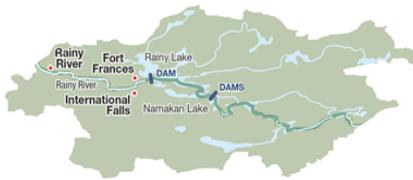




International Rainy and Namakan Lakes Rule Curves Study Board

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Factsheet # 4

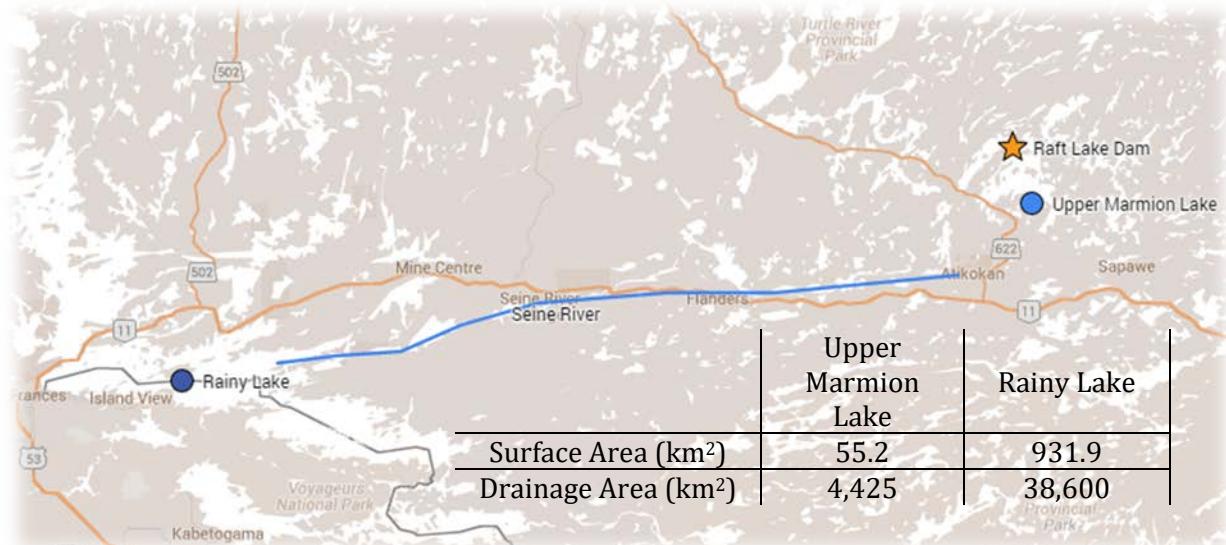
Title: Marmion Reservoir Storage

Background

At a workshop in International Falls in March, 2016, the Study Board was asked to examine whether storing water in Upper Marmion Lake could help reduce high water at Rainy Lake during high flow periods, such as occurred in 2014. This Factsheet examines this question.

Location and Description

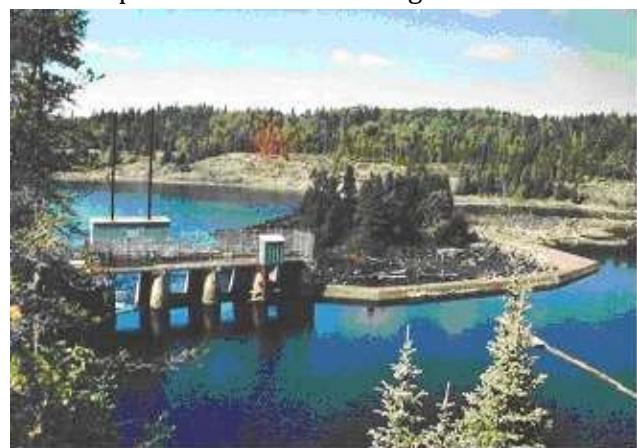
Upper Marmion Lake is located in Ontario, upstream of the Seine River and Rainy Lake. Flow out of Upper Marmion Lake is controlled by a dam on Raft Lake, just downstream of Upper Marmion Lake.



By surface area, Rainy Lake is approximately 17 times larger than Upper Marmion Lake. By surface area, Upper Marmion is small for its watershed size when compared to most other large lakes in the region. In general, this means its levels fluctuate more under similar rainfall conditions.

Raft Lake Dam

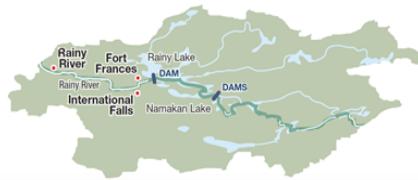
The Raft Lake dam was constructed in 1943 as part of the Seine River – Steep Rock Mine diversion project. It is currently owned and operated by H2O Power LP. This dam has four log-sluices for adjusting flow rate, as well as a 244 m (800 ft) long spillway which allows for uncontrolled flow out of the lake. The control over outflow from Raft Lake





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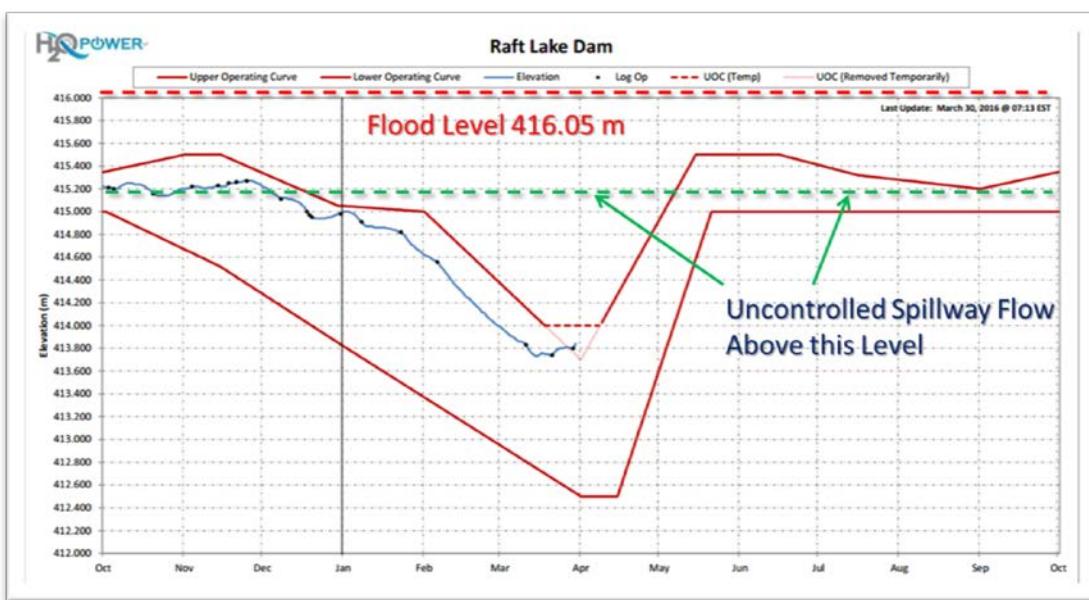


diminishes as the water level rises above the elevation of the spillway (415.17 m).

The lake levels of Upper Marmion Lake are regulated by means of a Rule Curve set established by the Province of Ontario (see below). H2O Power LP is required to target lake levels within this Rule Curve range throughout the year. These regulations also stipulate a "Flood level", the maximum elevation set for Upper Marmion Lake, of 416.05m.



The Raft Lake Dam spillway, June 2014



Raft Lake Rule Curve

The International Joint Commission does not have jurisdiction over this lake or its controls as it is entirely within Canada and therefore not a boundary water as defined in the 1909 Boundary Waters Treaty.

Upper Marmion Operations in 2014

The graph below illustrates the level of Upper Marmion Lake during 2014 as well as the flow out of the lake. For this exercise, the potential storage from 2014 is the difference between the Flood Level (in red, 416.05 m), and the peak of the lake level around June 23 (approximately 415.55 m),



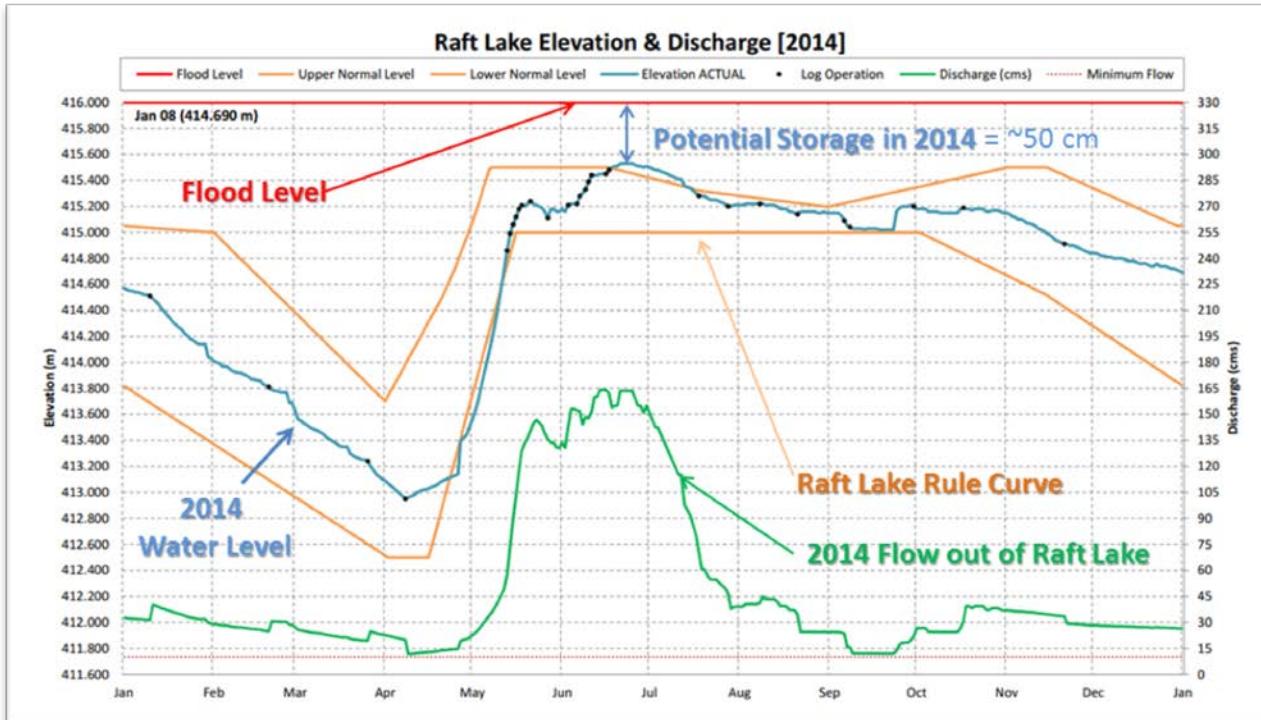
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or 50 cm (19.7 in). In principle, the lake could have risen by an additional 50 cm in June and stayed at or below the official Flood Level.

The volume of water contained in 50 cm depth of Upper Marmion is roughly 27 million cubic meters. On Rainy Lake, 27 million cubic meters fills roughly 3 cm (1.2 in) of the lake due to its much larger surface area.



If there were no overflow spillway, adding logs to the sluices to reduce outflow by approximately $40 \text{ m}^3/\text{s}$ for one week would have stored enough water in the lake to reach Flood Level in the last week of June.

However, this level of control is not possible with the spillway. If water is flowing into the lake faster than it is flowing out then, as logs are inserted into the sluices, the lake level rises above the spillway and the flow rate over it quickly increases. Filling Upper Marmion Lake to the Flood Level in 2014 would have required much higher flows into the lake, and resulted in much higher flows out of the lake. At the Flood Level, the uncontrolled rate of flow from the spillway alone, $382 \text{ m}^3/\text{s}$, is more than double the maximum flow recorded in 2014.

Conclusions

Storage of water in Upper Marmion Lake is not a viable option for preventing or reducing high water in Rainy Lake. The reservoir is too small relative to the size of Rainy Lake, the dam does not allow for full flow control at moderately high lake levels, and it is subject to regulatory controls that are outside of the jurisdiction of International Joint Commission.