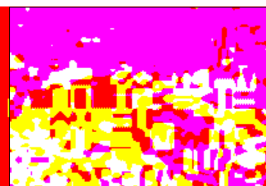
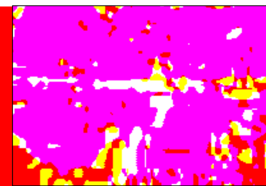
Muskoka River

Water Management Plan



Final Plan

January 2006

Amended February 2018

Muskoka River

Water Management Plan

Final Plan Report

January 2006

Amended February 2018

Table of Contents

List of Tables

blank back

List of Figures

Number Title

Number Title

blank back

Glossary of Abbreviations

AP	Algonquin Power
ARSP	Acres Reservoir Simulation Program
ASI	Archaeological Services Inc.
BBG	Bracebridge Generation Ltd.
BMA	Bear Management Area
BMP	Best Management Practice
BSC	Bird Studies Canada
CSV	Comma Separated Variable
DOM	Dam Operations Manual
DMOM	District Municipality of Muskoka
EBR	Environmental Bill of Rights
FDZ	Flood Damage Zone
GSC	Geodetic Survey of Canada
GPS	Geographic Positioning System
GS	generating station
HFT	High Flow Trigger
HWZ	High Water Zone
IESO	Independent Electricity System Operator
LCD	Local Construction Datum
LFT	Low Flow Trigger
MOE	Ontario Ministry of the Environment

NOZ	Normal Operating Zone
ODPW	Ontario Department of Public Works
OFSC	Ontario Federation of Snowmobile Clubs
OLL	Ontario Living Legacy
OPG	Ontario Power Generation
OPGC	Orillia Power Generation Corporation
OSAP	Ontario Stream Assessment Protocol
PAC	Public Advisory Committee
RWL	Regulated Water Level
SAC	Steering Advisory Committee
SEV	Statement of Environmental Values
SLIN	Spring Littoral Index Netting
SPIN	Summer Profundal Index Netting
TOL	Target Operating Level
WMP	water management plan
WMU	Wildlife Management Units
WPCP	wastewater pollution control plant
WSC	Water Survey of Canada

1 Plan Approval

APPROVAL STATEMENT
WATER MANAGEMENT PLAN FOR WATERPOWER
for the
Muskoka River System
District of Parry Sound, Southern Region
Ontario Power Generation Inc.
Orillia Power Generation Corporation
Algonquin Power Fund (Canada) Inc.
Bracebridge Generation Ltd.

In submitting this plan, we confirm that this water management plan for waterpower has been prepared in accordance with *Water Management Planning Guidelines for Waterpower,* as approved by the Minister of Natural Resources on May 14, 2002. The signing parties agree that this plan will supercede the operational plans and strategies for various Muskoka Lakes outlined in the Hackner-Holden Agreement of 1940 and the subsequent Addendum of 1969.

____
Peter Murray, NEPG and Evergreen Energy, date
Ontario Power Generation Inc.
(Trethewey, Hanna Chute, South Falls, Ragged Rapids and Big Eddy waterpower facilities)

____
John Mattinson, Orillia Power Generation Corporation date
(Matthias waterpower facility)

____
David Kerr, Algonquin Power Fund (Canada) Inc. date
(Burgess waterpower facility)

____
Chris Litschko, Bracebridge Generation Ltd. date
(High Falls, Wilson Falls and Bracebridge waterpower facilities)

I concur that this water management plan has been prepared in accordance with *Water Management Planning Guidelines for Waterpower,* as approved by the Minister of Natural Resources on May 14, 2002, and that direction from other sources, relevant policies and other obligations have been considered. I recommend this plan be approved for implementation.

____
Andy Heerschap, A/District Manager date
Parry Sound District, MNR

Approved by: ____
Ray Bonenberg, A/Regional Director, Southern Region date
Ontario Ministry of Natural Resources

In 1994, MNR finalized its Statement of Environmental Values (SEV) under the Environmental Bill of Rights (EBR). The SEV is a document that describes how the purposes of the EBR are to be considered whenever decisions are made that might significantly affect the environment are made in the ministry. During the development of this water management plan, the ministry has considered its SEV.

Disclaimer

This water management plan (WMP) sets out legally enforceable provisions for the management of flows and levels on this river within the values and conditions identified in the WMP.

In instances where, due to emergency energy shortages, the Independent Electricity System Operator (IESO) requests that owners of the waterpower facilities and associated water control structures seek relief from certain provisions of this WMP, the Ministry of Natural Resources (MNR) will consider those requests expeditiously and, after consultation with the IESO, may allow short-term relief from certain provisions.

The mandatory provisions of this WMP will be waived, as appropriate, when the dam owners (which may include other dam owners, such as MNR) are requested to do so by a police service or other emergency measures organization.

In instances of unscheduled facility imperatives (e.g. emergency maintenance etc), MNR will consider requests from the owner for temporary relief from the plan expeditiously with consideration to the relative priorities of both MNR and the owner

This plan does not authorize any other activity, work or undertaking in water or for the use of water, or imply that existing dams(s) meet with safe design, operation, maintenance, inspection, monitoring and emergency preparedness to provide for the protection of persons and property under the *Lakes and Rivers Improvement Act*. Approval of this WMP does not relieve the dam owners from their responsibility to comply with any other applicable legislation. For the purposes of this plan, an operational plan means a plan for the management of flows and levels.

Approval of this plan does not grant a dam owner the right to flood Crown land or the land of any other person without first obtaining the Crown's or that person's consent, nor does it authorize any infringement of the rights of the Crown or of any other person.

Ministry of Natural Resources and Forestry

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Ministère des ressources naturelles et des forêts

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February 22, 2016

Subject: Ministry of Natural Resources and Forestry Approval of Administrative Amendment to Extend the Term of the Muskoka River Water Management Plan

This letter is to advise that the Muskoka River Water Management Plan has been amended under Section 23.1(6) the *Lakes and Rivers Improvement Act.* An administrative amendment was undertaken and approved February 22, 2014. The amendment extended the term of the plan for an additional 5 years. This will ensure that the existing water management plan remains in effect while providing time for the results of the proposed changes to provincial requirements for the preparation, amendment and review of water management plans under the *Lakes and Rivers Improvement Act* to be known. The plan will now expire in March 31, 2021.

Changes as a result of this amendment are reflected in the updated (March 2016) version of the Muskoka River Water Management Plan.

Regards,

Jane Ireland

Jane Ireland
Region Director
Southern Region
Ministry of Natural Resources and Forestry

Ministry of Natural Resources and Forestry

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Ontario

February 16, 2018

Subject: Ministry of Natural Resources and Forestry Approval of Administrative Amendment to Align the Muskoka River Water Management Plan with Current Provincial Policy

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This letter is to advise that the Muskoka River Water Management Plan has been amended under Section 23.1 (6) of the *Lakes and Rivers Improvement Act*. An administrative amendment was undertaken by the Ministry of Natural Resources and Forestry, and was approved on February 16, 2018. The amendment was undertaken to align the Muskoka River Water Management Plan with direction in the approved 2016 Maintaining Water Management Plans Technical Bulletin.

Changes as a result of this amendment are reflected in the updated (February 2018) version of the Muskoka River Water Management Plan. A summary of this amendment can be found in the History of Amendments on the following page and in more detail in Appendix H.

Regards,

Sharon Rew
Regional Director
Southern Region
Ministry of Natural Resources and Forestry

February 16, 2018 Amendment

On February 16th, 2018, the Ministry of Natural Resources and Forestry (MNRF) approved an amendment to the Muskoka River Water Management Plan to align the plan with the approved 2016 Maintaining Water Management Plans Technical Bulletin (refer to Appendix H for a complete summary of amendment text changes).

This administrative amendment resulted in changes to the following sections of the Plan:

Expiry Date	The expiry date has been **removed**.
Amendments	Section 17 has been **replaced.**
Standing Advisory Committee	Section 16.2 has been **revised.**
Compliance	Sections 13.4.1 and 13.4.2 have been **replaced**.
Effectiveness Monitoring	Section 14 has been **revised**.
Implementation Reporting	Section 16.3 has been **replaced** and Section 16.4 has been **removed**.

2 Introduction

2.1 Study Area – The Muskoka River Watershed

The Muskoka River watershed is located in central Ontario's lake country, with the main population centres being Huntsville, Bracebridge and Gravenhurst. Highway 11 bisects the watershed in a north/south direction (Figure 2.1). The watershed originates on the western slopes of Algonquin Provincial Park and extends southwesterly for a distance of some 210 km to Georgian Bay. It is 62 km at its widest point. The watershed encompasses an area of approximately 5100 km^2 and includes about 78,000 ha of lakes.

From its headwaters in Algonquin Park, the Muskoka River flows through a series of connecting lakes to two outlets in Georgian Bay (Figure 2.2). The watershed is divided into three subwatersheds: the North and South Branches, and the Lower Muskoka subwatershed (Figure 2.3). The North and South Branches comprise approximately the eastern two-thirds of the watershed, originating in the highlands of Algonquin Park. They flow southwesterly until converging in Bracebridge and then flow into Lake Muskoka. The Lower Muskoka subwatershed covers approximately the western one-third of the watershed, and receives the inflow from the North and South Branches as well as Lakes Joseph and Rosseau. This combined flow passes through the Moon and Musquash rivers and discharges into Georgian Bay.

The Muskoka River supports a wide range of aquatic and wildlife ecosystems, and numerous human uses, including water power generation, swimming, canoeing, boating, angling, hunting and trapping, and tourism operations. There are 42 water control structures (dams and/or dam/powerhouse combinations) on the Muskoka River system and three navigation locks. The MNR owns and operates 29 of the control structures, while the waterpower industry, [Ontario Power Generation (OPG), Algonquin Power, Bracebridge Generation, and Orillia Power Generation Corporation] own/operate 11 structures. The District Municipality of Muskoka owns and operates one while the remaining one is privately owned and operated.

Many of the original dams were constructed in the late 1880's to early 1900's to facilitate the transport of logs to sawmills or the diversion of water to power the mills, and to aid in commercial river navigation. Originally constructed of rock and timber, many of these structures were taken over and rebuilt with concrete during the 1940 to 1970 period by the Ontario Department of Public Works (ODPW). In the early 1970's, the responsibility for the operation and maintenance of the dams was transferred from the ODPW to the MNR. Figures 2.2 and 2.3 shows the location of the various dams and other water control structures (i.e., generating stations) in relation to the watershed features.

Over time, the operational emphasis of some of the dams has evolved from one of commerce and transportation, to recreation, fisheries enhancement and flood control (during period of high flows). As the demand for recreational opportunities increased, so has the demand for shoreline cottage/holiday homes with the concomitant expansion of the tourism industry. The Muskoka River, and its connecting lakes and tributaries, now supports a range of economic, recreational and tourism activities that are enjoyed by residents and visitors year-round.

Hydroelectric power generation has taken place on the Muskoka River since 1894. The 10 generating stations on the river system were constructed from that date through to 1950. In 1940, the Ontario Government and the Hydroelectric Power Commission of Ontario (now Ontario Power Generation - OPG) signed the Hackner-Holden agreement, which formalized the control of lake levels and river flows within the Muskoka River drainage area. The agreement, amended in 1969, continues to form the basis of the operational management plans for many of the Muskoka lakes and their control structures[*].

Since assuming responsibility for the majority of the control structures in the mid-1970's, the MNR has strived continually to improve their operation in a manner that recognizes the different, and changing needs and uses of the waterway (e.g., fish and wildlife, navigation, electric power generation, recreation, flood control) while still respecting the terms and conditions of the Hackner-Holden agreement. These adjustments are contained within the operating plans for each MNR dam (MNR, 1997), which are used to guide their operation and integrate them with the operating plans of the waterpower facilities. Dams operated by waterpower producers are all located in riverine sections of the watershed (i.e., none at the

[*] The 1940 Hackner-Holden Agreement established guidelines for selected water bodies within the Muskoka River watershed and focused on providing adequate flows for power generation while increasing the spring flood response capability (i.e., winter drawdown of lakes). The 1969 Amendment recognized the growing importance of recreational uses and ecological needs within the watershed, and revised the drawdown limits on some of the lakes. It also established fall and winter drawdown limits in most of the lake trout lakes to encourage trout propagation.

outlets of natural lakes) and have their own operational plans and strategies. While each facility has its own operating limits, these facilities are all considered ‘run-of-the-river’ as they have a limited water storage capability and limited ability to influence river flows. Most importantly, the operation of these facilities is coordinated with the operation of the MNR controlled structures to ensure that appropriate flow conditions are maintained.

The Muskoka River Water Management Plan focuses on the flows and levels within the Muskoka River and its managed lakes and tributaries. Forest management or land-based information may be referenced as background, but are not the primary focus of this plan unless they are directly related to water flow and level management.

2.2 Goals and Background

The goal of water management planning is to contribute to the environmental, social and economic well being of the people of Ontario through the sustainable development of waterpower resources and to manage these resources in an ecologically sustainable way for the benefit of present and future generations (MNR, 2002). This will be achieved through the management of water levels and flows as they are affected by the operations of waterpower facilities and associated water control structures.

MNR and the local waterpower companies (OPG, Orillia Power Generation Corporation, Bracebridge Generation and Algonquin Power) commenced the water management planning process for the Muskoka River in spring 2002 by collecting background information (ecological, social and economic), and reviewing the present operational management plans (i.e., water levels and flows) for the water control structures in the watershed. The Background Information Report [Acres & Associated (A&A)[*], 2003a] documented the characteristics of the river system and identified the major issues and concerns relating to current operational practices. Subsequently, the Muskoka River Water Management Plan Planning Team identified which issues could be addressed by altered dam operations, as well as those that were outside the scope of the planning process.

[*] Acres & Associated Environmental Limited (A&A) was retained to undertake Phase 1 (Background Information Collection), with assistance from Acres International Limited (Acres). A&A reverted back to the parent companies in 2003 and Acres International Limited completed the rest of the project.

An Options Report (Acres, 2004) was then developed outlining the process that had been followed in reaching a preferred strategy for operating the various control structures. The following principals guide the preparation, review, approval and implementation of this plan.

2.3 Guiding Principles of Water Management Planning

In 2002, MNR finalized the guidelines for water management planning (MNR, 2002). The following principles guide the preparation, review, approval and implementation of this plan:

- **Maximum Net Benefit to Society:** Water management plans should strive to maximize the net environmental, social and economic benefits derived from the management of water levels and flows by waterpower facilities and other water control structures on a river.

- **Riverine Ecosystem Sustainability:** At a minimum, the water management plan should stop any on going degradation of a riverine ecosystem and seek to improve and, where possible, restore riverine ecosystems.

- **Planning Based on Best Available Information:** The best available information at the time of decision making must be used in water management planning. A key task in the planning process is to collate all existing baseline data and identify data gaps (this task was undertaken in A&A 2003a, Background Information Report).

- **Thorough Assessment of Options:** A thorough assessment of options for management of water flows and levels in a river system must be undertaken in an open and participatory way (this is explained in detail in Acres, 2004a Options Report).

- **Adaptive Management:** Changing the operation of water control facilities may affect complex ecological processes and interaction. These effects can be estimated but the actual degree of impact is not necessarily known. Adaptive management is a long-term process which allows for adjustments to the system on a continual basis to obtain improvements to resource management and limit failures. Monitoring of the system is essential to ensure that the anticipated effects of changes to flows and levels are realized. Information from the monitoring program will be used to determine whether further refinements to the plan are required.

- **Timely Implementation of Study Findings:** If study findings arise after the water management plan has been approved that are likely to improve social, environmental or economic benefits without having adverse impacts, they should be implemented in a timely manner.

- **Aboriginal and Treaty Rights:** Water management planning will be undertaken without prejudice to the rights of Aboriginal people.

- **Public Participation:** Public participation is required to ensure accountability and transparency in the planning process (details of the public consultation program are provided in detail in Appendix D).

Since the initiation of the water management planning process, increased emphasis is being placed on renewable energy options for the Province of Ontario. The Ontario government's strategic directions (Strategy 2.1), as outlined in 'Our Sustainable Future' (MNR, 2005) encourages economic growth for Ontario communities by providing new ventures in renewable energy (water, wind, co-generation, biofuels). MNR will plan and implement this direction through the 'preparation and review of policies to support wind and waterpower generation, including consideration of environmental effects, and implementation of site release policies to stimulate new opportunities. The waterpower industry supports these MNR initiatives.

In summary, the following plan has been developed under a cooperative, consensus-based approach. MNR and the waterpower industry proponents will maintain the cooperative working relationship established during preparation of the plan, and will assist each other when necessary in an ongoing working relationship.

2.4 Terms of Reference for Water Management Plan

Separate Terms of Reference were issued for each of the following phases of the water management plan:

- Phase 1 – Background Information Collection
- Phase 2 – Options Development, Plan Report and Implementation.

Phase 1

Phase 1 was carried out by A&A with support from local social (French Planning Services, Bracebridge) and natural environment (Tanith Enterprise, Huntsville) subconsultants and Acres International Limited (Acres) (hydrologic model setup and calibration). This phase included the following tasks:

- collection of all available background information on the Muskoka River watershed related to flows and water level operations
- determination of gaps in information and the need for further data compilation
- formation and coordination of a Public Advisory Committee (PAC)
- implementation of a public consultation program, consisting of open houses, presentations to stakeholder groups, establishment of an internet web site, and preparation of public consultation materials (i.e., project newspaper, questionnaire, mailouts, etc)
- maintenance of a public consultation record
- establishing a hydrologic model for the Muskoka watershed and undertaking a 'base case' model run of existing conditions
- preparation of a preliminary list of issues/conflicts to be addressed by the final plan (e.g., managing levels for one lake versus another, dam operations versus fisheries impacts)
- preparation of a Background Information Report summarizing the existing environmental features and sensitivities, dam operations and key issues/concerns, and an Executive Summary
- undertake a number of reviews/investigations to fill data gaps.

Phase 2

Acres was retained to finalize the water management plan. The following tasks were identified to complete the water management planning process:

- Evaluation of issues/conflicts identified in Phase 1, to determine those that could be addressed within the current operating framework, those requiring further studies, and those which were outside the water management planning process.

- Undertake additional investigations to fill priority data gaps.
- Develop general and specific goals and objectives for the water management planning process for the Muskoka River watershed using existing information, supplemented with data for additional studies.
- Refine hydrologic model, and undertake a series of runs (adjusting water levels and flows) to provide options for control structure operations.
- Develop evaluation criteria to compare and assess the merit of the proposed operating strategy with the current operating plans.
- Undertake public and First Nation consultation to present the preliminary preferred strategy.
- Prepare an Options Report summarizing the process undertaken to develop a new strategy for operating the water control structures on the Muskoka River system.
- Preparation of a Draft Plan (this document) summarizing the water management planning process and provide the proposed operating plans for each control structure. Monitoring plans are included to ensure the effectiveness of and compliance with the proposed strategy.
- Preparation of Final Plan, incorporating public and First Nation comments on the Draft Plan.

2.5 Issues, Resource Values and Interests Identified through Scoping

Through a series of Planning Team, PAC and Steering Committee meetings and discussions (Appendix A) a number of key values of the Muskoka River watershed were given primary consideration in the development of goals and objectives for the Water Management Planning process.

The more important values identified include the following:

- Many of the larger lakes and associated river reaches within the watershed are extensively developed for recreational use, with well established, long-term, high value infrastructure (cottages, boathouses, resorts, camps, etc).

- Recreational boating occurs to varying degrees on almost all watershed lakes, with commercial navigation (tour/sight-seeing boats) an important commercial activity on the larger lakes.

- Ecological conditions within the watershed are generally good, although the potential for improvement in specific areas was identified.

- The existing operational plan (as documented in the Muskoka River Dam Operation Manual, MNR, 1997) provided specific amounts of base flow below individual dams throughout the watershed. While these flow targets were often met in lower portions of the watershed, the provision of base flow in upper watershed river reaches and the specific contributions from individual lakes/reaches were less well defined.

- The dams have increasingly less ability to control water levels and river flows as inputs (i.e., rainfall) increase to the system. During high input periods, such as the spring freshet and other large seasonal storm events, limited control is exerted, and dams are intentionally opened to allow this flow to pass unhindered through the system.

- The waterpower sites within the watershed are all located on riverine portions of the watershed, and are essentially run-of-river operations (i.e., less than 48 hours of water storage as per draft Terra Choice Eco-Logo certification criteria). The release of water by the management and operation of the MNR controlled dams at the outlet of upstream lakes provides the flow required for the operation of these facilities.

- Existing structures have specific limits in terms of flow passage and water retention capability. Only water level and flow changes that could be accommodated within the operational constraints of the present structures should be considered.

2.6 Planning Objectives

A number of basic planning objectives were utilized in developing the water management plan for the Muskoka River system, as follows:

- Existing operational plans and the strategies employed therein to address river system issues and concerns will be the starting point for plan review and option development.

- Realistic goals and objectives will be established which seek to balance the water resource needs and uses of various interest groups.

- Existing, presently available information on river system characteristics and conditions will be utilized to the maximum extent in decision-making.

- It is recognized that this is the first cycle in an ongoing planning process related to water management, and that not all issues and concerns will be addressed in this cycle. Adaptive management will be utilized as a guiding principle to obtain incremental improvements over time.

- Monitoring and data collection programs arising from this plan will be utilized to verify that changes implemented during this round of planning are appropriate and effective in meeting the stated objectives.

General ecological, social and economic objectives, as well as specific objectives for individual river reaches and lakes within the river system were developed to assist with plan preparation, and are provided in future sections of this report (Sections 9 and 10).

2.7 Report Organization

This final water management plan is organized in 17 sections and 7 appendixes that presents background information and the preferred operating strategy for the Muskoka River system (in terms of flows and water levels). Section 1 identifies the plan partners and provides approval of the plan by their respective organizations. This section presents the rationale for water management planning and the goals and objectives for the Muskoka River system. Section 3 describes the physical and biological environment of the lakes and river segments within the system, while Section 4 describes the social and economic environment.
Section 5 describes the water control structures within the river system and their current operating strategies, while issues, resource values and interest related to present water management activities are provided in Section 6. Initial data gaps and deficiencies are provided in Section 7, while baseline data collected during the preparation of this plan is summarized in Section 8. Section 9 describes the options development process, while Section 10 describes the evaluation criteria used to assess alternate operational strategies. Section 11 compares the preferred operating strategy with the existing operating plans, while Section 12 presents the detailed operating plans for each structure. Section 13 presents the compliance monitoring plan for the waterpower facilities, while Section 14 outlines the data

gaps, and science and information needs that will be assessed during the present iteration of the plan (to 2016). Section 16 presents the plan implementation strategy, while Section 17 outlines the details of the plan amendment, review and renewal process. Lists of tables and figures are provided within the report Table of Contents. Various abbreviations and/or acronyms are used throughout the report. A Glossary of Abbreviations is also provided at the front of the report in association with the Table of Contents.

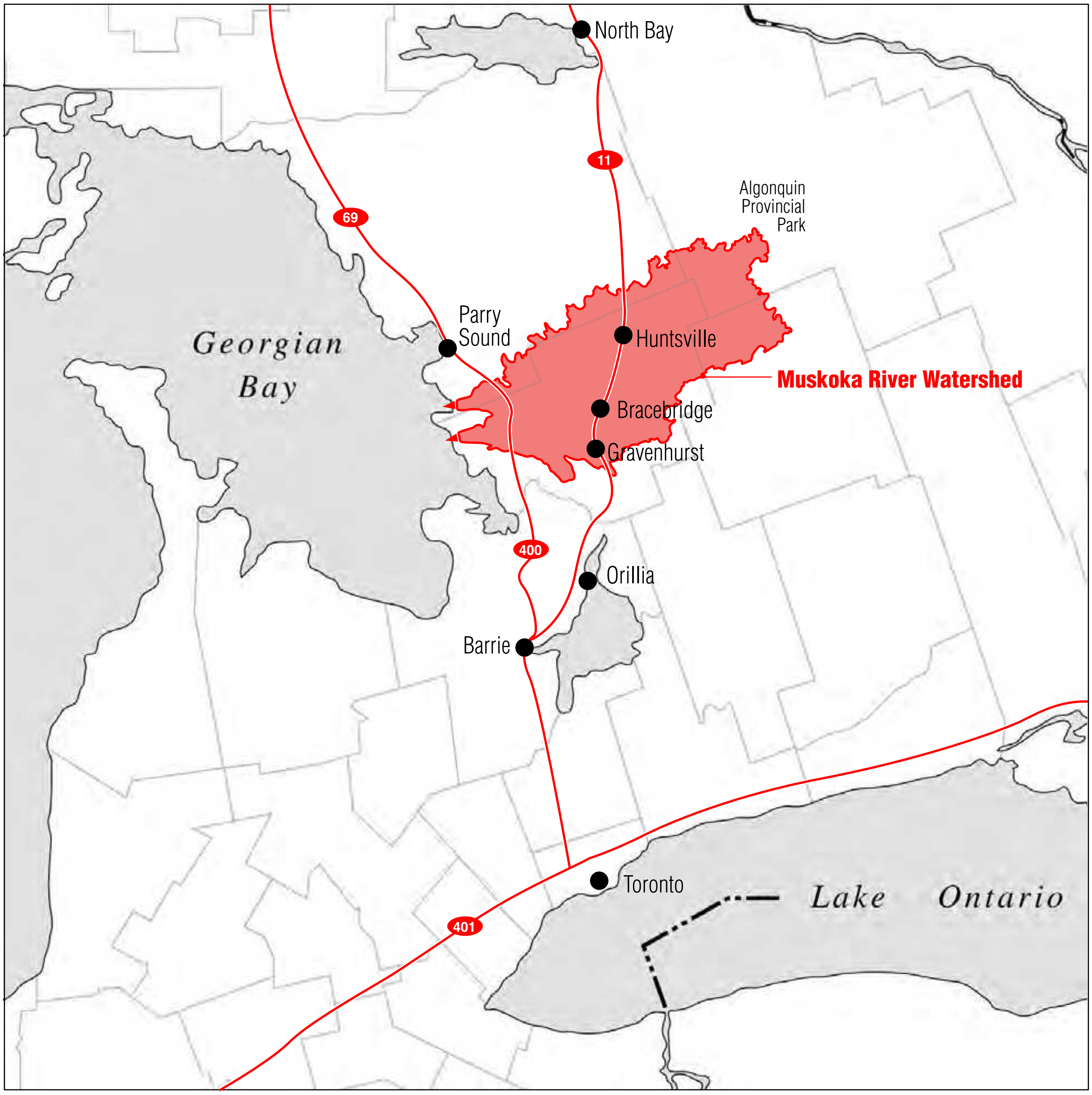


Figure 2.1
Muskoka River Water Management Plan
Location Map

ACRES
International

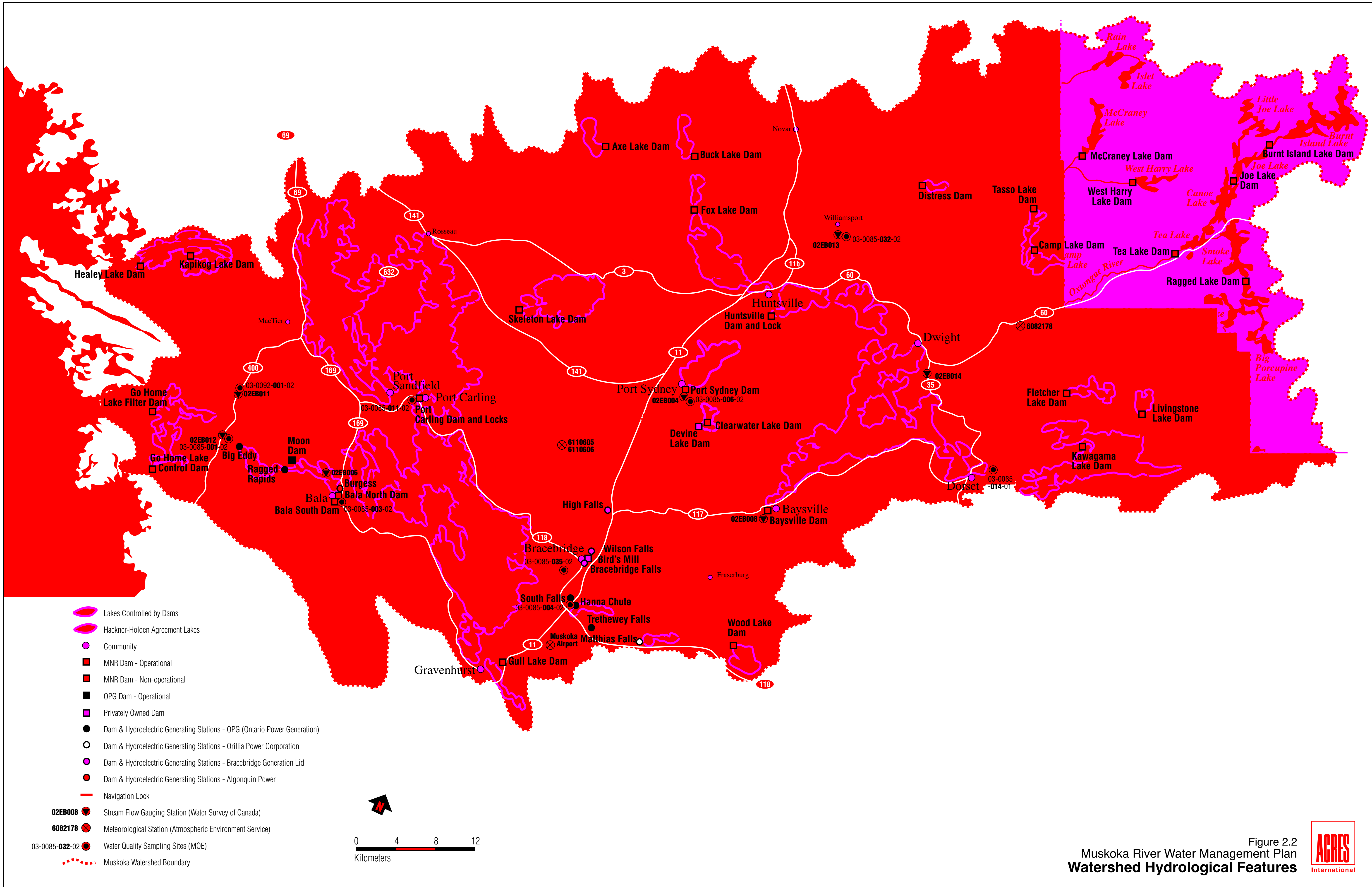
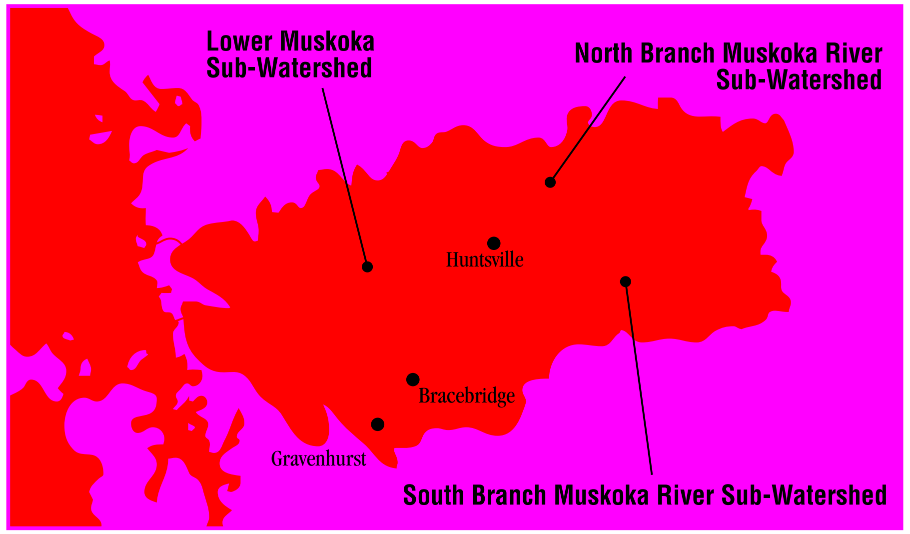
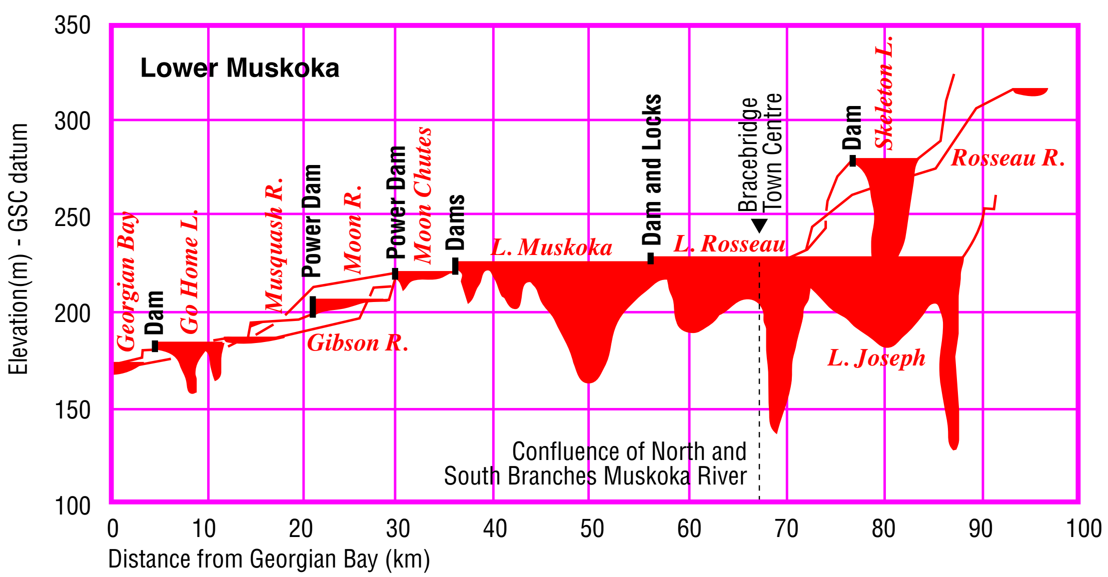


Figure 2.2
Muskoka River Water Management Plan
Watershed Hydrological Features



The watershed is composed of three sub-watersheds as shown above.
River profiles for the 3 sub-watersheds are shown in the adjacent figures.



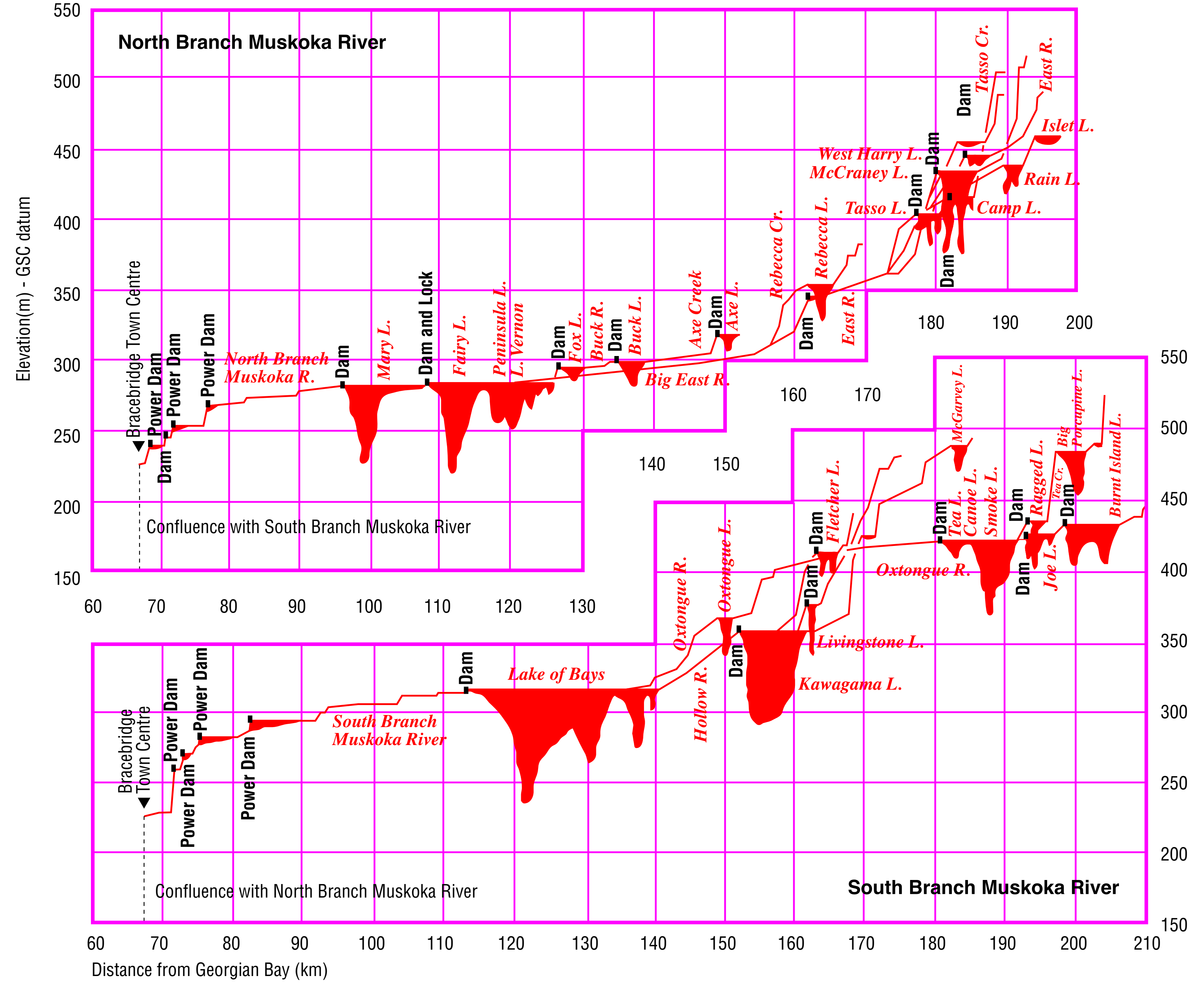


Figure 2.3
Muskoka River Water Management Plan
Water Surface Profiles

3 Physical and Biological Environment

The following summarizes the information provided in full in the Background Information Report (A&A, 2003a).

3.1 Physical Environment

3.1.1 Climate

The climate of the Muskoka River watershed study area is continental with a moderating influence due to the presence of Georgian Bay. Winters are cool and summers are warm, and it is one of the wetter areas in the province. January is the coldest month with a mean daily minimum temperature of -16EC and July is the warmest month, with a mean daily maximum temperature of 24EC. The average number of continuous frost-free days is 113 for Muskoka Airport, beginning in late May and continuing till mid September (Environment Canada, 1982). Lakes and streams typically begin freezing in December, and thaw in late March to early April (MNR, 1997). The average annual precipitation at Huntsville is 1032 mm with 746 mm falling as rain and 286 cm as snow. Muskoka Airport has slightly more precipitation than Huntsville with an annual average of 1099 mm (809 mm as rain and 334 cm as snow). Snowfalls can occur from October to May with the heaviest snowfall occurring in December and January. September has the highest rainfall, with September and November being the wettest months. February to April is the driest period. Snowpack accumulation is usually at its maximum at the beginning of March (MNR, 1997). Lake evaporation is an important consideration during extended dry periods in the summer when flows are reduced, compounding the reduction in lake levels. Evaporation rates are highest in June, July and August.

3.1.2 Physiography

The Muskoka River watershed crosses three north-south trending physiographic units (Chapman and Putnam, 1984). The river rises on the western slopes of the Algonquin Highlands physiographic unit. This domed area is underlain by gneiss and other metaphoric rocks of the middle and late Precambrian Age. Moving westward, there is a strip of sand, silt and clay deposits that follow the alignment of Highway 11 (i.e., from Gravenhurst, through Port Sydney and north to Huntsville) and is known as the Number 11 Strip physiographic unit. This strip formed just below a shoreline of glacial Lake Algonquin and received deposits from streams entering the lake from the adjacent highlands to the east. The western half of the watershed crosses the Georgian Bay Fringe. This physiographic unit was washed by waves from glacial Lake Algonquin leaving only very shallow, coarse soils and exposing bare rock knobs and ridges of the Precambrian Age.

3.1.3 Topography and Surficial Geology

The watershed reaches an elevation of over 525 m at its boundary in the northeast, dropping to the lowest elevation of 177 m at the Georgian Bay shoreline. The terrain maps for the area (Mollard, 1981) classify the topography in the extreme northeast as high local relief that is ridged and hummocky. Throughout the central section, relief is defined as moderate, with a variety of local features including gulleying, knobs, plains and undulating. In the lower sections of the watershed (west of Lake Joseph/Lake Muskoka), the topography is mapped as low local relief varying from plains to undulating and hummocky conditions.

Generally, surface drainage in the upper and central portions of the watershed is good, providing dry soil conditions with rapid runoff occurring from the exposed bedrock areas. Wet surface conditions are restricted to isolated organic terrain sites (i.e., local low lying areas). In the lower part of the watershed (Moon and Musquash Rivers), much of the landscape is low relief, and is traversed by a series of parallel bedrock ridges and intervening bogs.

Overall, the surficial geology mirrors the physiographic units. Soils are thin in the upper and lower stretches of the watershed that contain extensive areas of exposed bedrock. Local patches of thicker sandy, gravelly deposits are found within the upper valleys. Deposits of sand, till and silt are extensive within the Number 11 Strip physiographic unit. These have weathered to give deep, often sandy loam soils that can support limited agricultural activities (Chapman and Putnam, 1984).

3.1.4 Geology, Mineral and Aggregate Resources

The entire watershed is situated on the Canadian Shield with formations from the middle and late Precambrian Age. The majority of the bedrock is composed of banded, veined and homogeneous pink and grey migmatitic gneisses (Hewitt, 1967). Mineral potential is moderate in the very western part of the watershed but there is now no active mineral mining anywhere within the watershed (MNDM, website 2002). There are a number of stone quarries in the watershed, particularly in the Finlayson/Lake of Bays area (MNDM, 2002). Mainly decorative pink granite and gneiss are being quarried for flagstone, building stone and landscaping purposes. Extensive sand and gravel deposits are located within the Highway 11 corridor. There are numerous pits here that have been predominantly used for local road and building construction requirements. Peat deposits are found throughout the area, with major deposits in the geographic townships of Oakley, McLean and Macauley (now all part of the Town of Bracebridge) (MNR, 1983).

3.1.5 Watershed Characteristics

The Muskoka River watershed is located in Central Ontario’s lake country and belongs to the southern Lake Huron/Georgian Bay drainage basin. The watershed is divided into three subwatersheds: the North and South Branches, which comprise approximately the eastern two-thirds of the watershed, and the Lower Muskoka subwatershed, which comprises the western one-third. The North Branch originates in Algonquin Park in a number of small lakes (McCraney and West Harry Lakes), whose discharges converge to form the Big East River. Tributaries of the Big East include Cripple and Tasso Creeks, which meet the river at the site of the former Finlayson Reservoir, and the Little East River. The Big East River drains into the eastern edge of Lake Vernon. The other main inlet of Lake Vernon, located at the northern end of the lake, is the Buck River, which drains Axe, Round, Buck and Fox Lakes. Outflow from Lake Vernon flows past the Town of Huntsville into Fairy Lake, which also receives inflow from Peninsula Lake. These three Lakes (Vernon, Fairy and Peninsula) are collectively known as the ‘Huntsville Lakes’. Outflow from Fairy Lake, through Huntsville Dam, forms the North Branch of the Muskoka River, which flows through Mary Lake and a cascading series of waterfalls (High, Wilson and Bracebridge Falls) and hydropower generating stations. The North Branch then converges with the South Branch just south of the Town of Bracebridge.

The South Branch of the Muskoka River is also divided into two distinct headwater areas. The Oxtongue River originates in Algonquin Park in a series of small lakes (with Burnt Island, Little Joe, Joe, Canoe, Ragged, Smoke and Tea Lakes being the major ones). The river flows through Oxtongue Lake and drains into the north end of Lake of Bays, near the Town of Dwight. South of the Oxtongue River subwatershed, a number of small lakes (Fletcher, Livingstone, Rockaway and Wildcat, among others) empty into Kawagama Lake (formerly known as Hollow Lake). The outflow of this lake forms the Hollow River, which flows into the southeast corner of Lake of Bays, near the Town of Dorset. The outflow of Lake of Bays, which is the fourth largest lake in the watershed (by surface area), passes through the Baysville Dam, in the Town of Baysville, and is known as the South Muskoka River from this point on. The river flows generally southwest, through the Town of Fraserburg and converges with the outflow from Wood Lake. From here the river flows west past Matthias Falls and turns slightly north to flow through Trethewey, Hanna Chute and South Falls generating stations prior to converging with the North Branch in Bracebridge.

Following convergence of the two branches, the Muskoka River flows a short distance before emptying into the southern edge of Lake Muskoka, the largest lake in the watershed. Lake Muskoka also receives inflow from lakes Rosseau and Joseph, with the three collectively known as the ‘Muskoka Lakes’. Drainage from Rosseau and Joseph, respectively the second and third largest lakes in the watershed, flows into the Indian River, past the locks and dam at Port Carling and into the north end of Lake Muskoka. Outflow from Lake Muskoka passes through the dams at Bala and into the Moon Chutes and Bala Reach area of the Moon River. Approximately 5 km downstream from Bala, the river forks into the Moon and Musquash Rivers. The Moon flows northwest and receives input from Kapikog and Healey lakes before emptying into Woods Bay, and subsequently Georgian Bay. The Musquash flows west through Ragged Rapids GS and swings northwest before flowing past Big Eddy GS on its way to Go Home Lake. This lake has two outlets, both of which empty into Georgian Bay.

Floodplain Areas

In the Muskoka System, there are two basic types of flood events, spring freshet and major storm events. The impacts of spring freshets may be reduced through operational changes of the control structures, however because of the infrequent and unpredictable nature of major storms, there may be fewer opportunities to lessen their impacts. None of the dams regulating the 23 major lakes in the watershed were built for flood control purposes (MacLaren, 1985). The dams regulating these larger lakes were built originally for commercial navigation purposes and in some cases for storage for hydropower generation. Flood control benefits of the lakes were never large and were of most use in the spring when the lakes had been drawn down to their minimum levels. Although extensive flood damage has not occurred in the Muskoka River watershed, flood control remains an important element of water management and local problem areas do exist (A&A, 2003a).

3.1.6 Streamflow Characteristics

Streamflow in the Muskoka River watershed has been measured since 1915. A total of seven streamflow measurement sites have been operated by the Water Survey of Canada (WSC) in the watershed over different periods. Details of the record lengths, drainage areas and average flows of the river flow gauging sites in the watershed are given in Table 3.1. Their locations are shown in Figure 2.2. In addition, details of the available natural streamflow data for adjacent rivers to the Muskoka River watershed are included in Table 3.1.

Based on a comparison of recorded peak flows, maximum annual flows vary proportionally to drainage area from upstream gauges to downstream gauges in the Bala reach and on the Moon and Musquash Rivers. This suggests that although the number of lakes in the watershed is great and storage volumes are considerable relative to the total drainage area of the basin, the amount of available storage is moderate. The distribution of the specific runoff is fairly uniform with a slight decrease in specific runoff from the North to South and Main branches. The watershed experiences the highest per unit of area flows on the Big East River. Several factors contribute to this phenomenon, including possible differences in soil and bedrock conditions, differences in forest cover in the upstream and downstream areas of the watershed, as well as differences in precipitation amounts due to orographic uplift.

Table 3.1							
Summary of Water Survey of Canada (WSC) Gauges within and near Muskoka River System							
WSC River Flow Gauge	**Total Drainage Area**	**Mean Daily Flow**[1]	**Regulation**	**Period of Daily Record**	**Specific Runoff**[2]	**Mean Annual**[3] **Maximum**	**Minimum**
	(km^2)	(m^3/s)			($L/s/km^2$)	(m^3/s)	(m^3/s)
Within Muskoka River Watershed							
02EB013 - East River near Huntsville	593	11.3	Regulated	1973-1999	19.1	15.9	7.0
02EB004 - N. Muskoka River at Port Sydney	1390	24.1	Regulated	1915-1999	17.3	40.3	13.6
02EB014 - Oxtongue River near Dwight	601	10.6	Regulated	1981-1999	17.6	13.1	6.4
02EB008 - S. Muskoka River at Baysville	1390	24.8	Regulated	1941-1995	17.8	31.8	12.7
02EB011 - Moon River at Hwy 69	4707	22.1	Regulated	1965-1999	4.7	41.3	4.3
02EB012 - Muskoka River (Musquash) at Hwy 69	4724	53.8	Regulated	1965-1999	11.4	77.7	39.2
Adjacent to Muskoka River Watershed							
02EC002 - Black River near Washago	1520	21.9	Natural	1915-1997	14.4	32.9	13.1
02EA005 - Magnetawan River near Burk's Falls	321	5.6	Natural	1915-1997	17.4	10.4	3.2

[1] Based on long-term WSC flood records

[2] Calculated from mean daily flows divided by drainage area

[3] Calculated from monthly historic records

Source: Environment Canada, 2001

Based on the flows at station 02EB006 (Bala Reach), the long-term average stream flow of the watershed is approximately 76.7 m^3/s (see Table 3.5). Relative to the 4670 km^2 watershed drainage area, this flow is equivalent to a specific runoff (i.e., streamflow per unit drainage area) of 16.4 $L/s/km^2$. The sum of mean daily flows below the Bala reach (stations 02EB011 and 02EB012) is also approximately 76 m^3/s indicating the local drainage area between the location of the latter two gauges and the Bala reach is small. However, the incremental drainage area below stations 02EB011 and 02EB012 and Georgian Bay is significant and was digitized from 1:50,000-scale mapping to be approximately 430 km^2. This would imply a total drainage area and mean flow for the entire Muskoka River basin as 5100 km^2 and 85 m^3/s respectively. Flow in the Bala reach is split between the Moon and Musquash Rivers such that the Musquash River has a maximum flow capacity of 113 m^3/s. Flows in the Bala reach in excess of this magnitude are diverted into the Moon River using the Moon Dam log sluices. The temporal variability of streamflow is summarized in Table 3.2 and this pattern is typical of the flows at the other locations in the watershed.

Data on river channel slopes on the North, South, and Main river channels is available in the Muskoka River Dam Operation Manual (MNR, 1997). Travel times for river flow between main points in the river are also provided in the manual.

3.1.7 Water Balance Budget

A hydrologic model is not available for the Muskoka River watershed. In order to provide a review of the historic rainfall-runoff relationship for the Muskoka basin, precipitation and flow data from available gauges within the basin were used to derive mean annual precipitation and runoff depth estimates and thus to establish a runoff coefficient for the basin. The calculations indicated that on average 51% of all precipitation falling on the watershed runs off and becomes streamflow in the river. The evapotranspiration amount is 49%. This relatively high value may be due to the presence of numerous lakes in the Muskoka River watershed.

Table 3.2 Muskoka River Below Bala Dams, Station 02EB006 Monthly and Annual Discharges (m^3/s) for 1937 to 1997													
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
1937							19.8	25	24.1	38.1	112	84.3	
1938	44	48.9	140	272	95.1	71.3	20.9	18.1	34.4	44.7	53.5	61.8	75.2
1939	48.5	54	89.3	155	241	30.9	26.5	30.1	36	35.2	42.7	34.4	68.8
1940	37.3	35.7	36	67.4	130	73.1	28.7	32.2	57.3	54.2	88.6	93.2	61.2
1941	84.3	62.8	61.8	163	86.2	21.9	21.4	19.6	16.4	26.8	101	88.9	62.7
1942	86	58.6	92.4	189	135	80.5	28.2	23.6	14.9	46.3	103	87.2	78.6
1943	67.2	75.4	104	163	290	74	43.3	40.1	29.1	25.7	39.6	49.8	83.6
1944	40.5	48.3	47.1	88.5	95.9	41.2	38.5	34.2	27.7	40.2	57.4	64.8	52
1945	48.5	41.3	138	149	113	95.1	42.3	27.9	26.9	35.1	61.5	67.5	70.6
1946	81	102	166	103	69.9	54.1	25.4	14	16.1	23.5	22.1	55.7	60.8
1947	70.6	78.5	115	232	263	128	37.7	40	22.4	24.4	22.5	37.6	89.3
1948	42	57.7	116	253	92.6	54.8	27.6	21.4	16.9	18.7	61.3	79.1	69.8
1949	82.7	109	121	259	73.7	43.2	39.9	19.4	11.1	19	19.7	60.3	71.1
1950	182	137	72.2	138	83.2	36.4	22.6	17.5	16.9	19.2	41.7	95.1	71.4
1951	85.2	60.2	112	317	187	25.8	28.7	25.8	22.8	53.6	153	123	99.5
1952	112	78.5	67.9	211	99	46.5	26.9	24.1	46.2	26	45.1	101	73.5
1953	69.4	64.3	132	156	77.6	38	28.6	18.8	17.4	20.1	19.4	57.9	58.3
1954	52.1	55.8	133	170	94.7	68.9	23.6	20.1	43.9	176	118	73	85.9
1955	54.1	71.7	74.4	192	60.1	18.6	14.8	12.8	11.5	23.3	86.6	43	54.9
1956	42.4	46	69.7	78.3	164	82.4	68.2	21.7	57.3	51.6	45.7	78.4	67.3
1957	74.8	88.1	101	99.9	32.1	56.1	171	15.4	65.5	48.9	132	150	86.1
1958	133	79.1	85.7	65.5	8.06	15.3	27.8	17.3	34.5	45.4	58.9	61	52.5
1959	45	81.6	91	196	170	43.5	18.4	26.3	37.3	48	117	108	81.7
1960	85.2	70.6	77.1	260	200	61.6	57	29.2	28.2	28.3	54.3	42.5	82.7
1961	44.4	35.4	81.9	129	92.4	36.9	35.7	27.3	28.7	20.8	24	45.4	50.2
1962	52.2	80.8	64.6	108	69.7	16.6	6.79	10.6	15.2	36.3	26.5	42.6	43.9
1963	53.7	46.5	51.7	132	110	33.3	11.1	20	35.3	29	34.3	63.6	51.7
1964	56.3	79.9	83	53.6	76.7	15.2	8.58	10.9	25.8	32	21.8	58.8	43.5
1965	89.9	90.7	83.6	139	129	12.8	11.9	24.5	60.3	161	89.8	162	88.1
1966	111	78.8	105	81.7	55.8	44.3	12.2	8.86	20.1	28.6	117	240	75.3
1967	96.3	99.5	91.3	202	52.8	95.8	51.9	29.9	58.7	96.7	222	125	101
1968	101	121	115	111	26.3	18.8	26.7	30.3	51.6	33.7	35	77.6	62.1
1969	71.6	85.8	91.4	164	153	70.2	39.1	16.4	28.4	42.9	118	82.5	80.1
1970	71.1	68.4	70	135	136	34.9	106	50.6	37.9	86.3	89.7	88.7	81.5
1971	73.3	81.6	130	189	132	29.8	20.5	16.9	27	20.1	32	70.6	68.5
1972	81.5	85.3	94.6	176	170	47.5	58.3	72.8	46.4	57.5	103	88.5	90.1

Table 3.2
Muskoka River Below Bala Dams, Station 02EB006
Monthly and Annual Discharges (m^3/s) for 1937 to 1997

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
1973	106	134	210	198	120	98.7	47.7	45.1	28	47.2	67.8	100	99.9
1974	85.3	105	150	203	203	52.5	25.6	16.5	42.5	97	117	95.6	99.4
1975	72.2	81.8	145	154	133	12.9	9.29	15.3	42.7	42.9	37.5	128	73
1976	87.5	93.3	168	233	88.3	32.3	42.3	17.5	22.5	22.2	34.4	79.8	76.6
1977	52.8	55.9	154	161	44.8	6.76	19.5	14	52.5	124	112	112	75.8
1978	97.6	74.6	70.2	113	142	50.3	14.3	16.7	49.4	69.3	60.9	84.7	70.2
1979	84.7	91.5	166	239	149	43.2	14.8	22	39.3	75.4	117	151	99.3
1980	112	82.2	88.7	258	77.5	68.1	59.8	58.2	72.9	118	117	92	100
1981	76	109	184	129	75.8	48.5	20.4	9.39	196	107	62.7	68.9	90.2
1982	68.5	79.7	96.6	199	92	65.4	24.3	15.2	41.4	63.9	121	205	89.2
1983	156	110	130	87.3	203	78.5	16.1	5.34	20.5	62.7	51.2	98.9	85
1984	83.6	136	154	161	84.8	92.6	40.2	11.6	35.7	44.2	77.8	103	85.1
1985	167	102	172	252	167	43	39.8	32.4	119	111	117	108	119
1986	90	96.9	111	192	83.8	73.5	29.2	29.2	57.9	134	48.5	75.1	84.9
1987	52.9	70.7	94.4	117	24.4	24.5	17.1	4.92	5.36	28.2	33.8	109	48.3
1988	95.1	116	115	200	92.6	23.7	4.17	8.92	34.8	71.4	140	77.6	81.2
1989	78.3	76.7	119	200	117	92	21.7	6.65	15.3	28.9	39.8	84.2	73.1
1990	78.4	112	149	165	94.3	48.3	12.3	10.6	8.24	83.1	90.1	156	83.7
1991	111	81	157	254	71.4	34.6	10	8.79	23.6	62.7	84.3	144	86.8
1992	86	73.9	127	150	75.3	13	28.6	29.9	111	123	231	149	99.7
1993	124	89.5	67.1	137	59.6	101	75.6	15.1	51.8	141	120	106	90.6
1994	72.6	60.5	80.7	71.1	103	73.8	76.7	34.2	49.8	44.4	119	124	75.9
1995	141	121	113	68.4	141	53.8	39.7	39.2	41.7	62.8	205	119	95.3
1996	96.3	138	124	160	151	71.4	61.1	43.7	50.6	62	134	100	99
1997	151	147	141	202	187	33.2	18.2	6.04	17.8	36	25.5	51.6	84.4
QMEAN	83.3	83.3	109.9	165.0	114.1	50.9	33.5	23.1	39.0	57.0	80.9	92.9	77.7
QMAX	182.0	147.0	210.0	317.0	290.0	128.0	171.0	72.8	196.0	176.0	231.0	240.0	119.0
QMIN	37.3	35.4	36.0	53.6	8.1	6.8	4.2	4.9	5.4	18.7	19.4	34.4	43.5
S.D.	32.2	26.7	37.0	60.6	57.7	27.1	26.4	13.2	29.6	37.9	49.3	39.6	16.3
NO.	60	60	60	60	60	60	61	61	61	61	61	61	60

3.1.8 Surface Water Quality

Water quality data from Ontario Ministry of the Environment (MOE) monitoring stations on the Muskoka River were examined to assess the general characteristics of river and tributary waters. The MOE collected data at 14 stations between 1984 and 1995 (last year data collected), with a variety of parameters measured at each site. Of these 14 stations, the results of 9 were selected as being representative of watershed conditions (A&A, 2003a) and the following summarizes this data:

- General physical/chemical parameters including alkalinity, conductivity, pH, chloride ion, and turbidity are not unusual, and are reflective of the watershed's location in Ontario and on the Canadian Shield (low alkalinity, conductivity and turbidity, good pH level given the low buffering capacity of the water).

- Concentrations of arsenic, nickel and zinc were generally at or below applicable guidelines, although individual samples were occasionally over the limit, as well as zinc levels in 1992/1993.

- Copper and lead were marginally over the guidelines at most sampling sites during most sampling years, although no clear trend can be deduced from the data.

- Iron values were generally below guidelines with the exception of mean values at Station 032 on the Big East River near Williamsport, and several yearly maxima in the Moon and Musquash Rivers.

- Mean phenol concentrations were below the applicable federal guideline (revised upward in 1999) and provincial guideline, but at most sampling stations, yearly maximums slightly exceeded provincial guidelines.

3.2 Biological Environment

Information on the biological environment is provided on a sub-watershed basis in Figures 3.1a to 3.1c.

3.2.1 Fisheries

General Description

A detailed description of the fisheries for each of the larger lakes with actively operated control structures is provided in the Background Information Report (A&A, 2003a). Table 3.3 identifies fish species, fishing pressure and fishing quality by lake and river reach for the Muskoka River watershed. The following provides a general description of the fish resources for the watershed.

The lakes and rivers located in Algonquin Park are popular with anglers for their excellent trout fisheries. The remoteness of the lakes, prohibitions on the use of mechanized travel in the interior of the park, and restrictive fishing season regulations (i.e., no winter fishing), have all resulted in a low intensity, high quality fishery for lake trout (*Salvelinus namaycush*) and brook trout (*Salvelinus fontinalis*). In the well-traveled Highway 60 corridor, fisheries for smallmouth bass (*Micropterus dolomieu*) (stocked along the railway early in the 20th Century) also comprise a substantial amount of the fishing in this area. Fish stocking, popular in Algonquin Park in the mid to late 1900's, has been curtailed, and is now only used to provide short-term angling opportunities along the Highway 60 corridor. Fisheries management in this area is strongly focused on fisheries for both lake trout and brook trout, and to a lesser degree, splake (a hybrid of brook trout and lake trout) and rainbow trout (*Oncorhynchus mykiss*). All four species are stocked to varying degrees but the main management tools are regulations (i.e., seasons, bag limits, and size limits). For the most part, the lakes provide lake trout and smallmouth bass fisheries, while brook trout and rainbow trout are found mainly in the connecting river reaches. Natural reproduction of rainbow trout is not known to occur in the Muskoka River system, and any local populations of this species are maintained solely by stocking of hatchery fish.

A much more complex fish community has developed in the lower parts of all the subwatersheds, although lake trout are still present in the large lakes. Northern pike, walleye and muskellunge (*Esox masquinongy*), as well as a variety of non-game species such as yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigromaculatus*), pumpkinseed (*Lepomis gibbosus*), bluegill (*Lepomis macrochirus*) and rock bass (*Amblopites rupestris*) are all part of the fish community of the larger lakes. Walleye, northern pike and lake trout are major species sought in lakes Muskoka and Rosseau. Lake trout is the primary species of interest in Lake Joseph. The walleye spawning areas of the South Branch of the Muskoka River are believed to be the major contributor of walleye to Lake Muskoka, with the Bracebridge Falls site being the major spawning area. Walleye also comprise an important part of the sport fishery in Bala Reach, Go Home Lake and the Moon and Musquash Rivers. The area below Moon Falls on the Moon River serves as an important spawning site for Georgian Bay walleye.

3.2.2 Wetlands

The Muskoka River watershed contains several provincially significant wetlands (i.e., Axe Lake Wetland, Novar Bog, Big East Delta Wetland, Siding Lake Wetland, Fawn Lake Wetland, Boyne River Wetland, and the Bruce Lake Wetland), as well as numerous small wetlands, many of which would have significance on a local scale (see Figures 3.1a to 3.1c). The Big East River Delta Wetland, a complex of 15 individual wetlands, is the only provincially significant wetland in the watershed that could be potentially affected by water level manipulation activity resulting from water management planning. This is because it is located on a regulated lake (Lake Vernon at the mouth of the Big East River). The Axe Lake wetland is located at the head of Axe Lake. The Axe Lake Dam is operated as an overflow weir with no other level or flow control upstream from it and therefore there will be no changes to the current water management practices.

However, most wetlands, even those not classified as provincially significant, serve important ecological and social functions. Many species of fish and wildlife (birds, amphibians, reptiles, mammals, insects) depend on wetlands for at least some, if not all, of their life. Wetlands also serve important water quality and flood storage and attenuation functions. As a result, potential manipulations of current water management practices need to take into consideration their effect on wetland areas throughout the watershed.

Table 3.3
Lake and River Reach Fisheries Data

Lake	Watershed Code	Lake Area (ha)	Max Depth (m)	Mean Depth (m)	Fish* Species	Fishing Pressure	Fishing Quality**
North Branch Subwatershed							
Rain	2EB15	168.4	23.5	5.5	LT, SMB	Unknown	Unknown
Islet	2EB15	137.2	7.3	3.6	SMB	Unknown	Unknown
West Harry	2EB15	118.9	13.7	3.0		Unknown	Unknown
McCraney	2EB15	361.0	61.3	14.2	BT, LT	Light	Good
Camp	2EB15	189.3	42.7	15.0	LT	Heavy	Medium
Tasso	2EB15	170.0	22.3	6.2	LT, SMB, BT	Heavy	Poor
Bella	2EB15	327.9	40.0	16.2	LT, LW, SMB	Medium	Medium
Rebecca	2EB15	210.5	29.0	7.9	LT, LW, SMB	Medium	Medium
Axe	2EB13	265.1	12.8	2.5	LMB, C	Light	Good
Round	2EB13	190.2	21.4	6.7	BT, LW, SMB, NP, LMB, C, YP	Unknown	Unknown
Buck	2EB13	265.5	23.5	9.9	SMB, NP, W, LMB, C	Heavy	Good
Fox	2EB13	136.6	12.2	5.7	SMB, NP, W	Heavy	Medium
Waseosa	2EB16	156.6	19.2	6.5	LT, BT, RT, SMB	Light	Medium
Vernon	2EB13	1505.1	37.2	12.7	LT, LW, SMB, NP, W, RT	Medium	Medium
Fairy	2EB13	711.5	69.5	22.1	LT, LW, SMB, NP, W, RT	Light	Poor
Peninsula	2EB13	864.8	34.1	9.7	LT, SMB, NP, W, RT	Medium	Medium
Mary	2EB13	1065.4	56.4	24.7	BT, LT, LW, SMB, NP	Medium	Medium
Cripple Creek					BT, SMB, NP	Light	Unknown
Big East River					SMB, NP, W	Light	Unknown
Little East River					BT	Light	Unknown
N. Muskoka River 1					SMB, NP	Unknown	Unknown
N. Muskoka River 2					SMB, NP	Unknown	Unknown
N. Muskoka River 3					SMB, NP	Unknown	Unknown

Table 3.3
Lake and River Reach Fisheries Data

Lake	Watershed Code	Lake Area (ha)	Max Depth (m)	Mean Depth (m)	Fish* Species	Fishing Pressure	Fishing Quality**
South Branch Subwatershed							
Burnt Island	2EB11	854.3	32.9	10.8	LT, LW	Unknown	Unknown
Little Joe	2EB11	47.8	11.9	3.0	LW, SMB	Light	Unknown
Joe	2EB11	137.6	24.2	6.1	LT	Light	Unknown
Potter	2EB11	83.0	12.2	2.9	BT, LT, SMB	Light	Good
Canoe	2EB11	344.5	36.6	12.8	BT, LT, LW, SMB	Light	Medium
Tea	2EB11	156.1	14.8	5.4	LT, LW, SMB	Light	Poor
Smoke	2EB11	607.1	54.9	16.2	BT, LT, SMB	Medium	Good
Big Porcupine	2EB11	235.3	31.7	7.5	LT	Light	Good
Ragged	2EB11	629.4	37.8	5.8	LT, LW	Light	Good
Oxtongue	2EB11	249.3	26.8	8.9	BT, LT, LW, RT, SMB	Heavy	Medium
Lake of Bays	2EB10	6904.1	70.1	22.2	BT, LT, LW, RT, SMB	Medium	Good
Livingstone	2EB12	189.1	36.6	12.7	BT, LT, SMB	Medium	Medium
Fletcher	2EB12	255.8	23.2	7.9	BT, LT	Medium	Medium
Kawagama	2EB12	2818.8	73.2	21.8	BT, LT, LW, SMB	Light	Good
Wood	2EB09	378.0	14.3	5	SMB, W, LMB	Unknown	Unknown
Oxtongue River					BT, RT	Light	Light
Hollow River					BT	Unknown	Unknown
S. Muskoka 1						Unknown	Unknown
S. Muskoka 2						Unknown	Unknown
S. Muskoka 3						Unknown	Unknown
S. Muskoka 4						Unknown	Unknown
Lower Subwatershed							
Muskoka	2EB04	12205.8	66.5	15	BT, LT, LW, NP, SMB, W, MU, RT	Light	Unknown
Rosseau	2EB05	6374.4	90.0	23.2	LT, LW, SMB, W, MU, RT	Light/Med	Good

Table 3.3
Lake and River Reach Fisheries Data

Lake	Watershed Code	Lake Area (ha)	Max Depth (m)	Mean Depth (m)	Fish* Species	Fishing Pressure	Fishing Quality**
Joseph	2EB05	5155.6	93.0	24.7	LT, LW, SMB, W, RT, LMB	Light/Med	Good
Skeleton	2EB07	2155.5	64.7	28.9	LT, LW, RT, SMB, BT	Light	Medium
Three Mile	2EB08	929.2	11	3.4	SMB, W, LMB	High	Medium
Bent River					BT	Unknown	Unknown
Lower Muskoka River					NP, W, SMB	Unknown	Unknown
Bala Reach					W, SMB, MU	Unknown	Unknown
Moon River					LMB, MU, NP, SMB, YP, W, CHS, LS	Light	Poor
Musquash River						Unknown	Unknown
Healey Lake	2EB02	762.8	22.9	5.7	NP, SMB, LMB	Unknown	Unknown
Kapikog Lake	2EB02	316.9	15.6	5.6	NP, SMB, LMB	Unknown	Unknown
Go Home Lake	2EB02	666.0	32.6	8.6	NP, SMB, W, LMB, C	Unknown	Unknown

* BT = Brook Trout
C = Cisco
CHS = Chinook Salmon
LMB = Largemouth Bass
LS = Lake Sturgeon
LT = Lake Trout
LW = Lake Whitefish
MU = Muskellunge
NP = Northern Pike
RT = Rainbow Trout
SMB = Smallmouth Bass
YP = Yellow Perch
W = Walleye

** Fishing Quality – is an assessment based on information from MNR historical files, and may not represent present conditions nor angler views pertaining to fishing quality for individual species in the respective lakes.

3.2.3 Vegetation

The entire Muskoka Watershed is part of the Great Lakes-St. Lawrence Forest Region. The precolonization forest was dominated by white pine (*Pinus strobus*) and hemlock (*Tsuga canadensis*), as well as assorted tolerant hardwoods such as sugar maple (*Acer saccharum*), yellow birch (*Betula allegheniensis*), beech (*Fagus grandifolia*) and red oak (*Quercus rubra*). The great pine forests attracted lumbermen who cut the pines for ships of the Royal Navy, and hemlocks for the tanbark (tanning) industry. The resultant forest is dominated by a mixture of hardwood species, most notably sugar maple, yellow birch and red maple (*Acer rubrum*), but stands of mature pine and hemlock continue to characterize the Muskoka skyline, and contribute greatly to the aesthetic appeal of the region.

Several areas in the Muskoka River watershed support remnants of Atlantic coastal plain flora, including Axe Lake, the Spence Lake area (a tributary of the South Branch), the northwest shore of Lake Joseph, Bala Reach, the Musquash River upstream from Go Home Lake and the Gibson Lake area. The Axe Lake wetland is the second most significant example of this habitat type in Ontario (NHIC, 2002). This shoreline vegetation type is sensitive to water level changes and, in fact, it benefits from fluctuating water levels, which help to prevent shrub growth (Environmental Protection Agency et al, 1996). Twenty-three species of plants, many of which are rare, threatened or endangered, have been identified as characteristic coastal plain flora in the Muskoka area (Keddy and Sharp, 1989). Virginia meadow beauty (*Rhexia virginica*), listed as rare to uncommon (possibly common) (NHIC, 2002) is a characteristic species of this habitat in the Muskoka watershed.

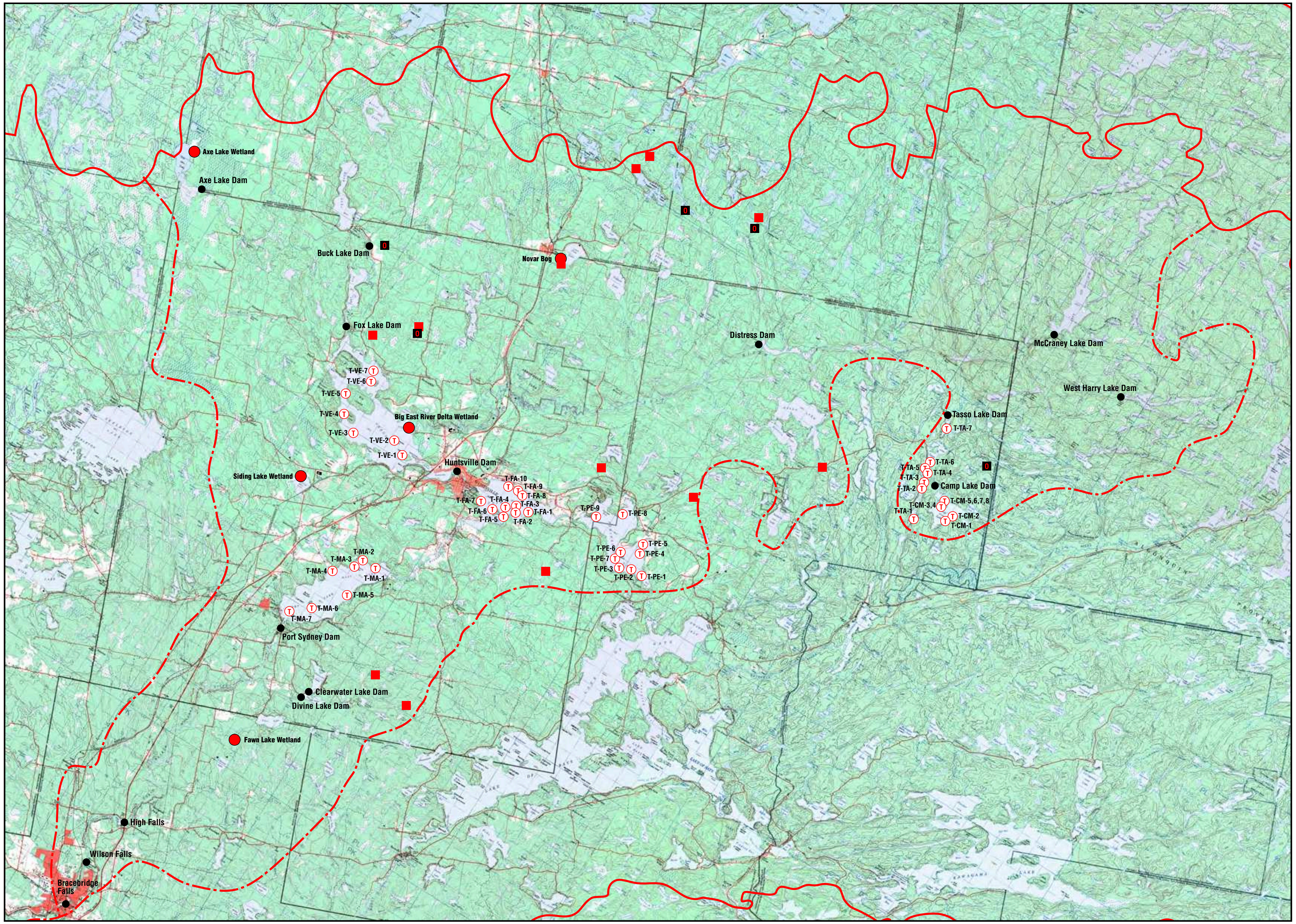
3.2.4 Wildlife

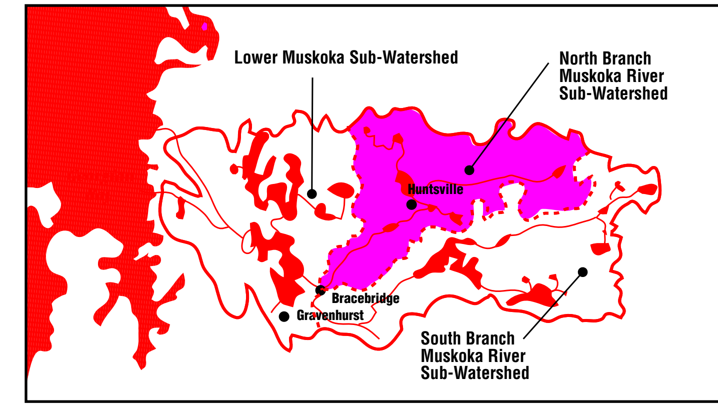
The Muskoka River watershed is home to a variety of wildlife species, both game and non-game. Big game species include moose (*Alces alces*), deer (*Odocoileus virginianus*) and black bear (*Ursus americanus*). Recently introduced elk (*Cervus elaphus*) have found their way into the region from a release site in the Bancroft area though they are currently not permitted to be hunted.

Although the Muskoka region does not lie on one of the major flyways, many migratory waterfowl species are found in the watershed. Some of the more common species include: mallard duck (*Anas platyrhynchos*), black duck (*Anas rubripes*), great blue heron (*Ardea herodius*), Canada goose (*Branta canadensis*) and common loon (*Gavia immer*). Heronries are identified in the French-Severn Forest Management Plan and are protected by sustainable forestry practices.

Loons are relatively common in the lakes of the Muskoka watershed, but detailed, long-term records are available for only one lake (Smoke Lake) where four pairs of loons persisted on the lake and did not appear to be adversely affected by water management activities on that lake. The main causes of reproductive mortality over the 20+ year observation period has been predation (raccoons, bears, gulls) and flooding during the nesting period. Loons are one of the wildlife species that could be most susceptible to shoreline development and human use of lakes.

Virtually no information is available on the abundance and/or distribution of other wildlife species (turtles, frogs and other amphibians) in the watershed.





Historic and/or Present Fish Spawning Areas

- T-SL-1 T Lake Trout
- W-SL-1 W Walleye
- P-SL-1 P Pike
- M-SL-1 M Muskellunge

Historic and/or Present Nesting Areas

- Heron
- O Osprey

Wetlands

- Provincially Significant Wetland
- Life Science ANSI

0 2 4 6
kilometres

Figure 3.1a
Muskoka River Water Management Plan
Biological Features - North Muskoka Sub-Watershed

ACRES International

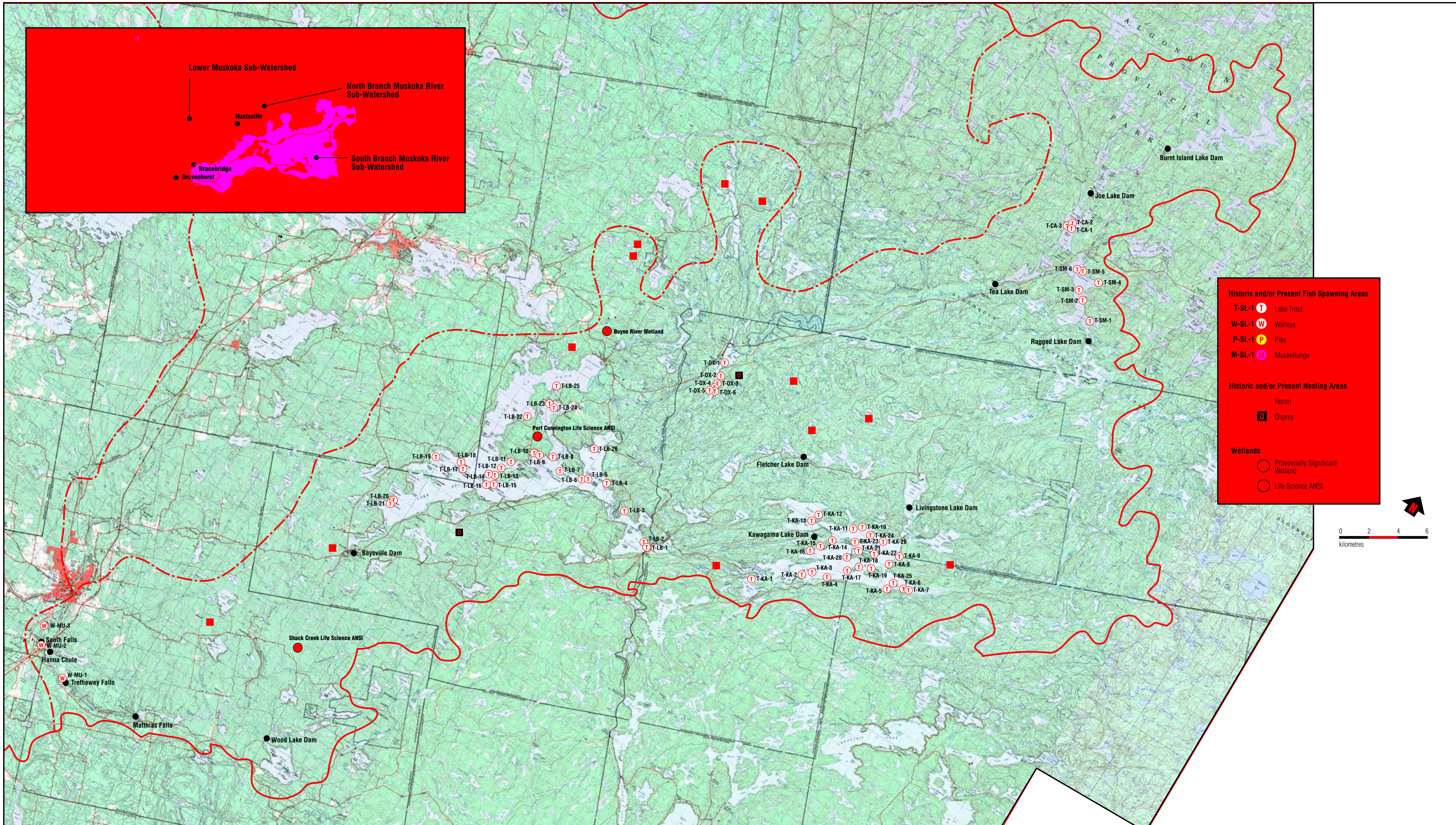
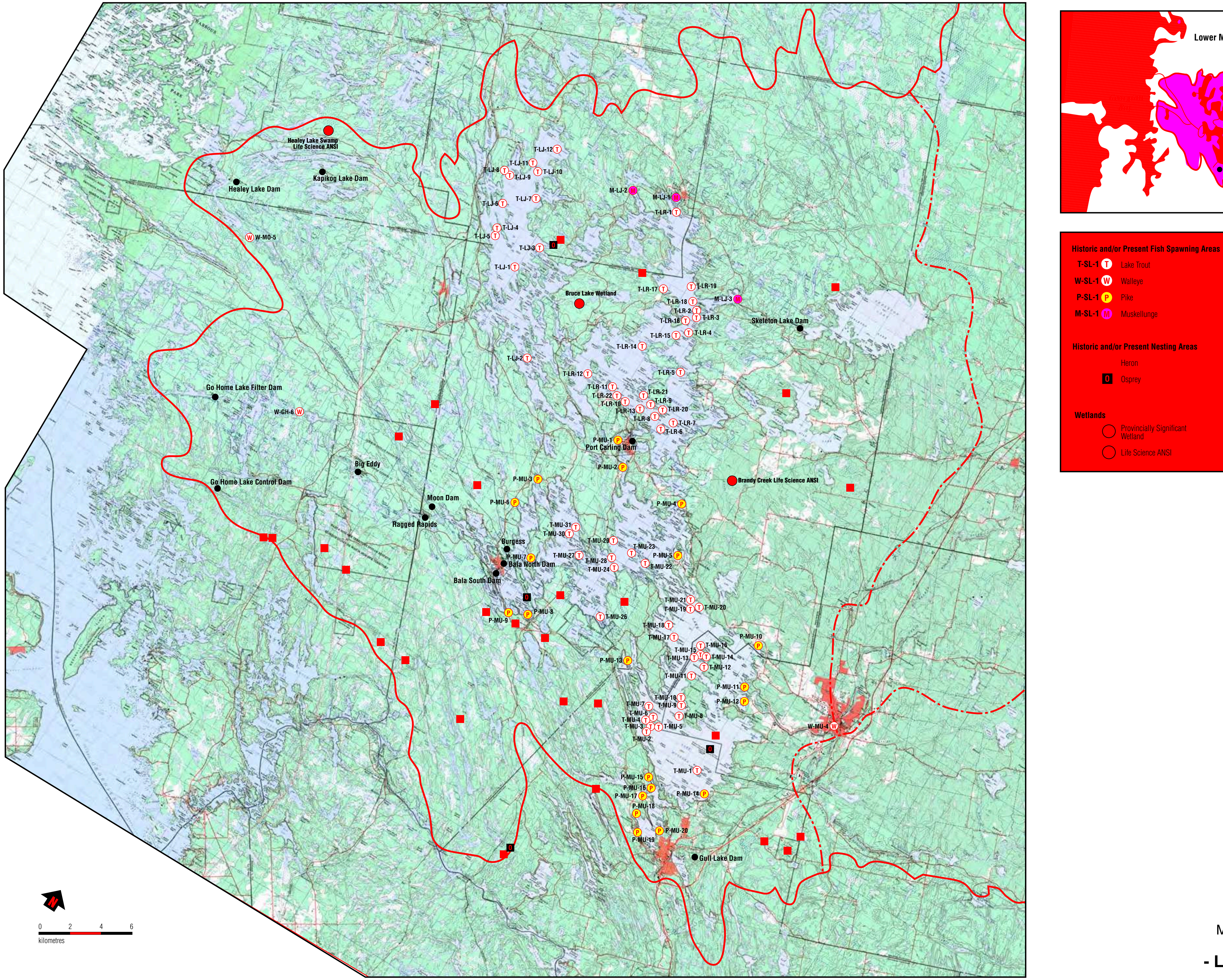


Figure 3.1b
Muskoka River Water Management Plan
Biological Features - South Muskoka Sub-Watershed

ACRES International



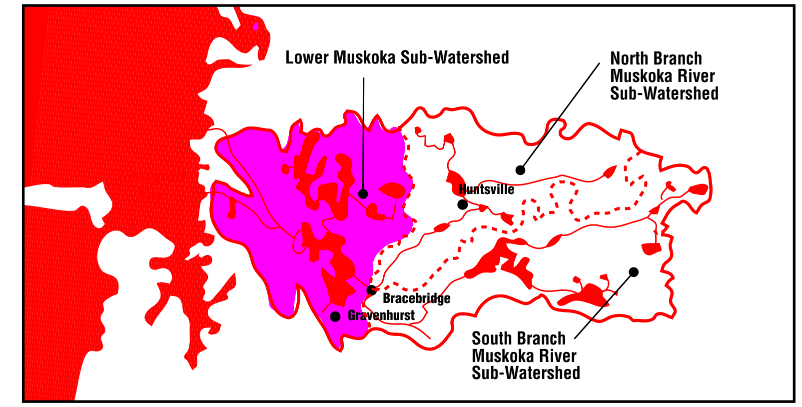


Figure 3.1c
Muskoka River Water Management Plan
Biological Features
- Lower Muskoka Sub-Watershed

ACRES International

4 Social and Economic Environment

The Muskoka River system has provided a means of commercial and recreational transportation of people and goods for the past 150 years. Early settlement of the district started in 1861 and was first encouraged by the growth of the lumber and farming industry. Waterways played an important role as transportation corridors for timber and early visitors to the watershed.

In the mid reaches of the watershed, the construction of dams first occurred in the late 1800's to aid in the movement of logs in the spring freshet for the lumber industry. In the 1870's, dams were constructed on the Muskoka Lakes (Muskoka, Rosseau and Joseph), the Huntsville Lakes (Mary, Fairy, Peninsula and Vernon) and Lake of Bays to improve water levels for commercial navigation. Construction of locks in Port Carling (1871) and Huntsville (1877) opened the lakes to commercial navigation by steam ship. Resorts grew, and hundreds of private cottages followed.

Hydropower resources were investigated in the late 1800's, with the first power generating stations constructed at Bracebridge Falls on the North Branch and at South Falls on the South Branch in 1892. Eventually another seven generating stations were constructed, the last being Matthias Falls power plant in 1950.

In the 1950's the transportation network grew and Highways 11 and 69 opened access from the southern more populated areas and thousands of cottages were constructed. The steam ship business ended in the 1950's and was reestablished in the 1980's as a commercial tour operation. Today, private cottages are found along almost every shoreline on the system, and there is an increasing trend to convert them for year-round residence use.

Land ownership within the watershed is approximately 65% patent and 35% Crown land. The lower portion of the watershed (west of Bala) and the eastern uplands (east of Dorset) are predominantly comprised of Crown land (Figure 4.1). The Wahta Mohawk Territory comprises a land base of 5993 ha[*] in the lower watershed and both the Moon and the Musquash Rivers flow through their territory (Figure 4.1). Private land predominates the entire midsection of the

[*] Land area as of 2002, an additional area of approximately 3300 ha was added to the Reserve in February 2005 as part of a land claim settlement with the Ontario government.

watershed, including the Muskoka Lakes, the Huntsville Lakes, the North and South Branch of the Muskoka River and Lake of Bays.

The major economic activities in the watershed are related to tourism, forestry and some limited agriculture. Tourism has grown substantially and provides the largest source of employment. The forestry industry is more prevalent in the upper reaches of the watershed (Algonquin Highlands) where Crown lands dominate land ownership patterns. Agriculture land use is limited to areas around Huntsville, Bracebridge, east of Port Carling, and north of Gravenhurst and west of Baysville.

4.1 Community Profile and Infrastructure

4.1.1 Municipal Structure

The Muskoka River Watershed crosses 3 districts, 1 county, 33 geographic townships and Algonquin Park. Table 4.1 provides a list of these municipalities and geographic townships, while Figure 4.1 shows their boundaries. About 75% of the watershed is in the District Municipality of Muskoka.

About 15% of the watershed is within the District of Nippissing (Algonquin Park) and contains the headwaters to both the North Branch and South Branch of the Muskoka River.

4.1.2 Economic Profile/Employment

According to the "Muskoka Tourism 2000 Strategic Plan" (Parnell Kerr Forster Consulting Inc., 1999), the District of Muskoka has "a primarily service based economy, with 38.8% of the 1996 Muskoka labor force employed in retail/service sectors, including accommodation, food and beverage and retail sales". Despite efforts to diversify the economy, the District of Muskoka continues to rely heavily on the tourism industry. Since 1991, those employed in the service sectors has increased 3.8% to 37.6% of the total labor force.

Table 4.1
Municipalities, First Nations,
Geographic Townships and Communities

Municipality	Geographic Township	Communities in Watershed
District Municipality of Muskoka		
Town of Bracebridge	Macaulay, Monck, Oakley, Draper	Bracebridge, Fraserburg
Town of Gravenhurst	Muskoka, Wood	Gravenhurst
Town of Huntsville	Stisted, Chaffey, Stephenson, Brunel	Huntsville, Port Sydney
Township of Georgian Bay	Freeman, Gibson, Baxter	MacTier
Township of Lake of Bays	Sinclair, Finlayson, Franklin, McLean, Ridout	Baysville, Dorset, Dwight
Township of Muskoka Lakes	Cardwell, Watt, Medora, Wood, Monck	Port Carling, Bala
District of Parry Sound		
Township of The Archipelago	Conger	None in watershed
Township of Sequin	Humphrey, Conger	Humphrey, Rosseau
Township of Perry	Perry	None in watershed
Township of McMurrich Monteith	McMurrich, Monteith	None in Watershed
The Town of Kearney	Bethune	None in Watershed
District of Nippissing		
Town of Kearney	McCraney	None in watershed
County of Haliburton		
Municipality of Dysart et al	Havelock, Eyre	None in watershed
Municipality of Algonquin Highlands	Sherbourne, McClintock, Livingstone	Dorset
First Nation		
Wahta Mohawks	Gibson	

Selected demographic, social and economic statistics for the Muskoka River "custom geography" extent was retrieved by Statistics Canada and other surveys the agency administers (Statistics Canada, 2005). This data indicates that as well as service sectors (hotels, motels, resorts and restaurants), residential construction and trade sectors are the largest industries based on establishment count and employee size range in the Muskoka River extent.

The greatest increase in terms of employment in the District of Muskoka has been a result of spending by seasonal residents. Statistics Canada indicates that Haliburton has one of the highest unemployment rates in the Province of Ontario due to its dependency on seasonally driven business in both the tourism and forestry sectors. It has been projected that unemployment can reach highs of 30% to 50% between December and the end of February

In the District of Muskoka there has been a direct expenditure of $475 million and an estimated 7000 jobs generated in the tourism industry, which are seen to be vital to the economic well being of the district. On average, expenditures on tourism have increased by 54% between 1991 and 1998 (Parnell Kerr Forster Consulting Inc., 1998).

4.1.3 Demographics

The total population within the Muskoka River watershed in 2001 was estimated to be 185,674, of which 31% (56,725) was permanent and 69% (128,949) was seasonal (Table 4.2). About 85% of the total watershed population was located within the District of Muskoka. The estimated number of households is 47,255, of which 20,939 were permanent and 26,316 were seasonal. Within the watershed the greatest concentration of permanent and seasonal population is located on the Muskoka lakes (Joseph, Muskoka and Rosseau), the Huntsville lakes (Mary, Peninsula, Fairy and Vernon) and Lake of Bays. It is expected that the permanent population will increase from 50,305 in 1996 to 75,040 in 2016 (Marshall Macklin Monaghan, 1997) (Table 4.3).

Demographic information for the Muskoka River extent indicates that the total population within the Muskoka River 'custom geography' extent is approximately 50,000 and of this population, the largest populated group (10% of the total population) are aged 65 to 74 (Statistics Canada, 2004).

Table 4.2
Population and Households in Muskoka Watershed - 2001

Location	Households			Population		
	Total	Permanent*	Seasonal*	Permanent	Seasonal	Total
Municipalities						
District of Muskoka [7]	40,939	19,312	21,627	53,106	105,972	159,078
Bracebridge [7]	6,832	4,770	2,062	13,751	10,104	23,855
Georgian Bay [7]	5,359	932	4,427	1,991	21,692	23,683
Gravenhurst[7]	6,700	3,586	3,114	10,899	15,259	26,158
Huntsville[7]	7,773	5,982	1,791	17,338	8,776	26,114
Lake of Bays[7]	4,561	1,309	3,252	2,900	15,935	18,835
Muskoka Lakes[7]	9,714	2,733	6,981	6,042	34,207	40,249
County of Haliburton						
Algonquin Highlands[1]	4,262	891	3,371	1,836	16,518	18,354
Dysart[2]	-	-	-	-	-	-
District of Parry Sound						
Archipelago[2]	-	-	-	-	-	-
Kearney[2]	-	-	-	-	-	-
McMurrich/Monteith (estimated)[3]	110	50	60	103	294	397
Perry (estimated) [4]	472	200	272	630	1,333	1,963
Seguin (estimated) [5]	1,472	486	986	1,104	4,831	5,935
Subtotal	47,255	20,939	26,316	56,594	128,949	185,543
First Nation						
Wahta[6]	-	-	-	131	-	131
Totals				**56,725 (31%)**	**128,949 (69%)**	**185,674 (100%)**

Source A&A, 2003a

Notes:

1- 2000 Ontario Municipal Directory, Association of Municipal Managers, Clerks and Treasurers of Ontario. Estimated Population is based on 2.06 persons per permanent household and 4.9 per seasonal household.

2- Only a small portion of The Archipelago (Healey and Kapikog Lakes) and Dysart (Southeast corner of Kawagama Lake) is located within the Muskoka watershed. Most of these lands are either crown owned or remotely developed private lands. The population is estimated to be 0.

3- McMurrich Monteith – Total population is 666 and total household is 736[2]. For the purposes of providing general population statistics the population is estimated, based on the number of households and household size as per note 1 (primarily Round, Axe and Buck Lakes).

4- Perry Township – Total Population is 1,907 and total households are 1,431. For the purposes of providing general population statistics the population within the watershed is estimated to be 1/3 of the total population.

5- Seguin Township – Total population is 3,346 and total household is 4,460. For the purposes of providing general population statistics the population within the watershed is estimated to 1/3 of total Township population (primarily Lake Joseph, and Village of Rosseau).

6- On Reserve Population - Registered Indian Population by Sex and Residence 2000, Department of Indian Affairs and Northern Development (March 2001).

7- District of Muskoka – Census Canada 2001, District of Muskoka Assessment Information (DOM Website).

* Permanent households reside within the area on a full-time basis; seasonal households reside within the area on an intermittent basis, potentially totalling up to 6 mo/yr.

Table 4.3 Population Projections – District of Muskoka					
Municipality	**1996**	**2001**	**2006**	**2011**	**2016**
Bracebridge	13,220	15,336	17,488	19,819	22,532
Georgian Bay	2,230	2,244	2,261	2,245	2,213
Gravenhurst	10,030	10,803	11,402	11,947	12,540
Huntsville	15,915	18,163	20,429	22,852	25,658
Lake of Bays	2,850	3,256	3,622	4,007	4,452
Muskoka Lakes	6,060	6,345	6,774	7,186	7,646
Totals	**50,305**	**56,148**	**61,976**	**68,056**	**75,040**

Source: Marshall Macklin Monaghan, 1997

4.1.4 Land Use and Settlement Patterns/Communities

Local municipal Official Plans generally recognize three types of private land settlement patterns: communities, waterfront and rural. The three largest urban centres in the watershed are all located on Highway 11 in the middle of the watershed; Gravenhurst, Bracebridge, Huntsville. Waterfront areas include lands that physically and functionally relate to lakes and rivers. These areas are scattered across the entire watershed and are primarily comprised of shoreline residential (permanent and seasonal) and commercial resorts, campgrounds, marinas and the construction service industry. Table 4.4 identifies those lakes that are mostly affected by water level management and provides an estimate of the number of shoreline lots. The three most heavily populated waterfront areas are the Muskoka lakes (Muskoka, Rosseau and Joseph), the Huntsville lakes (Mary, Fairy, Peninsula and Vernon) and Lake of Bays. Other lakes with substantial development include Skeleton, Three Mile and Kawagama. Private septic and water systems service all of these areas, with few exceptions. The rural areas include the remaining land areas and are generally not affected by water level management.

Shoreline Infrastructure

Table 4.5 shows the number of shoreline structures by lake and by river reach for a number of lakes in the Muskoka watershed. Not all lakes have been surveyed.

Table 4.4
Number and Development Status of Lots by Lake

Lake/Reach	Developed	Vacant	Commercial	NDP*	Total
Lower Watershed					
Go Home Lake	382	12	2	71	467
Moon River	36	8	1	47	92
Subtotal	**418**	**20**	**3**	**118**	**559**
Lake Muskoka	3,398	778	31	75	4,282
- North Basin	1,118	248	11	14	1391
- South Basin	1,589	380	19	24	2012
- Bala Bay	190	25	0	9	224
- Dudley Bay	250	29	0	8	287
- Whiteside Bay	92	11	0	0	103
- Muskoka Bay	159	85	1	20	265
Lake Joseph	1,128	188	8	3	1,327
- Cox Bay	70	13	4	0	87
- Main Body	938	157	4	3	1102
- Little Joseph	120	18	0	0	138
Lake Rosseau	1,612	352	17	15	1,996
- Brackenrig Bay	49	9	0	1	59
- Humphrey Twp	238	24	0	0	262
- Main Body	1,190	279	17	10	1496
- Portage Bay	73	20	0	0	93
- Skeleton Bay	62	20	0	4	86
Skeleton Lake	414	106	4	17	541
Muskoka River	272	54	1	4	331
- N. Branch M. R. Bay	93	16	0	1	110
- Bracebridge to Lake Muskoka	179	38	1	3	221
Subtotal	**6,824**	**1,478**	**61**	**114**	**8,477**
North Branch					
North Muskoka River	842	489	10	67	1,408
- Muskoka R. North	388	230	4	41	663
- S. Branch	290	231	5	25	551
- N. Branch Fairy to Mary	164	28	1	1	194
Mary Lake	253	118	4	1	376
Fairy Lake	182	23	7	3	215
Peninsula Lake	272	62	4	5	343

Table 4.4
Number and Development Status of Lots by Lake

Lake/Reach	Developed	Vacant	Commercial	NDP*	Total
- East Peninsula Lake	84	12	2	0	98
- West Peninsula Lake	188	50	2	5	245
Lake Vernon	340	145	4	9	498
- Hunters Bay	34	6	0	0	40
- Main Basin	202	107	3	5	317
- North Basin	104	32	1	4	141
Fox Lake	70	24	1	1	96
Buck Lake	27	7	0	0	34
Axe Lake	0	0	0	2	2
Big East River	96	82	1	48	227
- Huntsville	90	61	1	4	156
- East River	6	21	0	44	71
Subtotal	**2,082**	**950**	**31**	**136**	**3,199**
South Branch					
South Muskoka River (Spence to Confluence)	26	17	0	3	46
Spence Lake	21	8	0	4	33
Wood Lake	199	57	2	6	264
Lake of Bays	898	267	6	19	1,190
Kawagama Lake					900
Subtotal					
TOTAL					**13,963**

* NDP – No Development Potential.

Source: Muskoka Lakes Limnology CD, District Municipality of Muskoka (2000).

Table 4.5
Number of Shoreline Structures by Lake

Lake	Boathouse	Docks					Shorewalls
		Crib	Pole	Floating	Other	Total	
Muskoka [1]	1805	2586	312	209	619	3726	1129
Joseph[1]	677	697	48	53	104	902	238
Rosseau[1]	887	804	77	121	142	1144	366
Fairy [2]	70	267	25	25	-	317	-
Peninsula [2]	86	310	50	37	-	397	-
Brandy [3]	16	8	8	85	1	102	-
Totals	3541	4672	520	530	866	6588	1733

Source
1. District of Muskoka. 2000.
2. Cornelisse & Evans. 1999.
3. District of Muskoka Planning Department. 2002.

Waste Treatment Infrastructure

There are many private and municipal facilities that treat wastewater and release treated water into waterbodies in the Muskoka River watershed. These facilities are required to obtain permits and provide annual reports to the MOE. Some industries release water that has not been altered and is therefore not treated, however, a permit and annual report are still required. Table 4.6 provides the total daily outflow from private sources. The only major industrial user is the Kimberly Clark mill, requiring 2.8 m^3/s (100 ft^3/s) flow for dilution of effluent on the Big East River.

Table 4.6
Private Outflows

Receiving Waterbody	Use of Outflowing Water	Daily Total Outflow (L)
Muskoka River – North Branch	Industrial cooling water	380,000
Paint Lake (St. Mary's Lake)	Rinse bottles and wash analytical equipment (reverse osmosis water)	1,275
Paint Lake (St. Mary's Lake)	Fish culture station	30,000

Source: Ministry of Environment, Barrie Office (2002).

Table 4.7 indicates the general location of private seasonal retention lagoons and the timing and volume of their discharge as determined from MOE files (i.e., Certificate of Approval issued). There are five resorts in the Muskoka watershed having private sewage lagoons that are treated on site and released into the nearest waterbody. The release of water from these private lagoons can only occur after ice out and before May 15, or after October 15 and before ice in.

Table 4.7
Private Seasonal Retention Lagoons

Receiving Waterbody	Discharge Timing	Total Discharge (m^3)
Clearwater Lake	Before May 15 and after October 15	4,533
Lake Muskoka	Before May 15	12,560
	After October 15	6,047
Saw Lake	After October 15	1,068
Skeleton Lake	After October 15	8,500
Lake Vernon	Before May 15 and after October 15	1,250

Source: Ministry of Environment, Barrie Office (2002).

There are six local wastewater pollution control plants (WPCP) within the Muskoka River watershed, which discharge into various portions of the river/lake system. Only one municipal lagoon facility is in the watershed, and it is located in Bracebridge on Lagoon Lane. This municipal sewage lagoon's contents are transported to the local WPCP for treatment prior to release into the Muskoka River (see Table 4.8 for discharge details).

4.1.5 Water Taking Infrastructure

There are many private and municipal organizations that take water for domestic and commercial purposes. All surface water taking is subject to approval by MOE, and a water-taking permit is required. The consumptive use of water for water supply purposes in the basin is relatively small and no significant problems have been reported in meeting the demand.

Table 4.8
Municipal Wastewater Discharge
(Data from 2001 Reports)

Receiving Water Body	Site Name/ Location	Yearly Total (m^3)	Monthly Effluent (m^3)	Average Daily Effluent (m^3/d)	Peak Daily Effluent (m^3/d)	Highest Monthly Effluent (m^3)
Muskoka River	District of Muskoka – Lagoon Lane WPCP	1,085,778*	85,439	2,975	3,325	April – 101,880
Moon River	Bala – Indian Road WPCP	89,425	7,452	244	367	April – 10,044
Lake Muskoka	Gravenhurst – Beach Road WPCP	886,156	73,846	2,422	3,229	April – 93,877
N. Muskoka River	Huntsville – Mountview WPCP	869,057	72,421	2.381	3,254	April – 94,257
Fairy Lake	Huntsville – Golden Pheasant WPCP**	799,481	66,623	2,190	2,993	April – 79,333
Indian River	Port Carling – Medora Road WPCP	132,286	11,024	363	522	April – 15,413
Source – District of Muskoka Public Works Department						

* Lagoon Lane WPCP also discharges from its lagoons in April and May with a total effluent equaling 60,510 m^3, which is included in the above "Yearly Total".

** Golden Pheasant WPCP provides irrigation for the Grandview Clublink Golf Course from April through to October. The Monthly Irrigation Flow for 2001 totaled 185, 098m^3, which is not included in the above data totals.

There are eight municipal water treatment plants, servicing seven communities (see Table 4.9).

Water supplies for most residential development outside of the communities is provided by drilled wells, dug wells or adjacent surface water. Water supplies for many commercial operations also depend on drilled wells, dug wells or adjacent surface water. Table 4.10 identifies those establishments where water-taking permits have been issued by the MOE.

Table 4.9
Municipal Water Intake

Water Treatment Plant Location	Lake Supplying Water	Peak Daily Flow Rate (m^3)	Yearly Total 2001 (m^3)
Gravenhurst – Muskoka Beach Rd.	Lake Muskoka	N/A	1,287,175
Huntsville	Peninsula Lake	5,260	1,193,613
Huntsville – Hidden Valley	Fairy Lake	1,285	282,860
Port Sydney	Mary Lake	83	14,595
Port Carling – Stephens Rd.	Lake Rosseau	8,591	218, 590
MacTier – MacTier Beach Ave.	Stewart Lake		107,122
Bala – Minto Street	Lake Muskoka		1156,690
Bracebridge – Kirby's Beach	Lake Muskoka	6,506	1,313,420

Source: District of Muskoka Public Works Department.

Table 4.10
Private Water Taking

Source Name	Use of Inflowing Water	Maximum Amount Taken/Day (L/d)	Maximum No. of Days Taken/Year
Big East River	Industrial – cooling water	9,467,000	365
Fairy Lake	Irrigation – golf course	3,960,000	150
Lake of Bays	Commercial – public supply	1,632,960	365
Mary Lake	Commercial – camp/retreat	50,000	365
Mayflower Lake	Domestic Water Supply	163,380	365
Muskoka River	Commercial – amusement attraction	327,312	100
	Commercial – tent/trailer park	40,000	60
	Industrial	13,082,300	365
Lake Muskoka	Industrial	392,774	153
	Irrigation – golf course	1,308,500	153
	Irrigation/Commercial – golf course/resort	2,725,488	100
	Commercial – resort water supply	300,000	365
	Irrigation – golf course	68,200	30
Nutt Lake	Irrigation – golf course	382,200	30
Lake Rosseau	Commercial – youth camp	252,000	365
	Irrigation – golf course	1,226,470	180
	Irrigation – golf course	1,816,992	150
Skeleton Lake	Commercial – camp	408,000	210
Lake Vernon	Industrial – cooling water	654,624	365
Ponds with unnamed creek Muskoka Ward	Industrial – irrigation	163,800	365

Source: Ministry of Environment, 2002.

4.1.6 Major Infrastructure

Three major highway corridors run through the Muskoka River watershed (Figure 4.1); Highways 11, 69/400 and 60. Highway 11 runs in a north/south direction, and bisects the watershed near its midpoint connecting the towns of Gravenhurst, Bracebridge and Huntsville. It provides a major corridor connecting Toronto to North Bay. Highway 69/400 (TransCanada Highway) runs north/south through the western reaches of the watershed and connects Toronto to Sudbury. Highway 60 runs east/west along the north shore of the Huntsville Lakes and crosses Oxbow Creek and Oxtongue River before crossing the entire width of Algonquin Park from east to west. A short section of Highway 35 passes through the southeast corner of the watershed and crosses the Hollow River at Dorset. There are numerous other paved highways (including District roads 169, 118, 141 and 117) that are maintained by the local municipalities. There are no roads that travel the entire length (east/west) of the watershed. As well, there are many gravel side roads and forest access roads that provide access to rural and remote areas.

There are three major railway lines that cross the Muskoka River watershed (Figure 4.1). TransCanada Pipeline has twin natural gas high-pressure transmission pipelines which run virtually parallel to Highway 11. A twin (two 500-kV) electric transmission line runs north/south through the lower reaches of the watershed crossing the Moon, Gibson and Musquash rivers (Figure 4.1). There are dozens of other single transmission lines that cross the North and South Muskoka River as well as the narrows on Lake of Bays.

4.2 Water Power Generation

Water management in the Muskoka River watershed is very important in relation to hydroelectric power production. Hydroelectric generation provides a significant source of revenue and supports the recent initiative to produce “green” power. Recent government renewable energy initiatives recognize decreasing respiratory illness and disease, reduction of smog and load flowing ability (i.e., the ability of waterpower to make quick changes in generation output to meet consumer needs). Waterpower, as a form of “green” power, achieves these objectives by reducing smog and greenhouse gases and associated health and ecosystem effects.

There are 10 hydroelectric stations totaling 28.3 MW and generating about 150,000 MWh/yr (see Section 5 for details). Five of the plants are owned and operated by OPG, and represent over 80% of the energy produced on the entire system. More than 50% of energy production is from two OPG sites located below Bala (Big Eddy and Ragged Rapids). About 40% of the energy production occurs along the South Branch, and 7.5% is produced on the North Branch by Bracebridge Generation. Other waterpower companies on the system are Orillia Power Corporation and Algonquin Power.

Looking at the potential for developing more water power on the Muskoka River, there are some sites that show potential for small development. Upward of 25 MW of undeveloped waterpower is noted for the river (Small Hydro Atlas, 2005). In March 2005, MNR released the Bala North site for development proposals. In conjunction with a development at the Bala North site, the successful developer would also be required to take over operation of the Bala South dam. As of January 2006, one group had submitted a proposal for future waterpower development at the site.

4.3 Forest Industry

Eighty five percent of the Crown land forests in the Muskoka River watershed are within the French-Severn Management Unit, which includes all Crown lands within the MNR District of Parry Sound. The remaining 15% are in Algonquin Park, under the Algonquin Forest Authority. Commercial forestry activities also occur on private lands throughout the watershed and only the District Municipality of Muskoka has a tree cutting by-law to regulate these activities. There are seven operators that work in the Muskoka River Watershed, however, almost all primary materials are transported to larger sawmills and pulp mills outside the watershed. The products are primarily saw logs destined for Tembec Inc. in Huntsville and Mattawa, Roy's Lumber in Britt, Agawa Forest Products in Sault Ste. Marie and Fryer Forest Products in Monetville. Fuelwood and pulpwood markets are relatively small. The removal of sunken logs has occurred in many locations across the watershed in the past 10 years.

4.4 Agriculture

The Muskoka River Watershed is located on the Precambrian Shield and there are only limited areas that provide adequate soil conditions for agricultural use.

Ninety percent of land in the Muskoka River watershed is classified as having no capability for arable culture or permanent pasture. Agriculture operations are centralized around the communities in the middle reaches of the watershed: Huntsville, Bracebridge, east of Port Carling, north of Gravenhurst, and west of Baysville. The only crop that may be detrimentally affected by water level is the production of cranberries. However, no commercial operations are affected by the management of the dams within the scope of this study.

4.5 Hunting and Trapping Activities

The watershed is part of six provincial Wildlife Management Units (WMU♣s). These units are the geographical basis for the setting of seasons for wildlife harvesting. Hunting has been, and continues to be a traditional activity in the region. Harvests of both moose and deer are regulated by lottery draw systems. The bear hunt is managed by outfitters operating in 11 bear management areas (BMA♣s).

Trapping, especially adjacent to Algonquin Park and in the more remote areas of the upper and lower watershed, is managed by MNR on Crown land. There are 38 registered traplines: 16 in the upper watershed and 22 in the lower watershed. As well, there are a number of private land trappers. Furbearers such as beaver and muskrat still provide a small trapping industry, but trapping activity is reduced. There is no indication that current water level management regimes are having a negative impact on furbearer populations in the Muskoka Watershed.

4.6 Navigation and Boating Use

Commercial and recreational boating activity on the waterway runs from about mid-May to mid-October. Contracting barges are in operation during most ice-free months. There are three general areas where commercial navigation has occurred in the past and are currently buoyed: the Muskoka Lakes (Muskoka, Rosseau and Joseph), Huntsville Lakes (Vernon, Fairy, Peninsula and Mary) and Lake of Bays (see Figure 4.2). Three navigation locks are located on the system; two in Port Carling and one just south of Huntsville. The Port Carling Locks are owned by the District Municipality of Muskoka and operated by the Township of Muskoka Lakes. There are two locks at this location, with a lift of 0.65 m. The small lock is for average sized recreational boats, and the large lock handles contractor's barges, tourist boats (such as the Segwun) and other large vessels.

The Brunel Lock, located south of Huntsville, was built from 1873 to 1877 to overcome the difference in height between Fairy Lake and Mary Lake. Today Brunel Lock Park is a popular picnic area from which one can watch boats making their way through the system. The lock is operated by the Town of Huntsville, and draws an annual activity of about 2000 boats. The difference in height of water levels is about 3 m (10 ft).

Seaplane Bases

There are four seaplane bases in the Muskoka watershed:

- Lake Vernon
- Lake Rosseau (near Port Carling)
- Smoke Lake (Algonquin Park)
- Lake Muskoka (Mortimer's Point).

The four airbases are not affected by water management strategies.

4.7 Recreation/Tourism and Parks

4.7.1 Recreation and Tourism

Resort development was initiated on Muskoka, Rosseau and Joseph lakes as early as 1871 aided by the steamship era and the connection to the Northern Railway at Gravenhurst. The first private cottages started on these lakes in the 1870s and 1880s. The same trend occurred on Mary, Fairy, Peninsula and Lake of Bays in the late 1880s and 1890s as train and steamship services took longer in coming to this area. Over the years, tourism has changed in Muskoka from an industry that was totally dependent on steamship navigation to one that uses the Muskoka River system for recreational boating. After World War II with easier access to cars and the growth of the transportation network as well as the gas-powered motorboats, fewer relied on the steamers for passage or supplies and the steamship era ended in 1981.

Tourism and associated recreational activities are extremely important to the Muskoka watershed area. The eastern portion (headwaters) is used primarily for wilderness camping and canoe tripping while the central and western portion of the watershed are used extensively by private cottaging and resort operators. Tourism activities are summarized in Figure 4.2. Table 4.11

indicates the number of resorts, marinas and campgrounds on waterbodies throughout the watershed.

Table 4.11
List of Total Commercial Operations by Lake/Reach

Lake/Waterbody	Number of Resorts	Number of Marinas	No. of Tent and Trailer Parks
Moon River	6	1	
Go Home Lake		1	
Healey Lake		2	
Lake Muskoka	31	14	2
Lake Rosseau	13	5	1
Lake Joseph	6	6	
Medora Lake			1
Skeleton River			1
Gull Lake	1	2	
Gullwing Lake			1
Three Mile Lake	7		2
Butterfly Lake	1	1	1
Bass Lake	1	1	
Skeleton Lake	3		1
Muskoka River	14	1	1
Bonnie Lake			1
Deer Lake			1
Mary Lake	8	1	
Lake Vernon	2	1	-
Fairy Lake	8	1	
Peninsula Lake	8		
Big East River	-	-	2
Lake of Bays	22	2	1
Kawagama Lake		2	
Total	**131**	**41**	**16**

Source: Tourism Guides and local telephone books, includes inns, resorts, cottage resorts, bed and breakfasts, etc.

The attractions that rely on the physical features of the Muskoka watershed include:

- the Muskoka Lakes (Lake Muskoka, Rosseau Lake and Lake Joseph)
- Lake of Bays

- the Huntsville Lakes (Peninsula Lake, Fairy Lake, Mary Lake and Lake Vernon)
- downhill skiing (Hidden Valley Highlands, Peninsula Lake)
- cross-country skiing
- snowmobiling (about 2,000 km of groomed trails)
- the many waterfalls and chutes for sightseeing.

The most significant man-made attractions and events that directly relate to water include:

- lake cruises on the RMS Segwun and Wenonah II (Gravenhurst, Lake Muskoka)
- lake cruises on the Lady Muskoka (Bracebridge, Muskoka River and Lake Muskoka)
- Santa's Village (Bracebridge, Muskoka River).

Recreation

Water related recreational activities include:

- summer – swimming, sailing, boating, water skiing, canoeing, fishing
- winter – snowmobiling, skiing and ice fishing.

The major recreation lakes are Muskoka, Rosseau, Joseph, Lake of Bays, Mary Lake, Fairy, Peninsula, Lake Vernon, and Kawagama. Canoeing is a popular recreational activity throughout the entire watershed. Figure 4.2 shows the location of published canoe routes in the watershed. Major canoe routes and wilderness camping are more prevalent in the headwaters of the watershed, especially within Algonquin Park. There are ten active snowmobile clubs in the watershed area that are members of the Ontario Federation of Snowmobile Clubs (OFSC). Figure 4.2 - Recreational Opportunities, indicates the location of the trails that are maintained by these groups. There are 24 golf courses in the Muskoka watershed. The boom in golf course development in the 1990's resulted in 11 new courses or expansions. In some cases, construction activities resulted in increased soil and sediment transport to Muskoka water bodies. Water intakes and out flows for these golf courses are included in Section 4.3.1.

4.7.2 Provincial Parks and Wildlife Reserves

Federal Reserve

Eleanor Island is the only Federal Reserve located in the watershed and is designated a national wildlife area. Herring gulls and great blue herons nest there in large numbers and have painted the island white with their droppings. The island is located about 1.5 km from the nearest mainland and is in the southern portion of Lake Muskoka. Access to the island is strictly prohibited and it is administered by the Canadian Wildlife Service and the MNR.

Provincial Parks

There are nine provincial parks located within the Muskoka River Watershed (Figure 4.1). The most important of the parks is Algonquin which contains the headwaters of the Muskoka watershed and comprises about 10 to 15% of the Muskoka River watershed. Algonquin Park is a major destination for national and international travelers who are seeking opportunities for a diversity of low intensity recreational experiences. The park attracts over half a million visitors annually, from all over the world. The majority (85%) of visitors originated from the immediate vicinity of the park and southern Ontario, and the remainder from outside of the province. Their principal activities while in the park include; canoeing, camping, fishing, picnicking, sightseeing, cross-country skiing and hiking.

There are six water control structures in the park. Any proposal to alter lake level regulations would need to be evaluated on its effect on canoeing activities from May to September. Management of downstream sections of the Muskoka River could be improved by allowing more flexibility in the operation of lakes within Algonquin Park.

Within the Muskoka River watershed of Algonquin Park, there are three main reaches where Park and private recreation facilities exist: Burnt Island, the Joe Lake System and Tea, Smoke and Canoe Lakes. Table 4.12 provides the total number of private facilities (lodges, youth camps and private cottages) and Park run facilities (campgrounds and interior camp sites) located within the Muskoka River watershed portion of Algonquin Park. All private facilities are managed through a lease agreement and none of the facilities would be classified as a significant water taker.

Conservation Reserves

The recent Ontario's Living Legacy (MNR, 1999) exercise proposed 13 Conservation Reserves within the Muskoka River Watershed, 10 of which have been subsequently approved. Five conservation reserves are located on waterways affected by water management, however the impact on the conservations reserves should be minimal (see Figure 4.1).

Table 4.12
Algonquin Park
Private and Park-Operated Tourist Facilities

Lake/ Waterbody	Lodges	Youth Camps	Private Cottages	Major Access Points	Campgrounds	Interior Camp Sites
Burnt Island	0	0	0	0	0	52
Joe Lake System	1/125*	1/300*	6	0	0	61
Tea, Smoke and Canoe	0	3/805*	162	1 (Smoke) 1 (Canoe)	1/250** (Tea)	0
Total	**1/125***	**4/1105***	**168**	**2**	**1/250****	**113**

* Capacity of people that can be accommodated.
** Number of individual campsites.

Source: Henry Checko, Algonquin Park Staff, 2003.

Natural Heritage Areas

The Muskoka Heritage Areas are regionally significant natural areas and features within the District of Muskoka. The Natural Heritage Evaluation study was a result of a District of Muskoka led project in cooperation with the Muskoka Heritage Foundation and the MNR. These areas cover a total of 25,500 ha or 6% of the land base of Muskoka District. Approximately half of this total area occurs on public lands. There are 68 heritage sites within the Muskoka watershed. The goal of the Natural Heritage Program is to protect the designated areas from incompatible activities by means of municipal land use policy and Crown land management.

4.8 Commercial Fishing

Commercial fishing is restricted to the harvest of baitfish under licence from the MNR. Much of the baitfish harvesting activity occurs away from the main stem of the Muskoka River. Licensed areas contain parts of the river and associated lakes, and some harvesting activity can be expected to occur in these areas. There is no requirement of the harvesters to report their catches by waterbody, just by zone, so the impact of baitfish harvesting on the Muskoka River is unknown.

4.9 First Nations

4.9.1 Wahta Mohawks (Gibson Territory)

In 1881 the Ontario government sold a block of land in Gibson Township to the federal government to be set aside as a reserve for the Mohawks of Gibson. The establishment of the Gibson reserve was confirmed by an Order-in-Council dated June 18, 1918 (see Figure 4.1). The Wahta Mohawks journeyed from Kanesatake (Oka, Quebec) in 1881 to the present territory of 5983 ha near Bala, Ontario. With a membership of approximately 550 people, Wahta's elected Council consists of four Councilors and a Chief. Services offered include: social services, health, children's program, economic development, library, home support for the elderly, public works and education assistance and counseling.

Mixed forests, rocks, lakes, and marshes make up the Wahta Territory. Maple trees are abundant, and the Mohawk word "Wahta" means the sugar maple. The Mohawks main industry is cranberry production. The low lands enabled the development of Iroquois Cranberry Growers, which is the largest cranberry operation in Ontario. This internationally known community business has been used to help finance other community economic development since 1969. Private businesses at Wahta vary, and most are geared to the service industry.

4.9.2 Port Carling Site

Wahta Mohawks and Chippewas of Rama co-own the Indian River Reserve, 2.5 acres of land in the middle of the village of Port Carling. The waterfront property is used primarily for craft outlets in summer, just as it was earlier in the 1900's.

4.10 Archaeological and Heritage Resources

Although the Muskoka River watershed was not permanently inhabited by First Nations, the area was used for hunting and fishing and was considered part of the territory of the Algonquin Indians. While it is suspected that the Muskoka River was visited by French explorers and fur traders, there is no written record until 1826. At that time, Lieutenant Henry Briscoe was the first to report on the Muskoka River when interest arose to find a connection from the Ottawa River and Georgian Bay. Early settlement of the district started mainly after 1860 with the growth of the lumber industry. Water control structures were soon constructed thereafter to provide commercial navigation of the major lakes and log driving within the headwaters of the watershed.

A Stage 1 Cultural Heritage Assessment of the Muskoka River was undertaken by Archaeological Services Inc. (ASI). Their complete report is presented in Appendix G4 of the Background Information Report (A&A, 2003a). A total of 87 archaeological sites have been registered within the project study area. The general paucity of archaeological/heritage sites in the study area is due to the lack of detailed archaeological survey in the area, rather than any lack of inhabitation or land use, either before or after European settlement. Considering the nature of the terrain and the reliance of the population on water base activities, the areas with highest potential for archaeological sites are in, or in close proximity to, water. Numerous ships are known to have been wrecked in the major lakes and rivers of the study area and represent one type of archaeological resource.

The potential for submerged archaeological/heritage sites throughout the study area is considerable. Submerged sites take one of two basic forms: underwater or inundated resources. Underwater sites are those that have formed through the deliberate or inadvertent deposition of material in bodies of water. Canoe spills and refuse disposal are typical processes which lead to the formation of such sites. Inundated sites, on the other hand, are those which were formerly terrestrial, such as shoreline occupation sites, which have subsequently been submerged due to changes in local hydrology.

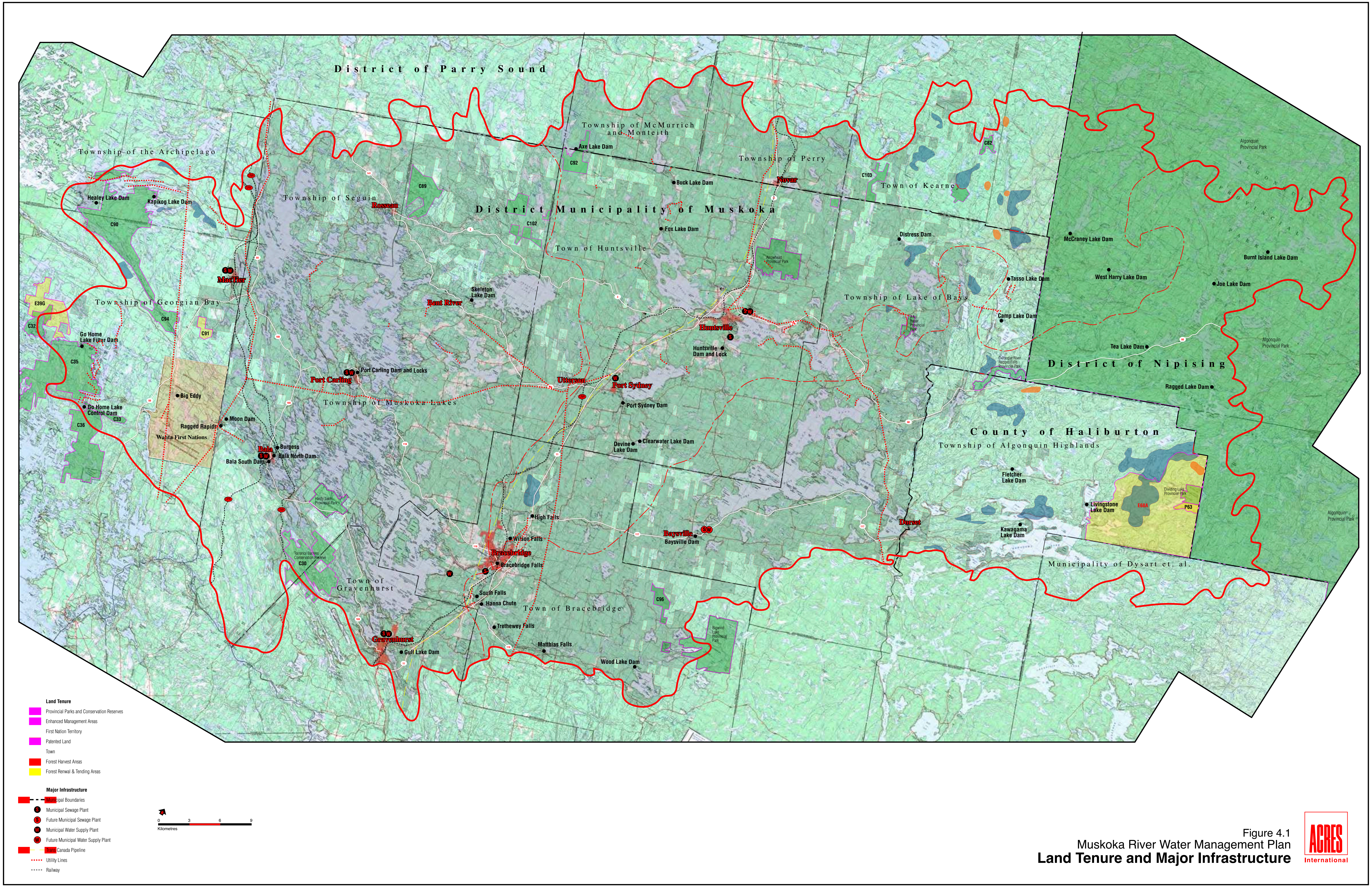


Figure 4.1
Muskoka River Water Management Plan
Land Tenure and Major Infrastructure

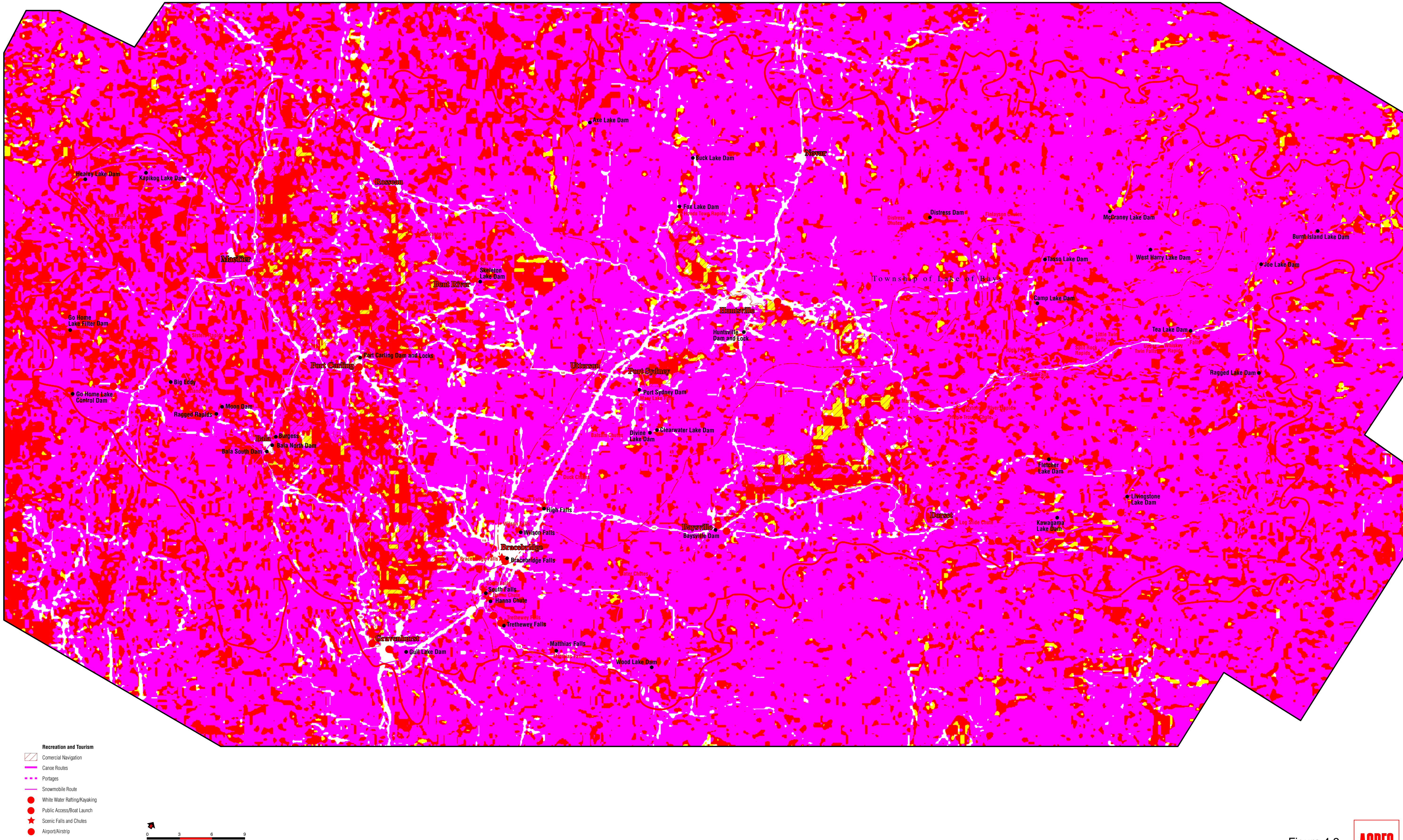


Figure 4.2
Muskoka River Water Management Plan
Recreation and Tourism

ACRES International

5 Water Control Structures and Water Power Facilities

This section describes the water control structures on the Muskoka River system and the existing operating regimes. Changes proposed as part of the WMP are presented in Sections 11 and 12.

5.1 Introduction

5.1.1 Water Control Structures

There are 42 different control dams and spill structures within the Muskoka River watershed that are used to control and maintain water levels of the lakes and river reaches throughout the basin (Figures 5.1a, b and c*). Of these structures, 11 are associated with power facilities, while 29 are owned and operated by MNR. The District of Muskoka owns and operates one while the remaining one is privately owned/operated. A listing of the dams, including a summary of their physical features is given in Tables 5.1(a) and 5.1(b), while the interrelationship of these structures is shown schematically in Figure 5.2. Table 5.2 provides further information regarding the physical characteristics of the dams/facilities and present flow and operating constraints.

5.1.2 Current Water Management

The basis for all current water management in the Muskoka River watershed is the Hackner-Holden Agreement. While the original 1940 agreement focused primarily on lake regulation for waterpower production, the 1969 Addendum took the needs of recreational users, fisheries and flood control into account in the establishment of the "rule curves"** for the main storage lakes within the system. While that document continues to be the basis for operation of the structures within the system, a number of other water management goals (i.e., to enhance fish spawning opportunities in specific river reaches) have been integrated into the operational procedures over the years to create a more ecosystem-based approach to water management within the Muskoka River system. Typical operational strategies are shown in Figures 5.3 and 5.4 for watershed lakes and river reaches.

* All figures and tables are placed at the end of this section.

** Rule curves were used to define operating limits and to establish water level curves for specific periods of the year. Under the new plan, the operating limits will be defined as the 'operating plan' and will establish Target, Normal and High and Low Water Operating Levels.

MNR's Dam Operation Manual (MNR, 1997) provides dam operators with specific instructions on how/when the stop logs/valves in the MNR controlled dams must be operated in order to meet the lake water level limits and downstream flow requirements throughout the watershed. Tables and charts denote flow passage capability at specific stop-log settings and water levels, and provide passage time from structure to structure within the watershed. By strategically controlling stop logs and valves, the dams can normally be utilized to maintain water levels within the operating limits for each lake (see Figure 5.3). All dams in the system are manually operated (i.e., personnel must make the required adjustments). It must be stressed that coordination of dam operations between locations within the watershed, and operator experience and judgment are extremely important factors in ensuring that the anticipated lake levels and river flows are achieved.

Dams operated by waterpower companies are all located in riverine sections of the watershed (i.e., none at the outlets of natural lakes, with the exception of Burgess GS) and have their own operational plans and strategies. While each facility has its own operational limits, these facilities are considered 'run-of-the-river' as they have a limited water storage capability and limited ability to influence river flows. Most importantly, the operation of these facilities is coordinated with the operation of the MNR controlled structures to ensure that appropriate flow conditions are maintained.

As a general principle, dam operations should be undertaken during weekdays in order to duce weekend water level fluctuations and associated 'out of compliance' issues for MNR and water power producers. MNR and industry will communicate and cooperate to achieve this objective.

The following sections provide brief descriptions of each dam on the Muskoka River, organized by subwatershed, indicate the purposes currently served by that dam as denoted by the "Dam Operation Manual" (MNR, 1997) and the strategies that are utilized to control flows and water levels within the system.

5.2 North Branch Structures and Current Operating Strategies

There are 16 water control structures on the North Branch of the Muskoka River and its tributaries. Of these, 11 are owned and operated by MNR, 3 are owned and operated by Bracebridge Generation Limited, one is owned by the District Municipality of Muskoka and one is privately owned. The operation of the dams at West Harry Lake, Clearwater Lake, Distress Lake, Axe Lake and Divine Lake dams will not be changing and were not considered further in the WMP. The location, key characteristics and a photo of each structure are also provided in Figure 5.1a.

West Harry Lake Dam

Watershed Location - This MNR dam is located at the outlet of West Harry Lake, in the headwaters of the Big East River within the boundaries of Algonquin Provincial Park. Outflow from the dam discharges into the Big East River, which is joined by McCraney Creek approximately 7.3 km downstream. It controls a drainage area of 36.9 km^2. The upstream lake has a surface area of 1.52 km^2.

Structural Characteristics - The timber dam, originally constructed in 1949 and reconstructed in 1974, is approximately 15 m long, 3 m high, and equipped with a 0.91 m diameter slide control valve. The spillway crest elevation is 31.8 m LCD

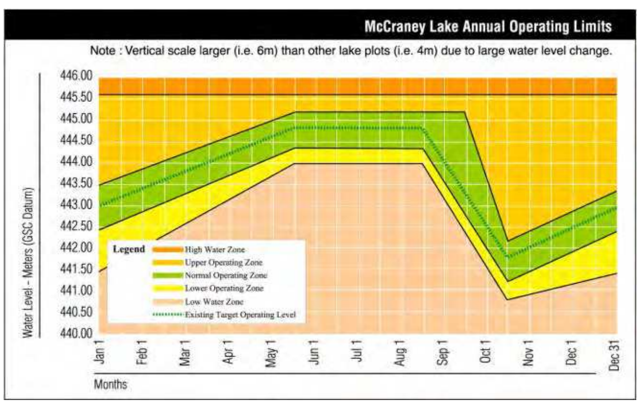
Operational Characteristics - The valve was historically used to undertake a drawdown of the lake of approximately 1 m in the fall to augment summer flows in the Big East River. This drawdown was discontinued in 1993.

Goal/Purpose of Dam Operation
Water levels are maintained within the lake for recreational purposes (canoeing, fisheries, etc).

McCraney Lake Dam

Watershed Location - This MNR dam is located in Algonquin Park at the outlet of McCraney Lake and controls a drainage area of 44.3 km^2. The lake has a surface area of 4.4 km^2. Outflow from the dam flows into McCraney Creek, which joins the Big East River approximately 2.7 km downstream from the dam.

Structural Characteristics - The concrete dam is approximately 6 m high and 12 m long, and contains a 7.6-m wide overflow spillway, one 4.3-m wide sluiceway structure (not operated) and an operational slide valve (0.76 m in diameter). The sill elevation is 440.0 m and the crest elevation of the spillway wall is 444.85 m GSC. The dam contains a maximum of 16 stop logs and retains 4.9 m of water (at the dam face) under normal summer conditions.



Operational Characteristics - The operational characteristics are shown in the figure. The summer water level is maintained at a target operating level of 444.85 m (the crest of the wingwall). The slide valve is open between mid-August and mid-October to release 2 to 3 m^3/s to augment downstream flows on the Big East River. This release results in a 3-m drawdown of the lake. The lake refills on its own after the valve is closed in mid-October.

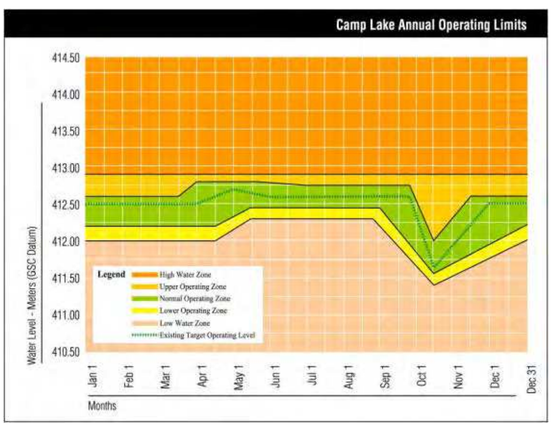
Goal/Purpose of Dam Operation

The dam maintains lake levels for canoeing, other recreational pursuits and power production. Other goals of dam operation include protection of the lake fisheries (lake trout) in the fall (no drawdown is permitted after October 15), providing some storage for spring flood control, power production and low flow augmentation downstream on the Big East River.

Camp Lake Dam

Watershed Location - This MNR dam is located at the outlet of Camp Lake, which discharges into Tasso Creek, and subsequently into Tasso Lake approximately 0.5 km downstream. The dam controls a drainage area of 17.8 km^2 and the upstream lake has a surface area of 2.2 km^2.

Structural Characteristics - This concrete dam, originally constructed in 1924 and reconstructed in 1965 and 1994, is approximately 3 m high and 40 m long, and consists of a 36.8-m spillwall, one 3.05-m sluice with 9 stop logs and a low-level square (0.76 m) outlet valve.



Operational Characteristics - The stop logs are not operated. The summer water level is maintained at a target operating level of 412.6 m GSC. A fall drawdown, between September 1 and October 15, of 1 m is achieved through the operation of the valve. The valve is then closed and the lake refills naturally.

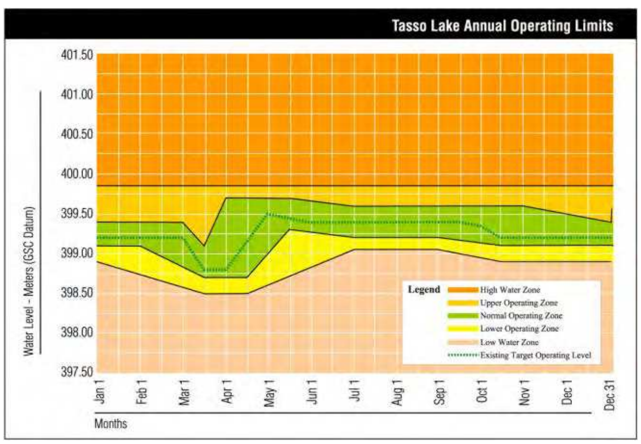
Goal/Purpose of Dam Operation

The primary purpose of this dam is recreation. Lake trout spawning protection is achieved by the fall drawdown.

Tasso Lake Dam

Watershed Location - This MNR dam is located at the outlet of Tasso Lake, which drains into Tasso Creek and joins the Big East River 4 km downstream at the site of the former Finlayson Pond.

Structural Characteristics - The dam, originally constructed in 1902 and reconstructed several times since, is approximately 4 m high and 4.3 m long. It consists of a single stop-log bay, with eight stop logs, set between two concrete piers, which form the embankment for a road over the top of the dam. The sill elevation is 397.12 m and the crest elevation of the stop logs is 399.56 m

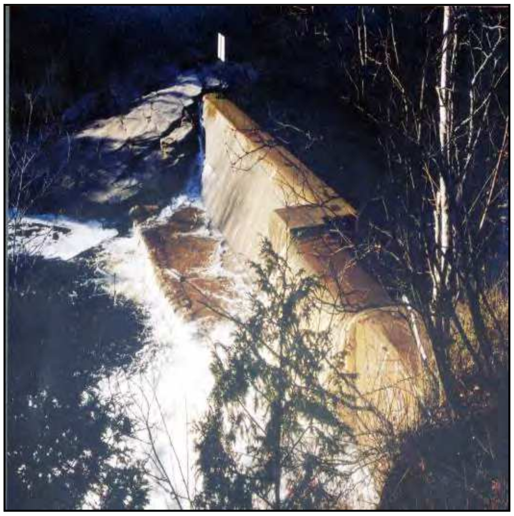


Operational Characteristics- The dam is operated on a regular basis since all flow must pass through the single sluiceway (flow over the top of the dam could wash out the road embankment) and upstream flooding is a concern. The summer target water elevation is 399.4 m. Drawdown of 0.4 m in March for spring flood control.

Goal/Purpose of Dam Operation

The purpose of this dam is recreational, but also provides municipal road access over Tasso Creek.

Distress Dam



Distress Weir

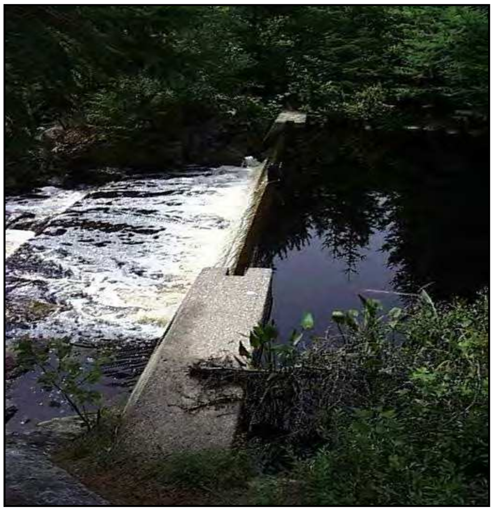
Watershed Location - This MNR concrete overflow weir is located on the Big East River approximately 25 km downstream from the McCraney Lake Dam and controls a drainage area of 455 km^2. The upstream lake has a surface area of approximately 0.93 km^2. Outflow from the dam passes into Lake Vernon (part of the Huntsville lakes chain) approximately 23 km downstream.

Structural Characteristics - The original dam was constructed in 1930 as a timber crib structure, and was subsequently rebuilt as a stop log equipped concrete gravity dam in 1953. In 2000, MNR reconfigured the dam as an overflow weir with notch but no gates. The dam is 3.5 m high and 30.54 m long with a 4.0 m wide notch. Notch crest is at 99.1 LCD and spillway crest is 99.4 m.

Operational Characteristics - The dam is no longer operated.

Purpose/Goal of Dam Operation
The purpose of the dam is to maintain summer water levels in the upstream reservoir for recreational purposes.

Axe Lake Dam



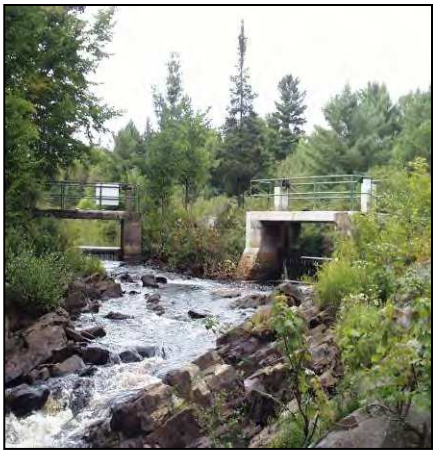
Watershed Location - This self-regulating MNR spill structure is located on Axe Creek near the community of Yearley, 4 km downstream from the outflow of Axe Lake and controls an upstream drainage area of 48.4 km^2. The discharge from the dam flows approximately 4 km downstream to Buck Lake.

Structural Characteristics - The concrete structure is approximately 15 m long and 1.5 m high, and holds back less than 1 m of water at normal summer levels. There are two 5.8 m wide sluices each containing one stop log each and two overflow spill wall.

Operational Characteristics - Dam is not operated. Summer regulated water level is 29.33 LCD.

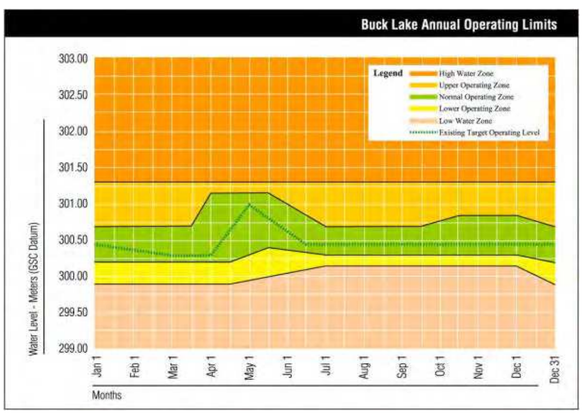
Purpose/Goal of Dam Operation
The dam provides summer water level regulation on the lake and creek for recreational purposes, as well as fire protection for the community of Yearley.

Buck Lake Dam



Watershed Location - This MNR dam is located on the Buck River, approximately 2.2 km downstream from the outlet of Buck Lake. Outflows from the dam drain into the Buck River, which enters Fox Lake 3.6 km downstream. It controls a drainage area of 205 km^2 and the upstream lake has a surface area of 2.75 km^2.

Structural Characteristics - This 3-m high concrete dam, was reconstructed in 1954. It contains two 4.27-m wide sluice structures each containing three stop logs and has three overflow spillwalls for an overall length of 38.3 m. The sill elevation is 299.3 m and the stop-log crest elevation is 300.2 m GSC.



Operational Characteristics - All stop logs are removed in the winter. The MNR dam holds back 0.92 m of water at normal summer operating levels with a target operating level of 300.45 m.

Purpose/Goal of Dam Operation

The dam is operated to control the summer water levels on Buck Lake and Fawn Lake for recreational purposes.

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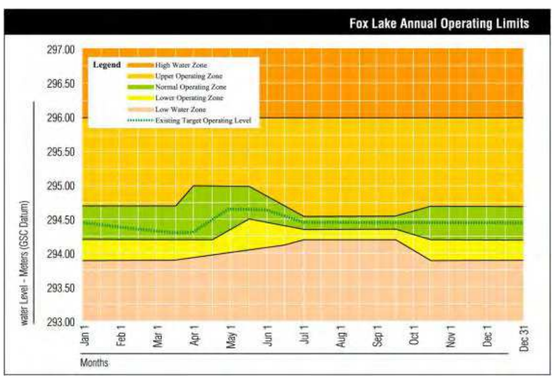
Fox Lake Dam

Watershed Characteristics - This MNR dam is located at the outlet of Fox Lake on the Buck River. Outflow from the dam flows through a steep, 0.5-km section of the Buck River known as Hoodstown Rapids, prior to entering Lake Vernon (part of the Huntsville lakes chain). The dam controls a drainage area of 220 km^2 and the upstream lake has a surface area of 1.4 km^2.

Structural Characteristics - The dam is approximately 3 m high and 15 m long. The dam, originally constructed in 1949, was reconstructed as a concrete, 2-sluice structure in 1979. The two sluices are 4.27 m wide and contain 4 stop logs, with a height of 1.22 m from the sill to top of normal stop-log settings. There are two spillwalls, 2.15 m and 4.45 m wide with crest elevations of 295.46 m.



Operational Characteristics - The summer operating level is maintained at a target operating level of 294.45 m GSC and within a summer operating range of 0.2 m. The dam maintains a normal summer head of 1.2 m of water. One log in each sluice is removed in the fall and winter drawdown begins January to March 15. Lake fills naturally and all logs are gradually replaced after spring run-off has passed.

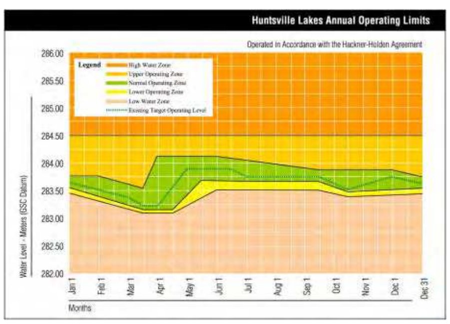
Goal/Purpose of Dam Operation

Dam is operated for recreational purposes.

Huntsville Dam

Watershed Location - This MNR dam is located on the North Branch Muskoka River, 0.7 km downstream from the outlet of Fairy Lake, and 5 km downstream from the Town of Huntsville**.** It controls the water level of Fairy, Peninsula and Vernon lakes (collectively known as the Huntsville lakes). It controls a drainage area of 1160 km^2 and the upstream lake has a surface area of approximately 30.8 km^2. Outflow from the dam passes into Mary Lake and through the Port Sydney dam before flowing through the North Branch hydroelectric generating stations.

Structural Characteristics - The 6-sluice, 4.5-m high concrete dam (51.24 m long), was originally constructed of timber in 1876 and was most recently reconstructed in 1997. There are 7 to 8 stop logs/sluice, with sill elevations from 281.56 m to 281.87 m and crest elevation of 284.0 m GSC. There is 57.91-m long spillwall with a crest elevation of 281.87 m. The dam contains a navigation lock, the concrete retaining wall is part of the lock approach channel.



Operational Characteristics - The dam is operated in accordance with the Hackner-Holden agreement. The Port Sydney (Mary Lake) dam must be operated at the same time as this dam. The dam is operated to meet a summer operating range of 30 cm with a target operating level of 283.77 m GSC. The lake is drawn down 24 cm between September 15 and October 15 prior to lake trout spawning, maximum drawdown of 0.5 m between October 15 and March 1 for egg protection. A drawdown of 0.54 m between December 1 and March 15 is for power production and spring flood protection. A minimum outflow of 3 m^3/s is to be maintained. The dam has a medium degree of difficulty to operate.

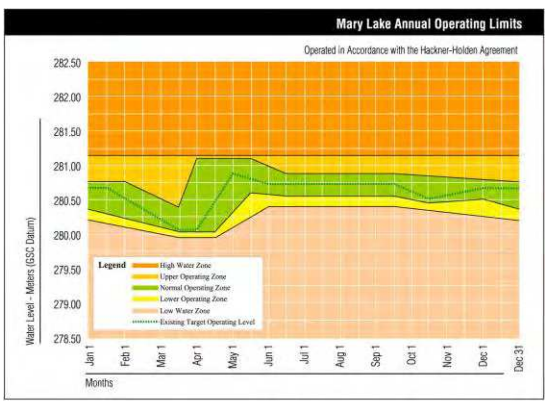
Purpose/Goal of Dam Operation

The dam is used to control water levels and flows for recreation, navigation, spring flood control, power production and fisheries. A minimum downstream flow is to be maintained for water quality and fisheries needs throughout the summer.

Mary Lake/Port Sydney Dam

Watershed Location - This MNR control dam is located in the Village of Port Sydney at the outlet of Mary Lake on the North Branch Muskoka River. Outflow from this MNR dam flows approximately 17 km downstream to the High Falls hydroelectric generating station. The dam controls a drainage area of 1394 km^2 and Mary Lake has a surface area of approximately 10.25 km^2.

Structural Characteristics - The 4-m high, 97.4-m long structure, contains seven sluiceways and one overflow spillwall. The stop-log bays are approximately 5.64 m wide and contain 5 to 7 stop logs per bay. The stop logs maximum crest elevation is between 280.85 and 280.87 m GSC, with sill elevations between 279.07 and 278.75 m GSC. The 57.91-m long spillwall has a crest elevation of 281.87 m. The dam was originally constructed as a timber crib structure in 1881, and was converted to a stone rubble masonry dam in 1914, with concrete resurfacing occurring in 1981-1982 and major repairs in 1999.



Operational Characteristics - The dam is operated in accordance with the Hackner-Holden agreement. It has a medium to high degree of difficulty to operate. All operations must be coordinated with Huntsville Dam. Normal summer operating range is 34 cm with a target operating level of 280.73 m GSC. A minimum summer baseflow of 3 m^3/s must be maintained for water quality and fisheries requirements. Fall drawdown of 22 cm occurs between September 15 and October 15 for lake trout spawning, with a maximum 0.5-m drawdown between October 15 and March 1 to help protect lake trout eggs. A 0.48-m maximum drawdown is permitted over December 15 to March 15 for spring flood control and hydro power production.

Goal/Purpose of Dam Operation

Its uses include power production, spring flood control, fisheries, navigation and recreation.

Clearwater Lake Dam

Clearwater Lake Dam

Watershed Location - This MNR dam is located at the outlet of Clearwater Lake, which flows to Devine Lake and on to the North Branch. It controls a drainage area of 3.2 km^2 and the upstream lake has a surface area of 0.8 km^2.

Structural Characteristics - The small concrete dam (1 m high) was constructed in 1939 and consists of one, 1.83 m wide sluice with one 2 x 8-in. stop log/board.

Operational Characteristics - The stop log/board is no longer operated. The lake has a normal summer head of water above the sill of 0.38 m.

Purpose/Goal of Dam Operation

The purpose of the dam is recreational.

Devine Lake Dam

Watershed Location - This small, privately owned dam is located at the outlet of Devine Lake, and discharges into a tributary to the North Muskoka River approximately 3.5 km downstream from the Port Sydney Dam.

Structural Characteristics - This concrete dam (1.5 m high) has a single 2 m wide sluice with 4 to 10 cm stop logs.

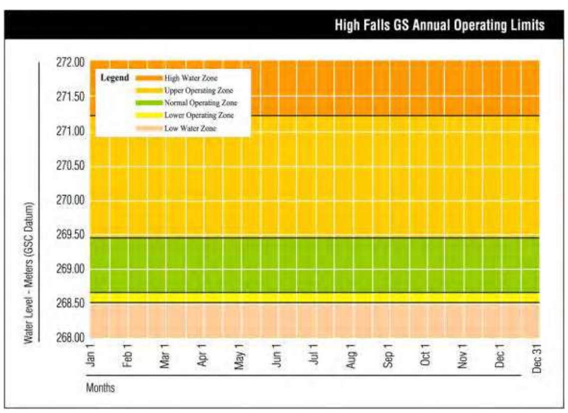
Operational Characteristics - The dam is drawn down 0.2 m after October 1 for spring flood control.

Goal/Purpose of Dam Operation
The dam is used for summer recreation, flood control and as a single-lane bridge.

High Falls Dam and Generating Station

Watershed Location - The facility is located immediately upstream of High Falls with an upstream drainage area of 1523 km^2.

Structural Characteristics - The High Falls facility consists of a concrete dam and a generating station owned and operated by Bracebridge Generation Limited. The dam is approximately 3 m high and 28 m in length, and consists of a concrete overflow weir, an automated sluiceway and the power station intake. The facility was constructed in 1947. The powerhouse is located in a natural canyon on the west bank of the river.



Operational Characteristics - This is a run-of-river facility, with an estimated plant capacity of 10.14 m^3/s. It has an operational head of 14.6 m. If the river falls below the required plant capacity, generation is scaled back. Any excess flow is spilled, by-passing the plant. Normal summer water level is 268.83 m GSC.

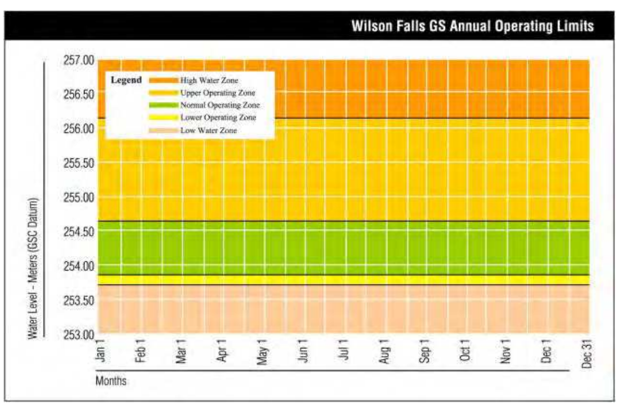
Purpose/Goal of Dam Operation

The main purpose of the dam is for power production. The total installed capacity of the generating station is 0.8 MW

Wilson Falls Dam and Generating Station

Watershed Location - This facility is located on a bend in the North Branch, approximately 2.4 km upstream of the Town of Bracebridge. The upstream watershed has a drainage area of 1556 km^2.

Structural Characteristic - The Wilson Falls facility consists of two concrete dams and a 0.6-MW generating station owned and operated by Bracebridge Generation Limited. The main dam consists of a 109.5-m long overflow section and a 7-m wide electric gate at the apex of the river bend (upper picture). The dam elevates upstream water levels in a secondary channel near the base of the bend. The head-pond dam is located across this channel, and consists of an 8 to 10 m high concrete dam with one sluiceway and the power intake gate (lower picture). The powerhouse is located at the foot of the dam, on the downstream side of the river bend. The facility was constructed in 1909.

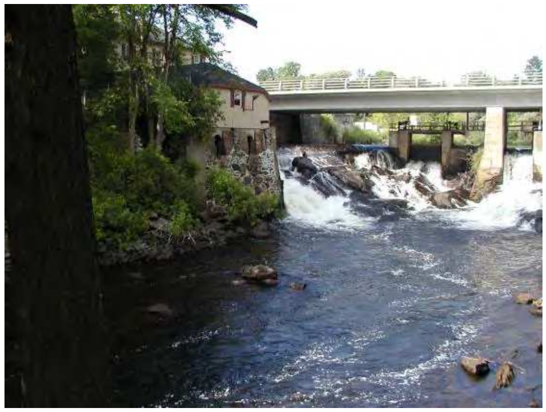


Operational Characteristics - This is a run-of-river facility, with an estimated plant capacity of 8.5 m^3/s. It has an operational head of 12.5 m. If the river falls below the required plant capacity, generation is scaled back. Any excess flow is spilled, by-passing the plant. Normal summer water level is 254.08 m GSC.

Purpose/Goal of Dam Operation

The main purpose of the dam is for power production. The total installed capacity of the generating station is 0.6 MW.

Bird's Mill Dam



Watershed Location – The dam is located in Bracebridge beneath Muskoka Road 37 approximately 200 m upstream of the Bracebridge Falls Dam and generating station. The dam is owned by the District Municipality of Muskoka.

Structural Characteristic - The dam is primarily a masonry structure and makes efficient use of the natural rock outcrops within the river. It resembles an "L" shape and is comprised of three sluiceways. Each sluiceway is fitted with 12-in square stop logs.

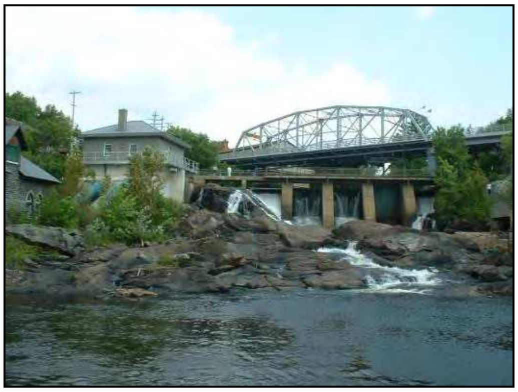
On the west bank of the river, a short channel has been constructed to direct a portion of the river flow through the Bird's Mill Pump House. This flow drives the wheels operating the water pumps which are a tourist attraction. There are also two minor natural spillways, one on either side of the concrete pier for the Bird's Mill Bridge between two of the sluiceways.

Operational Characteristics
The Bird's Mill Dam has no power generating facilities and its principal role is to facilitate nearby recreational uses (navigation, fishing, etc). The streamflow through the dam is entirely dependent on the water that is available in the natural flow of the river. The main objective of dam operation is to regulate water levels within the reach of river from Bird's Mill Dam to Wilson's Falls, with the greatest effect of the dam limited to the area between Bird's Mill Dam and a natural rock outcrop within the river, some 1000 m upstream of the dam, known locally as "Bass Rock".

Purpose/Goal of Dam Operation
The majority of the dam structure was once used in the production of hydroelectricity. A small section of the dam was once used to divert river flow to water driven pumps that were, in turn, used to pump potable water to the citizens of Bracebridge. Also, at the turn of the 20th Century, the dam was used to assist in log transportation

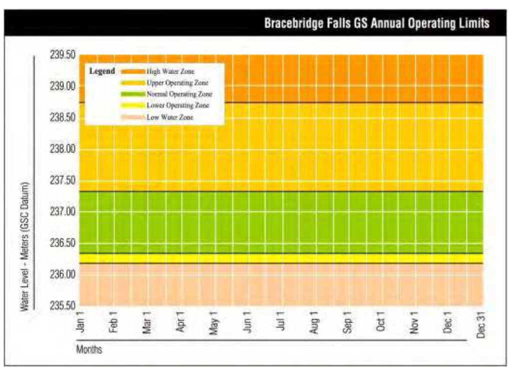
The dam is no longer used for these or any other purposes relating to the production of goods and services.

Bracebridge Falls Dam and Generating Station



Watershed Location
The facility is located at Bracebridge Falls within the Town of Bracebridge and has an upstream drainage area of 1568 km^2.

Structural Characteristics - The Bracebridge Falls facility, owned by Bracebridge Generation Limited, consists of a 32.3 m long dam (including 4 sluices and 3 spillways) and powerhouse. It was originally constructed in 1900 (second generator added in 1904), and produces 0.6 MW of power from two 300-kW generators that are still in service. The powerhouse is original, while the dam was rebuilt in 1957.



Operational Characteristics - This is a run-of-river facility, with an estimated plant capacity of 10.5 m^3/s. It has an operational head of 10.4 m. If the river falls below the required plant capacity, generation is scaled back. Any excess flow is spilled, by-passing the plant. Normal summer water level is 235.64 m GSC.

Purpose/Goal of Dam Operation
The main purpose of the dam is for power production. The total installed capacity of the generating station is 0.6 MW.

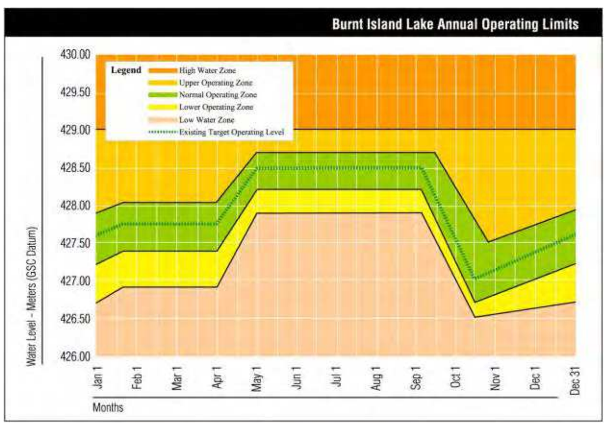
5.3 South Branch Structures and Current Operating Strategies

There are 13 water control structures on the South Branch of the Muskoka River and its tributaries. Of these, 9 are owned and operated by MNR, while 3 are owned and operated by OPG and 1 by Orillia Power Generation Corporation. The location, key characteristics and a photo of each South Branch structure is provided in Figure 5.1b. Livingstone and Fletcher Lake dams are not operated as control dams and were not considered further in the WMP.

Burnt Island Lake Dam

Watershed Location - This MNR dam is located at the outlet of Burnt Island Lake in Algonquin Park, approximately 13 km north of Highway 60. It controls a drainage area of 59.1 km^2 and the upstream lake has a surface area of 8.8 km^2. The lake forms part of the headwaters of the Oxtonque River that eventually drains into Lake of Bays.

Structural Characteristics - The 4-m high concrete dam was rebuilt in 1957, has a single 3.66-m wide sluiceway with 9 stop logs, a low flow valve that has been permanently closed and has two overflow spill walls with a total length of 16.5 m.



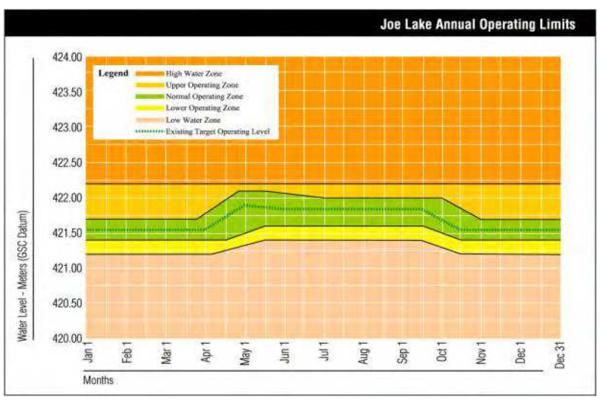
Operational Characteristics - The summer target operating level is 428.5 m GSC with a summer operating range of 0.5 m. The lake is drawn down between September 1 and October 15 by 1.5 m for lake trout spawning. Three stop logs are not replaced in the dam until just prior to the spring freshet, when they are returned and capture the entire spring freshet. No spring flows are released out of the dam into Joe Lake, thus, providing some flood control to the lower part of the system.

Goals/Purpose of Dam Operation
Dam is used for maintaining summer recreational water levels, lake trout spawning protection and flood control.

Joe Lake Dam

Watershed Location - This MNR dam is located within Algonquin Park at the outlet of Joe Lake and controls water levels on Joe Lake as well as Little Joe, Tepee, Littledoe, Bluejay and Tom Thomson lakes. Outflow from this dam is the main inflow into Tea Lake. The dam controls a drainage area of 117.9 km^2 and the total lake surface area is 5.83 km^2.

Structural Characteristics - This 4.5-m high concrete dam has a single 4.27-m wide sluice with up to 9 stop logs, a low flow valve that has been permanently closed, and approximately 21 m of overflow spillwall. The sill elevation is at 418.94 m and the spillwall is at 421.99 m. It was rebuilt in 1963.



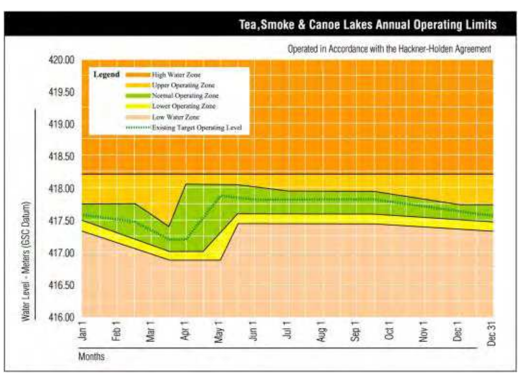
Operational Characteristics - Operation is moderately difficult as no road access is available. The summer target operating level is 421.85 m GSC with a summer operating range of 0.4 m. The lake is drawn down between September 1 and October 15 by 0.3 m for lake trout spawning. There is no further winter drawdown and levels remain above 421.40 m. Two stop logs are replaced just prior to the spring freshet to capture some of the runoff.

Goal/Purpose of Dam Operation
It is operated for summer recreational needs, flood control purposes and fisheries protection (i.e., spawning lake trout).

Tea Lake Dam

Watershed Location - The Tea Lake dam is located 0.3 km north of Highway 60, within the boundaries of Algonquin Park, and is also owned and operated by MNR. The dam controls water levels in Tea, Bonita, Canoe and Smoke Lakes. Tea Lake, Bonita Lake and Canoe Lake are on the Oxtongue River, while Smoke Lake is on Tea Creek, a tributary to the Oxtongue River. The dam controls a drainage area of 344 km^2 and the surface area of the upstream lakes is12.53 km^2. Outflow from this dam drains into the Oxtongue River, Oxtongue Lake and subsequently into Dwight Bay on Lake of Bays, approximately 30 km downstream.

Structural Characteristics - This 4-m high, 36-m long concrete dam consists of a 27.4-m long overflow spillwall, two sluiceways with 9 stop logs, and a low-level valve. The sill elevation is 415.21 m and the spill wall crest is 417.95 m GSC, the dam retains a normal summer head of 2.61 m.



Operational Characteristics - The dam is operated in accordance with the Hackner-Holden agreement. The summer water level is maintained at a target operating level of 417.82 within a normal operating range of 0.35 m. There is a drawdown of 0.34 m between September 15 and February 15, to minimize ice-cracking at the shoreline and a further drawdown of 0.28 m February 15 to March 15. Minimum outflow of 1.4 m^3/s is required for downstream fisheries and water quality needs.

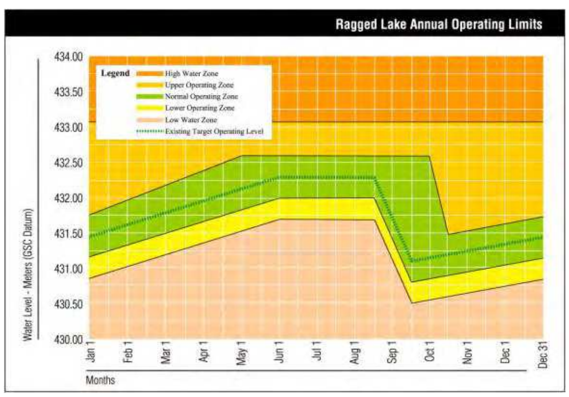
Goals/Purpose of Dam Operation

Tea Lake is used as storage to prevent flooding on Lake of Bays. Its primary purposes are controlling summer recreation levels, navigation, spring flood control, fisheries and winter power generation.

Ragged Lake Dam

Watershed Location - This MNR dam is located approximately 7.6 km south of Highway 60 in Algonquin Park at the outlet of Ragged Lake (which is adjacent to the southwest park boundary), with outflows entering the south end of Smoke Lake. The dam controls a drainage area of 69.9 km^2 and Ragged Lake has a surface area of 4.12 km^2.

Structural Characteristics - The 112-m long, 3.5-m high concrete dam consists of one inoperable 2.4-m wide sluice (consisting of 9 stop logs), two extended spillwalls and a low-level outlet valve (0.76 m x 0.76 m).



Operational Characteristics - The valve is opened mid August and closed in the beginning of October to provide a fall drawdown of 1.1 m. The long spillwalls have enough discharge capacity to eliminate wide fluctuations of water level, and a 5-m long 0.75-m deep breach in one spillwall serves to establish the summer water level

Goals/Purpose of Dam Operation
Dam provides summer water levels for recreational uses (i.e., canoeing).

Livingstone Lake Dam

This small concrete dam (2 m high, 20 m long) is located at the outlet of Livingstone Lake on Livingstone Creek, which discharges into Kawagama Lake. This MNR structure is not operated and functions as an overflow weir. The dam maintains a normal summer head of 0.6 m for recreational purposes.

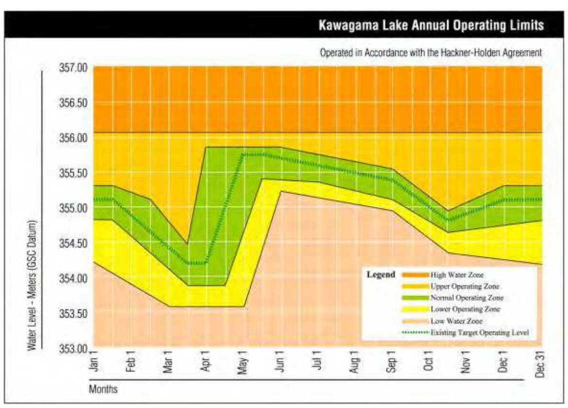
Fletcher Lake Dam

This 30.4-m long dam is located at the outlet of Fletcher Lake and discharges through Fletcher Creek into Fletcher Bay on Kawagama Lake. The 3.5 m high MNR dam was constructed in 1963 with a low-level valve, which has been permanently sealed in the closed position. The dam serves to maintain recreational uses, and holds back a normal summer water depth of 2.3 m.

Kawagama Lake Dam

Watershed Location - This dam is located at the outlet of Kawagama Lake in River Bay, approximately 13 km east of Dorset. Outflow from the lake passes through the Hollow River and into Trading Bay on Lake of Bays approximately 11 km downstream. The dam controls a drainage area of 380 km^2 and the upstream lake has a surface area of 31.9 km^2.

Structural Characteristics - This 5 m high dam is approximately 54 m long and was originally constructed of timber in 1890. It was subsequently reconstructed of stone rubble masonry in 1926 and resurfaced with concrete in 1985. The dam has two 4.27-m wide sluices with a maximum of 11 stop logs each (usually the bottom 4 logs are not removed). The sill elevation is at 352.25 m GSC. There are two spill walls with a total length of 44.26 m. The spillwall crests are at 356.21 m and 356.45 m GSC. The normal summer (July 1) head of water held by the dam is 3.35 m.



Operational Characteristics - This MNR dam was owned by Ontario Hydro until 1968, and is operated in accordance with the Hackner-Holden agreement. This is the only lake on the system with a summer drawdown. The target level for May 15 is 355.76 m and for September 1 is 355.38 m (0.38-m drawdown). There is a fall drawdown of 0.28 (September 1 to October 15) and winter drawdown of 0.61 m (October 15 to March1).

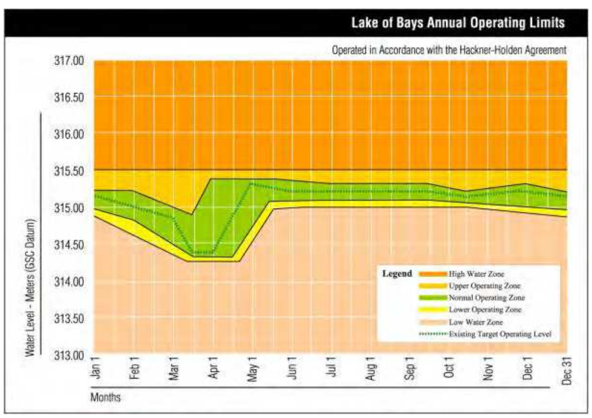
Goal/Purposes of Dam Operation

Purposes of the dam include recreation, navigation, spring flood control, fisheries and winter drawdown for downstream power generation. The fall drawdown of 0.28 m was established to force lake trout to spawn at a lower level to help protect eggs from winter drawdown for hydro production. Maximum winter drawdown was set to protect lake trout eggs. The winter drawdown for hydro production is aimed to maintain a flow of 16.8 m^3/s at the Trethewey generating station

Lake of Bays/Baysville Dam

Watershed Location - This MNR dam is located in the village of Baysville at the outlet of Lake of Bays into the South Muskoka River. Inflows to the lake are primarily from the Oxtongue River and Hollow River, there are a few other minor tributaries. Outflow past the dam travels approximately 25 km before reaching the Matthias Falls hydroelectric generating station, the first in a line of four power stations on the South Muskoka River. The dam controls a drainage area of 1481 km^2 and the surface area of the upstream lake is 68.4 km^2.

Structural Characteristics - The 3.5-m high dam consists of nine, 4.3-m wide sluices (with 6 stop logs) and a 32.1-m spillwall (70.5 m total length). The sill elevation is 313.53 m GSC and the crest of the spillwall is 315.29 m GSC.



Operational Characteristics - The dam is operated in accordance with the Hackner-Holden Agreement. The target summer operating level is 315.22 m GSC within a normal operating range of 0.22 m (for channel navigation and summer recreation). The dam holds back 1.7 m of water at the normal Lake of Bays summer water level. Minimum outflow from the lake is 2.8 m^3/s. There is a fall drawdown of 0.06 m between September 15 and October 15 (for lake trout spawning) and a 0.27 m maximum winter drawdown (October 15 to March 1) to protect lake trout eggs with a further 0.46 m allowed March 1 to April 1 for hydro generation. The aim is to provide a winter flow of 16.8 m^3/s for the Trethewey generating station. All dam operations must be coordinated with downstream power operators.

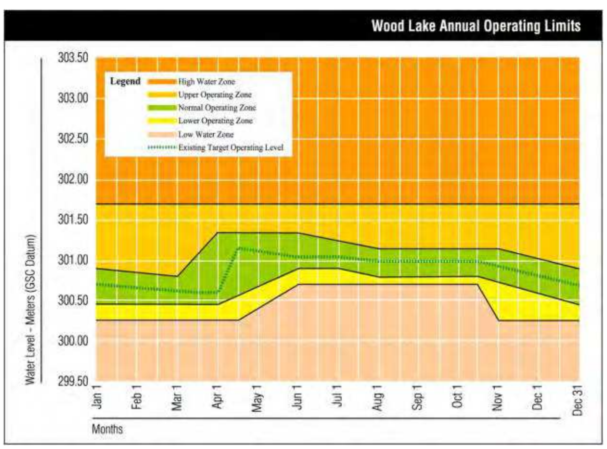
Goals/Purpose of Dam Operation

The dam provides power production, fisheries, recreation, navigation and spring flood control.

Wood Lake Dam

Watershed Location
The dam is located approximately 32 km southeast of Bracebridge at the outlet of Wood Lake and controls Wood Lake only. It has a drainage area of 34.7 km^2 and the upstream lake surface area is 3.76 km^2. Flow from Wood Lake discharges into the South Muskoka River at a point approximately 5.5 km upstream from the Matthias Falls Generating Station.

Structural Characteristics - This 2.5 m high MNR dam was originally constructed of timber in 1949 and subsequently reconstructed of concrete in 1983. The dam consists of one 4.3-m sluiceway with 4.5 stop logs and a 1.22-m long spillwall. The sill elevation is 299.84 m GSC and the crest of the spillway is 301.06 m GSC.



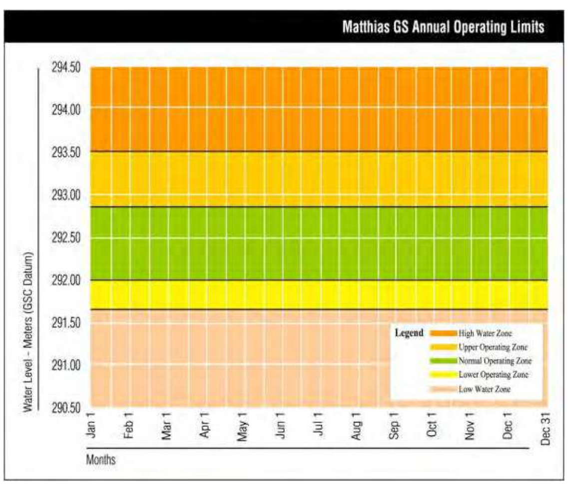
Operational Characteristics - The lake has a relatively narrow summer operating range of 0.3 m as there is extensive shoreline development. The normal summer head of water is 1.22 m. There is a fall drawdown from October 15 to November 1 of 0.56 m. The dam is not operated in the winter. The logs are usually replaced after spring runoff around May 1.

Purpose/Goal of Dam Operation
The dam is operated for recreational purposes.

Matthias Falls Dam and Generating Station

Watershed Location - Matthias Falls is located on the South Branch of the Muskoka River about 10 km directly southeast of Bracebridge. It is the most upstream of four generating stations on the South Branch and has an upstream drainage area of 1642 km^2.

Structural Characteristics - The Matthias Falls dam and generating facility was constructed in 1950 and is owned and operated by Orillia Power Generation Corporation. The current dam is 13.7 m high, approximately 270 m long, and contains 3 sluiceways (2 manual, 1 remotely operated) and the intake for the downstream powerhouse. Water is passed to the powerhouse through a 4.6 m diameter penstock.



Operational Characteristics - The plant is mainly operated as a run-of-river facility with 2.7 days storage at maximum discharge capacity. On an hourly and daily basis, the head pond typically fluctuates over a 0.92 to maximum of 1.8 m range. Nominal head pond level is 292.91 with a maximum of 293.5m. A minimum flow of 3.0 m^3/s is to be released for walleye spawning requirements at the base of South Falls

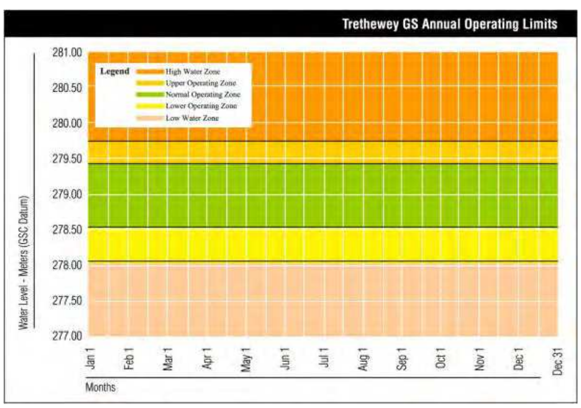
Goal/Purpose of Dam/Generating Station

The facility is capable of generating 2.81 MW of electricity at normal operation. .

Trethewey Falls Dam and Generating Station

Watershed Location - The Trethewey Falls dam and generating station are owned by OPG, and located approximately 5 km downstream from Matthias Falls. Outflow from the facility discharges into the forebay of the Hanna Chute station, located 3.2 km downstream. The dam controls a drainage area of 1656 km^2.

Structural Characteristics - The 12-m high concrete dam contains three 4.57-m sluiceways, and the power station intake, and extends a total length of 67 m. The powerhouse is located approximately 22.9 m to the west of the sluiceways, and discharges to a tailrace separated from the main sluiceway channel by a small island. The dam and powerhouse were completed in 1929.



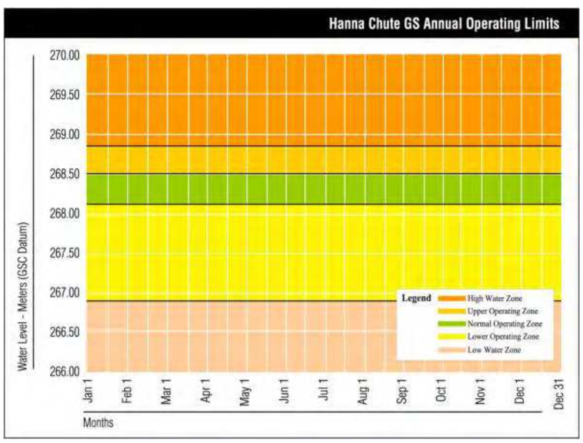
Operational Characteristics - Plant is a run-of river operation with no seasonal water level changes. Nominal head-pond level is 278.98 m with a normal and absolute operating range of 0.91 (to 279.43 m) and 1.68 m (to 268.84 m) respectively. Maximum plant capacity is 19.9 m^3/s.

Goals/Purpose of Facility
The facility has 1.74 MW of generating capacity. The dam provides an operating head of 10.7 m.

Hanna Chute Dam and Generating Station

Watershed Location - The dam and generating station are located approximately 750 m upstream from the South Falls dam and has a drainage area of 1683 km^2.

Structural Characteristics - The OPG owned Hanna Chute dam and powerhouse are an integrated structure. The dam consists of 2 (35 m and 12 m long) wingwalls, the powerhouse, and three 4.9-m wide sluiceways. The dam is approximately 13.5 m high.



Operational Characteristics - The facility is a run of river operation with no seasonal water level changes. Normal operating range is 0.39 m (268.11 m to 268.5 m) with a maximum possible range of 1.95 m). The dam exerts an upstream influence to the foot of Trethewey Falls, and maintains a normal head of approximately 9 m above the South Falls head pond.

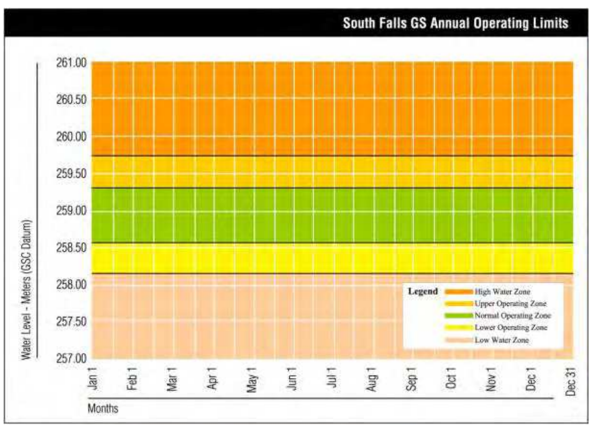
Goal/Purpose of Dam Operation

The facility has 1.46 MW of generating capacity under normal conditions.

South Falls Dam and Generating Station

Watershed Location - The South Falls dam and generating station are owned by OPG, and are located on the South Muskoka River approximately 4 km upstream from its confluence with the North Muskoka River. It has a drainage area of 1683 km^2. It is immediately downstream of Hanna Chute.

Structural Characteristics - The 6-m high, 11-m long concrete dam was built in 1904, and contains three power station intakes (connections to penstocks), two operable sluiceways, and is located on the east side of Highway 11. The powerhouse is situated 308 m downstream on the west side of Highway 11, and is connected to the dam by three wood stave penstocks.



Operational Characteristics - The facility is a run-of-river operation with no seasonal water level changes. Normal operating range is 0.73 m (259.32 m to 258.59 m) with a maximum possible range of 1.56 m. A downstream flow release of 3 m^3/s is required during the walleye spawning period (for walleye spawning in the South Falls bypass channel).

Goal/Purpose of Dam Operation
The facility has three units with a total generating capacity of 5 MW.

5.4 Lower Subwatershed Structures and Current Operating Strategies

There are 13 water control structures on the Lower Subwatershed of the Muskoka River and its tributaries. Of these, 9 are owned and operated by MNR, 3 by OPG, and 1 by Algonquin Power. The location, key characteristics and a photo of each Lower Subwatershed structure is provided in Figure 5.1c. Four of these structures are spill dams (Kapikog Lake, Healey Lake, Gull Lake and Go-Home Lake Dam No. 2) and the operation of a further two dams (Skeleton Lake and Go-Home Lake) will not change. These dams are described in this section, but are not further discussed in this WMP as no changes to their operations are proposed.

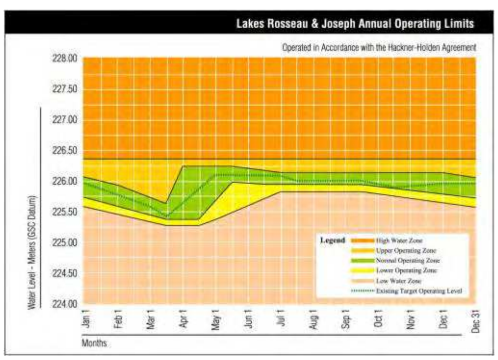
Skeleton Lake Dam

This MNR dam is located at the outlet of Skeleton Lake, which discharges into the Bent River and subsequently Lake Rosseau located approximately 5 km downstream. The dam was reconstructed in 2001 as a 10-m long overflow spillwall with a low-level valve, which maintains a normal summer head of 0.53 m of water. The dam is maintained for recreational purposes.

Port Carling Dam

Watershed Location - This MNR dam is located on the Indian River at the outlet of Lake Rosseau in the Village of Port Carling. It controls the levels in both Lake Rosseau and Lake Joseph. The dam controls a drainage area of 798 km^2 and the upstream lakes have a total surface area of 116.3 km^2. Outflow from the dam drains into the north end of Lake Muskoka (*Indian River).*

Structural Characteristics - The 3.5-m high concrete dam consists of six 4.27-m wide sluices (with 8 stop logs) and 12.4 m of overflow spillwall, and holds back 0.62 m of water in the upstream lakes (Rosseau and Joseph) during normal summer conditions. The sill elevation is 223.73 m GSC and the spillwall crest elevation is 226.47 m GSC. A set of navigation locks, used for small recreational vessels, is incorporated into the structure. The dam and small navigation locks form one structure located in a natural outlet channel from the lake while a large navigation lock is located in a diversion channel on the west side of the island.



Operational Characteristics - The dam is operated in accordance with the Hackner-Holden agreement. The lakes are maintained with a narrow summer operating range (0.2 m), with a target operating level of 226.02 m GSC, to facilitate navigation of large boats (steam ships) through the locks and access to many of the docks around the lake. The large lock must be maintained with a minimum depth of 2.65 over the sill. The normal summer head is 0.62 m. Fall drawdown is 0.1 m from September 15 to October 15 to set level for lake trout spawning and there is a maximum winter drawdown between October 15 to March 1 of 0.45 m to protect incubating lake trout eggs. A minimum discharge of 0.7 m^3/s is required during dry conditions for water quality purposes. The flow from the lake to the dam is through a narrow 200 m rock channel in the Indian River which can result in water levels of up to 0.2 m between the lake level and dam in high flows. Dam discharges greater than 20 m^3/s can affect navigation through the locks and flows in excess of 42.5 m^3/s downstream causes flood damage.

Goal/Purpose of Dam Operation

The dam is used for navigation, recreation, spring flood control, fisheries, and power production.

Gull Lake Dam

This MNR dam is located on the Hoc Roc River, immediately downstream from the outlet of Gull Lake. The dam is a non-operational weir that regulates water levels on Gull Lake for recreational and cottage purposes. The dam was reconstructed in 1953 by the Ontario Department of Public Works. The Town of Gravenhurst removes debris from the dam when necessary. Flow from the river drains into South Bay on Lake Muskoka.

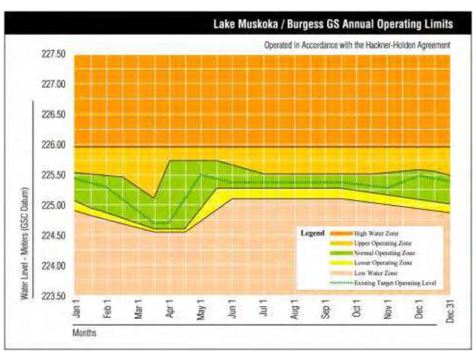
Bala North and South Dams

Bala North Dam

Watershed Location - MNR's Bala North and Bala South dams are located at the main outlets of Lake Muskoka – the largest lake in the watershed. They control water levels on Lake Muskoka up to the Port Carling dam to the north and Bracebridge Falls (on the North Muskoka River) to the east. Water from the entire Muskoka watershed up to this point drains through these dams. Outflow from the dams enters the Bala Reach of the Moon River. The dam controls a drainage area of 4683 km^2 and the surface area of the lake of 120 km^2.

Bala South Dam

Structural Characteristics - Both dams were originally constructed in 1915 and have since been repaired/upgraded several times. The North dam is 4 m high and contains six sluices with 7/8 stop logs, being approximately 35 m in length. The South dam is also 4 m in height, and contains eight sluices (with 8 stop logs each) and approximately 24 m of overflow spillwall for a total length of 58 m.



Operational Characteristics - The dams are operated under the Hackner-Holden agreement. The dams are located at the lower end of the watershed and complex operation of the dams is required. Flooding can occur both upstream and downstream of the dams during heavy rainfall events and a balance is required between flooding the lake and the downstream Bala Reach. Outflows greater than 283 m^3/s causes downstream flooding. The downstream operating flows below the Bala Dams are shown in the adjacent chart. A 85 m^3/s outflow is maintained where possible during the winter for down stream power production. A minimum flow of 3.0 m^3/s is required for downstream water quality. The normal summer operating range for the lake is 0.24 m with a target operating level of 225.4 m GSD. A fall drawdown of 9 cm from September 1 to November 1 is to assist lake trout spawning and there is a maximum winter drawdown between October 15 and March 1 of 0.45 m for lake trout egg protection. Any dam operation must be coordinated between the Baysville, Port Sydney and Port Carling dams upstream and OPG must be contacted every time any log changes are made

Goal/Purpose of Dam Operation

The dam is used for flood protection, recreation, navigation, fisheries and power production purposes.

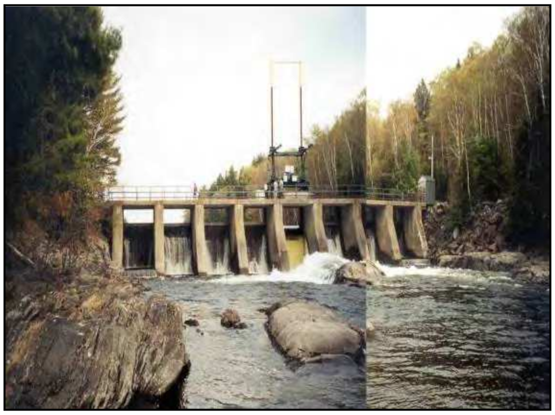
Burgess Generating Station

Watershed Location - The Burgess generating station, owned by Algonquin Power (Fund) Canada Inc. and operated by Algonquin Power Systems Inc., is located on the most northerly outlet from Lake Muskoka to the Bala Reach.

Structural Characteristics – The dam and powerhouse are integrated into one structure, which is situated in a constructed channel. The facility has two units.

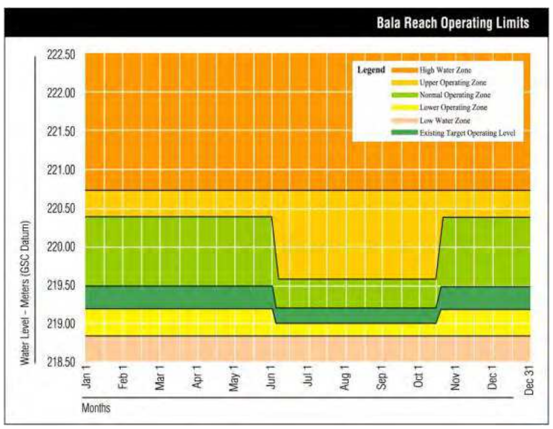
Operational Characteristics - The facility is rated at 0.14 MW, and operates when Lake Muskoka water levels are within an acceptable range. The facility has no spill capacity as upstream water level control is provided by the Bala North and Bala South dams.

Moon Dam



Watershed Location - The Moon Dam, owned and operated by OPG, is located on the Moon River less than 1 km downstream from its junction with the Musquash River. The dam stores and directs water away from the Moon River and into the Musquash to provide flow for the Big Eddy and Ragged Rapids Power plants. The dam has a drainage area of 4707 km^2.

Structural Characteristics - The dam is 8 m high, 76.5 m long and contains eight sluices.

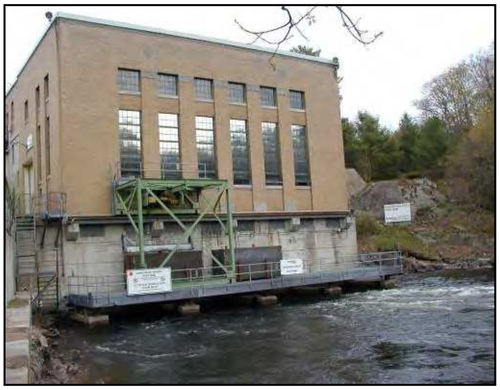


Operational Characteristics – In conjunction with the Ragged Rapids Dam and Generating Station, the Moon Dam maintains water levels in Bala Reach, and provides flow in the Musquash River for the Ragged Rapids and Big Eddy generating stations. The dam is normally closed, but opened when flows exceed 85 m^3/s (the capacity of the Musquash River plants) to progressively pass water into the Moon River. The normal summer operating range in Bala Reach is 0.27 m (219.0 m to 219.27 m GSC) and the winter range is 0.3 m (219.21 m to 219.51 m GSC). The flood damage zone occurs at elevation 220.75 m GSC, which corresponds to flows of approximately 283 m^3/s. While not a routine occurrence, flows of this magnitude can occur during the spring freshet and during severe summer or fall storm events. The Moon Chutes, a constriction in the river channel at the downstream end of Bala Reach, restricts flow above approximately 80 m^3/s, and aggravates high water levels in Bala Reach during high flows. A target flow of 14 m^3/s has generally been passed through the dam during the walleye spawning period (mid-April to June 1), although lower flows (8 to 10 m^3/s) have been targeted in recent years in an attempt to provide sustained flow throughout the walleye spawning period.

Goal/Purpose of Dam Operation

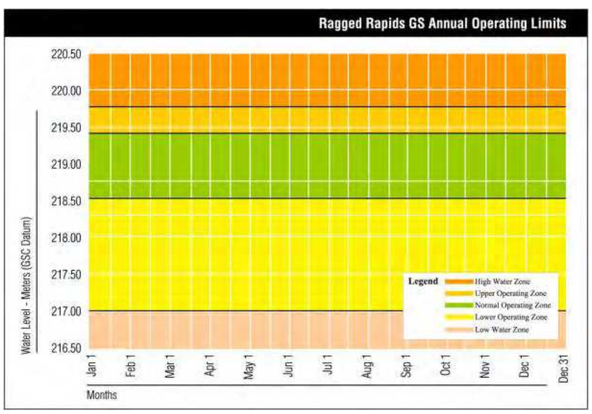
The dam is used to divert water for power production and operated to provide flow for the walleye spawning area at Moon Falls.

Ragged Rapids Dam and Generating Station



Watershed Location - The dam and powerhouse at OPG's Ragged Rapids facility are located approximately 1 km downstream from the junction of the Moon and Musquash rivers, and 6.4 km from Bala. Water discharged from the facility continues down the Musquash River to the Big Eddy GS. The upstream drainage area from the dam is 4707 km^2

Structural Characteristics - The 10 m high dam, spillway and integral powerhouse were constructed in the mid 1930's at the site of a former 9-m high waterfall. The one 6.1-m wide spillway has a sill 4.6 m below the normal water level. There are two bulkhead wingwalls with top width of 0.9m.



Operational Characteristics - The station is operated in conjunction with the Moon Dam, and is a run-of-river facility. The normal operating range is 0.92 m (218.54 to 219.46 m) with a maximum possible range of 2.77 m. Low water levels are the typical occurrence, particularly during high flow periods, as the Ragged Rapids head pond is lowered to encourage flow out of Bala Reach through the Moon Chutes. Typically a flow of 84 m^3/s is passed down Musquash River to Go-Home Lake if sufficient flows are available. The maximum flow to Go-Home Lake is restricted to 113 m^3/s to avoid flooding/high water conditions.

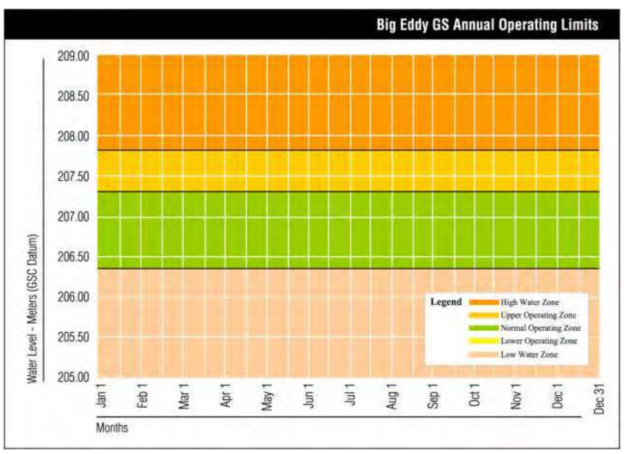
Purpose/Goal of Generating Station

The facility is rated at 8 MW generating capacity.

Big Eddy Dam and Generating Station

Watershed Location - OPG's Big Eddy dam and generating station are located on the Musquash River approximately 7.2 km downstream from the Ragged Rapids facility. It has a drainage area of 4724 km^2. Water is discharged downstream to Go-Home Lake.

Structural Characteristics – The Big Eddy powerhouse is a duplicate of the Ragged Rapids facility. Head-pond levels are controlled by a 29-m long dam with four 4.47-m long sluiceways, which provides head at the powerhouse. There is also an 88.39-m spillwall. The facility was constructed in 1941.



Operational Characteristics - This is a run-of-river operation with no seasonal water level changes. The normal operating range is 0.95 m (207.3 m to 206.35 m GSC) with a maximum possible range of 1.47 m (to elevation 207.82 m GSC). The maximum flow into Go-Home Lake is 113 m^3/s to avoid flooding/high flow conditions on the lake. The generating station is operated in conjunction with Moon Dam and Ragged Rapids Generating Station.

Purpose/Goal of Generating Station

Big Eddy has the same generating capacity (8 MW) as the upstream Ragged Rapids facility.

Kapikog Lake Dam

This MNR dam is located at the outflow of Kapikog Lake, which flows into Healey Lake. The dam, constructed in 1967 to replace a failing beaver dam, consists of a 9-m long concrete spillway with a low-level valve that is no longer operated. The long spillwall serves to adequately maintain summer water levels for recreational purposes.

Healey Lake Dam

This MNR dam is located on Conger Creek approximately halfway between the outlet of Healey Lake and the Moon River. The dam, originally constructed in 1930, was reconstructed as a non-operable concrete weir in 1993. The weir now maintains lake levels for recreational purposes.

Go-Home Lake Dams

Two dams control the outflow from Go-Home Lake, being an operational dam at the south end of the lake at its outlet to the Musquash River, and a filter dam at the north end of the lake which discharges into the Go-Home River. The main control dam is a 5.5-m high concrete dam with four sluiceways, that is the last dam on the Muskoka River system before it empties into Georgian Bay. It was last reconstructed in 1960 and is operated to maintain lake levels for recreational purposes. The filter dam is constructed of porous rock fill, is non-operable and allows some leakage into the downstream channel.

Dam Site No.	(1) Structure Name (Location)	(2) Watercourse	(3) Type of Structure	(4) Description of Dam	(5) Approx. Height (m)	(6) Control Section Details	(7) Drainage Area (km^2)	(8) Lake Surface Area (km^2)	(9) Summer RWL (m)	(10) Owner/ Operator	(11) Purpose/Use of Structure	(12) Est. Mean Monthly Flow (m^3/s)	(13) WL Gauge (Y/N)
Control Dams													
1	Kawagama Lake Dam	South Muskoka River	Concrete	Sluices (2), Spillwalls (2)	5	2-4.27 m sluices, 14.26 m, and 1-31.0 m spillwalls	380	31.9	355.6 GSD	MNR	Rec., Nav., WC, P, Fish.	n/a	Y
2	Burnt Island Lake Dam	Joe Lake	Concrete	Sluice (1), Spillwalls (2), Valve (1X)	4.2	1-3.66 m sluice, 0.75 m and 6.78 m spillwalls, 0.76x0.76 m valve	59.1	8.8	428.5 GSD	MNR	Rec., Fish.	n/a	Y
3	Joe Lake Dam	Oxtongue River	Concrete	Sluice (1), Spillwall (1), Valve (1X)	4.5	4.27 m sluice, 20.73 m spillwall, 0.91x0.91 m valve	117.9	5.83	421.85 GSD	MNR	Rec., Fish., WC	n/a	Y
4	Tea Lake Dam (Canoe, Smoke & Tea Lakes)	Oxtongue River	Concrete	Sluices (2), Spillwall (1), Valve (1X)	4	2-4.27 m sluice, 27.47 m spillwall, 0.91x0.91 m valve	344	12.53	417.82 GSD	MNR	Rec., Nav., WC, P, Fish.	6.2	Y
5	Baysville Dam (Lake of Bays)	South Muskoka River	Concrete	Sluices (9), Spillwall (1)	3.5	4.27 m sluice, 32.1 m spillwall	1481	68.4	315.22 GSD	MNR	Rec., Nav., WC, P, Fish.	23	Y
6	Wood Lake Dam	South Muskoka River	Concrete	Sluice (1), Spillwall (1)	2.5	4.27 m sluice, 1.22 m spillwall	34.7	3.76	301.06 GSD	MNR	Rec.	n/a	Y
7	Camp Lake Dam	Tasso Creek	Concrete	Sluice (1), Spillwall (1), Valve (1)	3	3.05 m sluice, 36.8 m spillwall, 0.76x0.76 m valve	17.8	2.2	412.6 GSD	MNR	Rec.	n/a	Y
8	Tasso Lake Dam	Tasso Creek	Concrete	Sluice (1)	4	4.27 m sluice	42	1.89	399.4 GSD	MNR	Rec.	n/a	Y
9	McCraney Lake Dam	Big East River	Concrete	Sluice (1), Spillwall (1), Valve (1)	6	4.27 m sluice, 7.58 m spillwall, 0.76x0.76 m valve	44.3	4.4	444.85 GSD	MNR	Rec., P	n/a	Y
10	Buck Lake Dam	Buck River	Concrete	Sluices (2), Spillwalls (5)	3	2-4.27 m sluices, 7.32 m, 3.15 m, 7.32 m, 7.85 m, and 4.11 m spillwalls	205.1	2.75	300.45 LCD	MNR	Rec.	n/a	Y
11	Fox Lake Dam	Buck River	Concrete	Suices (2), Spillwalls (2)	3	2-4.27 m sluices, 2.15 m, 4.45 m spillwalls	218.8	1.4	294.45 GSD	MNR	Rec.	n/a	Y
12	Huntsville Dam (Vernon, Peninsula, Fairy Lakes)	North Muskoka River	Concrete	Sluices (6), Spillwals (1), Nav. Lock	4.5	4-5.6 m sluices, 5.3 m and 6.1 m sluices, 15 m spillwall	1160	30.8	283.77 GSD	MNR	Rec., Nav., WC, P, Fish.	n/a	Y
13	Port Sydney Dam (Mary Lake)	North Muskoka River	Masonry & Concrete	Sluices (7), Spillwall (1)	4	3-5.67 m sluice, 4-5.64 m sluices, 57.91 m spillwall	1391	10.25	280.73 GSD	MNR	Rec., Nav., WC, P	24.3	Y
14	Clearwater Lake Dam	Trib. To N. Muskoka	Concrete	Sluice (1)	1	1-1.83 m sluice	3.15	0.79	30.3 LCD	MNR	Rec.	n/a	N
15	Skeleton Lake Dam	Bent River	Concrete	Spillwall (2), Valve (1X)	2	6.0 and 4.0 m spillwalls, 1-0.91 m diameter valve	70.6	20.4	280.69 GSD	MNR	Rec.	n/a	Y
16	Port Carling Dam (Lakes Rosseau & Joseph)	Indian River	Concrete	Sluices (6), Spillwalls (2)	3.5	6-4.27 m sluices, 5.4 m, and 7 m spillwalls	798	116.3	226.02 GSD	MNR	Rec., Nav., WC, P	n/a	Y
17	North Bala Dam (Lake Muskoka)	Muskoka River	Concrete	Sluices (6)	4	1-4.88 m sluice, 5-6.1 m sluices	4683	120	225.4 GSD	MNR	Rec. Nav., Fish., P	76.3	Y
18	South Bala Dam (Lake Muskoka)	Muskoka River	Concrete	Sluices (8), Spillwalls (2)	4	8-4.27 m sluices, 18.77 m, and 5.13 m spillwalls	4683	120	225.4 GSD	MNR	Rec. Nav., Fish., P	76.3	Y
19	Go-Home Lake Dam #1	Musquash River	Concrete	Sluices (4)	5.5	4-4.27 m sluices	4802	6.76	185.15 GSD	MNR	Rec.	62.7	Y
20	Moon Dam	Moon River	Concrete	Sluices (8)	8	8-4.27 m sluices	4707	n/a		OPG	WC, Fish.	n/a	Y
21	Mathias Falls Dam	South Muskoka River	Concrete	Sluices (2), 1 waste gate	13.7	3-4.87 m sluices	1642	n/a	292.61 LCD	OPC	P	n/a	Y
22	Trethewey Falls Dam	South Muskoka River	Concrete	Sluices (3), Spillwalls (1)	12	3-4.57 m sluices, 1-55.5 m spillwall	1656	n/a	279.0 GSD	OPG	P	n/a	Y
23	Hanna Chute Dam	South Muskoka River	Concrete	Sluices (3)	13.5	3-4.57 m sluices	1683	n/a	268.3 GSD	OPG	P	n/a	Y
24	South Falls Dam	South Muskoka River	Concrete	Sluices (3)	7	3-4.42 m sluices	1683	n/a	259.0 GSD	OPG	P	n/a	Y
25	High Falls Dam	North Muskoka River	Concrete	Sluices (5)		2-4.87 m sluices, 2.44 m, 11.28 m, and 4.27 m sluices	1523	n/a	268.83	BGL	P	n/a	Y
26	Wilson Falls Main Dam	North Muskoka River	Concrete	Sluices (3), Spillwalls (3)		Main Dam: 1-7 m gate, 3- spillwalls 109.5m long Spill Dam: 1-2.87 m sluice, 1-3.05 m gate	1556	n/a	254.1	BGL	P	n/a	Y
27	Bracebridge Falls Dam	North Muskoka River	Concrete	Sluices (4), Spillwalls (3)		2-4.87 m sluices, 1-4.57 m sluice, 1-2.44 m sluice 5.79 m, 5.33 m, and 4.45 m spillwalls	1568	n/a	235.64	BGL	P	n/a	Y
28	Ragged Rapids Dam	Musquash River	Concrete	Sluice (1)	10	1-6.1 m sluice	4707	n/a	219.2 GSD	OPG	P	n/a	Y
29	Big Eddy Dam	Musquash River	Concrete	Sluices (4), Spillwall (1)	10	4-4.27 m sluices, 1-88.39 m spillwall	4724	n/a	206.8 GSD	OPG	P	n/a	Y
30	Ragged Lake Dam	Tea Creek	Concrete	Sluice (1), Spillwalls (2), Valve (1)	3.5	1-2.44 m sluice, 44.3 m and 65.8 m spillwalls, 0.76x0.76 m valve	69.9	4.12	432.3 GSD	MNR	Rec., WC	n/a	Y
31	Bird's Mill Dam	North Muskoka River								DMOM			
32	Burgess Dam	Muskoka River	Concrete	Power Intake	4	n/a	4683	120	225.4 GSD	AP	P	n/a	Y

Abbreviations:
P - Hydropower; WC - Water control
IWS - Industrial Water Supply; Rec. - Recreation
Nav. - Navigation; Fish. - Fisheries
LF - Low Flow Augmentation
DWS - Domestic Water Supply; FP - Fire Protection of village/town
RC - Reinforced concrete
RWL - Regulated Water Level
LCD - Local Construction Datum
GSD - Geodetic Survey Datum
MNR - Ministry of Natural Resources
OPG - Ontario Power Generation
AP - Algonquin Power
OPC - Orillia Power Generation
BGL - Bracebridge Generation Ltd.
DMOM - District Municipality of Muskoka

Notes:
Mean monthly flow values were derived from WSC gauges directly below the dams in question, with exception of Go-Home Dam.
WSC gauges used to estimate mean monthly flow included: 02EB004, 02EB006, 02EB008, 02EB012, 02EB013, 02EB014
Mean monthly flow for Go-Home Dam represents dam inflow, all other flows represent dam outflow.
WSC flow data below Distress, Bala, and Tea Dams was prorated to these respective dam sites.
X - valve not operational

Table 5.1 (b)
Physical Features of Spill Structures

Dam Site No.	(1) Structure Name (Location)	(2) Watercourse	(3) Type of Structure	(4) Description of Dam	(5) Approx. Height (m)	(6) Control Section Details	(7) Drainage Area (km^2)	(8) Lake Surface Area (km^2)	(9) Summer RWL (m)	(10) Owner/ Operator	(11) Purpose/Use of Structure	(12) Est. Mean Monthly Flow (m^3/s)	(13) WL Gauge (Y/N)
Spill Structures													
33	Kapikog Lake Dam	Trib. To Moon River	Concrete	Spillwall(1), Valve (1)	2.5	9.75 m spillwall, 1-0.9x1.2 m valve	14.8	2.85	30.3 LCD	MNR	Rec.		N
34	Fletcher Lake Dam	Fletcher Creek	Concrete	Spillwall (1), Valve (1X)	3.5	1-30.4 m spillwall, 1-0.94x0.94 m valve	24.3	2.61	27.84 LCD	MNR	Rec.	n/a	Y
35	Livingstone Lake Dam	Livingstone Creek	Concrete	Sluice (1), Spillwall (1)	2	1-4.27 m sluice, 15.4 m spillwall	48.4	1.86	372.1 GSD	MNR	Rec.	n/a	Y
36	Distress Dam	Big East River	Concrete	Spillwalls (4)	5	4 m, 19.5 m, 3.1 m, 4 m	454.5	0.93	30.2 LCD	MNR	Rec.	8.9	N
37	Axe Lake Dam	Buck River	Concrete	Sluices (2), Spillwalls (2)	1.5	2-3.86 m sluices, 3.9 m, and 3.05 m spillwalls	48.4	n/a	29.33 LCD	MNR	Rec., FP, WC	n/a	N
38	West Harry Lake Dam	Big East River	Timber	Spillwall (1), Valve (1)	3	14.9 m spillwall, 0.91 m diameter valve	38.9	1.52	31.8 LCD	MNR	Rec., LF	n/a	Y
39	Devine Lake Dam	Trib. To N. Muskoka R.	Concrete	Sluice (1)	1.5	1-2 m sluice	12.1	0.38	29.5 LCD	Private	Rec.	n/a	N
40	Go-Home Lake Dam #2	Musquash River	Concrete	Filter Dam	5.5	Filter Dam	4802	6.76	185.15 GSD	MNR	Rec.	62.7	Y
41	Healey Dam	Trib. To Moon River	Concrete	Spillwall (2)	1.5	1-0.9 m spillwall, 1-23.5 m spillwall	69.9	10.4	99.77 LCD	MNR	Rec.		
42	Gull Lake Dam									MNR			

Abbreviations:
P - Hydropower; WC - Water control
IWS - Industrial Water Supply; Rec. - Recreation
Nav. - Navigation; Fish. - Fisheries
LF - Low Flow Augmentation
DWS - Domestic Water Supply; FP - Fire Protection of village/town
RC - Reinforced concrete
RWL - Regulated Water Level
LCD - Local Construction Datum
GSD - Geodetic Survey Datum
MNR - Ministry of Natural Resources
OPG - Ontario Power Generation
AP - Algonquin Power
Orillia - Orillia Power Generation
Bracebridge - Bracebridge Generation Ltd.
DMOM - District Municipality of Muskoka

Notes:
Mean monthly flow values were derived from WSC gauges directly below the dams in question, with exception of Go-Home Dam.
WSC gauges used to estimate mean monthly flow included: 02EB004, 02EB006, 02EB008, 02EB012, 02EB013, 02EB014
Mean monthly flow for Go-Home Dam represents dam inflow, all other flows represent dam outflow.
WSC flow data below Distress, Bala, and Tea Dams was prorated to these respective dam sites.
X - valve not operational

Table 5.2
Existing Flow and Water Level Operating Constraints
for Muskoka River Dams

Area of Watershed	Control Structure	Purpose	Flooding	Fisheries and Wildlife	Water Quality	Recreation	Municipal/Industrial/Other
NORTH MUSKOKA RIVER							
BIG EAST RIVER							
West Harry Lake Dam	Controls levels on West Harry Lake Timber dam – 3 m high Spillway Crest– 14.9 m long Slide control valve 0.91 m diameter Valve not operated since 1993	Recreation	• Start of flood damage zone (FDZ) identified at 33.0 m (LCD), but no development on lake.			• Summer water levels maintained within wide operating range of 0.8 m for recreational use	
McCraney Lake Dam	Controls levels on McCraney Lake Concrete dam – 6 m high 1- 4.27 m wide sluice with stop logs – stop logs operated only during repairs/maintenance 1- 7.58 m wide spillwall Slide control valve - 0.76 m diameter Valve opened mid August and closed by mid October annually	Recreation, Low flow augmentation on Big East River Power production Fisheries protection	• Start of FDZ for McCartney Lake is 445.79 m (GSC).	• Lake must not be drawn down after October 15th to protect lake trout spawning.	• Low flow augmentation in Big East in late summer	• Summer water levels maintained within wide operating range of 0.8 m for recreational use	
Camp Lake Dam	Concrete dam – 3 m high 1 – 3.05 m wide sluice with stop logs Stop logs operated only for repairs/maintenance 1- 36.8 m wide spillwall Square slide control valve 0.76x 0.76 m Valve opened late Sept for 0.95 m drawdown, reduce opening to <5 cm prior to Oct. 15, close valve in November Valve settings coordinated with Tasso Lake Dam	Recreation, fisheries protection	• Start of FDZ for Camp Lake is 412.90 m (GSC) • Cottage development on lake moderately susceptible to flooding	• Valve opening reduced by Oct 15 prior to lake trout spawning,, closed completely in November to keep fish spawning shoals covered.	• No specified flow or water level requirement for water quality considerations	• Summer water levels maintained within wide operating range of 0.3 m for recreational use	
Tasso Lake Dam	Concrete dam with road across the top – 4 m high 1- 4.27 m wide sluices with 8 stop logs	Recreation Road	• Start of FDZ for Tasso Lake is 399.85 m (GSC). • Dam must not be overtopped as no spillwall and roadway embankments will erode • Cottage development on lake moderately susceptible to flooding • Dam is operated in flood periods, lake rises quickly during flooding	• No specified flow (leakage only) or water level requirements for fish or wildlife considerations.	• 0.5 cms minimum outflow maintained by leakage for downstream water quality	• Summer water levels maintained within operating range of $\pm$ 0.2 m for recreational use	The dam doubles as a road bridge over Tasso Creek
Distress Dam	Controls Distress Pond on Big East River Concrete overflow weir – 3.5 m high and 30.54 m in length containing a 4.0 m wide low flow notch	Recreation	• Start of FDZ is 101.3 m (LCD).	• No specified flow or water level requirements for fish or wildlife considerations	• No specified flow or water level requirement for water quality considerations		
AXE CREEK							
Axe Lake Dam	4 km downstream of Axe Lake outlet Concrete dam – 3 m high 2 – 5.8 m wide sluices with 1 stop log each and 2 overflow spill walls Operated as self regulating spill dam/weir	Recreation, fire protection for Yearley	• Long meandering upstream channel between dam and Axe Lake restricts outflow from lake in high flows	• No specified flow or water level requirements for fish or wildlife considerations	• No specified flow or water level requirement for water quality considerations	• Dam provides increased water levels for recreational pursuits on Axe Lake	Fire protection for Yearley
Buck Lake Dam	Also known as Campbell Dam - 2.2 km downstream of Buck Lake outlet. Controls levels on Buck and Fawn Lakes Concrete dam – 3 m high 2 – 4.27 m wide sluices with 3 stop logs each 3 - overflow spill walls	Recreation	• Start of FDZ for Buck Lake is 301.30 m (GSC). • Operation of dam required during any summer flood period • Flood storage capacity for downstream flood control in spring is small • Some flow restrictions at Buck Lake bridge at lake outlet under high flows	• No specified flow or water level requirements for fish or wildlife considerations	• No specified flow or water level requirement for water quality considerations	• Summer water levels are maintained within the normal summer operating levels for recreational purposes	
Fox Lake Dam	On outlet to lake on the Buck River Concrete dam 2 – 4.27 m wide sluices with 4 stop logs each 2- 2.15 m and 4.45 m wide spillwalls	Recreation	• Start of FDZ for Fox Lake is 295.72 m (GSC).	• No specified flow or water level requirements for fish or wildlife considerations.	• No specified flow or water level requirement for water quality considerations	• Maintain summer RWL of 294.45 (GSC) to within ± 0.2 m.	

Table 5.2
Existing Flow and Water Level Operating Constraints for Muskoka River Dams

Area of Watershed	Control Structure	Purpose	Flooding	Fisheries and Wildlife	Water Quality	Recreation	Municipal/Industrial/Other
NORTH MUSKOKA RIVER							
Huntsville Dam	Regulated under Hackner-Holden Agreement 5 km downstream of Highway 11b bridge in Huntsville and 0.7 km downstream of outlet from Fairy Lake Controls levels on Fairy, Peninsula and Vernon lakes Concrete control dam – 4.5 m high 6 – stop log bays (5 – 6.1 m wide, 1 – 5.74 m wide) 7 to 8 logs/bay 2.85 m high from stop log sill to crest of retaining wall – medium degree of difficulty to operate Navigation lock – concrete retaining wall of dam is part of lock approach channel	Recreation, Navigation, Spring flood control, Winter power production, Fisheries	• Start of FDZ for Huntsville lakes is 284.62 m (GSC). • Huntsville lakes experience the largest fluctuations of all lakes in the watershed, due to uncontrolled runoff from the Big East River – frequent dam control required to react to the flows from the Big East • Flooding can be a major issue in summer when summer lake levels higher and more residents affected • Some flow restriction at bridge in Huntsville may cause higher water levels in Lake Vernon • Flooding can occur along channel below dam when flows exceed 141 m^3/s • If snow water content above normal by early March draw down may be lowered below Mar 15 normal • 0.54 m draw down Dec. 1 to March 15 for spring flood control	• Lake draw down of 24 cm from September 15 to October 15 prior to lake trout fall spawning period • Lake trout draw-down rule of maximum 0.45 m between October 15 and March 1 to help protect lake trout eggs on spawning shoals (Hackner-Holden agreement) • .Minimum outflow of 3 m^3/s to be maintained by leakage for water quality and fisheries throughout summer	• Minimum outflow of 3 m^3/s to be maintained by leakage for water quality and fisheries throughout summer	• Maintain summer (July 1 – Sept. 15) RWL of 283.77 m (GSC) within a normal summer operating range of 30 cm. • Navigation lock incorporated into east side of dam – channel adjacent to dam leading to lock entrance • Minimum crest elevation of earth dike along upstream lock approach channel of 284.25m must not be exceeded at dam or danger of washing out dike wall and draining lakes • River below dam is navigational to Mary Lake • During fall/winter thaws to stay within summer rule curve to protect docks otherwise lake ice will lift/damage docks	• Winter drawdown is for downstream hydro power production - 11 m^3/s is plant capacity at 3 Bracebridge Generation Limited plants on North Muskoka River No use of lake storage in summer for power production • Downstream dam at Port Sydney must be operated any time Huntsville dam is operated
Port Sydney Dam	Regulated under Hackner-Holden Agreement At outlet to Mary Lake on North Muskoka River –controls level on Mary Lake Concrete control dam – approximately 4 m high 7- stop log bays (~ 5.64 m wide) with 5 to 7 logs/bay - medium to high degree difficulty to operate 1 – 57.91 m long spillwall at 281.87m (GSC)	Recreation, Navigation Spring flood control Winter power production Fisheries	• Start of FDZ for Mary Lake 281.15 m (GSC) • 0.48 m draw down Dec 15 – Mar 15 for spring flood control and hydro power production • If snow water content above normal by early March draw down may be lowered below Mar 15 normal	• Winter draw down rule for lake trout is 0.45 m maximum Oct 15 to Mar 1 • Fall draw down 0.22 m from Sept 15 to Oct 15 prior to lake trout fall spawning • Minimum outflow of 3 m^3/s to be maintained by stop log manipulation and leakage for water quality and fisheries throughout summer	• Minimum outflow of 3 m^3/s to be maintained by stop log manipulation and leakage for water quality and fisheries throughout summer	• Maintain summer (June 15 – Sept. 15) RWL of 280.73 m (GSC) within a normal summer operating range of 0.34 m (+0.15 m / -0.18 m) • During fall/winter thaws to stay within summer rule curve to protect docks otherwise lake ice will lift/damage docks	• Winter drawdown is for spring flood control and downstream hydro power production - 11 m^3/s is plant capacity at 3 Bracebridge Generation Limited plants on North Muskoka River– maintain this flow where possible during drawdown • No use of lake storage in summer for power production • All stop log operations to be coordinated with Huntsville dam upstream and hydro operations downstream
High Falls	Located at immediately upstream of High Falls Concrete dam is 3-m high and 28-m in length and consists of a concrete overflow weir, an automated sluiceway and the power station intake Owned and operated by Bracebridge Generation Limited Estimated operating head of 14.63 m Run of river facility	Power production	• Run of river facility, with estimated plant capacity of 12 m^3/s - if river falls below the required plant capacity, generation is scaled back • Flow in excess of plant capacity is spilled by passing the plant • Normal summer water level 268.83 m	• No specified flow or water level requirements for fish or wildlife considerations	• No specified flow or water level requirement for water quality considerations	• No specified flow or water level requirement for recreational considerations	• Total installed capacity of 0.8 MW
Wilson Falls	Located approximately 2.4 km upstream from the Town of Bracebridge Main dam consists of a 109.5-m long overflow section and a 7-m wide electric gate Secondary dam consists of an 8-10 m high concrete dam with one sluiceway and the power intake gate	Power Production	• Run of river facility, with estimated plant capacity of 12 m^3/s - if river falls below the required plant capacity, generation is scaled back • Flow in excess of plant capacity is spilled by passing the plant • Normal summer water level 254.08 m	• No specified flow or water level requirements for fish or wildlife considerations	• No specified flow or water level requirement for water quality considerations	• No specified flow or water level requirement for recreational considerations	• Total installed capacity of 0.6 MW
Bird's Mill	Concrete and masonry dam – approximately 5 m high - spillways and 3 active spillways Owned by District Municipality of Muskoka Originally developed to power tannery, woolen mill and pump municipally supplied water	Historic site	• No established rule curve – operated to pass flood flows in conjunction with upstream and downstream structures	• No specified flow or water level requirement for water quality considerations	• No specified flow or water level requirement for water quality considerations	• No specified flow or water level requirement for recreational considerations	• Bracebridge historical site • Dedicated as an American Waterworks Association Canadian Waterworks landmark
Bracebridge Falls	Facility consists of a 32.3 m long dam (4 sluices, 3 spillways) and powerhouse located at Bracebridge Falls Owned and operated by Bracebridge Generation Limited	Power Production	• Run of river facility, with estimated maximum plant discharge of 12 m^3/s - if river flow falls below the plant capacity, generation is scaled back. • Excess flow is spilled by passing the plant • Normal summer water level 235.64 m	• No specified flow or water level requirements for fish or wildlife considerations	• No specified flow or water level requirement for water quality considerations • Walleye spawning area below falls	• No specified flow or water level requirement for recreational considerations	• Total installed capacity of 0.6 MW

Table 5.2
Existing Flow and Water Level Operating Constraints
for Muskoka River Dams

Area of Watershed	Control Structure	Purpose	Flooding	Fisheries and Wildlife	Water Quality	Recreation	Municipal/Industrial/Other
DIVINE CREEK							
Clearwater Lake Dam	Located at outlet to Clear (water) Lake Concrete dam – 1 m high 1 – 1.83 m wide sluice with 1-2 x 8 inch board	Recreation, minor spring flood control	• No established FDZ • Board removed in October and replaced after run-off in May	• No specified flow or water level requirements for fish or wildlife considerations.	• Some low flow maintained downstream by notches in board	• Maintain summer RWL of 18 cm below top of dam - self regulating lake by the single gate	
Divine Lake Dam	Controls Divine Lake Concrete dam (1.5 m high) includes bridge deck 1 2m wide sluice with 4 – 10 cm stop logs	Recreation, Bridge, spring flood control	• No established FDZ • Fall draw down of 0.2 m after Oct. 1 for spring flood control	• No specified flow or water level requirements for fish or wildlife considerations.	• No specified minimum flow for water quality since minimum flow is maintained by leakage through the dam.	• Maintain summer RWL of 29.5 m (LCD).	• Single lane road bridge
SOUTH MUSKOKA RIVER							
OXTONGUE RIVER							
Burnt Island Lake Dam	Controls levels on Burnt Island Lake only Must coordinate log changes with Joe Lake and Tea Lake dams downstream Concrete dam – 4 m high 1 – 3.66 m wide sluice with up to 9 stop logs (normally 8 are used) 2 – overflow spill walls 1 – 0.76 x 0.76 m valve (not operational) Normal summer head – 2.82 m	Recreation, fisheries	• Start of FDZ for Burnt Island Lake is 429.0 m (GSC), although there is no development around the shoreline because it is within Algonquin Provincial Park	• Fall draw down must be completed by mid-October to protect fall-spawning fish populations	• No specified minimum flow for water quality since minimum flow is maintained by leakage through the dam.	• Summer levels maintained within wide operating range of 0.5 m for recreation within Algonquin Park	
Joe Lake Dam	Controls Joe, Little Joe, Tepee, Littledoe, Bluejay and Tom Thomson lakes Concrete dam – 4.5 m high Lake lowered 0.3 m between Sep. 15 – Oct. 15 and 0.55 m between Feb. 15 – Mar. 15 1 – 4.27 m wide sluice with 9 stop logs 1 – 20.73 m long spillwall Normal summer head – 2.91 m	Recreation, flood control, fisheries	• Start of FDZ for Joe Lake is 422.20 m (GSC) • Operated to try to reduce spring flooding in Lake of Bays, Lake Muskoka and the Muskoka River	• Fall draw down must be completed by October 15 to protect spawning lake trout • Winter draw down limit of 0.55 m to protect spawned fish eggs	• No specified minimum flow for water quality since minimum flow is maintained by leakage through the dam.	• Summer levels maintained within wide operating range of 0.4 m for recreation within Algonquin Park	• If lake rises after Oct. 15, water is stored for gradual release through the winter for downstream hydro power generation
Ragged Lake Dam	Concrete dam – 3.5 m high 1 – 2.44 m wide sluice with max. of 9 stop logs 2 – spillwalls with a total length of 110 m 1 – 0.76 x 0.76 m valve Dam acts as self-regulation overflow dam except in fall when valve is used for drawdown (1.2 m between Sep. 15 and Oct. 15) A 5 m long breach in the spill wall, about 0.75 m deep, controls summer water levels	Recreation, flood control	• Start of FDZ for lake is at 433.05 m (GSC) • Lake is used as a storage lake in spring and high flow periods to relieve flooding on downstream lakes	• No specified flow or water level requirements for fish or wildlife considerations.	• No specified minimum flow for water quality since minimum flow is maintained by leakage through the dam.	• Summer levels maintained within wide operating range of 0.6 m for recreation within Algonquin Park (i.e., canoeing)	
Tea Lake Dam	Controls Tea, Bonita, Canoe and Smoke Lakes Regulated under Hackner-Holden agreement Draw down of 0.34 m (Sep. 15 – Feb. 15) and 0.28 m (Feb. 15 – Mar. 15) (Total 0.62 m) Concrete dam – 4 m high 2 – 4.27 m wide sluices with 9 stop logs each 1 – 27.47 m long spill wall 1 – 0.91 x 0.91 m valve (kept closed but maintained operational) Normal summer head – 2.61 m	Recreation, navigation, spring flood control, winter power generation, fisheries	• Start of FDZ for Tea Lake is 418.20 m (GSC) • Tea Lake is used as storage to help reduce flooding on Lake of Bays	• Minimum outflow of 1.4 m^3/s	• Minimum outflow of 1.4 m^3/s	• Summer levels maintained within wide operating range of 0.35 m for recreation within Algonquin Park where there is less shoreline development	• Draw down in restricted until mid Feb. to prevent sloping and cracking of ice at the shoreline to allow MNR ski-equipped aircraft access to Smoke Lake hangar dock • If lake rises after Oct. 15 due to fall rains, store water for gradual natural release over winter for use in downstream hydro power generation
HOLLOW RIVER							
Livingstone Lake Dam	Controls Livingstone Lake only Concrete dam – 2 m high 1 – 4.27m wide sluice with 2 stop logs (not operated) 1 – 15.4 m long spillwall Normal summer head – 0.6 m	Recreation	• Dam has sufficient spill way capacity to pass most high flows without causing problems on the Lake	• No specified flow or water level requirements for fish or wildlife considerations.	• Free outflow at all flows	• Summer water levels maintained within the normal operating range by self-regulating nature of dam	

Table 5.2
Existing Flow and Water Level Operating Constraints for Muskoka River Dams

Area of Watershed	Control Structure	Purpose	Flooding	Fisheries and Wildlife	Water Quality	Recreation	Municipal/Industrial/Other
Fletcher Lake Dam	Controls Fletcher Lake Concrete dam – 3.5 m high Dam is a self regulating, 30.4 m long weir with no sluice There is one valve that is sealed shut, and is not operational Normal summer head – 2.29 m	Recreation	• Storage in lake is to small for downstream use • Lake has a small watershed area compared to its surface area and can store much of the spring run-off with only a small rise in lake level • Downstream road culvert may be exceeded during large flood events	• No specified flow or water level requirements for fish or wildlife considerations.	• Free outflow at all flows	• Summer water levels maintained within the normal operating range by self-regulating nature of dam	
Kawagama Lake Dam	Dam is regulated by Hackner-Holden agreement Concrete faced, stone filled dam – 5 m high 2 – 4.27 m wide sluice with 4 stop logs 2 spillways Summer drawdown of 0.38 m (May 15 – Sep. 1) (only lake in watershed) Fall drawdown of 0.28 m (Sep. 1 – Oct. 15) Winter Drawdown of 0.61 m (Oct. 15 – Mar. 1) Normal summer head (July 1) – 3.35 m	Recreation, navigation, spring flood control, winter power generation, fisheries	• Heavy rainfall periods or above average snowmelt will cause lake to exceed normal operating range • During winter thaws, if lake starts to rise, outflow must be increased to protect docks and boathouses from damage from rising ice layers. • Lake is used as a storage lake in spring to relieve high flows on Lake of Bays, Lake Muskoka and the connecting rivers • Channel restriction upstream from dam (i.e., old cofferdam) makes it difficult to get water out of the lake	• Fall drawdown of 0.28 m between Sep. 1 – Oct. 15 to set level at which fish are forced to spawn to help protect eggs from winter draw down for hydro production • Maximum winter drawdown rule of 0.61 m between Oct. 15 – Mar. 1 to protect lake trout eggs	• Minimum outflow of 2.8 m^3/s is maintained by summer drawdown	• Summer operating range of 0.40 m and a summer drawdown of 0.38 m (May 15 – Sep. 1)	• Winter drawdown (Jan. 15 – Mar. 15) for downstream hydro production at plants on the South Muskoka River • Coordinate all flow changes with downstream dams at Baysville and Matthiasville
SOUTH MUSKOKA RIVER							
Baysville Dam	Controls Lake of Bays Dam is regulated by Hackner-Holden agreement Fall drawdown of 0.06 m (Sep. 15 – Oct. 15) Winter drawdown of 0.76 m (Oct. 15 – Mar. 15) Concrete dam – 3.5 m high 9 – 4.27 m wide sluices 1 – 32.1 m long spillwall Normal summer head – 1.7 m	Recreation, navigation, spring flood control, winter power generation, fisheries	• During winter thaws, if lake starts to rise, outflow must be increased to protect docks and boathouses from damage from rising ice layers. • Full discharge capacity of dam can only be used with caution during extremely high water to prevent excessive downstream flooding • Stage large stop log removals over two or more days when possible to minimize sudden large flow increases downstream • Flooding damage on lake and river must be balanced in flood situations	• Minimum outflow for fisheries downstream • Fall drawdown completed by Oct. 15 to protect lake trout spawning • 0.45 m maximum winter drawdown rule from Oct. 15 to Mar. 1 to protect spawned lake trout eggs	• Minimum outflow of 2.8 m^3/s is to be maintained during dry periods	• Summer water level range limited to 0.22 m under normal conditions for recreational purposes (i.e., channel navigation, dock and marina access)	• Winter drawdown for hydro production at downstream generating stations – try to maintain flow of 16.8 m^3/s (plant capacity at Trethewey Power dam), while staying in normal operating range
Wood Lake Dam	Controls Wood Lake (a tributary to Lake Muskoka) Winter draw down of 0.40 m (Oct. 15 – Mar. 10) Concrete dam – 2.5 m high 1 – 4.27 m wide sluice with 4.5 stop logs 1 – 1.22 m wide spillway Normal summer head – 1.22 m	Recreation	• All stop logs not removed in spring unless above normal runoff threatens increased flooding in lake	• No specified flow or water level requirements for fish or wildlife considerations.	• No specified minimum flow for water quality since minimum flow is maintained by leakage through the dam.	• Moderately narrow summer operating range (0.30 m) because of extensive shoreline development and recreational use	
Matthias Falls	Dam and generating station owned by Orillia Power Corporation Concrete dam is 13.7-m high, approximately 270 m long and consists of 3 sluiceways (2 manual, 1 remotely operated)	Power generation	• Plant mainly limited to run of river operation – 2.7 days storage at maximum plant discharge • On an hourly and daily basis, the head pond typically fluctuates over a 0.92 m to maximum of 1.8 m range • Nominal head pond elevation 292.91 m, with maximum to 293.5 m	• OPC has issued a memorandum to its operators to release a minimum flow of 3.0 m^3/s to allow OPG to provide this minimum flow quantity to protect walleye spawning at the base of South Falls .	• No specified flow or water level requirements for water quality considerations.	• No specified flow or water level requirements for recreational considerations.	• Total installed capacity of 2.81 MW • Water passed to the powerhouse through a 4.6 m diameter penstock
Trethewey Falls	Dam and generating station owned by OPG Concrete dam (max. height 6 m) with 3 sluiceways and two flanking spillways for a total length of 67 m – powerhouse located approximately 22.9 m away from the sluices Dam provides total operating head of 10.7 m (natural head of 7.3 m at falls)	Power generation	• Area between Matthias and Trethewey – 20 summer cottages and a few permanent homes are located on the north side of the river within a flood hazard area. Access roads are located closer to the watercourse and are frequently inundated • Nominal head pond elevation 278.98 m with normal and absolute operating ranges of 0.91 (to 279.43 m) and 1.68 m (to 279.74 m) respectively	• No specified flow or water level requirements for fish or wildlife considerations.	• No specified flow or water level requirements for water quality considerations.	• No specified flow or water level requirements for recreational considerations.	• Structure consists of one , 1.74-MW hydroelectric generating unit • Discharges directly into the forebay of Hanna Chute • Maximum plant discharge 19.9 m^3/s
Hanna Chute	Dam and generating station owned by OPG Concrete dam consists of 35 m long wingwall, the powerhouse and a 12 m long wingwall joining the powerhouse to 3, 4.9 m wide sluices Normal head of 9 m above the tailwater (regulated by South Falls GS)	Power generation	• No specified water level or flow management for flooding considerations • Nominal head pond elevation 268.31 m with normal and absolute operating ranges of 0.39 (to 268.5 m) and 1.95 m (to 268.84 m) respectively	• No specified flow or water level requirements for fish or wildlife considerations.	• No specified flow or water level requirements for water quality considerations.	• No specified flow or water level requirements for recreational considerations.	• Plant consists of one generating unit with a maximum continuous power rating of 1.46 MW • Head pond extends to foot of Tretheway Falls GS, approximately 3.2 km upstream • Maximum plant discharge 23.7 m^3/s

Table 5.2
Existing Flow and Water Level Operating Constraints for Muskoka River Dams

Area of Watershed	Control Structure	Purpose	Flooding	Fisheries and Wildlife	Water Quality	Recreation	Municipal/Industrial/Other
South Falls	Dam and generating station owned by OPG Located approximately 4 km upstream from the confluence of the North and South Muskoka Rivers Concrete dam is 6 m high and 11 m long Powerhouse is 308 m downstream, fed by three wood stave overland penstocks	Power generation	• No specified water level or flow management for flooding considerations • Nominal head pond elevation 258.96 m with normal and absolute operating ranges of 0.73 (to 259.32 m) and 1.56 m (to 259.75 m) respectively	• 3.0 m^3/s flow maintained through over-flow structure for walleye reproduction in the spring	• No specified flow or water level requirements for water quality considerations.	• No specified flow or water level requirements for recreational considerations.	• Plant consists of three generating units with a total capacity of 5 MW • Maximum plant discharge 19.2 m^3/s
LOWER MUSKOKA RIVER WATERSHED							
LAKE MUSKOKA WATERSHED							
Skeleton Lake Dam	Controls Skeleton Lake only Located on the Bent River, a small tributary flowing into Lake Rosseau Winter drawdown of 0.1 m (Jan. 1 – Mar. 31) Concrete overflow weir – 10 m long by 1.7 m high, with a low flow notch (0.19m) and an operational valve (0.91 m) Normal summer head – 0.53 m	Recreation	• Start of FDZ in Skeleton Lake is 281.00 m (GSC) • Weir is self-regulating during low flow conditions • Maximum outflow above which flooding problems in downstream community is 3.8 m^3/s and maximum downstream water level is 279.58 m.	• Minimum flow of 0.4 m^3/s maintained during normal summer conditions • Minimum flow reduced to 0.2 m^3/s during drought conditions.	• Minimum flow of 0.4 m^3/s for water quality downstream (for domestic use purposes).	• Low summer water levels cause navigation problems and dock access difficulty • Summer normal operating range of 0.2 m (Jul. 1 – Dec. 31) • Summer RWL (Jul. 1 – Sep. 15) of 280.5 m (GSC)	• Minimum downstream flow and water level requirements for water intakes and wells near river in community of Bent River • Downstream flow and water level requirements = 0.4 m^3/s minimum and 279.29 m in elevation minimum water level. During dry periods the minimum downstream flow decreases to 0.2 m^3/s
Port Carling Dam	Controls water levels on Lake Rosseau and Lake Joseph Dam is associated with two navigational locks Regulated under the Hackner-Holden Agreement Fall drawdown of 0.1 m (Sep. 15 – Oct. 15) Winter drawdown of 0.46 m max. (Jan – Mar. 15), although logs are gradually removed starting in November Concrete dam – 3.5 m high 6 – 4.27 m wide sluice gates with 8 stop logs 2 spillwalls with total length of 12.4 m Normal summer head – 0.62 m	Navigation, recreation, spring flood control, winter power production, fisheries	• Lake is slow to drop in high flows due to high tailwater level in the Indian River, influenced by backwater from Lake Muskoka • High lake levels cause high flows through the dam and high levels in the channel downstream causing flooding – flood damage starts at flows exceeding 42.5 m^3/s • Outflow from lake to dam (200 m channel in Indian River) is restricted by a natural rock narrows resulting in water level of up to 0.2 m between lake and dam during high flows	• Maximum winter drawdown rule of 0.45 m between Oct. 15 and Mar. 1 to protect incubating lake trout eggs	• Minimum flow discharge through dam is 0.7 m^3/s (the total of leakage flow and lock flow) during dry periods	• Lakes are maintained within a narrow summer operating range (0.2 m) to facilitate navigation of large boats (i.e., steam ships) through locks and access to the many docks around the lake • The large lock must be maintained with a minimum depth of 2.65 m over the sill • Valves in large lock are left open during winter to protect from freezing; insignificant effect on lake level	• If snow water content is above average, early spring drawdown may exceed normal levels, although not past bottom of buffer zone to protect water intakes • Water intakes may freeze if lakes drop below normal spring minimum level • Winter drawdown from Jan to mid Mar. to supplement river flows for downstream power production • Coordinate operation with Bala Dams downstream • Dam discharge greater than 20 cms (approximately) and flows can affect navigation into the small locks, and the large locks for bigger vessels
Gull Lake Dam	Controls Gull Lake levels and drains into Hoc Roc River and subsequently Lake Muskoka Non-operational weir -	Recreation	• Free flow past dam	• No specified flow or water level requirements for fish or wildlife considerations.	• No specified flow or water level requirements for water quality considerations	• Weir maintains water levels in Gull Lake for recreational and cottage purposes	

Table 5.2
Existing Flow and Water Level Operating Constraints
for Muskoka River Dams

Area of Watershed	Control Structure	Purpose	Flooding	Fisheries and Wildlife	Water Quality	Recreation	Municipal/Industrial/Other
Bala North and South Dams	Dams controls Lake Muskoka, the largest lake in the watershed, as well as the Muskoka River up to the foot of Bracebridge Falls, and the Indian River to the Port Carling Dam North dam located at the top of Bala Falls, South dam discharges south of the falls Dams operated under the Hackner-Holden Agreement Concrete structures – 4 m high North Dam 6 sluices – 1 with seven, 4.88 m long stop logs, 2 with seven, 6.1 m long stop logs and 3 with eight, 6.1 m long stop logs No spillwall South Dam 8 – 4.27 m wide sluices with 8 stop logs each 2 spillwalls with a total length of ~24 m Winter drawdown (maximum of 0.7 m) starts in December and ends Mar. 15, taking into account the winter lake trout rule South dam is operated in winter because it has shorter stop logs and therefore easier operation (north dam is set for winter in Nov.) Normal head of water held by dams – 2.44m (South Dam) and 2.45 m (North Dam)	Recreation, navigation, fisheries, winter power production, flood control	• When outflows through Bala Dams are greater than approximately 283 m^3/s, flooding damages begin in the Bala Reach downstream from the dams (flooding complaints start at flows of 200 m^3/s) • Upstream flood damage to docks and boathouses occurs when levels are 0.3 m above the top of the summer operating range • During heavy rainfall events, dams require frequent operation to minimize flooding on the lake and balance flood damage between the lake and downstream Bala Reach • Both dams are left open up to and during the spring runoff • During the winter, dams can be opened to pass flow of up to 85 m^3/s, above this OPG must be contacted to coordinate flows with the Moon River dam • Lake Muskoka flood control range of 0.6 m above the normal summer operating level • Flood control capacity in Lake Muskoka reduced in summer because of requirement to keep lake high for recreation	• Fall drawdown (0.15 m) extends from Sep. 15 – Nov. 1 to protect spawning lake trout and help meet the 0.45 m maximum winter drawdown rule (Oct. 15 – Mar. 1) for lake trout protection • Lake Muskoka level held up to 12 cm above the normal summer level during lower base flow periods to provide steady flow for walleye spawning at the Mouth of the Moon River from late April to May • Minimum flows during the walleye spawning period are 14 m^3/s continuous from April 15 to June 1	• Minimum outflow of 3.0 m^3/s from each dam is to be maintained by leakage or log removal to maintain downstream water quality • Burgess Power Station provides an additional minimum flow of 4 cms	• Lake Muskoka is the largest lake in the watershed and recreation is the major use • Regulation range throughout the year is moderately wide to accommodate the high inflows • Summer operation is required to keep the dam in the normal summer operating range (0.24 m) after a normal rainfall • July and August are the peak recreational boating months, while commercial navigation occurs from April to December • Attempt to maintain summer level in upper range to provide enough depth at navigation locks at Port Carling	• Dam operation is coordinated with Baysville, Port Sydney and Port Carling dams upstream • Dams are operated on same day as Go Home lake dam to coordinate flow changes (except in winter when Go Home is not operated) • OPG must be contacted every time log changes are made • After Oct. 15, OPG has the right to store water in the lake up to the maximum normal summer water level if sufficient water is available • Maintain 85 m^3/s outflow if possible during the winter drawdown to sustain power plants near peak capacity
Burgess	Integral dam and generating station, owned and operated by Algonquin Power Located at the most northerly outlet from Lake Muskoka to Bala Reach	Power generation	• Flood flows are bypassed through MNR's Bala North and South dams • Maximum plant capacity approximately 4 m^3/s, no spill capacity	• No specified flow or water level requirements for fish or wildlife considerations	• No specified minimum flow for water quality since minimum flow is maintained by leakage through the Bala dams (owned and operated by MNR)	• No specified water level or flows required for recreational purposes	• Burgess facility requires a flow of 0.5-4 m^3/s during normal conditions – facility may be shut down if Lake Muskoka levels fall below the normal operating zone
MOON RIVER							
Moon Dam	Located less than 1 km downstream from the Moon and Musquash River Fork Owned and operated by OPG Dam stores and directs water away from the Moon River and into the Musquash River to feed the Big Eddy and Ragged Rapids hydro plants 8 sluice gates equipped with stop logs with a total length of 76.5 m	Power production, Bala Reach level control fisheries	• Moon dam is normally closed to divert water into the Musquash River to the downstream power facilities • When flows reach 85 m^3/s (that capacity of the downstream plants), the Moon Dam is progressively opened to pass water into the Moon River • Partially opening the Moon Dam will lower the water level in the Bala Reach to alleviate flooding which can occur there • Large sudden flow increase will cause flooding concerns to downstream residents (First Nations)	• Minimum flow of 14 m^3/s must be passed through the dam during the walleye spawning period (mid-April – June 1) • Minimum flow reduced to 8 m^3/s during 2001 and 2002 on an experimental basis • High flows during walleye spawning cause walleye to utilize substrates that are dewatered as flows recede • High flows may also scour previously deposited eggs	• No specified minimum flow for water quality since minimum flow is maintained by leakage through the dam	• No specified water level or flows required for recreational purposes	• Moon dam is normally closed to divert water into the Musquash River to the downstream power facilities • When flows reach 85 m^3/s (that capacity of the downstream plants), the Moon Dam is progressively opened to pass water into the Moon River • Moon Dam and Ragged Rapids GS are operated together to control water level in Bala Reach under low flow conditions. A summer range of 219.0 to 219.27 m is targeted. The range of the rest of the year is 219.21 to 219.51 m. Higher levels occur under high flow conditions.
Kapikog Lake Dam	Controls Kapikog Lake water levels Concrete structure with one 0.91 m x 1.22 m control valve, which is only operated when lake water level reaches 2.987 m 1 – 9.14 m long wing wall Normal head of 2.83 m	Recreation	• Lake has little to no inflow so valve must be closed completely following high water periods or low water will be experienced all summer	• No specified flow or water level requirements for fish or wildlife considerations	• No specified flow or water level requirements for water quality considerations	• Water levels maintained for recreational purposes (i.e., cottages, lake navigation)	
Healey Lake Dam	Controls Healey Lake which drains through a short channel into the Moon River Concrete overflow weir (not operated) Approximately 17 m long	Recreation	• Flooding problems not normally experienced on lake as all cottages built at suitable shoreline elevations following dam construction	• No specified flow or water level requirements for fish or wildlife considerations	• No specified flow or water level requirements for water quality considerations	• Water levels maintained for recreational purposes (i.e., cottages, lake navigation)	

Table 5.2
Existing Flow and Water Level Operating Constraints for Muskoka River Dams

Area of Watershed	Control Structure	Purpose	Flooding	Fisheries and Wildlife	Water Quality	Recreation	Municipal/Industrial/Other
MUSQUASH RIVER							
Ragged Rapids	Generating Station owned by OPG Dam and powerhouse integrated into one unit Located approximately 1 km downstream from the fork of the Moon and Musquash Rivers 1 Sluice way opening 6 m wide with the sill 4.6 m below the normal water level 2 bulkhead wingwalls with top width of 0.9 m Operating range of 0.92 m	Power generation, Bala Reach level control	• Flow in excess of 113 m^3/s must be diverted down the Moon River to avoid flood related damage in Go Home Lake • Normal operating target is approximately 85 m^3/s • Start of FDZ in Bala Reach is 220.75 m. • Nominal head pond elevation 219.0 m with normal and absolute operating ranges of 0.92 (to 219.46 m) and 2.77 m (to 219.79 m) respectively	• During walleye spawning period in the spring (April 15 – June 1) a minimum flow of 14 m^3/s must be passed into the Moon River	• No specified flow or water level requirements for water quality considerations	• Water levels maintained for recreational purposes (i.e., cottages, lake navigation)	• The generating station consists of two units with a total capacity of 8.04 MW, each fed by 2 intakes from the dam • Maximum plant discharge 92.4 m^3/s • Moon Dam and Ragged Rapids GS are operated together to control water level in Bala Reach under low flow conditions. A summer range of 219.0 to 219.27 m is targeted. The range of the rest of the year is 219.21 to 219.51 m. Higher levels occur under high flow conditions.
Big Eddy	Dam and generating station owned by OPG Dam and separate powerhouse located approximately 7.2 km downstream from the Ragged Rapids GS 4 sluice gates, each 4.27 m wide, integrated into the 29 m long dam Sluice gates normally remain closed to create head of 4.9 m above the sluice sills Operating range of 0.95 m	Power generation	• Flow in excess of 113 m^3/s must be diverted down the Moon River to avoid flood related damage in Go Home Lake • Normal operating target is approximately 85 m^3/s • Nominal head pond elevation 206.83 m with normal and absolute operating ranges of 0.95 (to 207.3 m) and 1.47 m (to 207.82 m) respectively	• During walleye spawning period in the spring (April 15 – June 1) a minimum flow of 14 m^3/s must be passed into the Moon River	• No specified flow or water level requirements for water quality considerations	• Maintains water level on head pond upstream of facility	• Excavated power canal leading to the two units in the GS is approximately 230 m long • Total capacity of 8.08 MW • Facility located within Wahta First Nation Territory • Maximum plant discharge 95.2 m^3/s
Go Home Lake Control Dam	Controls Go Home Lake, located at the outflow of the lake into the Musquash River Last dam on the Muskoka River system before the outlet at Georgian Bay Concrete dam – 5.5 m high 4 to 4.27 m wide sluices with 8 stop logs each No spillwall due to narrow lake outlet Fall drawdown is 0.75 m (Nov. 15 to Feb. 15)	Recreation, flood control	• Flood storage capacity in lake is small and operation is required to pass summer floods without resulting flood damage • Flood complaints on Go Home lake start at 185.45 m while flood damage begins at 186 m • When sufficient flows exist, dam stop logs set before lake freeze up to accommodate spring freshet flows	• No specified flow or water level requirements for fish or wildlife considerations	• Minimum outflow maintained by leakage through the dam	• Maintains a summer operating range of 0.3 m for recreational purposes • Inflows from Ragged Rapids during the winter are restricted to less than 84 m^3/s to reduce slush on Go Home Lake to allow easier snowmobile travel	• Ontario Power Generation normally passes water released from Bala Dams through Go Home Lake Dam, as Moon Dam is only operated during high flows • Upstream storage for hydro production during the summer results in minor water level fluctuations
Go Home Lake Filter Dam	Located on the west side of Go Home Lake at the Go Home Chute Filter dam located at the head of the chute to maintain lake levels – No operation required Designed to leak to provide constant flow to downstream channel	Recreation	• Flood flows do not overtop filter dam	• Seepage flow through the dam may benefit spawning salmonids downstream	• Seepage flow through the dam is approximately 1.4 m^3/s during summer months	• Maintains lake levels for recreational purposes	

Note: FDZ - Flood Damage Zone
RWL - Regulated Water Level
LCD - Local Construction Datum
GSC - Geodetic Survey of Canada Datum

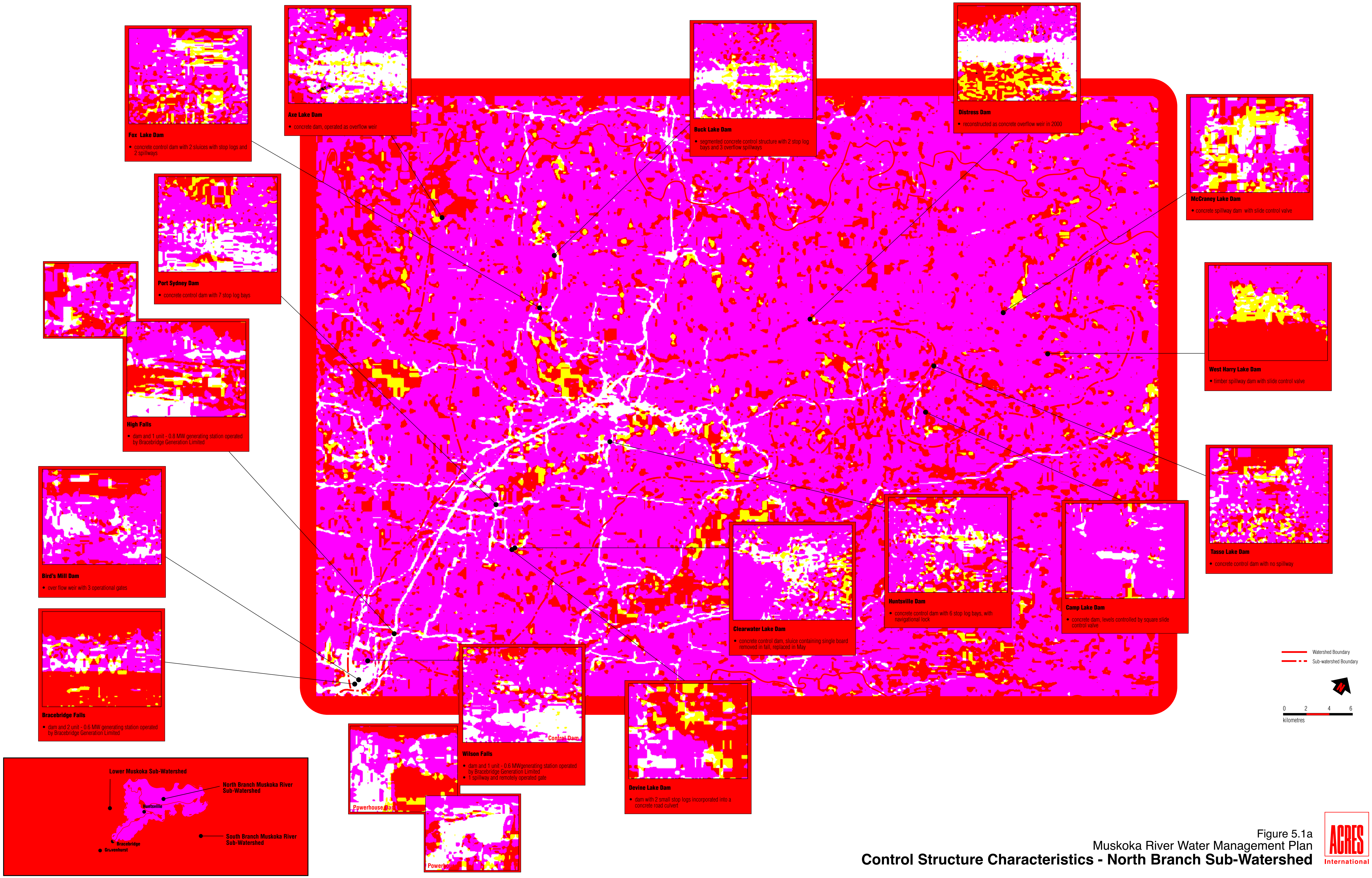


Figure 5.1a
Muskoka River Water Management Plan
Control Structure Characteristics - North Branch Sub-Watershed

ACRES International

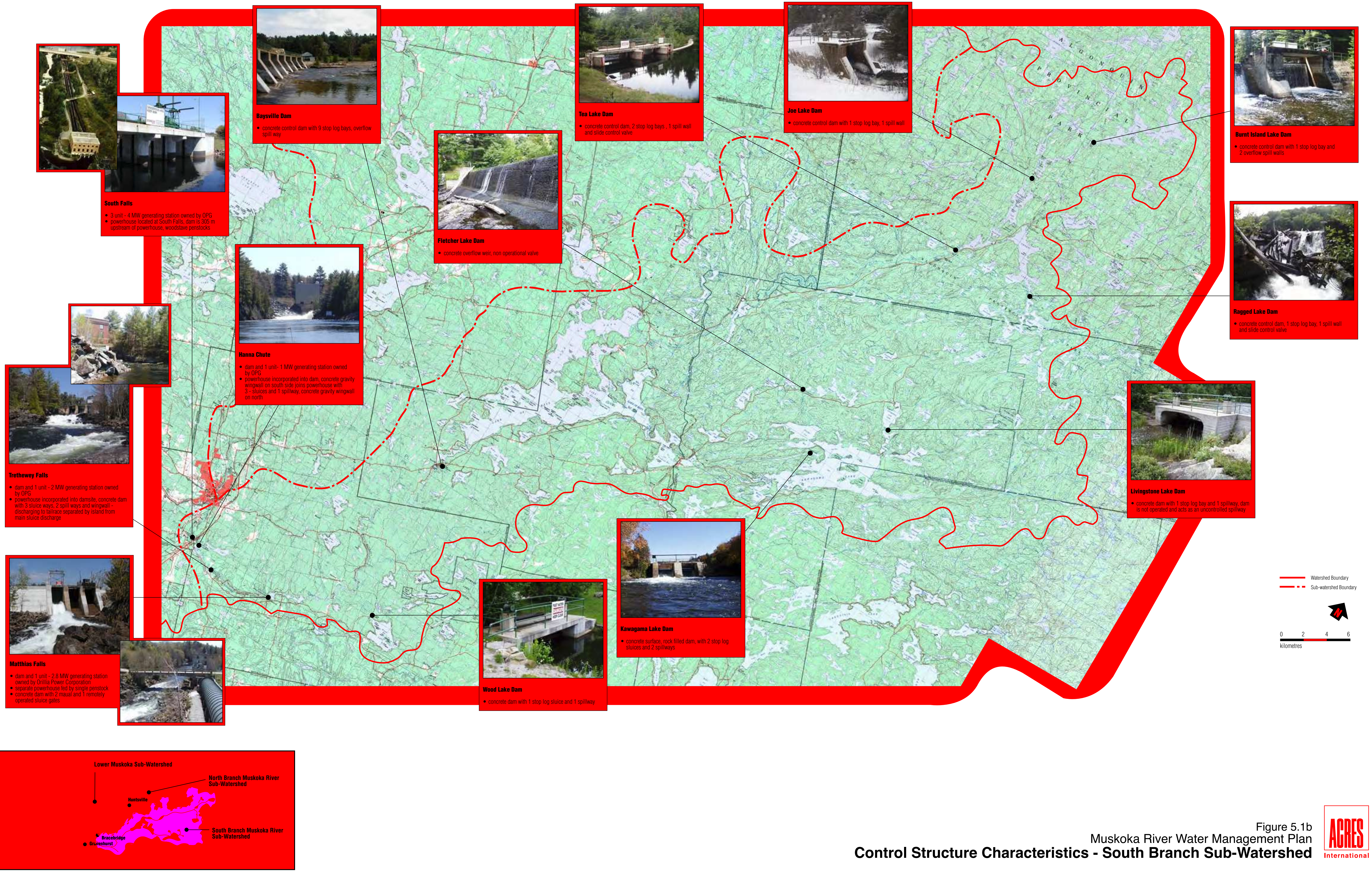


Figure 5.1b
Muskoka River Water Management Plan
Control Structure Characteristics - South Branch Sub-Watershed

ACRES International

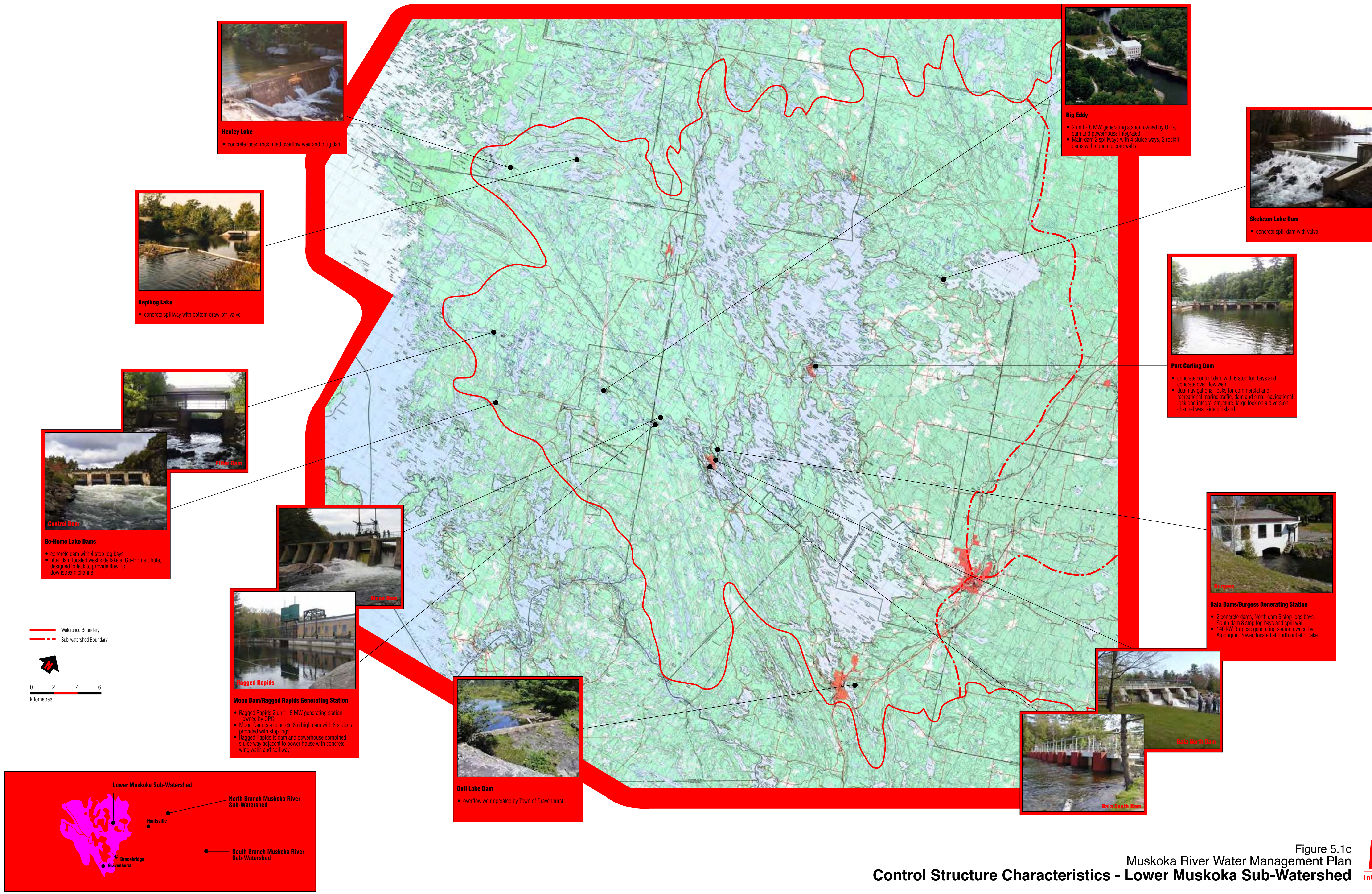


Figure 5.1c
Muskoka River Water Management Plan
Control Structure Characteristics - Lower Muskoka Sub-Watershed

ACRES International

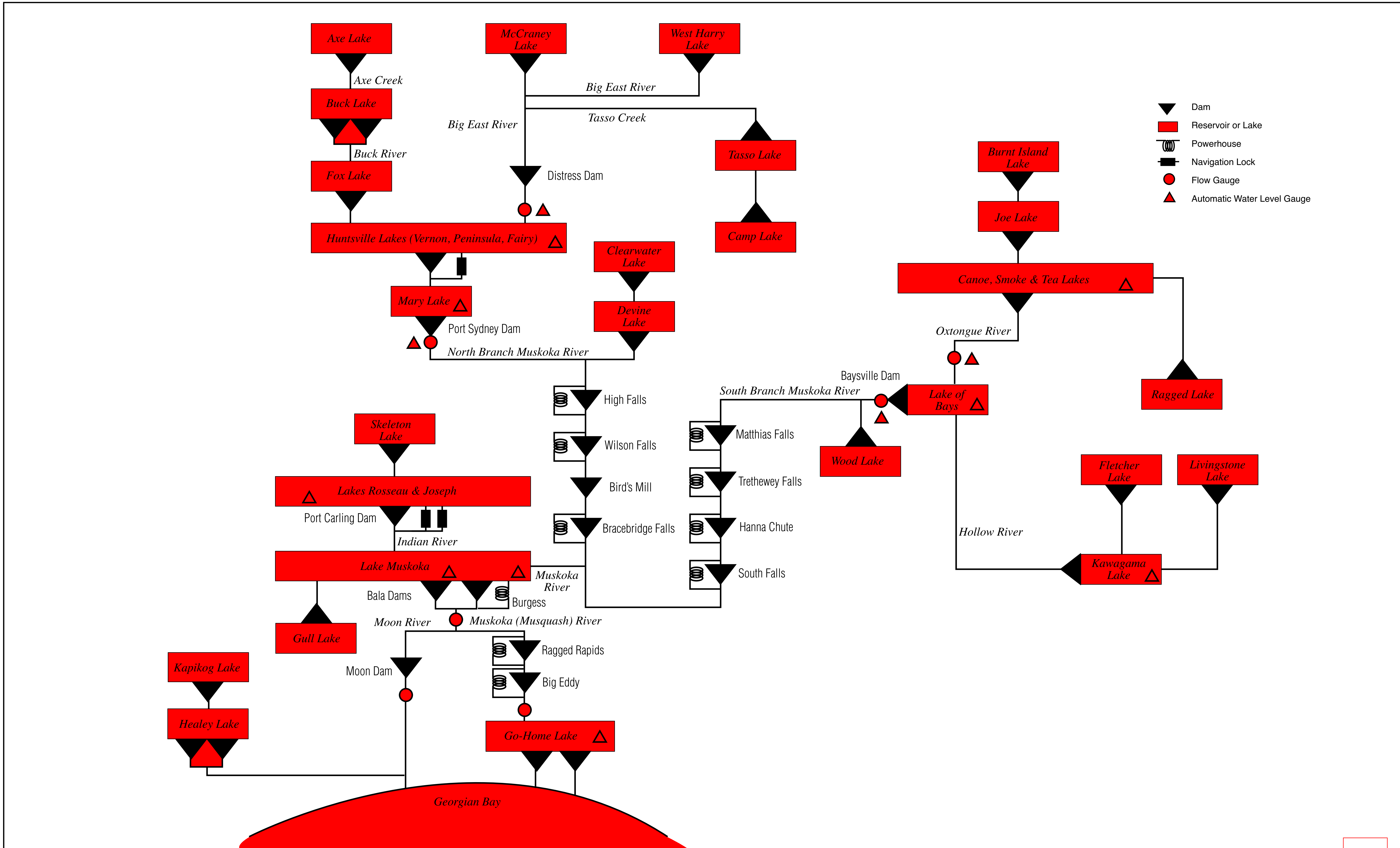
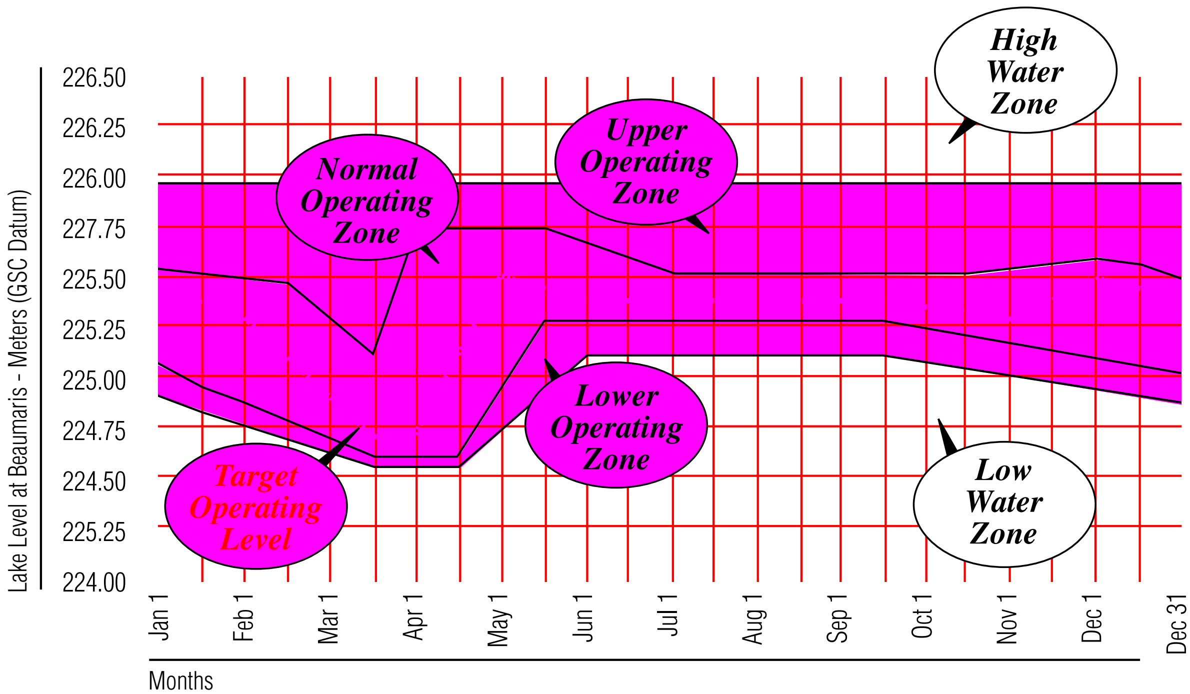


Figure 5.2
Muskoka River Water Management Plan
Control Structure Schematic



Operating the System

Operating plans are in place for 20 of MNR's 30 control dams on the system (other structures are non-operational overflow structures).
Zones of operation have been developed to reflect low, normal and high water levels, which are used as benchmarks for comparison against actual water levels. The graph above illustrates a typical seasonal operational plan for the Bala dams at the outlet of Lake Muskoka.

Target Operating Level

- represents the target seasonal water level that incorporates input from stakeholders and considers physical and ecological characteristics of the watershed. The intent is to aim for this level on a seasonal basis, but to allow some degree of fluctuation around this level.

Normal Operating Zone

- defines the acceptable range of water level fluctuations that will best suit the needs of the majority of users, and incorporates a certain amount of fluctuation to accommodate normal weather events.

Upper/Lower Operating Zone

- the Upper Operating Zone is used to facilitate storage and controlled release of flood runoff throughout the year, while the Lower Operating Zone provides contingency storage to allow augmentation of minimum flow releases during dry periods of the year.

High/Low Water Zone

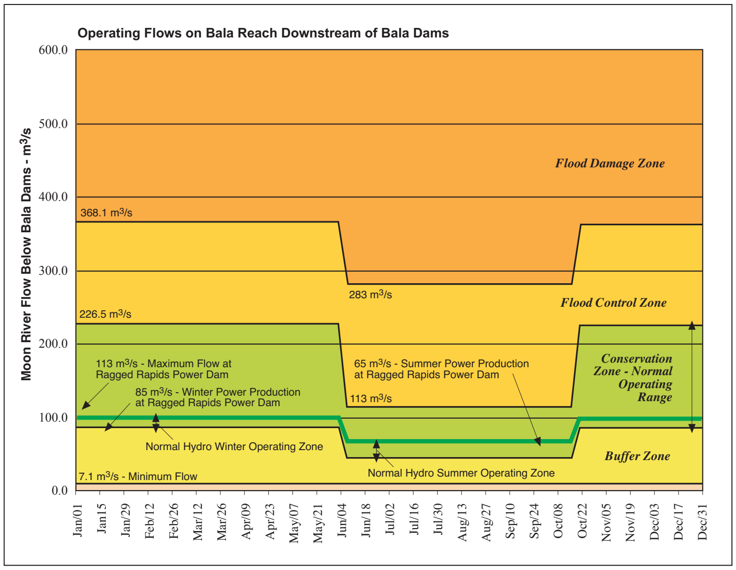
- water levels entering into the High Water Zone may result in flooding while levels dropping into the Low Water Zone may cause both environmental and recreational hardship.

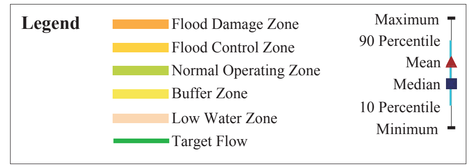
Typical Yearly Operation

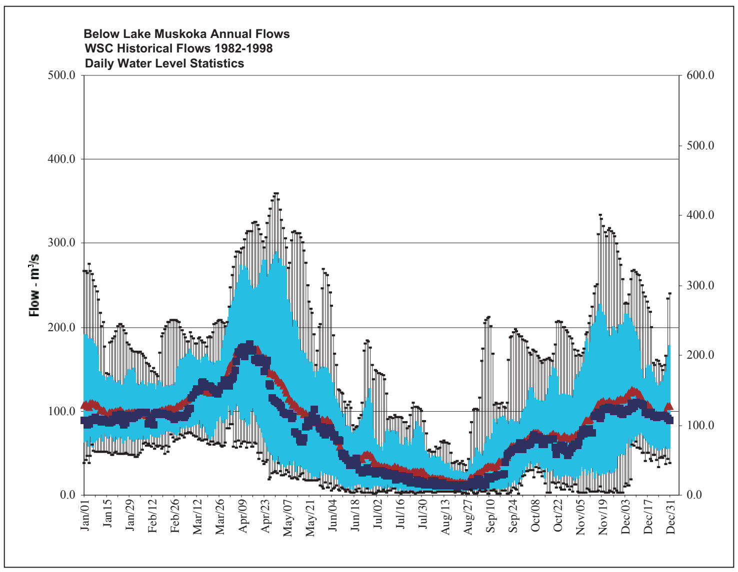
- water levels are lowest during the winter
- water levels are lowered during late fall and winter
- water levels naturally increase with the spring runoff
- water levels are relatively stable during the summer and early fall

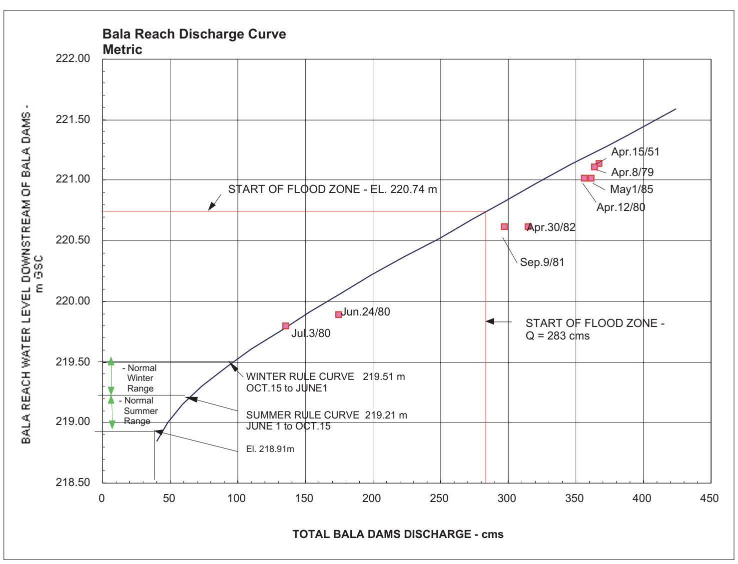
Figure 5.3
Muskoka River Water Management Plan
Lake Muskoka Annual Water Operating Limits - Bala Dams

ACRES International









Operating the System

MNR's Muskoka River Dam Operation Manual (1997) provides a series of tables and curves for each dam that establish the discharge characteristics for the various structures based on lake elevation and the number of stop logs present in each sluiceway of the dam. Operators utilize this information to establish the appropriate stop-log or valve settings to achieve the target lake levels and downstream flows. Operating ranges for flows have been established for most structures, with typical flow targets displayed in a similar format as lake level. Operating flow ranges for Bala Reach downstream of Bala dams, the corresponding historical flow data from the period 1982-1998, and the flow/water level rating (relationship) curve for Bala Reach are presented in the adjacent plots.

Target Flow – this is the preferred flow for hydropower generation at downstream power facilities as specified in the Hackner-Holden Agreement. This flow is well within the capacity of the downstream reach, and would meet other social and ecological needs.

Minimum Flow – the flow required to maintain ecological integrity, and is defined over a specific time period; i.e. 7Q20 is the 7 day low flow that occurs approximately once every 20 years.

Normal Operating/Conservation Zone – the range of flows that meets the majority of social and ecological needs (including hydropower) while providing flexibility to account for normal weather events.

Flood Control Zone – this zone is used to facilitate the controlled release of flood runoff throughout the year.

Buffer Zone – this zone establishes the minimum flow requirements for the downstream river reach to meet ecological and social requirements. Careful balancing of lake levels and river flow is required when these conditions are reached in the watershed.

Flood Damage Zone – flows above this limit are known to result in downstream flooding.

Low Water Zone – flows below this limit may cause booth environmental and recreational hardship.

Figure 5.4
Muskoka River Water Management Plan
Operating Flows on Bala Reach Downstream of Bala Dams

6 ISSUES, RESOURCE VALUES AND INTERESTS

A number of issues, resource values and interests of importance to stakeholders within the Muskoka River system were identified during the preparation of the background information document (A&A, 2003a). These issues included:

- preliminary issues based on background data
- agency and public consultation issues
- MNR issues
- waterpower producer issues
- First Nation Issues.

This section summarizes the major issues identified by the end of Phase One of the planning process. The final list of issues/considerations used in the assessment of potential changes to water management for each structure in the system is presented in Section 9.

6.1 Issues Identified from Background Data

6.1.1 Natural Environment Issues and Concerns

Specific fish and wildlife concerns applicable to water management planning (i.e., those concerns related to water levels and flows) in the Muskoka River system were identified during the background information review. Specific concerns, which are discussed in detail below, include:

- fall and winter water level drawdown and lake trout spawning, egg incubation and fry emergence

- walleye spawning, incubation and fry emergence at walleye spawning sites in the watershed

- water level fluctuations and fish habitat in Matthias head pond

- brook trout habitat and Big East River flows (below McCraney, Camp and Tasso lake dams)

- water level fluctuations and loon nesting

- water level fluctuations and wetland and littoral zone habitats.

Lake Trout and Fall/Winter Drawdown

Lake trout are one of the most sought after game fish species in the Muskoka River watershed. As such, healthy lake trout populations represent an important component of the economic and recreational aspects of the area. Lake trout deposit their eggs in the fall in areas of the lakes that have clean, well oxygenated substrates with plenty of interstitial spaces and good water circulation. Eggs and early life stages remain within the substrate until approximately late-April to mid-May, when they disperse to open water environments. Spawning depth typically ranges from 0.5 to 2.0 m, but may be as shallow as a few centimeters. Lake trout are therefore vulnerable to water level manipulation/fluctuation, especially during the winter incubation/ hatching and spring fry development periods. Decreasing water levels during the winter/spring period can expose spawning areas, resulting in desiccation and freezing of eggs and/or early life stages.

The Hackner-Holden agreement, which governs the manipulation of water levels in the major reservoirs/lakes in the watershed, was originally developed in 1940 to more effectively utilize the available water resources for hydropower production while protecting navigation and recreational interests (i.e., reduce the potential for spring flooding on recreational lakes). It was amended in 1969 to balance the needs of hydropower production with the needs of lake trout stocks and recreational users. Lake trout protection measures (i.e. fall and winter drawdown levels) were based on information available at that time regarding lake trout spawning, incubation, and fry emergence and dispersal. A fall drawdown was initiated on many of the lakes to encourage lake trout to spawn deeper, and hence be less susceptible to the successive winter drawdown. At that time, it was known that lake trout eggs hatch by early February, and provided the rationale to limit the winter drawdown on the majority of the lakes to no more than 1.5 to 2 ft (45 to 60 cm) below the previous fall's October 15 water level before March 1. In this manner, developing eggs would be protected, and further lowering of water levels would be undertaken after March 1 (after eggs had hatched). However, what was not known at that time, is that the early life stage fry remain within the spawning substrate for a period of up to 3 months before dispersing to open water. Thus, the practice of limiting the extent of the winter drawdown before March 1 may not be having the desired positive effect on lake trout populations, and may be negative, depending on the amount of the post March 1 drawdown, and the characteristics of lake trout populations within individual lakes (i.e., depth of spawning shoals, proportion that utilize shoals within the drawdown range, etc). The ideal situation in terms of providing the most protection to lake trout stocks would be one where the winter drawdown level is no lower than the fall drawdown elevation.

Information on spawning shoal depth and susceptibility of lake trout eggs and/or fry to winter drawdown was subsequently obtained for those lakes within the watershed for which data was available from MNR files. Information was compiled and provided for consideration in the development of water management practices for lake trout lakes.

Walleye Spawning Below Dams

Walleye are known to spawn below several dams in the Muskoka River watershed, including the spillway channel below the South Falls dam and in the Moon River below Moon Falls. Walleye spawning, egg incubation and fry emergence can be susceptible to the impacts of water management. In a natural stream setting, walleye typically spawn when water levels are rising or stable, and depend on a slowly receding hydrograph to prevent exposure and desiccation of eggs prior to hatching. Abnormally high flows/water levels during the spawning period may encourage walleye to spawn in areas that will be dewatered prior to the end of the incubation period.

The present water management regime in the watershed includes a number of measures designed to maintain and/or enhance some of these important walleye spawning habitats (Section 5). Habitat improvements have been undertaken and a specified minimum flow (3 m^3/s) is provided at South Falls to enhance spawning habitat and survival of eggs and fry. Further complications at both sites include a protracted spawning period, as fish respond to rising and falling temperature cues.

The area immediately below Moon Falls on the Moon River is an historically significant spawning area for walleye, with progeny from this area historically providing the basis for a destination fishery in Georgian Bay. MNR records indicate that the spawning population using this area has declined substantially, although a reduced population (compared to historic data) still utilizes this area as a spawning location.

Since 1969, MNR and OPG have attempted to maintain a consistent, targeted flow of 14 m^3/s in the Moon River for the duration of walleye spawning and egg incubation periods in the months of April and May. This quantity was thought to have been identified as a target in the Hackner-Holden Agreement, although historic documentation is lacking in this regard. A flow of 14 m^3/s was considered the quantity that could be provided from one year to the next through April and May, while also minimizing the impact on power production at OPG facilities on the Musquash River. A higher flow value was not chosen as the target as it could not be provided on a consistent basis, which was thought to be essential to yearly production of walleye at this site. However, in reality, flows are often variable, with high volume, short duration peaks above the targeted 14 m^3/s a common occurrence.

Further observations and investigations have revealed that managing for stable, low flows on the Moon River often results in unanticipated peaks in flow when rain events or sudden snowmelt events occur within the watershed. These events cause dramatically increased outflow from the watershed, requiring excess water to be passed down the Moon River as the hydropower facilities on the Musquash River typically pass a maximum of 85 m^3/s (the other outflow channel for the watershed). These peaks in flow increase water levels below Moon Falls and allow spawning walleye to access habitat that will be dewatered as flows recede. This results in stranding of walleye eggs deposited during these high flows. In recent years, a lower consistent flow (8 m^3/s) has been targeted due to dry conditions in the watershed. As a whole, the fluctuations in flows in the Moon River are a result of water withdrawal for hydro generation (by OPG) coupled with a limited ability (by MNR) to store/control spring runoff in upstream lakes and provide flow into the latter part of the incubation period for walleye. Further information on studies undertaken to investigate the relationship between Moon River walleye population dynamics and flow is contained within the Background Information Report, Addendum 1 (Acres, 2005).

Other known or potential walleye spawning locations in the Muskoka River watershed include constructed habitat below the Bala Dams, and natural habitat downstream of Fox Lake dam (at Hoodstown rapids), and potential spawning sites below the Go Home Lake dam on the Musquash River. Limited information is available regarding the status of walleye spawning at these sites and further investigations (i.e., habitat mapping, flow measurement and/or spawning surveys) may be necessary to determine if there is any potential for improvement (i.e., by providing increased or more stable flows or improved habitat during the spring spawning and incubation period).

Fish Habitat in Matthias Head Pond

Water level fluctuations within the Matthias Falls head pond during the spring and early summer period (i.e., May 1987 and 2001) have been noted to dewater shorelines along the edge of the reservoir, and potentially affect fish habitat. While water level fluctuations are a common occurrence on natural systems, they generally occur slowly and have both seasonal and annual components. Rapid, large magnitude water level fluctuations pose a concern for aquatic organisms and fish that have restricted mobility and/or ability to quickly respond to a water level change. The degree and extent of water level fluctuation has been identified as a concern on other riverine reaches within the river system as well.

Brook Trout in the Big East River below McCraney Lake

McCraney Lake dam is one of several headwater lakes that discharge into the Big East River. The concrete dam contains an overflow spillway, a sluice structure (not operated) and an operational valve. Presently, the valve is opened between mid-August and mid-October (2 to 3 m^3/s release) to augment late summer flows on the Big East River. This release results in a 3-m drawdown of the lake, and little or no flow in the reach immediately below the dam after the valve is closed. Stranding of brook trout and other fish species has been observed below the dam after closure of the valve.

The Big East River is an important cold-water river in the watershed, and has been the focus of recent efforts to improve brook trout habitat (i.e., removal of Finlayson Dam). Brook trout spawning typically occurs from late September to November (Scott and Crossman, 1973) with eggs deposited in excavated nests (redds) on gravel substrate in shallow streams with areas of groundwater upwelling. The reduction in flows to the Big East River, commencing mid-October, due to the closure of the valve in the McCraney Lake dam, may be adversely affecting brook trout spawning and/or egg and fry development. Continued flow limitations into the winter months (i.e., as the lake refills to its overflow level) could also reduce brook trout over-wintering habitat or lead to exposure/freezing of eggs in redds.

Other headwater lakes in the upper portion of the Big East watershed that contain dams (i.e., Camp and Tasso lakes) are operated primarily to maintain a stable summer water level for recreational interests. A lack of water in river sections during the summer would reduce the amount of refuge habitat (i.e., deep, well oxygenated pools that allow fish to escape the heat of the summer), and also affect the quantity and quality of benthic invertebrate habitat, which brook trout depend on for food. Opportunities to enhance flow management for brook trout should be further investigated.

Water Level Fluctuations and Loon Nesting

The Common Loon generally breeds on lakes of the Canadian Shield and northward, with a few pairs along the edge of the Shield in southern Ontario. Larger lakes are preferred, and may support several pairs in visually separated bays, while smaller lakes (generally >5 ha) usually support only one pair (Cadman et. al., 1988). Nesting and incubation occurs in late spring-early summer, with nests constructed close to the water's edge, and often on small islands or points (sometimes on beaver lodges or on floating islands in marshes). Loons generally produce one or two, rarely three, eggs per year (McIntyre and Barr, 1997). Due to their proximity to the water's edge, nests are susceptible to water level manipulation during the incubation period (for approximately 1 month), and may be flooded out by rising water levels. If eggs from early nesting attempts are lost, a second attempt may be made. A large decline in water level, particularly on a low gradient shoreline, can also be a concern, as adult loons have difficulty traveling on land. Low water levels after nesting may also subject eggs and hatchlings to increased mortality from terrestrial predators. Upon hatching, the young (chicks) are downy and able to move about the water by themselves. Chicks up to 2 weeks old can often be observed riding on the back of one of their parents, and their survival is less affected by human disturbance (Cadman et al., 1988).
In addition to water level manipulation, loon populations and loon reproductive success are sensitive to impacts resulting from numerous other factors, including lake acidity, mercury poisoning, lead poisoning (due to ingestion of lead sinkers and shot), loss of nesting sites due to shoreline development, and/or disturbance of nesting due to human activity (Weeber, 1999). During the background information review, it was noted that the loon population of Smoke Lake does not appear to be affected by present water management activities. Comments from public consultation noted that current water management activities may be adversely affecting Fox Lake loon

populations, and suggested an earlier drawdown to the summer level as a potential solution. It was unclear whether current water management practices on other lakes within the system were affecting loon nesting success (see Section 8.2.2).

Impacts of Water Level and Flow Fluctuations on Wetland Habitats

Wetland habitats are among the most ecologically productive environments in Canada. They provide essential habitat for many species of fish and wildlife (including birds, mammals, insects, amphibians and reptiles) as well as important social and biological functions including flood attenuation, water quality improvement and low flow augmentation. The effects of water level management on wetland development and composition are not fully understood at this time, although several large scale studies are underway in the Great Lakes basin to determine how water level/flow management may be impacting wetlands (IJC, 1999).

Wetlands provide essential habitat for spawning, nursery and feeding for many of the fish species that are found in the Muskoka River watershed. Species such as northern pike and muskellunge utilize seasonally flooded wetland habitats (i.e., within the floodplains of rivers or in lakeshore marshes) for spawning and as a juvenile nursery in the spring. Spawning and egg incubation are particularly susceptible to negative impacts resulting from water level manipulation. Decreased flood levels (e.g., as a result of measures to minimize flood damage to shoreline property) may inhibit access to spawning grounds (i.e., seasonally flooded sedge meadows), thereby denying fish a suitable place to spawn. A quicker spring drawdown to the preferred summer water level (as may be desired by recreational users) may impact incubating eggs or early life stages by stranding them on the floodplain.

Water management could also have significant impacts on furbearers (beaver and muskrat), amphibian and reptile populations in the Muskoka River watershed, primarily due to their dependency on wetlands and riparian zones (i.e., use of temporary wetland ponds and seasonally flooded shoreline pools for breeding and early life stages). Water management strategies aimed at reducing the impact of high spring levels on structures and recreational properties may eliminate access to the floodplain habitats necessary for propagation of these species.

Impacts of Water Level and Flow Fluctuations on Littoral Zones

The littoral zone of lakes and rivers (i.e., shallow waters along shorelines) provides essential feeding, breeding and cover habitat for many of the fish species in the Muskoka River watershed. Most of the spawning areas identified for lake trout, walleye, northern pike and muskellunge are closely associated with the shoreline, and are for the most part, located in fairly shallow (less than 2 m deep) water. As well, major prey species (minnows, perch, sunfish, aquatic invertebrates, crayfish, etc) are largely found in the littoral zone, and rely heavily on shallow areas for their reproduction and foraging requirements. Water management activities that excessively impact littoral zone habitat quality and quantity, may in turn impact fish community dynamics and population levels.

6.1.2 Socioeconomic Issues and Concerns

The following socioeconomic issues were identified during the collection of the background information presented in this document.

Public Safety

- Spring freshet and other storm events passed through the system without loss of life.
- Maintain access for emergency vehicles.
- Extreme fluctuations minimized.
- Public access to and safety around water control structures (particularly the downstream areas during high flow events).
- Municipal, commercial and industrial water taking and waste discharges (adequate quantities and flows).
- Clean and sufficient quantity of water (flowing, not stagnant) for swimming and other nonconsumptive uses such as bathing, washing clothes, etc (i.e., summer low flow in South Branch near Fraserburg).
- Stability of winter ice cover (for winter recreational activities – ice fishing, snowmobiling, cross country skiing, etc).

- Stable and consistent water depths and river flows during summer recreational boating season (as related to personal safety).

Property

- Flood management to protect shoreline infrastructure (docks, shorewalls, boathouses, cottages, homes, resorts, businesses, etc).

- Limited floodplain mapping (not throughout entire river system).

- Minimize shoreline erosion (erosion prone sites at Kawagama Lake, Fox Lake, Lake of Bays, and on Big East River at Arrowhead Provincial Park).

- Residences and businesses within floodplain that may be flooded during high flow events (i.e., Big East River, Huntsville and Bracebridge urban cores).

- Avoidance of ice damage to infrastructure (boathouses, shorewalls, docks).

- Residential and seasonal water taking (shoreline water intakes).

- Real estate values.

Economic (Tourism/Recreation/Power)

- Tourist industry (resorts, lodges, camps, cottages) requires stable summer water levels for water based recreational activities (boating, water skiing, fishing, canoeing, swimming, etc).

- Local and provincial tourism strategies rely on the natural beauty and attraction of the Muskoka area, including the waterways (lakes, rivers, waterway and provincial parks, etc).

- Power producers require consistent flow on a regular basis to maintain their ability to supply residents with electricity.

- Preservation of historic and archaeological sites of interest.

- Aesthetics/attraction of heritage and scenic sites (historical and natural heritage sites, falls, chutes, etc).

- Fishing opportunities need to be maintained or enhanced by protection of habitat (spawning, rearing, foraging, resting, etc) and provision of an appropriate flow regime during specific life stages (as required).

- River flows for higher energy recreational pursuits (canoeing, kayaking, white water rafting, etc).

- Impacts of development (cottages, resorts, lodges, camps, marinas, golf courses, etc) on water quality and the natural environment.

- Protection of Muskoka Heritage Areas and Ontario Living Legacy (OLL) sites.

- New opportunities for power production.

Navigation

Navigation of recreational and commercial vessels can be affected by both water levels and in some limited cases (especially near control structures) water velocity. Issues are related to adequate water depth for safe navigation of the lakes and access to shoreline structures such as docks and boathouses.

- Specific water bodies that are managed for commercial and/or recreational navigational purposes include:
  - Huntsville Lakes (Vernon, Peninsula and Fairy), including the canal between Fairy and Peninsula lakes, the Huntsville lock, and the downstream reach of the North Branch Muskoka River to Mary Lake.
  - Muskoka Lakes (Muskoka, Joseph and Rosseau) including the mouth of the Muskoka River in Bracebridge, the large and small lock in Port Carling, and associated reaches and ports of call.
  - Algonquin Park lakes and canoe routes.
  - Lake of Bays (commercial tour boat).

From a previous study, “Water Management Improvement Study of the Muskoka River System” (MacLaren Plansearch, 1985) a number of constraints to navigation were identified (see Table 6.1).

Table 6.1
Navigational Constraints

Lake	Navigation Constraints
Gray Lake	• Low water levels below Big Eddy dam on Friday nights affect access to Gray Lake cottages
Moon River - Bala Reach	• Fluctuating water levels may affect unattended boats (i.e. fixed docks are sensitive to changing water levels) • Low water reduces access to docks, shorelines and beaches • High discharge can cause strong currents, particularly along the north shoreline • High flows through the Moon Chutes cause strong currents at the constriction and is dangerous to boaters
Rosseau and Joseph	• Maintenance of water levels in the upper conservation zone to provide adequate draft for numerous docks and boathouses • Lowering of water levels >0.15 m below rule curve will create boating hazards within the shallow portions of the lake • Minimum draft should be maintained until freeze-up to enable the movement of construction barges. • Potential navigation difficulties for larger cruise vessels
Indian River	• Large and small lock at Port Carling • When Lake Muskoka water level is 0.10 m below the rule curve, a rock ridge in the channel downstream of the smaller lock interferes with the passage of pleasure craft and tour boats
Lake Muskoka	• Water access to Beaumaris Marina and Alport Bay on the Muskoka River may be difficult with lower levels • Minimum draft should be maintained until freeze-up to enable the movement of construction barges.

Table 6.1
Navigational Constraints

Lake	Navigation Constraints
Mary Lake	• Releases from Mary Lake dam must be coordinated with the Huntsville Locks Dam (releases enter Mary Lake in 2 hours) • Navigation problems occur at the entrance to Mary Lake on the North Muskoka River when levels fall below the rule curve due to a sand bar • Low water levels may prohibit larger craft and commercial tour vessels from traveling downstream from the lock to Mary Lake (downstream entrance to lock)
McCraney Lake	• Low late summer lake levels restrict canoe access to Rain and Sawyer Lakes
Vernon, Fairy and Peninsula	• Shallow water depths in the nearshore makes navigation and dockage difficult • On connecting waterways (Canal, Muskoka River), shallow waters (below rule curve) may expose rocks and outcrops
Big East River	• Low flows during summer create unsatisfactory conditions for boating (below Arrowhead Park) and canoeing
Kawagama Lake	• Docks appear to have been adjusted to deal with draw down of 0.39 m over the summer period • Limited road access results in increased water access which may be difficult in shallow near shore areas • Unexpected lowering of water levels may strand unattended boat • Low water levels affect access between Lake Kawagama and Bear Lake.
Oxtongue Lake	• Rock dam does not provide sufficient regulation of summer water levels

Source - MacLaren Plansearch (1985) (4-16 to 4-25)

Miscellaneous Socioeconomic Issues

- Historic water management practices have set the precedent for future expectations.

- Recreational season has expanded beyond the traditional ‘July/August’ summer period to span from early May to late October – more recreational users for a longer time period.

- Communication of significant events to affected parties.

6.1.3 Engineering Issues

The current water management strategies for MNR operated dams are based on the Hackner-Holden Agreement, which was developed to provide a solution to the various demands for water within the watershed. Recreational use of the watershed has continued to increase since that time, and current operational strategies have attempted to keep pace with those changes by means of small adjustments. Engineering issues pertaining to the operation of the dams include:

- reduced budgets and staff levels
- operations react to rising or falling water levels, no ability to forecast flow and flood changes and act accordingly
- ability to pass flood flows through the system with minimal impact to existing infrastructure (roads, bridges, docks, boathouses, cottages, etc)
- dam integrity and safety
- engineering methods to reduce costs of operations.

6.2 Agency and Public Consultation Issues

6.2.1 Agency Consultation Issues

A number of agencies were contacted at the beginning of the study. The purpose of agency consultation as a component of the water management planning process was to:

- inform the various levels of government and local municipalities of the water management planning process
- receive input to the water management planning process with respect to the collection of background data and/or jurisdictional matters of an agency/municipal-specific nature in the Muskoka River watershed

- determine any issues/concerns they might have with respect to current operational practices

Besides ongoing input from MNR personnel, the following federal, provincial and municipal government agencies were consulted during the water management planning process:

Federal Government
- Environment Canada
- Canadian Coast Guard
- Fisheries and Oceans Canada
- Department of Indian and Northern Affairs
- Parks Canada (Georgian Bay Islands National Park)

Ontario Government
- Ministry of the Environment
- Ministry of Tourism and Recreation
- Ministry of Northern Development and Mines
- Ontario Native Affairs Secretariat
- Ministry of Transportation
- Ministry of Agriculture, Food and Rural Affairs
- Ministry of Municipal Affairs and Housing
- Leslie M. Frost Natural Resource Centre
- Ontario Parks (Algonquin Provincial Park)

Municipal Government and Planning Boards
- District of Muskoka
- County of Haliburton
- Township of Georgian Bay
- Township of the Archipelago
- Township of Seguin
- Township of Dysart
- Township of McMurrich/Monteith
- Township of Muskoka Lakes
- Township of Lake of Bays
- Township of Algonquin Highlands
- Town of Bracebridge
- Town of Huntsville
- Town of Kearney
- Town of Gravenhurst
- Archipelago Planning Board
- Parry Sound Area Planning Board

Power Companies/Associations
- Orillia Power Corporation
- Ontario Power Generation (Evergreen Energy Division)
- Bracebridge Generation Limited
- Algonquin Power
- Ontario Waterpower Association

The mechanisms that were used to ensure adequate opportunities for agency input to the planning process were as follows:

- Pre-public release information session (May 29, 2002).

- Mailouts.

- Telephone contacts to request background data and/or to discuss specific matters pertaining to policy interpretation.

- Meeting with municipal councils and/or representatives to discuss aspects of the water management planning process.

Table 6.2 summarizes the comments received in writing from agencies (A&A, 2003a.

Table 6.2
Agency Consultation Comments

Agency	Comments
Ministry of Transportation	"No concerns at this time". Requested that the Ministry be informed of any proposed changes in water levels or increase in flow rates as this might impact downstream structures.
Ministry of Municipal Affairs and Housing	"Our office has no concerns with the proposal"
Ministry of Culture	"A principal concern of this office is the adverse effects that undertakings such as the above mentioned might have on cultural heritage resources. If any development projects proposed as a result of this study have the potential to impact cultural heritage resources, then our office would recommend that a heritage assessment be conducted…If any significant heritage or archaeological resources are identified, then any negative impacts will have to be mitigated by either avoidance or excavation…The Local Archaeological Conservation Committee within your study area should be contacted."

Table 6.2 Agency Consultation Comments	
Agency	**Comments**
Canadian Coast Guard	Dams are named works under the Navigable Waters Protection Act and require approval under Section 5(1). Existing structures can be approved under Section 6(4) and any modifications can be approved under Section 10.
Environment Canada	Provided a list of legislation relevant to the study. Recommended that the study identify all Valued Ecosystem Components that could be potentially impacted by water level and flow manipulations and then develop a plan which has due regard for these components in concert with identified water users in the watershed.

6.2.2 Public Consultation Issues

Public consultation is an integral component of the water management planning process. The consultation record is provided in its entirety in Appendix D, while a summary of the issues identified by the public is provided below. Table 6.3 summarizes the major issues and concerns, as identified from the open house questionnaire. Specific issues and concerns are summarized below on a sub-watershed basis.

Table 6.3 Summary of Public Issues and Concerns					
	Number of Comments				
Issue*	**North Branch**	**South Branch**	**Lower Watershed**	**Total**	**Nature of Comments**
Low Water (26%)	7	53	5	65	Navigation Property Damage (boats, docks) Access to property Ability to draw water Freezing intake lines Decreasing property values Smelly water Dry wells Recreation Fish and wildlife
Water Level Fluctuation (27%)	7	50	10	67	Fish and wildlife Wetlands Scenery Water Quality Makes navigation dangerous Access to/from property (can strand owners) Impossible to construct docks at correct levels Impacts trapping

Table 6.3
Summary of Public Issues and Concerns

Issue*	Number of Comments: North Branch	South Branch	Lower Watershed	Total	Nature of Comments
High Water (17%)	8	31	4	43	Property damage (i.e., docks and boathouses) Damage resulting from ice Loss of property frontage Shoreline erosion Loss of beach area Fish and wildlife habitat Navigational concerns Flooding of wells Impacts to cruise line navigation
Water Quality (13%)	4	24	3	31	Drinking water Recreational use (i.e., swimming) Fish and wildlife Stagnation / no natural flushing Contamination through faulty septic systems
Winter Drawdown (3%)	1	6		7	Lake trout spawning, incubation and hatching Littoral zone ecology
Fish & Wildlife (10%)	3	20	3	26	Management not geared towards them Fish populations decreasing Water level fluctuations affecting loon nesting Lack of habitat More attention to levels during spawning Dried up fish eggs in the South Muskoka Moon River fish populations
Shoreline Erosion (3%)	1	6		7	Loss of property Fish and wildlife Water quality
Siltation (1%)		1	1	2	Impairs navigation Fish and wildlife

* Percent compared to all issues identified.

North Branch

Of the 18 ratings received for the current water management practices on the North Branch, 72% identified it as being excellent, good or adequate, while 28% identified it as poor. The most common concerns of respondents from the North Branch of the Muskoka River were low water (23%), water level fluctuation (23%) and high water (26%). The largest single number of responses came from residents of Mary Lake (8 comments) with water level fluctuation, resulting in impacts to property, being the primary concern. However, the majority of responses regarding Mary Lake identified the present water management strategy as excellent or good, with only one adequate rating. Specific responses regarding the Huntsville Lakes (Vernon, Peninsula and Fairy) identified the present management as adequate to poor.

South Branch

Overall, the greatest number of responses within the watershed (118 or 72%) came from residents of the South Branch of the Muskoka River. The most common issues were low water levels (28%), water level fluctuation (26%), high water levels (16%) and poor water quality (13%). However, results for different river reaches and lakes in the South Branch were markedly different. The one response received from the headwaters of the South Branch (Little Joe Lake) indicated that present management was adequate and that water levels should remain the same (i.e., through this water management study). Two responses from Oxtongue Lake indicated that operation of Tea Lake Dam resulted in rapid variation of the water levels in the lake, resulting in dry wells in the summer, damage to boats due to grounding during low water or damage to docks (and/or docks floating away) during high water levels.

The most commonly cited problem from Kawagama Lake respondents was high spring water levels, which result in shoreline erosion, loss of beach area, loss of property frontage, and impacts on boat docking and navigation. Levels in excess of 15 cm above the normal summer water levels were indicated to result in typical high water problems. Other common issues and concerns included the degree of water level fluctuation, the effects of winter drawdown on lake trout populations, and other fish and wildlife concerns. Low water levels in winter and early spring also resulted in freezing of water lines and low well levels. Several respondents felt that Lake of Bays and Muskoka Lake levels were controlled at the expense of Kawagama Lake property owners.

The most frequently cited problem from Lake of Bays respondents was high water levels resulting in shoreline erosion, property damage, loss of beaches, and fisheries issues. The effect of winter drawdown on lake trout was one of the primary concerns.

The greatest number of responses received from any one area in the entire watershed came for the South Branch, in the reach from Baysville Dam to Matthias Falls. Of these, 79% indicated that current water management practices were poor and 18% indicated that they were only adequate. Low water levels were the primary concern in this reach (38% of all comments received). Commonly cited problems resulting from low water included restricted access their water-access only property, impaired ability to draw domestic water and damage to water pumps, adverse effects on fish and wildlife, effects on property values, and foul smelling river water. Water level fluctuation [which some respondents indicated as being up to 1.5 m (5 ft) on a daily basis] was the next most commonly indicated problem (31%). Water level fluctuation was directly indicated as affecting fish and wildlife, wetlands, water quality and the scenic value of the river. Water quality, especially for drinking water, was also a common concern among residents. Many respondents indicated that the concerns of lakes upstream from this reach (i.e., Lake of Bays and Kawagama) are being met without any attention given to the effects on downstream uses. Respondents indicated that maintaining more consistent water levels would be the preferred solution to water management issues in this reach.

Lower Watershed

The greatest number of responses from the lower watershed (7) came from residents located below the Bala Dams, of which, 3 were from residents of Bala Reach (from Bala to Ragged Rapids) and 4 were concerning the Moon River below the Moon Dam. All seven responses indicated that the current management practices were poor. Bala Reach concerns pertained to the high degree of water level fluctuation (i.e., high water floods properties and causes damage, while low water leaves docks high and dry, and may damage boats and impair access), while fisheries management issues were of paramount concern to Moon River residents. Residents feel that water level fluctuations and low water during the walleye-spawning period is inhibiting spawning and incubation success, and may be the primary cause of the walleye population collapse. Also of concern was stagnation (i.e., poor water quality) of the Moon River during the summer months. Some respondents indicated that the Muskoka Lakes (i.e., Muskoka, Rosseau and Joseph) were receiving priority treatment at the expense of downstream areas (i.e., Moon and Musquash River), with not enough consideration being given to the effects of Bala dam operation on downstream uses.

The primary concern of Lake Muskoka residents was high water levels during ice break up and the spring freshet, which result in property damage (i.e., to docks and boathouses). However, all responses from this lake indicated that the present management was excellent, good or adequate. Single responses from each of Rosseau Lake and the Indian River rated current water management practices as excellent.

One response from Gray Lake on the Musquash River (prior to Go-Home Lake) indicated that the rapid variation in the water level of the river presented a dangerous situation for navigation and access to their water-access only property. It was noted that access to property was possible by boat one day (because of sufficient water levels), but quickly falling levels the next day had stranded them because water levels have dropped so low as to make navigation dangerous or impossible.

6.3 MNR Issues

6.3.1 Provincial Policy Issues

Any potential changes to the water management strategies for the Muskoka River system will need to be consistent with current provincial direction and policy, such as:

- Algonquin Park Master Plan and amendments
- Ontario Living Legacy Land Use Strategy
- District Land Use Guidelines
- District Fisheries Management Plans and updates/revisions
- Forest Management Plans
- Provincial Policy Statement (2005)
- Our Sustainable Future.

6.3.2 Resource Management Issues

Fish and wildlife issues identified during the collection of background information are documented in Section 6.1.1 above, and included those areas within the river system that were identified by MNR as being of primary concern. These areas are:

- South Falls (walleye spawning and egg incubation)
- Moon River (walleye spawning and egg incubation).

In each case, the concerns relate to the provision of an adequate and constant flow within the area utilized by the majority of the spawning population. Specifics for each area are as follows.

South Falls

The provision of a constant flow at South Falls requires cooperation and coordination between MNR (Baysville dam), OPC (Matthiasville dam) and OPG (Hanna Chute and South Falls dams). Presently, OPG installs a block within the stop logs at the South Falls dam to ensure that 3 m^3/s (100 cfs) is passed into the spillway and through the walleye spawning and incubation area. MNR concerns relate to the variable daily/hourly flows arriving at the South Falls dam, which provide further flow fluctuations on top of the relatively stable discharge from the blocked stop logs. Higher flows/levels encourage walleye to spawn above the preferred spawning area, and essentially "wastes" some of the spawning effort as eggs at higher elevations are usually dewatered before the end of the incubation period.

Moon River

Flow to the walleye spawning area in the lower reaches of the Moon River (at Moon Falls) is provided through the Moon Dam which is operated in conjunction with the Bala dams and Ragged Rapids GS to provide the following flows during the corresponding hydrologic periods (as per MNR Dam Operations Manual):

Normal Spring	Maintain a constant flow of 40 m^3/s for the period from April 15 to June 1
Wet Spring	Maintain a constant flow of 60 m^3/s for the period from April 15 to June 1
Dry Spring	Maintain a constant flow of 15 m^3/s for the period from April 15 to June 1.

However, the ability to provide the above-noted flows is extremely difficult, as storage in the upstream watershed is limited, and spring water management is a balance between walleye spawning needs, flood protection on upstream lakes and river reaches, and power generation. Provision of 15 m^3/s during dry conditions has been difficult, and a minimum flow of 8 m^3/s has been tested and utilized during dry years as a more sustainable alternative. The effectiveness of either 8 or 15 m^3/s in providing sufficient production of walleye to maintain the Georgian Bay population is uncertain. The relationship between Moon River flows and habitat quality for walleye spawning and incubation are significant issues.

6.3.3 Operational Issues

One of MNR's primary issues is the manpower and the costs associated with operating and maintaining the various water control structures on the Muskoka River system.

Recent government policy statements indicate that MNR is no longer in the business of operating dams and maintaining waterways for recreational pursuits (MNR, 1999a). However, the Muskoka River system is different from most other river systems within the province of Ontario, in that a formal agreement (Hackner-Holden) is in place which outlines the operating procedures for each MNR controlled dam within the system. While MNR has continued to refine their operations over the years to integrate the concerns of other users of the resource (river/lake system) into their operational plans, many of the benefits to the power producers on the systems that were built into the original "rule curves" still exist. The degree to which various users benefit from MNR's operation of these dams is largely unquantified.

6.4 Power Producer Issues and Comments

Power producers (OPG, OPC, BG, AP) also identified their issues with the current operation of the Muskoka River system, as follows:

- **Divestment of MNR Structures** – concern was expressed that future divestment of a Crown owned resource to a recreation based group (such as a Cottage Association) could impact flows and the financial viability of current waterpower operations.

- **Education of the General Public** – it was noted that a general lack of knowledge concerning dams, waterpower facilities and their operations can lead to misunderstanding and improper allocation of blame for flow events outside the normal range of operations. The current infrastructure (dams and powerhouses) cannot control all naturally occurring events.

- **Smoothing of Flows** – less fluctuation in flows received from upstream facilities would enhance operational performance and generally be more beneficial to all stakeholders.

Recent government renewable energy initiatives recognize waterpower has important social benefits, including: displacement of greenhouse gases, decreasing respiratory illness and disease, reduction of smog and load following ability (i.e., the ability of waterpower to make quick changes in generation output to meet consumer needs). Waterpower, as a form of "green" power, achieves these objectives by reducing smog and greenhouse gases and associated health and ecosystem effects.

6.5 First Nation Issues

The Wahta Mohawks are the only First Nation community within the area of influence of this WMP. A meeting was held with the Chief and Administrative Assistant early in the planning process to discuss the consultation process and identify preliminary issues. The issues identified as a result of that meeting are as follows:

- Environmental Quality is a primary concern – factors such as stagnation of the water in the Moon River during the summer, timing and adequacy of flows for the Moon River walleye spawning population, and the Georgian Bay ecosystem as related to food quality and the impact of chemicals.

- OPG's Ragged Rapids and Big Eddy Stations – health and safety issues on the Musquash River associated with facility operation, and the need to occasionally pass high flows down the Moon River during traditionally low flow periods. Also the changes to water and sediment quality in a river system as a result of hydropower development.

- Priority of Interests – concern that the interests of upstream recreational users will take precedence over environmental quality issues. Environmental quality should supercede recreational interests.

- Compliance with approved water management strategies – monitoring and policing to ensure that approved plan is adhered to.

It was noted that both the Moon and Musquash rivers traverse First Nation lands. It was felt that the return to a more natural flow regime (daily and seasonal) would improve environmental conditions and the quality of both river ecosystems.

7 Initial Data Gaps and Deficiencies

Data gaps and deficiencies were identified during the course of the data collection exercise, and during consultation with the public, agencies and First Nations. Gaps and deficiencies are grouped below by major heading.

7.1 Natural Environment

Critical habitat areas for lake trout and walleye were identified from MNR District files. Available information has been summarized to document the effects of current water management practices (seasonal drawdowns) on lake trout spawning, and to a lesser extent, walleye spawning. Pike and muskellunge spawning areas are also identified. However, there are still a number of deficiencies that affect our ability to understand the effects of current water management strategies on fish and wildlife populations. They are as follows:

- Lake trout spawning bed exposure and potential for exposure of egg and/or fry to freezing/drying and associated mortality. Present information for Lake of Bays suggests that approximately 10% mortality associated with the present 0.76 m winter drawdown. No comparable information is available for McCraney Lake, Huntsville lakes, Mary Lake, Kawagama Lake, Skeleton Lake, Lake Rosseau and Lake Muskoka on the effect of the winter drawdown.

- Walleye use of and spawning success at the following areas, some of which have been the target of previous habitat improvement projects:
  - Bala Reach downstream of Bala dams
  - Lake Vernon downstream of Fox Lake dam
  - Indian River/Lake Muskoka downstream of Port Carling dam
  - Extent of walleye spawning activity below the Go Home Lake dams.

- Walleye spawning sites at Moon River and South Falls in terms of consistent and adequate flow characteristics.

- Fish community (composition and abundance) in various river reaches and lakes:
  - South Branch from Baysville dam to Hanna Chute dam
  - North Branch from Mary Lake to Bracebridge
  - Musquash River from Ragged Rapids to Go Home Lake
  - Moon River below Moon dam
  - Kawagama Lake – species other than lake trout
  - Lake Sturgeon presence and use of spawning habitat below Moon Falls.

- Matthias Falls head pond - aquatic habitat and fish community information.

- Baseflow below dams - present information is insufficient to determine whether existing releases provide suitable habitat conditions for aquatic and other riverine/riparian species (i.e., brook trout habitat in Big East River downstream of McCraney Lake dam.)

- Littoral Zone Wetted Habitat/Habitat Quality – there is no information on the quality or quantity of wetted habitat in riverine reaches during minimum and other seasonal flow periods. It has been suggested that habitat quality is degraded in some reaches (i.e., South Branch near Fraserburg).

- Wetland Communities – while only one provincially significant wetland (Big East River delta complex) has been identified as being within the influence of water management activities, numerous smaller wetlands exist throughout the watershed lakes and river system. Information regarding the status and ecological importance (fish spawning, wildlife habitat, effect of current management practices) of these smaller wetlands and potential effects of water level management is lacking.

- Atlantic Coastal Plain Flora - Atlantic Coastal Plain Flora is designated as a rare to uncommon (S3) vegetation community type in Ontario, and is very rare on a global scale. Representative populations of this vegetation community exist in several locations in the lower watershed of the Muskoka River (i.e., Moon and Musquash Rivers, from Bala to Georgian Bay). Specific sites include the Musquash River Candidate Life Science ANSI and the Gray Rapids Life Science Site. These communities exist on sand/peat shorelines and depend on fluctuating water levels and periodic flooding to prevent shrub growth. Stabilized water levels are a potential threat to these communities. Current water level fluctuations need to be documented at these rare vegetation communities.

- Loons, amphibians and other wildlife species – information is generally lacking on the effects of current water management activities on wildlife species that make extensive use of the water/land interface. Loon populations in Smoke Lake have been studied, but information is lacking on populations on other lakes. Amphibian, reptile and bird/mammal population (species and abundance) information is lacking throughout the watershed.

7.2 Socioeconomic Environment

The following gaps in socioeconomic information were noted upon completion of the background data collection process.

7.2.1 Public Safety

Water Quality Information

A number of comments were received concerning water quality in specific reaches of the river. Historically, the Ministry of Environment (MOE) collected and provided this information to other resource agencies and watershed users, but discontinued this activity after 1995. Available information for the river system was summarized in Section 3.1.11, and indicated that water quality was generally good, although high nutrient levels were present at the South Branch monitoring stations in 1992. The collection of additional data would determine whether water quality has degraded or is within historical limits.

Range of Short-Term Fluctuations/Extremes

Extreme high levels can result in public safety concerns (flooding, restricted access, etc), while extreme low levels may create navigational or other hazards. The historical range of these flood/drought events for lakes and rivers should be defined.

7.2.2 Property

Shoreline Infrastructure Information

Information on the number of docks and boathouses is available for some of the major lakes within the watershed (Table 4.5), and provides an indication of the amount of development on those water bodies. What is more important from the water management perspective is the potential for water level changes relative to existing structures. Preliminary investigations of shoreline infrastructure were undertaken in Kawagama Lake and Lake of Bays during the summer of 2002 to determine the amount of freeboard (distance) between the top of existing structures and the normal summer water level. This information is vital to the development of future water management options.

Shoreline Erosion

Shoreline erosion is known to occur at specific sites on various lakes/river reaches (Kawagama Lake, Lake of Bays, Fox Lake, Big East River at Arrowhead Provincial Park). The extent and potential causes are not known.

Ice Damage

While ice damage is occasionally reported to MNR, the present operating regime appears to minimize ice related damage to boathouses, docks and shorewalls. Additional information would be required if changes to existing operational levels are proposed.

Floodplain Mapping

Detailed floodplain mapping is present for only the Town of Bracebridge (18 km section from Lake Muskoka to above Wilson Falls) and Huntsville at the River Cove subdivision (Big East River and 4 km of Lake Vernon shoreline). The Town of Bracebridge identified regulatory flood limits on specific portions of the North and South Branch Muskoka River. No mapping is available for other communities/river reaches/lakes to identify areas at risk.

7.2.3 Navigation

Water Levels

Minimum water levels have been established in areas subject to commercial navigation (tour boats, etc). No similar information is available for areas that are used for recreational boating.

7.2.4 Economic (Tourism/Recreation/Waterpower)

Aesthetics of Falls and Chutes

The aesthetic value of Muskoka River falls and chutes is considerable, but is a highly subjective value. Information (photographs) on the various feature at different seasonal flow rates would assist in future evaluations.

Bait Fish Harvesting and Traplines

Bait fish harvesters and trappers are required to report their catches to MNR, but are not required to report by water body or location within the river system. As many of these species utilize shallow water areas, they are potentially susceptible to changes in water management activities. Contact with individual harvesters (bait fish and trappers) would be required to obtain site-specific information.

7.2.5 Miscellaneous Socioeconomic Issues

Communication Practices

Information on current 'best practices' for public consultation would assist with the development of the next phase program. The identification of opportunities and timeframes to integrate information releases with existing lake or cottage association mailouts or news releases could potentially improve communication practices.

Climate Change

What will be the impact of climate change on the Muskoka River watershed, and are there strategies in place to respond to those changes? While it was recognized that climate change may affect the amount of rainfall and hence river flows, present information is not definitive in terms of the potential for a long term increase or decrease. The primary expectation from climate change is enhanced variability/extremes.

7.3 Engineering/Operational

Engineering data gaps were identified which would affect the ability to establish current and future operational scenarios:

- **Dam Operation Costs -** Dam operation and maintenance consume staff time, resources and capital for both MNR and waterpower producers. These costs should be separated from other operational or production costs and used as a basis for future comparison.

- **The Acres Reservoir Simulation Program (ARSP)** was set up and calibrated to simulate the existing water management activities (resultant flows and water levels) within the Muskoka River system. The results of the base case run indicate that good agreement was obtained between historical flow and level data and the simulation model output (see A&A, 2003a).

  The ARSP model uses daily hydrology data to model inflow into the North, South, and Main Muskoka River branches, and to model local inflow between respective dams. The 31-yr long, daily hydrology record derived for the Muskoka system is the most important data parameter as all operational decisions are based on the quantity of water entering the system. The model also uses weekly rule curve data to represent operations of dams, and weekly flow constraints to represent demands for water. Based on the weekly operational data and daily hydrology, the model can adequately predict medium to long term water levels and flows in the system. For the purposes of the WMP, it is vital to model long-term flow patterns that capture flows ranging from extreme floods to extreme drought events. Therefore, a daily time step is considered appropriate and practical since many years of data are typically required to represent the hydrologic cycle of the river system.

While these longer-term water level fluctuations (days, weeks, seasons) are of interest to area residents, concern has also been expressed about shorter-term fluctuations within the 24-hour time period. It is important to note that the model presently developed for the Muskoka River system cannot analyze the shorter-term effects of hourly dam or power plant operations as it is based on daily data. The ARSP model is however capable of performing hourly flow simulation if a sufficient amount of detailed hourly data is provided. This would then require the collection and analysis of hourly flow and operational (water level) data.

- **Flow and Flood Forecasting -** There is presently no tool available to accurately predict flow and flood levels in a timely manner. A flow/flood forecast model could increase decision-making capability with respect to dam operations.

- **Water Power Development Opportunities -** The existing waterpower facilities on the Muskoka River have 28.3 MW of installed capacity. Opportunities for further development have been identified at a number of the current damsites. Upgrades to existing facilities could increase power output in some instances. The Bala North site has recently been released by MNR for development under the Renewable Energy Program.

7.4 Issues Beyond the Scope of the Water Management Plan

The WMP planning process is being undertaken to evaluate the adequacy of Muskoka River flows and water levels to provide opportunities for multiple use of the water resource (i.e., tourism, recreational activities, power production, maintenance and protection of natural resource values, flood passage, and other uses) in a balanced fashion. The issues that are beyond the scope of this water management planning process include:

- those related to land use practices such as shoreline development, road construction, etc, and their impact on water quality (unless it is related to inadequate flow as well)

- the impact of recreational fishing on fish communities

- hydropower development approvals (unless proposed as a WMP operational strategy).

8 Baseline Data Collection

8.1 Original Data Collection Program

Baseline data describing the physical, biological and socio-economic characteristics of the Muskoka River system and the various water control structures (and any issues associated with their operation) was collected from the following sources:

- published reports and data
- unpublished MNR data (natural resource values, water control structure characteristics and operations, etc)
- waterpower producers (OPG, OPGC, BBG, & AP)
- discussions with local agencies and municipalities
- information from the public.

The ARSP was set up to simulate the hydrologic characteristics of the managed lakes, reservoirs and river reaches within the Muskoka River system. A limited field investigation was undertaken during the Phase 1 data collection process to investigate the elevation of existing infrastructure (docks, boathouses, etc) in Lake of Bays and Kawagama Lake relative to typical operating levels. The Phase 1 data was summarized and reported in the Background Information Report (A&A, 2003a).

8.2 Information Collected During the Planning Period

Since Phase 1 was completed, a number of studies have been undertaken to fill specific data gaps as identified in Section 7. Only studies that were directly related to water levels and flow manipulations were approved by the Planning Team/Steering Committee. The following provides a brief description and summary of the results for those additional investigations.

8.2.1 Infrastructure Survey

An infrastructure survey was conducted on nine lakes within the Muskoka River watershed to investigate the elevation of existing shoreline infrastructure (i.e., docks and boathouses) in relation to lake water levels (Acres, 2003a). The lakes studied included:

- Lake Muskoka
- Lake Rosseau
- Lake Joseph
- Tasso Lake
- Camp Lake
- Lake Vernon
- Peninsula Lake
- Fairy Lake
- Mary Lake and North Muskoka River (south of Huntsville).

On each lake, a random sampling of infrastructure (docks and boathouses) was measured to determine the amount of freeboard to the top of the deck surface and the bottom of the splashboard, and the water depth/level at the entrance to the boathouse or at the end of the dock (if shallow water depth was considered to be a constraint to access to the structure). The average, minimum and maximum freeboard values were calculated and correlated to lake elevation.

The results of the study provided an indication of the average amount of freeboard for the structures on each lake, as well as the range of variability between lakes. These values can be used to determine the potential impact of different water level management options on shoreline infrastructure for each of the lakes.

8.2.2 Matthias Reservoir Fisheries Survey

During the Phase 1 public consultation activities, comments were received regarding the potential impact of Matthias GS head-pond operations on river flows, water levels, and fish and wildlife communities in the reservoir. At that time, no information was available on biological communities within the reservoir. A study was subsequently conducted in August 2003 (Acres, 2003b) to provide baseline information on the biological resources (i.e., fish communities, aquatic and wetland habitat conditions) of the reservoir to support development of the WMP.

The study methodology included a fish community assessment (gill nets, seine nets, minnow traps) to document species presence/absence and comparative species abundance, and a riparian/littoral zone habitat assessment to investigate any potential effects of water level fluctuations. The study revealed a warm water fish community dominated by centrarchid species (smallmouth bass, rock bass and pumpkinseed) with few large predators (only one large northern pike collected), and a forage base dominated by shiners. Habitat conditions appear to be conducive to centrarchid species, although a distinct drawdown zone was noted that contained a reduced vegetation community of limited habitat value. Extensive wetlands were present in two large embayments at the upper limit of the head pond, as well as smaller wetlands within small embayments along the periphery of the reservoir. These wetlands likely contribute valuable spawning and rearing habitat for spring spawning species. Extensive (i.e., >1 m) and long duration water level changes within the head pond during the spring could adversely affect the reproductive success of spring spawning species in these wetland environments.

8.2.3 Kawagama Lake Trout Spawning Survey

A study was conducted during the fall of 2003 (Acres, 2004b) to determine the potential impacts of water level management (i.e., fall and winter draw down) on lake trout reproductive success on Kawagama Lake. Specific aspects of the study included:

- lake trout spawning habitat assessment and mapping using Geographic Positioning System (GPS) technology to accurately map substrates and water depths over prospective spawning areas
- surveys of spawning lake trout at 18 potential spawning shoals
- lake trout egg collection at the two primary spawning sites
- estimation of egg deposition abundance within specific depth contours at each spawning site to determine proportion of eggs potentially susceptible to exposure during winter draw down of the lake.
- determination of egg/fry viability in late spring at the typical winter/spring drawdown level.

The study found that one shoal is the primary spawning location within the lake, and accounted for the majority of the spawning activity. Based on the results of the subsequent egg collection activities, it was estimated that approximately 30% of the eggs deposited on the primary spawning shoal were within the winter drawdown zone and would therefore be potentially subject to dewatering or ice scour prior to fry dispersion in late April/early May. Egg collections at a secondary spawning shoal revealed that all eggs at this location were deposited below the drawdown zone, although egg abundance was significantly lower than was observed at the primary spawning site.

Additional field studies were conducted in March 2004, when the lake reached its maximum drawdown level, in order to determine any potential impact of this drawdown on previously deposited eggs and developing fry. The study was able to differentiate between previously dead and frozen (but dead) eggs and larvae, and recovered frozen eggs and larva from the drawdown zone, indicating that the drawdown was directly responsible for the associated mortality. It was noted that all eggs or fry located more than 5 to 7 cm above the active lake water level were frozen/affected by the drawdown. The study concluded that the existing winter (0.62 m) drawdown was adversely affecting lake trout reproductive success and provided recommendations to reduce this mortality.

8.2.4 Wetlands, Littoral Zones and Water Level Fluctuations

The Planning Team identified the need for background information on the degree of water level fluctuation that is considered acceptable or 'healthy' for wetland communities and shoreline littoral zones. A limited literature review was undertaken to address this issue (A&A, 2003b).

Ecological principles acknowledge that seasonal and annual variability is an integral component of any normal ecosystem and contributes to the diversity of its flora and fauna. Studies have shown that water level regulation can impact riverine and lacustrine ecosystems by changing hydrological variables such as the annual water level fluctuation range, the year-to-year variability of water levels and the timing of water level fluctuation. These variables may impact numerous components of the aquatic and terrestrial ecosystem, including wetland and littoral zone vegetation composition, and its associated diversity and function, as well as the species (i.e., fish, insects, mammals) that depend on these habitats. A winter drawdown, whether for hydropower production or to provide water storage to reduce spring flooding, can also have significant negative impacts on aquatic ecosystems.

The literature review presented a number of generalizations that could be utilized in the ecological evaluation of alternative water management strategies for the Muskoka River watershed. These recommendations are most applicable to regulated waterbodies that exhibit typical altered hydrological regimes, in an effort to move them toward more natural hydrologic cycles. Recommendations include:

- Implement a gradual summer/fall drawdown so that stable water levels are attained before the ice forms.

- The amplitude of the water level fluctuation should more closely approximate natural fluctuations, and in particular, limit the amount of winter drawdown that occurs over natural conditions.

- In lakes with a considerable fall/winter drawdown, spring lake levels should reach a minimum sustainable level (based on habitat availability and hydrologic/hydraulic linkages) earlier in the season to allow fish to access appropriate spawning habitats.

- Maximum vegetation species richness can be achieved by managing water levels to provide either
  - decreased within-year and high among-year variation
  - moderate within-year and among-year variation
  - high within-year and low among-year variation.

- Employ an ecologically based regulation practice: adjust the timing, progression and magnitude of water level manipulation according to the specifics of the managed waterbody.

For example an analysis of the hydrologic tolerances and requirements of several common wet meadow vegetation species within the Muskoka River watershed indicates that these habitats should be flooded for at least 20 to 25 days during the growing season to facilitate their growth and survival (i.e., providing sufficient amounts of water to eliminate competition from non-wetland species). Another example of basing water level management decisions on ecological requirements of species found in the Muskoka watershed could involve northern pike, a typical species of many of the regulated lakes in the area. Recommendations for other controlled lakes (i.e., Rainy Lake/Namakan Reservoir) include an earlier spring rise in water levels to provide access for northern pike to flooded shoreline habitats, and maintenance of these levels for at least 30 days in order for fry resulting from spawning activities in these areas to return to the main water body. Therefore, any alterations in the water level management regime must take into account the requirements of particular plant and animal species found in and around the lake.

Several studies indicated that among-year variations were very important to maintain ecological functions by providing appropriate levels of environmental disturbance. Recommendations for appropriate ranges or timing of among-year variation included:

- variability in the yearly range of water level fluctuation (i.e., higher or lower than normal) should be allowed to occur more or less every 5 years

- the minimum range of fluctuation should encompass the water level exceeded 10% of the time and the level exceeded 90% of the time (in an unregulated waterbody), with both levels achieved at least once every 15 years.

The literature review concluded that appropriate ranges of water level fluctuation and timing of water level change are specific to individual watersheds, and cannot be specifically based on results from other watersheds. However, studies have concluded that the best way to enhance wetland and littoral zone ecological functions and the populations of flora and fauna that inhabit these areas in regulated waterbodies, is to implement a water management regime that more closely approximates the naturally occurring hydrologic regime that would be present in the absence of existing structures and water level regulation.

8.2.5 Loon Abundance and Distribution

A review of loon abundance and distribution data during the nesting season was undertaken to determine potential impacts of water management activities on loon populations (A&A, 2003d). Information on loon nesting on 11 lakes (6 regulated, 5 unregulated) within the Muskoka watershed was obtained from Bird Studies Canada (BSC), and analyzed to determine whether a correlation could be established between water level fluctuations and loon nesting success. Water level data for the regulated lakes was obtained from MNR to supplement water level data contained within the BSC data. In the Muskoka watershed, loon nesting and incubation generally occur in late May/early June, with the period of most susceptibility to water level changes extending to the end of June.

The results of the analysis of eggs and hatching success did not show any consistent trend in relation to water level. Five occurrences of eggs that did not hatch were noted on regulated lakes, but only one of these occurrences was during a water level fluctuation of more than 30 cm during the nesting period. All other occurrences of unhatched eggs were from years when there was no significant water level fluctuation. A further complication was that no eggs were observed on unregulated lakes (but young were later observed) during the survey period.

No consistent correlation could be established between production of young and water levels from the data either. The number of loon pairs with at least one large young increased from 1997 to 1999 within the regulated waterbodies within the watershed, but this trend was also consistent across most of Ontario and Quebec, and cannot be related to water level management. The reproductive success data from regulated lakes showed a slight trend toward improved productivity in years when water levels did not fluctuate more than 30 cm in June or July (the important nesting and incubation period). However, young loons were also produced during several years that experienced significant water level fluctuation. In addition, young were produced on unregulated lakes during years with significant water level fluctuation. In summary, the data indicate that water level is not the only influence on loon reproductive success.

Despite the lack of correlation of reproductive success with water levels in the Muskoka watershed lakes, the information on loon ecology and nesting characteristics can provide some direction for water management planning. Water management strategies that limit or provide gradual water level changes during the mid-May to late-June period would be preferred (to provide optimum conditions for loons) over those that make significant changes (i.e., >30 cm) during that time period.

8.2.6 Computer Modeling Studies

ARSP was set up during Phase 1 of the project to simulate current water management within the Muskoka River system (see A&A, 2003a for details of model set up and calibration). Once the model was established, it could be used to evaluate different flow and water level scenarios. The Planning Team authorized four studies to investigate the following topics:

- Flow available at Moon Falls for walleye spawning
- Flow available at South Falls for walleye spawning
- Base flow within river reaches below existing dams
- Comparison of historical versus simulated water level fluctuations at two lakes within the Muskoka River system.

This work was undertaken in order to provide better information on which to base the subsequent Phase 2 evaluation of alternative water management strategies.

Flow for Walleye Spawning in Moon River below Moon Dam
A study was undertaken in spring 2003 (A&A, 2003c) to address the availability of flow for walleye spawning at the Moon Falls location in relation to other demands for water (i.e., stable Lake Muskoka levels with no damage to infrastructure, power generation, etc). Flow originating from Lake Muskoka is divided below Moon Chutes, and passes through the Moon River and the OPG power stations (Ragged Rapids and Big Eddy) on the Musquash River. The provision of a consistent, reliable flow quantity at Moon Falls is considered an important component of improving the habitat conditions at the spawning site downstream of the falls. Further work is planned to define the flow value that provides adequate coverage of spawning substrates.

A number of scenarios were tested to determine the outcome of different water allocation strategies. Historical records from Lake Muskoka were examined to determine whether the required flow (walleye and waterpower) could be provided throughout the spawning and incubation period (approximately April 15 to June 3). The model utilized 31 years of simulated data, and also examined scenarios that utilized the full extent of the Normal Operating Zone (NOZ) of Lake Muskoka.

The first scenario examined the existing operating plan, and calculated the flow available for power generation if 14 m^3/s is provided to the Moon River for walleye spawning on a priority basis. Under average hydrologic conditions, a flow of at least 14 m^3/s could be provided for 29 of the 31 years modeled, with the annual value ranging from 7 to 141 m^3/s, and an overall (31 yr) average of 62 m^3/s. This shows that, during extremely dry years, there would not be enough water for walleye spawning, even if it is provided preferentially. In addition, the reported average flow would not necessarily provide 14 m^3/s throughout the entire spawning and incubation period, as the average value may be influenced by large, often short-duration flow peaks that usually occurs at some point during the April 15 to June 3 period. These flow peaks are the result of snow melt or rain events, which are presently passed through the system without attempting to store large portions in upstream lakes or reservoirs. When these high flows are bypassed to the Moon River, they may cause walleye to spawn in unsuitable areas that are subsequently dewatered when these flow peaks recede. The average flow available for power generation under this scenario ranges from 6 to 84 m^3/s, with a 31-yr average of 62 m^3/s. With the present operational strategy, it is apparent that there are a number of times when there is insufficient water available for walleye spawning, even when it is given preference over waterpower, and there are few years when the full waterpower potential (i.e., a flow of 85 m^3/s) is obtained.

A number of other scenarios were then evaluated, to determine whether an improved flow regime could be obtained if Lake Muskoka was utilized to capture and subsequently release a portion of the spring freshet. In each instance, upstream lakes were modeled according to historical operating practices, while Lake Muskoka was maintained within the NOZ (not allowed to enter upper or lower operating zone). The following walleye/waterpower flow scenarios were evaluated (in m^3/s):

- 8 for walleye and 85 for waterpower
- 14 for walleye and 85 for waterpower
- 14 for walleye and 42 for waterpower
- 28 for walleye and 42 for waterpower
- 21 for walleye and 42 for waterpower
- 14 for walleye and 42 for waterpower.

The results showed that utilization of the full operating zone improved the ability to provide a constant flow of 8 or 14 m^3/s for walleye and 85 m^3/s for waterpower throughout the walleye spawning period. There were however 4 years out of the 31 modeled that the allocation for waterpower was substantially less than 85 m^3/s if the constant flow of 8 or 14 m^3/s was maintained for walleye. For the third scenario, the 14 m^3/s for walleye and 42 m^3/s for waterpower could be provided for all but three of the 31 years modeled. For the fourth scenario, the 28 m^3/s for walleye and 42 m^3/s for waterpower could be provided all but 4 of the 31 years modeled with the overall average flow for power generation being 64 m^3/s. Similar to the third scenario, the fifth provided 21 m^3/s for walleye and 42 m^3/s for waterpower on all but 3 years, with the overall average for waterpower being 69 m^3/s if 21 m^3/s was provided for walleye spawning. Finally, the last scenario duplicated scenario three but allowed more change to Lake Muskoka water levels. When 14 m^3/s was provided on a constant basis for walleye spawning, an average flow of 67 m^3/s would be available for power production, with flows falling below 42 m^3/s on only 3 of the 31 years modeled.

The results of the scenarios showed that there was significant room for improvement of flows for walleye spawning and for hydropower during the spring freshet period if the storage within the NOZ of Lake Muskoka is used to its greatest extent. This would capture a larger part of the spring freshet than is presently undertaken, and then release it during the spawning period. In order to implement this type of operation, a foreknowledge of incoming flows is required, thus a flow forecasting system would be required for the Muskoka River basin. The first set of scenarios that were tested raised the water level to the top of the normal operating zone at least 50% of the time during the spring freshet for Lake Muskoka and it was anticipated that this would not be acceptable to the local residents. The last scenario discussed can be implemented with only a slight increase in the spring Target Operating Level (TOL). If the concept were applied to all the lakes in the Muskoka Basin, there could be a very significant improvement in flows for walleye spawning, as well as additional water for hydropower.

Base Flows for Walleye Spawning below South Falls

A study was undertaken in April 2003 (A&A, 2003c) to address the availability of flow during the spring for walleye spawning at the South Falls location. As noted in Section 8.2.2 above, peaking operations at Matthias GS occasionally resulted in the provision of less than the required flow at the spawning area. The study was undertaken to determine whether a higher base flow from Lake of Bays could improve the existing situation.

Historical flow records from Lake of Bays were examined to determine whether the required flow could be provided throughout the spawning and incubation period (approximately April 15 to June 3) by alternate operation of the dam, while still maintaining the lake within the NOZ. The ARSP model was used to determine whether the flow releases from Lake of Bays could be increased and maintained above the 3 m^3/s level. The basic premise was that Matthias could moderate its peaking operations and continue to provide a consistent minimum flow of 3 m^3/s if additional flow was available. Four scenarios were evaluated (flows of 6, 9, 12 and 27 m^3/s) under various operating regimes. The results showed that a constant flow release of up to 9 m^3/s could be provided from Lake of Bays during the walleye spawning period without significantly impacting water levels on Lake of Bays.

Base Flows below Operational Dams

This task looked at improving base flow throughout the entire river basin by utilizing the storage available in the NOZ below the TOL on the lakes. To perform this study the ARSP model was used to run base flow demands at each operational dam. The analysis showed, that the existing base flows, as identified in the Muskoka River Dam Operational Manual, are achievable at least 90% of the time at most of the dams in the lower part of the basin. In the upper part of the watershed, some of the established demands could be achieved, except at Camp Lake and Tasso Lake. There was also the possibility of increasing base flows at some of the dams, under normal conditions.

Review of Historical Water Level Fluctuation Events

Historical water level data for two representative lakes (Lake Muskoka and the Huntsville lakes) for the period from 1982 to 1998 was analyzed to determine the range of historical water level fluctuation around the TOL. This degree of fluctuation was then incorporated into the ARSP Base Case to allow the model to more closely simulate water level and flow conditions.

8.2.7 Matthias Infrastructure

A study to investigate water depth associated with docks and water lines in the Matthias head pond was undertaken in October 2004 to provide input into the development of the operating range for the facility (Acres, 2004c). All docks were investigated, with a number of measurements of water depth obtained at the offshore and inshore ends to assist with the evaluation of potential effects of water level fluctuation on access to the structures. If water lines were present, the water depth at the offshore was also measured.

The study found that many of the docks within the head pond were constructed with fixed and floating sections (similar to Kawagama Lake), which provide improved access during variable water levels. In these instances, water depth was obtained at both the offshore and inshore end of the floating section. In some cases, floating sections had been removed from their moorings and pulled onto shore in preparation for the winter season.

Of the 57 structures surveyed, 38 (approximately 67%) had their offshore end at or beyond the 292.0-m contour (>0.84 m depth on day of survey), while the floating section of 8 structures were entirely beyond the 292.0-m contour. All water lines (21) also extended beyond the 292.0 m contour. An additional 15 (26%) structures had their offshore end located between the 292.0-m and 292.3-m contour, and 4 (7%) were above the 292.3-m contour.

The study concluded that a reservoir water level of >292.3-m elevation would provide water access to the majority (93%) of the structures, and should address public concerns. It was suggested that the 292.3-m elevation be adopted as a Best Management Practice (BMP) lower operating limit within the Matthias GS operating plan.

9 Option Development Process

The process undertaken to develop a new operational strategy for the Muskoka River system (lakes and river reaches) is described in detail in the *Options Report Muskoka River Water Management Plan* (Acres 2004a). The process is summarized in Figure 9.1.

The option development process was initiated by the Planning Team during a series of 'brain storming' sessions (beginning with a 2-day meeting May 13 and 14, 2003) that examined the background information available for the Muskoka River system, the issues and concerns previously identified, and the data gaps and results of the recently completed data collection investigation (see Section 8). In addition, most Planning Team members worked and/or lived within the Muskoka River watershed, and were able to bring local knowledge and expertise to the table. The process continued through a series of Planning Team, Public Advisory Committee (PAC) and Steering Committee* meetings and discussions until a preliminary preferred option was developed.

The discussions resulted in the identification of a number of key features of the Muskoka River watershed that were given primary consideration in the development of goals and objectives for the Water Management Planning process. A number of the most important, relevant features are as follows:

- Many of the larger lakes and associated river reaches within the watershed are extensively developed for recreational use, with well established, long-term, high value infrastructure (cottages, boathouses, resorts, camps, etc).

- Recreational boating occurs to varying degrees on almost all watershed lakes, with commercial navigation (tour/sight-seeing boats) an important commercial activity on the larger lakes.

- Ecological conditions within the watershed are generally good, although the potential for improvement in specific areas had been identified (A&A, 2003a).

- The existing operational plan (as documented in the Muskoka River Dam Operation Manual, MNR, 1997) provided specific amounts of base flow

* Steering Committee, Planning Team, and Public Advisory Committee members are listed in Appendix A.

below individual dams throughout the watershed. While these flow targets were often met in lower portions of the watershed, the provision of base flow in upper watershed river reaches and the specific contribution from individual lakes/reaches was less well defined.

- The dams have increasingly less ability to control lake levels and river flows and levels as inputs (i.e., rainfall, snow melt) to the system increase. During high input periods, such as the spring freshet and other large seasonal storm events, no control is exerted and dams are intentionally opened to allow the flow to pass unhindered through the system.

- The waterpower sites within the watershed are all located on riverine portions of the watershed, and are 'run-of-river' operations. Management of the dams at the outlet of upstream lakes provides the flow required for the operation of these facilities.

- Existing structures have specific limits in terms of flow passage and water retention capability. Only water level and flow changes that could be accommodated within the operational constraints of the present structures should be considered.

These and other characteristics of the watershed were used to develop a series of goals and objectives for the water management planning process for the Muskoka River watershed, which have been grouped into three categories, being ecological, social and economic objectives. Subsequently specific features, issues and considerations were identified and documented for the various water bodies and river reaches. The results of additional studies or investigations were incorporated to provide a complete listing of watershed characteristics and issues.

9.1 General Watershed-Wide Objectives

9.1.1 Ecological Objectives

As noted in the Aquatic Ecosystem Guidelines (MNR, 2003), "The dynamic variability of a river's flow organizes and defines river ecosystems and their biodiversity, production, and sustainability. Native biota and riverine communities have evolved with, and adapted to, the natural flow regime of a river system, including the seasonal and inter-annual variability that is an ecologically important part of this natural cycle. A range of flows is necessary to scour and revitalize gravel beds, to import wood and organic matter from the floodplain, and to provide access to productive riparian wetlands. The natural flow regime of a river plays a critical role in sustaining a river's native biodiversity and protection ecological integrity through its influence on geomorphic and ecological processes and its control over the distribution and abundance of riverine species."

Ecological principles acknowledge that variability is an integral component of any normal ecosystem, and contributes to the diversity of its flora and fauna. Under natural conditions, lake levels and river flows fluctuate around some median level. Too little or too much fluctuation (as a result of imposed controls) can result in reduced diversity of both habitats and species. Accordingly, a number of ecological objectives were developed for the watershed as potential goals for the future operation of watershed lakes and rivers. Information from applicable guidance documents and the scientific literature was utilized in the development of these objectives.

1. Allow a reasonable amount of annual and inter-annual variability of lake levels. Based on information derived from the literature (A&A, 2003b, see also Section 8.2.4), the annual variability of lake levels (spring peak to late summer/fall minimum) could be up to 1.0 m (depending on lake size and inputs). On an inter-annual basis, this difference could approach 1.5 m once every 5 years.

2. Spring lake levels should be allowed to rise 30 to 50 cm above the level of established shoreline vegetation (30 to 50 cm increase not unusual in natural systems). Benefits arising from this objective include:

   - recharging of groundwater supplies
   - inundation of wetlands and shoreline vegetation and associated transfer of flood water nutrients to these areas
   - provision of access to spawning grounds and flooded shoreline vegetation for spring spawning species.

3. The duration of higher spring levels should be in the order of 45 days to allow offspring (fry) arising from spring spawning species that utilize the floodplain to return to the lake or river environment.

4. Lake levels should be allowed to fall during the summer (minimum 20 to 30 cm). Receding water levels provide new habitats for the development

of shoreline species, which will increase the overall diversity of the plant and animal communities of the water/land interface in the long term.

5. In the absence of detailed information on the location and depth of lake trout spawning shoals, the late winter/early spring water level in lake trout lakes should not be lower than the fall water level during lake trout spawning (approximately mid-late October). Where the depth of lake trout spawning shoals is known, the fall water level should strive to maintain a minimum water depth of 20 cm over the top of the spawning shoal.

6. Base flow should be maintained in all river reaches during normal hydrological conditions. During drought conditions, a minimum flow should be maintained to preserve ecological integrity of the river system.

9.1.2 Social Objectives

The following outlines the basic social objectives for the planning process.

1. Many of the large lakes within the Muskoka River system have well established, high-value shoreline infrastructure (cottages, boathouses, docks, and associated systems). Much of the infrastructure has been built around the present operational regime. Major changes to water levels or river flows that will significantly impact infrastructure will be avoided, unless they are being proposed to address significant other concerns. As a starting point, proposed changes will remain within the existing NOZ on those lakes where there is significant infrastructure.

2. The frequency and magnitude of flow changes within river reaches had been identified as a concern during the Phase I study. Daily flows should be compared to the maximum daily flow criteria outlined in the Dam Operation Manual (MNR, 1997) in river reaches with significant infrastructure. Equal consideration should be given to river flows/water levels as lake levels.

3. River system flows must provide adequate supplies for any water taking purposes (e.g., irrigation, domestic water supplies, and municipal requirements) as well as waste assimilation.

4. Recreational boating (primarily during the summer months) and commercial navigation on Lake Muskoka, Lakes Rosseau/Joseph and the Huntsville lakes from May to October are important traditional features of the Muskoka watershed. River reaches provide access between lakes (i.e., North Muskoka between Huntsville lakes and Mary Lake, Indian River between Lake Muskoka and Lakes Joseph and Rosseau) as well as other recreational opportunities (canoeing, kayaking, etc).

5. Winter sporting activities (snowmobiling, ice fishing, etc) that utilize or cross over frozen water bodies require stable lake levels and/or river flows to maintain ice integrity.

6. The beneficial aspects of waterpower generation, as a renewable energy resource, will be taken into account. Recent government renewable energy initiatives recognize waterpower has important social benefits, including: displacement of greenhouse gases, decreasing respiratory illness and disease, reduction of smog and load following ability (i.e., the ability of waterpower to make quick changes in generation output to meet consumer needs). Waterpower, as a form of “green” power, achieves these objectives by reducing smog and greenhouse gases and associated health and ecosystem effects.

To clarify water level constraints related to infrastructure, studies were undertaken in 2002 and 2003 to determine the elevation of existing infrastructure (boathouses and docks) in relation to water levels (A&A, 2002; Acres, 2003a and 2004c). The surveys were undertaken on Lake Muskoka, Lakes Rosseau and Joseph, Lake of Bays, Kawagama Lake, Matthias reservoir, Mary Lake (including the North Muskoka River south of Huntsville), Lake Vernon, Peninsula Lake, Fairy Lake, Tasso Lake and Camp Lake. Information from these studies was utilized by the Planning Team in the development and evaluation of alternative operating strategies.

9.1.3 Economic Objectives

The following economic objectives were used to guide the planning process.

1. Waterpower production should be maintained at its present level and/or enhanced if possible.

2. Opportunities to reduce the operation of MNR owned/operated control structures should be investigated/implemented as possible.

3. Existing commercial activities (e.g., marinas, boat tour operations, campgrounds, etc) should not be negatively impacted.

4. Practical solutions to water management should be sought which can be implemented within current budgetary constraints.

9.2 Subwatershed Issues and Considerations

While the above-noted general objectives applied broadly to most river reaches and lakes across the watershed, there were also a number of unique features of each subwatershed that needed to be taken into consideration in the development of any alternative water management strategy. Table 9.1 provides a summary of the issues considered by subwatershed and lake in the options development. This information is presented in full in Section 3 of the Options Report (Acres, 2004a).

9.3 Base Case Model

A computer model of the Muskoka River system was set up as part of the Phase I study and is fully described in the Background Information Report (A&A 2003a). ARSP was used to model the operation of the physical structures (dams and waterpower facilities) which store and release water throughout the river system. A Base Case model was set up to simulate the period from 1970 to 2000 (31 years of data) which represents the Muskoka River system as it is currently operated, and coincides with the period of time that the most recent version of the Hackner-Holden Agreement has been in effect.

The ARSP computer model is most easily thought of as a network of nodes and channels, where each node represents either a junction point or a storage location in the system (such as a lake or reservoir), and each channel represents a potential path for water to move through the basin. These channel types include river reaches, powerhouse turbines, dam spillways, locks and local inflows. Each channel originating at a lake or reservoir contains a structure that defines the maximum discharge limits through its outlet gates, spillwalls or valves into the downstream river reach. The schematic of the Muskoka River ARSP model, illustrating river reaches, junctions, lakes and structures, is shown in Figure 9.2. Other model input parameters that are required for accurate simulation of the watershed include the discharge rating curves for the dams and weirs, reservoir storage curves, evaporation losses, reservoir operating plans and criteria, and minimum and maximum flow constraints for various channel sections/river reaches.

As illustrated in Figure 5.3, the operation of the dams follows an established operating regime that targets a defined range of water levels during specific season intervals. The annual operating range for a managed lake typically includes a fall and/or winter drawdown, a rapid rise in lake level during the spring as the snowmelt and spring rains fill the lake, and a relatively stable summer water level. The exact timing and the magnitude of the drawdown and/or seasonal peak varies from lake to lake within the system, and depends on the contributions of the upstream drainage area, the operational characteristics of the structure, and various ecological, social and navigational constraints. The operating plans include a TOL around which water levels normally fluctuate. This NOZ is the typical variability around the target level. The frequency of dam operation varies throughout the watershed, with some of the more remote headwater dams, which are not readily accessible, operated on a seasonal basis, while other more accessible structures, may be operated on a daily or weekly basis in response to rainfall or snowmelt events.

In setting up the ARSP model, these operating regimes are entered into the model for each lake or reservoir. The water levels bounding the different operating zones are linked in the model with a penalty structure, which is used to describe the operating policy for each dam and associated lake. The NOZ is associated with a lower penalty than water levels within the higher or lower zones. The magnitude of the penalty increases as the water level moves away from the TOL, that typically has a penalty of zero. Likewise, flow constraints in river reaches are modeled in ARSP as flow ranges associated with penalties. A preferred flow range will have a low penalty and flows below minimum ecological requirements will have higher penalties, as will high flood flows. The model simulates the movement of water through the elements of the river system by allocating priorities to storage or release of water from the lakes and through river reaches, such that it minimizes the sum of all penalties incurred throughout the river and lake network. Appropriate model setup requires considerable expertise and is labor intensive as it is often a 'trial and error' process to establish the correct penalty structure that reflects actual system conditions.

The physical model is driven by inflow hydrology (flows that would result from rainfall events within the watershed) which represents flow entering the system at each sub-basin. These local inflows are indicated as inflow channels or arrows in the model schematic shown in Figure 9.2. The time series flow data used in model setup was derived from WSC gauges with long periods of record, being: the Black River WSC gauge number 02EC002 and the North Magnetawan River WSC gauge 02EA005, located in close proximity and in a similar hydrologic region to the Muskoka basin, and the Big East River WSC gauge number 02EB013, which is located in the study basin. These daily flows were pro-rated on a drainage area basis for each sub-basin in the system. In response to these inflows and the starting water levels for each lake, the model makes a decision for each simulation time step on whether to store or release and route water. During simulation runs, the model attempts to minimize the total penalty "cost" during the specified simulation period.

Incorporation of Historic Fluctuations

The Phase I Base Case model was calibrated and verified through a series of iterative model runs until the simulation results closely matched actual water level and flow data from the Muskoka River system. At the start of next phase of the WMP process, a modification to the model was initiated to make it more representative of natural conditions within the watershed, by incorporating the range of historic water level fluctuations into the base case model. While it was recognized that water level fluctuations are a direct result of rainfall and/or snowmelt events or periods of drought, those events are often moderated by operational changes at the dams in order to remain within the established operating zone. However, strict adherence to the TOL is unrealistic/not possible due to the excessive number of dam operations that would be required (micro-management) and the associated costs (time and manpower to operate the dams) that would be incurred.

Historic water level and flow data were obtained for Huntsville lakes, Mary Lake, Kawagama Lake, Lake of Bays, and Lake Muskoka for the period from 1980 to 1998, while only water level data was available for Lakes Joseph and Rosseau and Go Home Lake. An example of the historic water level and river flow data (for

Lake of Bays and Baysville dam outflow) is presented in Figure 9.3. Daily water level information is presented as a frequency distribution superimposed on the lake operating zone. The statistics summarize the range of levels recorded on each day over the period of record (1980 to 1998 for most lakes), and provide the mean and median daily water level, the daily minimum and maximum water level, and the 80% range (i.e., range within which daily water levels occur 80% of the time). Flows are summarized on a weekly basis. The plots indicate that historic water levels were within the NOZ most of the time, and that fluctuating lake level/river flows are a normal occurrence (i.e., it is very difficult to operate a dam so as to maintain lake level or river flow to a specific target level). Water levels occasionally move into the upper and lower operating zones, and less frequently into the high and low water zones (only during significant flood and/or drought events).

In order for the Base Case model to more closely reflect the historical water level variability, the ARSP penalty structure was “relaxed” to allow water levels to fluctuate within the NOZ. This often required successive iterations until a similar level of variability as was present within the historical data sets could be achieved in the model simulation. Relaxing the penalty structure eliminated the model’s tendency to maintain water levels at one preferred elevation (i.e., the TOL). As noted previously, the first phase model set-up simulated the 31-yr period (1970 to 2000) which corresponds to the implementation of the current Hackner-Holden Agreement. In addition, as the new WMP would replace the old agreement, it was deemed that an extended period of record (i.e., 50 years of hydrology data) would provide a better representation of the variability of the river system flows. The hydrology was therefore updated to include more information for subsequent modeling of the river basin. Available hydrologic data within the basin that best represents natural runoff is the Big East River - WSC Gauge 02EB013. Although there are a number of small control dams upstream of this gauge, the storage volume of those dams is small compared to the annual runoff, and the flow in the Big East River is very close to natural. To develop the 50 years of hydrology, the recorded flows for the Big East gauge were extended, by performing a regression analysis to develop equations that would transform known natural flows at North Magnetawan River near Burk’s Falls (WSC 02EA005), North Magnetawan River above Pickerel Lake (WSC 02EA010), and the Black River (WSC 02EC002) into estimated natural flows in the Big East River. These equations were used to develop flows from January 1939 to June 1973. Recorded flows in the Big East

River from July 1973 to December 2000 were used 'as is' to complete the 50-yr period of record.

The result of the final simulation runs of the existing operating regimes with the revised penalty structure and updated hydrology was termed Base Case 2. This model run was used as the basis for comparison with all alternate operating strategies developed during the remainder of the planning process.

9.4 Case One

A river system like the Muskoka is a complex series of interactions between lake levels and river flows and levels as water moves through the system. Changes to levels or flows within one lake or river section could result in changes to levels and flows within other parts of the system (particularly downstream) that may have adverse or cumulative effects. The Case One option was developed as a "first cut" that addressed primarily individual lake or river reach issues without prior knowledge of the potential adverse or cumulative effects which could arise at other locations within the river system if the proposed changes were implemented. The proposed modifications to the lake operating regimes were entered into the ARSP model, and a run was carried out to assess the effects (on a river system wide basis) of the proposed changes. The goals/expectations arising from the Case One model run were as follows:

- determine the effect of the proposed operating changes on spring flood levels
- determine the effect of the proposed operating changes on waterpower production
- identify any adverse or potentially 'cumulative' effects (i.e., a series of small changes in a number of upstream lakes could result in a large change in a downstream lake or river reach)
- assess the magnitude of any resultant changes.

The Case One model run was intended to evaluate the feasibility of the overall management strategy, and provide a starting point for subsequent "fine tuning" (i.e., development of a preferred option). No attempt was made to develop or refine the NOZ around the TOL at this early point in the planning process.

The results of the Case One model run were presented to the Planning Team and PAC on August 6, 2003 for review and discussion. Upon completion of the review and subsequent evaluation of the proposed changes, it became apparent that the overall strategy was workable, but additional "fine tuning" would be required to balance the various interests and issues identified within various lakes and river reaches, and integrate them into an operating plan that was functional on a watershed basis. An example of the Case One Option and model output for Lake of Bays is provided in Figure 9.4, while a complete description of the Case One Option for other managed lakes is provided in the Options Report (Acres, 2004a).

9.5 Case Two Option

The Case Two Option was developed as an iterative process in which successive changes were made to the operating regime of individual lakes (in some cases four or five different flow/water level options were postulated and assessed) to address identified concerns in those lake and/or associated downstream river reach (as identified at the completion of the Case One option evaluation) while resulting changes were monitored/evaluated on a river system wide basis. For example, spring water levels that were too high on an individual lake could be addressed by lowering the winter drawdown level in the affected lake (to increase lake storage volume and the ability to manage the spring freshet), or by altering the inflow to the lake by adjusting the operation of upstream lakes/river sections (if possible). Alternately, the effect of a change to the fall water level could be examined in terms of its impact on lake storage and spring water levels. The model allowed alternate operating strategies to be evaluated, and lead to the selection of a 'best or preferred' means of addressing particular issues while maintaining a system wide perspective.

In developing the Case Two Option, closer attention was paid to flows within individual river reaches (and specific flow constraints within those reaches) and the development of operational strategies that would respond to identified concerns. The main river reach concerns that were addressed were the day-to-day variability of flows and minimum flows. Under the Case Two Option, the available storage within the NOZ zone on the large lakes would be utilized to modulate the discharges from the dams to provide more gradual changes in river flows and provide minimum flows in the stream reaches. This would result in more frequent fluctuation in lake levels than with the Base Case, but these level changes would be gradual during average conditions and would be significantly less than the average fluctuations in river water levels. This also provides more consistent flows for hydropower, which would potentially increase generation of energy. The criteria used to compare/evaluate the Case 2 Option against the present operating regime (Base Case 2) are described in the following section.

Table 9.1

Issues and Considerations* Related to Water Levels and Flows (by Subwatershed and Lake)

	Environmental								Social										Economic/Engineering	
	Fish Habitat																			
	Lake Trout Lake	Brook Trout	Walleye Spawning	Cold Water Fishery	Warm Water Fishery	Downstream Base Flow	Littoral and Riparian Habitat	Shoreline Erosion	Recreational Lake	Infrastructure Requirements	Flooding	Navigation	Rapidly Fluctuating Water Levels	Ice Damage	Low Winter Water Levels	Water Quality	Drought – Low Water Levels	Aesthetics	Flow for Water Power (Hackner-Holden Agreement)	Difficult Operation
North Branch																				
McCraney Lake	✓	✓		✓		✓	✓		✓			✓							✓	✓
Camp Lake	✓	✓		✓		✓			✓	✓									✓	✓
Tasso Lake	✓	✓		✓		✓			✓	✓	✓	✓							✓	
Buck Lake					✓			✓												✓
Fox Lake			✓		✓			✓	✓											✓
Big East River		✓		✓					✓		✓									
Huntsville Lakes	✓			✓	✓	✓	✓		✓	✓	✓	✓		✓					✓	
Mary Lake	✓			✓	✓	✓			✓	✓	✓	✓				✓	✓		✓	
High Falls					✓	✓							✓			✓				
Wilson Falls					✓	✓							✓							
Bracebridge Falls			✓			✓														
South Branch																				
Burnt Island Lake	✓			✓					✓										✓	✓
Joe Lake	✓			✓					✓										✓	
Ragged Lake	✓			✓					✓										✓	
Canoe/Tea/Smoke Lakes	✓			✓		✓			✓	✓									✓	
Oxtongue River		✓		✓		✓			✓											
Kawagama Lake	✓			✓	✓	✓	✓	✓	✓	✓		✓		✓	✓				✓	
Lake of Bays	✓			✓	✓	✓			✓	✓				✓	✓				✓	
Wood Lake					✓				✓											
Baysville to Matthias Head Pond					✓	✓		✓				✓	✓			✓	✓	✓		
Matthias Head Pond					✓	✓						✓	✓							
Trethewey					✓	✓						✓	✓							
Hanna					✓	✓														
South Falls			✓		✓	✓														
Lower Subwatershed																				
Skeleton Lake	✓			✓	✓						✓	✓					✓			
Lakes Rousseau/ Joseph	✓			✓	✓	✓			✓	✓				✓	✓				✓	
Lake Muskoka	✓		✓	✓	✓	✓			✓	✓	✓	✓		✓	✓				✓	
Bala Reach			✓		✓	✓				✓	✓	✓	✓							
Ragged Rapids GS					✓															
Moon Dam			✓		✓	✓					✓		✓							
Big Eddy					✓								✓							✓
Go Home			✓		✓				✓	✓		✓	✓	✓	✓					✓

*Refer to Appendix D for a complete description of public comments and concerns.
✓indicates concern was raised, but provides no magnitude.

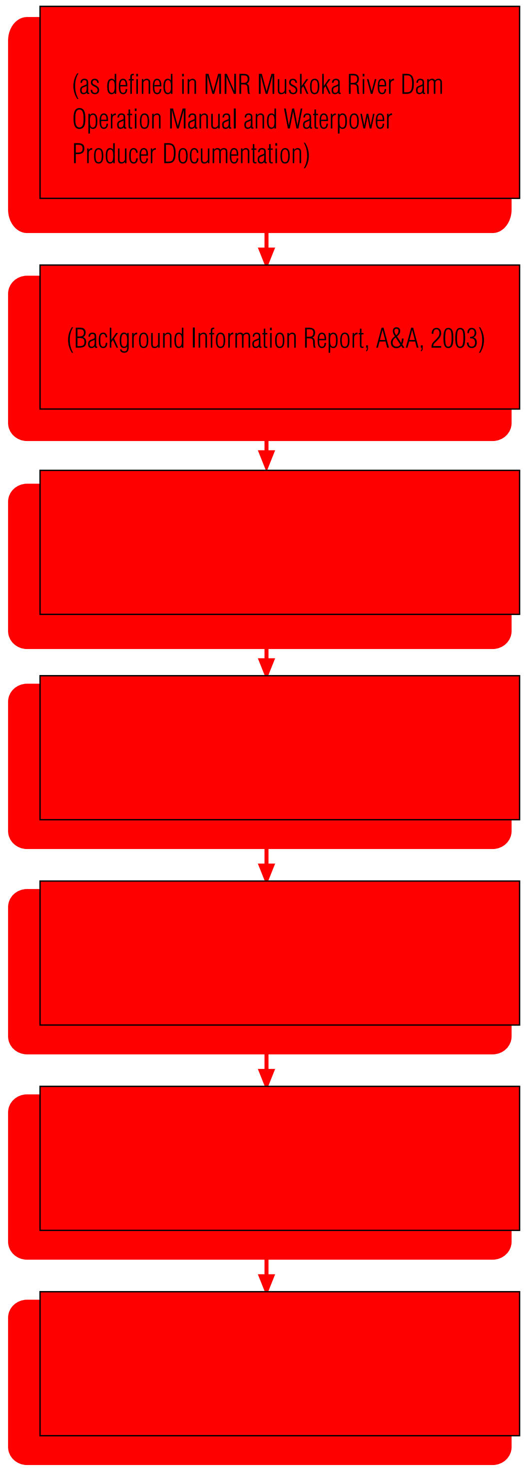


Figure 9.1
Muskoka River Water Management Plan
Option Development and Evaluation Process

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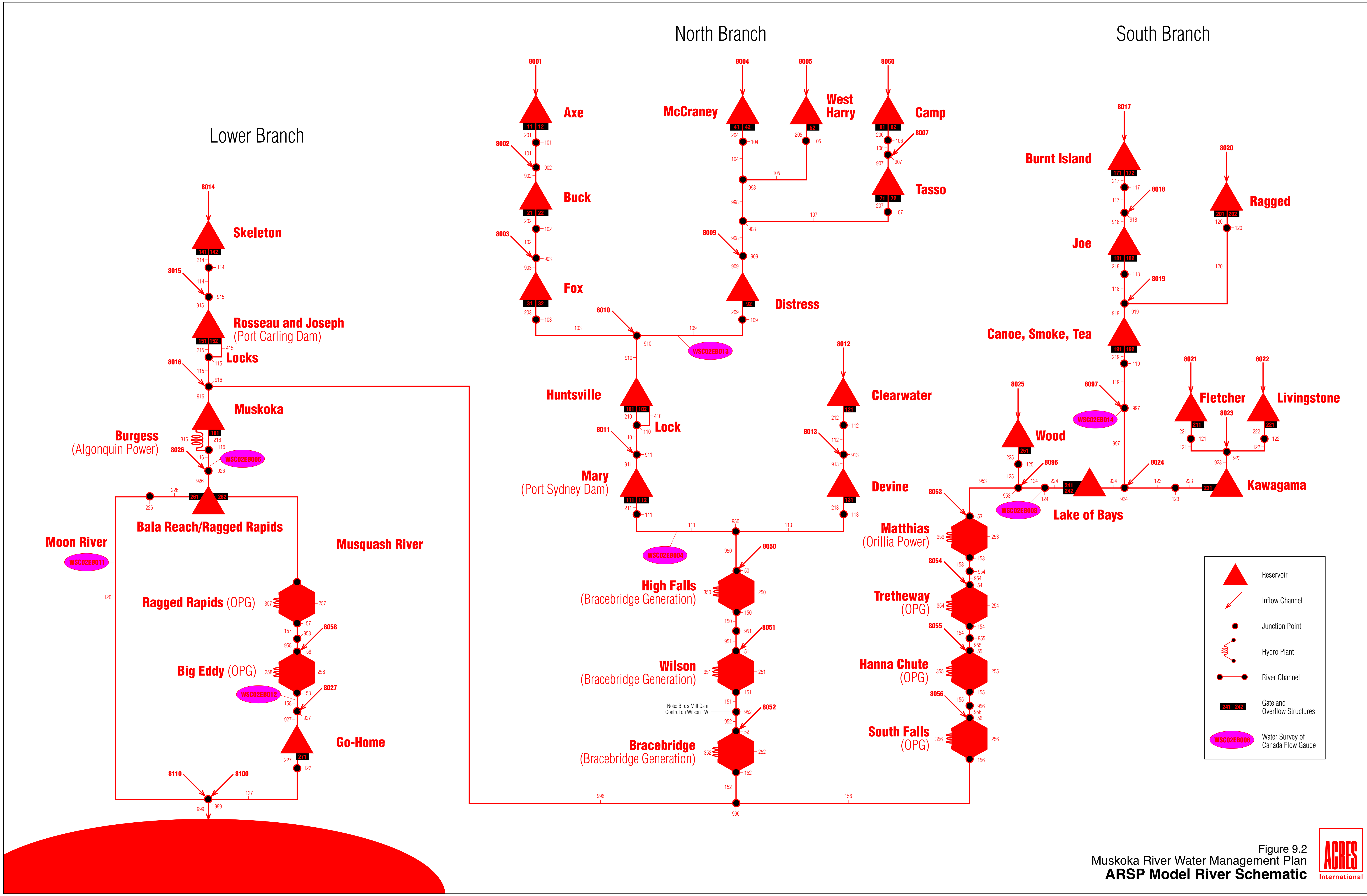

Figure 9.2
Muskoka River Water Management Plan
ARSP Model River Schematic

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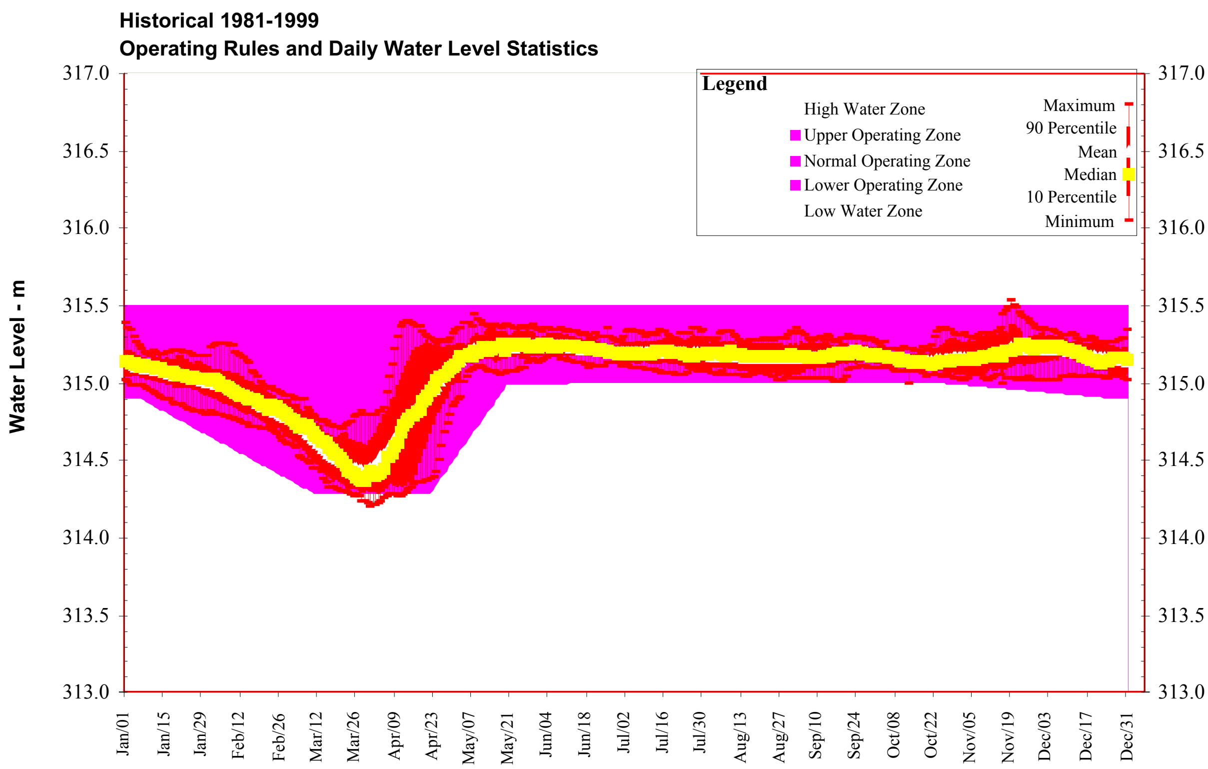

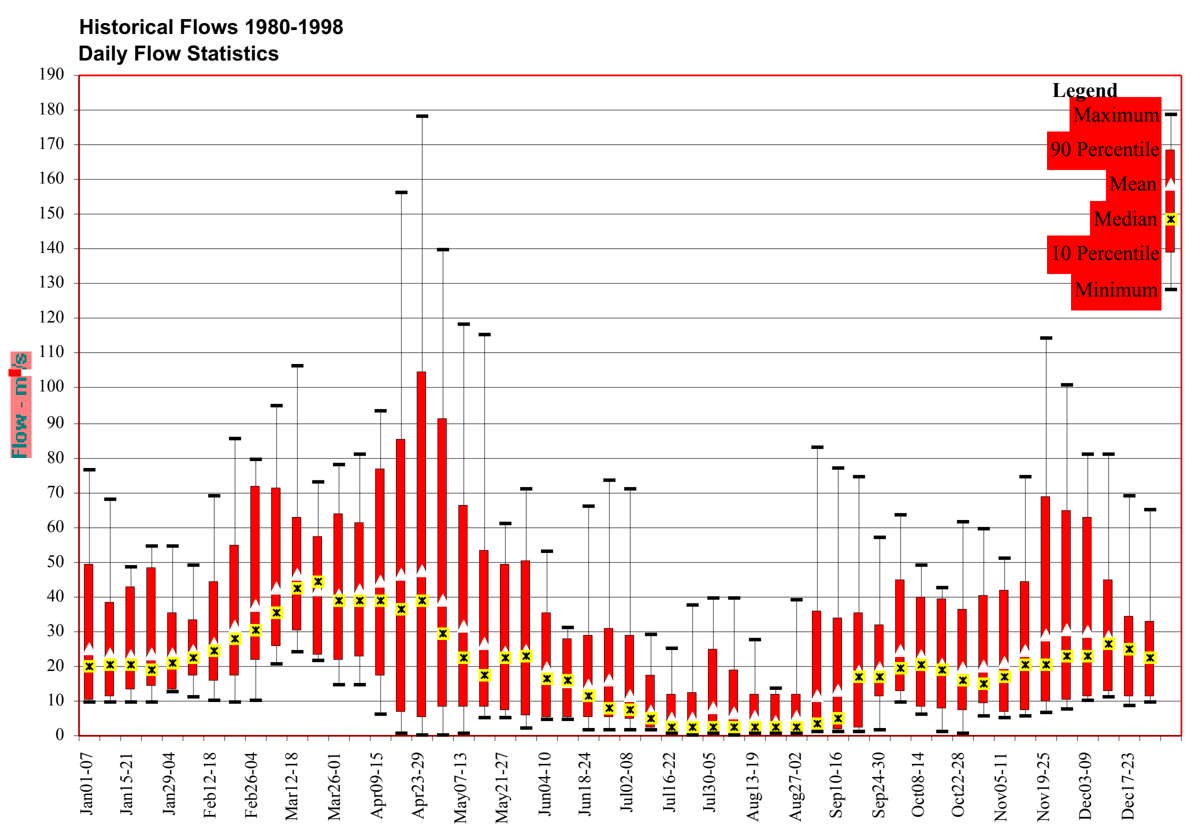

Figure 9.3
Muskoka River Water Management Plan
Historic Water Level and River Flow - Lake of Bays

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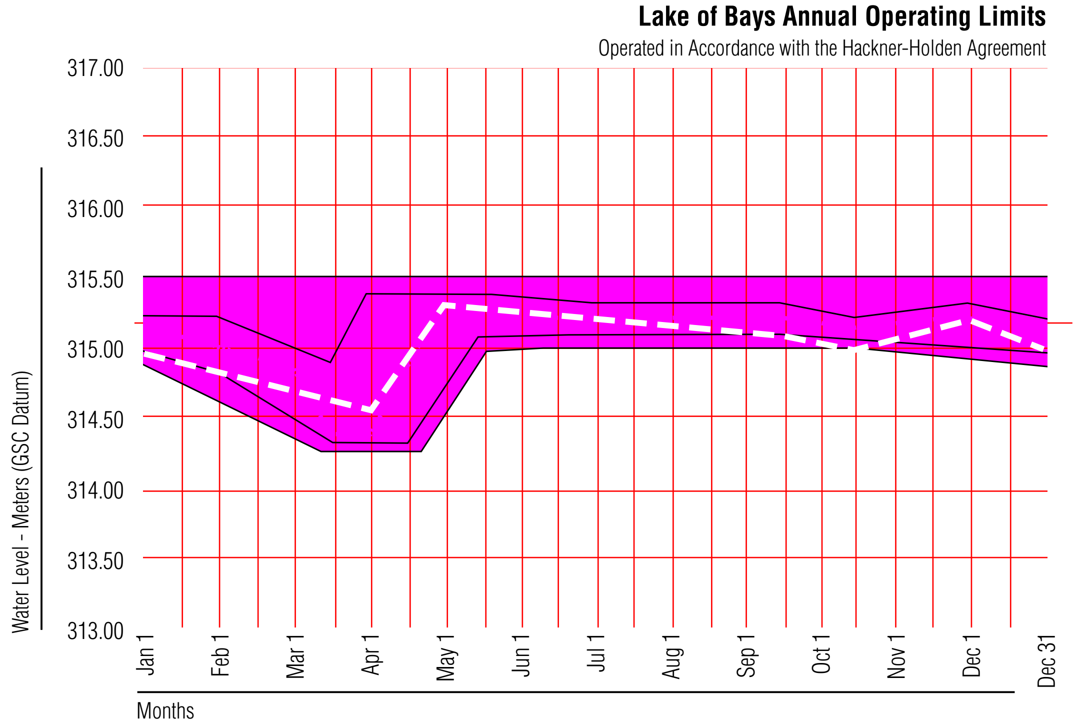

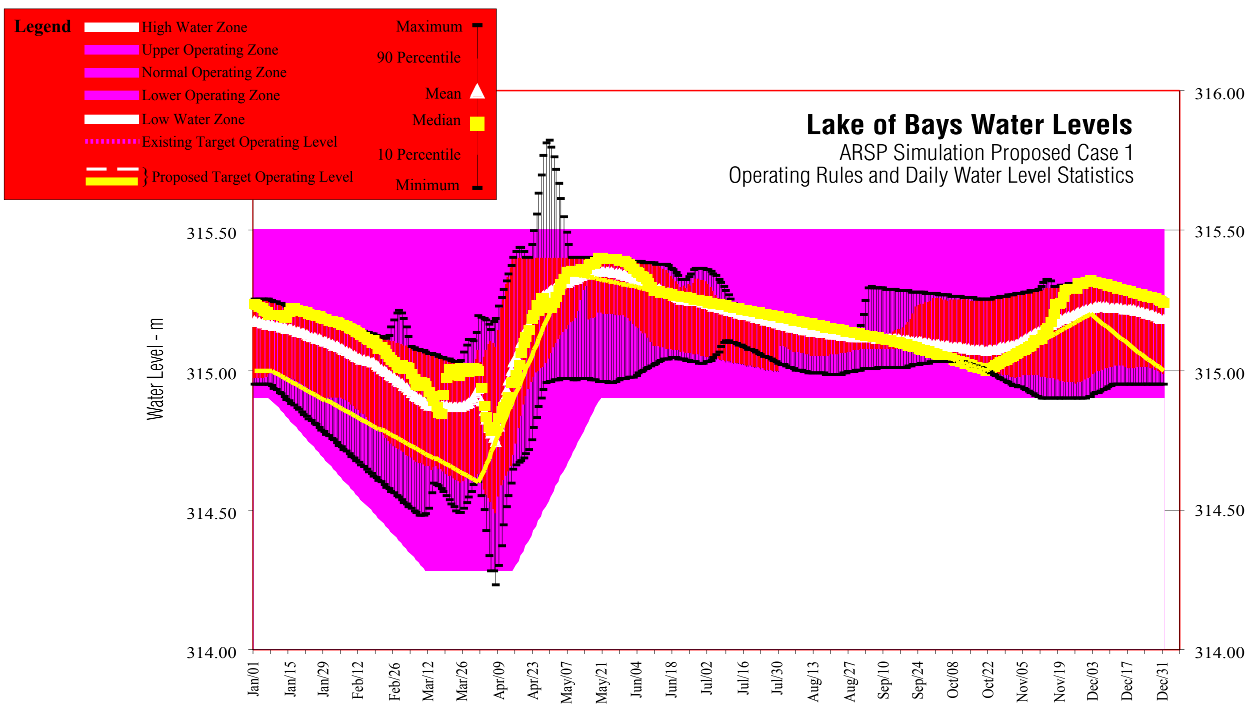

The proposed operating regime for Lake of Bays included

- a greater fall drawdown and less winter drawdown in order to improve lake trout habitat (reduced differential between fall and winter levels from 0.75 m to 0.4m).
- no change is proposed to the spring peak as ice damage during high water in the spring is a significant concern along the south shore of the lake.
- a gradual water level decline from spring to late summer is proposed (to provide base flow for ecological benefits and waterpower production).
- an additional decline to reach the proposed fall elevation.

The results of the ARSP model run indicated:

- the reduced winter drawdown level would exceed the high water zone (HWZ) elevation at least 10% of the time. This was a considerable negative effect compared to the base case that normally did not exceed the NOZ range.

Figure 9.4
Muskoka River Water Management Plan
Option 1 Operating Plan and ARSP Simulation Run

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10 Evaluation Criteria

An evaluation process was developed that would compare a proposed strategy with the current operating strategy (i.e., the Base Case). The following section describes the development of that evaluation procedure.

10.1 Overview

The identification of attributes, indicators and criteria within the watershed formed the basis for the assessment of alternative water management strategies. In compiling information on the river for which the WMP is being developed, issues and concerns were revealed as a result of consultation with the water control operators, government agencies, stakeholders and the public. From this information, a set of attributes or values was developed pertaining to priority issues within the watershed. These attributes are related to key objectives of the WMP and an approach to meeting the key objectives was then identified for each attribute. Then, by using the ARSP hydrologic computer model, the potential effects of the alternative water management strategies can be assessed using simplified indicators related to flows and water levels. The results of each alternative can be compared to the base case and to each other as a means to aid in the decision-making process. Based on conclusions drawn from these comparisons, the most effective water management strategy can be selected based on cost and others factors that included how well the preferred strategy would achieve the key objectives.

10.2 Attributes and Objectives

The identification of attributes for the Muskoka River system was founded on issues and considerations identified for the river system by the Planning Team, the PAC and through the public consultation process (as outlined in Section 3 of the Options Report and summarized in Sections 9.1 and 9.2 of this report). Based on this information, it was evident that the priority issues for the river system can be broadly grouped into those occurring within the natural environment, the social and economic environments. The key objectives of the planning process were then identified, and were used to develop indicators that were used as the basis of comparison.

These objectives and the approach to meeting the specific objective are provided in Table 10.1.

10.3 Indicators and Criteria

In order to determine whether a proposed operating strategy is an improvement over the present situation, a series of indicators were developed as the basis of comparison with the base case. Indicators are defined as specific features that can be used to evaluate the effect of a new strategy compared to the existing operating plan. Indicators provide a measurable means of determining whether the key objectives are being met.

As per MNR's Water Management Guidelines (MNR, 2002), indicators can be either quantitative or qualitative. For the Muskoka River system, estimates of water levels on the lakes and flows in the river were used as the primary indicators, and were supplemented with indicators for power generation (flow available for generation). Table 10.2 lists the indicators that were identified for each attribute. The water level and flow indicators were applied to every reservoir (defined as the affected lake upstream of the control/spill dam) and river reach (defined as the affected river section downstream of a control/spill dam). The flow available for waterpower indicator was applied at all of the waterpower sites.

Rating/evaluation criteria were developed for each indicator to define the quantitative bounds or conditions, against which effects were identified and their magnitude assessed. Criteria are defined as the numeric measures that determine if the indicator effect is positive, negative or not significant. Three criteria ratings were established to enable comparison with the base case condition. The purpose of the ratings was to determine if an alternate water management strategy is better, worse or no different than the base case.

Table 10.1
Attributes and Approach to Meeting Objectives

Attribute	Key Objective	Approach to Meeting Objective
Ecology and Natural Environment	Overall improvement in aquatic ecology	Allow a reasonable amount of annual and inter-annual variability in lake levels (based on available information and lake size).
	Recharge groundwater supplies Improve nutrient supplies to shorelines/wetland areas Access to shoreline spawning areas by spring spawning species	Raise spring levels 30 to 50 cm above established shoreline vegetation.
	Improve success of spring spawning fish species	Allow spring floodwaters to inundate shorelines for at least 45 days.
	Improve biodiversity of shoreline riparian habitat	Allow water levels to fall during the summer period by at least 20 to 30 cm.
	Improve summer baseflow in river reaches below control dams to ensure healthy aquatic ecosystems	Increase minimum flows through control dams in summer months.
	Improve lake trout spawning success	Ensure late winter/spring drawdown does not exceed fall drawdown. Preferably, the fall drawdown elevation should be 20 cm higher than the top of lake trout spawning shoals.
	Improve walleye spawning success	Maintain sufficient and consistent flows (target 14 m^3/s and 3 m^3/s in Moon River and South Falls, respectively) during the walleye spawning season (April 15 to June 3).
Social and Economic Environments	Minimize/avoid high water damage to infrastructure	TOL's on lakes not to extend above established NOZ. Minimize peak high water levels on lakes with extensive shoreline development Flows downstream of dams not to exceed maxima identified in DOM.
	Minimize ice damage to infrastructure	Delay spring high water levels until the end of April (the later the high water level the greater the potential for ice to have melted).
	Maintain continued tourism and recreational uses of lakes and waterways and access to infrastructure	Avoid excessive water level fluctuations during the summer season – target less than a 15-cm change from the present water level range between June 15 and September 30 Maintain minimum flows below dams and minimize flow fluctuations.
	Improve water quality/waste assimilation. Ensure domestic and municipal uses of water requirements met	Ensure minimum flows identified in DOM are maintained.
	Optimize power generation from renewable energy sources.	Operate control dams to release sufficient flows to meet power producer requirements.

DOM = Dam Operations Manual (MNR, 1997).

Table 10.2
Criteria for Evaluating Alternative Water Management Strategies

Attribute	Indicator	Rating/Evaluation Criteria
Natural Environment		
Lake Trout Spawning Habitat	Differential between Fall Water Level (FWL) and Winter Water Level (WWL)	10 if FWL >30 cm lower than WWL 8 if FWL is 10 to 30 cm lower than WWL 6 if FWL is 0 to 10 cm lower than WWL 4 if FWL = WWL 2 if FWL is 10 to 30 cm higher than WWL 0 if FWL is >30 cm higher than WWL
Spring Wetland/ Fisheries Habitat	Elevation of Spring Peak	+ve if >10 cm higher neutral if change is within 10 cm -ve if >10 cm lower
	Timing of Spring Peak	+ve if >5 days earlier neutral if within 5 days -ve if >5 days later
	Water Level Change in 30 Days	+ve if >15 cm increase neutral if change is less than 15 cm -ve if > 15 cm decrease
Walleye Spawning	Spring Sustainable Flow	+ve if change >10% higher neutral if change is within 10% of base case -ve if change is >10% lower
	Spring Flow Duration	+ve if duration exceeds target neutral if change is within 10% of base -ve if duration is less than target
	Spring Peak Flow	+ve if change >10% lower neutral if change is within 10% of base case -ve if change is >10% higher
Summer Ecosystem Health	7Q2 and 7Q10 flows	+ve if change >20% higher neutral if change is within 20% of base case -ve if change is >20% lower
Social Environment		
Lakes - High Water Levels	Maximum Daily Water Level	+ve if change is >15 cm lower neutral if change is within 15 cm -ve if change is >15 cm higher
	High Water Zone Exceedances	+ve if change >20% fewer neutral if change is within 20% of base case -ve if change is >20% more
Ice Damage Potential	Maximum Daily Water Level	+ve if change is >15 cm lower neutral if change is within 15 cm -ve if change is >15 cm higher
River Reaches - High Water Levels	Maximum Daily Flows	+ve if change >20% lower neutral if change is within 20% of base case -ve if change is >20% more
	High Flow Exceedances	+ve if change >20% fewer neutral if change is within 20% of base case -ve if change is >20% more

Table 10.2
Criteria for Evaluating Alternative Water Management Strategies

Attribute	Indicator	Rating/Evaluation Criteria
Summer Recreational Water Level (June 15 to September 30 period)	Seasonal Range – Median summer Level	+ve if change is <15 cm neutral if change is within 15 cm -ve if change is >15 cm
	Seasonal Range – 80% of the time	+ve if change is <15 cm neutral if change is within 15 cm -ve if change is >15 cm
Water Levels for Infrastructure Access	Minimum Distance to Top of Average Structure	+ve if change is <15 cm neutral if change is within 15 cm -ve if change is >15 cm
	Maximum Distance to Top of Average Structure	+ve if change is <15 cm neutral if change is within 15 cm -ve if change is >15 cm
Summer Recreational River Flows (June 15 to September 30 period)	Minimum daily flow (over a 7 day period)	+ve if change >20% higher neutral if change is within 20% of base case -ve if change is >20% lower
	Number of daily flow fluctuations over pre-set limits	+ve if change >20% fewer neutral if change is within 20% of base case -ve if change is >20% more
Domestic/Municipal Usage	Median Weekly Flow - Summer Period - Winter Period	+ve if change >10% higher neutral if change is within 10% of base case -ve if change is >10% lower
	Minimum Weekly Flow - Summer Period - Winter Period	+ve if change >10% higher neutral if change is within 10% of base case -ve if change is >10% lower
Economic		
Flow Available for Power Generation	Quarterly and Average Annual Flows	+ve if >2% increase neutral if change is within 2% of base case -ve if change is >2% decrease

+ve – positive
-ve – negative
7Q2 – the 7Q2 is the 7-day low flow that would occur every 2 years.
7Q10 – the 7Q10 is the 7-day low flow that would occur every 10 years.

Table 5.2 lists the criteria that were developed for each indicator, while the following sections provide the rationale for the selection of the indicators and the rating criteria.

10.3.1 Natural Environment

The health of aquatic and riparian habitat is directly affected by water levels and flows, and reacts to year-to-year, seasonal and daily patterns of fluctuation. As noted previously (Section 3), natural ecosystem have limits, and may respond negatively to imposed changes that significantly reduce or increase variability (i.e., changes that are too large or too small). The following identifies the ecological/natural environment indicators that were selected for the Muskoka River watershed and provides the rationale for their selection and the proposed limits of change (as pertaining to water levels or flows):

- **Differential between Fall and Winter Water Level for Lake Trout Habitat** -- On many of the large lakes, water levels are drawn down in the late winter/spring to reduce the potential for spring flooding (increases storage to capture the spring freshet) and provide flow for waterpower production during the winter months. Lake trout are present in many of these managed lakes, and spawn during the fall (mid-late October) in water as shallow as 0.1 m deep. Eggs and developing fry remain within the spawning substrate until late April-early May before the juveniles disperse to open water. A late winter/early spring water level that is lower than the level during lake trout spawning may be exposing eggs or fry to desiccation or ice scour.

  The differential between fall and winter water level was used as the basis for this comparison. The evaluation criteria ranks the current and the proposed operating strategy, and then compares the two values to provide an overall rating. Considering the possibility of ice cover/ice scour, the best case scenario is one in which the winter drawdown level is 30 cm above the fall drawdown level (i.e., there would be at least 40 cm of water/ice over eggs/fry during the incubation and development period). While this situation is considered the best, the least favorable case is one where the winter drawdown is 30 cm or more below the fall level. In this situation eggs or fry near the top of the shoal may be dewatered and exposed or subjected to ice scour. A range of scores was developed for potential scenarios between those two limits.

- **Spring Water Levels for Wetlands/Fisheries** -- Spring water levels, that inundate the riparian zone and maintain that high level for a longer time period (so as to allow progeny of spring spawning fish and amphibian species that utilize floodplain habitat to return to the main water body) would provide preferred conditions for wetlands and the species that depend upon them. In addition, higher spring levels recharge groundwater supplies and transfer flood water nutrients to the riparian zone. Three indicators were developed to evaluate this attribute. The elevation of the spring peak, the timing/date of the spring peak (earlier or later), and the duration of the spring peak (as measured by the amount of water level change over the 30-day period after the spring peak) were used to assess whether spring lake conditions were improved for wetland ecology and spring spawning fish species.

- **Spring Flows for Walleye Spawning** -- A consistent, sustainable flow for the entire duration of the spawning season is an extremely important factor in hatching/incubation success. In addition, large variability in flows and/or peak flows could induce spawning in areas that are subsequently dewatered later in the season when flows naturally decline, and/or could result in stranding or dislocation of eggs/fry and are therefore considered a negative effect. Three indicators were developed to evaluate whether spring flows in the two major walleye spawning areas (South Falls and the Moon River) were improved.

- **Summer Base/Low Flows for Ecosystem Health** -- Low flows/base flows within a river system are an indicator of the ability of the system to sustain aquatic life during periods of drought and provide a good indicator of ecosystem health. In addition, flow values that would be present under an undeveloped or natural flow regime, can be calculated and compared to the existing situation and any proposed case. For this comparison, the indicators selected for this attribute were the 7Q2 and 7Q10 flow values. The 7Q2 is the 7-day low flow that would occur once every 2 years, while the 7Q10 is the 7-day low flow that would occur once every 10 years. An increase of more than 20% was deemed to be a positive effect.

10.3.2 Social Environment

The social indicators were developed primarily to assess the potential effects of water level and flow changes on the built environment (i.e., docks and boathouses) and shoreline residents who require access to these structures. The availability of water to meet domestic and municipal needs was also assessed. The social indicators include the following.

- **Maximum Lake Levels --** High spring levels may inundate docks, boathouses and other shoreline structures, and result in damage to the integrity of these structures. Two indicators were developed to compare the base and proposed case concerning the potential effect of high water levels on lakes. The maximum daily water level, calculated as the average of the maximum daily level over 50 years of simulated data, was used to compare the base case and a proposed case. An increase of more than 15 cm (6 in.) was considered significant, and would be a negative effect. Similarly, a 15 cm lower level would be a positive effect. The second indicator was the number of exceedances of the high water zone (HWZ) as defined by the elevation identified for each lake on the present operating curves. The HWZ elevation has been identified as the lake elevation above which the chance of property damage increases. Fewer exceedances of this HWZ level would be considered a positive outcome.

- **Ice Damage Potential** -- High spring water levels can increase the potential for ice damage to docks and other structures, and can be used to compare the two operating strategies with respect to their potential for ice damage. Ice-out dates are variable throughout the years, are not a reliable indicator of the potential for damage, and are therefore not taken into consideration. Again, average maximum water levels that are more than 15 cm (6 in.) higher have an increased potential to result in ice damage to structures, and would be rated negatively for this criteria. Water levels 15 cm lower would be positive.

- **Maximum River Levels/Flows** -- Two criteria were developed to examine the potential effect of high river water levels and flows. While no information is available to relate flows to water levels for the river reaches throughout the watershed, an indication of improved or deteriorated conditions can be obtained by comparing maximum flows. Similar to maximum water level, the flow value selected for comparison is the average of the maximum daily flow over 50 years of simulated data. A maximum flow value greater than 20% lower is considered a positive effect, while a maximum flow 20% higher is considered negative. The second criteria compared the number of exceedances of the maximum flow value for individual reaches as identified in the DOM with the maximum daily flow value derived from the model runs. Fewer exceedances of the DOM value (by >20%) were considered a positive outcome, while an increase of more than 20% was considered to be negative.

- **Summer Recreational Season Water Levels** -- Two indicators were used to assess the effect of the proposed strategy on summer recreation season water levels. The first examined median water levels during the June 15 to September 30 period, and compared the seasonal range (determined as the difference between the maximum median level and the minimum median level during the above-noted time period) between the two operating strategies. The second examined the 80^{th} percentile range over the same seasonal time period. While the first criteria would provide average conditions, the second would provide more wide-ranging conditions (i.e., the seasonal range that could be expected 80% of the time). In both cases, a change of 15 cm was considered significant (positive if less than 15 cm, negative if more).

- **Infrastructure Access** -- The average elevation for the top of docks and docks associated with boathouses on most developed lakes was determined during the study (A&A, 2002 and Acres, 2004c). These elevations were compared to the maximum and minimum median water levels during the summer recreation season (June 15 to September 30) to determine whether the proposed strategies improved or hindered access to this infrastructure. An increase of more than 15 cm was considered negative, while a reduction of more than 15 cm was considered positive.

- **Summer Recreation Season River Flows** -- Two indicators were developed to examine river low flows and the change in river flow (on a daily basis) during the summer recreation season. The first indicator compared the minimum flow value over a 7-day period between the base case and the proposed case. The second indicator examined the change in river flow on a daily basis above a pre-established flow value that varied according to location within the watershed. The indicator compared daily flow fluctuations greater than 1 m^3/s for upstream river reaches, daily flow changes above 3 m^3/s for mid watershed river reaches, and daily flow changes greater than 5 m^3/s for the lower watershed reach (i.e., below Bala dams). The various flow values were selected on the basis of the existing target base flows within the respective watershed areas.

- **Domestic/Municipal Water Uses** -- Four indicators were used to assess this attribute. Median and minimum weekly flows for both the summer period (May to October) and winter period (November to April) were evaluated. Flows that were 10% higher were considered to provide a positive rating.

10.3.3 Economic Indicator

While it is recognized that many of the social indicators noted above have economic implications (particularly with respect to access to resort docks and facilities, suitable water levels for recreational activities, etc), a single indicator was selected to compare economic attributes between the present and future strategy, being a comparison of the flow available for waterpower generation. Flow was intentionally selected, as opposed to megawatt-hours or dollars of power generated, as the opening of the competitive electricity market allowed producers to target specific daily or seasonal periods, which means that available flow may be utilized selectively. Quarterly and annual average flows were calculated and compared, with an increase of over 2% considered to be a positive outcome, while a 2% reduction would be a negative outcome.

11 Preferred Strategy and Comparison with Current Operation

The preferred strategy was developed as an iterative process in which successive changes were made to the present operating plan to address identified concerns in each lake or river reach. As noted in Section 9, the initial strategy was to adjust rule curves to address biological or social concerns documented for each lake or river reach, and then utilize the ARSP model to evaluate the magnitude of the resultant changes (in terms of seasonal lake levels and river flows), the cumulative effect (if any) of the changes, the effect on hydropower generation potential, and the potential applicability of the overall strategy on a watershed scale perspective. Specific concerns identified during the Case One evaluation were then addressed by further revisions to the rule curves, and additional model runs (often more than one) to determine whether the proposed revision met the project objectives (watershed wide and lake/reach specific objectives).

These refinements lead to the development of a strategy for each lake/river that met the specific lake or reach objectives. This overall strategy was then subjected to a detailed analysis to evaluate its conformity with project objectives and its applicability on a river-system scale perspective. The analysis utilized the 22 evaluation criteria identified in Section10, and compared the proposed strategy (Case Two) with the current operating plans (Base Case). The results of that detailed analysis are presented in Appendix F (Tables F1.1 to F1.5) and summarized in Tables 11.1 and 11.2.

The lake-by-lake comparison (Table 11.1) indicates that the Case Two option resulted in 31 positives ratings, 127 neutral, and 18 negative ratings in the North Branch subwatershed. Slightly more positive ratings (on a comparative basis) were obtained for natural environment attributes than social attributes. In the South Branch subwatershed, there were 61 positive ratings, 92 neutral and 19 negative ratings. Natural and socioeconomic attributes were fairly evenly balanced. In the lower subwatershed, there were 21 positive ratings, 43 neutral and 5 negative ratings, with improvements in natural and socioeconomic attributes evenly balanced.

Table 11.1
Summary of Case Two Criteria Attribute Ratings*

Lake	Natural Attributes			Socioeconomic Attributes			Total		
	+ve	neutral	-ve	+ve	neutral	-ve	+ve	neutral	-ve
North Branch									
McCraney Lake	0	5	1	6	6	1	6	11	2
Camp Lake	2	3	1	8	7	0	10	10	1
Tasso Lake	1	4	1	3	10	2	4	14	3
Buck Lake	1	4	0	0	12	1	1	16	1
Fox Lake	1	4	0	0	12	1	1	16	1
Distress Dam	1	1	0	1	5	2	2	6	2
Huntsville Lakes	1	4	1	0	12	3	1	16	4
Mary Lake	2	3	1	1	11	3	3	14	4
Wilson Falls	0	2	0	1	6	0	1	8	0
High Falls	0	2	0	1	6	0	1	8	0
Bracebridge Falls	0	2	0	1	6	0	1	8	0
Subtotal	***9***	***34***	***5***	***22***	***93***	***13***	***31***	***127***	***18***
South Branch									
Burnt Island Lake	1	3	2	7	6	0	8	9	2
Joe Lake	1	4	1	4	5	4	5	9	5
Ragged Lake	2	3	1	7	5	1	9	8	2
Canoe, Tea, Smoke Lakes	2	3	1	3	9	1	5	12	2
Kawagama Lake	3	3	0	4	10	1	7	13	1
Lake of Bays	3	3	0	4	10	1	7	13	1
Wood Lake	0	5	0	3	10	0	3	15	0
Matthias Falls	1	1	0	4	2	1	5	3	1
Trethewey Falls	1	1	0	3	3	1	4	4	1
Hanna Chute	1	1	0	3	2	2	4	3	2
South Falls	1	1	0	3	2	2	4	3	2
Subtotal	***16***	***28***	***5***	***45***	***64***	***14***	***61***	***92***	***19***
Lower Subwatershed									
Lakes Rosseau and Joseph	4	2	0	6	8	1	10	10	1
Lake Muskoka	1	5	0	1	14	0	2	19	0
Burgess	0	2	0	3	4	0	3	6	0
Ragged Rapids	0	2	0	3	2	2	3	4	2
Big Eddy	0	2	0	3	2	2	3	4	2
Subtotal	***5***	***13***	***0***	***16***	***30***	***5***	***21***	***43***	***5***
Watershed Total	***30***	***75***	***10***	***83***	***187***	***32***	***113***	***262***	***42***

* Raw data used to summarize the attributes noted herein, are contained within the Options Report (Acres, February 2004).

Table 11.2
Case Two Attribute Rating Comparison*

Attribute Criteria	Rating		
	+ve	neutral	-ve
Natural Environment/Aquatic Ecology Attributes			
Fall/Winter Water Levels for Lake Trout Habitat			
Outcome	5	5	3
Spring Water Levels for Wetlands/Fisheries			
Elevation of spring peak	6	10	0
Timing of spring peak	3	9	4
Water level change in 30 days	0	16	0
Summer Baseflow for Ecosystem Health			
7Q2	6	20	1
7Q10	10	15	2
Subtotal	***30***	***75***	***10***
Social Environment Attributes			
Spring Water Level and Flow Management			
Maximum daily spring lake level	0	14	2
Number of high water zone exceedances	2	14	0
Ice damage potential	0	14	2
Maximum daily river reach flow	1	16	0
Number of exceedances of DOM flow limit	0	15	2
Summer Recreation Season Water Levels			
Mean daily level	4	9	3
80th percentile daily level	5	10	1
Summer Recreation Season Water Levels Infrastructure Comparison			
Minimum distance	0	8	0
Maximum distance	1	7	0
Summer Recreation Season River Flows			
Minimum daily flow (7 day)	17	10	0
Number of flow fluctuations	9	16	2
Domestic/Municipal Usage			
Median Weekly flow - Summer - Winter	6 6	7 7	4 4
Minimum weekly flow - Summer - Winter	11 5	6 9	0 3
Subtotal	**67**	**162**	**23**
Economic Environment Attributes			
Flow Available for Power Generation			
Quarterly	14	17	9
Annual	2	8	0
Subtotal	***16***	***25***	***9***
Summary			
Natural Environment	30	75	10
Social Environment	68	160	24
Economic Environment	16	25	9
Total Number/Percent	***113 / 27%***	***262 / 63%***	***42 / 10%***

* Raw data used to summarize the attributes noted herein, are contained within the Options Report (Acres, February 2004).

In the comparison by attributes (Table 11.2), the Case Two option was assessed as providing improvements for the natural environment in 30 instances, remained unchanged 75 times and provided less favourable conditions 10 times. For the social attributes evaluated, the Case Two option provided 67 positive ratings, compared to 162 neutral ratings and 23 negative ones. For power generation, the Case Two option provided 16 positive ratings, 25 neutral and 9 negative ratings. Overall, throughout the river system, 63% of the attributes examined remained unchanged, while 27% showed an improvement, and 10% exhibited less favourable conditions. The analysis indicated that there would not be a major change in the river system characteristics with the adoption of the Case Two option, but that there would be a modest improvement over the current situation. The strategy adopted at the beginning of the planning process of generally restricting water level adjustments to within the present NOZ (particularly for those large lakes with extensive built infrastructure) has limited the amount of change that could occur.

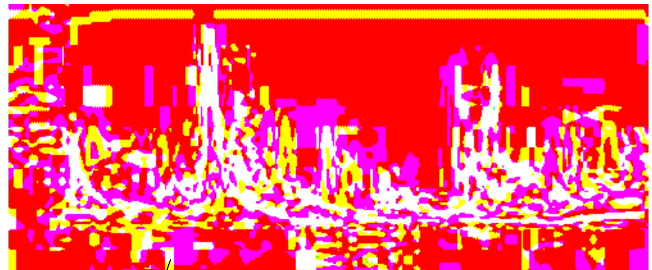
11.1 Overview of the Preferred Strategy

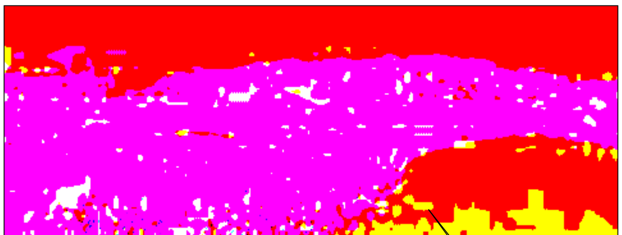
In developing the preferred strategy, close attention was paid to flows within individual river reaches (and specific flow constraints within those reaches), and the development of operational strategies that would respond to documented concerns throughout the entire river system (lakes and river reaches). The main concerns expressed for river reaches were the day-to-day variability of river flows and the maintenance of a minimum flow. In lakes, the main concerns were related to the improvement of ecological conditions (lake trout spawning habitat, spring spawning fish habitat, riparian zone and wetland habitat) and the maintenance or improvement of social values and water power potential. In some cases, the proposed operating regime formalized hydrologic features (i.e., earlier and/or higher spring water levels) that were not well captured by the current operating plans. Generally, the overall goal of the new strategy was to enhance natural environment features, while remaining within the current operating zone limits, so as to maintain water power, recreational and navigational needs. These features are shown in a generic fashion in Figure 11.1, while they are presented in detail for the various river system lakes, reservoirs and river reaches in the following sections.

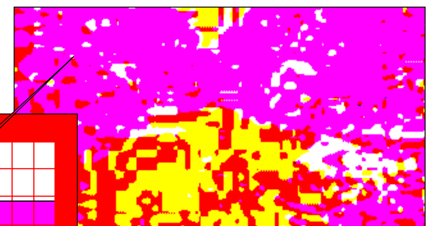
- The Preferred Strategy for the operation of the 28 dams that control water levels and flows within the Muskoka River system responds to a number of common issues and concerns
- For each lake or downstream river reach, specific issues/considerations were then integrated into the preferred strategy
- The overall strategy applied to the majority of the lakes/river reaches is illustrated in a general fashion in the graphic below

Sloped Target Operating Level

- help maintain river base flow during normal hydrologic conditions
- consider 'natural flow regime' in developing new operating strategy

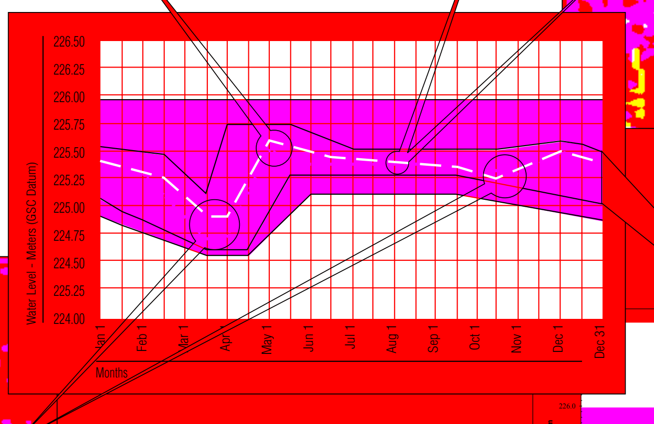




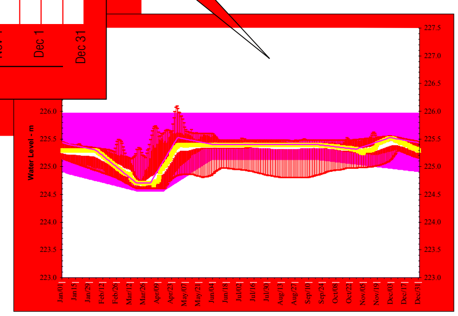


Higher Spring Water Levels

- recharge groundwater supplies
- inundate wetlands and shoreline vegetation and transfer flood water nutrients/sediment to these areas
- provide access to spawning grounds for spring spawning fish species



- lake trout fry (yolk sac larva) are immobile after hatch, and remain in the gravel until late April/early May until they emerge and disperse
- less differential between fall and winter water levels will reduce the risk of lake trout fry being dewatered by the winter drawdown



ARSP Simulation Base Case
- Operating Rules and Daily Water Level Statistics

- proposed operating level remains within the Normal Operating Zone (NOZ) to maintain waterpower recreational and navigational needs
- ARSP modelling confirms that levels will remain within the NOZ during most conditions

Figure 11.1
Muskoka River Water Management Plan
Preferred Strategy

ACRES International

Back of figure

The preferred strategy will target high spring water levels with a gradual release throughout the spring and summer season. High spring levels help to recharge groundwater supplies, transfer nutrients and sediments to wetlands and shoreline riparian zones, and provide access for spring spawning fish and amphibians to wetland and shoreline riparian zone spawning habitats.

The slow, gradual decline allows nutrients and sediments to settle out within wetlands and shoreline riparian zones, ensures that floodwaters are absorbed into shoreline soils and wetland areas, thereby recharging groundwater supplies, and allows the progeny of spring spawning fish and amphibians that utilize these shoreline areas to return to the main water body (lake or river reach). However, the need to restrict spring water levels to protect established infrastructure often limited the ability to increase spring water level beyond the existing level on developed lakes. Hence, this objective was most applicable to lakes that have no or limited infrastructure.

During the summer season, the preferred strategy will utilize the available storage within the NOZ zone on the large lakes to modulate the discharge from the dams, so as to minimize changes in river flow and provide a minimum flow in the stream reaches under normal operating conditions. This is expected to result in more frequent lake level fluctuation than with the Base Case, but these level changes would occur gradually, and would be significantly less than the average fluctuations in river water levels. This strategy also provides slightly higher and more consistent flows for hydropower during the summer season, which will offset the lower flows over the winter period.

The preferred strategy also proposes to improve lake trout habitat conditions, while maintaining the shoreline infrastructure protection that results from the winter drawdown. Presently, many of the large lakes are lowered over the winter to increase their capacity to store the spring freshet, and so maintain spring water levels at a reasonable level (to avoid infrastructure damage). This process also benefits waterpower producers, as the water that is released from the lakes during the winter is routed through downstream waterpower facilities for hydropower production. However, advances in the understanding of lake trout biology since the development of the previous operating strategy indicate that lake trout eggs and/or fry are likely being dewatered (within shoreline spawning shoals) when winter drawdown levels are more than 20 cm below the fall drawdown level. Therefore, the preferred strategy has attempted to reduce this differential, while ensuring that the proposed change does not negatively affect a lake's ability to store a sufficient portion of the spring freshet to maintain protection of shoreline infrastructure. Reduced over-winter flows for waterpower production will be compensated by higher summer flows.

A preliminary version of the preferred strategy was presented to the public for review and comment in October 2003, and was subsequently documented in the *Options Report Muskoka River Water Management Plan* (Acres, 2004a). Since then, comments have been received from various stakeholder groups, and new operating zones have been established for waterpower facilities on the system. In accordance with water management planning guidelines, single operating zones have been developed for the waterpower facilities, which will replace the multiple zone operating plans presently under use. The new zones establish clearly defined, enforceable operating zones (i.e., 'compliance' zones) for those facilities, yet include provisions to address season and/or unusual flow events.

In the following pages, the proposed plan for each lake/reservoir and waterpower facility within the river system is compared to the existing operational plan. Operating limits, TOL and/or BMP for various structure and/or seasons are presented.

The TOL will be used to guide dam operations. When compared to actual lake level, it provides an indication to MNR operators whether dam adjustments are required to stay within the NOZ. While the line denotes a "target" operating level, it is recognized that water levels will fluctuate within the NOZ in response to typical changes in seasonal and annual rainfall, snow melt and associated runoff. Lake levels may also go outside the NOZ during extreme events (flood or drought – see accompanying figures for lake-specific information).

BMP provide similar guidance pertaining to 'preferred' water levels within waterpower facility head ponds. The term "Best Management Practice" shall be defined as a guideline for operation during favourable conditions and shall be applied solely at the discretion of the dam owner/operator. Operating away from the "BMP" guideline shall not be deemed to constitute an 'out of compliance' incident within this WMP, and shall not be considered a reportable occurrence. 'Favourable conditions' are further defined as operational, hydrological and/or environmental.

High and low flow situations are addressed in Section 13.3 (for waterpower facilities) through the identification of High Flow Triggers which represents the discharge above which downstream flooding will occur and Low Flow Triggers which represent flows below which facilities may have difficulty maintaining water levels due to leakage, infiltration and evaporation.

Criteria that were of importance for decision-making for a particular lake, reservoir, river reach or waterpower facility are provided in the 'Comments' column. Changes resulting from stakeholder discussions have been incorporated (as applicable). River flow (in the reach below the dam) resulting from the proposed lake/reservoir operating strategy is generally provided with the respective lake, but may be provided under a separate heading if deemed appropriate. Flow values are predicted by the ARSP model using 50 years of simulated data. Watershed lakes and waterpower facilities are presented sequentially, commencing at the upstream limit of each subwatershed and proceeding downstream, beginning at the North Branch subwatershed, then the South Branch, and finally, the lower sub-watershed. A detailed presentation of individual operating plans, and the manner in which they respond to identified issues and concerns, is provided in Section 12.

11.2 North Branch Muskoka River

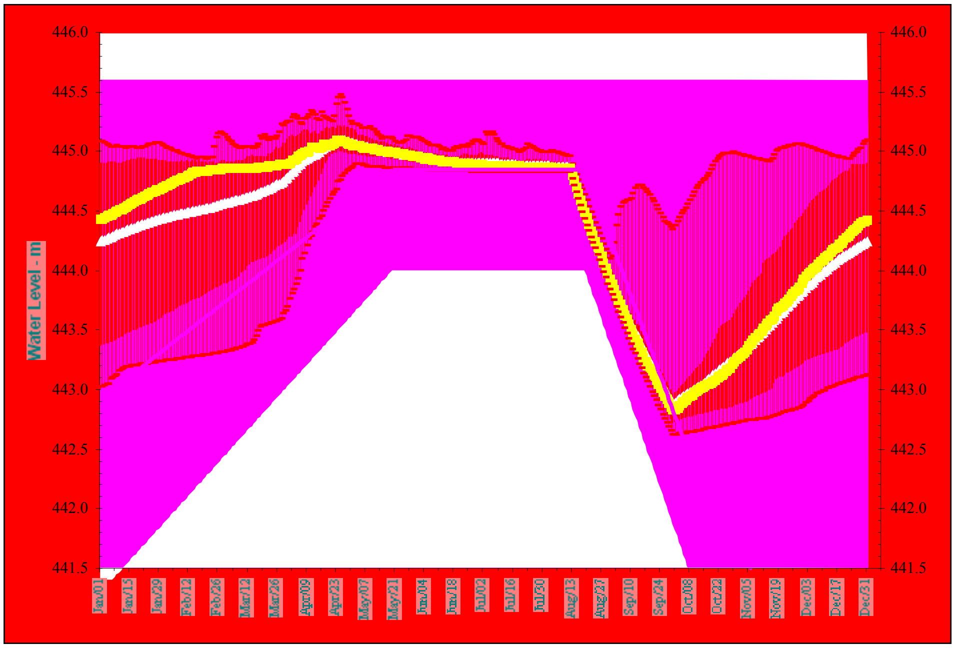
11.2.1 McCraney Lake

The proposed plan is compared to the existing operating plan in Table 11.2.1 and Figure11.2.1. Proposed changes for this lake are significant, and require the development of a new NOZ to accommodate the TOL revisions. Fewer operations of the dam will be required to achieve the desired flows and water levels, and the dam could be set to function as, or be converted to, a self-regulating structure.

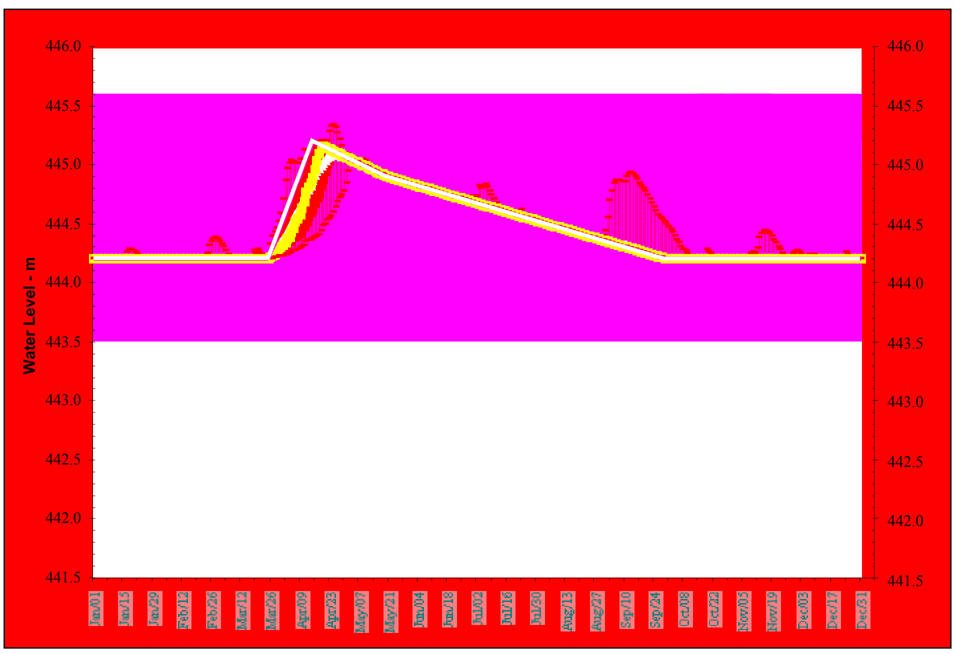
Table 11.2.1
McCraney Lake

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date* TOL Change WL Direction	445.2 444.0 444.85 Apr 21 0 -	445.5 – 445.3 444.4 – 444.3 445.2 – 444.85 Apr 20 0.35 Down	More natural water level regime with higher spring peak and gradual spring/summer drawdown from May 1 to Sept 30. Less change in summer levels will improve summer recreational potential and ecological conditions.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	445.2 444.0 – 442.8 444.85 – 443.33 1.52 Down	445.3 – 444.55 444.3 – 444.0 444.85 – 444.3 0.65 Down	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	445.2 – 442.2 442.8 – 441.2 443.33 – 441.8 1.53 Down to Oct 15, then natural rise.	444.55 – 445.2 444.0 444.3 – 444.2 0 Down to Oct 15, then natural rise.	Stable fall water levels should improve lake trout habitat in long term
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	442.92 – 444.53 441.92 – 443.51 442.52 – 444.03 1.51 Rise	445.2 – 444.6 444.0 444.2 0 No induced change	Stable winter water level will eliminate freezing of littoral zone sediments and associated ice damage.
Downstream River Reach and Lake Outflow Characteristics	Planned flow release & timing Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	2-3 m^3/s, Aug 15 to Oct 15 0.76 m^3/s 0.01 m^3/s 0.22 m^3/s 4.51 m^3/s 0.01m^3/s 0.01m^3/s	0.5 m^3/s, year round 0.68 m^3/s 0.47 m^3/s 0.39 m^3/s 4.62 m^3/s 0.01m^3/s 0.01m^3/s	Lower, but more consistent summer, fall and winter flows are provided from this headwater lake. The late summer release of 2 –3 m^3/s is not possible with the new plan.

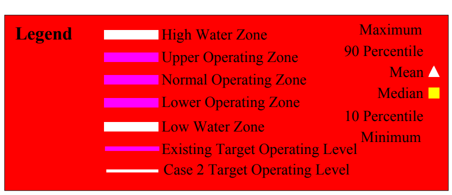
McCraney Lake



a) Existing Operating Plan and Water Level Statistics *



b) Proposed Operating Plan and Water Level Statistics *



Note : Vertical scale larger (i.e. 6m) than other lake plots (i.e. 4m) due to existing large seasonal water level change.

* Derived from ARSP Model

Figure 11.2.1
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - McCraney Lake

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Back of figure

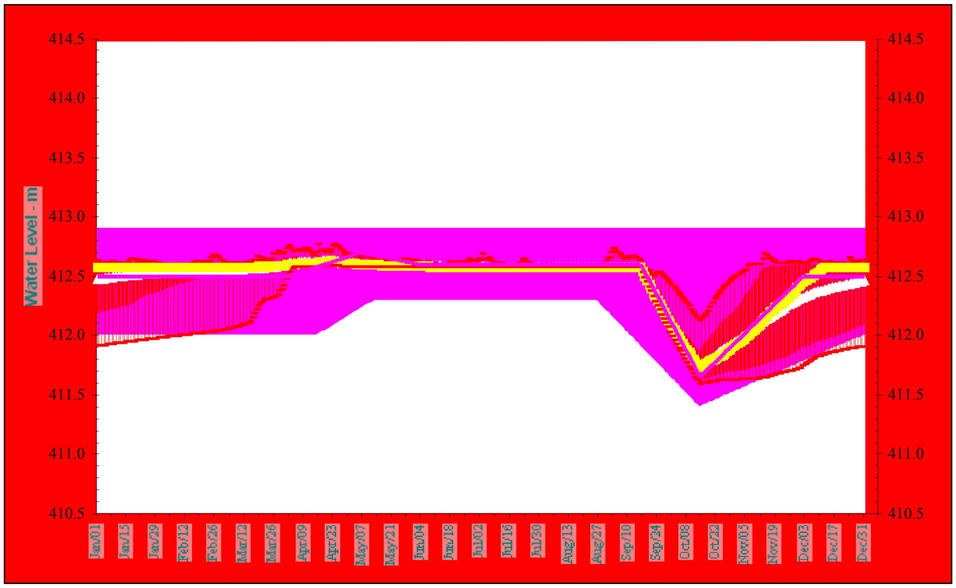
11.2.2 Camp Lake

The proposed plan is compared to the present operating plan in Table 11.2.2 and Figure 11.2.2. The proposed changes for this lake are mostly related to a reduced fall drawdown, which required an adjustment to the limits of the present NOZ during that time period. It is anticipated that fewer dam operations will be required to achieve the proposed water level and flow regime.

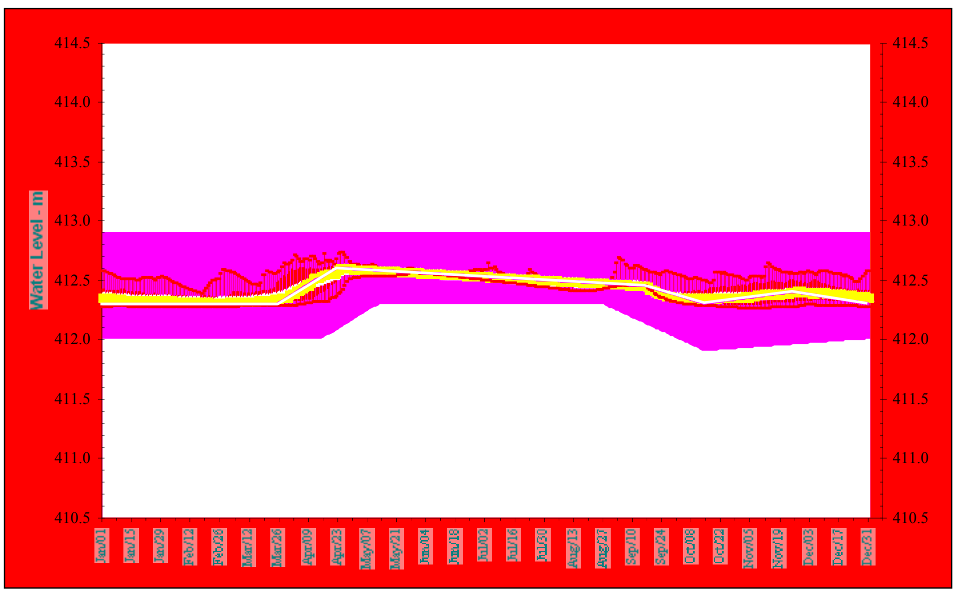
Table 11.2.2
Camp Lake

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date TOL Change WL Direction	412.8 412.2 – 412.45 412.7 – 412.6 April 16 0.1 Down	412.8 412.2 – 412.45 412.75 – 412.65 April 23 0.1 Down	Same NOZ, but higher spring peak with gradual spring/summer drawdown to September 30.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	412.8 – 412.75 412.45 – 412.15 412.6 0 -	412.8 412.45 – 412.3 412.5 – 412.45 0.2 Down	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	412.75 –412.0 412.15-411.55 412.6 – 411.65 0.95 Down to Oct 15, then a natural rise.	412.75 – 412.6 412.3 – 412.0 412.45 – 412.15 0.3 Down to Oct 15, then a natural rise.	More stable fall water levels (less drawdown) should improve lake trout habitat in the long term.
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	412.6 411.95 – 412.2 412.5 0 -	412.6 412.15 – 412.2 412.5 0 -	Stable winter water level.
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	1 m^3/s, by leakage $0.19\ m^3/s$ $0.16\ m^3/s$ $0.07\ m^3/s$ $2.18\ m^3/s$ $0.01\ m^3/s$ $0.01\ m^3/s$	$0.25\ m^3/s$, year round $0.22\ m^3/s$ $0.25\ m^3/s$ $0.1\ m^3/s$ $2.04\ m^3/s$ $0.09\ m^3/s$ $0.07\ m^3/s$	Consistent summer, fall and winter flows to maintain habitat values in Tasso Creek (especially for brook trout).

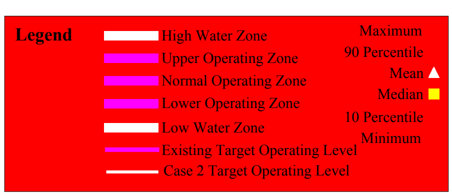
Camp Lake



a) Existing Operating Plan and Water Level Statistics *



b) Proposed Operating Plan and Water Level Statistics *



* Derived from ARSP Model

Figure 11.2.2
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Camp Lake

ACRES International

Blank back

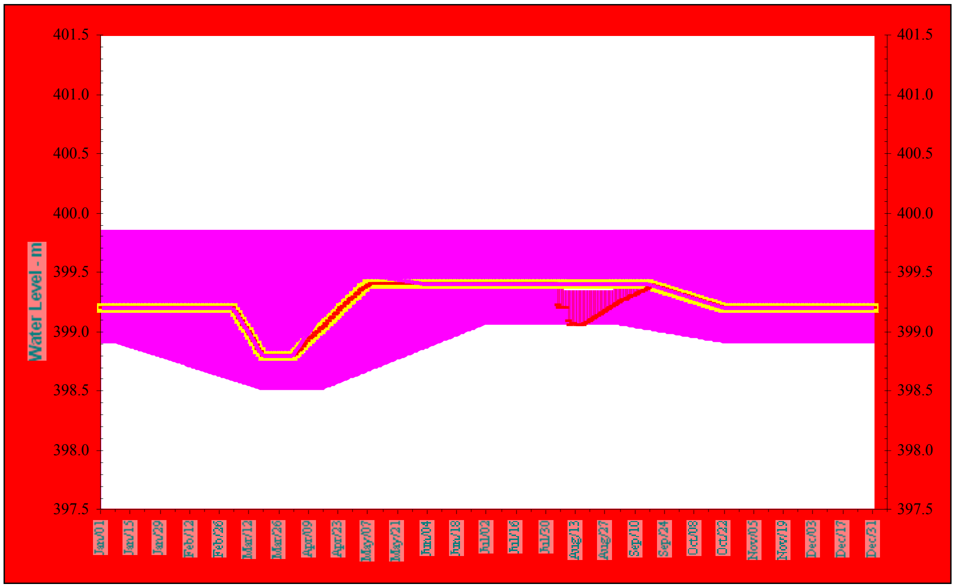
11.2.3 Tasso Lake

The proposed plan is compared to the present operating plan in Table 11.2.3 and Figure 11.2.3. The proposed changes for this lake are minor and were accommodated within the limits of the present NOZ. It is anticipated that a similar number of dam operations will be required to achieve the proposed water level and flow regime.

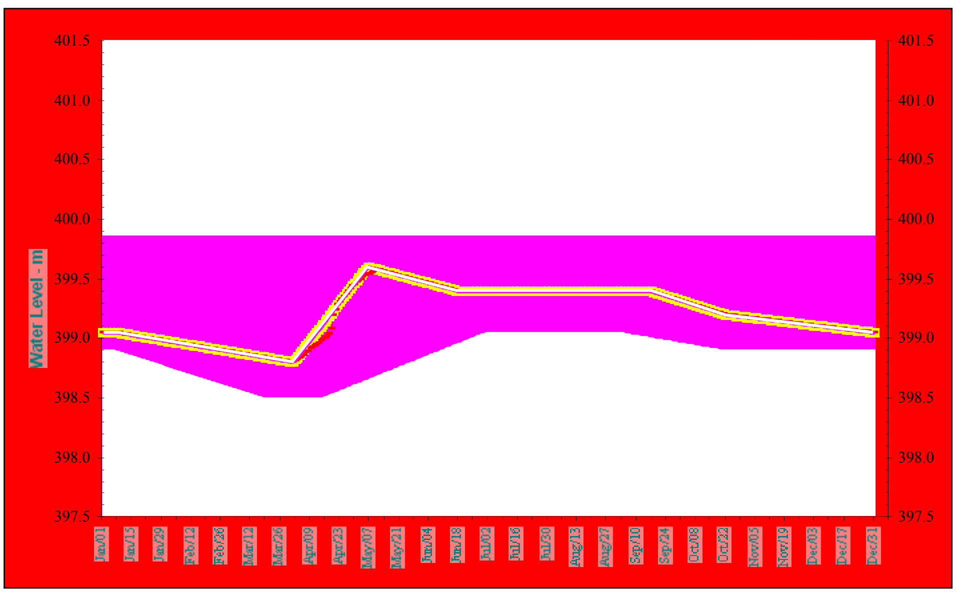
Table 11.2.3
Tasso Lake

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date* TOL Change WL Direction	399.7 – 399.67 398.7 – 399.27 399.5 – 399.4 May 6 0.1 Down	399.7 – 399.65 398.7 – 399.2 399.6 – 399.5 May 6 0.1 Down	Same NOZ, but higher spring peak. No change to summer level.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	399.67 – 399.6 399.27 – 399.17 399.4 0 -	399.65 – 399.6 399.2 – 399.15 399.5 – 399.4 0.1 Down	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	399.6 – 399.5 399.17 – 399.1 399.4 – 399.2 0.2 Down to Oct 15, then a constant level.	399.6 – 399.5 399.15 – 399.05 399.4 – 399.1 0.3 Down, proceeds into winter.	Fall drawdown proceeds smoothly into winter drawdown (same end point). Lake trout not affected by fall drawdown.
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	399.5 – 399.4 399.1 – 398.5 399.2 – 398.8 0.4 Down, March 1 to 15.	399.5 – 399.15 399.05 – 398.7 399.1 – 398.85 0.25 Down, to March 15	Gradual decline to winter target level rather than a sharp drop.
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	0.5 m^3/s, by leakage 0.49 m^3/s 0.5 m^3/s 0.17 m^3/s 5.43 m^3/s 0.12 m^3/s 0.05 m^3/s	0.5 m^3/s, year round 0.52 m^3/s 0.61 m^3/s 0.19 m^3/s 5.06 m^3/s 0.14 m^3/s 0.01 m^3/s	Consistent summer, fall and winter flows to maintain habitat value in Tasso Creek (especially for brook trout).

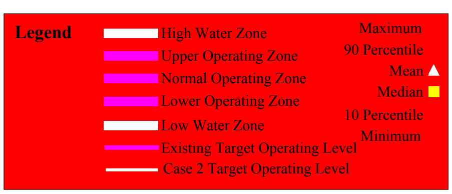
Tasso Lake



a) Existing Operating Plan and Water Level Statistics *



b) Proposed Operating Plan and Water Level Statistics *



* Derived from ARSP Model

Figure 11.2.3
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Tasso Lake

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Back of figure

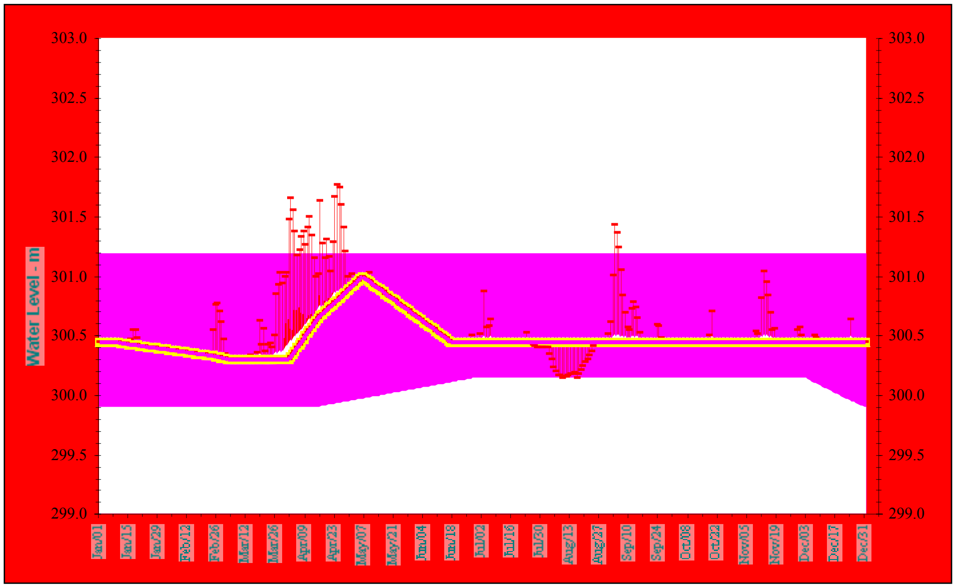
11.2.4 Buck Lake

The proposed plan is compared to the present operating plan in Table 11.2.4 and Figure 11.2.4. The proposed changes for this lake are minor and were accommodated within the limits of the present NOZ. It is anticipated that a similar number of dam operations will be required to achieve the proposed water level and flow regime.

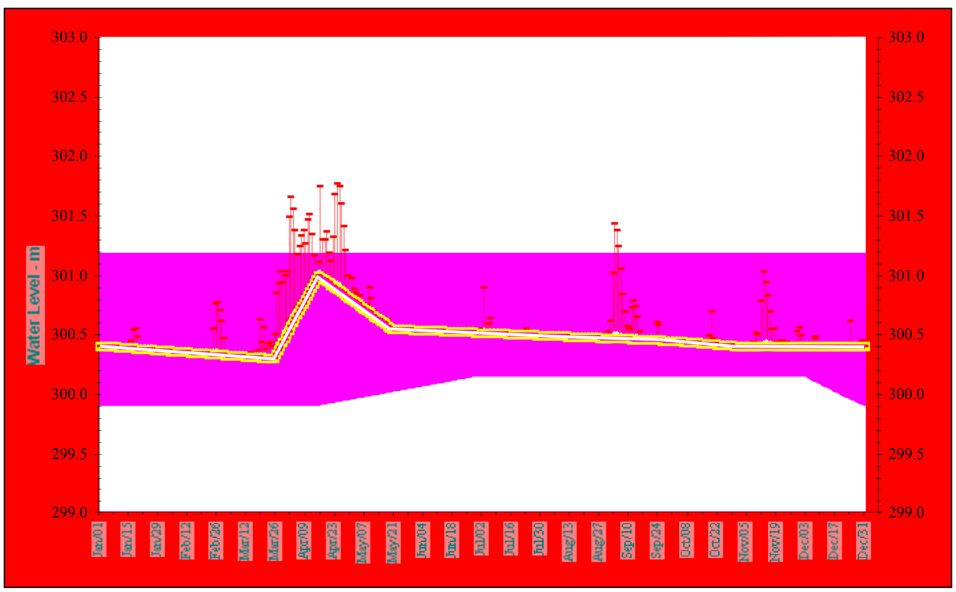
Table 11.2.4
Buck Lake

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date* TOL Change WL Direction	301.15 – 301.0 300.2 – 300.4 301.0 – 300.63 May 6 0.37 Down	301.15 – 301.0 300.2 – 300.4 301.0 – 300.55 April 15 0.45 Down	Same NOZ, but earlier spring peak. Gradual decline to same September 15 level over the summer.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	301.0 – 300.7 300.37 – 300.3 300.63 - 300.45 0.18 Down, before June 15	301.0 – 300.7 300.37 – 300.3 300.55 – 300.45 0.1 Down, over summer	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	300.7 – 300.85 300.3 300.45 0 -	300.7 – 300.85 300.3 – 300.2 300.45 – 300.4 0.05 Down proceeds into winter.	Gradual drawdown through fall and early winter.
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	300.85 – 300.7 300.3 – 300.2 300.45 – 300.3 0.15 Down, Jan 1 to March 15	300.85 – 300.7 300.2 300.4 – 300.3 0.1 Down, to March 15	More gradual decline to same winter target level.
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	None, some leakage $2.14\ m^3/s$ $2.73\ m^3/s$ $0.83\ m^3/s$ $24.69\ m^3/s$ $0.75\ m^3/s$ $0.41\ m^3/s$	$1\ m^3/s$, year round $2.11\ m^3/s$ $2.7\ m^3/s$ $0.85\ m^3/s$ $25.64\ m^3/s$ $0.68\ m^3/s$ $0.38\ m^3/s$	Consistent summer, fall and winter flows to maintain habitat value in Buck River into Fox Lake.

Buck Lake



a) Existing Operating Plan and Water Level Statistics *



b) Proposed Operating Plan and Water Level Statistics *

* Derived from ARSP Model

Figure 11.2.4
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Buck Lake

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Back of figure

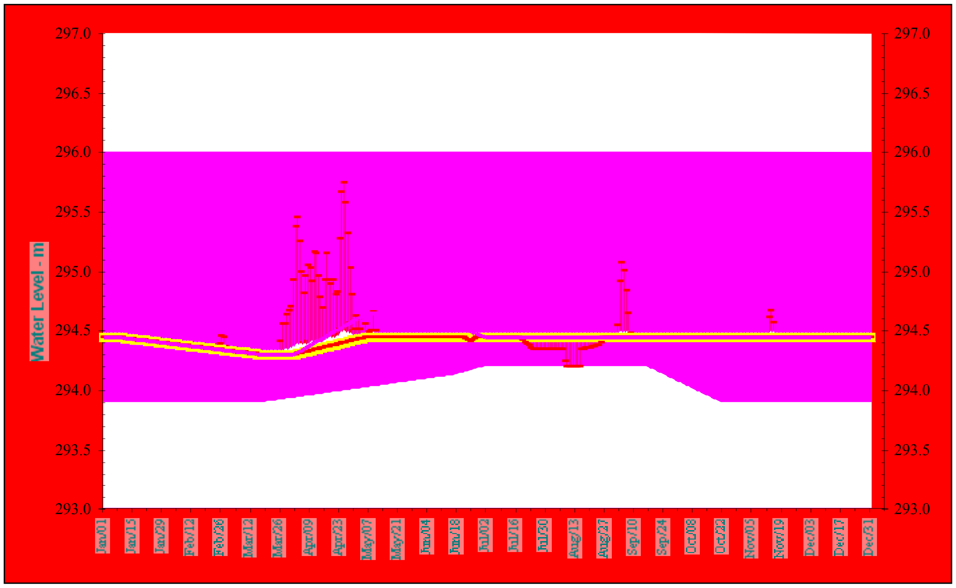
11.2.5 Fox Lake

The proposed plan is compared to the present operating plan in Table 11.2.5 and Figure 11.2.5. The proposed changes for this lake were the subject of additional discussion with lake representatives, and resulted in an adjustment to the lower limit of the NOZ to accommodate a lower late summer TOL. It is anticipated that a similar number of dam operations will be required to achieve the proposed water level and flow regime.

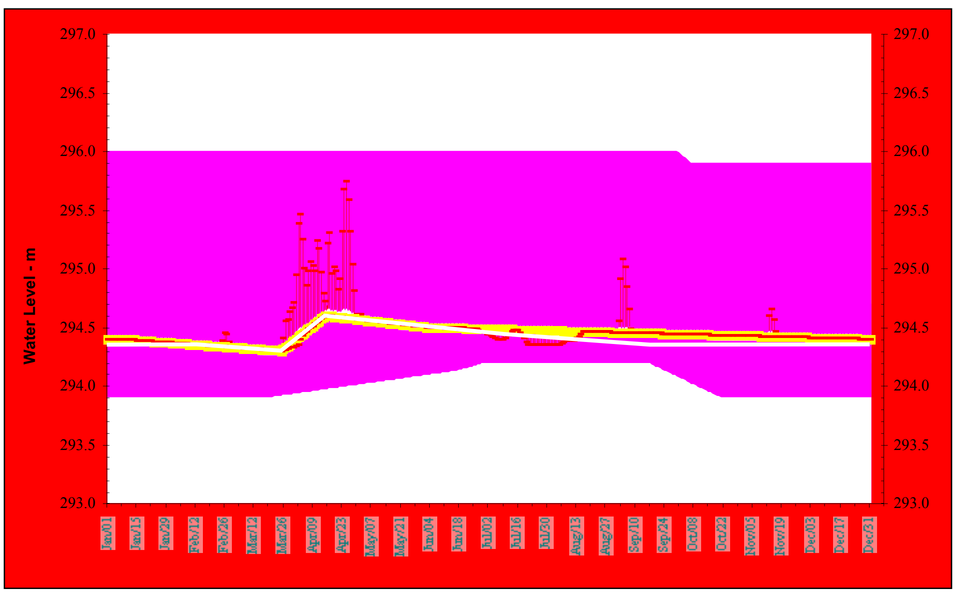
Table 11.2.5
Fox Lake

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date* TOL Change WL Direction	295.0 – 294.85 294.2 – 294.5 294.65 April 26 0 -	295.0 – 294.85 294.2 – 294.35 294.6 – 294.5 April 15 0.1 Down	Slightly earlier spring peak, and expanded NOZ to accommodate lower summer level requested by lake residents. Gradual decline over the summer period to a 10 cm lower level by September 15 level.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	294.85 – 294.55 294.45 – 294.35 294.65 – 294.45 0.2 Down, before July 1	294.85 – 294.55 294.35 – 294.25 294.5 – 294.35 0.15 Down, over summer	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	294.55 – 294.7 294.35 – 294.2 294.45 0 -	294.55 – 294.7 294.25 – 294.2 294.35 0 -	Ten centimeter lower fall level, with no water level change through fall and early winter.
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	294.7 294.2 294.45 – 294.3 0.15 Down, Jan 1 to March 15	294.7 294.2 294.35 – 194.3 0.05 Down, to March 15	More gradual decline to same winter target level.
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	0.7 m^3/s, by leakage 2.28 m^3/s 2.92 m^3/s 0.88 m^3/s 25.55 m^3/s 0.8 m^3/s 0.43 m^3/s	1 m^3/s, year round 2.25 m^3/s 2.87 m^3/s 0.91 m^3/s 26.76 m^3/s 0.66 m^3/s 0.36 m^3/s	Consistent summer, fall and winter flows to maintain habitat value in Buck River into Fox Lake.

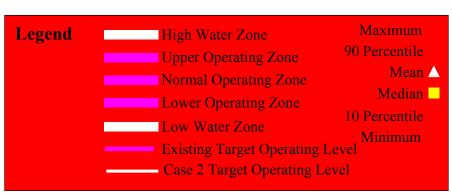
Fox Lake



a) Existing Operating Plan and Water Level Statistics *



b) Proposed Operating Plan and Water Level Statistics *



* Derived from ARSP Model

Figure 11.2.5
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Fox Lake

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Back of figure

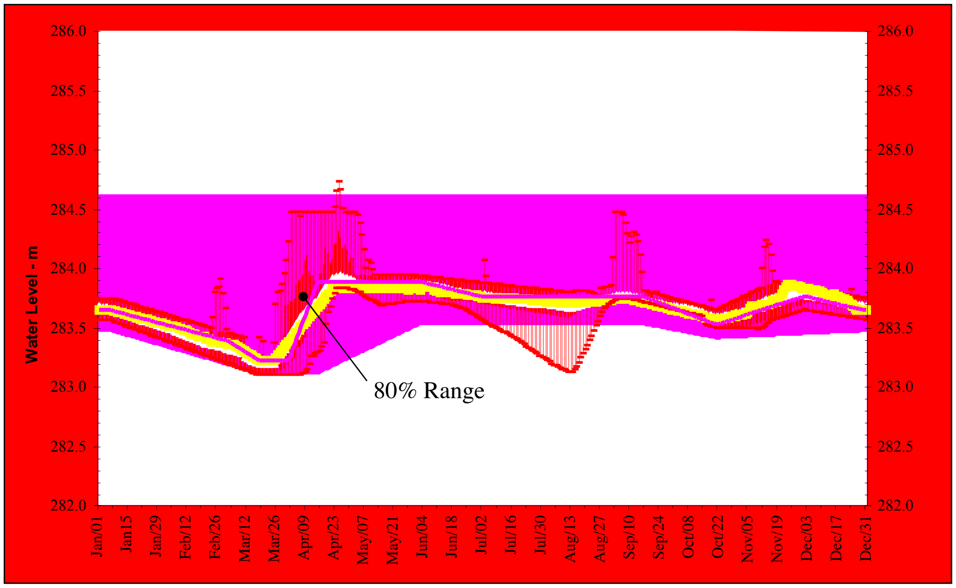
11.2.6 Huntsville Lakes

The proposed plan is compared to the present operating plan in Table 11.2.6 and Figure 11.2.6. The proposed changes for these lakes are minimal and were accommodated within the limits of the present NOZ. It is anticipated that a similar number of dam operations will be required to achieve the proposed water level and flow regime.

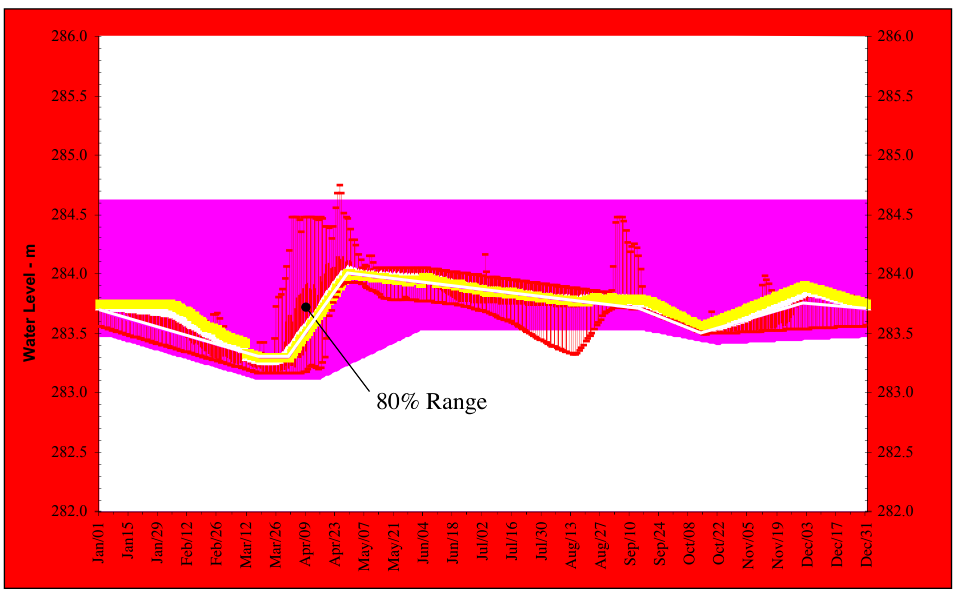
Table 11.2.6
Huntsville Lakes

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date* TOL Change WL Direction	284.13 283.16 – 283.7 283.89 April 22 0 -	284.13 283.16 – 283.7 284.0 – 283.9 April 29 0.1 Down	Same NOZ, but slightly higher spring peak. Gradual decline to slightly lower September 15 level over the summer.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	284.13 – 283.89 283.7 – 183.68 283.89 – 283.77 0.12 Down, before July 1	284.13 – 283.89 283.7 – 183.68 283.9 - 283.7 0.2 Down, over summer	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	283.89 283.68 – 283.49 283.77 – 283.53 0.12 Down, Sept 15 to Oct 15, followed by natural rise.	283.89 283.68 – 283.49 283.7 - 283.5 0.2 Down, Sept 15 to Oct 15, followed by natural rise.	Similar fall drawdown (for lake trout habitat).
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	283.89 – 283.55 283.53 – 283.16 283.77 – 283.23 0.54 Down, Jan 1 to March 15	283.89 – 283.55 283.53 – 283.16 283.75 – 283.3 0.45 Down, to March 15	Slightly less winter drawdown to reduce fall/winter water level differential to improve lake trout habitat.
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	3 m^3/s - summer 11 m^3/s, winter 12.94 m^3/s 17.5 m^3/s 4.63 m^3/s 123.28 m^3/s 4.2 m^3/s 1.52 m^3/s	3 m^3/s, year round 11 m^3/s, winter 11.26 m^3/s 15.56 m^3/s 4.82 m^3/s 126.85 m^3/s 4.19 m^3/s 1.62 m^3/s	Consistent summer, fall and winter minimum flow to maintain social and ecological habitat values in North Branch leading into Mary Lake.

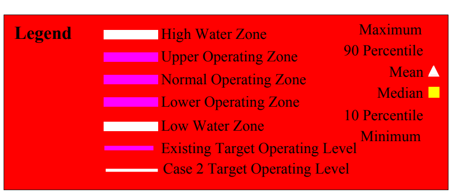
Huntsville Lakes



a) Existing Operating Plan and Water Level Statistics *



b) Proposed Operating Plan and Water Level Statistics *



* Derived from ARSP Model

Figure 11.2.6
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Huntsville Lakes

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Back of figure

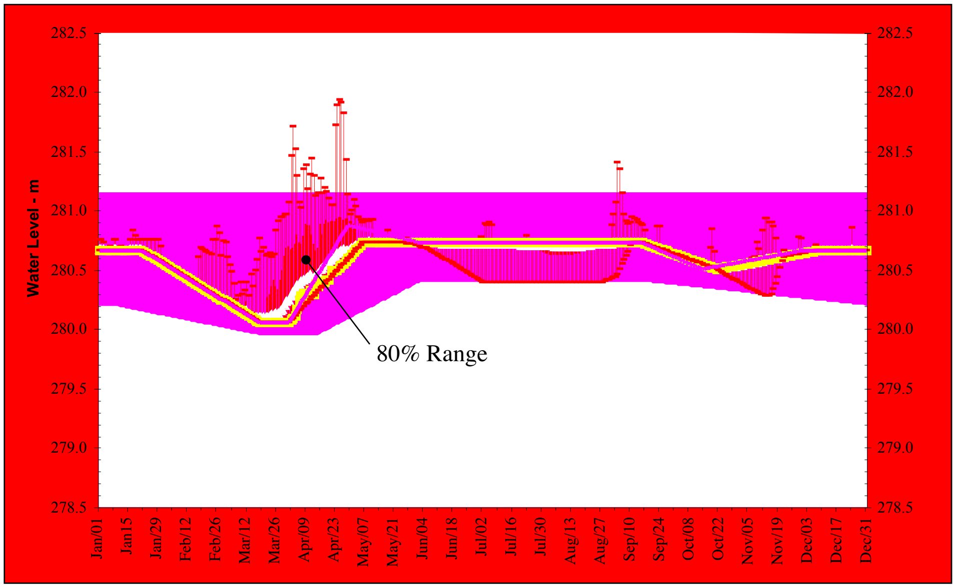
11.2.7 Mary Lake

The proposed plan is compared to the present operating plan in Table 11.2.7 and Figure 11.2.7. The proposed changes for this lake were accommodated within the limits of the present NOZ. It is anticipated that a similar number of dam operations will be required to achieve the proposed water level and flow regime.

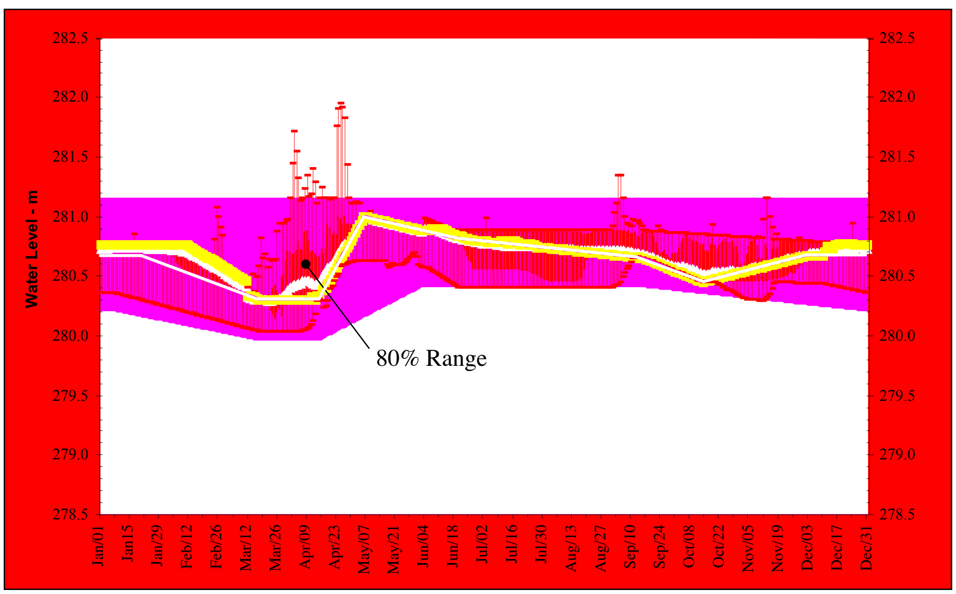
Table 11.2.7
Mary Lake

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date* TOL Change WL Direction	281.1 - 281.0 280.03 - 280.6 280.88 – 280.73 April 26 0.15 Down	281.1 - 281.0 280.03 - 280.6 281.0 – 280.9 May 6 0.1 Down	Same NOZ, but slightly higher (12 cm) spring peak and early summer level with a gradual decline during the summer to a 0.08 cm (3”) lower September 15 level.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	281.0 – 280.88 280.6 – 280.55 280.73 0 -	281.0 – 280.88 280.6 – 280.55 280.9 – 280.65 0.25 Down, over summer	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	280.88 – 280.79 280.55 – 280.45 280.73 – 280.51 0.22 Down, Sept 15 to Oct 15, followed by natural rise to 280.67 by Dec 1.	280.88 – 280.79 280.55 – 280.45 280.65 – 280.45 0.2 Down, Sept 15 to Oct 15, followed by natural rise to 280.67 by Dec 1.	Slightly more fall drawdown (0.06 m) for lake trout habitat.
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	280.79 – 280.39 280.51 – 280.03 280.67 – 280.06 0.61 Down, Jan 15 to March 15	280.79 – 280.39 280.51 – 280.03 280.67 – 280.3 0.37 Down, Jan 15 to March 15	Less winter drawdown to reduce fall/winter water level differential (from 0.45 m to 0.15 m) to improve lake trout habitat.
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	3 m^3/s, summer 11 m^3/s, winter 14.92 m^3/s 20.47 m^3/s 5.61 m^3/s 136.55 m^3/s 4.91 m^3/s 3.0 m^3/s	3 m^3/s, year round 11 m^3/s, winter 13.57 m^3/s 17.77 m^3/s 5.89 m^3/s 140.55 m^3/s 5.09 m^3/s 3.0 m^3/s	Consistent summer, fall and winter minimum flow to maintain social and ecological habitat values in North Branch leading into Mary Lake.

Mary Lake



a) Existing Operating Plan and Water Level Statistics *



b) Proposed Operating Plan and Water Level Statistics *

Legend

- High Water Zone
- Upper Operating Zone
- Normal Operating Zone
- Lower Operating Zone
- Low Water Zone
- Existing Target Operating Level
- Case 2 Target Operating Level

Maximum
90 Percentile
Mean
Median
10 Percentile
Minimum

* Derived from ARSP Model

Figure 11.2.7
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Mary Lake

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Back of figure

11.2.8 High Falls Generating Station and Head Pond

The proposed plan is compared to the present operating plan in Table 11.2.8 and Figure 11.2.8. The facility is run-of-river, presently has no legally defined operating limits, and has generally remained within the self-imposed NOZ elevations noted in Table 11.2.8 (see present operating summary in part a) of Figure 11.2.8). The absolute operating range for the facility (i.e., which would either result in flooding of facilities or insufficient water to operate the generator) spans a distance of 2.75 m (268.5 m elevation to 271.25 m elevation).

Bracebridge Generation has received the necessary government approvals and is currently expanding the facility to include a second generator. The expansion is expected to be completed by the end of 2005. A specific seasonal flow regime over the falls was agreed upon during the environmental process (EA) process and will be provided after the expansion is complete (see Section 12.1.8 for details). The operating levels presented in this document will be adhered to at all times after plan implementation (including after installation of the new unit).

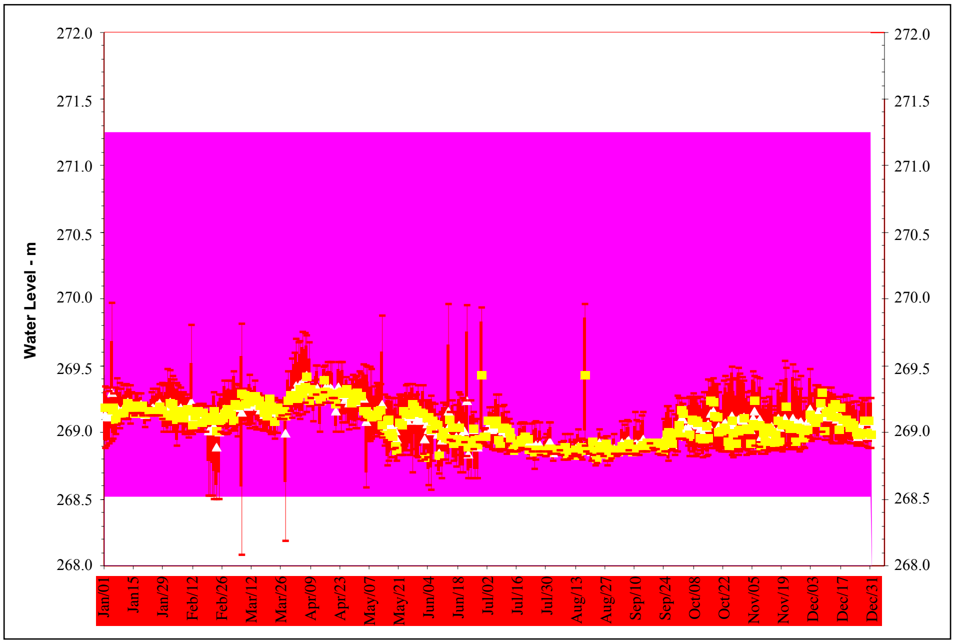
The new NOZ will be considered the compliance zone for the facility (see Section 13 for definition of compliance) and will create legally enforceable upper and lower limits during normal operating conditions.

A TOL is not proposed as waterpower operators require flexibility to vary water levels in their head ponds in response to energy demands. However, a ‘BMP’ line has been established at 269.0 m elevation from June 15 to September 15 to address public comments concerning head pond levels below the crest of the overflow weir (weir crest at 269.1 m) during the summer recreation period. BBG has agreed to operate above this level during the noted period unless unusual circumstances prevail. It is anticipated that more attention to dam operation will be required to ensure river levels are maintained within the proposed NOZ than with the present operating plan.

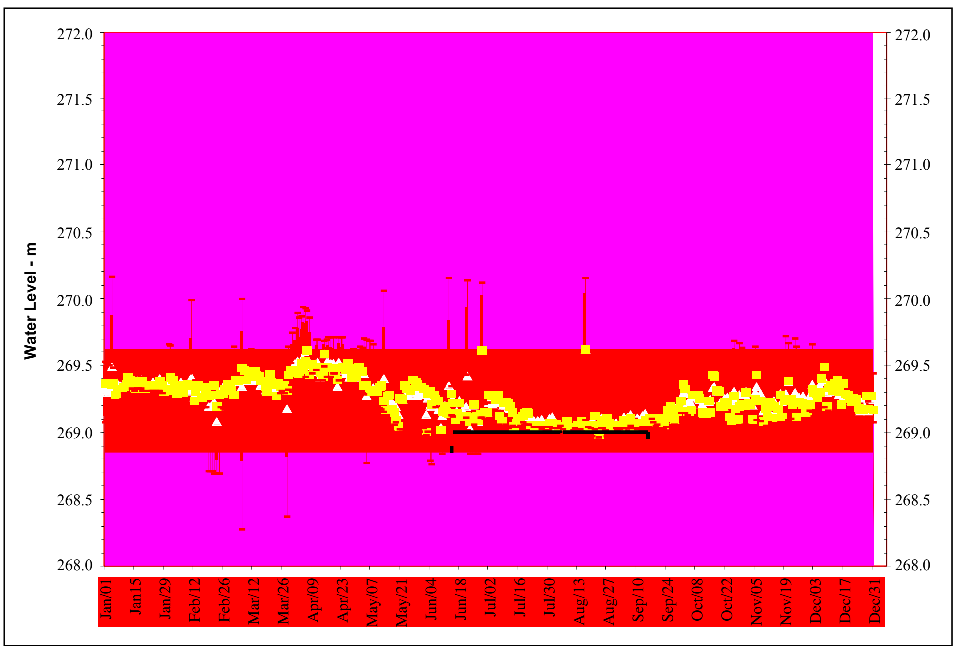
Table 11.2.8
High Falls Generating Station and Head Pond

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	271.25 269.43 268.66 268.5 None None None	Upper NOZ 269.62 268.85 Lower NOZ None 80 3	Historic water level fluctuations were typically 0.5 m on average, although absolute fluctuations could be as much as 1.5 m. The proposed plan provides an operating range of 0.77 m under normal operating conditions.
Summer Water Level (June 1 to Sept 15)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	271.25 269.43 268.66 268.5 None None None	Upper NOZ 269.62 268.85 Lower NOZ None 80 3	
Fall Water Level (Sept 16 to Nov 30)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	271.25 269.43 268.66 268.5 None None None	Upper NOZ 269.62 268.85 Lower NOZ None 80 3	
Winter Water Level (Dec 1 to March 15)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	271.25 269.43 268.66 268.5 None None None	Upper NOZ 269.62 268.85 Lower NOZ None 80 3	
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	10.25 m^3/s annual average 16.24 m^3/s 22.17 m^3/s 5.89 m^3/s 150.96 m^3/s 5.33 m^3/s 3.25 m^3/s	10.35 m^3/s annual average 15.03 m^3/s 19.43 m^3/s 6.18 m^3/s 155.46 m^3/s 5.55 m^3/s 3.28 m^3/s	Consistent summer, fall and winter minimum flow to maintain social and ecological habitat values in North Branch leading into Lake Muskoka. Some redistribution of flow to summer season to offset lower winter flow in river system

High Falls GS



a) Existing Operating Plan and Historical Water Level Statistics



b) Proposed Operating Plan and Historical Water Level Statistics

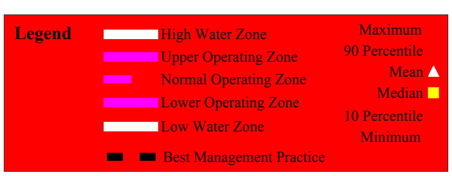


Figure 11.2.8
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - High Falls GS

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Back of figure

11.2.9 Wilson Falls Generating Station and Head Pond

The proposed plan is compared to the present operating plan in Table 11.2.9 and Figure 11.2.9. The facility is run-of-river, presently has no legally defined operating limits, and has generally remained within the self-imposed NOZ elevations noted in Table 11.2.9 (see present operating summary in part a) of Figure 11.2.9). The absolute operating range for the facility (i.e., which would either result in flooding of facilities or insufficient water to operate the generator) spans a distance of 2.45 m (256.15 m elevation to 253.7 m elevation).

Additional investigations were undertaken during the development of the plan to resolve an identified discrepancy between historic water level elevations and the elevations of known, fixed points at the facility. As a result, the water levels noted in part a) of Figure 11.2.9 are considered inaccurate, although the range of water level change is considered representative of the range of water levels experienced in the head pond and river upstream of the facility. The range and specific levels provided for the new plan are based on a topographic survey of the facility and structures, and an engineering evaluation of the flow handling capacity of the various structures (i.e., powerhouse and main dam). Reporting of operational parameters (see Section 13) will confirm that the new operating range is appropriate for the facility.

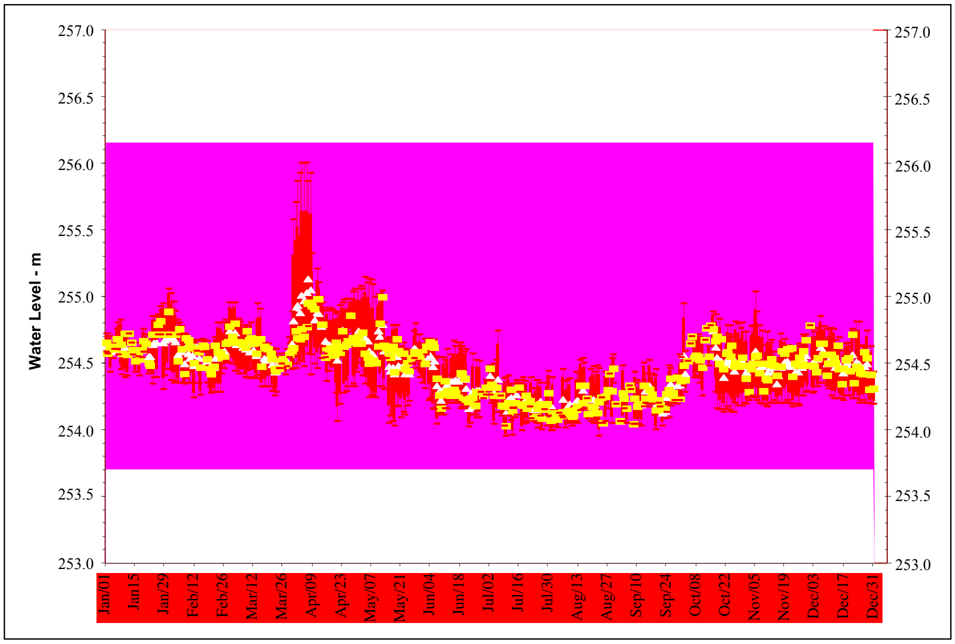
The new NOZ will be considered the compliance zone for the facility (see Section 13 for definition of compliance) and will create legally enforceable upper and lower limits during normal operating conditions.

A TOL is not proposed as waterpower operators require flexibility to vary water levels in their head ponds in response to energy demands. However, a ‘BMP’ line has been established at 254.29 m elevation from June 15 to September 15 to address public comments pertaining to head-pond levels below the crest of the overflow weir (weir crest at 254.34 m) during the summer recreation period. BBG has agreed to operate above this level during the noted period unless unusual circumstances prevail. It is anticipated that more attention to dam operation will be required to ensure river levels are maintained within the proposed NOZ than with the present operating plan.

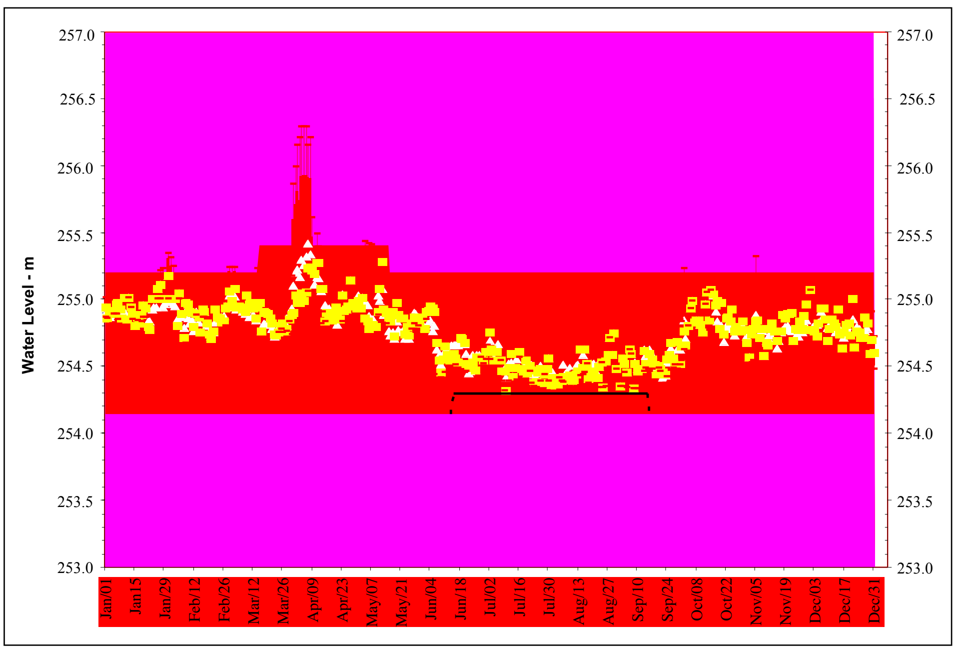
Table 11.2.9
Wilson Falls Generating Station and Head Pond

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 15)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	256.15 254.68 253.85 253.17 None None None	Upper NOZ 255.4 254.14 Lower NOZ None 65 3	Historic water level fluctuations were typically 1.0 m on average, although absolute fluctuations could be as much as 2.0 m. The proposed plan provides an operating range of 1.26 m under spring high flow conditions and 1.06 m for the remainder of the year.
Summer Water Level (May 15 to Sept 15)	Upper Limit (m) Upper Zone (m) Lower Zone (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	256.15 254.68 253.85 253.17 None None None	Upper NOZ 255.2 254.14 Lower NOZ None 65 3	
Fall Water Level (Sept 16 to Nov 30)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	256.15 254.68 253.85 253.17 None None None	Upper NOZ 255.2 254.14 Lower NOZ None 65 3	
Winter Water Level (Dec 1 to March 15)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	256.15 254.68 253.85 253.17 None None None	Upper NOZ 255.2 254.14 Lower NOZ None 65 3	
Downstream River Reach and Lake Outflow Characteristics	Planned flow release	10.28 m^3/s annual average	10.37 m^3/s annual average	Consistent summer, fall and winter minimum flow to maintain social and ecological habitat values in North Branch leading into Lake Muskoka. Some redistribution of flow to summer season to offset lower winter flow in river system
	Median Wkly Flow		15.32 m^3/s	
	- Summer	16.56 m^3/s	19.84 m^3/s	
	- Winter	22.55 m^3/s	6.27 m^3/s	
	Minimum Daily Flow (7-d average)	6.0 m^3/s		
	Maximum Daily Flow (50-yr average)	154.9 m^3/s	159.4 m^3/s	
	7Q2 (2-yr min)	5.43 m^3/s	5.66 m^3/s	
	7Q10 (10-yr min)	3.32 m^3/s	3.34 m^3/s	

Wilson Falls GS



a) Existing Operating Plan and Historical Water Level Statistics



b) Proposed Operating Plan and Historical Water Level Statistics

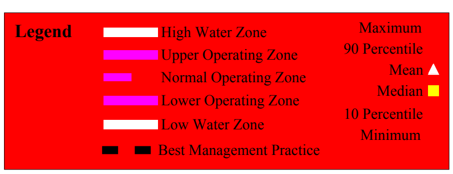


Figure 11.2.9
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Wilson Falls GS

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Back of figure

11.2.10 Birds Mill Dam

The Bird's Mill Dam has no power generating facilities and its principal role is to facilitate nearby recreational uses (navigation, fishing, etc). The streamflow through the dam is entirely dependent on the water that is available in the natural flow of the river. Compliance with the operating levels noted herein will be on a voluntary basis.

The main objective of the dam operation is to regulate water levels within the reach of river from Bird's Mill Dam to Wilson's Falls. In actual fact, the greatest effect of the dam on water level is limited to the area between Bird's Mill Dam and a natural rock outcrop within the river, some 1000 m upstream of the dam, known locally as "Bass Rock".

Water levels are controlled by the placement or removal of stop logs within the three sluices. Gradual logging will take place to reduce the impact at the Bracebridge Falls facility downstream. The dam is typically operated in response to seasonal flow changes and information provided by the MNR, a reaction to high flow events or diminishing flows. Despite the use of the dam to facilitate recreational activities an over-riding consideration in operating the dam is the avoidance of flooding on River Road. To a great extent, the spillways naturally regulate water levels.

Current Operating Procedures

Fall Operation

- River flows can vary substantially during this period and water levels are controlled in response to flow information provided by the MNR.
- Sluiceway operation is usually limited to Dam No. 1 and Dam No. 2.

Winter Operation

- Normally the dam is not operated in winter.
- Most of the stop logs are in place.

Spring Operation

- River flows due to spring runoff usually warrant the removal of most, if not all of the stop logs in all three sluiceways.
- As the river flow decreases, stop logs are set back in place to maintain desired water levels.

Summer Operation

- Normally the dam is not operated during the summer.
- Most of the stop logs are in place.
- An attempt is made to have the water level at a point where the river flow cascades over the concrete retaining wall (spillway) between Dam No. 2 and Dam No. 3, for aesthetics.

Proposed Operating Range

The operating range is based on two factors: to facilitate recreational use of the river reach and to avoid flooding of River Road. No historical information is available on water levels.

The elevation of the top of a catch basin grate on River Road is 243.08. In determining the upper level, a 0.3-m freeboard from this grate is desirable. The lower level is exclusively dependent on the natural flow of the river. Suggested lower level could be 0.3 m below the concrete retaining wall (spillway) between Dam No. 2 and Dam No. 3 (elevation = 242.076 m).

Operating Range

- Upper Level – 242.7 m
- Lower Level – 241.7 m.

11.2.11 Bracebridge Falls Generating Station and Head Pond

The proposed plan is compared to the present operating plan in Table 11.2.10 and Figure 11.2.10. The facility is run-of-river, presently has no legally defined operating limits, and has generally remained within the self-imposed NOZ elevations noted in Table 11.2.10 (see present operating summary in part a) of Figure 11.2.10). Historic data is extremely limited as the facility was manned on a regular basis, with operational levels established by reference to fixed, visual points (i.e., data was not recorded). The absolute operating range for the facility (i.e., which would either result in flooding of facilities or insufficient water to operate the generator) spans a distance of 3.16 m (235.6 m elevation to 238.76 m elevation).

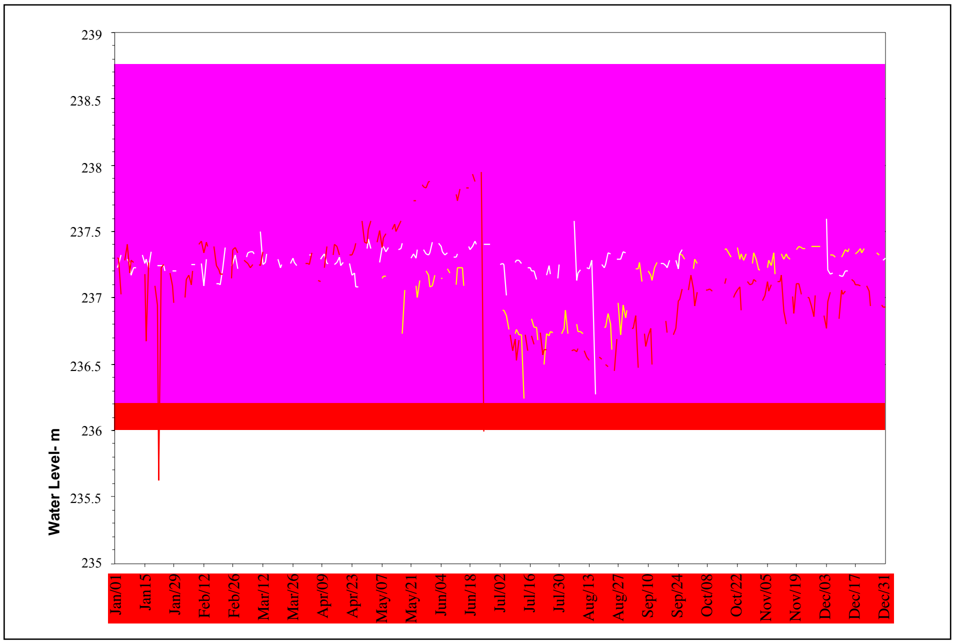
The new NOZ will be considered the compliance zone for the facility (see Section 13 for definition of compliance) and will create legally enforceable upper and lower limits during normal operating conditions.

A TOL is not proposed as waterpower operators require flexibility to vary water levels in their head ponds in response to energy demands. A relatively wide operating zone is proposed due to the very small size of the head pond (approximately 100 m long by 35 m wide) and its ability to be strongly influenced by inflows and operational changes, a general absence of environmental and social values in the head pond, and its location immediately downstream of another operational structure that is not controlled by Bracebridge Generation (flows may change quickly due to operating changes at that structure). It is anticipated that more attention to dam operation will be required to ensure river levels are maintained within the proposed NOZ than with the present operating plan.

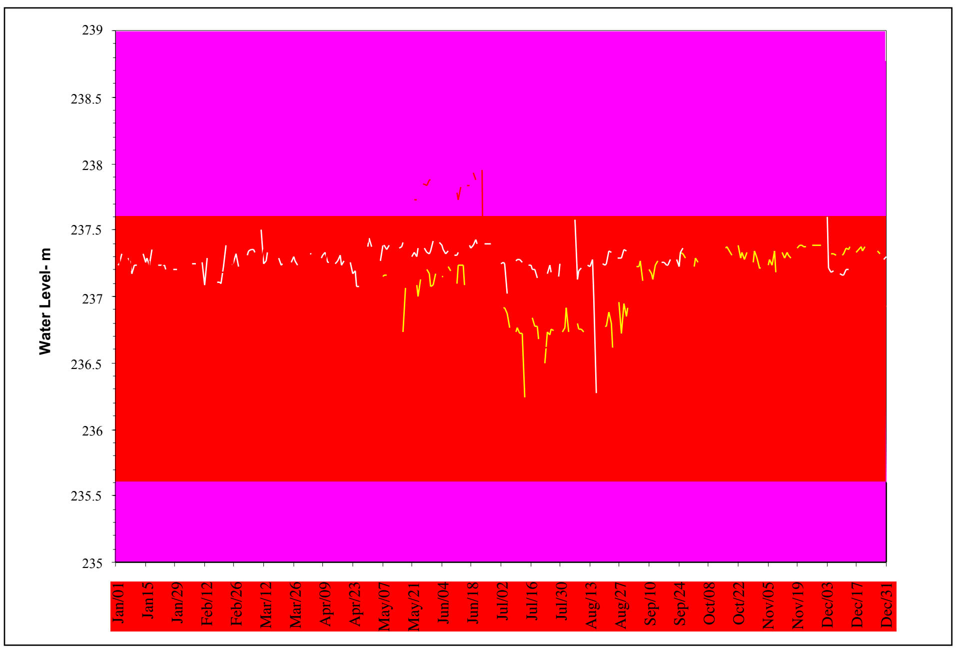
Table 11.2.10
Bracebridge Falls Generating Station and Head Pond

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	238.76 237.36 236.35 235.6 None None None	Upper NOZ 237.6 235.6 Lower NOZ None 65 3	Historic water level fluctuations were often 1.5 m or more, although limited data is available. The proposed plan provides an operating range of 2.0 m throughout the year.
Summer Water Level (June 1 to Sept 15)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	238.76 237.36 236.35 235.6 None None None	Upper NOZ 237.6 235.6 Lower NOZ None 65 3	
Fall Water Level (Sept 16 to Nov 30)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	238.76 237.36 236.35 235.6 None None None	Upper NOZ 237.6 235.6 Lower NOZ None 65 3	
Winter Water Level (Dec 1 to March 15)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	238.76 237.36 236.35 235.6 None None None	Upper NOZ 237.6 235.6 Lower NOZ None 65 3	
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	11.87 m^3/s annual average 16.68 m^3/s 22.69 m^3/s 6.19 m^3/s 156.35 m^3/s 5.47 m^3/s 3.34 m^3/s	12.01 m^3/s annual average 15.44 m^3/s 20.0 m^3/s 6.6 m^3/s 161.01 m^3/s 5.7 m^3/s 3.37 m^3/s	Consistent summer, fall and winter minimum flow to maintain social and ecological habitat values in North Branch leading into Lake Muskoka. Some redistribution of flow to summer season to offset lower winter flow in river system

Bracebridge Falls GS



a) Existing Operating Plan and Historical Water Level Statistics



b) Proposed Operating Plan and Historical Water Level Statistics

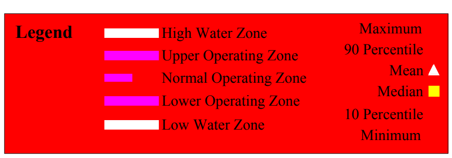


Figure 11.2.10
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Bracebridge Falls GS

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Back of figure

11.3 South Branch Subwatershed

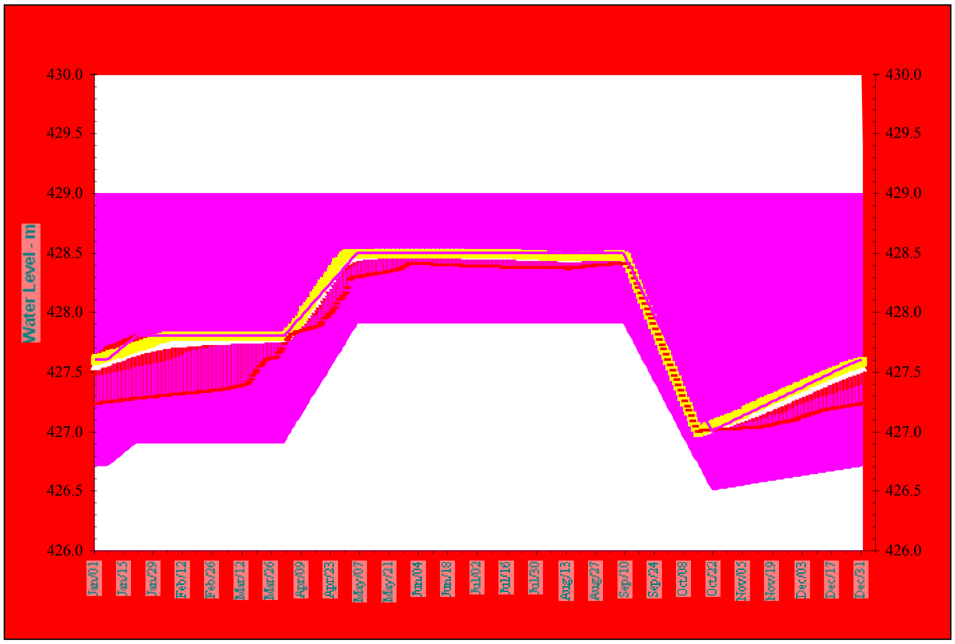
11.3.1 Burnt Island Lake

The proposed plan is compared to the present operating plan in Table 11.3.1 and Figure 11.3.1. The proposed changes for this lake required an adjustment of the NOZ to accommodate the changes in the fall and winter water levels. It is anticipated that a similar number of dam operations will be required to achieve the proposed water levels and flow regime.

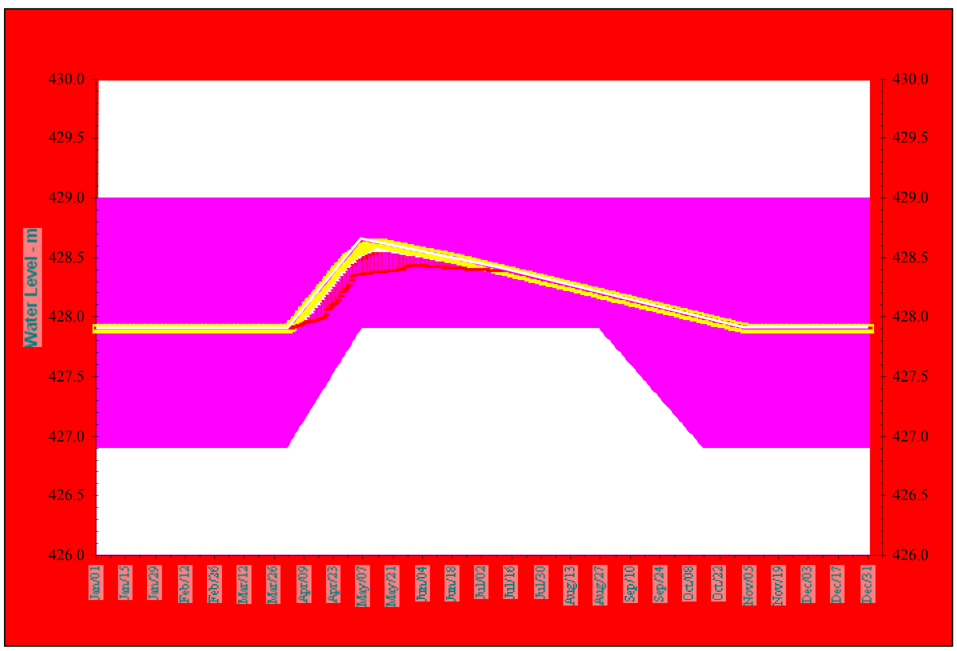
Table 11.3.1
Burnt Island Lake

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date* TOL Change WL Direction	428.7 428.2 428.5 May 2 0 -	428.7 428.2 428.65 – 428.55 May 12 0.1 Down	A more natural water level regime with a higher spring peak and gradual seasonal drawdown will improve ecological conditions for wetlands and spring spawning amphibians and fish species. Reduction in late summer drawdown will improve recreational uses.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	428.7 428.2 – 427.83 428.5 – 428.13 0.37 Down	428.7 – 428.5 428.2 – 427.83 428.55 – 428.1 0.45 Down	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	428.7 – 427.5 427.83 – 426.7 428.13 – 427.0 1.13 Down	428.5 – 428.05 427.83 – 427.4 428.1 – 427.9 0.2 Down	Potential to improve lake trout habitat by reducing seasonal drawdown range.
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	427.73 – 428.05 427.0 – 427.35 427.4 – 427.75 0.35 Rise	428.05 427.4 427.9 0 -	Stable over-winter level
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	5-6 m^3/s, Sept 15 to Oct 15 only 0.6 m^3/s 0.05 m^3/s 0.35 m^3/s 8.1 m^3/s 0.0 m^3/s 0.0 m^3/s	0.5 m^3/s annual average 0.94 m^3/s 0.66 m^3/s 0.64 m^3/s 7.82 m^3/s 0.0 m^3/s 0.0 m^3/s	More consistent summer, fall and winter flows are provided from this headwater lake – the fall release (September 15 to October 15) of 5-6 m^3/s is eliminated.

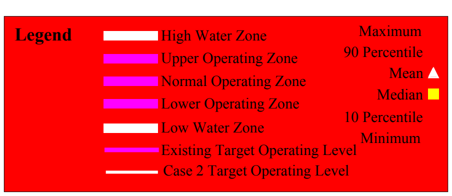
Burnt Island Lake



a) Existing Operating Plan and Water Level Statistics *



b) Proposed Operating Plan and Water Level Statistics *



* Derived from ARSP Model

Figure 11.3.1
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Burnt Island Lake

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Back of figure

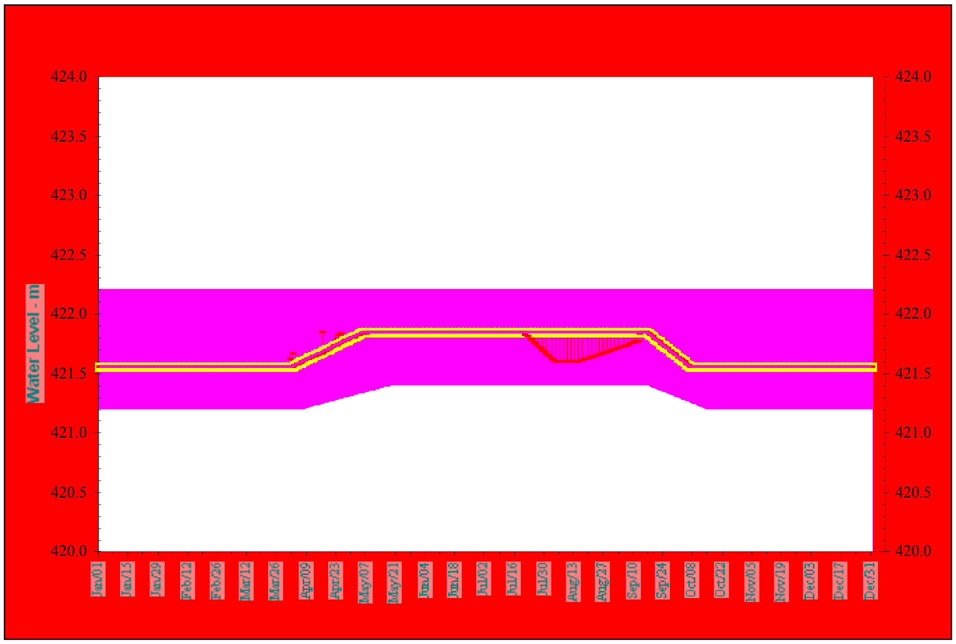
11.3.2 Joe Lake

The proposed plan is compared to the present operating plan in Table 11.3.2 and Figure 11.3.2. The proposed changes increase the range of the TOL, but remain within the NOZ. It is anticipated that a similar number of dam operations will be required to achieve the proposed water levels and flow regime.

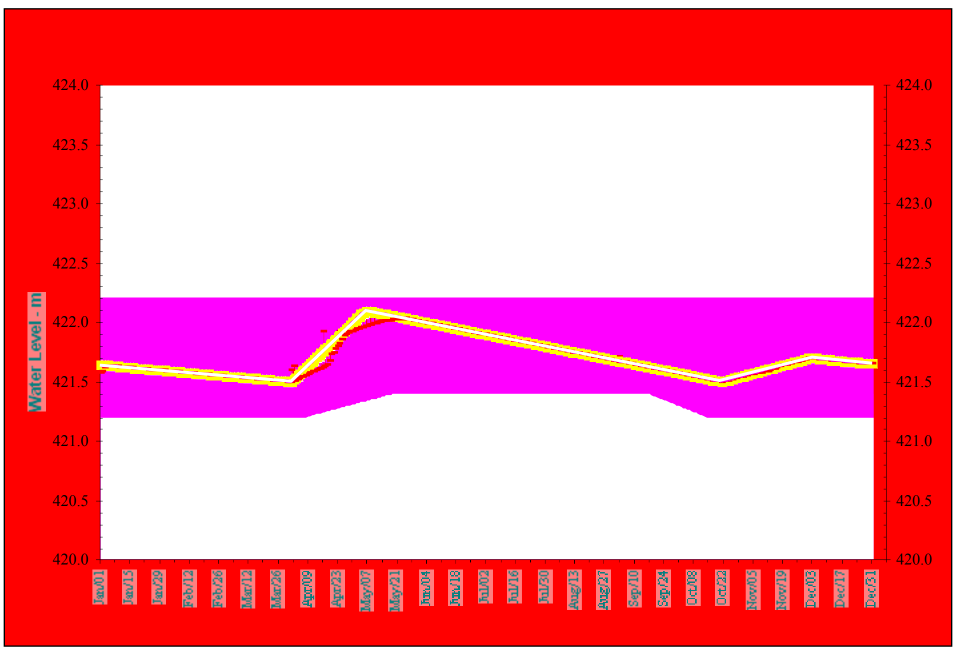
Table 11.3.2
Joe Lake

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date* TOL Change WL Direction	422.1 421.4 – 421.6 421.9 May 6 0 -	422.1 421.4 – 421.6 422.1 – 422.0 May 7 0.1 Down	A more natural water level regime with a higher spring peak and gradual seasonal drawdown will improve ecological conditions for wetlands and spring spawning amphibians and fish species.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	422.1 – 422.0 421.6 421.9 – 421.85 0.05 Down	422.1 – 422.0 421.6 422.0 – 421.63 0.37 Down	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	422.0 – 421.7 421.6 – 421.4 421.85 - 421.55 0.3 Down	422.0 – 421.7 421.6 – 421.4 421.63 – 421.5 0.2 Down, then natural rise to 421.7	Drawdown to similar October 15 level for lake trout spawning, followed by natural rise to pre-drawdown level by the end of November.
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	421.7 421.4 421.55 0 -	421.7 421.4 421.7 – 421.5 0.2 Down	Slow decline over winter to a similar elevation as the present plan.
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	$0.7 m^3/s$, Sept 15 to Oct 15 only $1.33 m^3/s$ $0.97 m^3/s$ $0.6 m^3/s$ $15.29 m^3/s$ $0.33 m^3/s$ $0.06 m^3/s$	$0.5 m^3/s$ annual average $1.74 m^3/s$ $1.41 m^3/s$ $1.11 m^3/s$ $15.48 m^3/s$ $0.26 m^3/s$ $0.0 m^3/s$	More consistent summer, fall and winter flows are provided from this headwater lake – the fall drawdown (September 15 to October 15) is eliminated.

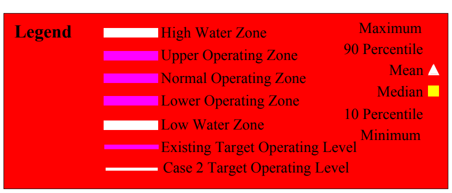
Joe Lake



a) Existing Operating Plan and Water Level Statistics *



b) Proposed Operating Plan and Water Level Statistics *



* Derived from ARSP Model

Figure 11.3.2
Muskoka River Water Management Plan

Comparison of Present and Proposed Operating Strategies - Joe Lake

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Back of figure

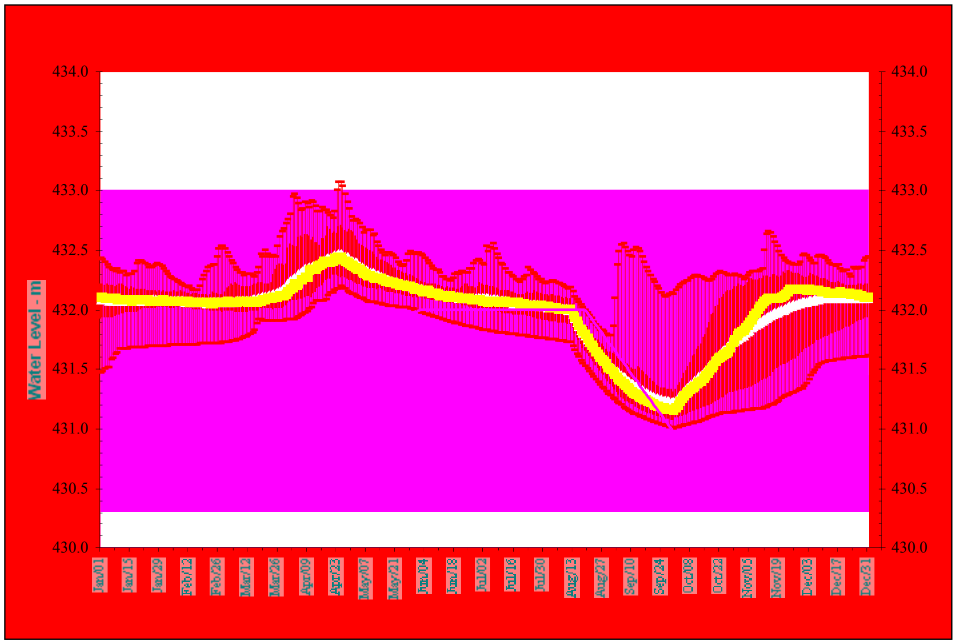
11.3.3 Ragged Lake

The proposed plan is compared to the present operating plan in Table 11.3.3 and Figure 11.3.3. The dam has not been operated since 2002, is partially breached, and will not be repaired. The operating plan replicates the water levels that are presently taking place under the normal range of hydrologic conditions (i.e., with no operation of the dam) and will allow the lake to be self-regulating. The NOZ provided encompasses the natural variability of lake levels, while the TOL replicates the long-term average levels. No future dam operations are proposed.

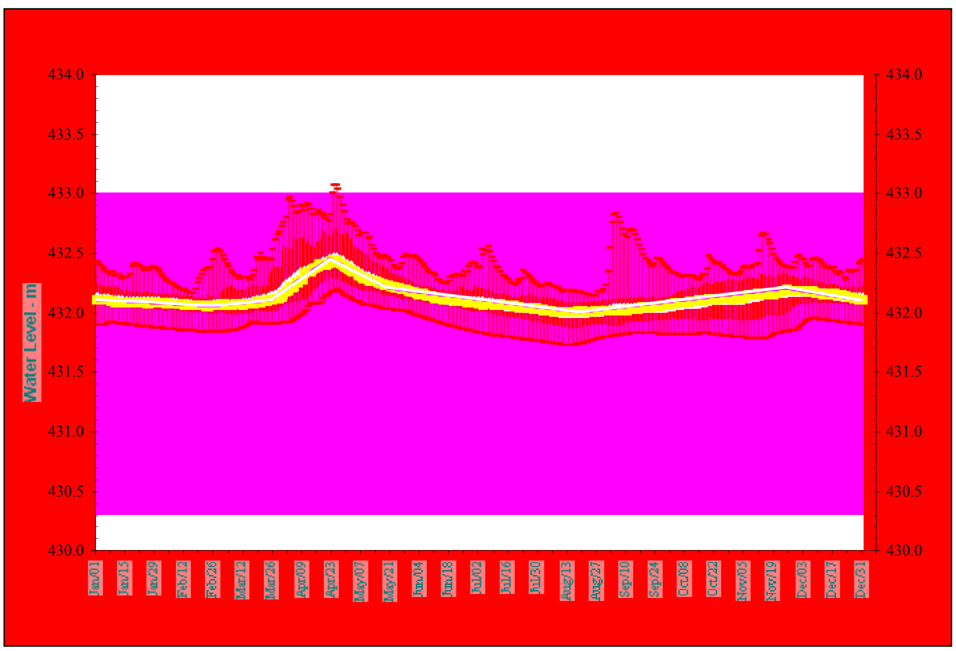
Table 11.3.3
Ragged Lake

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date* TOL Change WL Direction	432.6 431.75 – 432.0 432.3 April 20 0 -	432.9 – 432.75 431.8 432.45 – 432.15 April 20 0.3 Down	A more natural water level regime with a higher spring peak and gradual seasonal drawdown will improve ecological conditions for wetlands and spring spawning amphibians and fish species.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	432.6 432.0 – 430.8 432.3 –431.1 1.2 Down	432.75 – 432.5 431.8 432.15 – 432.0 0.15 Down, followed by natural rise	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	432.6 – 431.48 430.8 – 431.05 431.1 - 431.35 0.25 Down	432.5 431.8 432.05 – 432.2 0.15 Rise	Natural rise in response to fall rains.
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	431.64 – 432.28 431.05 – 431.58 431.35 – 431.88 0.53 Rise	432.5 431.8 432.2 – 432.05 0.15 Down	A slow decline over the winter.
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	2.0 m^3/s, Aug 15 to Sept 15 only 1.03 m^3/s 0.87 m^3/s 0.16 m^3/s 6.74 m^3/s 0.01m^3/s 0.0 m^3/s	0.5 m^3/s annual average 0.74 m^3/s 0.97 m^3/s 0.42 m^3/s 7.82 m^3/s 0.42 m^3/s 0.26 m^3/s	More consistent summer, fall and winter flows are provided from this headwater lake. Higher base flow values in downstream reach.

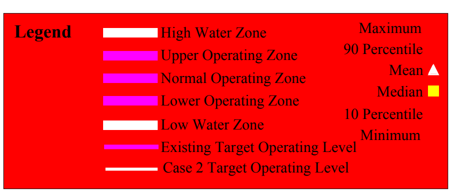
Ragged Lake



a) Existing Operating Plan and Water Level Statistics *



b) Proposed Operating Plan and Water Level Statistics *



* Derived from ARSP Model

Figure 11.3.3
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Ragged Lake

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Back of figure

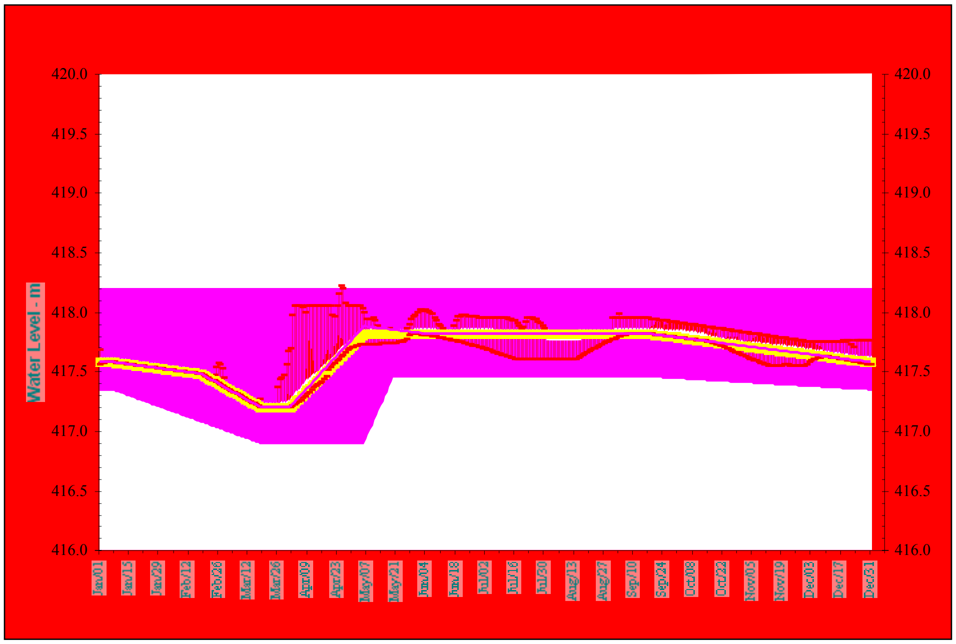
11.3.4 Canoe, Tea and Smoke Lakes

The proposed plan is compared to the present operating plan in Table 11.3.4 and Figure 11.3.4. The proposed changes increase the range of the TOL, and are within the current NOZ for these lakes. It is anticipated that a similar number of dam operations will be required to achieve the proposed water levels and flow regime.

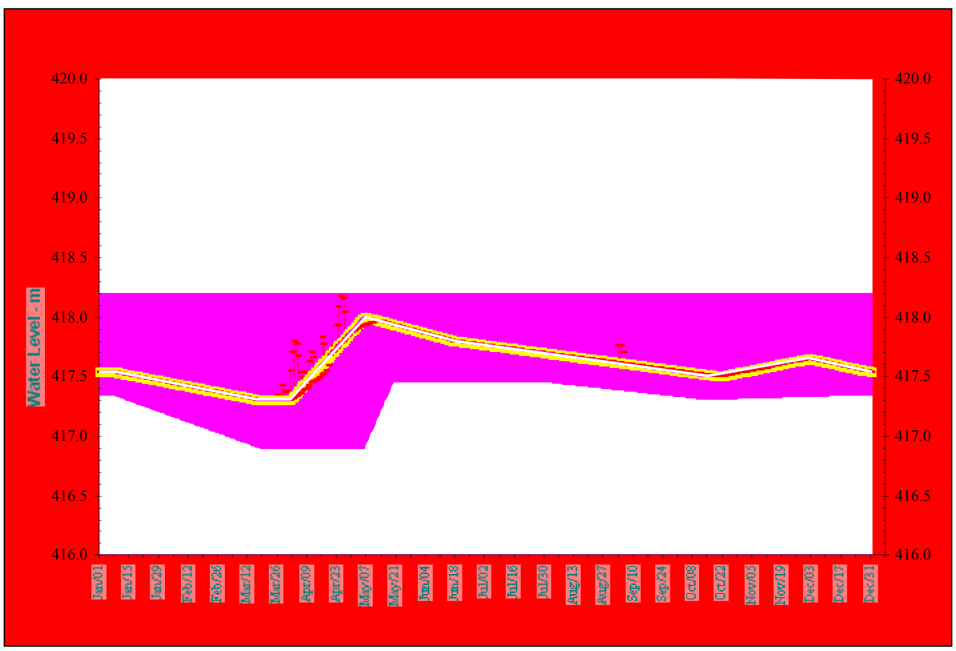
Table 11.3.4
Canoe, Tea and Smoke Lakes

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date* TOL Change WL Direction	418.05 417.02 – 417.3 417.88 - 417.82 May 6 0.06 Down	418.05 417.6 418.0 – 417.9 May 6 0.1 Down	A more natural water level regime with a higher spring peak and gradual seasonal drawdown will improve ecological conditions for wetlands and spring spawning amphibians and fish species.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	418.0 – 417.95 417.6 417.82 0 -	418.05 – 417.95 417.6 – 417.5 417.9 – 417.6 0.3 Down	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	417.95 – 417.75 417.6 – 417.51 417.82 - 417.65 0.17 Down	417.95 – 417.75 417.5 – 417.45 417.6 – 417.5 0.1 Down, then natural rise to 417.65	Fall drawdown for lake trout spawning slightly increased (to 417.5 m), followed by natural rise to pre-drawdown level by the end of November.
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	417.75 – 417.4 417.51- 417.02 417.65 – 417.2 0.45 Down	417.75 – 417.4 417.45 – 417.02 417.5 – 417.3 0.2 Down	Slow decline over winter to slightly higher winter target elevation to improve lake trout habitat.
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	1.4 m^3/s minimum flow 4.59 m^3/s 4.32 m^3/s 1.93 m^3/s 38.88 m^3/s 1.4 m^3/s 0.15 m^3/s	1.5 m^3/s minimum flow 4.4 m^3/s 4.61 m^3/s 2.5 m^3/s 39.4 m^3/s 1.48 m^3/s 0.0 m^3/s	Very similar, consistent summer, fall and winter flows are provided from this lake.

Tea,Smoke & Canoe Lakes



a) Existing Operating Plan and Water Level Statistics *



b) Proposed Operating Plan and Water Level Statistics *

Legend

- High Water Zone
- Upper Operating Zone
- Normal Operating Zone
- Lower Operating Zone
- Low Water Zone
- Existing Target Operating Level
- Case 2 Target Operating Level

Maximum
90 Percentile
Mean
Median
10 Percentile
Minimum

* Derived from ARSP Model

Figure 11.3.4
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Tea, Smoke and Canoe Lakes

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Back of figure

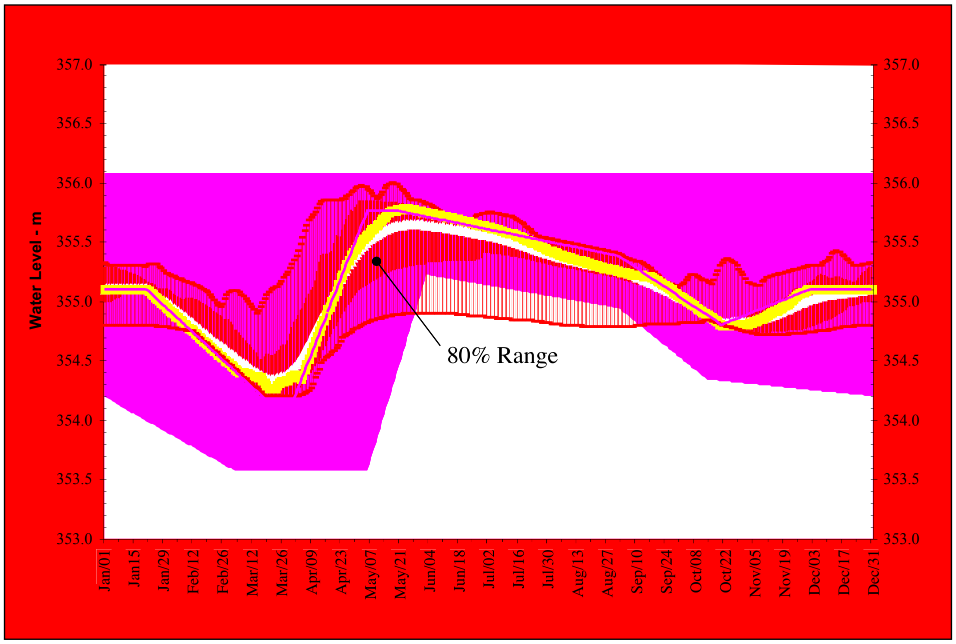
11.3.5 Kawagama Lake

The proposed plan is compared to the present operating plan in Table 11.3.5 and Figure 11.3.5. The proposed plan decreases the differential between the highest and lowest water levels of the TOL as well as the NOZ for the lake. It also provides a second BMP level which will be used to guide dam operations when conditions are favourable (i.e., when more than the average amount of rainfall and runoff is available during the summer season). This latter feature of the plan responds to comments provided by the Kawagama Lake Cottager's Association on the preliminary preferred strategy contained within the Options Report. It is anticipated that a similar number of dam operations will be required to achieve the proposed water levels and flow regime.

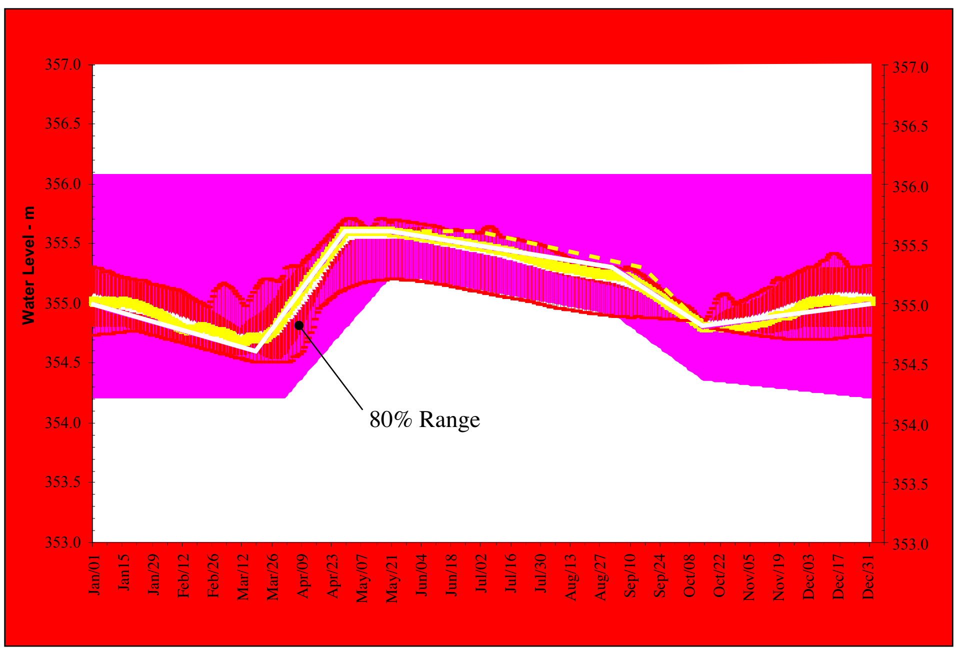
Table 11.3.5
Kawagama Lake

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date* TOL Change WL Direction	355.85 353.87 – 355.39 355.76 – 355.71 May 1 0.05 Down	355.7 354.5 – 355.4 355.6 – 355.55 May 1 0.05 Down	A lower spring peak to mitigate shoreline erosion. Summer levels approximately 0.1 m lower, and will follow the same drawdown pattern during normal or below normal rainfall and runoff years. When sufficient inflows are available, the lake will be operated to the higher and longer summer operating level (see Section 12 for additional detail).
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	355.85 – 355.34 355.39 – 354.94 355.71 – 355.19 0.52 Down	355.7 – 355.35 355.4 – 355.0 355.55 – 355.15 0.4 Down	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	355.34 – 354.94 354.94 – 354.63 355.19 – 354.8 0.39 Down, then natural rise to 355.1	355.35 – 354.95 355.0 – 354.7 355.15 – 354.8 0.35 Down, then natural rise to 355.0	Drawdown to same October 15 level for lake trout spawning, followed by a natural rise prior to winter drawdown.
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	355.3 – 354.46 354.73 – 353.87 355.1 – 354.18 0.92 Down	354.8 – 355.3 354.73 – 354.5. 355.0 – 354.6 0.4 Down	Slow decline in over-winter level to higher winter target elevation.
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	3 m^3/s summer, 0.92 m, Jan 1 to Mar 15 1.5 m^3/s 8.07 m^3/s 0.72 m^3/s 18.17 m^3/s 0.0 m^3/s 0.0 m^3/s	1.5 m^3/s summer, 0.4 m, Jan 1 to Mar 15 1.49 m^3/s 6.27 m^3/s 0.75 m^3/s 22.9 m^3/s 0.75 m^3/s 0.75 m^3/s	Similar summer outflows, lower winter outflows, and higher base flow values.

Kawagama Lake



a) Existing Operating Plan and Water Level Statistics *



b) Proposed Operating Plan and Water Level Statistics *

Legend

- High Water Zone
- Upper Operating Zone
- Normal Operating Zone
- Lower Operating Zone
- Low Water Zone
- Existing Target Operating Level
- Case 2 Target Operating Level
- BMP Operating Level

Maximum
90 Percentile
Mean
Median
10 Percentile
Minimum

* Derived from ARSP Model

Figure 11.3.5
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Kawagama Lake

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Back of figure

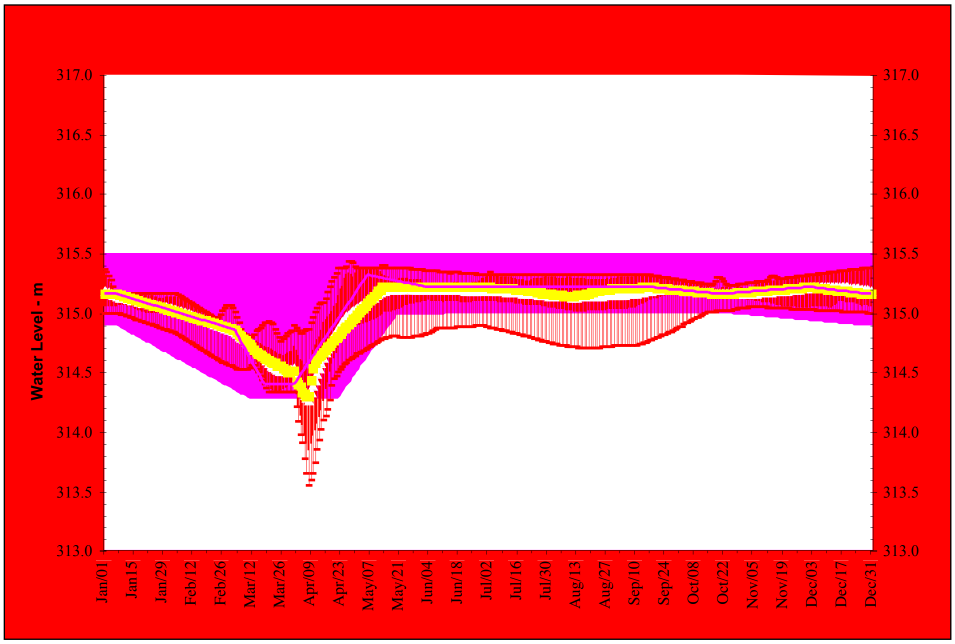
11.3.6 Lake of Bays

The proposed plan is compared to the present operating plan in Table 11.3.6 and Figure 11.3.6. The proposed plan decreases the differential between highest and lowest water levels of the TOL, but expands the lower limit of the NOZ during the fall period. A minimum flow of 5 m^3/s will be provided from the Baysville dam during the April 15 to June 1 period to ensure that adequate flow is available at the South Falls walleye spawning area. It is anticipated that a similar number of dam operations will be required to achieve the proposed water levels and flow regime.

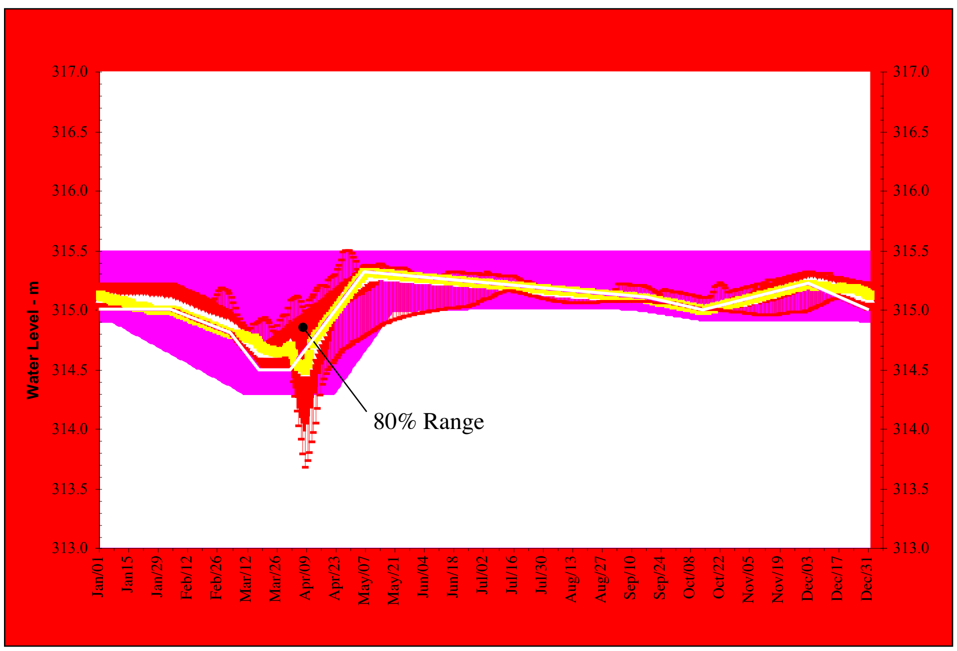
Table 11.3.6
Lake of Bays

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date* TOL Change WL Direction	315.38 314.34 – 315.09 315.32 – 315.22 May 14 0.1 Down	315.38 314.34 – 315.09 315.32 – 315.27 May 6 0.05 Down	A similar spring high water level, followed by a gradual summer drawdown to a target elevation approximately 0.14 m lower.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	315.38 – 315.29 315.09 – 315.09 315.22 – 315.19 0.03 Down	315.38 – 315.29 315.09 – 315.09 315.27 – 315.05 0.22 Down	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	315.22 – 315.32 315.09 – 315.01 315.19 – 315.16 0.03 Down, then natural rise to 315.22	315.22 – 315.32 315.09 – 315.0 315.15 – 315.0 0.15 Down, then natural rise to 315.22	Lower October 15 drawdown level for lake trout spawning (by 0.16 m); followed by a natural rise to the same December 1 elevation prior to the winter drawdown.
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	315.32 – 314.9 315.01 – 314.34 315.22 – 314.4 0.82 Down	315.32 – 314.9 315.0 – 314.34 315.22 – 314.5 0.68 Down	Slow decline in over-winter level to slightly higher (0.1 m) winter target elevation.
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	3 m^3/s summer, 17 m^3/s Oct 15 to Mar 1 nominally 6.76 m^3/s 25.75 m^3/s 2.86 m^3/s 77.45 m^3/s 1.5 m^3/s 1.5 m^3/s	5 m^3/s summer, 17 m^3/s Oct 15 to Mar 1 nominally 8.04 m^3/s 27.2 m^3/s 3.76 m^3/s 85.92 m^3/s 3.0 m^3/s 3.0 m^3/s	A minimum outflow of 5 m^3/s during the walleye spawning period (April 15 to June 1) to ensure a minimum flow of 3 m^3/s is available at the South Falls spawning site. Slightly higher summer and winter median weekly flow, and higher base flow values.

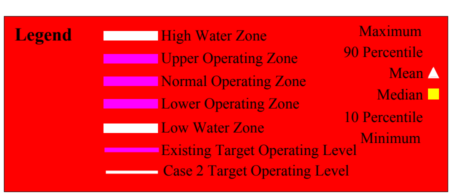
Lake of Bays



a) Existing Operating Plan and Water Level Statistics *



b) Proposed Operating Plan and Water Level Statistics *



* Derived from ARSP Model

Figure 11.3.6
Muskoka River Water Management Plan

Comparison of Present and Proposed Operating Strategies - Lake of Bays

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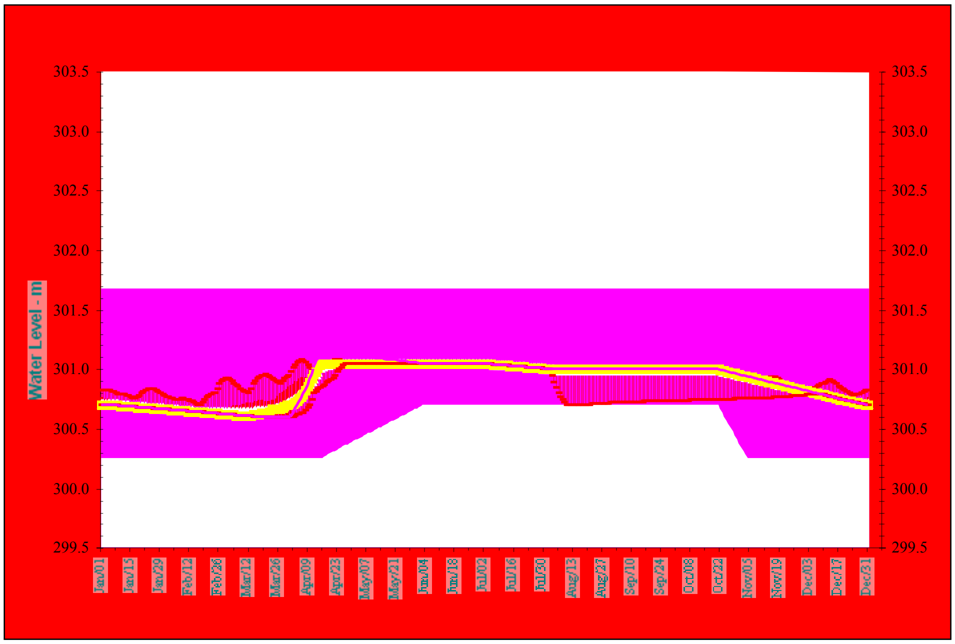
Back of figure

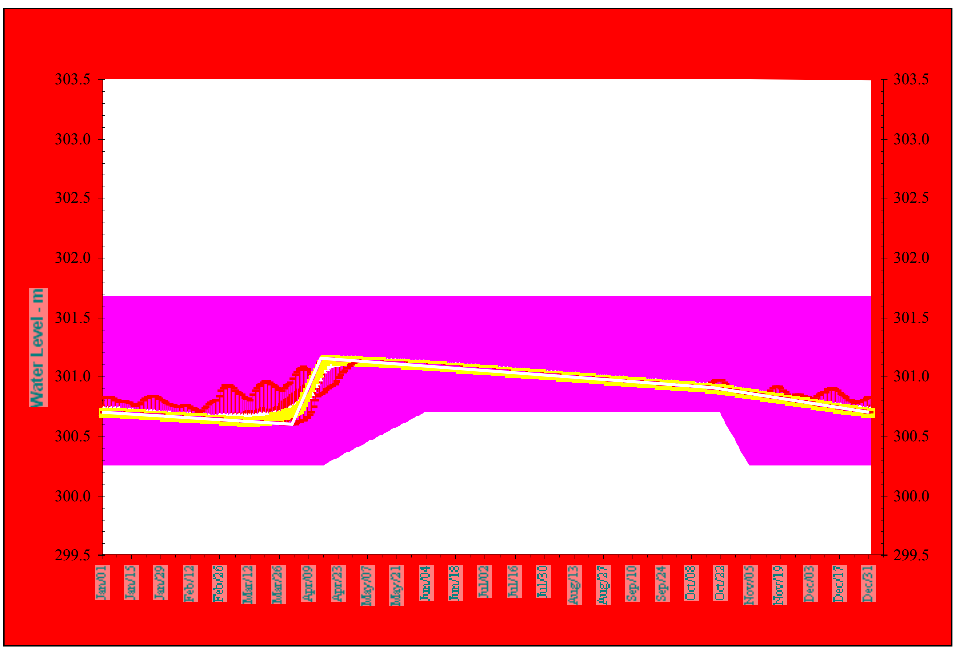
Table 11.3.7
Wood Lake

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date* TOL Change WL Direction	301.35 300.45 – 300.9 301.15 – 301.05 April 16 0.1 Down	301.35 300.45 – 300.9 301.15 – 301.1 April 17 0.05 Down	Same NOZ with same spring peak and gradual decline over the summer to a slightly lower (0.05 m) end of summer elevation.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	301.35 – 301.15 300.9 – 300.8 301.05 – 301.0 0.05 Down	301.35 – 301.15 300.9 – 300.8 301.1 – 300.95 0.15 Down, over summer	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	301.15 – 301.03 300.8 – 300.59 301.0 – 300.82 0.18 Down, proceeds into winter.	301.15 – 301.03 300.8 – 300.59 300.95 – 300.8 0.15 Down, proceeds into winter.	Gradual drawdown through the fall.
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	301.03 – 300.8 300.59 – 300.45 300.82 – 300.6 0.22 Down, Oct 15 to March 15	301.03 – 300.8 300.59 – 300.45 300.8 – 300.6 0.2 Down, Oct 15 to March 15	Gradual decline to same winter target elevation.
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	None, some leakage 0.16 m^3/s 0.57 m^3/s 0.05 m^3/s 2.59 m^3/s 0.02 m^3/s 0.0 m^3/s	0.1 m^3/s, year round 0.19 m^3/s 0.53 m^3/s 0.11 m^3/s 2.58 m^3/s 0.0 m^3/s 0.0 m^3/s	Consistent summer, fall and winter release to maintain flow and habitat value into the South Branch Muskoka River.

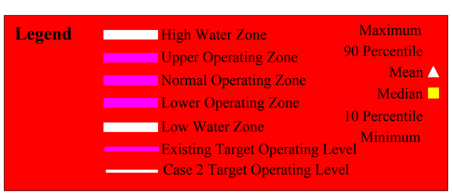
Wood Lake



a) Existing Operating Plan and Water Level Statistics *



b) Proposed Operating Plan and Water Level Statistics *



* Derived from ARSP Model

Figure 11.3.7
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Wood Lake

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Back of figure

11.3.8 Matthias Generating Station and Head Pond

The proposed plan is compared to the present operating plan in Table 11.3.8 and Figure 11.3.8. The facility is considered run-of-river, and OPGC has flooding rights within the head pond up to an elevation of 293.5 m. OPGC also has the legal right to develop waterpower at the site, which is a result of the long tenure of waterpower at the site (i.e., prior to March 1911 as defined under the Beds of Navigable Waters Act). The facility has generally remained within the NOZ elevations shown in Figure 11.3.8(a) (292.91 to 292.0 m elevation), and prefers to remain near the top of that zone (to enhance generation capacity). During exceptional circumstances (i.e., when power demand was well above normal) the facility has utilized the full operating band. The absolute operating range for the facility (i.e., which would either result in flooding of facilities or insufficient water to operate the generator) spans a distance of 1.8 m (293.5 m elevation to 291.7 m elevation).

The proposed changes reduce the overall operating limits for the facility, and establish new limits that approximate the present NOZ. The revised limits incorporate a higher (than the current NOZ) spring water level for environmental considerations (spring spawning fish and amphibians), a slightly higher (than the current NOZ) upper level the rest of the year to accommodate the historical operational ranges, and an elevated lower limit (higher than their operational lower limit) for social and environmental enhancements. The new NOZ will be considered the compliance zone for the facility (see Section 13 for definition of compliance) and will create legally enforceable upper and lower limits during normal operating conditions.

A TOL is not proposed as waterpower operators require flexibility to vary water levels in the head ponds in response to energy demands. However, three BMP lines have been established to address specific ecological or social considerations. Adherence to these BMP elevations will be undertaken voluntarily by OPGC when favourable conditions exist (i.e., suitable operational, hydrological and/or environmental conditions). The first BMP (mid March to end of May) was developed to enhance conditions for spring spawning species (fish, amphibians, etc), with the line considered to be similar to the TOL noted above for MNR lakes. The second (June 1 to 15) addresses spawning requirements for centrarchid species (bass, pumpkinseed, etc), with the intention that water levels remain above the noted level during that time period. The third (mid-June to mid-September) addresses water levels for summer recreational use, with the intention that water levels remain above the noted level during that time period. It is anticipated that more attention to dam operation will be required during the spring to maintain levels in the vicinity of the mid-March to end of May BMP line. At other times of the year, a similar level of dam operation will be required to remain within the proposed NOZ as with the present operating plan.

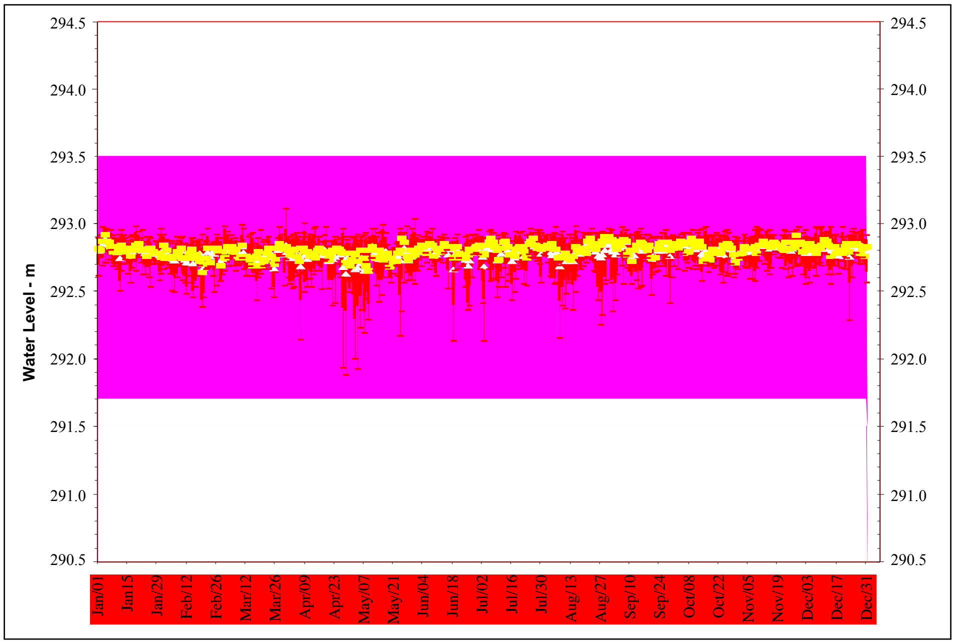
In addition, OPGC has agreed to provide a minimum outflow of 3 m^3/s through either the generator or spill gates at Matthias GS during the spring walleye spawning period to provide an adequate flow at the South Falls walleye spawning site (in spillway channel, adjacent to powerhouse). MNR will provide a minimum outflow of 5 m^3/s at Baysville to ensure that 3 m^3/s is available at Matthias GS.

Blank front - YES

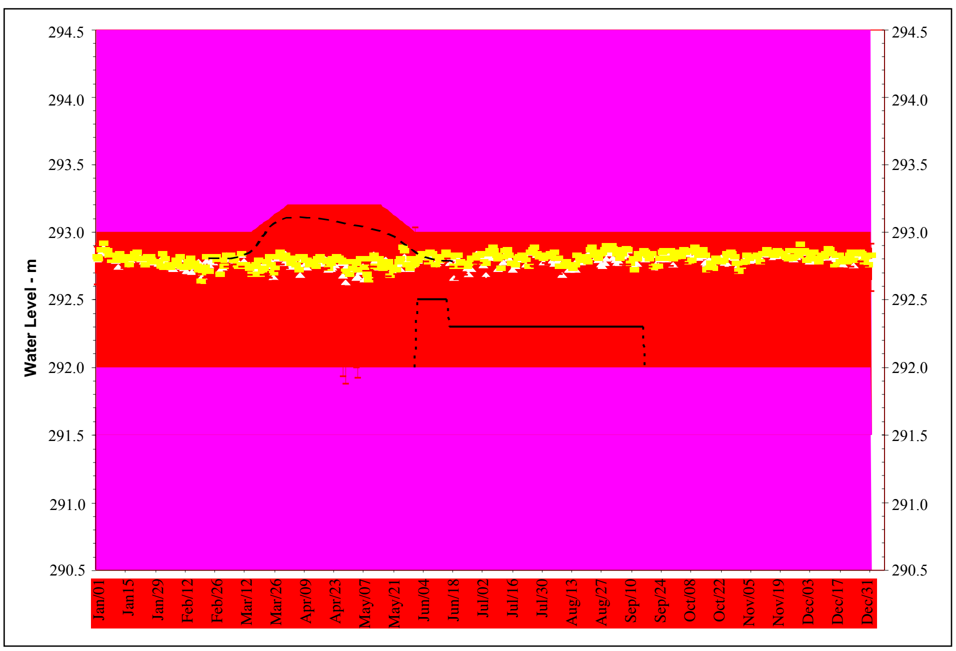
Table 11.3.8
Matthias Generating Station and Head Pond

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	293.5 292.91 292.0 291.7 None None None	Upper NOZ 293.0 – 293.2 292.0 Lower NOZ None 109.8 3	Historic water level fluctuations were typically 0.5 m on average, although absolute fluctuations could be as much as 1.5 m. The proposed plan provides an operating range of 1.0 to 1.2 m under normal operating conditions. BMPs are provided to enhance ecological and social uses when conditions permit.
Summer Water Level (June 1 to Sept 15)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	293.5 292.91 292.0 291.7 None None None	Upper NOZ 293.0 292.0 Lower NOZ None 109.8 3	
Fall Water Level (Sept 16 to Nov 30)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	293.5 292.91 292.0 291.7 None None None	Upper NOZ 293.0 292.0 Lower NOZ None 109.8 3	
Winter Water Level (Dec 1 to March 15)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	293.5 292.91 292.0 291.7 None None None	Upper NOZ 293.0 292.0 Lower NOZ None 109.8 3	
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	16.43 m^3/s annual average (for power) 7.71 m^3/s 28.88 m^3/s 1.56 m^3/s 90.29 m^3/s 3.22 m^3/s 1.63m^3/s	16.79 m^3/s annual average (for power) 8.84 m^3/s 29.33 m^3/s 3.12 m^3/s 100.32 m^3/s 3.33 m^3/s 3.17 m^3/s	Minimum flow of 3 m^3/s (on hourly basis) from April 15 to June 1 for walleye spawning at South Falls. Consistent summer, fall and winter minimum flow (3 m^3/s) to maintain social and ecological habitat values in the South Branch. Some redistribution of flow from the winter to the summer season to enhance summer base flows.

Matthias GS



a) Existing Operating Plan and Historical Water Level Statistics



b) Proposed Operating Plan and Historical Water Level Statistics

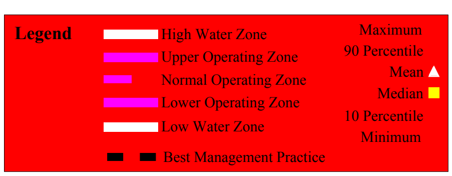


Figure 11.3.8
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Matthias GS

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Back of figure

11.3.9 Trethewey Generating Station and Head Pond

The proposed plan is compared to the present operating plan in the Table 11.3.9 and Figure 11.3.9. The facility is considered run-of-river, and OPG has flooding rights within the head pond up to an elevation of 280.35 m. The facility has generally remained near the middle of the 0.91 m NOZ shown in Figure 11.3.9(a) (279.43 to 278.52 m elevation), and has rarely extended beyond the NOZ levels. The absolute operating range for the facility (i.e., which, if exceeded, would either result in flooding of facilities or insufficient water to operate the generator) spans a distance of 1.88 m (279.74 m elevation to 278.06 m elevation).

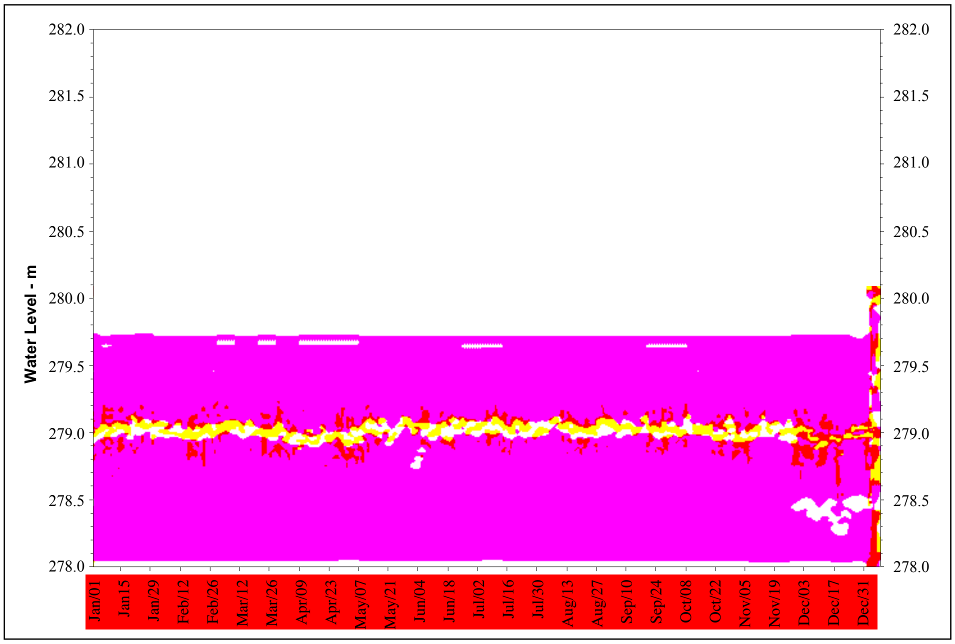
The proposed changes reduce the overall operating limits for the facility, and establish new limits that are the same as the present NOZ. The new NOZ will be considered the compliance zone for the facility (see Section 13 for definition of compliance) and will create legally enforceable upper and lower limits during normal operating conditions.

A TOL is not proposed as waterpower operators require flexibility to vary water levels in the head ponds in response to energy demands. It is anticipated that a similar number of dam operations will be required to achieve the proposed plan as is required for the present plan.

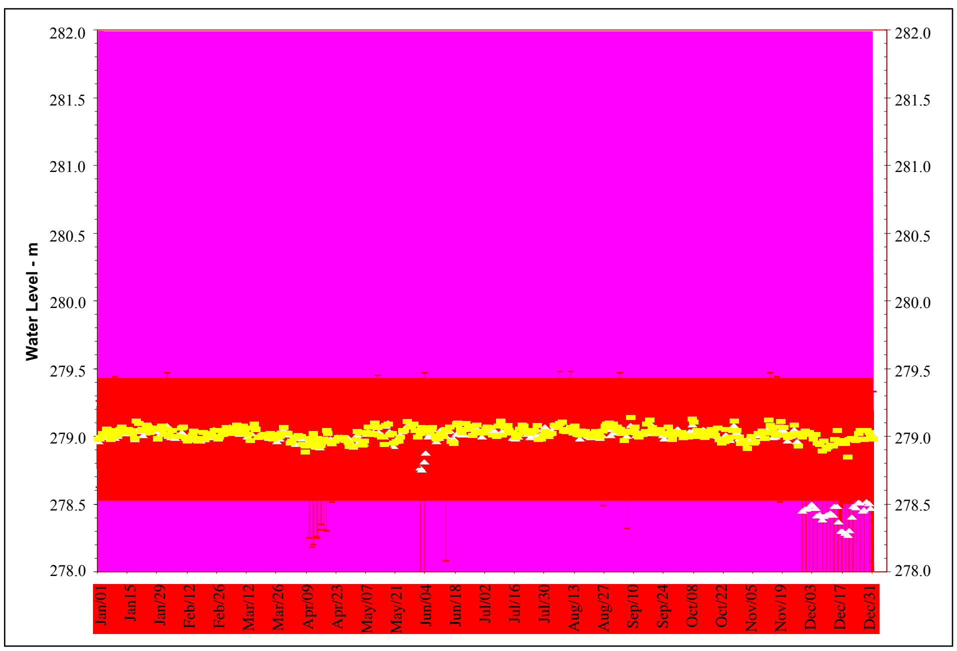
Table 11.3.9
Trethewey Generating Station and Head Pond

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	279.74 279.43 278.52 278.06 None None None	Upper NOZ 279.43 278.52 Lower NOZ None 110.8 3	Historic water level fluctuations were typically 0.6-0.7 m, although absolute fluctuations could be as much as 1.3 m. The proposed plan provides an operating range of 0.91 m under normal operating conditions.
Summer Water Level (June 1 to Sept 15)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	279.74 279.43 278.52 278.06 None None None	Upper NOZ 279.43 278.52 Lower NOZ None 110.8 3	
Fall Water Level (Sept 16 to Nov 30)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	279.74 279.43 278.52 278.06 None None None	Upper NOZ 279.43 278.52 Lower NOZ None 110.8 3	
Winter Water Level (Dec 1 to March 15)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	279.74 279.43 278.52 278.06 None None None	Upper NOZ 279.43 278.52 Lower NOZ None 110.8 3	
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	13.34 m^3/s annual average (for power) 7.91 m^3/s 29.53 m^3/s 1.57 m^3/s 93.15 m^3/s 3.26 m^3/s 1.66 m^3/s	13.48 m^3/s annual average (for power) 8.88 m^3/s 29.48 m^3/s 3.12 m^3/s 101.38 m^3/s 3.34 m^3/s 3.18 m^3/s	Consistent summer, fall and winter minimum flow (3 m^3/s) to maintain social and ecological habitat values in the South Branch. Some redistribution of flow from the winter to the summer season to enhance summer base flows.

Trethewey GS



a) Existing Operating Plan and Historical Water Level Statistics



b) Proposed Operating Plan and Historical Water Level Statistics

Legend

- High Water Zone
- Upper Operating Zone
- Normal Operating Zone
- Lower Operating Zone
- Low Water Zone

Maximum
90 Percentile
Mean
Median
10 Percentile
Minimum

Figure 11.3.9
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Trethewey GS

Back of figure

11.3.10 Hanna Chute Generating Station and Head Pond

The proposed plan is compared to the present operating plan in the Table 11.3.10 and Figure 11.3.10. The facility is considered run-of-river, and OPG has the flooding rights within the head pond up to an elevation of 269.66 m. The facility has a very narrow NOZ (0.39 m, being from 268.5 to 268.11 m elevation), and generally remained within that narrow band as shown in Figure 11.3.10(a). Water levels do however extend beyond the NOZ elevations during high or low flow events. The absolute operating range for the facility (i.e., which, if exceeded, would either result in flooding of facilities or insufficient water to operate the generator) spans a distance of 1.95 m (268.84 m elevation to 266.89 m elevation).

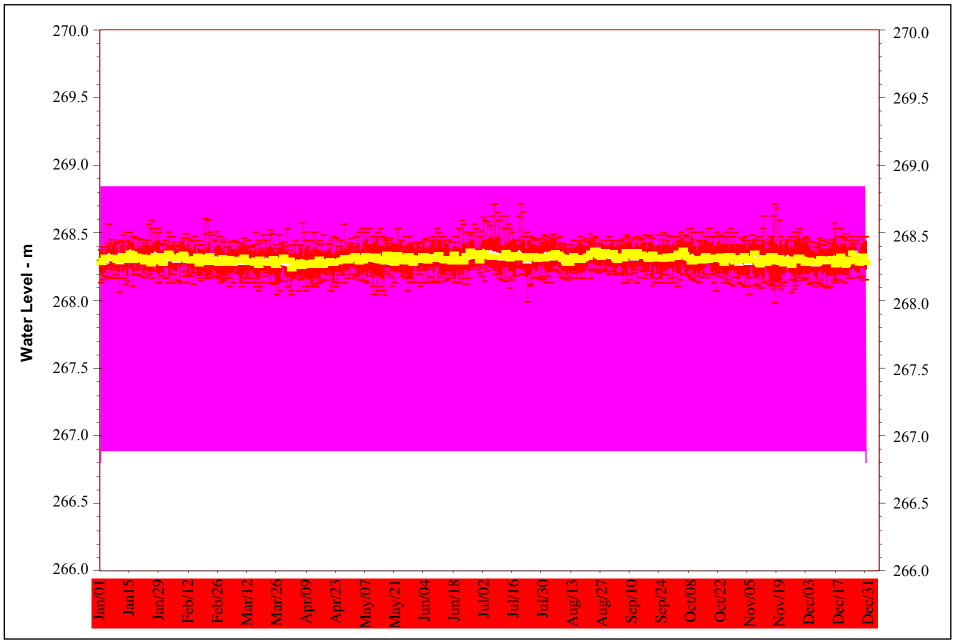
The proposed changes reduce the overall operating limits for the facility, and establish new limits that are slightly larger than the present NOZ. The new NOZ (268.11 to 268.71 m) will be considered the compliance zone for the facility (see Section 13 for definition of compliance) and will create legally enforceable upper and lower limits during normal operating conditions.

A TOL is not proposed as waterpower operators require flexibility to vary water levels in the head ponds in response to energy demands. It is anticipated that a similar number of dam operations will be required to achieve the proposed plan as is required for the present plan.

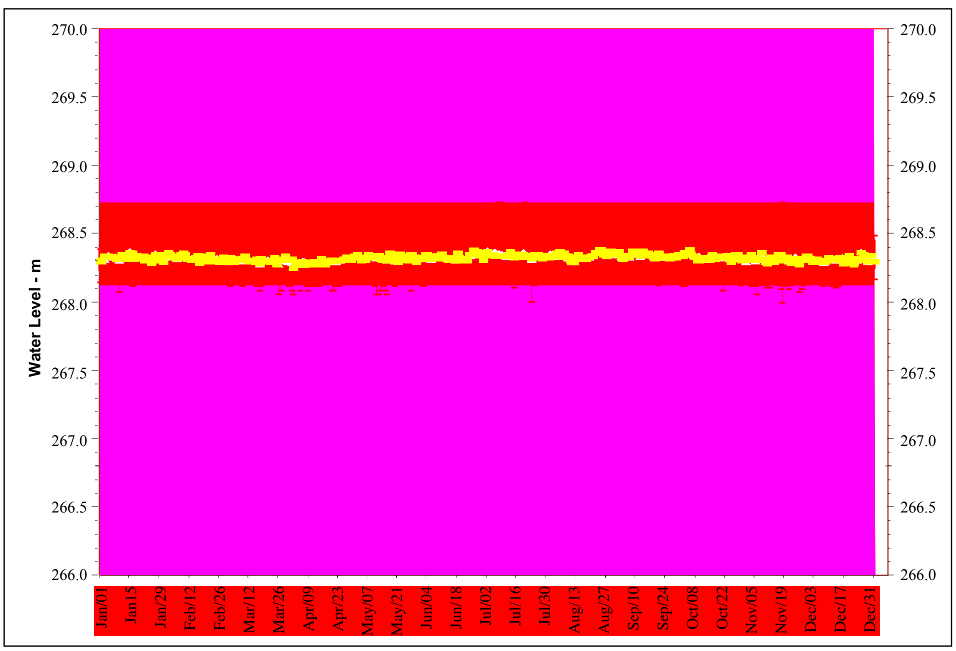
Table 11.3.10
Hanna Chute Generating Station and Head Pond

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	268.84 268.5 268.11 266.89 None None None	Upper NOZ 268.71 268.11 Lower NOZ None 112.6 3	Historical range typically within the NOZ (0.39m), but did extend beyond the upper and lower levels during exceptional flow events (floods and/or droughts). New operating range would provide a slightly larger NOZ which encompasses the historical range of water level fluctuation.
Summer Water Level (June 1 to Sept 15)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	268.84 268.5 268.11 266.89 None None None	Upper NOZ 268.71 268.11 Lower NOZ None 112.6 3	
Fall Water Level (Sept 16 to Nov 30)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	268.84 268.5 268.11 266.89 None None None	Upper NOZ 268.71 268.11 Lower NOZ None 112.6 3	
Winter Water Level (Dec 1 to March 15)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	268.84 268.5 268.11 266.89 None None None	Upper NOZ 268.71 268.11 Lower NOZ None 112.6 3	
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	14.37 m^3/s annual average (for power) 7.91 m^3/s 29.54 m^3/s 1.57 m^3/s 93.71 m^3/s 3.26 m^3/s 1.66 m^3/s	14.53 m^3/s annual average (for power) 8.99 m^3/s 29.78 m^3/s 3.13 m^3/s 103.44 m^3/s 3.38 m^3/s 3.19 m^3/s	Consistent summer, fall and winter minimum flow (3 m^3/s) to maintain social and ecological habitat values in the South Branch. Some redistribution of flow from the winter to the summer season to enhance summer base flows.

Hanna Chute GS



a) Existing Operating Plan and Historical Water Level Statistics



b) Proposed Operating Plan and Historical Water Level Statistics

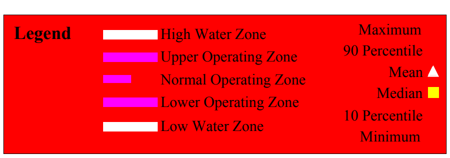


Figure 11.3.10
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Hanna Chute GS

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Back of figure

11.3.11 South Falls Generating Station and Head Pond

The proposed plan is compared to the present operating plan in the Table 11.3.11 and Figure 11.3.11. The facility is considered run-of-river, and OPG has flooding rights within the head pond up to an elevation of 259.75 m. The facility has a NOZ of 0.73 m (259.32 to 258.59 m elevation), and has remained within that band most of the time as shown in Figure 11.3.11(a). Water levels occasionally extend beyond the NOZ elevations during high or low flow events, and the absolute operating range for the facility (i.e., which, if exceeded, would either result in flooding of facilities or insufficient water to operate the generator) spans a distance of 1.56 m (259.75 m elevation to 258.19 m elevation).

The proposed changes reduce the overall operating limits for the facility, and establish new limits that are slightly larger than the present NOZ. The new NOZ will be considered the compliance zone for the facility (see Section 13 for definition of compliance) and will create legally enforceable upper and lower limits during normal operating conditions.

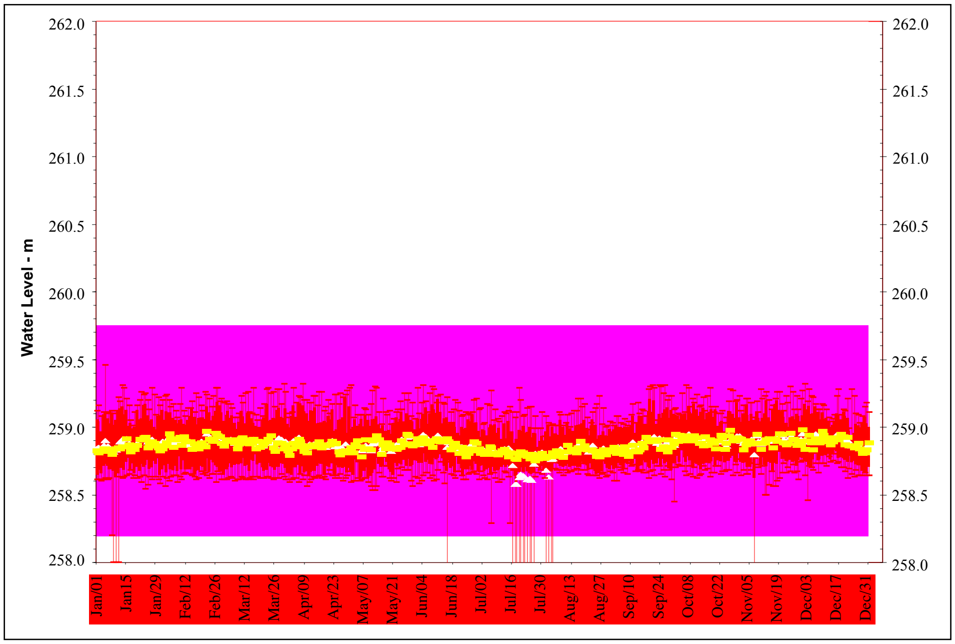
A TOL is not proposed as waterpower operators require flexibility to vary water levels in the head ponds in response to energy demands. It is anticipated that a similar number of dam operations will be required to achieve the proposed plan as is required for the present plan.

In addition, OPG has agreed to provide a minimum outflow of 3 m^3/s through the spillway at South Falls GS during the spring walleye spawning period to provide an adequate flow at the walleye spawning site adjacent to the powerhouse. MNR will provide a minimum outflow of 5 m^3/s at Baysville, and Matthias GS will provide a minimum outflow of 3 m^3/s at Matthias GS to ensure that the required volume is available at South Falls.

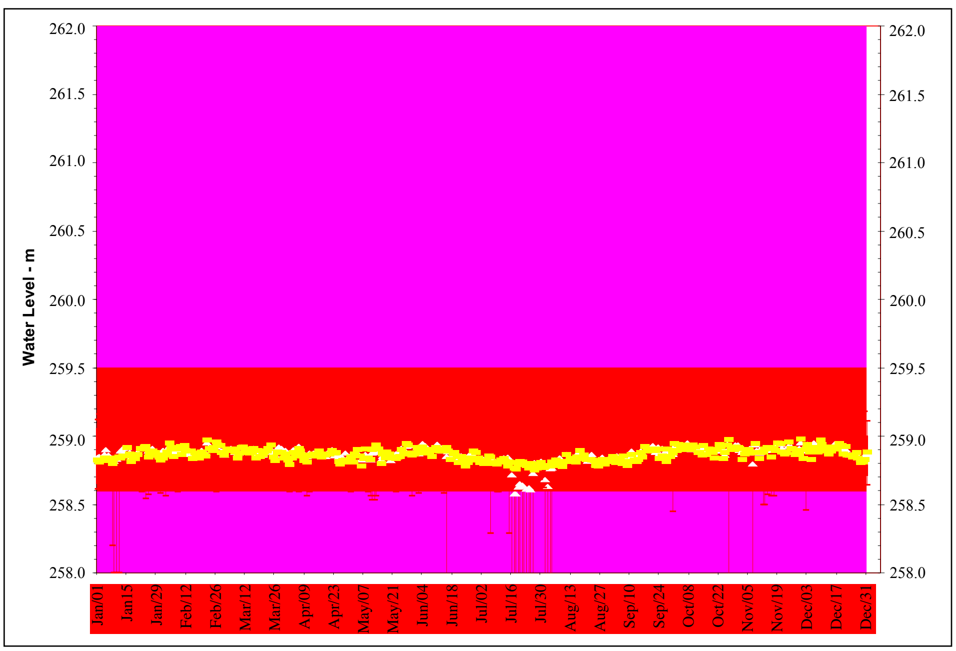
Table 11.3.11
South Falls Generating Station and Head Pond

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	259.75 259.32 258.59 258.19 None None None	Upper NOZ 259.5 258.59 Lower NOZ None 112.6 3	Historical range typically within the NOZ (0.73m), but did extend beyond the upper and lower levels during exceptional flow events (floods and/or droughts). New operating range would provide a NOZ that encompasses the historical range of water level fluctuation.
Summer Water Level (June 1 to Sept 15)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	259.75 259.32 258.59 258.19 None None None	Upper NOZ 259.5 258.59 Lower NOZ None 112.6 3	
Fall Water Level (Sept 16 to Nov 30)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	259.75 259.32 258.59 258.19 None None None	Upper NOZ 259.5 258.59 Lower NOZ None 112.6 3	
Winter Water Level (Dec 1 to March 15)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	259.75 259.32 258.59 258.19 None None None	Upper NOZ 259.5 258.59 Lower NOZ None 112.6 3	
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	13.26 m^3/s annual average (for power) 7.91 m^3/s 29.54 m^3/s 1.57 m^3/s 93.17 m^3/s 3.26 m^3/s 1.66 m^3/s	13.4 m^3/s annual average (for power) 8.99 m^3/s 29.78 m^3/s 3.13 m^3/s 103.46 m^3/s 3.38 m^3/s 3.19 m^3/s	Minimum flow of 3 m^3/s (on an hourly basis) provided through the spillway channel from April 15 to June 1(or as requested by MNR) to maintain walleye spawning site adjacent to the South Falls powerhouse. Consistent summer, fall and winter minimum flow (3 m^3/s) to maintain social and ecological habitat values in the South Branch. Some redistribution of flow from winter to summer season to enhance summer base flows.

South Falls GS



a) Existing Operating Plan and Historical Water Level Statistics



b) Proposed Operating Plan and Historical Water Level Statistics

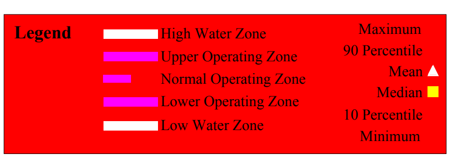


Figure 11.3.11
Muskoka River Water Management Plan

Comparison of Present and Proposed Operating Strategies - South Falls GS

Back of figure

11.4 Lower Watershed

11.4.1 Skeleton Lake

The dam at the outlet from Skeleton Lake was replaced in 2001 with an overflow weir that has limited ability to influence lake water levels. The hydrologic regime arising from the weir is very similar to one that would arise under natural conditions (i.e., if there was no control at the outlet), therefore no changes from the present rule curve are proposed. MNR is presently consulting with lake stakeholders and reviewing dam operations to determine whether the weir meets the objectives for water management for the lake. Table 11.4.1 and Figure 11.4.1 provide the existing conditions.

Table 11.4.1 Skeleton Lake			
Component	**Operating Characteristics**	**Present Plan**	**Comments**
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	280.90 280.65 – 280.4 270.75 – 280.5 0.25 Down	Flood damage zone starts at 281.0 m on lake.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	280.87 – 280.75 280.68 – 280.5 280.7 – 280.6 0.1 Down	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	280.75 280.50 280.60 0	
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	280.75 – 280.65 280.5 – 280.4 280.6 – 280.5 0.1 Down	
Downstream River Reach and Lake Outflow Characteristics	Planned flow release	0.4 m^3/s summer, reduced to 0.2 m^3/s during drought conditions. Spring outflow below 3.8 m^3/s to minimize downstream flooding.	Minimum flow provided to maintain downstream water quality

Skeleton Lake

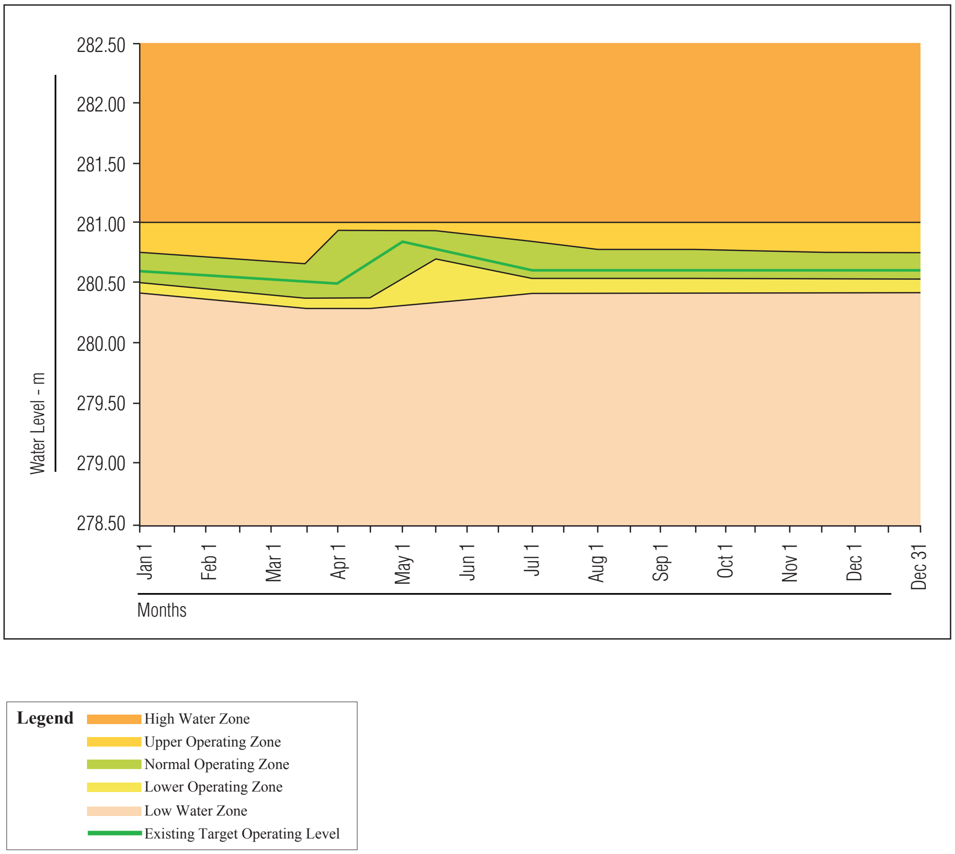


Figure 11.4.1
Muskoka River Water Management Plan
Present Operating Strategy - Skeleton Lake

Back of figure

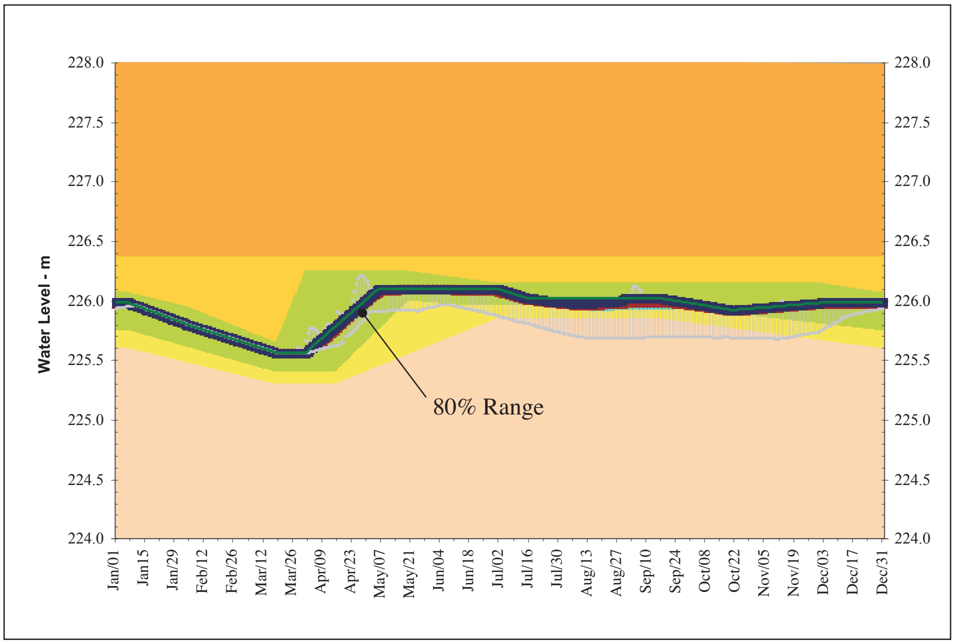
11.4.2 Lakes Rosseau and Joseph

The proposed plan is compared to the present operating plan in Table 11.4.2 and Figure 11.4.2. The proposed changes for this lake were accommodated within the limits of the present NOZ. It is anticipated that a similar number of dam operations will be required to achieve the proposed water levels and flow regime.

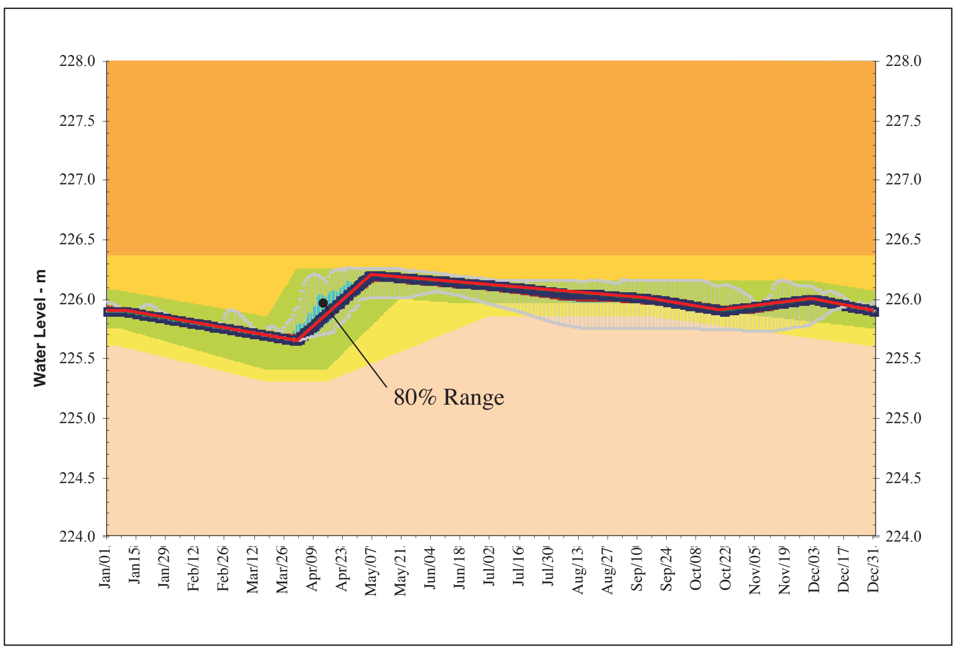
Table 11.4.2
Lakes Rosseau and Joseph

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date* TOL Change WL Direction	226.25 225.4 – 226.0 226.12 – 226.1 May 7 0.02 Down	226.25 225.4 – 226.0 226.2 – 226.15 May 7 0.05 Down	A slightly higher (0.08 m) target spring water level, followed by a gradual summer drawdown to a similar end of summer target elevation.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	226.25 – 226.15 226.0 – 225.96 226.1 – 226.02 0.08 Down	226.25 – 226.15 226.0 – 225.96 226.15 – 226.0 0.15 Down	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	226.15 225.96 – 225.8 226.02 – 225.92 0.1 Down, then natural rise to 225.98	226.15 225.96 – 225.8 226.0 – 225.9 0.1 Down, then natural rise to 226.0	Similar fall drawdown on October 15 for lake trout spawning, followed by a natural rise to the same December 1 elevation prior to the winter drawdown.
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	226.15 – 225.65 225.8 – 225.4 225.98 – 225.46 0.52 Down	226.15 – 225.65 225.8 – 225.4 226.0 – 225.65 0.35 Down	Slow decline in over-winter level to a 0.19 m higher target winter elevation.
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	0.7 m^3/s summer, 0.52 m, Dec 1 to Mar 15 4.22 m^3/s 13.94 m^3/s 0.53 m^3/s 83.08 m^3/s 0.45 m^3/s 0.45 m^3/s	1 m^3/s summer, 0.35 m, Dec 1 to Mar 15 5.56 m^3/s 12.03 m^3/s 1.05 m^3/s 64.8 m^3/s 0.7 m^3/s 0.7 m^3/s	Slightly higher summer outflow, lower winter outflow, and marginally more base flow.

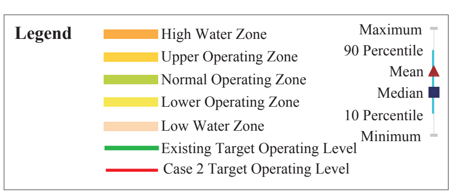
Lakes Rosseau & Joseph



a) Existing Operating Plan and Water Level Statistics *



b) Proposed Operating Plan and Water Level Statistics *



* Derived from ARSP Model

Figure 11.4.2
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Lakes Rosseau and Joseph

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Back of figure

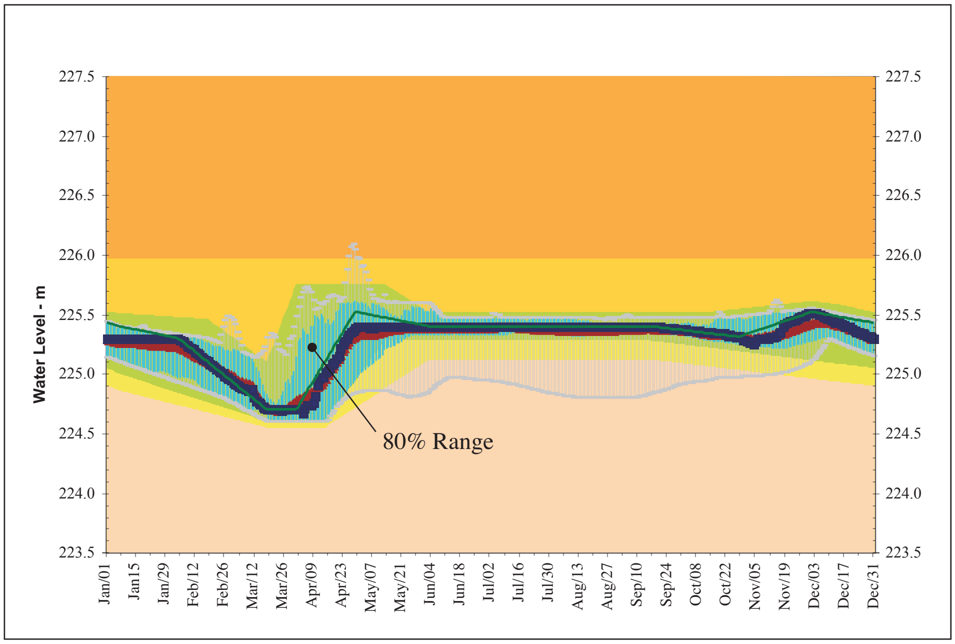
11.4.3 Lake Muskoka

The proposed plan is compared to the present operating plan in Table 11.4.3 and Figure 11.4.3. The proposed plan decreases the extent of the TOL, as well as the lower limit of the NOZ for the fall period. It is anticipated that a similar number of dam operations will be required to achieve the proposed water levels and flow regime.

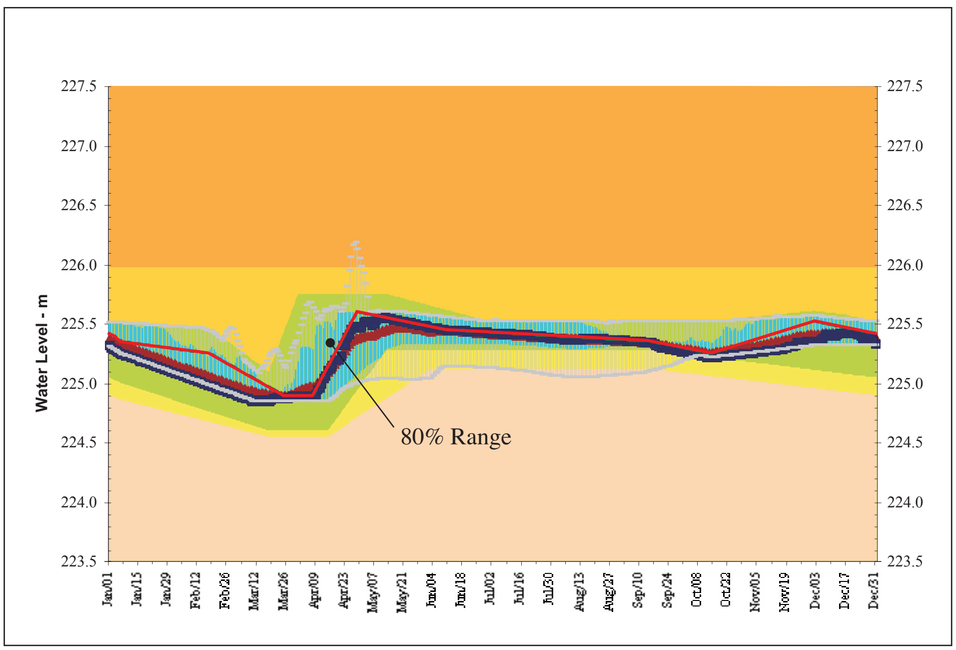
Table 11.4.3
Lake Muskoka

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date* TOL Change WL Direction	225.75 224.6 – 225.28 225.52 – 225.4 April 29 0.12 Down	225.75 224.6 – 225.28 225.6 – 225.48 May 1 0.12 Down	A slightly higher spring high water level, followed by a gradual summer drawdown to a target elevation approximately 0.05 m lower.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	225.75 – 225.52 225.28 225.4 0 -	225.75 – 225.52 225.28 225.48 – 225.35 0.13 Down	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	225.52 – 225.61 225.28 – 225.12 225.4 – 225.31 0.09 Down, then natural rise to 225.52 by Dec 1	225.52 – 225.61 225.28 – 225.12 225.35 – 225.25 0.1 Down, then natural rise to 225.52 by Dec 1	Drawdown to 0.06 m lower October 15 level for lake trout spawning; followed by a natural rise to the same December 1 elevation prior to the winter drawdown.
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	225.61 – 225.1 225.12 – 224.6 225.52 – 224.7 0.82 Down	225.61 – 225.1 225.12 – 224.6 225.52 – 224.9 0.62 Down	Slow decline in over-winter level to slightly higher (0.2 m) winter target elevation.
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	6 m^3/s summer, 0.82 m, Dec 1 to Mar 15 29.66 m^3/s 84.84 m^3/s 7.34 m^3/s 299.79 m^3/s 5.0 m^3/s 3.0 m^3/s	6 m^3/s summer, 0.62 m, Dec 1 to Mar 15 31.25 m^3/s 88.08 m^3/s 10.16 m^3/s 309.57 m^3/s 7.78 m^3/s 3.0 m^3/s	Higher summer flow, slightly more fall drawdown (September 15 to October 15) and less winter drawdown.

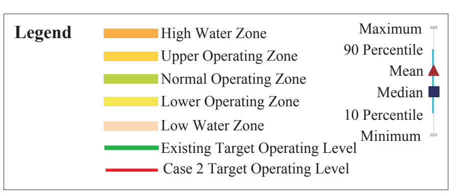
Lake Muskoka / Burgess GS



a) Existing Operating Plan and Water Level Statistics *



b) Proposed Operating Plan and Water Level Statistics *



* Derived from ARSP Model

Figure 11.4.3
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Lake Muskoka

Back of figure

11.4.4 Burgess Generating Station

No changes are proposed to the operating plan for this facility. The facility is located on Lake Muskoka adjacent to the MNR controlled Bala North and Bala South dams, and provides a flow of 0.5 to 4 m^3/s into Bala Reach. The facility is advised (by MNR) when there is sufficient water to operate, and when it must shut down (typically when both Bala North and Bala South dams are closed and water levels on Lake Muskoka are falling below the NOZ). The facility will cease operations within 24 hrs of the notification by MNR to shut down.

The upper and lower limits are typically the NOZ of Lake Muskoka, but these are not a compliance zone for the facility. As outflow from Lake Muskoka increases, flow is sequentially allocated to Burgess GS, then Bala South and lastly Bala North dam. Under declining flows, the priority of flow sequence is reversed.

Burgess Generating Station				
Component	**Operating Characteristics**	**Present Plan**	**Proposed Plan**	**Comments**
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) Peak Date*	225.75 224.6 – 225.28	225.75 224.6 – 225.28	Operating range is the same as that of Lake Muskoka. No change is proposed. Facility will shut down at MNR's request if insufficient flow is available in the system.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	225.75 – 225.52 225.28	225.75 – 225.52 225.28	
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	225.52 – 225.61 225.28 – 225.12	225.52 – 225.61 225.28 – 225.12	
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	225.61 – 225.1 225.12 – 224.6	225.61 – 225.1 225.12 – 224.6	
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	4.0 m^3/s annual average (for power) 4.0 m^3/s 4.0 m^3/s 2.23 m^3/s 4.0 m^3/s 0 m^3/s 0 m^3/s	4.0 m^3/s annual average (for power) 4.0 m^3/s 4.0 m^3/s 2.62 m^3/s 4.0 m^3/s 0 m^3/s 0 m^3/s	Consistent spring, summer, fall and winter flow when Lake Muskoka water levels are within the desired levels. During low flow periods, Burgess GS will be shut down (as per MNR's request) to allow MNR to assume control of Lake Muskoka levels and outflows.

11.4.5 Bala Reach, Ragged Rapids GS and Moon Dam

The proposed operating plan for Bala Reach is presented in Table 11.4.4 and Figure 11.4.4. Levels on Bala Reach are affected by both the operation of the upstream Bala dams, and the operation of the downstream waterpower facility (Ragged Rapids) and control dam (Moon Dam). Water level management is further complicated by the action of Moon Chutes (a natural constriction at the downstream end of Bala Reach) which restricts water passage out of Bala Reach at river flows above approximately 85 m^3/s. Water level management in Bala Reach is a joint effort between MNR and OPG, as MNR controls input into the reach, while the Moon Chutes and OPG control outflow from the reach.

During high flow events (>100 m^3/s), high water levels are a common occurrence in Bala Reach due to the constriction at Moon Chutes. Under these conditions, water levels in Bala Reach are typically inversely correlated with Ragged Rapids water levels, as the Moon Dam is opened to pass excess flow down the Moon River (see Figures 11.4.4a and b). This in turn lowers the Ragged Rapids head-pond level, although the constriction at Moon Chutes reduces the effectiveness of these actions as flows progressively exceed 85 m^3/s. Low levels at Ragged Rapids are utilized to “draw” water through the Moon Chutes, in order to achieve lower water levels in Bala Reach.

The present operational regime for Bala Reach includes a TOL band, a NOZ and Upper and Lower Operating Zones (see Figure 11.4.4a). The summer TOL band was revised in 2003 as a result of discussions between OPG and the Moon River Cottage Owners Association. As a result, the summer (June 1 to October 15) TOL is from 219.0 to 219.3 m, while the fall, winter and spring (June 16 to May 30) TOL remained from 219.2 to 219.5 m. The NOZ extends upward to 219.6 m during the summer period, and to 220.38 m during the remainder of the year.

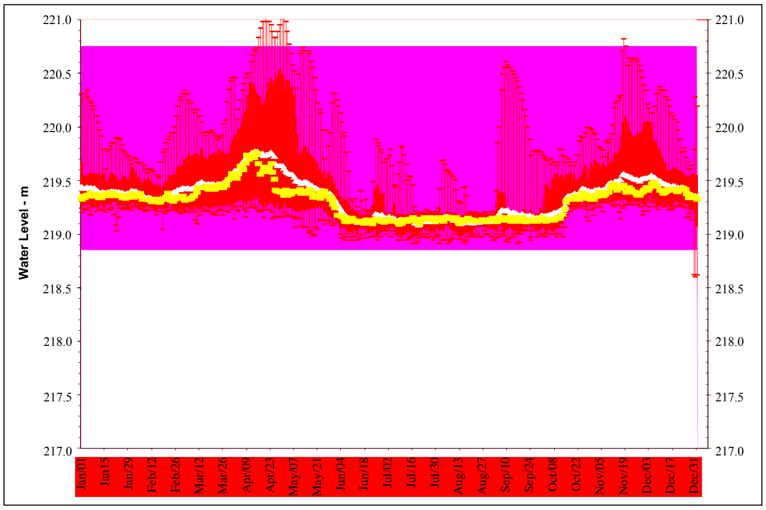
The Bala Reach TOL band (219.0 to 219.3 m from June 1 to October 15, and 219.2 to 219.5 m during the remainder of the year) will become the compliance zone (see Section 13 for definition of compliance) for the Ragged Rapids and Moon Dam facilities, and will create legally enforceable upper and lower limits during normal operating conditions.

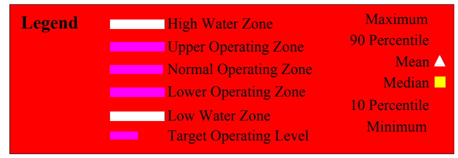
Due to the need to utilize the Ragged Rapid GS and Moon Dam to maintain Bala Reach water levels within the TOL during normal hydrologic conditions, and to try to reduce water levels in Bala Reach during extreme flow events (i.e., >85 m^3/s), no compliance zone is established for the Ragged Rapids head pond. The current operating zones for the Ragged Rapids head pond will be maintained by OPG for information, and to assist with their day-to-day operations. It is anticipated that a similar number of dam operations will be required to achieve the proposed water levels and flow regime.

Table 11.4.4
Bala Reach, Ragged Rapids Generating Station and Moon Dam

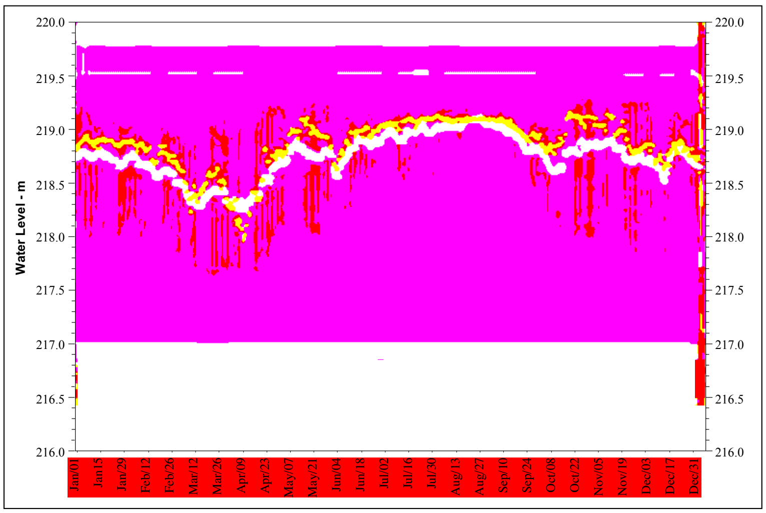
Component	Operating Characteristics (Bala Reach)	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper Limit (m) Upper NOZ (m) Upper TOL (m) Lower TOL (m) Lower NOZ (m) Lower Limit (m) HFT (m^3/s) LFT (m^3/s)	220.74 220.38 219.5 219.2 219.2 218.85 None None	Upper TOL Upper TOL 219.5 219.2 Lower TOL Lower TOL 85 6	Ragged Rapids head pond is actively used to decrease Bala Reach water levels during high flow conditions. The previous TOL band will become the compliance zone for the facility, in conjunction with a HFT that takes into account the action of Moon Chutes on flows and levels.
Summer Water Level (June 1 to Oct 15)	Upper Limit (m) Upper NOZ (m) Upper TOL (m) Lower TOL (m) Lower NOZ (m) Lower Limit (m) HFT (m^3/s) LFT (m^3/s)	220.74 219.6 219.3 219.0 219.0 218.85 None None	Upper TOL Upper TOL 219.3 219.0 Lower TOL Lower TOL 85 6	
Fall Water Level (Oct 16 to Nov 30)	Upper Limit (m) Upper NOZ (m) Upper TOL (m) Lower TOL (m) Lower NOZ (m) Lower Limit (m) HFT (m^3/s) LFT (m^3/s)	220.74 220.38 219.5 219.2 219.2 218.85 None None	Upper TOL Upper TOL 219.5 219.2 Lower TOL Lower TOL 85 6	
Winter Water Level (Dec 1 to March 15)	Upper Limit (m) Upper NOZ (m) Upper TOL (m) Lower TOL (m) Lower NOZ (m) Lower Limit (m) HFT (m^3/s) LFT (m^3/s)	220.74 220.38 219.5 219.2 219.2 218.85 None None	Upper TOL Upper TOL 219.5 219.2 Lower TOL Lower TOL 85 6	
Downstream River Reach and Lake Outflow Characteristics below Ragged Rapids	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	53.9 m^3/s annual average (for power) 27.66 m^3/s 81.41 m^3/s 0 m^3/s 92.23 m^3/s 5.03 m^3/s 0 m^3/s	54.18 m^3/s annual average (for power) 31.34 m^3/s 84.79 m^3/s 0 m^3/s 88.88 m^3/s 5.73 m^3/s 0 m^3/s	A minimum target flow of 14 m^3/s will be provided as a best management practice from April 15 to June 1 for walleye spawning at Moon Falls when flows exceed 20 m^3/s or greater. When 20 m^3/s cannot be sustained, flows may be reduced to 8 to 10 m^3/s on the Moon River and 4 to 6 m^3/s on the Musquash River. An adaptive management approach will be followed to provide a flow regime that addresses spring walleye spawning issues and Moon River habitat during other parts of the year.

Bala Reach and Ragged Rapids

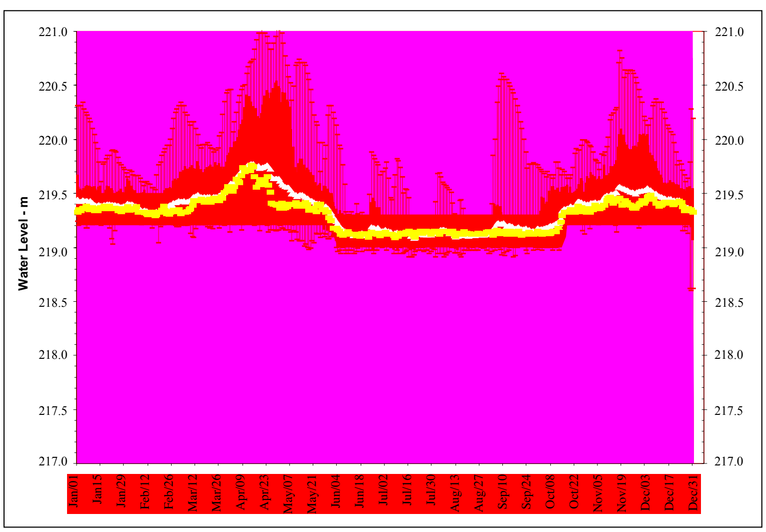




a) Existing Operating Plan and Historical Water Level Statistics - Bala Reach



b) Existing Operating Plan and Historical Water Level Statistics - Ragged Rapids



c) Proposed Operating Plan and Historical Water Level Statistics - Bala Reach

Figure 11.4.4
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Bala Reach and Ragged Rapids

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Back of figure

11.4.6 Big Eddy Generating Station and Head Pond

The proposed plan is compared to the present operating plan in Table 11.4.5 and Figure 11.4.5. The facility is considered run-of-river, and OPG has the flooding rights within the head pond to an elevation of 208.03 m. The facility has typically operates near the upper end of the NOZ, and often exceeds those elevations during high flow periods as shown in Figure 11.4.5a. The absolute operating range for the facility (i.e., which would either result in flooding of facilities or insufficient water to operate the generator) spans a distance of 1.47 m (207.82 m elevation to 206.35 m elevation).

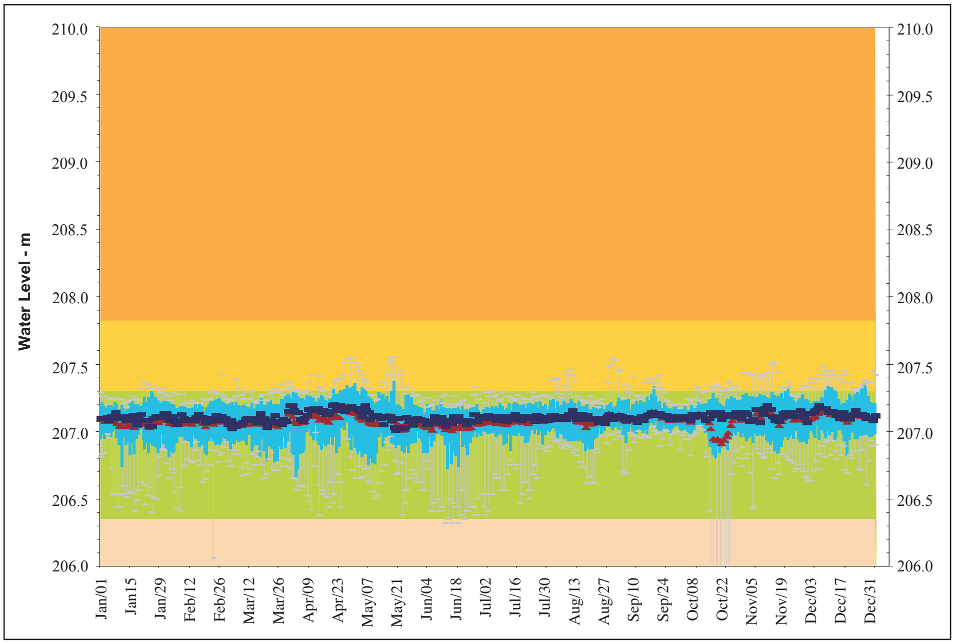
The proposed changes reduce the overall operating limits for the facility, and establish new limits that are equal to the present NOZ. The new NOZ will be considered the compliance zone for the facility (see Section 13 for definition of compliance) and will create legally enforceable upper and lower limits during normal operating conditions.

A TOL is not proposed as waterpower operators require flexibility to vary water levels in the head ponds in response to energy demands. It is anticipated that a similar number of dam operations will be required to achieve the proposed plan as is required for the present plan.

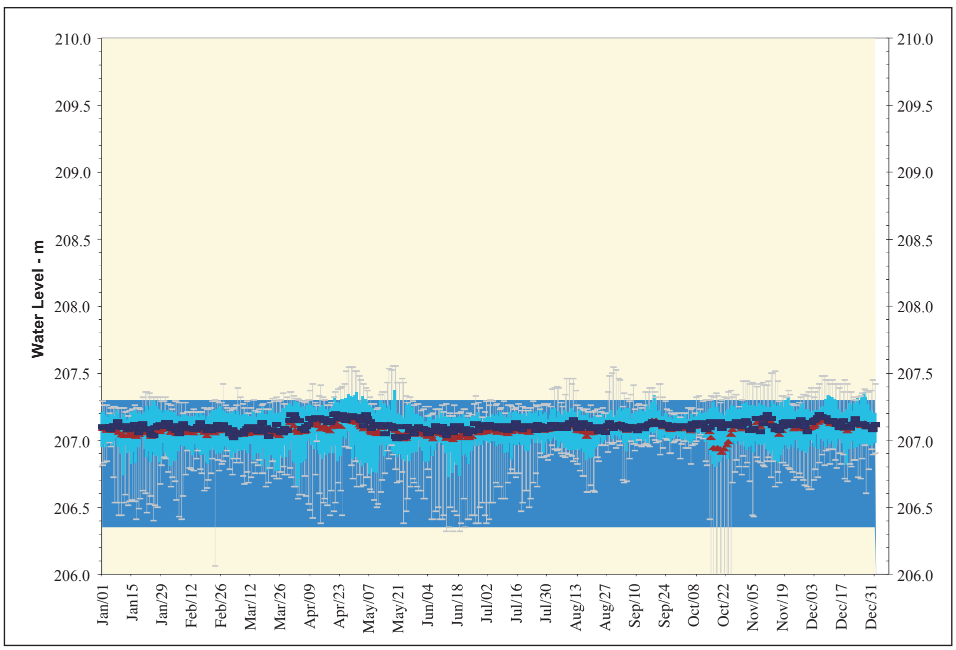
Table 11.4.5
Big Eddy Generating Station and Head Pond

Component	Operating Characteristics	Present Plan	Proposed Plan	Comments
Spring Water Level (freshet to May 30)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	207.82 207.3 206.35 206.35 None None None	Upper NOZ 207.3 206.35 Lower NOZ None 85 3	Typical historical range 0.95 m but did extend beyond the upper and lower levels during exceptional flow events (floods and/or droughts). New operating range would fix the upper and lower limits at the present NOZ.
Summer Water Level (June 1 to Sept 15)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	207.82 207.3 206.35 206.35 None None None	Upper NOZ 207.3 206.35 Lower NOZ None 85 3	
Fall Water Level (Sept 16 to Nov 30)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	207.82 207.3 206.35 206.35 None None None	Upper NOZ 207.3 206.35 Lower NOZ None 85 3	
Winter Water Level (Dec 1 to March 15)	Upper Limit (m) Upper NOZ (m) Lower NOZ (m) Lower Limit (m) TOL (m) HFT (m^3/s) LFT (m^3/s)	207.82 207.3 206.35 206.35 None None None	Upper NOZ 207.3 206.35 Lower NOZ None 85 3	
Downstream River Reach and Lake Outflow Characteristics	Planned flow release Median Wkly Flow - Summer - Winter Minimum Daily Flow (7-d average) Maximum Daily Flow (50-yr average) 7Q2 (2-yr min) 7Q10 (10-yr min)	54.14 m^3/s annual average (for power) 27.76 m^3/s 81.73 m^3/s 0.03 m^3/s 93.6 m^3/s 5.05 m^3/s 0.16 m^3/s	54.45 m^3/s annual average (for power) 31.41 m^3/s 85.8 m^3/s 0.03 m^3/s 90.29 m^3/s 5.83 m^3/s 0.19 m^3/s	Water level fluctuations in Go Home Lake resulting from Big Eddy flow releases to be addressed by installation of automated flap gate in Go Home Lake dam.

Big Eddy GS



a) Existing Operating Plan and Historical Water Level Statistics



b) Proposed Operating Plan and Historical Water Level Statistics

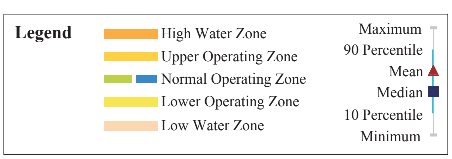


Figure 11.4.5
Muskoka River Water Management Plan
Comparison of Present and Proposed Operating Strategies - Big Eddy GS

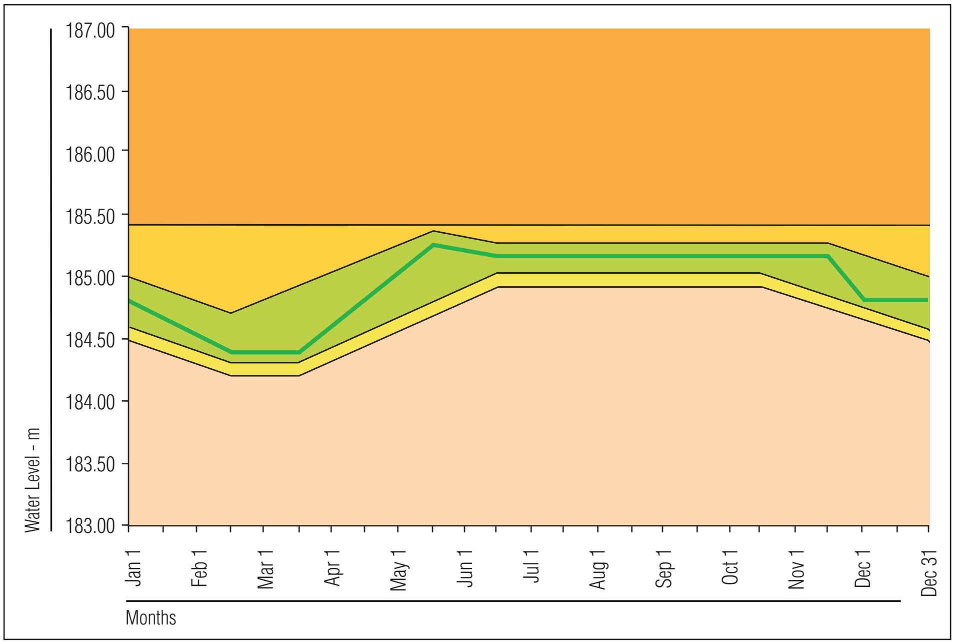
Back of figure

11.4.7 Go Home Lake

No changes to the operation of Go Home Lake dam are proposed as part of this WMP. A remotely operated sluice gate is to be installed in the Go Home Lake dam to address short-term water level fluctuations in the lake as a result of upstream waterpower operations. Sensors will be used to monitor lake levels and activate gate operations accordingly so as to mitigate large water level changes. Table 11.4.6 and Figure 11.4.6 provide the existing operating conditions for the lake. Comments from the Go Home Lake Cottage Owners Association in the Draft Plan are also provided in Table 11.4.6.

Table 11.4.6 Go Home Lake			
Component	**Operating Characteristics**	**Present Plan**	**Comments**
Spring Water Level (freshet to May 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	185.05 – 185.4 184.43 – 184.93 184.63 – 185.24 0.61 Up	Flood damage zone starts at 281.0 m on lake.
Summer Water Level (June 1 to Sept 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change WL Direction	185.3 185.05 185.18 0 -	Remotely operated gate proposed to reduce short-term lake level fluctuations.
Fall Water Level (Sept 16 to Nov 30)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	185.3 185.05 – 184.87 185.18 0 -	
Winter Water Level (Dec 1 to March 15)	Upper NOZ (m) Lower NOZ (m) TOL (m) TOL Change (m) WL Direction	185.2 – 184.7 184.78 – 184.3 184.8 – 184.4 0.4 Down	
Downstream River Reach and Lake Outflow Characteristics	Planned flow release - Control Dam - Filter Dam	As required to match OPG facility outflows. 1.4 m^3/s seepage through dam	
Draft Plan Comments			
Water Levels and Dam Operation	"…appear that the operating plan proposed will have little effect on Go Home Lake." "…recognize that the improved regulation of flows upstream may in fact help reduce the fluctuations in water levels that we experience. The draft plan identifies the proposed automation of one sluiceway, at the outfall of our lake, but does not include the fact that the Ministry does not have the funds to proceed with this work and are currently reevaluating this project. We ask that more emphasis be put on the need for this improvement in the plan so that this project may proceed in the near future." "This dam is part of the Muskoka River system and therefore should be entrenched in the overall plan."		MNR and industry partners in the WMP welcome the comments of the Go Home Lake Cottage Owners Association and will keep them apprised of progress toward the installation of a remotely operated gate at the Go Home Lake control dam.

Go Home Lake



Legend

- High Water Zone
- Upper Operating Zone
- Normal Operating Zone
- Lower Operating Zone
- Low Water Zone
- Existing Target Operating Level

Figure 11.4.6
Muskoka River Water Management Plan
Present Operating Strategy - Go Home Lake

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12 Operating Plans

The following section provides the detailed operating plans which identify flow and level compliance requirements for the individual control structures on the Muskoka River system. For each structure, the operating plan is provided in descriptive and graphic format. The manner in which each operating plan meets objectives and considerations is noted. Public comments are summarized and the manner in which the plan addresses those comments is noted. Additional detail pertaining to public consultation is contained in Appendix D. Operating plans for watershed lakes/reservoirs and waterpower facilities are presented sequentially, commencing at the upstream limit of each subwatershed and proceeding downstream, beginning at the North branch subwatershed, then the South Branch and finally the Lower sub-watershed.

Flood and Drought Definitions

Definition of a Flood Situation and Terminology – Within a lake or river system, a flood situation is typically defined by a specific elevation, beyond which, some level of damage (to persons, property or infrastructure) is known to occur. Within the Muskoka River system, historical information has been incorporated into the current operating plans for the various MNR controlled lakes, such that an elevation has been identified as the beginning of this zone. While similar information is not available for river reaches to define the specific 'water level' at which damage may start to occur, historical 'flow levels' which have resulted in damage and or complaints have been integrated into the current operating plans. The term used to describe either the 'lake level' or the river 'flow level', beyond which damage may start to occur, is the High Water Zone (HWZ).

Within the following section and this WMP, the term 'Flood Allowance' is used to define the distance within the MNR controlled lakes between the top of the NOZ and the beginning of the HWZ. For downstream river reaches (below those structures), the term also refers to the flow volume at the beginning of the HWZ (as identified in MNR's Muskoka River Dam Operations Manual).

For waterpower facilities, this WMP will establish fixed operating limits (in terms of head-pond levels) under normal operating conditions. However, these facilities are located on river sections, have no direct control over the operation of dams on upstream lakes, and have limited ability to control head pond elevations during high flow situations. Additionally, if they are operated to discharge the maximum discharge possible downstream flooding with occur. Accordingly, a High Flow Trigger (HFT) has been established for each power generating facility, which represents the maximum discharge possible while minimizing downstream flood damages. Therefore as outlined in Section 13.3 at discharge flows above the HFT the High Water Indicator will be met and operators will not be considered to be out of compliance with the water level requirements of the WMP. Under those circumstances, waterpower facility operators will coordinate their operations with MNR facilities to address the situation. Flood messages, as defined by the Provincial Flood Forecasting and Warning Committee, would be issued by MNR as appropriate, depending on the severity of the event.

Flooding is not a concern within the watershed during an average spring with slow snowmelt spread out over a 2 to 3 week period. However, a sudden melt, alone or in combination with significant rainfall, can increase the potential for flooding. As such, the present operating plans for the MNR controlled lakes included provisions to lower the March drawdown level beyond the Target Operating Level should conditions within the watershed indicate that there is a higher than normal risk of spring flooding associated with above normal snow pack water content, high temperatures and/or spring rainfall. In order to maintain this capacity to respond to the risk of a spring flood under these circumstances, the following provisions are incorporated into the new operating plans:

1 - If snow pack water content is >25% above normal on March 15 on the North Branch of the Muskoka River, lakes controlled by MNR will be lowered to the bottom of the NOZ.

2 - If snow pack water content is >50% above normal on March 15 on the South Branch of the Muskoka River, lakes controlled by MNR will be lowered to the bottom of the NOZ.

3 - If snow pack water content is >100% above normal on April 1 on both branches of the Muskoka River, lakes controlled by MNR will be lowered to the bottom of the LOZ.

Should the above-noted conditions occur, MNR will take snow courses on a weekly basis after March 15 to monitor/evaluate the potential for the development of abnormal hydrologic conditions and assist in the development of an appropriate course of action.

Similarly, frequent rain and/or high temperatures and/or frozen ground can contribute to abnormal runoff and/or flow events. The following additional provisions apply under those conditions:

1 - On unfrozen ground, with 25 mm of rain in 1 day or 50 mm rainfall over several days and/or >10°C during the day for more than 2 days or above 0°C overnight for more than 2 days, lakes controlled by MNR will be lowered to the bottom of the NOZ.

2 - On frozen ground, with 25 mm of rain in 1 day or 25 mm rainfall over several days and/or >10°C during the day for more than 2 days or above 0°C overnight for more than 2 days, lakes controlled by MNR will be lowered to the bottom of the NOZ.

Definition of a Drought Situation and Terminology – A provincial "Ontario Low Water Response" procedure has been developed to allow provincial agencies that have specific roles and responsibilities related to water management to undertake a coordinated response to a drought situation (MNR et al, 2003). Three levels of drought are identified within that document, each with specific characteristics and level of response, ranging from conservation, to conservation and restriction on non-essential use, to conservation, restriction and regulation of all uses. Those procedures will remain in effect and will apply to the Muskoka River system should the appropriate conditions develop.

Section 13.3 identifies low water conditions where operators will not be considered to be out of compliance with the plan if they operate outside of the NOZ. Low Flow Triggers (LFT) have been defined which represent flows below which facilities may have difficulty maintaining water levels due to leakage, infiltration and evaporation. Under those circumstances, waterpower facility operators will coordinate their operations with MNR facilities to address the situation.

Similarly, the provision of adequate flow for walleye spawning on the South Branch below OPG's South Falls facility has been based on historical flow data and the ability to manipulate upstream lakes during the walleye spawning/

incubation period (approximately April 15 to June 1, as determined by MNR based on actual site temperatures) to provide the required quantity of flow (5 m^3/s from Baysville dam, which provides 3 m^3/s below Matthias GS and 3 m^3/s in the South Falls bypass/walleye spawning channel on an hourly basis). Should those values not be attainable in the future (e.g., due to extreme low water conditions, perhaps as a result of climate change), MNR, OPGC and OPG will cooperate to develop a response to this situation.

12.1 North Branch Muskoka River

12.1.1 McCraney Lake

The operating plan for McCraney Lake is shown in Figure 12.1.1, and has the following characteristics:

Target Operating Level Range:	444.2 to 445.2 m
Normal Operating Zone Range:	444.0 to 445.5 m
Absolute Range:	443.5 to 445.6 m
Summer* Range (Typical):	445.3 to 443.45 m
Winter Drawdown:	None
Flood Allowance (lake/river):	445.5 to 445.6 m/none
Maximum Daily Flow:**	4.6 m^3/s
Minimum Daily Flow*:**	0.5 m^3/s target
Natural Environment Constraints:	Base flow in downstream reach for ecological improvement. Cold-water lake with naturally reproducing lake trout population. Shoal locations unknown.
Social Constraints:	Minimum lake level of 444.2 during summer recreation season for canoe access to upstream lakes
Other:	None

* Summer period defined as June 1 to September 15.
** 50-year average.
***7-day average.

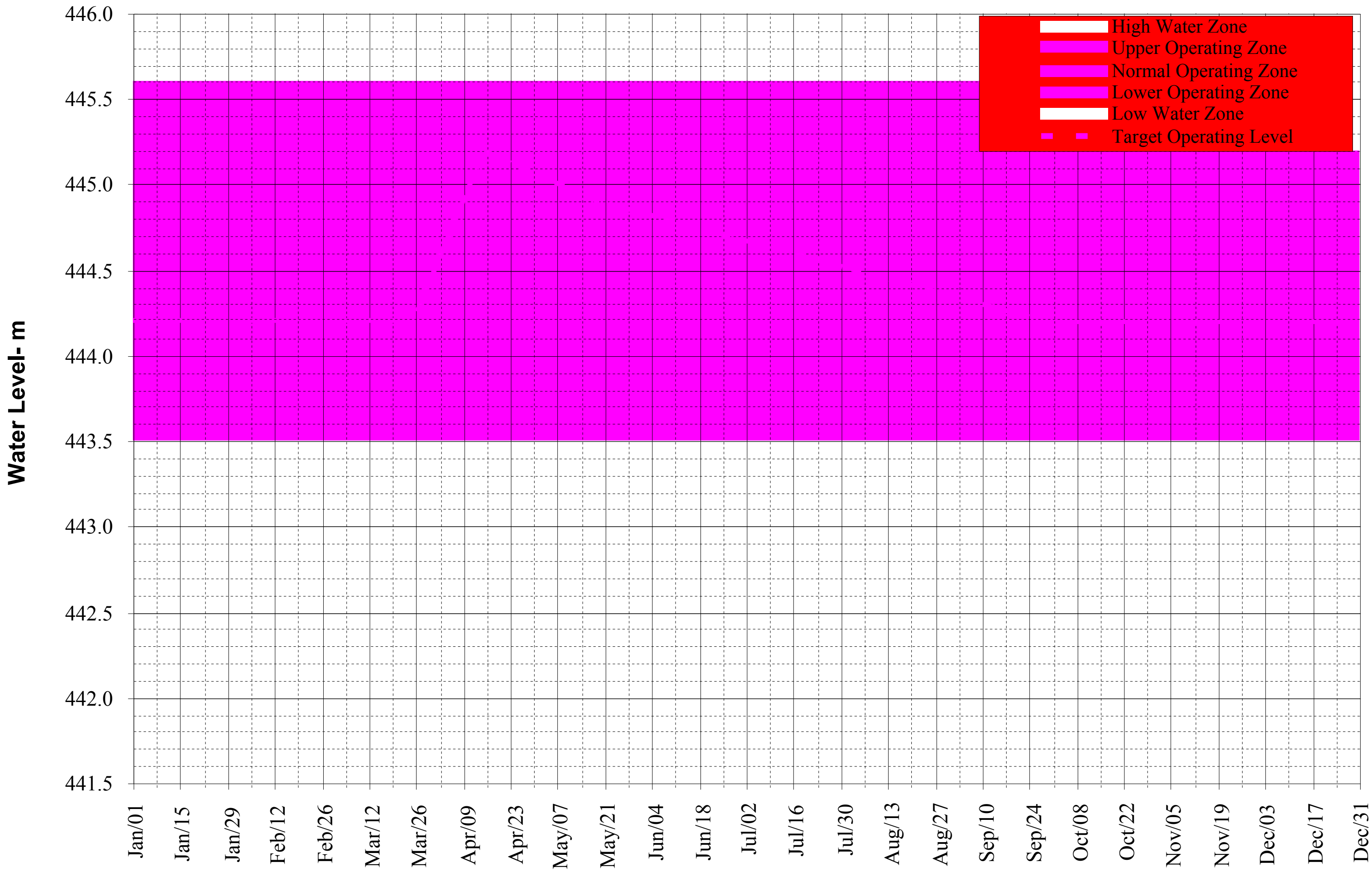

Figure 12.1.1
Muskoka River Water Management Plan
McCraney Lake Operating Plan

Back of figure

Benefits and Resolution of Issues

- The elimination of the previous late summer draw down of 2 to 3 m is expected to provide a number of fisheries and ecological benefits within the lake ecosystem, including
  - improved littoral zone communities (not subjected to late summer dewatering and/or winter freezing/ice scour when the lake did not refill before the onset of winter)
  - improved upper riparian zone due to less annual variability in spring water levels
  - improved lake trout habitat due to higher and more stable fall water levels (stable late summer/early fall water levels will allow spawning areas to be subjected to cleansing wave action, and increase potential for egg survival/future recruitment)
- The operating plan closely simulates a natural flow regime, which meets the objectives of MNR's water management planning guidelines and Algonquin Parks management policies.
- The maintenance of a consistent outflow from the lake will improve habitat conditions in the reach immediately below the dam (by eliminating the cessation of flow in late October when the valve is closed after the drawdown is complete) including the maintenance of a base flow in the Big East River.
- Less variable water level will improve Algonquin Park canoe route access to Rain and Sawyer lakes, especially during late August and early September.
- The operating plan is expected to reduce operational visits (dam can be set to self-regulate) and expenditures in the long term.

Conflicts

- Eliminating the late summer/early fall drawdown eliminates this seasonal source of flow for the Big East River, and could affect late summer navigation (i.e., canoeing).
- Eliminating the late summer/early fall drawdown reduces the outflow from the lake and the water available in the North Branch for waterpower generation at this time of the year.

Public Comments

None

Information and Science Needs

- Baseline information is required on the ecology of the reach immediately below the dam (benthic and/or fish community to use as indicator of change)
- Baseline information on brook trout populations and associated habitat below the dam and in the upper portions of the Big East River.

12.1.2 Camp Lake – MNR

The operating plan for Camp Lake is shown in Figure 12.1.2, and has the following characteristics:

Target Operating Level Range:	412.15 to 412.75 m
Normal Operating Zone Range:	412.0 to 412.8 m
Absolute Range:	411.9 to 412.9 m
Summer* Range (Typical):	412.3 to 412.8 m
Winter Drawdown:	None
Flood Allowance (lake/river):	412.8 to 412.9 m/none
Maximum Daily Flow:**	2.0 m^3/s
Minimum Daily Flow*:**	0.25 m^3/s target
Natural Environment Constraints:	Cold-water lake with naturally reproducing lake trout population. Shoal locations known.
Social Constraints:	Infrastructure (fixed dock) heights range from 412.82 to 413.17 m.
Other:	None

Benefits and Resolution of Issues

- No change to NOZ during the summer and winter periods. Revised NOZ during the fall to accompany the higher fall TOL.
- The reduced fall drawdown is expected to improve lake trout habitat. Higher fall water levels will provide a larger area for spawning and improved habitat conditions in long term (spawning areas will be more susceptible to cleansing wave action, and increased potential for egg survival/future recruitment).
- The reduced fall drawdown also reduces the overall range of lake levels, and is anticipated to enhance recreational access to docks and structures, especially in the latter part of the fall season.
- The operating plan closely simulates a natural flow regime, which meets the objectives of MNR's water management planning guidelines.
- The maintenance of a consistent outflow from the lake throughout the year will improve habitat conditions in the reach immediately below the dam and into the Big East River. Reducing the magnitude of the fall drawdown

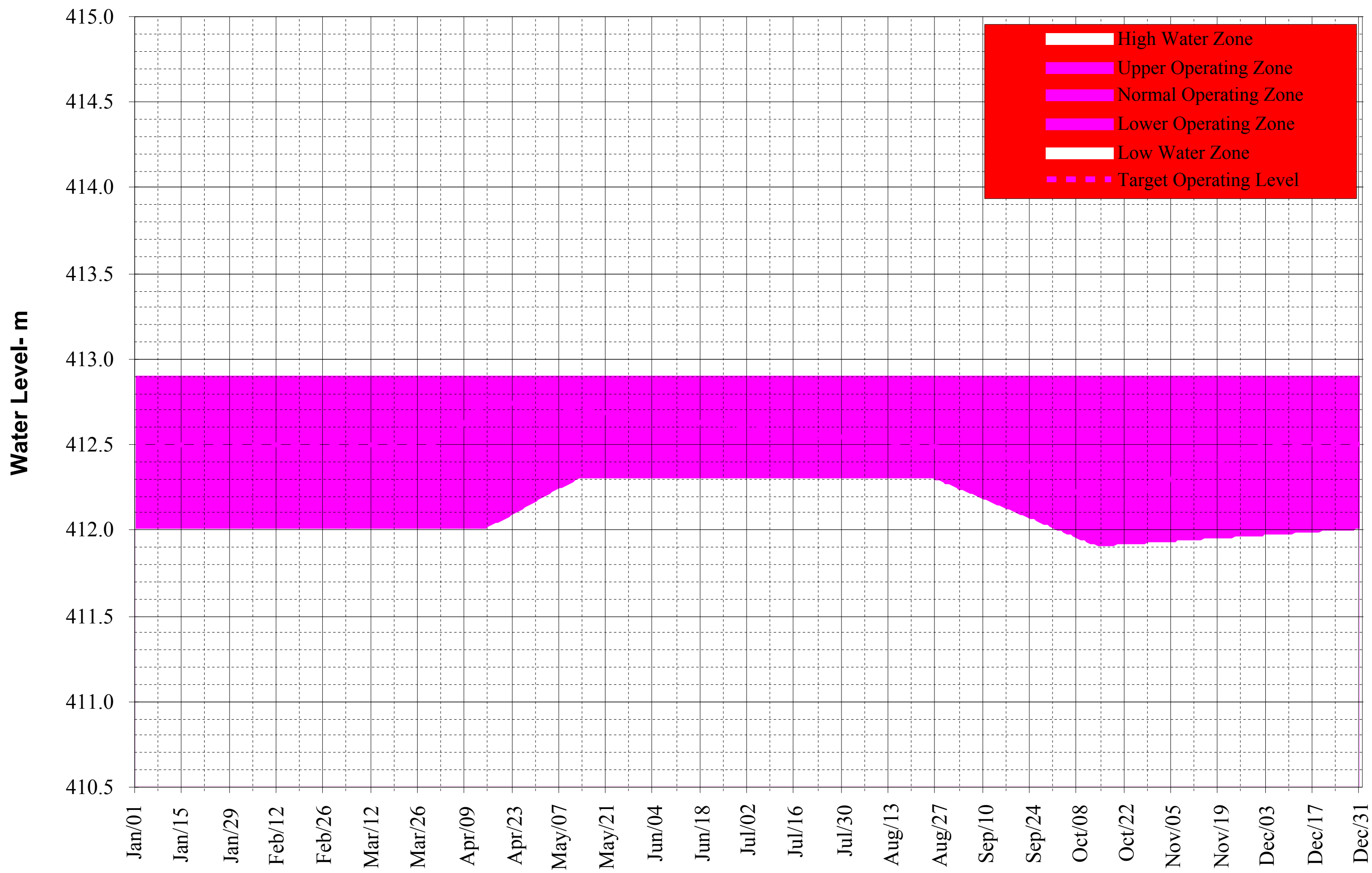

Figure 12.1.2
Muskoka River Water Management Plan
Camp Lake Operating Plan

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Back of figure

will reduce the impact of the late October-early December flow cessation as the lake refills to the winter elevation.
- The operating plan is expected to reduce operational visits and expenditures in the long term.

Conflicts
- Reducing the fall drawdown reduces this late season source of flow for the Big East River, and could affect late season navigation (i.e., canoeing).

Public Comments

None

Information and Science Needs
- Baseline information is required on the ecology of the reach immediately below the dam (benthic and/or fish community to use as indicator of change)
- Baseline information on brook trout populations and associated habitat below the dam, in Tasso Creek and in the upper portions of the Big East River.

12.1.3 Tasso Lake – MNR

The operating plan for Tasso Lake is shown in Figure 12.1.3, and has the following characteristics:

Target Operating Level Range:	398.8 to 399.6 m
Normal Operating Zone Range:	398.7 to 399.7 m
Absolute Range:	398.5 to 399.85 m
Summer* Range (Typical):	399.4 to 399.48 m
Winter Drawdown:	399.1 to 398.85 m
Flood Allowance (lake/river):	399.7 to 399.85 m/none
Maximum Daily Flow:**	5.1 m^3/s
Minimum Daily Flow*:**	0.5 m^3/s target
Natural Environment Constraints:	Base flow required in downstream reach to maintain healthy brook trout population. Cold-water lake with naturally reproducing lake trout population. Shoal locations known.
Social Constraints:	Boat access to/from South Tasso Lake through a culvert under Muskoka Road 8 to be maintained – no change in summer/early fall water levels. Infrastructure (fixed dock) heights ranged from 399.59 to 400.29 m, with many including a floating section. Overtopping of the dam would create concerns due its use as a public access road.
Other:	None.

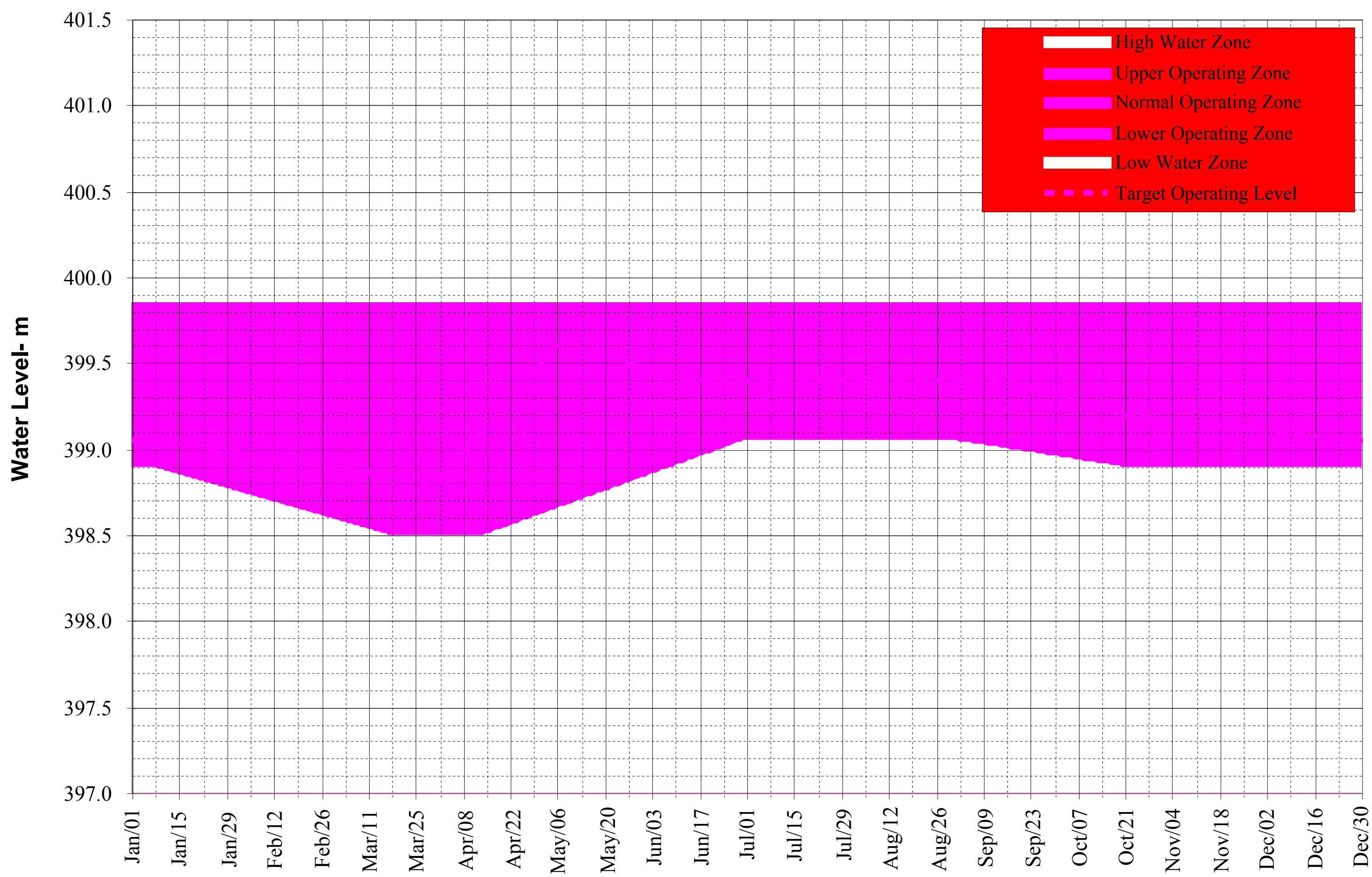

Figure 12.1.3
Muskoka River Water Management Plan
Tasso Lake Operating Plan

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Back of figure

Benefits and Resolution of Issues

- No change to NOZ.
- Slightly higher spring peak (0.2 m) and slow drawdown anticipated to improve habitat conditions for wetlands and spring spawning fish species
- Fall drawdown proceeds slowly into winter drawdown (elimination of a sharp drop) to maintain more consistent flow into downstream habitats.
- Consistent summer, fall and winter flows to maintain brook trout habitat value in Tasso Creek.

Conflicts

- Higher spring water levels enhance flooding/ice damage potential to infrastructure. However, not considered significant due to present use of floating sections combined with elevated shoreline portions.

Public Comments

None

Information and Science Needs

- Baseline information is required on the ecology of the reach immediately below the dam (benthic and/or fish community to use as indicator of change)
- Baseline information on brook trout populations and associated habitat below the dam, in Tasso Creek and in the upper portions of the Big East River.

12.1.4 Buck Lake – MNR

The operating plan for Buck Lake is shown in Figure 12.1.4, and has the following characteristics:

Target Operating Level Range:	300.3 to 301.0 m
Normal Operating Zone Range:	300.2 to 301.15 m
Absolute Range:	299.9 to 301.19 m
Summer* Range (Typical):	300.30 to 301.0 m
Winter Drawdown:	300.4 to 300.3 m
Flood Allowance (lake/river):	301.15 to 301.19 m/none
Maximum Daily Flow:**	25.6 m^3/s
Minimum Daily Flow*:**	1 m^3/s target
Natural Environment Constraints:	Shoreline erosion is a concern during high water events.
Social Constraints:	None.
Other:	None

Benefits and Resolution of Issues

- No change to NOZ. Spring water level peak approximately 2 weeks earlier to improve habitat conditions for wetlands and spring spawning fish species.
- No change to elevation of spring peak, and quicker reduction to summer TOL will address resident spring high water concerns.
- Consistent summer, fall and winter flows to maintain habitat values in Buck River downstream from the dam.

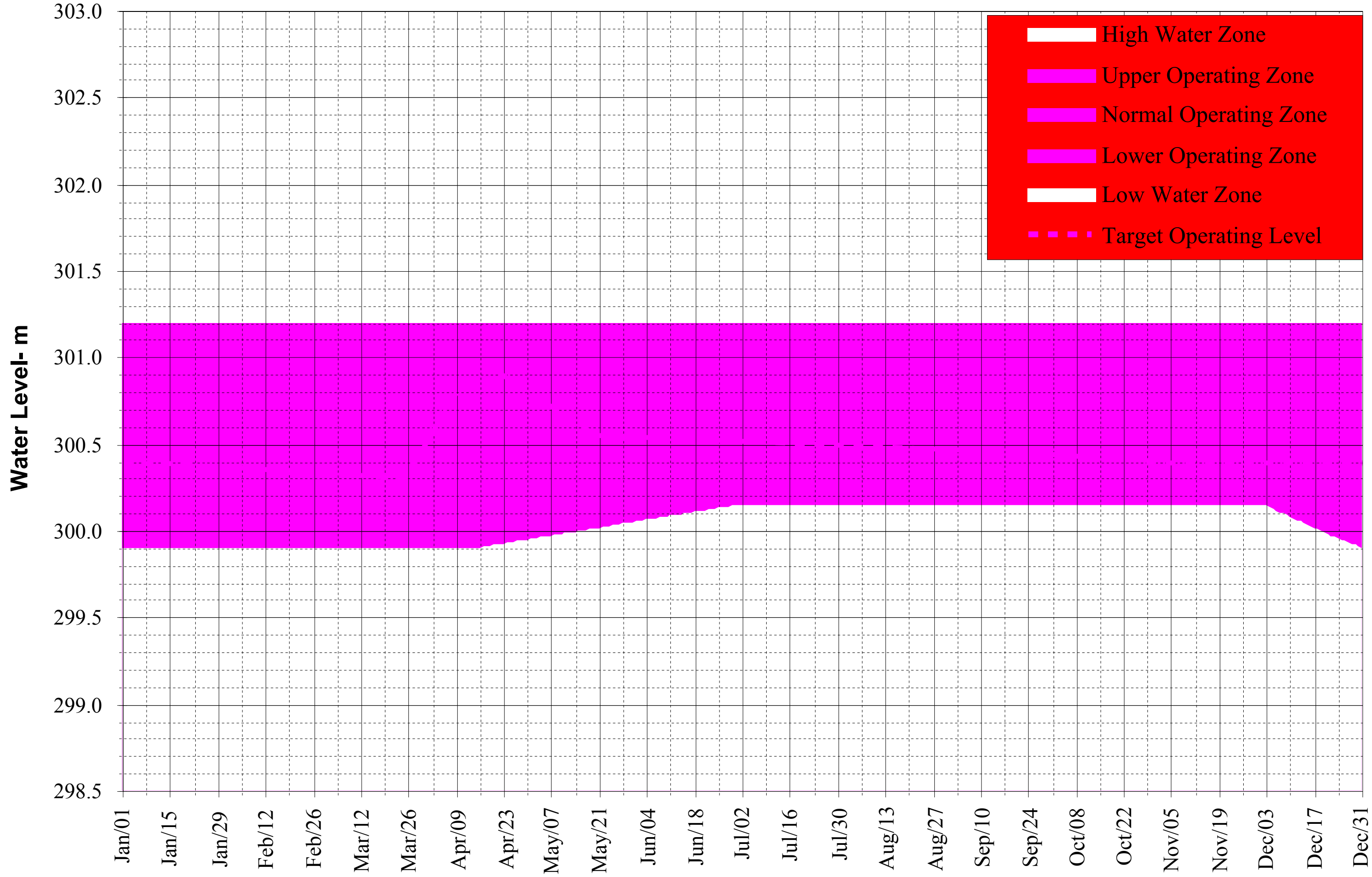

Figure 12.1.4
Muskoka River Water Management Plan
Buck Lake Operating Plan

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Conflicts

- Difficult to maintain the TOL in the spring as the lake is slow to drain (constricted outlet).

Public Comments

None

Information and Science Needs

None

12.1.5 Fox Lake – MNR

The operating plan for Fox Lake is shown in Figure 12.1.5, and has the following characteristics:

Target Operating Level Range:	294.3 to 294.6 m
Normal Operating Zone Range:	294.2 to 295.0 m
Absolute Range:	293.9 to 296.0 m
Summer* Range (Typical):	294.35 to 294.5 m
Winter Drawdown:	294.35 to 294.3 m
Flood Allowance (lake/river):	295.0 to 296.0 m/9.9 m^3/s
Maximum Daily Flow:**	26.7 m^3/s
Minimum Daily Flow*:**	1 m^3/s target
Natural Environment Constraints:	Potential disturbance to loon nesting due to water level management.
Social Constraints:	Concerns expressed by residents regarding high summer water levels and shoreline erosion – summer TOL of 294.37 m preferred to reflect a traditional level, and to reduce shoreline erosion and changing shoreline vegetation patterns
Other:	Difficult to mitigate high water events due to constriction at downstream bridge.

Benefits and Resolution of Issues

- No change to upper NOZ. Slightly higher (0.1 m) and earlier (11 days) spring water level peak will improve habitat conditions for wetlands and spring spawning fish species.
- Quicker reduction to summer TOL will address resident concerns over early summer high water concerns and shoreline erosion.
- Lower late summer NOZ and TOL to address resident concerns regarding high summer levels.
- Consistent summer, fall and winter flows to maintain habitat values in the river reach downstream from the dam.

Conflicts

None

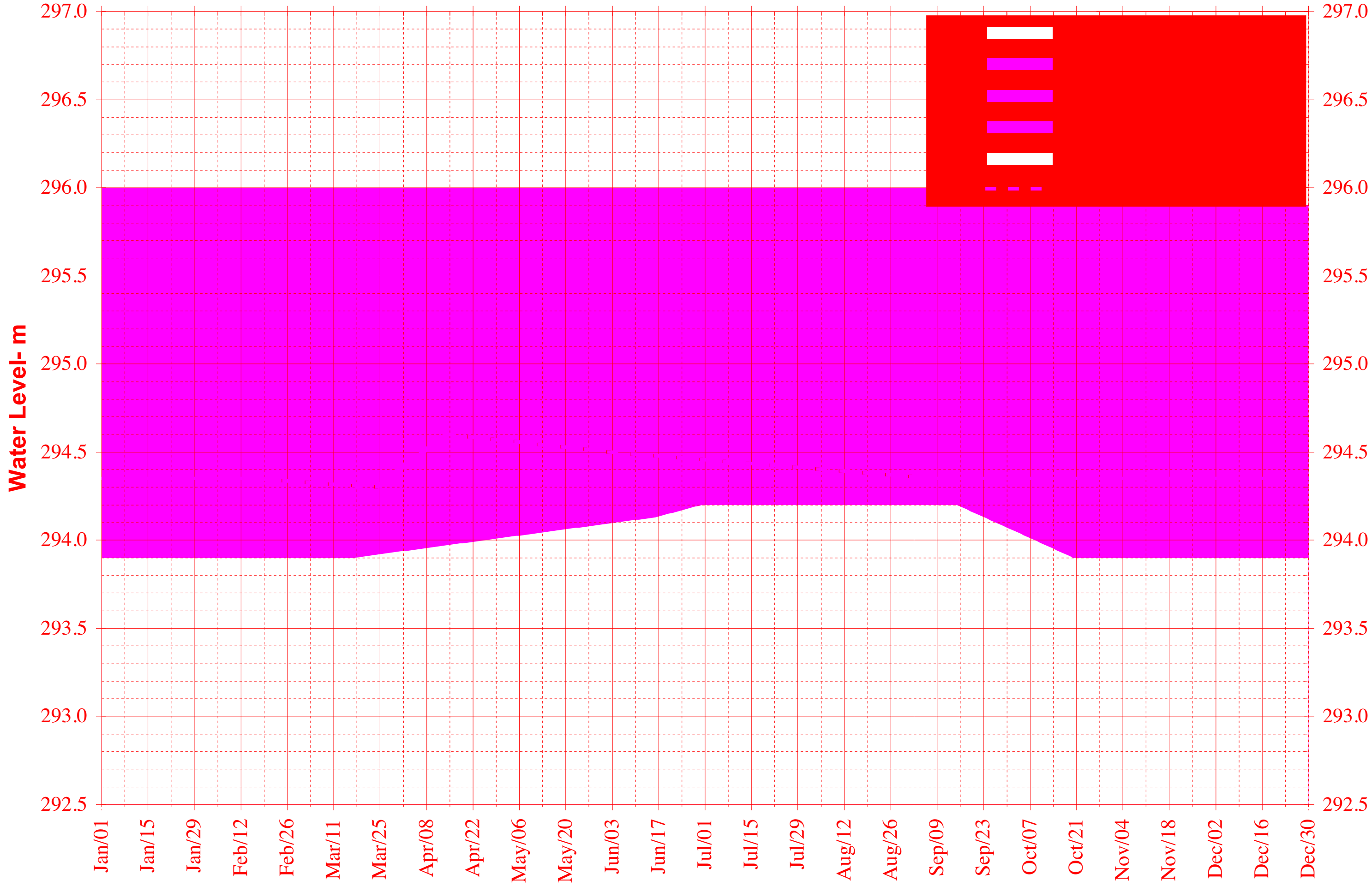

Figure 12.1.5
Muskoka River Water Management Plan
Fox Lake Operating Plan

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Back of figure

Public Comments

Environmental Component	Comment	Resolution
Shoreline erosion	"instead of leaving the water level high…over the fall/winter/spring period when we experience the harshest onshore winds and waves on the east side of the lake, the water is raised to the midpoint [of our]… beach…in the fall. This results in heavy erosion of the sandy beaches due to undercutting. Later in the fall, the logs are pulled and the water is left low over the winter. We have no erosion problems once it is dropped to this lower level….Once the spring freshet is over, you [MNR] lower the water level again to mid-point and we again get severe erosion (usually May/June). The water levels are then lowered very slowly over the May, June, July period, not reaching their optimum summer levels [294.35 to 294.40] usually until about the first of August. During this period of gradually lowering water levels, we experience the most major erosion of the year on our beaches." "If summer levels are maintained too high, significant shoreline erosion occurs…a summer level of 294.4…seems adequate." "…the target summer operating level for Fox Lake should be 294.37 m to reflect a traditional pattern and to reduce the continuing shoreline erosion and changing shoreline vegetation patterns caused by the current operational level of 294.45 m."	The spring peak water level will be achieved 11 days earlier and drawdown to the summer level will commence immediately. There will be a gradual decline over the summer period (June 1 to September 15) to a 10-cm lower level. No water level change through fall and early winter, with a more gradual decline to the same target winter level.
Loon nesting	"Almost every year…loons build a nest…in the north end of the lake. Usually nest building commences by early June and they, of course, build close to the water's edge. As you [MNR] have not dropped the water to its summer levels and you continue to drop the water slowly over the next 2 months, the loons often experience difficulty in reaching their nest prior to hatching of their eggs, usually in July. This can result in nest abandonment"	A study was undertaken to assess the effect of water level fluctuations on loon reproductive success in the Muskoka River watershed (Acres, 2003). The study recommended that any water management strategy should attempt to minimize the magnitude of fluctuation in water levels during loon nesting and incubation period. The proposed water management strategy in this lake will address this recommendation by having an earlier spring peak and a quicker reduction to the summer water level.

Information and Science Needs

None

12.1.6 Huntsville Lakes (Vernon, Fairy and Peninsula) – MNR

The operating plan for the Huntsville Lakes is shown in Figure 12.1.6, and has the following characteristics:

Target Operating Level Range:	283.3 to 284.0 m
Normal Operating Zone Range:	283.16 to 284.15 m
Absolute Range:	283.1 to 284.62 m
Summer* Range (Typical):	283.7 to 283.9 m
Winter Drawdown:	283.75 to 283.3 m
Flood Allowance (lake/river):	284.13 to 284.62 m/142 m^3/s
Maximum Daily Flow:**	126.8 m^3/s
Minimum Daily Flow*:**	3 m^3/s, year round target 11 m^3/s, winter target
Natural Environment Constraints:	Cold-water lake with known lake trout spawning shoals in all three of the lakes.
Social Constraints:	Lakes have extensively developed shoreline, with water-based recreation activities continuing well into fall. Infrastructure elevations ranged from 283.89 to 284.49 m.
Other:	Limited ability of the dam to respond to high water levels/flow events due to limited flow capacity in lake connecting channels. A target outflow of 11 m^3/s is provided during the winter months to provide storage for the spring freshet and meet waterpower needs.

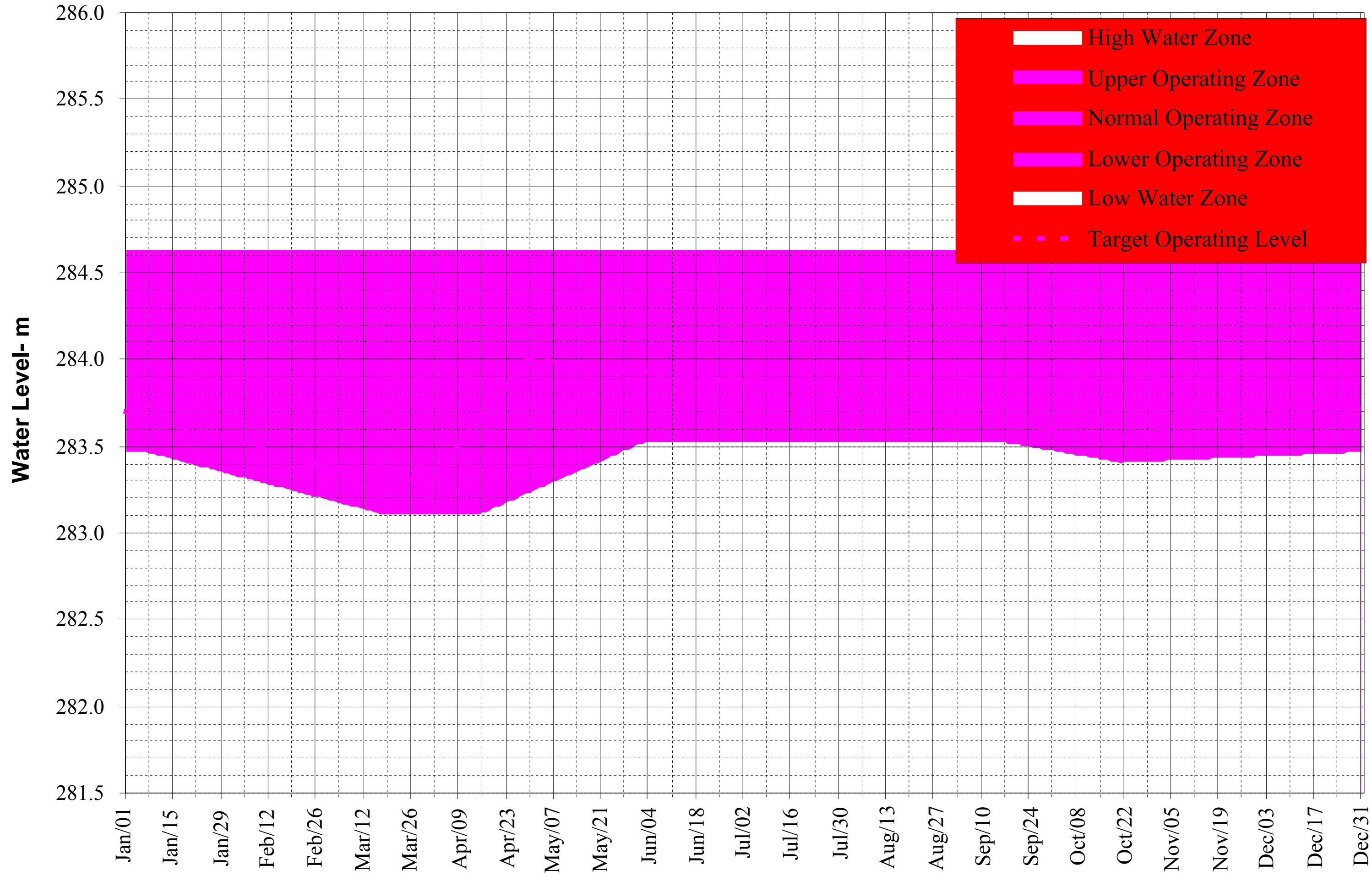

Figure 12.1.6
Muskoka River Water Management Plan
Huntville Lakes Operating Plan

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Back of figure

Benefits and Resolution of Issues

- No change to NOZ. Average maximum high water level essentially unchanged (4 cm higher) and no change to number of High Water Zone exceedances.
- Operating plan with a gradual, continual reduction in TOL throughout the spring and summer recreation season will eliminate the previous stepped operating levels approach. Fall/early winter TOL unchanged.
- Less differential between fall and winter water levels (0.2 m vs 0.3 m presently) to improve lake trout reproductive habitat.
- Consistent outflow from the lake to improve habitat conditions in the downstream river reach below the dam.
- Proposed water level and flow regime will more closely simulate a natural flow regime to enhance littoral zone conditions.

Conflicts

- No change to maximum spring outflow level, but a predicted increase in the number of years when downstream flood damage zone flows are exceeded (17 in 50 vs 11 in 50 presently).
- The summer range of water levels (at 80th percentile level) is predicted to increase by up to 12 cm relative to present conditions.

Public Comments

Environmental Component	Comment	Resolution
Access and Navigation	"When the water is too low, boats can't access docks/slips and can hit underwater obstacles" "boat/motor damage during unusually low water levels"	Maintain existing NOZ and TOL during the fall season.
Infrastructure	"dock…damage due to high water" "water intake freeze in spring due to levels below normal" "In some years, if the water is high when the ice is going out, we sustain structural damage to our docks and boathouses"	No predicted change in spring high water levels or ice damage potential.
Shoreline Erosion	"Beach damage due to high water"	No predicted change in spring high water levels.
Flooding	"if water is too high our property becomes flooded…water level is often too high [in springtime]" "in spring, out boathouses and docks are flooded when the water is high"	No predicted change in spring high water levels.
Water Levels	"keep water levels similar from season to season"	Not possible – levels fluctuate in response to natural events (rainfall, drought). Lakes managed to balance needs of infrastructure, recreation, natural environmental and socioeconomic components.
Natural Environment	"the late winter drawdown of water from Peninsula Lake leaves the littoral zone and all the resting eggs and larvae exposed to long periods of intense cold" "Concern is lake life health for Peninsula; amphibian life seems to have been ignored. Compensate negative impact of trout spawning shoals by re-stocking. Extreme winter level drawdown affects aquatic and amphibian life in subtle ways. It should be limited to the extent possible, regardless of power generation needs. Can winter drawdown be delayed to second half of March with improved control method at Mary Lake locks?"	Reduced differential between late winter and fall drawdown levels (0.2 m) is anticipated to provide some benefit to eggs and larvae. Huntsville Lakes are managed to balance needs of infrastructure, recreation, natural environmental and socio-economic components. Lake trout stocking is no longer considered appropriate due to limited survival and adverse impact on remaining natural stocks (i.e. dilution of gene pool with fish that are not adapted to unique conditions within lake). Drawdown is undertaken gradually during the winter to ensure storage volume is

Environmental Component	Comment	Resolution
	"Aggressive winter/fall drawdown is causing a large amount of Pen Lake shore to be exposed to temperature extremes and desiccation during January, February and March. This is destroying many of the overwintering (eggs/larvae) species of the littoral zone"	available when needed for spring freshet, to limit adverse effects on lake ice cover and levels and downstream flow regime, and make most efficient use of outflow for waterpower generation. Less winter drawdown would increase spring levels and aggravate flooding concerns.
	"Is there any room for input from those of us that live on the shores or Pen Lake? Can we contact someone when levels are too high or low"	Input and/or water level concerns can be forwarded to the Water Control Technologist at the Bracebridge MNR office.

Information and Science Needs

None

12.1.7 Mary Lake – MNR

The operating plan for Mary Lake is shown in Figure 12.1.7, and has the following characteristics:

Target Operating Level Range:	280.3 to 281.0 m
Normal Operating Zone Range:	280.03 to 281.1 m
Absolute Range:	279.95 to 281.15 m
Summer* Range (Typical):	280.9 to 280.65 m
Winter Drawdown:	280.67 to 280.3 m
Flood Allowance:	281.1 to 281.15 m/141.6 m^3/s
Maximum Daily Flow:**	140.6 m^3/s
Minimum Daily Flow*:**	3 m^3/s, year round target 11 m^3/s, winter target
Natural Environment Constraints:	Several lake trout spawning shoals located within the current late winter/early spring drawdown zone.
Social Constraints:	Lake has extensively developed shoreline, with water-based recreation activities continuing well into fall. Infrastructure elevations ranged from 280.95 to 281.63 m.
Other:	Dam is operated in conjunction with the Huntsville Dam to provide summer recreational opportunities, a minimum downstream flow, and a winter release for infrastructure protection and waterpower generation.

Benefits and Resolution of Issues

- No change to NOZ. Summer water levels will decline gradually over the summer season to simulate a natural flow regime and provide more natural ecological conditions.
- Slightly higher spring water level to improve ecological conditions for wetlands and spring spawning fish species.
- Fewer High Water Zone exceedances.
- Less differential between fall and winter drawdown levels to improve lake trout spawning habitat conditions. Decreased winter drawdown will increase the amount of available aquatic habitat.

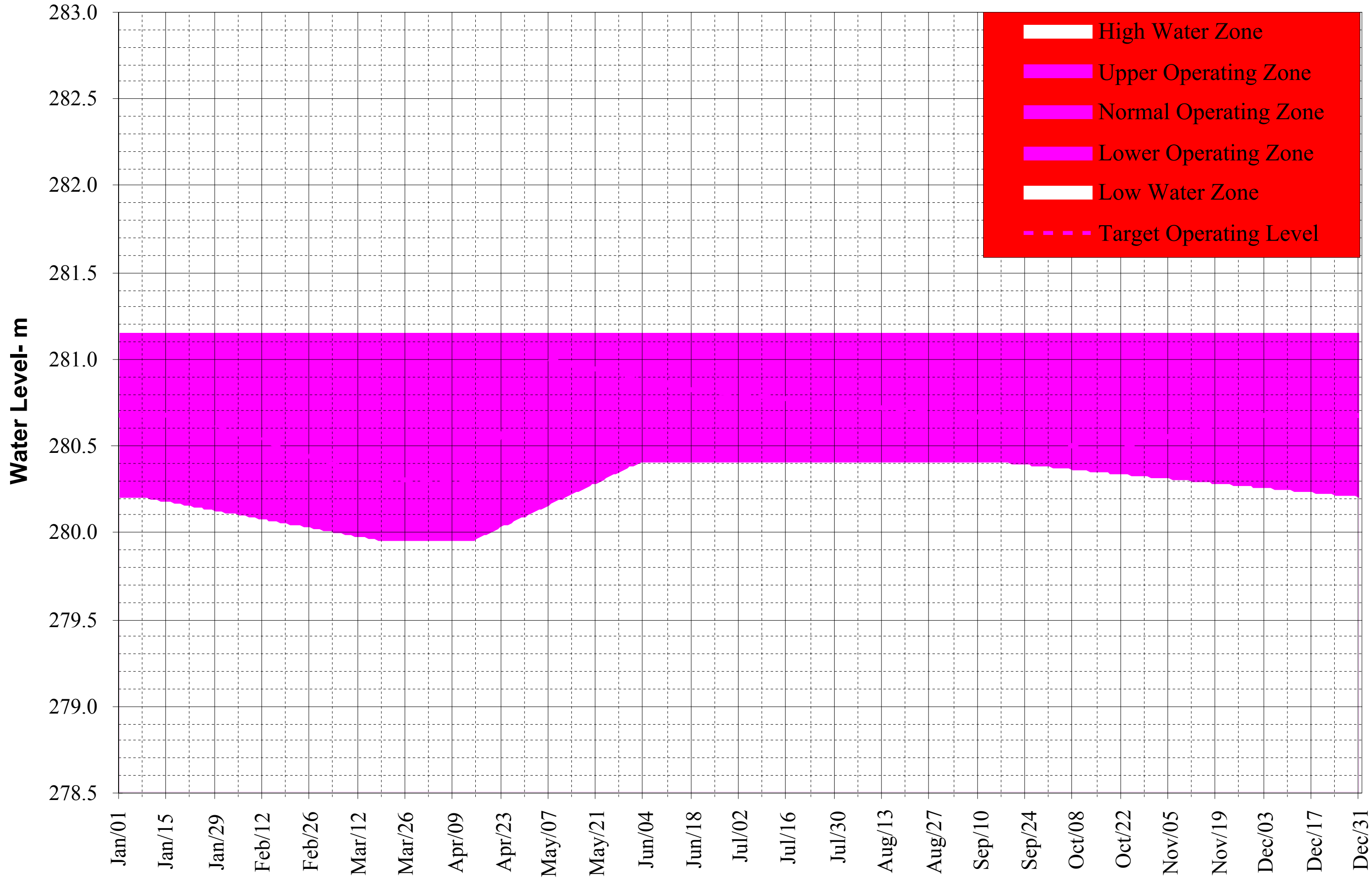

Figure 12.1.7
Muskoka River Water Management Plan
Mary Lake Operating Plan

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- The maintenance of a consistent outflow from the lake will improve habitat conditions in the reach below the dam.

Conflicts
None

Public Comments

Environmental Component	Comment	Resolution
Mary Lake		
Infrastructure	"if the flows are not controlled the water level will be too affected, making the docks too high or too low" "Consistent water levels are essential so that guests may use our dock to moor boats" "we maintain four major swimming/boating areas with docks…avoid major swings in water level June to September…keep summer level at design level"	Limited ability to control extreme flow events. Operating plan maintains current NOZ, with a gradual decline in water level throughout the spring, summer and fall seasons.
	"When I was a child (1940's and 50's) there was usually 3 to 4 ft of water [at dock and boathouse] – now there is often less than 12"…maintain a greater depth of water in Mary Lake and the downstream section of river"	Plan will provide a more natural flow regime with higher levels in spring and early summer, gradually declining into the fall.
North Branch Downstream from Mary Lake		
Hydrology	"maintain more even flow in the system [downstream from Mary Lake]" "riverfront property [downstream from Mary Lake] is occasionally flooded in spring"	Limited ability to control flows and levels during extreme events. Average maximum daily flow unchanged. No increase in number of exceedances of reach flow limit.
Fish and Wildlife (downstream from Mary Lake"	"I am concerned about [fluctuations in water levels] effects on fisheries, water quality and shoreline erosion"	Goal of new operating plan is to provide more consistent river flows throughout the seasons.
General	"low water levels are greatest concern"	As above
Commercial Activities	Impacts of water level fluctuation on fur trapping along this stretch of river	As above
Infrastructure	"When river level grows (say 3' higher than normal) it floods our artesian well"	Limited ability to control flows and levels during extreme events.
Draft Plan Comments		
Water Levels	"Noted very little change in water levels from May to October and no change to the NOZ, therefore, no concerns with this proposal."	Accepted

Information and Science Needs
None

12.1.8 High Falls – Bracebridge Generation Limited

The operating plan for High Falls is shown in Figure 12.1.8, and has the following characteristics:

Normal Operating Zone:	268.85 to 269.62 m
Best Management Practice:	Remain above 269.0 m from June 15 to September 15
Summer* Range (Typical):	269.0 to 269.62 m (with BMP)
Winter Drawdown:	None
Flood Allowance:	None. However, the facility has limited discharge capacity and cannot control river levels beyond the specified High Flow Trigger. Levels may exceed the upper extent of the NOZ at this time (see Section 13.3).
Maximum Daily Flow:**	155.5 m^3/s
High Flow Trigger:	80 m^3/s
Minimum Daily Flow*:**	None for facility; Flow Distribution Plan for High Falls
Low Flow Trigger:	3 m^3/s
Energy Emergency:	None
Scenic Flow Regime:	Scenic regime to be implemented as per EA agreement on completion of facility expansion. Agreed regime varies seasonally and weekly as follows: - 5 m^3/s on weekends and holidays from May 1 to June 15 and September 15 to October 31 - 3 m^3/s on weekends and holidays from June 15 to September 15 - 1.5 m^3/s during weekdays from May 1 to October 31
Natural Environment Constraints:	None
Social Constraints:	Previous commitments made during facility expansion EA are integrated into operating plan (to be implemented when expansion is complete), including implementation of the Flow Distribution Plan which specifies minimum flows between May 1 and October 31, and monitoring commitments.
Other:	A minimum flow of 3 m^3/s is to be released from Mary Lake (by MNR) to maintain baseflow in the river system during the summer period.

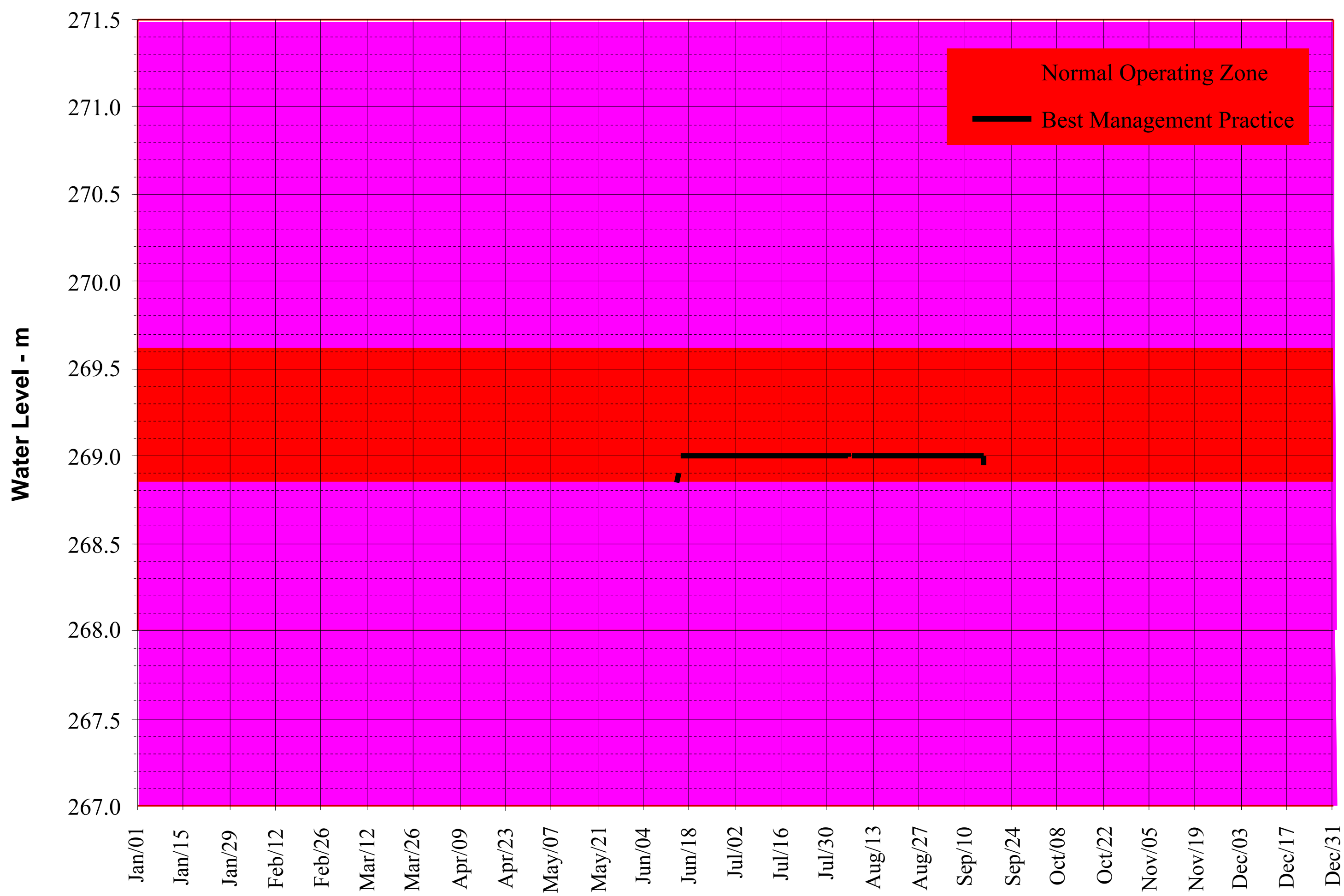

Figure 12.1.8
Muskoka River Water Management Plan
High Falls Reservoir Operating Plan

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Back of figure

Benefits and Resolution of Issues

- Reduced and defined absolute operating range, with legally enforceable upper and lower limits under normal operating conditions. High and Low Flow Triggers to address flow extremes (whether naturally occurring or the result of upstream dam operation).
- BMP established during the summer recreation period to promote maintenance of higher head-pond levels during that period.
- Consistent summer, fall and winter minimum flow to maintain social and ecological habitat values in North Branch leading into Lake Muskoka.

Conflicts

- The facility is considered run-of-river, and relies on flow provided from Mary Lake and associated upstream waterbodies. More coordination between MNR and BBG will be required to allow BBG to remain within the narrower operating range.
- The narrower absolute range within the plan reduces the flexibility of waterpower operator to alter head pond levels in response to energy demands.

Public Comments

- Head-pond water level fluctuations were identified as a concern during initial public consultation
- Poor water quality was noted for the reach below High Falls

Environmental Component	Comment	Resolution
High Falls		
Levels and Flows	"better flow in later summer period"	New operating plan is anticipated to provide more consistent river flows throughout the spring, summer and fall seasons.
Aesthetics	"None of what I have seen addresses the mess (fencing?) created at High Falls"	Site safety and compliance with regulatory requirements is outside scope of plan.
Power Generation	"there needs to be a major use of all the dam structures to generate hydro-electric power. The equipment is all available for run-of-river generation in low-head/no-head situations and should be used" "plan takes all aspects into consideration … good to have local generation available" A total of 3 similar comments received.	Objective of plan has been to maintain or improve existing waterpower generation potential.

Information and Science Needs

None

12.1.9 Wilson Falls – Bracebridge Generation Limited

The operating plan for Wilson Falls is shown in Figure 12.1.9, and has the following characteristics:

Normal Operating Zone:	254.14 to 255.4 m
Best Management Practice:	Remain above 254.29 m from June 15 to September 15
Summer* Range (Typical):	254.29 to 255.2 m (with BMP)
Winter Drawdown:	None
Flood Allowance:	None. However, the facility has limited discharge capacity and cannot control river levels beyond the specified High Flow Trigger. Levels may exceed the upper extent of the NOZ at this time.
Maximum Daily Flow:**	159.4 m^3/s
High Flow Trigger:	65 m^3/s
Minimum Daily Flow*:**	None
Low Flow Trigger:	3 m^3/s
Energy Emergency:	None
Scenic Flow Regime:	None
Natural Environment Constraints:	None
Social Constraints:	None
Other:	A minimum flow of 3 m^3/s is released from the upstream lakes to maintain baseflow in the river system during the summer period.

Benefits and Resolution of Issues

- Reduced and defined absolute operating range, with legally enforceable upper and lower limits under normal operating conditions. High and Low Flow Triggers to address flow extremes (whether naturally occurring or the result of upstream dam operation).
- BMP established during the summer recreation period to promote maintenance of higher head-pond levels during that period.

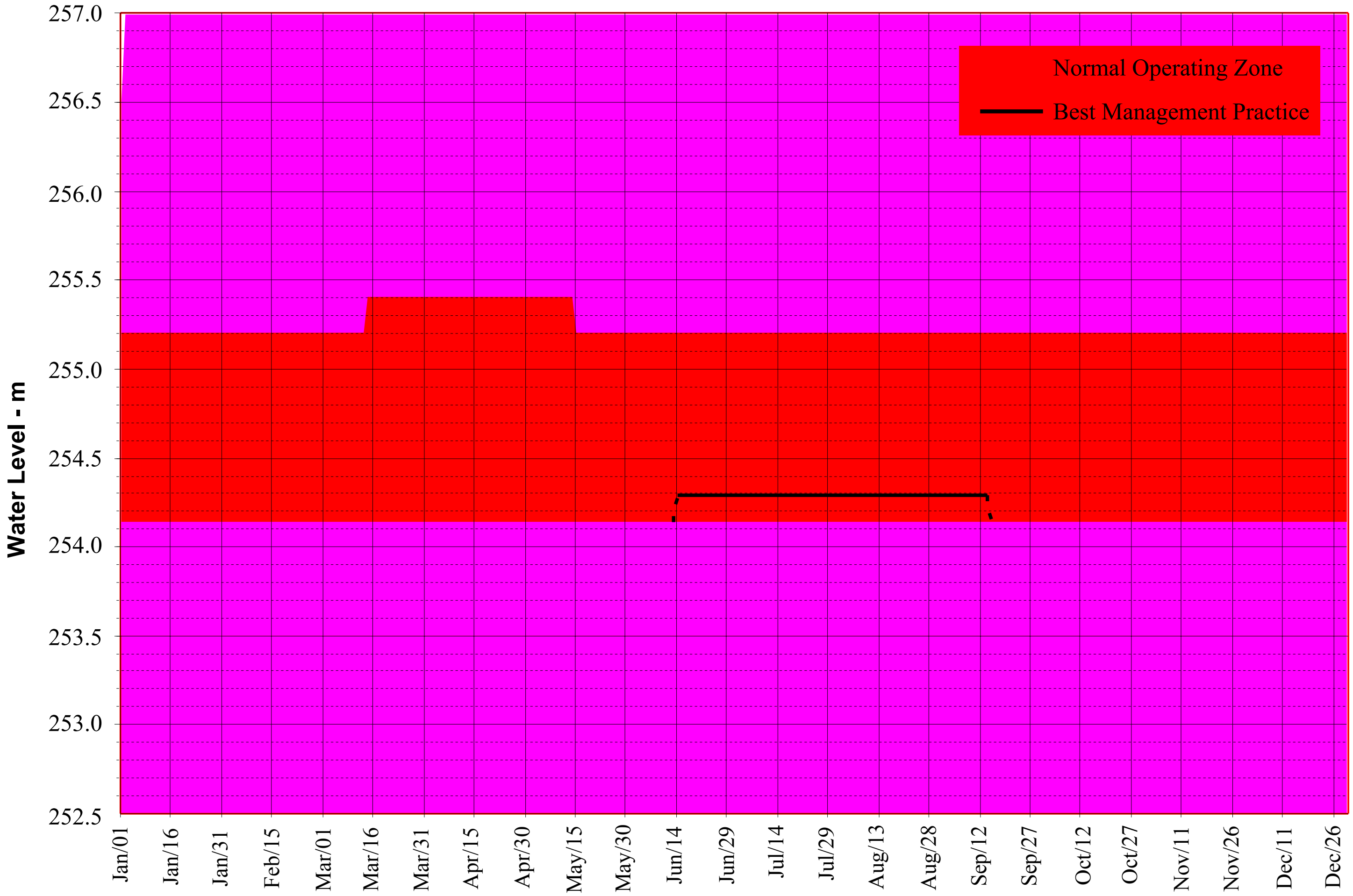

Figure 12.1.9
Muskoka River Water Management Plan
Wilson Falls Reservoir Operating Plan

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- back of figure

- Consistent summer, fall and winter minimum flow to maintain social and ecological habitat values in North Branch leading into Lake Muskoka.

Conflicts

- The facility is considered run-of-river, and relies on flow provided from Mary Lake and associated upstream waterbodies. More coordination between MNR and BBG will be required to allow BBG to remain within the narrower operating range.
- The narrower absolute range within the plan reduces the flexibility of waterpower operator to alter head pond levels in response to energy demands.

Public Comments

- Head-pond water level fluctuations were identified as a concern during initial public consultation.

Information and Science Needs

None

12.1.10 Bird's Mill Dam – District Municipality of Muskoka

The operating plan for Bird's Mill Dam is shown in Figure 12.1.10 and has the following characteristics:

Normal Operating Zone:	241.7 to 242.7 m
Summer* Range (Typical):	242.0 to 242.3 m
Winter Drawdown:	None
Flood Allowance:	None. The discharge capacity of the facility is unknown, and it may not be able to control river levels beyond certain flows. The specified High Flow Trigger is equivalent to the trigger applied to upstream and downstream facility (to maintain continuity). Water levels may exceed the upper extent of the NOZ above this flow value.
Maximum Daily Flow:**	~160 m^3/s
High Flow Trigger:	65 m^3/s
Minimum Daily Flow*:**	None (see Low Flow Trigger)
Low Flow Trigger:	3 m^3/s
Natural Environment Constraints:	Brown trout stocked into area between Bird's Mill dam and Wilson Falls.
Social Constraints:	Maintain recreational use potential of river reach above the dam. Avoid flooding of Bracebridge streets by maintaining approximately 0.3 m of freeboard between the upper NOZ and the water level that would result in flooding of River Road (approximately 243.1 m).
Other:	No historical water level data to confirm range of head-pond elevations. Water level data will be collected to allow future evaluation of the of facility water levels. Proposed water level range will be a guideline for facility operations, not legally binding limits (i.e., voluntary levels).

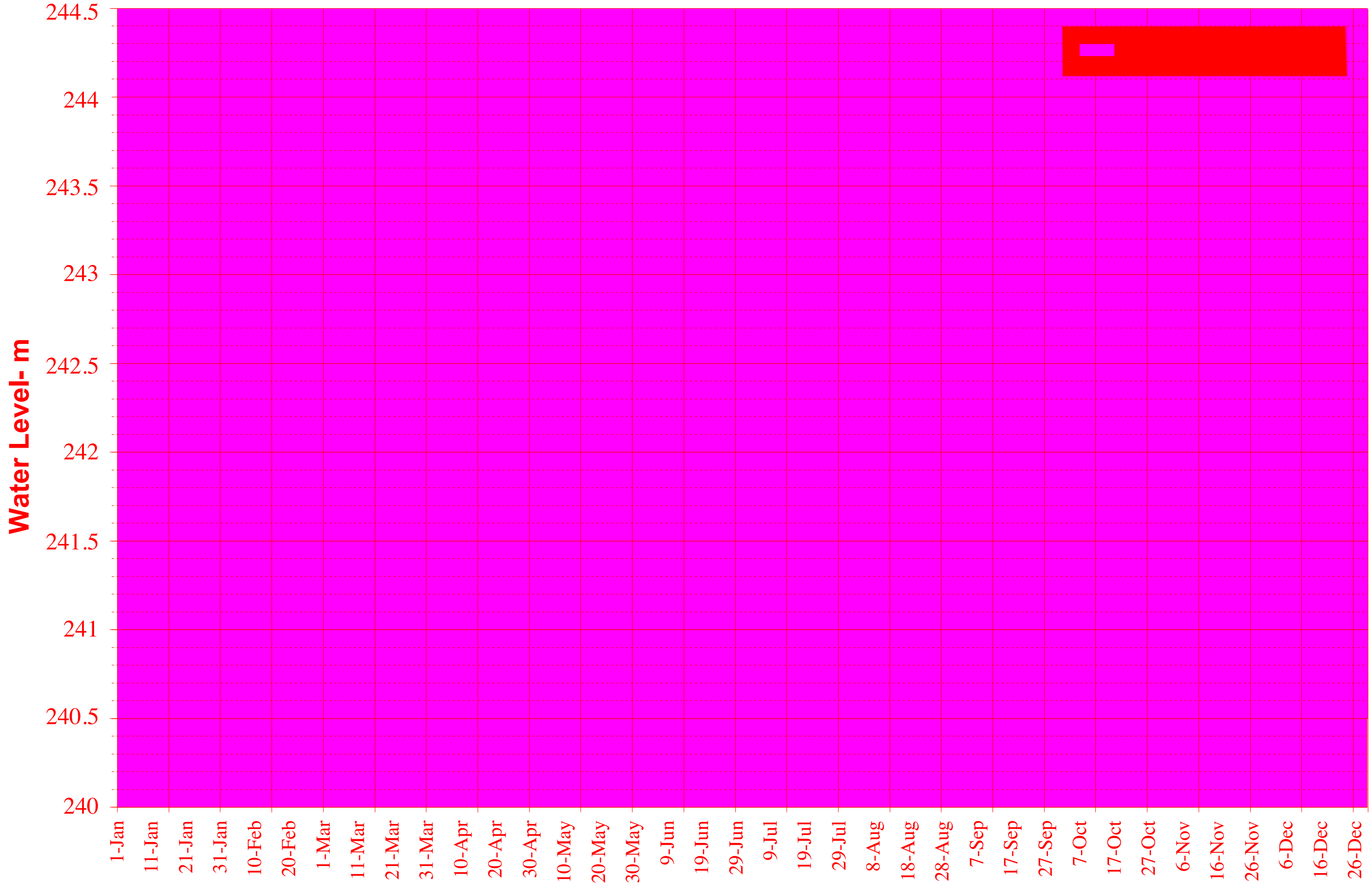

Figure 12.1.10
Muskoka River Water Management Plan
Bird's Mill Dam Operating Plan

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Back of figure

Benefits and Resolution of Issues
- Previous operating levels were not recorded. New operating plan strives to duplicate the range of water levels that have occurred historically. Operating levels will be recorded in future to assess validity of selected range.
- Plan will maintain recreational use of river reach and current environmental features and values.
- Plan will maintain provision to operate existing equipment (turbines, pumps, etc) in its capacity as a museum, historic landmark and tourist attraction.
- Operating plan responds to potential high water/flooding issues.
- Plan formalizes communication strategies between dam operators on the North Branch Muskoka River.

Conflicts
None

Public Comments
None

Information and Science Needs
- Monitor head-pond water levels to assess range of levels that occur under normal and extreme flow regimes.

12.1.11 Bracebridge Falls - Bracebridge Generation Limited

The operating plan for Bracebridge Falls is shown in Figure 12.1.11, and has the following characteristics:

Normal Operating Zone:	235.6 to 237.6 m
Best Management Practice:	None
Summer* Range (Typical):	235.6 to 237.6 m
Winter Drawdown:	None
Flood Allowance:	None. However, the facility has limited discharge capacity and cannot control river levels beyond the specified High Flow Trigger. Levels may exceed the upper extent of the NOZ at this time.
Maximum Daily Flow:**	161.0 m^3/s
High Flow Trigger:	65 m^3/s
Minimum Daily Flow*:**	None
Low Flow Trigger:	3 m^3/s
Natural Environment Constraints:	None
Social Constraints:	None
Other:	A minimum flow of 3 m^3/s is released from the upstream lakes to maintain baseflow in the river system during the summer period.

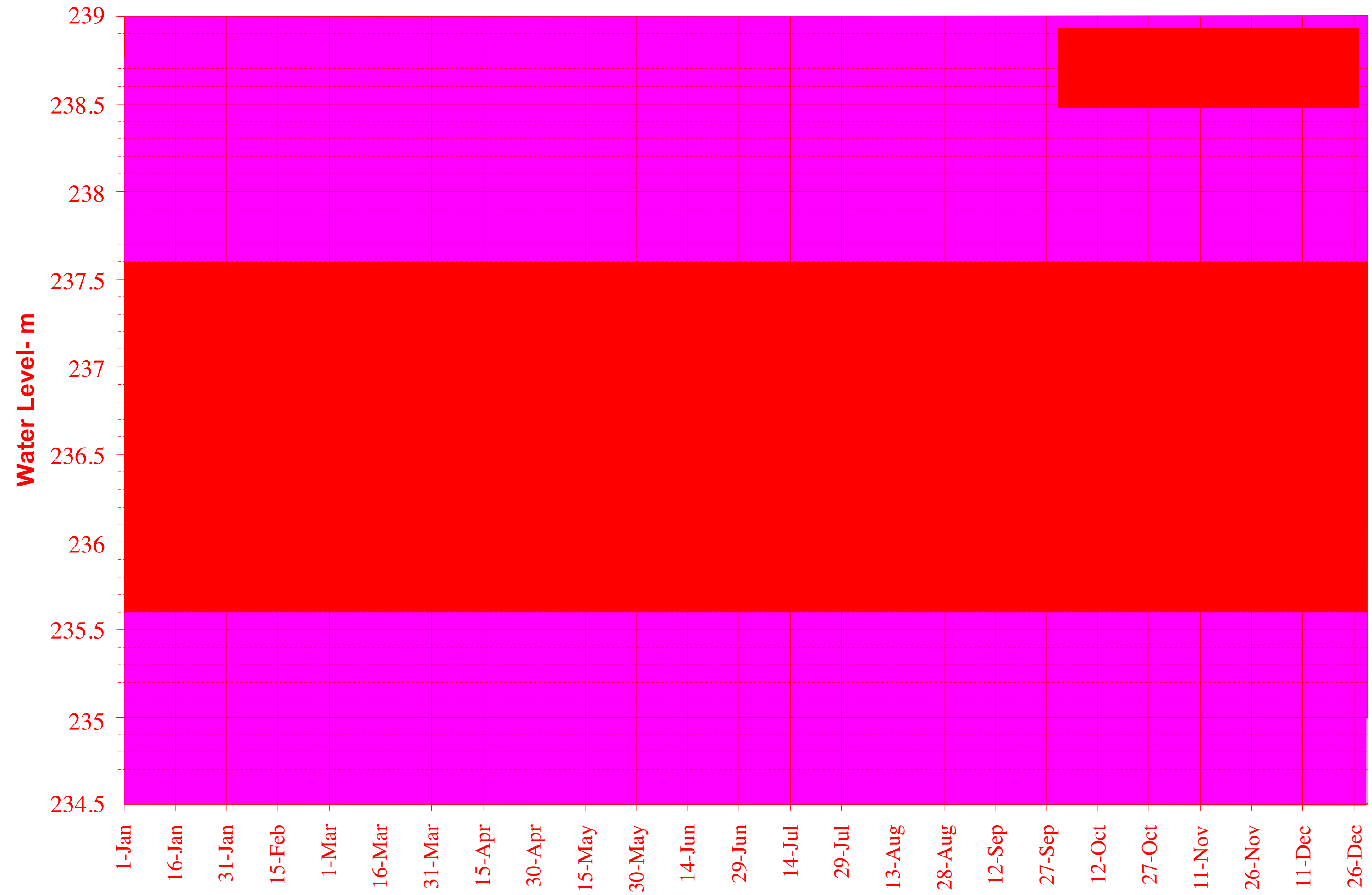

Figure 12.1.11
Muskoka River Water Management Plan
Bracebridge Falls Reservoir Operating Plan

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Back of figure

Benefits and Resolution of Issues

- Defined absolute operating range, with legally enforceable upper and lower limits under normal operating conditions. High and Low Flow Triggers to address flow extremes (whether naturally occurring or the result of upstream dam operation).
- Consistent summer, fall and winter minimum flow to maintain social and ecological habitat values in North Branch leading into Lake Muskoka.

Conflicts

- The facility is considered run-of-river, and relies on flow provided from Mary Lake and associated upstream waterbodies. More coordination between MNR and BBG will be required to allow BBG to remain within the narrower operating range.

Public Comments

None received.

Information and Science Needs

None

12.2 South Branch Muskoka River

12.2.1 Burnt Island Lake – MNR

The operating plan for Burnt Island Lake is shown in Figure 12.2.1, and has the following characteristics:

Target Operating Level Range:	427.9 to 428.65 m
Normal Operating Zone Range:	427.4 to 428.7 m
Absolute Range:	426.9 to 429.0 m
Summer* Range (Typical):	428.1 to 428.55 m
Winter Drawdown:	None
Flood Allowance (lake/river):	428.7 to 429.0 m/none
Maximum Daily Flow:**	7.8 m^3/s
Minimum Daily Flow*:**	0.5 m^3/s, annual average target
Natural Environment Constraints:	Cold-water lake with naturally reproducing lake trout population.
Social Constraints:	Lake forms part of an Algonquin Park canoe route with wilderness camp sites.
Other:	Dam is water access only and is operated by Algonquin Park staff.

Benefits and Resolution of Issues

- Maintain the current summer NOZ. Fall and winter NOZ adjusted to fit the new TOL during those periods.
- The reduced fall drawdown is expected to provide a number of fisheries and ecological benefits within the lake ecosystem including
  - improved littoral zone communities (not subjected to late summer/early fall dewatering and/or winter freezing/ice scour when the lake did not refill before the onset of winter)
  - improved upper riparian zone due to less annual variability in spring water levels, and
  - improved lake trout habitat due to higher and more stable fall water levels (stable late summer/early fall water levels will allow spawning areas to be subjected to cleansing wave action and increase potential for egg survival/future recruitment).

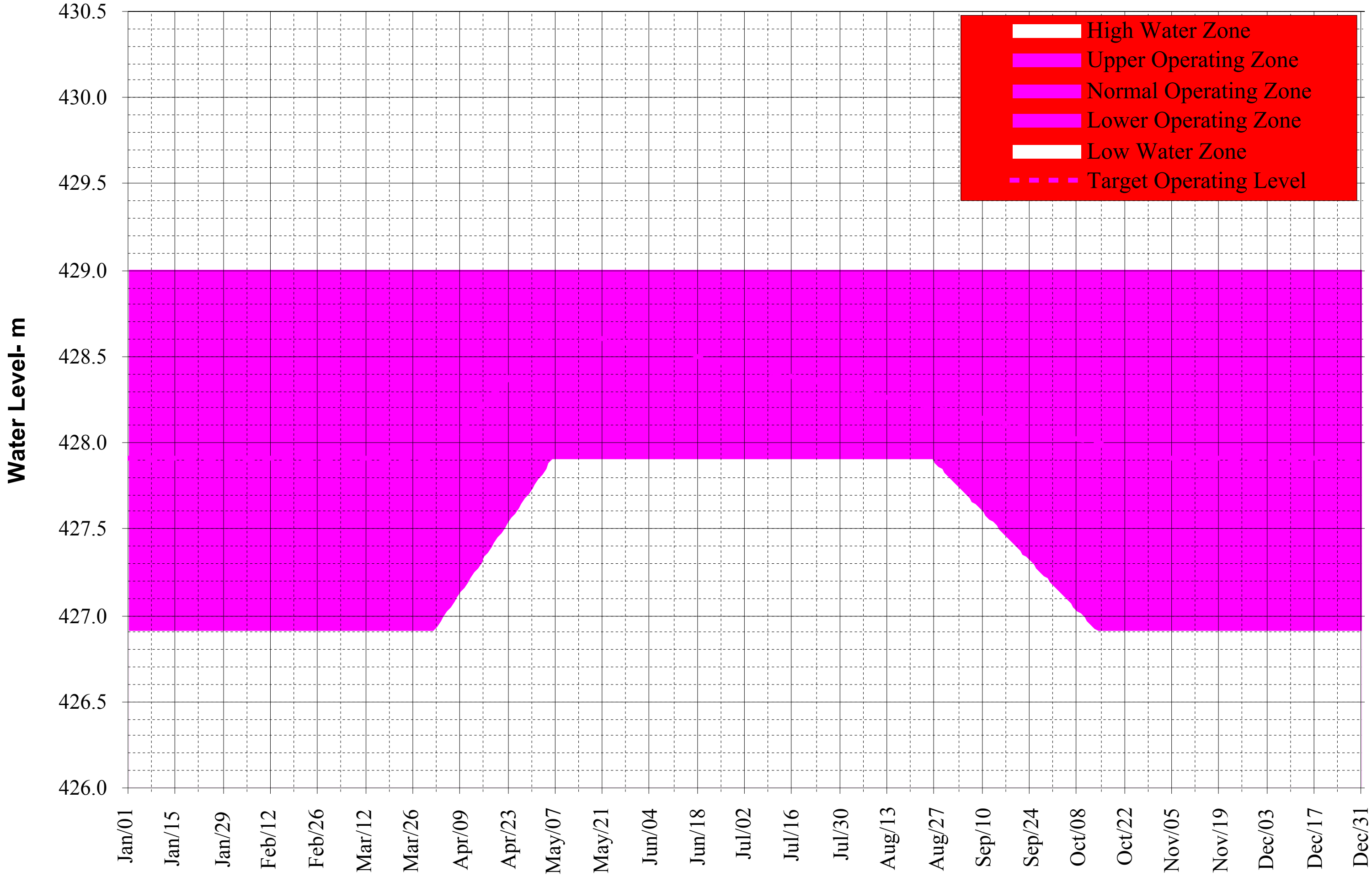

Figure 12.2.1
Muskoka River Water Management Plan
Burnt Island Lake Operating Plan

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Back of figure

- The operating plan closely simulates a natural flow regime, which meets the objectives of MNR's water management planning guidelines and Algonquin Park's management policies.
- The maintenance of a more consistent outflow from the lake will improve habitat conditions in the reach immediately below the dam (by eliminating the cessation of flow following completion of the fall drawdown)
- Reduced seasonal drawdown range that will eliminate the effect of the previous late summer/early fall drawdown on recreational uses.
- Potential to eventually eliminate dam operation (convert dam to an overflow structure with slot or valve to accommodate summer base flow release).

Conflicts

- Eliminating the late summer/early fall drawdown eliminates this seasonal source of flow for the Oxtongue River, and could affect late summer navigation (i.e., canoeing) in that reach.
- Eliminating the late summer/early fall drawdown reduces the outflow from the lake and the water available in the South Branch for waterpower generation at this time of the year.

Public Comments

None

Information and Science Needs

None

12.2.2 Joe Lake – MNR

The operating plan for Joe Lake is shown in Figure 12.2.2, and has the following characteristics:

Target Operating Level Range:	421.5 to 422.1 m
Normal Operating Zone Range:	421.4 to 422.1 m
Absolute Range:	421.2 to 422.2 m
Summer* Range (Typical):	421.63 to 422.0 m
Winter Drawdown:	421.5 to 421.7 m
Flood Allowance (lake/river):	422.1 to 422.2 m/none
Maximum Daily Flow:**	15.5 m^3/s
Minimum Daily Flow*:**	0.5 m^3/s, annual average target

Natural Environment Constraints:	Cold-water lake with naturally reproducing lake trout population.
Social Constraints:	The lake forms part of an Algonquin Park canoe route with several developments along the shoreline.
Other:	Dam has road access and is operated by Algonquin Park staff.

Benefits and Resolution of Issues

- Maintain the current NOZ throughout the year.
- Higher spring peak and gradual seasonal drawdown will improve ecological conditions for wetland species and spring spawning fish species
- Allowing the lake level to rise in the fall replicates the natural flow regime and is expected to result in improved habitat for lake trout.
- The maintenance of a more consistent outflow from the lake will improve habitat conditions in the reach below the dam.
- Reduced operational demands (potential to convert to non-operational structure).

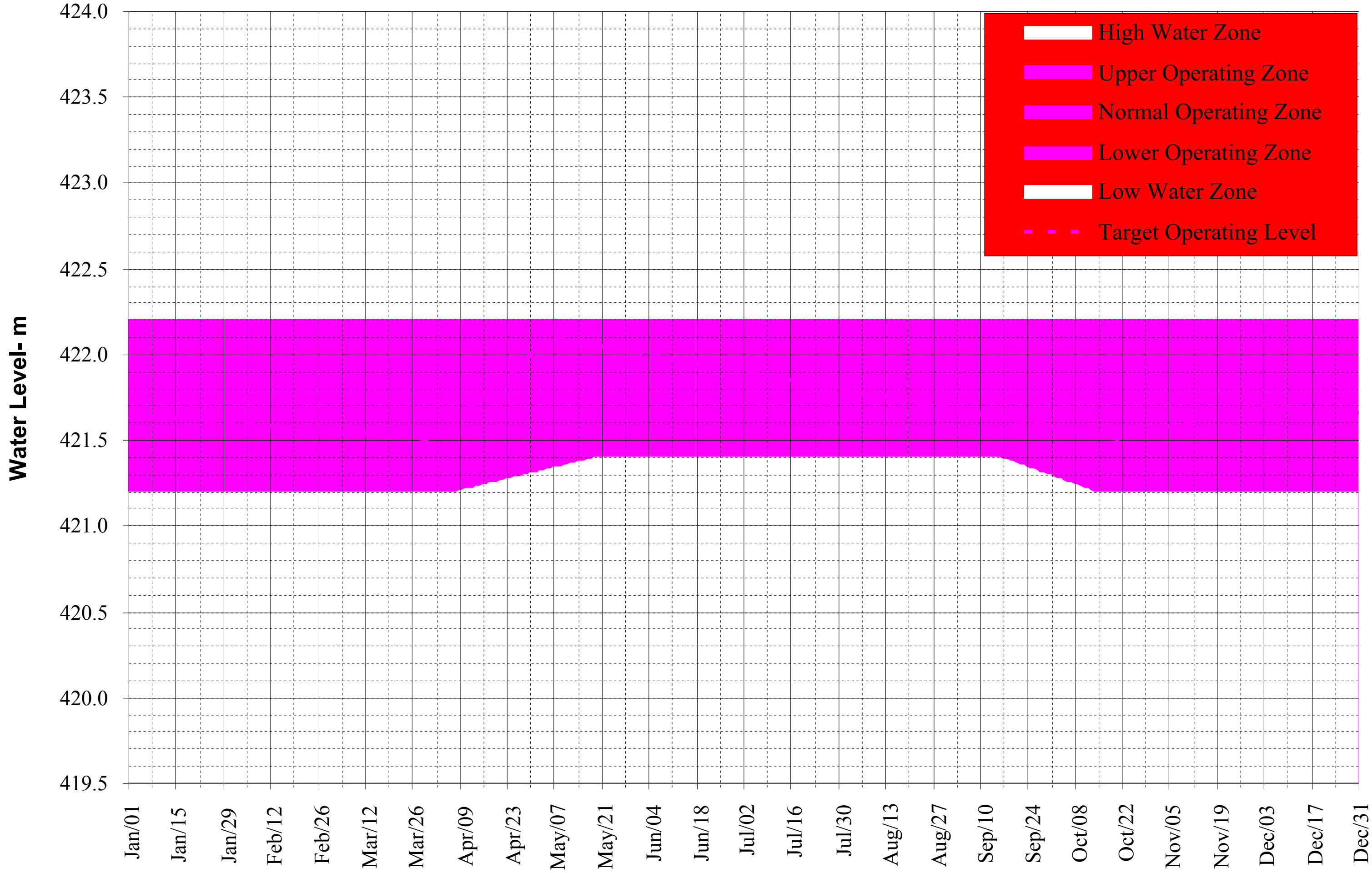

Figure 12.2.2
Muskoka River Water Management Plan
Joe Lake Operating Plan

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Back of figure

Conflicts

- Higher spring water level creates greater potential for ice damage to existing docks (1 lodge, 1 youth camp and 5 private cottages)
- Greater change in levels during summer recreational season, but limited effect anticipated as motorized vessels are not allowed on the lake.

Public Comments

None

Information and Science Needs

None

12.2.3 Ragged Lake – MNR

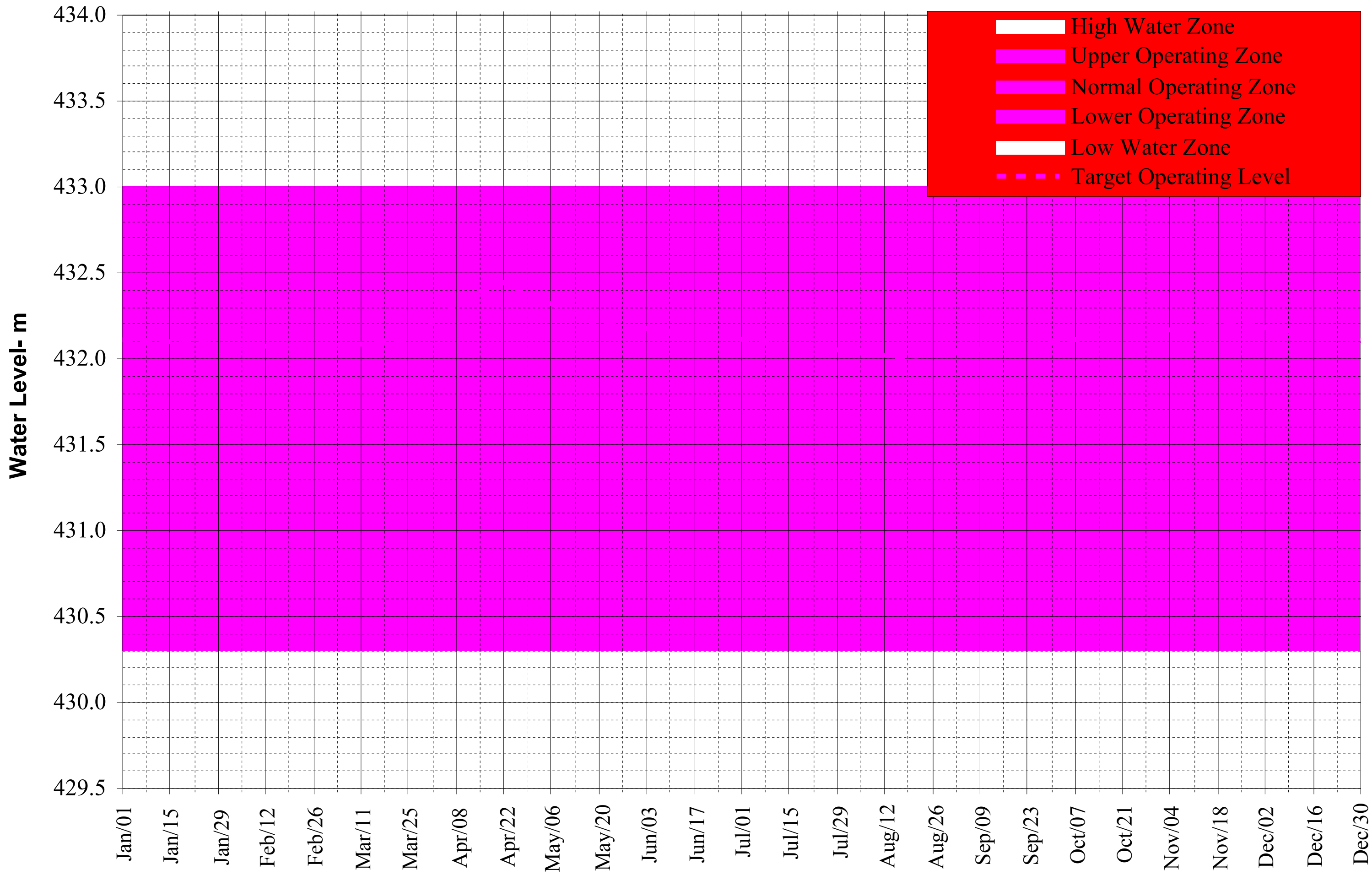
The operating plan for Ragged Lake is shown in Figure 12.2.3. The dam has partially failed (section of right abutment washed out), there are no plans to repair it, and no plans to operate the dam in the future. The operating plan noted below replicates the water levels that are predicted to naturally occur within the lake under those conditions.

Target Operating Level Range:	432.0 to 432.45 m
Normal Operating Zone Range:	431.8 to 432.9 m
Absolute Range:	430.3 to 433.0 m
Summer* Range (Typical):	432.0 to 432.15 m
Winter Drawdown:	432.2 to 432.05 m
Flood Allowance (lake/river):	432.9 to 433.0 m/none
Maximum Daily Flow:**	7.8 m^3/s
Minimum Daily Flow*:**	1.5 m^3/s, annual average target

Natural Environment Constraints:	Cold-water lake with naturally reproducing lake trout population.
Social Constraints:	Lake is located within Algonquin Park and used primarily for canoeing.
Other:	Dam has partially failed and is no longer operated by MNR.

Benefits and Resolution of Issues

- The operating plan closely replicates the water level and flow regime that will occur naturally, given the lake's hydrology and dam outflow characteristics. The plan meets the objectives of MNR's water management planning guidelines.
- Elimination of the fall drawdown and higher winter water levels will improve lake trout habitat in the long-term by providing more stable seasonal water levels.
- Reduced operating demands, as the structure will no longer be operated.
- Elimination of the fall drawdown will provide a more natural downstream flow regime.



* Dam not operated, plan reflects natural hydrologic conditions

Figure 12.2.3
Muskoka River Water Management Plan
Ragged Lake Operating Plan

ACRES International

Back of figure

Conflicts

None

Public Comments

None

Information and Science Needs

None

12.2.4 Canoe/Tea/Smoke Lakes – MNR

The operating plan for Canoe/Tea/Smoke Lake is shown in Figure 12.2.4, and has the following characteristics:

Target Operating Level Range:	417.3 to 418.0 m
Normal Operating Zone Range:	417.02 to 418.05 m
Absolute Range:	416.89 to 418.2 m
Summer* Range (Typical):	417.6 to 417.9 m
Winter Drawdown:	417.5 to 417.3 m
Flood Allowance (lake/river):	418.05 to 418.2 m
Maximum Daily Flow:**	39.4 m^3/s
Minimum Daily Flow*:**	1.5 m^3/s, target

Natural Environment Constraints:	Cold-water lakes with naturally reproducing lake trout populations. Location of lake trout spawning shoals known on Smoke Lake.
Social Constraints:	Lakes are on one of the most heavily used canoe routes in Algonquin Park. Considerable shoreline infrastructure (i.e., docks).
Other:	Winter release of 1.4 m^3/s is currently provided for waterpower generation.

Benefits and Resolution of Issues

- Maintain upper limit of NOZ throughout year. Lower limit of NOZ adjusted late summer and early fall to accommodate a lower October 15 TOL.
- Higher spring peak and gradual seasonal drawdown to improve ecological conditions for wetland species, spring spawning fish species, and riparian and littoral zone habitats.
- Less differential between fall and winter TOLs to improve lake trout spawning habitat conditions.
- Less winter drawdown will provide more aquatic habitat.
- Gradual decline in lake levels throughout the ice-free season will improve minimum flows in the Oxtongue River.

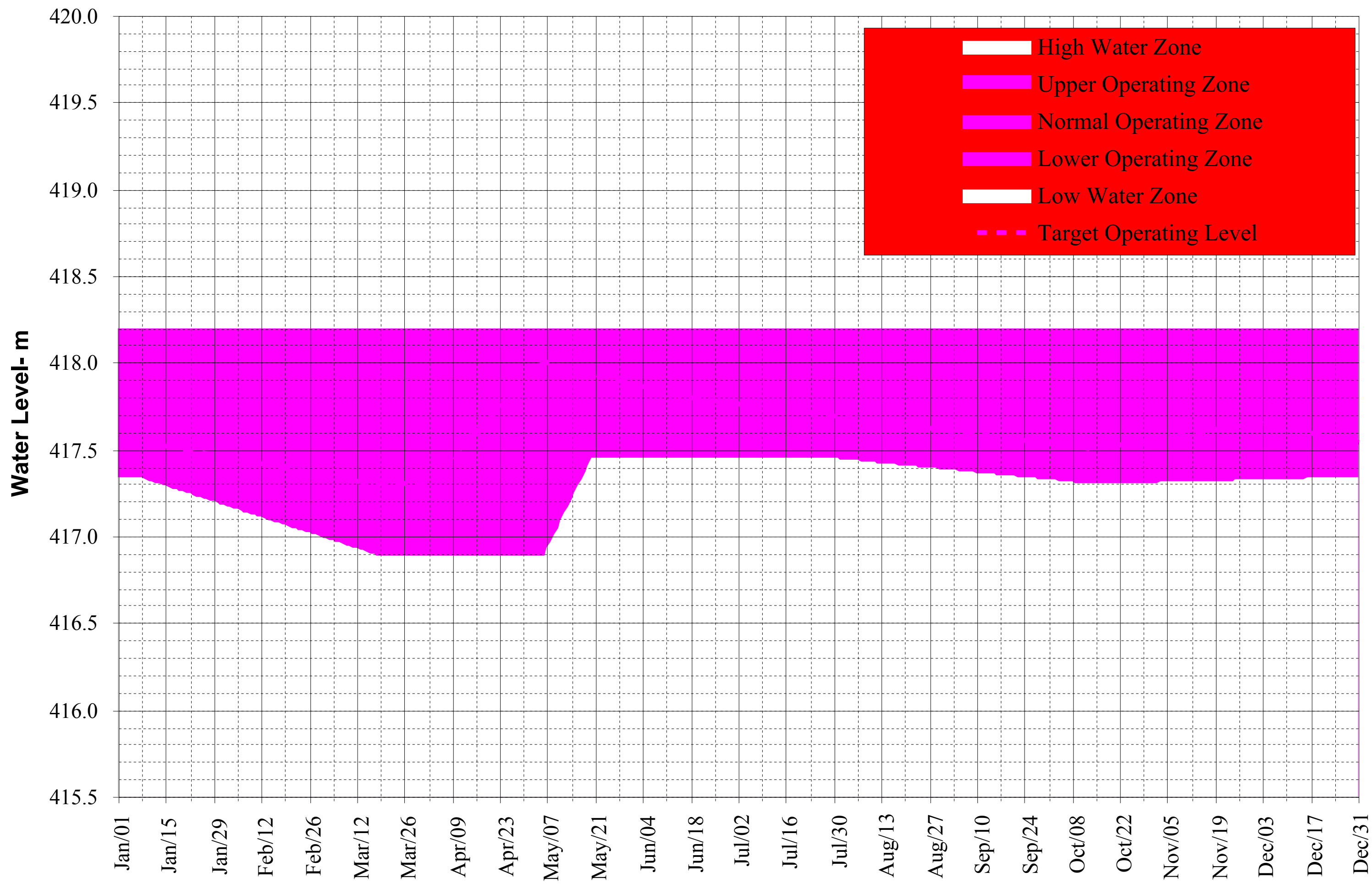


Figure 12.2.4
Muskoka River Water Management Plan
Canoe, Smoke and Tea Lakes Operating Plan

ACRES International

- back of figure

- The maintenance of a more consistent outflow from the lake will improve habitat conditions in the reach below the dam.

Conflicts

- More change in recreation season lake level (up to 0.20 m more) may cause some access and infrastructure concerns. However, this amount of fluctuation is not uncommon on other watershed lakes.

Public Comments

None

Information and Science Needs

None

12.2.5 Kawagama Lake – MNR

The operating plan for Kawagama Lake is shown in Figure 12.2.5, and has the following characteristics:

Target Operating Level Range:	354.6 to 355.6 m
Normal Operating Zone Range:	354.5 to 355.7 m
Absolute Range:	354.2 to 356.07 m
Summer* Range (Typical):	355.15 to 355.55 m
Best Management Practice:	TOL of 355.6 from May 30 to July 1 TOL of 355.6 to 355.3 from July 1 to September 15, followed by fall drawdown to 354.8 by October 15
Winter Drawdown:	355.0 to 354.6 m
Flood Allowance (lake/river):	355.7 to 356.07
Maximum Daily Flow:**	22.9 m^3/s
Minimum Daily Flow*:**	1.5 m3/s summer, 0.4 m, January 1 to March 15
Natural Environment Constraints:	Significant portion of primary lake trout spawning shoal in lake dewatered by the present winter drawdown.
Social Constraints:	Shoreline infrastructure ranged from 355.83 to 355.98 m. High spring water levels may cause ice damage and shoreline erosion. Fall drawdown levels may impact navigation. Low winter water levels are a concern for dug well and water lines.
Other:	Lake is often hard to fill in the spring if snowmelt and rainfall is less than normal. Lake operated to provide winter flow that contributes to the hydropower potential of the South Branch

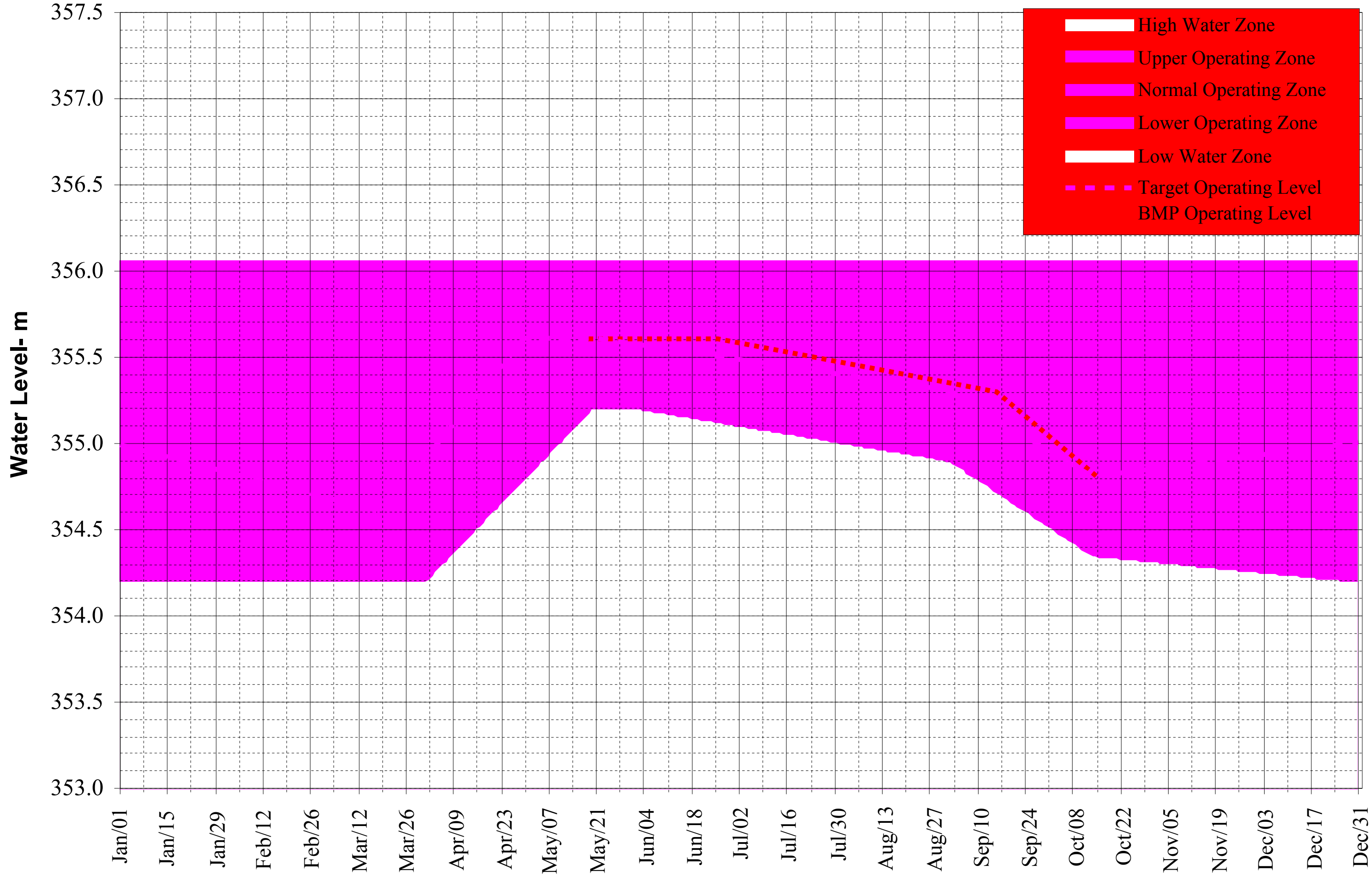


Figure 12.2.5
Muskoka River Water Management Plan
Kawagama Lake Operating Plan

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Back of figure

Benefits and Resolution of Issues

- Reduced NOZ and TOL with less difference between seasonal levels.
- Lower spring peak to address shoreline erosion concerns on east end of lake (windward side).
- BMP instituted to take advantage of those years with more rainfall/runoff in response to resident concerns about lower summer levels. BMP retains existing summer TOL and delays initiation of fall drawdown until September 15 (provided hydrologic conditions are adequate)
- Reduced winter drawdown will decrease the differential between the fall and winter drawdown levels to improve lake trout spawning habitat.
- Less winter drawdown will increase the amount of winter aquatic habitat
- Identified baseflow into the Hollow River matches the levels historically provided (lake was not providing 3 m^3/s during most summer seasons).

Conflicts

- Reduced winter flow regime may impact waterpower potential during that time of year. Compensated by increased flow during the summer season from other lakes within the watershed.

Public Comments

Environmental Component	Comment	Resolution
Infrastructure	"low water levels in March sometimes cause the water level in our dug well to be very low" "fluctuating flows or levels affect docks" Four other similar comments re: infrastructure	March 15 TOL is 42 cm (16.5") higher than with the previous operating plan. Overall differential between fall and winter levels reduced by the same amount.
Navigation/boat access/seasonal water level change	"These rapid drawdowns also put severe limitations on extended water access to shoreline properties in the fall season" "these early drawdowns increase navigation risks as hazards are now just below the surface during early fall" "the number one problem for our membership [Kawagama Lake Cottager's Association] is the rapid fall drawdown making it impossible for many cottagers to use their boats up to and including the Thanksgiving weekend."	Initiation of fall drawdown delayed to September 15 when hydrologic conditions permit (as per BMP).
	"I think it's safe to say that Kawagama property owners (the majority) are going to be seriously disappointed (with Case Two option as described in the Options Report). They were looking for more equity throughout the system – we still have almost twice the range that any other settled lake on the system has" Fifteen other similar comments re: navigation / boat access/seasonal water level change	Large lake area and limited inflow make it difficult to maintain summer levels unless outflow from the lake was reduced to zero. Fall (October 15) elevation maintained to allow lake trout to utilize historic spawning areas. Enhancements to lake trout spawning habitat attained by elevating winter drawdown level as opposed to lowering fall drawdown level (so as to reduce water level differential between those two time periods).
Erosion	"we have lost at least 30' of beach and dunes, many hundred year old trees because of high water level" "the entire shoreline of the east end is being eroded when the water level is high in the spring" Six other similar comments re: erosion	Spring (May 1 to 15) TOL reduced by 0.16 m compared to present operating plan.

Environmental Component	Comment	Resolution
Fish and Wildlife	"Impacts [of water level drawdown and fluctuation] are believed to include a negative effect on lake trout propagation, loon nesting" "the marsh area has lost area where many ducks and birds spawn" Seven other similar comments re: fish and wildlife	Reduced winter drawdown will result in less mortality of lake trout eggs and maintain a greater wetted area and lake volume during the winter season.
Draft Plan Comments		
Water Levels and Lake Trout Habitat	"…accept the conclusion drawn from Kawagama Lake Spawning Study which indicated that raising the fall drawdown should destroy the primary spawning bed and virtually wipe out the lake trout population." "…Accept that the October 15 drawdown target could not be changed without breaking the law which states that it is illegal to knowingly destroy fish habitat." "…Pleased with the compromise postponing the start of the drawdown from September 1 to September 15 that was reached and that has been built into the new plan." "…Can count on your support and appropriate volunteer assistance as the monitoring proceeds. We are hopeful as you are that the changes will bring about a significant improvement in lake trout fishery in Kawagama.	MNR and industry partners in the WMP welcome the support and assistance of Kawagama Lake volunteers to assist with future monitoring and research projects.

Information and Science Needs

- Undertake lake trout spawning surveys on regular basis over term of plan to evaluate future use and hatching success at primary spawning shoal, as well as any expansion to new or presently unused spawning sites. Further investigate any spawning site expansion should it be noted.
- Undertake adult population studies over term of plan to evaluate whether improvements to egg survival translate into increased adult populations.
- Undertake creel/harvest surveys over the term of the plan so as to take harvest variability into account in the assessment of adult populations and the evaluation of the success of water management changes.

12.2.6 Lake of Bays – MNR

The operating plan for Lake of Bays is shown in Figure 12.2.6, and has the following characteristics:

Target Operating Level Range:	314.5 to 315.32 m
Normal Operating Zone Range:	314.34 to 315.38 m
Absolute Range:	314.28 to 315.5 m
Summer* Range (Typical):	315.05 to 315.35 m
Winter Drawdown:	315.22 to 314.5
Flood Allowance (lake/river):	315.38 to 315.5 m/99.1 m^3/s
Maximum Daily Flow:**	85.9 m^3/s
Minimum Daily Flow*:**	5 m^3/s from April 15 to June 1 (or dates as determined by MNR based on water temperature at South Falls).
Natural Environment Constraints:	Cold-water lake with a number of lake trout spawning shoals partially within or close to late winter/early spring drawdown zone
Social Constraints:	Extensive high value shoreline development. Infrastructure elevations range from 315.47 to 316.03 m. Potential for ice damage (in the spring) when high winds and high water levels occur simultaneously.
Other:	Target outflow of 17 m^3/s provided during winter for waterpower generation.

Benefits and Resolution of Issues

- No change to upper extent of NOZ; slight downward expansion of NOZ in the fall to accommodate a lower October 15 TOL.
- No change to summer recreation season attributes.
- Earlier and slightly higher spring peak with a gradual seasonal drawdown to improve ecological conditions for wetlands, spring spawning fish species and shoreline riparian areas.

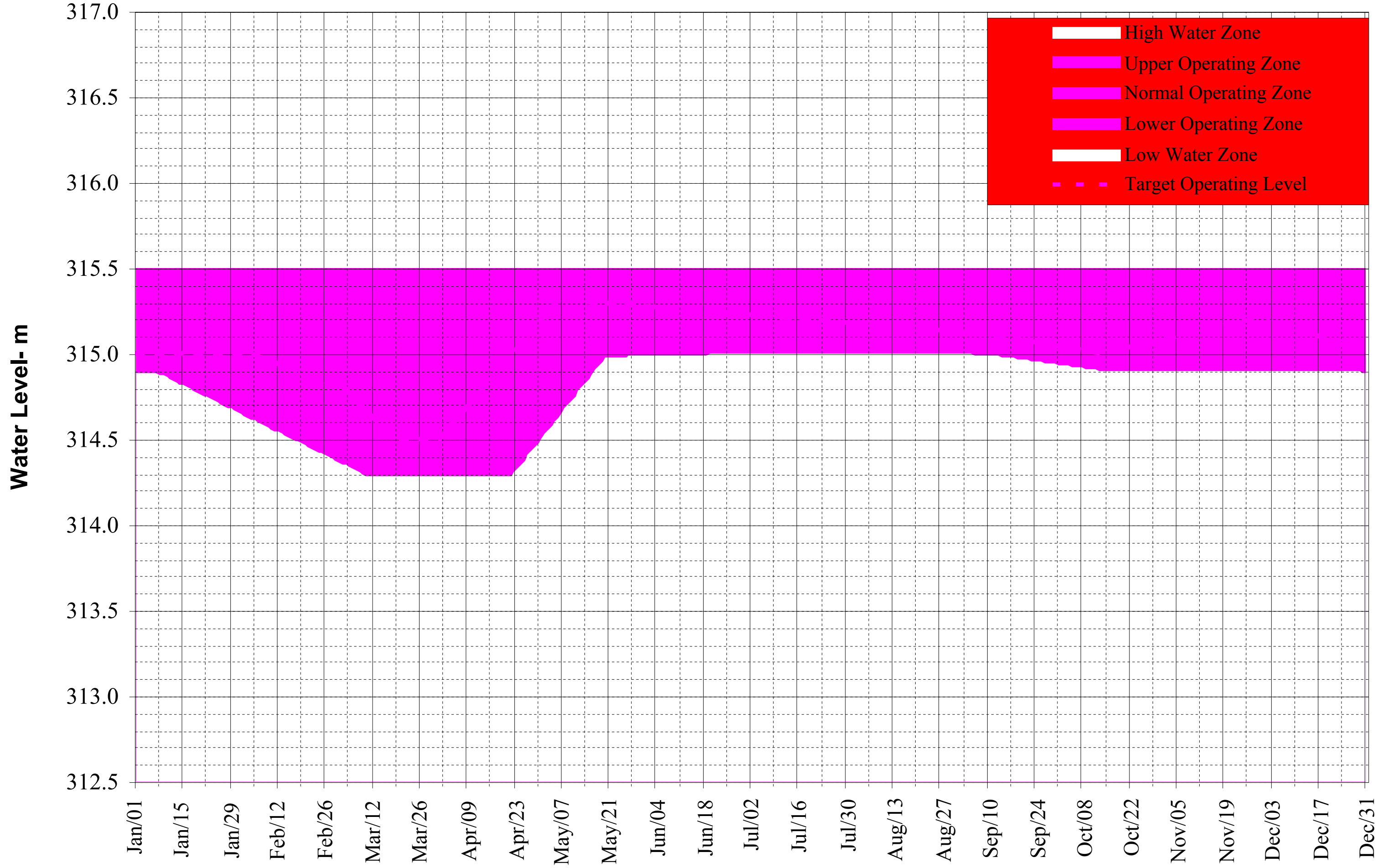

Figure 12.2.6
Muskoka River Water Management Plan
Lake of Bays Operating Plan

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- back of figure

- Less differential between fall and winter levels to improve lake trout spawning habitat conditions.
- Improved downstream minimum and base flows in summer (higher and more consistent flow).

Conflicts

- Similar overall summer water level range, but more change to median summer water level due to gradual seasonal drawdown. Potential for negative response by residents accustomed to static summer levels.
- Lower October 15 TOL to enhance lake trout spawning habitat may create negative response from some lake residents.
- Slightly higher maximum outflow (approx 11%) and more exceedances of downstream flow limit (but only by 1 m^3/s in 26 of the 27 simulated cases) during high flow periods.

Public Comments

Environmental Component	Comment	Resolution
Infrastructure	"any water level excursion significantly above normal causes….dock damage problems…no late fall floods" "low water – water lines freeze" "try to keep water levels lower during ice break up and shortly following it in order to minimize damage of docks and other structures" "levels in excess of 6" above normal summer cause…dock damage"	Lower late summer and early fall water levels should lessen potential impact of late fall floods. Winter TOL 10 cm higher No change to spring peak.
Recreation	"water too high – no beach for our guests" "high water levels virtually eliminate my beach"	Gradual spring/summer season reduction will provide a range of water levels during the recreation season.
Erosion	"any water level excursion significantly above normal causes serious erosion…no late fall floods" "water too high -…erosion due to high water" "high water – shorelines subject to erosion from wave action" "levels in excess of 6" above normal summer cause erosion of shoreline" "high water levels…contribute to shoreline erosion"	Lower late summer and fall levels should address fall shoreline erosion concerns.
Navigation	"low water - …water travel becomes hazardous, access for boats becomes difficult" "water too low – docking issues, this however would have to be extreme too be a problem"	Gradual spring/summer season reduction will provide a range of water levels during the recreation season.
Lake trout spawning	"try your best to keep spawning trout covered until they hatch…I'd try to lower levels in September prior to spawning then raise them till freeze up – hold that level till after spawn and then drop for spring runoff" "allow lowering water only after lake trout spawn has hatched" "winter drawdown affects the lake trout spawning beds"	Lower fall TOL and higher winter TOL to reduce differential between these two critical levels (to 0.5 m vs 0.76 m presently) as it relates to lake trout spawning, incubation, hatch and eventual emergence from the spawning gravel. Studies being undertaken in Kawagama Lake (as a test lake) to assess effectiveness of strategy.

Environmental Component	Comment	Resolution
	"trout spawning beds need cover until they hatch"	
Waterpower	"I would like to see more green power, such as water generation. I feel that what is being proposed is very adequate, and should be our main concerns where water generation is involved"	Objective of plan has been to maintain or improve existing waterpower generation potential.
Downstream River Flows and Water Levels - Fraserburg Area		
Water Quality	"My major concern is the very low levels in the summer. The water stagnates, and I'm sure is unhealthy for wildlife and humans alike" "during summer months, the river is so low and flow is non-existent, that it smells and it is stagnant, even the possibility of E. coli exists" "..low water levels (not moving) will cause high levels of bacteria…this is our main source of drinking water" "at low level river stinks" A total of 28 comments regarding this topic were received.	Lake operating regimes revised to provide more consistent downstream flow during summer low flow period. Commitment by MNR to maintain flow of 3 m^3/s at Baysville dam, and utilize the range within the NOZ rather than focusing on the TOL.
River Flows/ Flooding	"The release of water at Baysville into the South Branch should be more effectively controlled so as to minimize the possibility of flooding the lower-lying properties in Fraserburg" "2.5 cms water flow too low, and 48 cms water flow is flood zone" "…the most important part of water management is communicating of level adjustments between the parties. The MNR doesn't seem to consider that they have a responsibility to the other operators or the residents. But, of course, they must have adequate staff of responsible people to do this work" "water levels on South Muskoka River be properly coordinated between dams so that no sudden drawdown occurs between June and September"	Current operating strategy for the river system is to quickly pass high flow events through the system to return lakes to NOZ levels. Greater recognition of adverse effects of this practice was gained as a result of this planning process. MNR to obtain operational tools (i.e., flood forecast model) to improve operational capabilities. More emphasis on equitable distribution/sharing of high levels between lakes and river reaches during high flow events.

Environmental Component	Comment	Resolution
	A total of 10 comments regarding this topic were received.	
Erosion	"land is flooded in the spring and fall causing erosion along the shore" "in recent years we have seen chunks of land floating down the river due to this quick variations in water levels" A total of 7 comments regarding this topic were received.	Current operating strategy for the river system is to pass high flow events through the system to return lakes to NOZ levels. Greater recognition of adverse effects of this practice as a result of this planning process. MNR to obtain operational tools (i.e., flood forecast model) to improve operational capabilities. More emphasis on equitable distribution/sharing of high levels during high flow events.
Navigation / boat access / docks	"When the water level goes way down, the boat usually gets stuck in mud" "maintain a higher level, consistently avoiding damage to docks and boats" A total of 25 comments regarding this topic were received.	Lake operating regimes revised to provide more consistent downstream flow during summer low flow period. Commitment by MNR to maintain flow of 3 m^3/s at Baysville dam, and utilize the range within the NOZ rather than focusing on the TOL.
Infrastructure (water lines)	"if they keep on dropping water levels and flows it will affect our water line. This is our water source. If they drop it any lower it could start sucking mud…which could cost thousands of dollars to repair" "tenuous low levels expose foot valve in summer, in fall exposed line freezes" A total of 12 comments regarding this topic were received.	Lake operating regimes revised to provide more consistent downstream flow during summer low flow period. Commitment by MNR to maintain flow of 3 m^3/s at Baysville dam, and utilize the range within the NOZ rather than focusing on the TOL.
Fish and Wildlife	"water levels fluctuate too much in the summer and will affect fish spawning and other wildlife" "there are countless fish spawning sites, especially bass nests which become exposed when the water level drops too far. Also marsh nesting birds become vulnerable" A total of 24 comments regarding this topic were received.	Lake operating regimes revised to provide more consistent downstream flow during summer low flow period. Commitment by MNR to maintain flow of 3 m^3/s at Baysville dam, and utilize the range within the NOZ rather than focusing on the TOL.

Environmental Component	Comment	Resolution
Recreation (e.g., swimming)	"swimming precarious during high water" "poor swimming due to frequent low water level" A total of 6 comments regarding this topic were received.	Lake operating regimes revised to provide more consistent downstream flow during summer low flow period. Commitment by MNR to maintain flow of 3 m^3/s at Baysville dam, and utilize the range within the NOZ rather than focusing on the TOL.
Draft Plan Comments		
Water Levels and Flora and Fauna Investigations	"…resolved that the Council of the Corporation of the Township of Lake of Bays recommends to the Ministry of Natural Resources that they continue to study the impacts of fluctuating water levels on flora and fauna." "Resolution supports conclusions/ recommendations of Ms. Judi Brouse, Director of Waters Program for the District Municipality of Muskoka dated September 16, 2005 in that the data required to fully understand the implications of water fluctuations on flora and fauna is incomplete. It is recommended that the MNR continue to study the impact of fluctuating water levels on the flora and fauna of the watershed and that operating procedures be reviewed and updated from time to time to incorporate new findings and understandings.	MNR and partners will keep the Township of Lake of Bays apprised of progress and results from monitoring programs.

Information and Science Needs

- Develop procedures to assess potential improvements to summer riverine habitat as a result of higher summer base flows
- Compare results of Kawagama Lake investigations to existing studies from Lake of Bays. Decide upon need for similar investigations in Lake of Bays during next term of plan.

12.2.7 Wood Lake – MNR

The operating plan for Wood Lake is shown in Figure 12.2.7, and has the following characteristics:

Target Operating Level Range:	300.6 to 301.15 m
Normal Operating Zone Range:	300.45 to 301.35 m
Absolute Range:	300.25 to 301.67 m
Summer* Range (Typical):	300.95 to 301.1 m
Winter Drawdown:	300.8 to 300.6 m
Flood Allowance (lake/river):	301.35 to 301.67
Maximum Daily Flow:**	2.6 m^3/s
Minimum Daily Flow*:**	0.1 m^3/s target

Natural Environment Constraints:	Warm-water lake, no identified environmental constraints.
Social Constraints:	Extensive shoreline property development.
Other:	None

Benefits and Resolution of Issues

- No change to NOZ. Minor adjustment to TOL to provide more consistent spring, summer, and fall downstream flows to maintain habitat and social values in the South Branch.

Conflicts

None

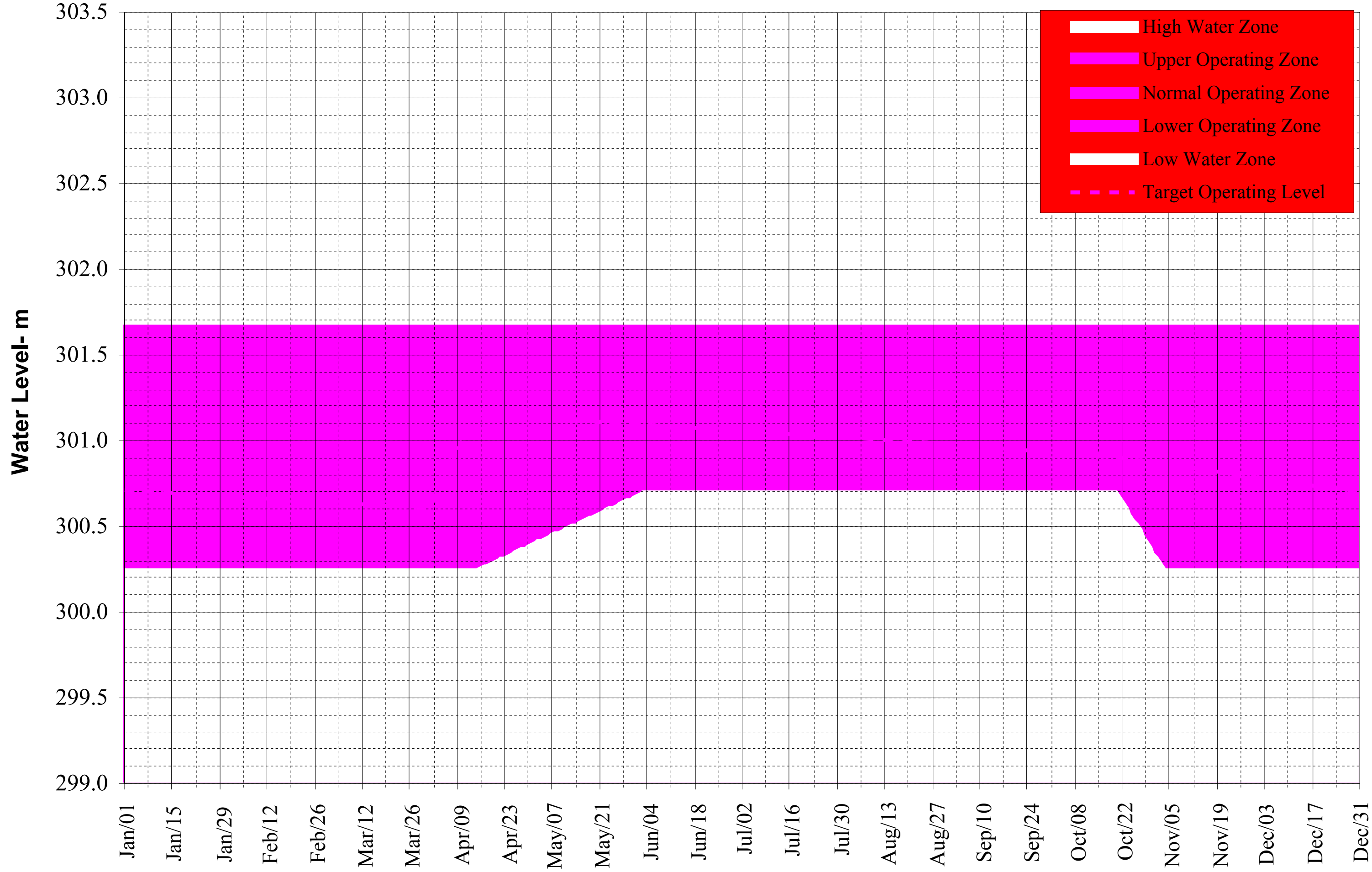

Figure 12.2.7
Muskoka River Water Management Plan
Wood Lake Operating Plan

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Back of figure

Public Comments

Environmental Component	Comment	Resolution
Shoreline erosion	"High water level on Wood Lake should be kept below 301.6 m – Experience over 53 years shows that levels above 301.6 m can cause significant shoreline erosion at the east end of Wood Lake"	NOZ unchanged (300.45 to 301.35 m), TOL is 10 cm higher in the spring, declining over the summer to 5 cm below the previous end of summer level.

Information and Science Needs

None

12.2.8 Matthias Generating Station - Orillia Power Corporation

The operating plan for Matthias Generating Station is shown in Figure 12.2.8, and has the following characteristics:

Normal Operating Zone:	292.0 to 293.2 m (spring) 292.0 to 293.0 m (rest of year)
Best Management Practice:	Follow March 15 – June 1 water level curve Remain above 292.5 m from June 1 to June 15 Remain above 292.3 m from June 15 to September 15
Summer* Range (Typical):	292.0 to 293.0 m
Winter Drawdown:	None
Flood Allowance:	None. The facility has adequate discharge capacity and will coordinate their operations with upstream and downstream facilities when river levels pass beyond the specified High Flow Trigger. Levels may exceed the upper extent of the NOZ at this time.
Maximum Daily Flow:**	100.32 m^3/s
High Flow Trigger:	109.8 m^3/s
Minimum Daily Flow*:**	3 m^3/s measured on an hourly basis, from April 15 to June 1 (or dates as determined by MNR based on water temperature at South Falls).
Low Flow Trigger	3 m^3/s
Energy Emergency:	None
Natural Environment Constraints:	Extensive wetlands at upper end of reservoir – positively affected by higher spring water levels, adversely affected by large scale mid-season fluctuations. Minimize water level fluctuation during centrarchid spawning/hatch period.

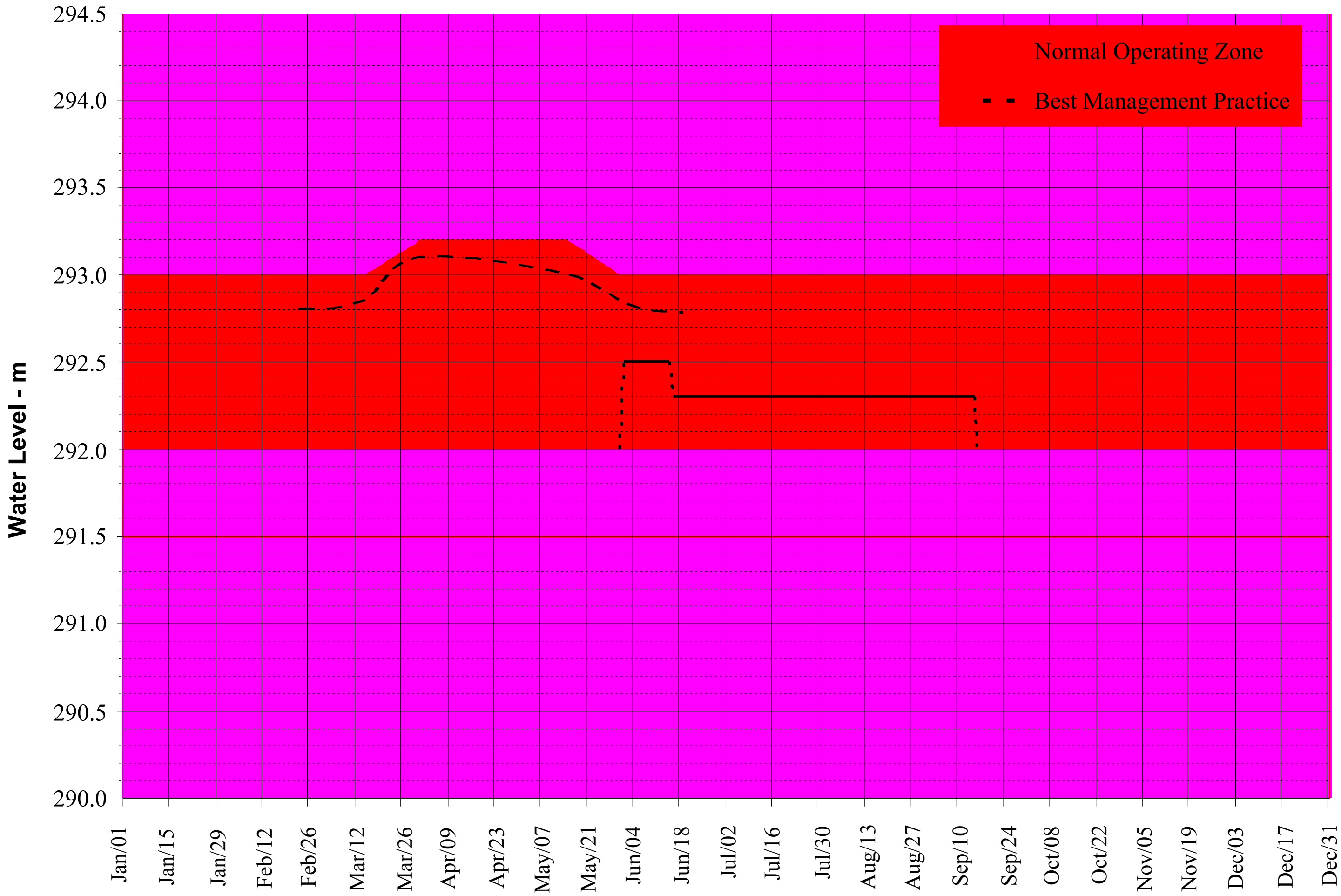

Figure 12.2.8
Muskoka River Water Management Plan
Matthias Reservoir Operating Plan

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Back of figure

Social Constraints: Large water level fluctuations adversely affect access to docks and shoreline property.

Other: A minimum flow of 3 m^3/s is released from the upstream lakes to maintain base flow during the summer season.

Benefits and Resolution of Issues

- Reduced absolute operating range, with legally enforceable upper and lower limits under normal operating conditions. High and Low Flow Triggers to address flow extremes (whether naturally occurring or the result of upstream dam operation).
- BMP established for spring period to provide ecological improvements for wetlands, amphibians, spring spawning fish species and shoreline riparian zone areas.
- BMP established during centrarchid spawning period to provide improvements
- BMP established during the summer recreation period for social enhancements (e.g., improved navigation, access to shoreline properties, maintaining water intakes) and environmental enhancements (benefits for fish and wildlife and wetland plants species).
- Minimum flow release during the walleye spawning period to ensure consistent flow at South Falls.
- Consistent summer, fall and winter minimum flow (3 m^3/s provided from Baysville dam) to maintain social and ecological habitat values in the South Branch.

Conflicts

- The facility is considered run-of-river, and relies on flow provided from Lake of Bays and associated upstream waterbodies. More coordination between MNR and OPGC will be required to allow OPGC to remain within the narrower operating range.
- The narrower absolute range within the plan reduces the flexibility of the waterpower operator to alter head-pond levels in response to energy demands.

Public Comments

Environmental Component	Comment	Resolution
Navigation/boat access/water levels	"if water levels are too low we have no access to the property. We have been stranded on several occasions due to low water levels, not being able to leave our property" "Orillia Hydro has done a much better job of water control for the last couple of years…" ""'… water levels were much more stable this past year. Perhaps this study has already encouraged dam operators to be more contentious, coordinate actions up and downstream, etc" "Hydro users are entitled to the flow and that's all. With modern controls at their disposal, levels can be kept to within ½ m, and that should be their limit" "If you do not have control of water levels above Matthias GS to be kept in the normal "green" zone, you are wasting everyone's time" A total of 12 comments regarding this topic were received.	Reduced absolute operating range. BMP implemented by OPGC during the summer recreation period in recognition of shoreline resident's concerns regarding low water levels. Summer BMP provides a voluntary range of up to 0.7 m.
Erosion	"we have lost numerous trees and 2 ft of shoreline in the past 20 years" A total of 3 comments regarding this topic were received.	Current operating strategy for the river system is to pass high flow events through the system to return lakes to NOZ levels. Greater recognition of adverse effects of this practice as a result of this planning process. MNR to obtain operational tools (i.e., flood forecast model) to improve operational capabilities. More emphasis on equitable distribution/sharing of high levels between lakes and river reaches during high flow events.
Infrastructure	"when water level drops dramatically our… water supply valve is barely in water and sucking mud"	Reduced absolute operating range. BMP implemented by OPGC during the summer recreation period in recognition of shoreline resident's concerns regarding low water levels.

Environmental Component	Comment	Resolution
Fish and Wildlife	"pike and bass are prevalent – nests are in danger when water down, lots of geese and ducks – same problem with nesting" "Do not see the "proposals" as a concern at this time, but rather as a benefit, since historically, this section of the Muskoka River has received very little attention – re: the impacts of water level fluctuations. Pleased to see study of fish populations above Matthiasville Dam." "…we have a wetland area which serves fish, otters, herons, etc. When severe drawdowns occur, this habitat is left high and dry" A total of 13 comments regarding this topic were received.	Reduced absolute operating range. BMP implemented by OPGC during the spring and early summer in recognition of concerns regarding fish spawning, and riparian and littoral zone habitat.
Recreation (i.e., swimming)	A total of 5 comments were received regarding water management's affect on swimming, particularly low water levels.	Reduced absolute operating range. BMP implemented by OPGC during the summer recreation period in recognition of shoreline resident's concerns regarding low water levels.
"Green" power	"I would like to see more green power used" "Explore new technology to generate more power from the same flow rates" A total of 3 comments regarding this topic were received.	Goal of present operating strategy is to maintain or enhance existing waterpower potential throughout the river system.

Information and Science Needs

- Further investigations of fish spawning activity (northern pike, yellow perch, smallmouth bass, rock bass and pumpkinseed) during the spring and early summer to better define areas being utilized and extent of use relative to river and head pond water levels.

12.2.9 Trethewey Generating Station – OPG

The operating plan for Tretheway Generating Station is shown in Figure 12.2.9, and has the following characteristics:

Normal Operating Zone:	278.52 to 279.43 m
Summer* Range (Typical):	278.52 to 279.43 m
Winter Drawdown:	None
Flood Allowance:	None. However, the facility has limited discharge capacity and cannot control river levels beyond the specified High Flow Trigger. Levels may exceed the upper extent of the NOZ at this time.
Maximum Daily Flow:**	101.4 m^3/s
High Flow Trigger:	110.8 m^3/s
Minimum Daily Flow*:**	None
Low Flow Trigger	3 m^3/s
Energy Emergency:	None
Natural Environment Constraints:	Low water levels may impact fish habitat. Flow balancing required with upstream and downstream facilities during walleye spawning.
Social Constraints:	Low water levels may impact navigation.
Other:	A minimum flow target of 3 m^3/s is released from the upstream lakes to maintain base flow in the river system during the summer period.

Benefits and Resolution of Issues

- Reduced absolute operating range, with legally enforceable upper and lower limits under normal operating conditions. High and Low Flow Triggers to address flow extremes (whether naturally occurring or the result of upstream dam operation).
- Consistent summer, fall and winter minimum flow (3 m^3/s) to maintain social and ecological habitat values in the South Branch leading into Lake Muskoka.

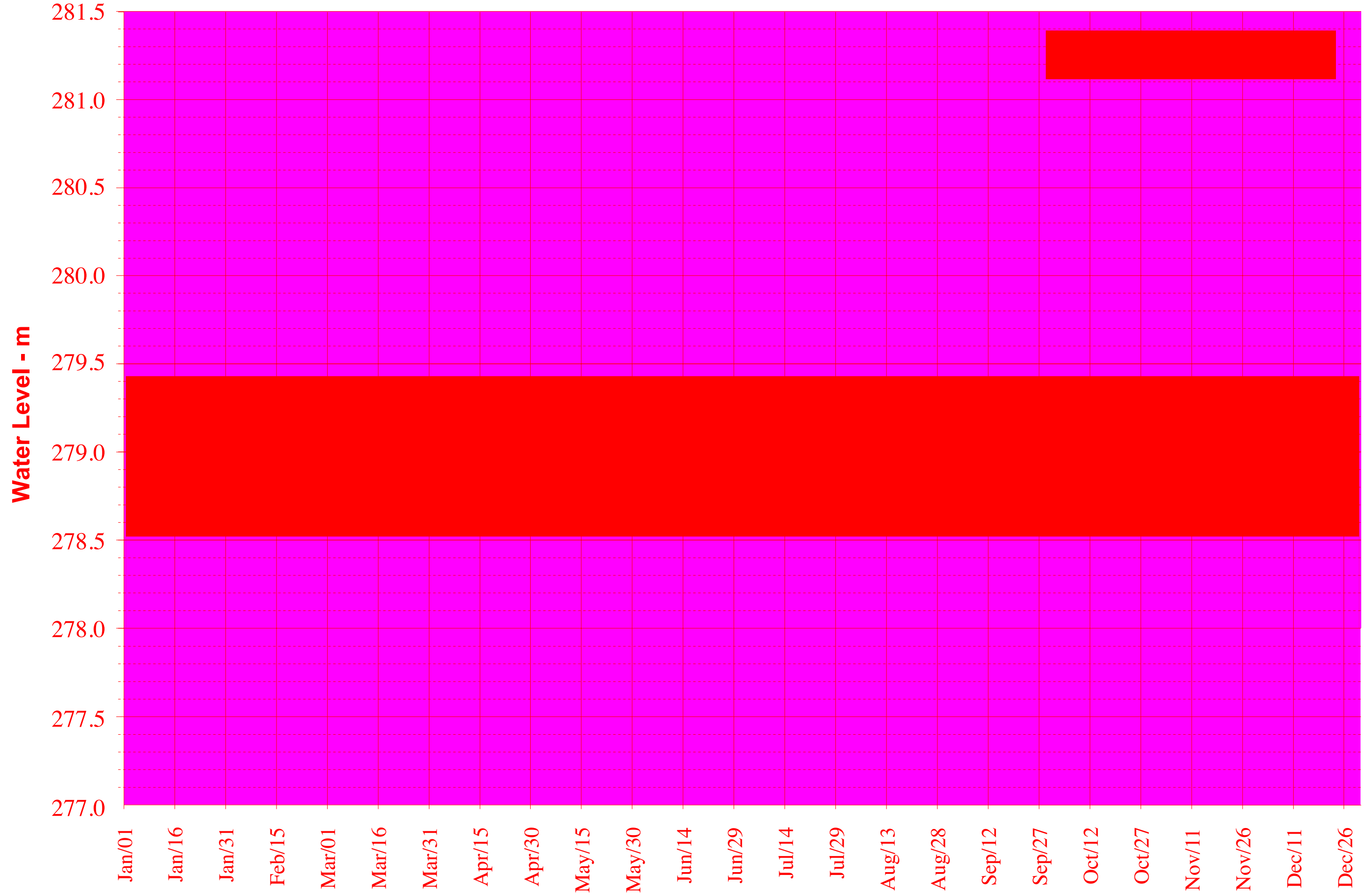

Figure 12.2.9
Muskoka River Water Management Plan
Trethewey Reservoir Operating Plan

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Back of figure

Conflicts

- The facility is considered run-of-river, and relies on flow provided from Lake of Bays and associated upstream waterbodies. More coordination between MNR and OPGC will be required to allow OPGC to remain within the narrower operating range.
- The narrower absolute range within the plan reduces the flexibility of the waterpower operator to alter head pond levels in response to energy demands.

Public Comments

Environmental Component	Comment	Resolution
Water Levels (Between Matthias GS and Trethewey GS)	"We wish there was a way to lessen the dramatic water level changes. Our water levels change often." "Power generation targets re liable to add to river level fluctuations. It is apparent that the extreme water level fluctuations will not be addressed by the proposed plan. River levels that swell and recede hourly will continue. It is obvious that the chief concern will be selling hydro-electric power. Only serious investment to homogenize turbine capacities can mitigate the problem. Anything less neglects harm done" "I would like to see the water level differentials to be closer" A total of 4 similar comments on this topic were received.	Reduced absolute operating range, but continued ability to fluctuate water levels within that narrower, legally enforceable zone. Lake operating regimes revised to provide more consistent downstream flow during summer low flow period. Commitment by MNR to maintain flow of 3 m^3/s at Baysville dam, and utilize the range within the NOZ rather than focusing on the TOL.
"Green" power	"I would like to see more green power used" "Explore new technology to generate more power from the same flow rates" A total of 4 similar comments on this topic were received.	Goal of present operating strategy is to maintain or enhance existing waterpower potential throughout the river system.

Information and Science Needs

None

12.2.10 Hanna Chute Generating Station – OPG

The operating plan for Hanna Chute GS is shown in Figure 12.2.10, and has the following characteristics:

Normal Operating Zone:	268.11 to 268.71 m
Summer* Range (Typical):	268.11 to 268.71 m
Winter Drawdown:	None
Flood Allowance:	None. However, the facility has limited discharge capacity and cannot control river levels beyond the specified High Flow Trigger. Levels may exceed the upper extent of the NOZ at this time.
Maximum Daily Flow:**	103.5 m^3/s
High Flow Trigger:	112.6 m^3/s
Minimum Daily Flow*:**	None
Low Flow Trigger	3 m^3/s
Energy Emergency:	None
Natural Environment Constraints:	Flow balancing required with upstream and downstream facilities during walleye spawning.
Social Constraints:	None
Other:	A minimum flow target of 3 m^3/s is released from the upstream lakes to maintain base flow in the river system during the summer period.

Benefits and Resolution of Issues

- Reduced absolute operating range, with legally enforceable upper and lower limits under normal operating conditions. High and Low Flow Triggers to address flow extremes (whether naturally occurring or the result of upstream dam operation).
- Consistent summer, fall and winter minimum flow (3 m^3/s) to maintain social and ecological habitat values in the South Branch leading into Lake Muskoka.

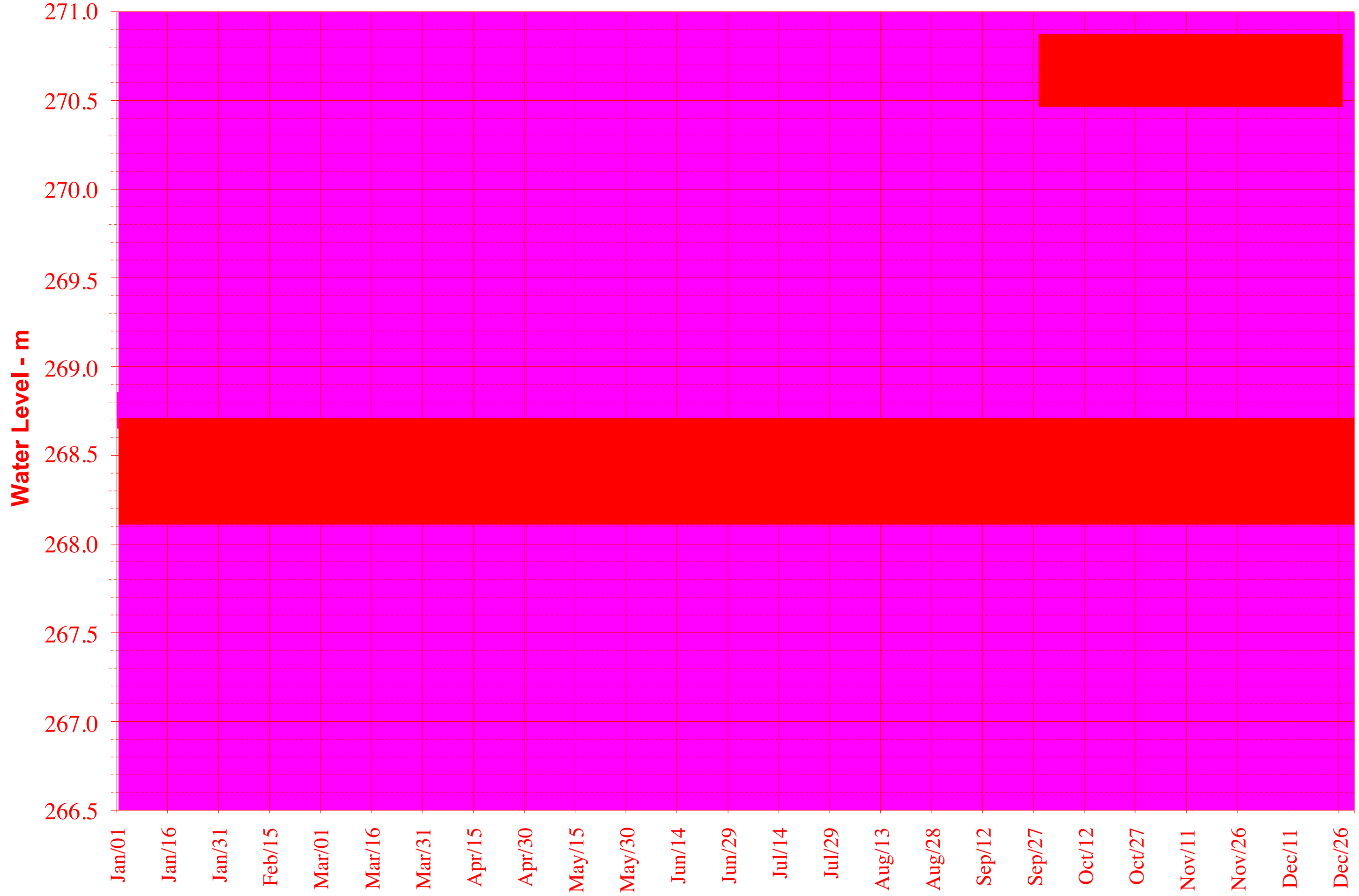

Figure 12.2.10
Muskoka River Water Management Plan
Hanna Chute Reservoir Operating Plan

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Back of figure

Conflicts

- The facility is considered run-of-river, and relies on flow provided from Lake of Bays and associated upstream waterbodies. More coordination between MNR and OPGC will be required to allow OPGC to remain within the narrower operating range.
- The narrower absolute range within the plan reduces the flexibility of the waterpower operator to alter head-pond levels in response to energy demands.

Public Comments

None

Information and Science Needs

None

12.2.11 South Falls Generating Station – OPG

The operating plan for South Falls GS is shown in Figure 12.2.11, and has the following characteristics:

Normal Operating Zone:	258.59 to 259.5 m
Summer* Range (Typical):	258.59 to 259.5 m
Winter Drawdown:	None
Flood Allowance:	None. However, the facility has limited discharge capacity and cannot control river levels beyond the specified High Flow Trigger. Levels may exceed the upper extent of the NOZ at this time.
Maximum Daily Flow:**	103.5 m^3/s
High Flow Trigger:	112.6 m^3/s
Minimum Daily Flow*:**	None
Low Flow Trigger	3 m^3/s
Energy Emergency:	None
Natural Environment Constraints:	Major walleye spawning area (for Lake Muskoka) below South Falls. OPG to provide a consistent minimum flow of 3 m^3/s through the spillway and over the spawning bed during the walleye spawning period (dates to be established by MNR based on temperature data collected at site).
Social Constraints:	None.
Other:	A minimum flow of 3 m^3/s is released from the upstream lakes to maintain base flow in the river system during the summer period.

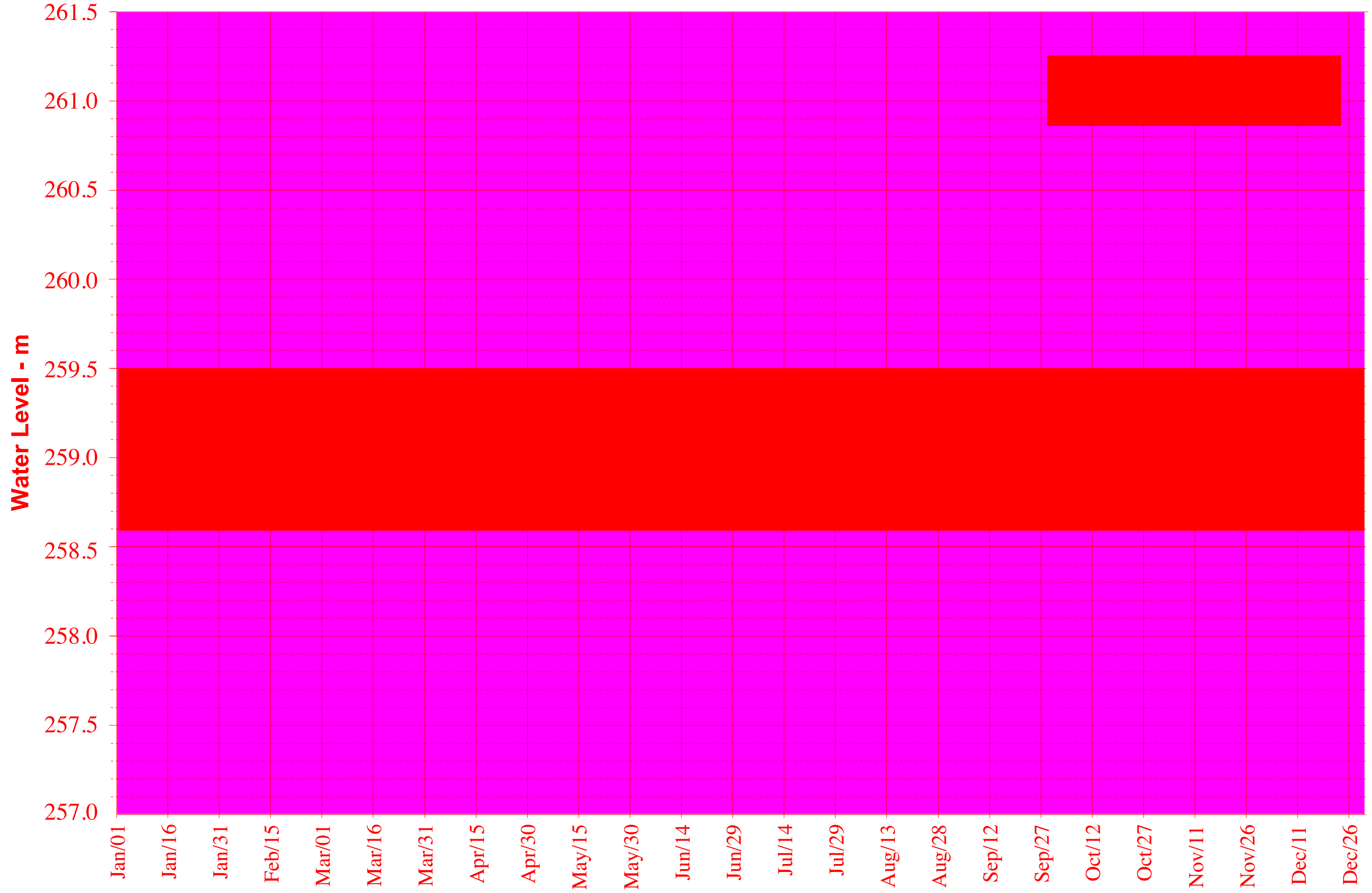

Figure 12.2.11
Muskoka River Water Management Plan
South Falls Reservoir Operating Plan

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Back of figure

Benefits and Resolution of Issues

- Reduced absolute operating range, with legally enforceable upper and lower limits under normal operating conditions. High and Low Flow Triggers to address flow extremes (whether naturally occurring or the result of upstream dam operation).
- Minimum flow of 3 m^3/s (measured on an hourly basis) provided through the spillway channel from approximately April 15 to June 1* to maintain walleye spawning site adjacent to the South Falls powerhouse.
- Consistent summer, fall and winter minimum flow (3 m^3/s) to maintain social and ecological habitat values in the South Branch.

Conflicts

- The facility is considered run-of-river, and relies on flow provided from Lake of Bays and associated upstream waterbodies. More coordination between MNR and OPG will be required to allow OPG to remain within the narrower operating range.

Public Comments

Environmental Component	Comment	Resolution
Recreation	"I do not understand why the beach at Muskoka Falls cannot enjoy a consistent, nice water level when OPG controls both South Falls and Hanna Chute. It is a small beautiful bay."	Reduced absolute operating range, but continued ability to fluctuate water levels within that narrower, legally enforceable zone.

Information and Science Needs

- Evaluate operational data (i.e., flows from Baysville, Matthias and South Falls) to determine whether management plan is providing the desired result of a consistent minimum flow of 3 m^3/s during the walleye spawning period.

* Dates to be established by MNR based on water temperature at site.

12.3 Lower Muskoka River

12.3.1 Lakes Rosseau and Joseph – MNR

The operating plan for Lakes Rosseau and Joseph is shown in Figure 12.3.1, and has the following characteristics:

Target Operating Level Range:	225.65 to 226.2 m
Normal Operating Zone Range:	225.4 to 226.25 m
Absolute Range:	225.3 to 226.37 m
Summer* Range (Typical):	226.0 to 226.15 m
Winter Drawdown:	226.0 to 225.65 m
Flood Allowance (lake/river):	226.25 to 226.37 m/42.0 m^3/s
Maximum Daily Flow:**	64.8 m^3/s
Minimum Daily Flow*:**	1 m^3/s, summer target

Natural Environment Constraints:	Lake trout spawning shoals on Lake Rosseau potentially within the winter drawdown zone.
Social Constraints:	Extensive high value shoreline development with infrastructure ranging from 226.25 to 226.97 m. Potential for spring ice damage to infrastructure due to high spring levels. Navigational constraints at Port Carling Locks from April 15 to October 15.
Other:	Lake difficult to fill in the spring if lower than normal snowmelt and rainfall. Lake level difficult to maintain during dry summers due to limited inflow and high evaporative losses.

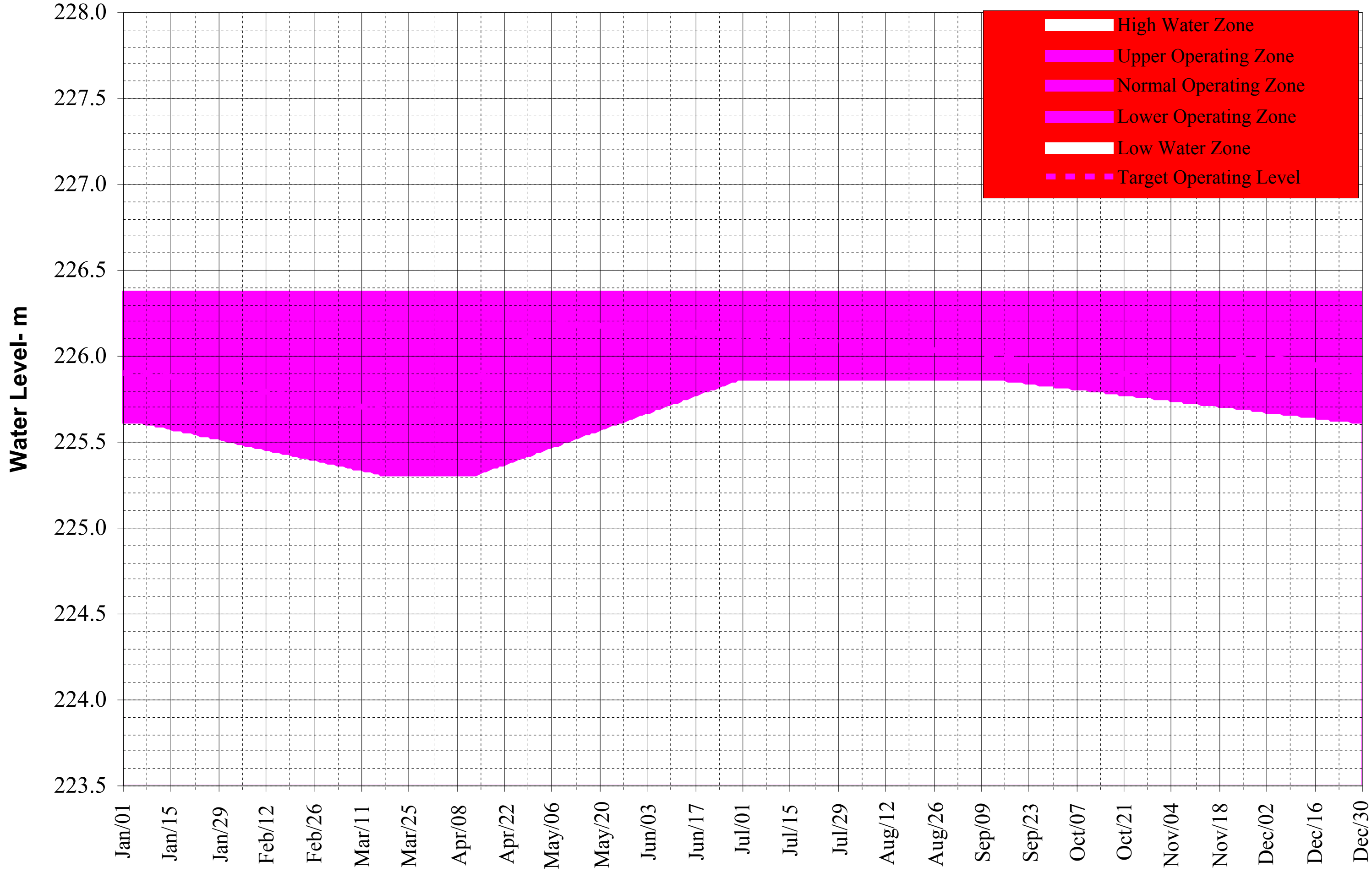

Figure 12.3.1
Muskoka River Water Management Plan
Lakes Rosseau & Joseph Operating Plan

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Back of figure

Benefits and Resolution of Issues

- A slightly higher spring peak with gradual seasonal drawdown to improve ecological conditions for wetland species, spring spawning fish species and shoreline riparian habitat.
- Less differential between fall and winter drawdown levels to improve lake trout spawning habitat conditions. Reduced winter drawdown will increase the amount of available aquatic habitat during this time period.
- Slightly higher summer target outflow and marginally more baseflow to improve downstream flow conditions for ecological health.

Conflicts

None

Public Comments

Environmental Component	Comment	Resolution
Infrastructure	"Indian River at Port Carling…low water levels any time from May to Oct/Nov result in our…boats (at the bow) bumping the sand bottom or resting on it, in their boathouse slips"	Difficult to maintain summer levels during those years when there is below normal rainfall, limited inflow and high evaporative losses.
Shoreline Erosion	"Serious shoreline erosion...during high water"	No change to NOZ or upper operating limit.

Information and Science Needs

None

12.3.2 Lake Muskoka – MNR

The operating plan for Lake Muskoka is shown in Figure 12.3.2, and has the following characteristics:

Target Operating Level Range:	224.9 to 225.6 m
Normal Operating Zone Range:	224.6 to 225.75 m
Absolute Range:	224.55 to 225.97 m
Summer* Range (Typical):	225.28 to 225.65 m
Winter Drawdown:	225.52 to 224.9 m
Flood Allowance (lake/river):	225.75 to 225.97 m/368.1 m^3/s (spring)/ 283.0 m^3/s (summer)
Maximum Daily Flow:**	309.6 m^3/s
Minimum Daily Flow*:**	6 m^3/s summer target (inclusive of 4 m^3 from Burgess)
Natural Environment Constraints:	Lake trout spawning shoals Flows for walleye spawning at Moon Falls
Social Constraints:	Extensive high value shoreline development with infrastructure ranging from 225.64 to 226.44 m Potential for spring ice damage to infrastructure. Low level can impede navigation access at Port Carling locks. High lake levels and high flows from Port Carling dam can cause flooding of Marinas on Indian River
Other:	Winter drawdown undertaken for downstream hydropower production

Benefits and Resolution of Issues

- Slightly higher spring peak with gradual seasonal drawdown to improve ecological conditions for wetland species, spring spawning fish species and shoreline riparian zone habitat.
- Less differential between fall and winter drawdown levels will improve lake trout spawning habitat conditions. Higher winter water levels will increase the available aquatic habitat during this time period.

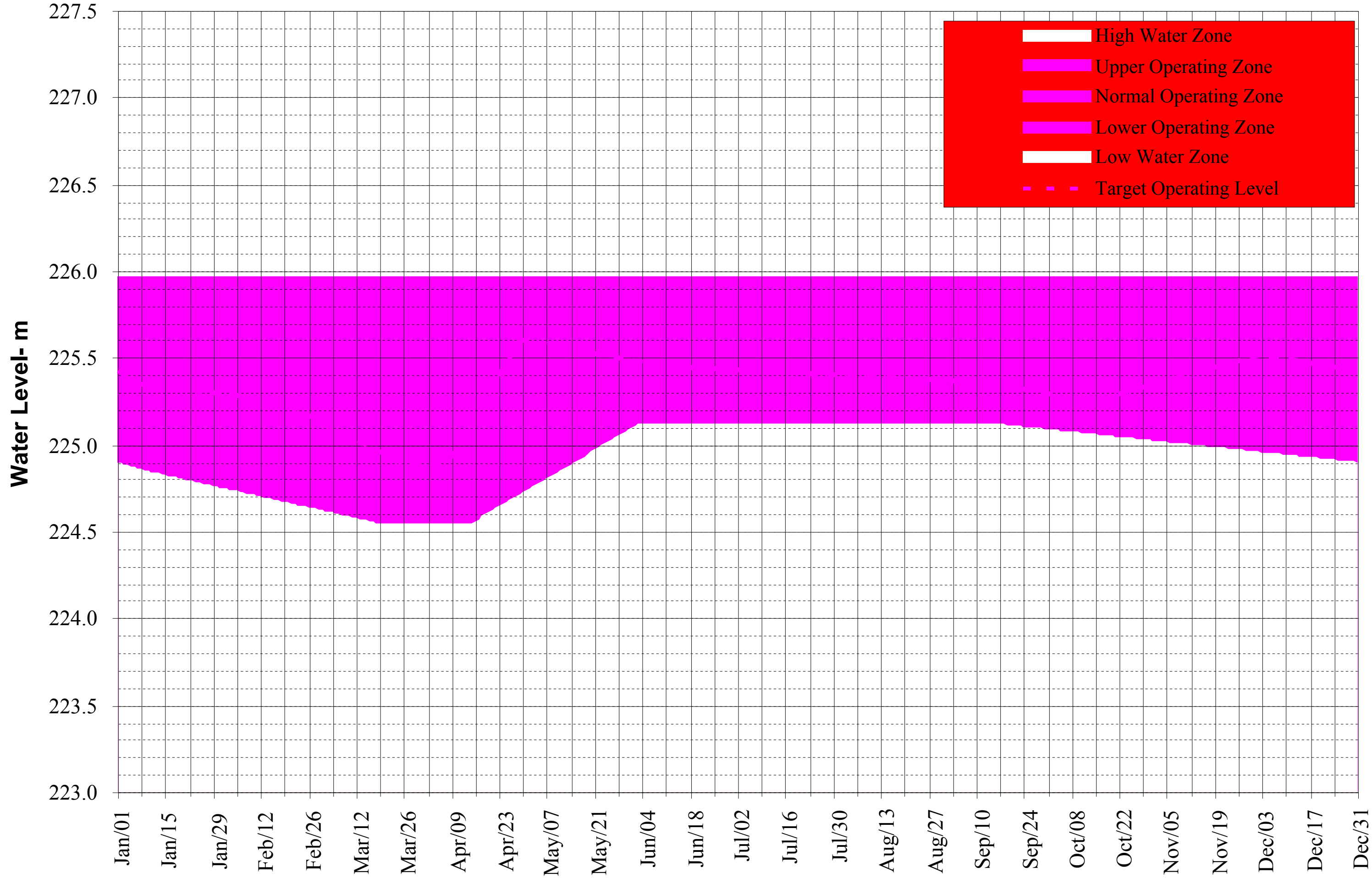

Figure 12.3.2
Muskoka River Water Management Plan
Lake Muskoka Operating Plan

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Back of figure

Conflicts

In March 2005, MNR released the Bala North site for potential waterpower development, with the intention that the successful developer would take over operation of both Bala dams. As of January 2006, one group had submitted a proposal to develop the site. Waterpower development at the site would follow the review and approval process noted below:

- Environmental Screening under Ontario Regulation 116/01 (Electricity Projects Regulation) administered by the MOE
- Federal Screening under the Canadian Environmental Assessment Act (CEAA)
- Integration of the requirements of the Water Management Planning Guidelines for Waterpower, administered by MNR, into the above-noted screenings
- Federal approvals (as required), potentially including Fisheries Act and Navigable Waters Protection Act authorizations
- Provincial approvals (as required), including Lakes and Rivers Improvement Act (MNR), Public Lands Act (MNR), Permit to Take Water (MOE), as well as various construction permits and approvals, etc
- Other municipal or local approvals/permits as required.

The timeline associated with the environmental assessment and approval process can range from 1 to 2 years.

Presently, the Bala dams are operated by MNR according to the operating strategy described in Sections 5 and 11 (page 5-36, Table 5.2, Section 11.4.3). Lake levels and outflows fluctuate around target levels in response to varying watershed conditions (i.e., rainfall, drought, etc) with the goal of maintaining levels with the NOZ and meeting downstream flow requirements.

Comments received during public consultation on the Draft Plan focused on a perceived change in operating strategy, with short-term water level fluctuations becoming a more common event. Comments are summarized in the table below and provided in their entirety in Appendix D.

Public Comments

Environmental Component	Comment	Resolution
Flooding	"Spring runoff, levels at ice break-up [impact me]" "Flooding, dock damage"	No change to flood or ice damage potential
Navigation	"Navigation on waterways…mouth of [Muskoka] River is silting in" "Navigation [at the mouth of the Muskoka due to silt]" "Lake Muskoka Levels …fluctuate enough to make navigation challenging" "Planning for a new dock requires good information about projected spring levels and the timing and target level for October. I have to deal with shallow water at my dock"	No navigation changes. Silting of river mouth on Lake Muskoka is outside the scope of this WMP.
Power generation	"very necessary strategy for the entire watershed… we need more hydropower generation – efficient and clean"	Goal of present operating strategy is to maintain or enhance existing waterpower potential throughout the river system.
Infrastructure	"It seems to me that MNR should be interested in whether improvements could be made in any way if money were available to modify the control structures"	Plan takes operating constraints and operational limits into consideration. Reviews of the integrity and safety of MNR structures are undertaken on a regular basis.
Upstream Reach between Bracebridge and Lake Muskoka		
Navigation/ Infrastructure	"lower summer levels would have possible negative impact on river and lake navigation and docking" "delay fall drawdown to mid October to avoid interference with boating"	Summer levels to remain within the previous NOZ. Fall drawdown needs to be completed by mid October for lake trout spawning.
Draft Plan Comments		
Power Generation at Bala North Site	"…gravely concerned about the potential impact of the proposed power generation installation at the Bala North damsite on the management of Lake Muskoka and the upper lakes." "…object to the development of a hydro generation plant at the Bala North damsite which would result in unacceptable and damaging fluctuations of Lake Muskoka water levels as it would become a head-pond reservoir."	A development at the Bala north site would be subject to federal and provincial environmental assessment (EA) processes, as well as MNR's Water Management Planning Process. These processes provide numerous and varied opportunities for public and stakeholder input into the proposed operational regime of the facility. Stakeholder and public groups are urged to take advantage of the various consultation opportunities

Environmental Component	Comment	Resolution
	"too large a range above and below its (Lake Muskoka's) summer target operating level. This range appears to open up the opportunities for the new operator to build up and release a potential head of water of approximately 38 cm/15 in for production of hydro in the high need season of the summer."	to review operational strategies and express their views.

Information and Science Needs

- MNR will obtain new operational tools (i.e. flood forecast model) to assist with the management of flows and levels throughout the Muskoka River system. A review of operational capabilities vs model predictions will be undertaken to assess the effectiveness of the new operating strategy in meeting flow and level goals and objectives
- An assessment of the ability to provide higher, more consistent flow, with fewer high volume peaks, throughout the spring walleye spawning period.

12.3.3 Burgess Generating Station - Algonquin Power

No changes are proposed to the operating plan for this facility. The facility is located on Lake Muskoka adjacent to the MNR controlled Bala North and Bala South dams, and provides a flow of 0.5 to 4 m^3/s into Bala Reach. The facility is advised (by MNR) when there is sufficient water to operate, and when it must shut down (typically when both Bala North and Bala South dams are closed and water levels on Lake Muskoka are falling below the NOZ). The facility will cease operations within 24 hours of the notification by MNR to shut down. As outflow from Lake Muskoka increases, flow is sequentially allocated to Burgess GS, then Bala South and lastly Bala North dam. Under declining flows, the priority of flow sequence is reversed. The operating range is the same as that of Lake Muskoka (see Figure 12.3.2 for Lake Muskoka operating ranges).

12.3.4 Bala Reach, Ragged Rapids and Moon Dam – OPG

The operating plan for Bala Reach, which is controlled by OPG's Ragged Rapids GS and Moon Dam, is shown in Figure 12.3.3 and has the following characteristics:

Normal Operating Zone:	219.0 to 219.3 m summer 219.2 to 219.5 m spring, fall & winter
Summer* Range (Typical):	219.0 to 219.3 m
Winter Drawdown:	None
Flood Allowance:	None. However, the facility has limited discharge capacity and cannot control river levels beyond the specified High Flow Trigger. Levels may exceed the upper extent of the NOZ at this time.
Maximum Daily Flow:**	88.9 m^3/s
High Flow Trigger:	85 m^3/s (at Bala Dams)
Minimum Daily Flow*:**	None
Low Flow Trigger	3 m^3/s
Energy Emergency:	None
Natural Environment Constraints:	Walleye spawning at Moon Falls in the spring (approximately April 15 to June 1 annually). Adequate flow in the Moon River during the summer low flow period.

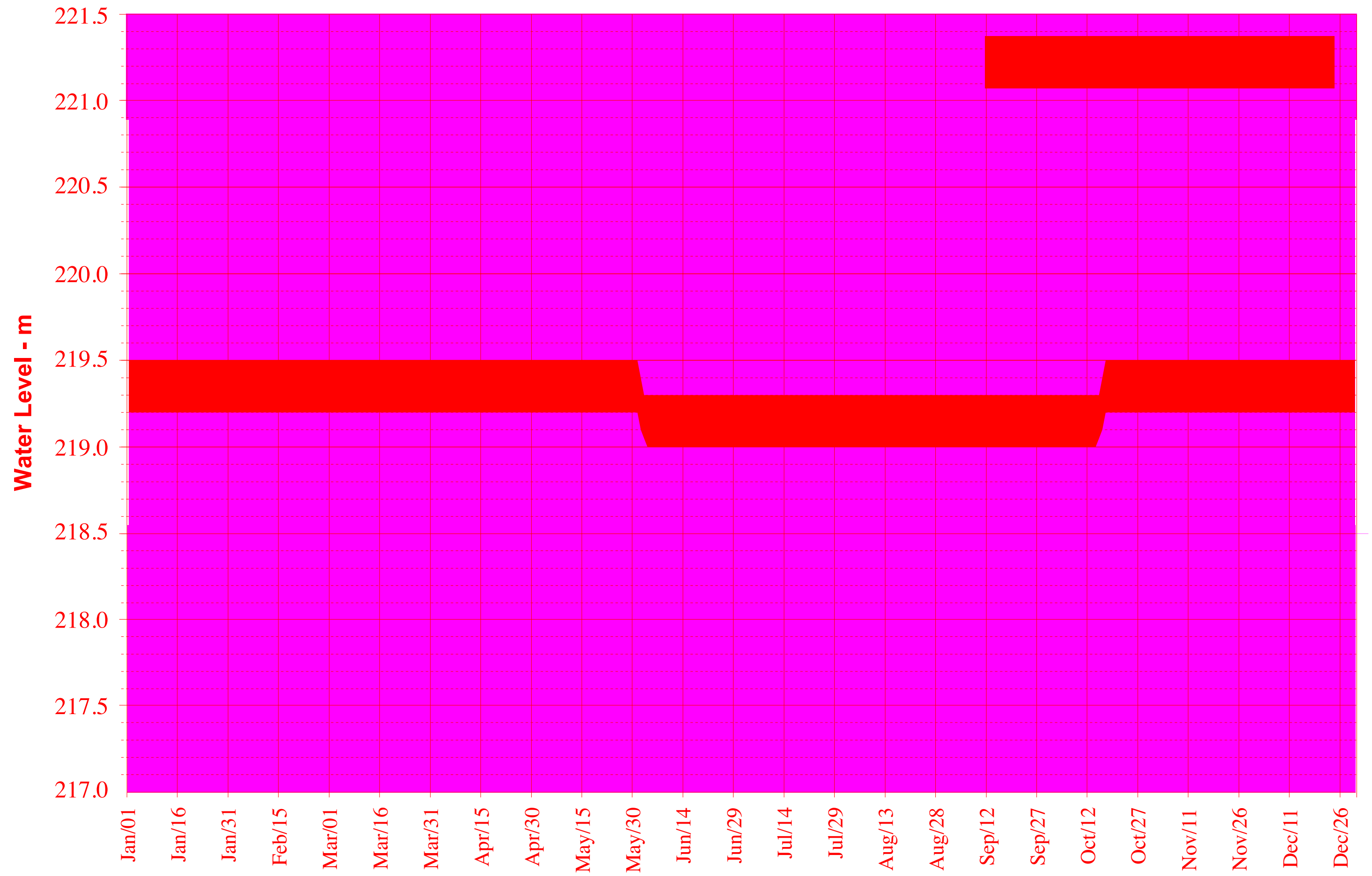

Figure 12.3.3
Muskoka River Water Management Plan
Bala Reach, Ragged Rapids and Moon Dam Operating Plan

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Back of figure

Social Constraints:	High water levels in Bala Reach may affect septic beds and inundate docks and cottage crawl spaces Low water levels in Bala Reach may restrict access to docks and properties.
Other:	Moon Chutes, located at the downstream end of Bala Reach, restricts outflow from Bala Reach at flows in excess of 85 m^3/s resulting in progressively higher levels as flows continue to increase. Flows and levels in Bala Reach are managed jointly by MNR and OPG. Optimum flow withdrawal for waterpower generation at Musquash stations (Ragged Rapids and Big Eddy) is 85 m^3/s.

Benefits and Resolution of Issues

- No change to the operational levels for the Bala Reach area. The TOLs, as recently agreed between OPG and area stakeholders, will become the legally enforceable upper and lower limits under normal operating conditions. High and Low Flow Triggers are provided to address flow extremes (whether naturally occurring or the result of upstream dam operation).
- Ragged Rapids head pond and Moon Dam are utilized by OPG to provide flow into the Musquash River for waterpower generation and to respond to high flow events. No operational limits established for Ragged Rapids head pond given the need to vary its levels to maintain Bala Reach within its TOL.
- Flow of approximately 4 m^3/s provided into Bala Reach via the Burgess Generating Station. An additional 2 m^3/s provided via leakage at the Bala dams to achieve an overall flow target of 6 m^3/s in the reach (see Lake Muskoka minimum flow target) during the summer low flow period.
- Summer flow (approximately 1 m^3/s) in the Moon River provided via leakage through the Moon Dam to maintain social and ecological habitat values. Studies to be undertaken to assess environmental values in this river reach.

Conflicts

- Water levels in Bala Reach are jointly managed by MNR and OPG (MNR operates Bala dams which provide flow into Bala Reach, OPG operates Ragged Rapids GS and Moon Dam which releases flow from Bala Reach). More coordination between MNR and OPG will be required to allow OPG to remain within the legally defined operating range.
- High water levels will still occur in Bala Reach during high flow events due to the limited storage available in upstream lakes. Utilization of management tools (i.e., operational model using flood forecast information) may enhance ability to reduce severity of short term, moderate flow events.
- The operating strategy for the Moon River will continue to target 14 m^3/s at the Moon Falls walleye spawning site during the walleye spawning and incubation period when flows at Bala are greater than 20 m^3/s as a best management practice. When overall watershed conditions indicate that 20 m^3/s cannot be sustained through the utilization of storage in the upper lakes, flows may be reduced to 8 to 10 m^3/s in the Moon River and 4 to 6 m^3/s in the Musquash River. Increased flow during the spring period has been suggested to enhance walleye spawning opportunities and survival at the Moon Falls spawning site. Amendments to flow management for the Moon River are expected as new information becomes available (see Section 15), through an adaptive management process.

Public Comments

Environmental Component	Comment	Resolution
Infrastructure	"Moon River properties…flood to extreme or are left with docks high and dry" "property damage/loss occurs regularly on our section of the river due to fluctuations of 3 to 4 feet. The damage/loss can be to shoreline structures (mainly docks) or to boats" "consistent water levels make it easier to keep our docks where we want them and means less loss of property if a sudden rise in water level occurs and floats things away"	Maintain seasonal operating zones agreed to between OPG and local stakeholders. District Municipality of Muskoka to establish flood levels. MNR to obtain and implement management tools to enhance ability to moderate short term, moderate flow events. MNR and OPG to enhance communication and information sharing pertaining to the management of flows and levels in Bala Reach.
Fluctuation	"Moon River levels are extremely inconsistent from hour to hour, day to day, season to season and year to year" "…water levels on the Moon River at Bala fluctuate only within a 1 ft range in the summer"	MNR and OPG to enhance communication and information sharing pertaining to the management of flows and levels in Bala Reach.

Environmental Component	Comment	Resolution
	"…the perception has been that when the level in Lake Muskoka rises even a minimal amount, the excess gets dumped in the Moon River, causing it to sometimes rise to totally unacceptable levels…" "OPG understands the normal operating level required on the Bala Reach, and if maintained properly, I have no concerns about damage. Nice to see stakeholders working to get consensus on such a significant issue" A total of 6 comments on this topic were received.	
Fish and Wildlife	"[fluctuating water levels] impact all shore life" "concern that enough water flows through the river to be sure that it is healthy for fish and frogs" "low flows on the Moon River and drastic fluctuations are having a major negative impact on walleye reproduction" "the fishery of the receiving waterbody (Georgian Bay) is being impacted [by water level and flow management]"	Studies to be undertaken to establish resource values in the Moon River and flow required to maintain viability of Moon River walleye population. An adaptive management approach to be undertaken by MNR and OPG.
Water Quality	"we need enough flow to be sure that the river, including the bays, flushes itself so that bacteria is not allowed to grow causing problems in more stagnant areas"	Studies to be undertaken to establish resource values in the Moon River. An adaptive management approach to be undertaken by MNR and OPG.
Draft Plan Comments		
Power Generation at Bala North Site	"…all of the values which we worked to have reviewed and considered in the development of this plan are respected by any power generation operation." "In the past, MNR and OPG have cooperated to address many issues in the management of this very complex riverine/lake-like body with its complicating natural restrictions at the Chutes. The potential dramatic negative impacts on the human and	A development at the Bala North site would be subject to federal and provincial environmental assessment (EA) processes, as well as regulation by MNR under the Water Management Planning Process. These processes provide numerous and varied opportunities for public and stakeholder input into the proposed operational regime of the facility. Stakeholder and public groups are urged to take advantage

Environmental Component	Comment	Resolution
	other life forms existing below the Bala dams as a result of a power plant must be addressed in this plan to protect the integrity of the intent of the plan – to provide a more 'natural' control system for the Muskoka River."	of the various consultation opportunities to review operational strategies and express their views.

Information and Science Needs

- Establish natural resource values in the Moon River relative to existing flows and levels.
- Define walleye spawning areas and habitat characteristics at Moon Falls
- Define the relationship between flow (in terms of wetted area) and walleye spawning habitat at Moon Falls
- MNR will obtain new operational tools (i.e., flood forecast model) to assist with the management of flows and levels throughout the Muskoka River system. Undertake an assessment of the ability to provide higher, more consistent flow, with fewer high volume peaks, throughout the spring walleye spawning period.

12.3.5 Big Eddy Generating Station – OPG

The operating plan for Big Eddy GS is shown in Figure 12.3.4, and has the following characteristics:

Normal Operating Zone:	206.35 to 207.3 m
Summer* Range (Typical):	206.35 to 207.3 m
Winter Drawdown:	None
Flood Allowance:	None. However, the facility has limited discharge capacity and cannot control river levels beyond the specified High Flow Trigger. Levels may exceed the upper extent of the NOZ at this time.
Maximum Daily Flow:**	90.3 m^3/s
High Flow Trigger:	85 m^3/s
Minimum Daily Flow*:**	None
Low Flow Trigger	3 m^3/s
Energy Emergency:	None
Natural Environment Constraints:	None
Social Constraints:	Flow releases from Big Eddy may result in water levels fluctuations on downstream reaches and lakes.
Other:	Automated sluice gate to be installed in one bay of Go Home Lake dam to address water level changes due to Musquash River flow changes.

Benefits and Resolution of Issues

- Reduced absolute operating range, with legally enforceable upper and lower limits under normal operating conditions. High and Low Flow Triggers to address flow extremes (whether naturally occurring or the result of upstream dam operation).
- Water level fluctuations in Go Home Lake resulting from Big Eddy flow releases to be addressed by installation of automated flap gate in Go Home Lake dam.

Conflicts

- The facility is run-of-river and relies on flow provided from upstream waterbodies and facilities. More coordination will be required to remain within the narrower operating range.
- The narrower absolute range within the plan reduces the flexibility of the waterpower operator to alter head pond levels in response to energy demands.

Public Comments

Environmental Component	Comment	Resolution
Navigation/boat access	"this river [Musquash and Gray Lake] can be considered quite dangerous due to the fluctuation of water levels and force of current when the dams are in operation"	Warning signs have been installed by OPG to advise of dangers associated with increased flow when plants are operational.
Infrastructure	"there have been many occasions where our boat has been marooned on land as the water has retreated drastically"	Lake operating regimes revised to provide more consistent downstream flow during the summer low flow period. Commitment by MNR to maintain minimum flows at Baysville and Port Sydney dams, and utilize the range within the NOZ rather than focusing on the TOL.
Erosion	"this constant extreme fluctuation is certainly taking its toll on the erosion of the surrounding land"	Lake operating regimes revised to provide more consistent downstream flow during the summer low flow period, which will reduce the frequency of stops/starts of the generating units.
Fish and wildlife	"this constant extreme fluctuation is certainly taking its toll on the…wildlife in the area and the fish in these waters"	Lake operating regimes revised to provide more consistent downstream flow during the summer low flow period, which will reduce the frequency of stops/starts of the generating units.

Information and Science Needs

None

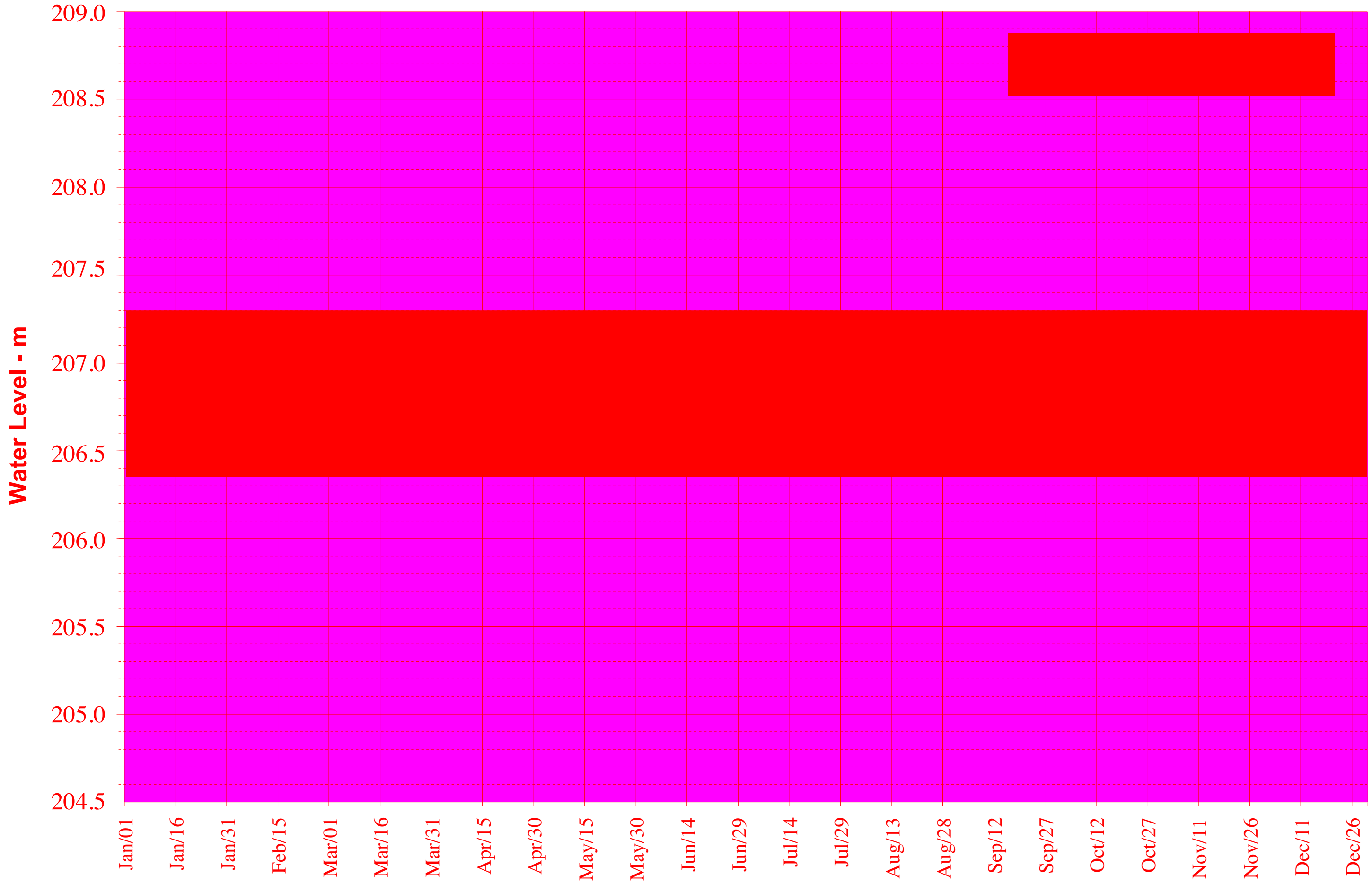

Figure 12.3.4
Muskoka River Water Management Plan
Big Eddy Reservoir Operating Plan

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Back of figure

13 Compliance Monitoring Plan

The Compliance Monitoring Plan defines the parameters (levels and/or flows) that will be monitored to determine whether the waterpower facility is within the established operating range (see Section 12 for facility operating plans and operating zones), identifies exceptional operating circumstances, establishes the reporting procedures and format, and establishes the format for data reports. While it is recognized that MNR may audit waterpower facility operations at any time to verify compliance, the procedures contained herein pertain to self-reporting by waterpower industry facilities to meet the requirements of the Muskoka River Water Management Plan.

13.1 Compliance Definitions

Twenty-four hour daily average data elevations will be the basis of all compliance and enforcement auditing, monitoring, inspections and reporting. Average daily water levels that are outside the 'NOZ' will be reported under all circumstances. Reporting procedures are described in Sections 13.3 and 13.4.

Flows arriving at waterpower facility dams are typically the result of operation of upstream MNR controlled dams, and are not under the control of waterpower operators. No compliance limits for river flow are established at waterpower facilities outside the spring walleye spawning period.

During the spring walleye spawning period (as determined by MNR[*]) hourly flow data will be recorded and reported at Matthias Generating Station and South Falls spillway channel. Hourly flows that are less than the values noted below will be considered to be out of compliance, unless the flow from the upstream MNR-controlled dam is below the noted minimum value. In the event that the flow at Baysville Dam falls below 5 m^3/s, the South Branch facilities will endeavor to maintain a minimum consistent flow of 3 m^3/s at the walleye spawning site at South Falls during the walleye spawning period until such time as reservoir water levels reach the lower limit of the NOZ.

[*] Approximately the third week of April to June 1 annually.

	Mathias/South Falls*	**Baysville Dam**
Minimum flow	3 m^3/s	5 m^3/s

Flow for the Moon Falls walleye spawning site is provided through the Moon Dam, which is operated by OPG. During the walleye spawning period (as determined by MNR), a flow of 14 m^3/s will be provided as a BMP. OPG and MNR will cooperate and coordinate operation of their respective dams (Moon dam and Bala dams, respectively) to achieve the proposed daily flow value. Amendment to flow management for the Moon River are expected as new information becomes available (see Section 15), through an adaptive management process.

13.2 Exceptional Operating Circumstances

The proponents of the Muskoka River Water Management Plan recognize that there may be exceptional circumstances which can affect the ability of each partner to maintain flows and water levels within the prescribed ranges as noted in Section 12 of this document. Natural, anthropogenic and mechanically induced occurrences may result in levels or flows outside the normal operating range. Reporting of these “out of range” occurrences will take place as noted in Section 13.2.1.

1. Significant rain or drought events which exceed the high or low water triggers established for each facility (as identified in Section 12). Reporting of high and low water triggers shall be undertaken at the beginning and end of each event.

2. Large scale operation of an upstream MNR dam during a high flow period may cause an exceedance of a waterpower facility’s high water trigger. Such events will be reported immediately to the local MNR office (Senior Water Control Technologist or alternate).

3. An Independent Electricity System Operator (IESO) or provincially declared energy emergency. If requested to respond to such an emergency, MNR and waterpower operators would work together to optimize power output from the river system. Waterpower facility operations outside the NOZ would be reported as per Section 13.4.1.

* South Falls minimum flow provided through the spillway channel.

4. Failure of generating station monitoring, mechanical equipment, or structures may result in the facility going outside its NOZ. Such events will be reported immediately to the local MNR office (Senior Water Control Technologist or alternate) and to the central WMP 'reporting line' as noted in Section 13.4.1.

5. Icing of physical structures and monitoring equipment may result in the loss of operational/monitoring capability with that equipment. Such events will be reported immediately to the local MNR office (Senior Water Control Technologist or alternate) and to the central WMP 'reporting line' as noted in Section 13.4.1. MNR will be notified of the expected return to service time/date.

6. An electrical distribution system outage may cause generating plants to be isolated from the distribution network, and need to be shut down. Under these conditions, head-pond levels may rise temporarily until flow can be diverted through spillways or bypass channels. Such events will be reported immediately to the local MNR office (Senior Water Control Technologist or alternate) and to the central WMP 'reporting line' as noted in Section 13.4.1.

7. Short-term flow or water level changes resulting from dam safety tests (i.e., to ensure that stop logs can be removed to pass high flow events). Such events will be reported immediately to the local MNR office (Senior Water Control Technologist or alternate) and to the central WMP 'reporting line' as noted in Section 13.4.1.

13.2.1 Reporting During Exceptional Operating Circumstances

1. Reporting during exceptional operating circumstances will be via telephone to the Senior Water Control Technologist at the MNR Bracebridge Area office immediately upon verification of an out of range event.

2. Subsequent reporting will be as per Section 13.4.1.

13.3 Deviations from Mandatory Compliance with Natural Variations in Water Supplies

MNR recognizes that weather conditions and their impacts on water supplies are a source of ongoing uncertainty in managing water power facilities and other control structures.

Operators will **not** be considered to be out of compliance with their WMP when they operate outside the specified operating range as a result of a high or low water conditions as defined below.

Low Water Indicator

Facilities with minimum downstream flow and minimum reservoir/head-pond water level requirements are in a low water condition when all of the following conditions are met:

- outflow from the facility is at or below the minimum flow targeted in each branch

- water level in the head pond/reservoir is at or below the minimum water level stipulated in the WMP, and

- the head pond/reservoir water level is decreasing.

Facilities with no minimum downstream flow requirements but having a minimum reservoir/head-pond water level are in a low water condition when all of the following conditions are met:

- outflow from the facility is at the minimum possible
- the head pond/reservoir water level continues to decrease.

High Water Indicator

High water conditions exist at a facility when all the following conditions are met:

- water level in the head pond/reservoir is at or above the maximum water level stipulated in the approved WMP, and

- head pond/reservoir water level is increasing, and

- discharge facilities have been operated to discharge the maximum discharge possible (while minimizing upstream and downstream flood damages).

In instances where waterpower operators report that they can no longer operate within the approved operating range because a low or high water indicator has been met, they will

- immediately advise MNR and file an event report
- comply with any conditions/components contained in the WMP related to these circumstances.

MNR requires owners of facilities that have mandatory water flow and level requirements to convene the Standing Advisory Committee (SAC) to assess options once a low water indicator has been met. Assessments will consider the circumstances of the situation against the priorities that were set during the planning process and will make recommendations accordingly. SAC's do not have a regulatory role. The role is to provide advice during low water conditions where operations are outside of the approved plan (MNR, 2002).

MNR requires that an official record be maintained of all recommendations made by the SAC to the operator and copied to MNR.

Once a high or low water trigger has been met, the Plan will permit the owner/operator to deviate outside the operating range while continuing to meet any other requirements of the Plan until the condition described by the trigger ends (i.e., as long as the conditions applies, operations outside of the approved operating range will be in compliance with the Plan).

MNR may request appropriate existing data and information to confirm or assess the high or low water conditions, or may independently verify the situation. MNR has indicated that reports generated as a result of such a review will not constitute non-compliance reports unless the owner/operator is found to be deliberately or negligently operating outside the approved operating range.

13.4 Reporting Procedures and Format

13.4.1 Self-Monitoring, Data Reporting and Incident Notification

All facilities are required to self-monitor mandatory water flow and level limits, and report on any incidents where a deviation from the operating requirements of the WMP (mandatory water flow and level), or other mandatory conditions of the Muskoka River WMP. All incidents must be reported to the MNRF.

An initial notification to the MNRF (via telephone to the Bracebridge Area office or other office as per MNRF direction) is required within 24 hours of the occurrence of the incident or when the proponent(s) first becomes aware of the incident.

The report should include:

- The date, time and nature of the deviation;
- The extent of the deviation;
- Possible causes of the deviation;
- Known or anticipated impacts associated with the deviation; and
- Steps taken or to be taken, including the timeframe, to correct the deviation.

The facility owner/operator is then required to provide a written report via fax to the MNRF Bracebridge Area office within 30 days, outlining the details of the incident, any additional information not provided in the incident notification and subsequent remediation. The report must be signed and dated. (See event report form located at the end of Section 13).

Proponents shall make water flow and level data available to the Ministry upon Request.

13.4.2 Annual Compliance Reporting

Each individual plan proponent will prepare and submit an Annual Compliance Report. The report will contain a summary and description of all incidents and any remedial action(s) proposed or undertaken. In the event there were no recorded incidents of noncompliance, the report will state as such.

13.4.3 Data Reporting Format

The following reporting format will be used.

1. Recording Formats:

   a. **Flow Data**: Hourly (during walleye spawning period at designated facilities) - date, hour, hourly flow value.

Daily
- High Falls (as per Flow Distribution Plan, when second unit in operation)
- Burgess.

b. **Water Level Data**: Daily – date, average daily water level (average of 24 hourly values)

2. Data Reporting – Data to be archived for a period of 5 years. Any data collected near the end of the WMP term must be retained for 5 years from the day it is collected.

3. Data will be provided electronically as Comma Separated Variable (CSV) format, Microsoft Excel Version 97 or above, or equivalent. If agreed by both parties, electronic data can be sent via e-mail.

13.4.4 Data Reporting Exceptions

It is acknowledged that at times mechanical failure may cause data to be unavailable for specific time intervals. Industry will notify MNR the next business day of any mechanical failures to monitoring equipment. Under these conditions, manual readings will be taken as possible, and will be recorded and reported. MNR shall understand that the water levels and flows may be out of compliance until such time that the mechanical failure is identified and rectified. Industry shall make all reasonable efforts to make the required repairs in a timely manner, and will inform MNR when equipment is operational.

13.5 Reporting by MNR

MNR will notify waterpower industry operators of all dam operations that change flow within the downstream reach below Port Sydney (Mary Lake), Baysville (Lake of Bays) and Bala (Lake Muskoka) dams. Industry will be notified of the change by means of a telephone call to their respective operational centres. Under unusual circumstances (i.e., a flow change that exceeds the high or low water triggers), the call will also provide immediate notification and provide the opportunity to develop joint strategies to deal with the situation. MNR will advise industry of any loss of active gauging capability (i.e., Mary Lake and Baysville).

Flows in excess of the high or low water trigger values shall be reported to the central WMP ‘reporting line’ by MNR Bracebridge Area Office.

MNR Fax No.: (705) 645-8372

Event Report (Jan 31, 2005)
Muskoka River Water Management Plan

Tracking No.: ______________________

Date of Observed Event: ___________________ Time of Observed Event: ________________

Reported to MNR by Phone to: □ Bracebridge Area Office □ Provincial Coordination Centre

Date: __________________________ Time: _________________________

Recorded 24-Hour Average Water Level (m) __________________

Recorded Hourly Average Water Flow for Walleye (m^3/s) __________________

Nature of Incident:

- □ Low Water Trigger Met *Start Date/Time* ___________ *End Date/Time* _____________
- □ High Water Trigger Met *Start Date/Time* ___________ *End Date/Time* _____________
- □ Equipment Failure ____
- □ ISO Request and Approval by MNR *Contact Person:* ________________________
- □ Emergency ____
- □ Upstream Dam Operations *Upstream Dam:* _________________________________
- □ Facility or Dam Maintenance ____
- □ Other ____

Is corrective action required to bring the operation back into Plan? Please describe:

____

____

How long will it be before the operation is expected to be back into Plan?

____

____

________________________ ______________________

Owner/Operator (Signature) Date

____

Name (Print)

□ additional information attached

Facility Codes:

Matthias MF	Trethewey TR	Burgess BUR
Hanna Chute HC	South Falls SF	Big Eddy BE
High Falls HF	Bird's Mill BM	Ragged Rapids RR
Bracebridge BF	Wilson Falls WF	Moon River Dam MR

14 Effectiveness Monitoring Program

The effectiveness monitoring program will determine whether the operational changes arising from implementation of the WMP result in the anticipated ecological and social improvements. Results from these monitoring activities will be utilized in an adaptive management approach to provide continued improvements throughout the river system over time. Sharing of data and maintenance of good communication procedures between plan partners (MNR, OPG, OPGC, BBG, and AP) is crucial to the effective and long-term implementation of the plan.

For the Muskoka River Water Management Plan, the operational changes within lakes and river reaches were intended to address/improve the following ecological conditions:

- spring riparian zone habitat for spring spawning fish and amphibians
- sustainable minimum flow at walleye spawning sites
- aquatic habitat in riverine sections during the summer low flow period
- lake trout spawning habitat and over-winter survival of eggs/fry.

The operational changes were also intended to maintain/improve the following social objectives:

- access to and continued enjoyment of lake-based shoreline recreational structures
- higher, sustainable summer low flows in river reaches
- waterpower production.

The following pages detail the programs proposed to verify the anticipated ecological and social improvements, and outline the data sharing and communication between WMP partners as well as other watershed stakeholders. In some cases, methodologies/techniques are presently not available to provide the level of monitoring and statistical confidence required for successful evaluation of water management related changes or improvements. These instances are noted in the appropriate subsection. Section 15 outlines the activities that will be undertaken to investigate/address identified data gaps and science and information needs, so as to provide improved decision-making capability for the subsequent iteration of the plan. Table 14.1, located at the end of the section, provides a summary of monitoring goals and activities, and assigns responsibility for specific programs.

14.1 Ecological Objectives Monitoring

14.1.1 Spring Riparian Zone Habitat

A goal of the WMP is to maintain high spring water levels for a longer duration that would inundate floodplains and a portion of the riparian zone. The anticipated positive result of this change would be improved access to spawning grounds (i.e., wetlands and flooded shoreline vegetation) for spring spawning fish and amphibian species, recharge of groundwater supplies, and improved riparian zone and lake communities in the long term. Specific programs to assess the effectiveness of the above-noted anticipated changes are as follows:

Water Level Monitoring

Water levels are monitored on a daily basis by MNR by means of automatic water level recorders at nine of the larger watershed lakes, and monitored on a less regular basis (whenever personnel are at dams) at other lakes. This water level data will continue to be recorded, and compiled at MNR's Bracebridge and Algonquin Park offices. Summaries of lake level data will be prepared at year 3 after plan implementation, and again after year 8. Post-plan implementation data will be compared to pre-implementation water level data to verify that the anticipated water level changes have occurred.

14.1.2 Walleye Spawning Site Flows and Spawning Success

Improved consistency of flow for walleye spawning at South Falls and Moon Falls were goals of the water management planning process. The monitoring program will consist of a flow and temperature monitoring component at South Falls. Uncertainty regarding the effectiveness of the past flow target of 14 m^3/s for the Moon River during the spring spawning period for walleye, at allowing successful production of walleye, has highlighted the need for further collection of information. As a result, data collection and investigations at Moon Falls will occur as described in Section 15, Data Gaps, Science and Information Needs.

Flow and Temperature Monitoring

South Falls - Hourly flow data will be collected at South Falls GS during the walleye spawning period as part of the Compliance Monitoring Program (see Section 13 for details). This data set will provide overall flow quantity within the river system and hourly/daily variability. At South Falls, the primary walleye spawning area is located at the base of the bypass channel, and is provided with a minimum flow by means of a block installed within the stop logs leading to this channel. A gauge will be installed within this channel by OPG by summer 2005 to record flows passing through this area. Existing temperature sensors will be utilized to obtain temperature data.

An operational change due to plan implementation is the provision of a minimum flow of 5 m^3/s (on an hourly basis) from the Baysville dam throughout the walleye spawning period (as determined by MNR). A comparative assessment of flow data from South Falls bypass channel, Matthias GS and Baysville dam will be undertaken annually by MNR to decide whether the minimum flow release from Baysville dam during the spawning period is providing the desired result of a consistent flow of 3 m^3/s within the South Falls bypass channel.

Spawning Habitat and Spawning Activity

No effectiveness monitoring programs directed at walleye spawning habitat or spawning success investigations will be undertaken at the South Falls location. Spawning habitat in the bypass channel at South Falls has been examined on a number of occasions in the past, with alterations to channel planform undertaken to encourage walleye to utilize areas that will remain watered throughout the spawning and incubation period. These channel alterations have been generally successful, and minimize spawning excursions into unsuitable areas and associated egg mortality. Additional modifications of the spawning channel plan form may be proposed to further reduce the occurrence of spawning in unsuitable areas. No additional investigations of spawning habitat or spawning activity are required provided flows are maintained above the 3 m^3/s level.

As discussed above, further work is planned at Moon Falls to provide additional information concerning site conditions, the relationship between flow and quantity of spawning habitat, and spawning success. These studies are described in Section 15. It is anticipated that from this work, a clearer relationship will be identified between different flow rates and amounts of available wetted walleye spawning habitat. From this work, further discussions with OPG will occur regarding flow rates for the Moon River. Pending the outcome of these discussions and a potential amendment to flow management for the Moon River, an effectiveness monitoring plan will be developed.

14.1.3 Summer Riverine Habitat

The revised operating strategy for many of the watershed lakes is anticipated to provide higher and more uniform flows in river reaches throughout the summer low flow period. This is expected to improve habitat conditions for aquatic and riparian communities during that period. Flows will be monitored at a series of locations throughout the river system as noted below. Based on the outcome of those measurements, and the development of appropriate methodologies to assess habitat improvements in deep water river reaches (see Section 15), habitat may be monitored during the next plan iteration.

Flow Monitoring

Presently, river flow in the main branches of the river system is monitored by a series of gauges operated by Water Survey of Canada. These gauges provide information on an hourly basis, and are located as follows:

North Branch
- Williamsport on the Big East River
- Below Mary Lake dam

South Branch
- Oxtongue River near Dwight
- Below Baysville dam

Lower Subwatershed
- Moon River at Hwy 69
- Musquash River at Hwy 69

Information derived from these gauges will be used to monitor flows in larger reaches of the river system.

In addition, flow monitoring will be undertaken within a number of smaller reaches within the river system to determine whether flows arising from these tributaries are as expected. Spot measurements will be taken three times during July and August at standardized measurement sites established at each of the following locations:

- McCraney Lake dam
- Tasso Lake dam
- Fox Lake dam
- Burnt Island Lake dam
- Tea Lake dam
- Kawagama Lake dam
- Moon dam.

Information will be summarized and compiled in report format. Summaries of flow data will be prepared at year 3 after plan implementation, and again after year 8. Post-plan implementation data will be compared to predicted flow values (ARSP output) to verify that the anticipated flow changes have occurred.

14.1.4 Lake Trout Habitat and Spawning Success

Lake trout spawning activity and incubation success within the drawdown zone of Kawagama Lake was monitored during the fall and winter of 2003/2004 to assist with option development for the plan. Those studies confirmed that the current operational strategy was adversely affecting egg survival, and provided the rationale for reduced differential between fall and winter water levels. Subsequently, Kawagama Lake was selected as the “test lake” to evaluate the success of lake trout oriented water management changes (i.e., reduced differential between fall and winter water levels, and associated effects on developing eggs and fry). Lake trout oriented effectiveness monitoring is described in the following section and the initial part of Section 14.1.5.

The fall 2003/2004 lake trout spawning survey will be repeated the first year following plan implementation. The survey would consist of the following activities:

- lake-wide spawning shoal survey to determine the number and location of spawning groups and shoals that are actively utilized (as well as any expansion into new territory)

- an estimate of spawning activity (i.e., number of fish) at each shoal. Determination of egg density and mortality due to fall/winter water level differential at highly used shoals.

Subsequently, the spawning shoal survey and enumeration of fish on actively used shoals would be undertaken every 3 to 4 years to determine whether any changes in spawning shoal usage and distribution patterns are occurring within the lake. A specific goal would be to establish whether lake trout are increasing their usage of other shoals within the lake, and/or are expanding to new sites.

If increased usage of existing shoals or usage of new shoals is confirmed, a determination of egg density and water level differential induced mortality would be undertaken at those shoals once within the 10-yr term of the plan.

14.1.5 Fish Community Assessments

Fish community assessments will be undertaken at Kawagama Lake and in Matthias reservoir during the course of the WMP to determine whether the proposed operational changes provide the anticipated positive effect on their fish communities. Brook trout populations will also be assessed at two select locations as noted below to determine whether the proposed water management changes have a positive effect on their populations.

Kawagama Lake

The positive outcome arising from a reduced differential between fall and winter water levels is an increased number of viable lake trout eggs. These eggs have the potential to develop into adult fish. A greater number of viable eggs should ultimately result in an increase in the Kawagama Lake lake trout population.

Kawagama Lake will be monitored to determine whether the anticipated changes resulting from implementation of the WMP result in the predicted (i.e., positive) change to the lake's lake trout populations. Presently, the lake trout population of Kawagama Lake has been monitored on a semi-regular basis by MNR as part of their ongoing data collection activities. These programs will continue, and will be expanded as follows:

- Previous surveys of lake trout populations were undertaken using the Spring Littoral Index Netting (SLIN) approach. Recently, the Summer Profundal Index Netting (SPIN) approach has been found to provide a better estimate of population characteristics. SPIN surveys (using approximately 50 net sets per survey) will be undertaken annually during the term of the plan to provide a measure of lake trout population (and associated changes) within the lake. Yearly sampling is required to provide statistically defensible results.

- A creel survey of lake trout populations in Kawagama Lake was undertaken in 2001, and will be repeated again 5 years after plan implementation. In the interim, a reduced version of the creel survey will be undertaken annually during the 10-yr term of the plan to provide a consistent record of harvest/ exploitation within the lake. This reduced program (6 to 7 days of sampling effort) will be undertaken between mid-February and mid-March annually, and will serve to provide a long-term data set to determine the effects of harvest on the population.

Matthias Reservoir

Investigations of aquatic habitat and fish community characteristics were undertaken during the preparation of the WMP, and a preliminary examination of spawning habitat in the upper reaches of the reservoir was undertaken by MNR during the spring of 2004. Operational changes proposed during implementation of the WMP should lead to improved habitat conditions for spring/early summer spawning species (higher spring levels, more stable early summer levels), and subsequently, enhanced populations of northern pike, yellow perch and centrarchids. The following programs are proposed:

- Undertake a more detailed assessment of spawning activity in spring/early summer 2006, targeting northern pike, yellow perch, smallmouth bass, rock bass and pumpkinseed. Repeat the survey in 2008 and 2013.

- Repeat the aquatic habitat/fish community assessment undertaken in summer 2003 (Acres, 2003b) in 2008 and 2013.

Brook Trout Populations

Improvements to brook trout populations are expected in the upper portions of the North Branch as a result of proposed changes to McCraney Lake and Camp/Tasso Lake dam operations. MNR's Ontario Stream Assessment Protocol (OSAP) will be utilized as the sampling methodology to assess fish community health in the affected areas. The OSAP approach is being adopted province-wide as the standard stream monitoring techniques, and contains a series of modules that can be selectively applied to assess specific environmental components (i.e., fish community module, benthic community module, etc). The methodology provides a standardized, repeatable technique with which to monitor the potential for long-term change in brook trout populations. The proposed locations and sampling regime are as follows:

- Big East River below McCraney Lake dam – summer 2005, 2010 and 2014
- Tasso Creek below Tasso Lake dam – summer 2005, 2010 and 2014.

The 2005 monitoring will be undertaken to establish baseline data.

14.2 Social Objectives Monitoring

14.2.1 Lake-Based Recreation Monitoring

The effectiveness monitoring program for this component of the plan would compare post-implementation lake levels with the predictions of change noted in Tables 6.3 and 6.4 of the Muskoka River Water Management Plan Options Report. Parameters to be compared would include:

- maximum daily spring lake level
- number of high water exceedances
- mean daily level during the summer recreation season
- the 80^{th} percentile daily water level range during the summer recreation season
- the minimum and maximum distances to infrastructure during the summer recreation season.

Water level information derived from existing MNR water level monitoring stations on the Huntsville lakes, Mary Lake, Canoe, Smoke and Tea lakes, Kawagama Lake, Lake of Bays, Lakes Joseph and Rosseau, and Lake

Muskoka will be utilized to develop the data base required for this analysis. The analysis will be undertaken twice during the term of the WMP, the first time in 2009, using data from 2006 to 2008; and the second time in 2014, using data from 2009 to 2013.

14.2.2 River Flow Suitability Monitoring

The effectiveness monitoring program for this component of the plan would compare post-implementation river flows with the predictions of change noted in Tables 6.3, 6.4 and 6.5 of the Options Report. Parameters to be compared would include:

- spring maximum daily flow
- number of exceedances of MNR's Dam Operations Manual flow limits during the spring season
- minimum daily flows (7-day low flow) during the summer recreation season
- number of flow fluctuations during the summer recreation season
- median weekly flows during the summer and winter
- minimum weekly flow (10^{th} percentile) during summer and winter
- flow available for power generation on an annual basis.

There are currently six flow gauges within the watershed that can be utilized to provide the data for this monitoring program. Information derived from this program will be also be used to verify that the new operational plan is meeting anticipated objectives. This analyses will be undertaken once (in 2010) during the plan.

14.2.3 Comments Related to Facility Operations

Waterpower facility operators and MNR will maintain a record of public comments and/or concerns related to the operation of their facilities/structures and their responses (if any) to those comments. This information will be summarized and provided for discussion/action at the annual MNR/waterpower review meeting.

14.3 Monitoring of Waterpower Production

Industry will be responsible for monitoring the effectiveness of the WMP in optimizing waterpower production and associated revenues. Industry will undertake a comparative analysis of flow available for power production in their monitoring approach.

14.4 Data Sharing and Communication

Reporting on the results of the effectiveness monitoring program will occur through submission of the Implementation Report as outlined in Section 16.3.

A formal data sharing agreement will be established between MNR and the four waterpower producers to facilitate sharing of data collected during the WMP. As part of that process, regular meetings will be held throughout the year to discuss operational matters and improve efficiencies. An annual meeting will be scheduled in early February to review the previous year's operations, identify operational strategies that worked well or caused problems, and develop a proactive, adaptive management style approach to communication, issue identification and resolution.

In addition, working arrangements/stewardship agreements will be actively pursued with other watershed stakeholders and members of the research community to assist with monitoring, data analysis and the filling of data gaps. Potential partners include the following organizations/groups:

- Fox Lake Association
- Fairy and Peninsula Lakes Associations
- Kawagama Lake Cottager's Association
- Lake of Bays Association
- Muskoka Lakes Association
- Moon River Property Owners Association
- Muskoka Watershed Council
- Algonquin Ecowatch
- District Municipality of Muskoka
- Trent University (Dr. Dave Evans).

Table 14.1
Effectiveness Monitoring Plan Summary

No.	Objective	Actions	Who	How	Section
Ecological					
1	Spring Riparian Zone Habitat – achieve high spring water levels for a longer duration that would inundate floodplains and a portion of the riparian zone	Water Level Monitoring	MNR	Automatic water level recording on a daily basis on nine lakes; recording on a less regular basis on other lakes; summary of lake level data will be prepared at year 3 after plan implementation and after year 8	14.1.1
2	Walleye Spawning Site Flows and Spawning Success – improved consistency of flow for walleye spawning at South Falls and Moon Falls	Flow and Temperature Monitoring	OPG	Hourly flow data collected at South Falls GS during the walleye spawning period	14.1.2
3	Summer Riverine Habitat – higher and more uniform flows in river reaches throughout the summer low flow period	Flow Monitoring	MNR using hourly data from gauges operated by the Water Survey of Canada	Information derived from these gauges will be used to monitor flows in larger reaches of the river system.	14.1.3
			MNR/OPG (Moon Dam only)	Spot measurement will be taken three times during July and August at standardized measurement sites at - McCraney Lake dam - Tasso Lake dam - Fox Lake dam - Burnt Island Lake dam - Tea Lake dam - Kawagama Lake dam - Moon Dam	14.1.3

Table 14.1
Effectiveness Monitoring Plan Summary

No.	Objective	Actions	Who	How	Section
4	Lake Trout Habitat and Spawning Success – Kawagama Lake	Lake trout spawning survey – to determine if lake trout are increasing their usage of other shoals within the lake and/or are expanding to new sites	MNR	Lake-wide spawning shoal survey to determine the number and location of spawning groups and shoals that are actively utilized (as well as expansion into new territory) – once during the fall after plan implementation and every 3 to 4 years following	14.1.4
			MNR	An estimate of spawning activity (i.e., number of fish at each shoal. Determination of egg density and mortality due to fall/winter water level differential at highly used shoals – once during the fall after plan implementation and every 3 to 4 years following	14.1.4
5	Fish Community Access	Kawagama Lake – positive change in lake trout population	MNR	Annual Summer Profundal Index Netting (SPIN) and Annual Reduced Creel survey (6 to 7 days of sampling effort) between mid-February to mid-March starting in 2007. Creel survey every 5 years after plan implementation	14.1.5
		Matthias Reservoir – improved habitat conditions for spring/early summer spawning species (higher spring levels, more stable early summer levels)	OPGC/DFO	Spring/early summer spawning activity assess-ment in 2006, 2008 and 2013. Aquatic habitat/fish community	14.1.5

Table 14.1
Effectiveness Monitoring Plan Summary

No.	Objective	Actions	Who	How	Section
				assessment in summer 2008 and 2013.	
		Brook Trout Populations - increased brook trout populations in upper portions of the North Branch	MNR	Ontario Stream Assessment Protocol (OSAP) will be used to monitor the potential long-term change in brook trout populations at - Big East River below McCraney Lake dam – summer 2006, 2010 and 2014 - Tasso Creek below Tasso Lake dam – summer 2006, 2010 and 2014. Note: 2005 monitoring will be undertaken to establish baseline data.	14.1.5
Social					
1	Lake-based Recreation Monitoring	Changes in lake levels	MNR	Comparison of post-implementation lake levels with the predictions of change. Parameters include - maximum daily spring lake level - number of high water exceedances - Mean daily level during the summer recreation season - the 80th percentile daily water level range during the summer recreation season - the minimum and maximum distances to infrastructure	14.2.1

Table 14.1
Effectiveness Monitoring Plan Summary

No.	Objective	Actions	Who	How	Section
				during the summer recreational season	
2	River flow suitability monitoring	Changes in river flows	MNR	Comparison of post-implementation river flows (from stream flow gauge information) with predictions for change. Analysis undertaken in 2010	14.2.2
3	Public comments related to operations	Comments/concerns and responses	MNR and industry	Comments and responses will be recorded and summarized and provided for discussion/action at annual MNR/industry review meeting	14.2.3
Other					
4	Waterpower production	Effectiveness of the WMP in optimizing waterpower production and associated revenues	Industry	Industry will undertake a comparative analysis of flow available for power production	14.3
5	Data Sharing and Communication	Data sharing agreement between MNR and Industry	MNR, DFO and industry	Agreement will be established to facilitate sharing of data collected during the WMP	14.4
		Operations meetings	MNR and industry	Regular meetings will be scheduled throughout the year to discuss operational matters and improve efficiencies. Annual meeting will be scheduled in early February	14.4

15 Data Gaps, Science and Information Needs

This section identifies data gaps, science and information needs that need to be investigated during the term of the current plan. These investigations will provide background data on portions of the river system for which information is presently lacking or inadequate, and will provide the basis for an adaptive management approach to resolution of specific issues (e.g., Moon River walleye spawning/flow duration and fluctuations). Results from these investigations will assist in determining whether future operating plan changes are required and/or warranted. The data gaps, science and information needs, are summarized in Table 15.1 and discussed in additional detail in the following sections.

15.1 Riparian Zone Habitat

Higher spring water levels are anticipated to provide an improvement in riparian zone habitat on a number of lakes within the river system (i.e., McCraney Lake, Fox Lake, Mary Lake, Tea Lake, Matthias Reservoir, Lake Muskoka). However, the consensus among Planning Team participants, taking into account input from MNR Science personnel, was that there is no standard protocol available at this time to evaluate whether a change in spring water levels will result in a detectable (i.e., statistically significant) change in riparian habitat. Over the course of the plan, an appropriate sampling framework will be developed to address this deficiency. Guidance and assistance will be sought from MNR's Wetland Specialist (Mr. B. Potter), the Muskoka Watershed Council, and appropriate federal and provincial agencies and academic institutions (i.e., Trent University, etc) in the development of this methodology. The MNR and OPGC will take the lead in developing the prescribed methodology within a year of plan approval. Once developed, sampling will be implemented within 2 years.

15.2 Moon River Walleye Spawning Habitat and Spawning Activity

As discussed in Section 6, the Moon River represents one of the significant fisheries issues identified through the water management planning process in the Muskoka watershed. To complement past work, further investigations are proposed to more clearly establish the quantity and quality of spawning habitat below Moon Falls (See Figure 15.1) at various Moon River flows. The information gathered in this study will allow MNR and OPG to more precisely relate the quantity of spawning habitat available to walleye with the different flow rates that are present within the river system. From this work, discussions with OPG regarding how different flow rates impact available spawning substrate for walleye below Moon Falls will occur. Future amendments to the Plan are anticipated as a result of these discussions and will likely include changes to flow management down the Moon River and/or engineered solutions. It is anticipated that the work to be conducted will form the basis of an adaptive management approach which will attempt to improve walleye spawning success and numbers below Moon Falls, and ultimately improve recruitment to the Georgian Bay fishery.

15.2.1 Spawning Habitat Investigations

Spring 2005

A rating curve within the Dillon (1983) report provided a general correlation between flow and water level for the pool immediately below the falls (Lower Pool) and the area beyond the Second Narrows (outlet from Lower Pool). Field investigations during the spring 2005 freshet will provide a better correlation of river flow with the quantity and quality of spawning habitat, and specifically of the areas inundated in the vicinity of Second Narrows. Investigations will commence when water temperatures reach 6^{o} C and/or when notified by a local observer (B. McRobb) that walleye are staging in the area. Multiple transects will be established across the river below Moon Falls with sampling locations along those transects. Water level (compared to a standard benchmark) and wetted perimeter (the width of the wetted river channel) will be obtained at flow increments of approximately 10 m^3/s (flow information to be provided by OPG). Transects will be spaced 10 m apart to a sufficient distance downstream to capture all available spawning habitat (approximately 400 m). Physical and biological data (flow velocity and vector presence/absence of spawning fish and/or eggs, etc) will be gathered along each transect as water levels recede from the highest level experienced during the freshet. All sampling locations will be determined with differentially corrected GPS.

Summer 2005

While observations of river bottom substrate characteristics will be undertaken as available during the spring survey, it is likely that high water levels and flows will limit data collection along the lower portion (i.e., deepest part) of each transect. River channel substrate characteristics will be determined at 5-m intervals along each sampling transect (i.e., those surveyed during the spring) in August under low flow conditions according to the classification scheme developed by Northeast Science and Information of OMNR (see Table 15.2). All data collection sites will be located with Differential GPS, and will be correlated with data collected during the spring sampling period.

The collection of geographically referenced spawning substrate data will allow the amount of suitable walleye spawning habitat to be correlated with river flows through time. This information will result in the production of a detailed map, which correlates spawning habitat with water level and river flow. Further discussions can then occur between MNR and OPG regarding suitable flows for spawning walleye and walleye spawning habitat below Moon Falls and what flow management regime will be in place for the future.

15.2.2 Spawning Activity and Populations

In concert with flow/habitat data collection, further investigations of spawning activity and numbers are proposed to determine the size of the walleye spawning population using the spawning area below Moon Falls. In addition the area below Moon Falls has been identified as an historically significant lake sturgeon spawning area. As such, sturgeon assessment is planned, to investigate the presence of sturgeon below Moon Falls. Opportunities to investigate solutions proposed in previous studies will also be assessed. Programs to be undertaken include:

- consolidation of all available biological and physical data, and preparation of a background information document which summarized present information concerning the Moon River walleye stocks and their issues

- field investigations of walleye spawning activity and numbers, including locations of spawning walleye and areas of egg deposition, in 2005 and at 5-yr intervals thereafter to monitor progress toward a larger walleye population

- investigate existing engineering options (Dillon report and similar alternatives) and test potential solutions to stranding and/or downstream displacement of eggs (i.e., fencing to limit access to higher elevation spawning sites, addition of coarse substrate to improve egg retention, in-channel weir to increase spawning habitat area and/or limit access to unfavorable spawning areas, etc) on collection of flow/habitat relational data

- sturgeon short set gillnetting in 2005 to investigate the presence of sturgeon below Moon Falls.

Information from these studies will be used in an adaptive management approach to develop a long-term solution to improved walleye and sturgeon spawning success at the Moon Falls site, and ultimately improved recruitment to the Georgian Bay fishery. This may entail amendments to the Plan. MNR and OPG will work together to develop and undertake the above-noted programs.

15.3 Summer Riverine Habitat

Higher base flow in river reaches is anticipated to provide improvements to aquatic and riparian habitat within those river segments. Presently, the MOE is using the sampling method described in the Ontario Benthos Biomonitoring Network Protocol Manual to evaluate invertebrate population change over time in small wadeable streams. These standard protocols will be used to collect background information at two locations within the river system (McCraney Creek, Tasso Creek), as a potential prelude to the adoption of these procedures to evaluate flow-related changes at other river system sites.

However, standard protocols are not available for larger, deeper stream reaches that would provide a similar level of statistical confidence. Over the course of the plan, appropriate methodologies will be developed to address this deficiency. Guidance and assistance will be sought from MNR's Wetland Specialist (Mr. B. Potter), the Muskoka Watershed Council, and appropriate federal and provincial agencies and academic institutions (i.e., Trent University, etc) in the development of this methodology. The MNR will take the lead in developing the prescribed technique within a year of Plan approval. Sampling will be initiated no later than 2 years after development and/or selection of the appropriate technique.

15.4 Moon River Sturgeon

The area below Moon Falls has been identified as an historically significant lake sturgeon spawning area. An assessment is required to investigate the current use of and/or abundance of spawning sturgeon in this area. This will be undertaken as and when funding becomes available.

15.5 Operational Model Using Flood Forecast Information

High water levels on the river system and in particular, on the Bala Reach, are difficult to control due to limited storage availability in upstream lakes. Utilization of management tools (i.e., operational model using flood forecast information) may reduce the severity of short term, moderate flow events. MNR will pursue funding opportunities to develop and implement a model for the Muskoka River.

Table 15.1 Data Gaps, Science and Information Needs					
No.	**Objective**	**Data Gap**	**Who**	**How**	**Section**
Ecological					
1	Riparian Zone Habitat - achieve high spring water levels for a longer duration that would inundate floodplains and a portion of the riparian zone	Sampling technique and implementation within riparian zone	MNR	Develop a sampling technique within one year of plan approval; sampling will be initiated no later than 2 years after develop-ment and/or selection of the appropriate technique	15.1
2	Moon River Walleye Spawning Habitat and Spawning Activity	Spawning Habitat Information	MNR and OPG	Spring 2005 water level and wetted perimeter study; Summer 2005 collection of geographically referenced spawning substrate data; correlation of substrate data with water flows during the spawning period	15.2.1
		Spawning Activity and Population Information	MNR and OPG	Consolidation of biological and physical data; field investigations of walleye spawning activity and numbers in 2005 and at 5-yr intervals thereafter; investigate potential engineering options; develop an adaptive management approach to improve walleye and sturgeon spawning success at the Moon Falls spawning site	15.2.2

Table 15.1 Data Gaps, Science and Information Needs					
No.	**Objective**	**Data Gap**	**Who**	**How**	**Section**
3	Summer Riverine Habitat	Standard methodology for larger, deeper river reaches	MNR	Develop a prescribed sampling technique within one year of plan approval and initiate sampling at two locations (McCraney Creek, Tasso Creek) no later than 2 years after development and/or selection of the appropriate technique; develop over time a standard methodology for larger, deeper stream reaches in partnership with other agencies and academic institutions.	15.3
4	Moon River Sturgeon Spawning Habitat and Spawning Activity	Current use and/or abundance of spawning sturgeon	MNR and OPG	Carry out an assessment of current use and/or abundance below Moon Falls as funding is available; develop an adaptive management approach to improve sturgeon spawning success at the Moon Falls spawning site	15.4
Engineering					
1	Operational Model using Flood Forecast Information to reduce the severity of impacts of short-term, moderate events	Operational model using flood forecast information	MNR and other partners	Develop an operational model using flood forecast information and implement the model for the Muskoka River as funding is available	15.5

Note:
Some of the above actions, to some extent, are already being done. Other actions involve the need to develop partnerships with other organizations, and other actions, requiring financial resources and staff time from MNR, will be addressed as resources become available to achieve them.

Table 15.2
Particle Size Classification of Bottom Substrate
(Rosgen, 1996)

Particle Description	Size Range (mm)
Silt/Clay	<.062
Very Fine	0.062 – 0.125
Sand – Very Fine	0.125 – 0.25
Medium	0.25 – 0.50
Coarse	0.50 – 1.0
Very Coarse	1.0 – 2.0
Gravel – Very Fine	2.0 – 4.0
Fine	4.0 – 6.0
Fine	6.0 – 8.0
Medium	8.0 – 12.0
Medium	12.0 – 16.0
Coarse	16.0 - 24.0
Coarse	24.0 – 32.0
Very Coarse	32.0 – 48.0
Very Coarse	48.0 – 64.0
Cobble – Small	64 – 96
Small	96 – 128
Large	128 – 192
Large	192 – 256
Boulder – Small	256 – 384
Small	384 – 512
Medium	512 – 1024
Large – Very Large	1024 – 4096
Bedrock	

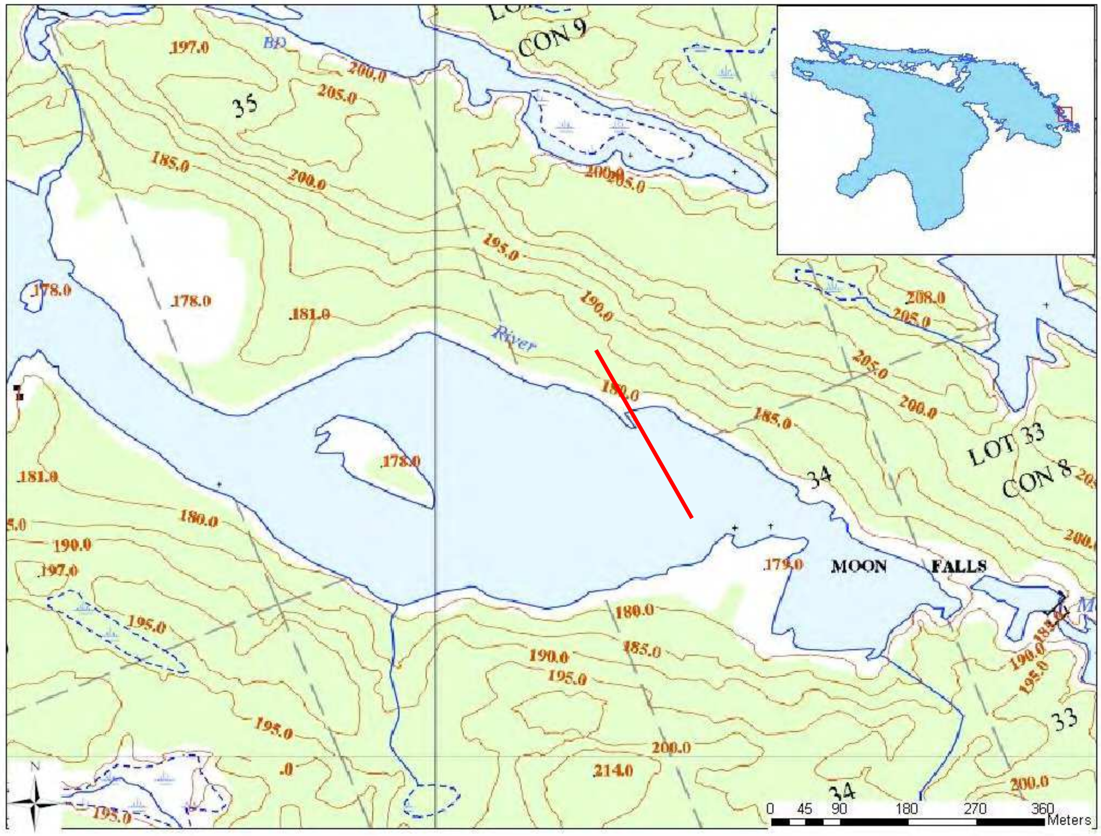


Figure 15.1
Site of Moon River Walleye Habitat Investigations

16 Plan Implementation

The Muskoka River Water Management Plan (WMP) has been prepared by and will be implemented by the Ontario Ministry of Natural Resources, Ontario Power Generation, Orillia Power Generation Corporation, Bracebridge Generation Ltd. and Algonquin Power. The plan describes a new operating strategy for lakes and river reaches on the Muskoka River which attempts to balance environmental, social and economic interests on the river system through the management of water flows and levels. This section describes the manner in which the plan will be implemented.

16.1 Plan Implementation Team

The Plan Implementation Team (PIT) will be comprised of the management and technical staff of MNR and the waterpower companies that will undertake the day-to-day operations required to achieve the flows and water levels established within this plan. The PIT will meet on a regular basis throughout the year to discuss operational matters, and will utilize a proactive, adaptive management approach to communication, issue identification and resolution. An annual meeting will be scheduled in early February of each year to review the previous year's operations, identify operational strategies that worked well or caused problems, and will develop solutions/new approaches to flow and water level management as required.

The PIT is responsible for reporting on compliance, enforcement and effectiveness monitoring.

16.2 Standing Advisory Committee

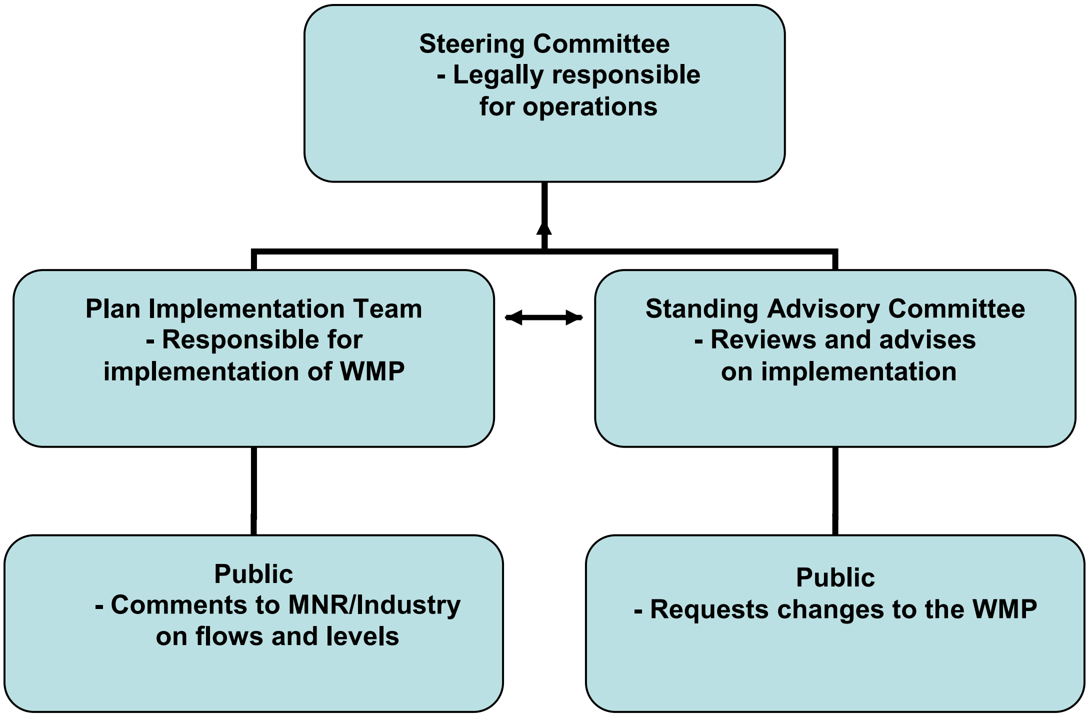
A SAC is not a mandatory requirement. SACs are recommended as a best management practice to provide plan proponent(s) with a mechanism for engaging First Nation and Métis communities and the public. Any proposal to discontinue an established SAC should be informed by advice from the MNRF, advice from the SAC and consideration of the level of public, stakeholder and First Nation and Métis community interest in dam operations. Where a plan proponent(s) makes this recommendation, an amendment to the WMP with appropriate rationale will be required to remove the provision for a SAC from this WMP.

Plan proponent(s) are responsible for administering the SAC (if applicable), and SACs will work directly with the plan proponent(s). Proponents are required to report on the status of the SAC (if applicable) every five years as a component of ongoing Implementation Reports as outlined in Section 16.3.

The role of the SAC (if applicable) is to serve as an advisory group, as defined through a terms of reference. The terms of reference will outline the membership, scope, duration and roles and responsibilities of the SAC and its relationship with the plan proponents. MNRF will define what role it will have, if any, in the SAC.

A SAC (if applicable) should include representatives with a broad range of interests on the river such as First Nation and Métis communities, riparian land owners, municipalities and interested groups.

The SAC will be composed of a number of citizens (up to 5) that represent a diversity of interests and knowledge bases along the course of the river. The SAC will report to the Steering Committee (SC), will provide a conduit for the transfer of public comments related to plan implementation to the operating partners (MNR and waterpower companies), and will provide advice on the implementation of the plan. The organizational relationship between the SC, the PIT, the SAC, and the general public is provided in the following organizational flowchart.



16.3 Implementation Reporting

Plan proponents for the Muskoka River WMP shall submit an Implementation Report to the MNRF every five years. This report shall be a collective submission from all plan proponents.

The Implementation Report will provide status updates, transparency of dam operations and inform adaptive management considerations. The Implementation Report is not intended to initiate a fundamental review of the WMP.

The Implementation Report will include:

- Summary of all amendment requests received, including the rationale for completed amendments and how proposed amendments that did not proceed were addressed;
- Status of the Standing Advisory Committee, where applicable;
- Report on the results of the effectiveness monitoring program (EMP), if applicable, including a summary of monitoring conducted and findings, a determination of whether operations are having a negative or unintended

impact, and an assessment of whether revisions to the facility operations, or the EMP, are required; and

- Status and results of any data or information collection outlined in the WMP's data collection program, if applicable, and a determination of whether revisions to the program are required.

The MNRF will review the report for completeness but will not formally approve the report. If the report is not complete, the MNRF will request that additional information be provided. The MNRF may also audit records used by the proponent(s) to prepare the Implementation Report and may request any additional information to verify the information presented.

Upon confirmation from the MNRF that the Implementation Report is complete, plan proponents will make the report publicly available. The report will be provided to the SAC (if applicable), key stakeholders, and Wahta Mohawks, and made available to the public on request. The SAC will review this information, and may request that actions are taken to address issues or concerns as appropriate. The SC will determine whether the issues/concerns merit an amendment to the plan, maintenance of the status quo, or an early review of the WMP.

In accordance with the Technical Bulletin, the first Implementation Report to cover the initial term of the Muskoka River WMP should be submitted to MNRF no later than December 31, 2021, as outlined in the OWA schedule. Also, in accordance with the Technical Bulletin, Implementation Reports must be submitted every five year thereafter.

The report will be provided to the SAC, key stakeholders, the Wahta Mohawks, and made available to the public on request.

17 PROVISION FOR PLAN AMENDMENTS

17.1 PLAN AMENDMENTS

In order for the Muskoka River WMP to remain current and to address future issues, the plan may be amended by following the amendment process set out in this section. Any change to the Muskoka River WMP requires an amendment to be submitted to the plan proponents and approved by MNRF. From time to time, new data, information, or issues may arise. MNRF retains the authority to amend a plan at any time, or issue an Order for the plan proponent(s) to amend the WMP.

17.2 The Amendment Process

Any party (Plan Proponent, MNRF, or 3rd Party) with an interest in the WMP may request an amendment to the WMP by bringing forward issues to the attention of the plan proponent(s).

An amendment request must be accompanied by sufficient information to allow the proponent(s) to determine whether the proposed amendment should proceed, and whether the amendment should be treated as minor or major. Proponent(s) must apply due diligence when considering proposed amendments.

The plan proponent(s) are responsible for:

- Receiving amendment requests;
- Assessing amendment requests based on criteria outlined in this section;
- Proposing amendments to MNRF; and
- Preparing amendment proposals for MNRF review

The multiple proponents for this WMP will work together when assessing an amendment request and prepare an amendment proposal (where necessary).

MNRF will review proposed amendments to ensure that plan proponents screen and process amendments consistent with the 2016 Maintaining Water Management Plans Technical Bulletin.

17.2.1 Types of Amendments

Changes to the Muskoka River WMP may include simple text corrections to significant modifications to an operating regime. In order to provide flexibility for a range of potential amendment requests, two categories of amendments (minor and major) exist. The categories are mainly differentiated by the expected level of public interest in the proposed change to the WMP.

Amendments may be subject to public and First Nations and Métis community engagement or consultation, dependent on the category of amendment (described below), as detailed in Section 3.5 of the Maintaining Water Management Plan Technical Bulletin, 2016.

17.2.1.1 Minor Amendments

Minor amendments are changes that do not affect the operating regime, plan objectives, are not expected to generate a high level of public interest, and are not expected to adversely affect Aboriginal and treaty rights. Minor amendments will not be subject to public and First Nations and Métis community engagement or consultation beyond discussions with a SAC (if applicable). Minor amendments may include:

- Changes in the presentation of information, factual or text corrections; and/or
- Changing a WMP to include a new dam and its associated Operating Plan (Section 2.1 of the Maintaining Water Management Plan Technical Bulletin, 2016)

17.2.1.2 Major Amendments

Major amendments are more significant in scale such as: changes to the operating regime or plan objectives, changes that could be expected to generate a high level of public interest or changes that might adversely affect Aboriginal and treaty rights. A major amendment will be subject to public, First Nations, and Métis community engagement or consultation. For major amendments where equivalent consultation and engagement has previously occurred through another process (e.g. previous notification that a change will be required, or amendments required after public consultation in other planning processes), the MNRF may exercise discretion to process the proposed change as a minor amendment on a case by case basis.

17.2.2 Amendment Request

Individuals submitting an amendment request shall clearly articulate concerns and potential solutions. Amendment requestors shall participate in good faith opportunities undertaken to obtain Indigenous Communities, public and stakeholder input on proposed major amendments and should consider their ability to contribute towards those engagement opportunities.

An amendment request should provide sufficient information to allow plan proponent(s) to determine whether an amendment request should be investigated further. It is the responsibility of the individual(s) requesting the amendment to demonstrate that the request is credible, worthy of consideration and within the scope of the Muskoka River WMP and the LRIA.

The amendment request must contain the following information:

- A description of the changes being requested;
- The rationale for the changes being requested;
- Results of any pre-consultation completed with potentially affected parties; and
- Where changes in operations are proposed, a description of how the proposed operation changes may impact other dams subject to the WMP.

Upon receipt of an amendment request from a third party, the plan proponent(s) will acknowledge receipt of the request in writing to the third party and notify the MNRF that a request has been received. Where the MNRF receives an amendment request from a third party, the request will be forwarded to the plan proponent(s).

Where plan proponent(s) are considering submitting an amendment request to the MNRF, prior consultation with the MNRF, the SAC (if applicable) and other plan proponents may occur.

Plan proponents will maintain records for all amendment requests.

17.2.3 Review of Amendment Request and Categorization of Amendment

The proponent(s) is responsible for screening amendment requests to determine if the request should proceed through the amendment process, and for categorizing the amendment as minor or major. This determination will ensure the appropriate degree of public consultation for the plan amendment.

The assessment will consider the following criteria:

a) Is the amendment consistent with this Technical Bulletin?
b) Is the amendment consistent with the Muskoka River WMP objectives, or does the amendment propose a change to the WMP objectives?
c) Is there an alternative method to deal with the request rather than amending the WMP?
d) Is the request within the scope of the Muskoka River WMP?
e) Is the request related to any ongoing data or effectiveness monitoring commitments?
f) Is the request supported by other potentially affected parties?
g) Is the amendment required to comply with other regulatory requirements?
h) Has the amendment request been considered previously?
i) Does the amendment have the potential to negatively affect dam safety/public safety?
j) Does the amendment have potential impacts on socio-economic or environmental considerations?

Where an amendment request does not contain sufficient information to complete an assessment or make a recommendation to MNRF, the plan proponent will return the proposed amendment to the third party with a request for additional information.

When a plan proponent(s) has completed the screening of the amendment request, written notification will be provided to MNRF. The notification will include: a summary of the amendment request and supporting rationale, results of the assessment, a recommendation of whether the request should be further considered, and if so, the appropriate category for the amendment.

17.2.4 Review of Assessment Results

The MNRF will review the plan proponent's screening results and will:

- Agree with the recommendation;
- Request additional information; or
- Disagree with the recommendation.

Where the plan proponent(s) recommends against proceeding with the amendment request, and the MNRF is in agreement, the plan proponent(s) will notify the requestor of the decision with supporting rationale.

Where the MNRF agrees that the amendment request should proceed, the plan proponent(s) will develop and submit the final amendment proposal for MNRF consideration. The plan
proponent(s) will undertake any necessary planning, consultation, information gathering or other investigative activities associated with the amendment. Where the amendment is requested by a third party, the third party may be expected to support engagement activities.

Where the MNRF disagrees with the recommendation, the MNRF will discuss the proposed amendment with the plan proponent(s). The MNRF may subsequently direct the plan proponent(s) to proceed with consideration of the plan amendment.

17.3 Ordering an Amendment

When a decision is made to proceed through the plan amendment process, the MNRF may formalize the decision through the issuance of an Order to prepare an amendment or approve the amendment under the authority of LRIA Section 23.1(6). Plan proponent(s) may also request that the MNRF issue an Order to amend the plan.

The MNRF retains the authority to require a plan proponent to undertake a WMP amendment where the plan proponent is unwilling to consider reasonable requests or where there are significant concerns regarding a facility's operation.

When MNRF intends to order a plan proponent to amend a plan, the proponent(s) will be provided a notice of intent to issue an Order to amend the plan prior to the issuance of the Order. Upon receipt of a notice of intent to issue an Order to amend a plan, the proponent(s) has 15 days to submit a request for an inquiry to the MNRF. Requests for an inquiry under the LRIA are referred by the MNRF to the Office of the Mining and Lands Commissioner (OMLC). Additional detail regarding appeals to the OMLC are referenced in MNRF's LRIA Administrative Guide and Section 11 of the LRIA.

17.4 Amendment Preparation

Where the MNRF has determined that a proposed amendment request should proceed, the plan proponent(s) shall prepare the final amendment proposal, including completing consultation activities or information gathering in support of the proposed amendment. Where the amendment is requested by a third party, the third party requester should discuss opportunities for collaboration in preparing the amendment.

For minor amendments, the plan proponent(s) must engage the MNRF, other plan proponent(s) and the SAC (if applicable). Public and First Nations and Métis community engagement and consultation requirements for major amendments are described in the subsections 17.4.1 and 17.4.2.

17.4.1 Consultation and Engagement Requirements for Major Amendments

Plan proponent(s) and in certain circumstances third party amendment requestors, shall undertake public and First Nations and Métis community engagement and consultation when developing a major amendment. Specific requirements shall be discussed with the MNRF in advance. The scope of consultation and engagement may vary depending on:

- Scope and scale of the proposed major amendment;
- Level of public, stakeholder and First Nation and Métis community interest in dam operations;
- Level of potential impact on Aboriginal and treaty rights;
- Potential impacts on other regulatory approvals; and
- Potential impacts within the scope of the LRIA and the WMP.

Consultation and engagement approaches may include:

- Direct written notice;
- Open houses;
- Information sessions;
- Public notice; and/or
- Community meetings or workshops/focus groups.

Sufficient opportunity for reasonable engagement shall be provided and information regarding the amendment shall be communicated in concise plain language.

17.4.2 Consultation and Engagement Requirements Where EA Applies

In some instances, proposed changes to existing operations of the WMP will be subject to the Environmental Assessment (EA) Act, such as MNRF's Resource Stewardship and Facility Development Class EA, or the OWA Class EA.

In such cases, the EA Act requirements shall be completed in advance of submitting an amendment request. The plan proponent(s) is not required, but may elect, to incorporate WMP amendment considerations during the EA Act process.

Where proposed changes are subject to an EA, the proponent may not be required to complete any additional public and First Nations and Métis community engagement and consultation in support of the proposed WMP amendment where sufficient engagement activities have been completed as part of the EA process.

MNRF determination of whether consultation and engagement completed during the EA is sufficient for purposes of a WMP amendment shall be made as part of the Ministry's assessment of the WMP amendment screening results. Additional consultation and engagement shall not be required, unless the MNRF concludes that the EA consultation was insufficient. In this case, the MNRF will determine the scope and scale of additional consultation and engagement necessary for the purposes of the WMP amendment.

17.5 Amendment Submission

Following completion of any applicable consultation requirements, the plan proponent(s) will provide the MNRF, other plan proponent(s) where appropriate, and any third party requesters, a copy of the final amendment proposal including:

a) Amendment request and supporting rationale;
b) Proposed changes (replacement text) as they would appear within the approved plan;
c) Map of the area affected by the amendment (if applicable);
d) Record of consultation identifying the type of form of feedback sought, issues identified and steps taken by the proponent to modify the proposed amendment in response to comments (if applicable); and
e) Any other supporting information deemed applicable to the proposed amendment.

17.6 Amendment Review

All amendments to the Muskoka River WMP must be approved by the MNRF.

The MNRF will complete a review of the amendment submission. For proposed minor amendments, the MNRF will complete a review within 30 days of receipt of a complete submission. For proposed major amendments, MNRF will complete a review within 60 days of receipt of a complete submission.

During and/or following the review of the proponent's amendment submission, the MNRF may, with supporting rationale, request additional information required to complete the MNRF's review.

17.6.1 Requests for Additional Information

Where additional information is required, the MNRF will identify in writing the additional information requested and the rationale for the request. In such circumstances, the MNRF review timeline will be put on hold until the MNRF receives the requested information.

Upon receiving a request for additional information from the MNRF, the proponent may:

- Agree to provide the additional information by the specified time;
- Request a change to the specified time for submitting the information;
- Request a review by the Regional Director of the required information; or
- Refuse to provide the additional information.

Further details regarding the above scenarios can be found in Section 3.7.1 of the Technical Bulletin (2016).

17.7 Issuance of Decision

In issuing a decision on the proposed amendment, the MNRF shall either:

- Approve the amendment;
- Approve the amendment subject to changes considered advisable to further the purposes of the Act; or
- Refuse the amendment.

MNRF will provide the plan proponent(s) and any third party requester, as appropriate, written confirmation of its decision and supporting rationale.

If the amendment is approved, the WMP will be revised and a record of the amendment will be appended to the approved WMP.

Where the MNRF intends to refuse an amendment, a Letter of Intent to Refuse approval of the amendment will be issued to the proponent identifying the supporting rationale and any additional measures the proponent(s) can take to address any outstanding concerns. The Letter of Intent to Refuse approval of amendment will notify the proponent that unless the MNRF receives a request within 15 days from the proponent for an inquiry, the amendment will be refused.

Requests for an inquiry under the LRIA are referred by the Ministry of the Office of Mining and Lands Commissioner (OMLC). Additional information on appeals to the OMLC is detailed in MNRF's LRIA Administrative Guide.

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References and Reference Information

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Addendum for Background Information Report

Addendum for Background Information Report

Summary of Investigations
Moon River Walleye
Population Dynamics Versus Flow

Walleye Spawning Below Dams

Walleye are known to spawn below several dams in the Muskoka River watershed, including the spillway channel below the South Falls dam and in the Moon River below Moon Falls. Walleye spawning, egg incubation and fry emergence can be susceptible to the impacts of water management. In a natural stream setting, walleye typically spawn when water levels are rising or stable, and depend on a slowly receding hydrograph to prevent exposure and desiccation of eggs prior to hatching. Abnormally high flows/water levels during the spawning period may encourage walleye to spawn in areas that will be dewatered prior to the end of the incubation period.

The present water management regime in the watershed includes a number of measures designed to maintain and/or enhance some of these important walleye spawning habitats (Section 5). Habitat improvements have been undertaken and a specified minimum flow (3 m^3/s) is provided at South Falls to enhance spawning habitat and survival of eggs and fry. Further complications at both sites include a protracted spawning period, as fish respond to rising and falling temperature cues.

The area immediately below Moon Falls on the Moon River is an historically significant spawning area for walleye, with progeny from this area historically providing the basis for a destination fishery in Georgian Bay. MNR records indicate that the spawning population using this area has declined substantially, although a reduced population (compared to historic data) still utilizes this area as a spawning location.

Since 1969, MNR and OPG have attempted to maintain a consistent, targeted flow of 14 m^3/s in the Moon River for the duration of walleye spawning and egg incubation periods in the months of April and May. This quantity was thought to have been identified as a target in the Hackner-Holden Agreement, although historic documentation is lacking in this regard. A flow of 14 m^3/s was considered the quantity that could be provided from one year to the next through April and May, while also minimizing the impact on power production at OPG facilities on the Musquash River. A higher flow value was not chosen as the target as it could not be provided on a consistent basis, which was thought to be essential to yearly production of walleye at this site. However, in reality, flows are often variable, with high volume, short duration peaks above the targeted 14 m^3/s a common occurrence.

Further observations and investigations have revealed that managing for stable, low flows on the Moon River often results in unanticipated peaks in flow when rain events or sudden snowmelt events occur within the watershed. These events cause dramatically increased outflow from the watershed, requiring excess water to be passed down the Moon River as the hydropower facilities on the Musquash River typically pass a maximum of 85 m^3/s (the other outflow channel for the watershed). These peaks in flow increase water levels below Moon Falls and allow spawning walleye to access habitat that will be dewatered as flows recede. This results in stranding of walleye eggs deposited during these high flows. In recent years, a lower consistent flow (8 m^3/s) has been targeted due to dry conditions in the watershed. As a whole, the fluctuations in flows in the Moon River are a result of water withdrawal for hydro generation (by OPG) coupled with a limited ability (by MNR) to store/control spring runoff in upstream lakes and provide flow into the latter part of the incubation period for walleye. Further information on studies undertaken to investigate the relationship between Moon River walleye population dynamics and flow is contained within the Draft Plan, Section15 (Acres, 2005).

Although a few strong year classes have been observed (1960, 1965, 1982, 1985), these occurred in years when flows were high (generally 100 m^3/s or higher), and where these high flow levels were sustained throughout the majority of the walleye spawning and incubation periods. Recent work conducted below Moon Falls (UGLMU, unpublished data) has raised doubts that a flow of 14 m^3/s will consistently provide a sufficient quantity of wetted high quality spawning habitat to produce strong year classes of walleye.

To quantify the issues and concerns associated with the Moon River walleye population, a number of studies (i.e., Winterton, 1975; Dillon, 1983) have been conducted. These studies indicated that walleye production below Moon

Falls was strongly related to discharge and fluctuating water levels, as anecdotal reports have often confirmed. Winterton (1975) and Dillon (1983), both identified that as peak flows recede following the spring freshet, eggs are often dewatered during the latter part of the egg incubation period, and/or deposited eggs are scoured from spawning habitat and swept downstream by high flow events. Winterton (1975) concluded through his analyses that flows accounted for 89% of the variability in walleye production, and more specifically that high, sustained flows produced strong year classes. Further analysis by Reckahn and Thurston (1989) confirmed Winterton's analysis and strengthened it by adding May air temperature and maximum snow depth variables (as precursors to high spring flow events) to the analysis (Table 1). Both sets of analysis served to highlight that high, sustained flows are required for good walleye production below Moon Falls and that managing for low, stable flows would not allow for walleye production to occur in any substantial amount.

Table 1
Correlation Between Environmental Variables and Walleye

Predictor Variable	Regression Coefficient	Sum of Squares	Cumulative Sum of Squares	Cumulative d.f.	Adjusted r^2 x 100	P
FLOW	0.0516	495.73	495.73	1	84.5	0.000
TEMP	0.4991	43.91	539.63	2	92.5	0.000
SNOW	-0.1452	22.34	561.97	3	96.8	0.002
Residual		14.63	576.60	14		

Variable definitions:
- TEMP = May air temperature (°C)
- SNOW = Maximum snow depth (cm)
- FLOW = Mean April + May Moon River flow (m^3/s)
- Residual mean square = 1.33

As noted above, flow regulation is complicated by water withdrawals for hydropower generation (on the Musquash River) and the limited ability to store/provide sufficient flow from upstream lakes. As a result, the Dillon report provided a series of potential engineering solutions, including improved storage/regulation at upstream water control structures, channelization of specific river channel sections to reduce water level fluctuation associated with flow changes and installation of strategically placed weirs to reduce water level fluctuations. Most recently, the Upper Great Lakes Management

Unit of MNR undertook an assessment of spawning activity at the site during the spring of 2004. Although the Dillon report identified options, many of these were very costly and the identified flow regimes in the options portion of the report were not discreetly compared against walleye spawning habitat below Moon Falls. In addition, the opportunity to change flow regimes for the Moon River was not available at the time, as it is now, hence the emphasis on engineered solutions rather than modified flow regimes. The fisheries issues associated with the Moon River represent an ongoing issue, with the relationship between flows and available spawning substrates an outstanding data need. Please see Section 15 of the Draft Plan (Acres, 2005) for a description of proposed work and future plans for dealing with Moon River fisheries issues.