Terms of reference for the Evaluation of the 2000 Rainy - Namakan Rule Curves

This document should be read in conjunction with Directive for the *International Rainy – Namakan Lake Rule Curve Study Board (IRNLRCSB) and Directive for Communication and Public Outreach Activities.* If there is a conflict in wording between the three documents, the Directives shall be authoritative.

Summary

This Terms of Reference outlines the approach for the planned Rainy and Namakan Lake 2000 Rule Curve evaluation, including the planned study methodology, governance structure and public engagement strategy.

The 2000 Rainy and Namakan Lake Rule Curves were established in 2001 as part of a consolidated order, which stipulated a review of the 2000 Rule Curve in 2015. In 2009 a report outlining a Rule Curve review plan of study was issued and approved (Kallemeyn et al., 2009). That plan called for 18 studies to investigate the wide range of hydrologic, hydraulic, cultural and environmental risk factors. The last of those and subsequently identified required studies is scheduled for completion in October 2015, barring possible extensions.

The objective of this rule curve evaluation study is to provide to the IJC with scientifically supported recommendations for the modification or retention of the 2000 Rainy and Namakan Lakes Rule curves, considering the aforementioned risk factors. The evaluation scope of the original 2009 plan has been expanded, based on review by the International Rainy Lake of the Woods Watershed Board (IRLWWB) in 2014, to now include a Shared Vision Model (SVM) component allowing for a more integrated comparison of rule curve options linking the hydrology and hydraulics to the other investigated risk factors. The geographic scope of this study comprises the Rainy and Namakan Lakes, the connecting channels and the Rainy River downstream of Rainy Lake to the Lake of the Woods, and the riparian areas adjacent to these water bodies.

As outlined in the Directive this evaluation study will be managed by a six -person Study Board, advised by a two-person technical working group (TWG) and supported by a Study Manager. The TWG will perform the numerical modelling and rule curve scenario simulations and provide options and technical recommendations to the Study Board. The Study Board will be responsible for informing and soliciting feedback from the public, stakeholders, the IRLWWB and their Water Levels Committee (WLC) throughout the study and will be responsible for forming a Rule Curve Public Advisory Group (RCPAG), consisting of members of riparian associations and stakeholders active in the basin. The Study Board

will also be responsible for evaluating the recommendations from the TWG, considering feedback from stakeholders, and presenting a final report with recommendations to the IJC.

The project is anticipated to start in the fall of 2015 with an anticipated duration of one and one-half (1.5) years with an anticipated total cost of $295,000.

Background

In 2001 the International Joint Commission (IJC) issued an Order prescribing the method of regulating the levels of the boundary waters of Rainy and Namakan lakes, consolidating and replacing a number of previous orders and supplementary orders (International Joint Commission 2001). This "Consolidated Order" was effective on February 28, 2001, and contained the following provision: "This order shall be subject to review 15 years following adoption of the Commission's Supplementary Order of 5 January 2000, or as otherwise determined by the Commission. The review shall, at a minimum, consider monitoring information collected by natural resource management agencies and others during the interim that may indicate the effect of the changes contained in the Supplementary Order of January 5, 2000."

In 2007, the IJC formed a six-member Rule Curve Assessment Workgroup to develop a plan of study (POS) in which the Workgroup would prioritize the monitoring and analyses required to review the IJC Order in 2015. Specifically, the POS was written to identify priority studies and describe information/data that remained to be collected, identify appropriate entities to collect the data and perform the studies, and to provide an estimate for the cost to accomplish this work by 2015. The Plan of Study (POS) for the Evaluation of the International Joint Commission (IJC) 2000 Order for Rainy and Namakan Lakes and Rainy River was completed in 2009 (Kallemeyn et al., 2009).

The Workgroup, in its 2009 report, suggested that an expert panel should judge the rule curves based on the review of a simple matrix of positive, negative or neutral indicators for each monitored outcome, called the "weight of the evidence approach". A total of 18 studies were originally launched as part of this Rule Curve Review following from the 2009 report, to assess the changes in hydrology, hydraulics, flooding and other impacts due to the changes from the 1970 to the 2000 rule curves in the Rainy and Namakan reservoirs. Since the start of the Rule Curve Review study other needed studies have been added and others defunded, as the study team managed the study adaptively. The final list of studies in support of the Rule Curve Review is tabulated in Table 1. Additionally, IWI-funded studies may also provide results which could support the rule curve review, and these are listed in Table 2.

In 2014, as many of the studies were nearing completion, the scientists and stakeholders took stock of the results obtained to date. Questions were raised whether the expected results could lead to a definitive evaluation of the changes in the rule curve or reliably recommend alternative rule curves. The weight of the evidence approach originally outlined in the 2009 report is straightforward but has

shortcomings. The original proposed approach would also be unable to evaluate rule curve performance in other plausible hydrologic scenarios, including those with climate change.

On March 11, 2014, scientists and stakeholders involved in this work met in International Falls to consider the feasibility of the shared vision approach (Palmer et al, 2013) in developing a rule curve evaluation study similar to what has been successfully employed in the IJC Upper Great Lakes Study and the Lake Ontario – St. Lawrence River Study (IJC, 2012; IJC, 2006). The scientists and stakeholders determined it was feasible and advisable, and they recommended the work described in a project proposal for the evaluation of the Rainy and Namakan Rule Curves, provided to the IJC in May 2014 through the International Rainy-Lake of the Woods Watershed Board. The recommendations introduced a plan for a Shared Vision Model.

In light of these recommendations, the IJC adjusted the original study scope as outlined in the 2009 report and re-allocated study resources to facilitate the anticipated SVM study approach, resulting in the addition of several new studies and the defunding of others that are no longer necessary.

This Plan of Study outlined the Rule Curve evaluation study employs much of the IRLWWB 2014 proposal with the above items fully addressed.

Table 1 - Rule Curve Review Studies

Study Index	Rule Curve Review Studies
1 / 2	Reservoirs - develop reservoir hydrologic model & reservoir PHABSIM habitat model (1 - hydrologic, 2 - hydraulic)
3	Characterize the natural hydrology of Rainy River (HEC-RAS Model) vs. rule curves
4	Measure changes in benthic community in relation to curves, in the reservoirs
5	Aquatic vegetation (replicate Meeker and Harris 2009)
6	Reservoirs – northern pike spawning habitat and reproductive success
7	Rainy River – critical spawning and nursery habitats
8	Economic survey of impact of rule curves on tourist resorts on reservoirs
9	Relate rule curve changes to flooding and ice effects on reservoirs
10	Assess Effects of Water Level Fluctuation on Bioindicators Using Analytical Models
11	Detailed bathymetric mapping of the littoral zone of selected reservoir locations
12	Assess effects on cultural resources at a small number of sites on the reservoirs
13	Assess effects on cultural resources at benchmark sites on the Rainy River
14	Assess effects on reservoir habitats for marsh-nesting birds/herps at selected sites
15	Identify critical river benthic habitats at X-sections; model effects of curve change (defunded)
16	Measure Unionid (mussel) diversity and abundance in the Rainy River re: effects
17	Measure changes in fish community health (Index Biotic Diversity) re: effects
18	Measure critical spawning habitat for walleye on Namakan Reservoir re: effects
19	Examine municipal water treatment and hatchery data for Rainy River re: effects
20	Network Global Navigation Satellite System Surveys of Vertical Benchmarks
21	Development of a 2-D habitat model required to support Study No 7 "Rainy River –

Study Index	Rule Curve Review Studies
	critical spawning and nursery habitats"
22	Collect bathymetric data for selected shallow areas to assist in the development of a digital elevation model for Rainy Lake and Namakan Reservoir

Table 2 - IWI Studies supporting or complementary to the Rainy Rule Curve Review

IWI Studies
Seine River Temperature Study - Seine River First Nation
Cattails and Wild Rice Study - Seine River First Nation
Multi-year Rainy River Temperature Study
Namakan Pinch-Point Hydraulic Study

Public and Stakeholder Engagement

Residents and businesses, including recreation and tourism, along the shores of Rainy and Namakan Lakes have a high interest and concern about water levels control.   This fact makes it particularly important that the public engagement plan for the Rule Curve Review begin early in the process and maintain a high level of public and stakeholder engagement throughout the study.

As per the Directives the Study Board will be relying on IJC Communications staff, to assist it in organizing its communications and outreach program. These staff time costs are not included in the budget.

Scope and Objectives

Project Objectives

The objective of this study is to provide to the IJC scientifically supported recommendations for the modification or retention of the 2000 Rainy and Namakan Lakes Rule curves, considering a wide range of hydrologic, hydraulic, cultural and environmental risk factors.

Project Scope

This project study scope includes the evaluation of the 2000 Rule Curves for Rainy and Namakan Lakes and the identification of performance differences between the 1970 rule curves and estimated state-of-nature releases from those lakes. The geographic scope of this study comprises the Rainy and Namakan Lakes, the connecting channels and the Rainy River downstream of Rainy Lake to the Lake of the Woods, and the riparian areas adjacent to these water bodies. The rule curve evaluations will be conducted

using a weight of evidence approach as outlined in Kallemeyn et al. (2009), as well as a shared vision modelling approach detailed below. The SVM approach will also evaluate the influence of the rule curves under various climate change scenarios, and provide recommended modifications to the existing 2000 Rule Curves if appropriate, through the testing of rule curve alternatives.

Study Methodology

The TWG will conduct and execute two complimentary approaches to review the Rainy and Namakan Lake Rule Curves: the weight of evidence approach as outlined originally in Kallemeyn et al. (2009); and the added shared vision model (SVM) approach.

The TWG will develop a shared vision model using economic and environmental impact information from the already completed rule curve studies and based on an existing reservoir simulation model for Rainy and Namakan lakes and the existing hydrodynamic model of the Rainy River. The Rainy and Namakan lake model currently simulates lake levels and releases under the 1970 and 2000 Rule Curves using the historical water supplies and has been modified to consider other rules, in particular a "state of nature" release rules representing estimates of releases without the presence of hydraulic control structures or human influences.

A two-dimensional hydrodynamic model of the downstream Rainy River will be used to simulate the levels with the flows generated under the two Rule Curves and state of nature release rules as well as any other release rules developed. The shared vision model will thus include the Rainy River in an integrated simulation of the impacts of water levels throughout the system on economic and ecological indicators.

At the March 2014 review of the Kallemeyn approach, scientists involved in the Rule Curve Review studies, developed the list of performance indicators that could be prepared for programming into the modified reservoir simulation model including the Rainy River. They agreed that such programming would allow the evaluation of the impacts of any proposed new regulation approach on wetland evolution (cattails, wild rice and submerged plants), muskrat winter survival, loon nesting, and northern pike and walleye reproduction. Economic indicators, such as emergency conditions of flood and low levels, electric power production, and tourism, will also be programmed into the shared vision model (SVM). A list of the variables being considered for inclusion in the SVM is tabulated in Table 3.

Table 3 - Performance indicators for inclusion in the SVM

Proposed performance indicators for inclusion in the SVM
Rainy Lake / Namakan Reservoir Northern Pike population; reproduction or recruitment
Rainy Lake / Namakan Reservoir Walleye population; reproduction or recruitment
Rainy Lake / Namakan Reservoir Northern Pike spawning and nursery habitat
Both Rainy River and Namakan Reservoir Walleye spawning habitat
Rainy River Lake Sturgeon spawning habitat

Rainy River Log perch spawning habitat
Rainy Lake / Namakan Reservoir yellow perch mercury concentration (important and doable)
Rainy Lake / Namakan Reservoir beaver population/health
Rainy Lake / Namakan Reservoir common loon reproductive success modeling
Rainy Lake / Namakan Reservoir muskrat population model
Power Production
Flooding and ice damage on Rainy Lake and Namakan Reservoir,
Rainy Lake / Namakan Reservoir resort industry economic impact (revenue, employment)
Cultural Resources (erosion index for threat to artifacts)
Rainy Lake / Namakan Reservoir Wetlands
Rainy Lake / Namakan Reservoir Wild Rice
Rainy Lake / Namakan Reservoir Invertebrate community; biomass or indicator
Rainy River Benthic macroinvertebrate habitat (IJC still assessing feasibility of this)

Some indicators have no readily formulated algorithms that relate performance to water levels or flows. The TWG will present these indicators in the weight of evidence matrix to compare the 1970 and 2000 Rule Curves along with alternative curves for evaluation by the Study Board. An uncertainty analysis will attempt to determine the sensitivity of conclusions drawn about the rule curves to uncertainty about the future and our understanding of the relationship between impacts and water levels and flows. The weight of evidence matrix will be used in parallel to the SVM to improve the certainty and quality of the findings. It is anticipated that the matrix may improve the certainty of the findings with regard specifically to the comparison of the 1970 and 2000 Rule Curves.

Project Oversight

The bi-national Study Board will oversee the evaluation work, manage outreach and stakeholder engagement, write reports and provide recommendations to the IJC. The Study Board will be responsible for study findings, recommendations and conclusions with their evaluation based on both the shared vision model simulations and the weight-of-evidence matrix.

Shared Vision Model Development

The TWG will collaboratively develop a shared vision model to determine:

- whether the 2000 Rule Curves worked as expected
- whether they are better than the 1970 Rule Curves and why
- what benefits and/or negative impacts may have resulted from the 2000 rule curves relative to likely impacts of the 1970 Rule Curves
- what benefits and negative impacts would result from a "state of nature" operating plan

- what benefits and negative impacts would result from a few alternative operating policies or plans
- What benefits and negative impacts would result from changed climate

The scientists working on each relevant study will develop an algorithm for each performance indicator (listed in Table 3) representing the impacts of the water levels of each applicable water body of the system.   The TWG will be responsible for working with scientists and stakeholders to program the algorithms into the simulated water levels, creating the shared vision model (SVM). The TWG may rely on external technical expertise (e.g. postdoctoral fellows) to assist with the development of the SVM.

Two additional water supply data sets will be developed based on the historical supplies to test plausible and relevant concerns about how future supplies might expose weaknesses in any of these operating sets. The datasets will be created simply and cheaply by methods such as repeating a dry year to test the possibility of an extended drought or by redistributing historical annual supplies differently over the course of the year to represent the potential for earlier snow melt under climate change. The "state of nature" release rules will be programmed into the Rainy and Namakan lake model so that they can be applied to any water supply data set. The impacts of the resulting flows will be simulated in the Rainy River model.

The TWG will apply three water supply sets to the Shared Vision Model to discover how future water supplies may expose weaknesses, including the historical water supplies and two additional water supply sets based on the historical supply set.

Weight of Evidence Matrix Development

The TWG will also complete a weight of evidence matrix for those indicators which have no readily formulated algorithms that relate performance to water levels or flows. All indicators will be included in the matrix to improve the certainty and quality of the SVM for use by the Study Board in its evaluation.

Rule Curve Options - Review and Evaluation

The TWG may work with the WLC, RCPAG and other specialists and stakeholders as the Study Board sees fit, to develop alternative sets of rules curves. The alternatives will be programmed in the Rainy and Namakan lake model and the outflows simulated in the Rainy River model of the SVM. The number of alternatives will have to be limited given the overall study cost, but at least three alternatives will be formulated and modeled including variations such as:

1. 2000 Rule Curves, but with the target level set at the level that would result from the natural flow at that elevation rather than the mid-point of the upper and lower curves.
2. Modified shaping of the 2000 Rule Curves based on evidence from performance indicator scores from the evaluation of the 2000 Rule Curves.

3. 2000 Rule Curves, but with the target elevation shifted from the center by current data (soil moisture, temperature, snow pack, e.g.)

The SVM model will be used to run approximately 18 scenarios composed of:

1. Six operating plans (1970, 2000, State of Nature, 3 alternatives) times; and
2. Three water supply sets (historical, extreme, climate change)

The Study Board will oversee the work, review the results of the approximately 18 rule curve evaluations and will write a report, with assistance from the TWG, providing the summary of the analysis and results, and with recommendations to the IJC.

Review Process

The Study Board and TWG will employ a peer review process at various stages of this study. A two-person review panel, one from the US and one from Canada, will be employed for this purpose at three points during the study. Once the Board and TWG produce an evaluation methodology the review panel will review the methodology and provide recommendations to the Board. Additionally the review panel will review both the draft and final reports. All of the review panel's reports will be made public.

The IRLWWB and its WLC, along with its two advisory boards (CAG and IAG) will be asked to review final reports and recommendations of the Study Board prior to submission to the IJC. Following this period of review the Study Board will consider the views of these groups in their deliberations in authoring the final study report.

It is anticipated the IJC will conduct its own review of the recommendations after the final board report. After its review, the IJC may go back to the Study Board for clarification or additional information to be included in the Board's final report.

References

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[Signatures]