Keeyask Hydro Power Limited Partnership
Keeyask Generating Station
Licence Implementation Guide for Water Levels

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Foreword

Keeyask Hydro Power Limited Partnership (KHLP) has been issued a licence under the Water Power Act and the Environment Act for the development of the Keeyask Generating Project.

The KHLP is a limited partnership consists of 5022649 Manitoba Ltd., a wholly owned subsidiary of Manitoba Hydro, and general partner of the KHLP and four limited partners being the Manitoba Hydro-Electric Board, Cree Nation Partners Limited Partnership, comprised of Tataskweyak Cree Nation and War Lake First Nation, as well as York Factory First Nation Limited Partnership and Fox Lake Cree Nation Keeyask Investments Inc.

Development of the Keeyask Project is a collaborative effort between Manitoba Hydro and four Manitoba First Nations – Tataskweyak Cree Nation and War Lake First Nation (acting as the Cree Nation Partners), York Factory First Nation, and Fox Lake Cree Nation – working together as the KHLP.

The parties negotiated the Joint Keeyask Development Agreement (JKDA), an agreement that governs how the project will be developed. It also sets out understandings related to potential income opportunities, training, employment, business opportunities and other related matters.

Manitoba Hydro provides the administrative and management services for the KHLP and will own at least 75 percent of the equity of the partnership. The four Manitoba First Nations, known collectively as the Keeyask Cree Nations, together have the right to own up to 25 per cent of the partnership.

Manitoba Hydro has developed this document on behalf of the KHLP.

Executive Summary

Introduction

In collaboration with Manitoba Conservation & Water Stewardship, Manitoba Hydro prepared this guideline to document a common understanding of the water regime terms, the forebay limits in articles 4.2 and 4.3 of the Keeyask Interim Water Power Act licence and clause 48 of Environment Act Licence No. 3107. This guideline specifies determination of water levels, operating limits and reporting requirements that must be met for compliance with these licences. As such, this document sets out the mutually understood and agreed to:

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

Keeyask Generating Station
Article 1.2.5 of the JKDA requires the use of two (2) or more gauge locations for determining the Keeyask forebay water level elevation. The forebay level is calculated using a set of averaging and weighting techniques to remove the effects of wind and waves.

Compliance
Compliance with the licence will be measured against both the **Keeyask Hourly Water Level** and the **Keeyask Mean Daily Water Level (with wind and wave effects eliminated)**.

Annual reports will be issued to Manitoba Conservation & Water Stewardship. Special compliance reports will be issued as necessitated by deviations from licence conditions.

Change Management
Revisions to this Implementation Guide are anticipated to accommodate the change from pre-project monitoring to construction to plant operation. Proposed revisions will be discussed with Manitoba Conservation & Water Stewardship from time to time. Following review and approval of revisions by Manitoba Conservation & Water Stewardship, a revised copy of this Implementation Guide will be produced and distributed by Manitoba Hydro on behalf of the KHLP.

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1. Introduction

1.1 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) Manitoba Hydro benchmarks BM 14MH1, 14MH2, and 14MH08 provide vertical control for the Keeyask GS. All elevations at Keeyask are based on Geodetic Survey of Canada (GS of C), Canadian Government Vertical Datum (CGVD) 1928, 1929 Local Adjustment originating from GS of C benchmark 524D located in Gillam. Elevations were originally determined in the Keeyask area by Manitoba Hydro in 1976 utilizing precise leveling survey methods and subsequently confirmed and updated by GPS surveys (Geodetic Survey Division 1995 geoid model). These precise elevations exist only on benchmarks on the south side of the Nelson River. Elevations on the north side of the Nelson River at the three controlling benchmarks noted above have been determined relative to them by static GPS surveys over the past several years.

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

Keeyask 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 **Keeyask Forebay Gauges,** calculated as set forth in Section 2.2;

Keeyask Mean Daily Water Level (with wind and wave effects eliminated) means the arithmetic mean of all **Keeyask Hourly Water Level**s for a calendar day.

1.2 Datum

In accordance with Clause 10.3 of the Keeyask Interim Water Power Act Licence, water level information for the operation of the Keeyask Project is based upon GS of C, CGVD 1928, 1929 Local Adjustment.

1.3 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, 1929 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.

1.4 Quality Control

1.4.1 Benchmarks

Vertical control surveys have been performed to establish appropriate local benchmarks from Split Lake to the Keeyask Generating Station.

Keeyask Forebay Gauge benchmarks were established from **Controlling Benchmarks** using GPS and/or spirit leveling methods. These benchmarks are accurate to ± 10mm.

1.4.2 Direct water level measurements

Field staff will visit the **Keeyask Forebay 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.

1.4.3 Gauge readings

Manitoba Hydro uses pressure transducers to determine water levels at its existing hydrometric gauging stations and at the **Keeyask Forebay 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 1.4.2, 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 1.4.2, no change is made to the transducer setting.

1.5 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 1.4. This level of data is used in the daily operation of the Keeyask Generating Station. This data will be used for monthly reporting described in Subsection 3.2.2 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. This data will be used for annual reporting described in Subsection 3.2.3 of this guide.

2. Keeyask Forebay

2.1 Gauge location criteria

In accordance with the Keeyask Interim Water Power Act Licence, the Keeyask forebay water level elevation is measured at the powerhouse and at a second upstream location (as required by Article 1.2.5 of the JKDA). Detailed gauge descriptions are included in Appendix A.

Details and exact location of the powerhouse gauge will be determined at a later date once construction is further advanced. The upstream gauge 05UF596 is located by an island approximately 7 km upstream from Gull Rapids. This gauge is operated by the Hydrometric Section of Manitoba Hydro's Hydraulic Operations Department. Manitoba Hydro provides water level data at http://www.hydro.mb.ca/hydrologicalData/static/.

2.2 Keeyask Wind-Eliminated Water Level calculation procedure

Articles 4.2 and 4.3 of the Keeyask Interim Water Power Act Licence and clause 48 of Environment Act Licence No. 3107 place limits on Keeyask forebay water levels. Keeyask forebay water levels will be influenced by Keeyask 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 or rapid spring runoff. To properly evaluate the wind-eliminated water level, averaging techniques are used to remove these effects. For the Keeyask forebay, these weather and hydraulic effects can be smoothed out using two gauges, weighting and a daily average water level.

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

2.2.1 Hourly averaging

The **Keeyask Forebay 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.

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

where

$HAWL_g$ = hourly average water level for **Keeyask 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 level from each of the **Keeyask Forebay Gauges** will be used to determine the **Keeyask Hourly Water Level** as shown in Equation 2. To start, weights will be equally assigned between the two **Keeyask Forebay Gauges**. Weights will be reviewed regularly and current weights will be included in each annual compliance report. In a case where there is a blank reading for one of the gauges, the weighting for the remaining gauge will be set to 1.

$$KHWL = \sum_{g} \left(W_g \mathrm{HAWL_g} \right) \qquad [2]$$

where

KHWL = **Keeyask Hourly Water Level**
$HAWL_g$ = hourly average water level for **Keeyask Forebay Gauge** *g*
W_g = weighting factor for **Keeyask Forebay Gauge** *g*

and

$$\sum_{g} W_g = 1$$

2.2.3 Daily average

The **Keeyask Mean Daily Water Level (with wind and wave effects eliminated)** will be calculated as the arithmetic mean of the **Keeyask Hourly Water Levels** as shown in Equation 3.

$$KMDWL = \frac{\sum_{i=1}^{n} KHWL_i}{n} \qquad [3]$$

where

KMDWL = the **Keeyask Mean Daily Water Level (with wind and wave effects eliminated)**
$KHWL_i$ = the **Keeyask Hourly Water Level** for hour *i*
n = the number of available hourly readings for that calendar day

3. Compliance

3.1 Keeyask Forebay

Article 4.2 of the Keeyask Interim Water Power Act licence states that:

> *The Licensee shall not raise the forebay of its development above an elevation of 159.0 metres ASL as measured at the powerhouse, 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.*

Article 4.3 of the Keeyask Interim Water Power Act licence states that:

> *The Licensee shall not lower the forebay of its development below an elevation of 158.0 metres ASL as measured at the powerhouse, 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.*

Clause 48 of Environment Act Licence No. 3107 states that:

> *The Licencee shall, during normal operation of the Development, regulate Keeyask Generating Station to maintain a maximum reservoir level in the immediate forebay of 159 m above sea level and a minimum operating level of 158 m above sea level.*

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

1. The **Keeyask Mean Daily Water Level (with wind and wave effects eliminated)** does not exceed 159.0 metres, and
2. The **Keeyask Hourly Water Level** does not exceed 159.1 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 **Keeyask Mean Daily Water Level (with wind and wave effects eliminated)** does not recede below 158.0 metres.
2. The **Keeyask Hourly Water Level** does not recede below 157.9 metres more than two times for two consecutive hours each time in any 24 hour period.

3.2 Reporting

3.2.1 Compliance Reporting

In the event that the Keeyask Generating Station forebay level is not in compliance with the licence limits as described in Section 3.1 above, notification shall be made to Manitoba Water Stewardship 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 Conservation & Water Stewardship.

3.2.2 Regular Monthly Reporting

Monthly water level reports will be provided to Manitoba Conservation & Water Stewardship to document compliance with the Keeyask Interim Water Power Act licence. These reports will use raw data from the **Keeyask Forebay Gauges** including the **Keeyask Hourly Water Level** and the **Keeyask Mean Daily Water Level (with wind and wave effects eliminated)**.

3.2.3 Regular Annual Reporting

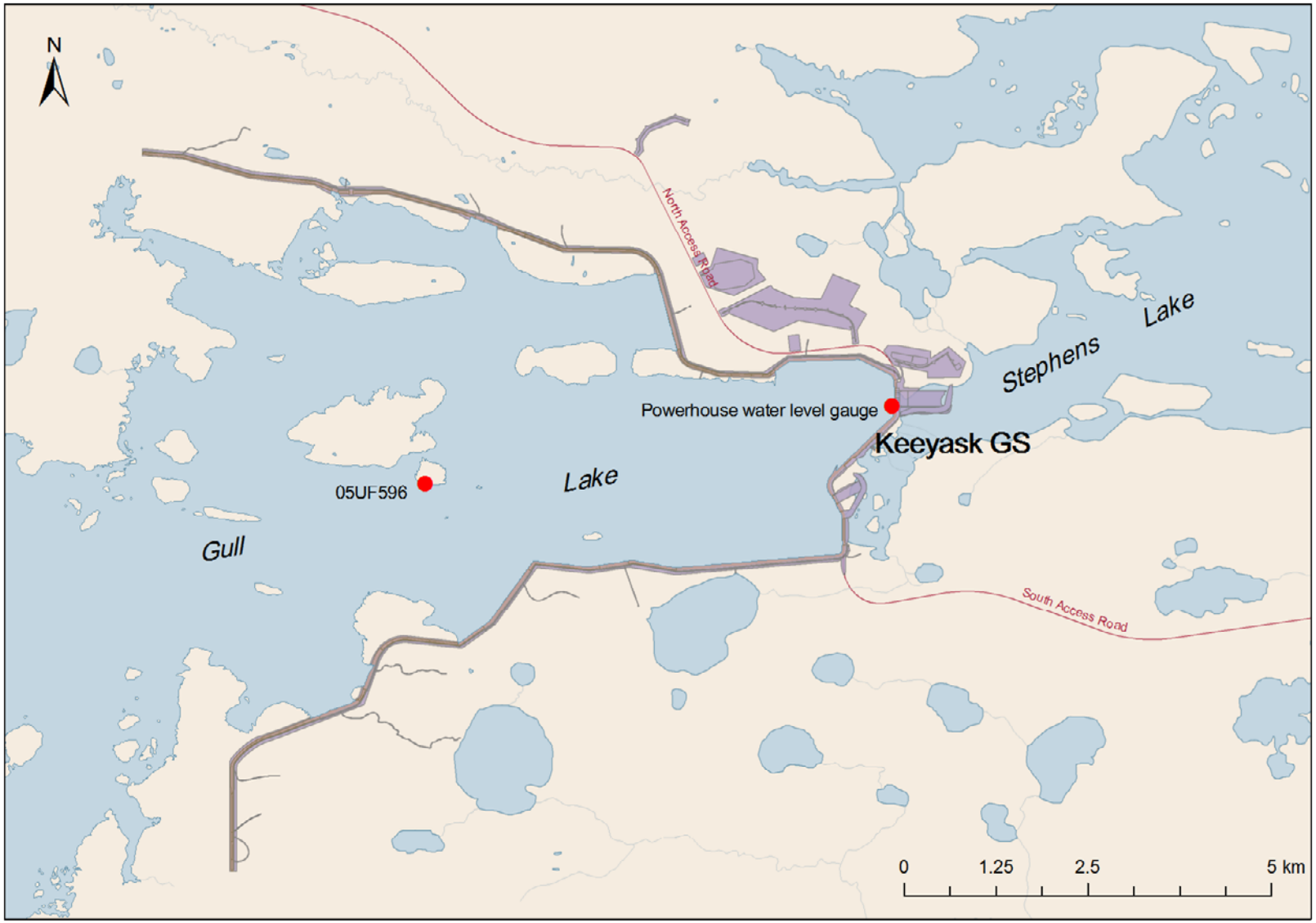
An annual water level report for each KHLP fiscal year (April 1 – March 31) will be provided to Manitoba Conservation & Water Stewardship to document compliance with the Keeyask Interim Water Power Act licence. This report will use final data from the **Keeyask Forebay Gauges**. The report will contain the final **Keeyask Hourly Water Level** and the final **Keeyask Mean Daily Water Level (with wind and wave effects eliminated)**. The annual report will also contain any compliance reports issued in that fiscal year. Due to the quality assurance processing time, this report will be issued by July 31 of the following fiscal year.

4. Change Management

4.1 Regular Updates

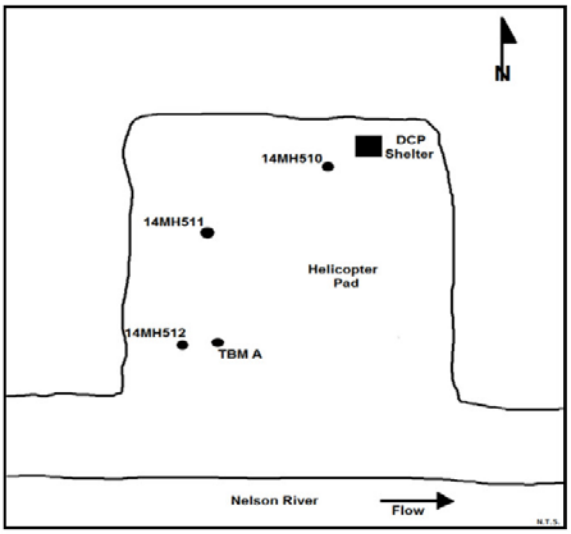
Revisions to this Implementation Guide are anticipated to accommodate the change from pre-project monitoring to construction to plant operation. Proposed revisions to this Implementation Guide will be reviewed with Manitoba Conservation & Water Stewardship from time to time. Following review and approval of revisions by Manitoba Conservation & Water Stewardship, a revised copy of this Implementation Guide will be produced and distributed by Manitoba Hydro on behalf of Keeyask Hydro Power Limited Partnership.

Appendix A
Water Level Gauge Description Sheets



Map 1: Post-impoundment view of the immediate Project area showing the location of forebay water level gauges.

Nelson River 7.0 km upstream of Gull Rapids



Number: 05UF596

Name: Nelson River 7.0 km upstream of Gull Rapids

DCP Id: 7DO2C1E8 Drainage Area (km2):

Latitude: 56° 20' 14.1" Longitude: -95° 18' 18.6"

UTM: 6246014.0 N 357473.0 E Zone: 15

Co-ordinate Source: NAD83

Operator: Manitoba Hydro, Thompson

Established: September 11, 2014

Location: The site is located on the south side of a large island on the Nelson River approximately 7.0 km upstream of Gull Rapids.

Equipment: FTS H2 data logger, firmware version 3.08, with a Sutron Accubar series 5600 and Air Liquide gas system installed with armour cable on a 22 kg steel orifice anchor. Includes a RM Young 61205V PA sensor and Campbell Scientific 44212B water temperature probe. Powered by a solar panel with a 12 V battery and housed in a Hanover metal building with a GOES Yagi antenna mounted externally.

Metering: N/A

Access: Helicopter and boat.

Station Status: Active

Station Operation: 12HR

Date: 2014-09-11

Datum: GS of C CGVD28, 1929 Local Adjustment

Benchmarks:

14MH510 – Master - Elevation - 159.440 m. A Manitoba Hydro brass cap on 5 lengths of 1.83 m of threaded copper ground rod driven to refusal, marked by 1.6 cm diameter bar, 1.2 m SW of the DCP shelter.

14MH511 – Elevation – 159.405 m. A Manitoba Hydro brass cap on 5 lengths of 1.83 m of threaded copper ground rod driven to refusal, marked by 1.6 cm diameter bar, 12.1 m SW of the DCP shelter.

14MH512 – Elevation – 159.376 m. A Manitoba Hydro brass cap on 5 lengths of 1.83 m of threaded copper ground rod driven to refusal, marked by 1.6 cm diameter bar, 28.5 m SW of the DCP shelter.

Additional Information:

Time Slot	00:23:50	Transmit Window	00:00:10
Transmitter	HDR	Baud Rate	300
Channel	19 E	Satellite Azimuth	156°
Report Rate	01:00:00	Antenna Angle	20°

Setup and operated as part of Keeyask PEMP. Also known as Keeyask PEMP Site #6.

Shef Codes: HG, TW, PA, VB, ZT

OSH Concerns: General site safety.

Compiled By: A.G. Tabak

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(Placeholder for powerhouse water level gauge description sheet – to be added in future revision)