

Wuskwatim Power Limited Partnership Wuskwatim Generating Station Licence Implementation Guide for Water Levels

Prepared for:

Manitoba Sustainable Development
200 Saulteaux Crescent
Winnipeg, Manitoba R3J 3W3

Prepared by:

Hydraulic Operations Department
Manitoba Hydro
360 Portage Avenue
Winnipeg, Manitoba R3C 0G8

On behalf of:

Wuskwatim Power Limited Partnership
360 Portage Avenue
Winnipeg, Manitoba R3C 0G8

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Rev_0	Initial version with test locations for water level gauges	2007/07/03
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Wuskwatim Power Limited Partnership Wuskwatim Generating Station Licence Implementation Guide for Water Levels

Original signed by, P.G. Chanel



PREPARED BY:

Original signed by, P.G. Chanel

REVIEWED BY:

Original signed by, B.W. Giesbrecht

NOTED BY:

Original signed by, W.V. Penner

DATE:

2016 06 03

REPORT NO:

PS&O 16/02



Foreword

Wuskwatim Power Limited Partnership (WPLP) has been issued licences under the Environment Act and the Water Power Act for the development of the Wuskwatim Generating Project.

The WPLP is a limited partnership of which 5022649 Manitoba Ltd., a wholly owned subsidiary of Manitoba Hydro, is the general partner and Manitoba Hydro and Taskinigahp Power Corporation, wholly owned by Nisichawayasihk Cree Nation, are limited partners.

The WPLP has entered in contracts with Manitoba Hydro for the management, construction and operation of the Wuskwatim generating station in accordance with the provisions of the applicable agreements as set out in the Project Development Agreement between Nisichawayasihk Cree Nation and Manitoba Hydro. Consistent with responsibilities set out in these agreements, Manitoba Hydro has prepared this report on behalf of the WPLP.

Executive Summary

Introduction

Manitoba Hydro prepared this guideline to document a common understanding of the water regime terms of the Wuskwatim licences. Environment Act Licence No. 2699 and an Interim Water Power Act licence specify operating limits and reporting requirements that must be met for compliance with the licences. As such, this document sets out the:

- calculation methodology to be used for determining critical levels,
- protocol for reporting to meet licence requirements, and
- manner in which compliance will be defined and assessed.

Wuskwatim Lake

As required by licence, data from a minimum of three water level gauges will be used to determine the Wuskwatim Lake level. A set of averaging and weighting techniques are employed to remove immediate operational effects and the effects of wind and waves.

Birch Tree Lake

As required by licence, data from a minimum of two water level gauges will be used to calculate the daily water level change on Birch Tree Lake. Weighting and averaging techniques are used to remove the effect of wind and waves.

Compliance

Compliance with the licence on Wuskwatim Lake will be measured against both hourly water levels and wind-eliminated water levels. In the event that the **Birch Tree Lake Daily Water Level Change** licence constraint is exceeded, a hydraulic model of the Burntwood River will be used to determine the change attributable to Wuskwatim operations. Compliance with the Environment Act licence will be measured against the model output.

Monthly and annual reports will be issued to MSD in accordance with the Environment Act licence. Special compliance reports will be issued as necessitated by deviations from licence conditions.

Change Management

Proposed revisions to this Implementation Guide will be discussed with MSD from time to time. Following review and approval of revisions by MSD, a revised copy of this Implementation Guide will be produced and distributed by Wuskwatim Power Limited Partnership.

A five year window is included in the Environment Act licence to review the appropriateness of the included water level parameters. This review window recognizes that the licence parameters are based on model simulations and that measured data may differ from what was anticipated.

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1. Introduction

1.1 Project Background

Wuskwatim Power Limited Partnership received Environment Act Licence No. 2699 and an Interim Water Power Act Licence in 2006 for the development of Wuskwatim Generating Station. While the initial development of this project was completed in June 2012, all the three turbines began producing electricity in September 2012 well in advance of the requirement of the Interim Licence.

The Wuskwatim Generating Station is located on the Burntwood River, in the Nelson House Resource Management Area, approximately 56 km southwest of Thompson, 35 km southeast of Nelson House, or approximately 830 km north by road from Winnipeg. The Wuskwatim Generating Station consists of a 3-unit powerhouse with a nameplate capacity of 209 MW, gravity dams and embankment structures, and a 3-bay spillway with heated gates. Inflow to Wuskwatim is largely dependent on the Churchill River Diversion, as controlled by the Notigi Control Structure. The generating station operates in a daily cycling mode within the allowed 0.25 m water level range on Wuskwatim Lake as specified in the Environment Act Licence.

1.2 Definitions

For the purposes of this Implementation Guide, unless the context otherwise requires, the following terms shall have the respective meanings set out below and grammatical variations of such terms shall have corresponding meanings:

ASL means above sea level;

Controlling Benchmarks means:

- (a) Wuskwatim Lake benchmarks were established by static GPS methods constrained on Geodetic Survey of Canada (GSC) benchmarks 69M591, 69M592, and 69M593 located near the Wuskwatim generating station.
- (b) Birch Tree Lake benchmarks were established by static GPS methods constrained on GSC benchmarks 69M587 located just west of Birchtree Lake at Pipe Lake mine and 69M575 located east of Ospwagan Lake along PTH #6. This geodetic control effectively surrounds Birch Tree Lake and allows for accurate benchmarks to be established on Birch Tree Lake.

Birch Tree Lake Gauges means the water level gauges established on Birch Tree Lake for the purpose of collecting data used in calculating the **Birch Tree Lake Hourly Water Level**;

Birch Tree Lake Hourly Water Level means the weighted average of available readings of water levels recorded from the top of one hour to the top of the following hour at the **Birch Tree Lake Gauges**;

Birch Tree Lake Daily Average Water Level means the arithmetic mean of all hourly water levels recorded at the **Birch Tree Lake Gauges** for a calendar day;

Birch Tree Lake Daily Water Level Change means the difference in the **Birch Tree Lake Daily Average Water Level** between one calendar day and the previous calendar day;

Wuskwatim Lake Gauges means the water level gauges established on Wuskwatim Lake for the purpose of collecting data used in calculating the **Wuskwatim Mean Daily Water Level (with wind and wave effects eliminated)**;

Wuskwatim Hourly Water Level means the weighted average of available readings of water levels recorded from the top of one hour to the top of the following hour at the **Wuskwatim Lake Gauges**;

Wuskwatim Daily Average Water Level means the arithmetic mean of all **Wuskwatim Hourly Water Levels** for a calendar day;

Wuskwatim Mean Daily Water Level (with wind and wave effects eliminated) means a three day moving mean of the **Wuskwatim Daily Average Water Level**.

1.3 Datum

In accordance with Clause 30(d) of Environment Act Licence No. 2699 and Section 10.3 of the Wuskwatim Site, Burntwood River Interim Water Power Act licence, water level information for the operation of the Wuskwatim Project is based upon Geodetic Survey of Canada (GS of C), Canadian Government Vertical Datum (CGVD) 1928, 1969 Local Adjustment.

1.4 Water Levels and Water Level Fluctuations

All water levels referenced in this Implementation Guide are to be inferred as measured in terms of elevations ASL, GS of C CGVD 1928, 1969 Local Adjustment. All water levels and water level fluctuations referenced in this Implementation Guide are to be inferred as measured excluding the effects of wind and waves.

1.5 Quality Control

1.5.1 Benchmarks

Vertical control surveys have been performed from **Controlling Benchmarks** to establish appropriate local benchmarks around Wuskwatim Lake and Birch Tree Lake at hydrometric gauging stations.

1.5.2 Direct Water Level Measurements

Field staff will visit the **Wuskwatim Lake Gauges** and the **Birch Tree Lake Gauges** on a two month cycle as a minimum. Additional site visits will be conducted as necessary to maintain gauge performance. Direct water level measurements are taken during these visits and compared to the level indicated by the water level sensor. Direct water level measurements for lakes of this size are typically accurate to within ± 5 mm with the instrument error accounting for ± 0.8 mm.

1.5.3 Gauge Readings

Manitoba Hydro uses pressure transducers to determine water levels at its existing hydrometric gauging stations and at the **Wuskwatim Lake Gauges** and the **Birch Tree Lake Gauges**. The error in the reading provided by the pressure transducer is ± 7.5 mm given the scale setting that is typically used by Manitoba Hydro. The transducers are temperature corrected, however, if the temperature correction malfunctions, the reading can drift between site visits by up to 0.1 metres, although drift of this magnitude is rare. If the technician visiting the site determines that the transducer reading is more than ± 5 mm different from the direct water level measured in accordance with Subsection 1.5.2, the transducer is reset to the direct water level measurement. If the transducer reading is less than ± 5 mm different from the direct water level measured in accordance with Subsection 1.5.2, no change is made to the transducer setting.

1.6 Quality Assurance Procedure for Water Level Data

Water level data exists in three degrees of quality assurance – raw, provisional and final.

Raw data is real-time data that has been transmitted from the field. The only level of quality assurance is that built in to the data collection system, described in Section 1.5. This level of data is used in the daily operation of the Wuskwatim Generating Station. This level of data is also reported monthly in accordance with Subsection 4.3.3 of this guide.

Provisional data is data processed by a qualified data assurance technician who reviews the field data and corrects obvious errors. The data is compared to all available relevant data in the area to verify its accuracy.

Final data has been through two levels of review by qualified technicians and a final review by a professional engineer. This data is considered publishable and has met the quality assurance standards of the National Hydrometric Program of Environment Canada. This data will be used for annual reporting described in Subsection 4.3.4 of this guide

2. Wuskwatim Lake

2.1 Gauge Location Criteria

In accordance with Clause 30(a) of Environment Act Licence 2699, three **Wuskwatim Lake Gauges** will be used in determining the water level of Wuskwatim Lake. A map showing the location of the gauges and detailed gauge descriptions are included in Appendix A. These locations were selected from an initial six test locations and were found to exhibit a minimum variation in water level due to wind.

2.2 Wuskwatim Wind-Eliminated Water Level Calculation Procedure

Clause 30(a) of Environment Act Licence No. 2699 and Section 4.2 of the Interim Water Power Act licence place limits on Wuskwatim Lake water levels. Wuskwatim Lake water levels will be influenced by Wuskwatim operations. Water levels will also be affected by local meteorological events and non-project hydraulic effects. Significant local weather impacts can result from heavy precipitation, the movement of high and low pressure cells and large wind events. Non-project hydraulic impacts may result from upstream storage and release of water caused by changing ice conditions, operation of Notigi Control Structure, and rapid spring runoff. To properly evaluate the wind-eliminated water level, averaging techniques are used to remove these effects. Small, short-term weather and hydraulic events can be smoothed out using multiple gauges, gauge weighting and a daily average water level. Larger, long-term events require a longer duration averaging technique. For a lake of this size, a three-day moving mean is appropriate.

In order to ensure that the Licensee's operations remain within the constraints of its licences, compliance will be measured against both the **Wuskwatim Hourly Water Level** and the **Wuskwatim Mean Daily Water Level (with wind and wave effects eliminated)**.

2.2.1 Hourly Averaging

The **Wuskwatim Lake Gauges** will be set to record continuous (e.g. 5 minute) water levels from which the hourly average water level at each gauge location will be calculated as shown in Equation 1.

$$HAWL_g = \frac{\sum_{i=1}^n WSL_{g,i}}{n} \quad [1]$$

where

$HAWL_g$ = hourly average water level for **Wuskwatim Forebay Gauge g**

$WSL_{g,i}$ = water level measurement at time, i, for gauge, g

n = the number of available water level measurements for that hour

2.2.2 Weighting

The hourly average water levels from each of the **Wuskwatim Lake Gauges** will be used to determine the **Wuskwatim Hourly Water Level** as shown in Equation 2. The **Wuskwatim Hourly Water Level** is one measure of compliance with Environment Act Licence 2699 and the Interim Water Power Act licence as discussed in Section 4.1, below.

$$WHWL = \sum_g (W_g HAWL_g) \quad [2]$$

where

WHWL = **Wuskwatim Hourly Water Level**

HAWL_g = hourly average water level for **Wuskwatim Lake Gauge g**

W_g = weighting factor for **Wuskwatim Lake Gauge g**

and

$$\sum_g W_g = 1$$

Weights are equally assigned between the three **Wuskwatim Lake Gauges**. In a case where there is a blank reading for one of the gauges, the weighting for the remaining gauges will be adjusted to total 1.

2.2.3 Three-Day Moving Average

As an intermediate step in determining the **Wuskwatim Mean Daily Water Level (with wind and wave effects eliminated)**, the **Wuskwatim Daily Average Water Level** will be calculated as the arithmetic mean of the **Wuskwatim Hourly Water Levels** as shown in Equation 3.

$$DAWL = \frac{\sum_{i=1}^n WHWL_i}{n} \quad [3]$$

where

DAWL = the **Wuskwatim Daily Average Water Level**

WHWL_i = the **Wuskwatim Hourly Water Level** for hour *i*

n = the number of available hourly readings for that calendar day

A three-day moving average as shown in Equation 4, will be applied to the **Wuskwatim Daily Average Water Level** data stream to produce the **Wuskwatim Mean Daily Water Level (with wind and wave effects eliminated)**.

$$WEWL_i = \frac{DAWL_{i-2} + DAWL_{i-1} + DAWL_i}{3} \quad [4]$$

where

$WEWL_i$ = Wuskwatim Mean Daily Water Level (with wind and wave effects eliminated) for day i

$DAWL_i$ = Wuskwatim Daily Average Water Level for day i

3. Birch Tree Lake

3.1 Gauge Location Criteria

In accordance with Clause 30(c) of Environment Act Licence 2699, a minimum of two water level gauges will be used in determining the **Birch Tree Lake Daily Water Level Change** for the purpose of licence compliance. A map showing the location of the gauges and detailed gauge descriptions are located in Appendix A. These locations were selected from an initial four test locations and were found to exhibit a minimum variation in water level due to wind.

3.2 Method to Determine Magnitude of Project Impacts on Birch Tree Lake Daily Water Level Change

Clause 30(b) of Environment Act Licence No. 2699 limits mean daily water level variation on Birch Tree Lake to 0.10 metres under open water conditions and 0.15 metres under winter conditions. Water level changes on Birch Tree Lake will be affected by Wuskwatim Generating Station operations. Water level changes are also influenced by local meteorological events and by non-project hydraulic effects. The **Birch Tree Lake Daily Water Level Change** is calculated using the method described below which attempts to eliminate the effect of wind-driven waves. If the **Birch Tree Lake Daily Water Level Change** exceeds the limits in Clause 30(b), hydraulic modeling will be completed to estimate the project impact and meteorological and non-project hydraulic impacts will be assessed.

3.2.1 Hourly Averaging

The **Birch Tree Lake Gauges** will be set to record continuous (e.g. 5 minute) water levels from which the hourly average water level at each gauge location will be calculated as shown in Equation 5.

$$HAWL_g = \frac{\sum_{i=1}^n WSL_{g,i}}{n} \quad [5]$$

where

$HAWL_g$ = hourly average water level for **Birch Tree Forebay Gauge g**

$WSL_{g,i}$ = water level measurement at time, i, for gauge, g

n = the number of available water level measurements for that hour

3.2.2 Weighting

The hourly average water levels from each of the **Birch Tree Lake Gauges** will be used to determine the **Birch Tree Lake Hourly Water Level** as shown in Equation 6.

$$BL = \sum_g W_g HAWL_g \quad [6]$$

where:

BL = Birch Tree Lake hourly water level

W_g = weighting factor for **Birch Tree Lake Gauge g**

$HAWL_g$ = hourly average water level for **Birch Tree Lake Gauge g**

and

$$\sum_g W_g = 1$$

Weights are equally assigned between the two **Birch Tree Lake Gauges**. In a case where there is a blank reading for one of the gauges, the weighting for the remaining gauge will be adjusted to 1.

3.2.3 Birch Tree Lake Daily Water Level Change Calculation

Wind and wave effect elimination will be accomplished by calculating a weighted daily average of the water levels recorded by the **Birch Tree Lake Gauges** as shown in Equations 7.

$$BLDA = \frac{\sum_{i=1}^m BL_i}{m} \quad [7]$$

where:

$BLDA$ = **Birch Tree Lake Daily Average Water Level**

BL_i = Birch Tree Lake hourly water level for hour i

m = the number of available hourly readings for that calendar day

The **Birch Tree Lake Daily Water Level Change** will be calculated as the absolute difference in **Birch Tree Lake Daily Average Water Level** between that calendar day and the previous calendar day as shown in Equation 8.

$$BLDC_j = |BLDA_j - BLDA_{j-1}| \quad [8]$$

where:

$BLDC_j$ = **Birch Tree Lake Daily Water Level Change** for calendar day j

$BLDA_j$ = the **Birch Tree Lake Daily Average Water Level** for calendar day j

3.2.4 Wuskwatim Operational Impact Determination

As part of the preparation of the Environmental Impact Statement for the Wuskwatim Generating Station, a hydraulic model was developed for the Burntwood River from Wuskwatim Generating Station to First Rapids (located 30 km upstream of Split Lake). In the event that the **Birch Tree Lake Daily Water Level Change** exceeds 0.10 metres

under open water conditions or 0.15 metres under winter conditions, such a model will be used to determine the magnitude of the **Birch Tree Lake Daily Water Level Change** that is attributable to Wuskwatim Generating Station operations. Actual Wuskwatim outflows preceding such an event will be used as the input hydrograph for the model. The model output will show the impact of Wuskwatim operations on the water level changes recorded on Birch Tree Lake.

3.2.5 Meteorological Impacts

Local weather can cause an impact on the **Birch Tree Lake Daily Water Level Change** that is not attributable to Wuskwatim Generating Station operations. Local precipitation can result in a rapid rise of Birch Tree Lake water level. The passage of pressure cells can temporarily raise or lower the lake level. Large wind events may produce an effect on water levels that cannot be removed using the weighting technique described above. Local precipitation data is available from the Environment Canada weather station at Thompson Airport, the Manitoba Hydro weather station at Wuskwatim Generating Station and the Manitoba Hydro weather station at Birch Tree Lake. These same weather stations provide atmospheric pressure data and wind speed and direction data. An estimate of the magnitude of the meteorological impact on the **Birch Tree Lake Daily Water Level Change** can be made when the licence limit is exceeded and the hydraulic model shows the full effect is not attributable to Wuskwatim operations.

3.2.6 Non-Project Hydraulic Impacts

Hydraulic impacts caused by factors other than Wuskwatim Generating Station operations can impact the **Birch Tree Lake Daily Water Level Change**. Such factors include but are not limited to varying upstream storage and release of water caused by ice conditions, varying ice conditions at Manasan Control Structure (located at the outlet of Birch Tree Lake - 9 km upstream of the Miles Hart Bridge at Thompson), operation of the Manasan Control Structure fuse plug and rapid spring runoff. An estimate of the magnitude of such an impact on the **Birch Tree Lake Daily Water Level Change** can be made when the licence limit is exceeded and the hydraulic model shows the full effect is not attributable to Wuskwatim operations.

4. Compliance

4.1 Wuskwatim Lake

Clause 30(a) of Environment Act Licence No. 2699 states that the Licensee shall operate the Development within the following parameters:

maintain the mean daily water level on Wuskwatim Lake (wind and wave effects eliminated) between 233.75 meters and 234.0 meters Above Sea Level (ASL), as determined by measurements from a minimum of three water level monitoring stations on Wuskwatim Lake

Section 4.2 of the Wuskwatim Interim Water Power Act licence states that:

The Licensee shall not raise the headwaters of its development above an elevation of 234.0 metres ASL as measured on Wuskwatim Lake, except as ordered by the Minister under Clause 72(b) of the Water Power Regulation or as fixed by the Minister under Clause 72(c) of the Water Power Regulation.

The forebay level shall be in compliance with the upper limit described above if:

1. The **Wuskwatim Mean Daily Water Level (with wind and wave effects eliminated)** does not exceed 234.0 metres, and
2. The **Wuskwatim Hourly Water Level** does not exceed 234.1 metres more than two times for two consecutive hours each time in any 24 hour period.

The forebay level shall be in compliance with the lower limit described above if:

1. The **Wuskwatim Mean Daily Water Level (with wind and wave effects eliminated)** does not recede below 233.75 metres, and
2. The **Wuskwatim Hourly Water Level** does not recede below 233.65 metres more than two times for two consecutive hours each time in any 24 hour period.

4.2 Birch Tree Lake

Clause 30(b) of Environment Act Licence No. 2699 states that the Licensee shall operate the Development within the following parameters:

maintain mean daily water levels on Birch Tree Lake such that the daily water level variations shall be less than 0.10 meters and 0.15 meters in open water and winter conditions (wind and wave effects eliminated) respectively. Any exceptions to these fluctuations shall be reported within one week to Manitoba Water Stewardship

For the purposes of licence compliance, open water will refer to the period from May 1 to October 31 and winter will refer to the period from November 1 to April 30. The **Birch Tree Lake Daily Water Level Change** shall be deemed to be in compliance when:

1. The **Birch Tree Lake Daily Water Level Change** is below these seasonal limits,
or

2. The **Birch Tree Lake Daily Water Level Change** is above these seasonal limits but the change attributable to Wuskwatim Generating Station is below these seasonal limits.

4.3 Reporting

4.3.1 Compliance Reporting

In the event that the Wuskwatim Generating Station forebay level is not in compliance with the licence limits as described in Section 4.1 above, notification shall be made to MSD within one week of the incident. A follow-up report on causes contributing to the event and changes to operations, if any are needed to prevent such an event in the future, will be provided to Manitoba MSD.

When the **Birch Tree Lake Daily Water Level Change** exceeds the open water or winter limit, notification shall be made to MSD within one week of the incident in accordance with Clause 30(b) of Environment Act Licence No. 2699. A follow-up report containing the modeled Wuskwatim-based contribution to the **Birch Tree Lake Daily Water Level Change** and a discussion of other factors affecting the **Birch Tree Lake Daily Water Level Change** shall be provided to MSD.

4.3.2 Maintenance and Emergencies

During maintenance and emergencies there may be times when Manitoba Hydro is required to deviate from a licence condition for safety or other purposes. Manitoba Hydro will be considered compliant with the licence as long as:

1. Notification by email is provided to MSD of the upcoming licence deviation together with the reason, a description of the operating plan, details of the expected licence deviation, a summary of impacts to stakeholders, and confirmation that stakeholders will also be notified; and
2. Notification is provided to stakeholders of pertinent impacts to flow and water levels; and
3. Following the work, notification by letter is provided to MSD on the final specifics of the licence deviation.

4.3.3 Regular Monthly Reporting

Clause 33 of Environment Act Licence No. 2699 states that:

The Licensee shall report, to Manitoba Water Stewardship, on a monthly and annual basis, the water levels monitored pursuant to Clauses 30 (a) and (c) of this Licence including other relevant station and related system operating characteristics. These reports shall also be provided to the Nelson House Resource Management Board, all communities on the Manitoba Hydro Churchill

River Diversion Augmented Flow Program notification list and posted on the Manitoba Hydro web site.

Monthly water level reports will be provided in accordance with Clause 33 of Environment Act Licence No. 2699. These reports will use raw data from the **Wuskwatim Lake Gauges** and the **Birch Tree Lake Gauges**. The reports will contain the **Wuskwatim Hourly Water Level** and the **Wuskwatim Mean Daily Water Level (with wind and wave effects eliminated)** calculated in accordance with Section 2.2 and the **Birch Tree Lake Daily Water Level Change** calculated in accordance with Section 3.2.

4.3.4 Regular Annual Reporting

An annual water level report for each calendar year will be provided in accordance with Clause 33 of Environment Act Licence No. 2699. This report will use final data from the **Wuskwatim Lake Gauges** and the **Birch Tree Lake Gauges**. The report will contain the final **Wuskwatim Hourly Water Level**, the final **Wuskwatim Mean Daily Water Level (with wind and wave effects eliminated)** and the final **Birch Tree Lake Daily Water Level Change**. The annual report will also contain any compliance reports issued in that year. Due to the quality assurance processing time, this report will be issued by June 1 of the following year.

5. Change Management

5.1 Regular Updates

Proposed revisions to this Implementation Guide will be reviewed with MSD from time to time. Following review and approval of revisions by MSD, a revised copy of this Implementation Guide will be produced and distributed by Wuskwatim Power Limited Partnership.

5.2 Comprehensive Review

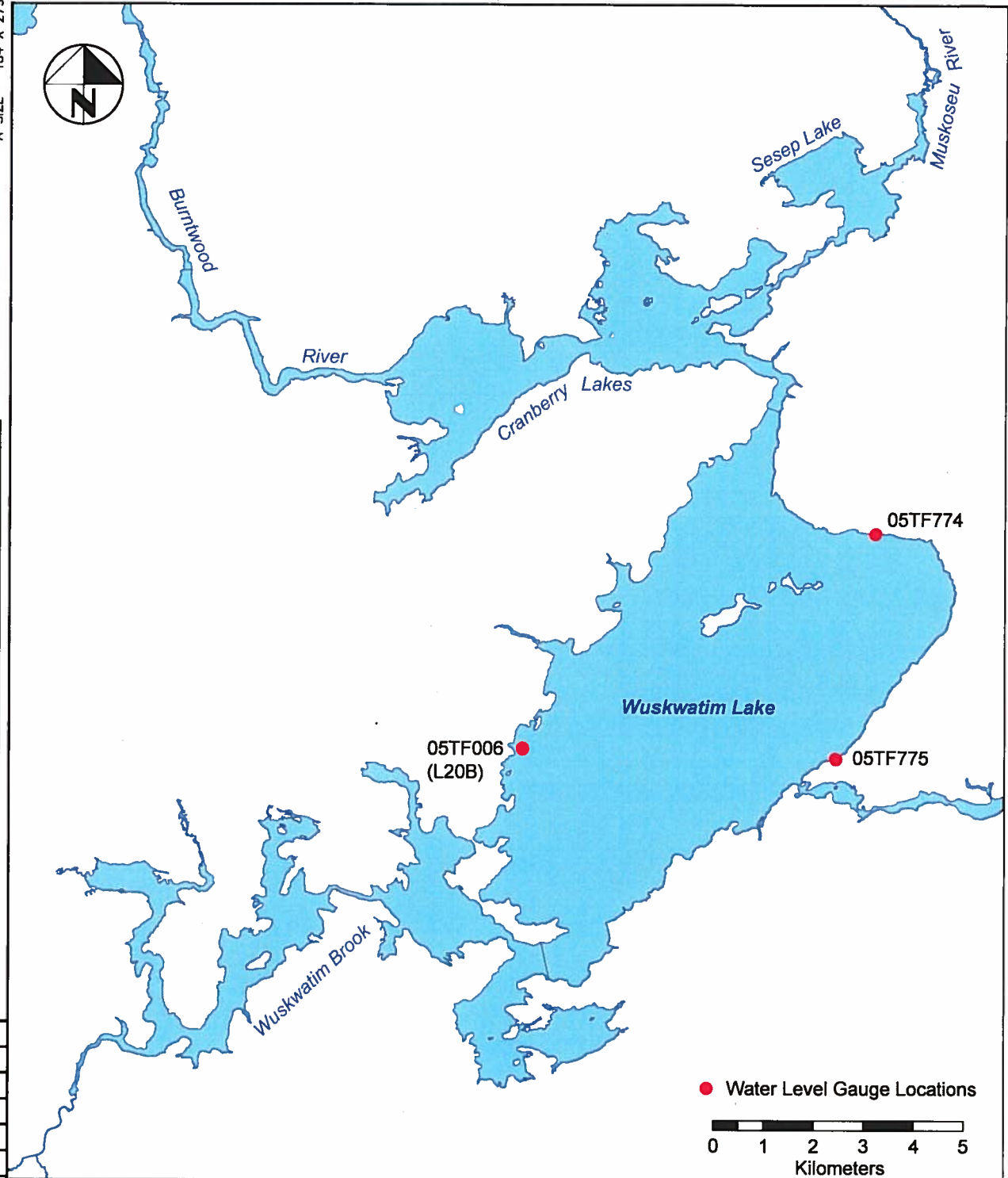
Clause 34 of Environment Act Licence No. 2699 states that:

The Licensee shall at the commencement of the operation of the Development and for a period of five years, unless otherwise directed by the Minister, monitor daily water level variations and the frequency and magnitude of exceedances for the purpose of confirming the appropriateness of the parameters prescribed in Clause 30 of this Licence or the need for adjustments to reflect local hydrological conditions.

The limits placed on water level and water level fluctuations in Environment Act Licence No. 2699 were based on hydraulic modeling results. This review period provided in Clause 34 was established to corroborate the modeling results with data collected after the generating station becomes operational. At the start of year four of Wuskwatim operation, a licence parameter review process will be initiated by Wuskwatim Power Limited Partnership in collaboration with MSD.

Appendix A
Water Level Gauge Description Sheets

A SIZE - 184 X 279



● Water Level Gauge Locations

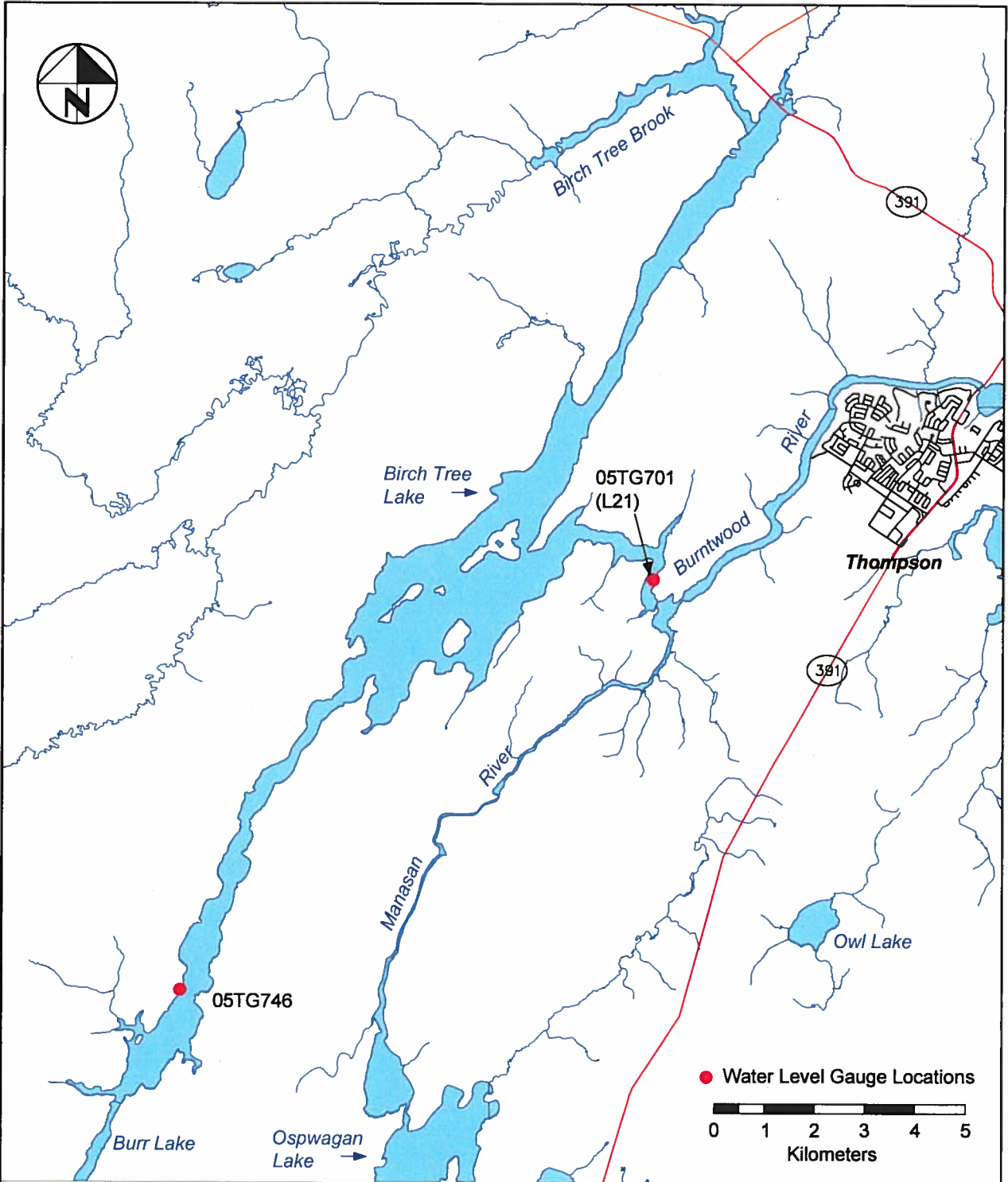
0 1 2 3 4 5
Kilometers

FOR MICROFILMING USE ONLY

NOTED	NO.	DATE	REVISIONS	BY	CKD.	APP.
DESIGN			MANITOBA HYDRO			
TELEPHONE			WUSKWATIM GENERATING STATION			
ELECTRICAL			WATER LEVEL GAUGE			
F.P. ENGINEER			LOCATIONS ON			
MECHANICAL	DRAWN	K.R.	WUSKWATIM LAKE			
DISTRIBUTION	DESIGN	BG				
PROJECT	DSCALE	AS SHOWN				
CONSTRUCTION	PSCALE	1/8" = 1'-0"				
MANAGER	DATE	15/02/03			SHT.	REV.
					0001	00

AUTOCAD ORIGINAL

* REDUCED SIZED PLOT



● Water Level Gauge Locations

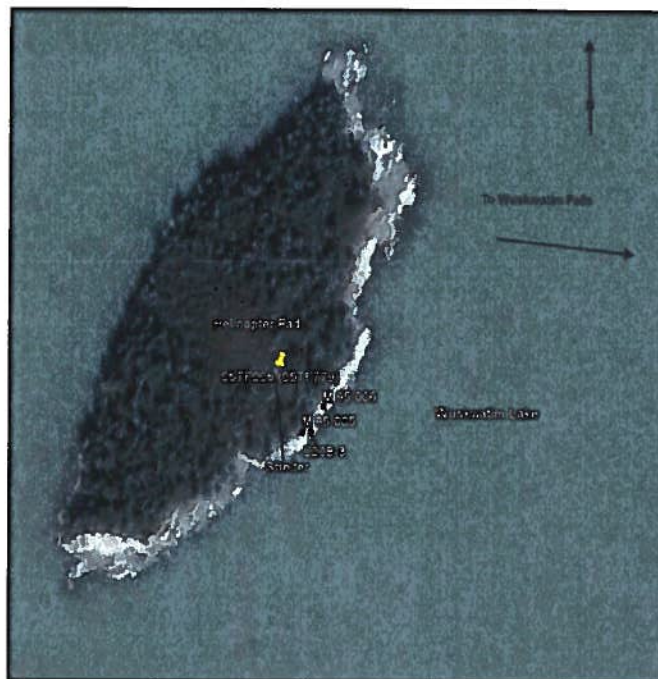
0 1 2 3 4 5
Kilometers

FOR MICROFILMING USE ONLY

NOTED	NO.	DATE	REVISIONS	BY	CKD.	APP.
DESIGN			MANITOBA HYDRO			
TELEPHONE			WUSKWATIM GENERATING STATION			
ELECTRICAL			WATER LEVEL GAUGE LOCATIONS ON BIRCHTREE LAKE			
F.P. ENGINEER						
MECHANICAL	DRAWN	K.R.				
DISTRIBUTION	DESIGN	BG				
PROJECT	DSCALE	AS SHOWN				
CONSTRUCTION	PSCALE	1/8"=1'-0"				
MANAGER	DATE	15/02/03				
				SHT.	REV.	
				0001	00	

AUTOCAD ORIGINAL

Wuskwatim Lake near Thompson



Number: **05TF006**

Name: **Wuskwatim Lake near Thompson**

DCP Id: 7D0962B8 Drainage Area (km2):

Latitude: 55° 32' 53.0" Longitude: -98° 36' 15.0"

UTM: 6155852.3 N 524957.0 Zone: 14

Coordinate Source: NAD83

Operator: Manitoba Hydro, Thompson

Established: November, 1995

Location: Approximately 56 km SW of Thompson and approximately 32 km SE of Nelson House on a small island along the W shore of the lake approximately 6 km directly W of the Wuskwatim Generating Station.

Equipment: A Sutron Satlink II DCP, firmware version 7.24, with an Accubar pressure transducer and YSI 55212 temperature sensor powered by 2 – 12 V batteries connected to a SunSaver and 20 W solar panel all housed in a metal clad enclosure with a GOES antenna.

Metering: N/A

Access: Helicopter, float plane, boat or snowmobile.

Period of operation: 12HR

Station Status: Active

Date: **2014-10-28**

Datum: GS of C CGVD28, 1969 Manitoba Hydro Local Adjustment

Benchmarks:

L20B-1 (M95005) - Master - Elevation 234.423 m. A Water Survey of Canada brass cap in bed rock approximately 30 m E of the shelter and marked with a rebar.

L20B-2 (M95006) - Elevation 234.187 m. A Water Survey of Canada brass cap in bed rock approximately 5 m NE of M95005 and marked with an aluminum pipe.

L20B-3 (05MH53) - Elevation 234.397 m. A Manitoba Hydro brass cap set in bedrock marked with a t-bar, stamped 05MH53, on the S side of the island approximately 30 m E of the recorder shelter's SE corner and next to M95005.

Additional Information:

Time Slot	00:38:00	Transmit Window	00:00:15
Transmitter	HDR	Baud Rate	300
Channel	113 East	Satellite Azimuth	156°
Archive Transmit	01:00:00	Antenna Angle	20°

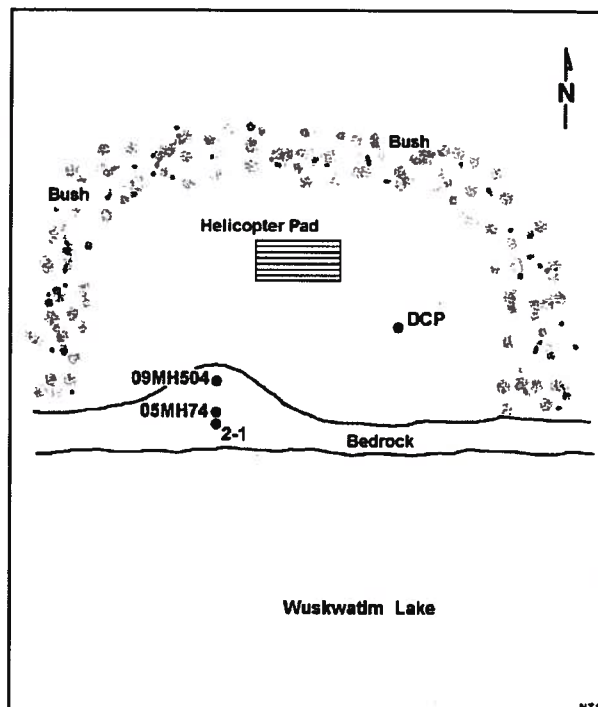
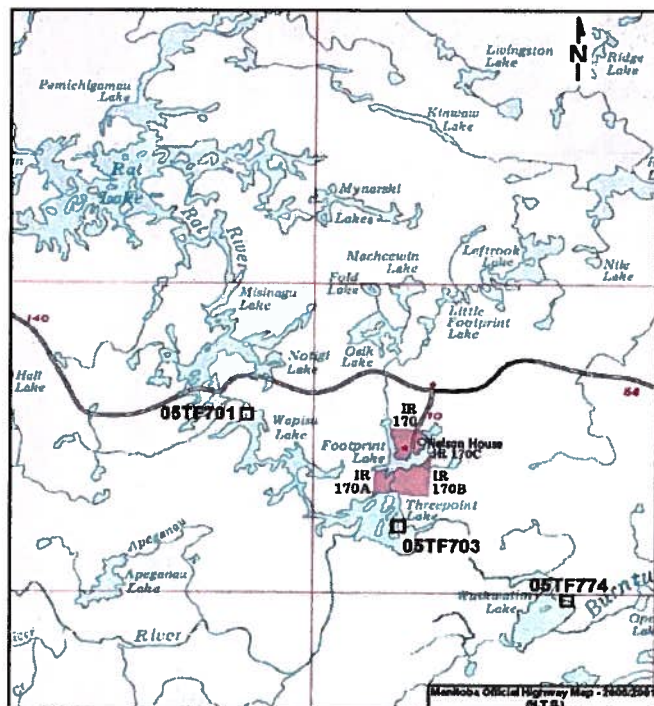
Water level is affected by Wuskwatim Generating Station operations.

Shef Codes: HG, TW, VB, ZT

OSH Concerns: **General site safety – slippery rocks.**

Compiled By: S. Herbert

Wuskwatim Lake - Northeast Shore



Number: **05TF774**

Name: **Wuskwatim Lake - Northeast Shore**

DCP Id: 7D07E0C4 Drainage Area (km2):

Latitude: 55° 35' 09.6" Longitude: -98° 29' 31.9"

UTM: 6160120.0 N 532009.2 E Zone: 14

Operator: Manitoba Hydro, Thompson

Established: August, 2005

Location: On the N shore of Wuskwatim Lake, approximately 3 km E of the inlet and approximately 3.5 km N of the exit.

Equipment: Sutron Satlink 2 DCP, firmware version 7.24, with an SDI-12 Keller pressure transducer powered by a solar panel, charge controller and 12 V gel cell battery in a Hanover steel shelter with GOES Yagi antenna.

Metering: N/A

Access: Helicopter, snowmobile and boat.

Station Status: Active

Period of Operation: 12HR

Date: **2014-10-17**

Datum: GS of C CGVD28, 1969 Manitoba Hydro Local Adjustment

Benchmarks:

05MH74 – Master - Elevation – 234.374 m. A Manitoba Hydro brass cap, stamped 05MH74, set in bedrock near water's edge. The brass cap is 15.2 m SW from the DCP and marked with a 1.6 cm diameter rebar. It is set in bedrock 0.16 m N of H.B.2-1.

H.B. 2-1 - Elevation – 234.377 m. A Hilti anchor bolt, flagged at the head of the bolt, drilled into bedrock near water's edge, marked with a 0.05 m diameter poplar tree, 15.2 m SW of the DCP and 0.16 m S of benchmark 05MH74.

09MH504 - Elevation – 234.923 m. A Manitoba Hydro brass cap stamped "09MH504" set in bedrock marked with a 1.6 cm rebar approximately 2.5 m N of Manitoba Hydro brass cap 05MH74 and approximately 15.0 m WSW of the DCP shelter on a tree.

Additional Information:

Time Slot	00:26:00	Transmit Window	00:00:10
Transmitter	HDR	Baud Rate	300
Channel	207 East	Satellite Azimuth	156°
Archive Transmit	01:00:00	Antenna Angle	20°

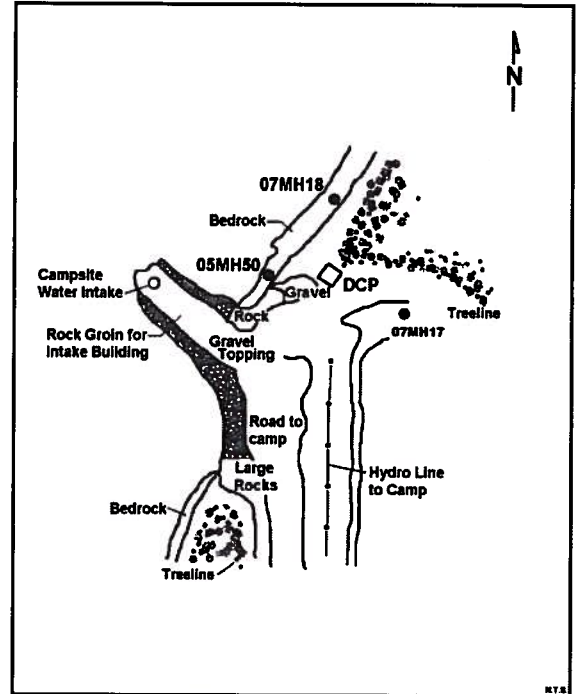
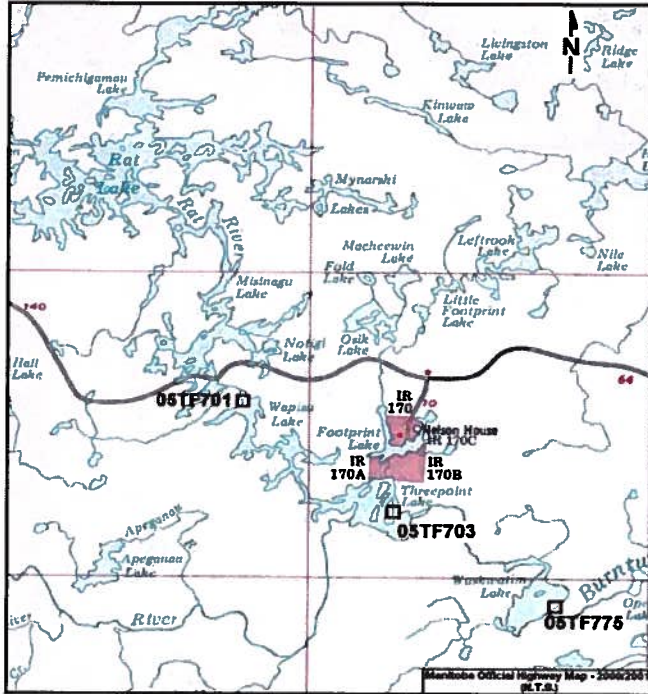
Water level is affected by Wuskwatim Generating Station operations.

Shef Codes: VB, TW, HG, ZT

OSH Concerns: **General site safety. Watch for driftwood along shoreline and slippery rocks.**

Compiled By: S. Herbert

Wuskwatim Lake – Southeast Shore



Number: **05TF775**

Name: **Wuskwatim Lake - Southeast Shore**

DCP Id: 7D07B0B8 Drainage Area (km2):

Latitude: 55° 33' 07.99" Longitude: -98° 29' 43.12"

UTM: 6156360.35 N 531839.23 E Zone: 14

Coordinate Source: NAD83

Operator: Manitoba Hydro, Thompson

Established: August, 2005

Location: On the SE shore of Wuskwatim Lake approx 1.5 km NE of Wuskwatim Lake outlet

Equipment: Sutron Satlink 2 data logger, firmware version 7.24, with an SDI-12 Keller pressure transducer in a Hanover steel DCP shelter. An external 12-volt gel cell battery in a cooler with a SunSaver 12-volt charger and regulator, solar panel and radio link antennae.

Metering: N/A

Access: Helicopter, boat, snowmobile and truck.

Station Status: Active

Period of Operation: 12HR

Source file last modified: **2012-12-18**

Datum: GS of C CGVD28, 1969 Manitoba Hydro Local Adjustment

BenchMarks:

05MH50 – Master - Elevation – 234.661 m. A Manitoba Hydro brass cap set in bedrock. It is located 17.5 m W of the most westerly corner of the recorder shelter.

07MH18 –Elevation – 235.118 m. A Manitoba Hydro brass cap set in bedrock. It is located 31.4 m N from the most northerly corner of the recorder shelter and 21.0 m NW of 07WL1, a destroyed nail in a spruce tree, flagged.

07MH17 - Elevation - 240.774 m. A Manitoba Hydro brass cap set in bedrock.

Additional Information:

Time Slot	00:25:30	Transmit Window	00:00:10
Transmitter	HDR	Baud Rate	300
Channel	207 East	Satellite Azimuth	156
Archive Transmit	01:00:00	Antenna Angle	20 deg.

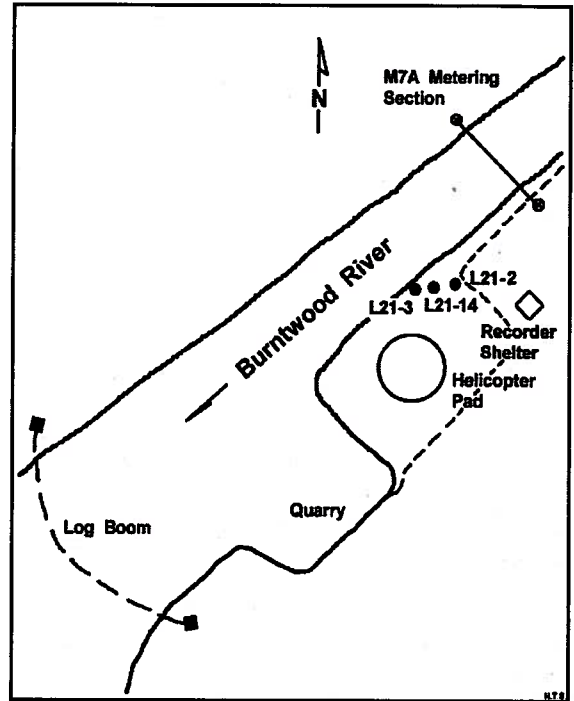
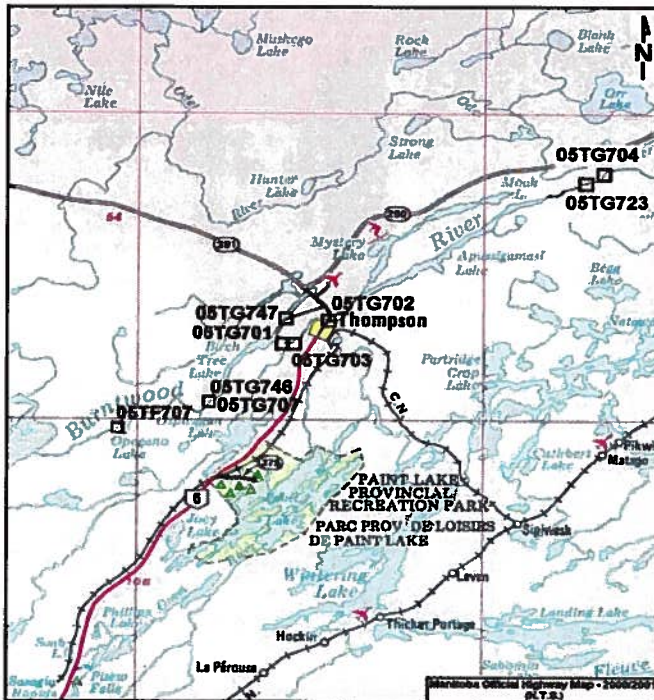
Water level is affected by Wuskwatim Generating Station operations.

Shef Codes: VB, TW, HG, ZT

OSH Concerns: Driftwood along the shore, slippery rocks. General site safety.

Compiled By: A.G.Tabak Checked By:

Burntwood River above Manasan Falls



Number: **05TG701**

Name: **Burntwood River above Manasan Falls**

DCP Id: 7D001274 Drainage Area (km²):

Latitude: 55° 43' 11.0" Longitude: -97° 56' 47.4"

UTM: 6175402.2 N 566181.5 E Zone: 14

Coordinate Source: NAD83

Operator: Manitoba Hydro, Thompson

Established: 1978

Location: Located on the left bank of the Burntwood River beside a rock quarry approximately 0.5 km upstream of Manasan Falls.

Equipment: Sutron Satlink 2 data logger, firmware version 7.24, with a Safe Purge bubbler system in a plywood shelter. Real time data is obtained using a YAGI antenna with the system being powered by a 12-volt battery on a 20 w solar panel. Water temperature is collected using a YSI temperature probe.

Metering: M7A discharge section. Discharge measurements are by boat, tagline and ice cover.

Access: Boat or helicopter.

Station Status: Active

Period of Operation: 12HR

Source file last modified: **2013-02-13**

Datum: GS of C CGVD28, 1969 Manitoba Hydro Local Adjustment

Bench Marks:

L21-2 – Master - Elevation - 199.504 m. A Manitoba Hydro brass cap on high rock outcrop 1.0 m from the edge of the bank and 13.7 m from the corner of the recorder shack. It is marked with a 0.9 m high t-bar.

L21-3 - (02MH117) - Elevation - 198.320 m. A Manitoba Hydro brass cap stamped 02MH117 on a low rock outcrop 1.0 m from bank edge and 5.5 m from L21-2.

L21-14 - Elevation - 199.309 m. A Manitoba Hydro brass cap in bedrock 7.5 m from L21-2 and 3.0 m from the edge of the bank.

Additional Information:

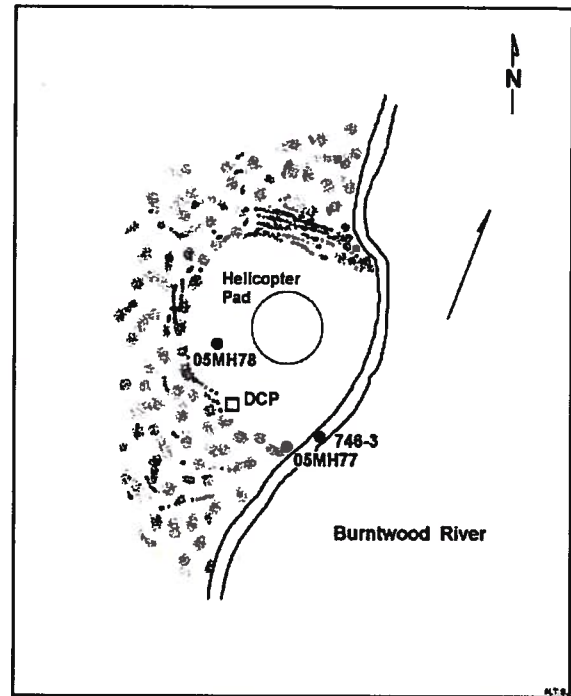
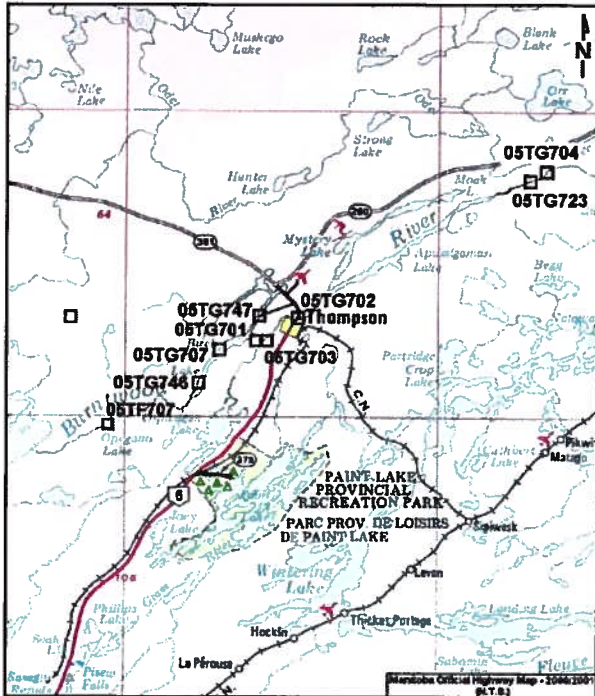
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Channel	143 East	Satellite Azimuth	156
Archive Transmit	01:00:00	Antenna Angle	20°

Shelf Codes: HG, TW, VB, ZT

OSH Concerns: Steep embankment. General site safety.

Compiled By: A.G.Tabak Checked By: B. F. Misener

Burntwood River above Birchtree Lake



Number: **05TG746**

Name: **Burntwood River above Birchtree Lake**

DCP Id: 7D09923C Drainage Area (km2):

Latitude: 55° 38' 52.9" Longitude: -98° 05' 48.7"

UTM: 6167280.0 N 556831.5 E Zone: 14

Co-ordinate Source: NAD83

Operator: Manitoba Hydro, Thompson

Established: October, 2005

Location: Left bank of the Burntwood River approximately 5 km below Kepuche Falls.

Equipment: FTS Model # H2-65-TLM DCP, firmware version 3.08, with an SDI-12 Keller pressure transducer in a metal clad shelter. Solar panel and an external 12 volt gel cell battery in a cooler. A Yagi antenna, Vaisala WXT510 weather sensor and a Pluvio precipitation sensor.

Metering: N/A

Access: Helicopter, boat and snowmobile.

Station Status: Active

Station Operations: 12HR

Date: 2014-06-03

Datum: GS of C CGVD28, 1969 Manitoba Hydro Local Adjustment

Benchmarks:

05MH77 (05-746-1) – Master - Elevation - 197.748 m. A Manitoba Hydro brass cap stamped 05MH77, set in bedrock near water's edge, located approximately 9.3 m SE of the DCP shelter. It is approximately 17 m SE of a Manitoba Hydro brass cap stamped 05MH78.

05MH78 (05-746-2) - Elevation – 201.761 m. A Manitoba Hydro brass cap stamped 05MH78, on a ground rod drilled into the ground 4.0 m, marked with a steel rod painted green. It is approximately 8.6 m NNW of the DCP shelter and approximately 17 m NW of a Manitoba Hydro brass cap stamped 05MH77.

08-746-3 – Elevation – 197.052 m. A Manitoba Hydro brass cap (low) not stamped but marked with rebar near water's edge approximately 11 m SE of the DCP shelter.

Additional Information:

Time Slot	00:39:15	Transmit Window	00:00:15
Transmitter	HDR	Baud Rate	300
Channel	113 East	Satellite Azimuth	156°
Archive Transmit	01:00:00	Antenna Angle	20°

Shef Codes: HG, PA, PC, TA, TW, UD, UD2, UD10, UG, US, US2, US10, UX, VB, XR, ZT

OSH Concerns: **General site safety.**

Compiled By: S. Herbert