FINAL Letter Report

Sustainable Rivers Program: Operating Plan Review Workshops

U.S. Army Corps of Engineers, St. Paul District
North Dakota, Minnesota, Wisconsin, and Iowa

US Army Corps of Engineers
St. Paul District

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Executive Summary

The Sustainable Rivers Program is led by the U.S. Army Corps of Engineers (Corps) Hydrologic Engineering Center to investigate ways in which Corps dams can be operated to provide benefits to natural resources. Under this program, a series of workshops were held to review potential operation changes for St. Paul District Corps reservoirs (except Mississippi River Lock and Dam pools). The aim of the workshops was to gather the expertise needed to identify potential operating changes, and to rank those changes based on general assessments of their potential benefits and obstacles to implementation.

The workshops were held over the course of several days with a couple hours devoted to each reservoir. A general discussion of current operations was followed with a brainstorming session to consider potential changes. Additionally, agency input on operations was obtained prior to the workshops and used to facilitate ideas. Potential changes were discussed and further evaluated in this report. Finally, the most probable changes to consider for each reservoir were included and ranked in Table 1 below. Highly-ranked studies would be the first considered for future SRP funding requests.

Table 1. Potential studies ranked for all St. Paul District reservoirs.

Project Name	SRP Study Rank	Likely Potential Study Focus
Baldhill Dam (Ashtabula)	low	Earlier fall drawdown; ramping rates for periodic inspections
Homme Dam	low	None currently
Orwell Dam	high	Minimum releases; pulse flows
Lake Traverse Project (Traverse and Mud)	underway	Summer drawdown; minimum releases
Red Lake	low	Increase in lake level
Hwy 75, Marsh, Lac qui Parle	high	Agency coordination/scoping; review downstream flood impact constraints
Winnibigoshish Dam	medium	Wild rice; fish passage
Leech Lake Dam	medium	Wild rice; fish passage
Pokegama Dam	medium	Spring pulse; fish passage
Big Sandy Dam	high	Leaf gate fish passage; ramping rates and wild rice
Cross Lake Dam	medium	Drawdown for whitefish; fish passage
Gull Lake Dam	low	Fall drawdown; algae dewatering
Eau Galle Dam	high	Hypolimnetic release; fall spawn

CHAPTER 1.

Introduction

1.1 Sustainable Rivers Program

The Sustainable Rivers Program (SRP) started in 1998 when The Nature Conservancy (TNC) approached the Corps Louisville District to collaboratively develop an operations plan for the Green River Dam. The program aims to improve the health and life of rivers by modifying reservoir operations to achieve ecologically sustainable flows while maintaining or enhancing other project benefits. In 2000, TNC and the Corps signed a Memorandum of Understanding to seek opportunities relating to the conservation, understanding, management and sustainable use of the Nation's water and related land resources. The Institute for Water Resources (IWR) plays a role in the implementation of this agreement and in managing the SRP.

Annually, the SRP receives funding that is used to support various efforts across the Nation. Corps Districts submit funding proposals for SRP efforts and IWR reviews those proposals and distributes funding to support them. This report, which summarizes the results of a series of workshops in the St. Paul District (District), was funded in this manner through the SRP. The basic premise of these workshops was to review the operating plans of each reservoir in the District, except the Mississippi River Lock and Dam pools, to identify potential future SRP efforts to modify reservoir operations.

1.2 St. Paul District Reservoirs

The District is responsible for the operation and maintenance of sixteen reservoirs: Lake Ashtabula, Homme Reservoir, Lake Traverse (and Mud Lake), Highway 75 Reservoir, Lac qui Parle (and Marsh Lake), Orwell Reservoir, Red Lake, Lake Winnibigoshish, Leech Lake, Pokegama Lake, Big Sandy Lake, Cross Lake, Gull Lake, and Eau Galle Reservoir (Table 2). Operating plans for each of the dams have been developed over time and are documented within individual Water Control Manuals. While these operating plans include some considerations for environmental impacts, there is the potential to improve operations at some or all of these reservoirs.

Table 2. St. Paul District reservoirs and authorized primary purposes

Project Name	Watershed	Primary Purpose
Baldhill Dam (Ashtabula)	Red River	Water Supply, Flood Control
Homme Dam	Red River	Water Supply, Pollution Abatement, Flood Control
Orwell Dam	Red River	Flood Control, Water Supply
Lake Traverse Project (Traverse and Mud)	Red River	Flood Control, Water Conservation
Red Lake	Red River	Flood Control, Water Supply and Pollution Abatement
Highway 75 Dam and Reservoir	Minnesota River	Flood Control
Marsh Lake Reservoir	Minnesota River	Flood Control
Lac qui Parle Reservoir	Minnesota River	Flood Control
Winnibigoshish Dam	Mississippi River	Navigation
Leech Lake Dam	Mississippi River	Navigation
Pokegama Dam	Mississippi River	Navigation
Big Sandy Dam	Mississippi River	Navigation
Cross Lake Dam	Mississippi River	Navigation
Gull Lake Dam	Mississippi River	Navigation
Eau Galle Dam	Mississippi River	Flood Control, Recreation, Fish and Wildlife

1.3 Workshops and Report Structure

The goal of the workshops was to conduct a scoping-level analysis to identify whether a reservoir has potential for increased environmental benefits through operational changes. Potential opportunities would undergo a more extensive evaluation under a later effort to examine the impacts of these potential changes.

Workshop participation included Corps personnel familiar with specific reservoirs and included a variety of disciplines including Operations, Water Management, Environmental and others as warranted.

Prior to the workshops, agency input was gathered to help identify areas of concern for reservoir operations. An email requesting input was sent to a group of agency representatives for each reservoir. These requests and responses can be found in Appendix C.

This report is divided up by reservoir to facilitate use in later efforts. Each reservoir chapter is divided into sections summarizing the attendees, agency input, workshop ideas carried forward for further study, and a recommendation summary. Supporting information including reservoir operating summaries and workshop notes are found in Appendices, A and B. Within the workshop notes tables are two columns labeled "Carry Forward" and "SRP" that can be filled in with a "Y" (yes), "N" (no), "M" (maybe). The "Carry Forward" column indicates the appropriateness of carrying forward an idea for future evaluation, regardless of the funding mechanism or authority. The "SRP" column indicates the appropriateness of carrying forward an idea for review utilizing SRP funding. SRP funding was generally considered appropriate for projects with potential environmental benefit that are relatively simple in scope with few potential adverse effects that would require a full ROPE study.

CHAPTER 2.

Baldhill Dam/Lake Ashtabula

2.1 Workshop Attendees/Date

The Baldhill Dam workshop was held on September 8, 2020. Attendees included: Elizabeth Nelsen, Jon Hendrickson, Mitch Weier, Jason Tidwell, Brian Johnson, Steve Clark, Megan McGuire, Dave Potter, Vanessa Alberto, Jeff Steere, Rich Schueneman, Terry Zien, and Nick Castellane.

2.2 Agency Input

The North Dakota Department of Water Resources (previously the State Water Commission) (NDDWR) and Cass County each provided comments regarding the operating plan of Baldhill Dam. Neither entity provided suggestions for operations to improve environmental conditions within or downstream of the reservoir. Their comments were, however, related to maintaining or improving operations as it relates to flood risk reduction, especially in the context of increased base flows related to pumping of Devils Lake water into the Sheyenne River by the NDDWR. These comments tend to indicate that some ideas for e-flows (environmental-flows) would likely be met with substantial local resistance under wetter hydrologic conditions experienced during the last several years.

2.3 Brainstorming and Ideas Carried Forward

A growing season drawdown was discussed but excluded from further consideration. The general consensus was there likely being a lack of support for a drawdown due to potential fishery impacts and that in-reservoir vegetation seems to be doing well now. Another in-reservoir consideration was the possibility of reducing water levels earlier in the fall to help mitigate impacts to amphibians and furbearers, while possibly improving conditions for waterfowl. It is unclear whether or not such operations would improve conditions for waterfowl, which would need further investigation. Another idea was attempting to hold water levels more steady during spring fish spawning, though there could be impacts to outflows that may render such a change unacceptable to downstream communities. After these conversations, all those but the drawdown option were considered possibilities that may be worth further investigation in the future.

A number of ideas affecting downstream habitats were also considered. Two ideas that were excluded from further consideration were looking for opportunities to increase lateral connectivity with the floodplain by raising flows, and considering water releases from lower in the water column to reduce downstream water temperatures. The first was excluded because the channel is incised too much to make this practical, and the second because the reservoir is not deep enough to have markedly cooler temps at depth.

There were some ideas that do warrant further investigation, though opportunities to implement them and their effects may be limited. The general theme of these ideas revolved around low-flow conditions. Currently, low flows are not limiting in the system, chiefly because of the pumping from Devils Lake. However, in the absence of this, low flows would be limiting in dry years. One idea was to allow some flushing flow during extended dry or drought conditions when rain events occur, rather than storing and gradually releasing the water. Depending on flows, these releases could flush sediments from deeper habitats. In a similar theme, reviewing rate of change requirements may also warrant study. Attempting to mimic more natural changes in flows (similar to what is suggested above) may be beneficial, though determining what the reference for "natural" is would require some thought and it may be determined that more gradual changes in flows, rather than faster changes, is more natural if the reference point is pre-settlement hydrology. It was suggested that a study of low-flow requirements (such as that done through the Instream Flow Incremental Methodology (IFIM; Bovee et al. 1998)) may be warranted, though as long as there continues to be pumping of Devils Lake, there may be limited benefit in looking into this now.

Finally, a question was raised regarding periodic inspections, maintenance, and ramping rates. Reducing flows to allow inspections can take days following the constraints of ramping. The low flows for periodic inspections may only be required for a few hours or less. It may be worthwhile to study the adverse impacts of these changes in flows over the course of a few days, relative to the potential impacts of short-duration dramatic changes in flows that are unconstrained by ramping. It is possible that unconstrained short-duration dramatic changes in flows may be less damaging than long-duration slower changes in flows.

2.4 Recommendation

Areas recommended for further study include: 1) lowering water levels earlier in fall; 2) steady reservoir water levels for spring spawning; 3) reviewing low flow requirements; and 4) review ramping rates for periodic inspections. While these are potential areas of study for improvement of environmental conditions, there seems to be limited opportunity and benefit for implementing these at this time.

Because of this, at the time of this writing the priority for this work at Baldhill Dam is lower than that for other reservoirs in the District.

CHAPTER 3.

Homme Reservoir

3.1 Workshop Attendees/Date

The Homme Reservoir workshop was held on September 8, 2020. Attendees included: Elizabeth Nelsen, Jon Hendrickson, Mitch Weier, Jason Tidwell, Brian Johnson, Steve Clark, Megan McGuire, Dave Potter, Vanessa Alberto, Jeff Steere, Rich Schueneman, Terry Zien, and Nick Castellane.

3.2 Agency Input

The North Dakota State Water Commission (NDSWC) provided comments regarding the operating plan of Homme Dam. No suggestions were provided for operations to improve environmental conditions within or downstream of the reservoir. They did suggest that it would be important to maintain flood storage as is done in the current operating plan. They also suggested that attempting the winter drawdown too early can cause ice buildup in the channel, limiting channel capacity.

3.3 Brainstorming and Ideas Carried Forward

The reservoir is known to have excessive algae blooms in the summer. One idea from brainstorming was the use of "solar bees", which are mechanical devices to circulate water to reduce the incidence of these blooms. This was eliminated from further consideration as the effectiveness is unknown and operating and maintaining these devices may be problematic.

Incidentally, the winter drawdown plan was reviewed and modified in an environmental assessment completed in 2014. The newly implemented drawdown targets were intended to alleviate concerns over ice damage and were assessed to have some benefits to aquatic habitat and fish. During brainstorming, it was suggested that the reservoir could be held higher through the winter. This idea was retained for further study, but in consideration of the above comments from the NDSWC, and the fact that this was investigated in 2014, this option is not a high priority of restudy at this time.

A number of ideas to affect downstream habitat were also discussed. Ways to reduce ice damage, low flow adjustments, and fish passage were all considered

but none were carried forward for future consideration for a variety of reasons, most of which are related to the limited availability of flow.

3.4 Recommendation

At this time, there are no areas recommended for further study for potential changes to improve environmental conditions within or downstream of Homme Reservoir. At this time the potential benefits are not great enough to warrant efforts to overcome the known constraints in the system.

CHAPTER 4.

Hwy 75, Marsh, LQP Reservoir

4.1 Workshop Attendees/Date

The Highway 75 Dam, Marsh Lake, and Lac qui Parle Reservoir workshop was held on September 9, 2020. Attendees included: Mike Knoff, Elizabeth Nelsen, Jon Hendrickson, Mitch Weier, Jason Tidwell, Brian Johnson, Steve Clark, Megan McGuire, Dave Potter, Vanessa Alberto, Jeff Steere, Randy Melby, and Nick Castellane.

4.2 Agency Input

Several comments were received from the Minnesota Department of Natural Resources (MNDNR) for these projects, primarily related to Highway 75 and Lac qui Parle. In general, their suggestions were good, but may require efforts greater in scope than is typically considered under the SRP, including construction of new habitat features and reconfiguring the dams. The lack of comments on Marsh, and the scope of projects for the other reservoirs is likely due to the fact that a habitat restoration project was just completed for Marsh Lake. One outcome of that project is that the MNDNR is now responsible for the day-to-day operation of the reservoir and do so to enhance habitat.

Larger-scale projects suggested included Section 1135 studies to consider features such as fish passages, river channel restoration, dam alteration and island construction. Dam operation-centric ideas included a Reservoir Operation Plan Evaluation (ROPE) study for the reservoirs as a system that could investigate numerous options for improvement (generally, a ROPE study is outside the scope of an SRP study in that it covers a full range of operation purposes beyond environmental, and it is much larger in scope). Some of those included reduced winter drawdown, minimizing water level fluctuations, releasing more water during flooding events, new summer and fall lake target levels, and growing season drawdowns as are being conducted at Marsh Lake. Finally, it was also suggested to form a cross-agency inter-disciplinary team to discuss management goals and objectives across the system (there currently is a team for Marsh Lake).

4.3 Brainstorming and Ideas Carried Forward

A large number of ideas were discussed for these reservoirs, and most of them reflected the comments received from the MNDNR. In general, it appears that

there is a lot of opportunity to investigate various measures here that range from simple and inexpensive, to complex and costly. Sustainable Rivers Program funding may be appropriate for some of the initial and simpler efforts, but larger-scale studies may be needed for later and complex ones, especially where construction of features may be required.

Initially, it may be worthwhile to form a cross-agency inter-disciplinary team to begin scoping various efforts and help determine a path forward (a similar effort is being implemented in 2021 for Traverse/Mud Lake under the SRP). Such an effort could be used to carefully consider some of the comments from the MNDNR and workshop attendees, to better understand the potential benefits and constraints.

Operational items that may be considered for implementation under the SRP that were carried forward from the workshop included reevaluating downstream flow constraints such as channel capacity, operating for a more natural flow regime, changing summer and fall water level targets, and growing season drawdowns. The scoping effort could be used to gage the acceptability of a growing season drawdown, which would be timely in consideration of the fact that the Marsh Lake drawdown has shown some success.

A full revaluation of the measures considered in the workshop would best be conducted under a full ROPE study, which would likely require substantial funding through the Operations budget. However, if that option were not available in the near future, and if a scoping effort were to determine that some simple measures such as a drawdown were worth pursuing for implementation, it may be possible to do so with SRP funding and could be considered.

Finally, some of the suggestions that require construction would need to be funded through other means such as an 1135 project. The efforts above could be used to discuss these, generate support, and even lead to the identification of a willing sponsor.

4.4 Recommendation

There seems to be enough interest and opportunity for benefits that pursuit of SRP funding for work at these reservoirs is warranted. The likely first step in such an effort would be the development of an inter-agency team, and discussions to scope a plan to develop and evaluate potential options. This scoping effort could also involve some public outreach to gage the acceptability of some options such as a growing season drawdown. There may also be some initial evaluations, especially related to hydrology and flooding impacts that could be conducted to help screen some options presented for consideration. Because of the interest and

potential for positive changes, an SRP study for this system was ranked relatively high among the other potential options.

CHAPTER 5.

Red Lake Reservoir

5.1 Workshop Attendees/Date

The Red Lake workshop was held on September 9, 2020. Attendees included: Mike Knoff, Elizabeth Nelsen, Jon Hendrickson, Mitch Weier, Jason Tidwell, Brian Johnson, Steve Clark, Megan McGuire, Dave Potter, Vanessa Alberto, Jeff Steere, Tim Rennecke, and Nick Castellane.

5.2 Agency Input

There was basically a single comment provided by the Red Lake Band and the MNDNR. Both commented that raising water levels would be beneficial. The MNDNR suggested that the raise be one foot to an operating level of 1175. The Red Lake Band fisheries biologist suggested that a raise would improve walleye and possibly whitefish recruitment, and it would also improve recreational lake access for Band members. Negative impacts to whitefish numbers may also be realized by reducing winter drawdown levels because they spawn under the ice in the fall, and reducing water levels during the winter can impact egg survival.

5.3 Brainstorming and Ideas Carried Forward

The suggestions to raise water levels and reduce winter drawdowns were also discussed during the workshop. No other ideas for environmental improvement were identified with the exception of modifications to rate of change constraints downstream; though there was no clear need to do so. It was suggested that a new ROPE study is warranted for Red Lake and would be required prior to implementing any raise in water level. Incidentally, high lake levels in the summer of 2020 caused concerns over residential flooding for some residents on the lake.

5.4 Recommendation

The recommendation at this time is to seek Operations funding and complete a ROPE study for Red Lake. At that time the concepts around raising lake levels and reducing or modifying the timing of winter drawdowns should be considered along with any other ideas from the workshop. This effort would be of greater scope and outside that of a typical SRP study. Therefore, an SRP study for Red Lake would be of much lower priority than other options presented here.

CHAPTER 6.

Lake Traverse and Mud Lake

6.1 Workshop Attendees/Date

The Lake Traverse/Mud Lake workshop was held on September 10, 2020. Attendees included: Mike Knoff, Elizabeth Nelsen, Jon Hendrickson, Mitch Weier, Jason Tidwell, Brian Johnson, Steve Clark, Megan McGuire, Dave Potter, Vanessa Alberto, Jeff Steere, Randy Melby, Rich Schueneman, and Nick Castellane.

6.2 Agency Input

The MNDNR provided two basic comments. The first was that optimization of fish and wildlife conditions in the pools is needed; however, the direct meaning of this was unclear. The second was that seasonal protected flow regimes are needed below the facilities to prevent fish kills in the Bois de Sioux River, particularly during the summer. This fundamentally means that minimum release requirements, not in place now due to infrastructure constraints, would be beneficial.

6.3 Brainstorming and Ideas Carried Forward

A number of ideas were discussed during brainstorming and there seems to be ample opportunities for modifying reservoir operation (Appendix A). For Traverse, two considerations were raising the conservation pool and reducing winter drawdown targets. These modifications would likely benefit the fishery there because Traverse is a relatively shallow basin and greater water volume would help maintain oxygen levels. Within Mud Lake, a general concept to consider operating it for shorebirds and waterfowl, similar to how moist soil units are operated, was a generally supported theme. This could entail allowing water levels to fall gradually after July 1st, and possibly increasing water levels in the late fall to provide flooded waterfowl habitat. A drawdown similar to this was conducted on Mud Lake in past, with an excellent shorebird response.

Downstream improvements for habitat would likely require consideration of releases from both reservoirs. There was an interest, including from the MNDNR, to consider minimum release requirements to support aquatic life in the

Bois de Sioux River. Operating Mud Lake as a moist soil unit, where water levels are gradually reduced over the winter, could compliment a plan to provide minimum releases.

There are some constraints that would have to be considered in evaluating these modifications. Of course, there needs to be some consideration for maintaining flood risk reduction benefits, especially in considering changes to drawdown levels at Traverse. Also, water released from Mud Lake is high in dissolved solids. This causes problems downstream for downstream water users and dischargers in that it may constrain their abilities to release treated wastewater effluent into the river. Another minor constraint is that the outlet channel of Mud Lake may have filled in to the point where a drawdown may be limited unless the channel is dredged.

6.4 Recommendation

It was recommended that these options are explored within the SRP. In fact, a proposal was submitted, approved, and funded to scope the options discussed above for FY21. If it is determined during this scoping effort that it is likely that any or all of these options are implementable, further investigation will be carried out for implementation. Incidentally, there is also a need to review and update the entire operating plan for these reservoirs, and funding has been requested through the Operations budget to conduct this review. It is possible that the current scoping effort could be used to inform this broader operations review to implement suggested changes.

CHAPTER 7.

Orwell Reservoir

7.1 Workshop Attendees/Date

The Orwell Reservoir workshop was held on September 10, 2020. Attendees included: Mike Knoff, Elizabeth Nelsen, Jon Hendrickson, Mitch Weier, Jason Tidwell, Brian Johnson, Steve Clark, Megan McGuire, Dave Potter, Vanessa Alberto, Jeff Steere, Randy Melby, Rich Schueneman, and Nick Castellane.

7.2 Agency Input

The MNDNR provided a few comments related to natural resource improvement at Orwell. One was to consider studying the construction of fish passage at the dam to improve native fish and mussel species in the Otter Tail River system. The other general comment pertained to minimum flow requirements below the dam. The Otter Tail River downstream of the dam provides habitat for a variety of mussel species, some of them state-listed as threatened or special concern. The specific comment was that habitat for mussels is quickly lost as flows fall below 300 cfs. The current minimum release requirement in the operating plan is 80 cfs.

7.3 Brainstorming and Ideas Carried Forward

Generally, there were few comments received from the MNDNR, especially as pertains to habitat within the reservoir. Some ideas for the reservoir were discussed during brainstorming, but it is clear that if any of them are pursued, more active engagement by the MNDNR would be needed to determine the priority of these ideas. One idea that was discussed was a growing season drawdown for vegetation improvement, especially in the shallow arms of the reservoir. Another was to lower the pool to reduce the amount of winter drawdown needed, or simply reducing the level of the drawdown and decreasing flood storage. Each of these options may require a ROPE study level of evaluation to determine potential impacts and benefits, especially if such changes were likely to impact flood risk reduction. Incidentally, Traverse and Mud Lakes would also benefit from a ROPE Study, and there would be utility in studying Orwell at the same time.

There seems to be more opportunity and interest in considering modifications to downstream flows at Orwell. The upper Otter Tail River generally provides high-quality and diverse riverine habitats despite the presence of several

impoundments. Also, there is a Section 1135 ecosystem restoration project about eight miles downstream of the dam currently being planned. The primary flow concern below the dam is inadequate minimum releases to maintain high-quality riverine habitats downstream. Incidentally, this also becomes an issue when minimum flows are requested to facilitate periodic dam inspections. Regarding the minimum release requirement of 80 cfs that is currently in the plan, there is evidence from the MNDNR that flows below 300 cfs start to become problematic for riverine habitats, especially for mussels as mentioned above. Other ideas pertaining to flows included the consideration of higher pulse flows for channel-forming processes and to periodically flood riparian vegetation. There would be a tradeoff in implementing such options, especially in drier years, in that reservoir levels may have to be lowered to provide the flows. As in most situations in dam operations, the tradeoff between within-reservoir effects and those downstream would need to be weighed in determining the best action. Incidentally, lower lake levels would likely benefit the flood storage purpose of the reservoir.

Another concept that should be considered is in the operation of Traverse and Mud Lakes. A concept to operate Mud Lake as a moist soil unit is currently being scoped. Such operation at Mud would require increased releases of water during the summer. However, Mud Lake water is high in dissolved solids which may limit the ability of downstream municipalities to release effluent to the Bois de Sioux River. If, however, the minimum releases from Orwell were also increased, there may be some dilution of the Mud Lake water to help mitigate the high dissolved solids.

Finally, while it would not be an option pursued under the SRP, the concept of a fishway was also discussed. Orwell is unique in that it doesn't have an emergency spillway. There could be an opportunity to develop a bypass-channel fishway that would also be able to serve as an emergency spillway. Depending on the design, it may also be worthwhile considering a possibility of including a method to provide higher minimum flows during periodic inspections.

7.4 Recommendation

The recommendation for Orwell is to conduct an SRP study of the minimum release requirements for the benefit of downstream habitat. Depending on the findings from the current scoping effort at Traverse and Mud Lakes, it may be beneficial to conduct this study in the near future. A primary point of study at Orwell would be determining potential reservoir impacts if minimum releases were increased to 300 cfs.

Of the other topics discussed during the workshop, pulse flows and a growing season drawdown may also warrant study under the SRP. However, there would first need to be additional agency coordination to determine if there is support or a

need for these modifications. This outreach could be under the minimum release review suggested above, as there is not likely enough interest in these ideas to study them under the SRP independently at this time.

CHAPTER 8.

Lake Winnibigoshish

8.1 Workshop Attendees/Date

The Lake Winnibigoshish (Winni) workshop was held on September 28, 2020. Attendees included: Mike Knoff, Elizabeth Nelsen, Jon Hendrickson, Mitch Weier, Brian Johnson, Steve Clark, Megan McGuire, Dave Potter, Vanessa Alberto, Randy Urich, Jeff Steere, Corrine Hodapp, Leigh Allison, Grant Halvorson, Shawn Weissenfluh, Jeff Cook, Timm Rennecke, Zach Kimmel, and Nick Castellane.

8.2 Agency Input

Comments were received from the U.S. Forest Service and the MNDNR. The Forest Service requested more active collaboration for the operation of Winni and Cass Lake. They did not provide any suggestions specific to improved environmental operations. The MNDNR commented that the high flows in fall and winter, and the low flows in spring, impact fish and wildlife habitat. They suggested that changing reservoir operations to better mimic a more natural hydrology would be beneficial.

8.3 Brainstorming and Ideas Carried Forward

The Headwaters ROPE study completed in 2009 extensively studied alternatives to improve the operations of these reservoirs for environmental benefit. Ultimately, the suggested changes were unacceptable to the public (lower water levels in late summer may impact recreation) and the plans were abandoned. There may be an opportunity in the future to revisit broad changes to these operating plans as public perceptions and values change. There is currently an SRP effort being conducted to begin building public support for operational changes, though the success and timing for building this support is unknown. For these reasons, the ideas considered for action in the near term in this study are limited to those that are likely to have minimal impacts on reservoir levels, and therefore, minimal risk of public opposition.

During brainstorming, there were suggestions to modify operations to better mimic natural hydrology as suggested by the MNDNR. These even included more specific suggestions such as reducing the winter drawdown by one foot, or to lower water levels sooner during the winter drawdown, or to conduct growing

season drawdown. All of these options would require extensive coordination with the public and agencies, and a ROPE study. There were a few suggestions that could be considered for study in the near future under the SRP. Additional suggestions included encouraging fish passage through the dam simply by manipulating gate openings or managing flows to improve downstream wild rice production. Depending on which combination of gates are opened under various flow conditions, it may be possible to facilitate water velocities and flow patterns in the tailwaters that would allow fish to pass upstream through the gates. For wild rice at certain times of the growing season, it may be beneficial to carefully adjust flows to avoid adversely impacting growing rice. By monitoring the affected rice beds, the potential impacts of changed operations can be assessed.

8.4 Recommendation

The recommendation for Winnibigoshish, as with the other Headwaters reservoirs in considering large-scale operating changes, is to continue the public outreach effort to build support. In the short-term, there may be an opportunity here to review gate operations for fish passage and downstream wild rice. Regarding the priority of these options for near-term SRP funding requests, it seems they are a moderate priority relative to other options available at this time.

CHAPTER 9.

Leech Lake

9.1 Workshop Attendees/Date

The Leech Lake workshop was held on September 28, 2020. Attendees included: Mike Knoff, Elizabeth Nelsen, Jon Hendrickson, Mitch Weier, Brian Johnson, Steve Clark, Megan McGuire, Dave Potter, Vanessa Alberto, Randy Urich, Jeff Steere, Corrine Hodapp, Leigh Allison, Grant Halvorson, Shawn Weissenfluh, Jeff Cook, Timm Rennecke, Zach Kimmel, and Nick Castellane.

9.2 Agency Input

The MNDNR provided comments that generally reflected the desire to mimic a natural hydrologic cycle to benefit fish and wildlife. They also suggested the consideration of either modifying the dam or replacing it with a rock weir structure to facilitate the passage of aquatic organisms.

9.3 Brainstorming and Ideas Carried Forward

The Headwaters ROPE study completed in 2009 extensively studied alternatives to improve the operations of these reservoirs for environmental benefit. Ultimately, the suggested changes were unacceptable to the public and the plans were abandoned. There may be an opportunity in the future to revisit broad changes to these operating plans as public perceptions and values change. There is currently an SRP effort being conducted to begin to build public support for such changes, though the success and timing for building this support is unknown. For these reasons, the ideas considered for action in the near term here would be limited to those that are likely to have minimal impacts on reservoir levels, and therefore, minimal risk of public opposition.

During brainstorming, there were suggestions to modify operations to better mimic natural hydrology as suggested by the MNDNR. As mentioned previously, such options would require extensive coordination and a ROPE study. There were a few suggestions that could be considered for study under the SRP. Similar to Winni, suggestions included encouraging fish passage through the dam simply by manipulating gate openings as well as managing flows to improve conditions for downstream rice beds. This is already being done to some degree for wild rice in Mud Lake, but it could be evaluated to determine if other locations would

benefit. Another suggestion was to consider flow manipulations to prevent fish stranding downstream of the dam.

There was also discussion around larger-scale projects for Leech Lake. Resource agencies, including the Leech Lake Band of Ojibwe have had a long-running interest in restoring the channelized reaches of the Leech Lake River downstream of the dam and in providing fish passage at the dam. There are a couple obstacles to these projects. For the restoration project to be beneficial, it would be best if more natural hydrology were in place. However, a more natural hydrologic regime tends to conflict with the flood risk management purpose of the reservoir. The primary obstacle for a fishway is available federal funding and the identification of a local sponsor willing to support the project through a cost-share. Of these two options, a fishway is more likely to be pursued in the future as its obstacles are easier to overcome.

9.4 Recommendation

The recommendation for Leech Lake, as with the other Headwaters reservoirs in considering large-scale operating changes, is to continue the public outreach effort to build support. In the short-term, there may be an opportunity here to review gate operations for fish passage, preventing fish stranding, and downstream wild rice. Regarding the priority of these options for near-term SRP funding requests, it seems they are a moderate priority relative to other options available at this time.

CHAPTER 10.

Pokegama Reservoir

10.1 Workshop Attendees/Date

The Pokegama Reservoir workshop was held on September 28, 2020. Attendees included: Mike Knoff, Elizabeth Nelsen, Jon Hendrickson, Mitch Weier, Brian Johnson, Steve Clark, Megan McGuire, Dave Potter, Vanessa Alberto, Randy Urich, Jeff Steere, Corrine Hodapp, Leigh Allison, Grant Halvorson, Shawn Weissenfluh, Jeff Cook, Timm Rennecke, Zach Kimmel, and Nick Castellane.

10.2 Agency Input

Just as for the other Headwaters reservoirs, the MNDNR commented that mimicking a natural hydrologic cycle benefits fish, wildlife, and wild rice. They also were concerned with the downstream effects of reduced spring flows on fish spawning as far down as Big Sandy. Finally, they cited concerns over recreational access resulting from spring low flows.

10.3 Brainstorming and Ideas Carried Forward

The Headwaters ROPE study completed in 2009 extensively studied alternatives to improve the operations of these reservoirs for environmental benefit. Ultimately, the suggested changes were unacceptable to the public and the plans were abandoned. There may be an opportunity in the future to revisit broad changes to these operating plans as public perceptions and values change. There is currently an SRP effort being conducted to begin to build public support for such changes, though the success and timing for building this support is unknown. For these reasons, the ideas considered for action in the near term here would be limited to those that are likely to have minimal impacts on reservoir levels, and therefore, minimal risk of public opposition.

Other than the general idea to operate the reservoir for more a more natural hydrology, the only other idea presented was to improve conditions for annual plants such as wild rice. Vegetation may be improved with growing season drawdowns, and also generally a more natural hydrology. However, these ideas are not being carried due to lack of public support, as previously explained.

Two concepts were carried forward for further consideration. First, as suggested by MNDNR, increased spring flows would benefit downstream fisheries while

allowing Pokegama to rise slower. As a result of the ROPE study, there is already a provision for pulse flows, but it may be worthwhile to study this in more depth, specifically for Pokegama, to determine if there is the possibility to create more effective pulse flows. Potential risks include increasing flooding in the event of sudden spring rains and reducing the chances of reaching summer water level targets in dry years. Lastly, another potential consideration is in operating the dam gates to better facilitate fish passage. This concept is also being proposed at the other Headwaters reservoirs and it may be beneficial to conduct a study to look at all of the Headwaters reservoirs.

10.4 Recommendation

The recommendation for Pokegama Lake, as with the other Headwaters reservoirs in considering large-scale operating changes, is to continue the public outreach effort to build support. In the short-term, there may be an opportunity here to review gate operations for fish passage, and also to review spring pulse flows through the SRP. Fish passage through gate operations may be worth reviewing in a study of all the Headwaters reservoirs. Regarding the priority of these options for near-term SRP funding requests, it seems they are a moderate priority relative to other options available at this time.

CHAPTER 11.

Big Sandy Reservoir

11.1 Workshop Attendees/Date

The Big Sandy Reservoir workshop was held on September 30, 2020. Attendees included: Mike Knoff, Elizabeth Nelsen, Jon Hendrickson, Mitch Weier, Brian Johnson, Steve Clark, Megan McGuire, Dave Potter, Vanessa Alberto, Randy Urich, Jeff Steere, Corrine Hodapp, Leigh Allison, Grant Halvorson, Brian Turner, Tammy Frauenshuh, Jason Hauser, Joe Schrotter, and Nick Castellane.

11.2 Agency Input

Just as for the other Headwaters reservoirs, the MNDNR provided a general comment to mimic a natural hydrologic cycle. They also noted that they are working with the Corps on a study to determine movement of fish and escapement past the dam from the reservoir. They have a concern that walleye and other fish species are moving downstream through the dam and are unable to pass upstream. There was also a general note that the effects of the dam are most notable during extreme flow conditions, presumably both high and low flows.

11.3 Brainstorming and Ideas Carried Forward

The Headwaters ROPE study completed in 2009 extensively studied alternatives to improve the operations of these reservoirs for environmental benefit. Ultimately, the suggested changes were unacceptable to the public and the plans were abandoned. There may be an opportunity in the future to revisit broad changes to these operating plans as public perceptions and values change. There is currently an SRP effort being conducted to begin to build public support for such changes, though the success and timing for building this support is unknown. For these reasons, the ideas considered for action in the near term here would be limited to those that are likely to have minimal impacts on reservoir levels, and therefore, minimal risk of public opposition.

Currently, the dam is undergoing a rehabilitation, including the installation of a leaf gate in the log sluice bay, which provides a good opportunity to study the best ways to operate this leaf gate. The leaf gate will allow the release of water from either the top or the bottom of the gate. Top releases may reduce the escapement of bottom-oriented fish such as walleye. Another brainstorming idea was to reconsider ramping rates, specifically eliminating them during critical wild rice

life stages to help stabilize lake water levels. There would possibly be an adverse effect downstream of the dam, but because of the short length of the Sandy River there, these adverse effects may be outweighed by the potential positive effects in the reservoir for wild rice. These potential benefits are great enough to warrant further investigation.

11.4 Recommendation

The recommendation for Big Sandy Lake, as with the other Headwaters reservoirs in considering large-scale operating changes, is to continue the public outreach effort to build support. In the short-term, there is an opportunity study the impacts of the leaf gate operations on fish passage and to review ramping rates to benefit wild rice. Fish passage through gate operations may be worth reviewing in a study of all the Headwaters reservoirs collectively, but a specific review of Sandy is warranted because of the new leaf gate. Regarding the priority of these options for Sandy in the near-term, it seems that a review of Sandy is a higher priority for SRP funding than the options at the other Headwaters reservoirs.

CHAPTER 12.

Cross Lake/Pine River

12.1 Workshop Attendees/Date

The Cross Lake workshop was held on September 30, 2020. Attendees included: Mike Knoff, Elizabeth Nelsen, Jon Hendrickson, Mitch Weier, Brian Johnson, Steve Clark, Megan McGuire, Dave Potter, Vanessa Alberto, Randy Urich, Jeff Steere, Corrine Hodapp, Leigh Allison, Grant Halvorson, Brian Turner, Tammy Frauenshuh, Jason Hauser, Joe Schrotter, and Nick Castellane.

12.2 Agency Input

Just as for the other Headwaters reservoirs, the MNDNR provided a general comment to mimic a natural hydrologic cycle. They also specifically asked to consider downstream effects of significant flow changes, maximum release flows and rate of flow changes on aquatic habitat but did not specify what environmental effects they are concerned with. They also included a request for a fishway bypass channel. Finally, one specific request that may be more manageable under the current conditions was to adjust the fall drawdown to support lake whitefish spawning. Whitefish spawn in the fall and eggs incubate under the ice. Stable fall and winter water levels are therefore beneficial.

12.3 Brainstorming and Ideas Carried Forward

The Headwaters ROPE study completed in 2009 extensively studied alternatives to improve the operations of these reservoirs for environmental benefit. Ultimately, the suggested changes were unacceptable to the public and the plans were abandoned. There may be an opportunity in the future to revisit broad changes to these operating plans as public perceptions and values change. There is currently an SRP effort being conducted to begin to build public support for such changes, though the success and timing for building this support is unknown. For these reasons, the ideas considered for action in the near term here would be limited to those that are likely to have minimal impacts on reservoir levels, and therefore, minimal risk of public opposition.

One idea carried forward for consideration, suggested by the MNDNR, is an adjustment to the timing of the fall drawdown. Drawing down faster in the fall may have a benefit to whitefish and hibernating wildlife on the reservoir. There may be some adverse downstream impacts to recreation by beginning the

drawdown prior to mid-September as discovered by the ROPE study. Nevertheless, it seems that reviewing minor adjustments in the fall/winter drawdown schedule may be worthwhile. Because of the potential difficulties in implementing these changes, an SRP review of this is a moderate priority.

The other potential study at Cross Lake is adjusting gate operations to support fish passage without new construction. As discussed for the other Headwaters reservoirs, this option could be studied collectively.

12.4 Recommendation

The recommendation for Cross Lake, as with the other Headwaters reservoirs in considering large-scale operating changes, is to continue the public outreach effort to build support. In the short-term, there is an opportunity here to review gate operations for fish passage collectively with other reservoirs. A study of fall drawdown timing to benefit whitefish and other wildlife is also recommended and is likely the best study option specific to Cross Lake at this time. Such a study is likely to only have minor benefits due to the existing constraints of flood risk reduction and recreational benefits, so it is prioritized lower than other potential SRP study options.

CHAPTER 13.

Gull Lake

13.1 Workshop Attendees/Date

The Gull Lake workshop was held on September 30, 2020. Attendees included: Mike Knoff, Elizabeth Nelsen, Jon Hendrickson, Mitch Weier, Brian Johnson, Steve Clark, Megan McGuire, Dave Potter, Vanessa Alberto, Randy Urich, Jeff Steere, Corrine Hodapp, Leigh Allison, Grant Halvorson, Brian Turner, Tammy Frauenshuh, Jason Hauser, Joe Schrotter, and Nick Castellane.

13.2 Agency Input

Just as for the other Headwaters reservoirs, the MNDNR provided a general comment to mimic a natural hydrologic cycle. They also specifically asked to consider a fishway to provide fish passage, especially for the native musky population.

13.3 Brainstorming and Ideas Carried Forward

The Headwaters ROPE study completed in 2009 extensively studied alternatives to improve the operations of these reservoirs for environmental benefit. Ultimately, the suggested changes were unacceptable to the public and the plans were abandoned. There may be an opportunity in the future to revisit broad changes to these operating plans as public perceptions and values change. There is currently an SRP effort being conducted to begin to build public support for such changes, though the success and timing for building this support is unknown. For these reasons, the ideas considered for action in the near term here would be limited to those that are likely to have minimal impacts on reservoir levels, and therefore, minimal risk of public opposition.

Simple specific ideas carried forward for Gull Lake were very limited. One proposal was to consider conducting the drawdown earlier in the fall to benefit hibernating wildlife. This would be similar to that considered for Cross, which could also benefit whitefish spawning. Whitefish spawning was not mentioned by the MNDNR for Gull though. It may be worth considering this change for Gull, but it seems less likely to be implementable than for Cross, and therefore, isn't a high priority for study.

Lastly, the only other potential option specific to Gull Lake was to conduct a short-term drawdown during the growing season to dewater and kill filamentous algae that persists on the rock rubble along the shore. This algae reduces the suitability of the rock rubble as spawning habitat. To be successful, further investigation would be needed to determine the timing and frequency of the drawdown. The timing of such as draw down and tangible benefits may or may not be acceptable to the public within the recreation season. Based on experiences with the ROPE Study at Gull Lake, the acceptability of such an option seems unlikely.

13.4 Recommendation

The recommendation for Gull Lake, as with the other Headwaters reservoirs in considering large-scale operating changes, is to continue the public outreach effort to build support. In the short-term, there are limited opportunities for specific actions at Gull. The recommendation at this time is to wait for the Headwaters SRP outreach effort to proceed and focus on other SPR actions in the District on other opportunities.

CHAPTER 14.

Eau Galle Reservoir

14.1 Workshop Attendees/Date

The Eau Galle Reservoir workshop was held on September 1, 2020. Attendees included: Elizabeth Nelsen, Jon Hendrickson, Mitch Weier, Brian Johnson, Jason Tidwell, Steve Clark, Megan McGuire, Trevor Cyphers, Vanessa Alberto, Randy Urich, Kevin Berg, Brad LaBadie, and Nick Castellane.

14.2 Agency Input

The WDNR provided comments that focused on impacts to the downstream trout fishery in the Eau Galle River. Their primary concern is that summer water temperatures have been observed that are too warm and at or above the lethal limit for trout. About 20 years ago the WDNR and the Corps worked to modify dam operations to increase the hypolimnetic release to 13 cfs. At the time, it was thought that base flow was about 20 cfs. Therefore, about 2/3 of the flow would be cooler hypolimnetic water, and the remaining 1/3 would be warmer flow over the morning glory. This plan was apparently successful for a number of years but in recent times base flows seem to have increased to as much as 30 cfs, resulting in a higher proportion of the flow being warmer, impacting downstream water temperature. The WDNR suggested that it would be beneficial to investigate the possibility of releasing more water from the low-flow gate to increase the proportion of colder water released.

14.3 Brainstorming and Ideas Carried Forward

During brainstorming, the only operating alteration proposed to be carried forward for further consideration for the reservoir was that of a growing season drawdown for vegetation improvement. This seems worth further consideration but there are a number of challenges. First the reservoir is a popular recreation site for the public and convincing the public that a drawdown is warranted may be challenging. The WDNR may or may not be a proponent of a drawdown, and they did not suggest one in their comments. Also, the watershed is rather flashy and it may be difficult to maintain a drawdown, especially with the limited flow capacity of the low-flow gate; the ability to maintain a drawdown would need to be studied. At this time, it doesn't seem there is enough interest in a drawdown here to prioritize this against other potential SRP work here or in other District reservoirs.

A number of ideas were discussed around the theme of downstream water temperatures. Fundamentally, the comment provided by the WDNR to increase hypolimnetic releases was considered to be something that should be investigated. In support of this, it was also thought that installing a network of temperature gauges in the reservoir to study temperature profiles would be beneficial. Retrofitting the morning glory or low-flow gate to allow a release from various levels in the reservoir was also discussed. While this idea was carried forward for consideration, it doesn't seem likely that it would be feasible. The existing low-flow release point is only about 23 feet below the surface and adding the ability to release water from a shallower depth isn't likely to add much benefit for what would be a substantial cost.

One consideration in operating the low-flow gate to increase hypolimnetic releases is that it would likely require additional gate changes by staff. The installation of an automated gate would help facilitate gate changes and should also be investigated.

Finally, two other ideas were carried forward for consideration. One was to operate in the fall in consideration of brown trout spawning. The specifics of this were not discussed but would likely entail working to provide more stable downstream flows in September and October. This could be studied in concert with a hypolimnetic release review. The other idea was the installation of a permanent low-flow pipe so that it would be easier to maintain flows during periodic inspections. Currently, pumps are used to maintain some minimum flow during inspections, but this is labor-intensive, and the flows maintained can be inadequate depending on water and air temperatures. The installation of a low-flow pipe, possibly within the conduit, would help address these issues.

14.4 Recommendation

There is a good opportunity here for an SRP study to address downstream flow temperatures and the recommendation is to request funding for an SRP study here in the near future. Past work to increase these flows under the current was addressed in an environmental assessment (EA) in 2000. The Section 1135 ecosystem restoration project to improve the channel downstream of the dam was evaluated in a 2003 EA. These documents would be a good reference in a new study of downstream flows. Among the potential SRP studies in the District, this would be considered a moderate priority.

References

Bovee, K. D., B. L. Lamb, J. M. Bartholow, C. B. Stalnaker, J. Taylor and J. Henriksen. 1998. Stream habitat analysis using the instream flow incremental methodology. U.S. Geologicial Survey, Biological Resources Division Information and Technology Report USGS/BRD-1998-0004. viii +131 pp.

Participant List

Participant	Discipline
Steve Clark	Environmental
Megan McGuire	Environmental
Dave Potter	Environmental
Trevor Cyphers	Environmental
Vanessa Alberto	Cultural/Tribal
Elizabeth Nelsen	Water Management
Mike Knoff	Engineering and Construction
Jon Hendrickson	Hydraulic Engineer
Mitch Weier	Water Management
Jason Tidwell	Water Management
Brian Johnson	Water Management
Leigh Allison	Water Management
Randy Urich	Operations (RNR)
Corrine Hodapp	Operations (RNR)
Jeff Steere	Operations (RNR)
Tim Rennecke	Operations (RNR)
Jeff Cook	Operations (RNR)
Brian Turner	Operations (RNR)
Tammy Frauenshuh	Operations (RNR)
Jason Hauser	Operations (RNR)
Rich Schueneman	Operations (RNR)
Randy Melby	Operations (RNR)
Kevin Berg	Operations (RNR)
Brad LaBadie	Operations (RNR)
Shawn Weissenfluh	Operations (RNR)
Terry Zien	Project Management
Nick Castellane	Project Management
Joe Schrotter	Project Management
Zach Kimmel	Project Management
Grant Halvorson	Engineering

Appendices

Appendix A. Reservoir Operation Summaries
Appendix B. Workshop Notes Tables
Appendix C. Correspondence/Agency Input

Appendix A.

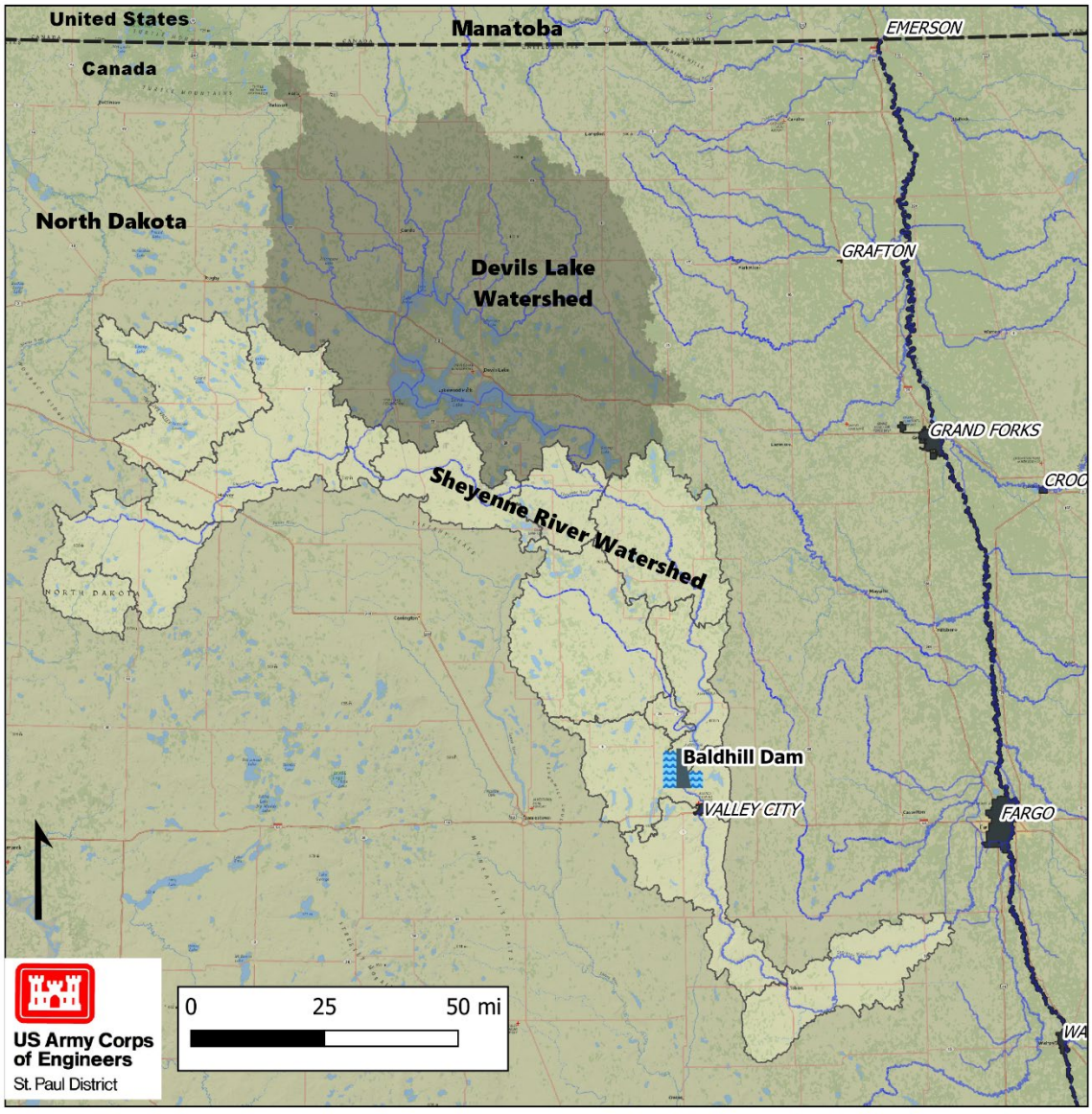
Reservoir Operation Summaries

St. Paul District SRP Workshop
All District Reservoirs - Environmental Flows

Reservoir Summary: Lake Ashtabula and Baldhill Dam

Project General Objectives: There are two general objectives for the operating plan; (1) Flood Control and (2) Water Supply. During the winter months, Lake Ashtabula is drawn down to provide flood storage volume for spring runoff. The conservation pool level is maintained throughout the summer for water supply and recreational benefits. Should a summer flood event occur, storage to the top of flood control is allowed to prevent damages downstream.

Basin Map:



Location: The impoundment created by Baldhill Dam is located on the Sheyenne River, 271 river miles upstream from the confluence of the Sheyenne River and Red River of the North. The dam site is about 16 river miles upstream of Valley City, North Dakota and about 75 highway miles west of Fargo, North Dakota. **Datum:** 1929 NGVD

Initial Project Purpose:		**Drainage Area:**	
Municipal Water Supply	38 %	Primary	1,690 sq mi
Rural Water Supply	31 %	Secondary	1,660 sq mi
Pollution Abatement	23 %	Noncontributing	462 sq mi
Flood Control	8 %	Devils Lake Basin	3,573 sq mi

Dam:

Type	Compacted Impervious Earth Fill
Total Length	1,650 feet
Crest: Top of Earth Dam	Elevation 1278.5 feet
Top of Tee-Wall	Elevation 1283.5 feet
Top Width of Earth Dam	20 feet
Max Height of Earth Dam	61 feet
Freeboard	5.0 feet above PMF
Emergency Spillway	
Type	Uncontrolled Broad Crest Weir
Length	880 feet
Crest	Elevation 1271.0 feet

Control Structure:

Service Spillway	
Type	Gravity Ogee
Length	140 feet total with two 10-foot piers
Gates	Tainter, 3 @ 40-ft wide, 20-ft high
Crest	Elevation 1252.0 feet
Maximum combined discharge = Rough estimate 60,000 cfs	
Low Flow Outlet	
Type	Two, 36-inch reinforced concrete conduits
Intake Invert	Elevation 1238.0 feet
Discharge Invert	Elevation 1234.5 feet
Maximum combined discharge = ~450 cfs	

Fish Siphons

Two siphons capable of drawing 9 cfs for USFWS fish ponds located immediately downstream of dam.

Reservoir:	Elevation	Storage	Area
Probable Maximum Flood	1278.5 ft	157,500 ac-ft	8,500 ac
Top of Flood Control	1271.0 ft	101,300 ac-ft	6,750 ac
Conservation Pool	1266.0 ft	70,600 ac-ft	5,500 ac
Normal Drawdown	1262.5 ft	52,250 ac-ft	4,375 ac
Maximum Drawdown	1255.0 ft	25,100 ac-ft	2,620 ac

Pool at Conservation Level

Length: 27 miles Width: 0.6 mile Shoreline Length: 78 miles

Watershed Characteristics

Baldhill Dam was built within the Sheyenne River Valley, which is a glacial outwash spillway that drained Glacial Lake Souris at the end of the last ice age. The watershed is characterized with a mix of quickly draining primary areas and slower draining or non-contributing network of prairie pothole wetlands or "sloughs".

This geology along with a semi-arid climate and pronounced spring snowmelt creates highly variable flows in the river. **Figure 1** shows a duration hydrograph of the discharges from Baldhill Dam. **Figure 2** shows a duration hydrograph of the elevations of Baldhill Dam.

Over the 70 year history, the average discharge is typically below 100 cfs for most of the year; however, the wet climate in recent years along with artificial pumping from the Devils Lake Outlets operated by the North Dakota State Water Commission has resulted in much higher outflows for much of the year. The Devils Lake Outlets can discharge up to 600 cfs during the non-winter months.

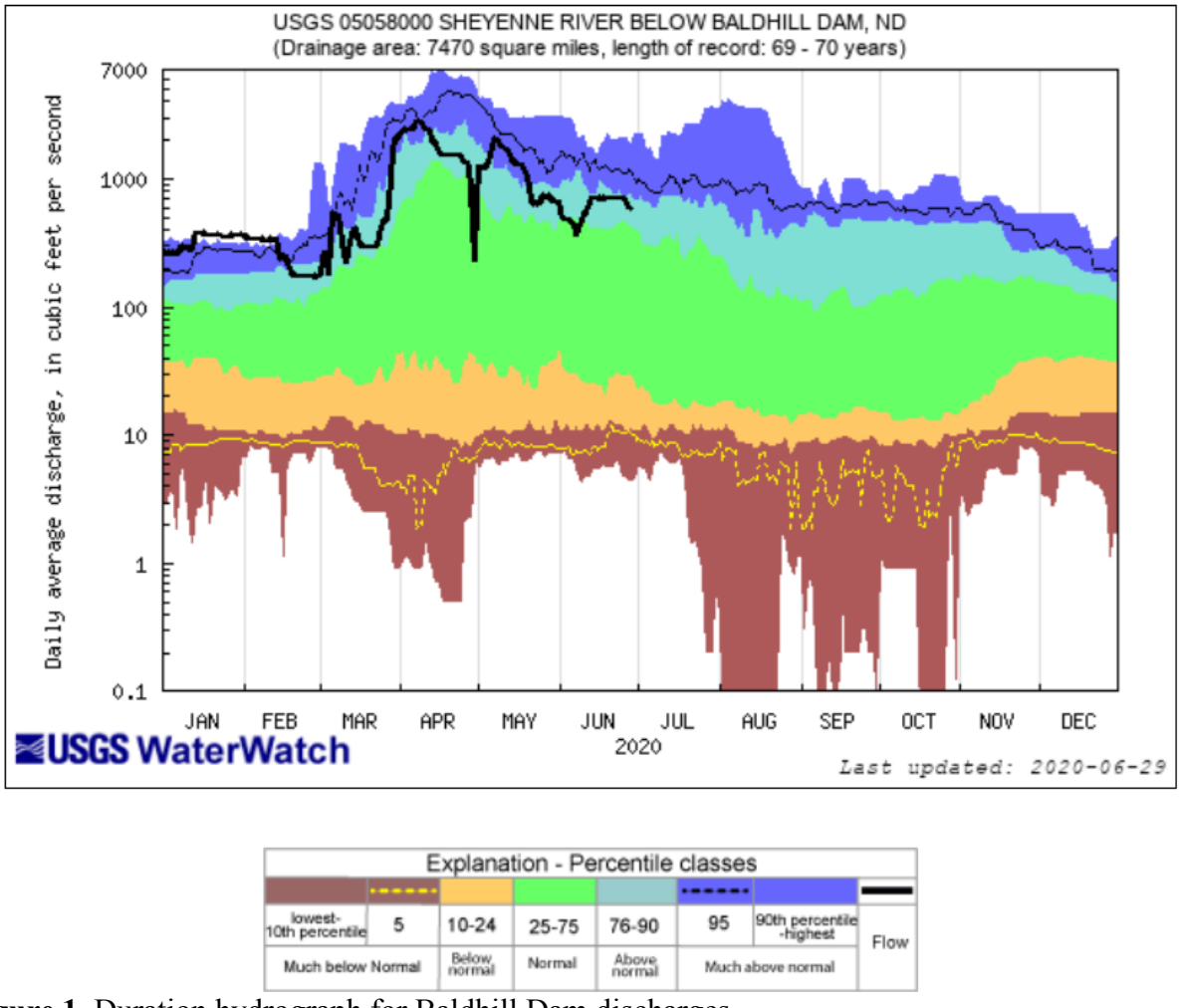


Figure 1. Duration hydrograph for Baldhill Dam discharges.

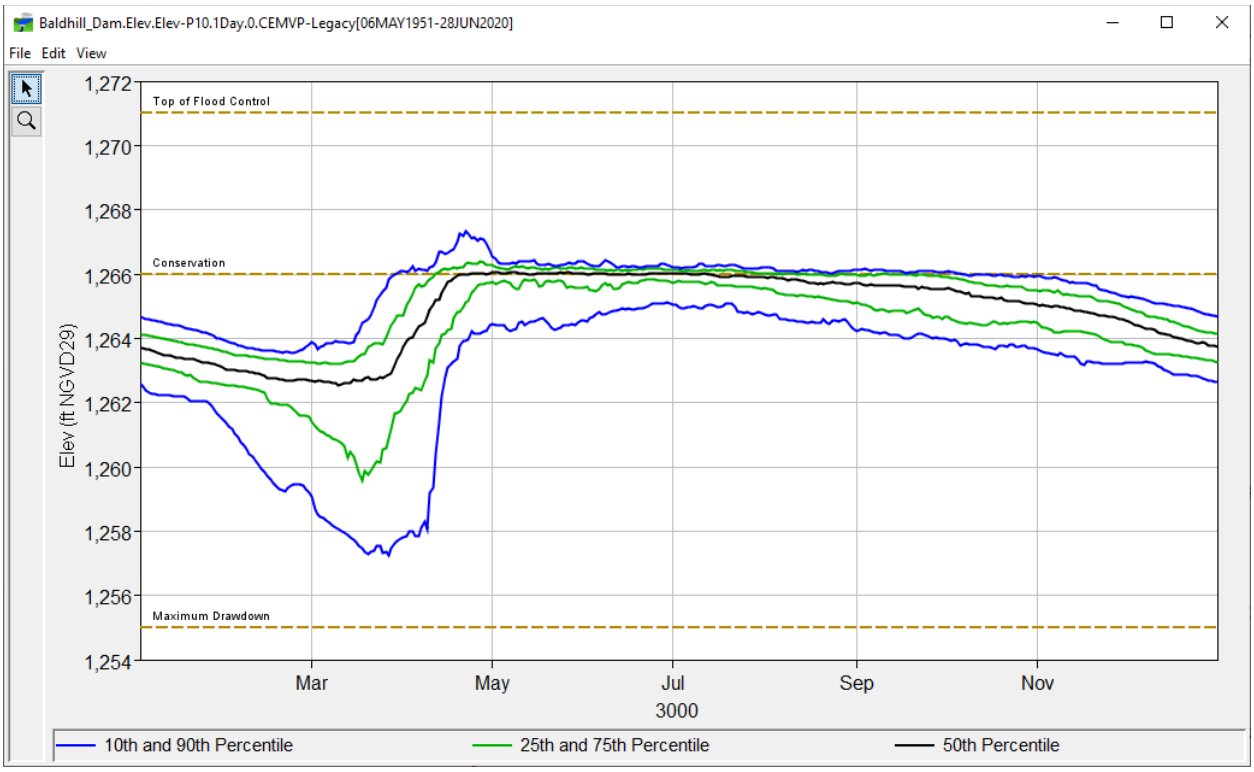
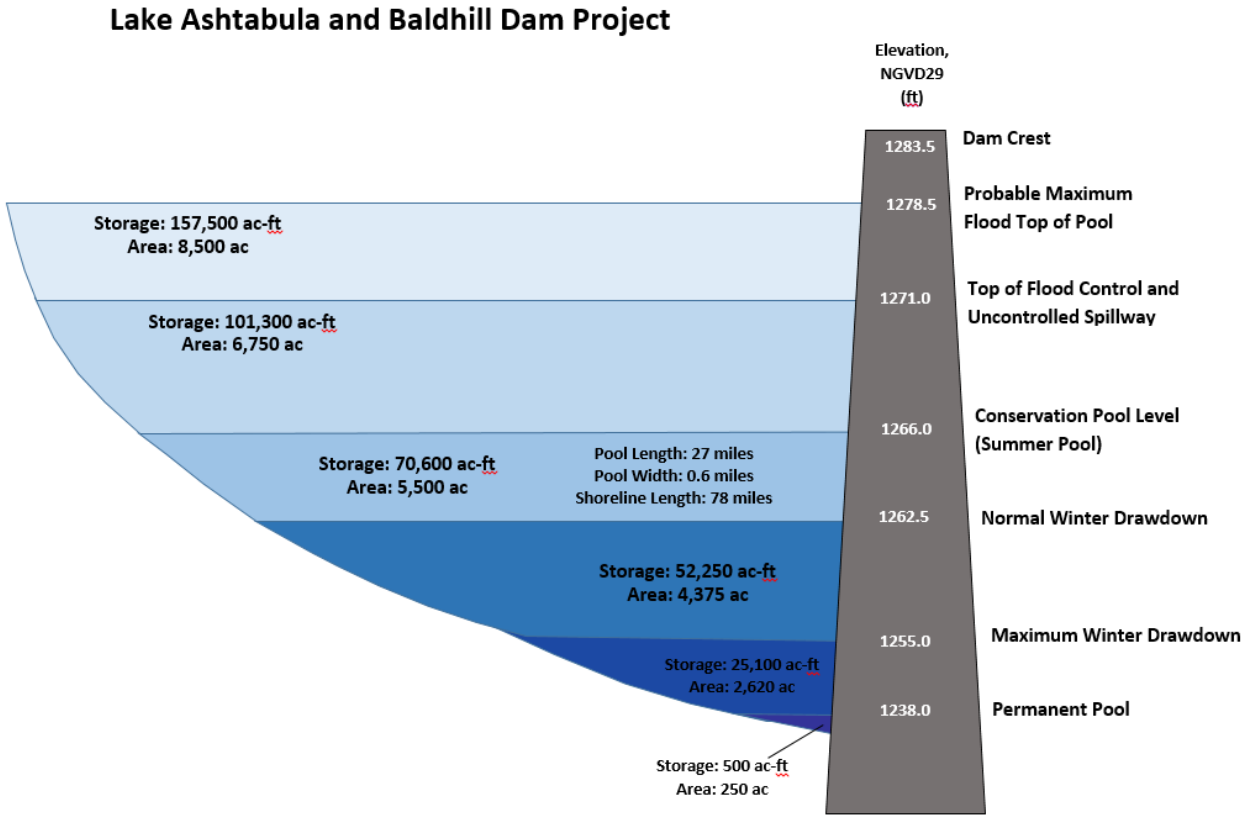


Figure 2. Duration hydrograph for Baldhill Dam elevations.

Pool Allocation



Overall Plan for Water Control
The overall plan calls for maintaining a pool for water supply and providing flood storage in the spring. During the summer months, the pool is maintained at the conservation pool level of 1266.0 ± 0.2 feet. The State of North Dakota (State) has permitted the entire conservation pool for beneficial use (mainly municipal) on an annual basis.

The State and USACE have an agreement to lower the pool below conservation prior to spring for flood control. The amount of lowering is dependent upon the basin average snow-water-equivalent. As spring runoff begins outflows are adjusted upward while maximizing storage use and minimizing flow releases. During summer rainfall events, storage to the top of flood control is allowed to minimize downstream damages.

Constraints:

Minimum discharge
13 cfs including USFWS demand. In practice this determined with consultation of the State of North Dakota because minimum flows are typically used when conservation pool is used (normally try to maintain at least 20 cfs).

Maximum discharge
Channel capacity flow is 2,400 cfs (typically outflows will be limited to 1,500 cfs) at Valley City, ND. Other downstream communities are considered during large events. Specific flow thresholds can be found in Chapter 7 of the Water Control Manual.

Discharge Rate of Change:
Primary objective to prevent sloughing of reservoir banks and stream banks.

Rate of Decrease = ½ half of the outflow, not to exceed 800 cfs, per 4 hrs
Rate of Increase = 800 cfs/4 hrs

Summer/Fall Operation Summary:
Conservation = 1266.0 ± 0.2 feet
Operation basically consists of "inflow equals outflow"; however, in the event of a significant rain, outflows will be reduced to prevent damages downstream and water may be stored to the top of flood control if necessary.

Fall/Winter Drawdown Summary:
Target reaching elevation 1262.5 feet by March 1.
Reach SWE dependent targets by March 31. May start additional drawdown between Jan 1 and Mar 15. Pool may be lowered as far as 1255 ft.

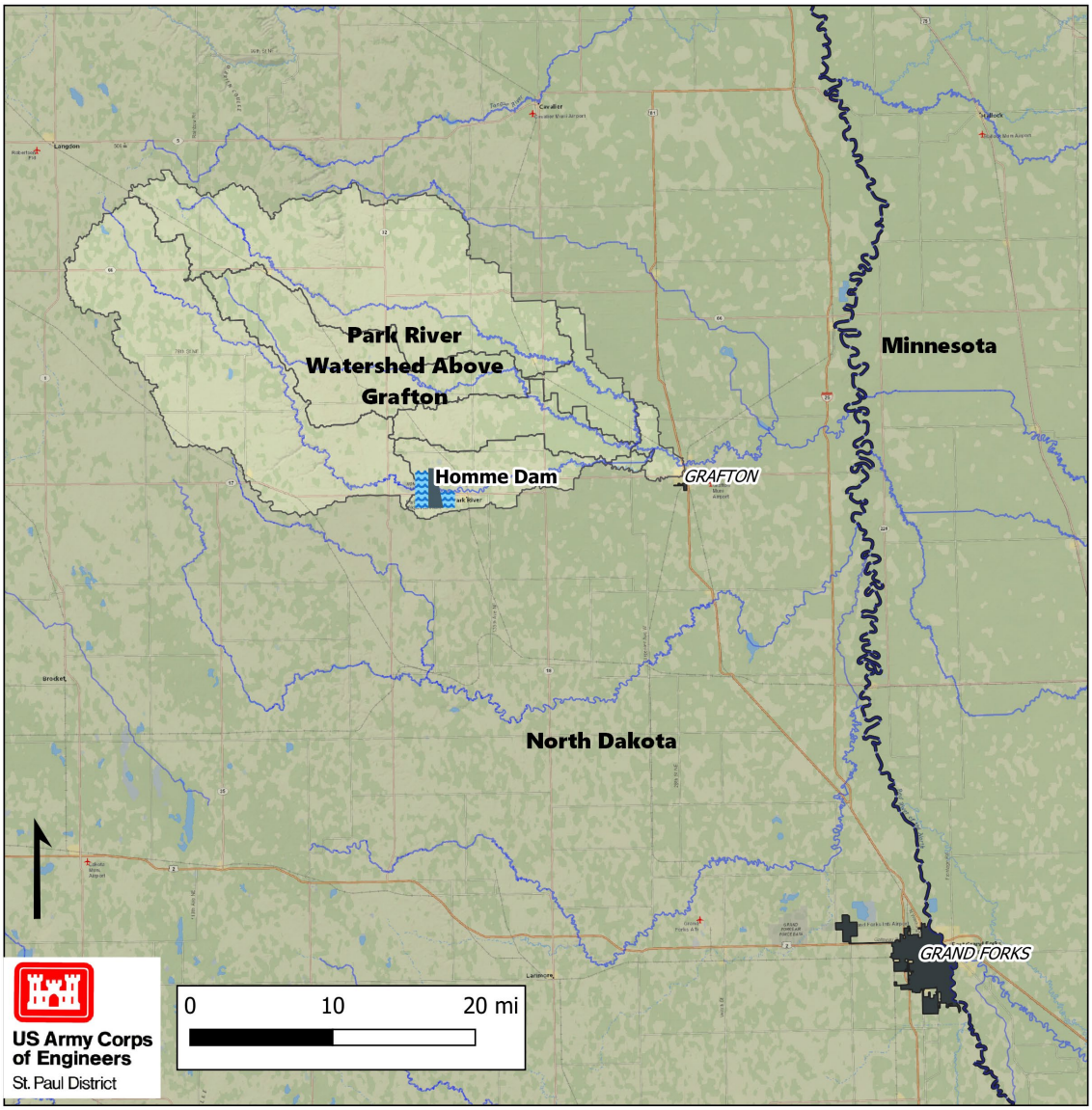
Spring Runoff Operation Summary:
Similar to summer runoff except more flood storage is available. Discharges are calculated by evaluating available flood storage, forecasted inflow volume, and downstream constraints.

St. Paul District SRP Workshop
All District Reservoirs - Environmental Flows

Reservoir Summary: Homme Lake and Homme Dam

Project General Objectives: There are two general objectives for the operating plan; (1) Flood Control and (2) Water Supply. During the winter months, Homme Lake is lowered to provide flood storage volume for spring runoff. The conservation pool level is the top of the spillway and maintained throughout the summer for water supply and recreational benefits. There is no flood storage available at conservation level.

Basin Map:



Location: Homme Dam is located in Walsh County, North Dakota on the South Branch of the Park River about 4 river miles upstream of the city of Park River. The dam is located in Section 19, Township 157N, Range 55W, Latitude 48º24'20"N, Longitude 97º47'10"W.

Total Drainage Area: 226.0 square miles **Datum:** 1929 NGVD

To convert to NAVD88 add 1.15 feet to NGVD29 elevations.

Real Estate Guide Taking Line for Title in Fee or Easement: Contour elevation 1090.0 ft

Embankment

Type:	Compacted earth-fill	Freeboard @ max design:	3.0 feet
Total Length:	865.0 feet	Freeboard at project pool:	19.0 feet
Crest Elevation:	1099.0 feet		
Top Width:	20.0 feet		
Maximum Height:	67.0 feet		

Spillway

Type:	Ogee-Crest	Stilling Basin	
Crest Elevation:	1079.80 feet	Length:	75 feet
Crest Length:	218.0 feet	Width:	218 feet
Design Event:	PMF	End Sill:	Elevation 1024.60 feet
Design Discharge:	53,400 cfs	Baffle Block:	Elevation 1026.85 feet
Max Design Pool:	1096.0 feet	Floor:	Elevation 1022.60 feet

Low Flow Outlet Control

Culvert

Diameter:	5.0 feet
Inlet Invert Elev.	1048.0 feet
Outlet Invert Elev.	1038.0 feet
Discharge Capacity: (pool elev 1080.0)	525 cfs

Inlet Sluice Gates

Sluice Gate Type:	Chapman
Gate Size:	36 in by 60 in
Number of Inlets:	2
Inlet Gates:	2 per inlet
Operable Inlets:	1

Outlet

Width at Outlet	7.0 feet
Width Stilling Basin:	13.0 ft – 24.0 ft
Stilling Basin Invert:	1027.0 feet
Top of End Sill:	1030.0 feet
Outlet Channel:	1032.0 feet

Outlet Sluice Gates

Number of Outlets:	1
Gate Size:	7 ft by 7ft

Area-Capacity Data

	Elevation (feet)	Area (acres)	Storage (acre-feet)
Design Flood (PMF)	1096.0	307	7,025
Flood Control Pool	1079.8	187	2,850
Normal Drawdown	1074.0	141	1,825
Maximum Drawdown	1064.0	86	670
Dead Storage	1048.0	0	0

Watershed Characteristics

Homme Dam was built within the South Branch Park River Valley, near an escarpment created by the lake shore of Glacial Lake Agassiz. West of the city of Park River, the South Branch flows in a valley that is from 75 to 100 feet deep, about one half mile wide, and extends for 25 miles through the escarpment and drift prairie. When these streams leave the escarpment, the valley depths decrease rapidly until the channel banks are at the same level or slightly higher than the adjacent plain.

This geology along with a semi-arid climate and pronounced spring snowmelt creates highly variable flows in the river. **Figure 1** shows a duration hydrograph of the discharges from Homme Dam. **Figure 2** shows a duration hydrograph of the elevations of Homme Dam. Over the 70 year history, the average discharge is typically below 40 cfs for most of the year.

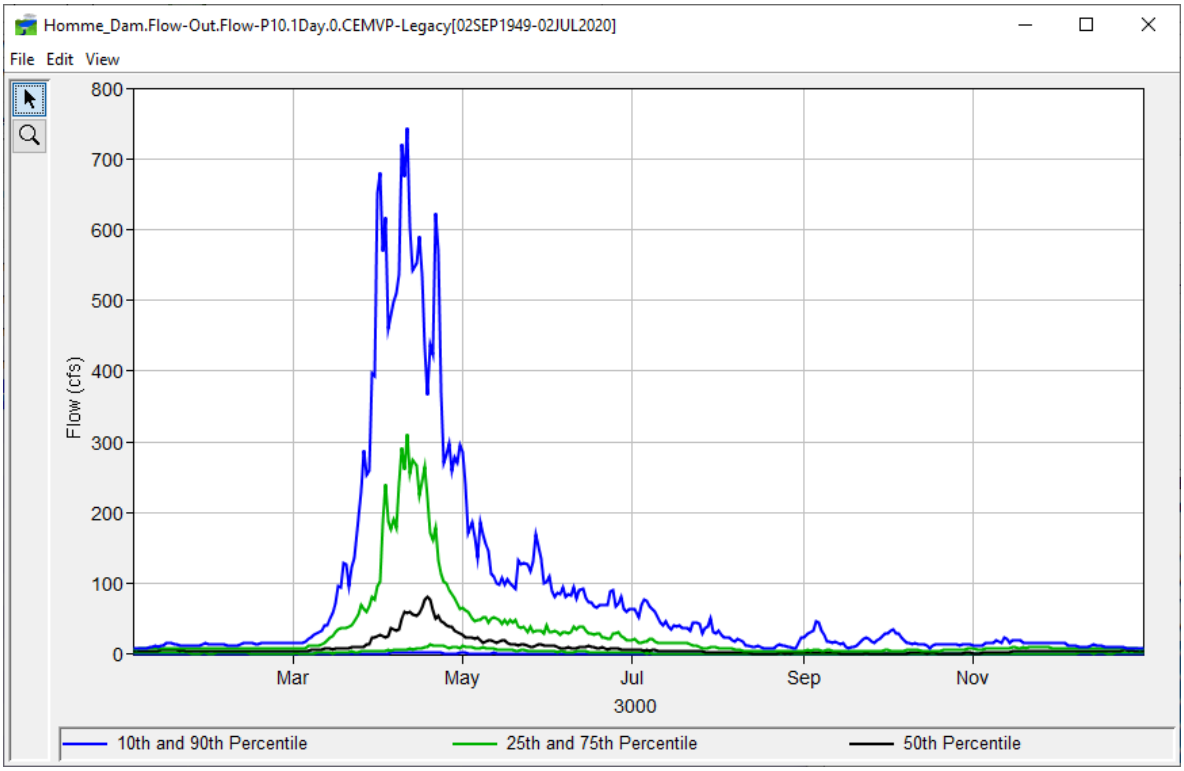


Figure 1. Duration hydrograph for Homme Dam discharges.

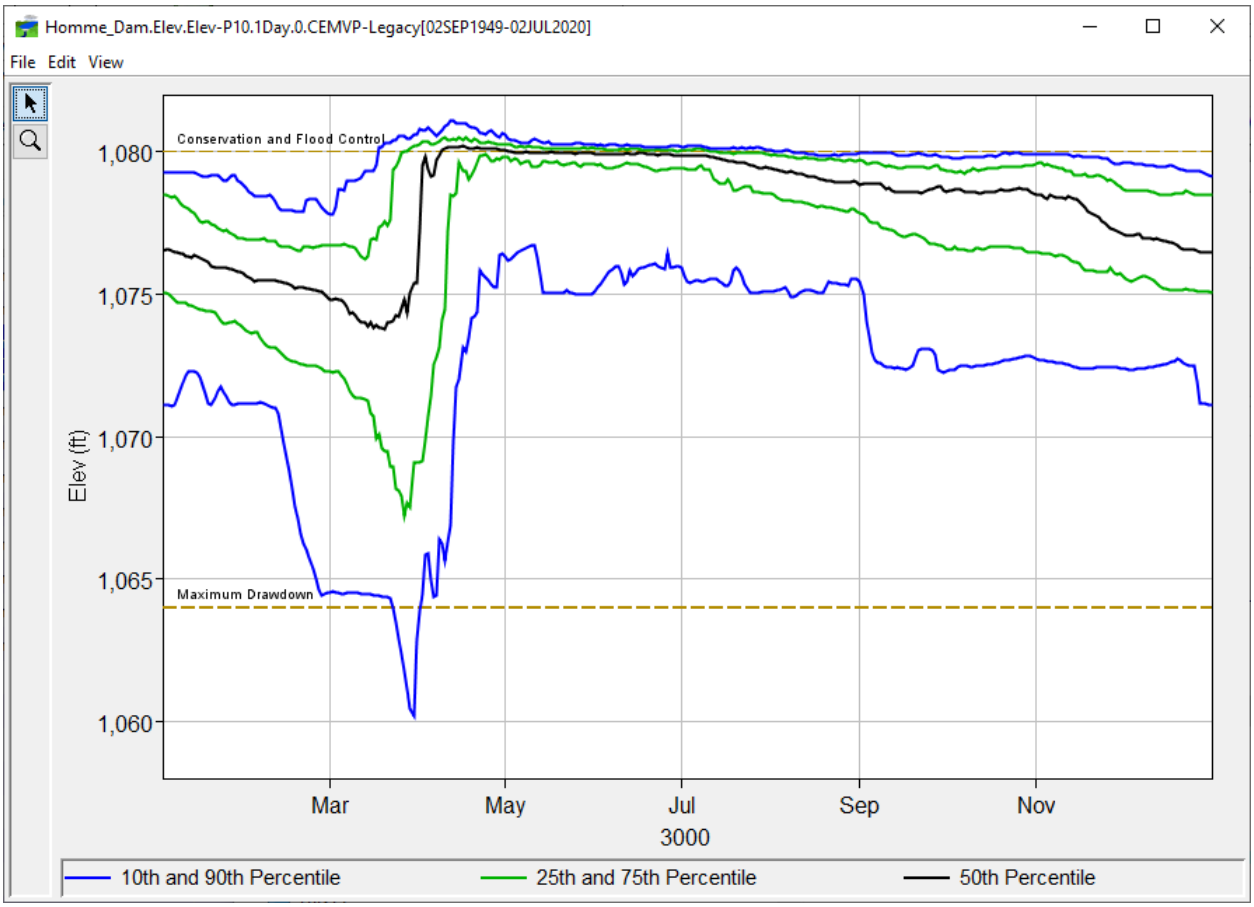
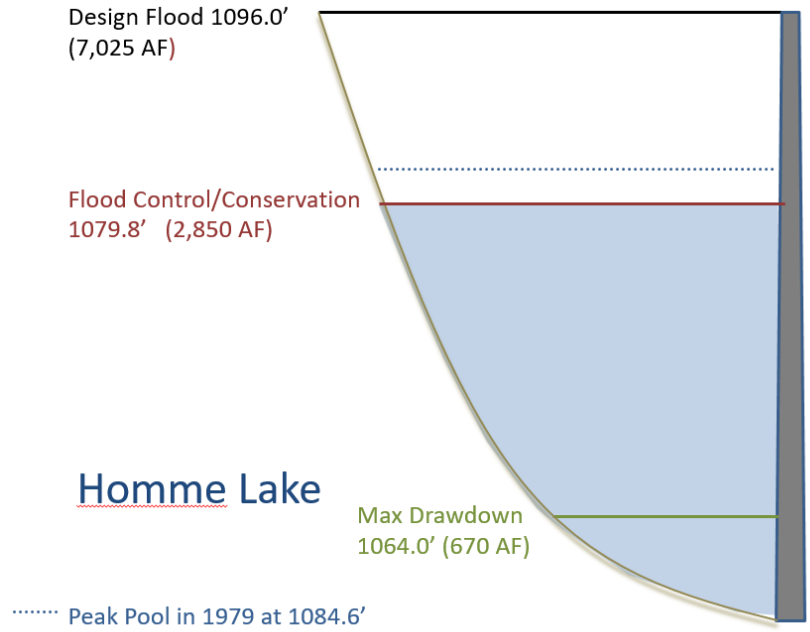


Figure 2. Duration hydrograph for Baldhill Dam elevations.

Pool Allocation



Overall Plan for Water Control
The overall plan calls for maintaining a pool for water supply and providing flood storage in the spring. During the summer months, the pool is maintained near the conservation pool level of 1079.8 by excess inflow spilling over the spillway. The State of North Dakota (State) has permitted the entire conservation pool for beneficial use (mainly municipal) on an annual basis. Park City, water permit holder, has direct access to the reservoir via a pipeline and can draw water as needed once the pipeline is opened during the summer months.

The State and USACE have an agreement to lower the pool below conservation prior to spring for flood control. The amount of lowering is dependent upon the basin average snow-water-equivalent. As spring runoff begins outflows from the low flow outlet are attempted to match inflow before inflow exceeds the low-flow outlet capacity and pool rises above the concrete spillway.

Constraints:

Minimum discharge
There is no minimum discharge.

Maximum discharge
Because of the lack of storage relative to the size of the watershed, there is no downstream constraint. Large flood events flow uncontrolled over the spillway. However, discharges below 750 cfs are desired at Park River and 1,500 cfs at Grafton are desired.

Discharge Rate of Change:
Discharges cannot exceed 50 cfs above the current inflow to prevent the reservoir from falling faster than 0.5 ft/day. This prevents sloughing inside the reservoir.

Summer/Fall Operation Summary:
Conservation = 1079.8
Operation basically consists of "inflow equals outflow". The low flow gate may be opened to lower the pool if the pool exceeds 1080.2 ft. If withdrawals from water users and evaporative losses exceed inflow, the pool will drop below the spillway crest.

Fall/Winter Drawdown Summary:
Normal winter drawdown to 1077 ft begins on November 1st and is completed by November 20th. Pool may be lowered as far as 1064 ft by the end of March if snow pack conditions warrant – additional drawdown would occur when weather conditions are favorable.

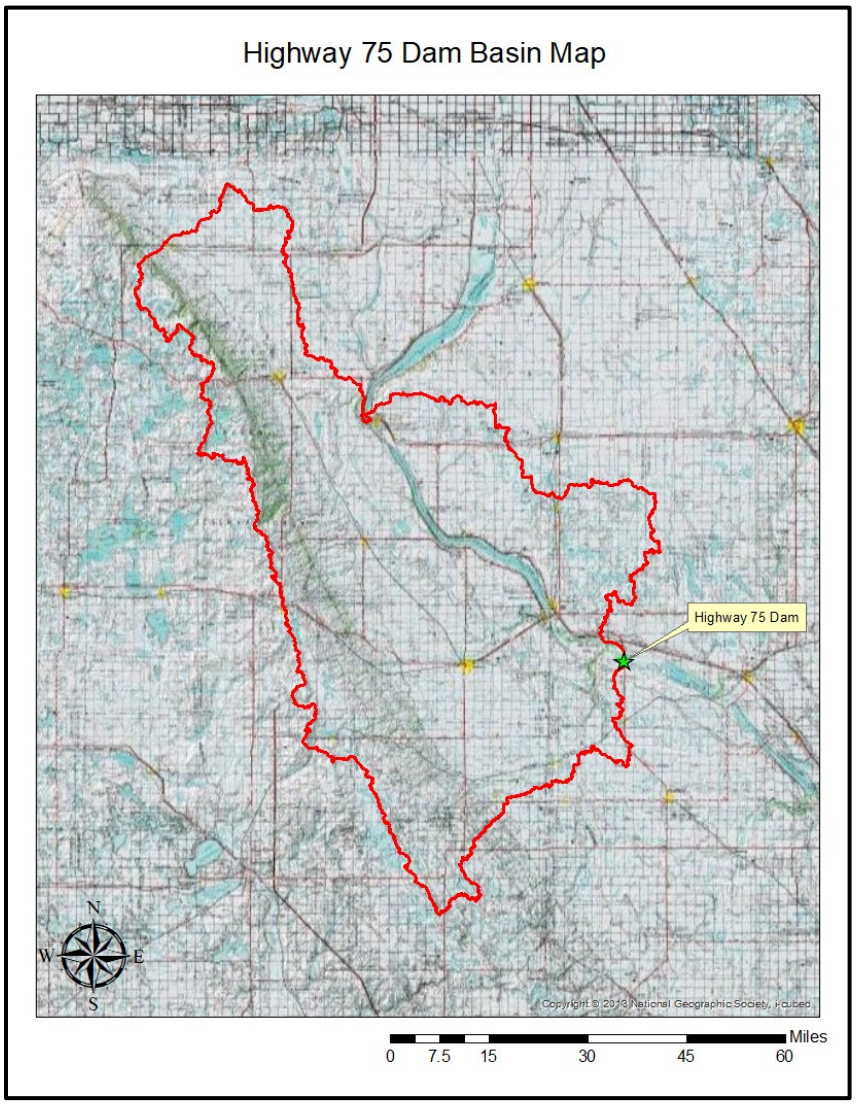
Spring Runoff Operation Summary:
The low flow outlet is used to match inflow until inflow exceeds the capacity of 550 cfs and water begins flowing over the spillway. At this time the low flow outlet is closed.

St. Paul District SRP Workshop
All District Reservoirs - Environmental Flows

Reservoir Summary: Highway 75

Project General Objectives: Highway 75 Dam and Reservoir was a mitigation feature to the improved outlet at Big Stone Lake, all of which were part of the Big Stone Lake-Whetstone River Flood Control Project. The improved outlet on Big Stone Lake was to improve lake conditions during flood events and the Highway 75 Dam and Reservoir was to provide the needed storage to prevent additional flooding downstream. Highway 75 Reservoir also enhances the fish and wildlife resources by maintaining a desirable range of pool levels.

Basin Map



Location: The impoundment created by the Highway 75 Dam is located on the Minnesota River below Ortonville, Minnesota in Big Stone and Lac qui Parle Counties. The dam site is about 9 miles downstream from Big Stone Lake and is located near Odessa, Minnesota just upstream of US Highway 75. **Datum:** 1929 NGVD

Initial Project Purpose:		**Drainage Area:**	
Flood Control	90 %	Primary	1,890 sq mi
Fish & Wildlife	10 %		
Dam:			
Type		Compacted Impervious Earth Fill	
Total Length		16,250 feet	
Crest: Top of Earth Dam		Elevation 964.5 feet	
Top Width of Earth Dam		20 feet	
Max Height of Earth Dam		25 feet	
Freeboard		3.1 feet above PMF	
Emergency Spillway			
Type		Uncontrolled grass-lined	
Length		715 feet	
Crest		Elevation 956.5 feet	
Notch Invert:		Elevation 955.5 feet	
Control Structure:			
Service Spillway			
Type		Reinforced Concrete	
Length		65 feet	
Gates		1 Bascule Leaf Gate	
Crest		Elevation 947.3 feet	
Low Flow Outlet			
Type		42-inch reinforced concrete conduit	
Intake Invert		Elevation 940.0 feet	
Discharge Invert		Elevation 939.0 feet	
Reservoir:		Elevation	Storage	Area
Top of Dam:		964.5		
Spillway Design Pool:		961.4	87,000	7,900
(Standard Project Flood)				
Reservoir Design Pool:		956.5	37,000	6,100
(Emergency Spillway Crest)				
Raised Bascule Leaf Gate:		952.3	12,000	2,800
Lowered Bascule Leaf Gate:		947.3	3,000	950

Constraints

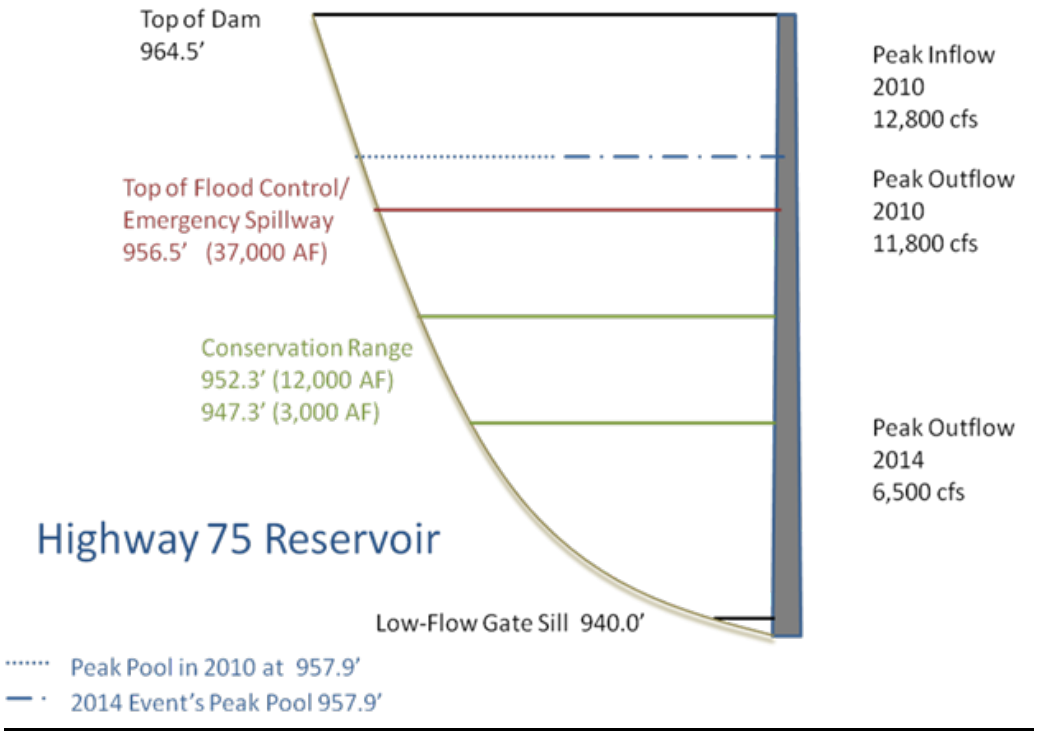
Pool: The pool is constrained between the elevations of 940.0 feet and 964.5 feet.

- The invert elevation of the low flow conduits is 940.0 feet making this the dead storage limit.
- Elevation 961.4 feet is the top of pool for the Standard Project Flood.

Flow: The reservoir has one low-flow culvert, a single bascule gate and an emergency spillway

- Low-flow culvert
  - Diameter = 42-inch (3.5 feet).
  - Inlet = 940.0 feet.
  - Maximum discharge = ~200 cfs.
- Bascule gate
  - Opening = 0 to 5.0 feet.
  - At maximum opening the top of the gate is at elevation 952.3 feet.
  - Maximum discharge = ~9,760 cfs with pool at 958.8 feet.
- Emergency spillway
  - Crest = 956.5 feet.
  - Length = 715 feet.

Allocation Graphic



Watershed Characteristics

Big Stone Lake is formed by a natural lake with a concrete dam just downstream of the outlet. Big Stone Lake has a contributing drainage area of approximately 1,160 square miles of which the Little Minnesota River and the Whetstone River are the major contributors. The Little Minnesota River forms the headwaters of the Minnesota River within the hills of eastern South Dakota and drains an area of about 440 square miles. The Whetstone River, with a drainage area of about 400 square miles, which is almost entirely within South Dakota, flows into Big Stone Lake just upstream of Big Stone Lake Dam. The original confluence of the Whetstone River was downstream from the dam until it was diverted in the 1930's. Big Stone Dam is operated by the Whetstone River Watershed District and is not a USACE controlled/owned project.

Highway 75 Dam is approximately nine miles downstream from Big Stone Lake Dam. The total contributing drainage area of the Minnesota River at the dam is about 1,890 square miles. The Yellow Bank River, with a total drainage of approximately 470 square miles, enters the Highway 75 reservoir just upstream of the dam. Add Average slope of the contributing watershed is 3.25 percent. The general shape and orientation of the contributing watershed is pear-shaped oriented from northwest to southeast. Percentage of watershed area cultivated is approximately 66%, with a percentage of area forested as roughly 2%. Stream slope is approximately 2.81-feet per mile (USGS, Streamstats, 2018).

The following tables present monthly inflow and outflow durations for the Highway 75 Dam (Tables 3a and 3b). The length of record in the duration analysis was 30 years. The average monthly inflows and outflows were computed from the digitally stored data files for the period of record starting in 1984 and going through 2017.

Table 3. Monthly inflow and outflow durations, Highway 75 Dam.

Table 3a: Highway 75 Inflow Durations (1986 – 2017)												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Percent Exceedance	Flow (cfs)											
0.200	2145.5	2720.4	10641	11368	4886.0	6955.7	5469.4	4175.2	1918.6	3037.2	3004.7	1273.7
0.500	1628.8	2716.4	8024	9390	4156.7	5493.3	4812.2	3678.1	1259.3	2211.4	2133.4	782.6
1.000	835.8	2145.5	7444	8684	3686.0	4750.5	4467.5	2865.1	847.0	1499.3	1661.2	693.4
2.000	835.8	2120.0	5613	7223	3376.7	3889.8	3766.5	2251.1	521.8	1283.3	1241.5	528.4
5.000	295.0	473.3	4050	5491	2503.0	2052.6	2468.5	1197.8	363.6	858.8	674.5	403.4
10.000	170.3	278.6	2359	3616	1757.1	1609.7	1454.9	694.8	279.6	449.4	333.4	286.3
15.000	148.0	206.7	1456	2764	1524.3	1232.5	797.3	450.3	232.4	323.0	203.5	157.0
20.000	131.5	174.8	924	2255	1317.7	975.6	590.0	322.0	203.6	273.0	163.7	128.9
30.000	90.6	103.0	455	1580	927.6	595.3	353.1	186.2	148.4	190.0	113.0	98.6
40.000	62.9	65.0	324	959	665.0	420.7	236.9	117.2	90.1	118.6	82.0	72.5

50.000	44.7	47.8	229	595	493.9	319.7	164.4	82.1	64.1	72.2	57.3	50.5
60.000	32.5	34.6	122	332	334.8	225.3	117.5	49.0	35.3	40.8	44.6	39.0
70.000	21.9	26.0	82	168	156.0	111.3	89.0	28.3	21.2	25.0	34.3	26.0
80.000	12.1	18.8	48	91	78.5	45.1	50.8	16.1	13.0	14.4	19.0	14.6
85.000	10.0	12.0	34	64	52.1	24.6	33.0	12.0	9.6	10.0	13.0	10.0
90.000	4.5	6.0	25	40	30.3	11.0	25.5	7.0	6.2	4.3	8.0	4.0
95.000	2.0	2.0	12	12	13.0	5.0	8.8	3.4	2.0	2.0	2.0	2.0
98.000	2.0	2.0	2	3	4.0	3.0	2.2	2.0	2.0	2.0	2.0	2.0
99.000	2.0	2.0	2	3	4.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
99.500	0.2	2.0	2	1	4.0	2.0	2.0	2.0	1.4	0.0	2.0	0.0
99.800	0.0	2.0	2	0	3.0	1.5	0.4	0.0	1.4	0.0	2.0	0.0

Table 3b: Highway 75 Outflow Durations (1986-2017)

	JAN	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
Percent Exceedance	**Flow (cfs)**											
0.200	434.79	2443.7	8424.2	8961.8	4562.7	5944.3	5041.2	4504.4	2021.3	2499.0	2628.9	982.77
0.500	377.62	2014.9	8156.9	8305.2	4374.9	5378.0	4827.5	3913.8	1118.2	2018.2	2231.7	730.35
1.000	320.00	2014.9	7460.4	7714.1	3831.0	4655.5	4467.0	2838.7	847.0	1517.7	1767.1	655.82
2.000	245.00	925.9	5809.7	7245.0	3431.2	3444.7	3620.0	2447.4	546.5	1282.3	1302.9	530.08
5.000	201.49	365.4	4312.5	5573.4	2465.7	2083.6	2521.0	964.2	350.0	944.4	707.6	398.00
10.000	148.00	243.4	2611.8	3883.8	1807.4	1650.2	1544.0	682.2	260.3	456.7	310.7	251.20
15.000	137.00	192.1	1642.8	2890.1	1573.2	1251.9	938.5	451.3	220.0	313.1	202.9	151.00
20.000	111.60	141.8	969.6	2426.8	1337.4	1006.6	603.0	337.8	181.0	273.0	167.6	121.00
30.000	81.00	98.4	438.8	1600.7	944.1	591.6	370.0	180.3	144.9	165.0	119.0	93.00
40.000	63.20	60.0	287.0	1020.0	670.8	438.0	250.0	130.0	84.2	94.8	85.0	69.00
50.000	40.00	54.0	171.5	638.0	478.0	317.0	186.0	83.5	40.0	47.0	52.0	42.00
60.000	28.00	32.4	89.0	329.6	340.2	220.8	128.0	41.0	19.0	20.0	37.0	30.00
70.000	12.00	20.0	54.0	150.9	176.5	106.1	99.0	30.0	10.0	10.0	11.0	12.00
80.000	10.00	10.0	25.0	88.8	71.6	41.2	79.0	14.0	7.0	6.6	6.0	10.00
85.000	5.00	6.0	10.0	54.0	40.0	23.0	32.5	8.0	2.0	4.0	4.0	4.00
90.000	2.00	2.0	3.0	21.0	5.0	5.0	19.0	2.0	2.0	2.0	2.0	2.00
95.000	2.00	2.0	2.0	3.0	4.0	5.0	3.0	2.0	2.0	2.0	2.0	2.00
98.000	2.00	2.0	2.0	3.0	4.0	2.0	2.0	2.0	2.0	2.0	2.0	2.00
99.000	2.00	2.0	2.0	3.0	3.0	2.0	2.0	2.0	2.0	2.0	2.0	2.00
99.500	2.00	2.0	2.0	3.0	3.0	2.0	2.0	2.0	2.0	2.0	2.0	2.00
99.800	2.00	2.0	2.0	3.0	3.0	2.0	2.0	0.0	0.0	2.0	2.0	1.95

Overall Plan for Water Control

Highway 75 Dam and Reservoir was a mitigation feature to the improved outlet at Big Stone Lake, all of which were part of the Big Stone Lake-Whetstone River Flood Control Project. The improved outlet on Big Stone Lake was to improve lake conditions during flood events and the Highway 75 Dam and Reservoir was to provide the needed storage to prevent additional flooding downstream. Highway 75 Reservoir also enhances the fish and wildlife resources by maintaining a desirable range of pool levels. An annual operating plan is prepared by the US Fish and Wildlife Service and is emailed to the Corps of Engineers, Water Management Section. The plan begins "following spring runoff" and will go into the winter months with a recommended pool elevation. While the plan recommends a winter pool elevation, the Corps of Engineers may perform a winter drawdown in preparation for spring runoff. Drawdown typically consists of lowering the gate to elevation 947.3 feet prior to spring runoff. The normally flat pool extends upstream about 7.5 miles but is not continuous over the entire distance since areas of high ground above elevation 952.3 feet are located within this reach. The shoreline of the reservoir, including that of the islands created by the high ground, is estimated to be 23 miles in length.

Summer/Fall Operation:

Operation basically consists of "inflow equals outflow"; however, in the event of a significant rain, outflows will be reduced to prevent damages downstream and water may be stored to the top of flood control if necessary.

Minimum flow is 2 cfs.

Spring Operation:

Target prior to spring runoff is 947.3 feet.

Operations during a flood event are a balance between storage and downstream flows.

Rate of Change: There are no rules regarding rate of release change, only guidelines. No rate of release change shall cause a drop in the pool level of 0.5 feet, or greater, within a 24-hour period. No gate change shall be made that will result in a rate of release change in excess of 1,000 cfs.

St. Paul District SRP Workshop

All District Reservoirs - Environmental Flows

Reservoir Summary: Lac Qui Parle, Marsh lake, Chippewa Diversion

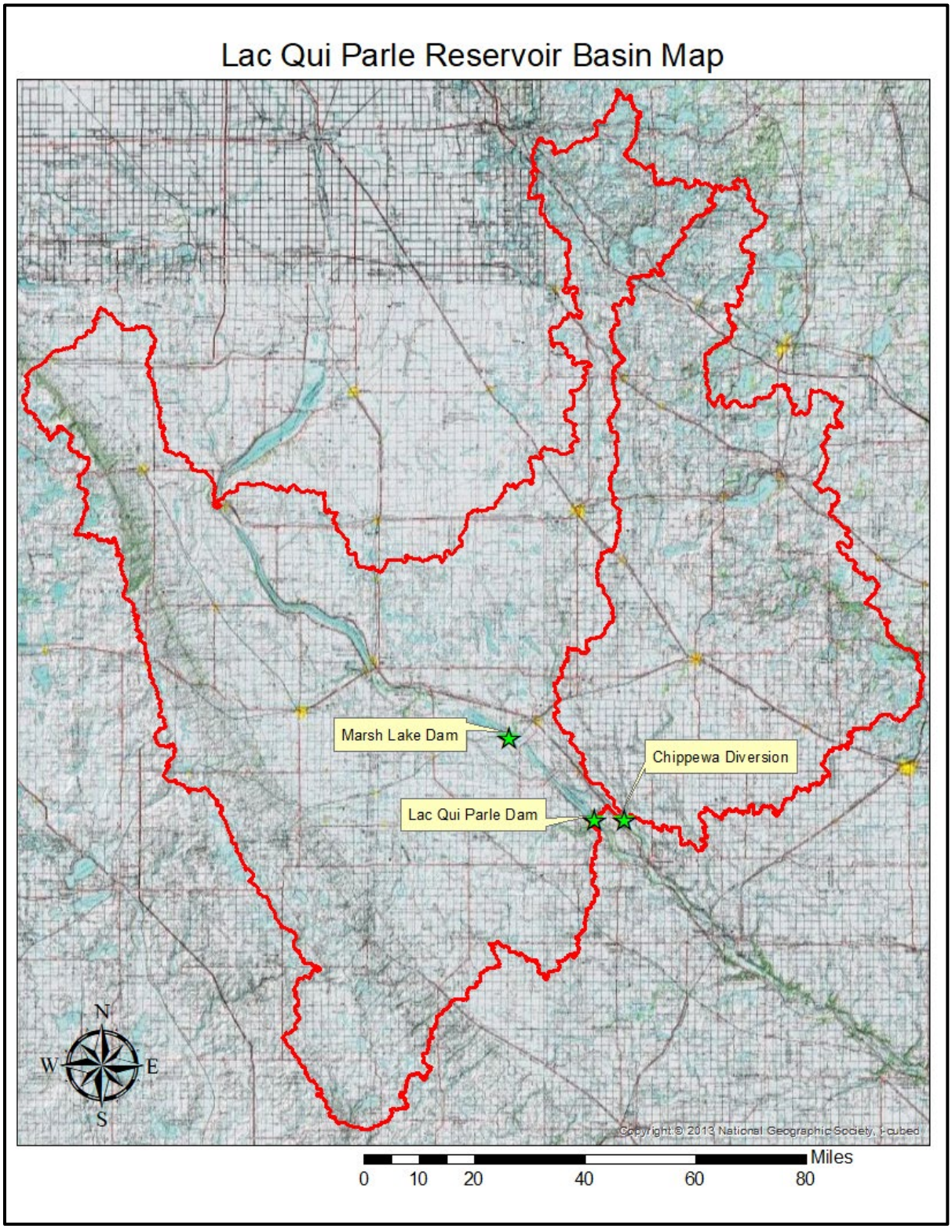
Project General Objectives: The Lac qui Parle Project consists of: Marsh Lake Dam, Lac qui Parle Dam, the Chippewa River Diversion structures, and the Minnesota River Channel down to Granite Falls, Minnesota.

The Lac qui Parle Project was authorized by the Flood Control Act of 1936 (22 June 1936) (Public Law 74-738). However, work on the project was started in October 1934 by the State of Minnesota as a Public Works Administration project. The 1936 Act authorized flood control as a federal project purpose. The project was constructed as a joint state and federal project. It is now a federal project.

The purpose of the Marsh Lake Ecosystem Restoration Project is to restore the aquatic and riparian ecosystems within the Marsh Lake project area. Impoundment of Lac qui Parle and Marsh Lake, along with diversion of the Pomme de Terre River into Lac qui Parle, and other river regulation activities have significantly altered the ecosystem state. The objectives of the project are: 1) reduce sediment loading to Marsh Lake, 2) restore natural hydrologic fluctuations to Marsh Lake, 3) restore geomorphic and floodplain processes to the Pomme de Terre River, 4) reduce sediment resuspension in Marsh Lake, 5) increase emergent and submergent aquatic plants in Marsh Lake, 6) increase waterfowl and native fish habitat, 7) restore aquatic habitat connectivity between Marsh Lake, the Pomme de Terre River, and Lac Qui Parle, and 8) reduce aquatic invasive fish in Marsh Lake.

The Chippewa River Diversion Dam and the Watson Sag Weir diverts high flows on the Chippewa River into Lac qui Parle Reservoir. The diverted flows help to control flood levels downstream at Montevideo, MN as well as at Granite Falls, MN. Generally, flows are split 50/50, half to Lac Qui Parle Reservoir, the other half downstream up to about an inflow of 2000 cfs, after which flows are not kept to the 50/50 split. After inflow exceeds 2000 cfs, the Diversion Structure will divide flow based on hydraulic conditions at the Diversion Structure.

Basin Map


Lac Qui Parle Reservoir Basin Map
Marsh Lake Dam
Chippewa Diversion
Lac Qui Parle Dam
N
W
E
S
Copyright © 2013 National Geographic Society, i-cubed
Miles
0
10
20
40
60
80

Location: Lac qui Parle, Chippewa, Swift and Big Stone counties, Minnesota, 7 miles northwest of Montevideo, Minnesota, 288.1 miles above the mouth of the Minnesota River, Latitude 45° 01' 17", Longitude 95° 52' 05" (Lac qui Parle Dam)
Datum: 1929 NGVD**.** To convert to NAVD88 add 0.67 feet to Marsh Lake, 0.71 feet to Chippewa Diversion and 0.56 to Lac Qui Parle.

Initial Project Purpose:

Flood Control	90 %	Wildlife Management	10 %

Drainage Area:

Above Marsh Lake Dam (does not include Pomme De Terre River)	2,014 sq mi
Above Lac Qui Parle (not including Chippewa River Drainage)	4,105 sq mi
Above Chippewa River Diversion Dam	2,070 sq mi

	Lac Qui Parle Dam:	**Marsh Lake Dam:**
Dam Type:	Rolled-earth Filled	Rolled-Earth Filled
Dam Length:	4,100 feet	12,500 feet
Dam Height:	23-32 feet	19.5 feet at Control Structure
Dam Top Width:	23 feet (roadway)	10 feet at Control Structure 26 feet on new alignment for SDF
Dam Freeboard:	4.9 feet (above full pool)	5 feet on new alignment for SDF

Lac Qui Parle Reservoir:	**Elevation (ft)**	**Capacity (ac-ft)**	**Area (ac)**
Gate Sills	922.70	---	---
Summer Conservation Pool (Mar 15 – Sep 1)	933.0	41,000	7,750
*Spring Conservation Pool (end of runoff – May 31)	933.5	44,750	8,050
Winter Conservation Pool (Oct 1 – Mar 1)	934.0	48,500	8,350
Top of Flood Control Pool/Emergency Spillway	941.1	158,700	21,450
Flowage Easement Level	945.0	253,500	27,450
Top of Dam	946.0	281,500	28,850
Marsh Lake Reservoir:			
Drawdown Control Structure:	934.0	1,300	1,300
Notch in Service Spillway Crest:	935.5	4,600	2,900
Conservation Pool / Service Spillway Crest	937.6	12,050	5,150
Emergency Spillway Crest	940.0	27,250	8,100

Constraints

Lac Qui Parle Pool: The pool at Lac Qui Parle is constrained between the elevations of 922.7 feet and 945.0 feet.

- The invert elevation of the gate sills is 922.7 feet making this the dead storage limit.
- Elevation 945.0 feet is the top of pool for the Probable Maximum Flood (PMF).
- Lac Qui Parle Dam Bulkheads: Bulkheads are not equipped with mechanisms to lift or lower to open or close a bay. It is very difficult to move them when water pressure is against them on the upstream side.
- Gates can get jammed by trees or debris. Sometime gates can't be fully closed due to lodged debris in the gates.
- Aggradation above Lac Qui Parle Dam: An area of deposition is forming upstream of the dam and can impede outflow and lowered dead storage above the dam.
- Lac Qui Parle State Park: There is a campground adjacent to the dam that inundate at a pool elevation of about 939.0 feet.
- Lac Qui Parle Emergency Spillway (2,500 ft in length): The original spillway low point has been raised by subsequent road overlays, thus raising the pool level where emergency spillway flows initiate.
- Outflow velocities must be controlled in order not to blow out the downstream channel. A hydraulic spreadsheet was created to help calculate velocities from various dam gate configurations in order to limit downstream scour.

Marsh Lake Drawdown Structure:

- The sill elevation of the drawdown structure is set at elevation 934.0. Other structures on Marsh do not control outflow in a managed operation.

Chippewa Diversion:

- The pool and channel above the diversion dam is subject to siltation which can sometimes block the low-flow outlet.
- The tainter gate at the diversion structure does not have a de-icing apparatus or heater so can sometime freeze into position and be rendered immovable until it thaws.
- Portions of the bridge were constructed low and as a result the tainter gate can no longer achieve its maximum opening. The maximum gate opening is now 5.5 feet.

Lac Qui Parle Flow:

- The Lac qui Parle Dam control structure consists of a concrete curtain wall section and a fixed concrete spillway section. The curtain wall section is divided into four bays, numbered 1 through 4, beginning from the left bank. The spillway section is divided into eight bays, numbered 5 through 12. All bays have a span of 17 feet and all piers are 3 feet wide. The piers support a bridge over the control structure with a deck elevation of 946.2 feet.
- Bays 1, 3, and 4 each have two 6.0- by 8.0-foot vertical lift gates with sill elevations at 922.7 feet. Bay No. 2 has three 4.0- by 4.0-foot vertical lift gates with sill elevations at 915.2 feet. These gates (Bay No. 2) are equipped with trash racks and are used for low flow regulation. Gates can pass around 3,000 cfs.
- In the spillway section, the crest elevation is 934.2 feet. Bays 5 through 7 are uncontrolled spillways with no gates. In bays 8 through 12, each bay has three sections of movable steel bulkheads. The bulkheads have a top elevation of 940.7 feet.
- Emergency spillway
    - Crest = 941.2 feet.
    - Length = 2500 feet.

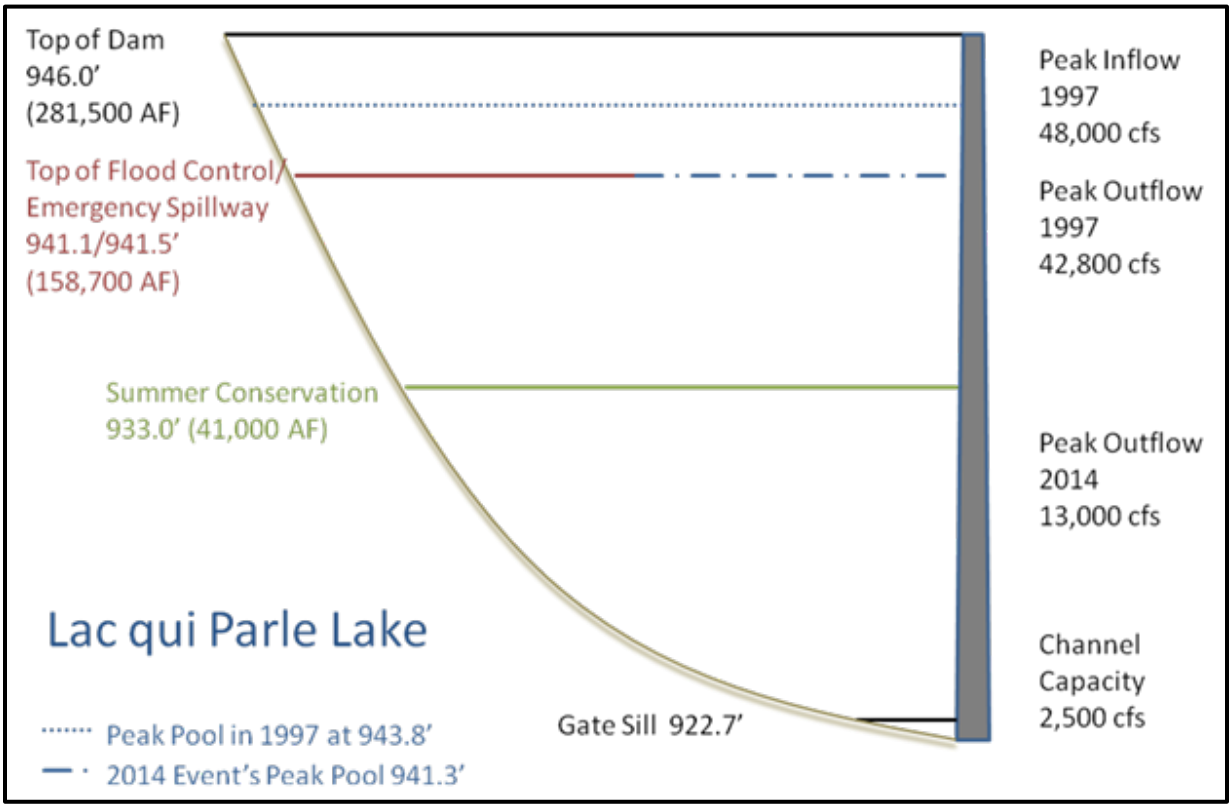
Marsh Lake Pool Flow: Marsh Lake has a Main Service Spillway (Fish Passage), and Auxiliary Spillway, and a Water Management Drawdown Structure.

- The main service spillway has been modified into a fish passage. The concrete fixed spillway crest elevation is 937.6 feet with a 30-foot wide notch set at an elevation of 935.5 feet.
- The Marsh Lake Dam auxiliary spillway (sometimes referred to as the emergency spillway) has a crest elevation of 940.0 feet. The spillway is 90 feet wide.
- The drawdown structure has six bays, each bay has two sluice gates. Each sluice gate is 5 feet wide by 6 feet tall. Sill is 934.0 feet. Top of sluice gates is 940.0 feet.

Chippewa Diversion Flow:

- Main Control Structure: The main control structure is a 5-span combination highway bridge and dam. Bays 1, 2, 4, and 5 have a fixed crest spillway elevation of 942.3 feet and are each 27 feet wide. Bay 3 provides the discharge control by means of a 27-foot wide Tainter gate. The top of the gate in the closed position is at elevation 942.3 feet which matches the crest elevation of the other bays. The gate's sill elevation is 932.9 feet.
- Low-flow Structure: About 300 feet west of the right abutment of the control structure is a low-water control culvert (4ft by 4ft). The entrance invert is at elevation 933.3 feet. Can pass 200-240 cfs.

Allocation Graphic



Overall Plan for Water Control

Following the spring runoff event, the Lac qui Parle pool level is held at elevation 933.5 ±.2 feet until 31 May. After 31 May the summer conservation pool elevation is 933.0 ±.2 feet. Starting 15 May, the outflow from Lac qui Parle Dam is regulated to maintain its spring/summer conservation elevation while not exceeding a release rate of 2,500 cfs. A minimum flow of 20 cfs is maintained for downstream water supply and pollution abatement. During the month of September, the pool is raised gradually to an elevation of 934.0 feet to reduce stress on the fish habitat. Before freeze-up starts, typically during the month of October (depending on inflow and the agricultural harvest), the spillway bulkheads (bays 8-12) are put in the raised (open) position. The bulkheads have only two positions: open and closed. During years when the pool is above elevation 934.2 late in the fall, the bulkheads will be raised as soon as possible after the pool is down to the winter conservation elevation of 934.0 ±.2 feet. The pool is then held at elevation 934.0 ±.2 until the end of February. On 01 March each year, the lowering of the Lac qui Parle pool will begin, in order to bring the pool to conservation elevation 933.0 by 15 March to provide room for flood control storage. During dry years the pool would be lowered to only

933.5 feet. From then on until 15 May, the spring regulation schedule is in effect. After 15 May, the summer/fall regulation schedule is in effect. The bulkheads in bays 8-12 are typically placed in the lowered (closed) position on May 16.

Normal operation of Chippewa Diversion Dam is to split the flow coming down the Chippewa River between the Chippewa River (50%) and the Lac qui Parle Lake (50%) via the Watson Sag weir.

Normal operation of Marsh Lake Dam is natural flow over the service (also known as the fishway) and auxiliary (also known as the emergency) spillways. MN DNR will inform Water Management when they want a drawdown to occur. The plan should include the desired dates of the drawdown, the targeted drawdown elevation, along with desired/maximum rates of rise/fall. Water Management will attempt to follow the MN DNR's plan dependent on inflow to Lac qui Parle.

Rate of Change:

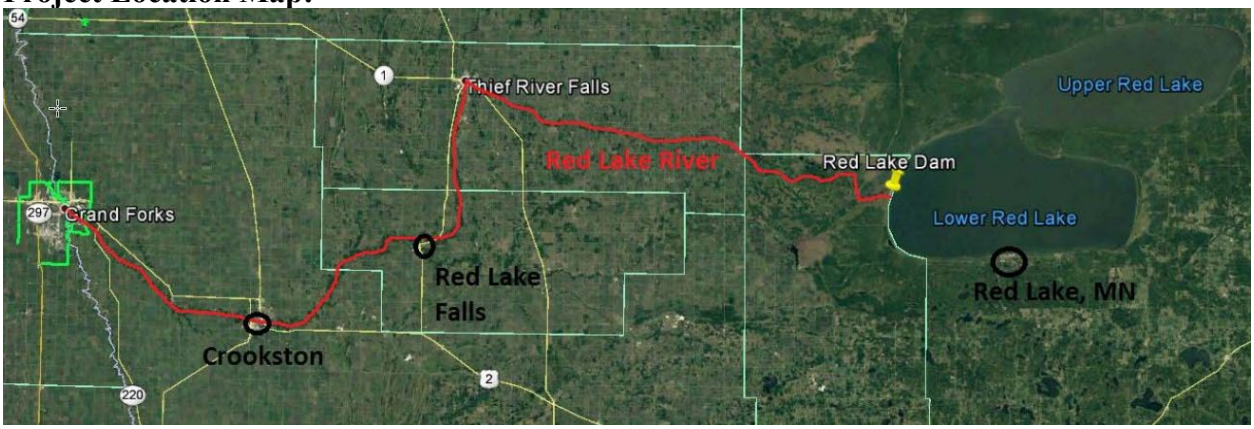
Guidelines for increasing outflow at Lac qui Parle Dam: no more than 2,000 cfs per day. If the required daily increase is more than 400 cfs, break up the increases into two or three equal steps. Guidelines for decreasing outflow at Lac qui Parle Dam: no more than 1,000 cfs per day. If the required daily decrease is more than 400 cfs, break up the decreases into two or three equal steps.

St. Paul District SRP Workshop
All District Reservoirs - Environmental Flows

Reservoir Summary: Red Lake and Red Lake Dam

Project General Objectives: There are two general objectives for the operating plan; (1) Flood Control and (2) Water Supply and Water Quality Abatement. During the winter months, Red Lake is lowered to provide flood storage volume for spring runoff.

Project Location Map:



General:

Project Location: Red Lake Dam is located at the outlet of Lower Red Lake in the northeastern part of Clearwater County, Minnesota, 188.45 miles above the mouth of the Red Lake River, Latitude 47° 57' 27", Longitude 95° 16' 35".

Drainage Area Above Red Lake Dam	1,950 square miles
Drainage Area Above High Landing, MN	2,300 square miles

Red Lakes Dam

Type:	Earth Dike Topped by a Road
Length:	36,500 feet
Crest Elevation:	1181.50 feet
Total Volume of Earth Dam:	140,285 cubic yards

Red Lakes Dam Control Structure:

Type:	Reinforced Concrete, Gated Broad Crested Weir
Crest Elevation:	1169.6 feet
Length of Crest:	64 feet
Gates:	3 - 16'x5' Lift Gates, 2 - 8'x5' Stop Log Sections

Indian Reservation Control Structure:

Type:	Concrete Weir
Crest Elevation:	1166.0 feet
Length:	80 feet

Channel Modification:

Red Lake River:	River Mile 154.28 to 178.54 and 3.2 miles below the dam
Clearwater River:	River Mile 41.6 to 79.1, Cleaned down to R.M. 31.8

Reservoir/Capacities/Areas:

Red Lakes Reservoir	**Elevation Feet**	**Capacity Ac-Ft**	**Area Acres**
Gate Sill	1169.6	580,000	NA
Conservation Pool	1174.0	1,810,000	288,000
Top of Dam	1181.5	3,985,000	NA

Watershed Characteristics

Red Lake Dam was built on the outlet of Red Lake, a very large freshwater lake that drains into the Red Lake River, and eventually, into the Red River. Most of the drainage basin is a relatively smooth plain once occupied by glacial Lake Agassiz. Much of the drainage area is wooded with marsh land.

This geology along with a climate and pronounced spring snowmelt creates fairly consistent flows with the peak occurring from spring melt. **Figure 1** shows a duration hydrograph of the discharges from Red Lake Dam.

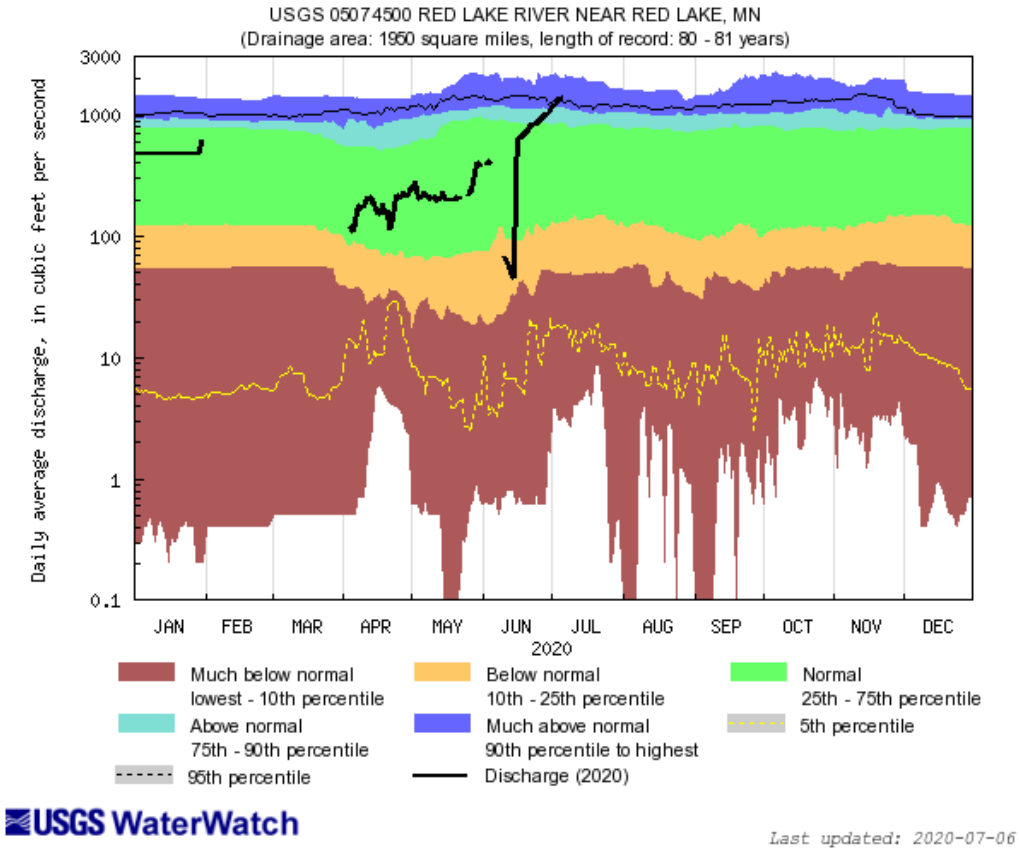
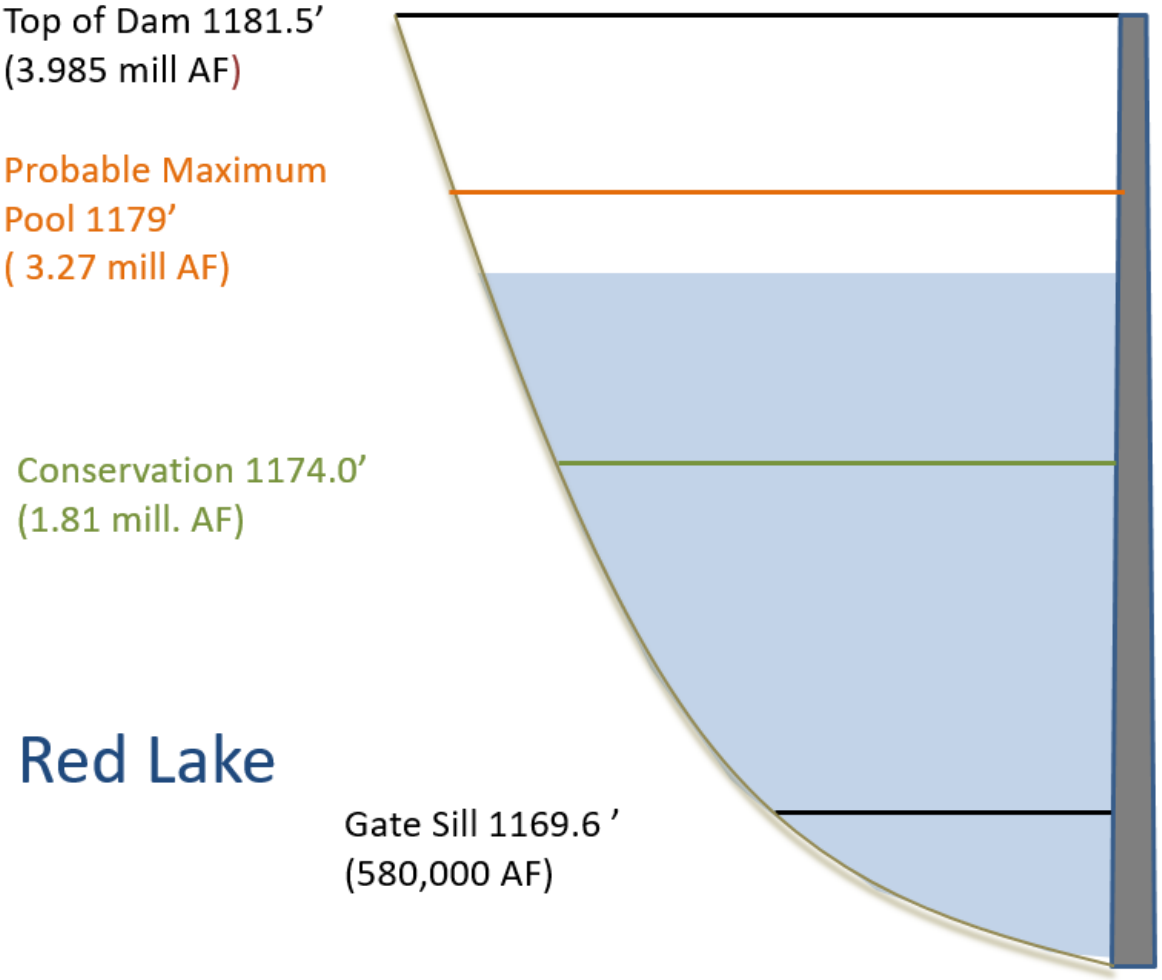


Figure 1. Duration hydrograph for Red Lake Dam discharges.

Pool Allocation



Overall Plan for Water Control

The operation of Red Lakes has a dual purpose, need control and the improvement of low-water flows. Duplicate use of the reservoir storage is possible due to the large capacity of the lakes. Normal pool is at elevation 1174.0 MSL 1912. However, the pool is lowered to elevation 1173.5 MSL 1912 annually to provide storage capacity for the spring runoff. Since the normal recharge is about 1.0 foot, the crest level of about elevation 1174.5 MSL 1912 is expected annually. However, should abnormally heavy rains occur, the lake could rise to elevation 1176.43, the maximum regulated elevation. Also the flow is reduced prior to spring melt or during rain flood events to prevent High Landing gage stage from exceeding 8.75 ft to the extent practical. The pool is typically lowered 0.5' each year prior to spring runoff.

A fish passage located just north of the dam outlet is operated by the Red Lake Nation to allow for walleye passage. Two outlets to the Zah Gheeng Marsh can also be operated to drain the marsh into the lake.

Constraints:

Minimum discharge:

Releases are managed to meet the stream flow requirements in Table 4 below.

Table 4. Stream flow requirements, Red River.

TABLE 4 - STREAM-FLOW REQUIREMENTS (CFS)

Month	For Water Supply: Red Lake River at Thief River Falls	For Water Supply: Red Lake River at Crookston	For Water Supply: Red Lake River at East Grand Forks	For Pollution Abatement: Red Lake River below Crookston	For Pollution Abatement: Red River below Grand Forks
January	1	9	10	5	115
February	1	2	2	5	106
March	1	2	2	5	85
April	1	2	2	3	11
May	1	2	2	3	18
June	1	2	2	3	23
July	1	2	2	3	23
August	1	2	2	3	23
September	1	2	2	3	22
October	1	9	10	3	13
November 1-15	1	9	10	3	8
November 16-30	1	9	10	5	144
December	1	9	10	5	124

Requirements shown are for critical points along the stream. When a requirement is not critical during some months, it has been omitted. The requirements as shown in the above tabulation have been used in the coordinated water plan studies for Red River of the North.

Maximum discharge

Discharges are limited to try and keep High Landing below 8.75 ft (1450 cfs).

Discharge Rate of Change:

None

Summer/Fall Operation Summary:

Conservation = 1174.0 MSL 1912

Operation basically consists of "inflow equals outflow".

Fall/Winter Drawdown Summary:

Normal winter drawdown to 1173.5 ft occurs over the winter.

Spring Runoff Operation Summary:

Just prior to the spring breakup the discharge from Red Lakes Dam is cut to a token flow necessary to sustain fish and wildlife and tor other downstream needs. The dam is kept at this low discharge until high water downstream is abated. When the lake is above elevation 1174.5,

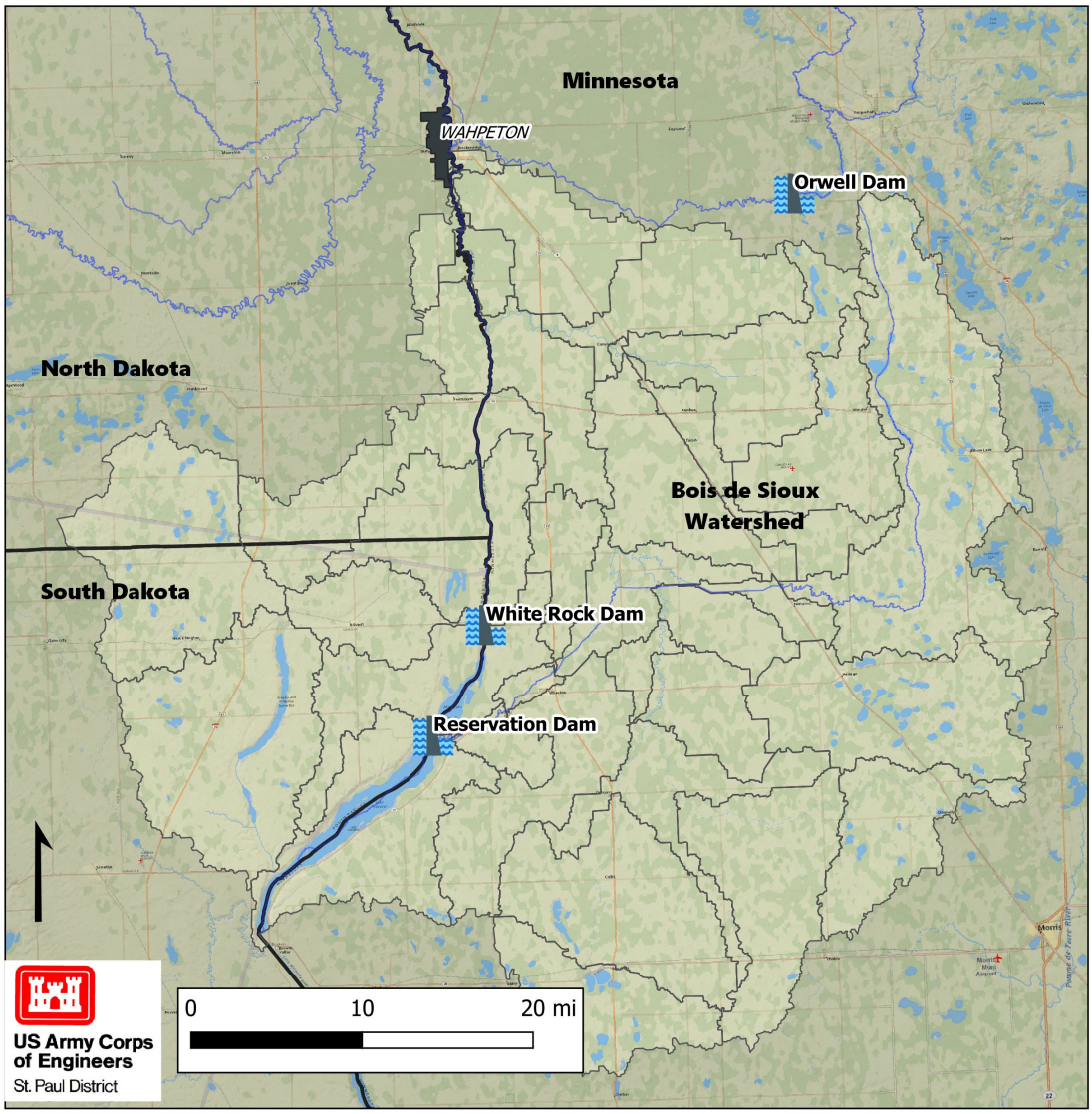
releases are made to lower the pool as soon as practicable. These releases are limited to amounts which will maintain 8.75 feet or less on the gage at High Landing, Minnesota.

St. Paul District SRP Workshop
All District Reservoirs - Environmental Flows

Reservoir Summary: Lake Traverse Project (Lake Traverse/Reservation Dam and Mud Lake/White Rock Dam)

Project General Objectives: There are two general objectives for the operating plan; (1) Flood Control and (2) Water Supply.

Basin Map:



General: Project Location: Traverse County, Minnesota, and Roberts County, South Dakota, Headwaters of the Bois de Sioux River, 30 Miles South of Wahpeton, North Dakota, Latitude 45 51′ 45″, Longitude 96 34′ 25″ (White Rock Dam)

Drainage Area Above White Rock Dam	1,160 square miles
Uncontrolled Drainage Area Above the Wahpeton, North Dakota Control Point	1,020 square miles

Dam:	**White Rock Dam:**	**Reservation Dam**
Type:	Rolled-earth Fill	Rolled-earth Fill
Length:	14,400 Feet	9,100 Feet
Height:	16 Feet	14.5 Feet
Top Width:	26 Feet (roadway)	26 Feet (roadway)
Freeboard:	4 Feet (above SDF[1])	Not Applicable
Volume of Dam:	329,200 Cubic Yards	188,000 Cubic Yards

Spillway:

Type:	Reinforced Concrete	Grouted Riprap Weir
Length:	3-16′H x 13′W Reversed Tainter Gates	19.7 ft Bladder Gate 65.6 ft Bladder Gate
Design Flood:	5,600 cfs	5,600 cfs
Invert Elev.:	965.00 Feet	972.26 Feet

Reservoir/Capacities/Areas:

White Rock Dam/Mud Lake	**Elevation (Feet)**	**Capacity (Ac-ft)**	**Area (Acres)**
Sill	965.00	0	
Conservation Pool	972.00	6,500	3,850
Top of Flood Control Pool	981.00	249,500	22,975
Maximum Pool	982.00	273,000	23,425
Flowage Easement Level	983.00	296,000	23,850
Top of Dam	986.00	368,000	24,800
Reservation Dam/Lake Traverse			
Sill	974.00	84,000	10,150
Conservation Pool	976.00	106,000	10,925
Conservation Pool (Upper)	976.80	115,000	11,200

Note: The two pools become one pool at approximately elevation 976.80 feet. Datum is MSL 1912.

1. SDF = Spillway Design Flood
2. Clear opening width

Watershed Characteristics

Reservation Dam was built at the outlet of Lake Traverse and White Rock Dam was built just downstream on Mud Lake. Along with Brown's Valley Dike, the dams make up the Lake Traverse Project located at the headwaters of the Bios de Sioux River which is a headwater tributary to the Red River of the Norh. During high water events, the two pools merge into one and the most downstream dam, White Rock Dam controls both pool elevations. The Mustinka River drains into Lake Traverse, and its watershed is very flat and agriculturally developed, not unlike the Red River of the North Valley.

The climate and spring snowmelt creates highly variable flows, consistent with other Red River of the North drainages. **Figure 1** shows a duration hydrograph of the discharges from White Rock Dam. **Figures 2** and **3** shows a duration hydrograph of the elevations of Reservation and White Rock Dam.

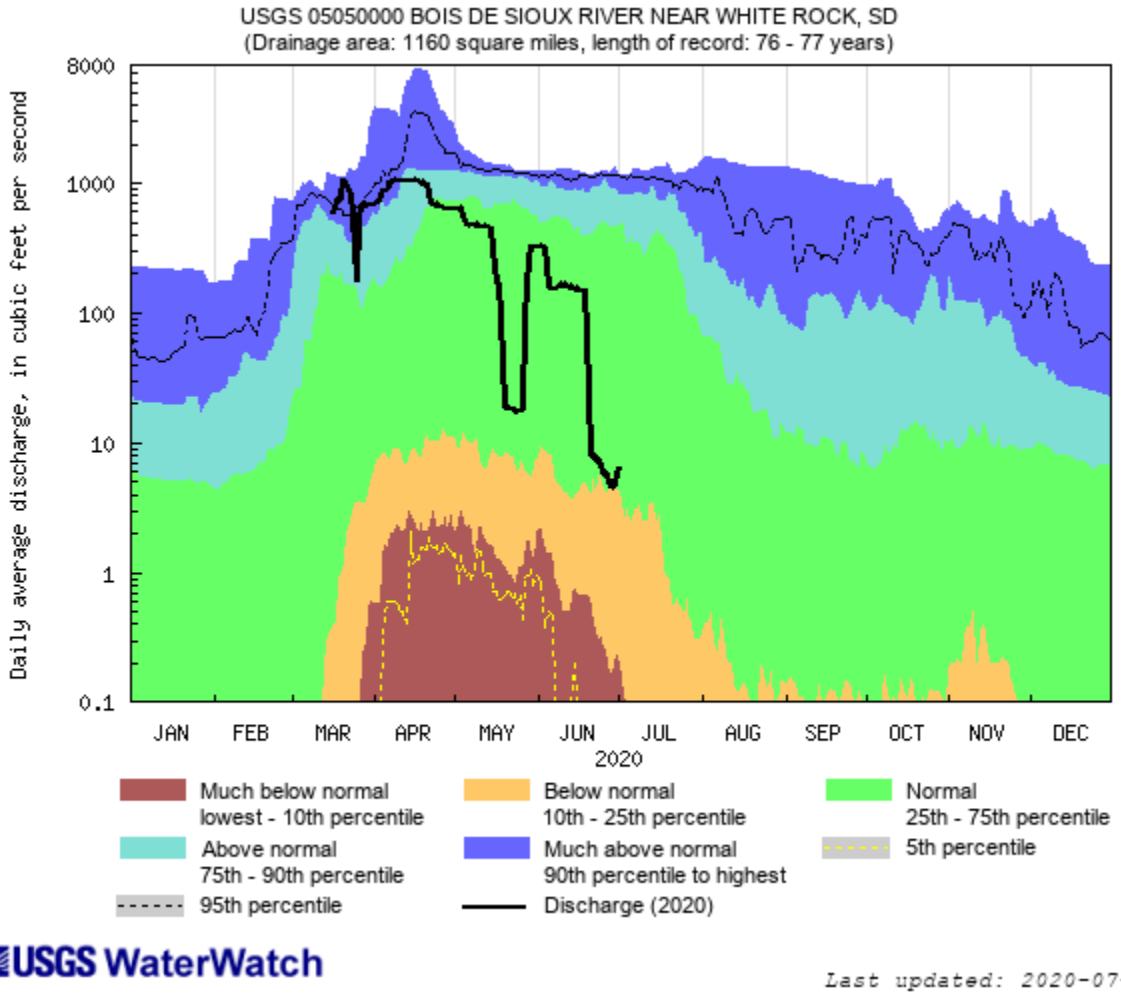


Figure 1. Duration hydrograph for Orwell Dam discharges (Note: includes 20 years of flow data before the dam was constructed in 1953).

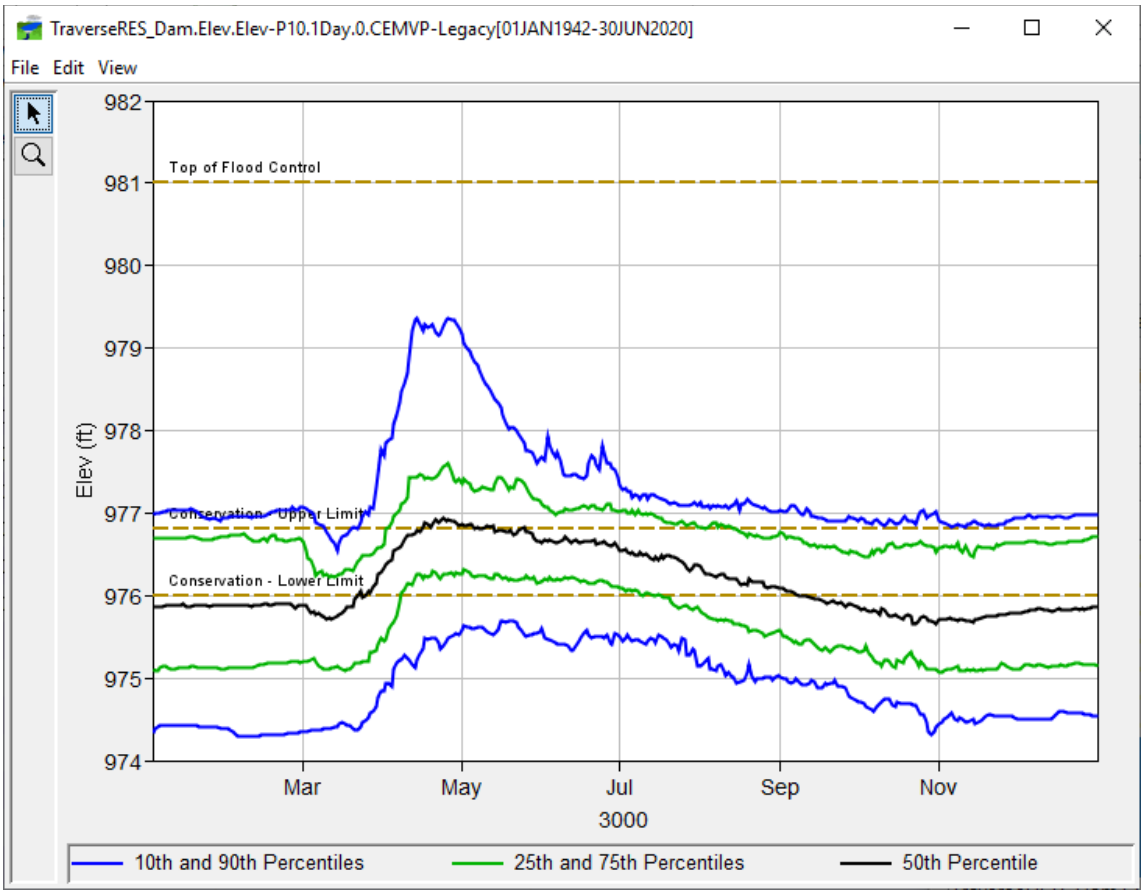


Figure 2. Duration hydrograph for Lake Traverse elevations.

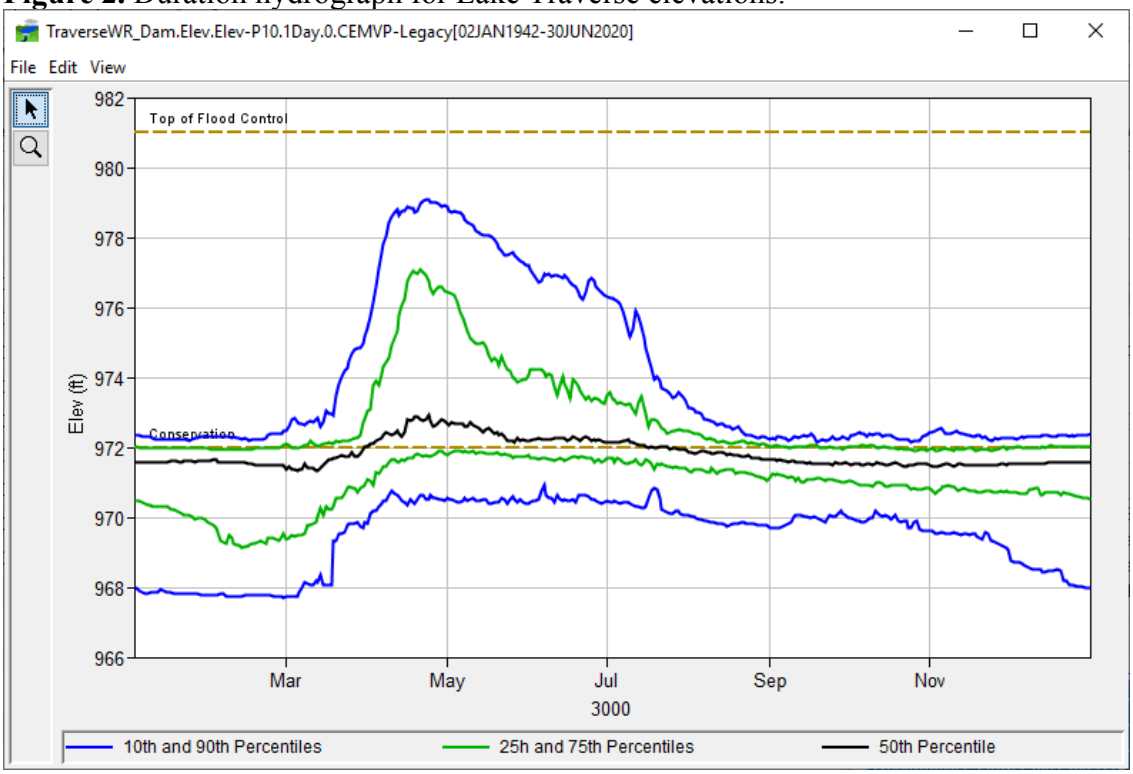
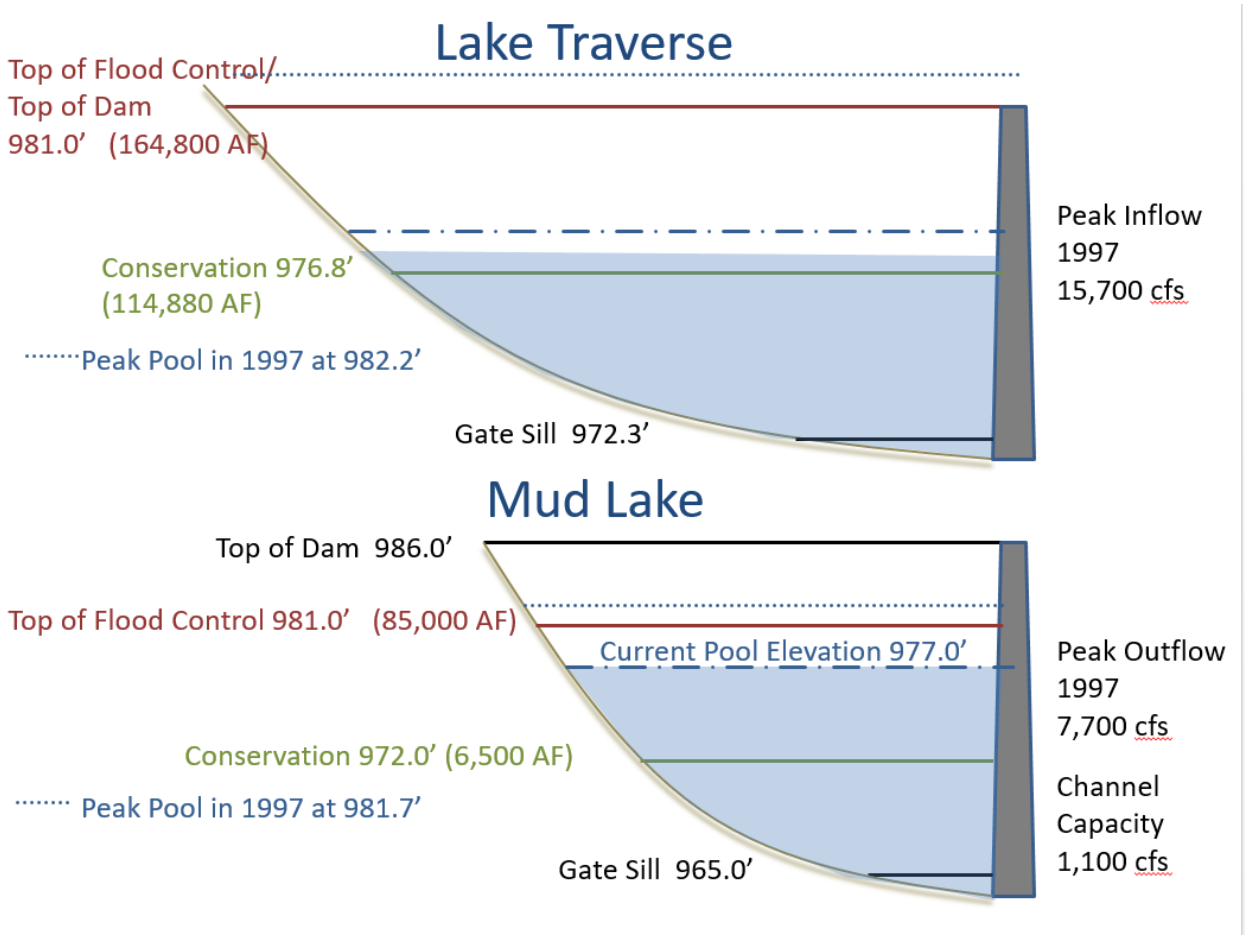


Figure 3. Duration hydrograph for Mud Lake elevations.

Pool Allocation



Overall Plan for Water Control

The overall plan calls for maintaining a pool for water supply and providing flood storage in the spring. Water quality is poor in the reservoirs, so the main purpose is flood control. Generally, the Lake Traverse and Mud Lake pools are maintained near their conservation pool levels except for flood control.

The pool may be lowered in the spring depending on snowpack conditions in the Otter Tail and Bois De Sioux Watersheds. The reservoirs along with Orwell Dam are primarily operated based on a stage at Wahpeton, ND. A Category I stage corresponds to 10 ft at Wahpeton, and a Category II stage corresponds 12 ft at Wahpeton. Once the stage at Wahpeton exceeds a Cat. I or Cat. II White Rock Dam is closed until Lake Traverse pool reaches top of flood control (in these conditions the pools have merged) or the stage at Wahpeton drops below the threshold. If the pool reaches top of flood control, discharges near the inflow rate are released.

Constraints:

Minimum discharge

There is no requirement for a minimum discharge. Water quality is poor.

Maximum discharge
Channel capacity is 1,100 cfs.

Discharge Rate of Change:
The rate of increase and decrease of discharges are listed in the tables below; however, it should be noted that a discharge below 40 cfs cannot in practice be achieved with the tainter gates (gate clogs up).

Table 7-2
Reducing Outflows, White Rock Dam
Suggested Rates of Change[1]

Flow Range	Rate of Change
From 1000+ cfs to 100 cfs	Reduce outflows over at least 2 days in approximately equal increments
From 100 cfs to 20 cfs	Reduce outflows over at least 3 days in at least 3 equal-ratio increments
From 20 cfs to 0 cfs	Reduce outflows over at least 4 days in approximately equal increments

1. Emergency conditions, including flood control operation, may warrant a substantial deviation from the values shown.

Table 7-3
Increasing Outflows, White Rock Dam
Suggested Rates of Change[1]

Flow Range	Rate of Change
From 0 cfs to 100 cfs	Increase outflow over at least 3 days in equal increments
From 100 cfs to 1000 cfs	Increase outflow over at least 3 days in approximately equal increments

1. Emergency conditions, including flood control operation, may warrant a substantial deviation.

Summer/Fall Operation Summary:
Lake Traverse Conservation = 976.8 (+/- 0.2 ft) – Upper Limit, 976.0 (+/-) – Lower Limit
Mud Lake Conservation = 972.0 (+/- 0.2 ft)

Lake Traverse conservation pool has a large range because of the high evaporative rate that occurs in the large, shallow lake, large swells driven by high winds, and the former outlet configuration of stop logs. Historically high winds blowing waves over the stop logs and evaporative loses have caused the pool to fall almost 2 feet over the summer, so to ensure the lake stays above 976.0, a conservation level of 976.8 ft was established. The outlets were upgraded to two pneumatically operated bladder gate weirs, but the Water Control Manual has not been upgraded since then.

Operation basically consists of “inflow equals outflow”. If inflow exceeds 1,100 cfs, the pool is allowed to climb to elevation 981 ft when near inflow is released. If Wahpeton is forecasted to

exceed 10 ft, White Rock Dam is closed until Wahpeton recedes below 10 ft or the Lake Traverse pool elevation reaches elevation 981 ft when near inflow is released.

Winter Drawdown Summary:

If snowpack conditions are heavy, a Category II condition is met and a drawdown may occur in Lake Traverse in the spring with a target elevation of 974.5 ft; however, this has never been achieved because of limitations from ice and lack of hydraulic head.

There is no drawdown at Mud Lake.

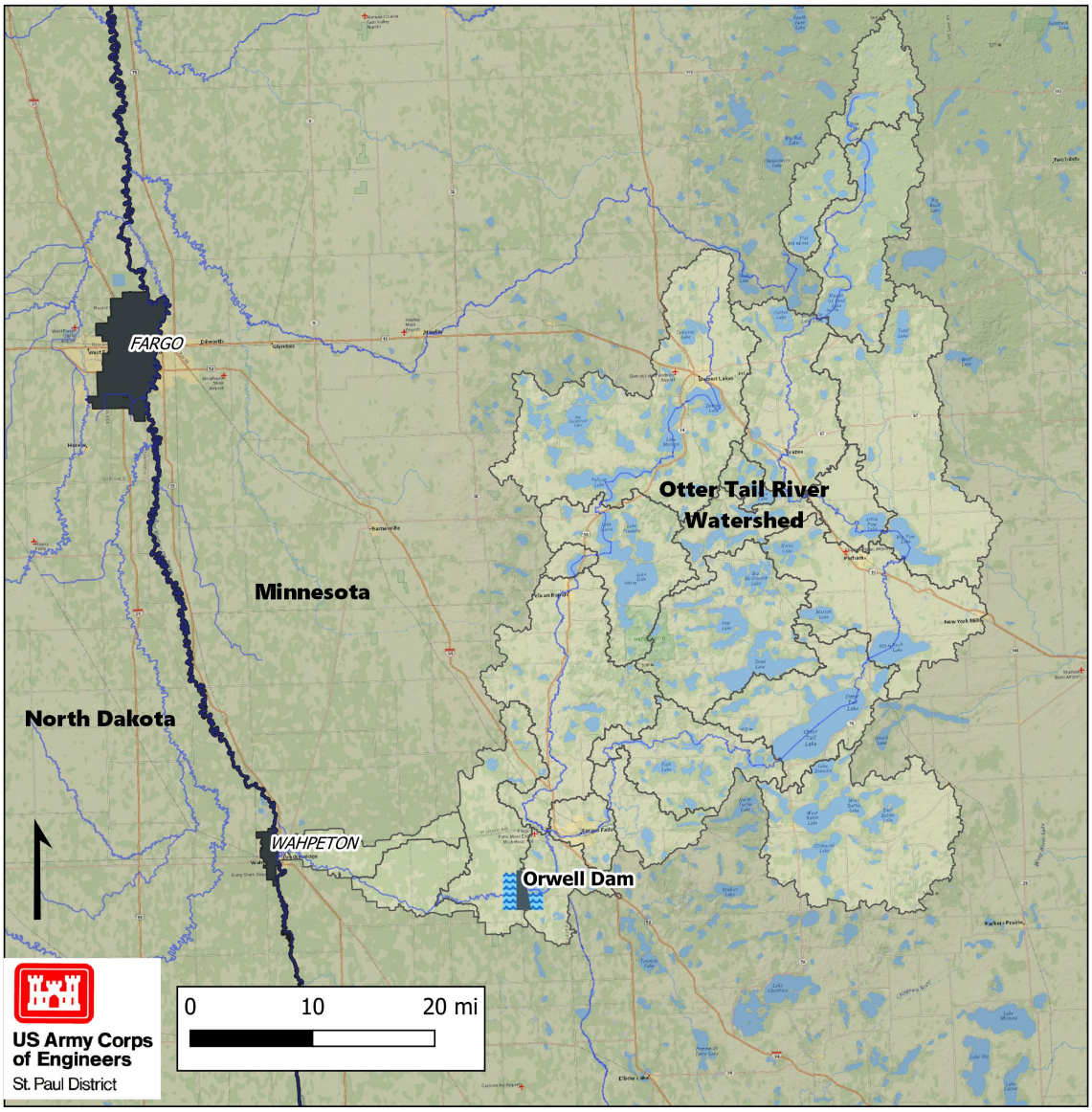
Spring Runoff Operation Summary:
Inflows are matched at Reservation Dam until inflow rates exceed outlet capacity. At White Rock Dam, inflows are matched up to 1,100 cfs to maintain drawdown until Wahpeton exceeds the target category stage. Outflows then cease and White Rock Dam remains closed until the stage at Wahpeton recedes below the target stage or the Lake Traverse pool reaches the top of flood control. The two pools merge during large events.

St. Paul District SRP Workshop
All District Reservoirs - Environmental Flows

Reservoir Summary: Orwell Lake and Orwell Dam

Project General Objectives: There are two general objectives for the operating plan; (1) Flood Control and (2) Water Supply. During the spring months, Orwell Lake is lowered to provide flood storage volume for spring runoff. The conservation pool level is 1064 ft MSL 1912 and maintained throughout the summer for water supply and recreational benefits. Top of flood control is 1070 ft, and the pool may be surcharged up to 1073 ft.

Basin Map:



Location: Orwell Dam is located on the Otter Tail River, 38.6 river miles upstream of Breckenridge, Minnesota, where the Otter Tail and Bois de Sioux Rivers combine to form the Red River of the North. The dam is situated in the southwestern part of Otter Tail County, approximately 6 miles southwest of Fergus Falls, Minnesota, 55 miles southwest of Fargo, North Dakota, and 170 miles northwest of the Minneapolis-St. Paul, Minnesota, metropolitan area, in Section 26, T132N, R44W, near Latitude 46º13'0"N, Longitude 96º10'40"W.

Total Drainage Area: 1,820 square miles **Datum:** MSL1912
To convert to NAVD88 add 0.24 feet to MSL1912 elevations.
Real Estate Guide Taking Line for Title in Fee or Easement: Contour elevation 1073.0 ft

Dam

Type:	Rolled Earth Fill	Maximum Height:	47 feet
Total Length:	1,355 feet	Top Width:	20 feet
Crest Elevation:	1079.8 feet	Side Slopes:	1V:3H
Parapet Wall Elevation:	1083.5 feet	Parapet Tie-in Elevations:	1082.5 feet

Control Structures

Type:	One-Tainter Gate	Type :	Two- Low Flow Conduits
Gate Width:	33.0 feet	Shape/Location	Circular/Abutments
Gate Height:	27.5 feet	Diameter:	2 feet
Gate Radius:	30.0 feet	Inlet Invert Elevation:	1040.0 feet
Weir Crest Elevation:	1044.0 feet	Control:	24 inch Slide Gates
Top of Gate (closed):	1071.5 feet		
Gate Seat Elevation:	1043.5 feet		

Spillway and Chute Outlet

Type Spillway:	Flared Concrete Ogee	Type Chute:	Flared Concrete
Crest Elevation:	1044.0 feet	Crest Width:	33.0 feet

Stilling Basin

Type:	Flared with Baffles	Rows of Baffle Blocks:	2
Floor Elevation:	1024.5 feet	End Sill Elevation:	1032.5 feet
		Length:	72.0 feet

Tailwater Control Structure

Type:	Concrete Box Culverts	Number of Culverts:	5
Dimensions of Culverts:	15.5 ft by 15.5 ft by 40 ft	Invert Elevation:	1032.5 feet

Elevation - Area - Storage

	Elevation (ft)	Area (acres)	Storage (acre-ft)
Deign Flood (PMF)	1078.8	1,700	26,320
Top of Surcharge Pool	1073.0	1,300	17,750
Flood Control Pool	1070.0	1,110	14,000
Conservation Pool	1064.0	782	8,300
Intermediate Drawdown	1060.0	598	5,500
Maximum Drawdown (pg 3-6)	1050.0	264	1,200
Dead Storage (low-flow invert)	1040.0	40	4

Watershed Characteristics

Orwell Dam was built on the Otter Tail River, a tributary to the Red River. The watershed includes many lakes and the vertical drop has allowed several hydropower dams to generate power. Runoff into the dam is highly attenuated with peak inflow occurring from snowmelt weeks after peak runoff occurs within the Red River Valley.

This attenuation effect and climate creates fairly steady flows in the river compared to other Red River drainages. **Figure 1** shows a duration hydrograph of the discharges from Orwell Dam. The figure includes 20 years of flow data from before the dam was built. **Figure 2** shows a duration hydrograph of the elevations of Orwell Dam.

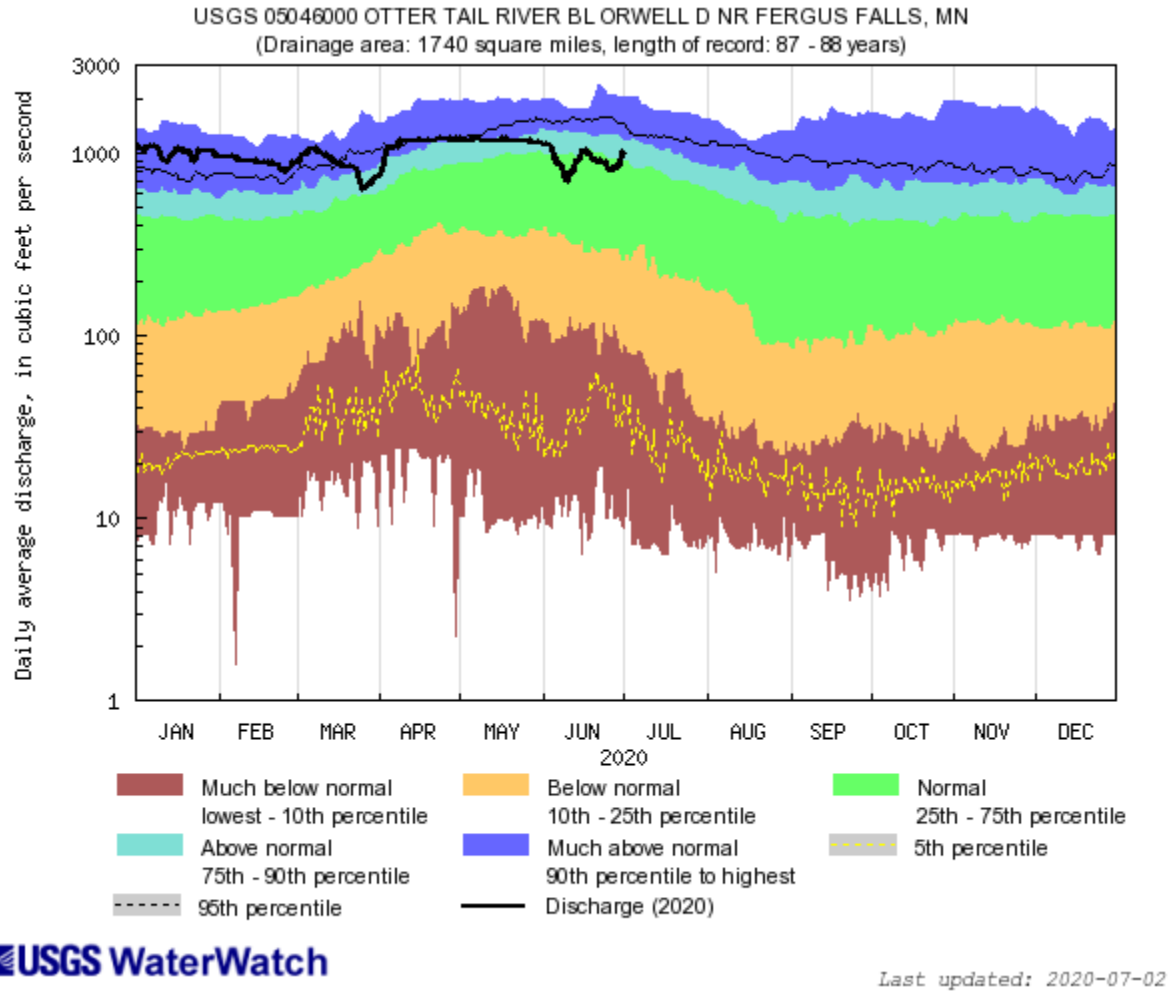


Figure 1. Duration hydrograph for Orwell Dam discharges (Note: includes 20 years of flow data before the dam was constructed in 1953).

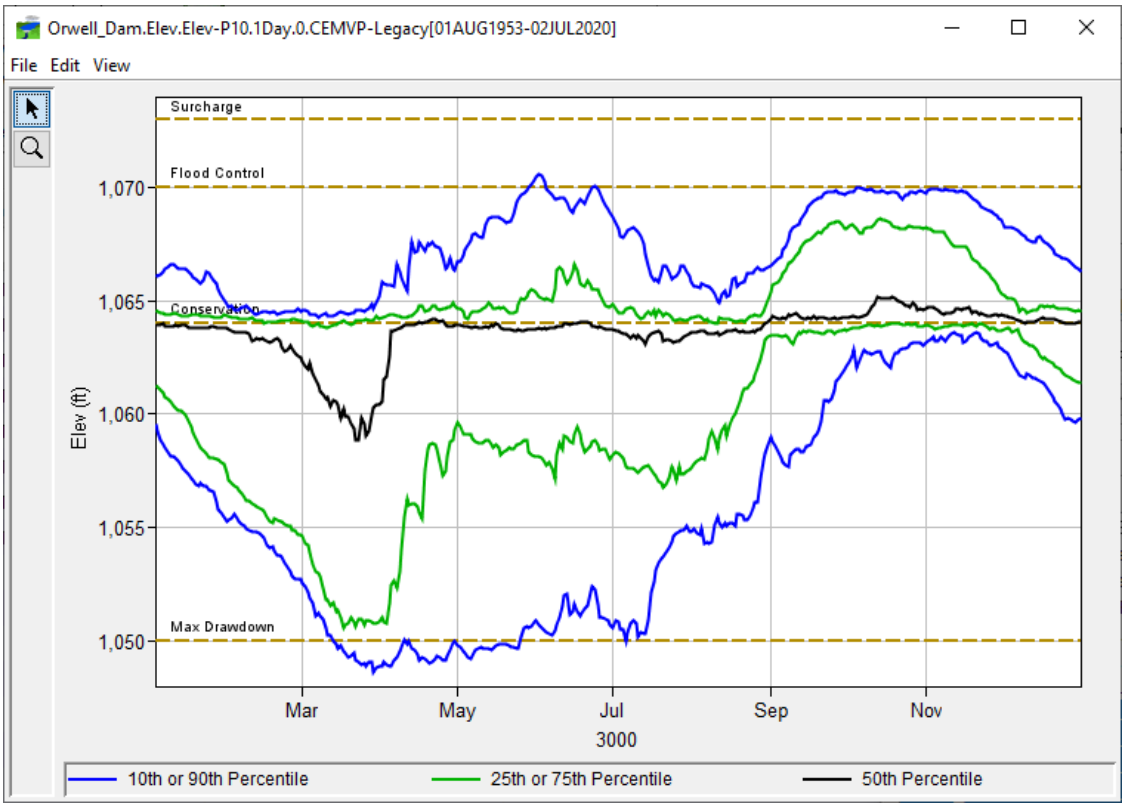
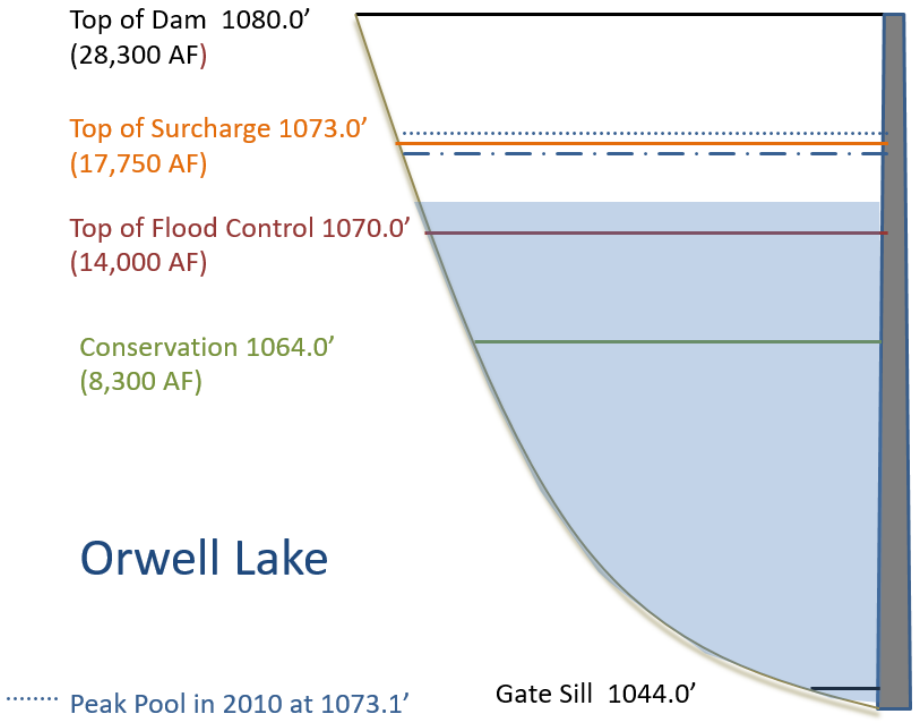


Figure 2. Duration hydrograph for Orwell Dam elevations.

Pool Allocation



Overall Plan for Water Control
The overall plan calls for maintaining a pool for water supply and providing flood storage in the spring. Generally, the pool is maintained near the conservation pool level of 1064.0 (+/- 0.5 ft) except for the following:

- Flood control
- Temporary fall pool raise up to 1066 ft to benefit migrating waterfowl
- Occasional lowering of pool to 1061 ft for Minnesota Department of Natural Resources sub-impoundment drainage after spring runoff

The pool may be lowered in the spring depending on snowpack conditions in the Otter Tail and Bois De Sioux Watersheds. The reservoir along with Lake Traverse is primarily operated based on a stage at Wahpeton, ND. A Category I stage corresponds to 10 ft at Wahpeton, and a Category II stage corresponds 12 ft at Wahpeton. Roughly 1 to 2 days before the forecasted flood peak at Wahpeton (above Cat. I or Cat. II depending on snowpack), discharges are lowered to reduce the peak at Wahpeton.

Constraints:

Minimum discharge
Inflow>80 cfs:
80 cfs
Inflow<80 cfs:

Table 7-2
Minimum Flow once Inflow is less than 80 cfs

Timing	Pool Elevation (ft)	Inflow (cfs)	Min Flow (cfs)
First 30 days	> 1060.0	---	80 cfs
	< 1060.0	---	Inflow[1]
Second 30 days[3]	> 1060.0	> 70	80 cfs
	< 1060.0	> 70	Inflow[1]
	> 1060.0	< 70	50 or Inflow + 10 cfs[2]
	< 1060.0	< 70	Inflow[1]

[1]Contact the MNDNR and take a week to ramp down to inflow
[2]Whichever is greater
[3]Continue for an additional 60 days and implement the Drought Contingency Plan

Maximum discharge
Channel capacity is 1,200 cfs and this constraint is held until the pool reaches top of flood control.

Discharge Rate of Change:
No more than a 300 cfs increase or decrease per day and pool should not drop more than 0.5 ft/day.

Summer/Fall Operation Summary:
Conservation = 1064.0 (+/- 0.5 ft)

Operation basically consists of "inflow equals outflow". If inflow exceeds 1,200 cfs, the pool is allowed to climb to elevation 1070 ft when near inflow is released. If Wahpeton is forecasted to exceed 10 ft, discharges will be reduced to mitigate the peak.

Winter Drawdown Summary:

If snowpack conditions are heavy, a Category II condition is met and a drawdown may occur in March as far as 1050 ft.

Spring Runoff Operation Summary:
Inflows are matched up to 1,200 cfs to maintain drawdown until 1 to 2 days before the forecasted peak at Wahpeton. Outflows are then cut and held until Wahpeton has crested and channel capacity (1,200 cfs) is released until the pool climbs to the top of Flood Control.

St. Paul District SRP Workshop

All District Reservoirs - Environmental Flows

Reservoir Summary: Lac Qui Parle, Marsh lake, Chippewa Diversion

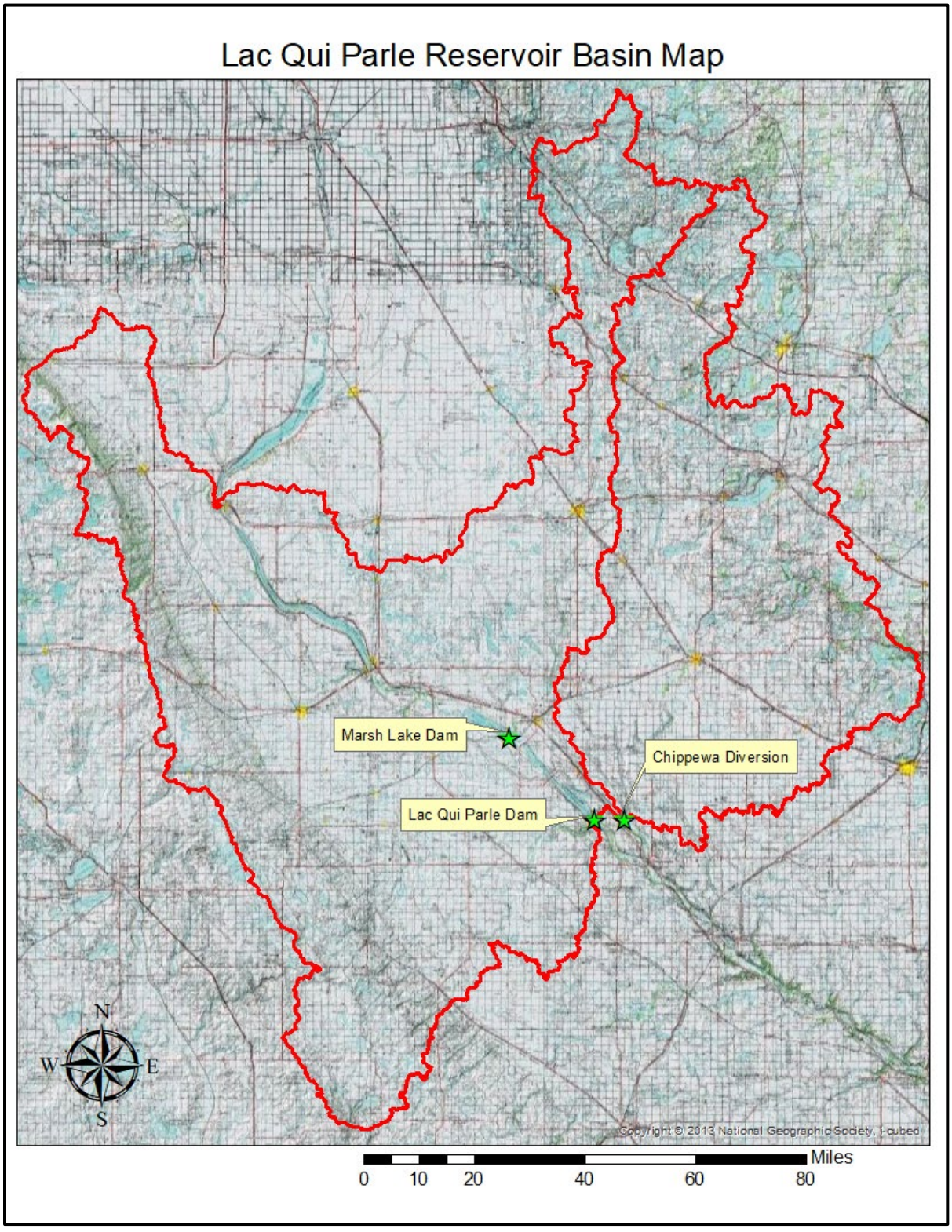
Project General Objectives: The Lac qui Parle Project consists of: Marsh Lake Dam, Lac qui Parle Dam, the Chippewa River Diversion structures, and the Minnesota River Channel down to Granite Falls, Minnesota.

The Lac qui Parle Project was authorized by the Flood Control Act of 1936 (22 June 1936) (Public Law 74-738). However, work on the project was started in October 1934 by the State of Minnesota as a Public Works Administration project. The 1936 Act authorized flood control as a federal project purpose. The project was constructed as a joint state and federal project. It is now a federal project.

The purpose of the Marsh Lake Ecosystem Restoration Project is to restore the aquatic and riparian ecosystems within the Marsh Lake project area. Impoundment of Lac qui Parle and Marsh Lake, along with diversion of the Pomme de Terre River into Lac qui Parle, and other river regulation activities have significantly altered the ecosystem state. The objectives of the project are: 1) reduce sediment loading to Marsh Lake, 2) restore natural hydrologic fluctuations to Marsh Lake, 3) restore geomorphic and floodplain processes to the Pomme de Terre River, 4) reduce sediment resuspension in Marsh Lake, 5) increase emergent and submergent aquatic plants in Marsh Lake, 6) increase waterfowl and native fish habitat, 7) restore aquatic habitat connectivity between Marsh Lake, the Pomme de Terre River, and Lac Qui Parle, and 8) reduce aquatic invasive fish in Marsh Lake.

The Chippewa River Diversion Dam and the Watson Sag Weir diverts high flows on the Chippewa River into Lac qui Parle Reservoir. The diverted flows help to control flood levels downstream at Montevideo, MN as well as at Granite Falls, MN. Generally, flows are split 50/50, half to Lac Qui Parle Reservoir, the other half downstream up to about an inflow of 2000 cfs, after which flows are not kept to the 50/50 split. After inflow exceeds 2000 cfs, the Diversion Structure will divide flow based on hydraulic conditions at the Diversion Structure.

Basin Map


Lac Qui Parle Reservoir Basin Map
Marsh Lake Dam
Chippewa Diversion
Lac Qui Parle Dam
N
W
E
S
Copyright © 2013 National Geographic Society, i-cubed
Miles
0
10
20
40
60
80

Location: Lac qui Parle, Chippewa, Swift and Big Stone counties, Minnesota, 7 miles northwest of Montevideo, Minnesota, 288.1 miles above the mouth of the Minnesota River, Latitude 45° 01' 17", Longitude 95° 52' 05" (Lac qui Parle Dam)
Datum: 1929 NGVD**.** To convert to NAVD88 add 0.67 feet to Marsh Lake, 0.71 feet to Chippewa Diversion and 0.56 to Lac Qui Parle.

Initial Project Purpose:

Flood Control	90 %	Wildlife Management	10 %

Drainage Area:

Above Marsh Lake Dam (does not include Pomme De Terre River)	2,014 sq mi
Above Lac Qui Parle (not including Chippewa River Drainage)	4,105 sq mi
Above Chippewa River Diversion Dam	2,070 sq mi

	Lac Qui Parle Dam:	**Marsh Lake Dam:**
Dam Type:	Rolled-earth Filled	Rolled-Earth Filled
Dam Length:	4,100 feet	12,500 feet
Dam Height:	23-32 feet	19.5 feet at Control Structure
Dam Top Width:	23 feet (roadway)	10 feet at Control Structure 26 feet on new alignment for SDF
Dam Freeboard:	4.9 feet (above full pool)	5 feet on new alignment for SDF

Lac Qui Parle Reservoir:	**Elevation (ft)**	**Capacity (ac-ft)**	**Area (ac)**
Gate Sills	922.70	---	---
Summer Conservation Pool (Mar 15 – Sep 1)	933.0	41,000	7,750
*Spring Conservation Pool (end of runoff – May 31)	933.5	44,750	8,050
Winter Conservation Pool (Oct 1 – Mar 1)	934.0	48,500	8,350
Top of Flood Control Pool/Emergency Spillway	941.1	158,700	21,450
Flowage Easement Level	945.0	253,500	27,450
Top of Dam	946.0	281,500	28,850
Marsh Lake Reservoir:			
Drawdown Control Structure:	934.0	1,300	1,300
Notch in Service Spillway Crest:	935.5	4,600	2,900
Conservation Pool / Service Spillway Crest	937.6	12,050	5,150
Emergency Spillway Crest	940.0	27,250	8,100

Constraints

Lac Qui Parle Pool: The pool at Lac Qui Parle is constrained between the elevations of 922.7 feet and 945.0 feet.

- The invert elevation of the gate sills is 922.7 feet making this the dead storage limit.
- Elevation 945.0 feet is the top of pool for the Probable Maximum Flood (PMF).
- Lac Qui Parle Dam Bulkheads: Bulkheads are not equipped with mechanisms to lift or lower to open or close a bay. It is very difficult to move them when water pressure is against them on the upstream side.
- Gates can get jammed by trees or debris. Sometime gates can't be fully closed due to lodged debris in the gates.
- Aggradation above Lac Qui Parle Dam: An area of deposition is forming upstream of the dam and can impede outflow and lowered dead storage above the dam.
- Lac Qui Parle State Park: There is a campground adjacent to the dam that inundate at a pool elevation of about 939.0 feet.
- Lac Qui Parle Emergency Spillway (2,500 ft in length): The original spillway low point has been raised by subsequent road overlays, thus raising the pool level where emergency spillway flows initiate.
- Outflow velocities must be controlled in order not to blow out the downstream channel. A hydraulic spreadsheet was created to help calculate velocities from various dam gate configurations in order to limit downstream scour.

Marsh Lake Drawdown Structure:

- The sill elevation of the drawdown structure is set at elevation 934.0. Other structures on Marsh do not control outflow in a managed operation.

Chippewa Diversion:

- The pool and channel above the diversion dam is subject to siltation which can sometimes block the low-flow outlet.
- The tainter gate at the diversion structure does not have a de-icing apparatus or heater so can sometime freeze into position and be rendered immovable until it thaws.
- Portions of the bridge were constructed low and as a result the tainter gate can no longer achieve its maximum opening. The maximum gate opening is now 5.5 feet.

Lac Qui Parle Flow:

- The Lac qui Parle Dam control structure consists of a concrete curtain wall section and a fixed concrete spillway section. The curtain wall section is divided into four bays, numbered 1 through 4, beginning from the left bank. The spillway section is divided into eight bays, numbered 5 through 12. All bays have a span of 17 feet and all piers are 3 feet wide. The piers support a bridge over the control structure with a deck elevation of 946.2 feet.
- Bays 1, 3, and 4 each have two 6.0- by 8.0-foot vertical lift gates with sill elevations at 922.7 feet. Bay No. 2 has three 4.0- by 4.0-foot vertical lift gates with sill elevations at 915.2 feet. These gates (Bay No. 2) are equipped with trash racks and are used for low flow regulation. Gates can pass around 3,000 cfs.
- In the spillway section, the crest elevation is 934.2 feet. Bays 5 through 7 are uncontrolled spillways with no gates. In bays 8 through 12, each bay has three sections of movable steel bulkheads. The bulkheads have a top elevation of 940.7 feet.
- Emergency spillway
    - Crest = 941.2 feet.
    - Length = 2500 feet.

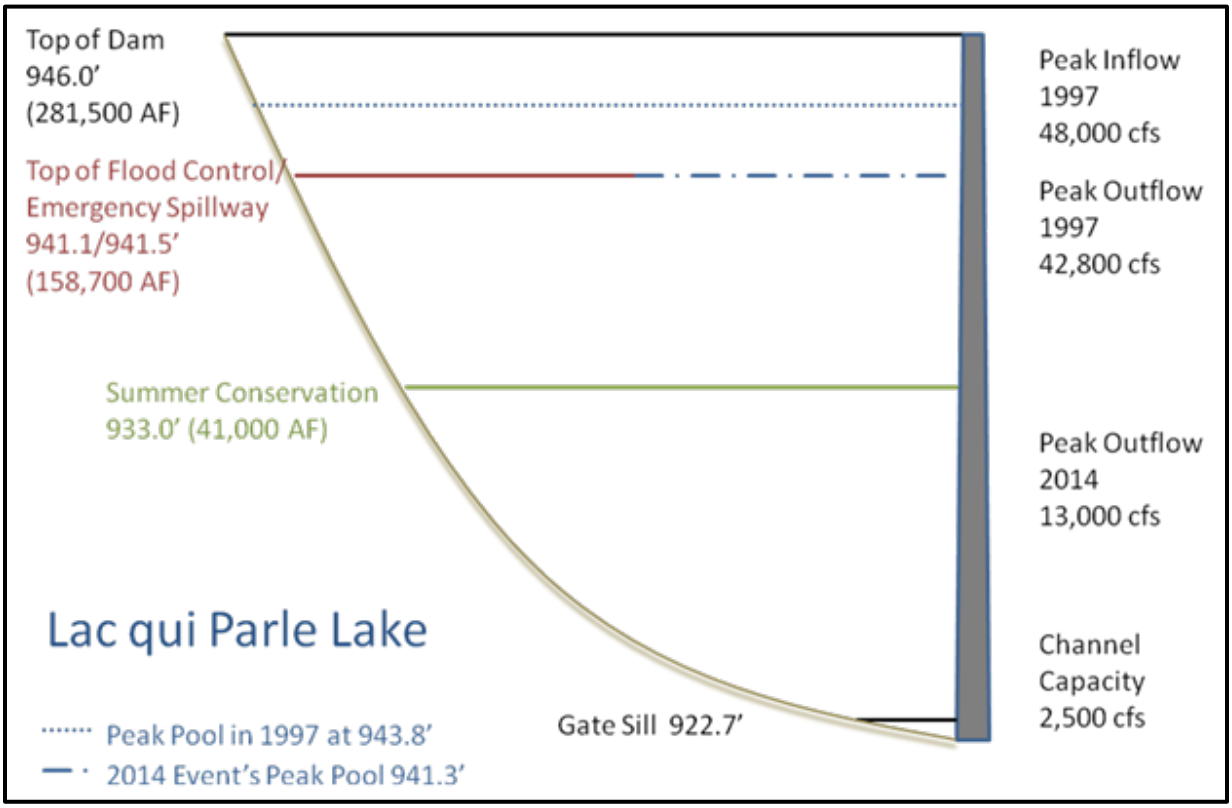
Marsh Lake Pool Flow: Marsh Lake has a Main Service Spillway (Fish Passage), and Auxiliary Spillway, and a Water Management Drawdown Structure.

- The main service spillway has been modified into a fish passage. The concrete fixed spillway crest elevation is 937.6 feet with a 30-foot wide notch set at an elevation of 935.5 feet.
- The Marsh Lake Dam auxiliary spillway (sometimes referred to as the emergency spillway) has a crest elevation of 940.0 feet. The spillway is 90 feet wide.
- The drawdown structure has six bays, each bay has two sluice gates. Each sluice gate is 5 feet wide by 6 feet tall. Sill is 934.0 feet. Top of sluice gates is 940.0 feet.

Chippewa Diversion Flow:

- Main Control Structure: The main control structure is a 5-span combination highway bridge and dam. Bays 1, 2, 4, and 5 have a fixed crest spillway elevation of 942.3 feet and are each 27 feet wide. Bay 3 provides the discharge control by means of a 27-foot wide Tainter gate. The top of the gate in the closed position is at elevation 942.3 feet which matches the crest elevation of the other bays. The gate's sill elevation is 932.9 feet.
- Low-flow Structure: About 300 feet west of the right abutment of the control structure is a low-water control culvert (4ft by 4ft). The entrance invert is at elevation 933.3 feet. Can pass 200-240 cfs.

Allocation Graphic



Overall Plan for Water Control

Following the spring runoff event, the Lac qui Parle pool level is held at elevation 933.5 ±.2 feet until 31 May. After 31 May the summer conservation pool elevation is 933.0 ±.2 feet. Starting 15 May, the outflow from Lac qui Parle Dam is regulated to maintain its spring/summer conservation elevation while not exceeding a release rate of 2,500 cfs. A minimum flow of 20 cfs is maintained for downstream water supply and pollution abatement. During the month of September, the pool is raised gradually to an elevation of 934.0 feet to reduce stress on the fish habitat. Before freeze-up starts, typically during the month of October (depending on inflow and the agricultural harvest), the spillway bulkheads (bays 8-12) are put in the raised (open) position. The bulkheads have only two positions: open and closed. During years when the pool is above elevation 934.2 late in the fall, the bulkheads will be raised as soon as possible after the pool is down to the winter conservation elevation of 934.0 ±.2 feet. The pool is then held at elevation 934.0 ±.2 until the end of February. On 01 March each year, the lowering of the Lac qui Parle pool will begin, in order to bring the pool to conservation elevation 933.0 by 15 March to provide room for flood control storage. During dry years the pool would be lowered to only

933.5 feet. From then on until 15 May, the spring regulation schedule is in effect. After 15 May, the summer/fall regulation schedule is in effect. The bulkheads in bays 8-12 are typically placed in the lowered (closed) position on May 16.

Normal operation of Chippewa Diversion Dam is to split the flow coming down the Chippewa River between the Chippewa River (50%) and the Lac qui Parle Lake (50%) via the Watson Sag weir.

Normal operation of Marsh Lake Dam is natural flow over the service (also known as the fishway) and auxiliary (also known as the emergency) spillways. MN DNR will inform Water Management when they want a drawdown to occur. The plan should include the desired dates of the drawdown, the targeted drawdown elevation, along with desired/maximum rates of rise/fall. Water Management will attempt to follow the MN DNR's plan dependent on inflow to Lac qui Parle.

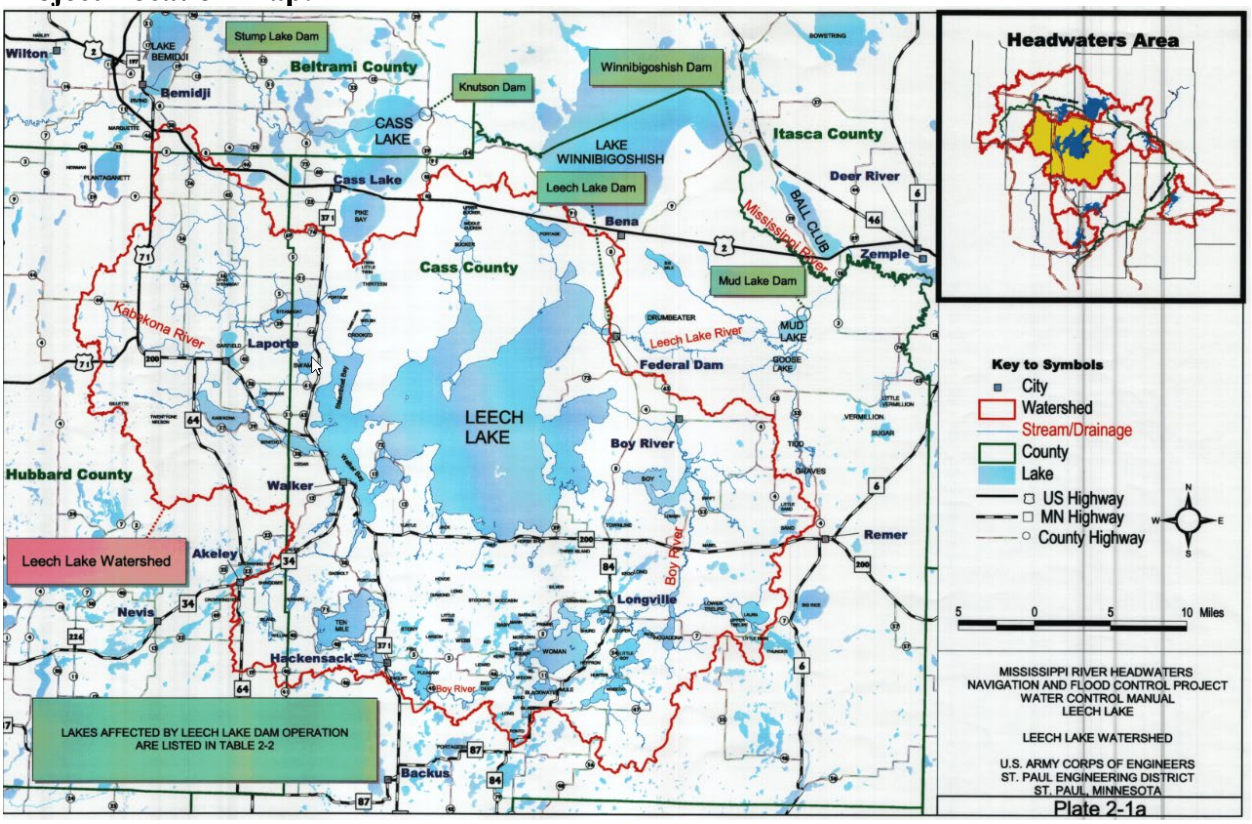
Rate of Change:

Guidelines for increasing outflow at Lac qui Parle Dam: no more than 2,000 cfs per day. If the required daily increase is more than 400 cfs, break up the increases into two or three equal steps. Guidelines for decreasing outflow at Lac qui Parle Dam: no more than 1,000 cfs per day. If the required daily decrease is more than 400 cfs, break up the decreases into two or three equal steps.

Reservoir Summary: Leech Lake and Leech Lake Dam

Project General Objectives: The reservoir is regulated primarily for recreation, flood control, fish and wildlife and Tribal Trust. The Water Control Plan supports recreation by maintaining, when possible, stable reservoir levels within a specified elevation band during the summer. Flood control objectives are met by a fall/winter drawdown schedule and a designated flood control storage pool, which provides storage capacity for spring and summer flood events. Water levels are managed, when conditions permit, for various fish and wildlife and Tribal Trust concerns. The low-flow plan manages water resources both upstream and downstream of the dam during critical periods.

Project Location Map:



Pertinent Data:
Datum = NGVD 29

Leech Lake	Elevation in Feet	Area in Acres	Cumulative Storage in Acre-Feet
Top of Control Structure	1299.54	174,500 (1)	1,233,300
Maximum Operating Limit	1297.90	161,000	1,037,000
Normal Summer Pool Level	1294.70	117,000	580,000
Minimum Operating Limit	1292.70	107,000	354,000
Gate Sill	1288.49	---	---
Stop Log Sill	1287.74	---	---
1. Extrapolated			

HYDROLOGY

Drainage Area	1,163 square miles
Storm Types	Thunderstorm, frontal rain, snow
Flood Season	March - June
Low Flow Season	July - October
Minimum Daily Inflow	Flow is very low during dry periods.
Minimum Mean Monthly Inflow	Flow is very low during dry periods.
Minimum Mean Annual Inflow	300 cfs, 1934
Maximum 24-hr. Average Inflow	20,600 cfs, 11 Oct 1973
Maximum Discharge	2,500 cfs, 7 June 1957 (result of dam failure)
Maximum Mean Monthly Inflow	3,940 cfs, May 1950
Maximum Mean Annual Inflow	1,100 cfs, 1985
Average Annual Inflow	720 cfs
Average Discharge	360 cfs (100 years of record)

Watershed Characteristics

Leech Lake Dam was built on the outlet of Leech, a very large lake draining into the Mississippi River headwaters. . The runoff from Leech Lake watershed is slow and significantly attenuated as a result of the relatively flat topography and the presence of many lakes and wetlands. Leech Lake Dam controls the runoff from a 1,163 square mile area, of which 65 percent is dry land, 10 percent is water, and 25 percent is wetlands. In general, the land not covered by wetlands is forested. The average overland slope is 6.9 feet per mile.

This geology along with a climate and pronounced spring snowmelt creates fairly consistent flows with the peak occurring from spring melt. **Figure 1** shows a duration hydrograph of the discharges from Leech Lake.

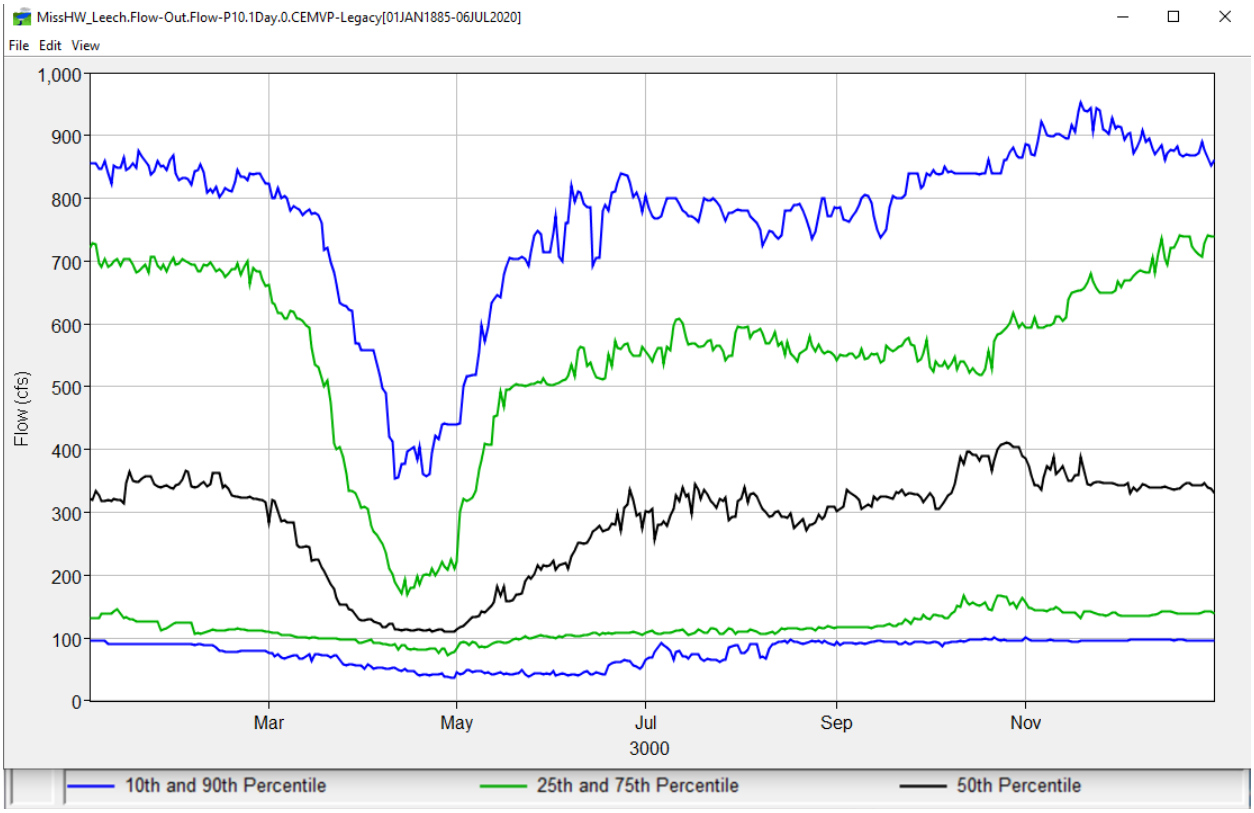
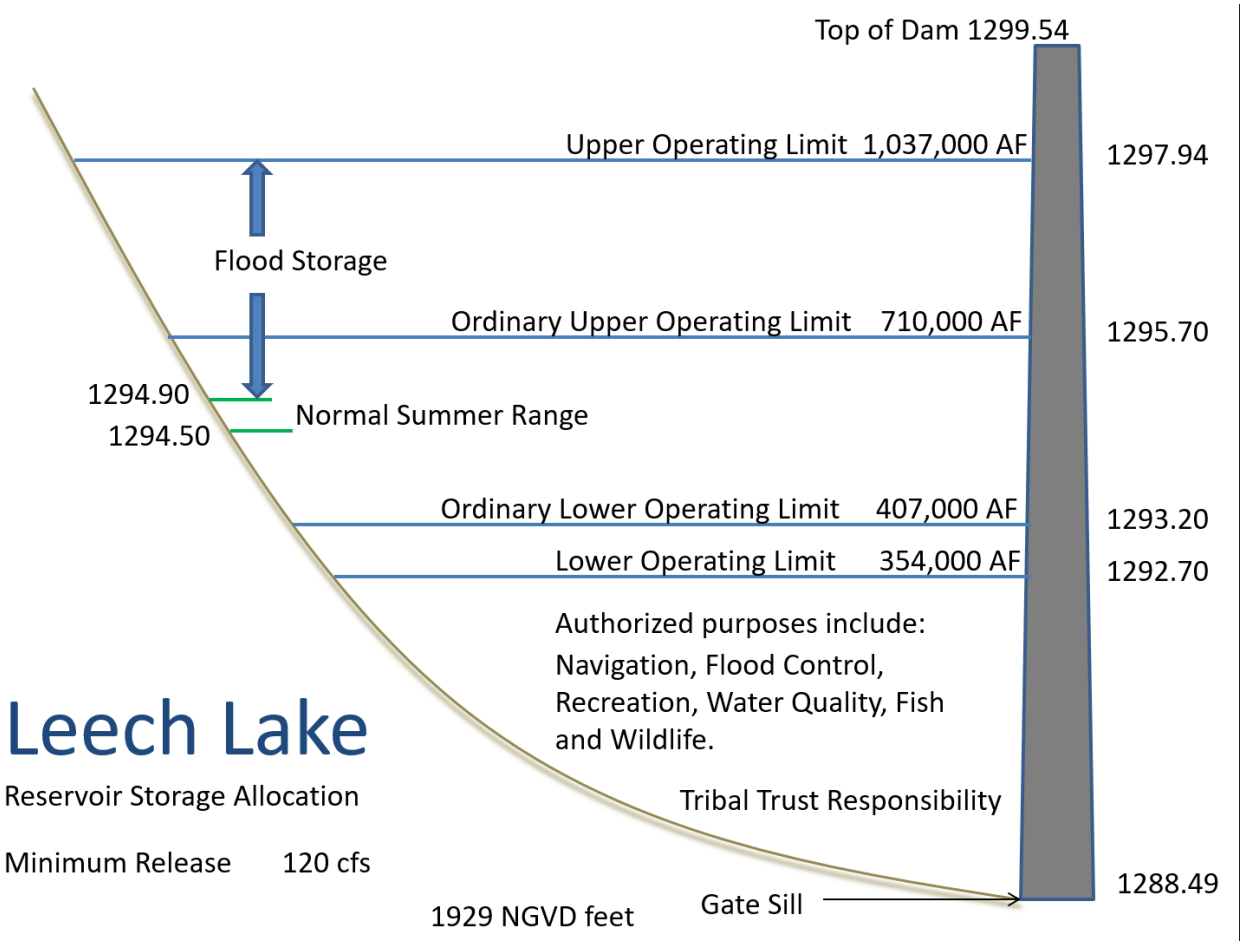


Figure 1. Duration hydrograph for Leech Lake discharges.

Pool Allocation



Overall Plan for Water Control

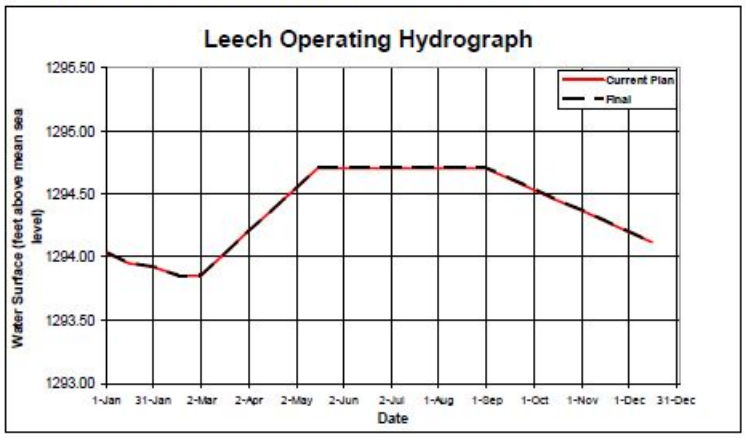
Leech Lake reservoir is regulated between a minimum elevation of 1292.70 feet and a maximum elevation of 1297.94 feet. If possible, the reservoir level should be within its summer range/band of 1294.50 feet to 1294.90 feet by the first day of the fishing season (approx. mid-May). The winter drawdown of the reservoir for spring flood control begins in the fall. The reservoir is usually drawn down to approximately elevation is 1293.80 feet, however the reservoir can be drawn down to 1292.70 feet if warranted by potential spring runoff conditions. Significant shoreline erosion begins to occur at approximately elevation 1295.70 feet but storage to elevation 1297.94 feet can be used if needed to prevent flooding downstream. Regardless of the season, the flood control operation is coordinated with Winnibigoshish and Pokegama reservoirs for flood control at Aitkin, MN and, if necessary, other downstream areas.

The Water Control Manuals (WCM) are in the process of being updated with the findings of the 2009 Reservoir Operating Plan Evaluation (ROPE) Study. The table below summarizes reservoir operation for both the WCM and ROPE parameters.

TABLE S-5
LEECH LAKE OPERATING RULES

	CURRENT	FINAL
Summer Band (elev. - feet)	1294.50-1294.90	1294.50-1294.90
Summer Target (elev. - feet)	1294.70	1294.70
Band Width (feet)	0.4	0.4
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	>=(1292.70): 100 cfs	>=(1292.70): 120 cfs
	<(1292.70): 50 cfs	<(1292.70): 60 cfs

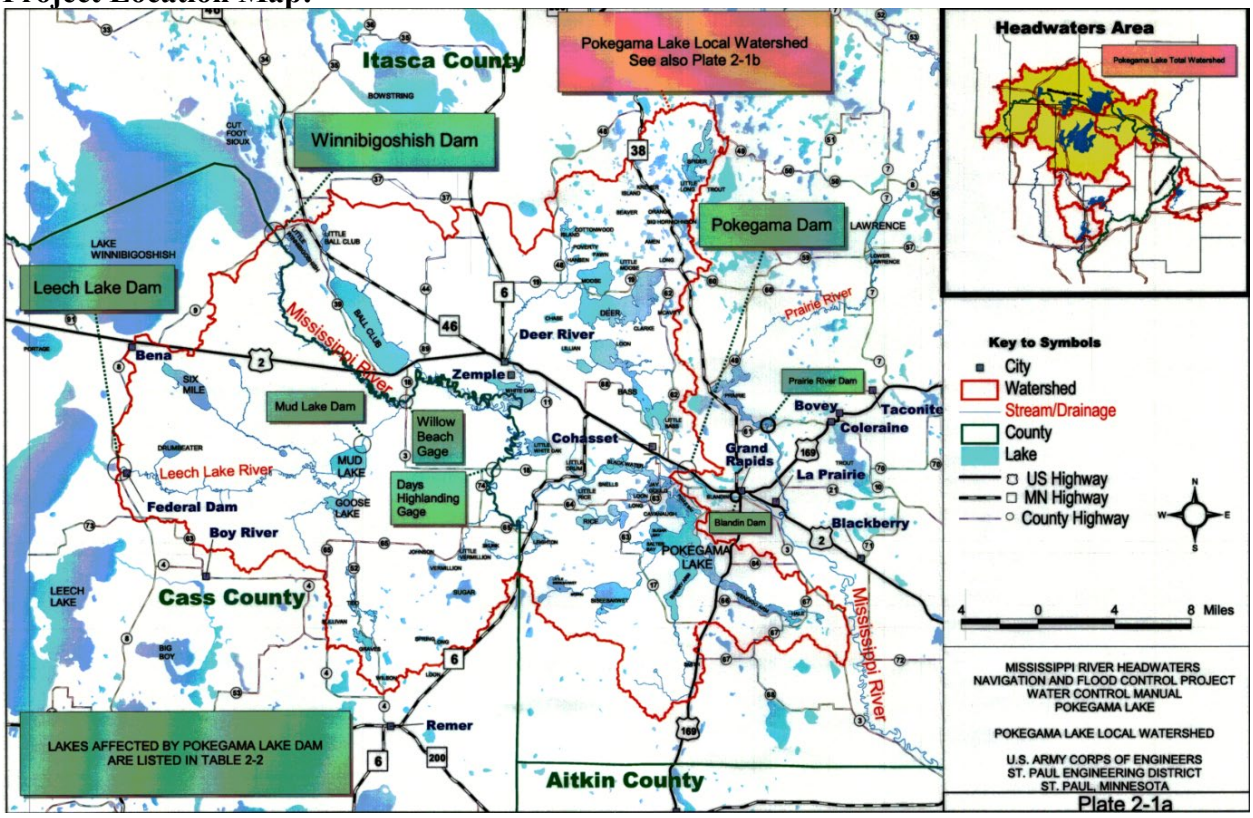
Figure S-3. Final Plan Operating Hydrograph, Leech Lake



Reservoir Summary: Pokegama Lake and Pokegama Lake Dam

Project General Objectives: The reservoir is regulated primarily for recreation, flood control, fish and wildlife and Tribal Trust. The Water Control Plan supports recreation by maintaining, when possible, stable reservoir levels within a specified elevation band during the summer. Flood control objectives are met by a fall/winter drawdown schedule and a designated flood control storage pool, which provides storage capacity for spring and summer flood events. Water levels are managed, when conditions permit, for various fish and wildlife and Tribal Trust concerns. The low-flow plan manages water resources both upstream and downstream of the dam during critical periods.

Project Location Map:



Pertinent Data:
Datum = NGVD 29

Pokegama Lake	**Elevation in Feet**	**Area in Acres**	**Cumulative Storage in Acre-Feet**
Top of Control Structure	1278.42	24,800	203,000
Maximum Operating Limit	1278.42	23,200	158,000
Normal Summer Pool Level	1273.42	16,800	98,000
Minimum Operating Limit	1270.42	12,000	55,000
Sill	1264.42	---	0

HYDROLOGY

Drainage Area	3,265 square miles
One Inch of Runoff Equals	35,200 acre-feet
Storm Types	Thunderstorm, frontal rain, snow
Flood Season	March - June
Low Flow Season	July - October
Minimum Daily Inflow	Flow is very low during dry periods.
Minimum Mean Monthly Inflow	Flow is very low during dry periods.
Minimum Mean Annual Inflow	No flow at times
Maximum 24-hr. Average Inflow	8,480 cfs, 9 April 1952
Maximum Mean Monthly Inflow	4,570 cfs, April 1906
Maximum Mean Annual Inflow	2520 cfs, 1901
Average Annual Inflow	1,200 cfs
Average Discharge	1176 cfs (101 years of record)
1950 Flood Volume	281,000 acre-feet
Name and Location of Stream-Flow Station	Grand Rapids, Minnesota 3 miles downstream of dam
Typical Maximum Snowpack	15 - 31 March
Number of Sediment Ranges	None

Watershed Characteristics

Pokegama Dam was built on the outlet of Pokegama Lake, on the Mississippi River headwaters. The runoff from Pokegama Lake watershed is slow and significantly attenuated as a result of the relatively flat topography and the presence of many lakes and wetlands. There are 3,265 square miles of drainage area above Pokegama Dam. There are 660 square miles of local drainage area between Pokegama and the upstream reservoirs (Winnibigoshish and Leech) of which 64.5 percent is dry land, 8.5 percent is water, and 27 percent is wetlands. In general, the land not covered by wetlands is forested. The average overland slope is 5.6 feet per mile. A very large portion of the inflow to Pokegama reservoir following a precipitation or snowmelt event comes from discharges from Winnibigoshish and Leech Lake Dams. Discharges from those two dams generally take 30 to 36 hours to reach Pokegama reservoir. A significant portion of the local area is non-contributing.

This geology along with a climate and pronounced spring snowmelt creates fairly consistent flows with the peak occurring from spring melt. **Figure 1** shows a duration hydrograph of the discharges from the Mississippi River at Grand Rapids located 3 miles downstream of Pokegama Dam.

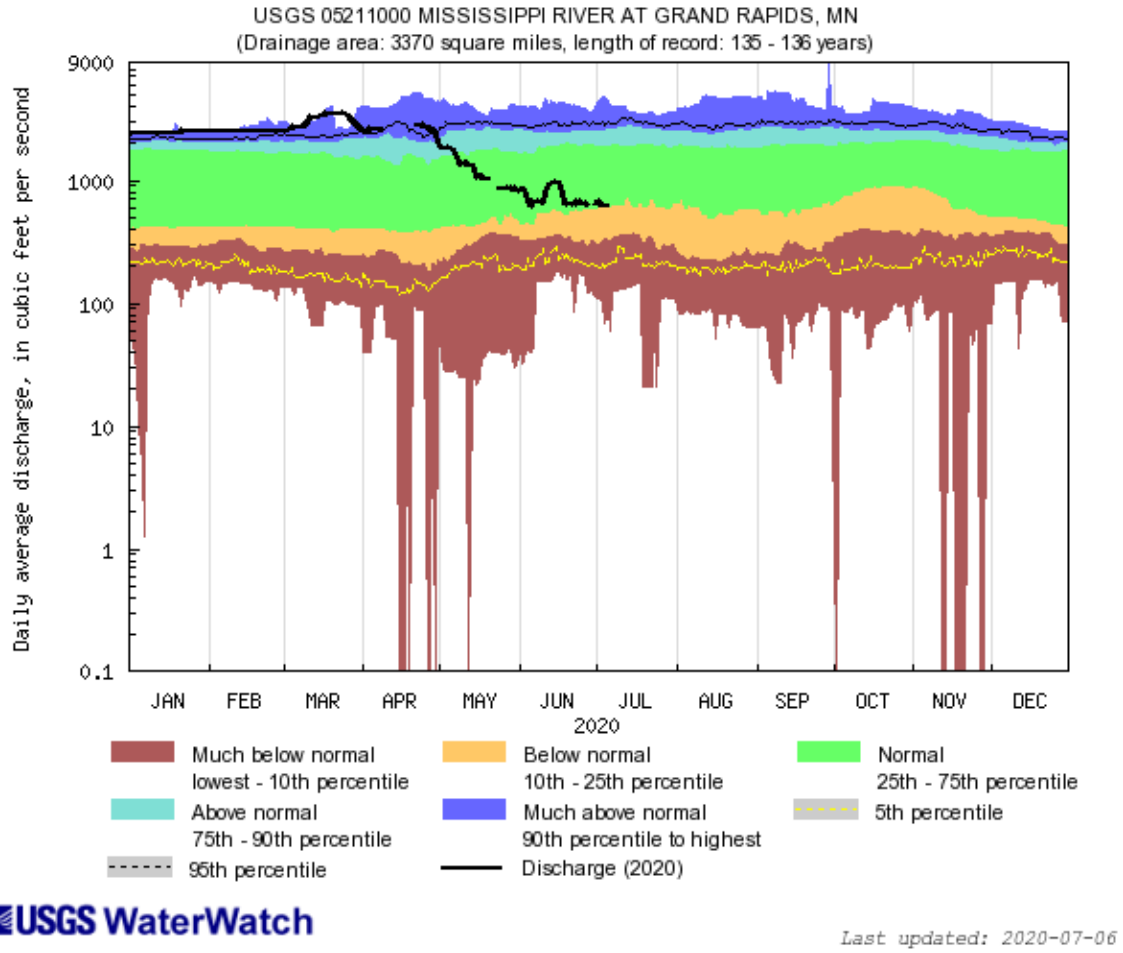
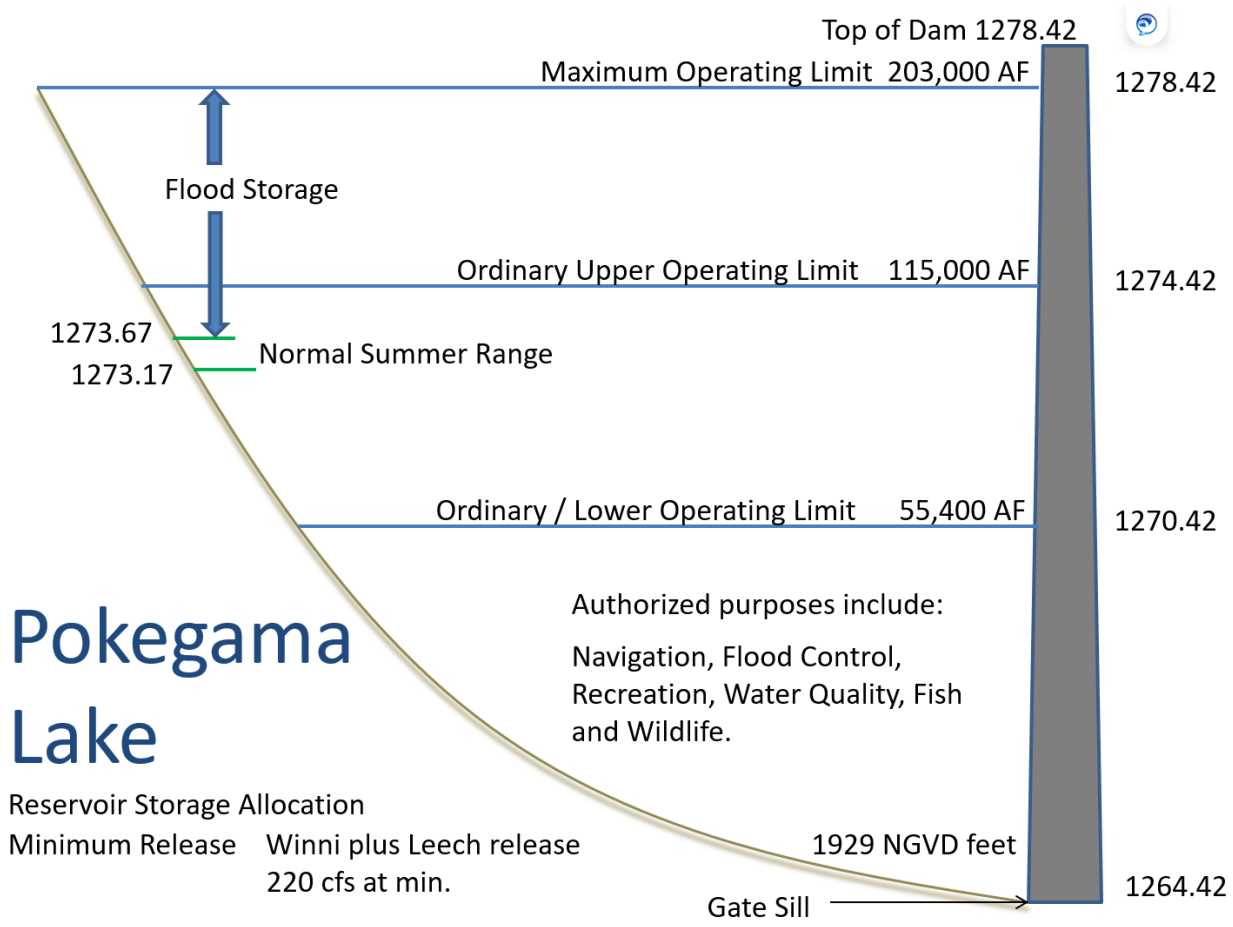


Figure 1. Duration hydrograph for Pokegama Lake discharges.

Pool Allocation



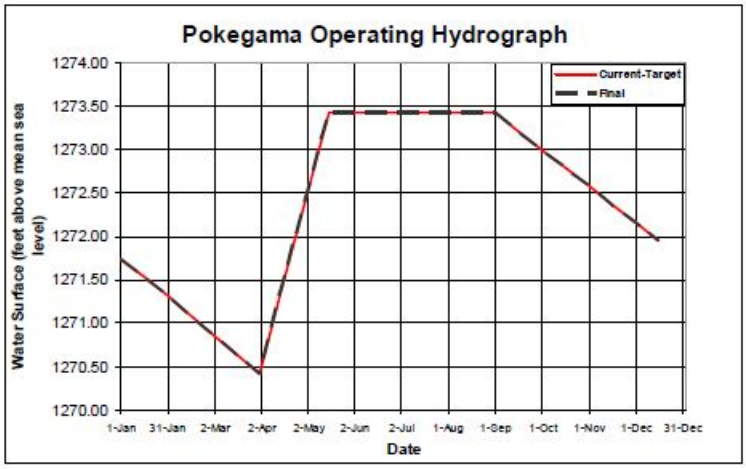
Overall Plan for Water Control

Pokegama Lake reservoir is regulated between a minimum elevation of 1270.42 feet and a maximum elevation of 1278.42 feet. If possible, the reservoir level should be within its summer range/band of 1273.17 feet to 1273.67 feet by the first day of the fishing season (approx. mid-May). The winter drawdown of the reservoir for spring flood control begins in the fall. The ordinary (normal) spring drawdown elevation is 1270.42 feet, which is the lower operating limit of the reservoir. Significant shoreline erosion begins to occur at approximately elevation 1274.42 feet but storage to elevation 1278.42 feet can be used if needed to prevent flooding downstream. Regardless of the season, the flood control operation is coordinated with Winnibigoshish and Leech reservoirs for flood control at Aitkin, MN and, if necessary, other downstream areas.

The Water Control Manuals (WCM) are in the process of being updated with the findings of the 2009 Reservoir Operating Plan Evaluation (ROPE) Study. The table below summarizes reservoir operation for both the WCM and ROPE parameters.

TABLE S-6 POKEGAMA LAKE OPERATING RULES		
	CURRENT	FINAL
Summer Band (elev. - feet)	1273.17-1273.67	1273.17-1273.67
Summer Target (elev. - feet)	1273.42	1273.42
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	>=(1273.17): 200 cfs	>=(1273.17): 200 cfs
	<(1273.17): Winni + Leech	<(1273.17): Winni + Leech

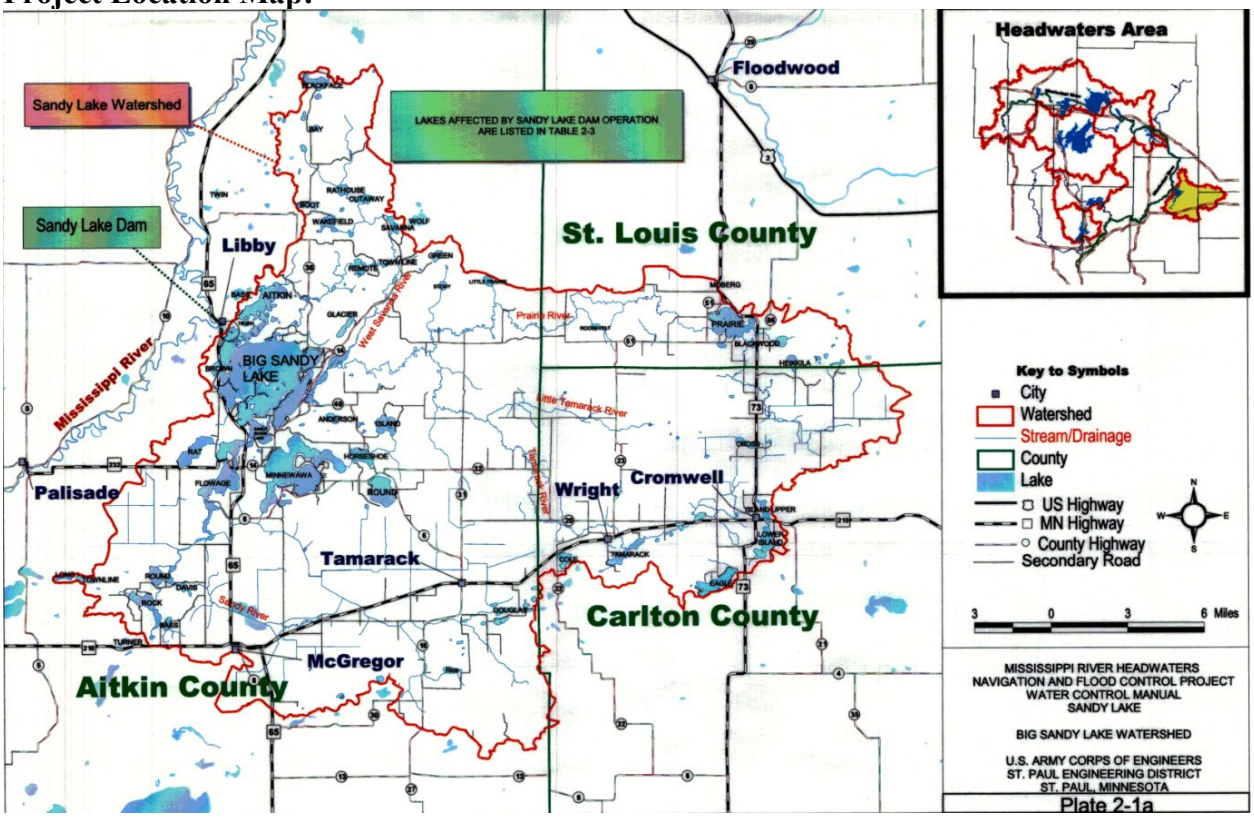
Figure S-4. Final Plan Operating Hydrograph, Pokegama Lake



Reservoir Summary: Big Sandy Lake and Big Sandy Lake Dam

Project General Objectives: The reservoir is regulated primarily for recreation, flood control, fish and wildlife and Tribal Trust. The Water Control Plan supports recreation by maintaining, when possible, stable reservoir levels within a specified elevation band during the summer. Flood control objectives are met by a fall/winter drawdown schedule and a designated flood control storage pool, which provides storage capacity for spring and summer flood events. Water levels are managed, when conditions permit, for various fish and wildlife and Tribal Trust concerns. The low-flow plan manages water resources both upstream and downstream of the dam during critical periods.

Project Location Map:



Pertinent Data:
Datum = NGVD 29

Sandy Lake	Elevation in Feet	Area in Acres	Cumulative Storage in Acre-Feet
Top of Control Structure	1221.31	12,900	118,000
Maximum Operating Limit	1218.31	10,700	82,000
Normal Summer Pool Level	1216.31	9,400	62,000
Minimum Operating Limit	1214.31	8,100	44,000
Sill	1207.31	---	0

HYDROLOGY

Drainage Area	421 square miles
One Inch of Runoff Equals	22,453 acre-feet
Storm Types	Thunderstorm, frontal rain, snow
Flood Season	15 March - June
Low Flow Season	July - October
Minimum Daily Inflow	Flow is very low during dry periods.
Minimum Mean Monthly Inflow	Flow is very low during dry periods.
Minimum Mean Annual Inflow	76 cfs, 1934
Maximum 24-hr. Average Inflow	6,910 cfs, 8 May, 1950
Maximum Mean Monthly Inflow	2,870 cfs, May 1950
Maximum Mean Annual Inflow	549 cfs, 1953
Average Annual Inflow	249 cfs, (Period, 1899-1985)
Maximum Flood Volume from Mississippi River included)	254,600 ac-ft, April 16 - June 8, 1950 (overflow
Name and Location of Key Stream-Flow Stations	Mississippi at Aitkin, Minnesota and Aitkin diversion channel

Watershed Characteristics

Sandy Lake Dam was built on the outlet of Sandy Lake, a lake on the Mississippi River headwaters. The runoff from Sandy Lake watershed is slow and significantly attenuated as a result of the relatively flat topography and the presence of many lakes and wetlands. Sandy Lake Dam controls the runoff from a 420 square mile area, of which 31 percent is dry land, 12 percent is water, and 57 percent is wetlands. In general, the land not covered by wetlands is forested. The average overland slope is 14.78 feet per mile

Figure 1 shows a duration hydrograph of the discharges from the dam.

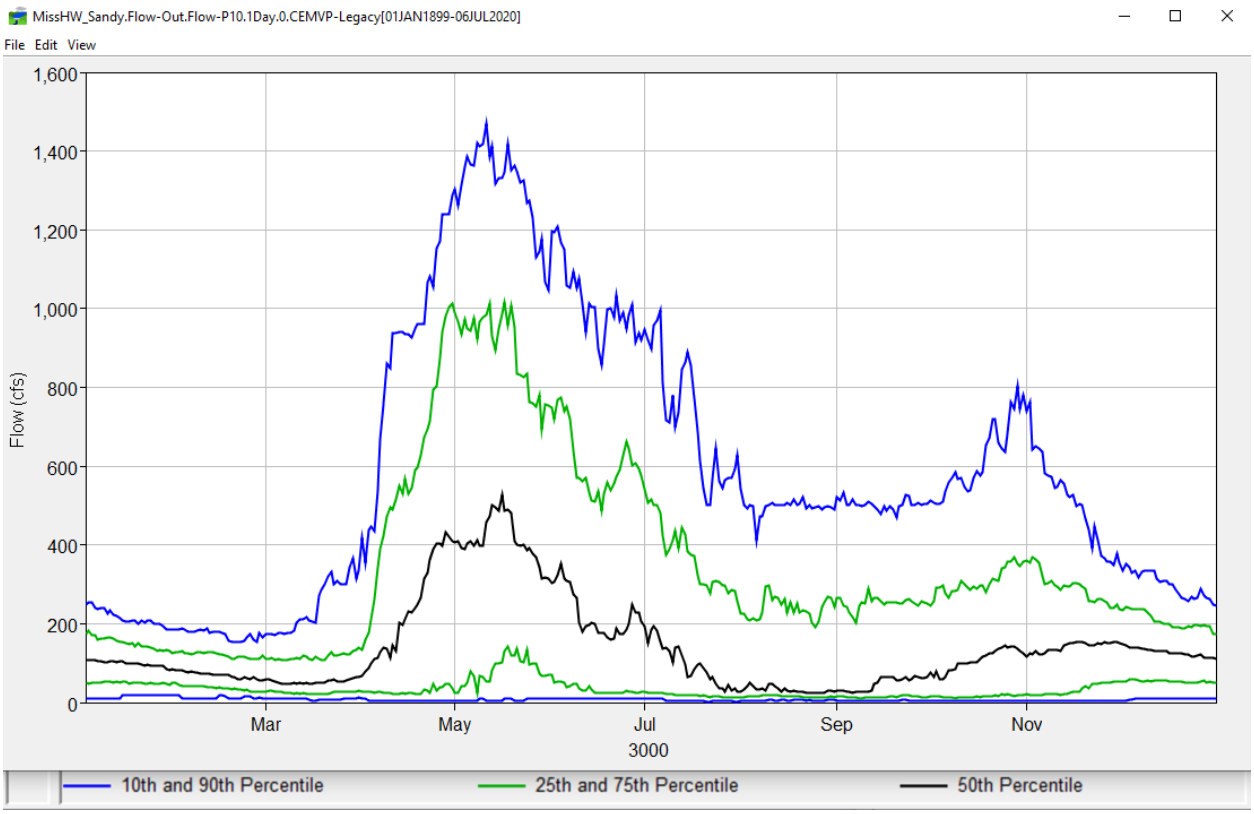
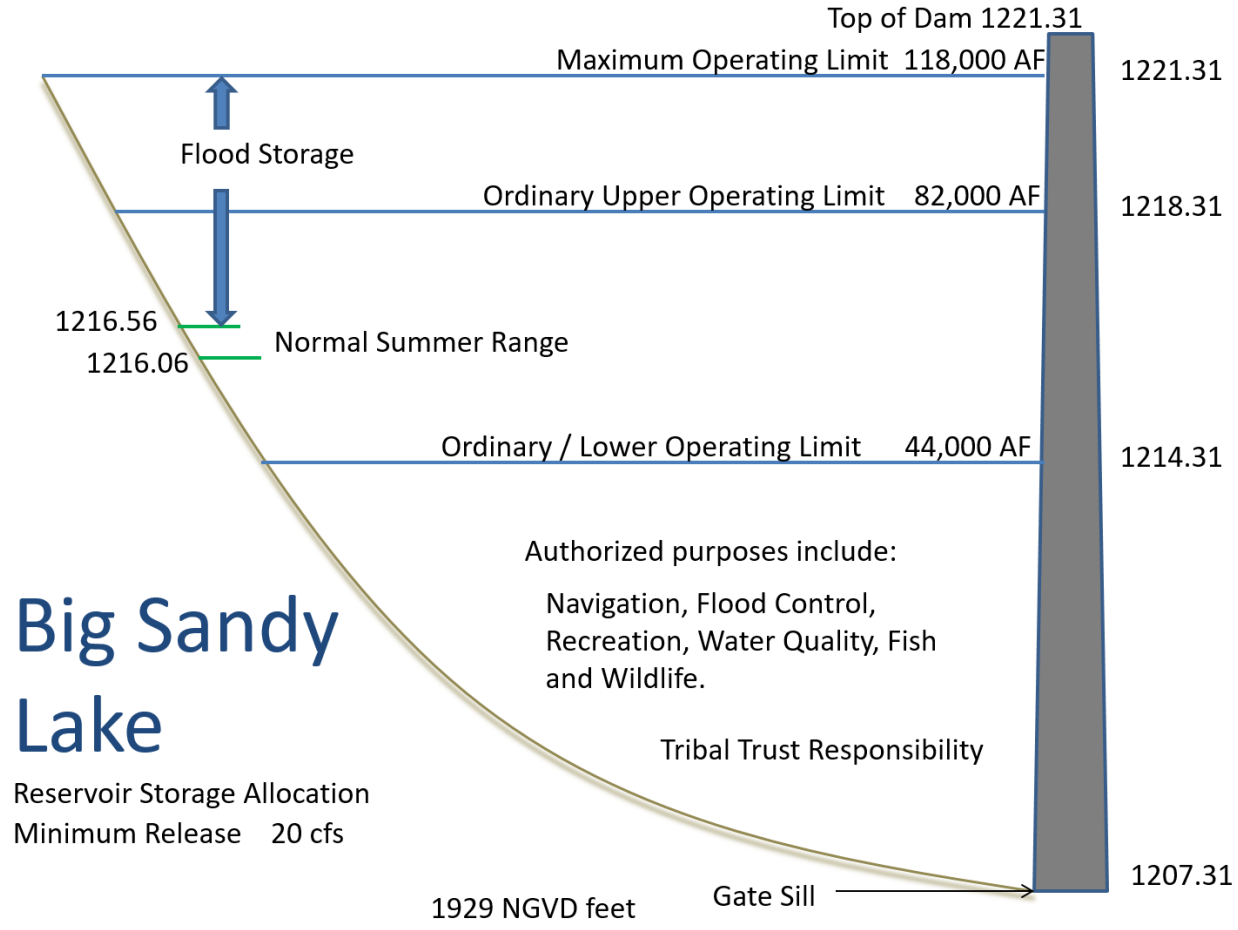


Figure 1. Duration hydrograph for Big Sandy Lake discharges.

Pool Allocation



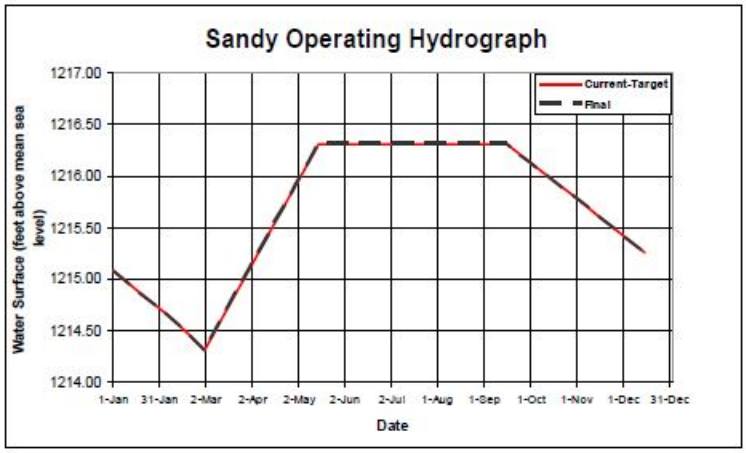
Overall Plan for Water Control

Sandy Lake reservoir is regulated between a minimum elevation of 1214.31 feet and a maximum elevation of 1221.31 feet. If possible, the reservoir level should be within its summer range/band of 1216.06 feet to 1216.56 feet by the first day of the fishing season (approx. mid-May). The winter drawdown of the reservoir for spring flood control begins in the fall. The ordinary (normal) spring drawdown elevation is 1214.31 feet, which is the lower operating limit of the reservoir. Significant shoreline erosion begins to occur at approximately elevation 1218.31 feet but storage to elevation 1221.31 feet can be used if needed to prevent flooding downstream.

The Water Control Manuals (WCM) are in the process of being updated with the findings of the 2009 Reservoir Operating Plan Evaluation (ROPE) Study. The table below summarizes reservoir operation for both the WCM and ROPE parameters.

TABLE S-7 SANDY LAKE OPERATING RULES		
	CURRENT	FINAL
Summer Band (elev. - feet)	1216.06-1216.56	1216.06-1216.56
Summer Target (elev. - feet)	1216.31	1216.31
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	>=(1214.31): 20 cfs	>=(1214.31): 20 cfs
	<(1214.31): 10 cfs	<(1214.31): 10 cfs

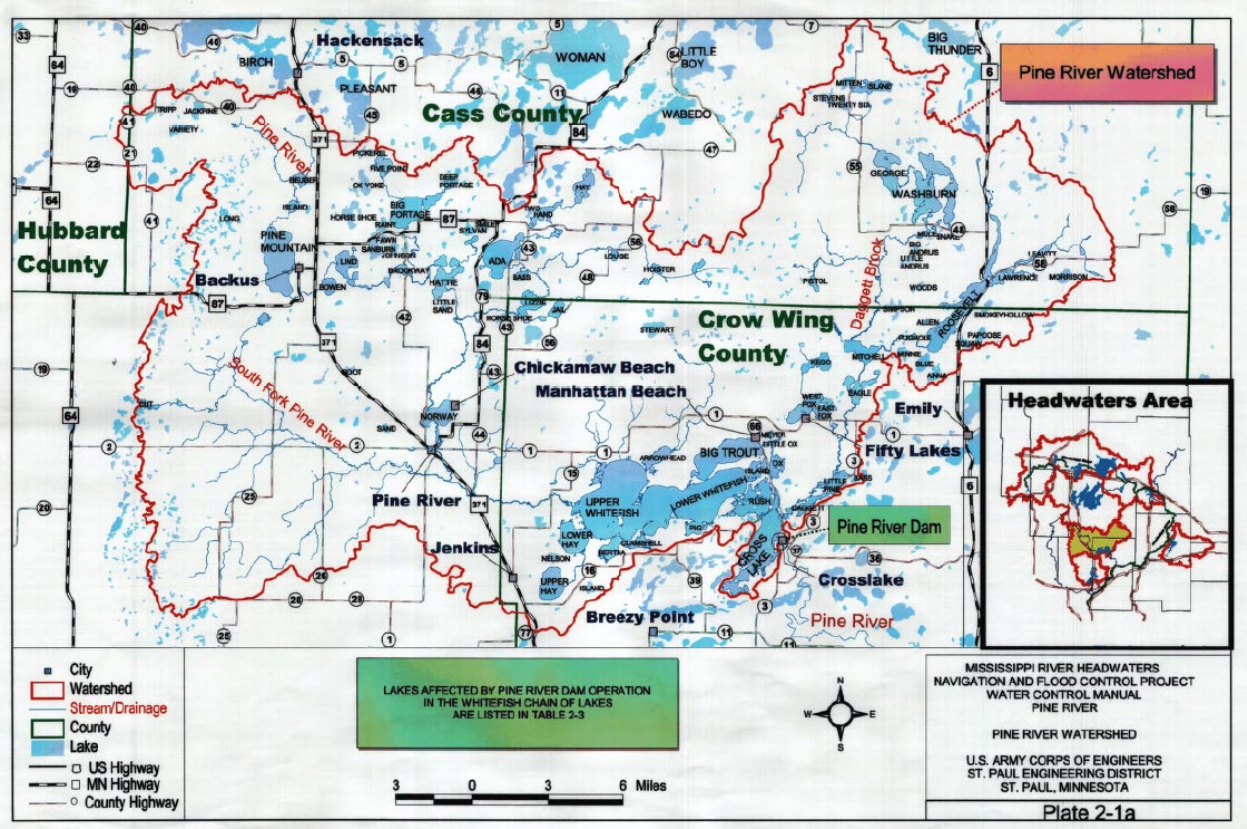
Figure S-5. Final Plan Operating Hydrograph, Sandy Lake



Reservoir Summary: Cross Lake Project

Project General Objectives: The reservoir is regulated primarily for recreation, flood control and fish and wildlife. The Water Control Plan supports recreation by maintaining, when possible, stable reservoir levels within a specified elevation band during the summer. Flood control objectives are met by a fall/winter drawdown schedule and a designated flood control storage pool, which provides storage capacity for spring and summer flood events. Water levels are managed, when conditions permit, for various fish and wildlife concerns. The lowflow plan manages water resources both upstream and downstream of the dam during critical periods.

Basin Map



Pertinent Data Sheet

Location	Pine River Dam is located at the outlet of Cross Lake on the Pine River at Crosslake, Minnesota, 14.5 miles upstream of the confluence with the Mississippi River. The confluence is at river mile 1023.8 above the Ohio River. The dam is in Crow Wing County, 22 miles north of Brainerd, Minnesota. It is at Lat. 45° 40 '09" N, Long. 96° 06' 44" W in Section 21, T137 N, R27 W.
Type of Project	Dam and Reservoir
Project Owner	U.S. Government, Department of the Army
Operating Agency	U.S. Army Corps of Engineers, St. Paul District.
Regulating Agency	U.S. Army Corps of Engineers, St. Paul District.
Closure Date	Dam discharge records begin 26 March 1886. Timber structure complete 1887. Timber replace by concrete structure 1905 to 1908.

RESERVOIR

Cross Lake Reservoir Pine River Dam	Elevation in Feet	Area in Acres	Cumulative Storage in Acre-Feet
Maximum Operating Limit	1235.3	15,500	188,000
Normal Summer Pool Level	1229.32	13,600	101,000
Minimum Operating Limit	1225.32	12,500	49,100
Slide Gate Sill	1216.65	---	0

Maximum Pool Elevation (Historic) 1234.73 ft., 7 July 1916 event

Real Estate Taking Line for Easement 4 ft. above a 18.5 ft stage = Elev. 1238.82 ft.

Reservoir Length at Top of Summer Pool Level 8.4 miles

Shoreline Length at Top of Summer Pool Level 112.0 miles

HYDROLOGY

Drainage Area	562 square miles
One Inch of Runoff Equals	29,973 acre-feet
Storm Types	Thunderstorm, frontal rain, snow
Flood Season	15 March - June
Low Flow Season	July - October

Note: All inflows are based on 24-hour averages from reverse routing.

Minimum Mean Daily Inflow	Flow is very low during dry periods.
Minimum Mean Monthly Inflow	Flow is very low during dry periods.
Minimum Mean Annual Inflow	90 cfs, 1934
Maximum 24-hr. Average Inflow	3,710 cfs, 2 June 1898
Maximum Mean Monthly Inflow	1,660 cfs, May 1950
Maximum Mean Annual Inflow	550 cfs,1905
Average Annual Inflow	270 cfs, (Period 1898-1985)

HYDROLOGY (continued)

Maximum Flood Volume	157,000 ac.-ft., 15 April - 10 June, 1950
Type of Meteorological Data Recorded at Site	Rainfall, snowfall, temperature, cloud cover, wind, snowpack
Number of Sediment Ranges	None

EMBANKMENT AND DIKES

Embankment	
Type	Earthfill with timber diaphragm with sheet pile, concrete capped wall
Slope Protection	Riprap and grass; bituminous top (roadway)
Length	1,552 ft. (total left and right)
Height	23.9 feet
Minimum Top Elevation	1240.3 feet
Perimeter Dikes	
Number	16
Purpose	Impoundment
Slope Protection	Varies; grass, some riprap and bituminous top
Length	9,805 feet total
Height	Varies; generally <20 feet
Type	Compacted earthfill
Minimum Top Elevation	1240.3 feet

OUTLET STRUCTURE

Type	Gated multi-bay reinforced concrete control structure with concrete apron.
Structure Length Between Abutments	150 feet
Number/Size/Type of Gates	13 - 6.0 ft wide x 17.0 ft. high slide gates

OUTLET STRUCTURE (cont)

Gate Sill Elevation	1216.65 ft.(slide gate bays)

SPILLWAY

No Service or Emergency Spillways | Gated concrete sluiceway outlet facility only

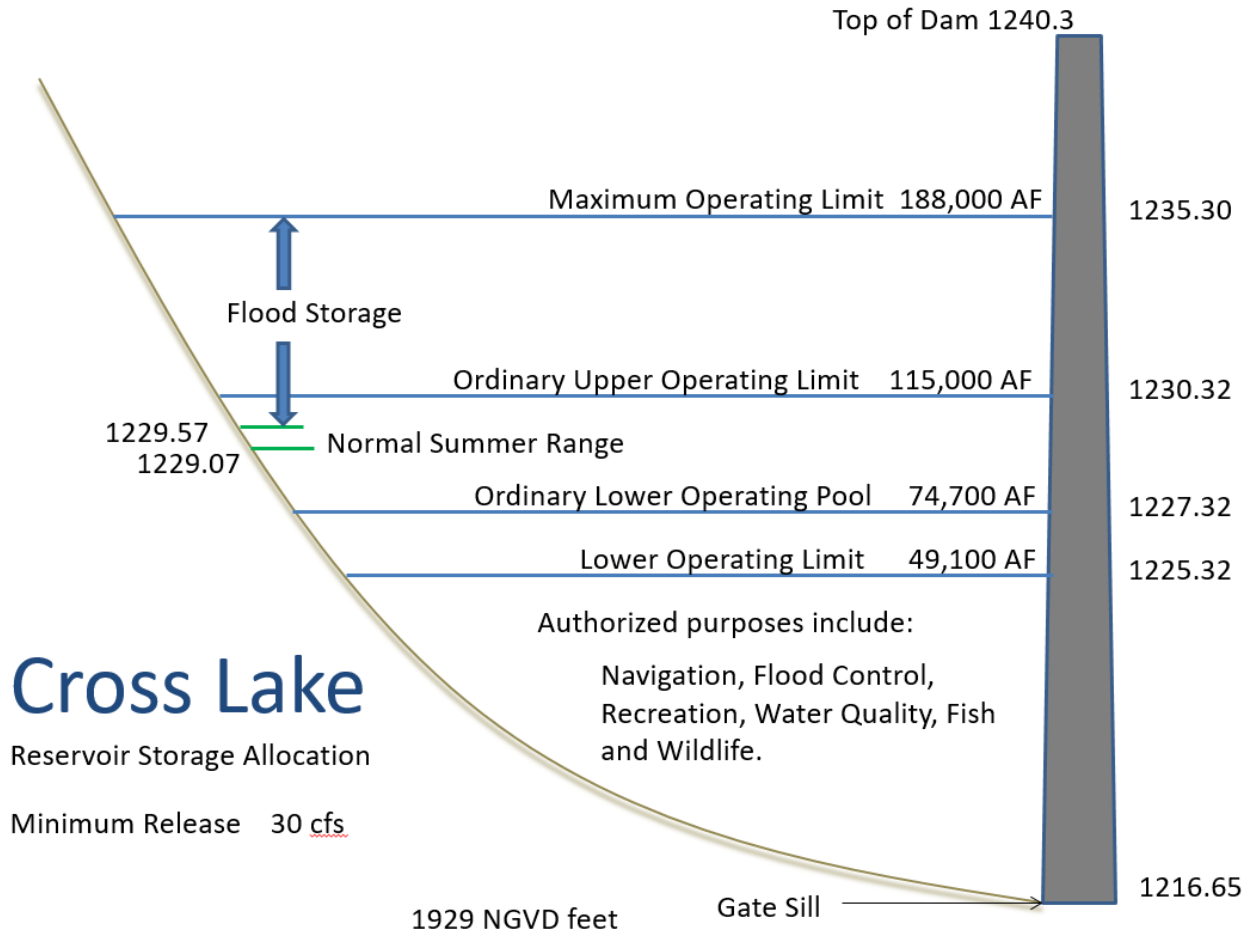
SPILLWAY APRON

Type:	Concrete and timber
Length:	55 feet
Width (between abutments):	150 feet
Floor Elevation:	1216.65 feet

Basin Characteristics

Cross Lake Dam is located on the Pine River 14.5 miles upstream of its confluence with the Mississippi River (at river mile 1023.8 above the Ohio River). The confluence of the Pine and Mississippi Rivers is at 5.9 river miles above Black Bear and Miller Lakes and 22.3 river miles above Brainerd, Minnesota. Cross Lake reservoir (Pine River Dam) watershed is slow and significantly attenuated as a result of the relatively flat topography and the presence of many lakes and wetlands. Pine River Dam controls the runoff from a 562 square mile area, of which 42 percent is dry land, 24 percent is water, and 34 percent is wetlands. In general, the land not covered by wetlands is forested. The average overland slope is 48.05 feet per mile.

Pool Allocation



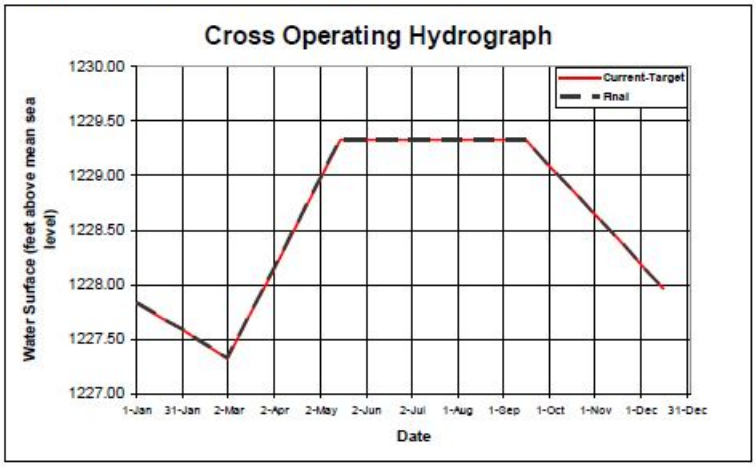
Overall Plan for Water Control

Cross Lake reservoir (Pine River Dam) is regulated between a minimum elevation of 1225.32 feet and a maximum elevation of 1235.30 feet. If possible, the reservoir level should be within its summer range/band of 1229.07 feet to 1229.57 feet by the first day of the fishing season (approx. mid-May). The winter drawdown of the reservoir for spring flood control begins in the fall. The ordinary (normal) spring drawdown elevation is 1227.32 feet, however the reservoir can be drawn down to 1225.32 feet if warranted by potential spring runoff conditions. Details of the water control plan are given in the following paragraphs. Significant shoreline erosion begins to occur at approximately elevation 1230.32 feet but storage to elevation 1235.30 feet can be used if needed to prevent flooding downstream. To promote whitefish spawning, the drawdown of the reservoir is coordinated with the Minnesota Department of Natural Resources

The Water Control Manuals (WCM) are in the process of being updated with the findings of the 2009 Reservoir Operating Plan Evaluation (ROPE) Study. The table below summarizes reservoir operation for both the WCM and ROPE parameters.

TABLE S-8 CROSS LAKE OPERATING RULES		
	CURRENT	FINAL
Summer Band (elev. - feet)	1229.07-1229.57	1229.07-1229.57
Summer Target (elev. - feet)	1229.32	1229.32
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	>=(1225.32): 30 cfs	>=(1225.32): 30 cfs
	<(1225.32): 15 cfs	<(1225.32): 15 cfs

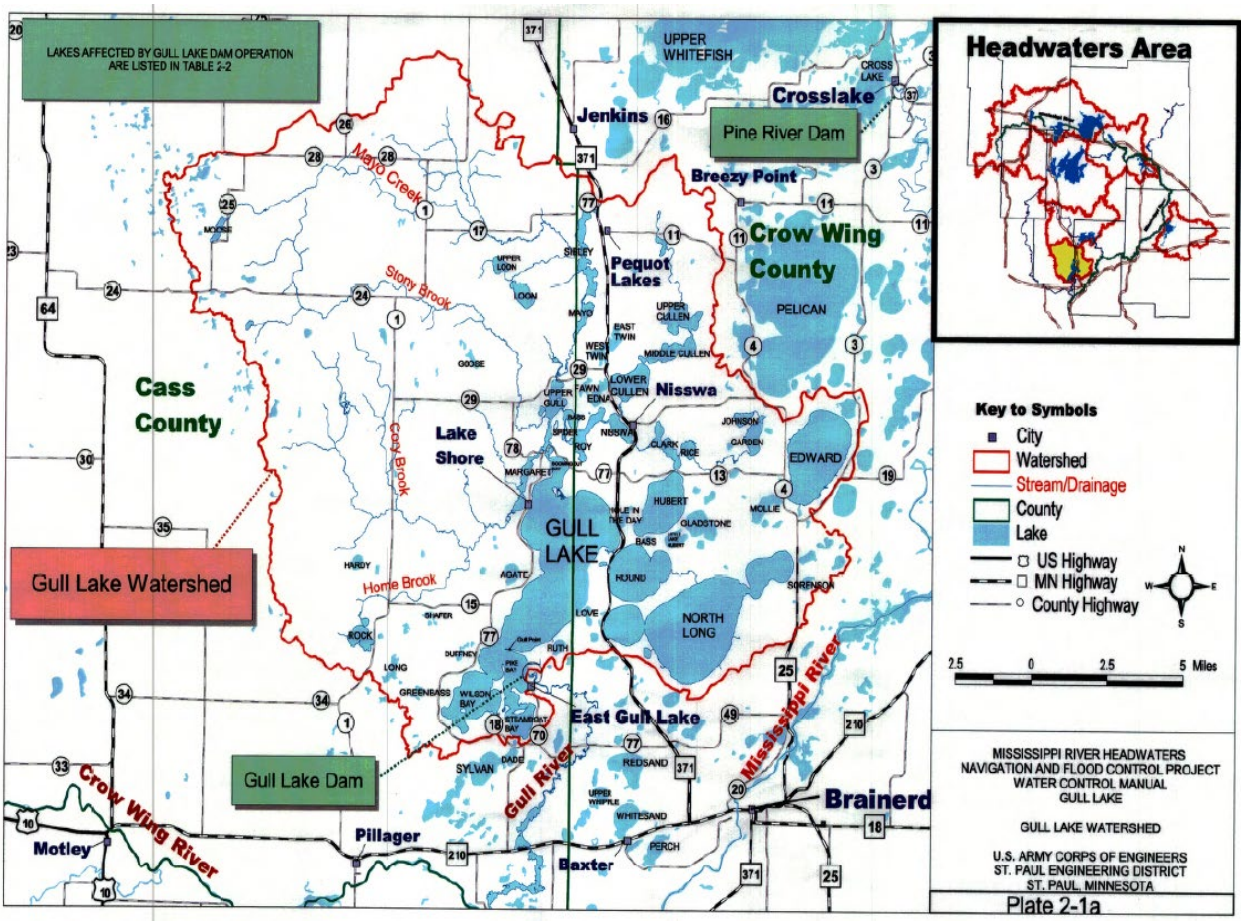
Figure S-6. Final Plan Operating Hydrograph, Cross Lake



Reservoir Summary: Gull Lake Project

Project General Objectives: The reservoir is regulated primarily for recreation, flood control and fish and wildlife. The Water Control Plan supports recreation by maintaining, when possible, stable reservoir levels within a specified elevation band during the summer. Flood control objectives are met by a fall/winter drawdown schedule and a designated flood control storage pool, which provides storage capacity for spring and summer flood events. Water levels are managed, when conditions permit, for various fish and wildlife concerns. The lowflow plan manages water resources both upstream and downstream of the dam during critical periods.

Basin Map



Pertinent Data Sheet

Location	Gull Lake Dam is located at the outlet of Gull Lake on the Gull River, 11 miles upstream of its confluence with the Crow Wing River. This confluence is 16 miles upstream of its confluence of the Crow Wing and Mississippi River. The confluence with the Mississippi River is at river mile 990.4 above the Ohio River. The dam is in Cass County, 8 miles northwest of Brainerd, Minnesota. It is at Lat. 46° 24' 40", Long. 94° 21' 12", in Section 20, T134 N, R29 W.
Type of Project	Dam and Reservoir
Project Owner	U.S. Government, Department of the Army
Operating Agency	U.S. Army Corps of Engineers, St. Paul District
Regulating Agency	U.S. Army Corps of Engineers, St. Paul District.

Closure Dam Dam discharge records begin 1 September 1911, concrete structure complete 1912. Some records for the logging dam at the outlet of Gull Lake are available back to September 1895.

Gull Lake	Elevation in Feet	Area in Acres	Cumulative Storage in Acre-Feet
Maximum Operating Limit	1194.75	13,100	71,000
Normal Summer Pool Level	1194.00	13,000	59,000
Minimum Operating Limit	1192.75	12,750	45,000
Sill	1188.75	---	0

Maximum Pool Elevation (Historic) 1195.09 ft., 22 July 1952 event

See Paragraph 4-06.e

Real Estate Taking Line for Easement	Elevation 1194.75 feet (See **Chapter 2**)
Reservoir Length at Top of Summer Pool Level	8.4 miles
Shoreline Length at Top Summer Pool Level	35.6 miles

HYDROLOGY

Drainage Area	287 square miles
One Inch of Runoff Equals	15,307 acre-feet

OUTLET STRUCTURE

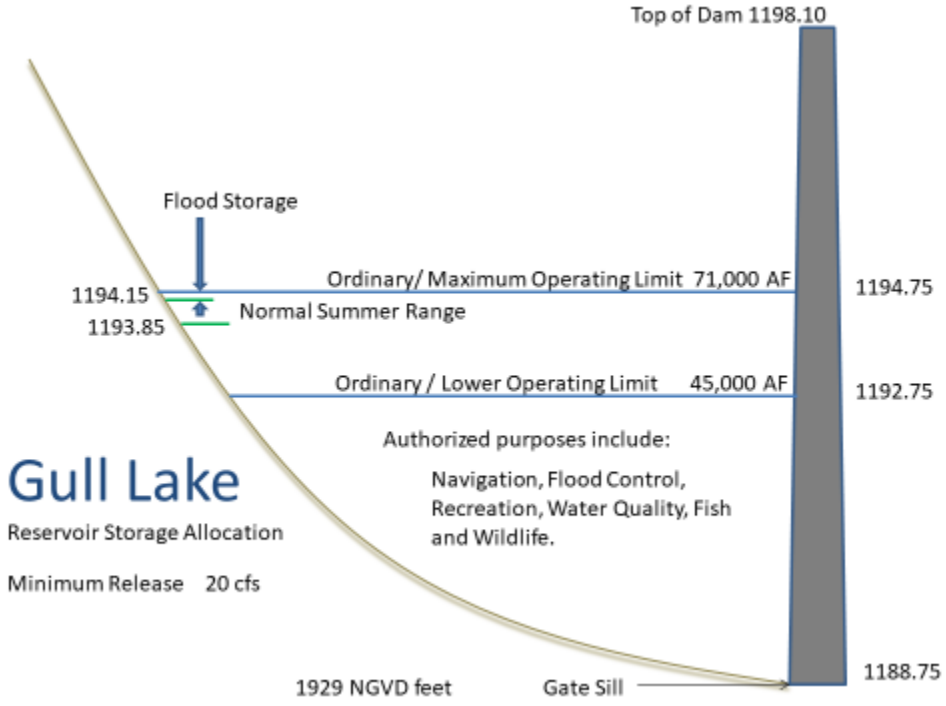
Type Gated multi-bay concrete control structure

	with concrete apron
Structure Length Between Abutments	68.9 feet
Number/Size/Type of Gates	5 - 5.0 ft. wide x 4.0 ft. high slide gates 1 - 11.0 ft. wide stoplog bay (log sluice) (The 5.0 ft. wide fishway is blocked off.)
Entrance Invert Elevation	1188.75 feet
Top of Roadway Elevation (top of the curb)	1199.75 feet

Basin Characteristics

Gull Lake Dam is located on the Gull River 11 miles upstream of its confluence with the Crow Wing River. The confluence of the Crow Wing and the Mississippi Rivers (at river mile 990.4 above the Ohio River) is approximately 16 river miles downstream of the dam and 11.5 river miles downstream from Brainerd, Minnesota. Gull Lake Reservoir watershed is slow and significantly attenuated as a result of the relatively flat topography and the presence of many lakes and wetlands. Gull Lake Dam controls the runoff from a 287 square mile area, of which 54 percent is dry land, 23 percent is water, and 23 percent is wetlands. In general, the land not covered by wetlands is forested. The average overland slope is 58.08 feet per mile.

Pool Allocation



Overall Plan for Water Control

Gull Lake reservoir is regulated between a minimum elevation of 1192.75 feet and a maximum elevation of 1194.75 feet. If possible, the reservoir level should be within its summer range/band of 1193.85 feet to 1194.15 feet by the first day of the fishing season (approx. mid-May). The winter drawdown of the reservoir for spring flood control begins in the fall. The ordinary (normal) spring drawdown elevation is 1192.75 feet, which is the lower operating limit of the reservoir.

The Water Control Manuals (WCM) are in the process of being updated with the findings of the 2009 Reservoir Operating Plan Evaluation (ROPE) Study. The table below summarizes reservoir operation for both the WCM and ROPE parameters.

TABLE S-9 GULL LAKE OPERATING RULES		
	CURRENT	FINAL
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	1193.0
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	>=(1192.75): 20 cfs	>=(1192.75): 20 cfs
	<(1192.75): 10 cfs	<(1192.75): 10 cfs

TABLE S-10 Gull Late Summer Elevations			
	Current (feet)	Final (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

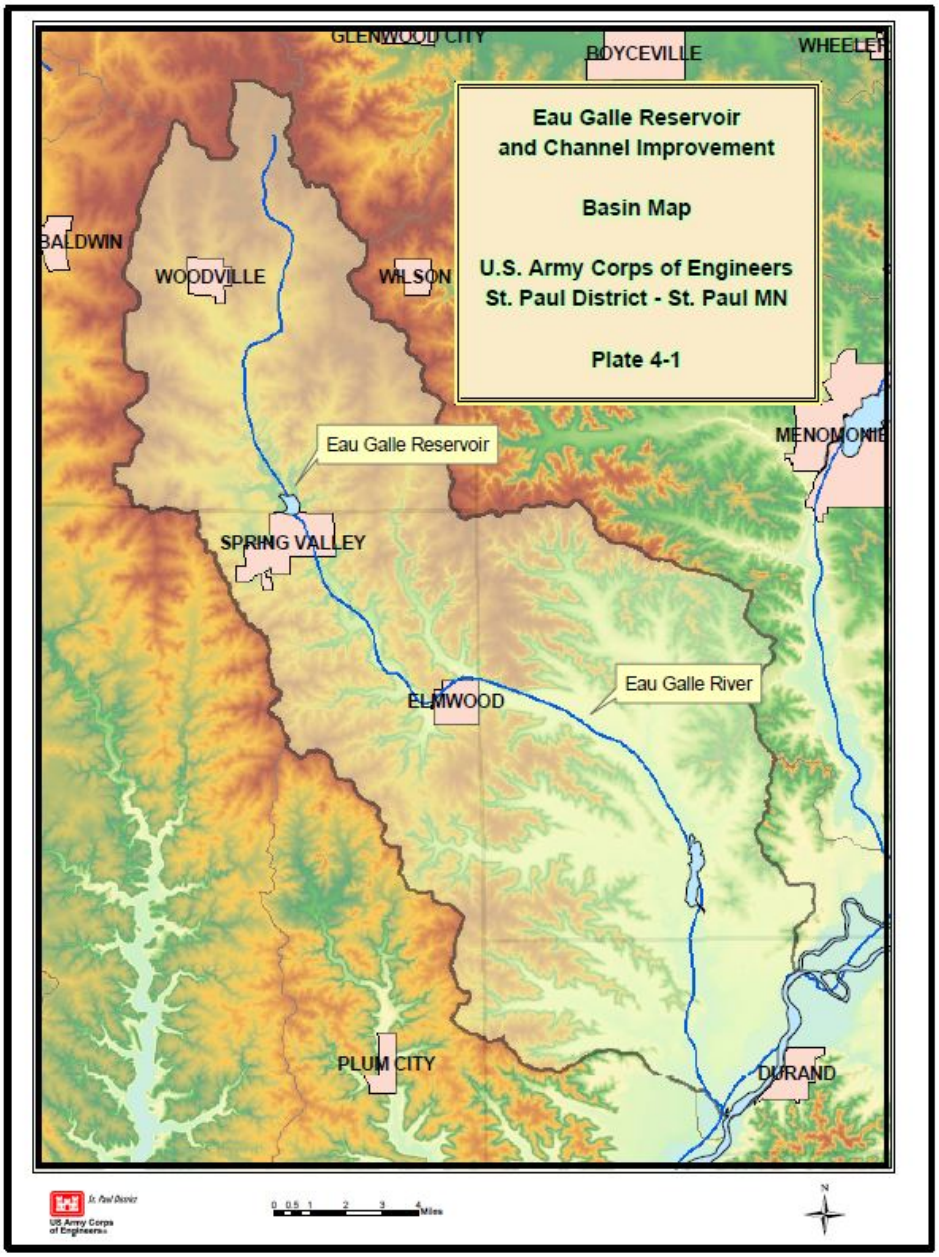
Note: The difference was calculated from the target in the current operating plan (1193.87), rather than the top of the band (1194).

St. Paul District SRP Workshop
All District Reservoirs - Environmental Flows

Reservoir Summary: Eau Galle Reservoir and Dam

Project General Objectives: The primary purpose of the Eau Galle Reservoir is flood control for the village of Spring Valley, Wisconsin, which is located immediately downstream of the dam. Recreation and enhancements for fish and wildlife are recognized as additional benefits.

Basin Map:



Location: Eau Galle Reservoir is located on the Eau Galle River, at river mile 30.3, immediately upstream of the village of Spring Valley, Wisconsin. It straddles the Pierce and St. Croix County line at approximately latitude 44°51'10" and longitude 92°14'17". The Eau Galle River is located in west-central Wisconsin midway between St. Paul, Minnesota and Eau Claire, Wisconsin. The Eau Galle River is a tributary to the Chippewa River, which is a tributary to the Upper Mississippi River.

Drainage Areas: Eau Galle River at Eau Galle Reservoir: 63.9 square miles
Eau Galle River at the mouth: 230.0 square miles

Datum: 1929 NGVD

Dam:

Type: Zone Embankment-Clay Core
Maximum Height: 122 feet
Length: 1800 feet
Top Width: 20 feet
Design Crest Elevation: 1038.5 feet
Side Slopes:
Crest Over-Burden Elevation: 1040.25 feet
To Elev 1033.5 ft 1V:2.5H
Crest Over-Burden Low Point: 1040.15 feet
Above 1033.5 ft 1V:2H

Freeboard above Spillway Design Flood (PMF): 3.95 feet
Freeboard above Conservation Pool Elevation: 100.15 feet

Control Structures:

Type: Morning Glory
Diameter: 25 feet
Elevation: 940.0 feet
Outlet: Horseshoe Conduit 9-feet 3-inch
Conduit Area: 67.2 sq ft
Conduit Length: 700 feet
Discharge at 1020.0 ft: 3,800 cfs

Type: Emergency Spillway
Length: 1930 feet Crest
Width: 100 feet
Crest Elevation
Design: 1020.0 feet
As-Built: 1019.53 feet
Side Slopes: Vertical
Max Discharge: 25,000 cfs

Type: Low Flow
Diameter: 48-inch
Inlet Gate: 4-foot Slide
Inlet Invert Elevation: 916.5 feet Outlet
Invert Elevation: 915.0 feet

Outlet Structure:

Type: Flared Stilling Basin
Length: 150 feet - 1 inch
Width at Inlet: 10 feet
Width at End Sill: 53 feet – 4 inches

Reservoir:
Conservation Pool Elevation: 940.0 feet Pool Area: 150 acres
Minimum Outflow
Normal Conditions: 13 cfs
Drought Conditions: 2 cfs
Name of Lake:
Project Pool Name: Eau Galle Lake or Reservoir
As Shown on State Highway Maps: Lake George

Watershed Characteristics

The main valley and the deeply cut tributaries of the Eau Galle River are characteristic of the topography found in a maturely dissected plateau region. Glacial deposits have given the upland areas a gently rolling topography; whereas, the lower reaches of the basin show less modification by glaciers. There is evidence that the earliest Nebraskan stage of glaciation covered the area but that glaciers of the last Wisconsin stage did not reach the area. The elevation of the Eau Galle River at the headwaters is 1267 feet. The river falls 572 feet to elevation 695 feet at its junction with the Chippewa River.

This geology along with a climate of temperate ranges from hot summers to cold winters creates highly variable flows in the river. **Figure 1** shows a duration hydrograph of the discharges from Eau Galle Dam.

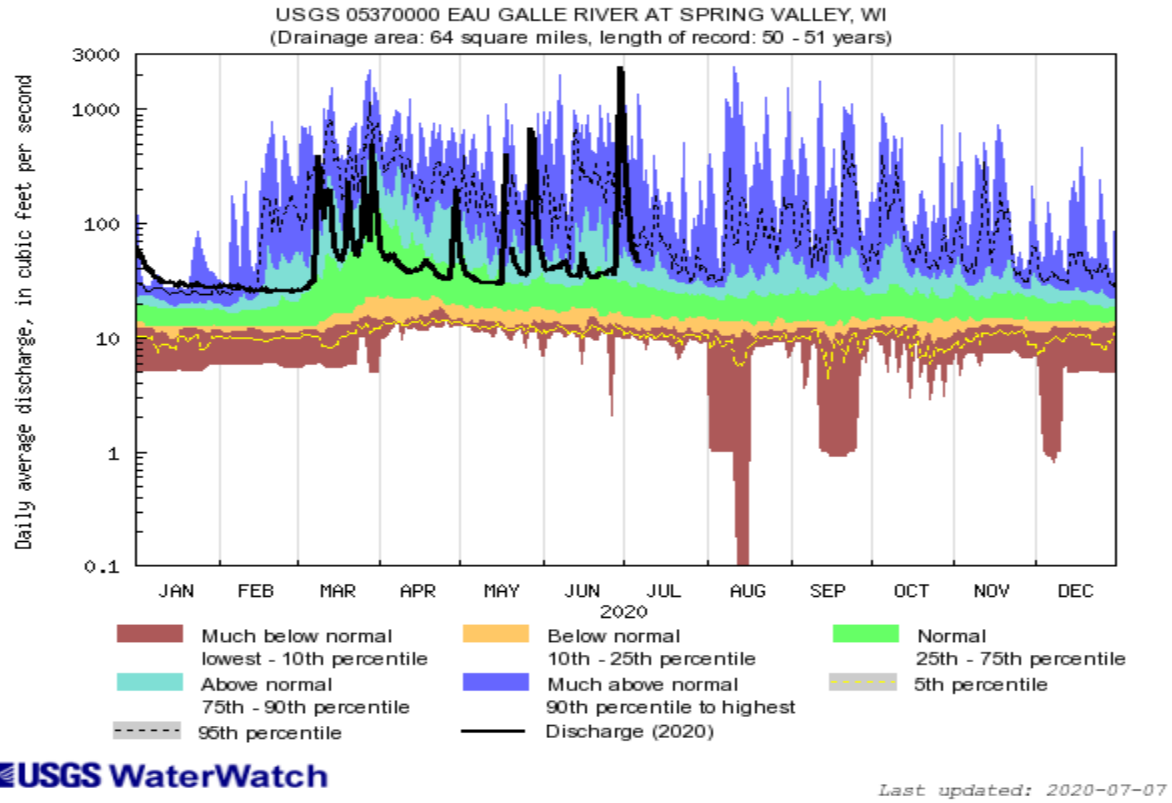
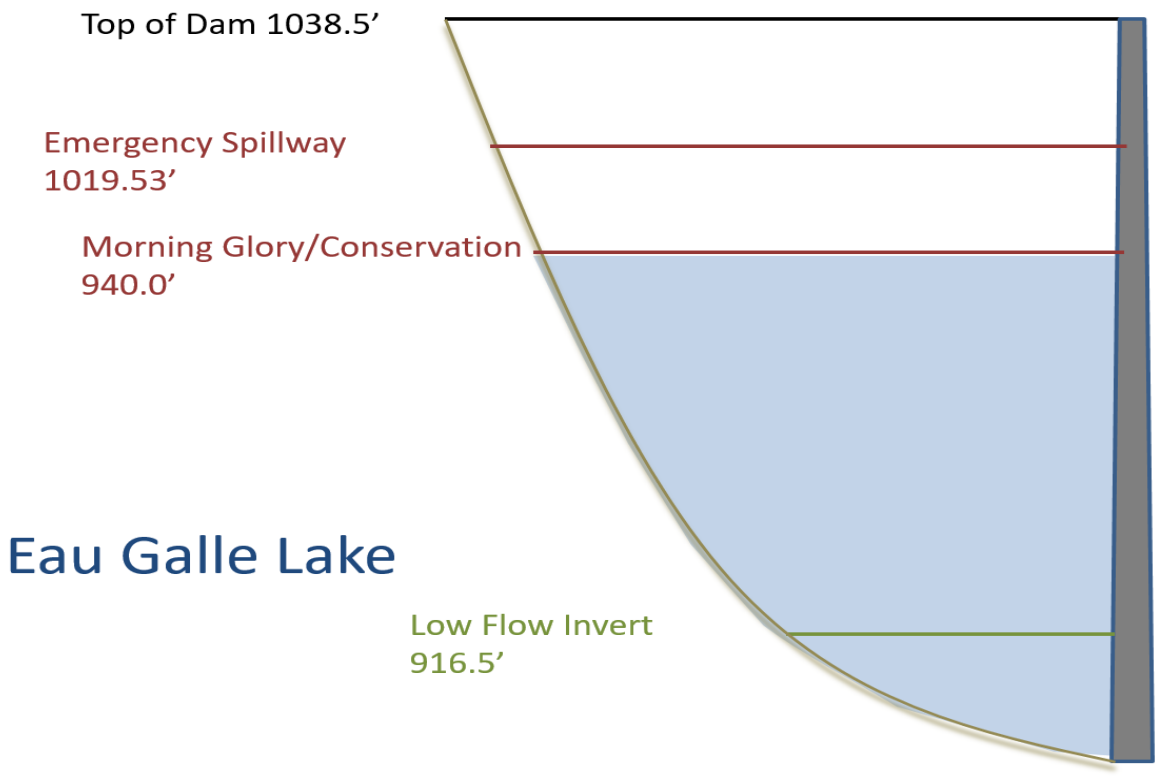


Figure 1. Duration hydrograph for Eau Galle Dam discharges.

Pool Allocation



Overall Plan for Water Control

The only outlet control is at the low flow culvert. The operating plan provides for maintaining a minimum discharge of 13 cfs whenever possible. During drought periods, if the pool falls below elevation 939.5 feet, minimum outflow may be reduced to 2 cfs (see Drought Contingency Plan 1992). During normal operations, the low flow outlet gate is typically set at 13 cfs and all additional inflow spills over the morning glory spillway, thus maintaining a conservation pool of elevation 940.0 feet (crest elevation of the morning glory spillway).

Regulation of the Eau Galle Reservoir is automatically controlled by the morning glory spillway up to the crest of the emergency spillway. The downstream channel capacity is 4,800 cfs. With the pool at the crest of the emergency spillway, outflow is approximately 3,800 cfs. When the pool rises above the crest of the emergency spillway (elevation 1019.53 feet), regulation remains automatic; however, flow is also going down the emergency spillway. Peak pool elevation is 1036.2 feet, as indicated by the routing of the Probable Maximum Flood.

Constraints

Low flow outlet has an invert elevation of 916.5 feet (1929 adjustment). For practical purposes, it is assumed drawdown of the pool is constrained to elevation 917.0 feet. Therefore, dead storage is 78 acre-feet, based on the 1987 sediment survey.

Due to cracking of the conduit, a grout and steel liner was installed over the winter of 1981–82. For a pool elevation of 1020.0 feet, the conduit capacity was reduced to 3,800 cfs. The emergency spillway has a crest elevation of 1019.53 feet. Routing of the Probable Maximum Flood indicated a peak pool elevation of 1036.2 feet. At this elevation, the capacity of the emergency spillway is 25,000 cfs.

Appendix B.

Workshop Notes Tables

Ideas Affecting Reservoir - **Baldhill**				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Reduce pool elevation and fall draw down early in the year to increase/improve water fowl habitat on the reservoir	M	Y	Check with local Agencies to help determine benefits and costs?
2	Consider a draw-down to improve vegetation (growing season)	N	Y	Could impact downstream if we enter a drought
3	Maintain the pool elevation during spring spawning season to cause less impacts to spawning fish.	M	Y	Do we have an issue with the fluctuations? Communities may have an issue, depending on length of time. If agencies say yes, see if there is a small time window that we could look at implementing a flat pool.
4	Drop reservoir levels sooner, so it assists in successful amphibian and fur bearing animals for hibernation/winter protection	M	Y	Check with local Agencies to help determine benefits and costs? May adversely impact fishery?
Ideas Affecting Downstream				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Mitigating outflow based on precipitation; match inflow and outflow, during drought matching inflows to flush out downstream if water supply needs are not impacted.	Y-w/7?	Y	Basically allow "flushing" flows that would occur during high rainfall events. But what is "natural" now? High flushing/runoff events may not be.
2	Mimicking river flows with gate openings, doing more changes than the required minimum; having more involvement from Env. In terms of how to implement. Reconsidering a rate of change.	Y	Y	Rate of change review to attempt to match natural river flow fluctuation.
3	Reduce impacts of Periodic Inspection-thinking of large decreases over a short time period to do the inspection--look at the attenuation and how far the impacts are below the reservoir	Y-w/2	Y	Consider ways to minimize impacts from PI's - rate of change restrictions may be more harmful than beneficial within the context of a PI.
4	Ensuring a strong lateral connectivity-for riparian vegetation/habitat	N	Y	Opportunity here is too limited; stream is too incised to allow this
5	Conduct a study to manage low flow to protect fish & mussels populations. Instream flow incremental methodology, fish habitat downstream of the dam.	M-w/1	Y	Minimum release review.
6	Directional release of flows due to temperature variance within levels of reservoir	N	Y	seems there is limited opportunity to affect water temperature - reservoir is relatively shallow and the river is a warm water system.
7	Periodic high flow release to change downstream bathymetry/geomorphology	M	Y	already running the stream at high flow, mostly due to Devil's lake pumping; but worth considering
8	Note for Consideration: Some sedimentation may be natural-but may have to keep in mind there are different geomorphic formations in different parts of the basin.	*---------	*----------	
Ideas Affecting Other Items				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Conduct a hydraulic study to determine the level of lake bounce required to reduce the frequency and duration of downstream flows that would typically result in the operation of the Sheyenne Diversion.	Y	N	Consideration of increasing minimum releases, is a flush or maintaining flows?
2	Alterations in the summer operations to reduce damages-hold conversation with downstream interests. Letter did not elaborate further/Alter the summer and fall operation to account for the Devil's Lake outlet flows and wetter climactic conditions./More frequently and fully utilize the available flood storage provided by the dam	Y	N	
3	Keep water elevations higher longer so people can utilize the access points longer throughout the year	Y	N	might coincide with broader operating plan review.
4	Begin discussions on invasive species (i.e. curly pond weed, zebra muscles) anything we can discuss to control the populations? Natural predators? How to handle in the future?	Y	N	
5	Conduct study to mimic current hydrology and model hydrology based on Climate Change	Y	M	Might be SRP appropriate, but would be in the context of a larger study.
6	Assessment for the possibility of bio-engineering for erosion control; An assessment including wind fetch along with higher water levels.	Y	N	
7	Look for weak areas above or below riprap where impacts occur due to annual fluctuations in water levels.	Y	N	
8	Enhancing connectivity of fish passage with structural changes	Y	N	

Ideas Affecting Reservoir - **Homme**				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Is there a benefit to keeping the reservoir higher? 1 foot drawdown as opposed to 3 foot.	Y	Y	Would have to be careful. Have to be at specific temperatures for drawdowns. There is a list of preferred temps-don't want to add ice to the channel.
2	Measure water usage of golf course and potatoes washing-how affects the reservoir? Would this possibly lead to having more water available for other uses?	M	Y	Likely a limited opportunity here.
3	"Solar Bees" to circulate the water? Mechanical help to mitigate algae	N	N	Would need further study to determine if these would be effective in solving an algae issue.
4				
Ideas Affecting Downstream				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Delay release until later in the winter to prevent ice build-up in the downstream channel	N	Y	Winter drawdown, including the effects of ice buildup, was reviewed and implemented in its current form in 2014.
2	Is there a way to improve conditions against low flow. Can there be a deeper pool for a fish refuge--advantage: reduced sediment transport, pools may last longer	N	Y	A deeper pool downstream with little or no flow would likely go anoxic and still not provide fish habitat. It may be better that the stream goes dry, and fish are forced to move downstream to other waters, rather than be encouraged to stay in a pool.
3	Low flow release mechanism-perhaps utilizing water column temperature variations to release	N	Y	Seems to be limited benefit at this time as the river periodically goes dry.
4	Fish Passage considerations	N	Y	Seems to be limited benefit at this time as the river periodically goes dry.
5	Add structures to the spillway to improved O2 levels/aeration	N	Y	Seems to be limited benefit at this time as the river periodically goes dry.
6				
Ideas Affecting Other Items				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Sediment retention basins?	N	N	Upstream basins may slow sedimentation in the reservoir, but would be costly and maybe of limited benefit here.
2	Decommissioning the project at end of life. Communities have different sources of water now	N	N	Out of scope for this effort.
3	Mitigate algae problem	N	N	Could study this in the future.
4	Start a field level soil saving practices to help fight sedimentation issues-multi-agency?	N	N	Out of scope for this effort.
5				

Ideas Affecting Reservoir - **Highway 75**				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
Ideas Affecting Downstream				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Provide base flow fish passage channels around or through the Big Stone National Wildlife Refuge (NWR) dams by constructing rock-arch fishways.	Y	N	This would be a major restoration project likely best funded through Section 1135
2	Restore the natural Minnesota River channel through the Big Stone NWR.	Y	N	This would be a major restoration project likely best funded through Section 1135
Ideas Affecting Other Items				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Conduct a new Reservoir Operating Plan Evaluation (ROPE) which takes into account changes in the watershed in the last two decades.	M	N	Is this reservoir a priority for a ROPE in the next 5 years?
2	Propose this reservoir for a Water Resources Development Act Section 1135 environmental restoration feasibility study, led by a Local Government Unit, in addition to the Sustainable Rivers Project.	M	N	Possible to pursue with idea #3.
3	Form a cross-agency inter-disciplinary team to discuss management goals and objectives and to recognize these reservoirs are part of one system, not independent basins. This is a similar approach as the Marsh Lake Adaptive Management Team.	M	N	Need to consider this further and identify potential funding to support it. If it is supported, it could be used to investigate support for idea #2.

Ideas Affecting Reservoir - **Marsh**				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Coordinate and Share the lessons learned with UMR drawdown efforts.	Y	N	Could offer this project as an example to the program for things that can be done for these reservoirs. Could put together a presentation or public outreach piece to show how we've worked on this.
2				
Ideas Affecting Downstream				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1				
Ideas Affecting Other Items				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Preserve island habitats, monitor erosion around islands	M	N	Recent project
2	Prevent drawdown disconnect between the two lakes, and its affect on fish	M	N	Possible future study effort.
3	Do selective trapping of Carp	N	N	Likely to be minorly effective, expensive, and would be a DNR role.
4	Consideration/Factor: Look into effect of wind fetch depth differences and how a drawdown may affect that.	M	N	Possible future study effort.
5				

Ideas Affecting Reservoir - **Lac que Parle**				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Discuss new Lac qui Parle Lake target water surface elevations during spring and fall periods for the benefit of fish and wildlife resources.	Y	Y	
2	Comment/Note: Avoid late fall and winter drawdown to provide winter cover/habitat.	M	Y	Already being done. Check with Agencies to ensure we are understanding their concern
3	Discuss releasing more water (after 15 May) during summer flood events to reduce in-lake degradation and recreational impacts.	Y	N	Recreation would not fit under SRP but this could be considered and may also have environmental benefit.
4	Growing Season Drawdown	Y	Y	Share lessons learned and coordinate with the UMR drawdown efforts; There is no low-flow gate at LQP for drawdown
5	Raising the summer conservation elevation to 934' to create deeper water for aquatic habitat.	Y	Y	Investigate but not sure it is possible.
6				
Ideas Affecting Downstream				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Reevaluate the downstream flow constraints at LQP	Y	Y	Channel capacity? Is 2500 too low? We may be able to go higher
2	Adjust Operating Plan to allow for or to mimic a more natural hydrograph often found on natural riverine shallow lakes including the concept of a growing season drawdown (Lac qui Parle Lake).	Y	Y	Could also be under the Reservoir Section.
3	Chippewa/Watson flows. Any changes there that can benefit the environment?	Y	Y	Needs more definition/study.
4	Permanent conservation flood areas downstream-	M	N	Component to increasing channel capacity to over 2500 cfs. Would be very challenging to acquire these easements.
5				
Ideas Affecting Other Items				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Form a cross-agency inter-disciplinary team to discuss management goals and objectives and to recognize these reservoirs are part of one system, not independent basins. This is a similar approach as the Marsh Lake Adaptive Management Team.	Y	Y	Likely a first step after a decision is made to begin a ROPE, or could be used to investigate support for an 1135.
2	Conduct a new ROPE study for Lac qui Parle and Big Stone to recognize and adapt to the myriad of changes that have occurred in the watershed over the past two decades.	Y	Y	Requires funding.
3	Evaluate the reservoirs past and current role in providing downstream flood protection in context of recent and future climate predictions, known watershed alterations, community flood mitigation measures, and floodplain retirement programs.	Y	M	Would be part of a ROPE.
4	Due to poor water quality and detrimental environmental effects of the Lac qui Parle flood control project, it would be a candidate for a Section 1135 (Water Resources Development Act of 1986) environmental restoration feasibility study, led by a LGU, in addition to the Sustainable Rivers Project.	Y	M	Would need to investigate support and a sponsor for an 1135.
5	Ensure management purpose is in sync with watershed-wide management for habitat and target species	Y	Y	Would be part of a ROPE or 1135
6	Explore restoring islands lost due to chronic high water in same area	Y	N	Could be part of an 1135
7	Clean out area of aggradation above Lac qui Parle dam if necessary to allow for water level management.	Y	M	Could be part of an 1135 or ROPE
8	Conduct feasibility study on restoring fish passage for all fish species at Lac qui Parle dam to restore a more natural fish assemblage within the Upper MN River. Add Chippewa Diversion and Watson Sag	Y	M	Could be part of an 1135
9	Lower the spillway to 938 elevation or lower to reduce flooding impact to Lac qui Parle State Park buildings, roads and trails or mitigate the raising of the original spillway elevation.	Y	N	Could be part of a ROPE
10	Minimize water level fluctuations with structure design including but not limited to increasing spillway width with increasing flow.	M	N	Static water levels may not be desired.
11	Any structures, including rock riffles or fish ladders, and other passive structures should incorporate a low flow section to concentrate flow, allowing for migration during low flow conditions.	Y	N	Would be part of an 1135.
12	Provide base flow fish passage channels around or through the Lac qui Parle, the Watson-Sag Weir and Chippewa Diversion by constructing rock-arch fishways.	Y	N	Would be part of an 1135.
13	Alter Lac qui Parle dam bulkheads to be able to raise or lower to maximize water level management capabilities.	N		This can currently be done, but maybe they want more intermediate steps
14	General reduction of Rough Fish through multiple means, i.e. drawdown, freeze, open season	Y	Y	Could be a measure in a ROPE or 1135
15	Increase the ability to manage flow levels into the Watson Sag	M	M	Could be part of an 1135 or ROPE
16	Retro-fit/Update gates to allow stop-logs to be able to conduct maintenance	M	N	Could be investigated in a ROPE
17	Repurposing the current islands to increase habitat for birds	M	N	Would be part of an 1135.
18	Clean out multiple areas of Silt accretion from different parts of the system- Will require dredging.	M	N	Would be part of an 1135.
19				

Ideas Affecting Reservoir - **Red**				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Increase normal (Conservation) Pool elevation from 1174' MSL to 1175' MSL	Y	N	Review through a ROPE Study
2	Increase fall drawdown target from 1173.5' MSL to 1174.5' MSL	Y	N	Review through a ROPE Study
3	Maintain slightly higher water levels to contribute to better walleye year classes and lake whitefish to prevent ice scouring of the spawning beds	Y	M	Review through a ROPE Study
4	Maintain slightly higher water levels to aid in tribal water access	Y	N	Review through a ROPE Study
5				
Ideas Affecting Downstream				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Look at Rates of Change, and possible benefits of changing them	M	Y	Review through a ROPE Study
2				
Ideas Affecting Other Items				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	ROPE Study may be appropriate to address flood impacts, and natural resources up and downstream.	Y	N	
2	Need to look at freeboard and determine if water levels could be raised.	Y	N	Considered under a ROPE
3	Discuss who is responsible for the maintenance downstream. Can be included in a maintenance project to improve the channel.	Y	N	could be part of a ROPE or the TPP
4	Determine what needs to be done to finally complete the original project.			not sure what this refers to
5	Determine if the marshes are functioning properly and if something can be done to improve them.	Y	N	Known to have issues for a long time, haven't fixed it because we're not certain what to do.
6	Remove the downstream weir--what would happen?	Y	N	How would this affect vegetation, water flow, etc.…Will be considering under a planned Tribal Partnership Program (TPP) project.
7	Re-meander the channels	Y	N	
8	Operate the fishway as a fishway (Its intended purpose)	Y	N	Carp introduction to Red may still be issue.
9	Create fish passage for sturgeon	Y w/#6	N	could be part of a ROPE or the TPP
10	Lesson's Learned about fish movement from Big Sandy Fish Movement Study.	Y	N	could be part of a ROPE or the TPP
11	Develop outreach or education/team/planning study team with local tribes, local communities, etc...	M	N	could be part of a ROPE or the TPP
12	Remote Operation of the Dam	Y	N	Considered under a ROPE
13	Fish escapement through dam	M	N	has been studied, may be worth a follow-up study.
14	Coordinate with the Red Lake Watershed District about Good Lake and how it relates to our operations	M	N	could be part of a ROPE or the TPP
15	Converting Stoplogs to gates	Y	N	Considered under a ROPE
16	Look at downstream channel constraints	Y	N	Considered under a ROPE
17	Note: Consider turning over dam to the Red Lake Water District or Red Lake Nation	M	N	Considered under a ROPE

Ideas Affecting Reservoir - **Traverse**				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Optimization of fish and wildlife conditions in the pools is needed	Y	Y	Need to look for specifics from Agency
2	A higher conservation on traverse	Y	Y	
3	Reduced winter drawdown	Y	Y	
4				

Ideas Affecting Downstream				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Seasonal protected flow regimes are needed below the facilities to prevent fish kills in the Bois de Sioux River, particularly during summer-Minimum Summer Flow	Y	Y	
2	Bois de Sioux is routinely dewatered by operations of the dams at Traverse. Low flow requirement is something that should be considered to prevent summer fish kills in the Bois de Sioux	Y	Y	
3	Look into changes to drawdown for Spring run-off-possibility of reducing the drawdown	Y	Y	
4				

Ideas Affecting Other Items				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Look into sharing time to return to conservation after flood			
2	A higher conservation on traverse or dredging-recreational access			
3	Look into changes to drawdown for Spring run-off			
4	Update the water control manual (To include the Breckinridge-Wahpeton Flood Control Project)			
5	Look at the interbasin transfer			
6	Fish passage b/n Traverse ad Mud Lake			
7				

Ideas Affecting Reservoir - **Mud Lake**				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Optimization of fish and wildlife conditions in the pools is needed	Y	Y	Need more information from Agencies
2	Growing Season Drawdown for habitat benefits	Y	Y	
3	Operate like a moist soil unit--would provide minimum releases; Starting July 1st allow the pool to fall.	Y	Y	
4	Operating the reservoir for wetland habitat instead of lake habitat	Y	Y	
5	Allow a flood in the fall to assist in waterfowl migration	Y	Y	
6				

Ideas Affecting Downstream				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Seasonal protected flow regimes are needed below the facilities to prevent fish kills in the Bois de Sioux River, particularly during summer	Y	Y	
2	Bois de Sioux is routinely dewatered by operations of the dams at Mud. Low maintenance is something that should be considered to prevent summer fish kills in the Bois de Sioux	Y	Y	
3	Look into different ramping rates in response to Wahpeton stages	Y	Y	
4				

Ideas Affecting Other Items				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Look into sharing time to return to conservation after flood			
2	Look at updating the rate of change rule due to infrastructure constraints			
3	Changing the structure to have a low flow mechanism			
4	Improve the approach channel to the dam's outlet (dredging)			May limit some of the other ideas
5	Look into fish passage			
6	Get some easements to allow us to reconstruct the channel to historical			
7	Look at constructing low flow channel within the localized channel			
8	Construct 3 islands on the upper stretch of the lake to help against wind fetch			
9	Operating the lakes for increasing water quality			
10				

Ideas Affecting Reservoir - **Orwell**				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Look into having a smaller drawdown; Look at not having such a dramatic drawdown leaving a vegetation void-Spring Run-off	Y	Y	Maybe ready for a ROPE Study?
2	Touch base with DNR to see if they're interested in using the pool for various evn. benefits-throughout the year	Y	Y	
3	Include in operating plan island and shoreline conservation/habitat	Y	M	not sure how to achieve this
4	Reducing and lowering of the pool-purpose: leading to less drawdown	Y	M	would require ROPE
5	Conduct a drawdown to encourage aquatic vegetation in the pools connected to Orwell-throughout the year	Y	Y	
6				

Ideas Affecting Downstream				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Keep flow above 300 cfs to fight against decline in habitat; For native mussels: peaks at 450 cfs with a rapid decrease below 300 cfs. Mussels are particularly vulnerable to rapid flow reductions as they move slowly. (Change the minimum Flow Rate)	Y	Y	
2	Make more subtle gate changes to allow for more natural pulses	Y	Y	
3	A flow release that would assist in riparian vegetation - flood pulse in spring	M	Y	This may be difficult to impliment as it could induce flood damages
4	Having a flow release in support of restoration of channel dimension pattern and profile	M w/#3	Y	
5	Periodic high flow events to create geomorphically important sandbars, scours, etc.	M w/#3	Y	
6				

Ideas Affecting Other Items				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Continue to work with USACE towards fish passage through the dam as it has major implications for sturgeon recovery as well as bigmouth buffalo and other fish species along with native mussels that depend on the presence and migrations of host fish species		N	
2	Provide better access for shore fishing		N	
3	Make improvements to the Carry in (above dam) lake take out, clearly mark the portage, and Carry in (below dam) river put in		N	
4	Look at making changes to surcharge rule		N	
5	Increase channel capacity in some flood events		N	Depending on downstream conditions/projects
6	Investigate Zebra mussel populations and look into reduction/eradication		N	
7	Put in a fishway that can double as a spillway		N	
8	Allow passing of sediments at the dam may help downstream conditions	M	N	Not sure how this would work
9	Gravel augmentation-place gravel below the damn and allow water to move it	M	N	Not likely to be feasible

Ideas Affecting Reservoir - **Winnibigoshish**				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Wildlife staff request changing the reservoir operations to mimic natural unregulated river and lake seasonal flows and fluctuations to benefit wildlife and habitat	M	Y	Wildlife staff report that current operations result in higher flows in the late fall and winter, and low flows occur in the spring, which impacts fish and wildlife habitat. More natural flow regime would impact flood management operations.
2	Better collaboration between the agencies regarding maximum summer pool, pool retention, and timing of drawdown (on Cass and Winnie) from year to year	Y	M	Study further to see what specifically we can do on a day to day basis. It's unclear if this would be for the benefit of e-flows, and if it would be an SRP effort.
3	Reduce winter drawdown by 1 foot	M	Y	Probably not feasible; would require investigation; how often would we have to increase pool to counter balance?
4	Drop reservoir levels sooner, so it assists in successful amphibian and fur bearing animals for hibernation/winter protection	M	Y	Probably hard to accomplish, as the reservoir is already drawn down early
5	Lower lake elevations to improve aquatic vegetation growth	M w/1?	Y	Would likely be opposed by public
6	Water level regulation to combat invasive species either currently or for the future possibility of invasive species	M w/1?		In general this concept is valid, but outside of operating for more natural flows, it is unclear what specific operational changes might apply.
7	Opportunity to use water level control in combination with seeding to promote wild rice growth	M	Y	The science around wild rice growth and what impacts it on a yearly basis is a bit unclear and needs more study.
8	Look to see if there is a correlation between water levels and success of water nesting birds	M	Y	Could be a good study to inform a future ROPE study
9				

Ideas Affecting Downstream				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Managing outflows to benefit downstream geomorphology	N		Already have a release pulse to try and maintain geomorphology
2	Try to manage downstream flows to manage wild rice	Y	Y	Would require a study? Would have to look at multiple downstream sites to coordinate this to function properly. Needs a basin wide approach.
3	Releasing various temperatures from reservoir stratification to manage downstream temperatures	N		Is there enough depth to have a significant thermocline difference?
4	Operate the dam to reflect more natural flows	M	Y	Potential for future with changes in public values.
5	Adjust gates to improve mussel habitat below the gates	M	Y	Not sure what this would entail, and mussel species are limited in the HW.
6	Fish passage through gate manipulation	Y	Y	May be worth study and would not impact water levels.
7				

Ideas Affecting Other Items				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Perhaps unstraightening or structural work to diversify the reach between Winni and Little Winni	M		Would require sponsor under 1135.
2	Empirical studies to coordinate precipitation with spawning seasons			
3	Install a fishway	M	N	Fish ladders may exist here already, but would be needed to change for targeted species
4	Gravel Augmentation: Is sediment passing through the dam optimal for fish spawning? May want to dump gravel below dam and have the water move it.			
5	Update previous Tribal Inventories from the ROPE Studies			
6	Opportunity to put a gates culvert to run through the fish ponds and mussels			
7	Note* Winni shoreline is fairly undeveloped and maintains natural conditions			
8	To use inventory information to determine if we have anything that we could use to encourage the species to use the habitat			
9	Install flow meters to see what is coming into the lake and exiting to ensure flow designs are accurate			
10				

Ideas Affecting Reservoir - **Leech**				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Manage water levels that best mimic the natural hydrologic cycle to the benefit of fish, wildlife, and their habitats	M	Y	Wildlife staff report that current operations result in higher flows in the late fall and winter, and low flows occur in the spring, which impacts fish and wildlife habitat. More natural flow regime would impact flood management operations.
2	Have reservoir level higher in the summer, but not too high that it destroys habitat	W/#1	M	
3	Drop reservoir levels sooner, so it assists in successful amphibian and fur bearing animals for hibernation/winter protection	M	Y	
4	Use water management to aid against invasive species	M w/1?		In general this concept is valid, but outside of operating for more natural flows, it is unclear what specific operational changes might apply.
5				
Ideas Affecting Downstream				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Spread out flows through dam to improve downstream conditions for fish passage	Y	Y	
2	Look to see how flow can be managed to prevent fish strandings	Y	Y	
3	Try to manage downstream flows to manage wild rice	Y	Y	This is already being done to some degree (Mud Lake), but could be evaluated.
Ideas Affecting Other Items				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Modify dam to facilitate fish passage if retaining the dam is a high priority, or replace the dam with a rock weir structure that facilitates aquatic organism passage	M	N	Could be done under Section 1135 with a sponsor
2	Re-meandering the river downstream of the dam…however, if we don't change the flooding situation the work wont be sustained	M	N	Could be done under Section 1135 with a sponsor
3	Continue research for a future changing climate for the headwaters area--does this affect the current/new operating plans?	M	M	
4	Reconfigure the downstream rirap to allow for fish passage to prevent strandings	M	N	
5	Replace Leech Lake Dam with a different structure?		N	What would we gain/lose if this is considered; replace with gates that flow over the top, than those which release underneath; Environmental Stewardship must be included in language
6				

Ideas Affecting Reservoir - **Pokegama**				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	allow for colonization of additional annual plants to help reduce shoreline erosion and promote growth of additional wild rice beds	N	Y	not sure how to facilitate this other than growing season drawdown.
Ideas Affecting Downstream				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	DNR Staff recommends allowing more time to reach summer pool level on Pokegama in order to provide higher downstream spring flows.	Y	Y	Fisheries staff reports that current operations results in unnaturally high flows during much of the winter. Flows are shut down in spring, and summer pool level is reached in mid-May, which has the effect of reducing downstream flows, all the way to Big Sandy, just as fish are spawning. These low flows also affect recreational use, primarily water access, on downstream lakes.
2	Wildlife staff request changing the reservoir operations to mimic natural unregulated river and lake seasonal flows and fluctuations to benefit wildlife and habitat			Wildlife staff report that current operations result in higher flows in the late fall and winter, and low flows occur in the spring, which impacts fish and wildlife habitat.
3	Fish passage through gate manipulation	Y	Y	
4				
Ideas Affecting Other Items				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Better channel connections between Pokegama and the Mississippi River	M	N	Would enhance management of lake level. Maybe creating deeper channels may be beneficial i.e. fish passage
2	Fish Passage-may have one but not working	N	N	
3	May be able to work collaboratively with FERC to work both dams as a system	N	N	FERC renewed this year, may have missed our window
4	Opportunities to place structural modifications to increase vegetation, reducing turbidity to increase water quality	N	N	
5	Move the lake gauge to a better location to monitor	M	N	
6	Losing capacity at the dam due to river sedimentation			
7	Create impoundments to hold river on unregulated watershed South and East would help reduce the inflows in Aiken and remove some pressure to Pokegama for flood regulation	N	N	
8				

Ideas Affecting Reservoir - **Sandy**				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Agency Noted: Fisheries staff reported working with the US Army Corps of Engineers to determine movement of fish and escapement past the dam from the reservoir, which might be abated with alternative operating regimes for the dam.			Concern is the release off the bottom leads to a concern of the walleye being sucked out the bottom; looking at changing to top and bottom leaf gates to release form either level.
2	Agency Noted: Wildlife staff noted that the effects of flow from the dam is felt most during extreme conditions.			noted
3	Operate gates differently depending on the tail waters of the Mississippi?	N	N	This is already being done to the best of our ability.
4	Can we anticipate the tail water increases to prepare the reservoir prior to being negatively affected?	N	N	This is already being done to the best of our ability.
5	Operating gates and water surface elevations in conjunction with specific fish species-a lot to consider, swimming abilities, movement of fish, behaviors etc. in reference to connectivity	Y	Y	Potential for operating the new leaf gate.
6	Maintain elevations to benefit amphibians and aquatic mammals	M	Y	was considered under 2009 ROPE and would require new ROPE as this may affect flood reduction purpose.
7	Does the new rehab invite possible changes to operation?			
8	Can we do anything in operating to reduce nutrients?	M	Y	Could be studied further. Water level fluctuations may influence nutrient cycling, but not the inflow of nutrients, which is likely the primary problem.
9	Rapid response discharge during rain events to provide more stable levels for wild rice production - eliminate rate of release to stabilize water levels for rice (specifically during floating leaf stage).	Y	Y	Will require study for downstream impacts.
10	Increase winter drawdown to increase wild rice production in the Spring	M	Y	This may have other adverse impacts that may preclude its implementation, but it may be worth reviewing.
12				

Ideas Affecting Downstream				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Operate gates differently depending on temperatures	M	Y	Not likely enough difference in temps between the surface and bottom of gates to have a benefit.
2	Increasing minimal flows; current minimum flow is not much water; however, increasing flow reduces effectiveness of maintaining pool level	M	Y	This may not have enough benefit due to the short reach of the Sandy River affected to may it worth the potential adverse effects on the lake.
3				

Ideas Affecting Other Items				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Movement of catfish into the lake; is there a way to keep desired fish in the lake and undesirable fish out of the lake during the high-tail water events.	Y	Y	With the dam rehab
2	Some sort of impoundment on the Prairie river to affect the stage/level prior to the Sandy River-will aid in decreasing flashiness	N	N	
3	Consider a fishway/passage	M	N	May affect operation for some authorized purposes
4	Place screens or behavioral avoidance measure in front of dam to prevent walleye from getting pulled out.	M	N	May be possible to consider. One concern is maintenance requirements.
5				

Ideas Affecting Reservoir - **Cross**				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Adjust fall drawdown to support Lake Whitefish spawning	Y	Y	Draw down faster prior to ice up, and maintain if possible
2	Adjust drawdown earlier to support amphibians, reptiles, and aquatic mammals prepare for hibernation	W/#1	Y	May affect Recreation Season
3	Modify the way we release water for the temperature to benefit fish and mussels	N	Y	Seems to be limited opportunity to affect temperatures with releases
4	Operate the gates to maximize fish passage	Y	Y	Consider for multiple reservoirs
5	Increase minimum flows	N	Y	was considered under 2009 ROPE and would require new ROPE
6	Put more pressure on reservoir (hold more water) during large events to relieve downstream environmental concerns (i.e.. Waterfowl, erosion, etc....)	N	N	was considered under 2009 ROPE and would require new ROPE
Ideas Affecting Downstream				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Consider downstream effects of significant flow changes, maximum release flows and rate of flow changes on aquatic habitat.	N	Y	was considered under 2009 ROPE and would require new ROPE
2	Operate gates to reduce fish stranding on the sill	W/#4	Y	
Ideas Affecting Other Items				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Enable Fish passage with a natural-like fishway bypass channel	M	N	Would likely require 1135 project with a sponsor
2	Have a weather station and a lake gauge on the North Side of watershed to help inform when flows should be adjusted	M	N	Consideration for Water Control
3	Anything we could do to benefit Big Trout Lake's naturally occurring lake trout population?	M	M	not likely a way to do this with dam operation
4	Evaluate the shoreline along the reservoir and downstream for erosion	M	N	Evaluation may help ID problem areas, but funding solutions on private property may be difficult.
5				

Ideas Affecting Reservoir - **Gull**				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Drawing down faster and earlier in the fall to help amphibians, reptiles, and mammals prepare for hibernation	M	M	was considered under 2009 ROPE and may require new ROPE
2	Operate the gates to the benefit of the native species communities and detriment of the invasive (fish, vegetation, water fowl, etc.…)	N	M	was considered under 2009 ROPE and would require new ROPE
3	Raise the top of the summer band to have more outflows rather than having 20cfs for a large chunk of the summer	N	N	The top of the band was raised in the 2009 ROPE. Lower the bottom of the band may allow increased minimums, but would likely require a new ROPE.
4	Increase the allowable ramping rate above 30% due to the flashiness of the area	N	Y	would require further study to determine if the reservoir benefit is worth the downstream impacts. A fast rate of river rise is likely more acceptable than a fast rate of fall.
5	Draw the lake down, or slow down the drawdown to the shoreline rubble area to allow better walleye spawning by allowing the slime algae to be dried out and naturally removed	M	Y	a single-season short-duration drawdown for this purpose may be acceptable to the public for this purpose. Further discussion with DNR is warranted.
6	Eliminate the winter drawdown to improve walleye spawning and bird nesting	N	N	likely unacceptable as it would impede ability to mitigate flood impacts. Could be considered under future ROPE.
7				
Ideas Affecting Downstream				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	The downstream river no longer has sandbars; is there anything that can be done to create a flood pulse to help create and maintain that habitat?	N	N	Flood pulse is built in to the operating plan currently
2	Place Fixed crest overflow bay in stead of gates-possibly help steady flows, reduce gate changes create a more natural flow in the channel	N	N	was considered under 2009 ROPE and would require new ROPE
3	Gravel Augmentation downstream of dam for fish habitat.	N	N	Would require studies to determine if it would be beneficial and likely would be very difficult to implement even if it was.
4	Eliminate the winter drawdown to improve walleye spawning and bird nesting	N	N	was considered under 2009 ROPE and would require new ROPE. Would be counter to flood reduction purpose.
5				
Ideas Affecting Other Items				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Explore fish passage with a natural-like fishway bypass channel, in order to benefit the native Muskellunge population	M	N	Would likely require 1135 project with a sponsor
2	Replace dam with a series of rock ramps	M/w#1	N	Would likely require 1135 project with a sponsor
3	Study to analyze operations from 20 years ago to determine if we are impacting walleye populations from previous years	N	N	It would be extremely difficult to infer a causational relationship between operations and walleye numbers; there are too many confounding factors.
4	Anything we could do in the downstream area to improve habitat for walleye, blanding turtle; building spawning reef below the structure	M	N	Would likely require 1135 project with a sponsor
5				

Ideas Affecting Reservoir - **Eau Galle**				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Drawdown below conservation level for improved habitat	Y	Y	Heavier lift with the public
2	Upstream of the reservoir, upstream study to see current condition and if there is anything we can do to improve it-Baseline study upstream for improvements via operation of the dam	N		WIDNR watches the upstream inlets (under General Regulations). Not certain it is worth effort for us as work for us would be limited
3	Consider a season-draw down for vegetation improvement	w/#1	Y	
4	Put in blue-gill habitat (i.e. Christmas trees)	N	N	Already being done
5	put fish cribs in the reservoir for habitat	N		Already being done
6	Dredging near landing area may provide some environmental benefit	Y	N	Maybe more recreational benefit
7	Dredging some sediment from the reservoir (lake depth survey shows areas)	N	N	Typically such actions in reservoirs are prohibitively expensive
8				

Ideas Affecting Downstream				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1	Fluctuating downstream flow, operating low flow instead of constant discharge	Y	Y	
2	Larger low flow opening during summer for trout, while watching pool elevations	w/#1	Y	Fundamentally similar to #1
3	Install a network of temperature gauges in reservoir, and potentially downstream to gather more info on temp profiles	M	M	Struggle during flooding (short gauges), need a new system
4	More downstream fish structures	N	N	1135 has been completed on this portion of the stream, WIDNR has been doing this further downstream-Others are already working it
5	Develop a temperature reservoir profile model	M	Y	Some stuff may have been done we can incorporate/ERDC has done studies, maybe they have some information
6	Retrofit to release from diff elevations from within the reservoir (from #5)	w/#5	N	Pretty major undertaking, Study will teach us more than just Temp Profile (#5)
7	Operate low flow when we can to draw colder water from the bottom of the reservoir (same as #1)	w/#1		Same as #1
8	Creating a deeper downstream pool, that would hold cooler water so in the hot summer the trout don't get stressed as easily	N		Not certain if we could make it large or deep enough to have the temp benefit
9	Automated low flow gate	Y	N	
10	When doing a PI, rent a pump to continue to provide low flow	N		Already being done
11	Late Spring 1' drawdown would increase flows through low flow moving more cold water	w/#3	Y	Not sure how this would be beneficial
12	Operating for optimum flows during brown trout spawning season	Y	Y	Carry forward to discuss in depth in the future
13	Structures down stream	N		1135 has been completed on this portion of the stream, WIDNR has been doing this further downstream-Others are already working it
14	Area before the weir is shallow and a lot of surface area may be warming area, maybe we can deepen it	Y	N	Keeping it shallow is probably better for water temps, but it may be good to narrow the channel to reduce the surface exposed to sunlight.
15	Siphon pipe from low reservoir level into stream	N	N	Physics will not allow syphon over dam height
16	Some sort of large subsurface geothermic system, rock, structures, piping	N	N	Expensive, may not work feasibly
17	Install permanent pipe so no need to utilize pumps during PI	Y	N	
18	Storm water management on downstream side of dam	Y	N	
19				

Ideas Affecting Other Items				
Idea #	Idea Description	Carry Forward (Y/N/M)	SRP	Reason to eliminate/Notes
1				
2				

Appendix C.

Correspondence/Agency Input

From: Clark, Steven J CIV USARMY CEMVP (US)
To:
Email addresses redacted
Cc:

Subject: Corps Operating Plan Review - Baldhill Dam (Lake Ashtabula) and Homme Reservoir
Date: Wednesday, July 15, 2020 3:20:00 PM
Attachments: BaldhillSummary.docx
HommeSummary.docx

Dear Agency Partners,

The Corps of Engineers, St. Paul District, is conducting a review of the operating plans for each of our reservoirs. The review is being initiated under our Sustainable Rivers Program (https://www.iwr.usace.army.mil/Missions/Environment/Sustainable-Rivers-Project/), and our intent is to determine if there are any opportunities to improve operations, with a focus on benefiting natural resources. If we do find opportunities, individual studies will be used to further investigate and review potential changes prior to implementation. Additionally, a National Environmental Policy Act (NEPA) document would be completed and distributed for review. You would be invited to comment on the proposed changes during that process. No changes to our operating plans are being proposed at this time.

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Once we have gathered all the feedback, we will review it, taking into consideration our authorities and other potential constraints, and then determine which operating plans warrant further study. Our review will be conducted via an internal Corps workshop attended by our local site managers, water control staff, biologists, and others. With our staff biologists, we will also be looking for opportunities to improve operations, in addition to suggestions provided by our partners.

Unfortunately, our timeline for completing this effort is short. Because of that, we are requesting your input by July 31st. If you need more time, please give me a call and there may be some opportunity extend this deadline.

If you have any questions, please don't hesitate to email or call either number below. Finally, if you know of someone else that should have received this email, please feel free to forward it on them.

Thank you in advance for your input,

Steve

Steven J. Clark
Chief, Environmental Compliance Section
Planning and Environment Division North
Army Corps of Engineers, St. Paul District

180 5th Street East, Suite 700
St. Paul, MN 55101-1678

From: Clark, Steven J CIV USARMY CEMVP (US)
To:
Email addresses redacted

Cc:

Subject: Corps Operating Plans - Big Stone, Marsh Lake and Lac que Parle
Date: Wednesday, July 15, 2020 3:49:00 PM
Attachments: BigstoneHighway75Summary.docx
LacQuiParleSummary.docx

Dear Agency Partners,

The Corps of Engineers, St. Paul District, is conducting a review of the operating plans for each of our reservoirs. The review is being initiated under our Sustainable Rivers Program (https://www.iwr.usace.army.mil/Missions/Environment/Sustainable-Rivers-Project/), and our intent is to determine if there are any opportunities to improve operations, with a focus on benefiting natural resources. If we do find opportunities, individual studies will be used to further investigate and review potential changes prior to implementation. Additionally, a National Environmental Policy Act (NEPA) document would be completed and distributed for review. You would be invited to comment on the proposed changes during that process. No changes to our operating plans are being proposed at this time.

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Chief, Environmental Compliance Section
Planning and Environment Division North
Army Corps of Engineers, St. Paul District

180 5th Street East, Suite 700
St. Paul, MN 55101-1678

From: Clark, Steven J CIV USARMY CEMVP (US)
To:

Email addresses redacted

Cc:

Subject: Corps Operating Plan Review - Orwell, Traverse and Mud
Date: Wednesday, July 15, 2020 3:42:00 PM
Attachments: OrwellSummary.docx
TraverseMudSummary.docx

Dear Agency Partners,

The Corps of Engineers, St. Paul District, is conducting a review of the operating plans for each of our reservoirs. The review is being initiated under our Sustainable Rivers Program (https://www.iwr.usace.army.mil/Missions/Environment/Sustainable-Rivers-Project/), and our intent is to determine if there are any opportunities to improve operations, with a focus on benefiting natural resources. If we do find opportunities, individual studies will be used to further investigate and review potential changes prior to implementation. Additionally, a National Environmental Policy Act (NEPA) document would be completed and distributed for review. You would be invited to comment on the proposed changes during that process. No changes to our operating plans are being proposed at this time.

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Steve

Steven J. Clark
Chief, Environmental Compliance Section
Planning and Environment Division North
Army Corps of Engineers, St. Paul District

180 5th Street East, Suite 700
St. Paul, MN 55101-1678

From: Clark, Steven J CIV USARMY CEMVP (US)
To:

Email addresses redacted

Cc:

Subject: Corps Operating Plan Review - Big Sandy, Cross (Whitefish Chain), and Gull
Date: Wednesday, July 15, 2020 4:17:00 PM
Attachments: BigSandySummary.docx
CrossSummary.docx
GullSummary.docx

Dear Agency Partners,

The Corps of Engineers, St. Paul District, is conducting a review of the operating plans for each of our reservoirs. The review is being initiated under our Sustainable Rivers Program (https://www.iwr.usace.army.mil/Missions/Environment/Sustainable-Rivers-Project/), and our intent is to determine if there are any opportunities to improve operations, with a focus on benefiting natural resources. If we do find opportunities, individual studies will be used to further investigate and review potential changes prior to implementation. Additionally, a National Environmental Policy Act (NEPA) document would be completed and distributed for review. You would be invited to comment on the proposed changes during that process. No changes to our operating plans are being proposed at this time.

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Steven J. Clark
Chief, Environmental Compliance Section
Planning and Environment Division North
Army Corps of Engineers, St. Paul District

180 5th Street East, Suite 700
St. Paul, MN 55101-1678

From: Clark, Steven J CIV USARMY CEMVP (US)
To:

Email addresses redacted

Cc:

Subject: Corps Operating Plan Review - Winni, Leech and Pokegama
Date: Wednesday, July 15, 2020 4:10:00 PM
Attachments: WinnibigoshishSummary.docx
LeechSummary.docx
PokegamaSummary.docx

Dear Agency Partners,

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Steven J. Clark
Chief, Environmental Compliance Section
Planning and Environment Division North
Army Corps of Engineers, St. Paul District

180 5th Street East, Suite 700
St. Paul, MN 55101-1678

From: Clark, Steven J CIV USARMY CEMVP (US)
To:

Cc: Email addresses redacted

Subject: Corps Operating Plan Review - Red Lake
Date: Wednesday, July 15, 2020 3:54:00 PM
Attachments: RedLakeSummary.docx

Dear Agency Partners,

The Corps of Engineers, St. Paul District, is conducting a review of the operating plans for each of our reservoirs. The review is being initiated under our Sustainable Rivers Program (https://www.iwr.usace.army.mil/Missions/Environment/Sustainable-Rivers-Project/), and our intent is to determine if there are any opportunities to improve operations, with a focus on benefiting natural resources. If we do find opportunities, individual studies will be used to further investigate and review potential changes prior to implementation. Additionally, a National Environmental Policy Act (NEPA) document would be completed and distributed for review. You would be invited to comment on the proposed changes during that process. No changes to our operating plans are being proposed at this time.

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Steven J. Clark
Chief, Environmental Compliance Section
Planning and Environment Division North
Army Corps of Engineers, St. Paul District

180 5th Street East, Suite 700
St. Paul, MN 55101-1678

From: Clark, Steven J CIV USARMY CEMVP (US)
To:
Email addresses redacted
Cc:

Subject: Corps Operating Plan Review - Eau Galle Reservoir
Date: Wednesday, July 15, 2020 4:20:00 PM
Attachments: EauGalleSummary.docx

Dear Agency Partners,

The Corps of Engineers, St. Paul District, is conducting a review of the operating plans for each of our reservoirs. The review is being initiated under our Sustainable Rivers Program (https://www.iwr.usace.army.mil/Missions/Environment/Sustainable-Rivers-Project/), and our intent is to determine if there are any opportunities to improve operations, with a focus on benefiting natural resources. If we do find opportunities, individual studies will be used to further investigate and review potential changes prior to implementation. Additionally, a National Environmental Policy Act (NEPA) document would be completed and distributed for review. You would be invited to comment on the proposed changes during that process. No changes to our operating plans are being proposed at this time.

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Steven J. Clark
Chief, Environmental Compliance Section
Planning and Environment Division North
Army Corps of Engineers, St. Paul District

180 5th Street East, Suite 700
St. Paul, MN 55101-1678

NORTH Dakota | Water Commission
Be Legendary.™

July 31, 2020

Steven J. Clark
Chief Environmental Compliance Section
U.S. Army Corps of Engineers, St. Paul District
180 5th Street East, Suite 700
St. Paul, MN 55101-1678

Mr. Clark;

Baldhill Dam

Thank you for the opportunity to comment on the operating plan for Baldhill Dam.

It is important to maximize temporary storage for flood damage reduction. The operating plan does adequately address the extent of drawdown to occur based on the water equivalent in the upstream watershed. We support using the maximum drawdown to 1255 msl when upstream conditions merit.

The Corps of Engineers have done a good job of informing agencies and the public of anticipated drawdowns and extent of discharge.

NDSWC will continue coordinating with Corps concerning discharges from Devils Lake.

Some downstream interests have expressed concerns that the available storage may not be used enough to reduce damages in their project areas. It is suggested that further conversation should be held with them to determine if some alterations in the summer operations could be made to improve their situation.

Homme Dam

Thank you for the opportunity to comment on the operating plan for Homme Dam.

It is important to maximize temporary storage for flood damage reduction. The operating plan does adequately address the extent of drawdown to occur based on the water equivalent in the upstream watershed.

(Park River, not Park City, has a water use permit.)

There had previously been discussion with the Walsh County Highway Department and Walsh County Emergency Management concerning the timing of releases when attempting to draw the reservoir down prior to spring runoff. They had a concern that attempting the drawdown too early caused ice to build up in downstream channel, limiting the capacity of the channel. They may have preferred that releases would occur later in the winter to reduce this problem. The Walsh County WRD, and other local entities, should be contacted to determine if it is possible to alter the operating plan to reduce their concerns.

Thank you,

Signature redacted

Jon Kelsch, P.E.
Development Division
Director

JFK/300/828

CASS COUNTY GOVERNMENT

Southeast Cass Water Resource District

Dan Jacobson
Manager
West Fargo, North Dakota

Keith Weston
Manager
Fargo, North Dakota

Dave Branson
Manager
Fargo, North Dakota

Carol Harbeke Lewis
Secretary-Treasurer

1201 Main Avenue West
West Fargo, ND
58078-1301

wrd@casscountynd.gov
www.casscountynd.gov

SENT VIA EMAIL

July 27, 2020

Steven J. Clark
Chief, Environmental Compliance Section
U.S. Army Corps of Engineers, St. Paul District
180 5th Street East, Suite 700
St. Paul, MN 55101-1678

Dear Mr. Clark:

RE: Baldhill Dam Operating Plan

Thank you for the opportunity to provide comment during the review of the Baldhill Dam Operating Plan. As you are aware, flood control dams throughout the Red River of the North watershed have been repeatedly tested in recent decades. The current wet cycle has reminded us of the importance of these facilities and we are appreciative of the Corps of Engineers (Corps) investment in flood risk reduction. The Southeast Cass Water Resource District (the District) strongly supports watershed impoundments that reduce peak flows on tributaries to the Red River and we understand the direct benefit seen by communities like Valley City and Lisbon. We also understand that the flow reduction benefits from Baldhill Dam carry much further downstream to communities located in Cass County near the confluence with the Red River.

As you may know, the District partnered with the Corps to construct the Sheyenne Diversion approximately 30 years ago. Shortly thereafter, the Sheyenne River Joint Water Resource District (of which the District is a member) partnered with the Corps to raise Baldhill Dam five feet in order to provide additional flood storage. The Diversion project, along with the Baldhill Dam raise, were two elements of a flood risk reduction strategy for the lower Sheyenne River that included a significant local investment.

The District wishes to advise the Corps that we support the current winter drawdown operating plan including the normal winter drawdown elevation, maximum winter drawdown elevation and snow water equivalent drawdown triggers. We believe the Corps winter and spring operations have been satisfactory given the uncertainties of predicting snowmelt hydrology. The District would be opposed to any operating changes that reduce the flood storage volume currently provided within the plan.

The District also wishes to comment on the summer and fall operations. As you know, the Devils Lake outlet project has provided a new challenge resulting in significantly increased base flows throughout the summer and fall. These flows, combined with wetter than normal conditions, create problems with regard to the operation of the Sheyenne Diversion project. As the owners and operators of the Sheyenne Diversion, the District can report that the frequency and duration of use by the Diversion project has greatly increased since the completion of the Devils Lake outlet. Specifically, the Horace Diversion begins to operate when the Sheyenne River exceeds 900 cfs and the flood gates at West Fargo require closure at about the same level. It seems we are seeing the 900 cfs threshold exceeded with regularity and the frequency and duration of gate closure has been well beyond the original design intent for the Diversion project in recent years. The closure of the gates creates an environmental stressor within the Sheyenne River corridor through West Fargo. In addition to the adverse environmental impacts, this situation has resulted in excessive Diversion channel erosion and sedimentation causing millions of dollars in maintenance expenditures over the past decade. Further, Sheyenne River flows in excess of 2,000 cfs causes flooding of agricultural lands adjacent to the Diversion as the water within the channel becomes higher than field elevation preventing gravity drainage.

The District requests that the Corps alter the summer and fall operation of Baldhill Dam to account for the Devils Lake outlet flows and wetter climactic conditions. The District strongly believes the Corps needs to more frequently and fully utilize the available flood storage provided by the dam and paid for in part by Cass County. Per the current plan, storage to the top of flood control is allowed to minimize downstream damages during the summer months. However, holding the conservation pool to a level of 1266.0 +/- 0.2 feet is contrary to this goal. We believe the Corps needs to more fully understand the Sheyenne Diversion operation triggers and develop a summer and fall operation plan for Baldhill Dam that is sensitive to those triggers. We recommend that a hydraulic study be completed to determine the level of lake bounce required to reduce the frequency and duration of downstream flows that would typically result in operation of the Diversion.

Thank you.

Sincerely,

SOUTHEAST CASS WATER RESOURCE DISTRICT

Signature redacted

Carol Harbeke Lewis
Secretary-Treasurer

From:	Ebbenga, Theresa (DNR)
To:	Clark, Steven J CIV USARMY CEMVP (USA)
Cc:	Thielen, Patty A (DNR); Roemhildt, Scott (DNR); Colvin, Steve E (DNR); Rivers, Erika (DNR); Olfelt, Dave P (DNR)
Subject:	[Non-DoD Source] US Army Corps of Engineers Operating Plan review MN DNR Comments
Date:	Friday, August 14, 2020 9:03:04 AM
Attachments:	image001.png image002.png image003.png image004.png US Army Corps of Engineers Reservoir Operating Plans Review_08142020.pdf

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Dear Mr. Clark, Thank-you for the opportunity to comment on several U.S. Army Corps of Engineers Reservoir Operating Plans as per your e-mails on July 15, 2020. And thank you for allowing additional time for DNR's review. Please see attached comment letter and if you have any questions, please contact me either by e-mail or phone below.

Thank-you,
Theresa.

Theresa Ebbenga
Regional Director

Minnesota Department of Natural Resources
2115 Birchmont Beach Rd NE
Bemidji, MN 56601

Northwest Regional Operations
2115 Birchmont Beach Road NE
Bemidji, MN 56601

August 14, 2020

Steven J. Clark
Planning and Environment Division North
US Army Corps of Engineers, St. Paul District
180 5th Street East, Suite 700
St. Paul, MN 55101-1678

Subject: US Army Corps of Engineers Reservoir Operating Plans Review

Dear Mr. Clark,

The Minnesota Department of Natural Resources (MN DNR) appreciates the opportunity to provide comments to the US Army Corps of Engineers (USACE), St. Paul District on the eleven operating plans indicated in your 15 July 2020 email. Please see below for comments by area, along with a DNR staff contact for each location.

Leech Lake:

DNR Contact: Doug Schultz, Fisheries

- Manage water levels that best mimic the natural hydrologic cycle to the benefit of fish, wildlife, and their habitats
- Modify dam to facilitate fish passage if retaining the dam is a high priority, or replace the dam with a rock weir structure that facilitates aquatic organism passage

Red Lake:

DNR Contact: Andy Thompson, Fisheries

- Increase normal (Conservation) Pool elevation from 1174' MSL to 1175' MSL
- Increase fall drawdown target from 1173.5' MSL to 1174.5' MSL

Orwell:

DNR Contact: Nick Kludt, Fisheries

- Orwell operations has rapid decline in habitat for most species when flows drop below 300 cfs
    - For native mussels, habitat peaks at about 450 cfs and decreases rapidly as flows drop below 300 cfs
    - Mussels are particularly vulnerable to rapid flow reductions since they move slowly

    - Flutedshell are state threatened, black sandshell are state special concern.
- Bois de Sioux is routinely dewatered by operations of the dams at Traverse and Mud Lake
    - Low flow maintenance is something that should be considered to prevent summer fish kills in the Bois de Sioux
- Continue to work with USACE towards fish passage through the dam as it has major implications for sturgeon recovery as well as bigmouth buffalo and other fish species along with native mussels that depend on the presence and migrations of host fish species
- Make improvements to the Carry in (above dam) lake take out, clearly mark the portage, and Carry in (below dam) river put in
- Provide better access for shore fishing

Traverse/Mud:

DNR Contact: Nick Kludt, or Chris Domeier, Fisheries

- Optimization of fish and wildlife conditions in the pools is needed
- Seasonal protected flow regimes are needed below the facilities to prevent fish kills in the Bois de Sioux River, particularly during the summer

Winnibigoshish:

DNR Contact: David Weitzel, Fisheries or Mark Spoden, Wildlife

- Fisheries staff report a positive working relationship between DNR area fisheries staff and the USACE on spring water levels to promote wallye spawning on the lake.
- Wildlife staff report that current operations result in higher flows in the late fall and winter, and low flows occur in gthe spring, which impacts fish and wildlife habitat. Wildlife staff request changing the reservoir operations to mimic natural unregulated river and lake seasonal flows and fluctutations to benefit wildlife and habitat. Wildlife staff also stated appreciation for the positive working relationship with USACE.

Pokegama:

DNR Contact: David Weitzel, Fisheries or Mark Spoden, Wildlife

- Fisheries staff reports that current operations results in unnaturally high flows during much of the winter. Flows are shut down in spring, and summer pool level is reached in mid-May, which has the effect of reducing downstream flows, all the way to Big Sandy, just as fish are spawning. These low flows also affect recreational use, primarily water access, on downstream lakes. Staff recommends allowing more time to reach summer pool level on Pokegama.
- Wildlife staff repeats its recommendations from operations of Winnibigoshish and also requests modifying operations to allow for colonization of additional annual plants to help reduce shoreline erosion and promote growth of additional wild rice beds.

Big Sandy:

DNR Contact: Rick Bruesewitz, Fisheries or Russell Reisz, Wildlife

- Fisheries staff reported working with the US Army Corps of Engineers to determine movement of fish and escapement past the dam from the reservoir, which might be abated with alternative operating regimes for the dam.
- Wildlife staff noted that the effects of flow from the dam is felt most during extreme conditions.

Cross Lake:

DNR Contact: Owen Baird, Fisheries

- Enabe fish passage with a nature-like fishway bypass channel;
- Adjust fall drawdown to support Lake Whitefish spawing, and
- Consider downstream effects of significant flow changes, maximum release flows and rate of flow changes on aquatic habitat.

Gull Lake:

DNR Contact: Owen Baird, Fisheries

Fisheries staff reported interest in exploring fish passage with a nature-like fishway bypass channel, inh order to benefit the native Muskellange population.

Big Stone/Hwy 75:

DNR Contact: Chris Domeier, Fisheries

- Form a cross-agency inter-disciplinary team to discuss management goals and objectives and to recognize these reservoirs are part of one system, not independent basins. This is a similar approach as the Marsh Lake Adaptive Management Team.
- Conduct a new Reservoir Operating Plan Evaluation (ROPE) which takes into account changes in the watershed in the last two decades.
- Propose this reservoir for a Water Resources Development Act Section 1135 environmental restoration feasibility study, led by a Local Government Unit, in addition to the Sustainable Rivers Project.
- Provide base flow fish passage channels around or through the Big Stone National Wildlife Refuge (NWR) dams by constructing rock-arch fishways.
- Restore the natural Minnesota River channel through the Big Stone NWR.

Lac qui Parle:

DNR Contact: Walt Gessler, Wildlife

- Form a cross-agency inter-disciplinary team to discuss management goals and objectives and to recognize these reservoirs are part of one system, not independent basins. This is a similar approach as the Marsh Lake Adaptive Management Team.
- Conduct a new ROPE study for Lac qui Parle and Big Stone to recognize and adapt to the myriad of changes that have occurred in the watershed over the past two decades.
- Conduct feasibility study on restoring fish passage for all fish species at Lac qui Parle dam to restore a more natural fish assemblage within the Upper MN River.
- Adjust Operating Plan to allow for or to mimic a more natural hydrograph often found on natural riverine shallow lakes including the concept of a growing season drawdown (Lac qui Parle Lake).
- Discuss new Lac qui Parle Lake target water surface elevations during spring and fall periods for the benefit of fish and wildlife resources.
- Discuss releasing more water (after 15 May) during summer flood events to reduce in-lake degradation and recreational impacts.
- Evaluate the reservoirs past and current role in providing downstream flood protection in context of recent and future climate predictions, known watershed alterations, community flood mitigation measures, and floodplain retirement programs.
- Due to poor water quality and detrimental environmental effects of the Lac qui Parle flood control project, it would be a candidate for a Section 1135 (Water Resources Development Act of 1986) environmental restoration feasibility study, led by a LGU, in addition to the Sustainable Rivers Project.
- Ensure management purpose is in sync with watershed-wide management for habitat and target species
- Minimize water level fluctuations with structure design including but not limited to increasing spillway width with increasing flow.
- Any structures, including rock riffles or fish ladders, and other passive structures should incorporate a low flow section to concentrate flow, allowing for migration during low flow conditions.
- Avoid late fall and winter drawdown to provide winter cover/habitat.
- Provide base flow fish passage channels around or through the Lac qui Parle, the Watson-Sag Weir and Chippewa Diversion by constructing rock-arch fishways.
- Explore restoring islands lost due to chronic high water in same area.
- Alter Lac qui Parle dam bulkheads to be able to raise or lower to maximize water level management capabilities.
- Lower the spillway to 938 elevation or lower to reduce flooding impact to Lac qui Parle State Park buildings, roads and trails or mitigate the raising of the original spillway elevation.
- Clean out area of aggradation above Lac qui Parle dam if necessary to allow for water level management.

Thank you for including MN DNR in the plan reviews and for consideration of these comments. Please feel free to contact us at the contact information provided for each area if you have any questions. We look forward to partnering with you as the operating plans move towards more formal study and revision phases.

Sincerely,

Signatures redacted

Theresa Ebbenga	Patty Thielen	Scott W. Roemhildt
Regional Director	Regional Director	Regional Director
Northwest Minnesota	Northeast Minnesota	Southwest Minnesota

ec: Division Directors, Minnesota Department of Natural Resources

Clark, Steven J CIV USARMY CEMVP (USA)

From: Morley, David A -FS
Sent: Monday, August 17, 2020 2:48 PM
To: Clark, Steven J CIV USARMY CEMVP (USA)
Cc: Tisler, Todd M -FS; Hodgson, Jon D -FS; Taylor, Craig S -FS; Hansen, Christine J -FS; Raitanen, Eric -FS
Subject: [Non-DoD Source] RE: Corps Operating Plan Review - Winni, Leech and Pokegama
Attachments: CassLkROPE.pdf; CassLkData.xlsx; WinnibigoshishSummary.docx

Steven,

I can't speak for the others on the Forest, but from what I can see comparing the K-dam and post K-dam hydrographs for Cass Lake, we're not having trouble managing within our summer operating band or building pool in the spring. However, it does appear we have some difficulty getting to the normal winter drawdown. Setting aside the influence of year-to-year variability in precipitation, perhaps there's room for better collaboration between the agencies regarding maximum summer pool, pool retention, and timing of drawdown (on Cass and Winnie) from year to year. I suspect that isn't news to anyone, but it's always nice to confirm it with hard data. I'll let my coworkers chime in as they see fit.

Thanks for the opportunity to share my thoughts.

David Morley
Interdisciplinary Hydrologist-Soil Scientist Forest Service Chippewa National Forest

201 Minnesota Ave E
Walker, MN 56484
www.fs.fed.us

Caring for the land and serving people

-----Original Message-----
From: Clark, Steven J CIV USARMY CEMVP (USA)
Sent: Monday, August 17, 2020 8:49 AM
To: Morley, David A -FS
Cc: Tisler, Todd M -FS; Hodgson, Jon D -FS; Taylor, Craig S -FS; Hansen, Christine J -FS; Raitanen, Eric -FS
Subject: RE: Corps Operating Plan Review - Winni, Leech and Pokegama

Sure David, just get it to me as soon as you can, preferably by the end of the week. Thanks.

Steve

-----Original Message-----
From: Morley, David A -FS

From:	Pat Brown
To:	Clark, Steven J CIV USARMY CEMVP (US)
Cc:	"Al Pemberton"
Subject:	[Non-DoD Source] Red Lake management plan
Date:	Wednesday, July 29, 2020 1:47:27 PM

Good Morning Steve,

Thank you for giving us the opportunity to review and comment on the current management plan of the Red Lake Reservoir. It has been over 20 years since we last revisited the operation plan and we have learned a lot on how lake level effects the fishery and access to this fishery. The Red Lakes are a central part of everyday life of the Red Lake people, and is always a topic of discussion in the community, especially the lake level.

The Red Lake Band has been cooperatively managing the Red Lake fishery for the past 30 years. During this time we have learned a lot about this fishery and there is fairly good evidence that slightly higher water levels contribute to better walleye year classes, which is an economically and culturally important species to the Band. There may also, be some benefit to lake whitefish, which lay their eggs in the Fall, and do not hatch until the Spring under the ice. Ice scouring of the spawning beds may be less prevalent with higher water levels going into Fall and subsequent in the Spring. Finally, lake access for tribal fishers can be extremely difficult when water levels are kept to low. We only have a few improved accesses on the reservation, and even these are not sufficient for easy access at low lake levels.

We would like to thank you again for letting us have the opportunity to review the management plan and we look forward to further discussing these concerns with you in the near future.

Sincerely,

Pat Brown
Fisheries Director
Red Lake Band of Chippewa Indians
15761 High School Dr.
P.O. Box 279
Red Lake, MN 56671

Clark, Steven J CIV USARMY CEMVP (USA)

From: Clark, Steven J CIV USARMY CEMVP (US)
Sent: Tuesday, July 28, 2020 11:39 AM
To: Benike, Heath M - DNR
Cc: Yallaly, Kasey L - DNR; Rogney, Michael R - DNR
Subject: RE: Corps Operating Plan Review - Eau Galle Reservoir

Thanks for your thoughts on this Heath. We will look into it when we review the plan and let you know what comes of it. The hypolimnetic release is probably the one aspect of dam operations there that we may have some ability to adjust.

Steve

-----Original Message-----
From: Benike, Heath M - DNR
Sent: Monday, July 27, 2020 1:00 PM
To: Clark, Steven J CIV USARMY CEMVP (US)
Cc: Yallaly, Kasey L - DNR; Rogney, Michael R - DNR
Subject: [Non-DoD Source] RE: Corps Operating Plan Review - Eau Galle Reservoir

Hey Steve,

Thanks for allowing us the opportunity to provide input.

Around 20 years ago we worked cooperatively with the Corps to initiate the current operating plan that includes the 13cfs discharge from the sub-surface gate to provide cooler water temperatures in the Eau Galle River downstream for the coldwater fishery. Since those changes have been made we have seen large improvements in trout abundance as well as some natural reproduction of trout occurring and these operational change are likely one reason for those improvements.

At the time we were targeting about 2/3 of the flow through the subsurface gate and 1/3 over the top during baseflow conditions. We were considering baseflow to be about 20cfs at that time. Within the past several years I have notice downstream water temperatures increasing in July and August. I attribute this increase likely to an increase in baseflow from precipitation patterns. Baseflow has been around 25-30cfs this summer and most of last 2 summers. Water temperatures have been in the mid 70's many days during this time period which is approaching lethal temperatures again for the downstream trout fishery.

I am wondering if we can look to have more water released from the subsurface gate when we are in wetter patterns like we are currently in. During dry period when inflow approached 20cfs again we could go back to the 13cfs gate setting.

The downstream USGS gauge has a good temperature and flow profile to provide good data to support and document some of these changes if you or one of your staff could look into this further.

I'd be happy to discuss this further if you have questions, comments or suggestions.

Thanks for the opportunity to comment.

Heath

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Heath Benike
Fisheries Supervisor-Eau Claire Fish Team Wisconsin Department of Natural Resources
1300 W. Clairemont Ave
Eau Claire, WI 54701

dnr.wi.gov

-----Original Message-----
From: Clark, Steven J CIV USARMY CEMVP (US)
Sent: Wednesday, July 15, 2020 4:21 PM
To: Email addresses redacted
Cc: Urich, Randall R CIV USARMY CEMVP (USA); LaBadie, Bradley R CIV USARMY (USA); Berg, Kevin F CIV (US); Nelsen, Elizabeth A CIV USARMY CEMVP (US); Castellane, Nicholas J CIV (USA)
Subject: Corps Operating Plan Review - Eau Galle Reservoir

Dear Agency Partners,

The Corps of Engineers, St. Paul District, is conducting a review of the operating plans for each of our reservoirs. The review is being initiated under our Sustainable Rivers Program (https://secure-web.cisco.com/1ETSxzFABb56Eb9gAP5EF6WpJ8l3rg3UWIeUNWjxmm4qqm-poDzcCLS_egWuMoHW_-Y3k4ajpImwt1y2Lmquq2D6DuZ-Hf0hqY_KUTIPqRuNQiv7xsCQccVx66iQqbEmVc_IxJ3Mze7bYvEFtP_0IcFuK3x9C2CmfTIT9r9s6vwzJKwlHGg3y7egCPKvfs_EIlglf1LXHZAhMuUkzySLidXRJ3EhcHKzyLbvZfUHCZkOqSofdClmKC5RWRf_QyTJqAcoVBhvF9toZwLWrS6e3Ew/https%3A%2F%2Fwww.iwr.usace.army.mil%2FMissions%2FEnvironment%2FSustainable-Rivers-Project%2F), and our intent is to determine if there are any opportunities to improve operations, with a focus on benefiting natural resources. If we do find opportunities, individual studies will be used to further investigate and review potential changes prior to implementation. Additionally, a National Environmental Policy Act (NEPA) document would be completed and distributed for review. You would be invited to comment on the proposed changes during that process. No changes to our operating plans are being proposed at this time.

You are receiving this email as an invitation to provide comment on the operating plans for the subject reservoir. You were identified as potentially having a specific interest in and/or local knowledge of this reservoir. Attached are summaries of the existing operating plan for the reservoir that will be useful in providing some background on how it is currently operated. We are most interested in receiving specific comments you may have regarding adverse or

beneficial effects for how we currently operate this reservoir, and any ideas how we would better operate it. All ideas are welcome, including broad-level generalities, to very specific seasonal changes. Of course, providing specific details would be most useful.

Once we have gathered all the feedback, we will review it, taking into consideration our authorities and other potential constraints, and then determine which operating plans warrant further study. Our review will be conducted via an internal Corps workshop attended by our local site managers, water control staff, biologists, and others. With our staff biologists, we will also be looking for opportunities to improve operations, in addition to suggestions provided by our partners.

Unfortunately, our timeline for completing this effort is short. Because of that, we are requesting your input by July 31st. If you need more time, please give me a call and there may be some opportunity extend this deadline.

If you have any questions, please don't hesitate to email or call either number below. Finally, if you know of someone else that should have received this email, please feel free to forward it on them.

Thank you in advance for your input,

Steve

Steven J. Clark
Chief, Environmental Compliance Section
Planning and Environment Division North
Army Corps of Engineers, St. Paul District

180 5th Street East, Suite 700
St. Paul, MN 55101-1678

Clark, Steven J CIV USARMY CEMVP (USA)

From: Yallaly, Kasey L - DNR
Sent: Wednesday, July 22, 2020 11:51 AM
To: Clark, Steven J CIV USARMY CEMVP (US)
Subject: [Non-DoD Source] RE: Corps Operating Plan Review - Eau Galle Reservoir

Hi Steve,

Unfortunately, we don't have any continuous temperature data. We only have temperature taken on the day that we sample fish which is usually in July or August. Here are our readings from the past few years. Please let me know if you need anything else.

Thanks!

Year	Station	Date	Temp
2014	EAU GALLE 18B- HWY 29 (DOWNSTREAM)	29-Jul-14	67
2015	EAU GALLE 18B- HWY 29 (DOWNSTREAM)	3-Aug-15	62
2016	EAU GALLE 18B- HWY 29 (DOWNSTREAM)	8-Aug-16	67
2017	EAU GALLE 18B- HWY 29 (DOWNSTREAM)	7-Aug-17	63
2018	EAU GALLE 18B- HWY 29 (DOWNSTREAM)	20-Aug-18	68
2019	EAU GALLE 18B- HWY 29 (DOWNSTREAM)	15-Aug-19	69
2019	EAU GALLE 18MATCONFLUENCE W/MINES CREEK	23-Jul-19	72

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Kasey Yallaly

-----Original Message-----
From: Clark, Steven J CIV USARMY CEMVP (US)
Sent: Tuesday, July 21, 2020 11:07 AM
To: Yallaly, Kasey L - DNR
Subject: RE: Corps Operating Plan Review - Eau Galle Reservoir

Thanks for the comment Kasey. I am aware of the water temperature issue in general, but if you have temperature data that you could share, that could be helpful too. We did in fact evaluate and implement a plan for hypolimnetic releases about 15 years ago, though we do need to take a look at that again under this effort to see how well it is working and if we could modify it further.

Steve

-----Original Message-----
From: Yallaly, Kasey L - DNR
Sent: Tuesday, July 21, 2020 10:30 AM
To: Clark, Steven J CIV USARMY CEMVP (US)
Subject: [Non-DoD Source] RE: Corps Operating Plan Review - Eau Galle Reservoir

Hi Steve,

Thanks so much for the chance to provide comments on the dam operating plans. I'm not totally sure that it is possible but my biggest concern with the current operation of the dam is the temperature of the river below the dam especially in the summer months. We annually sample the Eau Galle River in Handy Andy park and temperatures have been 69-72F when we are sampling usually in August. These temperatures are around the maximum thermal limit that trout can sustain for short periods of time, especially for native brook trout. I would highly recommend improving these temperatures in the summer months if possible, potentially be altering operation of the dam. I'm not sure if it's possible to draw water from a different level in the water column to improve downstream temperatures because of the design of the dam? In general, that is my biggest concern in addition to flow regimes remaining as constant and consistent as possible with our highly variable weather patterns.

Thank you!

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Visit our survey at http://dnr.wi.gov/customersurvey to evaluate how I did.

Kasey Yallaly

-----Original Message-----
From: Clark, Steven J CIV USARMY CEMVP (US)
Sent: Wednesday, July 15, 2020 4:21 PM
To: Email addresses redacted
Cc: Urich, Randall R CIV USARMY CEMVP (USA); LaBadie, Bradley R CIV USARMY
(USA); Berg, Kevin F CIV (US); Nelsen, Elizabeth A CIV USARMY CEMVP (US); Castellane, Nicholas J CIV (USA)
Subject: Corps Operating Plan Review - Eau Galle Reservoir

Dear Agency Partners,

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Thank you in advance for your input,

Steve

Steven J. Clark
Chief, Environmental Compliance Section
Planning and Environment Division North
Army Corps of Engineers, St. Paul District

180 5th Street East, Suite 700
St. Paul, MN 55101-1678