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To | Brown's Creek Watershed District

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From | Cecilio Olivier, PE & Ryan Fleming PE

Regarding | Long Lake Drawdown Feasibility Conclusions & Recommendations

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Background

Drawing the Long Lake water level down over the winter was identified as a method to improve water quality as well as to accomplish several other objectives identified in the 2006 Long Lake Management Plan.

The question of whether Long Lake can be drawn down to a level to achieve the following objectives has been addressed by conducting a feasibility study over the past several months.

- Consolidate loose bottom sediments
- Eliminate bottom-stirring rough fish
- Reduce nuisance submerged aquatic plants
- Stimulate growth of beneficial emergent aquatic plants
- Provide opportunity to remove sediment deltas and construct sediment trap/fore bays

The scope of the study is limited to answer the specific question: Is the drawdown of Long Lake a feasible alternative for obtaining these objectives. The report does not consider or attempt to articulate potential drawdown impacts beyond these items or permit considerations.

Conclusions

The study is split into individual components of analysis to address each of the objectives as briefly described below.

1) Lake Drawdown Hydrology

   Surveying was conducted to develop detailed bathymetric mapping of Long Lake and Jackson WMA. The District SWMM model was modified with the new information and drawdown simulations were run to establish the rate and time to drawdown for the Lake as well as investigate any temporary water level controls that would be necessary.

   - Long Lake and Jackson WMA can feasibly be drawn down within the time frame of late fall, prior to the water bodies icing in and at a rate that would not overwhelm downstream resources.
   - Groundwater flux into and out of Long Lake remains unknown. An effort to draw the lake down and remain at a low surface water elevation could be complicated by influx of groundwater.
   - Long Lake is separated by earthern berms into 3 minor sub-basins. Multiple pumps would be necessary to effectively draw the sub-basins and Jackson WMA down. Stationary pumps will be able to draw the lake down to within 2 feet of the bottom at the intake location.
   - The footprint of water remaining in the south and central sub-basins at the 1.5 foot depth still covers a large proportion of these areas (up to 80%), therefore requiring a significant effort, involving mobile pumps and platforms, to draw the lake water down to a level that will allow for adequate desiccation of sediments and vegetation.

- Drawing Long Lake down by pumping would allow the opportunity to remove sediment deltas that have accumulated at the lake inlets.
- The approximate cost of pumping Long Lake and Jackson WMA down ranges from $130,000 and $150,000 depending on the equipment used. This does not include the labor to draw the southern and central sub-basins down below the 1.5 foot depth due to the variability in level of effort required depending on the lake bottom profile and consistency once drawn down.

2) Lake Refill Hydrology

The Districts SWMM Model was run using various recent precipitation records with the initial condition of Long Lake and Jackson WMA starting empty to simulate a complete drawdown. Each of the last 3 years, a recent 'dry' time period, a recent 'wet' time period and an average precipitation period were run.

- Modeling simulations found that Long Lake and Jackson WMA will refill to the control elevation (at 72nd Street and at TH12) within the season following a drawdown. Dates to refill range from the end of June during a wet season to the middle of August during a relatively dry season.
- Upstream stormwater ponds will not be affected by drawing down Long Lake and Jackson WMA as they are controlled at elevations above the surface water elevation of these two water features.

3) Soil Desiccation and Rewetting Study

Sediment response to a drawdown was simulated through a Soil Desiccation and Rewetting Study. The study replicated the drying and re-wetting of lake bottom sediments. In the study, extracted sediment samples were subjected to air desiccation, re-wetting, and a series of freeze thaw cycles to simulate likely conditions lake sediments would endure after a lake drawdown. Soluble reactive phosphorus (SRP) was measured following the rewetting of the sediment samples.

- Average sediment core length was 0.84 feet; ranging from 0.60 to 1.10 feet. This is the distance a 2-inch sediment corer could be depressed until resistance precluded further advancement. Sediment below this depth is considered consolidated and would likely not exhibit desiccation following a drawdown.
- Average sediment consolidation was 0.22 feet; ranging from 0.12 feet to 0.29 feet. This small amount of consolidation would result in negligible gain of improved macrophyte rooting substrate and will not result in measurable water depths in Long Lake.
- Average SRP released following the desiccation experiment was 0.19 mg/L; ranging from less than 0.02 mg/L to 0.74 mg/L. Release of SRP following a drawdown could result in a phosphorus spike, which is consistent with findings on other Lake drawdown studies.
- Any gain of sediment consolidation achieved in the desiccation process may be negated by wave and wind action as the lake re-fills the following spring.

4) Rough Fish Removal and Restocking Plan

Drawing down the level of a lake over the winter is a management tool to induce winterkill. Shallow lakes do not necessarily form a layer of denser 4° C water that protects fish from the less dense but colder water above (the layer that forms ice). The shallow, cold water can then lead directly to fish mortality from freezing and can also exacerbate anoxic conditions.

- Koi and black bullhead, both surveyed and observed in Long Lake, are resilient to low oxygen conditions in winter that kill other fish (winter-kill). Even in conditions that kill many rough fish, some will survive and populations rapidly rebound.

- Chemical treatments with the piscicide Rotenone can guarantee full rough fish removal when applied to populations concentrated into smaller areas by a drawdown.
- There are 11 nearby ponds that contribute to Long Lake. Re-establishment of carp over these distances is highly likely. The ponds are small enough that rotenone application would be very effective and could be applied at the same time as the Long Lake treatment.
- Even rough fish elimination programs that have led to re-established sport fisheries and better water quality have been subject to re-invasion by rough fish within 10 years (Helsel et al., 2003).
- The MNDNR will not sponsor a fish restocking program unless the waterbody has public access, adequate aeration, and a predator control plan in place. In the absence of these items the DNR is willing to provide guidance to other entities in developing such plans.
- The approximate cost of rotenone treatment for Long Lake, Jackson WMA, and the surrounding ponds is $47,000 based on the acreage of surface to be treated and assuming a drawdown to 1.5 foot depth in Long Lake and Jackson WMA.

5) Vegetation Response to a Lake Drawdown

The potential exists for managing aquatic plants by manipulating the lake's water levels using a drawdown. Numerous studies show lake drawdown can cause both positive and negative impacts for controlling aquatic vegetation and that the response depends on multiple factors. Vegetation surveys have been conducted on Long Lake in 1979, 1997 and 2008.

- Lake drawdown can bring control of some rooted aquatic plant species if lake sediments are completely dewatered and a sufficient period of extreme (freezing cold or very hot) temperatures affects the lake while drawn down. Control of these species is has been found to be short-lived, on the order of 1 to 2 years before nuisance species regain root in the lake.
- Aquatic vegetation such as pondweeds and including coontail and elodea, can be strongly resistant to over-winter drawdown exposure, and in several studies actually responded by increased growth following winter drawdown (Turner et al. 2005). This is consistent with the experience of the MNDNR on these species.
- Long Lake historically has contained high levels of submerged aquatic vegetation, including macrophyte species coontail and elodea. Though these species are native to this area, they are considered present in nuisance levels. Drawdown of the lake could risk these species thriving in greater number in the following seasons.
- Long Lake has a sufficient seedbed of emergent macrophytes that includes both desirable and nuisance species (bulrush, cattail, reed canary grass) that would likely thrive following a lake drawdown.
- Drawdown of Long Lake would likely result in temporary control of floating leaved aquatics.

Recommendations

Given the conclusions arrived at for each component of the study, a full drawdown of Long Lake to achieve the goals set out in the Long Lake Management Plan is not recommended.

Partial drawdown of the lake to gain access to the sediment deltas at the southern end of the lake may be beneficial if this is viewed as a priority item for Long Lake. The nature of the dredged material and available disposal sites, as well as any permitting constraints will need to be assessed. The presence of groundwater flux into Long Lake should also be determined as it may negate any pumping of the lake for access and maintenance.

The northern sub-basin and Jackson WMA bathymetry are deep enough to potentially stratify and develop anoxic conditions which can augment the release of phosphorus from lake bottom sediments. A study to sample the actual phosphorus input from these areas of the Long Lake system, in combination with existing in-lake modeling, would determine the degree to which phosphorus loading from the sub-basins is disproportionate. If these areas in the system are found to contribute the majority of the internal phosphorus loading, a targeting treatment (alum, ferric chloride dosing, etc.) could be pursued.

Closing Remarks

Minor sub-tasks to support the soil desiccation and rewetting study remain and are anticipated to be complete in the month of May, 2009. These include obtaining laboratory results of spring pore water soluble reactive phosphorus concentration which would be similar to that refilling Long Lake following a drawdown as well as determination of the organic to inorganic ratio of sediment samples. These results will be included in the final draft of the Long Lake Drawdown Feasibility Report.

References

Helsel, D., T. Zagar. 2003. Big Muskego story: Rehabilitating a large shallow lake. Lakeline (Spring 2003), 21-28.

Turner, M.A. and others. 2005. Divergent impacts of experimental lake-level drawdown on planktonic and benthic plant communities in a boreal forest lake. Can. J. Fish. Aquat. Sci. 62: 991-1003.