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Government of Newfoundland and Labrador
Office of the Premier
P.O. Box 8700, St. John's NL,
Canada, A1B 4J6

Attention: Premier Dwight Ball, MHA, Humber-Gros Morne

Subject: Muskrat Falls Development

Dear Premier Ball,

Following our meeting held in St. John's on July 26th, 2017 and your letter dated July 28th, 2017, I reviewed with my colleagues the main aspects related to the drawdown of the reservoir during construction and your concerns regarding our recommendations related to potential landslides and generated landslide waves. We believe that the elements presented below will provide you with the necessary information to understand our position and will explain the main technical aspects to be considered for the Project. We are providing you this information within the context of our contractual relationship with Lower Churchill Management Corporation.

Risk of landslide along the Lower Churchill

There is a natural risk of landslides on the Churchill River between Gull Island and Muskrat Falls and also downstream from Muskrat Falls. Small landslides, without any consequence, are observed once in a while along the river. AMEC was mandated by Nalcor to review the situation and, in their 2011 report, they noted evidence of twenty-six (26) major historical landslides along the river, between km 33.7 and km 101. The last major landslide observed was in February 2010 at Edwards Island, prior to the construction of Muskrat Falls, about 30 km upstream of the Project site. Another landslide was observed in the winter 1978-79 downstream of Muskrat Falls. The formation of the major ice jam observed every year downstream of Muskrat Falls could have been one factor triggering the latter landslide due to the erosion of the toe of the riverbank.

It is noteworthy to mention that due to the lack of information on soil stratigraphy and ground water condition in each slope along the river, it is not possible to predict or to evaluate the probability with a significant confidence level that a landslide would occur along the river. However, we are able to identify factors that increase the risk of landslides, such as:

- Heavy rainfall;
- Erosion of the toe of the riverbank due to ice, flow velocity and waves;

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- Rapid lowering of the reservoir level, particularly when the riverbanks are saturated as is the case now after the river levels have been held at higher levels for a significant period.

The Project has no control on the rainfall on the area, however it can have some influence on the last two conditions mentioned above. Regarding the ice erosion, the raising of the water level at elevation 25 m, enables the build-up of ice cover upstream from the Project site in order to avoid the ice jam downstream and in consequence this will reduce the risk of landslides in the downstream area. Meanwhile, keeping a constant water level at the head pond with the ice cover upstream from the cofferdam is also meant to minimize erosion of the adjacent riverbanks.

With regard to the lowering of the reservoir, we note that in natural conditions, the lowering of the river level does occur after a flood period. However, floods occur in a relatively short duration and the riverbanks do not generally have time to become fully saturated, as opposed to the actual situation where the high water level was held stable for a lengthy period and riverbanks have had time to reach their saturation levels. Furthermore the decrease of the water level after a flood is gradual. During the construction period, since the water level is controlled by the spillway, there is an ability to control the water level, hence the variation can be much faster or very gradual, depending on how much one lets water pass through the spillway gates. For environmental and landslide issues, we recommend to minimize the drawdown of the head pond and maintain water elevation at a more or less constant elevation during the spring and summer months in order to minimise the potential risk of instability along the riverbanks.

After commissioning of the Project, i.e. when the water level will reach the full supply level (el. 39 m), superficial landslides may occur occasionally in the reservoir until stable conditions will be reached. This is a normal phenomenon that can be seen on most projects.

Temporary diversion during construction – Water level at the head pond

During the construction of the Project, one of the main objectives consists of avoiding an ice jam downstream from the Project site and possible site flooding during winter time. To do so, ice studies have shown that the water level should be raised to elevation 25 m during the winter season to promote the formation of the ice cover between Gull Lake and Muskrat Falls and to stop the frazil ice generated upstream from the site. In spring and summer conditions, it was recommended to keep the water level at elevation 24 m. The transition between these two elevations will be done gradually and to minimize rapid variation of the water level.

The proposed approach minimizes the environmental impacts as well as the risk of landslides, and potential landslide generated waves from reaching the Project site. Numerical studies have shown that the Project site is protected by a river bend and the "Rock Knoll" (left abutment of the North Dam), but that landslide generated waves could nevertheless increase the water level at the Project site; these levels of water were taken into account in the design to protect the Project structures.

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Specific answers to your questions raised in your July 28th letter are presented hereafter:

1. *"In light of your comments on the current state of the river and potential change in circumstances, do all of the elements in your above-noted correspondence still apply today? If not, what has changed"?*

The main objectives of the Project related to water management during the construction remain unchanged.

The control of the water level, by raising the head pond level to build a stable upstream ice cover, is a key aspect to avoid an ice jam on the downstream side of the Project site.

Other key aspects for minimizing fluctuations of the head pond level are to reduce the environmental impact on the newly submerged habitats and not to increase the risk of instability along the riverbanks, which could provoke landslides along the river.

During the winter of 2016-2017 the water elevation never reached 25 m, because of the problems observed at the cofferdam in November 2016. However, if the Project progresses as planned next winter, the Project will raise the water level to elevation 25 m to build the ice cover upstream. The water level will subsequently be drawn down gradually to a level which will enable grouting works at the dam in spring 2018 and in consideration of any particular constraints related to the cofferdam. This would be in line with all the technical aspects mentioned above and to help safeguard the public and all persons involved in this Project. Slight modifications to alter the water management plan may occur depending on the conditions observed at site, but modifications will always take into consideration the same principles.

2. *"If the risks are as you say they may be, why did you recommend for Nalcor to lower water levels in November 2016 by 8 metres in a matter of days after having flagged it as a risk just a month prior"?*

The raising of the water level in the head pond started in October 2016. In November 2016, when the water level had reached elevation 22.5 m, a small slip occurred at the upstream face of the cofferdam and a few occurrences of rapid increase of seepage through the cofferdam were also observed. In light of this situation and upon evaluating options, it was decided to rapidly lower the water level at the head pond down to the natural conditions (i.e. the water elevation at the cofferdam was about 14.5 m (mid-pool) and 17.5 m upstream of the Upper Muskrat Falls).

It is important to note that this decision was made to minimize the imminent threat of further damage to the cofferdam and to allow time to investigate the situation and apply corrective measures to stabilise, monitor and strengthen the affected areas. It is also noteworthy to mention that the process of raising the water level at the head pond had only started less than a month before the drawdown, and riverbanks would not have had time to fully become saturated by that time. In this case, the situation was similar to a spring flood conditions and the river banks did not have time to be fully saturated before the rapid lowering of the water level. As a result, with the benefit of these facts, we believe that the risk of landslides did not increase significantly at that time.

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Understandably, the drawdown was not planned, but it was a result of controlling an imminent threat at the cofferdam which was the correct decision at the time under that specific circumstance, as maintaining the levels would have resulted in consequences having a more negative impact on the Project.

3. *"Had you been advising government directly in October 2016, what would your advice have been with respect to lowering water levels vis-a-vis the risk of landslides"?*

At that time, we would have advised the government that a natural risk of landslide exists along the riverbanks. The probability of such landslides however small it may be, should be minimised where at all possible as the Project does not want to increase this risk of what could be an unnecessary and potentially costly disruption to the works during the construction period and after commissioning. In an effort not to increase the risk of landslide during construction, the Project recommends keeping the water level as constant as possible in consideration of the numerous constraints related to the Project. Should it be found necessary to lower the water level, it should be done gradually at a rate to be determined by the geotechnical specialists, unless we are facing an imminent risk whereby a more rapid rate would be favoured in the balance. Nonetheless, it is noteworthy to mention that the Project structures are designed to take into account loads and conditions that could arise from potential landslides along the riverbanks.

4. *"When water levels of the reservoir are raised to operational levels of 39 metres at project completion, what is the risk to future public safety if water levels must be quickly lowered due to an unforeseen event? Has this question been posed to you before, and if so, what was your advice at that time"?*

In the unforeseen conditions that the water level in the reservoir should be lowered quickly after reaching the operation level of 39 m, it is not expected that there would be any consequence on the safety of the public. The dam, the power house and the other control structures will be completed and have been designed for the Probable Maximum Flood that can reach elevation 45 m. Such elevation will not be reached by generated landslide waves.

It must also be pointed out that a rapid lowering of a reservoir is an exceptional event in the life of an hydroelectric project. This is not expected to happen in normal circumstances and if the reservoir should be lowered below the minimum operation level (38.5 m), it should be done gradually by increasing the discharge through the turbines.

5. *"Based on current conditions in the river, is your recommendation to immediately raise water levels back to 24-25 metres? If it is not your present recommendation, when should it occur"?*

For reasons beyond our control, it was decided to lower the water level of the head pond and this has been carried out in stages and under observation over the last few months down to its present elevation (i.e. from 21.50 m down to approximately 20.30 m).

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It is at this level of approximately 20.30 m, that some indicative signs of potential instability were observed during aerial inspection monitoring along the river, which was being carried out twice a week. For this reason, it was deemed prudent to stop the drawdown and maintain this level, while continuing to carrying out inspections to monitor the riverbanks and especially the area where the indicative signs were of concern. Since the situation is stable at the moment, we recommend to maintain the present water level until it is time to start raising the water level for the installation of the ice boom and subsequently for the formation of the desired ice cover upstream to control the ice jam. Typically the water level in the head pond should follow the recommended approach presented hereafter until summer 2018:

- Raising of the water level at the end of August 2017 or in early September 2017 to reach elevation 21.5 m for the installation of ice boom upstream of the cofferdam.
- Raising of the water level to elevation to promote the formation of an ice cover (i.e. target elevation 25 m). This elevation should be reached by late November 2017.
- Maintain the water level at target elevation until ice cover formation.
- Gradually reduce the water level to perform grouting works at Main Dam during spring-summer 2018.

Water elevation in fall and winter 2018-2019 will generally be kept 25m or higher, subject to the progress of the Project. Finally, the water level will ultimately reach elevation 39 m at impoundment.

Taking into account the problems observed at the cofferdam last year, we will be monitoring its behaviour during the raising of the water level to elevation 25 m this fall. If, from observations at that time, we should find it necessary to modify the above plan, we will work with LCMC to consider alternative plans to prioritise the safety of the workers and the public at that time.

I trust that the above provides the clarifications you are seeking and wish to reassure you that we remain steadfast in our commitment within our mandate to support LCMC to have the Project completed in a safe manner for both workers and the public.

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