Operational Practice

Southern Lakes and Schwatka Lake Water Management

yukon energy
the power of yukon

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LIST OF ACRONYMS AND ABBREVIATIONS

Name	Definition
EDI	Environmental Dynamics Inc.
EMO	Emergency Measures Organization
FSL	Full Supply Level
KGS	KGS Group
LSL	Low Supply Level
WRB	Water Resources Branch
WRGS	Whitehorse Rapids Generating Station
YG	Yukon Government

1 INTRODUCTION

Yukon Energy is the main generator and transmitter of electricity in the Yukon. Our vision is to lead the transition to a more reliable, robust and renewable Yukon electricity system that meets the demands of tomorrow while safeguarding the energy needs of today.

The Whitehorse Rapids Generating Station (WRGS) is a key piece of infrastructure for clean, renewable electricity generation year-round in the Yukon. The WRGS hydroelectric facility generates about 75% of the electricity used by Yukoners connected to the Yukon Integrated System during the summer, and about 40% of the electricity needed during the winter.

This Operational Practice describes Yukon Energy's operating conditions for the WRGS under our current Water Use License. It outlines considerations and decisions that we make when managing water levels or flows through the year to maximize hydroelectric generation. This Operational Practice will be updated with any future authorizations.

2 WRGS WATER MANAGEMENT

Yukon Energy operates the WRGS under a Water Use Licence issued by the Yukon Water Board. The Water Use Licence stipulates the following:

- Conditions under which Yukon Energy can utilize the Lewes Control Structure to regulate outflows from Marsh Lake into the upper Yukon River and Schwatka Lake (WRGS headpond)
- Authorization to use the Whitehorse Rapids Dam to regulate flows of water out of Schwatka Lake and downstream of WRGS on the Yukon River; and
- Authorization to use water to produce electricity at the WRGS.

Water in the Yukon River used to generate hydroelectricity at the WRGS, comes from the Southern Lakes watershed including Bennett, Tagish, and Marsh lakes, as well as further upstream from lakes like Atlin and Tutshi. Figure 1 shows elevations of the water system from Atlin to Schwatka Lake, upstream of the WRGS hydroelectric dam.

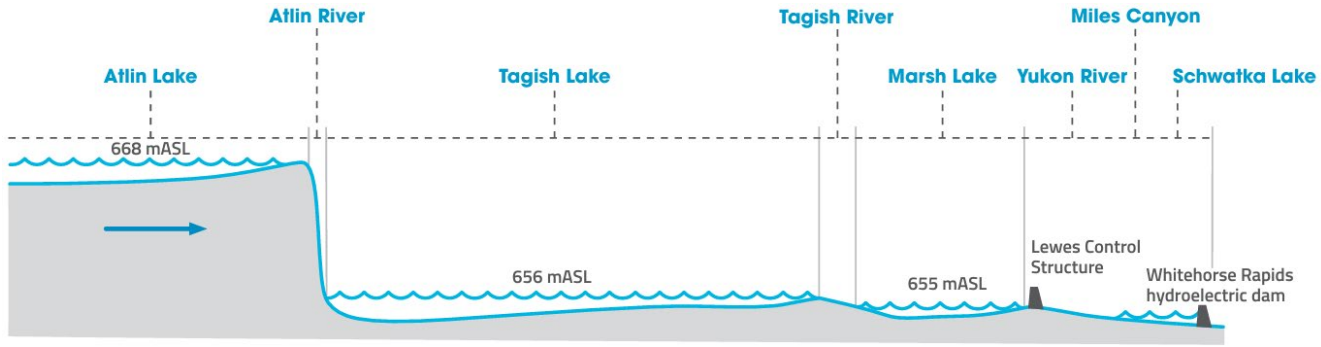

Figure 1: Longitudinal Water Profile from Atlin Lake to WRGS

Under the terms of the current Water Use Licence (HY99-010), Yukon Energy must meet the following operating conditions:

1. Maintain a minimum flow of 85 m^3/s in the Yukon River downstream of the Lewes Control Structure and Whitehorse Rapids Powerhouse.
2. Maintain Schwatka Lake operating levels within the following range:
    - Full Supply Level (FSL) of 653.339 metres; and
    - Low Supply Level (LSL) of 652.272 metres.
3. Maintain Marsh Lake operating levels within the following:
    - FSL of 656.234 metres; and
    - LSL of 653.796 metres.
4. All 30 Lewes Control Structure gates must remain fully open between May 15 and August 15 and when the water level on Marsh Lake is above FSL (656.23 m), except as required for repairs and maintenance, or as permitted by Condition 5, below.
5. Under extreme drought conditions, up to 20 gates at the Lewes Control Structure may be closed and at least 10 gates must remain open if the level on Marsh Lake does not reach minimum elevations by certain dates, as listed below:
    - July 7th 654.82 metres
    - July 21st 655.15 metres
    - August 10th 655.65 metres

    In addition to operating within the water levels prescribed under our Water Use Licence, Yukon Energy acts to maintain water levels below those that would result in increased hazard to WRGS infrastructure. Hazardous Levels for WRGS are listed below:
    - Marsh Lake Elevation at or above 656.934 meters; and
    - Schwatka Lake Elevation at or above 653.339 meters.

    Consistent with the terms of the Water Use Licence, Yukon Energy manages water flows to generate hydroelectricity in an annual cycle (Figure 2). During the summer (typically May 15 to August 15) WRGS is run-of-river as inflows exceed outflows in the Southern Lakes and the lakes refill or recharge. In the fall and early winter, we manage the system to maintain lake water levels at the Marsh Lake Full Supply Level. Then over winter, we manage lake outflows using the Lewes Control Structure to maximize electricity production and target the Marsh Lake Low Supply Level at spring freshet.

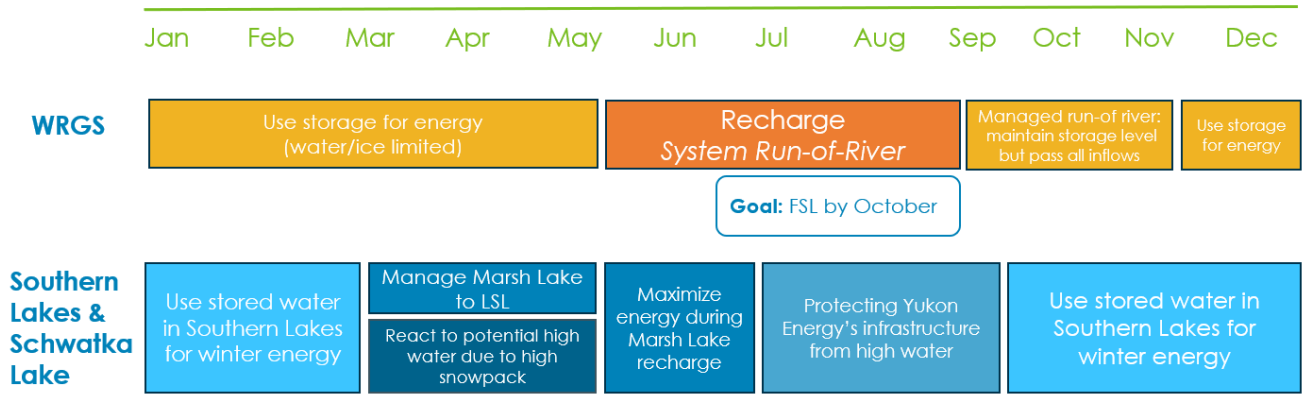

Figure 2: Annual Cycle of Water Management and Electricity Generation at WRGS

3 INFLOW AND WATER LEVEL FORECASTING

Yukon Energy actively monitors and forecasts water levels in the WRGS headwaters. We forecast water levels on both Marsh Lake and Schwatka Lake using both an inflow and a hydro-optimization model. The inflow model, HYDROTEL, considers historical data of average temperatures, precipitation, snow accumulation, and inflows. There are three predictors of water levels in Marsh Lake:

1. Snowpack and rate of snow melt.
2. Glacial melt (impacted by air temperature).
3. Summer precipitation.

The HYDROTEL model provides 14-day and monthly forecasts for temperature, precipitation, and snow cover in the Southern Lakes region. Yukon Energy regularly inputs the HYDROTEL forecasts into our hydro-optimization model, which predicts the water levels on Marsh Lake.

4 HEADPOND WATER LEVEL MANAGEMENT

Schwatka Lake is the headpond for the hydroelectric generators at WRGS and is licenced to be operated between a Full Supply Level (FSL) of 653.339 metres and Low Supply Level (LSL) of 652.272 metres. Table 1 identifies the goals, timeframes and considerations by Yukon Energy when deciding to operate Schwatka Lake at the top (FSL) or bottom (LSL) of the operating range. The dates of the periods are approximate and based on our records of historical observations.

Table 4.1: Summary of Seasonal Water Management Decisions and Considerations

Goal Description	Decision	Time Period	Benefits	Considerations for Decision
#1 – Winter electricity generation	Targeting Marsh Lake water levels to reach at/near LSL before the beginning of freshet.	September 15 – March 15	▪ Maximize use of stored water in Southern Lakes for generating electricity needed during winter.	▪ Downstream icing conditions in Marwell. ▪ Winter inflows. ▪ Availability of other winter generation resources. ▪ Timing of asset maintenance that would reduce available generation (e.g. grid splits).
#2 – Short-term pre-freshet adjustments of Marsh Lake water levels towards LSL	Schwatka Lake is lowered and/or open additional gates at the Lewes Control Structure to manage Marsh Lake towards LSL.	March 15 – May 15	▪ Maximize flow through the turbines and in turn, electricity generation at the WRGS by maximizing storage drawdown in Marsh Lake.	▪ Lake levels at Marsh Lake and inflow forecasts. ▪ Availability of generation at the WRGS due to maintenance.
#3 – Increase flows during Southern Lakes recharge	Schwatka Lake is lowered during Marsh Lake recharge.	May 15 – June 15	▪ Increase flows into Schwatka while Southern Lakes recharge. ▪ Maximize flows available for electricity generation at the WRGS.	▪ Pre-requisites to this decision: Marsh Lake levels are within the range of 653.9 and 654.9 metres. ▪ Consider the financial benefits of maximizing generation at the WRGS by reducing water that is spilled in the summer.
#4 – Protection of WRGS infrastructure during high water	Schwatka Lake is lowered during high water events.	June 15 – September 15	▪ Protecting Yukon Energy's infrastructure from high water.	▪ Pre-requisites to this decision: Marsh Lake level is forecasted to reach or exceed 656.9 metres.
#5 – Water management for high water/flooding in Southern Lakes	Maintain Schwatka Lake lowered and/or open additional gates at the Lewes Control Structure to manage Marsh Lake towards LSL.	March 15 – August 15	▪ Mitigation for high water/flood conditions for Southern Lakes shorelines.	▪ Pre-requisites to this decision: (1) Annual snow survey from YG, and (2) Snowpack expected to be >130% above average. ▪ Flood control request received from Emergency Measures Organization and Yukon Government.

5 SECURITY FOR YUKON ENERGY INFRASTRUCTURE DURING HIGH WATER

Yukon Energy manages infrastructure risks at WRGS consistent with the Dam Safety Guidelines from the Canadian Dam Association and has established hazardous water level thresholds for WRGS infrastructure: 656.934 meters for Marsh Lake and 653.339 meters for Schwatka Lake. Potential risks to WRGS include damage to foundations, water conveyance and generation infrastructure, and additional erosion.

When our models forecast that water levels on Marsh Lake and Schwatka Lake are approaching and may exceed Yukon Energy's hazardous levels, we take several steps to protect our assets by increasing flows through the WRGS, in accordance with the terms of our Water Use Licence, including the following:

- Open all gates at the Lewes Control Structure to increase flow in the Yukon River; and
- Lower water levels on Schwatka Lake to increase water flows through Miles Canyon.

In addition to operating within the terms and conditions in our Water Licence, there are several additional requirements when making water level adjustments in Schwatka Lake including:

- Maintaining adequate flows through the WRGS fish ladder when operational. This typically limits the rate of headpond drawn down to less than 3 cm per hour;
- Changing flows downstream of WRGS within Yukon Energy's Flow Reduction Ramping Procedure – Whitehorse (EMS-EJP-008); and
- Adjusting water levels during working hours so Yukon Energy personnel are readily available to monitor the adjustments, any effects and alter operations if needed.

5.1 Monitoring and External Communications

When Yukon Energy's hazardous thresholds have been reached (656.934 meters at Marsh Lake, 653.339 meters at Schwatka Lake) the following actions and increased monitoring at the WRGS structures will be triggered:

1. Yukon Energy will ensure that WRGS is staffed on a 24-hour basis.
2. On duty and on-call Operations staff will have a cell phone with them at all times.
3. Yukon Energy Civil Engineering staff will visit the Lewes Control Structure daily and the Whitehorse Rapids Dam at least two times daily to observe conditions at the structures, and to complete manual water level checks using available staff gauges on the structures.
4. RCMP will be informed that hazardous levels exist.
5. The City of Whitehorse will be informed that hazardous levels exist.
6. YG EMO will be informed that hazardous levels exist.

7. Yukon Energy will contact EMO emergency coordinators at least once daily.

The Communications team will work with EMO to issue updates to the public on an as-needed basis.

5.2 Internal Communications

When our forecasts indicate that Schwatka and Marsh Lake will approach and exceed hazardous levels, our internal communications protocol follows the following steps:

1. Planning informs Operations, Communications, and Senior Management teams and provides bi-weekly email updates on water levels and provide recommendations on valve changes and dispatch order of resources.
2. When the hazardous water levels are reached and increased monitoring at the WRGS is initiated, Planning provides daily updates on water level forecasts, sharing any critical changes promptly with Operations, Communications, and Senior Management teams.

The Senior Management Team decides on actions taken, including lowering Schwatka Lake, to mitigate the risk of damage to our infrastructure when Schwatka and Marsh Lake levels exceed the hazardous thresholds.

6 INFLUENCING PEAK WATER LEVELS IN THE SOUTHERN LAKES

Opening and closing gates in the Lewes Control Structure is the primary way that Yukon Energy influences water levels in the Southern Lakes. Except in drought conditions, all gates in the Lewes Control Structure are required to be open from May 15 to August 15 each year when water levels and flows naturally peak in the Southern Lakes.

When all gates at the Lewes Control Structure are open, the control structure has limited impact on the flow capacity of the river reach. Miles Canyon, located downstream of the Lewes Control Structure, acts as hydraulic control at high flows. This was reconfirmed by AtkinsRéalis (2024)[1] in a study to inform design of the reconstruction of the boat lock at the Lewes Control Structure. They conducted a hydraulic study of the Yukon River between Marsh Lake, the Lewes Control Structure, and the Whitehorse Rapids Generating Station.

Yukon Energy also manages water levels in Schwatka Lake. Lowering water levels in Schwatka Lake can increase head and flows out of Marsh Lake. When all the gates are open at the Lewes Control Structure and Marsh Lake is exceeding the Full Supply Level, water levels at Schwatka Lake have a limited effect on Marsh Lake. Due to the relatively smaller volume of Schwatka Lake compared to Marsh Lake, lowering water levels at Schwatka Lake to or close to LSL results in limited effects to water levels at Marsh Lake water when flows are low. At high flows in the system, these effects to water levels at Marsh Lake are even lower (10-13cm). This phenomenon is discussed below.

[1] AtkinsRéalis. 2024. *Lewes Boat Lock Replacement – Hydrotechnical Study*.

The limited influence of lowering Schwatka Lake on lake levels in Marsh Lake at high flows is confirmed by studies conducted by KGS (2010)[2], AtkinsRéalis (2024) and AtkinsRéalis (2025)[3]. AtkinsRéalis (2024) examined how lowering Schwatka Lake during high-water periods could influence upstream water levels, particularly in Marsh Lake. The study factored in the effects of climate change on flows and water levels. An update to that study was completed in April 2025 (AtkinsRéalis 2025) that modelled and validated that a constant increase in Marsh Lake outflow cannot be applied to the model.

The two studies found that during high-water, or flooding events on Marsh Lake, that lowering the water level of Schwatka Lake and keeping all gates at the Lewes Control Structure open have minimal impact on Marsh Lake's water levels. As an example, the model showed that lowering Schwatka Lake to the LSL of 652.27 metres (about 90 centimetres) and maintaining this throughout the entire flood season (March 15th until at least August 15th) would result in about 10 to 13 centimetres upstream impact on Marsh Lake. March 15th, when the first snow Yukon Government snow survey is available, is the earliest date that Yukon Energy can reasonably forecast that freshet inflows and water levels may be above average in that year. Overall, the study findings indicate that lowering Schwatka Lake has comparatively small effect on flood mitigation efforts and it takes several months to see small changes upstream of Schwatka Lake. It should be noted that the magnitude of the modelled impact on flood levels (10 to 13 centimetres) could be smaller than potential level variations caused by natural phenomenon, such as wind setup and wave run-up.

AtkinsRéalis (2025) presents two reasons for the variable outflows at Marsh Lake and throughout the river system:

1. The increase in outflow at Marsh Lake caused by the lowering of Schwatka Lake levels is more significant when water levels at Marsh Lake are lower or closer to LSL.
2. The river system is dynamic, meaning that the increase in flow capacity in the Southern Lakes cannot be sustained for extensive periods of time, mainly due to increased flow capacity leading to faster lowering of water levels at Marsh Lake, which over time will reduce outflows out of Marsh Lake.

The results of the modelling align with Yukon Energy's experience when we attempted to pre-emptively draw down Marsh Lake below LSL prior to the 2021 high-water event. Yukon Energy received approval to lower Marsh Lake water levels below LSL under an emergency Water Use Licence Amendment. Under that amendment additional monitoring and reporting was required (EDI 2022[4]).

The experience and monitoring under the high-water conditions of 2021 reaffirmed:

[2] KGS Group. 2010. *Hydraulic Modelling of Yukon River Marsh Lake to Schwatka Lake*.
[3] AtkinsRéalis. 2025. *Schwatka Lake Water Management and Impact on Flood Routing*
[4] Environmental Dynamics Inc. [EDI]. 2022. *2022 Marsh Lake Low Water Investigations*.

1. The major hydraulic features of the Yukon River, in particular Miles Canyon and the rapids near the area of McCrae, act as controls for water levels upstream of the WRGS. As a result, the water levels on Marsh, Tagish, and Bennett lakes are independent of the water levels on Schwatka Lake.
2. During high-water events, early drawdown of Marsh Lake to the LSL has limited influence on peak water levels as inflows quickly exceed outflows, constrained by Miles Canyon, resulting in rapidly rising lake levels. In 2021, Yukon Energy was able to temporarily lower the elevation in Marsh Lake slightly below the LSL (by up to 5.1 cm) from April 29 to May 23, 2022. Regardless, in early June the level of Marsh Lake rose quickly exceeding the Full Supply Level on July 3, 2022, and continuing to increase during the monitoring period.

6.1 Communications with External Parties During Periods of High Water in the Southern Lakes

YG Emergency Measures Organization (EMO) is responsible for the territory's preparedness for, response to, and recovery from major emergencies and disasters including flooding. During times of forecasted high water in Marsh Lake, Yukon Energy collaborates with the governments and provides our detailed water modelling and forecasting information. We share this information with the Yukon Government's (YG) Department of Environment, Water Resources Branch (WRB), Department of Community Services, and Emergency Measures Organization (EMO). During these times when heightened monitoring of the water levels is required, Yukon Energy also participates in weekly meetings with YG, WRB, EMO, and Environment and Climate Change Canada to discuss weather forecasts and emerging weather events that could cause the water levels in the Southern Lakes to rise.

The Yukon Government WRB monitors the levels on Marsh Lake to inform their high-water advisories, flood watches, and determine when they will implement flood protection measures at properties around Marsh Lake. The flood threshold levels that YG WRB uses are different from Yukon Energy's hazardous levels and are as follows:

- Heightened monitoring for high water advisories occurs when water levels are between 656.46 and 656.76 metres;
- Flood watch monitoring occurs when water levels are between 656.76 and 656.96 metres;
- Based on anecdotal site observations, first signs of flooding at low-lying properties on Marsh Lake were observed at a water level of 656.78 metres; and
- Flood protection measures such as sandbagging are implemented when water levels reach 657.06 metres.

7 CLOSURE

The Whitehorse Rapids Generating Station (WRGS) is a key piece of public infrastructure generating about 75% of the summer electricity and about 40% of the winter electricity needed in the Yukon. The use of water at WRGS is regulated through terms and condition in a Yukon Water Use Licence and this Operational Practice described how Yukon Energy makes decisions to maximize power generation under that licence.