

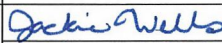
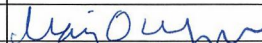

Nalcor Energy – Lower Churchill Project



LCP ICE FORMATION ENVIRONMENTAL EFFECTS MONITORING PLAN

Nalcor Doc. No. MFA-PT-MD-0000-EV-PL-0003-01

Comments:	Total # of Pages: (Including Cover): 30
-----------	---

B3	8 May 2014	Issue for Use	 J. Wells	 M. Organ	 R. Power
Status / Revision	Date	Reason for Issue	Prepared by	Functional Manager Approval	Project Manager (Generation + Island Link) Approval

CONFIDENTIALITY NOTE:
This document contains intellectual property of the Nalcor Energy – Lower Churchill Project and shall not be copied, used or distributed in whole or in part without the prior written consent from the Nalcor Energy – Lower Churchill Project.

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	2

TABLE OF CONTENTS

	PAGE
1 PURPOSE.....	3
2 SCOPE	4
3 DEFINITIONS	4
4 ABBREVIATIONS AND ACRONYMS	4
5 INTERNAL REFERENCES.....	5
6 PROJECT DESCRIPTION	5
6.1 Muskrat Falls Generation	5
6.2 Labrador Transmission Asset (LTA)	7
7 EXISTING INFORMATION	8
7.1 Ice formation at the Mud Lake crossing.....	9
7.2 Ashkui in the Lower Churchill Watershed.....	12
8 ENVIRONMENTAL EFFECTS MANAGEMENT.....	15
9 ENVIRONMENTAL EFFECTS MONITORING	16
9.1 Survey Protocols.....	16
9.1.1 Baseline Data Collection.....	17
9.1.2 Data Collection during Construction.....	17
9.1.3 Data Collection during Operations.....	22
9.1.4 Follow-up Program.....	23
10 SUMMARY	25
11 EXTERNAL REFERENCES	28

TABLE	PAGE
Table 7-1 Record of Break up and Freeze up at the Mud Lake Crossing	10
Table 10-1 Summary of the Ice Formation Environmental Effects Monitoring Plan	25

FIGURE	PAGE
Figure 6-1 Muskrat Falls Generating Facility	7
Figure 6-2 Labrador Transmission Asset.....	8

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	3

1 PURPOSE

The purpose of this Ice Formation Environmental Effects Monitoring Plan (IFEEMP) is to monitor the presence of ashkui within the lower Churchill River watershed as well as the development of ice cover in relation to the Mud Lake Crossing, an ice road / ice bridge across the Churchill River to Happy Valley-Goose Bay, approximately 30 kilometres (km) downstream of the Muskrat Falls reservoir. The IFEEMP will:

- identify any adverse environmental effects of construction and operation of the Lower Churchill River Hydroelectric Generation Project (the Project) on the Mud Lake Crossing (e.g., delayed formation of a safe ice thickness) and determine appropriate mitigation;
- establish a program for monitoring the effectiveness of mitigation measures; and
- identify the location and size of ashkui, areas of early open water, within the lower Churchill River watershed prior to the conduct of the Waterfowl-Ashkui surveys as described in the Avifauna Protection and EEMP (Nalcor 2013).

To comply with commitments made in the Environmental Impact Statement (EIS) and conditions of the EA release, this IFEEMP approach includes consideration of:

- Mitigation objectives – performance objectives in respect of each adverse environmental effect;
- Mitigation – measures planned to achieve the mitigation objectives;
- Metrics and targets – specific, quantifiable, relevant and time constrained;
- Follow-up or Monitoring Programs – how the Project will include follow-up or monitoring surveys to confirm that mitigation strategies are meeting the mitigation objectives; and
- Contingency – plan to be implemented should monitoring reveal that mitigation measures have not been successful.

The IFEEMP builds on existing information (Nalcor 2009a; Hatch et al. 2007, Hatch 2008, 2010a; SNC Lavalin 2012a,b), commitments made in the Environmental Impact Statement (EIS) (Nalcor 2009a) and through the Joint Review Panel (Panel) process, and any ice-related conditions of permits and licenses for the Project.

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	4

2 SCOPE

This plan addresses the environmental effects of ice formation on the Lower Churchill River following the impoundment of the Muskrat Falls Reservoir.

3 DEFINITIONS

Environmental Assessment: An evaluation of a project's potential environmental risks and effects before it is carried out and identification of ways to improve project design and implementation to prevent, minimize, mitigate, or compensate for adverse environmental effects and to enhance positive effects.

Environmental Management: The management of human interactions with the environment (air, water and land and all species that occupy these habitats including humans).

Environmental Management System: Part of an organization's management system used to develop and implement its environmental policy and manage its environmental aspects.

Environmental Protection Plan: Document outlining the specific mitigation measures, contingency plans and emergency response procedures to be implemented during the construction or operations of a facility.

Environmental Effects Monitoring: Monitoring of overall Project effects to confirm the predictions of EA and to fulfill EA commitments.

Environmental Compliance Monitoring: Monitoring of Project activities to confirm compliance with regulatory requirements and commitments made through the EA process.

Integrated Project Delivery Team: The integration of the Nalcor Energy and SNC Lavalin Inc. Environmental and Regulatory Compliance Teams.

4 ABBREVIATIONS AND ACRONYMS

CEAA	Canadian Environmental Assessment Act
EA	Environmental Assessment
EEMP	Environmental Effects Monitoring Plan
EMP	Environmental Management Plan
EPP	Environmental Protection Plan

Ice Formation Environmental Effects Monitoring Plan

Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	5

EMS	Environmental Management System
ERC	Environment and Regulatory Compliance
ERP	Emergency Response Plan
Gen	Generation
HSE	Health Safety and Environment
HVac	High voltage alternating current
LTA	Labrador Transmission Asset
LCP	Lower Churchill Project
OSEM	On-Site Environmental Monitor

5 INTERNAL REFERENCES

LCP-PT-MD-0000-PM-PL-0001-01	LCP Project Execution Plan
LCP-PT-MD-0000-PM-CH-0001-01	LCP Project Charter
LCP-PT-MD-0000-EA-PL-0001-01	LCP Generation Environmental Assessment Commitment Management Plan
LCP-PT-ED-0000-EA-SY-0001-01	Environmental Impact Statement and Supporting Documentation for the Lower Churchill Hydroelectric Generation Project
LCP-PT-ED-0000-EV-RG-0001-01	Lower Churchill Project Permit Registry
LCP-PT-MD-0000-SM-ST-0001-01	Post Environmental Assessment Release
LCP-PT-MD-0000-RT-PL-0001-01	Regulatory Compliance Plan
LCP-PT-ED-000-EN-PH-0031-01	Design Philosophy for Environmental Rehabilitation
LCP-PT-ED-0000-EN-PH-0007-01	Design Philosophy for Environmental Mitigation
LCP-PT-MD-0000-HS-PL-0001-01	Health and Safety Plan
LCP-PT-MD-0000-HS-PL-0004-01.	LCP Emergency Response Plan
LCP-PT-MD-0000-IM-PL-0003-01	Information Management Plan
LCP-PT-MD-0000-CO-PL-0001-01	Communications and Stakeholder Relations Plan
LCP-PT-MD-0000-EV-PL-0002-01	LCP Integrated Environmental Management Plan

6 PROJECT DESCRIPTION

6.1 MUSKRAT FALLS GENERATION

The Muskrat Falls Generation Project will include the following sub-components which are broken down under the five principal areas of the development:

Ice Formation Environmental Effects Monitoring Plan

Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	6

- 22 km of access roads, including upgrading and new construction, and temporary bridges;
- A 1,500 person accommodations complex (for the construction period); and
- A north roller compacted concrete overflow dam;
- A south rock fill dam;
- River diversion during construction via the spillway;
- 5 vertical gate spillway;
- Reservoir preparation and reservoir clearing;
- Replacement fish and of terrestrial habitat;
- North spur stabilization works;
- A close coupled intake and powerhouse, including:
 - 4 intakes with gates and trash racks;
 - 4 turbine/generator units at approximately 206 MW each with associated ancillary electrical/mechanical and protection/control equipment;
 - 5 power transformers (includes 1 spare), located on the draft tube deck of the powerhouse; and
 - 2 overhead cranes each rated at 450 Tonnes

Ice Formation Environmental Effects Monitoring Plan

Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	7



Figure 6-1 Muskrat Falls Generating Facility

6.2 LABRADOR TRANSMISSION ASSET (LTA)

LTA consists of the ac transmission line system from Churchill Falls to Muskrat Falls (see Figure 6-2), specifically:

- Churchill Falls switchyard extension;
- Muskrat Falls switchyard;
- Transmission lines from Muskrat Falls to Churchill Falls: double-circuit 315 kV ac, 3 phase lines, double bundle conductor, Single circuit galvanized lattice steel guyed suspension and rigid angle towers; 247 km long;
- 735 kV Transmission Line at Churchill Falls interconnecting the existing and the new Churchill Falls switchyards; and
- Labrador Fibre Project (Nalcor's participation in Aliant led initiative).

Ice Formation Environmental Effects Monitoring Plan

Nalcor Doc. No.

MFA-PT-MD-0000-EV-PL-0003-01

Revision

B3

Page

8

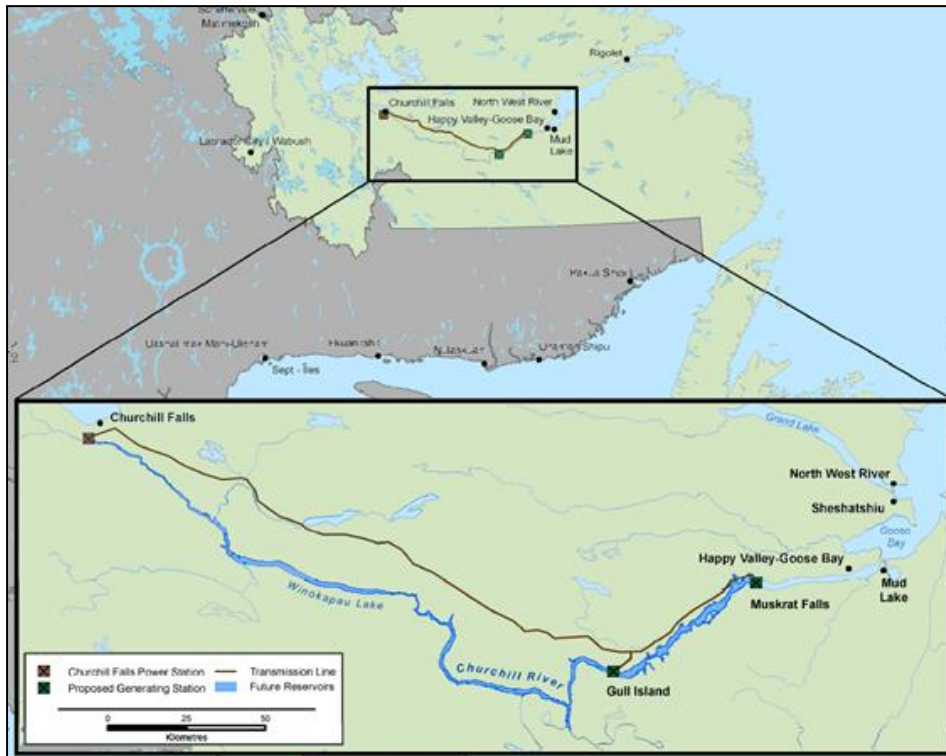


Figure 6-2 Labrador Transmission Asset

7 EXISTING INFORMATION

Existing information regarding ice formation within the lower Churchill River watershed area is summarized from the following sources:

- data compiled for Nalcor's Environmental Impact Statement (EIS) for the Project (Nalcor 2009a), which was based on a literature review, Project-specific baseline surveys, and component studies (Hatch et al. 2007; Hatch 2008) related to ice, and other sources including traditional environmental knowledge (Innu Nation 2009) and current land and resource use in the lower Churchill River watershed (Minaskuat Inc. 2009);
- historical data collected for the Mud Lake Crossing (JRP 2009); and
- data collected since EIS submission, including that reported by Hatch (2010a,b) and SNC Lavalin (2012a,b).

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	9

7.1 ICE FORMATION AT THE MUD LAKE CROSSING

Ice formation is a complex process controlled largely by flow characteristics, temperature and precipitation (Weber et al., 2003). Ice formation processes along the Churchill River are dynamic in nature and ice coverage can change dramatically over a short period of time (Nalcor 2009a). The typical ice formation processes commence as air temperatures fall below freezing; frazil ice forms in areas of turbulent open water and then frazil ice joins together to form larger pieces of surface ice or slush pans (Hatch et al. 2007). As frazil and slush pans accumulate on the leading (upstream) edge of the ice cover, the ice cover progresses up the river. The rate at which the ice cover forms and progresses upstream is highly dependent on factors including air temperature, river velocities, and river width (Hatch 2008).

The formation of ice during the freeze-up period and decay of river ice cover during the break-up period is important to evaluate the stability of ice and risk of flood, and to address the resulting adverse effects. The LCP is interested in ice formation below Muskrat Falls following Project construction at a few locations including, in particular, Mud Lake.

During consultation for the Project, Mud Lake residents expressed concerns relating to changes that may occur to the ice conditions on the Churchill River with the Project in place (e.g., delay of the formation of the ice bridge) (Nalcor 2009a). Mud Lake residents rely on the Churchill River as their transportation link to Happy Valley-Goose Bay, using boats to cross the river in summer and snowmobiles in winter. In winter, Mud Lake residents make between 80 and 140 snowmobile crossings of the Churchill River per week (JRP 2009).

When ice conditions are considered safe and the weather acceptable, non-Mud Lake residents also travel by snowmobile across the Churchill River to access cabins located on the south side of Lake Melville and for other recreational activities such as ice-fishing, sight-seeing, and informal snowmobile racing. Residents' concerns relate to Project effects on the timing of formation, duration and integrity of the Mud Lake Crossing between Mud Lake and Happy Valley-Goose Bay, especially during the four to seven day period in the late fall / early winter and in the spring when it is unsafe to cross the river by either boat or snowmobile. The residents of Mud Lake are concerned that the duration of unstable ice conditions will increase as a result of the Project.

The community of Mud Lake provided information on the ice freeze-up and break-up of the Churchill River in the Mud Lake area, including a long-term record of ice freeze-up and break-up dates (Nalcor 2009a). Dates of the first crossing of the Churchill River by Mud Lake residents by snowmobile and boat have been recorded in 1972 and from 1975 to 2008 as presented in Table 7.1. The average date of first snowmobile crossing is November 28, with the earliest and latest

Ice Formation Environmental Effects Monitoring Plan

Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	10

first snowmobile crossings recorded as November 13 in 1986 and December 23 in 1981 respectively (JRP 2009). The average date of first boat crossing is May 17, with the earliest and latest first boat crossings recorded as April 23 in 1987 and June 5 in 1972 respectively (JRP 2009).

Table 7-1 Record of Break up and Freeze up at the Mud Lake Crossing

Year	Date	
	Freeze-up (first snowmobile crossing)	Break-up (first boat crossing)
1972	22 Nov 72	5 Jun 72
1973	-	-
1974	-	-
1975	25 Nov 75	30 May 75
1976	17 Nov 76	17 May 76
1977	30 Nov 77	15 May 77
1978	19 Nov 78	27 May 78
1979	24 Nov 79	14 May 79
1980	29 Nov 80	17 May 80
1981	23 Dec 81	15 May 81
1982	28 Nov 82	1 Jun 82
1983	29 Nov 83	14 May 83
1984	23 Nov 84	15 May 84
1985	18 Nov 85	28 May 85
1986	13 Nov 86	7 May 86
1987	28 Nov 87	23 Apr 87
1988	1 Dec 88	12 May 88
1989	24 Nov 89	15 May 89
1990	1 Dec 90	22 May 90
1991	2 Dec 91	26 May 91
1992	19 Nov 92	27 May 92
1993	13 Nov 93	17 May 93
1994	27 Nov 94	22 May 94
1995	29 Nov 95	11 May 95
1996	1 Dec 96	4 May 96
1997	23 Nov 97	24 May 97
1998	30 Nov 98	12 May 98
1999	23 Nov 99	10 May 99
2000	25 Nov 00	11 May 00
2001	4 Dec 01	14 May 01
2002	22 Nov 02	22 May 02
2003	7 Dec 03	17 May 03

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	11

2004	7 Dec 04	18 May 04
2005	11 Dec 05	8 May 05
2006	4 Dec 06	4 May 06
2007	30 Nov 07	19 May 07
2008	5 Dec 08	7 May 08
2009	8 Dec 09	-
2010	-	20 Apr 2010
Average	November 28	May 17

The Lower Churchill Project (LCP) is currently working with scientists and the residents of Mud Lake to understand how changes in ice formation downstream of Muskrat Falls could affect the residents' travel across the ice. In addition to the historical ice data, the LCP has been observing ice processes on the lower Churchill River in relation to the Project since 2006 to improve its understanding of current river ice processes for consideration in Project design and construction, and to allow for predictions of post-Project ice conditions (SNC Lavalin 2012a). The LCP has also incorporated an analysis of ice freeze-up and break-up timing during Project operations (i.e., consideration for how Project operation [e.g., water volumes released, temperature of water release] may influence downstream hydrology) into modeling studies (Hatch et al. 2007, Hatch 2008).

Ice dynamics studies completed by Hatch et al. (2007) (Hatch 2008, 2010a) modeled water temperatures and ice generation under existing and post-Project conditions. Subsequent studies by SNC Lavalin in 2011 and 2012 included a review of ice study work to date (SNC Lavalin 2012a) and the Churchill River Ice Observation Study (SNC Lavalin 2012b). This ice observation program consisted of helicopter surveys, acquisition of satellite imagery near Gull Island and Mud Lake, collection of Environment Canada web camera (webcam) imagery at Grizzle Rapids and Mud Lake, a water temperature observation program, ice thickness measurements downstream of Muskrat Falls and at the Mud Lake Crossing, and a volumetric ice flow rate analysis. The 2010-2011 Ice Observation Study documented the ice processes near Mud Lake (SNC Lavalin 2012a).

Based on the data collected, Nalcor (2009a) predicted that during Project operation, the ice conditions below Muskrat Falls, including at the Mud Lake Crossing, would be sufficient (i.e., thickness and stability) to form ice roads. However, following Project construction, ice formation near Mud Lake is expected to be approximately two weeks later, and ice break-up is likely to be one week later (Nalcor 2009a; JRP 2009; Hatch 2010a). Therefore, the safe operational period of the Mud Lake Crossing is expected to be shortened by approximately one week over the winter season.

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	12

Increased temperatures in the fall, winter and spring due to climate change will no doubt have an effect on the ice conditions of the Churchill River. In theory, higher air temperatures would correspond to a lower rate of ice generation, which would correspond to a delay in ice bridging. Increased temperatures would also increase the period of time that the river has open water, and this would increase the relative use of boat transportation.

Ice monitoring on the Churchill River below the reservoir and at the Mud Lake Crossing location is ongoing to collect additional baseline information and information on the ‘ice bridging’ process prior to and during Project construction, as well as during Project operations, to help the LCP verify the predictions made in the EIS (Nalcor 2009a). Surveys include multi-day helicopter surveys during ice freeze-up and break-up, ice thickness and ice coring during the ice road season, and, analysis of available radar satellite imagery during ice formation.

In addition, the 2010-2011 Ice Observation Study (SNC Lavalin 2012a) showed that, even in the absence of upstream development, the ice formation and freeze-up processes along the Churchill River are not as predictable as previously thought. This information will be useful in the future if issues arise regarding changes in timing and duration of ice cover in relation to the Project.

7.2 ASHKUI IN THE LOWER CHURCHILL WATERSHED

Ashkui are areas where open water appears earlier in the spring than elsewhere or where water remains open (i.e., unfrozen) year-round on rivers, lakes and estuaries. Water temperature, depth and velocity are important factors for ashkui formation (Nalcor 2009a). Ashkui tend to be located where water flows are rough, such as at the confluences of rivers, and are known to exist at Muskrat Falls and the mouths of other rivers entering the Churchill River (e.g., Cache River, Pinus River) (Minaskuat Inc. 2009).

Ashkui provide important habitat for wildlife, with concentrations of waterfowl, fish and other wildlife found at these locations due to the presence of light and open water. Ashkui have special importance in the spring, but appear to have limited importance during the rest of the winter (Environment Canada 2002). In spring, ashkui provide staging habitat for migratory waterfowl such as surf scoter and Canada geese that rely on open water areas when interior wetlands are still ice-covered. In winter, ashkui are used by river otters as haul out sites; however, their primary importance for wildlife relates to waterfowl.

Ashkui are considered important by Innu for drinking water, fishing and hunting (Nalcor 2009b; JRP 2009), and are often sites of contemporary Innu family camps (Minaskuat Inc. 2009). For

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	13

Innu, the importance of the ashkui is in the overall relationship between the ashkui and the surrounding environment (Gorsebrook Research Institute 2001).

The Ashkui Project is a collaborative study between Environment Canada, Innu Nation, the Gorsebrook Research Institute of Saint Mary's University and Natural Resources to better understand ashkui and includes the study of the relationship between the hydraulics, hydrology and morphology of water bodies. Results from the Ashkui Project were considered in the prediction of ice conditions during Project operations (JRP 2009). During ice-cover conditions, several factors will influence the formation and size of ashkui. The locations where tributaries join the lower Churchill River, and therefore the location of ashkui, will be changed with reservoir creation. While some ashkui on the main stem of the lower Churchill River will likely be lost, the LCP has predicted that after reservoir creation ashkui will continue to form, but at different confluence locations and at higher elevation than they do now (based on formation under similar thermal and hydraulic conditions) (Nalcor 2009a; JRP 2009).

The identification and mapping of the location of ashkui as part of this IFEEMP is in relation to the completion of Waterfowl-Ashkui surveys to understand ashkui size and distribution, and use by waterfowl during Project construction and operations. The Panel concluded that any loss of ashkui would result in a loss in habitat for waterfowl, but would likely not be significant given the abundance of alternate habitat available (JRP 2011).

The Newfoundland and Labrador (NL) government does not regulate or permit ice roads. As such, the Mud Lake Crossing is not regulated or permitted; the crossing is used for snowmobile traffic only, by residents in the vicinity of Mud Lake, and is overseen by the Mud Lake Improvement Committee. There are no regulations related to ashkui in the lower Churchill River watershed. Although there are no regulatory requirements associated with the Mud Lake Crossing or with ashkui, the LCP made commitments during the Joint Panel Review process regarding ice formation monitoring in relation to both.

To comply with commitments made the LCP has, or will:

- conduct ice formation surveys to identify the location and size of ashkui on the Churchill River within the full supply level of the reservoir and downstream past Mud Lake (Nalcor 2009a);
- conduct ice formation surveys below Muskrat Falls and at the Mud Lake Crossing during Project construction and operation;
- identify mitigation options to support continued, safe use of the Mud Lake Crossing;

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	14

- conduct monitoring or follow-up, as appropriate, to determine the success of mitigation; and
- if required, implement contingency plans if the mitigation is found to be unsuccessful.

The intent of the IFEEMP is to allow the LCP to:

- evaluate and respond appropriately to the findings of the follow-up or monitoring programs as they relate to the Project effects during construction and operation on the viability of the ice bridge at the Mud Lake Crossing during the winter season; and
- identify suitable locations to conduct Waterfowl-Ashkui surveys.

In addition, the NL Reg. 18/12, also referred to as the *Lower Churchill Hydroelectric Generation Project Undertaking Order* releases the Project from environmental assessment and sets conditions for this release that LCP must meet. The release of the Project from environmental assessment under section 3 is subject to the following conditions:

- (a) Nalcor Energy shall abide by all commitments made by it in the Environmental Impact Statement dated February 2009, and all the Environmental Impact Statement Additional Information Requests made by the Lower Churchill Hydroelectric Generation Project Environmental Assessment Panel and consequently submitted by Nalcor Energy, and the submissions made by Nalcor Energy during the panel hearings and, subsequent to the hearings, to the panel, unless one or more of the commitments, or a part of a commitment is specifically waived by the minister;
- (e) Nalcor Energy shall prepare and abide by the requirements of environmental effects monitoring plans for all phases of the project, and those plans shall be submitted to and approved by the Minister of Environment and Conservation or the appropriate minister of the Crown before the commencement of an activity which is associated with or may affect one or more of the following matters:

(vii) ice formation

Submission of this EEMP satisfies the condition/requirement in NL Reg. 18/12 that Nalcor Energy prepare and submit to the Minister of Environment and Conservation or the appropriate minister of the Crown, an environmental effects monitoring plan for all phases of the project, before the commencement of an activity which is associated with or may affect the following matters:

(vii) ice formation

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	15

8 ENVIRONMENTAL EFFECTS MANAGEMENT

The effects management plans (i.e., mitigation measures outlined in the EIS [Nalcor 2009a] and the Generation and LTA Environmental Protection Plan and the commitments made by the LCP during the Information Request responses and the Joint Review Panel review process as they relate to ice formation at the Mud Lake Crossing location include the following:

- Conduct an ice observation monitoring program throughout the reservoir, downstream of Muskrat Falls to the mouth of the Churchill River, and Lake Melville to develop a better understanding of the ice processes,
- including timing of ice formation and break-up, area covered, and identification of open water areas including ashkui;
- Conduct satellite-based monitoring of ice progression and stability in the vicinity of Mud Lake and Happy Valley-Goose Bay;
- Monitor ice thickness at select locations on the Churchill River, and issue public advisories on the condition of ice (Nalcor 2009a Exec Summ, Land and Resource Use) to the communities affected;
- Consider alternative transportation options in the event that the transition period between use of the Mud Lake Crossing for snowmobile travel during the winter and boat travel in the spring across the Churchill River is lengthened by more than two weeks.
- The LCP will continue to consult with the residents of Mud Lake to discuss alternative means of traveling to Happy Valley-Goose Bay, if the duration of the transition period is extended by the Project (JRP 2009).
- The LCP and the Province will negotiate an agreement with the Mud Lake Improvement Committee, and the LCP will provide residents of Mud Lake alternative means of transportation if the time the residents are unable to cross the Churchill River during freeze-up or break-up exceeds two weeks, without requiring proof that the Project has caused the problem. Given the natural variability of ice formation among years, it is difficult to identify a reasonable threshold date from which to measure a two week exceedance. Therefore, the LCP and the Mud Lake Improvement Committee will communicate regularly to establish whether alternate transportation is required for a certain period of time.

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	16

It is noted that climate change may be a factor in any future changes in ice formation on the lower Churchill River (JRP 2011), and ice monitoring programs implemented by LCP, with the analysis of images from weather stations at Muskrat Falls and Mud Lake (NLDEC owned station) will provide long-term information on climate change effects as well as support the LCP’s commitments in relation to this IFEEMP. Nalcor will utilize data obtained from the weather station to be established at Muskrat Falls and other stations maintained by NLDEC throughout Labrador to better understand the potential effects of climate change on ice formation. This assessment will include data from studies commissioned by the Office of Climate Change and Energy Efficiency (CCEE) and incorporated into the annual IFEEMP reports.

9 ENVIRONMENTAL EFFECTS MONITORING

This IFEEMP contains both:

Follow-up Programs – studies or surveys designed and implemented to evaluate the predictions of the environmental assessment and to determine the effectiveness of any measure taken to mitigate the adverse environmental effects of the Project; and

Monitoring Programs – studies or surveys designed and implemented to determine whether the Project is implemented as proposed, and that mitigation measures proposed by the LCP to minimize the Project’s environmental effects are implemented and effective. A summary of the IFEEMP is presented in tabular format at the end of this document.

9.1 SURVEY PROTOCOLS

The LCP has committed to conduct follow-up and monitoring programs to evaluate the effectiveness of the effects management plans, and to determine if expansion or reduction or deletion of the indicated programs is appropriate (with justification). This would apply to the following, as appropriate:

- data collection during construction;
- data collection during operations; and
- follow-up and monitoring reporting.

Protocols for the data collection are discussed in the following subsections. Data collection includes metrics that are specific, quantifiable, relevant and time constrained. The goal is to collect meaningful data in a focused, defensible, repeatable approach, within an appropriate

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	17

timeline to ensure that the mitigation is appropriate. Where it is determined that the mitigation is not appropriate or can be improved, a contingency plan would be presented that the LCP would incorporate as per their adaptive management approach.

9.1.1 Baseline Data Collection

Baseline data collection refers to the determination of relevant data regarding ice formation and ice break-up at the Mud Lake Crossing of the Churchill River between Mud Lake and Happy Valley-Goose Bay, and the presence of ashkui in the lower Churchill River watershed. Ice data related to the Mud Lake Crossing has been collected for almost 40 years by residents of Mud Lake with valuable knowledge pertaining to the ice formation along the Mud Lake Crossing and has been summarized in the Existing Information section, Table 7-1. In addition, the LCP has undertaken ice monitoring specific to the lower Churchill River and, specifically, the Mud Lake Crossing since 2010 (Hatch 2010a; SNC Lavalin 2012a,b).

Baseline surveys have been conducted to document the presence of ashkui in the lower Churchill River watershed in the Project area. The survey results are presented in Minaskuat (2009) and are integral to data collection during construction and considered the initial part of that process.

9.1.2 Data Collection during Construction

The LCP initiated the collection of ice data in 2010, to be continued during Project construction. Reservoir creation involves construction to the winter head pond (water level at 25 m depth) by September 2015, and reaching the full supply level (39 m) by September 2016. The surveys discussed in the following subsections are being and will be conducted during the construction period.

9.1.2.1 Ice Observation Survey – Ice Formation Period

An aerial ice observation survey will be conducted along the lower Churchill River and specifically at Mud Lake during the ice formation period throughout Project construction (November to December, from 2012 to 2015) to identify the timing of ice formation. The optimum timing and conditions for the survey will be determined based on a daily review of images recorded by the web-camera (webcam) that has been installed for this purpose and in consultation with local residents with expert knowledge of the Mud Lake Crossing. The webcam is located at the end of the Mud Lake Crossing where it meets the Churchill River and near-real time meteorological data is presented by the NLDEC Water Resources Management Division (NLDEC 2013). An estimation of ice floe concentration will be

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	18

achieved via analysis of photographs taken during the helicopter surveys (during the period between the start of ice formation and the formation of the ice bridge at Mud Lake). This concentration will also avail of previous ice observation programs for the estimation. Estimates of ice floe velocity will also be obtained using the updated hydraulic model of the river.

The above noted estimate of volumetric flow rate will be acquired at four locations:

- Upstream of Muskrat Falls;
- Downstream of Muskrat Falls;
- Downstream of Blackrock Bridge; and
- Close to the Mud Lake Crossing.

The survey will be conducted by helicopter between Muskrat Falls and Mud Lake during one discrete multi-day field trip to observe the progression of the ice front. It is estimated that the survey will be completed over two consecutive days; however, if field conditions require a longer survey period, the survey period may be extended. Photographs will be taken with a Nikon GPS camera along the river for use in ice concentration analysis. Near vertical oblique photographs will be taken at predetermined locations for use in producing ice concentration maps using photo recognition software.

9.1.2.2 *Ice Observation Survey – Ice Break-up Period*

An ice observation survey will be conducted by helicopter during the ice break-up period throughout Project construction (mid-April to mid-June) during 2014, 2015 and 2016 to identify the timing of ice break-up. The optimum timing and conditions for the survey will be determined and the helicopter survey will be conducted as described in Section 9.1.2.1 (Ice Observation Survey – Ice Formation Period). An estimation of ice floe concentration will also be achieved during the ice break-up period, via analysis of photographs taken during the helicopter surveys (during the period between the start of ice formation and the formation of the ice bridge at Mud Lake). This concentration will also avail of previous ice observation programs for the estimation. Estimates of ice floe velocity will also be obtained using the updated hydraulic model of the river.

The above noted estimate of volumetric flow rate will be acquired at four locations:

- Upstream of Muskrat Falls;
- Downstream of Muskrat Falls;
- Downstream of Blackrock Bridge; and

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	19

- Close to the Mud Lake Crossing.

The ice break-up survey, going forward from 2014, will also involve the identification and mapping of ashkui. As indicated in the Waterfowl-Ashkui survey protocol described in the Avifauna Protection and EEMP (Nalcor 2013), a qualified avian biologist will be included in the ice monitoring survey to identify open water areas (ashkui) suitable as habitat for waterfowl such as surf scoter. The Waterfowl-Ashkui survey will subsequently be conducted to observe waterfowl use of the ashkui as staging areas prior to dispersal to breeding locations, and will include observations of the ashkui as well.

9.1.2.3 Ice Measurement Survey – Mud Lake Crossing

At the end of the ice formation survey (i.e., when a stable ice crossing forms), an ice survey will be conducted to monitor ice accumulation at the Mud Lake Crossing. Ice thickness measurements will be recorded and ice cores will be collected along the Mud Lake crossing each winter. Safety of the surveyors is considered paramount and reflected in the use of appropriate safety and personal protective equipment. Ice thickness and ice coring will not be conducted during the break-up period due to safety considerations.

Surveyors will travel by snowmobile to the Mud Lake Crossing at the survey start point on the south side of the Churchill River. Holes will be drilled using a combination of manual and gasoline powered ice augers at ten locations where data were collected in previous years (2010-2012). At each location, the ice thickness will be measured, an ice core collected, and photographic records will be taken. Ice cores will be collected approximately every 200 m along the Mud Lake Crossing, using core barrels attached to an ice auger motor. Ice cores will be visually assessed in the field by an individual experienced in ice mechanics. The assessment of the ice cores will be largely qualitative in nature to understand the ice integrity (e.g., solid, weakened, fractured portions). Based on the data collected, cross-sectional and longitudinal profiles of ice thickness at the Mud Lake Crossing will be established.

9.1.2.4 Radar Satellite Imagery – Interpretation and analysis

Satellite based ice monitoring will be focused on the lower Churchill River from Muskrat Falls to Mud Lake during the ice formation (November to December) and ice break-up (mid-April to mid-June) periods, with the objective of verifying ice progression and stability in the vicinity of Mud Lake and Happy Valley-Goose Bay, including the stability of the Mud Lake Crossing. This ice monitoring would occur through construction and the first five years of operations. Image acquisition and analysis will be coordinated with the LCP based on

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	20

weather observations and forecasts, with a target frequency of one image every two days and a total of 60 images per season. The analysis of radar satellite imagery will incorporate all available information including that from the Mud Lake webcams, other in-situ data, hourly Environment Canada weather data, and field observations from the LCP and contractor personnel, and will include the following:

- Generation of ice products indicating ice front location (i.e., grey scale image showing the extent of the ice cover) and classification (i.e., three classes: water, intact ice, consolidated ice) – for each image;
- Generation of ice products indicating cover change (i.e., change in backscatter observed in pairs of successive images) – for each available image pair; and
- Review of and comparison of the results with ice products from previous years to identify changing ice conditions.

After the first year of data gathering and analysis, recommendations will be made regarding the frequency of image acquisition (i.e., can it be reduced without compromising the analysis?), and the availability of other suitable imagery (e.g., data from Sentinel-1 at no cost) will be considered for use in subsequent years.

The Cosmo Sky-med constellation is being used for ice monitoring. During the freeze-up and break-up periods over Mud Lake and Muskrat Falls, C-CORE will be interpreting high resolution data (2.5 m) imagery collected daily. During the remainder of the ice season, the Project will be using medium resolution imagery to monitor the area between Mud Lake and Muskrat Falls. These images will be acquired every 3 to 4 days. A total of 60 images will be used during the 2013-1014 ice season. A schedule for image acquisition has been developed but this schedule is subject to change based on the ice dynamics of the season.

The following ice classification protocols will be used:

- Ice classification is based on ortho-rectified images that have been calibrated
- An unsupervised classification method is used for ice classification
- For each satellite image, ice products will be generated indicating ice front and classification
- Ice cover change products will be generated from all available image pairs
- Products will included the classified data as both images and in tabular form

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	21

9.1.2.5 Reporting

Reporting will include a summary of field results after each survey (Hatch 2010b). The data will be compiled once each year and evaluated to determine the timing of ice formation and break-up along the river and, specifically, for the Mud Lake Crossing. The data will also be used to calibrate and validate satellite imagery products for use in the Radar Satellite Interpretation and Analysis described above.

An annual report will be prepared to summarize results of all survey programs, analysis of data collected for that year (e.g., timing of ice formation and break-up [including information on ashkui], ice measurements, mapping, photographs) in relation to data acquired in previous years, and other relevant information as necessary (e.g., recommendations for satellite imagery acquisition). The LCP will provide the report to the Water Resources Management Division of NL Department of Environment and Conservation for their review and comments.

9.1.2.6 Lake Melville Monitoring Service

LCP funds the Lake Melville Ice Monitoring Service (Service) executed by C-Core. This Service provides satellite imagery data to advise local residents regarding the safety of ice for navigation in the Lake Melville region. The monitoring is achieved using Earth Observation (EO) data from radar and optical satellites. The Service includes a web portal where community members are able to log on to a website, to view current radar and optical images of Lake Melville, which show the lake ice conditions. This knowledge helps the community members plan safe travel routes, as they can identify and avoid areas of open water, areas of rough ice, pressure cracks, as well as identify when the ice starts to break down in the spring. The service also displays the ice thickness and snow cover.

It is an online service that provides the following near real-time products:

1. Spatial map highlighting where open water, thin leads, and fractures are located; and
2. Current ice thickness.

EO data are required to generate the first product, particularly Synthetic-Aperture Radar (SAR), because of its reliability to acquire data throughout the winter season. The SAR enables imaging in darkness as well as through clouds. The second product uses a thermodynamic lake ice thickness model and in situ observations.

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	22

The service starts about two weeks before ice freeze-up. Optical imagery is available on a daily basis and will be uploaded to the site when cloud free. The Service derives its optical products using NASA's Moderate-resolution Imaging Spectroradiometer (MODIS) sensor. SAR images will be acquired prior to the freeze-up at a frequency of twice a week until the ice has reached a thickness of 25 cm. The service will continue to provide SAR imagery on a bi-weekly basis as well as optical imagery when available until temperatures begin to rise near 0 Celsius. The service will then increase SAR acquisitions to twice a week until the ice is off of the lake in order to capture the break up period of the winter season.

In addition to the near real-time data posted online by C-CORE, the data coordinator at the Labrador Institute downloads, saves and stores the images acquired. This database will be valuable for monitoring and characterizing ice formation in the future. Any user has the opportunity to download the radar and MODIS images, once they are uploaded to the web portal.

9.1.3 Data Collection during Operations

9.1.3.1 *Post- Impoundment Ice Observation Survey – Ice Formation Period*

A survey as described in Section 9.1.2.1 for the construction period will be conducted annually during the period of ice formation during Project operation (i.e., once reservoir full supply level has been reached). The objective will be to identify the timing of ice formation at the Mud Lake Crossing, for comparison with the time of ice formation prior to and during construction. Results will be reported annually as described above.

9.1.3.2 *Post Impoundment Ice Observation Survey – Ice Break-up Period*

Similarly, a survey in Section 9.1.2.2 for the construction period will be conducted annually during the period of ice break-up during Project operation from Muskrat Falls downstream to Mud Lake. The objective will be to identify the timing of ice break-up at the Mud Lake Crossing, for comparison with the time of ice break-up prior to and during construction. Results will be reported annually as described above.

This ice break-up survey will also involve the identification and mapping of ashkui to support the Waterfowl-Ashkui survey protocol described in the Avifauna Protection and EEMP (Nalcor 2013). A qualified avian biologist will be included in the ice monitoring survey to identify open water areas (ashkui) suitable as habitat for waterfowl such as surf scoter. The Waterfowl-Ashkui survey will subsequently be conducted to observe waterfowl use of

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	23

the ashkui as staging areas prior to dispersal to breeding locations, and will include observations of the ashkui as well.

9.1.3.3 *Ice Measurement Survey – Mud Lake*

An ice survey as described in Section 9.1.2.3 for the construction period will be conducted annually during the period of ice formation during Project operation from Muskrat Falls downstream to Mud Lake. The objective will be to collect data to understand the formation of a stable ice cover and evaluate the composition of the ice cover. Results will be reported annually as described above.

9.1.3.4 *Radar Satellite Imagery – Interpretation and Analysis*

As described in Section 9.1.2.4, satellite based ice monitoring will continue on the lower Churchill River from Muskrat Falls to Mud Lake during the ice formation (November to December) and ice break-up (mid-April to mid-June) periods once reservoir full supply level has been reached (i.e., during Project operation). As for the survey during Project construction, the objective will be to verify ice progression and stability in the vicinity of Mud Lake and Happy Valley-Goose Bay, including the stability of the Mud Lake Crossing. Image acquisition will be based on recommendations made following the analysis conducted during the Project construction phase, and analysis will be completed as described for the construction period. Results will be reported annually as described above.

9.1.4 Follow-up Program

A final Follow-up and Monitoring Report will be generated based on compilation of information as discussed in the following subsections.

9.1.4.1 *Follow-up*

The Follow-up portion of the report will include the collation of all data related to ice formation in relation to the Mud Lake Crossing and ashkui locations collected during the pre-construction and construction periods, and during operations. The report will consider the data and discuss the effects observed in relation to the predictions made in the EIS in relation to the Mud Lake Crossing (i.e., a delay in freeze-up suitable for ice crossing formation by two weeks and delay in ice break-up by one week).

The data collected in relation to ashkui locations will immediately be provided to the avifauna surveyors for their use in completing the Waterfowl-Ashkui Surveys. The ashkui

Ice Formation Environmental Effects Monitoring Plan		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	24

data will be reported and discussed in the Avifauna Follow-up and Monitoring Report in relation to the Waterfowl-Ashkui Surveys.

9.1.4.2 Monitoring

The Monitoring portion of the report will summarize mitigation efforts undertaken and demonstrate that mitigation measures to minimize the Project’s adverse environmental effects on the Mud Lake Crossing were implemented appropriately. A subsection to address Compliance Monitoring will be included to ensure Project compliance with commitments made in the EIS, the responses the LCP provided to the information requests, and conditions of EA release. In the case that significant changes to ice formation downstream are observed and considered attributable to the MF Project, the LCP will consider mitigation options as per LCP’s adaptive management approach.

9.1.4.3 Contingency Plan

At this time, contingency plans are not anticipated in relation to ice formation at the Mud Lake Crossing and any changes to the LCP’s procedures or mitigation plans would be addressed through the adaptive management approach, if and as appropriate. The LCP is anticipating that the ice thickness and stability of the Mud Lake Crossing will be maintained for safe use during the winter season during Project operations, and therefore it will not be necessary for the LCP to provide or arrange for alternate means of transportation across the Churchill River. Any changes proposed by the LCP would be based on the findings of the Follow-up and Monitoring Programs.

If any effects are attributable to the Project, contingencies will be provided through alternate ground routes such as snowmobile trails or helicopter as deemed necessary.

LCP ICE FORMATION ENVIRONMENTAL EFFECTS MONITORING PLAN

LCP ICE FORMATION ENVIRONMENTAL EFFECTS MONITORING PLAN		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	25

10 SUMMARY

Table 10-1 Summary of the Ice Formation Environmental Effects Monitoring Plan

Survey Type	Objective	Location	Timing	Frequency	Contingency
Data Collection during Construction					
Aerial Ice Observation – Ice Formation Period (Note: this survey has been ongoing since the fall of 2010)	<ul style="list-style-type: none"> To observe the progression of the ice front during ice formation and identify the timing of ice formation suitable for the Mud Lake Crossing 	<ul style="list-style-type: none"> Between Muskrat Falls and Mud Lake 	<ul style="list-style-type: none"> Once annually in fall/early winter (November to December) 	<ul style="list-style-type: none"> Over a multi-day period in fall 	<ul style="list-style-type: none"> Communication with the Mud Lake Improvement Committee
Aerial Ice Observation – Ice Breakup Period (Note: this survey has been ongoing since the fall of 2010)	<ul style="list-style-type: none"> To identify the timing of ice break-up and when the Mud Lake Crossing is no longer viable To identify location and size of ashkui for Waterfowl-Ashkui Survey 	<ul style="list-style-type: none"> Between Muskrat Falls and Mud Lake 	<ul style="list-style-type: none"> Once annually in late winter/spring (mid- April to mid-June) 	<ul style="list-style-type: none"> Over a multi-day period in spring 	<ul style="list-style-type: none"> Communication with the Mud Lake Improvement Committee
Ice Measurements at Mud Lake	<ul style="list-style-type: none"> To characterize the ice composition and evaluate ice conditions at the Mud Lake Crossing based on measuring ice thickness and taking and visually analyzing ice cores. 	<ul style="list-style-type: none"> At the Mud Lake Crossing 	<ul style="list-style-type: none"> During the ice crossing season (November-December to April-June) 	<ul style="list-style-type: none"> Beginning when a stable ice crossing is obtained and bi-weekly while there are safe ice conditions on which to work 	<ul style="list-style-type: none"> Communication with the Mud Lake Improvement Committee

LCP ICE FORMATION ENVIRONMENTAL EFFECTS MONITORING PLAN

LCP ICE FORMATION ENVIRONMENTAL EFFECTS MONITORING PLAN		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	26

Survey Type	Objective	Location	Timing	Frequency	Contingency
Data Collection during Operations					
Aerial Ice Observation – Ice Formation Period	<ul style="list-style-type: none"> To observe the progression of the ice front during ice formation and identify the timing of ice formation suitable for the Mud Lake Crossing 	<ul style="list-style-type: none"> Between Muskrat Falls and Mud Lake 	<ul style="list-style-type: none"> Once annually in fall/early winter (November to December) 	<ul style="list-style-type: none"> Over a multi-day period in fall 	<ul style="list-style-type: none"> Communication with the Mud Lake Improvement Committee Provide alternate means of transportation if the time the residents are unable to cross the river exceeds two weeks.
Aerial Ice Observation – Ice Breakup Period	<ul style="list-style-type: none"> To identify the timing of ice break-up and when the Mud Lake Crossing is no longer viable To identify location and size of ashkui for Waterfowl-Ashkui Survey 	<ul style="list-style-type: none"> Between Muskrat Falls and Mud Lake 	<ul style="list-style-type: none"> Once annually in late winter/spring (mid-April to mid-June) 	<ul style="list-style-type: none"> Over a multi-day period in spring 	<ul style="list-style-type: none"> Communication with the Mud Lake Improvement Committee Provide alternate means of transportation if the time the residents are unable to cross the river exceeds two weeks.
Ground Level Ice Measurements at Mud Lake	<ul style="list-style-type: none"> To characterize the ice composition and evaluate ice conditions at the Mud Lake Crossing based on measuring ice thickness and taking and analyzing ice cores. 	<ul style="list-style-type: none"> At the Mud Lake Crossing 	<ul style="list-style-type: none"> During the ice crossing season (November-December to April-June) 	<ul style="list-style-type: none"> Beginning when a stable ice crossing is obtained and bi-weekly while there are safe ice conditions on which to work 	<ul style="list-style-type: none"> Communication with the Mud Lake Improvement Committee

LCP ICE FORMATION ENVIRONMENTAL EFFECTS MONITORING PLAN

Nalcor Doc. No.

Revision

Page

MFA-PT-MD-0000-EV-PL-0003-01

B3

27

Survey Type	Objective	Location	Timing	Frequency	Contingency
Data Collection during Operations					
Satellite Imagery Ice Monitoring	<ul style="list-style-type: none"> To analyze satellite imagery to monitor the formation and break-up of ice along the Lower Churchill River (to better understand the ice formation along the Lower Churchill River post-impoundment) 	<ul style="list-style-type: none"> Lower Churchill River from Muskrat Falls and Mud Lake 	<ul style="list-style-type: none"> During the Ice Formation (November to Decent) and ice break-up (mid-April to mid-June) periods for the first five years of operations 	<ul style="list-style-type: none"> Analyses of 60 satellite images over the period from ice formation to the ice break-up 	
Follow-up					
	<ul style="list-style-type: none"> Verify EIS predictions on the Project effects on the Mud Lake Crossing (i.e., delay in freeze-up suitable for ice road formation by two weeks and delay in ice break-up by one week) 	<ul style="list-style-type: none"> Mud Lake Lower Churchill River watershed (ashkui) 	<ul style="list-style-type: none"> Interim Report following construction; Final Report after first five years of operations 	<ul style="list-style-type: none"> One report post-construction; one report following five years of operations 	<ul style="list-style-type: none"> Communication with the Mud Lake Improvement Committee
Monitoring					
	<ul style="list-style-type: none"> Verify compliance to commitments during Project construction and operations 	<ul style="list-style-type: none"> Mud Lake Lower Churchill River watershed (ashkui) 	<ul style="list-style-type: none"> Ice surveys through construction and early operations; Interim Report following construction; Final Report after first five years of operations 	<ul style="list-style-type: none"> On-going 	<ul style="list-style-type: none"> Communication with the Mud Lake Improvement Committee

LCP ICE FORMATION ENVIRONMENTAL EFFECTS MONITORING PLAN		
Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	28

11 EXTERNAL REFERENCES

Environment Canada. 2002. The Ashkui Project: Understanding the Landscape of Labrador from Innu and Scientific Perspectives. Available at:
http://www.atl.ec.gc.ca/conservation/ashkui_e.html.

Gorsebrook Research Institute. 2001. The Ashkui Project Symposium Knowledge, Culture and the Innu Landscape; A multidisciplinary symposium sponsored by The Gorsebrook Research Institute, the Innu Nation, and Environment Canada. Held in conjunction with the Canadian Polar Commission January 25, 2001 In association with The Arctic Research Committee, Saint Mary's University & The Treaty and Aboriginal Rights Research Centre, Truro NS.

Hatch Ltd., Jacques Whitford, Minaskuat Limited Partnership, Innu Environmental Limited Partnership 2007. Hydroelectric Generation Project Environmental Baseline Report: Ice Dynamics of the Lower Churchill River, October 17, 2007. Prepared for Newfoundland and Labrador Hydro, St. John's, NL.

Hatch Ltd. 2008. Further Clarification and Updating of the 2007 Ice Dynamics Report. November 2008. Prepared for Newfoundland and Labrador Hydro, St. John's, NL.

Hatch Ltd. 2010a. Effect of the Lower Churchill Project on the Mud Lake Winter Crossing. Presentation by Amy Pryse-Phillips, Hatch Limited, February 15, 2010.

Hatch Ltd. 2010b. WTO GI1075 - Mud Lake Freeze-up Observation Final Report June 30, 2010.

Innu Nation. 2009. Innu Kaishitshissenitak Mishta-shipu (Innu Environmental Knowledge of the Mishta-shipu (Churchill River) Area of Labrador in Relation to the Proposed Lower Churchill Project). Report of the work of the Innu Traditional knowledge Committee prepared by Wolverine & Associates, Inc. for Innu Nation.

JRP (Joint Review Panel). 2009. Information Responses: Lower Churchill Hydroelectric Generation, CEEA Reference No. 07-05-26178. Joint Review Panel Report, Volume 2 IR# JRP.45 to JRP.75, October 2009.

JRP. 2011. Lower Churchill Hydroelectric Generation, Joint Review Panel Report, August 2011.

Minaskuat Inc. 2009. Current Land and Resource Use in the Lower Churchill River Area. Report prepared for the Lower Churchill Hydroelectric Generation Project.

Nalcor (Nalcor Energy). 2009a. Lower Churchill Hydroelectric Generation Project Environmental Impact Statement.

LCP ICE FORMATION ENVIRONMENTAL EFFECTS MONITORING PLAN

Nalcor Doc. No.	Revision	Page
MFA-PT-MD-0000-EV-PL-0003-01	B3	29

Nalcor. 2009b. Lower Churchill Hydroelectric Generation Project. A description of the proposed project and its potential effects on the environment. Plain Language Summary.

Nalcor. 2013. Lower Churchill Hydroelectric Generation Project Avifauna Protection and Environmental Effects Monitoring Plan (LCP-PT-MD-0000-EV-PL-0004-01), May 24, 2013.

Newfoundland Department of Environment and Conservation (NLDEC). 2013. Mud Lake WebCam. Accessed at http://www.env.gov.nl.ca/wrmd/ADRS/v6/Template_Station.asp?station=NLENCL0004.

SNC Lavalin Inc. 2012a. Lower Churchill Project Component 1: Review of Ice Study Work, March 26, 2012.

SNC Lavalin Inc. 2012b. Lower Churchill Project 2011-2012 Ice Observation Program Final Report, October 1, 2012.

Weber, F., Nixon, D. and Hurley, J. 2003. Semi-automated classification of river ice types on the Peace River using RADRASAT-1 Synthetic Aperture Radar (SAR) imagery. Can. J. Civ. Eng. 30: 11-27.