Water Management on Lake Bernard

Background Report

March 2024

Ministry of Natural Resources and Forestry

Ontario

Table of Contents

List of Figures

List of Tables

1.0 Executive summary

The Ministry of Natural Resources and Forestry (MNRF) has heard concerns from users of Lake Bernard about water levels on the lake. This report provides an overview of the lake's characteristics and the many factors that influence its water levels. The background information provided throughout the report is intended to build a shared understanding of the multiple factors considered when making water management decisions related to Lake Bernard.

Purpose of the report

The purpose of this report is to provide factual background information regarding Lake Bernard and to foster a better understanding of the various factors that are taken into consideration for Lake Bernard Dam operations.

1. **Factors that influence water levels:** The report documents factors influencing water levels, including:
    - seasonal temperature changes
    - hydrology – defined as the movement and flow of water affected by precipitation, runoff, evaporation, groundwater movement and dam operations

2. **Factors that influence shoreline damage:** The report documents factors influencing shoreline damage, including:
    - high winds and fetch of the lake
    - soft shorelines consisting of natural or modified material, such as sand, soil, vegetation and landscaped lawns

3. **Community feedback:** Concerns have been expressed about water levels and dam operations, including the following:
    - shoreline erosion due to high water levels in the spring and summer
    - low water levels in the summer negatively affect summer recreation and navigation activities, such as boating, access to boat launch areas and exposed rocks
    - low water in the winter negatively impacts Lake Trout eggs – deeper water in the winter offers incubating eggs more stable temperatures, ensures a substantial amount of oxygen, and provides some protection against predators
    - shoreline damage from ice push in the spring

4. **Legislative context around dam operations:** The report explains dam operations within legislative frameworks and policy guidelines governing water level management. It outlines the parameters and considerations guiding the government's operational decisions about water levels.

5. **Lake Bernard Dam operations:** The report covers the management of dam operations for the Lake Bernard Dam. It outlines the multiple guidelines and processes used for managing water levels and identifies the potential risks associated with operating the dam outside of the seasonal water management objectives. It highlights the need to balance dam operations with community concerns and potential impacts on the natural environment.

2.0 Lake Bernard and Lake Bernard Dam

This section provides a geographic context for Lake Bernard and background information on the Lake Bernard Dam, including its context within the Magnetawan River watershed.

2.1.1 Geographic context

Lake Bernard is located in central Ontario and is surrounded by the Village of Sundridge and the Township of Strong. It is part of the southern Lake Huron drainage basin and the Magnetawan River watershed.

The Magnetawan River watershed headwaters arise on the western slope of Algonquin Provincial Park. The Magnetawan River extends westerly from the western side of Algonquin Provincial Park for 196 km through a series of interconnecting lakes to its outlet at Byng Inlet on Georgian Bay (Acres International Limited, 2004).

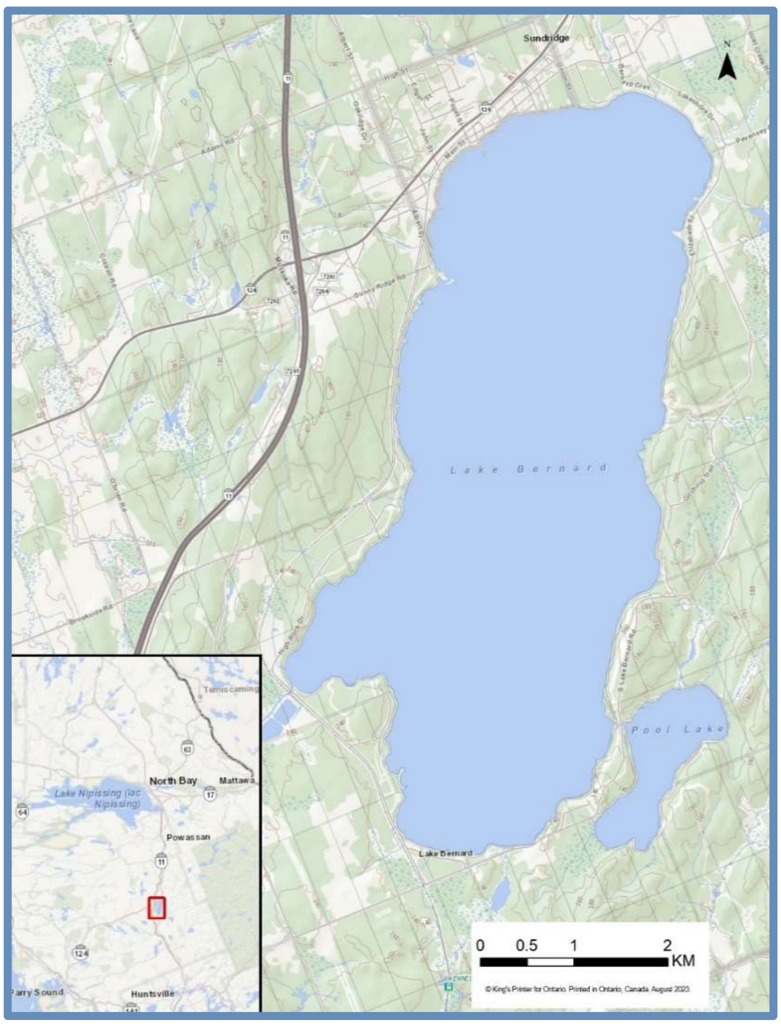

Figure 1: Geographic location of Lake Bernard

MNRF owns and operates the Lake Bernard Dam at the southwest outlet of Lake Bernard. Outflows from the dam drain into Stirling Creek, which is 4 km west of Burk's Falls. Stirling Creek flows into the Magnetawan River (Acres International Limited, 2004).

2.1.2 Dams on the Magnetawan River watershed

On the Magnetawan River watershed, there are 17 MNRF-owned water control structures used to regulate the water levels of the lakes and rivers throughout the basin:

- **10 are control dams** – A control dam is a structure built across a river or stream to regulate the flow of water. It requires the addition or removal of stoplogs and/or the manipulation of a valve to manage water levels and is operated to maintain water levels within broad ranges identified within established dam operating plans. These 10 dams are in the upper range of the watershed.
- **Seven are weirs** – A weir is designed to control the water level by allowing excess water to flow over it when the water reaches a certain height. Base flows from weirs are achieved through leakage with no target minimum flows established in the lower reaches of the watershed. These seven weirs are in the lower reaches of the watershed.

These structures are operated for aquatic habitat management, small hydro generation, and recreation / navigation requirements. This includes a set of marine locks in the Village of Magnetawan. The lakes and rivers controlled by the dams provide for a variety of economic, tourism and recreational uses, including boating, canoeing, kayaking and fishing. For clarity, ministry dams within the Magnetawan River watershed are not flood control structures.

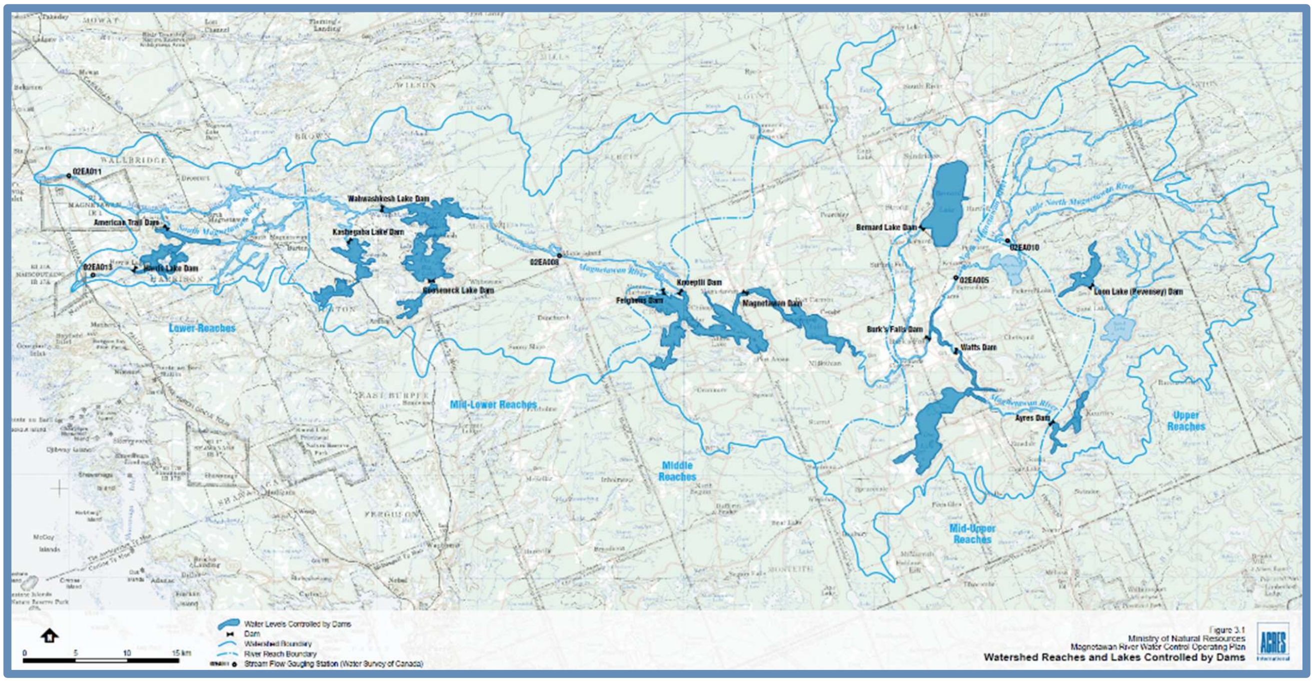

Figure 2: Magnetawan River watershed

2.1.3 Lake Bernard Dam

The Lake Bernard Dam is a control dam. It is a combined bridge-dam structure at the outlet of Lake Bernard and is not a flood control structure.

Flood control structures require a large lake or reservoir with draw-down capacity to store or hold back flood waters. This dam does not have the design or functional ability to mitigate flooding or keep water levels within the Normal Operating Zone during times of abnormal watershed conditions (flood or drought)(Ministry of Natural Resources, February 2000). A normal operating zone allows for water level fluctuations in response to typical rainfall, snow melt and associated runoff.

2.1.4 Lake Bernard Dam history

Ministry records indicate the current dam was built in 1959 to replace an older wooden structure that washed away in a spring flood a few years earlier. According to the Department of Public Works (now infrastructure Ontario) Central Registry, the original dam was constructed around 1913 by the Ontario government in response to requests from residents and tourists. Details from this time are limited.

Lake Bernard Dam

3.0 Community feedback and collaboration

There are approximately 300 private property owners on Lake Bernard, with some properties being used seasonally. Other lake users include commercial operators, naturalist clubs and associations, and municipalities (parks, docks and beaches). The lake is used recreationally and is a popular vacation destination, located less than three hours north of Toronto.

3.1 Soft shoreline ice damage mitigation trial

A Soft Shoreline Ice Damage Mitigation Trial was requested by the Village of Sundridge and concerned residents in the fall of 2018. This trial request consisted of:

1. Targeting fall dam operations to a lower water level no higher than 329.10 metres above sea level (masl) and no lower than 328.90 masl before December 25 annually.

2. Maintaining the lower water condition until ice has completely melted from the lake.

The Trial was not carried out by MNRF because the dam does not have the operational ability to lower water levels to the requested winter range consistently. Usually, all stoplogs are removed from the dam by mid-October, and water levels naturally decrease to around 329.10 masl during the fall and winter. Without stoplogs, water levels vary with precipitation. Sections 6.1 and 6.4 explain the winter and fall operations, showing that meeting the requested winter levels consistently hasn't been achievable based on observed data from 1985 to 2021.

Additionally, the request to maintain lower water levels during the spring until after ice has melted on the lake increases the risk of insufficient spring water levels to achieve the summer operational objectives. This is due to the small drainage area that feeds the lake, which may not be sufficient to refill the lake once the spring freshet has finished.

3.2 Water management concerns

Comments from the community

The ministry has received the following feedback from the community:

- spring dam operations are resulting in higher water levels, potentially worsening ice push and wave action that can damage shorelines
- requests to consider delaying dam operations until spring runoff is complete, given the unpredictable nature of weather patterns
- shoreline erosion impacts are negatively affecting the ecology and health of the lake, contributing to the presence of blue-green algae
- concerns about low water levels and the importance of maintaining summer water levels for recreation
- water levels within the normal summer range are too high, causing shoreline erosion, damage and loss
- the Dam Operating Plan is perceived as outdated, and should be reviewed using more recent data
- concerns from property owners that MNRF has been non-responsive to issues raised
- sentiment within the community that recreational use of the lake is the ministry's highest priority

MNRF’s response to the feedback received

On November 25, 2021, at the request of the Village of Sundridge, MNRF provided a presentation on water management on Lake Bernard during a tri-council meeting. The goal of the presentation was to provide information on Lake Bernard’s water management and foster an understanding of the various factors considered in operating the Lake Bernard Dam.

To assist with transparent decision-making around dam operations, MNRF increased communication efforts in spring 2023. The ministry proactively shared information about conditions and proposed dam operations with the local municipalities. In return, the municipalities provided weekly updates on observed water levels and ice conditions to ministry staff. This increased information sharing enabled the municipalities to understand MNRF’s dam operation decision-making process, ask questions, and convey recent information on dam operations to their communities.

4.0 Lake Bernard environment

This section provides a summary of the natural characteristics of Lake Bernard, including hydrological features of the lake, the composition of the lake's shoreline, and an outline of its fisheries.

4.1 Natural characteristics

The natural characteristics of Lake Bernard and associated drainage areas are a determining factor for how the lake may respond to external influences such as rain, temperatures, wind and water level management.

4.1.1 Water levels

Drainage area

Lake Bernard is the largest lake within the Magnetawan River watershed with a surface area of 20.6 square kilometers. The lake’s drainage area is approximately 101 square kilometers (Acres International Limited, 2004). The drainage area defines the landscape that provides water inputs into the lake. A drainage area encompasses the land that drains all streams and rainfall to a common outlet – the outlet for Lake Bernard’s drainage area being the MNRF dam at Stirling Creek.

Given the large surface area of the lake, Lake Bernard’s drainage area is small when compared to other waterbodies on the Magnetawan River watershed. This means that the water flow inputs from the drainage area into Lake Bernard are limited in comparison to other local water bodies (*Figure 3* illustrates the Lake Bernard drainage area relative to the lake’s surface area).

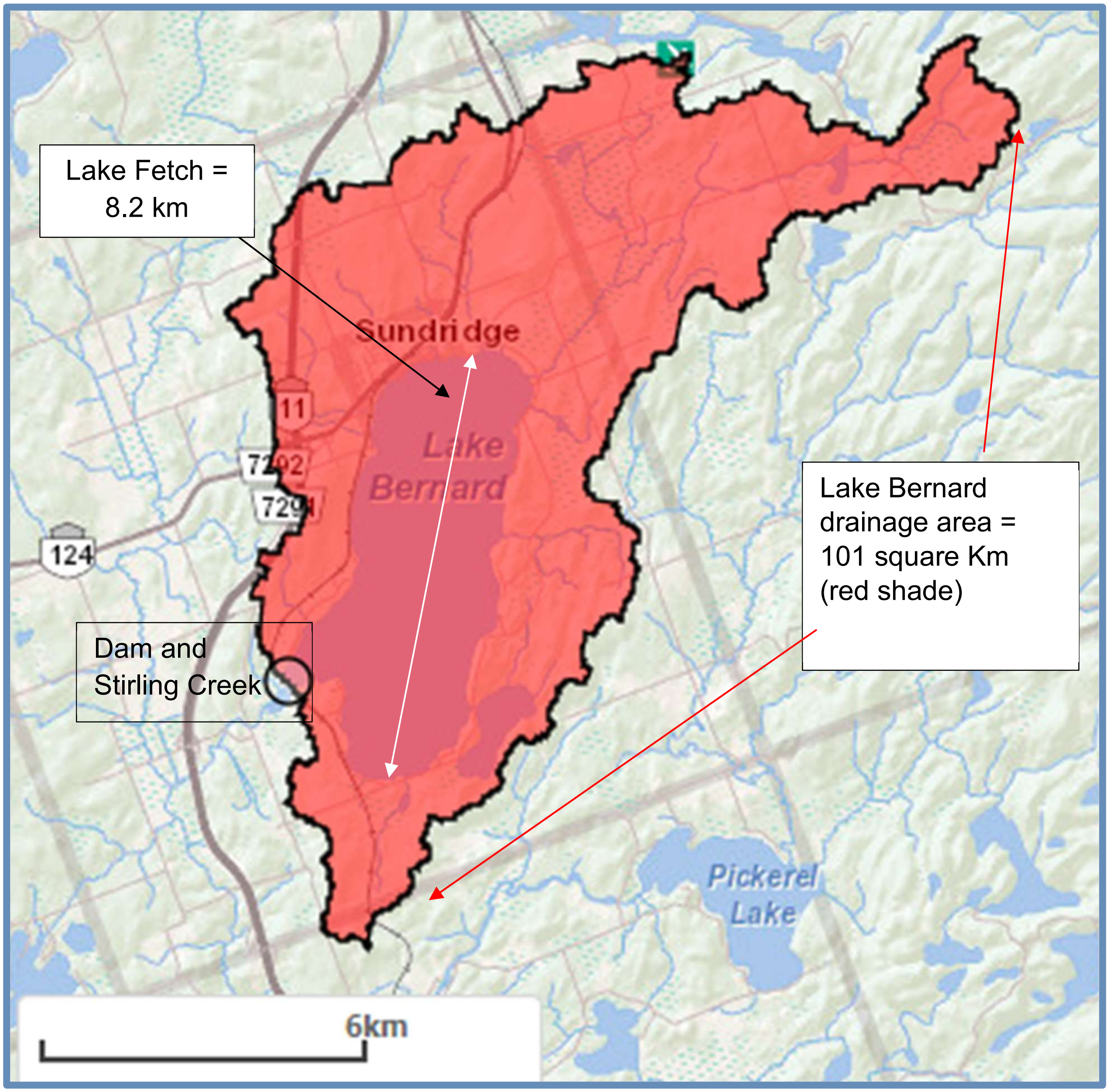

Figure 3: Lake Bernard drainage area

Annual water fluctuations

The relatively small drainage area affects water levels each year, causing decreases as the seasons transition from cold to hot. The pattern usually begins with snowmelt during the freshet with lots of rainfall and less evaporation in the wet spring, resulting in increased runoff. As the weather transitions to hot summer conditions characterized by reduced rainfall and higher evaporation rates, there is less runoff, contributing to lower water levels.

The lake fills up during the spring freshet period due to snow melt, rainfall and decreased evaporation. Throughout the summer, water levels naturally decrease based on weather conditions such as rainfall and evaporation. A hot, dry summer will mean little water entering the system, potentially leading to very low lake water levels. Dam operations aim to retain water but must allow for a minimum flow to waterways downstream.

Mean water level

The mean water level on Lake Bernard increases on average in the spring by approximately 35 cm, due to inputs to the lake through runoff and precipitation. Subsequently, it decreases on average approximately 10 cm from early June through late August each year, due to increased evaporation from the lake during the summer and reduced inputs from runoff and precipitation (refer to *Figure 11)*.

This annual trend of declining water levels throughout the summer suggests that the sources of water feeding into Lake Bernard are insufficient to maintain stable water levels as conditions become hot. Typically, evaporation rates exceed rainfall amounts during this period. This suggests water levels can be expected to decline over the summer during normal watershed conditions, characterized by hot summers with less precipitation and higher evaporation than other seasons.

For further information on the occurrence of declining lake water levels due to lake evaporation and low inflows, please refer to Section 12.3.5 of the Magnetawan River Water Control Operating Plan for Lake Bernard Dam.

4.1.2 Wave and wind climate

Fetch

Lake Bernard does not contain any islands. A long stretch of open water is called a “fetch”, which is the maximum distance wind can travel over water unimpeded by obstructions. The north-south fetch on Lake Bernard is 8.2 km.

Waves and wind

Waves result from the transfer of energy from wind across a smooth water surface. The characteristics of wave energy, including height and period, are influenced by the wind climate (hourly wind speed and direction), the length of fetch, and other factors like ice cover, which can limit wave generation (Ministry of Natural Resources, 1996). Wind-generated waves have the potential to contribute to shoreline erosion and damage to shoreline structures (Refer to *Figure 4*).

Dominant wind direction

NAV Canada, a non-profit organization overseeing air navigation services in Canada, manages air traffic control and weather briefings. Wind data from NAV Canada indicates a prevailing wind direction toward the North-West corner of Lake Bernard, aligning with the area most affected by shoreline damage. Specifically, during March and April (spring freshet), wind speeds consistently reach 50km/hr.

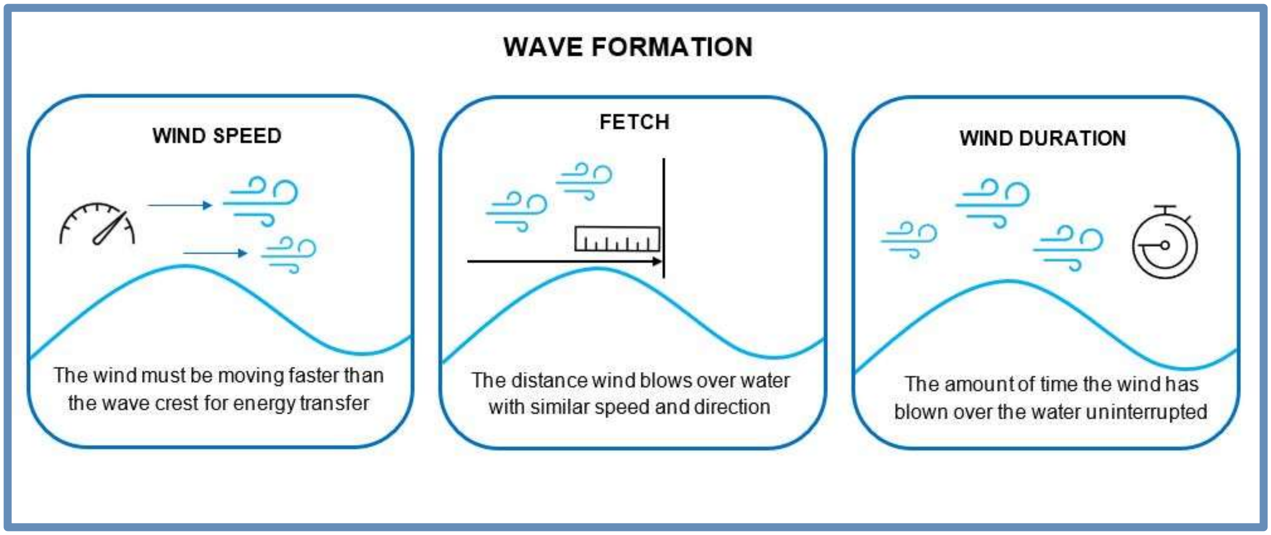

Figure 4: Wave formation

In general, shorelines exposed to long fetches in the direction of predominant winds are prone to frequent high wave energy. Conversely, shorelines sheltered from waves from predominant winds and severe storm wind directions are likely to experience much lower wave conditions (Ministry of Natural Resources, 1996).

The strongest waves and moving ice typically start in areas with a long unobstructed water area and constant strong winds. Lake Bernard's long and uninterrupted lake surface, combined with sustained wind speed and duration, can create significant wave action when the lake is not frozen. This can also result in substantial ice movement during ice break-up in the spring. Both wave action and ice movement have the potential to cause damage and erosion along the shoreline.

4.1.3 Lake ice

The maximum depth of Lake Bernard is approximately 46 metres, making it the deepest lake within the Magnetawan River watershed. Across the watershed, other lakes vary in depth from 45 metres in Wahwashkesh Lake to just 1.5 metres in Ayers Lake.

Lakes with deep water warm up in the spring in a way that can lead to rapid ice expansion, weakening the shoreline bond and causing damage due to ice movements. This expansion happens when extremely cold weather is followed by a sudden rise in temperature, causing thermal expansion of the ice (Alberta Environment and Parks, 2021). Wind speed, direction and duration of wind events may also contribute to the occurrence of ice push (Gilbert, 1991).

During the spring months, ice jams, piling or ridging may result in flooding or erosion problems along the shoreline, particularly at the outlet of lakes. Spring breakup typically begins with the ice melting first along the shoreline, where the ground is warmed by the sun and the ice is thinner. The ice then becomes detached from the shoreline and may be further broken up by the actions of winds and currents. Ice detached from the shoreline or lake ice piled up by wind action against the shoreline can damage structures close to the shoreline (Ministry of Natural Resources, 1996).

Significant damage to shoreline structures (docks, ramps, and other structures) as well as shoreline erosion can occur along the shorelines of lakes where a combination of early ice breakup and strong onshore winds results in large pieces of floating ice being driven into the shore (Ministry of Natural Resources, 1996).

While predicting the inland extent of ice incursion is challenging due to variables such as time of year, air temperature, stage of ice decay, wind conditions, ice thickness and strength, snow thickness, and strength of ice cohesion to the shoreline, the occurrence of this natural phenomenon on lakes is widely documented (Ministry of Natural Resources, 1996).

4.1.4 Geology

Quaternary deposits are the most recently laid rock and are found at or near the land surface. Around the perimeter of Lake Bernard, the quaternary deposits consist of a mix of sands, gravels, and gravelly/silty tills. The northern shoreline is primarily composed of finer glaciolacustrine deposits of sand, silt and clay. Moving south along the shoreline, the materials generally transition to tills (loose stony sands) and bedrock drift (gravel and silt tills). The finer-textured deposits, particularly those existing at the northern end of the lake, are generally more erodible than coarser deposits documented along much of the shoreline (Kor P. a., 1990).

4.1.5 Soft shorelines and erosion

The lake shoreline is populated by many cottages, public and private beaches, municipal, private, and commercial docks, and residential lots. Some of these structures and properties are located upon soft shorelines made of natural or modified elements like sand, soil, vegetation or landscaped lawns. These softer shorelines are more susceptible to damage from waves, water flows, and shifting sediment compared to natural rock or shorelines protected with armor stone, riprap or natural engineering such as slope modification with shrubs and trees. When ice pushes or impacts against these soft shores due to conditions like strong winds, loose ice, and a gently sloping shoreline, it can cause erosion and/or damage to structures (e.g., docks, boathouses). (Alberta Environment and Parks, 2021). This implies that soft shorelines around Lake Bernard may experience damage from ice push and erosion when conditions leading to these events occur.

Erosion is a natural shoreline process. The rate of erosion depends on the relative weakness/strength of the shore material and the presence of vegetation. Recession is the landward retreat of the shoreline by erosion of the shoreline material.

4.2 Hydrology and dam operations

Lake hydrology

Lake hydrology is the study of tributary and groundwater inputs to a lake, as well as the outflow of water from the lake. This study considers both annual and seasonal fluctuations. Through this study, we aim to present a better understanding of the dynamic nature of Lake Bernard's fluctuating water levels. The lake's surface area (20.8 km^2) and drainage area (101.4 km^2 at the lake outlet, Lake Bernard Dam) play pivotal roles in shaping its hydrology. With an extensive shoreline length of approximately 22.9 km, Lake Bernard experiences relatively minor annual fluctuations in water levels due to its large surface area compared to a small drainage area.

Dam operations

The Lake Bernard Dam has four gates or sluices, each controlled by square timbers that can be removed or installed to regulate water flow. In addition to these gates, the dam has a bypass pipe with a manually controlled valve that allows a "base flow" or environmental flow during low water conditions.

Typically, there are no logs in any of the four sluices of the Lake Bernard Dam from mid-October to mid-April. During this approximate six-month period, Lake Bernard operates like a natural lake.

Outlet Creek

Stirling Creek is the outlet creek that runs from Lake Bernard to the Magnetewan River, covering a distance of 24.75 km with an estimated elevation drop of 50 m. The creek maintains a narrow width, typically ranging from eight to 18 m wide, following a meandering path with numerous oxbow cutoffs. Oxbow cutoffs refer to the abandoned, curved segments of a meandering river or stream that were once part of the main channel.

Satellite imagery reveals modifications of Stirling Creek below Lake Bernard Dam, indicating dredging, artificially widening, and straightening of 1.15 km to Muskoka Road between 1970 and 1975. This effort involved landowners, the Township of Strong and the Department of Lands and Forests.

If all the logs are out of the Lake Bernard Dam, Lake Bernard water levels will be influenced by factors such as:

- Stirling Creek bed slope
- the presence of permanent or temporary beaver dams, between Muskoka Rd. And Robins Rd., approximately 1.15 to 2.3 km downstream of Lake Bernard Dam
- the top elevation of the rapids located 2.3 km downstream of Lake Bernard Dam
- ice jams between the dam and the rapids
- the sandbar upstream of the dam
- some combination of the factors noted above

The rapids, starting at the Robins Road crossing, indicates a 10-metre drop over 350 metres (refer to *Figure 5*).

Figure 5: Stirling Creek satellite imagery

Water level fluctuations: 2013 – 2022

There is a Water Survey of Canada water level gauge located just upstream of the Lake Bernard Dam (02EA020 – Lake Bernard at Sundridge), which has been recording and reporting lake levels since 2005. MNRF analyzed annual water level fluctuations and year-to-year variations at Lake Bernard using the most recent 10 years of this data.

Over the six years from 2017 to 2022, the average annual water level range was 0.57 metres in Lake Bernard, roughly equivalent to just under two feet between winter low water levels and spring high water levels.

Figure 6 illustrates these fluctuations and year-to-year variability, including dam operations. Logs are replaced in the spring to capture melting snow before the spring peak in water levels, except for 2019 when water levels peaked before log placement. This showcases that regardless of dam operations, natural conditions can lead to elevated water levels in the spring. High variability in water levels (low or high) can be expected from time to time due to annual variability in weather and runoff into the lake.

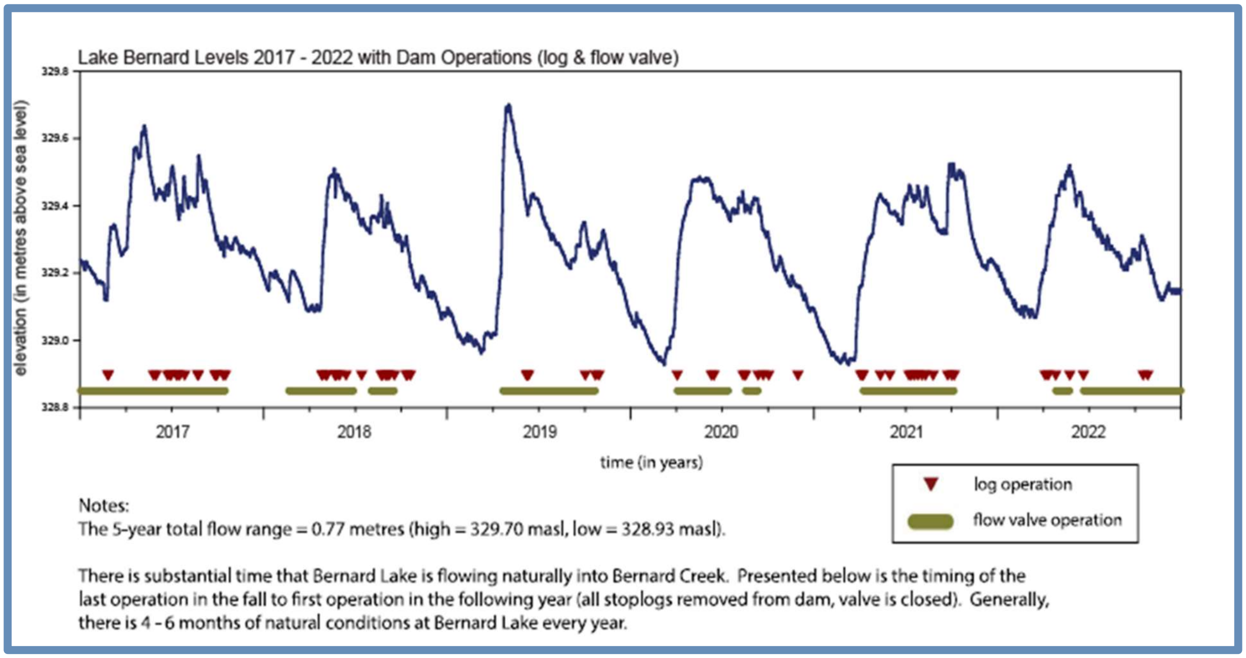

Figure 6: Levels with dam operations 2017-2022

Further research focused on the 2013-to-2022 timeframe and revealed an average spring water level increase of 0.51 m occurring over an average time span of 63.1 days, spanning from the lowest elevation point in winter to the highest in spring. This translates to an average daily water level rise of approximately 0.81 cm during the spring. In comparison, during the same period, Doe Lake on the Magnetewan River experienced an average daily water level increase of 5.4 cm per day, rising 1.83 m over an average of 33.6 days.

Under natural conditions, Lake Bernard typically experiences minimal fluctuations in water levels during the spring. For a detailed breakdown of dates and water levels from winter lows to spring peaks from 2013 to 2022, please refer to Table 1. Additional information on summer and fall water level trends can be found in Section 6.3 and 6.4.

Lake Bernard Spring Lake Level Rise										
	Winter Low				*Spring Peak*					
year	*day*	*gauge elv*	*julian day*	*masl*	*day*	*gauge elv*	*julian day*	*masl*	*total days*	*total elv (m)*
2022	Mar 18	8.207	77	329.06	May 23	8.659	153	329.51	76	0.45
2021	Mar 10	8.079	69	328.93	May 12	8.584	142	329.43	73	0.50
2020	Mar 9	8.079	68	328.93	May 18	8.635	148	329.49	80	0.56
2019	Mar 9	8.112	68	328.96	May 3	8.85	133	329.70	65	0.74
2018	Apr 11	8.236	101	329.09	May 21	8.659	151	329.51	50	0.42
2017	Feb 22	8.269	53	329.12	May 8	8.787	138	329.64	85	0.52
2016	Mar 8	8.23	67	329.08	Apr 7	8.61	97	329.46	30	0.38
2015	Mar 25	8.087	84	328.94	May 27	8.619	157	329.47	73	0.53
2014	Mar 18	8.081	77	328.93	May 17	8.659	147	329.51	70	0.58
2013	Mar 30	8.220	89	329.07	Apr 28	8.678	118	329.53	29	0.46
								10 year average	63.1	0.514

Table 1: Lake Bernard Spring Lake Level Rise

4.3 Fisheries

Lake fish community

Lake Bernard contains cold and warm water fish communities. The cold-water fish community is predominately populated by Whitefish and Lake Trout (Ministry of Natural Resources and Forestry, 2019). The lake is stocked by MNRF with these species and also contains Burbot, Brook Trout, Rainbow Trout and the invasive Rainbow Smelt (Ministry of Natural Resources and Forestry, 2019). The lake is stocked by MNRF with these species and also contains Burbot, Brook Trout, Rainbow Trout and the invasive Rainbow Smelt (Ministry of Natural Resources and Forestry, 2019). In contrast, the warm-water fish community in Lake Bernard is dominated by introduced species like Smallmouth Bass and Rock Bass, along with Yellow Perch and White Sucker (Ministry of Natural Resources and Forestry, 2019).

Fishing activity and pressure

Given its easy accessibility to the public, Lake Bernard experiences relatively high fishing pressure, particularly in winter when anglers actively pursue Lake Whitefish. Some limited fishing activity targets Walleye, Lake Trout, Rainbow Trout and Brook Trout.

Stirling Creek, classified as a cold-water stream, receives minimal fishing pressure for Brook Trout and Rainbow Trout. Fishing activity is understood to be extremely light.

4.3.1 Lake Trout spawning and dam operations

Lake Trout are particularly sensitive to water management practices, especially when water levels decrease during winter periods (Ministry of Natural Resources, 1987). These fish spawn in shallow shoals during the fall. Both their eggs and fry are vulnerable to water level changes, which could either expose their spawning location or lead to the crushing of eggs and fry by thickening ice during winter. Refer to *Figure 7* for the location of Lake Trout spawning shoals.

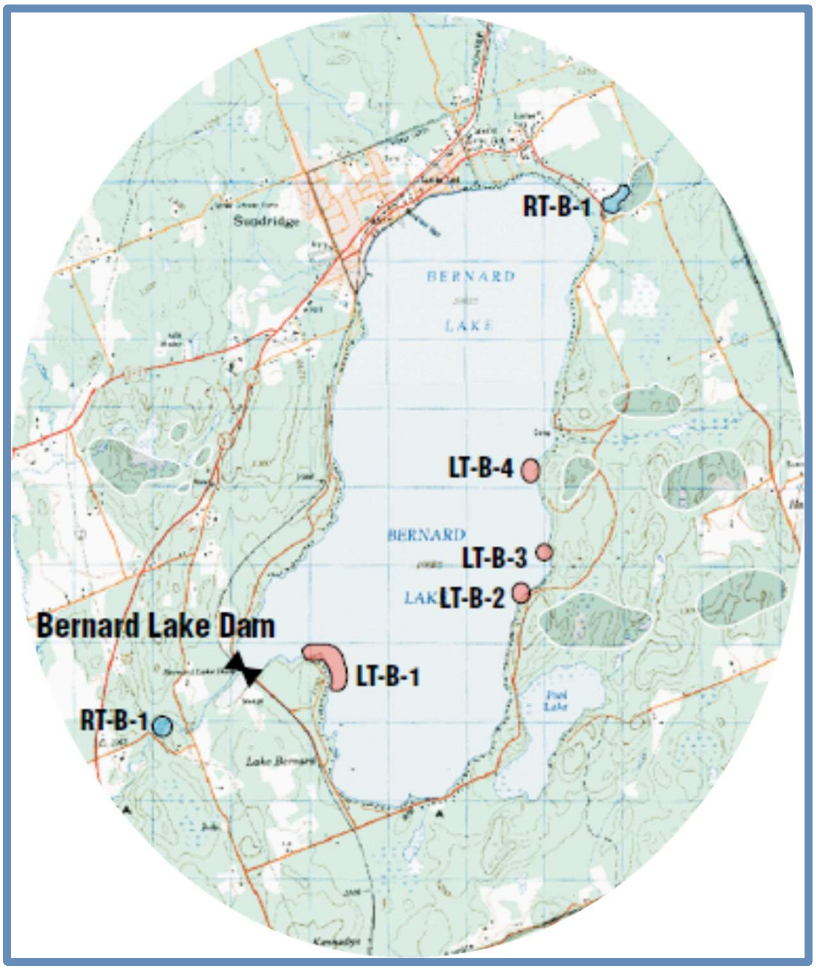

Figure 7: Approximate Lake Trout shoal locations

For more information regarding MNRF's broad-scale monitoring program and Lake Trout spawning information on Lake Bernard, please refer to Appendix C.

5.0 Legislative and operational framework for Ontario dams

5.1 Lakes and Rivers Improvement Act

MNRF is responsible for the administration of the *Lakes and Rivers Improvement Act* (LRIA). The LRIA provides MNRF with a legislative framework to regulate the construction, alteration, decommissioning and operation of dams.

Although the LRIA does not legally bind the Crown, the ministry often applies its guidelines and associated policies to ministry-owned dams and in-water works as a best practice.

Under the LRIA, MNRF has developed several documents that guide dam operations and decision-making for water management on the Magnetawan River watershed. The following documents describe broad water management objectives at a watershed scale to site specific flow requirements and are used collectively to guide decisions on operating the Lake Bernard Dam:

- Magnetawan River Water Control Operating Plan
- Magnetawan River Dam Operating Manual
- Lake Bernard Dam Operating Plan
- Best Management Practice Target Line

Dam operating plans – general overview

The goal of dam operating plans is to ensure due consideration is given to all the objectives in the LRIA (see Appendix A), and Indigenous communities' Aboriginal and treaty rights when determining the most suitable dam operating strategy. This strategy takes into account factors like power generation, flood control, and the management of natural resources in conjunction with commercial, recreational, cultural and heritage activities.

An operating plan provides instructions on when and how the dam should be operated. It outlines critical information necessary to identify desired water levels and flows, as well as specifying necessary maintenance activities. These plans can be highly detailed, offering step-by-step instructions for various tasks, such as pulling logs and installing booms.

5.1.1 Magnetawan River Water Control Operating Plan

In 2004, the Magnetawan River Water Control Operating Plan was developed and finalized following a two-year planning exercise. This process included engagement with the public and Indigenous communities to address water control structures within the Magnetawan River watershed, including the management of the Lake Bernard Dam.

The creation of the Magnetawan River Water Control Operating Plan aimed to achieve a more balanced approach in managing both lake levels and river flows. This endeavour drew insights from established operational practices and rule curves (like minimum flow guidelines) contained in the Magnetawan River Dam Operating Manual (refer to Section 5.1.1).

The Magnetawan River Water Control Operating Plan strives to strike a balance among the varied interests of stakeholders along the Magnetawan River system. It achieves this by setting water levels and flows that consider ecological and economic considerations.

Factors guiding dam operations and water levels for Lake Bernard encompassed several needs:

- Ensuring adequate water levels for summer recreational activities and navigation while maintaining minimum flows in Stirling Creek to support fish habitats.
- Safeguarding shorelines by monitoring and managing dam operations to keep water levels within the Normal Operating Zone of the rule curve.
- Implementing a winter drawdown to alleviate the impacts of spring freshets and high-water occurrences.
- Providing flood forecasting and warnings when watershed conditions suggest water levels might reach levels causing damage.

Indigenous communities

During the development of the Magnetawan River Water Control Operating Plan, two Indigenous communities expressed interest in the management of water levels on the Magnetawan River.

The ministry respects the Aboriginal and treaty rights of Indigenous communities which is acknowledged in Section 35 of the *Constitution Act, 1982*, and is committed to fulfilling its constitutional and other legal obligations regarding these rights. This includes the Crown’s duty to consult and accommodate.

The ministry assesses whether requests for changes to dam operations have the potential to adversely impact Aboriginal and treaty rights and require consultation with Indigenous communities prior to making a decision on the request.

5.1.2 Magnetawan River Dam Operation Manual

The Magnetawan River Dam Operation Manual contains a set of graphical plots known as rule curves. These curves establish specific target water levels, including upper and lower limits, and delineate operational objectives for lakes including Lake Bernard. These rule curves align with the broader water control objectives outlined in the 2004 Magnetawan River Water Control Operating Plan.

In 2000, the formal rule curve within the plan set the intended operating level for Lake Bernard. This determination was based on historic water level averages observed since the dam's construction and input from the Lake Bernard Property Owners Association (refer to Section 6.0).

In the past, while considering input from the local community, the ministry has introduced certain adjustments within these general parameters to enhance fisheries, recreational activities, navigation and overall water levels (refer to Section 5.1.4).

5.1.3 Lake Bernard Dam Operating Plan

The ministry oversees the operation of the Lake Bernard Dam, located at the Stirling Creek outlet, following guidelines laid out in the Lake Bernard Dam Operating Plan. This operational plan is guided by the rule curve specified in the Dam Operation Manual and aligns with the objectives delineated in the Magnetawan River Water Control Operating Plan.

Outlined within the Dam Operating Plan are seasonal targets and ranges for water levels, accompanied by specific aims, including directives for minimum flows. To ensure informed decision-making in dam operations throughout the watershed, including Lake Bernard, real-time data on Lake Bernard water levels is constantly supplied by the Water Survey of Canada gauge 02EA020, situated upstream of the dam.

The seasonal operating objectives for Lake Bernard encompass various aspects:

- **Summer**: Maintaining water levels to facilitate recreational activities and navigation while ensuring minimum flow for downstream ecological needs in Stirling Creek.

- **Fall and winter**: Managing dam operations to lower lake water levels before the spring thaw to create limited winter/spring storage while protecting Lake Trout eggs from potential dewatering during their winter incubation period.
- **Spring**: Coordinating dam operations to capture some water from spring runoff to ensure adequate water levels to support the summer recreational and navigation season and ensure adequate water supply to maintain minimum flows downstream.

Refer to Section 6 for more details regarding dam operations and seasonal operating objectives.

5.1.4 Best Management Practice target line

Stakeholder consultation outcome

In 2007, the Lake Bernard Property Owners Association consulted its members and lake property owners to determine a preferred summertime target operating water level for operations.

Implementation of Best Management Practice

Following the public consultation, MNRF adopted a Best Management Practice target line. The aim was to strike a balance between addressing concerns about high water and low water levels while ensuring continued minimum flow in Stirling Creek for ecological reasons.

Target line modification

This new target line modifies or replaces the original line specified within the rule curve developed in 2000 as described in Section 2.2 of the Magnetawan River Dam Operating Manual. Its purpose it to fulfil the seasonal operating objectives described in Section 6.

5.1.5 Lake Bernard Dam minimum flow conditions

In accordance with the Ontario Water Resources Act (OWRA), the operating plan for Lake Bernard Dam includes the maintenance of a minimum flow through the dam at all times. The initial purpose of a minimum flow was to address concerns about the fish population in Stirling Creek below the dam and later also addressed the need to dilute effluent from the Sundridge sewage lagoons near the outlet of Lake Bernard. This section of the report describes historic and current minimum flow considerations.

Operating strategy for the Magnetawan River watershed

The primary strategy outlined in the plan focuses on allowing lake levels to decrease during dry periods. This approach facilitates minimum discharge from dams, ensuring adequate flows downstream. This is crucial for sustaining aquatic habitat, including benthic invertebrates, which serve as a food source for fish and other aquatic species.

Minimum flow requirement

The plan formalized a minimum flow requirement of 0.2 m3/s below the Lake Bernard Dam. Initially established for fish habitat and dilution of the Sundridge sewage lagoon, this requirement became a part of the Plan's development.

Consideration of fish species and habitat

Previous discussions on water levels and dam operations highlighted the importance of careful stoplog replacement and the necessities for the Rainbow Trout spawning run. Historical data suggests the presence of Rainbow Trout in Stirling Creek, influencing dam flow considerations. It's crucial to consider fish and habitat protection for any fish species presently inhabiting Stirling Creek sections affected by dam flow alterations.

Legal provisions for fish protection

The federal *Fisheries Act* mandates protection for fish and their habitat, emphasizing the need to prevent harm or alteration of fish habitat during land or water work. This includes ensuring fish passage by preventing alterations in flow and water levels and refraining from obstructing or interfering with fish movement and migration. You can find more details at this link: https://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures-eng.html

Sewage lagoon considerations

The plan addresses Sundridge sewage lagoons as an operating restriction impacting municipal, industrial and other interests in the watershed. The discharge timing aligns with high creek flows in spring and fall, as outlined in Table 12.1 of the Plan.

Confirmation of minimum flow

When planning the Village of Sundridge sewage treatment lagoon, engineering consultants from Aecom asked the ministry for dam and minimum flow data. They sought confirmation that the 0.2 m3/s minimum flow, targeted in 2014, remained the ongoing objective.

This request from Aecom and the Ministry of the Environment, Conservation and Parks suggests that the design and approval of discharge rates for the present sewage treatment lagoon and corresponding Environmental Compliance Approval were based on the expectation of a continuous minimum flow below the Lake Bernard Dam in Stirling Creek.

Lake water level considerations

The maintenance of the 0.2 m3/s minimum flow through the Lake Bernard Dam has an impact on Lake Bernard water levels, especially during the typically dry summer months, which is described in detail within Section 6.3 Summer Operations. As the minimum flow is maintained through the dam during the summer months, water levels decline and normally fall to the lower portion of the normal operating zone during this period leading to concerns about low water levels at boat launches and shallower portions of the lake. The maintenance of a minimum flow and resulting decline in water levels highlights the importance of achieving spring target water levels to ensure the lake is full and can support the minimum flow requirement through the summer.

6.0 Lake Bernard Dam operations

The management of dam operations for Lake Bernard follow seasonal water management goals specified in the Water Control Operating Plan and the Dam Operating Manual for Magnetawan River.

The specific operating plan for the dam sets guidelines for water levels, allowing them to vary within a defined range. This plan typically follows a seasonal pattern (identified below).

Rule curve

The ministry uses a rule curve from the Dam Operating Manual with the goal of managing water levels consistent with the water control objectives outlined in the MRWCOP on Lake Bernard (refer to *Figure 8*).

- The red lines indicate the top of the high-water zone and the bottom of the low water zone.
- The yellow solid lines show the top of the normal operating zone (high water level) and the bottom of the normal operating zone (low water level).
- The solid green line reflects the target operating level in the MRWCOP.
- The green hatched line reflects the best management practice target water levels developed through consultation in 2007.
- The yellow hatched line reflects the top of the best management practice operating zone.

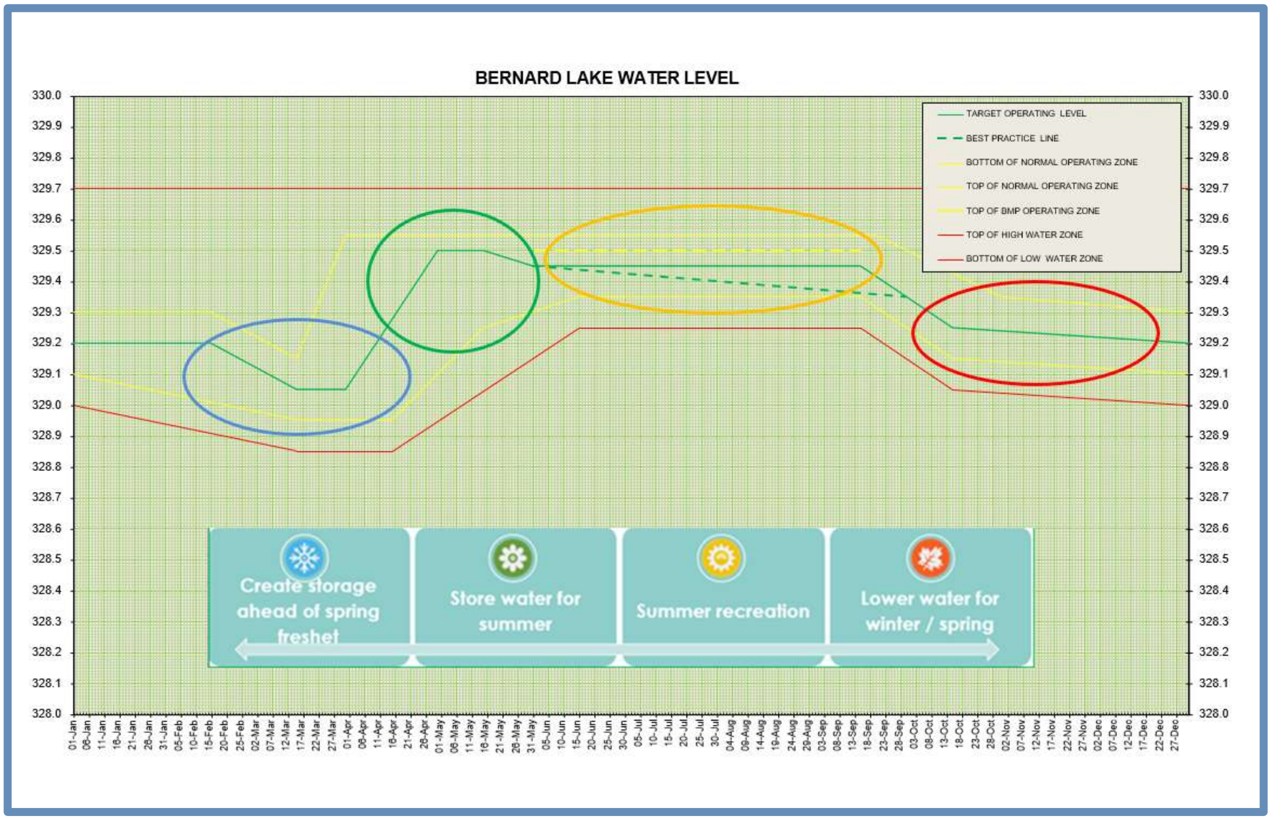

Figure 8: Lake Bernard Rule Curve with seasonal operating objectives

Dam operators use the rule curve, weather events, and historical and current water level data to determine when and how to operate the dam.

Seasonal operating objectives

Figure 8 outlines the seasonal operating objectives for the dam. These objectives are incorporated into the target operating level (green line) as follows:

Season	Dam operations
Winter	No logs in dam
Spring	Store water for summer during spring freshet– replace logs into dam
Summer	Maintain stable water levels for summer recreation and navigation - operate dam to respond to changing inputs and water levels

Season	Dam operations
Fall	Lower water levels to create winter/spring storage - remove all logs from dam

Table 2: Seasonal operating objectives

Daily monitoring

MNRF staff determine dam operations by checking water levels and local conditions daily. This helps inform when and how much to operate dams according to the plan.

- The lake water levels relative to the target operating level (green line) in relation to the lower normal operating zone (lower yellow line) and high-water zone (upper red line) provides a degree of flexibility in dam operations based on weather and other factors.

Target operating line

From a practical operational perspective, the target operating line is an aspirational objective. Water level fluctuations are normal, natural, and anticipated due to inflows and local weather conditions (e.g., precipitation inputs and drought).

To pass or retain water, MNRF staff operate the dam by removing or replacing stoplogs in reaction to increasing or decreasing water levels (rain or lack thereof). Weather variability (higher temperatures, more rain) and the practical design of the water control structure impacts the ability to manage water with absolute precision (refer to *Figure 9*). Ministry dam operators manage water levels within the broader range of the normal operating zone with the objective of achieving the target operating line.

Figure 9: Lake Bernard dam components

Operating the dam to maintain water levels above or below the normal operating zone given the variability of and inability to accurately forecast long term weather has implications for each season.

6.1 Winter operations

Monitoring

Ministry staff collect snowpack information two times per month at five locations across the Bracebridge – Minden – Parry Sound District, including a snow station in Magnetawan. This data is used to calculate the water equivalent of the snowpack and compare it to the historical average to understand the potential flood risk from melting snow during the spring freshet.

Dam operations

Typically, dam operations on Lake Bernard do not occur during the winter as all stoplogs are usually removed from the dam by the end of October. The stoplogs are generally replaced in the dam after the peak of the spring runoff has passed to capture water necessary for maintaining levels through the summer. Since there are usually no stoplogs in the dam during the winter months, snowpack water content data at this location is used for potential flood forecasting and warning messaging from MNRF, as well as determining the timing of log replacement in the spring following the peak of the spring freshet.

Implications to the normal operating zone

Water levels above the normal operating zone during the winter, which are beyond MNRF control due to the absence of logs in the dam, may lead to elevated spring water levels without the marginal water storage capacity created by the winter drawdown. The ministry uses this information to determine the timing and extent of spring dam operations, potentially resulting in a later placement of logs back into the dam.

Water levels below the normal operating zone during the winter have the potential to impact Lake Trout populations if they spawned during higher-than-normal water levels in the fall.

6.2 Spring operations

Monitoring

An important monitoring aspect for spring operations for the Lake Bernard Dam is snowpack water equivalent, determining the water content in the local snowpack. Ministry staff conduct snow measurements biweekly in the winter, increasing frequency during spring freshet. Snowpack water equivalent data helps to assess:

- flood risks
- when to start spring dam operations to capture melted snow water

Understanding the potential water volume within snow provides MNRF staff with important information for dam operating decisions. For instance, if snow depth is significant and the short-term weather forecast predicts daytime temperatures exceeding 10°C along with substantial rainfall, there may be an increased risk of flooding. This could result in the need to allow more water to flow through the dam to mitigate local high-water risks or the need to restrict additional water flow if there are enhanced downstream flooding risks.

During the freshet, the ministry deploys additional teams of dam operators to perform dam operations as required.

Dam operations

Runoff from melting snow is captured by replacing stoplogs into the dam following the spring freshet peak with an aim to ensuring target operating levels are maintained for summer recreation and navigation.

Historical snowpack observations from the Magnetawan snow station show that on average the snowpack water equivalent peaks in early March with close to 120 mm of water content in the snowpack dropping to approximately 40 mm by April 15. Although selecting a specific date to replace logs in the Lake Bernard Dam is not operationally feasible, dam operation records from 1985 to 2021 indicate the average date logs are placed back is April 16.

Figure 10 shows the Lake Bernard rule curve with the mean, maximum and minimum water levels recorded from 1985 to the end of 2021. On average, water levels increase by about 10 cm from when the first logs are placed in the dam. This demonstrates how dam operations capture snowmelt runoff to raise water levels towards the summer target.

Lake Bernard experiences fairly low annual water level fluctuations and year-to-year variability relative to other lakes within the watershed. Achieving summer target water levels on the lake is dependent upon capturing water during the spring thaw. Given the small drainage area for the lake, analysis of historical water levels suggests that seasonal rainfall and natural inputs alone are insufficient to ensure water levels reach the summer target level.

Capturing water from spring runoff is the only reliable operational action that MNRF can take to ensure the summer target water levels are achieved to mitigate the potential for water levels dropping below the operating zone later in the summer.

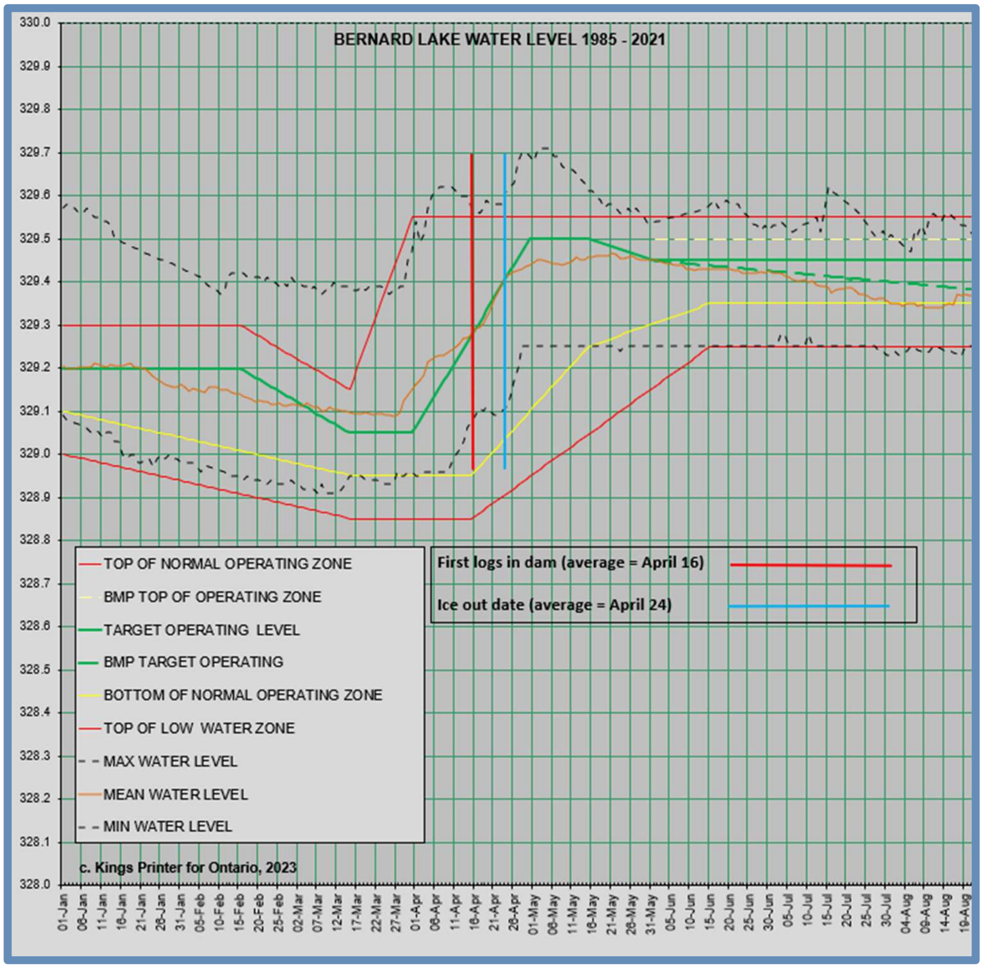

Figure 10: Mean, max, min water levels 1985-2021 vs. first logs in and ice out

Implications to the normal operating zone

In spring, operating above the normal operating zone could lead to shoreline erosion and damage to shoreline infrastructure (docks, piers, retaining walls, buildings) due to high water levels.

During flood conditions, water levels can be expected to rise above the normal operating zone despite removing all stoplogs from the dam.

Though high water can damage shorelines and shoreline infrastructure, it can have beneficial effects on lake ecology. In spring, higher water levels are targeted on other nearby watersheds to:

- give spring-spawning fish better access to shoreline vegetation
- flood shorelines and their wetlands, helping to replenish them for the summer

6.3 Summer operations

Monitoring

Water levels are monitored daily throughout the summer by accessing Environment Canada Real-Time Hydrometric data from the gauge located at Lake Bernard 02EA020. Daily water level readings from gauge 02EA020 are plotted against the rule curve to assess water level trends against the rule curve/operating plan and determine dam operations to maintain water levels within the rule curve/operating plan.

Dam operations

From late May to early September, water levels on the lake normally decline by approximately 10 cm (shown in *Figure 11*). The declining water level is due to:

- the difference between inputs from rainfall and outputs from evaporation
- the maintenance of a minimum downstream flow through the dam
    - The Magnetawan River Water Control Operating Plan and Dam Operating Manual identify a minimum flow of 0.2 cubic metres per second (m3/s) to be maintained from the dam at all times (see Section 5.1.5 for details).

Inputs and outputs	Historic averages from May to August	Effect on water levels
Precipitation	The historic average precipitation at the Environment Canada weather station located in Beatrice (Environment Canada, 1981-2010 Canadian Climate Normals.	+36.8 cm
Evaporation	The average amount of evaporation from lakes within the Magnetawan River watershed (Magnetawan River Dam Operation Manual, MNRF. 2000).	-47.0 cm
Minimum flow through the dam	The volume of water in the lake needed to maintain the minimum flow through the dam is about 1,555,200 m3 over a period of 90 days. This volume of water is about 9 cm deep on the lake. This means it will take a decrease of about 9 cm in the water level to maintain the minimum flow through the dam from June through August.	-9.0 cm

Inputs and outputs	Historic averages from May to August	Effect on water levels
TOTAL	**The difference in water leaving the lake through evaporation (47 cm) and through maintaining minimum dam flow (9 cm), and water entering the lake through precipitation (36.8 cm) is approximately 19 cm.**	**-19.2 cm**

Table 3: Inputs and outputs – effect on water levels

Due to the difference between inputs to the lake (e.g., precipitation), versus the outputs from the lake (e.g., evaporation and minimum flow through the dam), it is expected that water levels on Lake Bernard will normally decline from early May to the end of August each year. The lake normally declines by the total difference (-19.2 cm) and experiences an average water level decline from late May to early September of approximately 10 cm. This is possibly due to the presence of groundwater springs within the lake that provide some water inputs that has not been quantified by MNRF.

The maintenance of the minimum flow through the dam in combination with the difference between rainfall to replenish the lake and evaporation from the lake could exacerbate low water issues later in the summer if the season begins with lake levels lower than normal.

Implications to the normal operating zone

In summer, the implications of maintaining water levels above the normal operating zone include:

- shoreline damage
- loss of usable beaches, impacting recreational enjoyment of beaches
- potential difficulty using flooded boat launches

The implications of operating below the normal operating zone include impacts to recreation and navigation and possible inability to maintain the minimum flow of 0.2 m3/s to Stirling Creek (Ministry of Natural Resources, February 2000).

6.4 Fall operations

Monitoring

Water levels are monitored daily throughout the fall by accessing Environment Canada Real-Time Hydrometric data from the gauge located at Lake Bernard 02EA020. Daily water level readings from gauge 02EA020 are plotted against the rule curve to assess water level trends against the rule curve/operating plan and determine dam operations to maintain water levels within the rule curve/operating plan.

Dam operations

Observed historical water levels for late summer and early fall from 1985 – 2021 demonstrate that the mean water level of Lake Bernard by Labour Day is at the bottom of the normal operating zone when most logs are still in the dam with minimal dam operations. This indicates that under normal conditions the removal of all logs from the dam shortly after Labour Day could cause water levels to drop below the normal operating zone of the lake.

With early fall water levels near the bottom of the normal operating zone, dam operations will normally maintain a downward trend in water levels through the rest of the fall season. Once the logs are all removed from the dam in mid to late-October, lake water levels equalize with water levels in Stirling Creek downstream and slowly drop throughout the winter with normal watershed conditions.

Figure 11 shows the mean water level is at the bottom of the normal operating zone on Labour Day from 1985 to 2021.

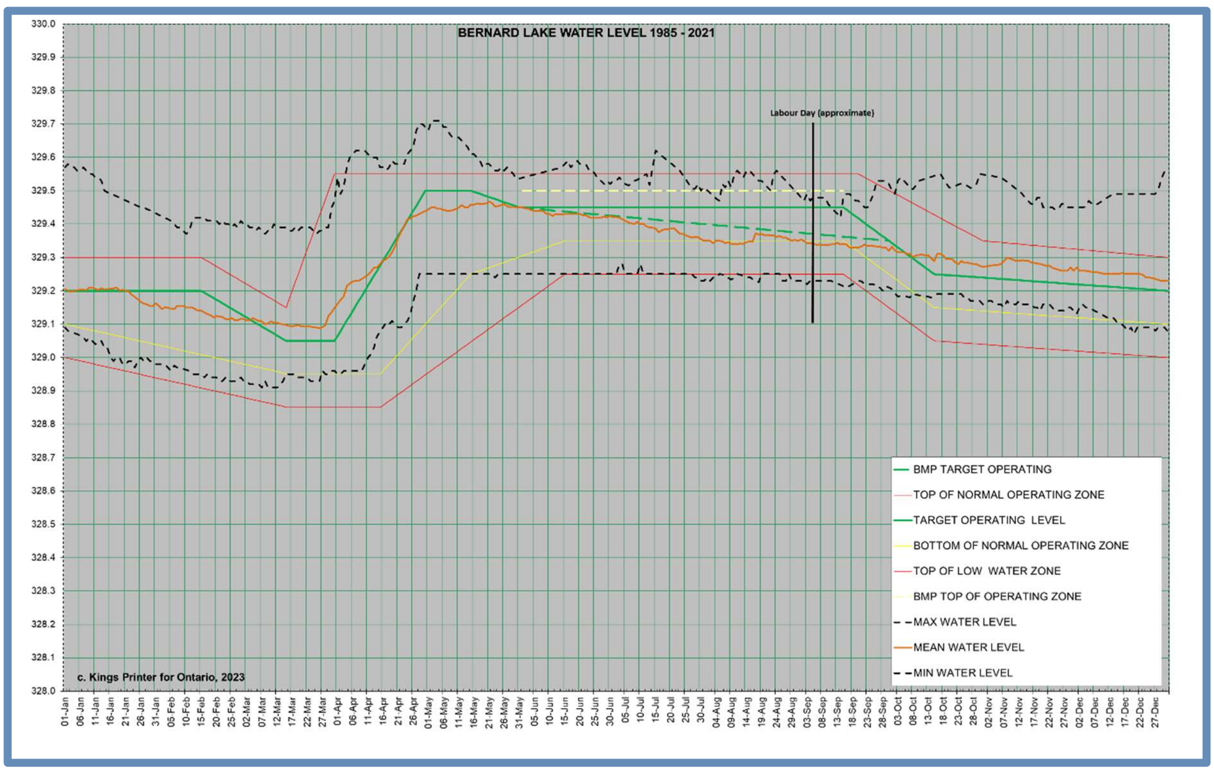

Figure 11: Minimum, maximum and mean observed levels 1985-2021

Implications to the normal operating zone

In the fall, operating above the normal operating zone carries the same potential social impacts as during the summer and spring, leading to issues such as shoreline erosion, damage to shoreline infrastructure and the loss of usable beaches.

Operating below the normal operating zone could have a positive impact on Lake Trout populations, as winter water levels are not likely to fall significantly below levels at which Lake Trout spawned in the fall. Low water levels during mid-October spawning might mitigate the impact on Lake Trout spawning, as the lake freezes in the winter at water levels similar to or not significantly lower than mid-October levels. However, low water levels could also have negative effects on recreation, navigation, and boat launch and removal from the lake, especially if launches are located in shallow areas.

7.0 Conclusion

Water management of Lake Bernard aims to balance a number of objectives and interests, including public health and safety, public and Indigenous community interests, legislative requirements, environmental impacts and the interests of the communities.

The report explored the history of water management for the lake, analyzed its current state, community concerns, potential impacts of changing dam operations, and provided the legislative framework and policies governing the ministry's dam operations at Stirling Creek.

Key facts

Several critical points have been extracted from the report to provide key facts about water management and an overview of the factors affecting Lake Bernard:

- **Stakeholder concerns:** Residents and property owners on Lake Bernard have competing interests. Concerns have been voiced about:
    - shoreline damage from ice push in the spring
    - shoreline erosion due to high water levels in the spring and summer
    - low water levels in the summer negatively affecting summer recreation and navigation activities
    - low water in the winter negatively impacting Lake Trout eggs

- **Dam operations:** The ministry operates all MNRF-owned dams located in the Magnetawan River watershed within the established rules. The ministry seeks to continually improve the overall management of the watershed through ongoing dialogue with the public, Indigenous communities and concerned stakeholders, including municipalities, members of the public, and lake associations.

  Operating the Lake Bernard Dam outside of the established seasonal water management goals can have a wide range of implications, including, but not limited to:
    - potential to impact Lake Trout populations
    - high water levels that could lead to shoreline erosion and damage to shoreline infrastructure
    - loss of usable beaches and recreational enjoyment
    - provide spring-spawning fish better access to shoreline vegetation
    - replenish wetlands
    - potential difficulty using flooded boat launches
    - inability to maintain the minimum flow to Stirling Creek

The Lake Bernard Dam at Stirling Creek is not a flood control structure. A flood control structure needs a large lake or reservoir with the ability to release or lower the water level within the reservoir to store or hold back flood waters. The dam at Stirling Creek does not have the design or local terrain to mitigate flooding or keep water levels within the normal operating zone of the lake during extreme watershed conditions such as flood or drought.

- **Lakes and Rivers Improvement Act (LRIA):** MNRF is responsible for the regulation and oversight of activities related to dam operations under the LRIA. MNRF's general practice is to apply the criteria and standards under the Act to all dams owned, maintained and operated by the ministry, including the Lake Bernard Dam.

  A dam operating plan is developed to provide a framework that balances the operational needs of the dam with environmental conservation, safety considerations and the interests of stakeholders. This plan provides instructions on when and how to operate the dam, outlines critical information necessary to identify target water levels and outlines required maintenance activities.

- **Factors influencing lake water levels:** Dam operations are not the only factor influencing water levels on Lake Bernard. The physical characteristics of the lake influence how rainfall, temperatures, wind and water level manipulation impact water levels.

  The lake's natural characteristics, such as soft shorelines and fetch, are conducive to shoreline erosion. In addition, lake depth can cause rapid expansion of ice causing shoreline damage from ice movement.

  With all the stoplogs removed from the dam in the fall and not put back into the dam until after the peak of the spring freshet has passed, the dam is minimally operated on an annual basis. Despite the dam being minimally operated, Lake Bernard experiences the second-lowest variation in annual water levels for Magnetawan system managed lakes at 0.36 m per year. The average annual water level variation within the system managed lakes is 0.57 m with Ayers Lake having the least amount of annual water level variation at 0.25 m and Doe Lake having the most annual water level variation at 1.12 m. Considering the minimal dam operations and the lower annual water level variation on Lake Bernard, the natural characteristics of the lake, like soft shorelines, fetch and ice expansion, are likely resulting in shoreline erosion and damage.

Figure 12 below shows the water levels that were observed at the Water Survey of Canada gauge 02EA020 gauge from January 1 through December 31, 2023. During 2023, water levels remained within the normal operating zone of the lake (upper and lower compliance limits) except for a couple weeks during the height of the spring freshet which saw minor flooding conditions across the region. The 2023 observed water levels reiterates the seasonal nature of water level trends on Lake Bernard. There were no reports of shoreline damage due to ice push during 2023.

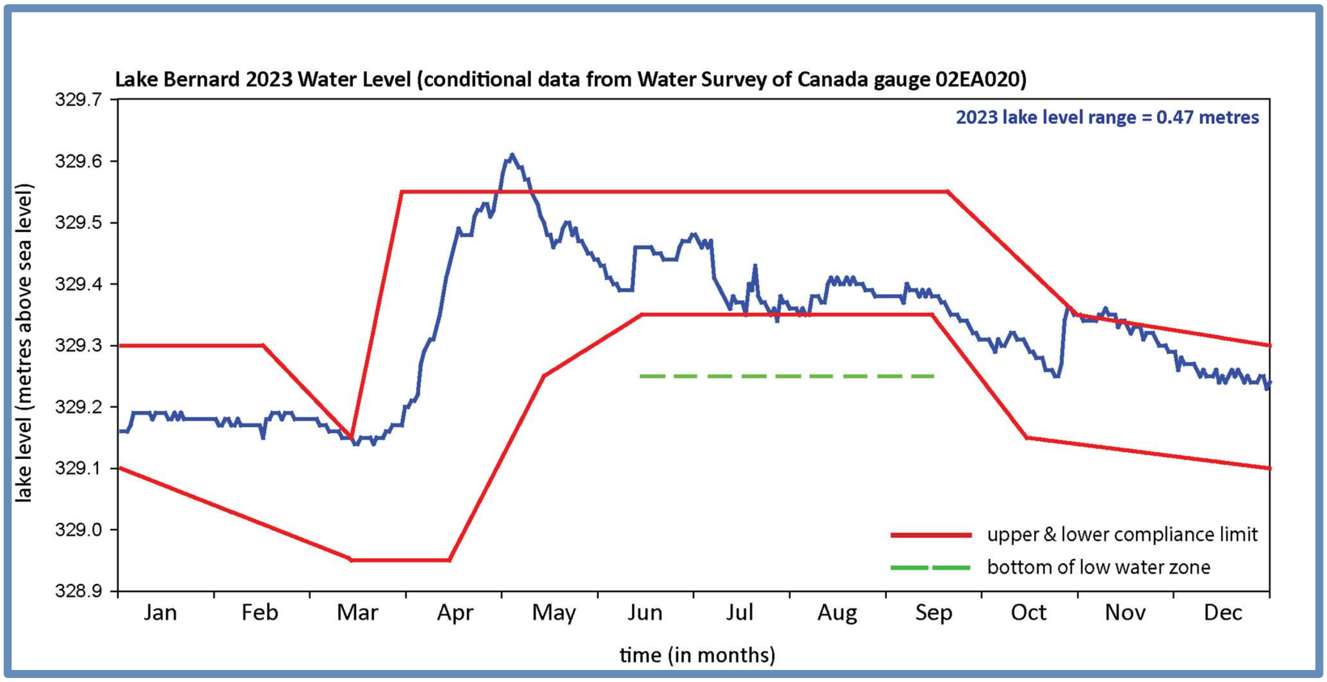

Figure 12: Lake Bernard 2023 water levels

In closing

The ministry recognizes the importance of addressing concerns about water levels on Lake Bernard. This report can serve as a resource document and provide a baseline of information to refer to in discussions surrounding water management issues on Lake Bernard.

Moving forward, a collaborative approach remains integral in charting a path that respects diverse concerns while balancing the risks and benefits associated with potential dam operational adjustments.

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APPENDIX A

Lakes and Rivers Improvement Act (LRIA)

Objectives of the LRIA

The LRIA serves multiple purposes, including management, protection, and utilization of water bodies and their lands, safeguarding public rights over these waters, and the preservation of natural resources and amenities.

These are outlined as follows:

a) management, protection, preservation and use of the waters of the lakes and rivers of Ontario and the land under them
b) protection and equitable exercise of public rights in or over the waters of the lakes and rivers of Ontario
c) protection of the interests of riparian owners
d) management, perpetuation and use of the fish, wildlife, and other natural
e) resources dependent on the lakes and rivers
f) protection of the natural amenities of the lakes and rivers and their shores and banks and
g) protection of persons and of property by ensuring that dams are suitably located, constructed, operated and maintained and are of an appropriate nature with regard to the purposes of clauses (a) to (e)

Dam definition and regulatory approval

The LRIA defines dams as a structure or work forwarding, holding back, or diverting water. Under Sections 14 and 16 of the LRIA, no person shall construct, alter, improve or repair a dam in any lake or river in the circumstances set out in Ontario Regulation 454/96 without approval for the location of the dam and/or its plans and specifications.

Operating plans and approvals

Operating plans for dams are established through LRIA Sections 14 (new dams), 16 (existing dams) and 23.1 (prepare a new or amend an existing plan), facilitating implementation and compliance.

Administration guidance and technical documents

The *Lakes and Rivers Improvement Act Administrative Guide*, along with technical bulletins and best management practices, offer direction to applicants and MNRF staff involved in the approval process, outlining mandatory requirements and technical guidance.

Location approval and operating plan development

The *Location Approval for Dams Technical Bulletin* (2015) guides proponents in developing an operating plan for new dams.

An operating plan is intended to provide clarity and certainty with respect to how water levels and flows will be managed. The level of detail in an operating plan will depend on the complexity of the dam, including factors such as existing social, economic and environmental constraints which may affect the dam's operation.

Consideration for operational changes

Under the LRIA, when contemplating changes to dam operations, MNRF considers the LRIA objectives. These include public health and safety, riparian owner (the owner of land that borders on a surface water source) and public interests, environmental impacts, and Indigenous community interests in decision making.

Prior to operational changes being implemented, this can include providing transparency through a public engagement process.

APPENDIX B

Magnetawan River Water Control Operating Plan

Amendment provisions

The plan outlines provisions for potential amendments under specific circumstances, addressing scientific advancements, new information, and plan-specific data collection.

Minor amendments

Minor amendments consistent with plan's objectives, pertaining to public interest and safety, might be executed by MNRF after a thorough review without public consultation. Copies of these minor amendments will be maintained in local ministry offices.

Major amendments

Significant changes in operating regimes or matters of substantial public interest will be deemed to be a major amendment by the ministry and are subject to public consultation. This may involve Environmental Registry postings, public meetings, engagement with Indigenous communities, or the involvement of a public advisory body.

APPENDIX C

Additional fishery information

Broad-scale monitoring program

Since 2008, the province has implemented a Broad-scale Monitoring (BsM) program for fisheries. This program collects data from representative lakes in various fisheries management zones across the province to help MNRF biologists manage provincial fisheries effectively. Lake Bernard is a “trend” lake within the BsM program and undergoes sampling once every five years within the established cycle.

This cyclical sampling aims to monitor long-term trends related to water quality, fish communities and the abundance of sport fish. Sampling occurred on Lake Bernard in 2009, 2013 and 2019, revealing an increased catch of Lake Trout over time, constituting one per cent of the total catch in 2009 and 2013, escalating to six per cent in 2019.

Most Lake Trout caught during BsM sampling are stocked fish. With recent stocking, Lake Bernard’s most recent BsM surveys indicate relative abundance within the range of typical natura Lake Trout lakes in FMZ 15. However, excluding stocked fish, the natural Lake Trout relative abundance remains very low compared to other natural Lake Trout lakes in FMZ 15, indicating impairment in Lake Bernard.

BsM bulletins, presenting snapshots of recent monitoring endeavors and netting outcomes, are publicly available on Fish ON-Line. Additional detailed information on the history of fisheries monitoring on Lake Bernard is available in the Lake Bernard Fisheries Fact Sheet at the following link:
http://www.muskokawaterweb.ca/images/mnr/bernard_lake.pdf

Lake Trout spawning on Lake Bernard

On Lake Bernard, Lake Trout spawn around mid-October in shallow rocky shoals, primarily in the lake’s southern half (refer to *Figure 7*). The findings of the 1987 Lake Trout Spawning Survey revealed that:

- 25 per cent of Lake Trout spawn in 40 centimetres of water or less (this would be a water level elevation of 328.95 to 329.00 masl at the time of the 1987 survey)
- 50 per cent spawn in 60 centimetres or less (this would be a water level elevation of 328.75 to 328.80 masl at the time of the 1987 survey)
- 75 per cent spawn in 1 metre or less (this would be a water level elevation of 328.35 to 328.40 masl at the time of the 1987 survey)
- 100 per cent spawn in less than 1.5 metres (this would be a water level elevation of 327.90 to 327.85 masl at the time of the 1987 survey)

Throughout the winter, water levels on Lake Bernard decrease, a process detailed in Section 6.0.

During the October 1987 Lake Trout spawning survey, water levels ranged between 329.35 and 329.40 masl. A comparison of the 1987 survey results with historic mean water levels (1985-2021) indicates an average difference of 20 cm between fall spawning levels (averaging 329.30 masl) and low winter water levels (averaging 329.10 masl).

Low water levels during mid-October spawning might mitigate the negative impact on Lake Trout spawning as the lake freezes in the winter and water levels decline further. Less differential between fall and winter water levels will reduce the risk of Lake Trout fry being dewatered by the winter drawdown.

Any changes to dam operations that increase the difference in water levels between Lake Trout spawning in the fall and low winter water levels would likely have a negative impact on the Lake Trout population since Lake Trout eggs deposited during the fall would be destroyed through desiccation (the removal of moisture) as a result of lower water levels during the winter.

APPENDIX D

Methodology

Below is a summary of methods and information used to prepare the report.

Ministry's commitment to collaboration

Information gathering

Lake Bernard data was collected by analyzing both numbers and qualitative information, such as descriptive information about the lake environment and qualitative observations. Refer to Section 4.0 for the lake environment and Section 6.0 for dam operations – that's where you'll find the quantitative and qualitative data analysis and results.

Summary of information sources

The report consolidates all MNRF accessible data concerning Lake Bernard and its dam operations. Sources include:

- Magnetawan River Water Control Operating Plan
- Magnetawan River Dam Operating Manual (Lake Bernard Dam)
- Topographic mapping tools
- Ontario Watershed Information Tool
- Water Survey of Canada (Environment Canada) gauge 02EA020 (Lake Bernard at Sundridge)
- MNRF Bracebridge / Minden / Parry Sound District historic water level and dam operation records
- Site visits and photographs
- Sundridge real-time weather information (available online)

Specific data analyses

MNRF staff undertook data analysis of Lake Bernard water levels to review current and historical levels and their relationship to compliance limits. The analysis involved:

- Examining Lake Bernard water levels over the last five years, considering the complete historical record.
- Use of Water Survey of Canada gauge 02EA020 and MNRF Parry Sound District office records for water level and dam operation information.
- Creation of plots and graphs showcasing water level fluctuations.
- Statistical analysis to ascertain magnitude, frequency, timing, duration and rate of change of water levels.

- Site visits conducted by the MNRF Regional Hydrologist on specific dates for lake level analysis.

Weather monitoring and basin study

- Monitoring daily meteorological data throughout the year.
- Reviewing Lake Bernard physiography and topography, calculating drainage basin area, including lake bathymetry, tributary inputs, and outlet creek (Stirling Creek) attributes and influence.
- Calculating fetch distances for wind impact assessment.
- Analyzing precipitation, temperature, evaporation potential, snow depth and melt timing.

Dam structure

- Reviewing Lake Bernard Dam structure drawings, engineering inspections and historical dam operations.
- Using the Magnetawan River Water Control Operating Plan and Magenetawan River Dam Operating Manual to validate watershed water management approach and specific dam operations details.

Fisheries review

- Assessing existing Lake Trout data and studies for understanding fisheries-related concerns. This included:
    - reviewing spawning shoal and spawning studied back to the 1980s
    - analyzing spawning shoal information with water level observations to identify potential impacts to Lake Trout
    - reviewing Broadscale Monitoring Program reports for Lake Bernard and summarizing results related to Lake Trough and other fish communities within the lake

Goal of information review

The goal of this review and analysis is to:

- compile facts using available information about how dam operations affect water levels on Lake Bernard
- facilitate an understanding of potential impacts resulting from alterations to the current dam operating plan