2022 Annual Report for the Navigable Waters Protection Act Authorization 8200-2013-700011-001e

Revision	Release / Revision Date	Revision Description	Prepared By	Approved By
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REVISION LOG

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1.0 PURPOSE

This 2022 Annual Report includes information requested by Transport Canada as part of the Navigable Waters Protection Act Authorization No. 8200-2013-700011-001, and as outlined in Section 11 of the Navigation Mitigation & Monitoring Plan (NMMP). This report is prepared annually and includes a description of environmental effects monitoring and follow up monitoring and associated reporting conducted during impoundment and the first five years of operations on various aspects related to navigation on the lower Churchill River. This is the fourth year of this report being issued.

2.0 BACKGROUND

The creation of the reservoir will have significant impacts to the current river system of the lower Churchill River. The changes are described below.

2.1 ICE FORMATION

The change from a river-based system to a reservoir will have an impact on the thermal regime of the lower Churchill River as it is changed to a deeper, low-velocity reservoir system. The reservoir system will store heat and release warmer water, which results in a time lag and reduction in the variability of water temperatures.
The two primary environmental effects of the Project on the thermal regime will be the introduction of a time lag and a reduction in the variability of water temperatures. The reservoir will form a stable ice cover; however, it is predicted that there will be a 2-week lag delay in the cool down period for ice formation on the reservoirs. It is also predicted that the freeze-up period will also be delayed by two weeks while the ice-break update would occur one week later downstream of the Muskrat Falls facility. This will result in a 1-week increase in the open water season downstream of Muskrat Falls.
Downstream of the reservoir, the start of ice progression from Goose Bay to Muskrat Falls is anticipated to be delayed in the post-impoundment scenario by approximately two weeks.

2.2 CHANGE FROM RIVER TO RESERVOIR SYSTEM

The construction and operation of the dam at Muskrat Falls will change the existing river system into a reservoir system that will be less variable in velocity such as steadies and rapids. Within the reservoir, water velocity will be reduced, and a laminar flow will occur over most of the created reservoir. None of the existing rapids will exist once the dam is operational. The Muskrat Falls reservoir will be relatively slow moving as compared to its current state.

2.3 DOWNSTREAM CHANGES

The Muskrat Falls facility is predicted to intercept Total Suspended Solids (TSS) coming from upstream areas causing the downstream areas to have reduced TSS. The reduction in TSS downstream of Muskrat Falls could lead to increased scour and may induce a shift from the present mildly braided river to a deeper, more consolidated meandering river channel.

The creation of a deeper, more consolidated channel may have navigational impacts on the residents of Mud Lake. There will be reduction of TSS migrating downstream as the reservoir system stabilizes, however, this will likely lead to a new equilibrium of erosion and deposition downstream of the Muskrat Falls facility. A deeper, more consolidated channel will remain navigable but may potentially result in a change in the current navigational patterns.

3.0 EFFECTS MONITORING

To confirm predictions and ensure successful mitigation of the impacts to navigation, monitoring will be conducted. Monitoring will occur through several programs as outlined below.

3.1 ICE SURVEY PROGRAM

An Ice Survey Program monitoring the formation and break up periods of the lower Churchill River has been occurring since 2013 and will continue for five years into operations. Information from this survey program will be useful to inform residents and river users of potential hazards and navigational impacts. The Ice Formation Environmental Effects Monitoring Plan contains the details regarding this program and is available on the Project website. Table 3-1 provides a list of ice survey program reports and a link to their location on muskratfalls.nalcorenergy.com

Table 3-1: Ice Formation Environmental Effects Monitoring Plan and Reports

Report Title	Website Link to Report
LCP Ice Formation Environmental Effects Monitoring Plan	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2018/03/LCP-Ice-Formation-Environmental-Effects-Monitoring-Plan.pdf

Report Title	Website Link to Report
2013/2014 Ice Observation Survey Mud Lake Crossing, Lower Churchill River	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2015/02/2013-14-Ice-Observation-Survey_Mud-Lake-Crossing_REPORT.pdf https://muskratfalls.nalcorenergy.com/wp-content/uploads/2015/02/2013-14-Ice-Observation-Survey_Mud-Lake-Crossing_APPENDIX-A-C.pdf https://muskratfalls.nalcorenergy.com/wp-content/uploads/2015/02/2013-14-Ice-Observation-Survey_Mud-Lake-Crossing_APPENDIX-D.pdf https://muskratfalls.nalcorenergy.com/wp-content/uploads/2015/02/2013-14-Ice-Observation-Survey_Mud-Lake-Crossing_APPENDIX-E-G.pdf
2014/2015 Ice Observation Survey Mud Lake Crossing, Lower Churchill River	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2014/08/ice-2014-15_Web_Report.pdf https://muskratfalls.nalcorenergy.com/wp-content/uploads/2014/08/Ice-2014-15_Web_Report-Appendices-Reduced.pdf
2015/2016 Ice Observation Survey Mud Lake Crossing, Lower Churchill River	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2014/08/2015-2016-Ice-Observation-Survey-V2.pdf
2016/2017 Ice Observation Survey Mud Lake Crossing, Lower Churchill River	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2018/10/2016-2017-Ice-Observation-Survey-1.pdf https://muskratfalls.nalcorenergy.com/wp-content/uploads/2017/10/Appendix-A.pdf https://muskratfalls.nalcorenergy.com/wp-content/uploads/2017/10/Appendix-B.pdf
2017/2018 Ice Observation Survey Mud Lake Crossing, Lower Churchill River	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2018/11/2017-2018-Ice-Observation-Survey-Mud-Lake-Crossing-Lower-Churchill-River.pdf https://muskratfalls.nalcorenergy.com/wp-content/uploads/2018/11/2017-2018-Ice-Observation-Survey-Mud-Lake-Crossing-Lower-Churchill-River-Appendix-A.pdf

Report Title	Website Link to Report
	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2018/11/2017-2018-Ice-Observation-Survey-Mud-Lake-Crossing-Lower-Churchill-River-Appendix-B.pdf
2018/2019 Ice Observation Survey Mud Lake Crossing, Lower Churchill River	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2020/02/Ice-Observation-Program-2018-2019-Final-Report_compressed.pdf
2019/2020 Ice Observation Survey Mud Lake Crossing, Lower Churchill River	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2020/09/2019-2020-Ice-Observation-Survey-Mud-Lake-Crossing.pdf
2020/2021 Ice Observation Survey Mud Lake Crossing, Lower Churchill River	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2021/11/Golder-Nalcor-Ice-Surveys-Lower-Churchill-River-2020-2021_REV_A.pdf
Lower Churchill River Ice Thickness Survey from Helicopter-mounted Ground Penetration Radar – Interim Report	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2018/03/Lower-Churchill-River-ice-thickness-survey-from-helicopter-mounted-GPR-Interim-Report_.pdf
Lower Churchill River Ice Thickness Survey from Helicopter-mounted Ground Penetration Radar – Final Report	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2018/11/Lower-Churchill-River-Ice-Thickness-Survey-from-Helicopter-mounted-Ground-Penetrating-Radar.pdf
2021-2022 Ice Formation Environmental Effects Monitoring Study, Lower Churchill River	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2022/11/Ice-Surveys-Lower-Churchill-River-2021-2022-Final-8-11-2022.pdf

3.2 AQUATIC ENVIRONMENTAL EFFECTS MONITORING PROGRAM

Following completion of the Muskrat Falls facility, sedimentation and erosion in the reach downstream of Muskrat Falls will be altered. The Aquatic Environmental Effects Monitoring (EEM) Program focusses on the effects downstream of Muskrat Falls, including bottom scour and shoreline erosion. Bathymetric mapping will also be used to monitor bottom scour, as well as indicate areas of slumping below Muskrat Falls. Table 3-2 provides a list of annual aquatic EEM reports that can be found at muskratfalls.nalcorenergy.com

Table 3-2: Aquatic Environmental Effects Monitoring Program Plan and Reports

Report Title	Website Link to Report
LCP Aquatic Environmental Effects Monitoring Plan	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2014/08/Aquatic-Environmental-Effects-Monitoring-Plan_Jul2014.pdf https://muskratfalls.nalcorenergy.com/wp-content/uploads/2014/08/Aquatic-EEMP_Addendum-to-Figure-2.20.pdf https://muskratfalls.nalcorenergy.com/wp-content/uploads/2014/08/2016-Addendum-Aquatic-EEMP.pdf
Aquatic Environmental Effects Monitoring Program, 1998 to 2012 Baseline Conditions, Muskrat Falls	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2013/03/Aquatic-Environmental-Effects-Monitoring-Program_1998-2012-Baseline-Conditions-MF_Report.pdf https://muskratfalls.nalcorenergy.com/wp-content/uploads/2013/03/Aquatic-Environmental-Effects-Monitoring-Program_1998-2012-Baseline-Conditions-MF_Appendices-A-G.pdf https://muskratfalls.nalcorenergy.com/wp-content/uploads/2013/03/Aquatic-Environmental-Effects-Monitoring-Program_1998-2012-Baseline-Conditions-MF_Appendix-H.pdf https://muskratfalls.nalcorenergy.com/wp-content/uploads/2013/03/Aquatic-Environmental-Effects-Monitoring-Program_1998-2012-Baseline-Conditions-MF_Appendices-I-J.pdf

Report Title	Website Link to Report
Aquatic Environmental Effects Monitoring Program, 1998 to 2013 Baseline Conditions, Muskrat Falls	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2014/08/Aquatic-EE-Monitoring-Program_1998-2013-Baseline-Conditions-MF.pdf
Aquatic Environmental Effects Monitoring Program, 1998 to 2014 Baseline Conditions, Muskrat Falls	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2014/08/Aquatic-EEMP_1998-2014-Baseline-Conditions-Muskrat-Falls_Sept2015.pdf
Aquatic Environmental Effects Monitoring Program, 1998 to 2015 Baseline Conditions, Muskrat Falls	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2014/08/LCP-AM-CD-9112-EV-RP-0007-01_2015-EEM-Baseline_Web.pdf
Aquatic Environmental Effects Monitoring Program, 1998 to 2016 Baseline Conditions, Muskrat Falls	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2018/02/Aquatic-Environmental-Effects-Monitoring-Program-1998-2016-Baseline-Conditions-Muskrat-Falls.pdf
Aquatic Environmental Effects Monitoring Program, 1998 to 2017 Baseline Conditions, Muskrat Falls	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2019/03/003-Part-A.pdf https://muskratfalls.nalcorenergy.com/wp-content/uploads/2019/03/003-Part-B.pdf https://muskratfalls.nalcorenergy.com/wp-content/uploads/2019/03/003-Part-C.pdf
Muskrat Falls Aquatic Environmental Effects Monitoring Program, 2018 Annual Data Report	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2019/04/TF13104119.1000-2018-EEM-Annual-Report-March-29-2019-Final.pdf
Muskrat Falls Aquatic Environmental Effects Monitoring Program, 2019 Annual Data Report	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2020/11/MF-Aquatic-EEP-2019-Monitoring-Report_Oct-2020.pdf
Muskrat Falls Aquatic Environmental Effects Monitoring Program, 2020 Annual Data Report	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2021/12/TF13104119.6600-2020-EEM-Annual-Report-10-25-2021.pdf
Muskrat Falls Project Aquatic Environmental Effects Monitoring Program 2021 Monitoring Report	https://muskratfalls.nalcorenergy.com/wp-content/uploads/2022/08/ME2110401.1000-2021-EEM-Annual-Report-final.pdf

3.3 STICK-UP ZONES

As presented in the 2020 Annual Report, stick-up zone locations were identified and quantified to determine the potential effects on navigation. Appendix A provides a map of the stick-up zones in the Muskrat Falls Reservoir. Zones were defined as follows:

Nearshore Steep – Areas where the trees were close to shore (no more than 10m but typically approximately 5m) and along steep shorelines. There does not appear to be any navigation hazard beyond that approximately 10m zone near the shore.

Nearshore Extended – Areas of shallower shoreline and where the stick ups extended beyond 10m from the shoreline. Even though they were out from the shoreline up to 50-100 m, it was apparent what shoreline they were associated with (there were stickups more or less throughout the area between the outer extent and the shoreline). They would be more of a navigation hazard throughout as it might not be obvious where the stickups were located.

Offshore – Areas of stickups that were not easily associated with either shoreline. There were not any areas where stickups "lead" to one shore or the other. These zones were more like "islands" of stickups with no clear safe path around them (one side of the stickups could be safe/unsafe as the other based on visual evidence upon approach).

3.4 DEBRIS MANAGEMENT

During the inundation of the reservoir, debris such as branches, may be disturbed and float to the surface, causing obstructions for boaters. Debris will be estimated, and an analysis conducted to determine overall navigational effects. Also, an evaluation of debris management activities and methods, such as specialized marine and land equipment to collect debris, will be conducted.

The seasonal debris boom was deployed on June 14, 2022 after peak spring flood and ice out and it was removed on October 26, 2022. Debris accumulation upstream of the Muskrat Falls facility has been significantly less than expected. Roughly 203 cubic meters were removed from the reservoir in 2022.

Monitoring of the reservoir began in October 2020, annually; observations of debris were logged during bi-weekly helicopter or boat surveys of the reservoir between Grizzle Falls and Muskrat Falls in conjunction with another monitoring program. During these surveys no debris was observed.

3.5 NAVIGATION AROUND FACILITY

A portage trail was constructed on the north bank around the Muskrat Falls facility to allow river users to safely navigate around the facility; signage was installed in three languages at various locations on the North Spur (see Figure 3-1). The portage route is being maintained during operations, and a floating safety boom is deployed across the river to guide vessels to the upstream portage access point and to prevent further downstream progress. The safety boom is installed annually after spring breakup and removed each fall prior to freeze up.

Figure 3-1: Portage signage installed in various locations along the North Spur

3.6 DOWNSTREAM CHANGES

The Aquatic EEMP, as described in Section 3.2, monitors parameters such as flow, velocity, sedimentation and erosion to determine if the downstream effects of the Muskrat Falls facility will significantly affect navigation. Table 3-2 provides a list of the relevant reports and a link to the muskratfalls.nalcorenergy.com website where the plan and reports are available.

4.0 ABREVIATIONS AND ACRONYMS

EA – Environmental Assessment

EIS –Environmental Impact Statement

EEMP – Environmental Effects Monitoring Plan

FSL – Full Supply Level (Reservoir; in metres of elevation)

JRP – Joint Review Panel

LCP – Lower Churchill Project

LSL – Low Supply Level (Reservoir; in metres of elevation)

NMMP – Navigation Mitigation and Monitoring Plan

NWPP – Navigable Waters Protection Program

NWPA *– Navigable Waters Protection Act*

TC – Transport Canada

TSS – Total Suspended Solids

5.0 REFERNECES

Minaskuat. 2009. *Land and Resource Use Baseline Report*.

Nalcor. 2009a *Lower Churchill Hydroelectric Generation Project Environmental Impact Statement – Volume 2A*

Nalcor. 2009b *Reservoir Preparation*. Information request No.148, JRP.

Nalcor. 2009c *Navigation*. Information request No.34, JRP.

Nalcor. 2009d *Navigation (Operation)*. Information request No.36 JRP.

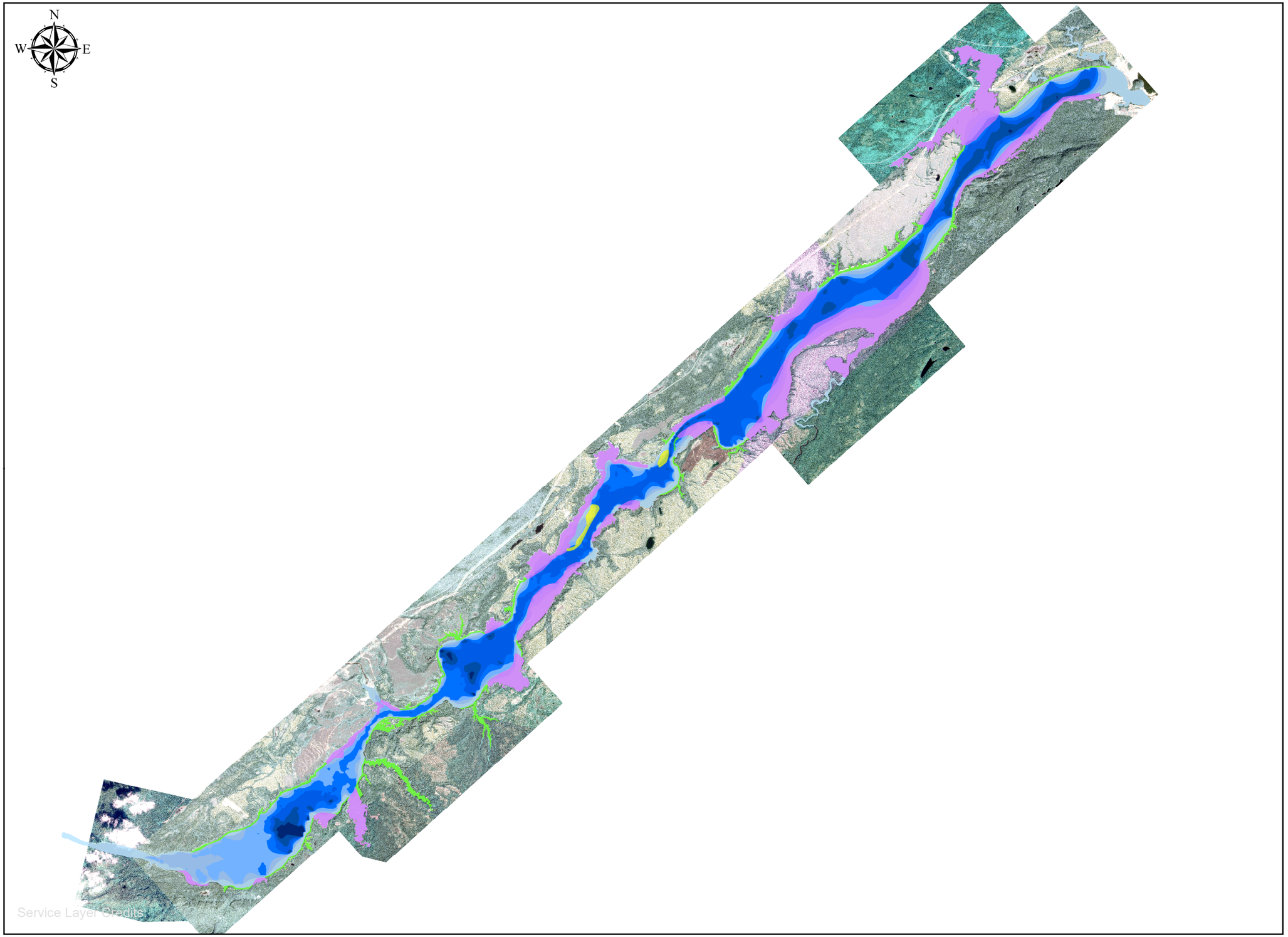
Nalcor. 2009e *Land and Resource Use – Access*. Information request No.72, JRP.

Nalcor. 2014 *Navigation Mitigation and Monitoring Plan.*

Transport Canada, *Technical Analysis of the EIS and Additional Information Documents.* February 21, 2011. Ces

Appendix A

Stick-Up Zones in the Muskrat Falls Reservoir



LEGEND:

- Nearshore Steep
- Nearshore Extended
- Offshore

Bathymetry (m)

0

-45

CLIENT: nalcor energy

wood.

TITLE:

STICK UP ZONE IN CHURCHILL RESERVOIR

PROJECT:

2020 FISH HABITAT COMPENSATION PLAN

PROJECT NO:	DATE:
TF13104119	**MARCH 2021**
REV NO: **0**	DWN BY/CHK'D BY: **JA/JM**
DATUM: **NAD83 CSRS 2010**	PROJECTION: **UTM ZONE 20 N**

FIGURE:

FIGURE 1

SCALE:

0 0.75 1.5 3 4.5 6

Kilometres

Path: E:\Jim\2021\TF13104119_Bathymetry_Stickup_March2021.mxd User: juanita.abbott Date: 3/24/2021