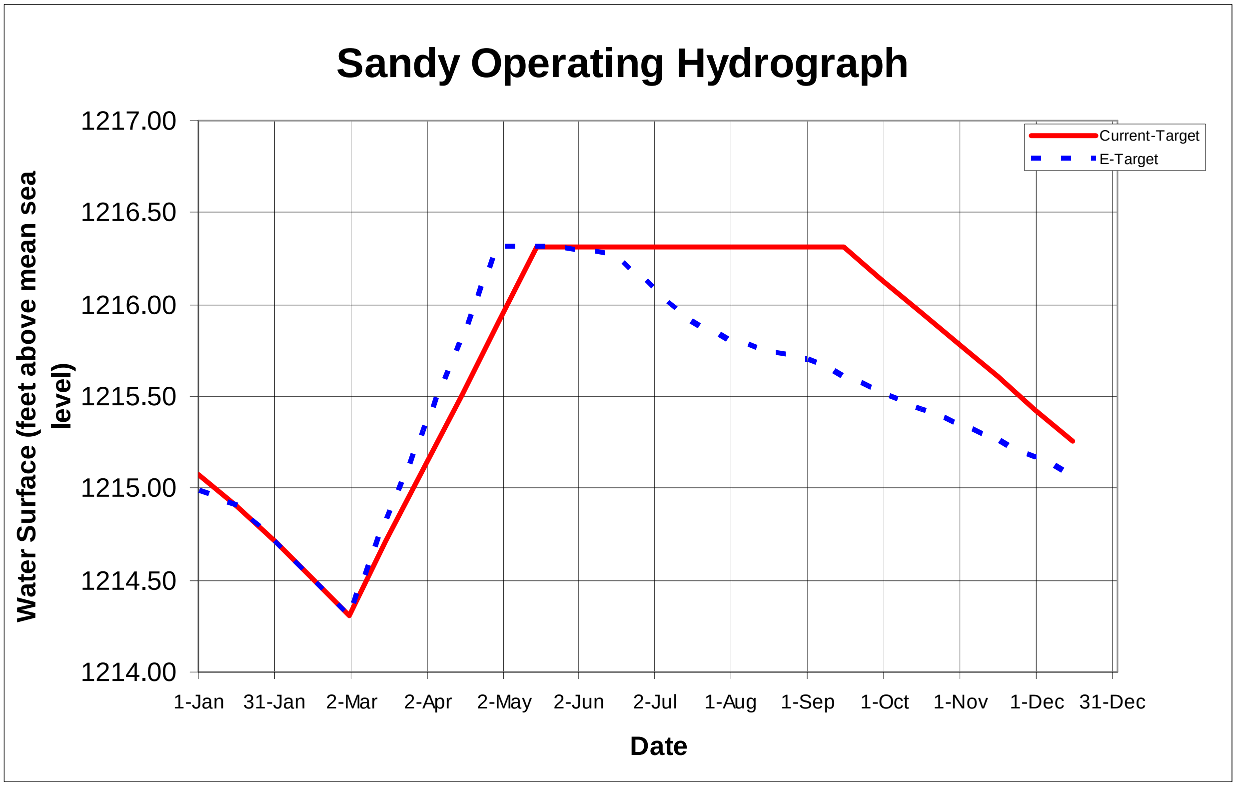


Figure 5.5.3.f. E Plan Operating Hydrograph, Whitefish Chain of Lakes

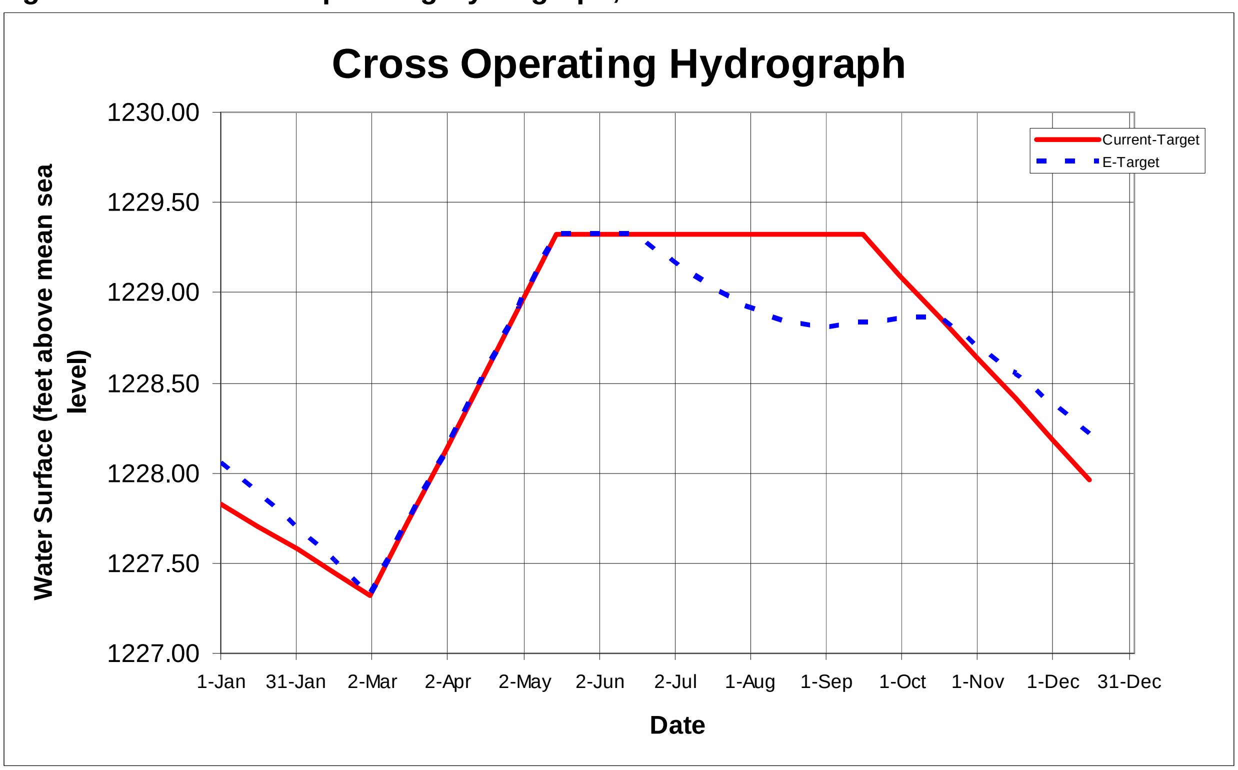
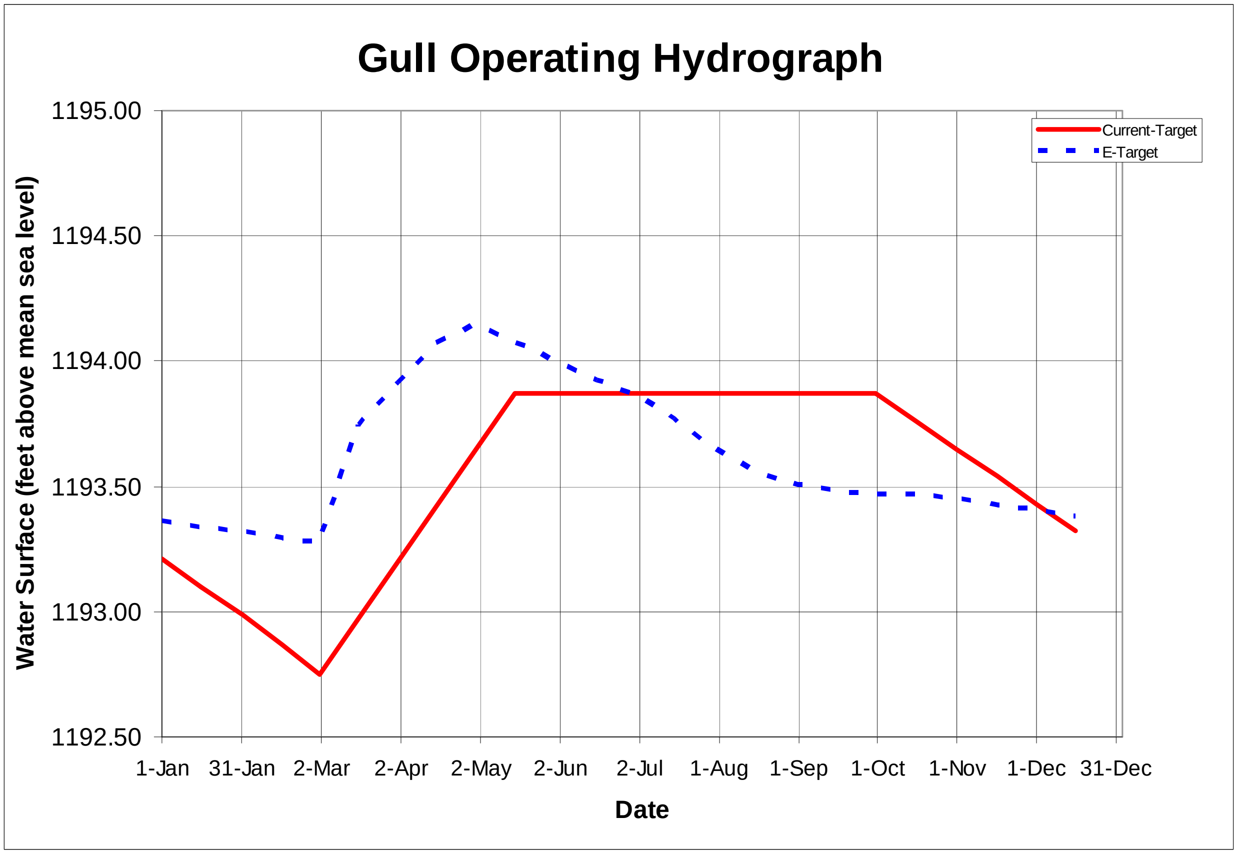


Figure 5.5.3.g. E Plan Operating Hydrograph, Gull Lake



5.5.4 T Plan

The T plan carries forward all of the components of the E plan with only minor changes, but attempts to minimize shoreline erosion by lowering water elevation targets during the open-water season an additional 6 inches.

Flood operations under the T plan would follow the procedure discussed in Section 5.3.6.3, which includes the Updated Guide Curves without Big Sandy Lake.

The water elevation targets were developed through the same process used in the E plan, except the weir elevation was adjusted to result in median summer water elevations about six inches lower than those found in the E plan. This simulated "unregulated" median water elevation was then plotted and manually readjusted to include the current drawdown targets found in Section 5.5.1. These adjusted water levels then best represented unregulated or "natural" water elevations and were used as the targeted water levels under the T plan as shown in Figures 5.5.4.a through 5.5.4.g.

The wide summer operating band component as described in Section 5.3.3.2 would be included in the E plan. This component basically consists of an 8 inch wide operating band for each reservoir.

Minimum release rules would be changed under this plan as listed in section 5.3.4.3 Revised Minimum Release Rules. The Federal Minimum Average Annual Flow would be withdrawn.

A spring pulse would be included as part of this plan as described in section 5.3.10.

The maximum winter drawdown targets would be unchanged, but the intermediate targets would be revised to reflect already lower water conditions that would occur on the reservoirs much earlier under this plan.

Specific values for this operating plan can be found in Table 5.5.4 and Figures 5.5.4.a through 5.5.4.g. Highlighted rows in the table are those that are different from the no-action alternative.

TABLE 5.5.4
BASIC PLAN COMPONENTS
T OPERATING PLAN

	Cass	Winnibigoshish	Leech	Pokegama	Sandy	Cross	Gull
Present/Total Operating Limit	NA	1294.94-1303.14	1292.70-1297.94	1270.42-1278.42	1214.31-1221.31	1225.32-1235.30	1192.75-1194.75
Ordinary Operating Limit	1300.25-1302.25*	1296.94-1300.94	1293.20-1295.70	1270.42-1274.42	1214.31-1218.31	1227.32-1230.32	1192.75-1194.75
Normal Summer **May 1 – Sep 1 **(see note 1)** **Band Elevation (ft)** **Target** **Band Width (ft)**	 target ± ½ width 1300.51-1301.51 0.67	 target ± ½ width 1297.22-1297.64 0.67	 target ± ½ width 1293.70-1294.22 0.67	 target ± ½ width 1272.44-1273.04 0.67	 target ± ½ width 1215.20-1215.80 0.67	 target ± ½ width 1228.31-1228.82 0.67	 target ± ½ width 1193.1-1193.64 0.67
Federal Min. Ave. Annual Flow	NA	NA	NA	NA	NA	NA	NA
Low Flow Limits (cfs) <u>**Min Flow Apr-Sep:**</u> **>= target** **target to (target-3”)** **target-3” to -18”** **< (target-18”)** <u>**Min Flow Oct-Mar**</u> **>= (target-6”)** **< (target-6”)**	 170 130 80 40 80 40	 210 160 110 50 110 50	 160 120 80 40 80 40	Lesser of: W+L+110 or 480 W+L+360 or 360 W+L+240 or 240 W+L+120 or 120 W+L+240 or 240 W+L+120 or 120	 100 70 50 20 50 20	 100 70 50 20 50 20	 50 40 20 10 20 10
Congressional Notification Levels	NA	1296.94 1303.14	1293.20 1297.94	1270.42 1278.42	1214.31 1221.31	1227.32 1235.30	1192.75 1194.75
Spring Pulse (cfs)	840	1060	790	2410	490	500	250
Winter Drawdown **Initial Drawdown, Target Date** **Normal Drawdown, Target Date** **(can vary based on Snow WC)**	 1299.75, Jan 15 1299.86, Feb 15	 1296.88, Jan 15 1296.87, Feb 28	 1293.70, Jan 15 1293.75, Feb 28	 1271.53, Jan 15 1270.42, Mar 31	 1214.53, Jan 15 1214.31, Feb 28	 1227.67, Jan 15 1227.32, Feb 28	 1192.84, Jan 15 1192.75, Feb 28
Maximum Winter Drawdown	NA	1294.94	1292.70	1270.42	1214.31	1225.32	1192.75
Rate of Release (change/day) **Insofar If Practicable**	20-30%	20-30%	20-30%	20-30%	20-30%	20-30%	20-30%

Rate of Release rules are not applicable when operating for flood control and/or to prevent property damage (particularly at Sandy and Gull). During other times, reasonable judgment must be exercised. For example, a large percent increase or decrease in the magnitude of the flow is not advisable (e.g. going from 300 cfs to 100 cfs in one gate move).
*For Cass Lake the Ordinary Operating Limits are defined differently than in the Corps' operating plan in that they are simply the total range of water elevations that could be expected in any given year as described in the Knutson Dam operating plan.

**Note 1: The summer band and target for this plan vary throughout the summer season. These numbers are the average elevations. Further detail of the targeted elevations can be seen from the individual reservoir lake level plots in Figures 5.5.4.a through 5.5.4.g.

Figure 5.5.4.a. T Plan Operating Hydrograph, Cass Lake

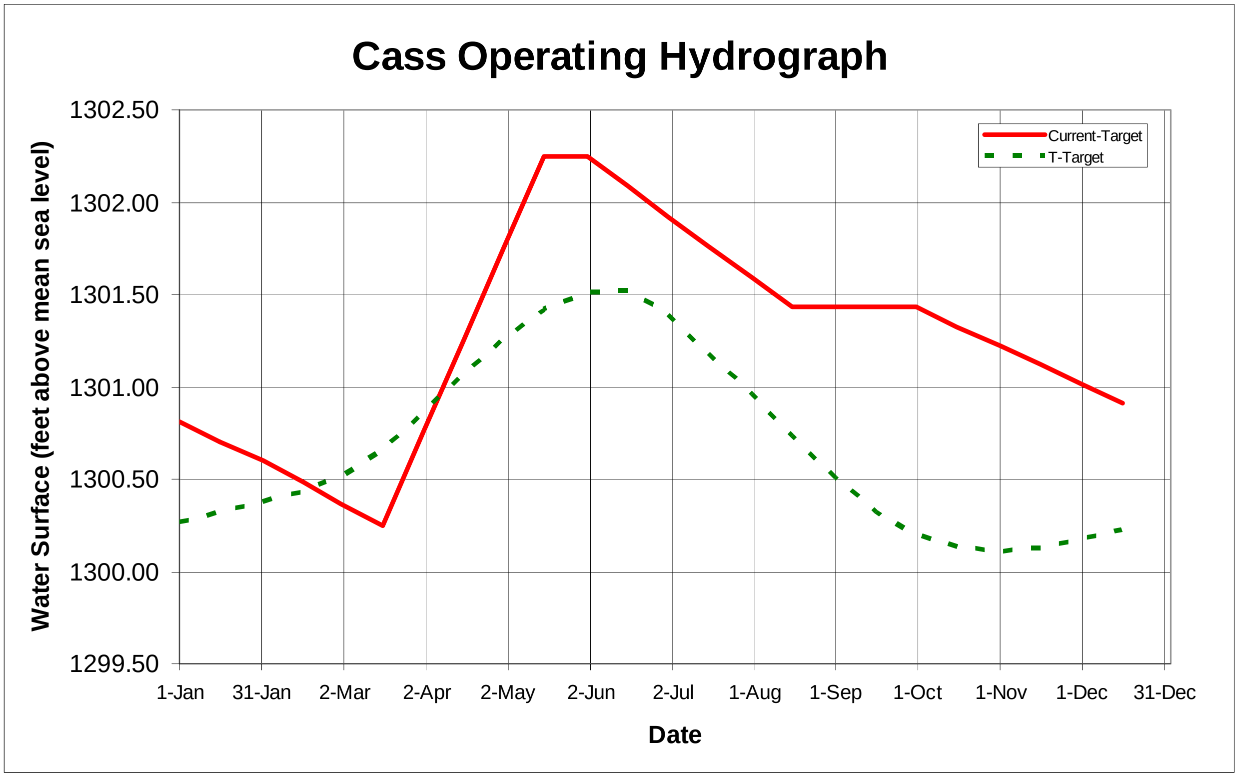


Figure 5.5.4.b. E Plan Operating Hydrograph, Lake Winnibigoshish

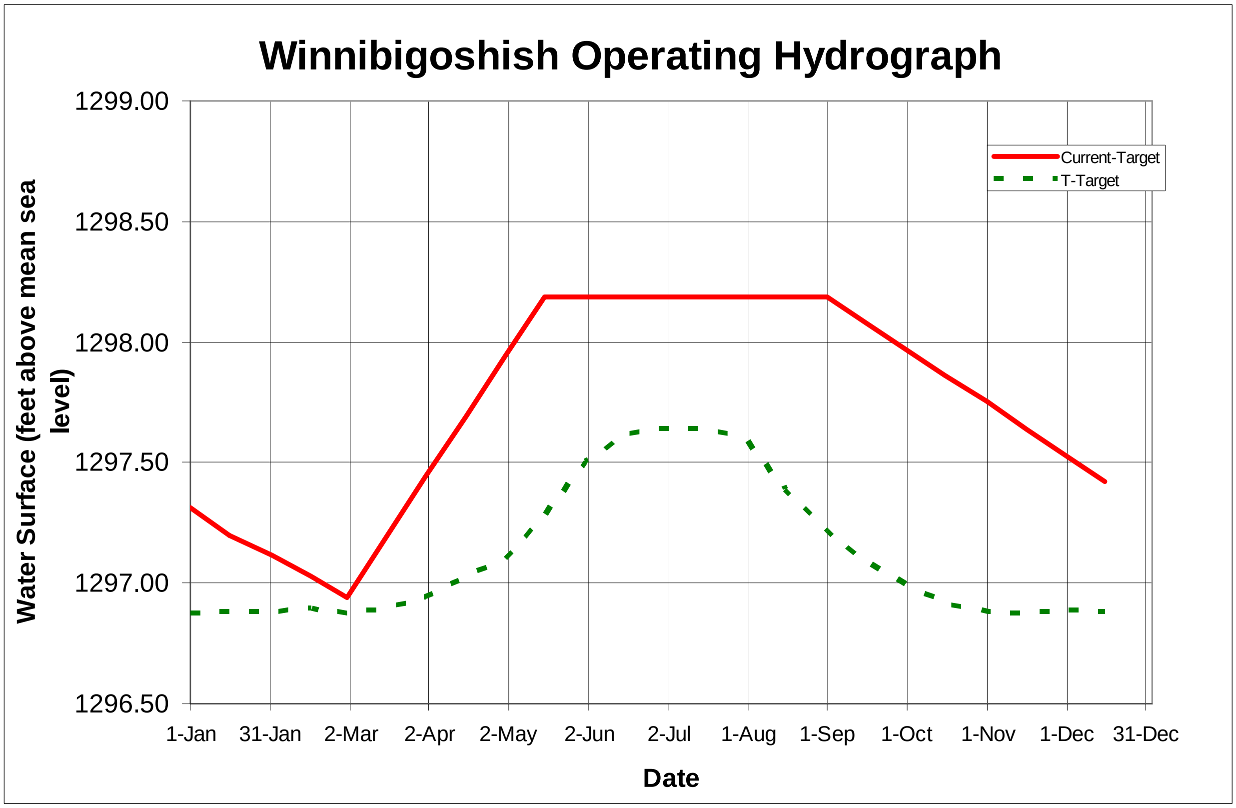


Figure 5.5.4.c. T Plan Operating Hydrograph, Leech Lake

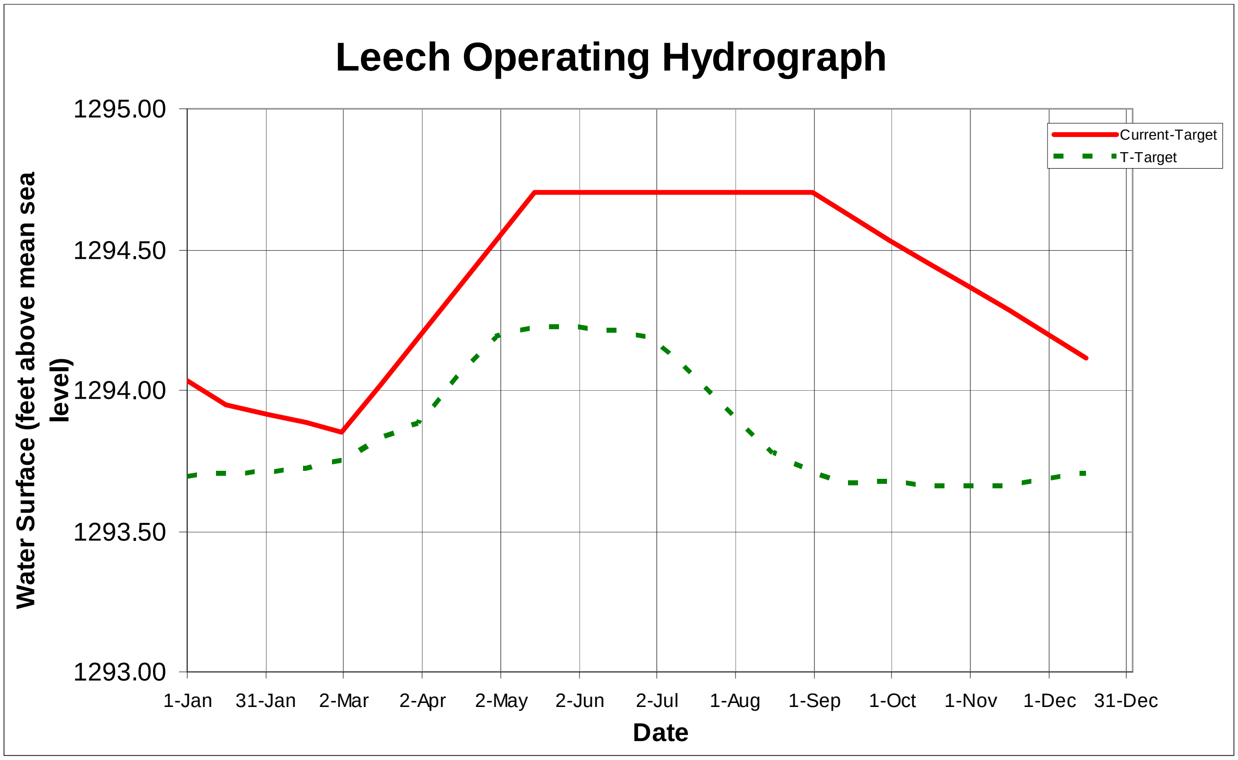


Figure 5.5.4.d. T Plan Operating Hydrograph, Pokegama Lake

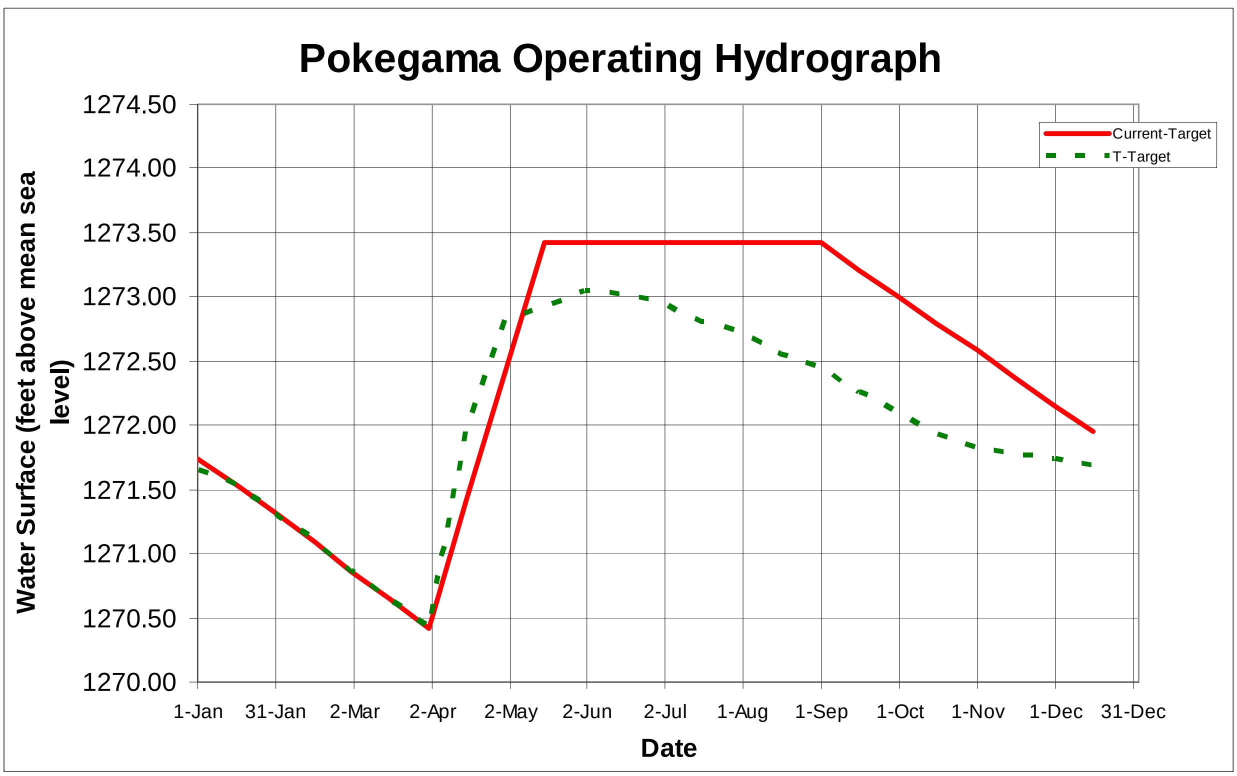


Figure 5.5.4.e. T Plan Operating Hydrograph, Sandy Lake

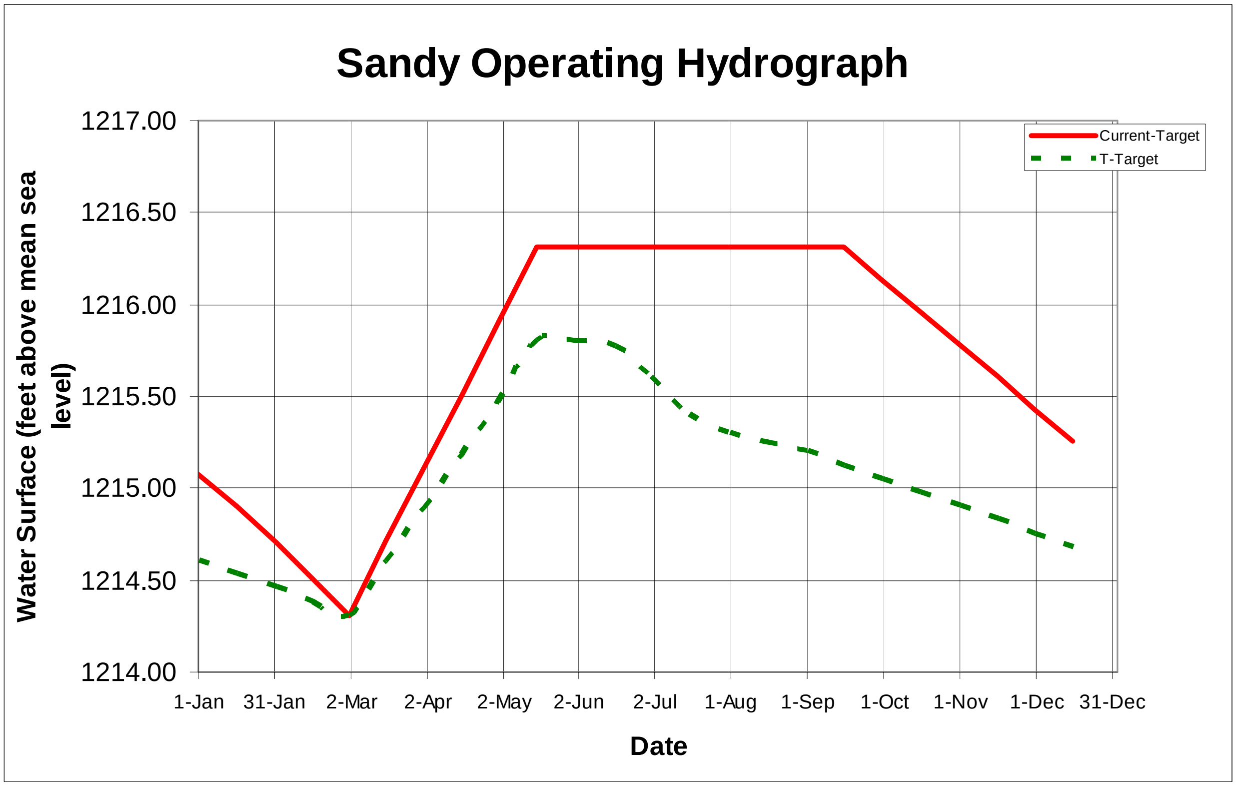


Figure 5.5.4.f. T Plan Operating Hydrograph, Whitefish Chain of Lakes

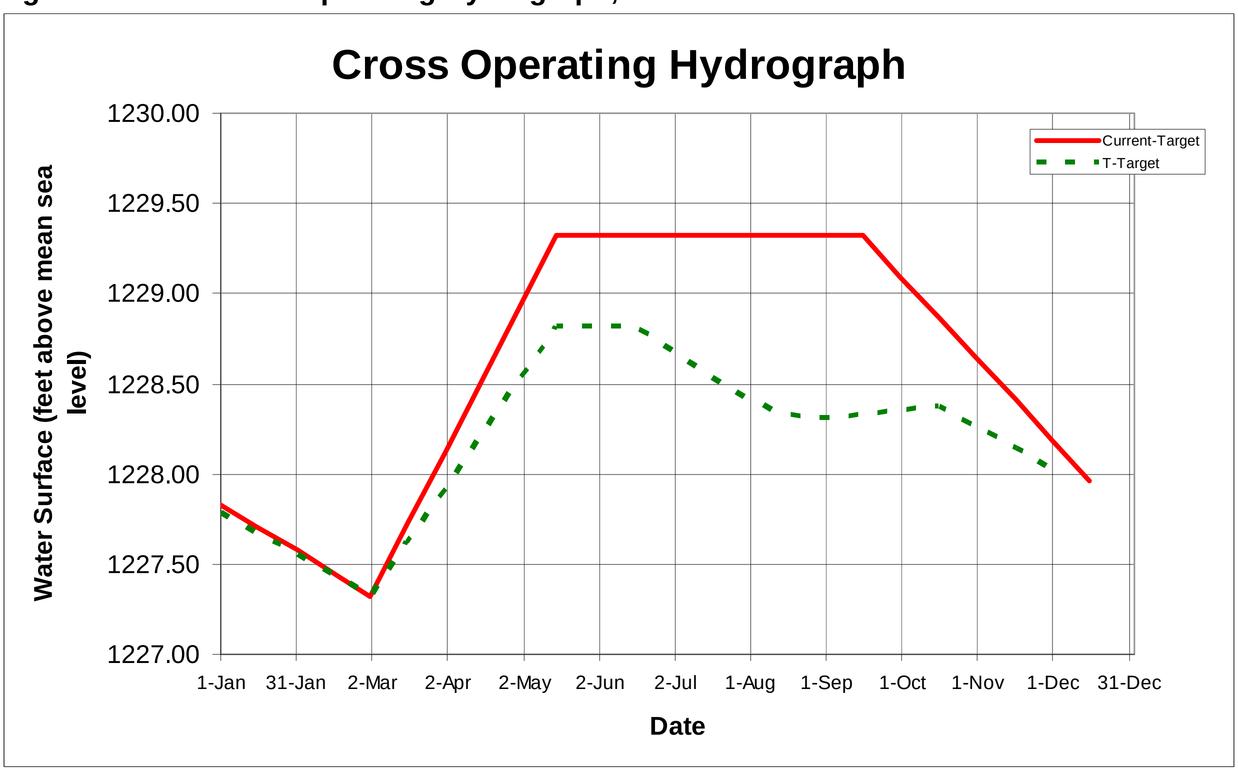
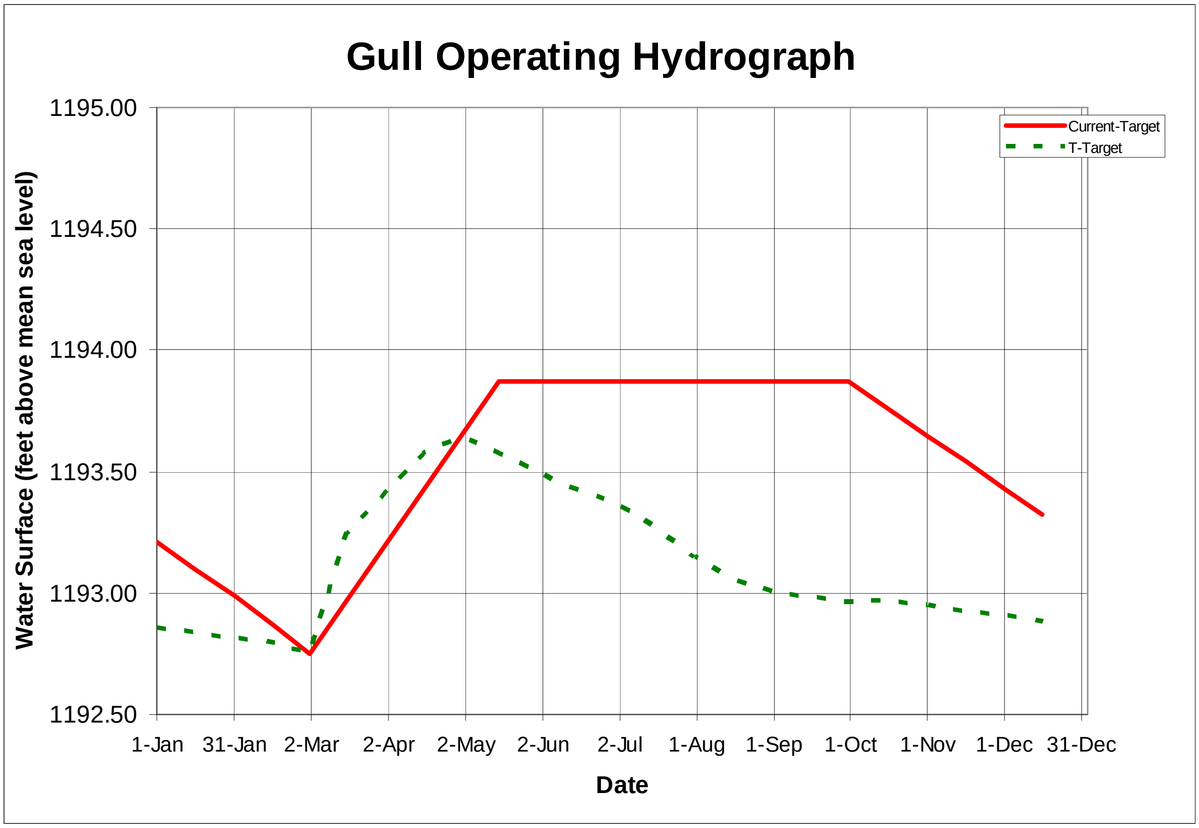


Figure 5.5.4.g. T Plan Operating Hydrograph, Gull Lake



5.5.5 P or Proposed Plan

This balanced plan attempts to provide the best mix of benefits and "costs" for all interests throughout the system. This plan was arrived at gradually by reviewing the components and impacts of the other plans and gauging public support for various changes. An attempt was made to incorporate the most beneficial component of each plan into this balanced plan. The details of this plan are discussed below with references to other sections for brevity. The tables and figures in this section should be referenced for detailed operating plan information.

Present/Total Operating Limits, Ordinary Operating Limits, Congressional Notification Levels, Reservoir Flowage Rights, and Channel Capacities are included in the proposed plan, are not modified from the current operating plan, and will not be discussed further here.

The reservoir water elevation targets would be modified from the current plan as shown in Figures 5.5.5.a through 5.5.5.g. In general, water levels on all the reservoirs would be unchanged from the current plan from early summer until July 15th. There are two exceptions to this however: 1) summer water levels would be targeted for the first of May rather than the middle of May, which may only be achievable in some years; 2) early summer water levels on Gull would be about 1.5 inches (0.13 feet) higher than the existing plan target. However, under the proposed plan after July 15th water levels would be allowed to fall on a linear trajectory such that by September 1st they would have dropped about three inches or less (see Table 7.6.1.b.). Water levels would begin to fall on Gull on September first.

The summer band would be only be modified slightly over the no-action plan. Band widths under this plan are six inches for all reservoirs but Gull, which is 3.8 inches. These are listed in Table 5.5.5 and discussed in Section 5.3.3.3.

Under the proposed plan, the Proposed Minimum Release Rules as discussed in Section 5.3.4.4 would be implemented. The Federal Average Annual Flow and the Existing Low Flow Guidelines would not be included in this plan. For Cass Lake, these revised minimums would not be implemented immediately due to the physical constraints and safety concerns with Knutson Dam (current minimum is 100 cfs which equals one gate fully open to limit the drowning risk associated with a partially-opened gate). The proposed minimums would be implemented after dam modification to improve discharge variability.

Flood operations under the proposed plan would follow the procedure discussed in section 5.3.6.3, which includes the Updated Guide Curves without Big Sandy Lake.

Normal winter drawdown targets would remain unchanged except for four minor modifications. One is to clarify that 1293.80 would be considered the normal drawdown elevation for Leech (Table 5.5.5). The second is that the drawdown guidance for Gull would be modified so that snow water content values would be raised from the current plan to reflect the higher summer pool level (1194.00) that is proposed for this plan (additional runoff needed to fill the pool) (Table 5.5.5.b). The maximum winter drawdown limits would not change under the proposed plan. Table 5.5.5.b. below would be included as guidance in the revised operating plan to assist the operator in determining draw down levels for each reservoir in any given year. The third is that the normal winter drawdown target for Cass Lake would be changed to 1300.4 to allow the reservoir to better reach summer levels as scheduled. The maximum drawdown of 1300.25 would remain in place to permit further drawdown in winters with a greater snowpack.

The fourth is that the final drawdown target date for Winnibigoshish and Leech would be moved two weeks to the end of February. This is because the earlier gradual drawdown would reduce the time needed to drain the marsh area above Pokegama.

The current Winnibigoshish/Leech outflow restriction of 2200 cfs would remain in the proposed plan.

A spring pulse as discussed in section 5.3.10 would be implemented under the proposed plan following the discharges listed in Table 5.5.5.

The rate-of-release guidelines would not be modified from the current operating plan and would be included in the proposed operating plan.

A wild rice operating component would be included in the proposed plan as described in Section 5.3.16.

Coordination meetings would be included as discussed in Section 6.2.

TABLE 5.5.5
BASIC PLAN COMPONENTS
PROPOSED OPERATING PLAN

	Cass	Winnibigoshish	Leech	Pokegama	Sandy	Cross	Gull
Present/Total Operating Limit	NA	1294.94-1303.14	1292.70-1297.94	1270.42-1278.42	1214.31-1221.31	1225.32-1235.30	1192.75-1194.75
Ordinary Operating Limit	1300.25- 1302.25*	1296.94-1300.94	1293.20-1295.70	1270.42-1274.42	1214.31-1218.31	1227.32-1230.32	1192.75-1194.75
Normal Summer **May 1 – July 15 **(see note 1)** **Band Elevation (ft)** **Target** **Band Width (ft)**	 1301.58-1302.25 1301.83-1302.0 0.5	 1297.94-1298.44 1298.19 0.5	 1294.45-1294.95 1294.70 0.5	 1273.17-1273.67 1273.42 0.5	 1216.06-1216.56 1216.31 0.5	 1229.07-1229.57 1229.32 0.5	 1193.85-1194.15 1194.0 0.3
Federal Min. Ave. Annual Flow	NA	NA	NA	NA	NA	NA	NA
Low Flow Limits (cfs) **<u>Min Flow Apr-Sep:</u>** **Within Band** **< Band to >= Band-15"** **< Band – 15"** **<u>Min Flow Oct-Mar</u>** **>= (target-6")** **< (target-6")**	 130 80 40 80 40	 160 110 50 110 50	 120 80 40 80 40	Lesser of: W+L+50 or 240 W+L+10 or 200 120 W+L+10 or 200 120	 40 20 10 20 10	 50 30 20 30 20	 40 20 10 20 10
Congressional Notification Levels	NA	1296.94 1303.14	1293.20 1297.94	1270.42 1278.42	1214.31 1221.31	1227.32 1235.30	1192.75 1194.75
Spring Pulse (cfs)	840	1060	790	2410	490	500	250
Winter Drawdown **Initial Drawdown, Target Date** **Normal Drawdown, Target Date** **(can vary based on Snow WC)**	 1300.7, Jan 15 1300.4, Mar 15	 1297.20, Jan 15 1296.94, Feb 28	 1293.95, Jan 15 1293.80, Feb 28	 1271.53, Jan 15 1270.42, Mar 31	 1214.90, Jan 15 1214.31, Feb 28	 1227.90, Jan 15 1227.32, Feb 28	 1193.10, Jan 15 1192.75, Feb 28
Maximum Winter Drawdown	1300.25	1294.94	1292.70	1270.42	1214.31	1225.32	1192.75
Rate of Release (change/day) **Minnesota DNR**	20-30%	20-30%	20-30%	20-30%	20-30%	20-30%	20-30%

Rate of Release rules are not applicable when operating for flood control and/or to prevent property damage (particularly at Sandy and Gull). During other times, reasonable judgment must be exercised. For example, a large percent increase or decrease in the magnitude of the flow is not advisable (e.g. going from 300 cfs to 100 cfs in one gate move).

*For Cass Lake the Ordinary Operating Limits are defined differently than in the Corps' operating plan in that they are simply the total range of water elevations that could be expected in any given year as described in the Knutson Dam operating plan.

**Note 1: The summer band and target shown in the table is for May 1 thru July 15th. The later half of the summer season is detailed in the graphs of each individual reservoir Shown in Figures 5.5.5.a. through 5.5.5.g. The target is within the center of the band.

Table 5.5.5.b. Proposed Plan Winter Drawdown Summary Proposed Plan: Miss. R. Headwater Reservoir System, Drawdown Information: Snow Water Content in Inches, Elev. in Feet						
Drawdown Level	**Winnibigoshish**	**Leech**	**Pokegama**	**Sandy**	**Cross L./Pine River**	**Gull**
Initial	Less Than Approx. 3 to 4 Inches Elev. 1297.20 or Higher	Less Than Approx. 3 to 4 Inches Elev. 1294.10 or Higher			Less Than or Equal To Approx. 2 Inches Elev. 1228.00 or Higher	Less Than or Equal To Approx. 2.5 Inches Elev. 1193.25 or Higher
						Approx. 2.5 to 3.5 Inches 1193.25 to 1193.00
Normal	Approx. 4 to 5 Inches 1297.20 to **1296.94**	Approx. 4 to 6 Inches 1294.10 to **1293.80** See Notes Below	**1270.42** See Notes Below	**1214.31** See Notes Below	Approx. 2 to 4 Inches 1228.00 to **1227.32**	**1192.75** See Notes Below
	Approx. 5 to 7 Inches 1296.94 to 1296.20	Approx. 6 to 8 Inches 1293.80 to 1293.50			Approx. 4 to 5 Inches 1227.32 to 1227.00	
	Approx. 7 to 9 Inches 1296.20 to 1295.40	Approx. 8 to 10 Inches 1293.50 to 1293.20 See Notes Below			Approx. 5 to 6 Inches 1227.00 to 1226.50	
Maximum	Extreme Conditions 1295.40 to **1294.94**	Extreme Conditions 1293.20 to **1292.70**	**1270.42** See Notes Below	**1214.31** See Notes Below	Greater Than Approx. 6 Inches 1226.50 to **1225.32**	Greater Than Approx. 4 Inches 1193.00 to **1192.75** See Notes Below

1. General: The above guidelines for **Winnibigoshish, Leech, Cross Lake and Gull** were developed after consultation with experienced regulators of the reservoir combined with the assumption of 30 percent runoff of the snowpack over their respective drainage areas. The Ordinary (Normal Drawdown) and Total Operating Limits (Maximum Drawdown) are in bold in the above table. The normal and maximum drawdown levels are equal at Pokegama, Sandy and Gull.

2. Winnibigoshish: Cass Lake is filled to elev. 1301.70 ft. after the spring runoff. The maximum drawdown level of Cass Lake is elevation 1300.25 ft. However, the U.S. Forest Service only draws down Cass Lake to elevation 1300.50 ft. (or higher) when the snow water content is less than or equal to 4 inches. The volume required to fill Cass L. from 1300.25 and 1300.50 ft. up to 1301.70 ft. is approx. 35,700 ac-ft and 30,400 ac-ft respectively which equals approx. 0.5 feet of elevation/storage on Winnibigoshish. This information, combined with the assumption of 30 percent runoff of the snowpack over the drainage area of 1,442 square miles, resulted in the above guidelines. However, close coordination with the U.S. Forest Service should occur every year.

3. Leech: Elevation 1293.20 is the previous "normal" drawdown level as published in the 2003 Water Control Manual. However, depending on the conditions, a drawdown to that level is not required very often as illustrated by the snow water content values listed above. Elevation 1293.80 feet is adequate for "normal" conditions. Therefore, a revised "normal" drawdown elevation of 1293.80 is proposed for this plan.

4. Pokegama, Sandy and Gull: At these locations, the normal and maximum drawdown elevations are equal. A maximum drawdown is necessary in most years at Pokegama and Sandy due to the relatively large drainages areas upstream of the reservoirs versus their storage capacity. Gull is also drawdown to the maximum most years although the above snow water content guidelines provide some flexibility. The snow water content values for Gull were revised upward from the current plan to reflect the higher summer pool level (1194.15) that is proposed for this plan (additional runoff needed to fill the pool).

Figure 5.5.5.a. Proposed Plan Operating Hydrograph, Cass Lake

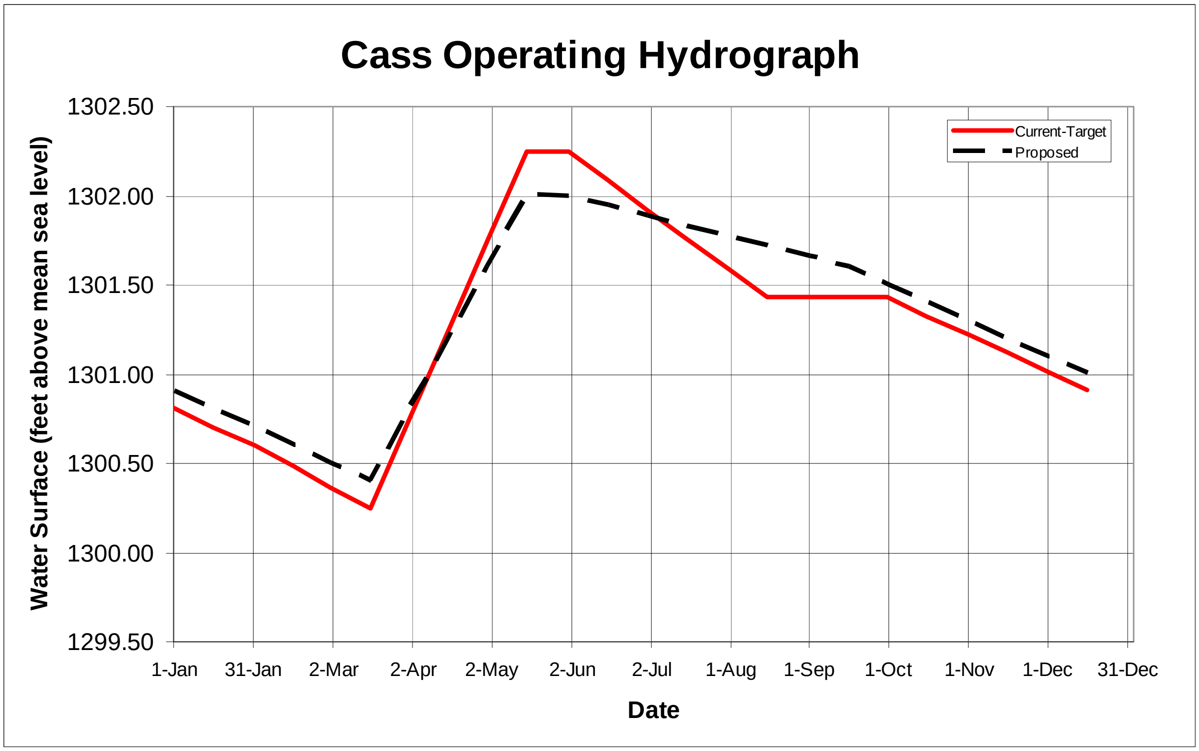


Figure 5.5.5.b. Proposed Plan Operating Hydrograph, Lake Winnibigoshish

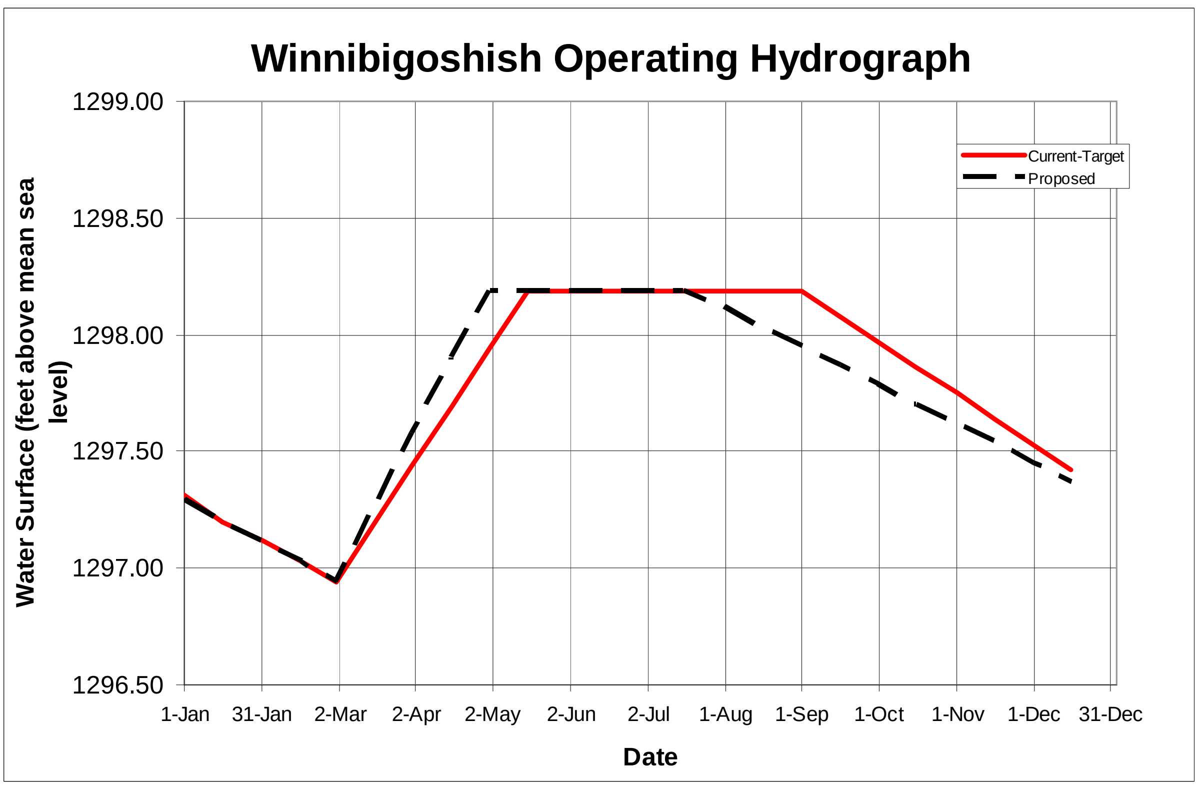


Figure 5.5.5.c. Proposed Plan Operating Hydrograph, Leech Lake

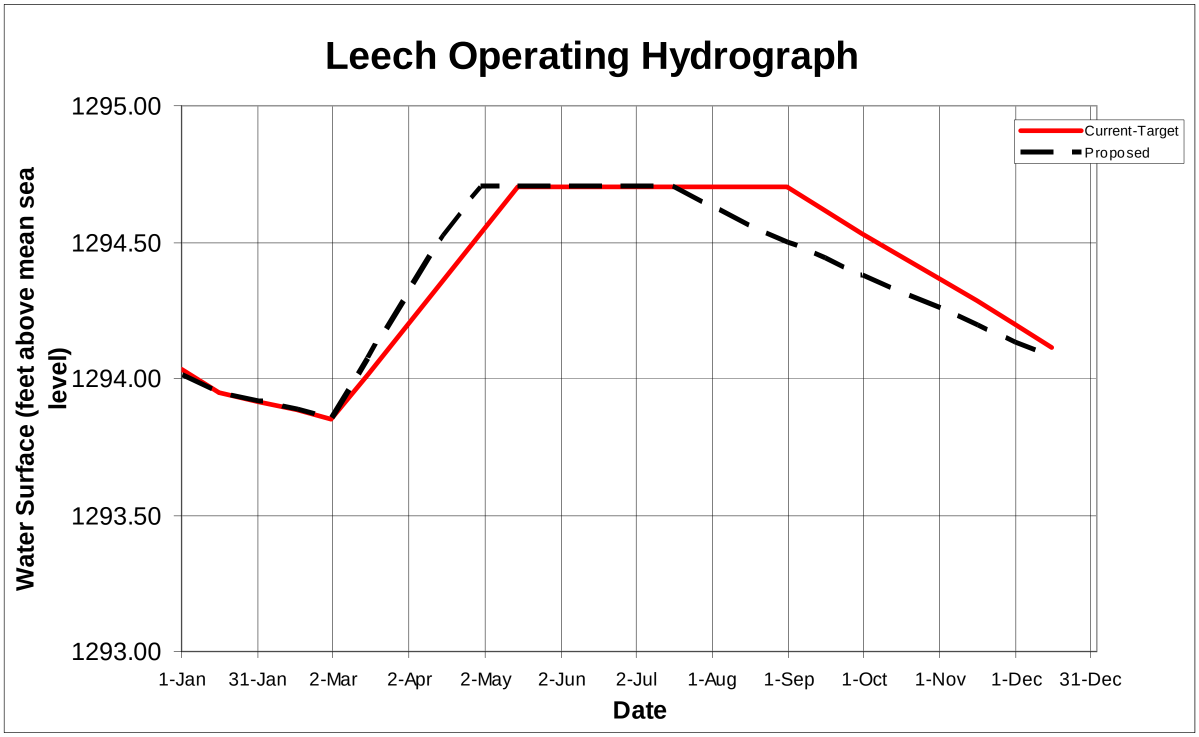


Figure 5.5.5.d. Proposed Plan Operating Hydrograph, Pokegama Lake

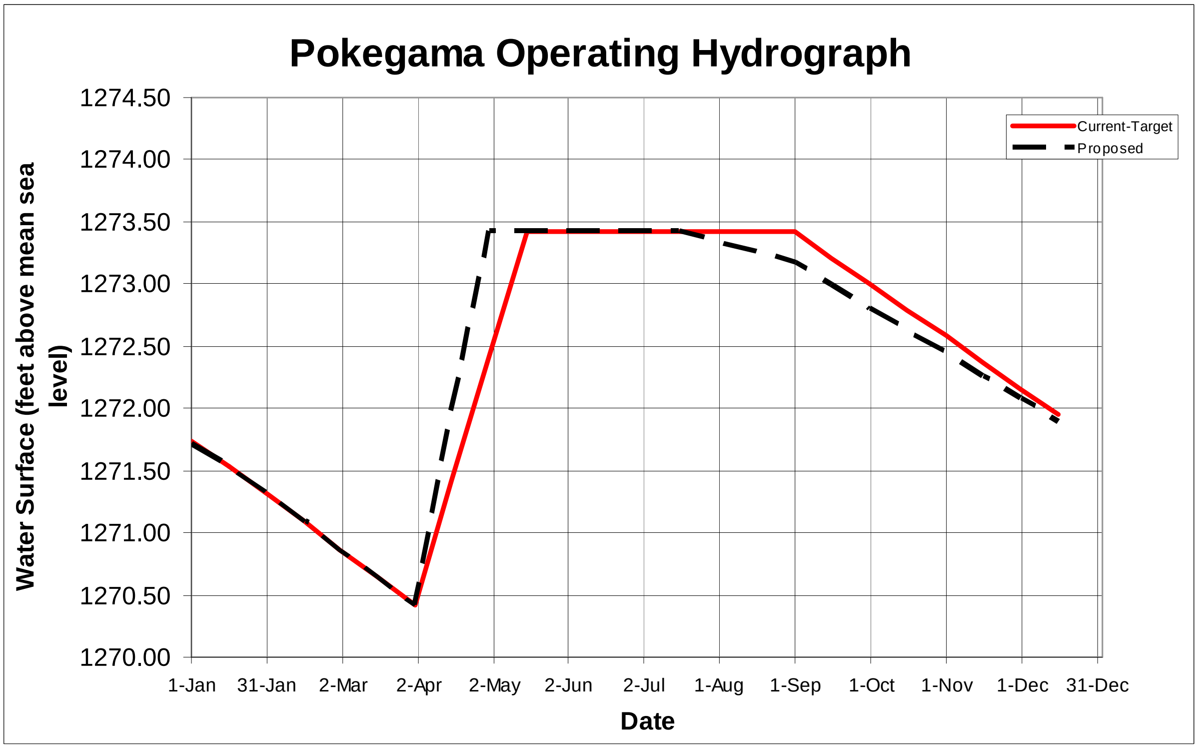


Figure 5.5.5.e. Proposed Plan Operating Hydrograph, Sandy Lake

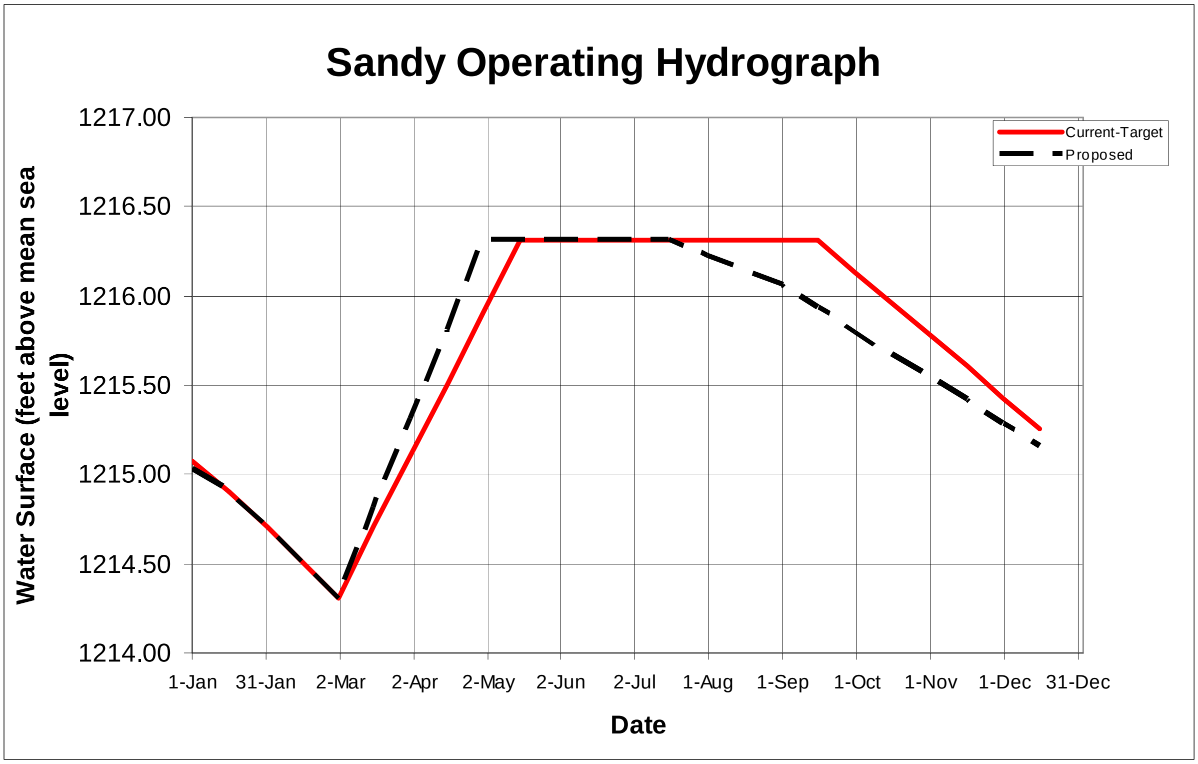


Figure 5.5.5.f. Proposed Plan Operating Hydrograph, Cross Lake

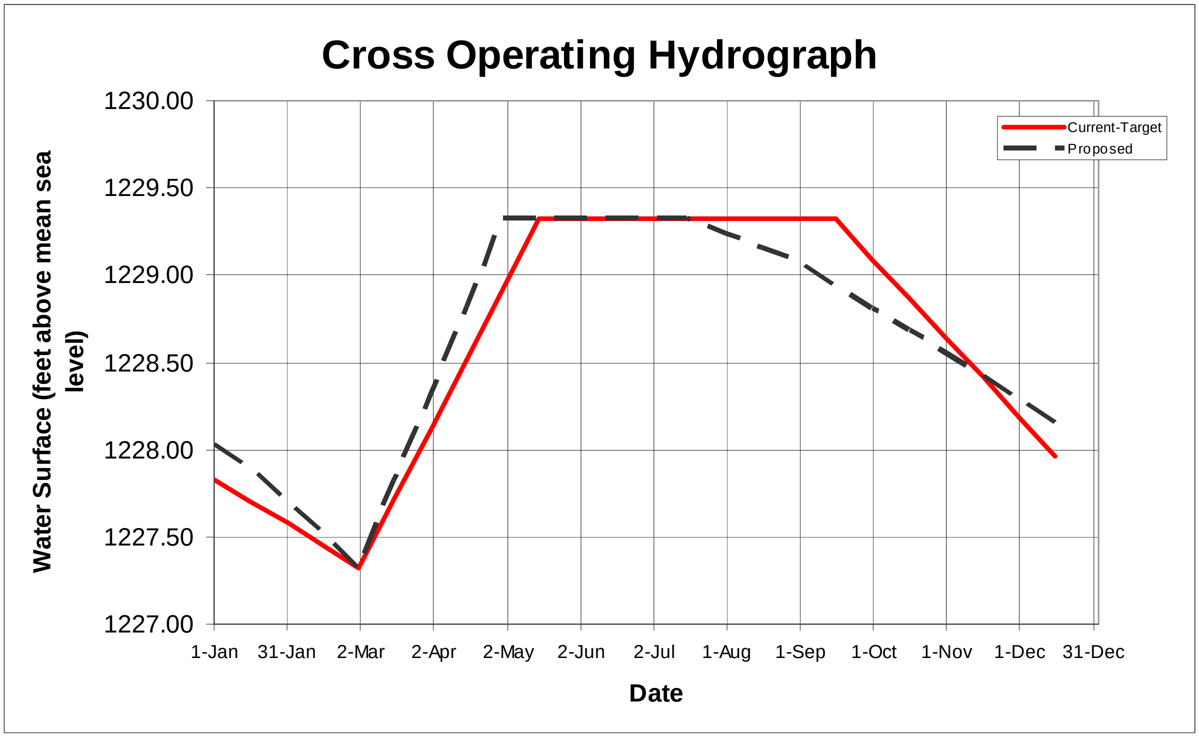
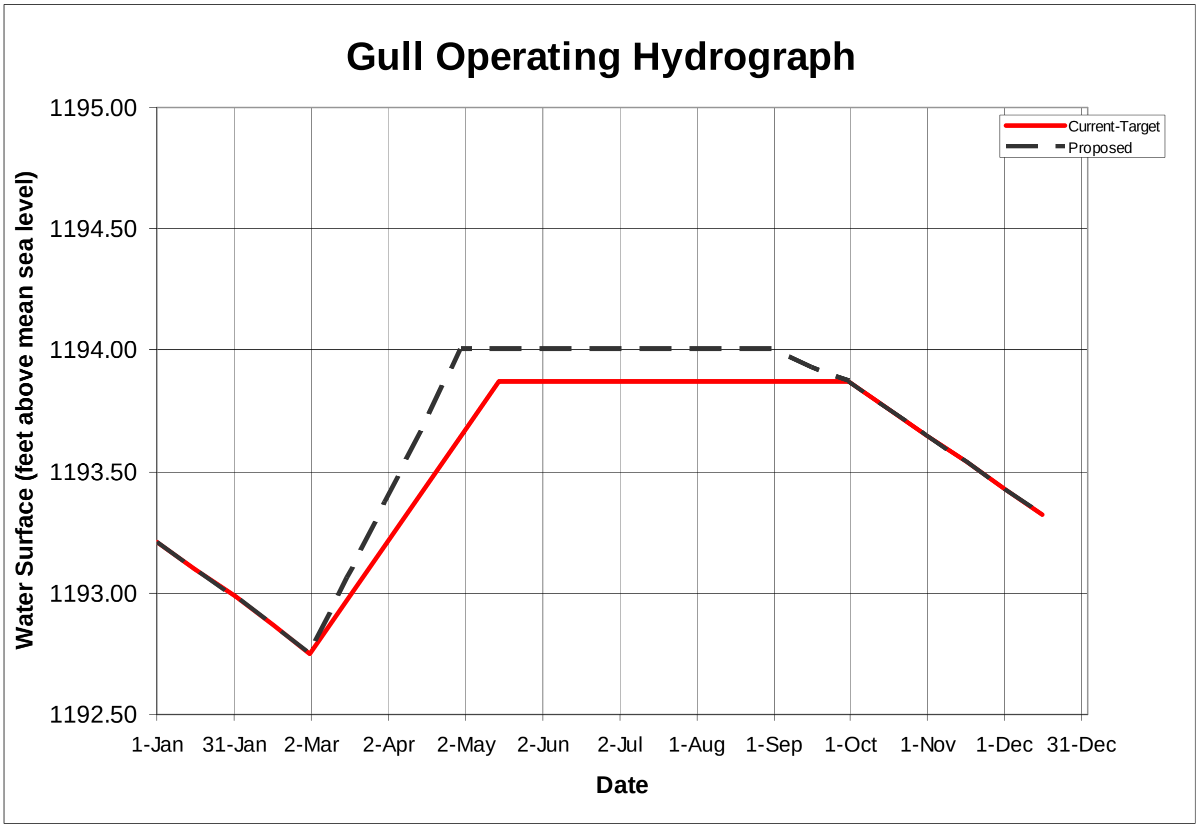


Figure 5.5.5.g. Proposed Plan Operating Hydrograph, Gull Lake



5.6 EVALUATION AND COMPARISON OF ALTERNATIVE PLANS

Plan evaluation criteria include completeness, efficiency, effectiveness, and acceptability. Completeness is the extent to which the alternative plans would provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other Federal and non-Federal entities. Effectiveness is the extent to which the alternative plans would contribute to achieve the planning objectives. Efficiency is the extent to which an alternative plan would be the most cost effective means of achieving the objectives. Acceptability is the extent to which the alternatives would be acceptable in terms of applicable laws, regulations, and public policies.

We coordinated with stakeholders and governmental agencies to solicit their input and assistance during this study. They helped identify potential solutions to the problems, helped screen the many alternatives to a manageable number for evaluation purposes, and provided feedback on effectiveness and acceptability of the alternative plans.

Each alternative plan is considered complete as each contains all the necessary components for reservoir regulation. The cost of implementation is minimal for any alternative and would be included in the existing operating budget for the reservoirs. Also, each plan is considered to be effective, but each would benefit different categories of resources to a different degree. Because of these factors, alternative evaluation was based on the evaluation of the environmental effects discussed in Chapter 7 and summarized in effects matrix in Section 7.1. The magnitudes of the various adverse and beneficial effects of the plans were compared in the effects summary matrix.

5.7 PLAN SELECTION

Selecting a plan is the final step in the planning process. The criteria for selecting a plan depend on the nature of the project and the type of outputs (benefits) produced. For this study, the plans have been analyzed in terms of the adverse and beneficial effects to the human environment. The beneficial and adverse effects to social, economic, natural, and cultural resources were compared and the plan was selected that would provide the greatest beneficial effects and the least adverse effects. Therefore, as a result of the planning process, Plan P is recommended for implementation.

CHAPTER 6. RECOMMENDED PLAN

6.1 RECOMMENDED PLAN

Plan P, as described in section 5.5.5., is recommended for implementation.

6.2 IMPLEMENTATION

The implementation of a new operating plan will occur following the completion of the ROPE Study. The new operating plan will be implemented simultaneously on all reservoirs in its entirety. It has been recommended by some members of the public that the plan be implemented in phases. However, any plan that is implemented, such as Plan P, will have strong interdependencies between components and relatively minor changes in elevations and discharges that would reduce the ease, effectiveness, and necessity of a staged implementation plan.

6.3 MONITORING, EVALUATION, AND ADAPTIVE MANAGEMENT

The planning process for the Headwaters ROPE is considered to be substantially complete. However, during the implementation of the proposed plan, it is possible that some adjustments to the plan could be required. If the modifications would be beyond the scope of this analysis, it might be necessary to prepare a supplement to this EIS to evaluate the effects of additional changes. A Supplement to the EIS would be subject to the same public and agency review process as the EIS.

Adaptive management is a process involving the implementation, monitoring, and modification of an action to reach a desired goal. For reservoir regulation in general and the ROPE study specifically, adaptive management is a process to be used to monitor and modify a new operating plan to ensure that the plan best achieves the goals for which it was originally developed. Adaptive management is especially useful when implementing a plan when there is some degree of uncertainty in its outcome. While the best available information was used in the development of the proposed operating plan, there is a possibility that some components of the plan will not produce the anticipated results. If all or portions of the operating plan for any or all of the reservoirs do not produce the intended results, the plan may be modified, but only in a manner such that modifications would make the plan more similar to the current operating plan, also referred to as the no-action alternative. If the operating plan for any given reservoir results in unforeseen and unacceptable negative impacts, the new operating plan could be entirely eliminated and the current operating plan would be reinstated. Depending on the circumstances, It is likely that a supplement to this EIS would not be required to make operating changes in a direction of effect and type toward the current operating plan; however, a public notice would be released prior to such changes. If changes to the operating plan are recommended that are different than the current or proposed plan in magnitude or direction of effect, then a supplement to this EIS will be drafted and released to the public for review and comment. The basic components of the adaptive management plan for the ROPE are outlined below.

6.3.1 Adjustment Period

For the first five years after the implantation of a new operating plan, changes to the plan will be resisted and will likely only be made if it is determined that there is a flaw in the operating plan itself. Such a flaw for example may be conflicting operating plan components that prevent the dam regulator from reaching intended stage or discharge targets. Such an adjustment period will allow some time for users to become accustomed to the changed water levels after plan implementation.

6.3.2 Annual In-House Coordination Meetings

Once a year (likely in January), or as often as needed, at least one member from Corps Water Control, Operations, Project Management, and Environmental (departments, offices, elements, or similar), and the Forest Service will meet to review and discuss operations from the previous year. Reservoir elevations and discharges will be reviewed and compared to plan targets. The general performance of the plan will be discussed, including feedback from the affected Tribes, the resource agencies, and the general public. The need for and development of operating plan changes will be discussed and forwarded to decision-makers as needed.

6.3.3 Periodic In-House Coordination Meeting

Once every five years, a Corps review team (Water Control, Environmental, Project Management, and Operations including branch chiefs) will review the past five years of project water management information to determine if changes to the plan are warranted. Potential plan changes will be presented to the District Engineer for approval.

6.3.4 Annual Tribal Coordination Meetings

The current operating plan does not include a scheduled meeting for tribal coordination. The component below has been included in the proposed plan to meet the need for improved tribal coordination.

Each year, likely in February, representatives from the District's Water Control and Environmental departments will travel to meet with staff members of the Department of Natural Resources of the Mille Lacs Band of Ojibwe, and the Leech Lake Band of Ojibwe Division of Resource Management to discuss Headwaters reservoirs water level operations of the previous and upcoming years. The intent will be to determine if the operating plan can be improved for the upcoming year to benefit resources of interest to the Bands, particularly wild rice. The discussions may also include plans for monitoring of important resources and other topics with the intent of improving operations.

6.3.5 Annual Reservoir Operators Coordination Meeting

The current operating plan does not include a scheduled meeting for coordination between other dam operators in the Headwaters. The component below has been included in the proposed plan to meet the need for improved coordination.

Each year, likely in March, a meeting will be hosted in the Headwaters by the District with participation by the operators of selected dams in the system. The primary purpose of this annual meeting would be to plan for spring runoff by sharing information regarding the snowpack and coordinating future operating activities. At a minimum, one representative from each of the non-Corps dams listed here would be encouraged to attend, with additional dams and personnel included as deemed appropriate: 1) Otter Tail Power (Stump Lake); 2) US Forest Service (Cass Lake); 3) Corps of Engineers (Lake Winnibigoshish, Leech Lake, Pokegama Lake, Sandy Lake); 4) MDNR (Mud Lake); 5) Minnesota Power (Blandin Dam); and 6) Minnesota Power (Prairie River Dam).

CHAPTER 7. ENVIRONMENTAL EFFECTS

The No-Action/Current Operating Plan alternative serves as the base condition against which the alternative operating plans will be compared for the purpose of evaluating impacts. The No-Action Plan assumes that the reservoirs will continue to be operated as the have been under the Current Operating Plan.

The assessment of the effects of the alternative operating plans is based on various techniques including simulated reservoir elevations, discharges, and river flows under each plan. Hydrologic data for a 70-year period (1930-2002) were used here. Model output exists for all reservoirs and numerous river locations throughout the project area. Some of this information is used below to help define potential impacts. However, due to the difficulty in interpretation and the high number of potential figures, they are not included here but examples are attached in Appendix E for further review.

7.1 ENVIRONMENTAL EFFECTS SUMMARY MATRIX

The effect summary matrix is a general representation of the potential types of effects under the different operating plan alternatives over the whole project area. There are unique differences and contradictions to these listed effects in specific locations and for different plans. These differences are discussed in detail in the sections that follow.

Table 7.1. Comparative Direct Short-Term Effects of Operating Plan Alternatives Generalized for the Project Area.

	Current Plan - Existing Condition Compared to Future	R Plan	E Plan	T Plan	Proposed Plan (P)
Air Quality	0	-1	+1	+1	+1
Terrestrial Habitat	-1	-1	+1	+2	+1
Sedimentation and Bank Erosion	-1	-1	+1	+3	+1
Wetlands	-1	-1	+1	+1	+1
Aquatic Habitat	-1	-1	+1	+3	+1
Fishery	-1	-1	+1	+3	+1
Biological Productivity	-1	-1	+1	+2	+1
Biological Diversity	-1	-1	+1	+2	+1
Water Quality	-1	-1	+1	+2	+1
Threatened & Endangered Species	0	0	0	0	0
Recreational Opportunities	0	+1	-2	-3	-1
Public Health/Safety	0	0	-1	-1	0
Community Cohesion	0	0	-1	-2	0
Community Growth and Development	0	+1	-1	-1	0
Controversy	0	-1	-2	-3	-1
Property Values	0	+1	-1	-2	0
Regional Growth	0	0	0	0	0
Employment	0	0	-1	-1	0
Business Activity	0	+1	-1	-2	0
Flooding Effects	0	-1	+1	+2	+1
Historic Architectural	0	0	0	0	0
Archeological	-1	-1	+1	+1	+1

Key:

+3 = Significant Beneficial

+2 = Substantial Beneficial

+1 = Minor Beneficial

0 = No Effect

-1 = Minor Adverse

-2 = Substantial Adverse

-3 = Significant Adverse

7.2 NO ACTION ALTERNATIVE

The no-action alternative is simply the continued operation under the existing operating plan for the next 20 years, the period of evaluation. Only minor modifications would be made as have been in the past. For more information on this alternative, please see section 3.3.1.

7.2.1 Water Levels/Elevations and Flows – No Action

There would be no effect on water levels under the no-action alternative. Numerous resources in the Headwaters, however, are and would continue to be affected by current water level patterns. A variety of hydrologic data were used throughout the study to assess the effects of the current operating plan. Regarding the no-action plan, actual measured data was utilized. The period of record reviewed included data from 1930 to present for the Corps of Engineers-owned reservoirs. A shorter record was available for Cass Lake. Some examples of these data are included in Appendix E for review; however, the amount of data available is too great for full reproduction in the EIS.

7.2.2 Natural Resource Effects – No Action

7.2.2.1 Introduction

The no-action alternative assumes that for the next 25 years, the current operating plan will remain in place with only minor modifications as needed. The effects of this plan discussed below are generally comparing conditions now to conditions in the future, out to about 25 years. Therefore, the discussions are focused on environmental changes as a result of continued reservoir operation into the future, and not on changes that occurred as a result of the original construction of the dams.

7.2.2.2 Air Quality

Air quality effects discussed here are primarily the result of the power production facilities, specifically the combination of thermal production (primarily coal-fired) and hydropower production facilities. Hydropower production capacity is inversely related to air quality because as hydropower production declines, thermal production and the resulting emissions to offset the loss of power would increase. Under the no-action plan, hydropower production would not change as a result of reservoir operation; therefore, there would be no effect on air quality under this alternative.

7.2.2.3 Terrestrial/Upland Habitat

There would be a minor adverse effect on upland habitat due to continued bank erosion, primarily around the reservoirs.

7.2.2.4 Sedimentation/Bank Erosion

Under the no-action plan there would be a minor adverse effect due to continued bank erosion and sedimentation. Water levels in the reservoirs are higher than prior to dam construction. The original shoreline and beach would have stabilized over thousands of years to a low beach angle that was in equilibrium. The original upland shoreline was steeper and the operation of the dams resulted in lake levels raising to where water is now acting on the steeper banks and eroding them. This erosion would occur until the shoreline lake bottom again reaches a shallow angle that is relatively stable.

All of the study reservoirs experience bank erosion under the current plan to some degree. Cass Lake, Lake Winnibigoshish, Sandy Lake and the Whitefish Chain of Lakes have significant levels of bank erosion. Some banks have been artificially stabilized, especially on Lake Winnibigoshish, but most of the banks are unprotected. This erosion will continue under the no-action plan.

As the banks erode, the sediment washes into the lake. This has an adverse effect on substrate composition by covering up course substrate such as gravel and cobble that is important fish spawning habitat. Under the no-action plan, this sedimentation would continue to adversely affect substrate.

River bank erosion is also occurring under the current operating plan and would continue under this alternative. To some degree, this is a natural process on river systems and is desireable (Florsheim et al. 2008). However, a significant level of undesirable river bank erosion occurs in wetlands by breaking off large sections of floating bog. Most likely this occurs as a result of higher flows during winter drawdowns, which would continue under the no-action plan. The higher flows act on frozen sections of floating bog, which causes them to break off in large sections. Under a more natural flow regime, winter flows would be relatively low and would not act on the floating mats to cause frequent mass failures.

7.2.2.5 Wetland/Floodplain habitat

The existing operating plan has likely had a minor adverse effect on wetland habitat through disruptions in the natural hydrologic regime. Higher water levels in the winter and lower water levels early in the spring relative to more natural conditions would impact wetland habitat quality for a variety of species of plants and animals. Altered hydrology can affect nutrient cycling, dissolved oxygen levels, turbidity, freeze/thaw cycles and a number of other variables.

It is difficult to speculate whether or not wetland and floodplain habitat quality would decline further under the no-action alternative. It is assumed that there would be a further decline of this habitat type, but that this decline is likely to be minor.

7.2.2.6 Aquatic Habitat

The continued operation under existing operating plan would result in a minor adverse effect to aquatic habitat on the reservoirs and rivers in the study area into the foreseeable future. This effect on the reservoirs would be due to continued shoreline erosion and sedimentation as previously discussed. Also, the altered hydrology, and specifically the lack of periodic or seasonal low water conditions would continue to inhibit the reestablishment of emergent plant beds. Emergent plants such as wild rice, cattail, bulrush, and arrowhead benefit by low water, as it encourages seed germination and, therefore, the expansion of emergent plant beds. A similar adverse effect in riverine

7.2.2.7 Fish

There would be a minor adverse effect on fish under the no-action alternative. Continued sedimentation in coarse-substrate spawning habitat would reduce the quality and availability of such habitat for numerous species including walleye. The declining availability of emergent plant beds would reduce the availability of spawning and nursery habitat for numerous species including northern pike. Riverine fish species would be impacted by unnatural hydrologic conditions. Spring flows under the existing plan occur later and at a lower magnitude than they would under natural conditions. This disrupts the timing of spawning due to the lack of a correctly timed spawn-triggering pulse, and the survival of fry by increasing the magnitude and frequency of high water after hatching. High flows during the winter months induce stress on fish that have moved into slow deep pools during the winter when cold water slows metabolisms.

Whitefish have been identified in the past as potentially been impacted by the late winter drawdown. This species spawns in the late fall; therefore, incubation and hatching can be adversely affected by declining water levels during the winter.

7.2.2.8 Mussels

There would be a minor negative effect on mussels in the project area under the no-action alternative. It seems likely that sedimentation would be the dominant contributing factor as it would cover hard substrates favored by many mussel species. Mussel diversity and density is generally lower in the study area than in other parts of the country however, and the number of individuals and species would be low relative to potential impacts in other areas of the Mississippi River drainage.

7.2.2.9 Birds

Under the no-action plan there would be a minor adverse effect on some bird species in the project area. Waterfowl nesting is currently impacted downstream of the reservoirs, especially Lake Winnibigoshish and Leech Lake. In spring, water is stored for flood damage reduction, often resulting in minimum releases from the reservoirs. This in turn results in low water levels in adjacent downstream wetlands during the time when some species of waterfowl are building nests and laying eggs close to the waterline. Under more natural hydrologic conditions, water levels in the rivers would have been higher during nest building, thereby encouraging birds to nest higher, which would have decreased the likelihood that subsequent high water would impact nests. However, under the current operating plan, once the primary flood season has ended, flows can be and are often greatly increased from the reservoirs late in spring, and nest flooding is often observed. Under the no-action plan, the adverse effect will continue into the future.

It is difficult to gauge the significance of this impact due to a lack of empirical data regarding the frequency of occurrence and the species it affects. Waterfowl in general are considered a significant resource and many species are in a state of general decline, presumably due to a decline in nesting habitat quality and availability.

7.2.2.10 Mammals

The no-action plan would have a minor adverse effect on semi-aquatic mammals in the study area. The disruption in the natural hydrology would negatively impact the wetland mammals whose life-histories are tailored to a natural hydrologic regime. More specifically, muskrats would be particularly impacted. Muskrats build their lodges within wetlands during the summer and fall in preparation for winter. If water levels in wetlands rise significantly during the winter months, as does occur below the reservoirs as a result of winter drawdown, lodges can be flooded out resulting in high muskrat mortality. This effect is probably most acute in the large wetland complex that exists between Lake Winnibigoshish, Leech Lake, and Pokegama Lake. Additionally, lodges constructed in the wetlands directly connected to the reservoirs upstream of a given dam can be impacted by winter drawdown through lowering water levels to the point where freeze-out can occur in the winter.

7.2.2.11 Biological Productivity

The no-action alternative would continue to have a minor adverse effect on biological productivity through the study period. It is likely that the artificial hydrology would continue to suppress biological productivity of many species in the study area through a number of mechanisms as discussed in more detail throughout Section 7.2.2.

7.2.2.12 Biological Diversity

The no-action alternative would have a minor adverse effect on biological diversity through the study period. It is likely that the artificial hydrologic regime has eliminated some species and reduced the abundance of others that are sensitive to changes in hydrology. This is most probable for species that have specific habitat requirements, and are considered specialists, and applies to plants and animals. Species that have more general requirements and are more adaptable would be less affected and could benefit with the decline in competition from more specialized species. This is likely most applicable to plant species, where more stable water levels on the reservoirs would tend to favor perennial deep-water species. In general, shallow and annual species such as bulrush and wild rice, respectively, benefit from periodic low water conditions for their germination and reduction in competition from other species.

7.2.2.13 Water Quality

Water quality in the project area is currently impacted primarily by mercury, turbidity, dissolved oxygen, and phosphorus. Mercury and phosphorus enter the system from external sources and are not directly impacted by reservoir operation. The cycling of mercury and phosphorus could be impacted by reservoir operation to a minor degree. Mercury methylation, the process by which inorganic mercury is converted to the more toxic form, methylmercury, could potentially be influenced by hydrology, though it is very difficult to determine how or to what magnitude. It is unlikely that phosphorus levels would be impacted by reservoir operation.

Riverine dissolved oxygen levels can be influenced by dam operation through the volume of water moving downstream. In general, higher downstream flows maintain higher dissolved oxygen levels through increase turbulence and air-to-water oxygen exchange. Also higher flows tend to help reduce water temperature, which is inversely related to the amount of oxygen which can be dissolved in water. Low minimum releases under the current operating plan increases the probability that oxygen depletion can occur downstream of the reservoirs, especially in summer months. However, no documented fish kills are known to have occurred from this factor, therefore, it is assumed that the continued impact under the no-action alternative would be minor.

Reservoir and riverine turbidity would continue to be influenced by eroding banks under the no-action alternative. This impact on water quality is considered minor and is not expected to change under this alternative during the study period.

7.2.2.14 Groundwater

There would be no effect to groundwater under the no action alternative during the study period because there would be no significant changes in hydrology or its impacts on groundwater.

7.2.2.15 Threatened and Endangered Species

There would be no effect on federally-threatened and endangered species under the no-action alternative.

7.2.2.16 Tribal Interests in Natural Resources

The original construction of the Headwaters Reservoirs and their subsequent operation was devastating to many aspects of Ojibwe life. The flooding of habitat critical to the plants and animals on which the Ojibwe relied had a significant detrimental impact to their ability to meet their most basic needs.

The operation of the reservoirs under the no-action plan would have a negative effect on the natural resources of the Headwaters region as discussed above. It has been stated by the Mille Lacs and Leech Lake Bands of Ojibwe, that all of the natural resources found in the Headwaters hold value and no one species can be singled out as having more value over another due to the web of interrelationships between all living things. However, in the context of this evaluation, wild rice deserves special consideration due to its dependence on water and due to its significance to the Ojibwe people. The primary concerns relative to wild rice and the operation of the Headwaters reservoirs is best summarized in the Leech Lake Band of Ojibwe Tribal Interest Inventory (LLOB, 2205):

> "Throughout the headwaters region there have been declines in the quantity and productivity of wild rice beds. Wild rice is an important cultural resource to Native Americans as well as an important food for wildlife, particularly waterfowl. Wild rice is an annual plant (grows from seed each year) so it is best adapted to conditions that include periodic disturbance, which results in old plant material being recycled back into the substrate. This can occur when water levels are low and wave action can penetrate deeper into the water, or as a result of ice action. In a stable situation most annual plants will be out-competed over time by perennial plants such as water lilies that store food materials in their roots and are able to grow much faster in the spring.

> Silt from erosion increases the turbidity of the water, which in turn reduces the ability of sunlight to penetrate to the substrate and stimulate germination of annual plant seeds or growth of young plants. Restoring some fluctuation to the water level should alleviate these problems."

There are likely a number of factors currently affecting wild rice such as nutrient loading, boat traffic, herbicides, hand-removal, and of course reservoir regulation. Under the no action plan, it is believed that the extent and productivity of wild rice in the project area would continue to decline and that the operation of the reservoirs would likely be a significant contributing factor. The unnaturally stable water levels induced by the current operating plan are likely detrimental to the extent and productivity of rice beds.

7.2.3 Social Effects – No Action

7.2.3.1 Noise

No transient noise impacts or changes in ambient noise levels are anticipated as a result of implementation of the No Action Alternative.

7.2.3.2 Aesthetics

Aesthetics can be defined as being concerned with the characteristics of objects or collections of objects (in this case the landscape) and the human perceptions that make them pleasing or displeasing to our senses. Sights, sounds, scents, tastes, and tactile impressions interact with natural resources and cultural influences to produce psychological feelings of pleasure in certain landscapes. However, all humans are different. Individual perceptions and values applied to the wide range of potential aesthetic attributes are subjective. The old saying that "beauty is in the eye of the beholder" is very applicable to judgments regarding aesthetics. A 1996 survey of public preferences for future management of the Upper Mississippi River System found that over 80 percent of respondents indicated that they agreed or strongly agreed with a statement that the ambience and aesthetics of the Upper Mississippi River System were important to them (Carlson 1999).

No change to the existing aesthetic values would be anticipated under the No Action Alternative. Reservoir operations would continue, unchanged from current conditions. Seasonal variations in water levels associated with winter drawdown would continue to occur as they have since the 1960s. Those accustomed to existing reservoir operations and the associated aesthetic effects would experience a continuation of the values they have come to expect and appreciate. However, concerns about the effects of current reservoir operations that may adversely affect aesthetic values were raised by some during scoping. Adverse aesthetic impacts resulting from lake shore erosion as a result of elevated lake levels, shoreline vegetation that has been altered from natural conditions, and river flows that altered from naturally occurring conditions would continue. Concerns about lakeshore development and associated effects to water quality will not be addressed under this or other alternatives, as it is outside the scope of the proposed action.

7.2.3.3 Recreation Opportunities

The current operating plan would not change under the no-action alternative (see Section 3.3.1). In the short term, there would be no effect to recreation opportunities under this alternative. However, there is the potential for a detrimental effect on some recreational opportunities in the long run under the no-action plan. Diminished quality of natural resources as described in Section 7.2.2 could lead to less satisfaction with recreation activities dependant on natural resource quality. Activities such as fishing and nature viewing are examples of activities that could be impacts indirectly by impacts to natural resources.

7.2.3.4 Transportation

The No Action Alternative would not affect ground transportation systems within the analysis area. Highway 2 crosses the river near the confluence of the Mississippi and Leech Rivers. This alternative includes a combined outflow restriction of 2200 cfs for Lake Winnibigoshish and Leech Lake. At this volume, the river is approximately bank full at the confluence of the Mississippi River and Leech River, and at other places it is slightly lower than bank full. This restriction is included in order to prevent the Highway 2 Bridge from overtopping.

Existing flood control procedures to prevent flooding in the Aitkin area would be continued, minimizing, to the extent possible, the potential for flooding of rural secondary roads located in close proximity to the river.

Existing water transportation routes would be unaffected by implementation of the No Action Alternative. At summer target levels, existing navigable routes between chain lakes would be maintained. Target water elevations at Leech Lake would continue to allow the use of sail boats and other large boats to navigate areas such as the Walker Narrows.

7.2.3.5 Public Health and Safety

No impacts to public health and safety would occur under the No Action Alternative. Gradual winter drawdown targets minimize ice safety risks. A major concern relevant to any large waterway is tied to the potential for flooding. Public health and safety risks associated with flooding include evacuations; contamination of drinking water; loss of electrical power and associated damages; flooding of buildings; introduction of such water contaminants as sewage, fuel oil, pesticides, solvents, etc.; and exposure of individuals to a variety of adverse health effects ranging from stress and trauma to potentially harmful molds and bacteria. The area of primary concern in the Headwaters of the Upper Mississippi is the community of Aitkin. Flood risks in the Aitkin area are minimized through coordinated flood control operations at Leech Lake, Winnibigoshish Lake, Pokegama Lake, and Big Sandy Lake. Additionally, as described earlier, the six miles of diversion channel and related structures just north of Aitkin, and two additional cutoffs downstream would continue to provide protection to that community.

7.2.3.6 Community Cohesion (Sense of Unity)

Existing community cohesion would be unaffected by implementation of the No Action Alternative. Community interests regarding management of the reservoirs within the Upper Mississippi Headwaters would be expected to continue to coalesce around common interests tied to individual reservoirs, the river, reservoir and river associated user groups, and the related benefits or risks that accrue to nearby communities.

Flooding events can serve to both strengthen and damage community cohesion. Cohesion can be strengthened as residents work together to fight the effects of flooding and protect their common interests. However, the aftereffects of a flood, such as damaged and destroyed homes and businesses, can result in disintegration of cohesion as neighbors are separated, in some cases permanently, due to some of long lasting flood effects. Flood control and prevention measures to protect the community of Aitkin would continue to contribute to its stability and community cohesion.

7.2.3.7 Community Growth and Development

No changes to the course of community growth and development would be expected as a result of the implementation of the No Action Alternative.

7.2.3.8 Business and Home Relocation

Implementation of the No Action Alternative would not result in a need to relocate any businesses or homes.

7.2.3.9 Existing and Potential Land Use

No changes to existing and potential land uses would be anticipated as a result of the implementation of the No Action Alternative.

7.2.3.10 Controversy

A subject of continuing controversy relative to the reservoirs of the Upper Mississippi River under all alternatives is the impact that the original dam construction and resultant higher water levels have had on lands occupied by the Ojibwe. Tribal lands, gathering camps, rice beds, and burial grounds were inundated when the reservoirs filled. This was and is considered a cultural tragedy by the Ojibwe people.

Controversy specifically associated with reservoir management under the No Action Alternative among the Ojibwe is the maintenance of high water elevations that do not reflect the natural fluctuations that would occur in an unregulated system. These high water elevations have resulted in erosion of cultural sites and changes in the biotic communities that the Native American community considers unacceptable.

There is controversy over management actions on the reservoirs conducted to maintain high water levels in support of boating and other reservoir based recreation activities at the expense of the river system and its associated biological communities. Many feel that the river has borne unfair and detrimental impacts in order to favor reservoir recreation. Because of the Ojibwe belief that all waters and the species that utilize them are important and should not be ranked, they also find that management that favors the reservoirs at the expense of the species and resources of the river system is unacceptable.

There is concern among local residents, and particularly among members of the Leech Lake Band of Ojibwe, as to who should have more input and influence regarding decisions affecting the reservoirs and their management. Members of the Band believe that the trust responsibilities of the Federal government require that the first priority be protection of Tribal Treaty obligations. Other land owners believe that because they own lands adjacent to the reservoirs and pay taxes for those properties, that their voices should be given priority in the decision process.

There is controversy over management that favors reservoir recreation despite detrimental effects to natural resource values. Natural biotic communities have been altered by the maintenance of higher water elevations. Shore erosion and the loss of beach areas as a result of establishing and maintaining higher water elevations are of concern to many.

Decisions affecting water elevations and their effects on popular recreation activities are a source of continuing controversy. Of particular concern to many users is the ability to navigate boats between chained lakes. Some users expect that water levels should be maintained as high as possible to facilitate these and other boating activities for as long as possible each summer. Effects to species and habitats associated with the reservoir and downstream areas are a secondary priority for some users. Drought conditions in recent years often resulted in anxious inquires attempting to ensure that everything possible was done to maintain water elevations at the highest point possible.

Operations at Leech Lake, Winnibigoshish Lake, Pokegama Lake, and Big Sandy Lake to control flooding at Aitkin are a subject of considerable controversy. Residents of Aitkin desire that these reservoirs be managed to retain as much water as possible during the spring runoff period in order to better to protect their community. However, retention of too much water can result in flooding and damage to the assets and properties of those who own property around these lakes resulting in competing demands that more water be released. Management activities by the Corps have attempted to balance the occurrence of flood damages in order to prevent one group from bearing a disproportionate share of the damages.

7.2.3.11 Tribal Social Effects

As mentioned above, the construction of the dams on the Upper Mississippi River, particularly the dams at Leech and Winnibigoshish Lakes was strongly opposed by the Ojibwe. Tribal lands, gathering camps, rice beds, and burial grounds were inundated when the reservoirs filled. Compensation for theses losses was delayed for years and is still considered inadequate by the Tribe.

Members of the Leech Lake Band of Ojibwe have strong opinions regarding who should influence decisions affecting the reservoirs and their management. Members of the Band believe that the trust responsibilities of the Federal government require that the first priority be protection of Tribal Treaty obligations. There is discomfort among tribal members with the level of priority placed on recreation uses in current reservoir operations. The Ojibwe believe that all waters and the species that utilize them are important and that no one species or system should be considered or treated as more important than another. Management practices that favor elevated and stable water levels at the expense of other resource values associated with the lake and downstream river ecosystems would continue under the No Action Alternative, continuing the disharmony perceived by Tribal members based on their cultural traditions and beliefs.

The Leech Lake Band of Ojibwe has expressed concern about negative effects of past management on the composition of aquatic vegetation communities as a result of high and stable water levels. The absence of naturally occurring fluctuations in water levels and wave action has resulted in detrimental effects to and loss of open sand beaches and adverse impacts to species dependent on these areas. Increased accumulations of silt as a result of lake shore erosion and lowered stream velocities have contributed to the loss of spawning beds and aquatic vegetation. Increased displacement and mortality is occurring among aquatic mammals and invertebrates due to the lack of water level fluctuations. These effects are expected to continue to occur under the No Action Alternative. The cultural practices and lifestyles of the Ojibwe people, long dependent on the natural resources of the lakes and waters of the Upper Mississippi, have been extensively altered over the years by these changes. While additional changes would not be expected under this alternative, the ones that have already occurred would nonetheless be maintained.

A resource important to the Ojibwe for cultural, economic, and subsistence reasons is wild rice. As described in Chapter 3, wild rice is an annual plant that benefits from periodic disturbance. Under this alternative, stable water elevations would continue to be maintained, favoring perennial plants at the expense of wild rice beds. Additionally, increased turbidity resulting from lake shore erosion would continue, reducing penetration of sunlight to the substrate and adversely impacting germination of annual plant seeds and the growth of young plants.

Damage to shoreline cultural resources, such as archeological sites would continue to occur as a result of artificially high water levels and resultant erosion. Loss and damage to these sites adversely impacts Ojibwe efforts to ensure that their cultural heritage is preserved and retained as a part of community life and traditions that can be passed on to future generations.

7.2.3.12 Environmental Justice

The Council on Environmental Quality (CEQ) defines a minority as “Individual(s) who are members of the following population groups: American Indian or Alaska Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic.” CEQ further directs that

> “Minority populations should be identified where either (a) the minority population of the affected area [emphasis added] exceeds 50 percent or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis…a minority population also exists if there is more than one minority group present and the minority percentage, as calculated by aggregating all minority persons, meets one of the above stated thresholds (CEQ 1997).”

Although minorities are an important presence within the analysis area, the percentage of minority persons is not large enough within the entire population of the analysis area to be consider a “minority population,” nor is the percentage of minorities in the analysis area “meaningfully greater than the minority population percentage in the general population" of the State of Minnesota (see Section 4.4.4, Table 3 and Table 4 above). However, five counties in the analysis area have minority populations that "meaningfully exceed" the minority population of the state. Hennepin and Ramsey Counties have Black or African American populations of 9.0 and 7.6 percent, exceeding the State average of 4.8 percent. There counties are primarily urban in nature, and more distant from affected reservoirs, no disproportionate adverse effects to minority populations are expected.

Beltrami, Cass, and Clearwater Counties have American Indian populations of 20.4, 11.5 and 8.6 percent respectively, compared to the state which has an American Indian population of 1.3 percent. Tribal effects are discussed under Sections 5.2.3.11 and 5.2.4.11. No disproportionate adverse effects are anticipated under the No Action Alternative.

CEQ defines "low-income population" as:

> "…in identifying low-income populations, agencies may consider as a community either a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions or environmental exposure or effect (CEQ 1997)."

Low income populations within the analysis area are described in Section 4.4.5. The 2005 estimated percentage of the population below poverty level exceeds the state average in 21 of the 31 counties in the analysis area. The counties with the largest percentages of individuals below poverty level were Aitkin, Beltrami, Cass, Clearwater, and Wadena Counties. Across the analysis area as a whole, the percentage of the population below poverty level was highest among minority groups, ranging from 13.9 percent for Naïve Hawaiian and Other Pacific Islander alone, to 29.1 percent among American Indian and Alaska Native alone. Based on the CEQ definition provided above, the analysis area does contain low-income populations.

Concerns about impacts to Native American populations were raised during scoping and throughout the course of alternative development and analysis. The impact that original dam construction and resultant higher water levels have had on lands occupied by the Ojibwe have long been considered to have had a disproportionate impact on Native Americans by the Ojibwe people. However, these past impacts are beyond the scope of the current analysis. Concern relative to the current proposed action are related to potential impacts to wild rice, to cultural sites adjacent to the affected reservoirs, and adherence to the Tribal Trust responsibilities. Impacts related to these issues are addressed above.

Effects to low-income populations would result primarily from economic or subsistence impacts resulting from the implementation of an alternative. The No Action Alternative would continue current management practices and therefore would not result in changes to economic circumstances or subsistence uses than have occurred due to past management practices.

7.2.4 Economic Effects – No Action

7.2.4.1 Property Values

Lakeshore property values throughout Minnesota have gone up during the past decade. In the State of Minnesota, assessors determine the market value of all taxable property within their jurisdiction as of January 2 of each year. The estimated market value is what the assessor believes the property would most likely sell for on an open market in a normal "arms length transaction." That means the price at which the property would sell for in an environment in which the buyer and seller are typically motivated and without influence from special financing considerations or the like.

The No-Action or continuation of the current operating plan alternative is expected to have no direct effect on property values. Any impacts to property values that might have resulted from the construction and the continuing operation of these reservoirs should already be reflected in the current valuations.

7.2.4.2 Tax Revenues

Owners of real property in Minnesota pay tax to their county, municipality, school district, and special taxing districts. Property tax is an ad valorem tax (in proportion to the value) that an owner pays on the value of the property being taxed for justification. Minnesota also has a 6.5% sales tax, but there is no sales tax on clothing, prescription medication, some services, or food items for home consumption. Any impact from a change in reservoir operation that affects income (personal or business), property values, or sales from which sales taxes are collected has the potential to impact tax revenues.

Similar to property values, the No-Action or continuation of the current operating plan alternative is expected to have no appreciable effect on tax revenues.

7.2.4.3 Public Facilities and Services

All of the Corps of Engineers headwaters reservoirs and the Forest Service's Knutson Dam have campground facilities associated with them.

There are approximately 3,000 public boat ramps on Minnesota lakes and streams. Over half are built and maintained by the DNR and the rest are administered by counties or local units of government. Boat accesses have concrete ramps where boats can be launched. They also have parking areas.

The No-Action/continuation of the current operating plan is judged to have no effect on public facilities and services.

7.2.4.4 Regional Growth

The No-Action/continuation of the current operating plan is judged to have no appreciable effect on regional economic growth.

7.2.4.5 Employment

The No-Action/continuation of the current operating plan is judged to have no appreciable effect on employment.

7.2.4.6 Business Activity

The No-Action/continuation of the current operating plan is judged to have no effect on business activity.

7.2.4.7 Farmland/Food Supply

The No-Action/continuation of the current operating plan is judged to have no appreciable effect on farmland or food supply.

7.2.4.8 Water Supply

In the Twin Cities metropolitan area, 108 municipal water supply systems serve portions of 121 communities.

Approximately 880,000 people in the metropolitan region rely, at least in part, on surface water as their drinking water source. The Mississippi River serves as the primary water source for the Minneapolis Water Works (MWW) and the St. Paul Regional Water Services (SPRWS), which together serve 16 additional communities with wholesale or retail water delivery. All of the water appropriated by Minneapolis is drawn from the Mississippi River. For St. Paul, the river represents about 70% of its appropriated water supply with the remainder pumped from high-capacity wells, the Rice Creek Chain of Lakes (Centerville Lake) and tributaries to Vadnais Lake.

In addition to supplying the two major water supply systems in the metropolitan area, the Mississippi River also provides navigation access, waste assimilation, recreation, aquatic and terrestrial habitat, and cooling water for two power plants. These competing uses are important considerations when evaluating the Mississippi River's potential capacity to supply drinking water.

Groundwater sources provide approximately two-thirds of the water consumed in the metropolitan area, and serve about 1.6 million people through municipal water systems.

In 2004 the metropolitan area used approximately 163 billion gallons (445 million gallons per day (mgd) of water. About 116 billion gallons (319 mgd) of that water was supplied through municipal systems serving residential, commercial and industrial customers. Residential customers, nearly 2.5 million people, used about 70% of the water supplied by municipal systems; about 290,000 people in the metropolitan area obtained their water from private wells.

Compared to 2004 populations, the metropolitan area is expected to grow by about 33% by 2030, and by about 60% by 2050. The Metropolitan Council's projections for related municipal water use demands include a 27% increase by 2030, and 52% increase by 2050. For these projections, the rate of water use increases at a slightly lower rate than population growth based on the assumption that use of water efficient appliances and general water conservation will increase in the future. Total water demand is projected to increase by only 16% between 2004 and 2030, and by 35% from 2004 to 2050. This is also due to expected improved efficiency as well as reductions in withdrawals associated with once-through cooling, quarry dewatering and agricultural uses during this period.

Between 2004 and 2030, the Council expects that the largest increases in water use will occur in areas served by the MWW and SPRWS. The Council projects the next tier of increases will occur in several rapidly growing suburbs and rural growth centers. Projections show several older suburbs and most rural areas experiencing nominal increases or even small decreases in water use. Similar water use trends are expected to continue in the region through 2050.

Under most conditions, Mississippi River supplies far exceed the water needed by communities that rely on the river. In times of drought or contamination, however, use of river water may be limited. The MWW currently has no alternative water sources to the Mississippi River. This leaves its system vulnerable to events that may limit availability of supplies from the river. SPRWS maintains a reserve to supply approximately 60 days of its ‘practical’ water demand. It stores its reserve in the Rice Creek Chain of Lakes (Centerville Lake) and tributaries to Vadnais Lake, where the water can be withdrawn for use if Mississippi River supplies are limited. The SPRWS recognizes that a 60-day supply may be enough during a summer dry spell but may not meet system needs during an extended drought or large contamination event, and is installing wells able to supply “average day”demands. The wells, scheduled for 2009 completion, would help SPWRS offset potential restrictions on water use from the Mississippi River.

Extremely dry conditions occurred regionally in the 1910s, 1930s, 1950s and, more recently, in the 1970s and 1980s. The more recent events raised public awareness about the recurring nature of drought and its impacts on water availability, especially for communities that depend upon the Mississippi River for drinking water. During the 1988 drought, the state recognized the need for an action plan to address water supply shortages during Mississippi River low flow periods. As a result, the Council prepared a Metropolitan Area Short-Term Water Supply Plan (Metropolitan Council 1990), which establishes a critical flow of 554 cubic feet per second (cfs) to supply municipal water systems, generate power, and allow navigation. These minimum flows assume that communities relying on the river as a source of drinking water would implement conservation measures to reduce high summer demands. Recent water use information suggests that the 85 mgd (132 cfs) and 45 mgd (70 cfs) volumes for the MWW and SPRWS, respectively, are still reasonable during critical flow periods. The flow for power plants assumes that the two plants on the Mississippi River in the metropolitan area would consume 1 cfs each as part of their operation, and the 350 cfs for navigation assumes 1 lockage per hour at the lock and dams in the Twin Cities. Lockages could be restricted or suspended during low-flow periods. Historical records indicate that flows at Anoka have been as low as 602 cfs in 1934, 529 cfs in 1976, 842 cfs in 1988, and 1530 cfs during the drought period in 2006. The 529 cfs measured in 1976 was an instantaneous flow resulting from automatic gate operations at the Coon Rapids Dam. The lowest daily average recorded that year was 728 cfs. The Metropolitan Area Short-Term Water Supply Plan also included a drought response plan that is triggered by a 72-hour average flow of 2,000 cfs at Anoka, with subsequent decision points occurring at 1,200, 1,000 and 750 cfs.

MISSISSIPI RIVER CRITICAL FLOW
The critical flow of 554 cfs at Anoka is broken down as follows:
MWW 132 cfs (85 MGD)
SPRWS 70 cfs (45 MGD)
Power Plants 2 cfs
Navigation 350 cfs

In 1992, the Army Corps of Engineers (ACOE) published the draft Drought Contingency Plans for the six Mississippi River Headwaters Reservoirs. The plans describe in detail how reservoir operating decisions will be made during a drought. In 1994, in response to a request from the City of Minneapolis, the ACOE prepared the Water Available from the Mississippi River at Minneapolis and Other Upstream Minnesota Locations During Low Flow Conditions report (ACOE, 1994). This study presents a tool for determining the volume and travel time for various releases from the headwaters reservoirs and how flows will recede at Anoka under a variety of conditions. The report illustrates the limited potential of relying on the headwater reservoirs as a source of water supply in the metropolitan area. For instance, if the flow at Anoka is 750 cfs and is forecast to fall to 554 cfs in 37 days, an extra 100 cfs released from Lake Winnibigoshish and Leech Lake (total of 200 cfs) would cause the flow at Anoka to rise to 760 cfs (a 10 cfs net increase) and extend the time it would take the flow at Anoka to fall to 554 cfs by 19 days.

The No-Action/continuation of the current operating plan is judged to have no appreciable effect on water supply.

7.2.4.9 Flooding Effects

Under the No-Action/continuation of the current operating plan there would be no change in the current operation for flood control, therefore there is no appreciable change in flooding effects as the same guidelines and procedures would continue to be carried forth into the future.

7.2.4.10 Energy Needs and Resources

With the No-Action plan the future energy production would be similar to the historic average. Hydropower production is dependant on river flows, especially because the hydropower facilities on the Mississippi River operate on a run-of-river basis, meaning their release is equal to their inflow. Because of this, these hydropower facilities can not store water for use during dry periods or for peak power production. Therefore, low flows can limit power production, thereby making the minimum release component of an operating plan a special interest for hydropower plant owners.

Because the no-action plan would not result in changes to releases to downstream hydropower facilities, it is judged to have no appreciable effect on energy resources.

7.2.4.11 Tribal Economic Effects

Wild rice is an important social and cultural component for Native American tribes and rural Minnesota communities. Minnesota has more acres of natural wild rice than any other state in the country. Wild rice has been historically documented in 45 of Minnesota's 87 counties and in all corners of the state. Anecdotal information suggests an even broader distribution prior to European settlement.

Wild rice is a persistent annual grass that reproduces each year from seed stock deposited in previous fall seasons. The plant typically grows in shallow to moderate water depths (1 – 3 feet) and is affected by water flow, turbidity, water quality and water level fluctuations. Wild rice is sensitive to varying water levels, and production in individual stands from year-to-year is highly variable depending on local water conditions.

The Leech Lake Indian Reservation is located in the north-central Minnesota counties of Beltrami, Cass, Hubbard, and Itasca. It is the land-base for the Leech Lake Band of Ojibwe. As of the 2000 census, it had a population of 10,205, making it the largest Indian reservation in the state by number of residents. It is the second-largest (to the White Earth Indian Reservation) in terms of land area at 972.517 square miles, although it would be the largest if water area were also considered, since over one-fourth of its territory comprises lakes, the largest of which are Leech Lake, Lake Winnibigoshish, and Cass Lake. Its total surface area, including water, is 1,309.909 sq mi.

The core areas of the Leech Lake Indian Reservation were established according to a treaty in 1855 as three smaller reservations for the Pillager Band of Chippewa Indians and modified several times thereafter. Under the Indian Reorganization Act of 1934, the contemporary Leech Lake Indian Reservation was formed from the merger of Leech Lake, Cass Lake and Lake Winnibigoshish Reservations of the Pillager Band, Chippewa Indian Reservation of the removable Lake Superior Band of Chippewa Indians and White Oak Point Indian Reservation of the Mississippi Chippewa.

Most of the reservation land is now taken up by the Chippewa National Forest, and only a very small percentage is owned by tribal members. The headwaters of the Mississippi River at Lake Itasca are also located within the reservation boundary but are part of Itasca State Park. About 40 area lakes are used for the production of wild rice and the community produces more rice than any other reservation in the state.

The No-Action/continuation of the current operating plan alternative is judged to have no appreciable effect on the Tribal economy.

7.2.5 <u>Cultural Resource Effects – No Action</u>

7.2.5.1 Archeological sites

There are no new effects under this alternative. Hundreds of archeological sites are known to exist along reservoir shorelines and downstream river reaches in the ROPE study area. The extent of damage to these sites due to erosion and inundation has not been thoroughly assessed. The effects of reservoir operations along downstream river reaches are not well understood and need to be further evaluated. It is clear, though, that operations are affecting archeological sites and that any change in operations may continue to affect them. Without action to stabilize erosion, it is likely that any fluctuations in water levels will continue to permanently damage these non-renewable archeological resources until those that are vulnerable to erosion are finally destroyed.

7.2.5.2 Tribal Cultural Effects

The no-action alternative would have a minor adverse effect on tribal cultural resources as described in the preceding section.

7.3 ALTERNATIVE OPERATING PLAN R

The R alternative was formulated to provide the maximum possible economic benefit while still considering impacts to other resource interests. This would be accomplished through holding water levels at similar or higher elevations than under the existing plan, and also delaying the winter drawdown until mid-October. Most other plan components would remain unchanged. For more detail regarding this alternative, please see Section 5.5.2.

7.3.1 <u>Water Levels/Elevations and Flows – Plan R</u>

A variety of hydrologic data were used throughout the study to assess the effects of the R alternative operating plan on reservoir water elevations and discharges. Various simulation models were used to predict potential water levels and discharges under this alternative. Such predictive models produce data that can be difficult to interpret; however, it is useful for assessing differences between different operating plans and gaining an understanding of average effects. In general, water levels under the R plan would follow a very similar pattern of variability as under the existing plan (see Appendix E), but on average, water levels would be somewhat higher in early fall and a result of the revised targets. During drought years such as 2006 and 2007, it is expected that water levels on the reservoirs would be the same as under the existing plan because hydrologic conditions in those years caused low water levels and the minimum releases would not be revised under the R alternative.

7.3.2 <u>Natural Resource Effects – Plan R</u>

7.3.2.1 Introduction

The R alternative was formulated to maximize benefits to recreation and flood damage reduction. Benefits to natural resources were only considered secondarily and therefore, this plan in general is less beneficial to natural resources than the no-action alternative.

7.3.2.2 Air Quality

The R alternative would have a minor adverse effect on air quality over the no-action plan. This is because under this plan minimum flows would occur more frequently, mainly in early spring and early fall, thereby reducing hydropower production, and increasing the use of thermal power generation, which has a negative impact on air quality.

7.3.2.3 Terrestrial/Upland Habitat

The R alternative would have a minor adverse effect on terrestrial habitat because of the increased bank erosion that would occur as a result of holding high stabile water levels on the reservoirs for a longer period of time.

7.3.2.4 Sedimentation/Bank Erosion

The R alternative would have a minor adverse effect on sedimentation and bank erosion on the reservoirs. This is because water levels would be held high and stable for a longer period of time than under the no-action alternative, thereby increasing the time in which water can erode unstable banks. This would also result in an increase in reservoir sedimentation.

7.3.2.5 Wetland/Floodplain habitat

The R alternative would have a minor adverse effect on wetland and floodplain habitat over the no-action alternative because high and stable reservoir water levels late in the summer and into early fall could further reduce opportunities for emergent plant germination on the reservoirs over the no-action plan. Wetlands adjacent to the receiving rivers would also be negatively affected to a minor degree due to increased flow manipulations caused by holding reservoir levels high and stabile for a longer period.

7.3.2.6 Aquatic Habitat

The R alternative would have a minor adverse effect on aquatic habitat in the reservoirs and rivers over the no-action alternative. In the reservoirs, this would be the result of increased sedimentation and a decline in aquatic plant diversity due to increased hydrologic stability. Riverine habitat would be affected by the increased frequency of minimum flows during the open-water (recreation) season, and an increased frequency of high flows during winter drawdowns caused by a later drawdown start.

7.3.2.7 Fish

The R alternative would have a minor adverse effect on fish in the reservoirs and rivers because of the impacts to aquatic habitat and hydrologic alteration. Reservoir sedimentation would increase over the no-action plan and would result in a further reduction in suitable spawning habitat for some species including walleye. The reduction in aquatic plant diversity and extent would reduce rearing and foraging habitat for other species such as northern pike and musky. Riverine fish would be adversely affected by further hydrologic alteration, most notably through increased frequencies of low-flow conditions in late summer and early fall, and increased flows during late fall and winter for winter drawdown.

Whitefish spawning would be adversely affected. High fall water levels would allow them to spawn in areas that may be too shallow following the winter drawdown.

7.3.2.8 Mussels

The R alternative would have a minor adverse effect on mussels in the reservoirs and rivers because of the impacts to aquatic habitat. Increased sedimentation can adversely affect suitable mussel habitat in reservoirs.

7.3.2.9 Birds

The R alternative would have no appreciable direct effect on birds over the no-action alternative. Waterfowl nesting would continue to be impacted under this plan in a similar manner as under the no-action plan. However, there would likely be minor negative indirect effects through the impacts to vegetation and the ecosystem in general, which could reduce suitable habitat.

7.3.2.10 Mammals

The R alternative would have a minor adverse affect on semi-aquatic mammals. This would be the result of further hydrologic alteration and the increased effects from winter drawdown as described under the no-action plan.

7.3.2.11 Biological Productivity

There would be a minor adverse effect on biological productivity caused primarily by further hydrologic alternation and the consequent disruptions in aquatic species' life history needs as discussed under the no-action alternative.

7.3.2.12 Biological Diversity

There would be a minor adverse effect on biological diversity under the R alternative. Reservoir water levels would be high and stable longer into the fall, which also results in a higher occurrence of minimum releases from the reservoirs. This, coupled with late fall and winter reservoir drawdowns and high river flows would be detrimental to many species of plants and animals which evolved under natural hydrologic conditions.

7.3.2.13 Water Quality

There would be a minor adverse effect on water quality under the R alternative. Increased frequencies of minimum releases in late summer and early fall would increase the probability for dissolved oxygen depletion downstream of the reservoirs.

7.3.2.14 Groundwater

The R alternative would have no appreciable effect on groundwater.

7.3.2.15 Threatened and Endangered Species

The R alternative would have no effect on federally-threatened or endangered species.

7.3.2.16 Tribal Interests in Natural Resources

Natural resources of special interest to the Ojibwe would be detrimentally affected by the R alternative. Wild rice would be negatively affected to the same degree as under the no-action plan because the higher water levels would normally occur after rice has been harvested. Increases in erosion could detrimentally affect rice under this alternative, but the mechanism for such an effect on rice is unclear.

7.3.3 Social Effects – Plan R

7.3.3.1 Noise

No transient noise impacts or changes in ambient noise levels are anticipated as a result of the implementation of Alternative R.

7.3.3.2 Aesthetics

Few changes to the existing aesthetic values would be anticipated upon implementation of Alternative R. Summer target water elevations would remain the same at all reservoirs, except Gull Lake, for which the target would be increased by a little over 5 inches. Summer target elevations would be reached earlier in the season (beginning of May) when conditions allow, at all reservoirs except Cross Lake, which would remain the same as occurs under existing operating rules. Additionally, the summer target would be maintained longer (until mid October) at all reservoirs. The longer duration of summer target water elevations would beneficially affect aesthetic values associated with summer time lake activities and views. Additionally, as winter draw downs would begin later in the year, fall water levels would remain somewhat higher, enhancing autumn lake activities and views.

Aesthetic values associated with lakeshore erosion as a result of elevated water levels would continue to be adversely affected. Shoreline vegetation that has been altered from natural conditions would continue to adversely affect those with a desire to experience the naturally occurring vegetation communities that existed prior to dam construction.

7.3.3.3 Recreation Opportunities

Alternative R investigated enhanced economic and recreational benefits. It results in generally holding water levels at or above the existing plan, with a delay in pool draw down until mid-October. Under dry conditions, water levels under the R plan would likely be no different than those experienced under the no-action plan. More details regarding this operating plan can be found in Section 5.5.2.

It is difficult to predict what types and amounts of recreational uses of the lakes would occur as a result of implementing any one of the proposed operating plans. It is reasonable to assume that the current recreational uses of the lakes would continue under any of the operating plans. However, the enjoyment of the lakes may be impacted to different degrees due to the changes in lake levels at various times of the year. This could impact a user's satisfaction due to the dependency of some activities on water levels. Over time, it is likely that users of the lakes would adapt to the new conditions and existing levels of satisfaction would return. How long this would take under any plan is unknown.

Under the R Plan, it is likely that there would be a short-term minor beneficial effect on recreation in the project area. The maintenance of the summer target for a longer period would facilitate navigation in and between chained lakes throughout the system until mid-October. During years with ample rainfall, holding water levels high into mid-October would extend the recreation season for those locations and activities currently limited by shallow water effects. However, in the long-term, there is a potential that the short-term benefits would be negated because many forms of recreation would experience an adverse effect if the deterioration of natural resources is experienced as described in Section 7.3.2. Specifically, a degradation of water quality through an increased frequency and extent of algal blooms would impact all forms of water-dependant recreation, and a decline in the fishery would adversely affect fishing.

Cass Lake. A minor short-term beneficial, and long-term adverse effect are expected as described above. Cass Lake has numerous eroding shorelines that would be adversely affected by holding water levels high for longer periods of time.

Lake Winnibigoshish. A minor short-term beneficial, and long-term adverse effect are expected as described above. Lake Winnibigoshish has numerous eroding shorelines that would be adversely affected by holding water levels high for longer periods of time.

Leech Lake. A minor short-term beneficial, and long-term adverse effect are expected as described above. Water levels at Leech Lake would continue to permit the use of sail boats, and extend the period during which these and other large boats can successfully navigate shallow areas such as the Walker Narrows during periods when rainfall levels permit higher lake levels.

Pokegama Lake. A minor short-term beneficial, and long-term adverse effect are expected as described above.

Big Sandy Lake. A minor short-term beneficial, and long-term adverse effect are expected as described above. Big Sandy has numerous eroding shorelines that would be adversely affected by holding water levels high for longer periods of time.

Cross Lake. A minor short-term beneficial, and long-term adverse effect are expected as described above. The Whitefish Chain of Lakes has numerous eroding shorelines that would be adversely affected by holding water levels high for longer periods of time.

Gull Lake. The current plan has a summer band of 1193.75 to 1194.0. Alternative R has a summer band of 1194.18 to 1194.43 with a target of 1194.3, increasing the summer target elevation a little over 5 inches to further improve boat access. Navigation from Round Lake into Gull Lake would be enhanced over existing conditions. It is anticipated that this change would have a positive impact on recreational use of the lake, though the long-term negative effects as described above would still be expected under this plan.

7.3.3.4 Transportation

Alternative R would have a minor beneficial effect to water transportation over the no-action alternative.

Alternative R would not affect ground transportation systems within the analysis area. As described above under the No Action Alternative, this alternative would also include a combined outflow restriction of 2200 cfs for Lake Winnibigoshish and Leech Lake in order to protect the Highway 2 Bridge near the confluence of the Mississippi and Leech Rivers.

Existing water transportation routes would be maintained and enhanced by implementation of Alternative R. The maintenance of the summer target for a longer period would facilitate navigation in and between chained lakes throughout the system until mid-October. Boat operators at Gull Lake would experience improved ability to navigate shallow areas such as Bishops Creek and Round Lake. Water levels at Leech Lake would continue to permit the use of sail boats, and extend the period during which these and other large boats can successfully navigate shallow areas such as the Walker Narrows. Higher water elevations at Gull Lake would improve the ability of resident and visiting boat operators to navigate between the chained lakes of this system.

Water transportation within river segments would be improved as a result of increases in the minimum release rules.

7.3.3.5 Public Health and Safety

Public health and safety risks and effects under Alternative R are the same as described above under the No Action Alternative.

7.3.3.6 Community Cohesion (Sense of Unity)

Existing community cohesion would be unaffected by implementation of Alternative R. Community interests regarding management of the reservoirs within the Upper Mississippi Headwaters would be expected to continue to coalesce around common interests tied to individual reservoirs, the river, reservoir and river associated user groups, and the related benefits or risks that accrue to nearby communities.

Flooding events can serve to both strengthen and damage community cohesion. Cohesion can be strengthened as residents work together to fight the effects of flooding and protect their common interests. However, the aftereffects of a flood, such as damaged and destroyed homes and businesses can result in disintegration of cohesion as neighbors are separated, in some cases permanently, due to some of long lasting flood effects. Flood control and prevention measures to protect the community of Aitkin would continue to contribute to its stability and community cohesion.

7.3.3.7 Community Growth and Development

The R alternative would likely have a minor beneficial effect on community growth and development. This alternative would result in the maintenance of the summer target at all reservoirs for a month to six weeks longer than currently occurs. The increased length of summer season target water elevations would contribute to increase recreation revenue for the area tourism industry. Increased revenues could contribute to expansion of existing businesses as well as increase the attractiveness of the area to new enterprises.

The longer periods of stable water elevations may contribute to increased values for lakeside property owners and businesses with ties to lake related recreation activities.

Additionally, the longer lake recreation season may also contribute to the attractiveness of the area to existing residents, and serve as an added inducement drawing new residents to the area.

7.3.3.8 Business and Home Relocation

Implementation of Alternative R would not result in a need to relocate any businesses or homes.

7.3.3.9 Existing and Potential Land Use

No changes to existing and potential land uses would be anticipated as a result of the implementation of the Alternative R.

7.3.3.10 Controversy

Areas of controversy under Alternative R are the same as described under the No Action Alternative (Section 7.2.3.10), with the following exceptions or additions.

Water levels would be maintained at the same elevations on all reservoirs, except Gull Lake, as would occur under the No Action Alternative. The elevations on Gull Lake would be raised by approximately five inches. However, when conditions allow, the target elevations on all lakes would be achieved earlier in the spring, and the target elevations on all lakes would be held later in the fall.

Implementation of this alternative may further exacerbate the controversy associated with Ojibwe concerns for the erosion effects of high sustained water elevations on cultural sites. Concerns about the inequity of resource management priorities would remain unchanged.

The controversy over management favoring recreation at the expense of other natural resource values would continue to be of concern, and may worsen under Alternative R.

Controversy related to the desire by recreation users to be able to navigate between chained lakes may be reduced if Alternative R were implemented. Navigation through shallow channels would generally be possible for a longer period of time at all reservoirs, absent drought conditions. The ability to navigate between chained lakes associate with Gull Lake would improve under this alternative, thereby reducing controversy in that area.

There are some stakeholders who questioned the need to make any changes to the management of the reservoirs. Increased controversy may result under Alternative R, based on the belief by some that current operations were satisfactory and concern that any implemented changes are the result of disproportionate influence by those who seek to maximize recreation benefits above other values.

Controversy related to effect on wild rice beds is expected to remain unchanged under Alternative R. Maintenance of water levels would contribute to the ability to navigate canoes and other craft into rice bed areas to conduct harvesting activities.

There may continue to be some level of controversy associated with the operations of Pokegama Lake, with the help of Winnibigoshish Lake and Leech Lake, for the protection of Aitkin. There would be little change in effects from the No Action Alternative, although clarification of operating rules when the stage at Aitkin is approaching 14 feet in the spring and 13 feet in the summer provides (see Section 5.3.6.3) for greater flexibility of operations and may provide a minor benefits to Pokegama Lake, Leech Lake, Winnibigoshish Lake, and Aitkin.

7.3.3.11 Tribal Social Effects

Tribal social effects under Alternative R are the same as described under the No Action Alternative (Section 7.2.3.11), except as described below.

Damage to shoreline cultural resources would continue to occur due to the maintenance of artificially high water levels, resulting in shoreline erosion. Because high water elevations would be maintained for a longer period of time each year under this alternative, additional erosion may occur, increasing the risk of damage to important Ojibwe cultural sites than would occur under the No Action Alternative as described above. There would likely be significant adverse social effects related to controversy as described above, as the Tribe would reject a plan that favors recreational benefits at the expense of natural resources.

7.3.3.12 Environmental Justice

Environmental justice impacts relative to minority and low income populations are the same as described under the No Action Alternative above (Section 7.2.3.12).

7.3.4 Economic Effects – Plan R

7.3.4.1 Property Values

The R plan alternative attempts to maximize the economic benefits from recreation by maintaining stable water levels as long as possible through the open-water season allowing for the fall recreation to occur on the headwaters lakes in the months of September. The maintenance of the summer target for a longer period would facilitate navigation in and between chained lakes throughout the system until mid-October. Boat operators at Gull Lake would experience improved ability to navigate shallow areas such as Bishops Creek and Round Lake. Water levels at Leech Lake would continue to permit the use of sail boats, and extend the period during which these and other large boats can successfully navigate shallow areas such as the Walker Narrows. Higher water elevations at Cross Lake would improve the ability of resident and visiting boat operators to navigate between the chained lakes of this system.

The longer periods of stable water elevations may contribute to increased values for lakeside property owners and businesses with ties to lake related recreation activities. Because of this, the R plan alternative might have a direct minor beneficial effect on property values in the headwaters lakes area and no effect in the Aitkin area and downstream.

However, the negative effects to natural resources that would result from this plan may have an adverse indirect effect on property values in the long term. Property value around these reservoirs is strongly tied to the quality of the area's natural resources such as water, fish, waterfowl, and many others. As discussed in Section 7.3.2, the R plan would be expected to have a detrimental effect on most natural resources.

7.3.4.2 Tax Revenues

Similar to property values, because property taxes are based on property valuation, the R plan alternative may have a beneficial effect on tax revenues in the headwaters lakes area and no effect in the Aitkin area and downstream.

7.3.4.3 Public Facilities and Services

The R plan will have no effect on public facilities and services. Although use of public campground and boat ramp facilities may increase in the headwaters area because stable water levels would be maintained as long as possible through the open-water season.

7.3.4.4 Regional Growth

The R plan alternative is judged to have no appreciable effect on regional growth; however, the longer lake recreation season may contribute to the attractiveness of the area to existing residents, and serve as an added inducement drawing new residents to the area.

7.3.4.5 Employment

The R plan alternative should have no effect on the employment conditions.

7.3.4.6 Business Activity

The R plan alternative should have minor beneficial effect on business activity. Any increase in recreation/tourism in the headwaters area that may result, because stable water levels would be maintained as long as possible through the open-water season, would be beneficial to tourism based businesses in the headwaters area. This increased length of summer season target water elevations may contribute to increase recreation revenue for the area tourism industry. Increased revenues could contribute to expansion of existing businesses as well as increase the attractiveness of the area to new enterprises.

7.3.4.7 Farmland/Food Supply

The R plan is judged to have no effect on farmland and food supply. This is because flood effects would not change appreciably under this plan.

7.3.4.8 Water Supply

The R plan alternative is judged to have no appreciable effect on water supply.

7.3.4.9 Flooding Effects

Under the R plan flood operations would be modified to follow the Updated Guide Curves plan component as described in Section 5.3.6.3. Overall, this plan would have a minor detrimental effect on flooding in the project area. Water levels on Gull Lake would be raised by approximately five inches. With this increase in elevation there would be an increased risk of flooding as the result of localized weather events upstream of the reservoir. At the other reservoirs the target elevations would be held later in the fall, thereby reducing storage capacity for a flood event occurring during this time of the year. Flood effects at Aitkin would be similar to the no-action plan.

7.3.4.10 Energy Needs and Resources

Hydropower production under the R plan may experience a minor adverse effect due to the retention of the existing minimum release rules and the need to operate at minimum releases for a longer period of time as a result of hold high reservoir levels longer into the fall.

7.3.4.11 Tribal Economic Effects

The R plan alternative is judged to have no appreciable tribal economic effects. Under this plan the maintenance of water levels should contribute to the ability to navigate canoes and other craft into rice bed areas to conduct harvesting activities.

7.3.5 Cultural Resource Effects – Plan R

7.3.5.1 Archeological sites

This alternative would have a minor adverse effect on cultural resources sites at all the Headwaters reservoirs. This operating plan will be at the upper target level of the current operating band for each of the Headwaters reservoirs, except for Gull Lake, for 1 to 2 months longer each year than under existing conditions. In the case of Gull Lake this operating plan will be 5 inches above the upper target level for its current operating band for 2.5 months longer than it is at the upper target level under the current operating plan. The adverse effect comes from the potential for increased erosion at or above the current upper target level at each of the Headwaters reservoirs due to the increased length of time the reservoir is held at those levels under the R Plan.

7.3.5.2 Tribal Cultural Effects

The R plan would have an adverse effect on cultural resources important to the Tribe due to the effects as described in Section 7.3.5.2.

7.4 ALTERNATIVE OPERATING PLAN E

Alternative E was formulated to enhance ecological benefits by restoring much of the simulated natural seasonal hydrology while still reaching existing summer water elevations on the reservoirs. Winter drawdown targets and flood operating rules would be included. Minimum release rules would also be modified to increase downstream flows. For more detailed information regarding this alternative, please see Section 5.5.3.

7.4.1 Water Levels/Elevations and Flows – Plan E

A variety of hydrologic data were used throughout the study to assess the effects of the E alternative operating plan on reservoir water elevations and discharges. Various simulation models were used to predict potential water levels and discharges under this alternative. Such predictive models produce data that can be difficult to interpret; however, it is useful for assessing differences between different operating plans and gaining an understanding of average effects. In general, reservoir water levels under the E plan would follow the targeted water levels (See Section 5.5.3). Revised minimum releases under this plan are discussed in detail in Appendix G.

7.4.2 Natural Resource Effects – Plan E

7.4.2.1 Introduction

The E alternative was formulated to maximize benefits to natural resources while holding summer reservoir water elevations near the exiting levels and maintaining flood damage reduction benefits. Lake elevations and discharges under the E plan during the open-water period would more closely mimic natural seasonal variability than the exiting operating plan. In general, the E alternative would have a significant beneficial effect on natural resources in the study area, particularly in the study area roughly north of Little Falls.

7.4.2.2 Air Quality

Because of the increase in minimum flows and the consequential increase in hydropower production capacity during otherwise low-flow periods, there would be a minor decrease in demand for thermal power production and the potential for a decrease in thermal power plant emissions. This would result in the E plan having a minor positive effect on air quality.

7.4.2.3 Terrestrial/Upland Habitat

Under the E plan, there would be a minor beneficial effect to terrestrial and upland habitat because of a reduction in bank erosion on the reservoirs.

7.4.2.4 Sedimentation/Bank Erosion

There would be a minor beneficial effect to sedimentation and bank erosion under the E plan. Reservoir bank erosion would be reduced because the period of time in which water is relatively high would be reduced, most notably during the last half of summer and into the fall. There would also be a minor increase in emergent and riparian vegetation growth caused by lower mid and late summer water levels. Increased vegetation would help prevent erosion by holding soil in place. It would also help trap sediment that does erode off banks, reducing the rate at which sediment would move into deeper water. Erosion of large sections of floating bog along the river would be reduced because increased flows in the winter for drawdown would basically be eliminated.

7.4.2.5 Wetland/Floodplain habitat

There would be a minor beneficial effect on wetland and floodplain habitat under the E alternative. This alternative would result in hydrology with seasonal variability more similar to natural conditions than the existing operating plan. Winter water levels in wetlands adjacent to the reservoirs and the receiving rivers would be more stable than under the current operating plan, which would help promote winter survival of numerous wetland species including but not limited to turtles, frogs, muskrats, and beavers.

7.4.2.6 Aquatic Habitat

The E plan would have a minor beneficial effect on aquatic habitat. A reduction in bank erosion and sedimentation would slow the degradation of spawning habitat. Riverine habitat would be improved through increased minimum release requirements which would reduce the likelihood of dissolved oxygen depletion. There would also be a decreased occurrence of high winter flows in the river, and the use of a spring pulse when possible just after ice-out would help clean spawning substrate of silt below the dams. The spring pulse would help clean fine sediment from spawning habitat downstream from the dams in years of non-flooding flows.

7.4.2.7 Fish

The E plan would have a minor beneficial effect on fish in the project area over the no-action plan. The spring pulse would trigger spawning in the river and would improve spawning substrate by washing silt off coarse substrates. Increased minimum releases would provide more favorable conditions during spring when reservoirs are storing water for flood damage reduction by providing more flow to keep spawning habitat free of silt and oxygenated. Increased minimum flows in late summer would decrease the probability of oxygen depletion. Reservoir habitat would be improved for fish spawning, rearing, and feeding through improvements in aquatic vegetation which provides cover for a variety of species and life stages.

7.4.2.8 Mussels

The E alternative would have a minor beneficial effect on mussels in reservoirs due to the decrease in sedimentation. Riverine mussel communities would benefit from

7.4.2.9 Birds

The E alternative would have a minor beneficial effect on birds compared to the no-action plan in the project area. Increased minimum releases in the spring when reservoirs are storing flood water could induce some waterfowl to nest slightly higher and experience less nest flooding than under the no-action plan. Improvements in near-shore vegetation would provide additional habitat for wetland birds.

7.4.2.10 Mammals

The E alternative would have a substantial beneficial effect on semi-aquatic mammals including muskrats and beavers. This alternative would provide more stable water levels in wetlands adjacent to the reservoirs and receiving rivers, which would help improve muskrat survival during the winter months.

7.4.2.11 Biological Productivity

The E plan would have a minor beneficial effect on biological productivity. Seasonal hydrologic variability that more closely approximates that under natural conditions would improve conditions for many aquatic species and would likely allow the abundance of some species to increase.

7.4.2.12 Biological Diversity

The E plan would have a minor beneficial effect on biological diversity. Seasonal hydrologic variability that more closely approximates that under natural conditions would improve conditions for aquatic species that are more sensitive to hydrologic changes. This could improve the abundance and extent of rare specialized species (rather than the more common generalist types) which would improve diversity in the project area.

7.4.2.13 Water Quality

The E plan would have a minor beneficial effect on water quality over the no-action plan. Reduced sedimentation in the reservoirs and increased emergent plant abundance would reduce turbidity. Increases in aquatic vegetation abundance would help tie up available nutrients and could reduce the abundance of algae. Increased minimum flows in the rivers would decrease the probability that anoxic conditions would occur.

7.4.2.14 Groundwater

The E alternative would have no appreciable effect on groundwater quality or abundance over the no-action plan.

7.4.2.15 Threatened and Endangered Species

The E alternative would have no effect on threatened or endangered resources.

7.4.2.16 Tribal Interests in Natural Resources

The implementation of the E plan would have a beneficial effect on natural resources in general in the study area, all of which are important to the Tribe. It is judged that wild rice would also benefit under this plan in the longer run, though some existing shallow rice beds may be negatively affected. Additionally, access to existing shallow rice beds would be impeded in many years, making rice harvesting more difficult in such areas. However, it is believed that rice would colonize other areas where it is not present now, and that marginal rice beds would likely improve in time. This would be caused by declining water levels in late summer, and also from even lower levels in drought years that would be unfavorable to perennial submerged species, thereby opening up areas to allow rice to colonize. In the long term, it is believed that wild rice would increase in abundance under this plan, over the no-action plan.

7.4.3 Social Effects – Plan E

7.4.3.1 Noise

No transient noise impacts or changes in ambient noise levels are anticipated as a result of the implementation of Alternative E.

7.4.3.2 Aesthetics

Implementation of Alternative E would adversely affect aesthetic values associated with summer time lake recreation activities and for those who maintain residences on the shoreline or in close proximity to all affected reservoirs. Target water elevations would fluctuate throughout the summer, peaking for one to two months in early to mid summer, and then declining much earlier in the summer season than has been experienced under current reservoir operating rules.

Aesthetic values associated with lakeshore erosion would be beneficially affected as the higher water elevation would be maintained for a much shorter period. The aesthetic values of those with a desire to experience the naturally occurring vegetation communities that existed prior to dam construction would be beneficially affected in the long-term under Alternative E, as this alternative would more closely approximate naturally occurring water level fluctuations. This would encourage vegetative communities to gradually return to more natural conditions.

Aesthetic values tied to a desire for a more natural river flows would also be beneficially affected. Increased minimum release rules, would contribute to improved aquatic and riparian habitat conditions. Many river users may perceive an improvement in boating, fishing and other river related recreation opportunities. Additionally, Alternative E would incorporate a discretionary spring pulse in an effort to obtain the benefits that natural spring time flow would afford to native biologic communities. These pulses would only be implemented in years where such an increase in flows would not induce downstream flooding.

Native Americans and others may perceive a decrease in aesthetic value at some lakes because lowered lake elevations during the last half of the summer season may adversely impact some wild rice beds in the short term. Individuals may find that maneuvering canoes or other water craft into rice beds to conduct harvesting activities at a few locations is more difficult due to shallow water. Additionally, lower water levels may contribute to an increased occurrence of ripened heads of rice falling over because of insufficient support.

As a result of lower lake levels and a perceived loss of aesthetic value, a small number of boat owners may elect to move their craft to other lakes, or operate for a shorter period each summer. This could result in improved aesthetic values for users with a primary interest in fishing. Many of these users find that the operation of motor boats reduces the quality of their fishing experience and therefore the aesthetic value of the lake in question. Fewer boats, or a shorter boating season, may improve the fishing environment and the associated aesthetic values.

Gull Lake. Residents of Gull Lake have expressed a clear preference for lake elevations that exceed 1,194 feet as much as possible and prefer that the bottom of the summer band be no lower than 1,193.75 because of shallow conditions on the east side of Gull, in Bishops Creek, and in Round Lake. Navigation in these areas is an important aesthetic value for these residents. Under Alternative E, many residents would perceive a reduction in the aesthetic value of Gull Lake after mid July; because lake elevations would fall below the 1,193.75 foot level for the remainder of the summer (see Gull Operating Hydrograph, Section 5.5.3).

Leech Lake. At the elevations projected under Alternative E, the aesthetic values of large boat owners and sail boat owners may be adversely impacted due to increased difficulties with shallow waters after early August when lake elevations drop below 1294.4 feet. Some areas of the lake may become unavailable to these users during this period, thereby reducing the lake's aesthetic value (see Leech Operating Hydrograph, Section 5.5.3).

Cross Lake. Increased difficulty and a potential loss of access to some lakes in the Cross Lake chain due to shallow connecting channels at a water elevation of 1229.22 or below, which would occur after the first part of July (see Cross Operating Hydrograph, Section 5.5.3). This may reduce the aesthetic value of this lake to some users under Alternative E.

Sandy Lake. The aesthetic values for some late season boaters in Sandy Lake would be diminished due to a smaller navigable area after the first part of September when water elevations approach 1215.61 or below (see Sandy Operating Hydrograph, Section 5.5.3).

7.4.3.3 Recreation Opportunities

Alternative E investigated enhanced environmental benefits, which was intended to simulate more natural hydrologic conditions. In general, reservoir water levels would rise in the spring and early summer and begin to decline shortly after. Details regarding this alternative can be found in Section 5.5.3.

It is difficult to predict what types and amounts of recreational uses of the lakes would occur as a result of implementing any one of the proposed operating plans. However, it is reasonable to assume that the current recreational uses of the lakes would continue under any of the operating plans. However, the enjoyment of the lakes may be impacted to different degrees due to the changes in lake levels at various times of the year. This could impact a user's satisfaction due to the dependency of some activities on water levels. Over time, it is likely that users of the lakes would adapt to the new conditions and existing levels of satisfaction would return. How long this would take under any plan is unknown.

Under the E Plan there would be a substantial adverse effect to recreational opportunities in the short-term. Boating access would likely be restricted in shallow areas and near boat ramps and lifts during much of the summer. Additionally, access through shallow connecting waterways would also be reduced. The increased minimum releases under this plan would likely lead to further reductions in lake elevations during dry years, further impacting recreational uses.

However, It is possible that in the long-term, forms of recreation that are dependant on the quality of natural resources could experience a minor beneficial effect under the E Plan that would override the adverse effects. The beneficial effects to natural resources as described in Section 7.4.2 could lead to an improved recreational experience for those engaged in activities dependant on such resources. Examples of such activities would include fishing and nature viewing. Also, activities such as swimming that are enhanced by improved water quality could also benefit under this plan in the long-term.

Cass Lake. It is anticipated that this plan would have a substantial adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above.

Lake Winnibigoshish. The current plan has a summer band of 1297.94 to 1298.44 with a target of 1298.19. Alternative E has a variable summer target of 1297.6 to 1298.14. It is anticipated that this plan would have a substantial adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above.

Leech Lake. The current plan has a summer band of 1294.5 to 1294.9 with a target of 1294.70. Alternative E has a variable summer target of 1294.25 to 1294.77. It is anticipated that this plan would have a substantial adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above. Water levels in summer would be too low for some types of water craft to navigate the Walker Narrows. Sail boats begin having difficulty navigating the Walker Narrows on Leech Lake when the elevation drops to approximately 1,294.4 feet. Under Alternative E, these users would begin to have difficulties from about the first of August through the end of the season. Sail boats and other large craft which require 3-4 feet of draft, may be unable to navigate in some harbors as well. Inability to move through the Walker Narrows into Walker Bay may preclude the use of the storage area located there or require that some craft be placed into storage much earlier in the season.

Pokegama Lake. The current plan has a summer band of 1273.17 to 1273.67 with a target of 1273.42. Alternative E has a variable summer target of 1272.94 to 1273.54. It is anticipated that this plan would have a substantial adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above. Boaters experience some difficulty at Pokegama when lake elevations decline to 1272.67 feet as a result of shallow water over sand bars and some rock hazards. Under the E plan, water levels would fall below this level around the last week of September.

Big Sandy Lake. The current plan has a summer band of 1216.06 to 1216.56 with a summer target of 1216.31. Alternative E has a variable summer target of 1215.7 to 1216.3. It is anticipated that this plan would have a substantial adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above. Access to many of the docks and lifts in the shallower bays would be adversely impacted when target lake elevations drop to 1215.61 feet. This would occur approximately September 15th under this plan.

Cross Lake. The current plan has a summer band of 1229.07 to 1229.57 with a summer target of 1229.32. Alternative E has a variable summer target of 1228.3 to 1229.8. It is anticipated that this plan would have a substantial adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above. Transportation between lakes in the Cross Lake chain becomes difficult at an elevation of 1229.22, which would be targeted by the first of July under this alternative. Under this plan it is likely some types of water craft would have difficulty navigating the Dagget Lake and Rush Lake Channels.

Gull Lake. The current plan has a summer band of 1193.75 to 1194.0, and the middle of the band is 1193.87. Alternative E has a variable summer target of 1193.5 to 1194.1. It is anticipated that this plan would have a substantial adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above. Navigation from Round Lake into Gull Lake becomes difficult when the lake level drops to 1,193.75 or below. Navigation into other lakes in the Gull Lake chain also becomes problematic at this level as many of the channels are only two to three feet deep. Therefore, navigation between lakes in the Gull chain would be difficult from about mid-July through the end of the summer under this alternative.

7.4.3.4 Transportation

Alternative E would not affect ground transportation systems within the analysis area. As described above under the all previous alternatives, this alternative would also include a combined outflow restriction of 2200 cfs for Lake Winnibigoshish and Leech Lake in order to protect the Highway 2 bridge near the confluence of the Mississippi and Leech Rivers.

Water transportation within river segments would be improved to a minor degree as a result of increases in the minimum release rules.

Existing water transportation routes within affected reservoirs would be adversely impacted to a substantial degree by the implementation of Alternative E. The early summer target levels for most reservoirs in the system would be approximately the same as the No Action Alternative for all reservoirs, except Pokegama and Gull, which would be about one and three inches higher respectively. However, water levels would begin to decline in the last half of the summer season, reaching a low point that would range from approximately three or four inches lower than the bottom of the current summer band at most reservoirs. These lower water elevations would result in restricted navigation between and within some chained lakes throughout the system.

Gull Lake. Navigation from Round Lake into Gull Lake becomes difficult when the lake level drops to 1,193.75 or below. Navigation into other lakes in the Gull Lake chain also becomes problematic at this level as many of the channels are only two to three feet deep. Therefore, navigation between lakes in the Gull chain would be difficult from about mid-July through the end of the summer (see Gull Operating Hydrograph, Section 5.5.3).

Cross Lake*.* Transportation between lakes in the Cross Lake chain becomes difficult at an elevation of 1,129.22. The target elevation from about the first of July through the end of the summer season (see Cross Operating Hydrograph, section 3.3.3 E Plan) would fall below this level under Alternative E (see Cross Operating Hydrograph, Section 5.5.3).

Leech Lake. Large boats and sail boats experience shallow water difficulties at Leech Lake when the elevation drops to approximately 1,294.4 feet. Under Alternative E, these users would begin to have difficulties from about the first of August through the end of the season (see Leech Operating Hydrograph, Section 5.5.3). Sail boat and other large craft which require 3-4 feet of draft, may be unable to navigate in some harbors and through channels such as the Walker Narrows. Inability to move through the Walker Narrows into Walker Bay may preclude the use of the storage area located there or require that some craft be placed into storage earlier in the season. Some users may choose to remove their craft from the water at other locations and seek alternative storage options for the winter. Some users may elect to move their boats to other lakes, adversely impacting resorts and businesses located at Leech Lake and benefiting businesses located on the new lake.

Pokegama Lake. Boaters may experience some difficulty at Pokegama when lake elevations decline to 1272.67 feet or less late in the summer (after August 1) as a result of shallow water over sand bars and some rock hazards (see Pokegama Operating Hydrograph, Section 5.5.3).

Sandy Lake. Access to many of the docks and lifts in the shallower bays would be adversely impacted when target lake elevations drop to 1215.61 feet. This would occur approximately July 1st through the end of the season. From about August 1 through the end of the season, when elevations would reach 1215.31 and lower, some of the shallower bays would not be passable. The channel between Aitkin and Big Sandy Lake, as well as Sandy and Prairie Rivers would be too shallow for large boats (see Sandy Operating Hydrograph, Section 5.5.3).

7.4.3.5 Public Health and Safety

Public health and safety risks and effects under Alternative E include those described above under the No Action Alternative, with the following exceptions. Clarification of flood operations at Pokegama when stages at Aitkin are approaching 14 feet in the spring and 13 feet in the summer may provide some minor increases in protection to this community. Additionally, lower target levels in the last half of the summer season on the reservoirs would further contribute flexibility to flood control operations in the event of late season events such as generalized weather conditions or events that occur further upstream.

Lower water elevations late in the season may result in a need for increased vigilance by boat operators on some reservoirs. Boating hazards, such as rocks and sand bars, may be more numerous at locations such as Pokegama and Sandy Lakes due to shallow waters in some areas under this alternative. Because of this, the E alternative is judged to have a minor detrimental effect on public safety in the short-term, and no-effect in the long term after people have had a chance to adjust to and recognize shallow boating hazards.

7.4.3.6 Community Cohesion (Sense of Unity)

Existing community cohesion would be tested and may be disrupted to a minor degree by the implementation of Alternative E. Community divides could develop as a result of the changed management focus under this alternative. Strong opposition from groups with economic ties and dependencies on reservoir recreation activities may develop. Tensions may develop between these groups and those favoring management that more closely approximates natural fluctuations in water levels and with those advocating increased river flows rather than retaining waters to maintain higher reservoir levels.

As described above, flooding events can serve to both strengthen and damage community cohesion. The increased flexibility afforded for flood control and prevention measures at stages approaching 14 feet in the spring and 13 feet in the summer under this alternative may provide a slight increase in the protection of the community of Aitkin and its stability and community cohesion.

7.4.3.7 Community Growth and Development

Fluctuating water levels resulting from the implementation of Alternative E may result in a minor decrease in property values for properties on or near each reservoir. Businesses dependent on lake recreation activities may experience a minor decline in property values and a minor contraction of lake related business. Lakeside properties may be perceived as less attractive by prospective residents or visitors than is currently the case.

In the long-term, residents and visitors would likely adjust to the increased fluctuation in water levels and adapt their customs and habits to accommodate and incorporate these fluctuations into their routines and lifestyles. Recreation uses and patterns would eventually adjust to accommodate the water resources available.

Gull Lake. Residents of Round Lake become concerned about declining property values when the lake elevation drops to 1193.75 or below because of the difficulty of navigating from Round Lake into Gull Lake. Residents on the east shore of Gull Lake also become concerned about declining property values at these elevations because they start having difficulty getting their boats off the lifts. Under this alternative, lake elevations would fall below this level from about mid-July through the end of the season (see Gull Operating Hydrograph, Section 5.5.3); therefore property values may decline, particularly for properties around Round Lake. Residents located on Gull Lake would be able to relocate lifts to accommodate the new elevations. Although such adjustments would require increased expenditures by these residents, any adverse effects to property values would be mitigated. Over the long-term, all property values would be expected to appreciate, despite the limitations on access between Round and Gull Lakes.

Cross Lake. Lower lake elevations and reduced ability to navigate between chained lakes from early July through the end of the summer, as discussed above under Transportation, could result in reduced property values under this alternative. In the long-term, property values would be expected to continue to appreciate.

Leech Lake. At the lake elevations projected from about the first of August through the end of the season under this alternative, shoreline owners along Leech Lake would experience difficulty with docks being too short or boat lifts not able to launch/remove boats. This could result in declining property values. In the long-term, property owners would likely move or lengthen docks and relocate lifts to accommodate the lower water levels, thereby improving property values.

Winnibigoshish Lake. In order to utilize facilities at Bowen's Resort on Winnibigoshish Lake after the about the first of September when the lake elevation is expected to decline to about 1297.69 or below (see Winnibigoshish Operating Hydrograph, Section 5.5.3), dock extensions would be needed, resulting in a one time increase in costs for the owners of this resort.

7.4.3.8 Business and Home Relocation

Implementation of Alternative E would not result in a need to relocate any businesses or homes.

7.4.3.9 Existing and Potential Land Use

No changes to existing and potential land uses would be anticipated as a result of the implementation of the Alternative E.

7.4.3.10 Controversy

Overall, the E plan would have a substantial adverse effect on controversy in the project area. Areas of controversy under Alternative E are the same as described under the No Action Alternative (Section 7.2.3.10), with the following exceptions or additions.

Water elevation under this alternative would fluctuate to a greater extent and would more closely resemble those of an unregulated system, while maintaining upper level water elevations similar to those experienced under the No Action Alternative. Additionally, increases in the minimum releases and implementation of spring pulses when appropriate would stimulate more natural riverine conditions. These adjustments may serve to reduce the level of controversy among members of the Ojibwe by giving greater and more equal attention to the effect on the reservoir and river aquatic ecosystems than occurs under current management. This more balanced approach to reservoir operations would better align with Ojibwe culture and beliefs.

The increased benefits to both river and reservoir ecosystem health may also contribute to reduced controversy associated with Ojibwe desire to ensure that the federal government is placing a higher priority on its responsibilities associated with Tribal Treaty obligations. However, there is a potential for adverse impacts to wild rice harvesting activities, which would again stir controversy. A portion of some rice beds could experience dryer conditions as a result of lower water elevations adversely impacting productivity or viability in the short term. Lower water elevations in the late summer may make it difficult or impossible to maneuver canoes or other craft into some existing rice bed areas in order to conduct harvest activities. Lower water levels may also reduce support to rice stems heavy with ripened rice, causing them to fall over. Adverse economic and subsistence impacts to the Ojibwe and other people dependent on wild rice harvests would increase the level of controversy in the short-term. Over the long-term however, any areas lost as a result of changed water levels would likely be replaced by newly developing wild rice beds, maintaining long term productivity and viability.

There would be reduced controversy for those who expressed concern that recreation values have, in the past, been elevated above the importance of ecosystem values. Alternative E would benefit the biotic communities associated with both reservoir and river systems. Additionally, the occurrence of shoreline erosion and loss of beach areas would be reduced under this alternative. However, the level of controversy experienced by those who support the prioritization of recreation related management objectives would be increased under this alternative.

Controversy associated with the effect of lower water elevations in the last half of the summer season would increase substantially. Many stakeholders expressed concern that drawing lake levels down starting in July was too early. The ability to navigate between chained lakes would be adversely impacted. Complains would increase from owners of sail boats and other large craft on Leech Lake who would begin having difficulty navigating through the Walker Narrows to access the storage area on Walker Bay from August to the end of the season, forcing them to store their boats earlier or find other storage facilities. Not only would boat owners contribute to the level of controversy, but so would resort and business owners in the areas surrounding the lakes. Boating use levels in the last half of the summer may decrease from current levels following implementation of this alternative, resulting in negative economic impacts and controversy among neighboring businesses.

7.4.3.11 Tribal Social Effects

Tribal social effects under Alternative E are the same as described under the No Action Alternative (Section 7.2.3.11), except as described below.

Fluctuations in water elevations under this alternative more closely resemble those of an unregulated system, although the water elevation would still exceed what would occur under natural conditions. The water elevation fluctuations would more closely align with desires expressed by the Leech Lake Band of Ojibwe. Increased minimum releases from all reservoirs and implementation of spring pulses when appropriate would benefit riverine ecosystems. These benefits to the aquatic ecosystems in the lakes and river would move management more toward the Ojibwe ideal of managing for all resources rather than prioritizing one above the others. This more balanced approach to reservoir operations would be more compatible with Ojibwe spiritual beliefs and culture as well as Tribal desires relative to Treaty obligations than would management under the No Action Alternative.

Damage to shoreline cultural resources, such as archeological sites would be reduced under this alternative as water elevations would be maintained at high levels for a shorter period of time each summer. The preservation of these cultural resources would assist the Ojibwe in the preservation of their cultural heritage.

In the short-term, lower water elevations may contribute to a reduction of wild rice beds and reduced access for wild rice harvesting activities. Lower water elevations in the late summer may make it difficult or impossible to maneuver canoes or other craft into some rice bed areas in order to conduct harvest activities. Lower water levels may reduce support to rice stems heavy with ripened rice, causing them to fall over. Some rice beds or portions there of, could experience dryer conditions as a result of lower water levels reducing their productivity and/or viability. Adverse economic and subsistence impacts to the Ojibwe and other people dependent on wild rice harvests may be experienced, depending on the extent of such impacts. However, such losses are expected to be relatively small under Alternative E.

In the long term, wild rice beds would be expected to adapt to, and benefit from the increased level of water elevation fluctuations. Ojibwe harvesting opportunities may increase in the long run.

7.4.3.12 Environmental Justice

American Indian populations in Beltrami, Cass, and Clearwater Counties and low-income populations may be adversely impacted in the short-term under Alternative Operating Plan E as lower water elevations may contribute to a reduction of wild rice beds and reduced access for wild rice harvesting activities. Some rice beds or portions there of, could experience reduced productivity and/or viability (see Section 7.4.3.11). However, such losses are expected to be relatively small. In the long term, wild rice beds are expected to benefit from increased water elevation fluctuations, thereby increasing harvesting opportunities in the long-term.

There may be minor adverse impacts employment as a result of negative impacts to business activity (see Sections 7.4.4.5 and 7.4.4.6). Any reduction in employment opportunities could negatively affect low-income populations.

Minor benefits to flood control operations at Winnibigoshish, Leech, and Pokegama reservoirs (Section 7.4.4.9) may also reduce the risk of adverse impacts to low-income residents.

7.4.4 Economic Effects – Plan E

7.4.4.1 Property Values

The E plan alternative attempts to provide maximum benefit to the lacustrine and riverine aquatic ecosystems. Because the E plan proposes greater fluctuation in water levels and levels sometimes lower than the current operating plan during the summer recreation season, the E plan alternative is expected to have a minor adverse effect on property values in the headwaters lakes area and no effect on property values in the Aitkin area and downstream.

Gull Lake. Residents of Round Lake become concerned about declining property values when the lake elevation drops to 1193.75 or below because of the difficulty of navigating from Round Lake into Gull Lake. Residents on the east shoreline of Gull Lake also become concerned about declining utility at these elevations because they start having difficulty getting their boats off the lifts. Under this alternative, lake elevations would fall below this level from about mid-July through the end of the season; therefore property values may decline, particularly for properties around Round Lake. Residents located on Gull Lake would be able to relocate lifts to accommodate the new elevations. Although such adjustments would require increased expenditures by these residents, any adverse effects to property values would be mitigated. Over the long-term, all property values would be expected to appreciate, despite the limitations on access between Round and Gull Lakes.

Cross Lake. Lower lake elevations and reduced ability to navigate between chained lakes from early July through the end of the summer could result in reduced property values under this alternative. In the long-term, property values would be expected to continue to appreciate.

Leech Lake. At the lake elevations projected from about the first of August through the end of the season under this alternative, shoreline owners along Leech Lake would experience difficulty with docks being too short or boat lifts not able to launch/remove boats. This could result in declining property values. In the long-term, some or most property owners would likely move or lengthen docks and relocate lifts to accommodate the lower water levels, thereby improving property values.

Winnibigoshish Lake. In order to utilize facilities at Bowen's Resort on Winnibigoshish Lake after the about the first of September when the lake elevation is expected to decline to about 1297.69 or below, dock extensions would be needed, resulting in a one time increase in costs for the owners of this resort.

7.4.4.2 Tax Revenues

Similar to property values, because property tax revenues are related to property valuation, the E plan alternative is expected to have an adverse effect on tax revenues in the headwaters lakes area and no effect in the Aitkin area and downstream.

7.4.4.3 Public Facilities and Services

The E plan alternative is judged to have no effect on public facilities and services.

7.4.4.4 Regional Growth

The E plan alternative is expected to have no appreciable effect on regional growth.

7.4.4.5 Employment

The E plan alternative may have a minor adverse effect on employment as a result of negative impacts to business activity. (See Business Activity 7.4.4.6)

7.4.4.6 Business Activity

In the short term, fluctuating water levels resulting from the implementation of Alternative E may result in a minor decline in activity for those businesses that are dependent on lake recreation activities.

In the long-term, residents and visitors would likely adjust to the increased fluctuation in water levels and adapt their customs and habits to accommodate and incorporate these fluctuations into their routines and lifestyles. Recreation uses and patterns would eventually adjust to accommodate the water resources available.

7.4.4.7 Farmland/Food Supply

Lower water levels on the reservoirs would contribute more flood storage capacity, especially in summer, available for flood storage and the reduction of crop damages at Aitkin; therefore, the E plan is judged to have a minor beneficial effect on farmlands. Short-term reductions in wild rice harvest may result in a minor negative effect on food supply for those that rely on wild rice as a food source. However, an improvement in wild rice productivity in the long-term would be a beneficial effect on food supply.

7.4.4.8 Water Supply

The E plan alternative is judged to have no appreciable effect on water supply.

7.4.4.9 Flooding Effects

Under the E plan flood damage reduction operation would be revised by implementing the Modified Existing Guide Curves and other rules as explained in section 5.3.6.3. With this plan there would be a minor benefit to flood control operations at Winnibigoshish, Leech and Pokegama reservoirs and in turn the City of Aitkin, MN. The effect at Big Sandy, Cross Lake and Gull reservoirs is unchanged from the existing.

With the E plan, target water elevations would fluctuate throughout the summer, peaking for one to two months in early to mid summer, and then declining much earlier in the summer season than has been experienced under current reservoir operating rules. These lower lake levels would allow for greater storage capacity during a flood event during this time of the year when compared to the current plan. Therefore, the E plan would have a minor beneficial effect on flooding.

7.4.4.10 Energy Needs and Resources

Future hydropower energy production under the E-plan would be similar to the historic average but may be slightly higher due to the increase in minimum flows found under this plan. Hydropower facilities on the Mississippi River are operated on a run-of-river basis and provide base-load power. Because of this, the amount of power produced is directly affected by river flow. Low-flow conditions limit energy production and, therefore, increasing minimum releases over the existing plan would increase the potential for energy production during low-flow periods. Because of this, the E plan would have a minor beneficial effect on hydropower production.

7.4.4.11 Tribal Economic Effects

The E plan alternative is judged to have a minor beneficial tribal economic effect because of its beneficial effects to aquatic and terrestrial habitat, water quality, fishery, and sedimentation and bank erosion. Fluctuations in water elevations under this alternative resemble those of an unregulated system, although the water elevation would still exceed what would occur under natural conditions. The water elevation fluctuations would more closely align with desires expressed by the Leech Lake Band of Ojibwe.

In the short-term, lower water elevations may contribute to a reduction of wild rice beds and reduced access for wild rice harvesting activities. Lower water elevations in the late summer may make it difficult or impossible to maneuver canoes or other craft into some rice bed areas in order to conduct harvest activities. Lower water levels may reduce support to rice stems heavy with ripened rice, causing them to fall over. Some rice beds or portions there of, could experience dryer conditions as a result of lower water levels reducing their productivity and/or viability. Adverse economic and subsistence impacts to the Ojibwe and other people dependent on wild rice harvests may be experienced, depending on the extent of such impacts. However, such losses are expected to be relatively small under Alternative E.

In the long term, wild rice beds would be expected to expand and benefit from the increased level of water elevation fluctuations. Ojibwe harvesting opportunities may increase in the long run.

7.4.5 <u>Cultural Resource Effects – Plan E</u>

7.4.5.1 Archeological sites

There are no new effects under this alternative, except at Gull Lake. At Gull Lake the water level will be up to 6 inches higher than the current operating band from 2 April to 2 July. This will result in no new effects or minor adverse effects as the six inch increase in lake level may start eroding a new band of that reservoir’s shoreline. At Pokegama the water level will be up to 1 inch higher than the current operating band from 15 May to 2 July with no new effects. For the other Headwaters reservoirs, this operating plan keeps water levels within their current operating bands, thus no new effects on prehistoric or historic archeological sites are expected. In all cases, water is kept at (or above) the upper target level for 1.5 to 3 months less than under the current operating plan, with the winter drawdown period beginning in mid-June to August. Therefore in general, the E plan would likely have a minor beneficial effect on archeological resources in the project area.

7.4.5.2 Tribal Cultural Effects

The E Plan would have a minor beneficial effect on cultural resources important the Tribe. Lower water levels would result in reduced erosion of important cultural sites around the reservoirs.

7.5 ALTERNATIVE OPERATING PLAN T

Alternative T was formulated to provide the maximum deviation from the existing operating plan for the benefit of natural resources. Basically, this plan is a modification of the E plan by lowering average reservoir water surface elevations under the E plan by an additional 6 inches. For more information regarding this alternative, please see Section 5.5.4.

7.5.1 Water Levels/Elevations and Flows – Plan T

A variety of hydrologic data were used throughout the study to assess the effects of the T alternative operating plan on reservoir water elevations and discharges. Various simulation models were used to predict potential water levels and discharges under this alternative. Such predictive models produce data that can be difficult to interpret; however, it is useful for assessing differences between operating plans and gaining an understanding of average effects. In general, reservoir water levels under the T plan would follow the targeted water levels (See Section 5.5.4).

7.5.2 Natural Resource Effects – Plan T

7.5.2.1 Introduction

The T plan is the same plan as the E plan except that targeted reservoir water levels, especially during the open-water season, are lower by 6 inches. This plan is considered to be a potential alternative that maximizes benefits to natural resources but in a manner that still may not unacceptably impact social and economic resources. This natural resource effects discussion has been limited to the changes in effect over the E alternative; therefore, all of the natural resource effects discussed for the E alternative apply to the T alternative unless noted below.

7.5.2.2 Air Quality

Because of the increase in minimum flows and the consequential increase in hydropower production capacity during otherwise low-flow periods, there would be a minor decrease in demand for thermal power production and the potential for a decrease in thermal power plant emissions. This would result in the T plan having a minor positive effect on air quality.

7.5.2.3 Terrestrial/Upland Habitat

The T plan would have a substantial beneficial effect on terrestrial habitat by significantly reducing bank erosion around the reservoirs.

7.5.2.4 Sedimentation/Bank Erosion

The T plan would have a significant beneficial effect on sedimentation and bank erosion on the reservoirs. Reducing reservoir water elevations would be the most effective way to reduce shoreline erosion. A water level decrease of 6 inches would reduce shoreline erosion, but erosion would still occur during periodic high water events, though less frequently than under any other alternative.

7.5.2.5 Wetland/Floodplain habitat

The T plan would have a minor beneficial effect to wetland habitat in the project area. A decrease in water levels on the reservoirs of six inches may have a minor impact on the distribution of wetland types around the reservoirs over time. However, the total extent and diversity of wetlands types would not change appreciably over the no-action plan. The hydrologic conditions would benefit wetland habitat in a manner similar to the E plan.

7.5.2.6 Aquatic Habitat

The T plan would have a significant beneficial effect on aquatic habitat in the reservoirs through a further reduction in sedimentation. This reduction would be the result of lower water levels and bank erosion, and the increased emergent plant beds that would help trap sediment that is washed into the reservoirs. Other benefits to aquatic habitat as discussed under the E plan would be applicable to the T plan as well.

7.5.2.7 Fish

The T plan would have a significant beneficial effect on fish in the reservoirs through a reduction in sedimentation in spawning beds. Other benefits as describe for the E plan would also occur under this alternative.

7.5.2.8 Mussels

The T alternative would have a minor beneficial effect on mussels in reservoirs due to the decrease in sedimentation. Riverine mussel communities would benefit from increased minimum flows and the resultant decrease in the probability that anoxic conditions would occur.

7.5.2.9 Birds

The T alternative would have a minor beneficial effect on birds compared to the no-action plan in the project area. Increased minimum releases in the spring when reservoirs are storing flood water could induce some waterfowl to nest slightly higher and experience less nest flooding than under the no-action plan. Improvements in near-shore vegetation would provide additional habitat for wetland birds.

7.5.2.10 Mammals

The T alternative would have a substantial beneficial effect on semi-aquatic mammals including muskrats and beavers. This alternative would provide more stable water levels in wetlands adjacent to the reservoirs and receiving rivers, which would help improve muskrat survival during the winter months.

7.5.2.11 Biological Productivity

The T plan would have a substantial beneficial effect on biological productivity. Reduced erosion and sedimentation would further increase productivity over that which would be expected under the E plan.

7.5.2.12 Biological Diversity

The T plan would have a substantial beneficial effect on biological diversity. Seasonal hydrologic variability that more closely approximates that under natural conditions would improve conditions for aquatic species that are more sensitive to hydrologic changes. This coupled with a further reduction in erosion and sedimentation could improve the abundance and extent of rare specialized species (rather than the more common generalist types) which would improve diversity in the project area.

7.5.2.13 Water Quality

The T plan would have a substantial beneficial effect on water quality in the project area. There would be further water quality benefits under the T plan relative to the E plan due to a further reduction in reservoir sedimentation and turbidity. Other benefits as described for the E plan would also occur under this alternative.

7.5.2.14 Threatened and Endangered Species

The T alternative would have no effect on threatened or endangered species.

7.5.2.15 Tribal Interests in Natural Resources

The same benefits to Tribal interests as discussed under the E plan would apply to the T plan as well. However, the short-term negative impact to existing shallow wild rice beds would be more significant. There would likely be a greater benefit to wild rice beds in the long-run, due the overall decline in water levels that would improve rice conditions in areas that are current too deep or dominated by perennial aquatic plants.

7.5.3 Social Effects – Plan T

7.5.3.1 Noise

No transient noise impacts or changes in ambient noise levels are anticipated as a result of the implementation of Alternative T.

7.5.3.2 Aesthetics

Implementation of Alternative T would have effects to aesthetic values similar to those described under Alternative E. However, the summer target water elevations would generally be approximately six inches lower. Adverse effects to aesthetic values associated with summer time lake recreation activities and for those who maintain residences on the shoreline or in close proximity to all affected reservoirs would be greater than under any of the other alternatives. Summer target elevations would fluctuate throughout the summer, peaking for one to two months in early to mid summer, and then declining much earlier in the summer season than has been experienced under current reservoir operating rules.

Aesthetic values associated with lakeshore erosion would be beneficially affected to a greater extent than would occur under Alternative E, as water elevations would be lowered by six inches, in an effort to minimize the occurrence of erosion. The aesthetic values of those with a desire to experience the naturally occurring vegetation communities that existed prior to dam construction would be beneficially affected under Alternative T in the long-term, as this alternative would more closely approximate naturally occurring water level fluctuations allowing vegetative communities to gradually return to more natural conditions.

Aesthetic values tied to a desire for more natural river flows would also be beneficially affected. Increased minimum release rules, would contribute to improved aquatic and riparian habitat conditions. Many river users may perceive an improvement in boating, fishing, and other river related recreation opportunities. Additionally, Alternative T would incorporate a discretionary spring pulse in an effort to obtain the benefits that natural spring time flow would afford to native biologic communities. These pulses would only be implemented in years where such an increase in flows would not induce downstream flooding.

As a result of lower lake levels and a perceived loss of aesthetic value by some due to increased vegetation, some boat owners may elect to move their craft to other lakes, or operate for a shorter period each summer. This could result in improved aesthetic values for users with a primary interest in fishing. Many of these users find that the operation of motor boats reduces the quality of their fishing experience and therefore the aesthetic value of the lake in question. Fewer boats or a shorter boating season may improve the fishing environment and the associated aesthetic values, perhaps stimulating an increase in the numbers of these users over time.

Gull Lake. Residents of Gull Lake have expressed a clear preference for lake elevations that exceed 1,194 feet as much as possible, because of shallow conditions on the ease side of Gull, in Bishops Creek, and in Round Lake. Navigation in these areas is an important aesthetic value for these residents. Under this alternative, many residents would perceive a reduction in the aesthetic value of Gull Lake, because lake elevations would be maintained below the 1,194 foot level throughout the summer season (See Gull Operating Hydrograph, Section 5.5.4).

Leech Lake. At the elevations projected under Alternative T (see Leech Operating Hydrograph, Section 5.5.4), the aesthetic values important to large boat and sail boat owners would be adversely impacted due to increased difficulties with shallow waters at elevations below 1294.40 feet. Some areas of the lake, such as Walker Bay, may become unavailable to these users, thereby reducing the lake's aesthetic value.

Cross Lake*.* Because lake elevations would remain below 1229.22 throughout the summer under Alternative T, users would experience loss of access to some lakes in the Cross Lake chain due to an inability to navigate shallow connecting channels (See Cross Operating Hydrograph, Section 5.5.4).

Pokegama Lake. Aesthetic values at Pokegama may decline for some boaters late in the summer when lake levels decline to 1272.67 and below because of an increase in the difficulty of maneuvering in shallow waters over sand bars and rock hazards in some locations (See Pokegama Operating Hydrograph, Section 5.5.4).

Sandy Lake. The aesthetic values for boaters on Sandy Lake would be diminished due to smaller navigable area (see discussion of Transportation below). Access to many of the docks and lifts in shallower bays is adversely affected at an elevation of 1215.61, which would be reached by approximately the first part of July. By about the first of August the elevation would drop to 1215.31 or lower, adversely affecting access to all docks (See Sandy Operating Hydrograph, Section 5.5.4). Additionally, there would be an increased occurrence of boating hazards such as rock reefs and sand bars.

7.5.3.3 Recreation Opportunities

Alternative T investigated maximizing environmental benefits relative to the other alternatives by simulating more natural hydrologic conditions as in the E Plan. However, under the T Plan lake levels would be reduced an additional 6 inches to further reduce shoreline erosion and sedimentation. In general, reservoir water levels would rise in the spring and early summer and begin to decline shortly after. Details regarding this alternative can be found in Section 5.5.4.

It is difficult to predict what types and amounts of recreational uses of the lakes would occur as a result of implementing any one of the proposed operating plans. However, it is reasonable to assume that the current recreational uses of the lakes would continue under any of the operating plans. However, the enjoyment of the lakes may be impacted to different degrees due to the changes in lake levels at various times of the year. This could impact a user’s satisfaction due to the dependency of some activities on water levels. Over time, it is likely that users of the lakes would adapt to the new conditions and existing levels of satisfaction would return. How long this would take under any plan is unknown.

Under the T Plan there would be a significant adverse effect to recreational opportunities in the short-term. Boating access would likely be restricted in shallow areas and near boat ramps and lifts during most of the summer. Additionally, access through shallow connecting waterways would also be reduced. The increased minimum releases under this plan would likely lead to further reductions in lake elevations during dry years, further impacting recreational uses. Many boat ramps, docks, and boat lifts would require modification to render them useable under this plan.

However, it is possible that in the long-term, forms of recreation that are dependant on the quality of natural resources could experience a minor beneficial effect under the T Plan similar to those discussed under the E Plan. The beneficial effects to natural resources as described in Section 7.5.2 could lead to an improved recreational experience for those engaged in activities dependant on such resources. Examples of such activities would include fishing and nature viewing. Also, activities such as swimming that are enhanced by improved water quality could also benefit under this plan in the long-term.

Cass Lake. It is anticipated that this plan would have a significant adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above.

Lake Winnibigoshish. The current plan has a summer band of 1297.94 to 1298.44 with a target of 1298.19. Alternative T has a variable summer target of 1297.1 to 1297.64. It is anticipated that this plan would have a significant adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above.

Leech Lake. The current plan has a summer band of 1294.5 to 1294.9 with a target of 1294.70. Alternative T has a variable summer target of 1293.75 to 1294.27. It is anticipated that this plan would have a significant adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above. Water levels in summer would be too low for some types of water craft to navigate the Walker Narrows. Sail boats begin having difficulty navigating the Walker Narrows on Leech Lake when the elevation drops to approximately 1,294.4 feet. Under Alternative T, water levels would only rise above 1294.4 during high precipitation events and basically, sail boats would not be able to navigate the Walker Narrows any time of the year. Sail boats and other large craft which require 3-4 feet of draft, would be unable to navigate many harbors as well. For these reasons, sail boating would likely decline on Leech Lake to a significant degree under the T alternative.

Pokegama Lake. The current plan has a summer band of 1273.17 to 1273.67 with a target of 1273.42. Alternative T has a variable summer target of 1272.44 to 1273.04. It is anticipated that this plan would have a significant adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above. Boaters experience some difficulty at Pokegama when lake elevations decline to 1272.67 feet as a result of shallow water over sand bars and some rock hazards. Under the T plan, water levels would fall below this level around the first week of August.

Big Sandy Lake. The current plan has a summer band of 1216.06 to 1216.56 with a summer target of 1216.31. Alternative T has a variable summer target of 1215.2 to 1215.81. It is anticipated that this plan would have a significant adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above. Access to many of the docks and lifts in the shallower bays would be adversely impacted when target lake elevations drop to 1215.61 feet. This would occur approximately July 1st through the end of the season under this plan. From about August 1 through the end of the season, when elevations would reach 1215.31 and lower, some of the shallower bays would not be passable. The channel between Aitkin and Big Sandy Lake, as well as Sandy and Prairie Rivers would be too shallow for large boats.

Cross Lake. The current plan has a summer band of 1229.07 to 1229.57 with a summer target of 1229.32. Alternative T has a variable summer target of 1228.3 to 1228.8. It is anticipated that this plan would have a significant adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above. Transportation between lakes in the Cross Lake chain becomes difficult at an elevation of 1229.22, which would not be reached under normal conditions under this alternative. Under this plan it is likely some types of water craft would have difficulty navigating the Dagget Lake and Rush Lake Channels.

Gull Lake. The current plan has a summer band of 1193.75 to 1194.0, and the middle of the band is 1193.87. Alternative T has a variable summer target of 1193.0 to 1193.6. It is anticipated that this plan would have a significant adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above. Navigation from Round Lake into Gull Lake becomes difficult when the lake level drops to 1,193.75 or below. Navigation into other lakes in the Gull Lake chain also becomes problematic at this level as many of the channels are only two to three feet deep. Under the T Plan, water levels would never reach this elevation under normal conditions and navigation of recreational boats would be impeded for the entire summer season under this alternative.

7.5.3.4 Transportation

Alternative T would not affect ground transportation systems within the analysis area. As described above under all previous alternatives, Alternative T would also include a combined outflow restriction of 2,200 cfs for Lake Winnibigoshish and Leech Lake in order to protect the Highway 2 bridge near the confluence of the Mississippi and Leech Rivers.

The summer target level in all upstream reservoirs is six inches lower under this alternative than would occur under Alternative E, increasing storage capacity in the spring, the primary flooding season. Gradually lowering water levels from mid-July through the end of the summer season at all reservoirs would further contribute to the likely success of flood control operations necessitated by less common summer events resulting from generalized weather conditions or local events occurring upstream from Sandy Lake. Aitkin area residents would benefit and the risk of flooding nearby road systems would be reduced to the greatest extent of all action alternatives considered.

Existing water transportation routes would be significantly adversely impacted by implementation of Alternative T. The early summer target levels for most reservoirs in the system would be approximately three to six inches lower than the No Action Alternative for all reservoirs under this alternative. Additionally, water levels would begin to decline in the last half of the summer season starting in mid-July, reaching a low point that would range from approximately three inches lower than the bottom of the current summer band at Cross Lake/Pine Reservoir and Gull Lake to nine to ten inches lower on the other reservoirs. These lower water levels would result in restricted navigation between and within some chained lakes throughout the system.

Gull Lake. Navigation from Round Lake into Gull Lake becomes difficult when the lake level drops to 1,193.75 or below. Navigation into other lakes in the Gull Lake chain also becomes problematic at this level as many of the channels are only two to three feet deep. Therefore, navigation between lakes in the Gull chain would be difficult for most of the summer under this alternative (See Gull Operating Hydrograph, Section 5.5.4).

Cross Lake. Transportation between lakes in the Cross Lake chain becomes difficult at an elevation of 1,129.22 feet. The target elevation for the entire summer season (see Cross Operating Hydrograph, Section 5.5.4 T Plan) would frequently fall below this level under Alternative T.

Leech Lake. Large boats and sail boats experience shallow water difficulties at Leech Lake when the elevation drops to approximately 1,294.4 feet. Under Alternative T, these users would have difficulties throughout the summer (see Leech Operating Hydrograph, section 5.5.4). Sail boat and other large craft which require 3-4 feet of draft, may be unable to navigate in some harbors and through channels such as the Walker Narrows. Inability to move through the Walker Narrows into Walker Bay would preclude the use of the storage area located there. This would force these users to remove their craft from the water at other locations and seek alternative storage options for the winter. Some users may elect to move their boats to other lakes, adversely impacting resorts and businesses located at Leech Lake and benefiting businesses located on the new lake.

Pokegama Lake. Boaters may experience some difficulty at Pokegama Lake when lake elevations decline to 1272.61 and below late in the summer (after August 1), resulting in shallow water over sand bars and some rock hazards (See Pokegama Operating Hydrograph, Section 5.5.4).

Sandy Lake. Access to many of the docks and lifts in the shallower bays would be adversely impacted as a result of maintaining water levels at target elevations that fall below 1215.61 feet from approximately July 1st through the end of the season. From about August 1 through the end of the season when elevations fall to 1215.31 feet and below, some of the shallower bays would not be passable. The channel between Aitkin and Big Sandy Lake, as well as Sandy and Prairie Rivers would be too shallow for large boats (See Sandy Operating Hydrograph, Section 5.5.4).

Wild Rice. The ability to navigate into some rice beds by boat to conduct harvesting activities may be reduced under Alternative T. Shallow waters in some areas may prevent access, potentially reducing annual harvest levels by Native American users and others. In the long term, additional rice beds may develop in areas that previously were too deep to allow rice to grow. However the extent of potential new rice beds or the length of time required for such beds to become established is unknown.

7.5.3.5 Public Health and Safety

Public health and safety risks and effects related to flooding under Alternative T are generally the same as described above under the Alternative E with the following exceptions. Coordinated flood control operations at Pokegama Lake, Leech Lake, and Winnibigoshish Lake would continue to be implemented for the protection of Aitkin. Alternative T would establish and maintain the lowest target water levels throughout the summer season at these reservoirs. These lower water retention levels would therefore allow a greater holding capacity in the event of flood conditions, providing the greatest level of flexibility for flood control operations throughout the spring and summer among the alternatives.

Lower water elevations may result in a need for increased vigilance by boat operators on some reservoirs. Boating hazards, such as rocks and sand bars, may be more numerous due to shallow waters in some areas under this alternative. Because of this, the T alternative is judged to have a minor detrimental effect on public safety in the short-term, and no-effect in the long term after people have had a chance to adjust to and recognize shallow boating hazards.

7.5.3.6 Community Cohesion (Sense of Unity)

Existing community cohesion would be tested and may be disrupted to a substantial degree by implementation of Alternative T, similar to, and perhaps greater than described under Alternative E. Community divides could develop as a result of the changed management focus under this alternative. Strong opposition from groups with economic ties and dependencies on reservoir recreation activities would likely develop. Tensions may develop between these groups and those favoring management that more closely approximates natural fluctuations in water levels and with those advocating increased river flows rather than retaining waters to maintain higher reservoir levels.

As described above, flooding events can serve to both strengthen and damage community cohesion. The increased flexibility afforded for flood control would benefit the community of Aitkin and its stability and community cohesion over that provided by the No Action Alternative.

7.5.3.7 Community Growth and Development

Fluctuating water levels resulting from the implementation of Alternative T may result in decreased property values for properties on or near each reservoir to a greater extent than would occur under Alternative E. In the short term, businesses dependent on lake recreation activities would experience a decline in property values and a contraction of lake related businesses may occur. There is an increased chance that the viability of some businesses may be adversely impacted. In the short-term, a perceived decrease in the attractiveness of some lakeside properties may lead some residents to seek homes elsewhere and could lead to a minor detrimental effect to community growth and development.

In the long-term, residents and visitors would likely adjust to the increased fluctuation in water levels and adapt their customs and habits to accommodate and incorporate these fluctuations into their routines and lifestyles. Recreation uses and patterns would eventually adjust to accommodate the water resources available.

Gull Lake. Residents of Round Lake become concerned about declining property values when the lake elevation drops to 1,193.75 feet or below because of the difficulty of navigating from Round Lake into Gull Lake. Residents on the east shore of Gull Lake also become concerned about declining property values at 1,193.75 ft. or below because they start having difficulty getting their boats off the lifts. Under this alternative, lake elevations would fall below this level for most of the summer (See Gull Operating Hydrograph, Section 5.5.4), therefore property values would likely decline, particularly for properties around Round Lake. Residents located on Gull Lake would have the option of relocating lifts to accommodate the new elevations. Over the long-term, all property values would be expected to appreciate, despite the limitations on access between Round and Gull Lakes.

Cross Lake. Lower lake levels and reduced ability to navigate between chained lakes, as discussed above under Transportation, could result in reduced property values under this alternative. In the long-term, values would continue to appreciate.

Leech Lake. At the lake elevations projected under this alternative, shoreline owners along Leech Lake would experience difficulty with docks being too short or boat lifts not able to launch/remove boats. This may result in declining property values. In the long-term, property owners would likely move or lengthen docks and relocate lifts to accommodate the lower water levels, mitigating the impacts to property values.

Winnibigoshish Lake. Lower water elevations early and late in the summer (beginning of summer until approximately June 15 and from about August 1 through the end of summer) would render most existing boat ramps and resort docks unusable. From June 15th through August 1st, most boat ramps and docks would be usable; however, some may need to be extended. Resort owners would experience adverse economic impacts in the form of lost business and the costs of lengthening and/or relocating/reconstructing docks and boat ramps to make them useable throughout the season.

7.5.3.8 Business and Home Relocation

Implementation of Alternative T would not result in a need to relocate any businesses or homes.

7.5.3.9 Existing and Potential Land Use

No changes to existing and potential land uses would be anticipated as a result of the implementation of the Alternative T.

7.5.3.10 Controversy

Overall, the T plan would have a significant adverse effect on controversy in the project area. Areas of controversy under Alternative T are the same as described under the Alternative E (Section 7.4.3.10), with the following exceptions or additions.

Water elevation under this alternative would be lower and would fluctuate to a greater extent than would occur under the No Action Alternative. Among the alternatives considered, water elevations and fluctuations under Alternative T would most closely resemble those of an unregulated system. These adjustments, together with increased minimum releases and implementation of spring pulses when appropriate, would serve to reduce the level of controversy among some members of the Ojibwe by giving greater and more equal attention to the effect on the reservoir and river aquatic ecosystems than occurs under current management. This more balanced approach to reservoir operations, giving increased weight to ecosystem values relative to recreational values would better align with traditional Ojibwe culture and beliefs.

However, impact to wild rice harvesting would create increased controversy. Individuals may experience increased difficulty in maneuvering canoes or other water craft into rice beds to conduct harvesting activities due to shallow water. Lower water levels would contribute to an increased occurrence of ripened heads of rice falling over because of insufficient support. Additionally, there is a potential that some wild rice beds could be lost in the short-term if the lower lake elevations leave rice beds dry. However, over time, new rice beds may develop in areas that previous could not support rice due to the depth of the water, thereby mitigating short-term losses.

Controversy associated with the effect that lower water elevations would have on navigation within and between chained lake systems would be greatest under Alternative T. As described above under Transportation, the lower water levels would prevent navigation through some shallow channels and may isolate some areas from the larger lake systems. Some boat owners may choose to move their boats and relocate to other areas. Resort owners and commercial interests tied to recreational boating may suffer adverse economic impacts, increasing controversy regarding implementation of this alternative.

Operations at Pokegama Lake, Leech Lake, and Winnibigoshish Lake to control flooding at Aitkin would remain a subject of controversy. Clarification of the flood operation rules increase flexibility and may provide a slight benefit to Pokegama Lake, Leech Lake, Winnibigoshish Lake, and Aitkin. The lower water elevations at these reservoirs increase storage capacity during a flood event. Together, these factors may serve to moderate concerns of Aitkin residents.

7.5.3.11 Tribal Social Effects

Tribal social effects under Alternative T are the same as described under the Alternative E (Section 7.4.3.11), except as described below.

Damage to shoreline cultural sites would be reduced to the greatest extent under this alternative. There is some concern that the lower water levels could reveal additional sites that were previously hidden beneath the surface of the lake, potentially exposing them to damage.

In the short-term, this alternative may have the greatest potential adverse impact to wild rice harvesting activities of all the alternatives. Water elevations would be lowered throughout the summer season under this alternative. These lower water elevations would likely contribute to a reduction of wild rice beds and would reduced access for wild rice harvesting activities. Lower water elevations in the late summer would make it difficult or impossible to maneuver canoes or other craft into some rice bed areas in order to conduct harvest activities. Reduced support to stems as a result of the lower water levels would result in an increase in the amount of rice lost when rice heads, heavy with ripened rice, fall over. Some rice beds or portions there of, could experience dryer conditions as a result of lower water levels reducing their productivity and/or viability. Adverse economic and subsistence impacts to the Ojibwe and other people dependent on wild rice harvests would likely be experienced.

7.5.3.12 Environmental Justice

American Indian populations in Beltrami, Cass, and Clearwater Counties and low-income subsistence users would likely be adversely impacted under Alternative Operating Plan T as lower water elevations would likely contribute to a reduction of wild rice beds and reduced access for wild rice harvesting activities. Some rice beds or portions there of, could experience reduced productivity and/or viability (see Section 7.5.3.11).

There may be minor adverse impacts employment as a result of negative impacts to business activity (see Sections 7.5.4.5 and 7.5.4.6). Any reduction in employment opportunities could negatively affect low-income populations.

Benefits to flood control operations at Winnibigoshish, Leech, and Pokegama reservoirs (Section 7.5.4.9) may also reduce the risk of adverse impacts to low-income residents to the greatest extent under this alternative.

7.5.4 Economic Effects – Plan T

7.5.4.1 Property Values

The T plan carries forward all of the components of the E plan, which attempts to provide maximum benefit to the lacustrine and riverine aquatic ecosystems, plus attempts to minimize shoreline erosion by lowering water elevation targets during the open-water season an additional 6 inches. Because the T plan proposes lower levels than the current operating plan during the summer recreation season, the T plan alternative is expected to have a substantial adverse effect on property values in the headwaters lakes area and no effect on property values in the Aitkin area and the areas downstream of Aitkin.

Gull Lake. Residents of Round Lake become concerned about declining property values when the lake elevation drops to 1,193.75 feet or below because of the difficulty of navigating from Round Lake into Gull Lake. Residents on the east shore of Gull Lake also become concerned about declining property values at 1,193.75 ft. or below because they start having difficulty getting their boats off the lifts. Under this alternative, lake elevations would fall below this level for most of the summer, therefore property values would likely decline, particularly for properties around Round Lake. Residents located on Gull Lake would have the option of relocating lifts to accommodate the new elevations. Although such adjustments would require increased expenditures by these residents, any adverse effects to property values would be mitigated. Over the long-term, all property values would be expected to appreciate, despite the limitations on access between Round and Gull Lakes.

Cross Lake. Lower lake levels and reduced ability to navigate between chained lakes could result in reduced property values under this alternative. In the long-term, values would appreciate.

Leech Lake. At the lake elevations projected under this alternative, shoreline owners along Leech Lake would experience difficulty with docks being too short or boat lifts not able to launch/remove boats. This may result in declining property values. In the long-term, property owners would likely move or lengthen docks and relocate lifts to accommodate the lower water levels, mitigating the impacts to property values.

Winnibigoshish Lake*.* Lower water elevations early and late in the summer (beginning of summer until approximately June 15 and from about August 1 through the end of summer) would render most existing boat ramps and resort docks unusable. From June 15th through August 1st, most boat ramps and docks would be usable; however, some may need to be extended. Resort owners would experience adverse economic impacts in the form of lost business and the costs of lengthening and/or relocating/reconstructing docks and boat ramps to make them useable throughout the season.

7.5.4.2 Tax Revenues

Similar to property values, because property tax revenues are related to property valuation, the T plan alternative is expected to have a substantial adverse effect on tax revenues in the headwaters lakes area in the short term and no effect in the Aitkin area and downstream.

7.5.4.3 Public Facilities and Services

The T plan alternative is judged to have no effect on public facilities and services.

7.5.4.4 Regional Growth

The T plan alternative is expected to have no appreciable effect on regional growth.

7.5.4.5 Employment

The T plan alternative may have a minor adverse effect on employment as a result of negative impacts to business activity. (See Business Activity 7.5.4.6)

7.5.4.6 Business Activity

The lower water levels associated with the T plan would prevent navigation through some shallow channels and may isolate some areas from the larger lake systems. Some boat owners may choose to move their boats and relocate to other areas. Resort owners and commercial interests tied to recreational boating may suffer adverse economic impacts with substantial negative impacts to business activity.

7.5.4.7 Farmland/Food Supply

Under the T plan there would minor beneficial effects to farmland and food supplies similar to those discussed for the E plan; however, the magnitude of these effects would likely be slightly greater.

7.5.4.8 Water Supply

The T plan alternative is judged to have no appreciable effect on water supply.

7.5.4.9 Flooding Effects

The further reduction in reservoir water levels over the E plan would have a substantial beneficial effect to flood damage reduction due to the additional storage capacity available during summer and fall flooding events.

7.5.4.10 Energy Needs and Resources

The T plan would have a minor beneficial effect on hydropower production due to the increase in minimum releases as discussed in the E plan.

7.5.4.11 Tribal Economic Effects

The T plan alternative is judged to have a beneficial tribal economic effect because of its beneficial effects to aquatic and terrestrial habitat, water quality, fishery, and sedimentation and bank erosion.

However, the ability to navigate into some rice beds by boat to conduct harvesting activities may be reduced under Alternative T. Shallow waters in some areas may prevent access, potentially reducing annual harvest levels. In the long term, additional rice beds may develop in areas that previously were too deep to allow rice to grow. However the extent of potential new rice beds or the length of time required for such beds to become established is unknown.

7.5.5 Cultural Resource Effects – Plan T

7.5.5.1 Archeological sites

There are minor beneficial effects under this alternative. Under this operating plan, the upper target level for all reservoirs would be kept 5 to 6 inches lower during the open water season than under the current operating plan, which may result in less erosion damage to archeological sites. In all cases, water is kept at the new upper target level for 1.5 to 3 months less than under the current operating plan, with the winter drawdown period beginning in mid-June to August. There is a risk that lower water levels would expose cultural resources under this plan, which would make them vulnerable to removal.

7.5.5.2 Tribal Cultural Effects

There would be a minor beneficial effect to tribal cultural resources due to a reduction in shoreline erosion around the reservoirs and a resultant reduced rate of erosion at cultural resource sites. There would, however, be a risk of exposure of currently inundated cultural resources, which would make them vulnerable to removal.

7.6 ALTERNATIVE OPERATING PLAN P

Alternative P, or the proposed plan, was formulated to be the best balance of benefit and costs when considering the full range of resources and interests affected by the operation of the study reservoirs. The intent was to provide benefits to resources currently being negatively impacted by the existing plan, while minimizing impacts to other resources. This plan includes a gradual summer decline in reservoir water levels, increases in minimum releases, minor modifications to the flood operating component, and other minor changes. For more detail regarding the proposed plan, please see Section 5.5.5.

7.6.1 Water Levels/Elevations and Flows - Plan P

Water levels under the proposed plan would follow the targeted levels as shown in Figures 5.5.5.a through 5.5.5.g in Section 5.5.5 on average. Of course at any given time water levels will vary around the target depending on hydrologic conditions. In order to better evaluate the performance of the proposed plan, a daily mass-balance model was developed to help estimate reservoir stage and discharges under this plan compared to those modeled for the existing plan. Some of the data for recent years is presented in Appendix E to show some basic examples of what the expected difference may be between the proposed and existing operating plans for various conditions.

7.6.1.1 Water Level Decline After July 15th

Table 7.6.1.1.a shows the actual targeted water levels for the first of August, September, and October under the proposed plan. Table 7.6.1.1.b shows the departure from the normally targeted water levels under the existing plan to those under the proposed plan. The departure in all cases is 3 inches or less on September 1st.

Table 7.6.1.1.a. Targeted Water Elevation (inches) Under the Current and Proposed Plans.

	Cass	Winni	Leech	Pokegama	Sandy	Cross	Gull
Aug. 1 Current	1301.59	1298.19	1294.70	1273.42	1216.31	1229.32	1193.87
Aug. 1 Proposed	1301.77	1298.12	1294.63	1273.34	1216.23	1229.24	1194.0
Sep. 1 Current	1301.43	1298.19	1294.70	1273.42	1216.31	1229.32	1193.87
Sep. 1 Proposed	1301.66	1297.95	1294.50	1273.17	1216.06	1229.07	1194.0
Oct. 1 Current	1301.43	1297.97	1294.53	1273.0	1216.13	1229.09	1193.87
Oct. 1 Proposed	1301.50	1297.79	1294.40	1272.81	1215.80	1228.81	1193.86

Table 7.6.1.1.b. Difference in Targeted Water Elevation (inches) Under the Proposed Plan Relative to the Current Plan

	Cass	Winni	Leech	Pokegama	Sandy	Cross	Gull*
Aug. 1	+2.16	-0.84	-0.84	-0.96	-0.96	0.96	+1.56
Sep. 1	+2.76	-2.88	-2.4	-3	-3	3	+1.56
Oct. 1	+0.84	-2.16	-1.56	-2.28	-3.96	3.36	0

* The difference for Gull was calculated from the target in the current operating plan (1193.87), rather than the top of the band (1194).

7.6.1.2 Revised Minimum Releases

The minimum releases in the proposed plan are described in Section 5.3.4.4. The effects of the minimum releases on water levels were assessed with various techniques including the application of the daily mass-balance model. Some example output from this model is available in Appendix E.

In general, the increased minimum releases will have no measurable effect on water levels during years with normal precipitation. During drought years such as in 2006 and 2007, the increases in minimum releases over the existing plan are expected have a minor adverse effect on water levels. It is likely that there would be no measureable effect even in dry years on Winnibigoshish and Leech due to the volume of water in those reservoirs relative to the increase in discharge. On the other reservoirs, the increased minimums are expected to result in water levels being no more than inches lower near the end of summer, relative to water levels experienced under the current plan. In most cases this water level difference is expected to be closer to one inch. It is important to note that if it is discovered that during a drought these increased minimums are resulting in greater impacts than those predicted here, the operating plan could be quickly modified through adaptive management procedures as described in Section 6.2.

7.6.2 <u>Natural Resource Effects - Plan P</u>

7.6.2.1 Introduction

The P plan, or the proposed plan, was formulated to provide a balance of benefits across all interests in the study area, including natural resource interests. Because of this, the proposed plan would have some beneficial impacts to natural resources over the no-action alternatives, but to a lesser degree than either the E or T plans.

Many of the benefits to natural resources expected under this alternative are a result of hydrology that is more similar to that of a natural system (see Section 4.4.4). The proposed plan includes a gradual decline of lake levels in late summer, similar to what happens on natural lakes. This in turn leads to a better ability to maintain adequate river flow, and helps reduce the amount of drop that would occur in winter for winter drawdown. The proposed plan also includes a spring pulse when possible, to simulate brief high flows that occur in the spring in unregulated river systems. These changes would result in more natural seasonal hydrologic variability which would have numerous benefits as described in more detail below.

The proposed plan does not include measures to approximate natural inter-annual variability however. Periodic events such as simulated drought with season-long low water would have numerous significant benefits to natural resources; however, as mentioned in Section 5.4.3., the significant negative social impacts render such an alternative unacceptable at this time.

7.6.2.2 Air Quality

The proposed plan would have a minor beneficial effect on air quality. Because of the increase in minimum flows, there would be an increase in hydropower production capacity during low-flow periods. This in turn would decrease the demand for thermal power production and fossil fuel consumption and, therefore, would result in a reduction in thermal power plant emissions that degrade air quality.

7.6.2.3 Terrestrial/Upland Habitat

Under the proposed plan there would be a minor beneficial effect to terrestrial habitat. This would be due to a minor decrease in shoreline erosion around the reservoirs resulting from the gradual late-summer water level decline. The decline would reduce the time water has to act on the shoreline and would help promote near-shore vegetation that would help stabilize the banks. There would be a minor adverse effect on terrestrial habitat on Gull Lake due to the minor increase in summer water levels. There would be no measurable effect on upland habitat adjacent to the receiving rivers because flood levels would not change as a result of changes to the operating plan.

7.6.2.4 Sedimentation/Bank Erosion

Bank erosion and sedimentation are two factors that have had and continue to have a significant adverse effect on the Headwaters reservoirs. Eroding banks contribute to sedimentation, which results in the degradation of course-substrate bottom habitat for invertebrates and fish spawning.

Under the proposed plan there would be a minor beneficial effect to bank erosion and sedimentation. Gradually declining water levels after July 15th would improve conditions for the growth of near-shore emergent vegetation. Emergent vegetation would help stabilize the toes of steep erodible banks by reducing wave energy and through the soil-holding ability of improved root structures. Furthermore, this vegetation would help trap sediment that is eroding from these banks, preventing it from moving quickly into deeper areas. Emergent vegetation can also help prevent the lateral movement of sediment along shorelines that is caused by wave action.

7.6.2.5 Wetland/Floodplain habitat

The proposed plan would have a minor beneficial effect on wetland and floodplain habitat. The gradual summer decline and reduced winter drawdown would improve hydrologic conditions in wetlands adjacent to the reservoirs and receiving rivers which would have numerous benefits. A gradual summer decline in reservoir water levels would encourage growth of emergent vegetation such as bulrush, cattail, and arrowhead in shallow wetlands. Improved diversity and abundance of vegetation provides cover, forage, nesting, rearing, and overwintering habitat for many wetland species. Lower late summer and fall water levels would encourage amphibians and turtles to overwinter in more permanent (deeper) areas where the risk of winter freeze-out is not compounded by winter drawdowns. The proposed plan would also help decrease and stabilize winter flows in the receiving rivers, relative to the no-action plan. This would reduce the incidence of muskrat lodge flooding in winter, which has been shown to cause significant mortality in other systems. Lower winter flows would also reduce the occurrence of large pieces of frozen floating bog breaking off and moving downstream.

In a paper from Northern Finland (Hellsten, and Riihimaki. 1996) it was clear that the number of species of plants in a regulated reservoir was much less than an unregulated lake of similar composition. Similar research has been performed on Namakan Reservoir in Voyageurs National Park. Changing lake levels are a natural phenomenon that contributes to the diversity of plant life in a lake. Reservoirs that are regulated for the maximum utility such as flood storage or recreation may be drawn down over the winter, rather than slowly during the summer as if controlled by evaporation. The exposure of shallow areas during late summer may allow for sediment consolidation and plant growth as well as eliminating exotic species. On the other hand, withdrawing water during winter exposes native plants to freezing of roots which may kill the plants and provide an opportunity for colonization by exotic species. In the shallow, periodically exposed zone, Namakan Reservoir had low growing plants that would be of little value for fish and other organisms while Rainy Lake, without the large winter drawdown, had species of emergent plants of much greater ecological value. (Kallemeyn, Cohen and Radomski, 1993).

7.6.2.6 Aquatic Habitat

The proposed plan would have a minor beneficial effect on aquatic habitat in the reservoirs and receiving rivers in the project area. Improved seasonal hydrologic variability would have numerous impacts. Reduced sedimentation in the reservoirs would improve spawning habitat for many species of fish including walleye. Expanded and more diverse aquatic vegetation would improve habitat by providing spawning, nursery, and feeding habitat for numerous species of animals. The spring pulse would trigger fish spawning and help clean coarse spawning substrate downstream from the dams. Increased minimum releases would help improve riverine aquatic habitat by increasing the wetted area and by reducing the chance for anoxic conditions.

7.6.2.7 Fish

The proposed plan would have a minor beneficial effect to fish in the reservoirs and receiving rivers in the project area. Improved vegetation would provide better spawning, rearing, and feeding habitat for numerous fish species. Increased minimum flows would help maintain fish habitat in the receiving rivers in dry conditions, and would also help maintain rearing habitat during spring when discharges are frequently reduced to near minimum under the existing plan to reduce downstream flooding. The proposed spring pulse would improve spawning conditions by washing sediment from coarse spawning substrate. The early summer decline would help reduce the need for high reservoir releases during the winter when high flows can stress fish in overwintering habitats.

It is believed that declining water levels subsequent to whitefish spawning can delay hatching and even crush eggs under the ice. Because of this, the early summer decline would likely improve conditions for whitefish spawning by reducing water level decline after spawning has occurred.

7.6.2.8 Mussels

The proposed plan would have a minor beneficial effect on mussels in the project area, primarily due to the increase in minimum flows, which would decrease the probability for low-dissolved oxygen conditions in late summer. There may also be a minor benefit from the mid-summer decline in lake levels that would induce the movement of mussels to deeper water, rather than a dramatic decline in winter as experienced under the existing plan, which could account for some stress and mortality.

7.6.2.9 Birds

The proposed plan would have a minor beneficial effect on birds in the project area, primarily those that utilize wetland habitat. Increased diversity and abundance of emergent vegetation would provide habitat for wetland birds. The spring pulse would help encourage some waterfowl nesting at a slightly higher elevation, thereby reducing the likelihood that late-spring floods or high reservoir releases would flood nests, which occurs frequently under the current operating plan especially downstream of Leech Lake Dam. Low spring water levels followed by flooding adversely affected aquatic bird nesting success in Namakan including loons, red necked grebes, pied-billed grebes, and black terns. (Kallemeyn, Cohen and Radomski, 1993).

7.6.2.10 Mammals

The proposed plan would have a minor beneficial effect on wetland mammals in the project area. Dramatic changes in water levels during the winter are known to cause increased mortality for wetland mammals that overwinter near the water surface. Beavers and muskrats are vulnerable to such water level changes. The proposed plan would result in less dramatic winter water level changes, and the gradual summer decline may also influence these animals to build winter lodges in deeper water, where winter drawdown is less likely to result in freeze-out.

High stable water levels on Namakan Reservoir in early summer and fall caused beavers to build their lodges and food caches at elevations that left them susceptible to drawdown. Nearly 80 percent of beavers were forced to abandon their lodges for woodchip nests leaving them more susceptible to predation and other misfortunes. Muskrats were similarly affected. Although they were able to rebuild their houses in deeper water, their food sources became inaccessible as the water level declined and forced them to forage in the open, they were more heavily preyed upon (Kallemeyn, Cohen and Radomski, 1993).

Muskrats were found in significantly greater numbers in Rainy Lake with minimal drawdown (1.0 meter) versus Namakan Reservoir with a significant drawdown (2.7 meters) (Thurber and Peterson, 1988).

7.6.2.11 Biological Productivity

The proposed plan would likely have a minor beneficial effect on biological productivity in the project area. Improved hydrologic, and consequently, habitat conditions for numerous species would help increase the abundance of these life forms and their ability to maintain higher population sizes.

7.6.2.12 Biological Diversity

The proposed plan would have a minor positive effect on biological diversity in the project area. Seasonal hydrologic variability that better follows natural patterns would improve the ability of native species to complete their lifecycles and increase their numbers. This would likely lead to increased species diversity in some areas. This is especially true for more specialized species that do not readily adjust to human disturbance and whose populations are being suppressed by current hydrologic conditions.

7.6.2.13 Water Quality

The proposed plan would have a minor positive effect on water quality in the project area. The increases in minimum flows would decrease the chance that oxygen depletion would occur during late summer. There is little information on the exact mechanisms by which mercury enter the food chain and none could be found relating changes in reservoir operations to changes in mercury contamination. It is likely though, that the proposed plan would have no measurable effect on mercury contamination in the project area. Turbidity in the receiving river may benefit slightly under the proposed plan due to reduced erosion in the summer.

7.6.2.14 Groundwater

The proposed plan would have no effect on groundwater quantity or quality in the project area. A study was conducted by the U.S. Geological Survey in 2005 in which an existing model was used to estimate the effects of reservoir and river water level changes on adjacent aquifers. One conclusion was that a water level decline of a foot on Pokegama Lake would have a minimal effect on local groundwater levels and would not substantially affect wells in the area which are constructed in the middle and lower aquifers (Jones, 2005). Water level changes for all reservoirs under the proposed plan are substantially less than one foot and, therefore, it is likely that no measurable change in groundwater levels would occur under this alternative.

7.6.2.15 Threatened and Endangered Species

As discussed in Section 4.4.14, species listed on, or recently delisted from, the Endangered Species Act include the Canada lynx, the gray wolf and the bald eagle.

None of the actions in the proposed plan would directly affect any of these species or their habitat. None of the proposed actions would result in gains or losses to prey species or their habitat.

The Corps of Engineers has evaluated the potential of the proposed plan to affect threatened and endangered species. It has been determined, in accordance with Section 7 of the Endangered Species Act, that the proposed plan would have no effect, beneficial or adverse, on Federally listed species.

7.6.2.16 Tribal Interests in Natural Resources

The Leech Lake and Mille Lacs Bands of Ojibwe have reservation lands within the project area and, therefore, have a strong interest in natural resources that may be affected by changes in the operating plan. Communication with the bands began early in the ROPE Study in order to determine which natural resources were most important to them and how reservoir operations may be modified to best benefit those resources. The Corps contracted with each of the bands to identify and prioritize natural resources based on their importance to band members. Two reports were completed and provided to the Corps (LLOB, 2005; MLOB, 2005), each of which basically concluded that all natural resources (species) found on reservation lands were of equal importance due to the interconnectedness of natural systems and, therefore, could not be prioritized. Further discussion was provided to indicate concerns over effects the current operating plan may be having on various natural resources.

The bands' positions fit quite well with the components of the proposed plan that restore more natural seasonal hydrologic variably. As stated numerous times in this assessment, the proposed plan would be beneficial for the native aquatic community as a whole because of the return to more natural hydrologic conditions. Therefore, the proposed plan is expected to have a beneficial effect on the natural resources that are important to the Ojibwe.

While it has been stated by the bands that all natural resources hold equal value to them, wild rice deserves special consideration here because its importance to the Ojibwe is significant. Wild rice holds economic, social, and spiritual value for the Ojibwe, and they also recognize that it holds significant ecological value. Many band members harvest wild rice, and their ability to do so under the proposed plan has been voiced as a concern. In general, under the existing operating plan there has been a prolonged gradual decline in the extent and productivity of rice beds, which has increased the sensitivity of the issue.

Wild rice benefits from stabile water levels during the floating-leaf stage of growth early in the summer. The proposed plan includes a provision to guide operations such that fluctuations during the floating-leaf stage will be minimized as much as possible (Section 5.3.16). This would be an improvement over the existing plan and there would likely be a beneficial effect to wild rice as a result of this.

The late summer decline in reservoir water levels of a couple inches per month could reduce the ability to harvest rice in shallow beds during some years. However, it is unlikely that this would increase the incidence in which rice is blown over by wind because the decrease in stem support caused by a decline in water levels of a few inches would be minor.

The proposed plan also includes a provision for annual communication with the Tribe to discuss past and future operation and its effects on natural resources, including wild rice.

This may lead to future ideas on how to best protect the natural resources in the study area for Tribal interests.

7.6.3 Social Effects – Plan P

7.6.3.1 Noise

No transient noise impacts or changes in ambient noise levels are anticipated as a result of the implementation of Alternative P.

7.6.3.2 Aesthetics

Few changes to the existing aesthetic values as described under the No Action Alternative would be anticipated upon implementation of Alternative P. Summer target water elevations would remain unchanged from about May 1 through mid-July at all reservoirs, except Gull, where the summer target would be raised by a little over one and half inches. Under this alternative, lake levels would begin to gradually decline in mid-July on all reservoirs but Gull, dropping below the bottom of the summer band by about the first of September. Gull would begin the decline in levels on September 1st reach the bottom of the existing summer band in mid-October, similar to current operations. Existing aesthetic values would be generally maintained, although, some may perceive an adverse effect resulting from the lowering of lake elevations earlier in the summer than occurs under current conditions.

Aesthetic values associated with lakeshore erosion as a result of elevated lake levels would be beneficially affected as the highest elevations would be maintained for a shorter period of time than would occur under the No Action Alternative. Shoreline vegetation that has been altered from natural conditions would continue to adversely affect those with a desire to experience the naturally occurring vegetation communities that existed prior to dam construction. Minimum releases would increase under this alternative, benefiting downstream aesthetic values. Additionally, Alternative P would incorporate a discretionary spring pulse to be implemented in years where such an increase in flows would not induce downstream flooding, in an effort to obtain the benefits that natural spring time flow would afford to native biologic communities. These pulses would only be implemented in years where such an increase in flows would not induce downstream flooding.

Aesthetic values tied to a desire for more natural river flows would also be beneficially affected. Increased minimum release rules, would contribute to improved aquatic and riparian habitat conditions. Many river users may perceive an improvement in boating, fishing and other river related recreation opportunities.

7.6.3.3 Recreation Opportunities

Alternative P was developed to provide a balance of benefits to all resources affected by the operation of the Headwaters reservoirs. In general, there would be no change to reservoir water levels during the first half of summer relative to the existing operating plan. After July 15th, water levels would be allowed to slowly decline at a rate of about 2 inches per month. More details regarding water levels under the P plan can be found in Sections 5.5.5.

It is difficult to predict what types and amounts of recreational uses of the lakes would occur as a result of implementing any one of the proposed operating plans. It is reasonable to assume that the current recreational uses of the lakes would continue under any of the operating plans. However, the enjoyment of the lakes may be impacted to different degrees due to the changes in lake levels at various times of the year. This could impact a user's satisfaction due to the dependency of some activities on water levels. Over time, it is likely that users of the lakes would adapt to the new conditions and existing levels of satisfaction would return. How long this would take under any plan is unknown.

Under the P Plan there would be a minor adverse effect to recreational opportunities in the short-term. Boating access would likely be reduced for larger water craft in shallow areas, including some boat docks and lifts late in the summer. Additionally, access through shallow connecting waterways could be reduced in some areas. Minimum releases would be increased under this plan; however, these increases would not substantially inhibit the regulators' ability to reach targeted water levels. Under dry conditions, such as those experienced in 2006 and 2007, it is judged that the increased minimums would likely reduce water levels by only an additional 1 to 2 inches over the minimum releases followed in the existing operating plan.

However, it is possible that in the long-term, forms of recreation that are dependant on the quality of natural resources could experience a minor beneficial effect under the P Plan which could outweigh the adverse recreational impacts caused by reduced boat access. The beneficial effects to natural resources as described in Section 7.6.2 could lead to an improved recreational experience for those engaged in activities dependant on such resources. Examples of such activities would include fishing and nature viewing. Also, activities such as swimming that are enhanced by improved water quality could also benefit under this plan in the long-term.

Cass Lake. Alternative P would result in lower water levels the first half of the summer, but slightly higher water levels the second half as shown in the tables in Section 7.6.1. It is anticipated that this plan would have a minor beneficial effect to recreational opportunities here in the short-term due to slightly improved boating access.

Lake Winnibigoshish. The current plan has a summer band of 1297.94 to 1298.44 with a target of 1298.19. Alternative P would retain the target of 1298.19 for the first half of summer, after which water levels would decline as shown in the tables in Section 7.6.1. It is anticipated that this plan would have a minor adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above.

Leech Lake. The current plan has a summer band of 1294.5 to 1294.9 with a target of 1294.70. Alternative P would retain the target of 1294.70 for the first half of summer, after which water levels would decline as shown in the tables in Section 7.6.1. It is anticipated that this plan would have a minor adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above. Sail boats begin having difficulty navigating the Walker Narrows on Leech Lake when the elevation drops to approximately 1,294.4 feet. Under Alternative P, the targeted water level would not fall to this elevation until October first, after the majority of the sailing season has ended. Sail boaters would likely plan to move their boats into Walker Bay prior to October first under this plan, as many already do now. During dry years such as in 2006 and 2007, the increased minimum releases proposed for the P plan are expected to reduce late summer water levels by less than one additional inch over those experienced under the existing plan, which is judged to be relatively inconsequential relative to already uncontrollably low water levels as a result of drought.

Pokegama Lake. The current plan has a summer band of 1273.17 to 1273.67 with a target of 1273.42. Alternative P would retain the target of 1273.42 for the first half of summer, after which water levels would decline as shown in the tables in Section 7.6.1. It is anticipated that this plan would have a minor adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above. Boaters experience some difficulty at Pokegama when lake elevations decline to 1272.67 feet as a result of shallow water over sand bars and some rock hazards. Under the P plan, targeted water levels would fall below this level around the middle of October when the summer recreation season has ended for most users.

Big Sandy Lake. The current plan has a summer band of 1216.06 to 1216.56 with a summer target of 1216.31. Alternative P would retain the target of 1216.31 for the first half of summer, after which water levels would decline as shown in the tables in Section 7.6.1. It is anticipated that this plan would have a minor adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above. Access to many of the docks and lifts in the shallower bays would are adversely impacted when target lake elevations drop to 1215.61 feet. Targeted water levels on Big Sandy would fall to this level after the middle of October under the P plan, after the recreation season has ended for most users.

Cross Lake. The current plan has a summer band of 1229.07 to 1229.57 with a summer target of 1229.32. Alternative P would retain the target of 1229.32 for the first half of summer, after which water levels would decline as shown in the tables in Section 7.6.1. It is anticipated that this plan would have a minor adverse effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term as described above. Transportation between some lakes in the Cross Lake chain becomes difficult at an elevation of 1229.22. The target elevation under this alternative would fall below this level after the first week of August. This could lead to increased difficulty in navigating the Dagget Lake and Rush Lake Channels.

Gull Lake. The current plan has a summer band of 1193.75 to 1194.0, and the middle of the band is 1193.87. Alternative P includes a raised summer target of 1194.0 for the first half of summer, after which water levels would decline as shown in the tables in Section 7.6.1. It is anticipated that this plan would have a minor beneficial effect to recreational opportunities here in the short term, and possibly a minor beneficial effect in the long term relative to indirect effects caused by changes in natural resource quality. Shorelines around Gull are not as prone to erosion as ones around the other reservoirs and the raise in water levels is not expected to appreciably affect erosion around Gull Lake. Navigation from Round Lake into Gull Lake becomes difficult when the lake level drops to 1193.75 or below. Navigation into other lakes in the Gull Lake chain also becomes problematic at this level as many of the channels are only two to three feet deep. Targeted water levels on Gull would not fall below 1193.75 until after the middle of October, after the summer recreation season has ended for most.

7.6.3.4 Transportation

Alternative P would not affect ground transportation systems within the analysis area. As described above under all previous alternatives, this Alternative P would also include a combined outflow restriction of 2200 cfs for Lake Winnibigoshish and Leech Lake in order to protect the Highway 2 bridge near the confluence of the Mississippi and Leech Rivers.

The risk of flooding at Aitkin is generally unchanged from the existing condition under this alternative. Clarification of operating rule at lower stages may provide minor benefits to Pokegama Lake, Leech Lake, Winnibigoshish Lake, and Aitkin; however, flooding effects to road systems are unlikely to be affected. Lower target levels in the last half of the summer season at these reservoirs would provide additional flood storage capacity that would be available for late summer and fall events, thereby potentially providing a flood benefit on the reservoirs and at Aitkin under the proposed plan. This would reduce the risk of flooding nearby road systems under such conditions in the Aitkin area.

Water transportation routes between connected lakes have the potential to open earlier in the summer season due to efforts to achieve the summer target as early as the beginning of May when conditions allow. There is the potential that some routes would be adversely impacted to a minor degree by implementation when lake levels begin to lower starting in mid-July. However, lake levels would not drop below the level of the current summer band before approximately September 1st.

7.6.3.5 Public Health and Safety

Public health and safety risks and effects under Alternative P are the same as described above under the No Action Alternative with the following exceptions. Flood control operations at Pokegama Lake, with help from Leech Lake and Winnibigoshish Lake, would continue to be implemented for the protection of Aitkin. Clarification of flood operating rules may provide minor benefits to these locations. Additionally, under Alternative P, water levels would be gradually lowered starting mid-July. This would contribute flexibility to flood control operations in the event of late season flood events. The late summer decline in lake levels is minor relative to fluctuations experienced due to weather conditions under the existing plan and; therefore, is not expected to have a measureable effect on public safety related to water hazards caused by lower water levels. Additionally, lower water levels would be expected and boaters would be able to adjust their habits to avoid submerged obstructions, similar to how these adjustments are made under the existing plan.

7.6.3.6 Community Cohesion (Sense of Unity)

Existing community cohesion would not be expected to change as a result of the implementation of Alternative P. Community interests regarding management of the reservoirs within the Upper Mississippi Headwaters would be expected to continue to coalesce around common interests tied to individual reservoirs, the river, reservoir and river associated user groups, and the related benefits or risks that accrue to nearby communities.

Flooding events can serve to both strengthen and damage community cohesion. Cohesion can be strengthened as residents work together to fight the effects of flooding and protect their common interests. However, the aftereffects of a flood, such as damaged and destroyed homes and businesses can result in disintegration of cohesion as neighbors are separated, in some cases permanently, due to long lasting flood effects. Flood control and prevention measures to protect the community of Aitkin would continue to contribute to its stability and community cohesion.

7.6.3.7 Community Growth and Development

No changes to the course of community growth and development would be expected as a result of the implementation of Alternative P.

7.6.3.8 Business and Home Relocation

Implementation of Alternative P would not result in a need to relocate any businesses or homes.

7.6.3.9 Existing and Potential Land Use

No changes to existing and potential land uses would be anticipated as a result of the implementation of Alternative P.

7.6.3.10 Controversy

The level of controversy under Alternative P would be similar to that described under the No Action Alternative above (Section 7.2.3.10) with the following exceptions. In general, a minor increase in the overall level of controversy is expected under the P plan due to a general resistance to change by the public. Therefore, the P plan is judged to have a minor adverse effect on controversy.

Controversy among the Leech Lake Band of Ojibwe, with regard to the maintenance of high water elevations would be reduced under this alternative. Increased fluctuation in water elevation, simulating naturally occurring fluctuations would beneficially impact aquatic biotic communities associated with the lakes. Increased minimum releases would beneficially impact riverine aquatic habitats and species. Increase fluctuations in water elevations would help to reduce shoreline erosion and the associated damage to cultural sites.

Controversy among those who disagree with management that favors recreation uses over ecosystem values would be reduced as management shifts to provide greater fluctuation in water elevations to mimic natural conditions. Additionally increased minimal releases and spring pulses to benefit riverine resources would also contribute to reducing the controversy regarding management priorities.

Controversy regarding the effects of water elevations on navigation between chained lakes would be increased overall somewhat under Alternative P. Water elevations would be sufficient to facilitate navigation between chained lake systems throughout the summer season and into the fall for most boaters, but some with larger boats may experience some difficulty. Some users in Cross and Leech Lakes may experience some difficulties navigating shallow channels after the first of September. Water elevations in Gull Lake would be raised, improving navigation between the chained lakes of that system and, therefore, controversy would be reduced there.

Flood control operations at Leech Lake, Winnibigoshish Lake, and Pokegama Lake and their effect on flooding at Aitkin would continue to be a subject of controversy. However, under Alternative P, at peak stages below 14 feet in the spring and 13 feet in the summer, clarification of operations provide for more flexibility of reservoir operations. This may result in slight benefits to each of these lakes and at Aitkin. Furthermore, the removal of Sandy Lake from the Aitkin guide curves from flood operations will promote a better understanding of how Sandy can or cannot be used for flood storage, which may reduce the controversy between Aitkin and Sandy Lake residents.

7.6.3.11 Tribal Social Effects

Tribal social effects under Alternative P would be similar to those described under the No Action Alternative above (Section 7.2.3.11) except as described below.

The Leech Lake Band of Ojibwe favors increased fluctuation in water elevations to simulate naturally occurring fluctuations to beneficially impact aquatic biotic communities associated with the lakes. Increased minimum releases would beneficially impact riverine aquatic habitats and species. Increased fluctuations in water elevations would help to reduce shoreline erosion and the associated damage to cultural sites. These changes from existing reservoir operations are favored by the Band and move management more toward traditional Ojibwe values and beliefs.

The Leech Lake Band of Ojibwe while expressing approval of Alternative P, in that it is considered a “step in the right direction,” has nonetheless expressed concern that decreased water elevations during the harvest period in Winnibigoshish Lake, may reduce access for harvesting in the Ravens Bay Flowage, resulting in adverse economic and subsistence impacts.

7.6.3.12 Environmental Justice

There may be a short-term adverse impact to American Indian populations in Beltrami, Cass, and Clearwater Counties and low-income subsistence users due to the potential for reduced access to some rice beds in some years. However, more favorable conditions for rice in the long-run would benefit these users (Sections 7.6.3.11 and 7.6.4.7).

No adverse employment impacts are expected under this alternative.

Minor benefits to flood control operations at Winnibigoshish, Leech, and Pokegama reservoirs (Section 7.6.4.9) may also reduce the risk of adverse impacts to low-income residents under this alternative.

7.6.4 Economic Effects – Plan P

7.6.4.1 Property Values

Under alternative P summer target water elevations would remain unchanged from about May 1 through mid-July at all reservoirs, except Gull, at which the summer target would be raised by a little over one and a half inches. With this alternative, lake levels would begin to gradually decline in mid-July on all reservoirs but Gull, dropping below the bottom of the summer band by about the first of September. The decline on Gull would begin on September first and Gull would reach the bottom of the existing summer band in mid-October, similar to current operations. Existing property values would be generally unaffected, although, some owners on lake chains may perceive an adverse effect resulting from the lowering of lake elevations that adversely impact connecting channels earlier in the summer than occurs under current conditions resulting in deceased utility or level of satisfaction.

Water transportation routes between chained lakes have the potential to open earlier in the summer season due to efforts to achieve the summer target as early as the beginning of May when conditions allow under Plan P. There is the potential that some routes would be adversely impacted by implementation when lake levels begin to lower starting in mid-July. However, under Plan P lake levels would not drop below the level of the current summer band before approximately September 1st.

In the long-term, it is possible that the proposed plan would lead to improved property values over the no-action plan. This is because property values on the reservoirs are influenced by the quality of the natural resources on and adjacent to the property. The proposed plan is judged to be beneficial to natural resources and the maintenance of natural resource quality could positively affect property values in the future over the no-action plan.

Cross Lake. Shallow channel concerns between lakes in the Cross Lake chain would begin to occur around the first of September when the lake's elevation falls to 1229.22 feet or below through the end of the season, adversely the affecting the ability of some users to navigate between some lakes in the chain.

Leech Lake. Large boats and sail boats would experience shallow water problems at an elevation of 1294.40 or below, which would occur by about mid-September under this alternative. Navigation in areas such as harbors and the Walker Narrows would begin to occur. These boat owners utilizing the storage area in Walker Bay would need to begin to store their craft for the winter by mid-September, or seek other winter storage options.

7.6.4.2 Tax Revenues

Similar to property values, the implementation alternative P is expected to have no appreciable effect on tax revenues.

7.6.4.3 Public Facilities and Services

The P plan alternative is judged to have no effect on public facilities and services.

7.6.4.4 Regional Growth

No changes to the course of regional growth and development would be expected as a result of the implementation of the Alternative P.

7.6.4.5 Employment

The P plan would have no appreciable effect on employment.

7.6.4.6 Business Activity

No changes in business activity would be expected as a result of the implementation of Alternative P. However, on Leech Lake large boats and sail boats experience shallow water problems at an elevation of 1294.40 or below, which would now occur by about October first under this alternative. Difficulty navigating in areas such as harbors and the Walker Narrows would begin to occur. These boat owners utilizing the storage area in Walker Bay would need to begin to store their craft for the winter by mid-September, or seek other winter storage options. There is a minor potential that this could lead to a reduction in sailboat use on Leech Lake, and a negative effect on the businesses that rely on sail boating.

7.6.4.7 Farmland/Food Supply

Under the proposed plan there would be no effect or a minor benefit to farmland and food supply due to reduced reservoir levels late in the summer and the resulting increased available storage capacity. This would help reduce flood risks late in summer and early fall. However, the benefit would be almost negligible due to the infrequency and normally localized nature of flooding events during this time of year.

Lower water levels during rice harvest may reduce harvest yields in some years under the proposed plan in the short term. However, yields could increase due to more favorable conditions for rice in the long-run over the no-action plan.

7.6.4.8 Water Supply

The P plan alternative is judged to have no appreciable effect on water supply.

7.6.4.9 Flooding Effects

Under the proposed plan there would be a minor benefit to flood control operations at Winnibigoshish, Leech and Pokegama reservoirs and in turn the City of Aitkin, MN. The effect at Big Sandy, Cross Lake and Gull reservoirs is unchanged from the existing plan.

The existing Pokegama, Big Sandy and Aitkin spring and summer flood control guide curves (see Figures 5.3.6.1.a and 5.3.6.1.b.), which also utilize storage in Winnibigoshish and Leech, were modified. Big Sandy was removed from the curves (see explanation in Section 5.3.6.2) and the flood control operation along portions of the curves below the damaging stages at Aitkin of 14 feet in the spring and 13 feet in the summer were better articulated. The relationship between Pokegama's reservoir water elevations and Aitkin stages remains the same as on the existing curves (see Figures 5.3.6.3.a and 5.3.6.3.b.).

The existing curves, and the accompanying text in the Water Control Plan, did not provide the operator with any details on how to follow the guide curves. The operator was left with the assumption that the curves needed to be followed along their entire length. To accomplish this, the operator had to interpolate the curves downward and begin operating for stages at Aitkin that were at least 2 to 3 feet or more below the aforementioned spring and summer damaging stages. The text in Section 5.3.6.2 clarifies this, thus allowing the operator more flexibility when operating the reservoir (now only Pokegama) for events at Aitkin when forecasted peak stages there are below the respective seasonal damage stages.

The result is that for the smaller forecasted events at Aitkin, Pokegama can utilize its flood control storage capacity more efficiently. For those events, this provides the potential for lower elevations on Pokegama and lower peak stages at Aitkin.

The outflow from Pokegama has a larger effect at Aitkin for stages in the 12 to 13 foot range as a percentage of the total flow. This is due to the large uncontrolled "local" drainage area below Pokegama. Although this is a bigger factor in the summer (with its damaging stage of 13 feet), a small spring event, that is later following by a similar event, could result in an overall benefit to both Pokegama and Aitkin.

7.6.4.10 Energy Needs and Resources

Future hydropower energy production under the proposed plan would be similar to the historic average but may be slightly higher due to the increase in minimum flows found under this plan. Hydropower facilities on the Mississippi River are operated on a run-of-river basis and provide base-load power. Because of this, the amount of power produced is directly affected by river flow. Low-flow conditions limit energy production and, therefore, increasing minimum releases over the existing plan would increase the potential for energy production during low-flow periods. Because of this, the proposed plan would have a minor beneficial effect on hydropower production. Under extreme drought conditions, low-flows under this plan could be lower than under the existing plan. However, such events would occur very rarely and the negative effect on hydropower production is deemed to be minimal and overshadowed by the positive effect during normal hydrologic conditions.

7.6.4.11 Tribal Economic Effects

The Leech Lake Band of Ojibwe while expressing approval of Alternative P in that it is considered a "step in the right direction," has nonetheless expressed concern that decreased water elevations during the harvest period in Winnibigoshish Lake, may reduce access for harvesting wild rice in the Ravens Bay Flowage, which could result in adverse economic and subsistence impacts.

7.6.5 Cultural Resource Effects – Plan P

7.6.5.1 Archeological sites

This alternative should have a minor beneficial effect on cultural resources sites at all the Headwaters reservoirs, except Gull Lake where there would be no effect. This operating plan reaches the current upper target level two weeks earlier than under the current operating plan, but except for Gull Lake, stays at that upper target level for 1 to 2.5 months shorter time than under the existing operating plan, with all operating level changes still within their respective reservoir's current operating band. This should result in a minor reduction in erosion damage to archeological sites on the shorelines of those reservoirs. The water level at Gull Lake will be up to 1.8 inches higher than the upper level of the current operating band over the open water season, being at or above that upper target level for one month longer than under the current operating plan. This minor increase in reservoir elevation and duration during the open water season will essentially have no new effect on cultural resources sites around Gull Lake's shoreline.

7.6.5.2 Tribal Cultural Effects

The proposed plan would have a minor beneficial effect on cultural resources important to the Tribe similar to those discussed in the previous section.

7.7 CUMULATIVE EFFECTS

7.7.1 Natural Resources

The watershed of the Mississippi River has been substantially altered since the beginning of European settlement. Numerous dams have been constructed, wetlands have been drained, land has been put under cultivation, often without soil conservation practices, forests have been cleared, and pervious soils necessary for ground water regeneration have been paved over or built over. Most of these practices have contributed to changes in hydrologic patterns to the detriment of the habitat quality of the Upper Mississippi River basin.

As people have become aware of the detrimental effects of reshaping the landscape, many have made efforts to reduce their effect on the environment by replanting native vegetation, adopting soil conservation practices, restoring or preserving wetlands, capturing runoff for groundwater recharge and so forth. These efforts are expected to continue and increase as awareness expands.

The modifications to reservoir operations proposed in this study are designed to complement environmentally beneficial practices by providing a more natural flow regime. This is intended to improve habitat conditions in the natural environment while maintaining attributes that provide socioeconomic benefits.

The ROPE project would make a positive contribution to the cumulative effects of human use of the environment in the Upper Mississippi River Basin.

7.7.2 Economic

There are a number of economic factors taking place outside the realm of the study that could have a significant impact on tourism, business activity, and the ownership of residential and commercial property in the headwaters lakes area.

This summer motorists face record prices for gasoline with prices approaching and even exceeding $4.00 per gallon with no decline in sight. High gas prices cut into people's disposable income. What impact this might have on tourism now and into the future for the headwaters lakes area is uncertain. A Kenai River, Alaska campground operator says summer bookings are down dramatically this spring, in large part a reaction to the rapidly rising cost of gasoline and diesel. In an online poll taken by Fosters, a newspaper chain in southeastern New Hampshire and southern Maine, more than 80 percent of the nearly 2,500 people who responded said higher gasoline prices are forcing them to cancel or cut back summer vacation plans.

The Michigan State University Tourism Center indicates that most Michigan tourists will take high gasoline prices in stride and not significantly alter their summer travel plans. This is according to Don Holecek, director of the center. "Nearly 70 percent of Michigan's tourists are Michigan residents, while most of the others are residents of Ohio, Indiana, Illinois, Wisconsin, and Ontario," Holecek said. "So, higher gasoline prices add a relatively small amount to the overall costs of a Michigan vacation." "But, even a relatively small increase in travel costs will force families on tight budgets and many others to change their travel behavior to offset higher gas prices."

Another key factor is the sharp drop in U.S. economic growth. The U.S. Department of Commerce says the economy grew at an annual rate of just 0.6 percent in the last three months of 2007. In the previous three months, between July and September, the economy was growing at an annual rate of 4.9 percent. The slowdown was triggered by a slump in building activity, which fell by 16.9 percent, the biggest fall in 25 years, as housing prices collapsed.

The housing instability has begum to have a negative impact on other sectors of the economy, leading some economists to predict that the nation is headed for a recession. Perhaps worse, consumers are curtailing spending. Consumer spending makes up 70 percent of economic activity. According to Tucker Hart Adams, Regional Economist and President of The Adams Group, "A severe spending slowdown could seriously impact the economy." "There's the inability to spend and the unwillingness to spend," Adams said.

What impact the economic downturn and the instability in the housing market might have in the study area now and into the future is uncertain. Many of the lake homes are second homes and are only used seasonally. As times get tougher and as disposable income gets stretched tighter and tighter, lake homes might become harder to afford and more difficult to sell. As an example, according to 2000 Census figures 45.0 percent of the homes in Cass County, in which all of Leech Lake and approximately ½ of Gull Lake are located, are classified as for seasonal, recreational, or occasional use.

These impacts would be combined with any impacts that might be associated with the implementation of the proposed plan. Establishing a clear cut cause and effect relationship for any of the various socioeconomic variables would be a difficult task. However, no serious long term negative economic impacts are expected as a result of the implementation of the proposed plan. Instead, the long term overall positive impacts of the plan should result in a healthier resource base that both residents and tourists can use and enjoy now and into the future.

7.7.3 Social

The escalating price of gasoline and the downturn in economic conditions may impact recreation activities and participation rates in the analysis area. The extent and duration of such impacts is currently unknown. While the general economic downturn is likely to be of limited duration, higher gas prices are projected to continue for the foreseeable future. Higher costs may result in reduced participation in some of the more expensive recreation activities such as boating. There may be a decrease in the number of non-local recreation visitors, as vacationers choose activities closer to home in order to minimize costs. Recreation activities of local residents may grow in proportion relative to those of non-local visitors. Participation in less expensive forms of recreation, such as fishing and picnicking, may increase.

Community growth and development may be slowed by the current economic downturn. The effects of alternatives with the potential to contribute to reduced property values or use levels (Alternatives E and T) may be exacerbated by these conditions. These economic effects are also likely to increase the importance of subsistence activities and cottage industries among members of the Ojibwe and others who utilize wild rice gathering and fishing to supplement other sources of income and sustenance. Therefore effects of the alternatives on these resources may become increasingly critical to these individuals or groups.

7.7.4 Cultural Resources

Hundreds of archeological sites are known to exist along the Headwaters reservoirs' shorelines and the downstream river reaches in the ROPE study area. The extent of damage to these sites due to inundation from the increased water levels of the reservoirs over their undammed original lakes and to erosion caused by wave action and ice shove along their shorelines has not been thoroughly assessed. The effects of reservoir operations along downstream river reaches are not well understood and need to be further evaluated. It is clear, though, that operations at the Headwaters reservoirs have and are affecting archeological sites and that any change in operations may continue to affect them. The proposed alternative operating plans will not change the type of effects on archeological sites, but may change the rate of shoreline erosion within the minimum and maximum water level operating band depending upon which alternative is chosen. Without action to stabilize the shorelines or decrease erosion, it is likely that any fluctuations in water levels will continue to permanently damage these non-renewable archeological resources until those that are vulnerable to erosion are finally destroyed.

CHAPTER 8. ENVIRONMENTAL COMPLIANCE AND REVIEW

8.1 APPLICABLE ENVIRONMENTAL LAWS AND EXECUTIVE ORDERS

The St. Paul District, U.S. Army Corps of Engineers, has conducted this ROPE study and NEPA process in accordance with Corps of Engineers planning guidance (ER 1105-2-100) and requirements of applicable laws and regulations.

The proposed action would comply with Federal environmental laws, Executive Orders and policies, and applicable State and local laws including the Clean Air Act, as amended; The Clean Water Act, as amended; The Endangered Species Act of 1973, as amended; the Fish and Wildlife Coordination Act of 1958, as amended; the Land and Water Conservation Fund Act of 1965, as amended; the National Historic Preservation Act of 1966, as amended; the National Environmental Policy Act of 1969, as amended; Executive Order 11988 Floodplain Management; Executive Order 11990 Protection of Wetlands; and Executive Order 12898 – Environmental Justice. The proposed action would not result in the conversion of farmland to non agricultural uses. Therefore, the Farmland Protection Policy Act of 1981 does not apply to this project.

8.2 COMMENTS ON THE DRAFT REPORT AND EIS

We request and welcome written comments on this draft integrated general reevaluation report and EIS. **Please provide written comments by November 3rd, 2008,** to the St. Paul District, U.S. Army Corps of Engineers, ATTN: Mr. Steven Clark, CEMVP-PM-A, 190 Fifth Street East, Suite 401, St. Paul, Minnesota 55101, email: Steven.J.Clark@usace.army.mil.

Comments from agencies and the public will be compiled and, along with written responses, will be included with the final report and EIS for transmittal to the Commander, St. Paul District of the Corps of Engineers for a Record of Decision.

8.3 REQUIRED COORDINATION

8.3.1 Public Involvement

Public involvement activities for this study are described in Section 2.4 above.

8.3.2 Clean Water Act

The MDNR, and MPCA actively participated in the planning process for this project. The effects of the proposed project were assessed and documented in this EIS. Because the recommended plan does not include construction or work in the water, there is no need to apply to the MPCA for Section 401 Clean Water Act certification.

8.3.3 Fish and Wildlife Coordination Act, Endangered Species Act

Throughout scoping, the plan formulation process and the preparation of the Draft EIS coordination was maintained with the Leech Lake Band of Ojibwe Division of Resource

Management, the Mille Lacs Band of Ojibwe Department of Natural Resources, the Minnesota Department of Natural Resources, the Minnesota Pollution Control Agency, and the Mississippi Headwaters Board. A representative of the U.S. Environmental Protection Agency, Region 5 attended early scoping meetings. The U.S. Fish and Wildlife Service was invited to actively participate in the study during scoping, but declined.

8.3.4 Cultural Resources

Pursuant to Sections 800.14(b) and 800.14(f) of the regulations (36 CFR Part 800, Protection of Historic Properties) implementing Section 106 of the National Historic Preservation Act (NHPA) coordination included initial consultation with the Minnesota State Historic Preservation Officer (SHPO) and the Advisory Council on Historic Preservation (Council). The Council chose not to participate. Coordination also included the U.S. Department of Agriculture, Forest Service, Chippewa National Forest (CNF) and the U.S. Department of the Interior, National Park Service, Mississippi National River and Recreation Area (MNRRA).

Tribal coordination letters were sent to the U.S. Department of the Interior, Bureau of Indian Affairs and to 26 Tribes in Minnesota, Wisconsin, North Dakota and South Dakota. Of these, only the Mille Lacs Band of Ojibwe and the Leech Lake Band of Ojibwe chose to participate. Each has a Tribal Historic Preservation Officer (THPO).

The Corps continues to consult with the Minnesota SHPO, CNF, MNRRA, the Mille Lacs THPO and the Leech Lake THPO for the purpose of complying with Sections 106 and 110 of the National Historic Preservation Act. Once the proposed plan for reservoir operations is selected, an agreement will be finalized among these parties covering historic preservation activities to be conducted at affected historic properties and burial sites. In addition, these parties are on the mailing list to receive scoping documents and the EIS for review and comment.

8.3.5 Farmland Protection

The Farmland Protection Policy Act is intended to minimize the impact Federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. It assures that—to the extent possible—Federal programs are administered to be compatible with State and local units of government and private programs and policies to protect farmland. Modification of Headwaters reservoirs operation would have no significant effect on farmland.

8.3.6 Environmental Justice

Compliance with Executive Order 12898 Environmental Justice requires consideration of social equity issues, particularly any potential disproportionate impacts to minority or low income groups. There has been continuing coordination with the Leech Lake and Mille Lacs Bands Ojibwe about this project.

8.4 DISTRIBUTION OF DRAFT REPORT/EIS AND STATEMENT OF RECIPIENTS

This draft report and EIS has been provided via computer .ftp server, by computer disk, and limited hard copy to stakeholders and agencies, organizations and public study participants. A list of recipients of this report is included in Appendix A. Paper copies of the report are available for review at the public libraries in Aitkin, Brainerd, Grand Rapids, Walker, Cass Lake, and Bemidji. It will also be available at the St. Paul District office, The Forest Service Cass Lake office, and at each of the Corps reservoir park offices. The entire report and appendices are available to download as .pdf files from the Corps of Engineers anonymous .ftp server at: ftp://ftp.usace.army.mil/pub/mvp/ROPE_DEIS/ and from the St. Paul District Internet site at: http://www.mvp.usace.army.mil/rope/

CHAPTER 9. COST SHARING

Cost of this general reevaluation study and implementation of modifications to the Headwaters Reservoirs project are funded 100-percent Federal by the operations and maintenance budgets of the Corps of Engineers and the U.S. Forest Service.

In April of 2003 the Corps of Engineers and the Forest Service signed a Memorandum of Understanding where the parties agreed that study costs from that time on would be shared at a ratio of 85% Corps of Engineers and 15% Forest Service. This allocation of costs was considered equitable by both parties as the Corps owns and operates six of the seven Federally owned reservoirs and the Forest Service owns and operates one of those reservoirs.

CHAPTER 10. CONCLUSIONS AND RECOMMENDATIONS

10.1 CONCLUSIONS

The St. Paul District, U.S. Army Corps of Engineers, prepared this final integrated general reevaluation report and EIS about the Mississippi River Headwaters Reservoirs operating plans to document the planning process, alternatives evaluated and findings.

Overall, the proposed plan would have a beneficial effect on the human environment in the project area. The majority of this effect would occur in the upper half of project area from approximately Little Falls upstream to Lake Bemidji.

In general, the proposed plan is expected to have a minor negative short-term and a minor beneficial long-term effect on socioeconomic resources in the study area. No serious long term negative economic impacts are expected as a result of the implementation of the proposed plan.

The proposed plan would have a beneficial effect on natural resources in the project area in the short- and long-term caused by hydrologic conditions that more closely resemble natural conditions relative to the existing operating plan.

The proposed plan would have no measurable effect on flooding over the existing plan.

10.2 RECOMMENDATION

The recommended alternative is Plan P, as described in Section 5.5.5. The potential effects of this plan are discussed in Section 7.6.

This report is a draft integrated general reevaluation report and EIS. At this stage, we recommend that the public, stakeholder agencies and organizations review this draft report and EIS and provide written comments by November 3rd, 2008, to the St. Paul District, U.S. Army Corps of Engineers, ATTN: Mr. Steven Clark, CEMVP-PM-A, 190 Fifth Street East, Suite 401, St. Paul, Minnesota 55101or email: Steven.J.Clark@usace.army.mil.

The St. Paul District will compile the comments, prepare written responses, seriously consider changes to this draft report, and will prepare a final report and EIS. The final report and EIS will be provided for agency and public review. We will compile comments received and transmit them along with the final Reservoir Operating Plan Evaluation and EIS to the St. Paul District Commander, U.S. Army Corps of Engineers in St. Paul Minnesota. Upon approval of the report, the St. Paul District Commander and Forest Supervisor of the U.S. Forest Service, Chippewa National Forest will take the recommendations in this report under consideration and will issue separate Records of Decision. The St. Paul District Commander will issue a Record of Decision for the Corps reservoirs and the Forest Supervisor will issue a Record of Decision for Knutson Dam on Cass Lake.

CHAPTER 11. LIST OF PREPARERS

An interdisciplinary and experienced group of scientists and engineers served on the Project Delivery Team and prepared this final general reevaluation report and EIS.

Richard D. Carlson – Regional Economist, Corps of Engineers
Responsibility: Flood Damage Reduction Task Force, Preparation of the EIS.
Professional Experience: 18 years
Education:
M.S. (1973) – North Dakota State University, Fargo, North Dakota. Major: Economics
B.A. (1969) – University of Minnesota, Duluth, Minnesota. Major: Business Administration Minor: Economics

Steven J. Clark – Project Manager/Fisheries Biologist, Corps of Engineers
Responsibility: Environmental Task Force, Preparation of the EIS
Professional Experience: 8 years
Education:
M.S. (2000) – Iowa State University, Ames, Iowa. Major: Fisheries Biology
B.A. (1996) – University of Wisconsin-Stevens Point, Stevens Point, Wisconsin. Major: Biology.

Jodell L. Kormanik-Sonterre, P.E. - Hydraulic Engineer/Reservoir Regulator, Corps of Engineers
Responsibility: Hydraulics Team Leader/Model Developer
Professional Experience: 10 years
Education: BCE (1998) - University of Minnesota Institute of Technology
Major: Civil Engineering
Licensed Professional Engineer - 2008

Barbara A. F. Ott – Social Scientist, USDA Forest Service, TEAMS Enterprise
Responsibility: Social impact analysis.
Professional Experience: 13 Years
Education:
M.S. (1995) – Colorado State University, Fort Collins, CO. Major: Management with an emphasis in public administration and a special study of rural community development.
B.A. (1977) – Chadron State College, Chadron, NE. Major: Business Administration

Virginia R. Gnabasik - Archeologist, Corps of Engineers
Responsibility: Cultural Resources input to EIS
Professional Experience: 25 years
Education:
M.A. (1981) - Eastern New Mexico University, Portales, New Mexico. Major: Anthropology-Archaeology.
B.A. (1976) - University of Wisconsin-Milwaukee, Milwaukee, Wisconsin. Major: Anthropology.

Bradley E. Perkl - Archaeologist, Corps of Engineers
Responsibility: Cultural Resources
Experience: 16 years

Education:
Ph.D. (ABD)-University of Minnesota, Minneapolis. Major: Anthropology
M.A. (1996)-University of Minnesota, Minneapolis. Major: Interdisciplinary Archaeological Studies
B.A. (1992)- University of Minnesota, Minneapolis. Major: American History.

Luke Rutten - Forest Hydrologist, Chippewa National Forest
Responsibility: Preparation of the EIS
Professional Experience: 10 years
Education:
M.S. (1998) - University of California, Davis. Major: Geology
B.S. (1994) - North Dakota State University, Fargo, ND. Major: Geology.

John T. Shyne - Fishery Biologist, Corps of Engineers
Responsibility: NEPA Compliance, Preparation of the EIS.
Professional Experience: 32 years
Education:
M.S. (1977) - St. Mary's University, Winona, Minnesota. Major: Biology (Aquatic Ecology)
B.A. (1968) - St. Mary's University, Winona, Minnesota. Major: Biology

Kenton E. Spading – Project Manager/Hydrologist/Asst. to the Chief of Engineering Division
Responsibility: Hydropower Task Force/Water Control Plan Review/Preparation of the EIS
Professional Experience: 23 years
Education: B.S. (1984) – University of Minnesota, Minneapolis, MN. Major: Civil Engineer

Terry R. Zien, P.E. – Project Manager/Hydraulic Engineer, Corps of Engineers
Responsibility: Project Management, Erosion Control/Flood Control Task Force, Preparation of the EIS
Professional Experience: 23 years
Education:
M.S. (1985) – University of Minnesota. Major: Civil Engineering (Hydrology and Hydraulics)
B.S. (1983) – University of Minnesota. Major: Geology

CHAPTER 12. REFERENCES

Anfinson, John O. 2003. *The River We Have Wrought: A History of the Upper Mississippi*. University of Minnesota Press, Minneapolis.

Benchley, E.D., B. Nansel, C.A. Dobbs, S. M. Myster and B. H. O'Connel. 1997. *Archeology and Bioarcheology of the Northern Woodlands.* Arkansas Archeological Survey, Fayetteville.

Birk, Douglass A. 1993. A Phase II or Erosion Evaluation of Three Archaeological Sites at Leech Lake Reservoir, Mississippi Headwaters, Cass County, Minnesota. Institute for Minnesota Archaeology, Reports of Investigations 288, Minneapolis.

Brower, Jacob V. 1898. Prehistoric Man at the Headwaters of the Mississippi River. Collections of the Minnesota Historical Society, 8. St. Paul.

Bryson, R.A. and F.K. Hare. 1974. Climates of North America. In Climates of North America. Edited by R.A. Bryson and F.K. Hare, pp. 1-47. World Survey of Climatology, vol II. Elsevier Scientific Publishing Co., New York.

Bureau of Economic Analysis. 2008. Regional Economic Accounts: CA1-3 Per Capita Personal Income, 2005. http://www.bea.gov/regional/reis/default.cfm?catable=CA1-3&section=2

Carlson, Bruce David. 1999. Multi-Use Management on the Upper Mississippi River System: Public Preferences for Future Management Actions. July. University of Minnesota.

Carroll, Jane. 1990. Dams and Damages: The Ojibway, the United States, and the Mississippi Headwaters Reservoirs. Minnesota History.

Cooper, Leland R., and Elden Johnson. 1964. Sandy Lake Ware and its Distribution. American Antiquity, 29(4):474-479.

Davidson-Peterson. 2006. The Economic Impact of Expenditures by Travelers on Minnesota, June 2005 – May 2006, Davidson- Peterson Associates. http://www.tourism.umn.edu/products/MNStateEconomicImpactJun05-May06.pdf

Fagan, B. M. 1991. Ancient North America: The Archaeology of a Continent. Thames and Hudson, New York.

Florsheim, J. L., J. F. Mount, and A. Chin. 2008. Bank erosion as a desirable attribute of rivers. *Bioscience* 58:6.

Gibbon, Guy E. and Terri Leistman. 1984. Cultural Resources Reconnaissance Survey of the Shoreline of Big Sandy Reservoir, Aitkin County, Minnesota: 1982. University of Minnesota, Minneapolis.

Gibbon, Guy E. and Terri Leistman. 2003. The Sioux: The Dakota and Lakota Nations. Blackwell, Oxford.

Hellsten, S. and J. Riihimaki. 1996. Effects of lake water regulation on the dynamics of littoral vegetation in northern Finland. *Hydrobiologia* 340:85-92.

Johnson, Elden. 1969. Prehistoric Peoples of Minnesota. Minnesota Historical Society, St. Paul.

Johnson, Elden. 1979. Cultural Resources Investigation of the Reservoir Shorelines: Gull Lake,Leech Lake, Pine River and Lake Pokegama. Archaeology Laboratory, University of Minnesota, Minneapolis.

Johnson, Elden, C. Harrison and J. Schaaf. 1977. Cultural Resources Inventory of Lands Adjacent to Lake Winnibigoshish. Archaeology Laboratory, University of Minnesota, Minneapolis.

Johnson, Elden and J. Schaaf. 1978. Cultural Resources Investigation at the Lake Winnibigoshish Dam Site-21IC4, Archaeology Laboratory, University of Minnesota, Minneapolis.

Jones, P.M. 2005. Simulated effects of water-level changes in the Mississippi River and Pokegama Reservoir on ground-water levels, Grand Rapids area, Minnesota: U.S. Geological Survey Scientific Investigations Report 2005-5139, 13p.

Kallemeyn, Larry, W. Y. Cohen and P. Radomski. Rehabilitating the Aquatic Ecosystem of Rainy Lake and Namakan Reservoir by Restoration of a More Natural Hydrologic Regime. U.S. Fish and Wildlife Service *Biological Report 19*. 1993. pp. 432-448

Kallemeyn, Larry. 1987. Effects of Regulated Lake Levels on Northern Pike Spawning Habitat and Reproductive Success in Namakan Reservoir, Voyageurs National Park. U.S. Department of the Interior, National Park Service, *Research/Resources Management Report MWR-8*. 15 pp.

Kluth, Rose A., and David W. Kluth. 2000. Chippewa National Forest Heritage Site Monitoring Shoreline Erosion Project Damage Assessment Summary Report. Leech Lake Heritage Sites Program, Cass Lake, Minnesota.

Koenen, Bruce. 2001. Archaeology in Minnesota: 2000 Project Report Summaries. Minnesota Office of the State Archaeologist, St. Paul.

Kraft, Kenneth J. 1988. Effects of Increased Winter Drawdown on Benthic Macroinvertebrates in Namakan Reservoir, Voyageurs National Park. U.S. Department of the Interior, National Park Service, *Research/Resources Management Report MWR-12*. 38 pp.

Leech Lake Band of Ojibwe (LLOB). 2005. Leech Lake Band of Ojibwe Tribal Interest Inventory. Document submitted to the US Army Corps of Engineers, St. Paul District.0

Mille Lacs Band of Ojibwe (MLOB). 2005. Mille Lacs Band of Ojibwe Tribal Interest Inventory For Reservoir Operation Plan Evaluation Army Corps of Engineers. Document submitted to the U.S. Army Corps of Engineers, St. Paul District.

Minnesota State Demographic Center. 2008. Post-2000 Population and Household Estimates. http://www.demography.state.mn.us/estimates.html

Minnesota State Demographic Center. 2007. Population projections for Minnesota counties, 2005 to 2030.

Minnesota State Demographic Center. 2007. Projected Minnesota Population by Age and Gender and by County, Region, and Metropolitan area, 2005 to 2035.

Minnesota State Demographic Center. 2008. Census 2000: Race Population by County. http://www.demography.state.mn.us/Cen2000redistricting/Cen00ctyracer.html

Minnesota State Historic Preservation Office (SHPO). 2006. Cultural Resource Files. On File at the Minnesota State Historic Preservation Office, St. Paul.

Mooers, Howard D., and C.A. Dobbs. 1993. Holocene Landscape Evolution and the Development of Models for Human Interaction with the Environment: An Example from the Mississippi Headwaters Region. Geoarchaeology, 8(6):475-492.

Patrick, Ruth. 1988. Importance of diversity in the functioning and structure of riverine communities. *Limnol.Oceanogr*. 33(6 Part I). 1304-1307.

Peterson Environmental Consulting, Inc. (PEC). 2004. Mississippi Headwaters ROPE Study Final GIS Data (01-21-04)(CD).

Poff, N. LeRoy, J. D. Allan, M.B. Bain, J.R. Carr, K.L. Prestegaard, B.D. Richter, R.E. Sparks and J.C. Stromberg. 1997. The Natural Flow Regime. *Bioscience* 47:11.

Pomerleau, Richard. No date. “Ice Effects at Headwaters Reservoirs.” Paper for US Army Corps of Engineers.

Richter, Brian D., J.V. Baumgartner, R. Wigington, D.P. Braun. 1997. How Much Water Does a River Need? *Freshwater Biology*, 37, 231-249

Thurber, Joanne M. and Rolf O. Peterson. 1988. Effects of Regulated Lake Levels on Muskrats in Voyageurs National Park, Minnesota. U.S. Department of the Interior, National Park Service, *Research/Resources Management Report MWR-9*. 27 pp.

US Army Corps of Engineers. 2001. Reconnaissance Study, Upper Mississippi River, Lake Itasca to Lock and Dam 2. Corps of Engineers, St. Paul District, June 2001.

US Census Bureau. 2008. Small Area Income and Poverty Estimates: Minnesota Counties, 2005. http://www.census.gov/hhes/www/saipe/saipe.html

US Census Bureau. 2008a. How the Census Bureau measures Poverty (Official Measure). http://www.census.gov/hhes/www/poverty/povdef.html

US Census Bureau. 2008c. Poverty Thresholds 2005. http://www.census.gov/hhes/www/poverty/threshld/thresh05.html

Webb, T. III, E.J. Cushing and H.E. Wright Jr. 1983. Holocene Changes in the Vegetation of the Midwest. In Late-Quaternary Environments of the United States, vol. 2, The Holocene, edited by H.E. Wright Jr., pp. 142-165. University of Minnesota, Minneapolis.

White, R. 1991. The Middle Ground: Indians, Empires, and Republics in the Great Lakes Region, 1650-1815. Cambridge University Press, Cambridge.

Wilcox, Dwight E. 1979. The Effect of Various Water Level Regimes on Fish Production in the Leech Lake Reservoir, Cass County, Minnesota. Final Report. Department of the Army, Corps of Engineers, St. Paul District. Contract No. DACW 37-77-C-0150. 39 pp. + Appendix.

Winchell, N. H. 1911. The Aborigines of Minnesota. Minnesota Historical Society, St. Paul.

Wright, H.E., Jr. 1971. Late Quaternary Vegetational History of North America. In The Late Cenozoic Glacial Ages, edited by Karl K. Turekian, pp. 425-464. Yale University Press, New Haven

Wright, H.E., Jr. 1972. Physiography of Minnesota. In Geology of Minnesota: A Centennial Volume, edited by P. K. Sims and G. B. Morey, pp. 561-578. Minnesota Geological Survey, St. Paul.

CHAPTER 13. APPENDICES

Appendix A. Report/EIS Distribution List
Appendix B. Scoping/Correspondence
Appendix C. Forest Service Regional Forester Sensitive Species Evaluation
Appendix D. Cultural Resource Coordination
Appendix E. Example Hydrographs
Appendix F. Sandy Lake Flood Operation Evaluation
Appendix G. Minimum Release Guideline Review
Appendix H. Brief History of the Headwaters Reservoirs