2021 Minong Flowage Winter Drawdown Plan

A Project for the Control of Eurasian Watermilfoil (EWM)

Updated for the Minong Flowage Association: August 16, 2021

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1.0 Background

The Minong Flowage (Flowage) is a 1,564-acre impoundment of the Totagatic River located on the Douglas County/Washburn County border. The surface area of the waterbody increases when adding that portion of the Minong Flowage known as Cranberry Flowage between the Hwy T bridge and the outlet of Cranberry Lake to 1,607.85 acres. Based on point-intercept (PI) aquatic plant survey data from 2008, 2014, 2018, and 2021, the Flowage is shallow with a maximum depth of 21.5 feet and a mean depth of 8.13 feet. The Totagatic River is the main inlet and outlet of the flowage. Cranberry Lake, a 169-acre drainage lake connected to Minong Flowage's north end, is not considered part of the flowage. The Minong Flowage is classified as a complex cool-turbid waterbody; complex meaning it has more than three species of gamefish and cool-turbid referring the water quality based on seasonal temperatures and water clarity. Trophic state index (TSI) is an index for evaluating the trophic state or nutrient condition of lakes. The Minong Flowage is considered a eutrophic or productive lake according to its TSI index. The Minong Flowage substrate is mostly composed of sand with some muck bottom bays. Aquatic vegetation is common in these bays. Stumps and woody debris are also common in the flowage, especially on the northern end.

Eurasian watermilfoil (EWM) was first identified in the Flowage in 2005, but it took until 2009 to complete a management plan and begin implementing control measures. From 2009 to 2011herbicide was used to reduce the amount of EWM in the system which in 2008 was over 330 acres of mostly dense growth EWM. In 2012, Washburn County was informed that they needed to upgrade the Minong Dam and in 2013 lowered the water level in the Minong Flowage by nearly 5.5-ft beginning in March of 2013. Original estimates were that the dam repair project would be complete by August 2013, but issues occurred delaying its completion. Ultimately the Flowage was filled back up again in February and March 2014.

This extended drawdown gave the Minong Flowage Association the opportunity to see how effective a drawdown could be to control EWM. Typically, only a winter drawdown is used to control an invasive plant species like EWM. Through the summer it became clear that EWM would not be killed by simply dewatering. The plant went into a type of holding stage and essentially waited until the water was back in the system. In June 2013, there was a 5" rainfall that put 20+ inches of water back in the Flowage in just a day or two. EWM immediately began growing again, putting on 20" of growth in just a few days. When the water level went back down, all the plants that had regrown lay on the substrate and grew tiny rosettes at each leaf node in contact with the ground forming a carpet of EWM throughout its former range in the Flowage. It was not until freezing conditions in the winter, that the plant was killed.

In the spring of 2014 only a few isolated stems of EWM could be found. By the fall of that year, only 15 acres of the Flowage had EWM present. In 2015, a new Aquatic Plant Management Plan was completed for the Minong Flowage, listing both winter drawdown and application of herbicides as effective control measures for EWM, and laid out criteria for when herbicides should be used and when a winter drawdown should be considered. Since 2017, the EWM in the Flowage has been evaluated to determine if the criteria for implementing a winter drawdown was met. In 2017, the criteria for implementing a winter drawdown was met, but issues with permitting, constituent education and information, and how to pay for

expected expenses including reimbursing Renewable World Energies (RWE), who operate the dam, for lost power generation revenue, it was delayed until at least 2018.

In 2018, and in 2019, the criteria in the APM Plan were not met and the winter drawdown was postponed again. In 2020, criteria in the plan were met and on-going discussions with the WDNR, RWE, Washburn County, and other stakeholders about funding led to the submittal and award of a 3-yr WDNR Aquatic Invasive Species (AIS) control grant to once again consider a winter drawdown to control EWM, and to complete the necessary supporting actions for a winter drawdown. The current plan is to implement a winter drawdown over the 2021-22 winter season. It is not expected that this date will be postponed again.

The purpose of this report is to lay out a detailed plan for completing a winter drawdown for control of EWM in the Minong Flowage.

2.0 Drawdown

Overwinter drawdown is a low cost and effective management tool for the long-term control of certain susceptible species of nuisance aquatic plants. Overwinter drawdown controls susceptible aquatic plants by dewatering a portion of the lake bottom over the winter, and subsequently exposing vascular plants to the combined effect of freezing and desiccation (drying). The effectiveness of drawdown to control plants hinges on the combined effect of the freezing and drying. If freezing and dry conditions are not sustained for 4-6 weeks, the effectiveness of the drawdown may be reduced.

For a lake, water depth is critical to aspects of the fish, benthic invertebrate and macrophyte communities and to water quality (Cooke et al, 2005). Water level is an important determinant of recreation through maintenance of depth, limiting the activity or size of boats, and affecting shoreline facilities. Water level in a lake is related to flood storage capacity and regulation for downstream flow variation. Outside of the lake, changing lake level may affect water levels in nearby shallow wells, and hydraulically connected wetlands.

Water level in a lake a may be kept relatively constant, fluctuate seasonally, or vary in a rapid or seasonally unsynchronized fashion. As an impoundment, the water level in the Minong Flowage is kept fairly constant by the dam. When discussing lake level changes, conflicts may occur when manipulating the water level is done for principally one reason (like invasive species control) without regard to competing uses like recreation and wetlands.

2.1 Desirable Effects of Drawdown

Aside from generally being a more cost-effective means to control certain species of unwanted aquatic vegetation, a drawdown may offer several other benefits including increasing shoreline emergent vegetation, consolidation of some lake sediments, making shoreline improvements easier (subject to WDNR permits), identifying possible septic system issues, and when used as a part of an integrated management plan, may reduce the amount of herbicides needed to control an unwanted species (Cooke et al, 2005). Another possible benefit would be the concentration of forage fish and game fish in the same area. This could lead to reduced forage fish through predation and larger game fish (Cooke et al. 2005).

2.2 Undesirable Effects of Drawdown

Possible undesirable side effects include negative impacts to benthic fauna, loss or reduction of desirable plant species, invasion by drawdown resistant undesirable plants, reduced attractiveness to waterfowl, possible fishkills if oxygen demand exceeds aeration efforts, loss of aesthetic appeal during drawdown, possible algal blooms after refill, reduction in water supply to wells, and impairment of recreational activities during the drawdown (Cooke et al, 2005). Amphibians and reptiles could also be impacted depending on their ability to move around and how fast lake level changes are made. An inability to rapidly refill a drawn down lake is a basic concern in evaluating the potential for a drawdown. By completing a winter drawdown, many of these side effects can be avoided.

3.0 Target Species

The plant species to be targeted by winter drawdown in the Minong Flowage is EWM. Winter drawdown has consistently shown to be effective in reducing the amount of EWM in a body of water provided freezing and drying occurs for at least a 4-6 week time period. During the 2021 Summer Survey the frequency of occurrence for EWM in the Flowage in the vegetated area of the littoral zone is 27.1%. As many as 78 other species of aquatic plants were identified in the Minong Flowage during the 2021 summer whole lake point-intercept survey (Matt Berg, ERS personal communication August 2021). While the purpose of the proposed winter drawdown on the Minong Flowage is to control EWM, it is recognized that other desirable aquatic plants may be impacted.

The susceptibility of the dominant nuisance plant species and the other species observed in the Minong Flowage to winter drawdown is summarized in Table 1.

Table 1: Aquatic plant species in the Minong Flowage and the impact of a winter drawdown on them

Plant Species	Common Name	Increase or Decrease
Myriophyllum spicatum	Eurasian water milfoil	Decrease
Ceratophyllum demersum	Coontail	Decrease
Elodea canadensis	Common waterweed	variable
Nymphaea odorata	White water lily	Decrease
Najas flexilis	Bushy pondweed	Increase
Potamogeton foliosis	Leafy pondweed	Increase
Potamogeton Richardsonii	Clasping-leaf pondweed	Increase
Potamogeton zosteriformis	Flat-stem pondweed	Increase
Scripus sp.	Softstem bullrush	Increase
Zizania palustris	Northern Wild Rice	Increase

Several of the species identified in the Minong Flowage are susceptible to control by overwinter drawdown including EWM, coontail, and white water lily. Species that reproduce primarily by seeds, such as the pondweeds (Potamogeton spp.) are not typically controlled by drawdown and may actually increase under post-drawdown conditions. Potamogeton species include curly-leaf, so it can be expected that there would be little impact to it in the Minong Flowage, although during the 2013 extended drawdown CLP also saw much control.

If implemented on an annual basis, the effectiveness of a winter drawdown may diminish over time. The diminished effectiveness is associated with the replacement of drawdown-susceptible species by drawdown-tolerant species after repetitive drawdown. In the Minong Flowage it is not expected that doing a winter drawdown will become a regular event. The current Aquatic Plant Management Plan

recommends winter drawdown only when EWM in the system exceeds a certain point. The type of growing season that is had, water quality, and the use of aquatic herbicides between drawdowns will determine how often they are done, but it is not expected that there would be less than five years between one winter drawdown and the next to control EWM.

4.0 Dam Structure

The following information is taken from the Minong Dam Reconstruction Drawing Index from Washburn County and Ayres Associates, February 2013 (Figure 1). The new dam constructed in 2013 consists of a hydro-electric power generating house and seven concrete bays. The 1st and 5th bays have a top elevation of 995.45 feet and are each approximately 23-ft wide and have a 2x12 splash boards on top. Bays 6 & 7 have a top elevation of 996.55 feet and are each 23-ft wide. Bays 2-4 are each 11.3-ft wide with an elevation at the crest of the concrete of 991.45 feet. Mechanical lift gates are in each bay and can be lifted from the top to allow water to pass through underneath. When closed, the gates can raise the level of the flowage to 997.9 feet. Normal pool elevation is between 995.45 feet and 996.45 feet, or on the local datum between 110 and 111 feet with a 110.8 target level. A 5-ft by 4-ft mudgate is in place between the third and fourth bays set at an elevation of 975.45 feet. This gate can be opened to lower the water level below the elevation of bays 2-4.

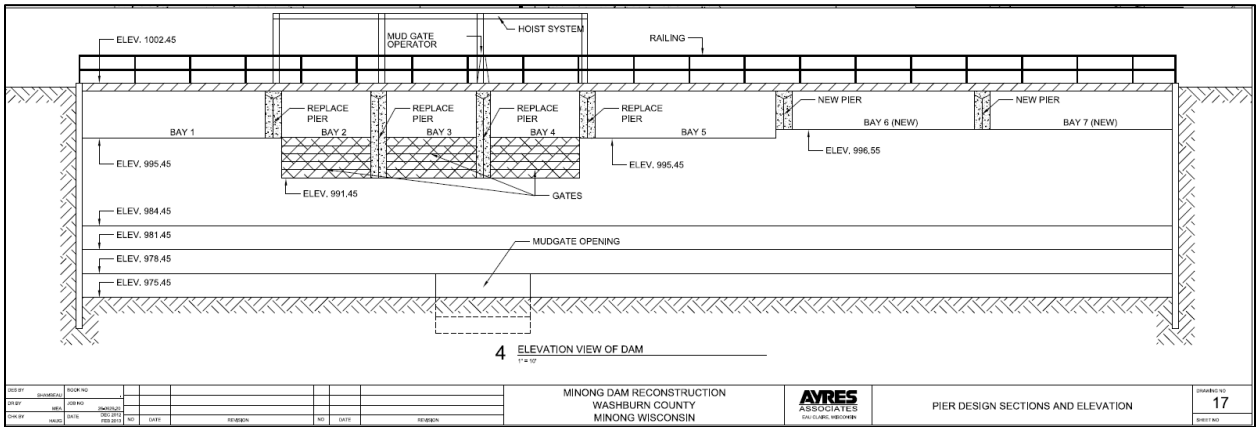

Figure 1: Minong Flowage Dam Reconstruction Drawing Index (Washburn County and Ayres Associates, 2013)

A 5-ft drawdown would necessitate opening the gates in bays 2-4 all the way lowering the water level by 4-ft to an elevation of 991.45 feet. The mud gate would then have to be opened to lower the water the remaining 1-ft to an elevation of approximately 990.45 feet. The bottom of the headworks that lets water flow into the powerhouse is set at 984.95 feet so it is expected that power generation would be able to continue even with the drawdown, however it might be limited.

Data collected from 2014 through 2020 by Renewable World Energies shows power generation averages between 99 and 234 mega-watt hours (MWH) between October and April (personal communication from Renewable World Energies, July 2021). At normal pool elevation, there is no water flow over the dam, only through the power house running two turbines in the summer and one in the winter. A minimum of at least 33-cfs through the dam must be maintained for downstream purposes, and a flow of >50-cfs is needed to maintain operation of at least one of the two power generating turbines (Johnson, J.A. email communication March 2015).

5.0 Area of Control

Eurasian water milfoil is established in 22.9% of the summer littoral zone in water up to 9.5-ft deep with 35% of points with EWM in water >5.0-ft (Summer 2021 data). The littoral zone of the Minong Flowage in 2021 is approximately 993 acres, with only 595 acres of that with vegetation. EWM presently is found in 36% of the littoral zone with plants. It's frequency of occurrence in the Flowage as a whole is 7.5%, and in the entire littoral zone, 17.25% (Matt Berg, ERS personal communication August 2021).

The last fall EWM bedmapping (2020) identified 112 acres of EWM in the Minong Flowage. During the most recent PI survey completed in August 2021, the areas with the most EWM are the DNR Landing Bay, North Basin, Serenity Bay, and the basin east of Smith Bridge (Figure 2).

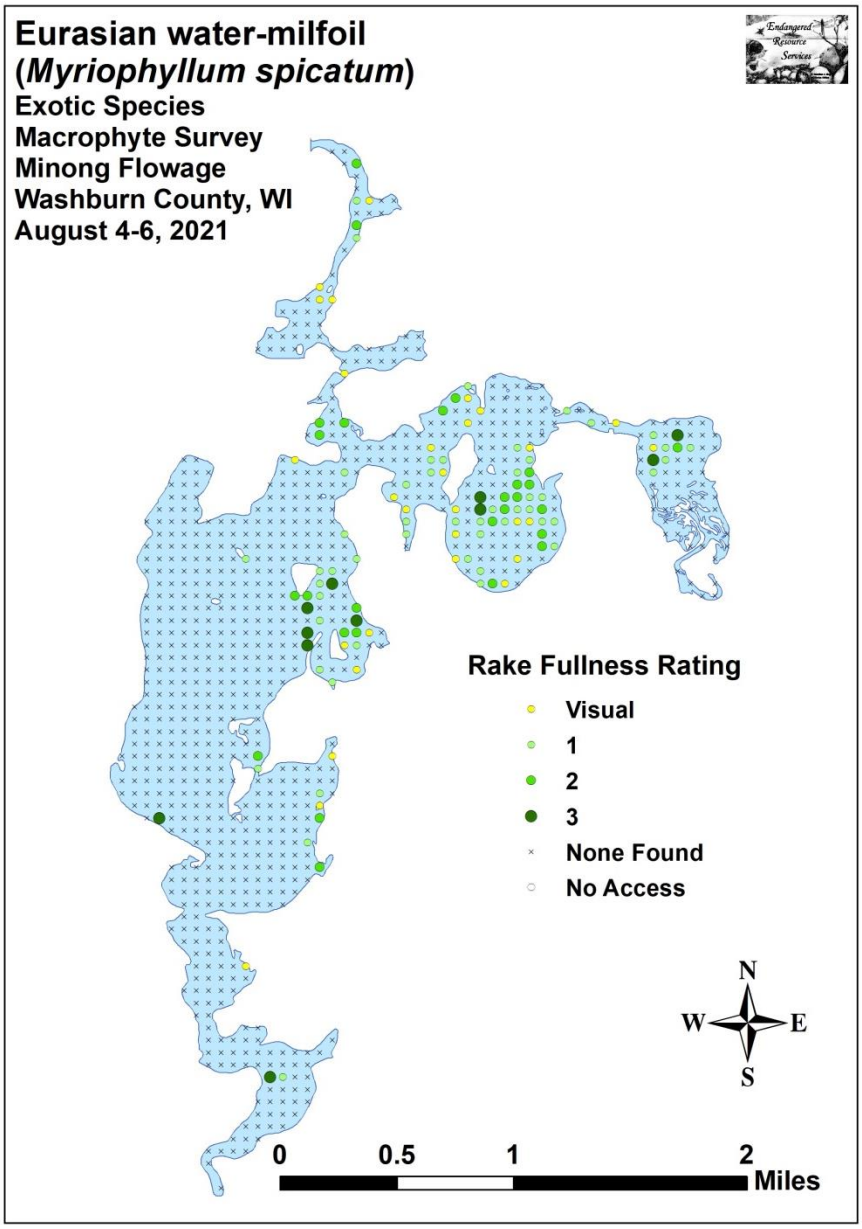

Figure 2: Summer 2021 EWM point-intercept survey results (ERS)

A winter drawdown of 5-ft is expected to negatively impact EWM in as much as 6.5-ft of water, or about 96% of the EWM in the Flowage.

5.1 Cost Analysis

The following is a brief discussion of the potential costs of EWM management on the Minong Flowage.

5.1.1 Herbicide Application

The first Aquatic Plant Management Plan for the Minong Flowage was completed in 2009 and recommended large-scale herbicide application to control what amounted to more than 335 acres of dense growth EWM in the Minong Flowage. The frequency of occurrence in the littoral or plant growing zone was estimated at about 37%. From 2009-2011 herbicide was applied to more than 280 acres (68 acres in 2009, 125 acres in 2010, and 87 acres in 2011) at a cost of more than $500/acre for herbicide and application only. Planning, herbicide concentration testing, aquatic plant survey work, and other expenses brought the number up closer to $1000/acre. The majority of this cost was covered by WDNR grant funding.

Financial costs associated with the 2013 extended drawdown are difficult to calculate as this was a mandatory drawdown to repair the dam, and all property owners shared the burden through additional taxes. It is expected that implementing a winter drawdown will have substantially less costs, with the greatest expense being possible reimbursement of the power company for lost revenue associated with less power to sell. The estimated cost for loss of power generation is $47.50/MWH. The average power generation by the Minong Dam over the time period of this proposed drawdown is 184 MWH per month. Based on power generation that was maintained during winter period of the 2013 drawdown, it is expected that about 58% of the power in MWH normally generated during the October to April time period will continue. This leaves a power generation loss of about 42% with an estimated value of $34,763.00. This is the estimated cost to RWE that they will have to be reimbursed for. It could be a bit more, or a bit less than this. We also have a commitment on the part of RWE, that they will reduce the total loss by 10% at the project's completion.

This cost is included in the grant funding that was awarded in early 2021.

5.1.2 Mechanical Harvesting

Mechanical harvesting is not a feasible management alternative on the areas most affected by the winter drawdown.

6.0 Hydrology

According to local sources, the flow going through the dam is approximately 240 cfs and it is assumed under normal conditions (no rain fall) that the same amount of water is coming into the Minong Flowage. Before the winter drawdown is commenced this number will be corroborated with new stream flow and volume data.

Based on 2021 data and including that area known as the Cranberry Flowage between Hwy T and the outlet of Cranberry Lake, a drawdown of 5-ft would remove approximately 7,123 acre-feet of water or about 54.5% of the total volume of 13,071.82 acre-feet. In terms of the surface area of the Flowage, open water would be reduced by 27.8% or about 447 acres (Figure 2).

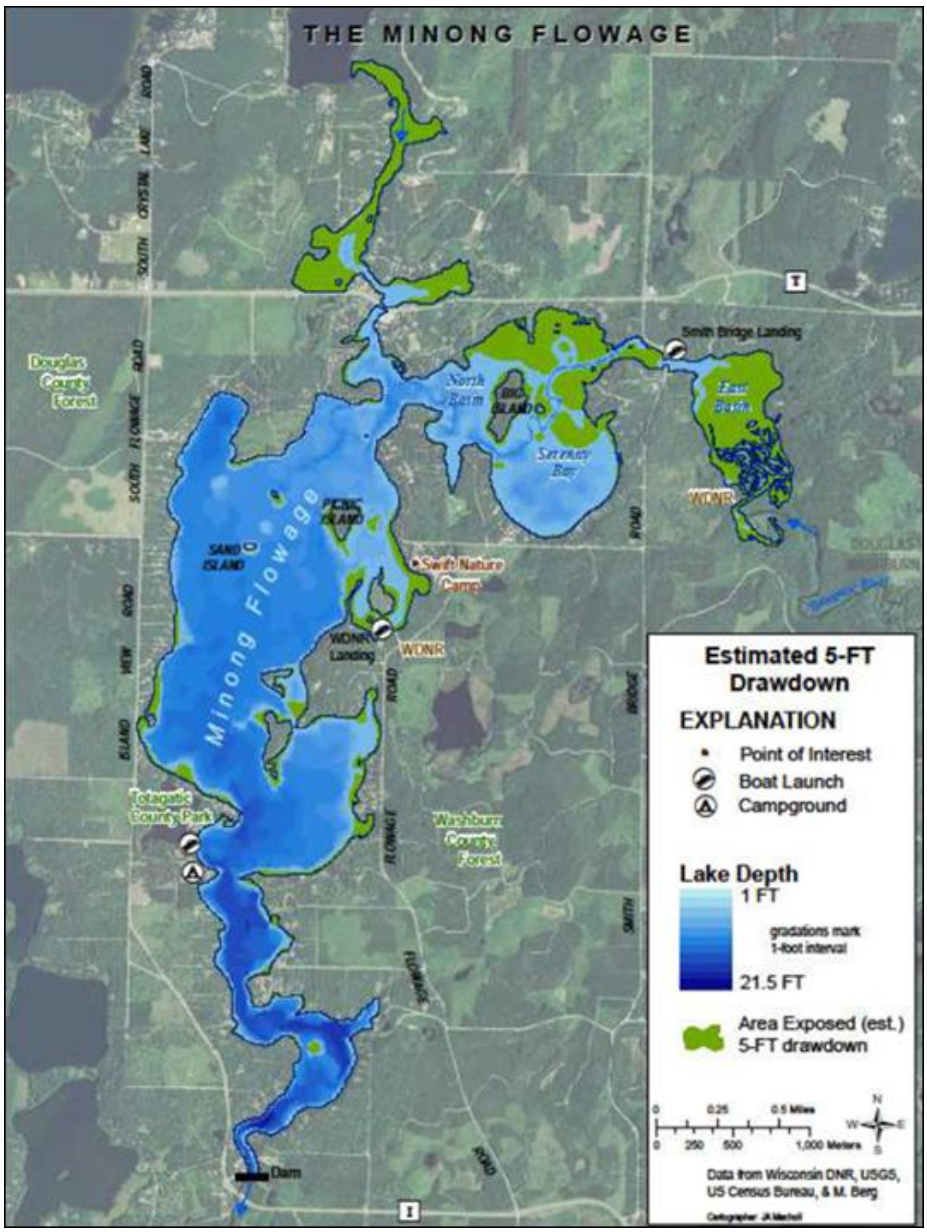

Figure 3: Estimated exposed surface area of the Minong Flowage after a 5.0-ft winter drawdown.

6.1 Taking Out the First 4-ft of Water

The time it would take to draw down the Flowage by 5-ft is controlled by how far and/or how many of the three gates on the dam (for the first 4-ft) and the mudgate (for the final 1-ft) are opened.

All three gates would have to be opened 12 inches to accomplish the drawdown in the desired time frame. The general weir equation[1], $Q=3.0 \times L \times H1.5$, where Q is the flow in cfs, L is the length of the combined gates in feet (33.9 feet), and H is the head over the structure in feet (1.0-ft if gates were opened 12 inches) can be used to estimate the time it would take to draw down the lake. Using this equation, it is estimated that opening all three gates by twelve inches would remove 4-ft of the required 5-ft drawdown in about 27.05 days at about 1.77 inches a day.

6.2 Taking Out the Remaining 1-ft of Water

The remaining 1-ft or 12" of drawdown would have to be completed by opening the mud gate. The mudgate has a dimension of 5-ft wide and 4-ft high. It can be open in increments, so does not have to be opened all the way to let water out. Using an orifice equation[2] that takes into account the area of the opening and water pressure above the opening, it is estimated that it would take an additional 5.6 days to remove the final 1,238 ac-ft of water (based in the difference in volume between a 4-ft and 5-ft drawdown) if the mudgate were opened 12 inches once the 4-ft reduction (water no longer able to flow over gates 2-4) was reached if the mudgate were opened ¼ of the way or 1-ft. During this time, the water level in the Flowage would drop by about 2.14-in per day.

Combined, a drawdown under these criteria would take approximately 33 days, 8 days ahead of the required 41 days to complete the drawdown set by the WI-DNR (August 2021). The extra 8 days are considered a cushion to allow for rainfall during the drawdown period and/or possible error in the drawdown calculations.

6.3 Spring Refill of the Flowage

According to information provided by the Washburn County Highway Department, a minimum flow of 33-cfs must be maintained for downstream purposes during any refilling event. To ensure minimum flow is achieved, the gates would be closed over a period of time and outflow would be visually monitored during refill. Maintaining the minimum flow is not anticipated to be a problem. At the end of the 2013-14 extended drawdown it only took a couple of weeks to refill the Flowage.

It is expected that under normal conditions, refill of the Flowage would be completed by or before the Wisconsin Fishing Opener, the first weekend in May.

[1] General weir equation taken from: http://irrigation.wsu.edu/Content/Calculators/Water-Measurements/Rectangular-Contracted-Weir.php

[2] Orifice equation taken from: https://engineering.fandom.com/wiki/Orifice_equation

7.0 Water Quality

Secchi depth is a measure of the clarity of the water, and helps determine the trophic state of a lake. The Secchi depth of a lake is affected by minerals dissolved in the water column as well as algae and sediment suspended in the water. A deeper Secchi depths means more light penetrates the water column allowing aquatic macrophytes to grow. Secchi disk reading of water clarity have been collected by volunteers since 1986 through the Citizen Lake Monitoring Network in Wisconsin, sponsored by the WDNR and UW-Extension Lakes program.

Summer Secchi depths for the deep hole near dam in the Minong Flowage have pretty regularly averaged about 4 feet since 2001 (Figure 3). This correlates to poor water clarity and eutrophic conditions. As reflected by the Secchi depth measurements, the amount of suspended particles in the lake increases during the growing season (May – September). This is most likely the growth of algae due to warmer temperatures, increased hours of daylight, and continuous contributions of nutrients through runoff, surface water inputs, or internal recycling from the sediments.

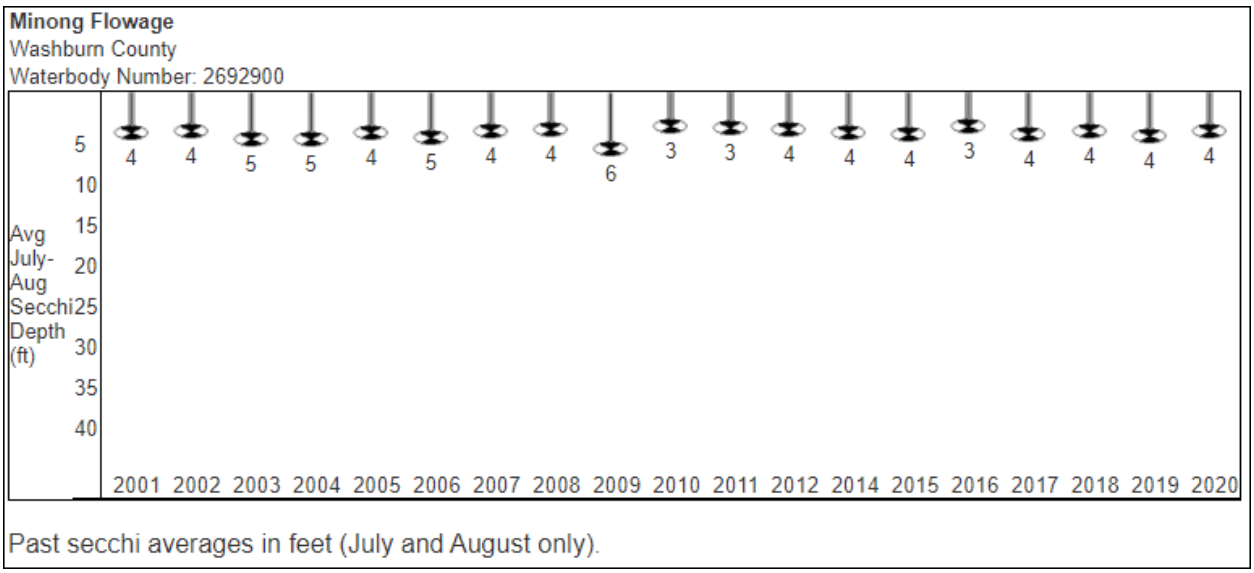

Figure 4: Average Summer Secchi Depth (feet) at the Deep Hole-Near Dam site

Water chemistry data has been collected on the Minong Flowage since 2001 by volunteers. Seasonal total phosphorus has ranged from 102 to 187-µg/L, and chlorophyll a has ranged from 60 to 94-µg/L. The trophic state of the Minong Flowage as determined by Secchi depth and water chemistry is shown in Figure 3, and a description of the general conditions is in Figure 4.

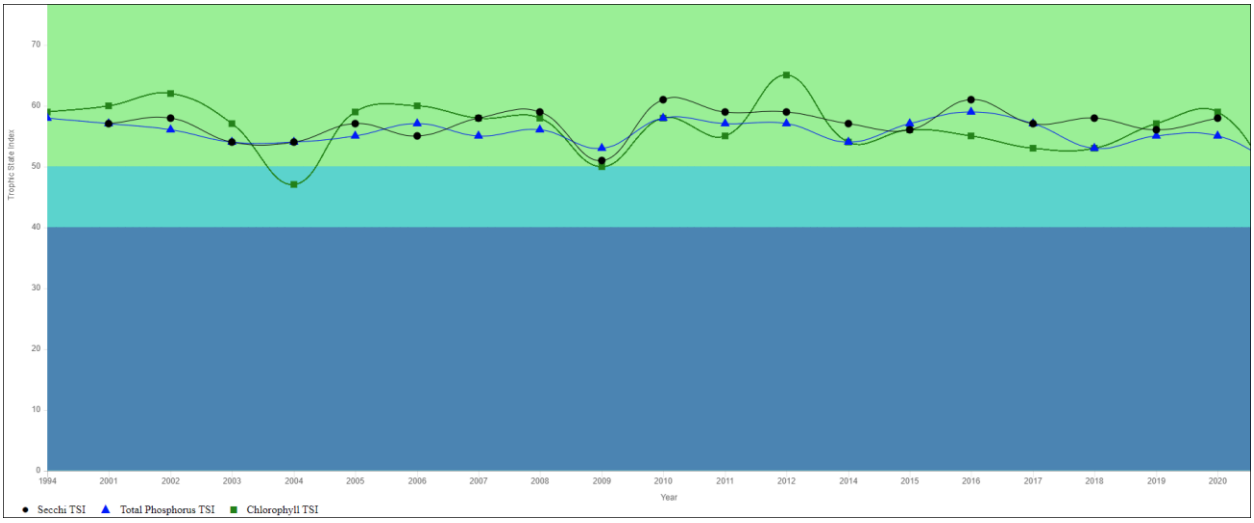

Figure 5: Average Summer TSI Values for Secchi, Chlorophyll, and Total Phosphorus at the Deep Hole Near Dam site

In a few cases, refilling after drawdown has led to an increased amount of available phosphorus (P) in the system and been blamed for algal blooms. Factors that may cause this to happen are P release from re-flooded sediments, fish consumption of algae grazers, and a reduction in plant biomass that would have otherwise used up some of the available P. Field reports of increased P are mixed. Water quality testing should be completed through the open water season following the drawdown.

8.0 Private Wells

Private wells, particularly those that are shallow or sand point wells, could be impacted by a winter drawdown. The number of property owners on the Minong Flowage with shallow wells is not known at the present time although during the 2013 extended drawdown, "many" wells went dry or at least property owners had issues with well water that could have been caused by the extended drawdown. Many of these same properties have now done things to upgrade their wells, and though a few may still go dry during the proposed winter drawdown, the number should be way less, and considering the duration of a winter drawdown, may not impact the property owner at all.

9.0 Fisheries

A comprehensive survey of the Minong Flowage, Washburn County, was conducted during the 2016 sampling season. The primary objective of this study focused on assessing the status of gamefish and panfish populations in the Minong Flowage. The secondary objective was to evaluate any potential fisheries impacts from the 2013 drawdown (March 2013 – April 2014).

The 2016 adult walleye population was estimated at 8,903 fish or 5.7 fish/acre. This population was similar to 2010 and decreased from 2005. The adult walleye density was higher than the Ceded Territory average for lakes that are sustained by natural reproduction.

Northern pike, largemouth bass, smallmouth bass, bluegill, and other panfish were also collected during 2016. A total of 187 northern pike were collected ranging in length from 10.5 to 39.0 inches (in). A total of 35 bass were collected ranging from 5.5 to 19.0-in. Forty-eight smallmouth bass were collected ranging from 7.5 to 17.0-in. A total of 81 bluegill were collected ranging from 1.6 to 9.5-in. Other panfish species collected were less abundant in the flowage.

Summary and management recommendations include:

1. The no minimum, one fish greater than 14-in limit should help improve walleye growth in the future.
2. Walleye recruitment is excellent.
3. The northern pike density is lower compared to 2005, which is likely related to habitat changes induced by the drawdown.
4. Largemouth bass are not common in the Minong Flowage
5. The smallmouth bass population saw a modest increase in 2013 compared to 2010.
6. There were fewer bluegill under 6 in collected in this survey than 2010, suggesting habitat changes associated with the drawdown impacted bluegill.
7. Based on available data, the 2013 drawdown did have some positive and negative impacts on the Minong Flowage's fishery that need to be considered during planning for future drawdown events.
8. Preventing the establishment of new invasive species and monitoring of established invasive species should continue.
9. Habitat preservation/reestablishment should be encouraged.

When asked what WDNR fishery concerns there were, Craig Roberts, WDNR Fisheries Manager for Washburn County had this to say.

From a fisheries standpoint, the main concerns are related to spring refill. The water level should be returned to normal by May 1st -15th (depending on winter). This timing helps nest building fish have stable water levels during spawning. The fish species to be concerned with are black crappie, bluegill, and largemouth bass in the flowage.

Partial winterkills may occur in more stagnant parts of the flowage during a winter drawdown. That is acceptable as long as drawdowns aren't being done so often that the fishery cannot recover. A total winterkill would by highly unlikely given that the river provides flow and oxygen in the winter. WDNR dissolved oxygen monitoring during the last drawdown showed that. A 5 year minimum between drawdowns would be needed in case of any significant fishery kills. This accounts for the ages that these fish species mature: bluegill (3 years old), black crappie (2 -4 years old), and largemouth bass (3-4 years old). The last drawdown did seem to impact bluegill more than the other species.

DNR fisheries monitoring will continue to monitor as we currently have. This means a periodic fall walleye assessment and a full survey every six years, based on our current rotation. This approach will allow us to watch the fishery and we can track any major changes just like the last drawdown with our current data collection methods.

9.1 Spawning

The typical spawning period for many warm water species (bass and panfish) is April to June. It is expected that the lake level would be restored very early in this time frame, so as not to impact the spawning of these species. Refilling is expected to take only a couple of weeks, and probably less, once started.

Northern pike may be most impacted by a winter drawdown as they begin spawning as soon as the ice begins to break up in the spring, late March or early April. Northern pike spawn in marshes with grasses, areas with sedges, rushes or aquatic plants, and in flooded wetlands (WDNR, 2008 Publ-FM-707-08)[3].

9.2 Other Fisheries Concerns

On lakes that experience a great deal of winter ice fishing pressure, there is concern that the concentration of fish species in a smaller area of the water body will be over-harvested by fisherman. On the Minong Flowage, this may be somewhat limited by reduced access to it under drawdown conditions. However, if there is tremendous concern, a voluntary limit on fish harvested could be recommended to fisherman during the drawdown.

[3] Taken from: https://dnr.wisconsin.gov/sites/default/files/topic/Fishing/Species_northernpike.pdf

10.0 Wetlands, Wildlife, and Benthic Organisms

A drawdown may be expected to impact more than just the fishery in a lake. Wetlands around the lake, wildlife that use the lake, and the tiny critters that live in the sediments of the lake can also be impacted, at least temporarily.

10.1 Wetlands

The impact of drawdown on wetlands which are hydraulically connected to the lake is often of great concern. Hydrology is generally considered the master variable of wetland ecosystems, controlling recruitment, growth and succession of wetland species. Drawdown of the water level in summer, if more than a week or two in duration, leads to desiccation and stress of wetland species in most cases. In contrast, a similar drawdown completed in the late fall or winter is expected to have little impact on dormant emergent plants, but may impact exposed littoral zone submergent plants and their root structures. Significant and long term changes in wetland hydrology can produce rapid changes in vegetative species, but most drawdown for lake management purposes constitute only a temporary influence on the hydrologic regime, and as such generally do not have a detectable, widespread effect.

10.2 Wildlife

Historically, water level drawdown has been used in waterfowl impoundments and wetlands for periods of a year or more, including the growing season, to improve the quality of wetlands for waterfowl breeding and feeding habitat. This is not the goal here, however, if the drawdown were to stimulate the growth of more desirable plants in the littoral zone (wild rice for example), the use of this area by waterfowl could benefit. The effects of drawdown on amphibians and reptiles have not been well studied, however that which has been done suggests the impacts are mixed depending on the mobility of the species. Those species with more limited mobility (snails, mussels, eggs, larvae, etc.) will likely experience the greatest impact. More mobile species (turtles, frogs, etc.) will suffer less negative impact.

The negative effects of a drawdown on these species can be reduced by the timing and duration of the drawdown event and the dewatering process. Slower reduction in water level over a greater period of time will provide more time for creatures to move. Since it is expected that emergent shoreline vegetation will increase as a result of a drawdown, the impacts on furbearers is expected to be mostly positive.

During the 2013 extended drawdown, many mussel/clam shells were seen on the lake bed exposed because of the drawdown. The majority of these species was seen during the summer months and may have been the results of predation. An area mussel expert identified the vast majority of species lost in the 2013 extended drawdown to be common mussels, not endangered or threatened. Moreover, it is expected that the shorter duration of the winter drawdown, assuming the mussels have an opportunity to move to the waters not drained, will have less impact on them.

10.3 Benthic Organisms

Almost all reports indicate a reduction of benthic (bottom) invertebrate abundance and diversity in the littoral zone exposed by the drawdown. Water level changes in gently sloping littoral zones negatively affect more benthic habitat than they do in steep littoral zones. The Minong Flowage has a mix of sloping and steep benthic zones. The frequency and duration of the water level fluctuations generally determine the annual loss of production and the potential for recovery. In small-scale drawdown, recolonization by invertebrate is usually rapid, although changes in species composition and diversity may occur (Cooke et al, 2005).

11.0 Recreational Water Use

The implementation of overwinter drawdown may interfere with winter recreational uses of the lake, particularly related to snowmobiling. A 5-ft drawdown will expose stumps and other debris that will pose hazards for snowmobilers. Adequate trail marking and warnings at access points to the Minong Flowage, and notice in all local businesses that support snowmobiling should be made. Additional issues could be encountered if property owners leave their docks in the lake over the drawdown period. This is not recommended, but if it is done, then efforts should be made to place reflective tape on the ends so they are more visible at night.

Drawdown, if accomplished before ice cover, is not expected to affect normal ice conditions on the lake. The usual conditions that affect ice will still be in play including warm weather, rain and snow events, and shoreline melting. The drawdown would not begin until late September, and the lake would be refilled early in the spring, so open water uses of the lake are not expected to be impacted.
Removal of docks and boats could be impacted due to lower water levels at the take out points if left in the water past the usual times lake owners wrap up their boating season.

12.0 Recommended Plan

On the basis of the above analysis, the use of a 5-ft winter drawdown for control of EWM in the Minong Flowage is feasible, likely without significant adverse impacts when undertaken in a carefully controlled and monitored setting. The following program is recommended to optimize control and minimize potential impacts:

- **Schedule**: Implement a 5-ft drawdown over the 2021-22 winter.
- **Frequency**: It is not expected that a winter drawdown would be repeated at any more regular of an interval than 5-years. Criteria have been set in the Minong Flowage Aquatic Plant Management Plan whereby a winter drawdown would be implemented. It is these criteria that help determine when a winter drawdown would be proposed.
- **Dewatering**: Dewatering should commence on or about September 20 at a rate of no more than 2" per day to provide sufficient time for dewatering prior to the formation of ice cover and for affected wildlife to move. It is expected that personnel tending the dam would administer the drawdown. As such, there may be expenses associated with the extra time needed for the Dam Attendant likely to be covered by the MFA and other Stakeholders.
- **Water Level Maintenance**: The lake level should be maintained at the desired drawdown level (approximately 105.8 local datum) from late November through spring ice out. Staff gauges to record water level changes have already been set up at several locations including Pogos, Smith Bridge, and the dam. Regular monitoring of changing lake levels will be recorded during the drawdown period. If significant rainfall occurs during the period when the drawdown is being implemented, more water can be removed – up to 6 inches per day by WDNR guidelines.
- **Refill**: Refilling of the lake should begin with ice out in the spring. A minimum outflow of 33-cfs should be maintained during the refill period. Maintaining a flow of at least 50-cfs will allow at least one generator in the powerhouse to continue running during the refill. Refill to normal pool elevation should occur within two weeks under most circumstances. Starting the refill at ice out eliminates conflicts with ice fisherman, prevents free floating ice sheets from damaging shoreline, and prevents the tearing up sediment and other bottom material that may be frozen to the bottom of the ice sheet.
- **Aeration:** Aeration is not expected to be needed.
- **Voluntary Bag Limits**: During the period of the drawdown, voluntary bag limits on panfish, bass, northern, and walleye should be considered.
- **Shoreland Maintenance**: Shoreland maintenance, stump removal, beach clearing, etc. is not recommended during this drawdown and would likely be an illegal activity on the part of the property owner.
- **Monitoring and Inspections**: The following program of inspections and monitoring should be conducted in conjunction with the implementation of drawdown. This monitoring and inspection program is designed to guide the drawdown program implementation as well as to provide and early detection for potential impacts to adjacent wells.
    - Well Monitoring – During the period of drawdown residents should periodically monitor water levels in their wells, or check water flows to ensure that sufficient water is available in the well. If adverse impacts are noted, residents should inform the Minong Flowage Association so they can be addressed.
    - Vegetation Surveys – Annual vegetation surveys should be completed to document the areal coverage and distribution of aquatic plants. Plant surveys should be conducted in mid to late summer to assess conditions under maximum plant coverage. A whole-lake,

point-intercept survey was completed in August 2021 and is expected to be repeated in the year following the winter drawdown.

- Water Quality Testing – expanded water quality testing including total phosphorus, total dissolved phosphorus, and chlorophyll a should be monitored at least once monthly throughout the open water season following the drawdown.
- Lake Water Level – The water level of the lake should be measured at the fixed staff gage on the Minong Dam on a daily basis during dewatering and refill, and weekly during the period of the drawdown.
- Outlet Channel Inspection – During the dewatering period, the downstream channel should be inspected for evidence of scouring or flooding and the discharge rate reduced if necessary. The outlet channel must be kept clear of obstructions. This could include monitoring the flow and volume in the Totogatic River just downstream of the dam.
- Fisheries Survey – The WI-DNR is planning to complete a comprehensive fisheries survey of the Minong Flowage in 2023. It is also planning on a walleye recruitment survey in September 2021 before the drawdown, and may do one after the drawdown is complete as well (Craig Roberts, WI-DNR personal communication August 2021).

13.0 Permitting

Permitting for a 2021-22 winter drawdown has already been obtained.

14.0 References

Cooke, G.D., E.B. Welch, S.A. Peterson, S.A. Nichols, 2005. Restoration and Management of Lakes and Reservoirs, 3rd ed. Taylor and Francis Group, Boca Raton, Florida. 591 pp.