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E.C. (Ted) Swabey
City Manager
City of Nanaimo
455 Wallace Street
Nanaimo BC V9R 5J6

Dear Mr. Swabey:

Re: Middle Chase River Dam and Lower Chase River Dam – Potential Safety Hazards

Thank you for your letter dated January 27, 2015 requesting an extension to our deadline of February 27, 2015 for the City of Nanaimo (the City) to prepare a revised plan that identifies and prioritizes the actions required to correct the potential safety hazards of both Middle Chase River (Middle) Dam and Lower Chase River (Lower) Dam. Thank you also for your letter dated February 6, 2015 outlining Council decision regarding mitigation of Middle and Lower Dams.

We are sorry to hear about a Councillor having a serious medical condition and hence the need to request an extension to our previous deadline. We wish him all the best in his recovery.

The City is to be commended for having gathered extensive information and undertaken many studies on Middle and Lower Dams to better determine the risks and to narrow down the options for remediation. Unfortunately it is not clear to us from Council's motion of February 2, 2015 what the City intends to do to address the potential safety hazards identified by City engineering consultants, Golder Associates (Golder), with respect to Middle and Lower Dams.

According to City and Golder documents available on the City's website, Golder was retained by the City to be technical advisor to the Colliery Dam Technical Committee (TC). The TC's mandate was to identify an environmentally minimally invasive, cost and time effective



remediation solution for the Colliery (Middle and Lower) Dam system that meets safety standards, among other things. The mandate also included the development of a permanent solution that would be put in place in 2014, if possible, but not later than 2015, with shorter term mitigation put in place, if required, in 2014.

Over the course of a year, Golder undertook a number of studies and produced several reports on the Colliery Dams, Nanaimo, BC including:

- Dam Stability (July 25, 2014);
- Risk Assessment (July 25, 2014);
- Hydrology, Hydraulics and Middle Dam Breach Analysis (July 25, 2014);
- Report on Dam Remediation Options (August 29, 2014);
- Consequence Classification (November 21, 2014); and,
- Auxiliary Spillway - Conceptual Design (January 16, 2015).

It should be noted that Golder's focus was on the remediation of Lower Dam only as they determined Middle and Lower Dams act together as a system, with primarily Lower Dam controlling downstream consequences. For this reason, Golder determined that the remediation of Lower Dam would provide greatest reduction in risk to those living downstream of the dams, and remediation of this dam should be given highest priority. Golder indicated, in its report, Dam Remediation Options (August 29, 2014), that the remediation of the Middle Dam would be addressed separately at a later date.

At no time has Golder suggested that Middle and Lower Dam were reasonably safe and that nothing needed to be done. Golder's work, through the TC, was undertaken on the understanding that Lower Dam would be remediated. Its Risk Assessment Report states "*This risk assessment has been carried out based on the assumption that the Lower Dam is remediated to increase flood routing capacity...*" (pg i, Executive Summary, Report on Colliery Dams, Nanaimo, BC Risk Assessment, Golder, July 25, 2014).

Further, Golder's Hydrology, Hydraulics and Middle Dam Breach Analysis (July 25, 2014) states (pg i, Executive Summary):

"These calculations have determined that the spillway for the Middle Dam has the capacity to convey the flows associated with approximately the 50-year (2% annual exceedance probability) rainfall event. Storms larger than the 50-year overtop the dam embankment. The spillway for the Lower Dam has the capacity to convey the flows associated with approximately the 25-year (4% annual exceedance probability) rainfall event. Storms larger than the 25-year overtop the dam embankment."

At these spillway capacities, neither Middle nor Lower Dam come close to meeting the annual exceedance probability target levels for floods for high and very high failure consequence classification dams as provided by the Canadian Dam Association (CDA) and accepted as general practice in the Province of BC. These target levels are available in Table 6-1B, Dam Safety Guidelines 2007 (2013 Edition), Canadian Dam Association (pg 64) and have been attached for your reference. Further, the Canadian Dam Association states: *“The ability to safely route floods through a reservoir system is of paramount importance for dam safety”* and goes on to provide design and operating points for flow control structures (including spillways) (pg 67, Dam Safety Guidelines 2007 (2013 Edition), Canadian Dam Association). Insufficient flood routing capacity is considered a potential safety hazard in British Columbia.

Golder recommends three dam remediation requirements for the Lower Dam, one which includes increasing the flood routing capacity to the target level given by the CDA. With respect to flood routing capacity, Golder states (pg 17, Colliery Dams, Nanaimo, BC, Report on Dam Remediation Options, Golder, August 29, 2014):

“...the risk of dam collapse due to flood events is significant and must be addressed by dam remediation to improve flood routing characteristics of the dam. The required flood routing capacity is given by the Table 6.1 CDA Guidelines, and is based on the Consequence Classification of the dam. For a Very High consequence dam, the dam must be able to pass a flood at least the equivalent of 2/3 of the way between a 1000 year and a PMF flood...”

In its Dam Remediation Options Report (August 29, 2014) and its Auxiliary Spillway Conceptual Design Report (January 16, 2015), Golder provided the City with three options that would appropriately remediate the Lower Dam so that runoff from larger storm events could be accommodated. One other option, dam removal (with or without replacement), was presented in a report commissioned by the City: Conceptual Costing of Rehabilitation and Replacement Options, Klohn Crippen Berger (April 30, 2013). The proposed (a) labyrinth spillway, (b) surface hardening of the dam, (c) auxiliary spillway, and (d) removal, are all viable options for reducing the risk posed by the undersized spillway for the Lower Dam.

Given these extensive studies and identification of viable options, the City now has the necessary information for a decision to be made for the remediation of Lower Dam. Once Lower Dam remediation has been completed, further studies and development of options for the remediation of Middle Dam may be required.

The City's consultant reports have been carefully reviewed by Ministry staff and we are in agreement with Golder's analysis that the Middle and Lower Dam spillways are undersized with insufficient flood routing capacity. Therefore, section 7.1 of the BC Dam Safety Regulation still applies to both Middle and Lower Dams with respect to potential safety hazards, and the City must undertake the following steps:

- Select an option for remediation of Lower Dam;
- Prepare and submit to this office, a revised plan that clearly identifies and prioritizes all actions required to correct the potential safety hazard with Lower Dam. The plan must outline the timeline for taking those actions that will address the recommended dam remediation requirements, as described by Golder, within a reasonably expeditious time frame;
- Prepare and submit to this office, a revised conceptual plan that identifies and prioritizes any actions required to correct the potential safety hazard with Middle Dam, along with a timeline for taking those actions within a reasonably expeditious time frame, timed to follow after completion of actions to correct the potential safety hazard with Lower Dam; and,
- Implement both revised plans, based on the priorities identified in the plans, within a reasonably expeditious time frame and in accordance with section 4 of the BC Dam Safety Regulation, as applicable to any alteration, improvement or replacement to all or any part of a dam intended to correct a potential safety hazard and which must be implemented in a timely manner.

As per your request, a one month extension for the City to submit the revised plans (described above and required under section 7.1 of the BC Dam Safety Regulation) has been granted to no later than 4 pm, March 27, 2015.

For your information, failure to comply with the BC Dam Safety Regulation is potentially an offence under the *Water Act*. Such failure may result in compliance and enforcement action being taken, which could include: an Order to drain the reservoir (s. 88(1)(j), *Water Act*); possible charges under the *Water Act* (s.93, *Water Act*); or possible initiation of proceedings to suspend or cancel your water licences (C61424 and C61423) (s. 23, *Water Act*).

Please be reminded that the failure consequence classification of Middle Dam has been lowered from 'extreme' to 'high' and the failure consequence classification of Lower Dam has been lowered to 'very high' based on Golder's assessments and reports but only if remediation of Lower Dam has been completed. Increasing flood flow capacity at Lower Dam reduces the probability that the Lower Dam will breach following from the cascade effect of a Middle Dam breach. Acceptance of the proposed failure consequence classification was based on the

understanding that the flood flow routing capacity of Lower Dam would be increased this year (2015), as outlined in Golder's remediation options and consistent with the TC's mandate. Should remediation of Lower Dam not occur this year, the failure consequence classification of Middle Dam will be assessed 'very high'.

In summary, the City's engineering consultant, Golder has determined that inflow floods from large storms will overtop both Middle and Lower Dam as both have undersized spillways. Golder has also determined that the risk of dam collapse is significant and must be addressed by dam remediation to improve flood routing characteristics of the dam. Insufficient flood routing capacity is considered a potential safety hazard. The City has completed numerous studies and now has sufficient information and options to make an informed decision on the course of action required to correct this potential safety hazard and bring the dams into compliance with the BC Dam Safety Regulation for the protection of public safety and the environment.

In the circumstances, the emergency evacuation signs in the community below the dams must remain until the potential safety hazards at the dams have been addressed. This was an agreed upon interim emergency measure taken in the fall of 2013, which must continue until the City has addressed these hazards.

To repeat, a revised plan for City action with an outline of a timeline for required steps to be taken to address these issues within a reasonably expeditious time frame, as described above, must be submitted to this office no later than 4 pm, March 27, 2015. Failure to comply may result in compliance and enforcement action being taken against the City.

Yours truly,



Glen Davidson, P.Eng.
Comptroller of Water Rights

pc: T. Seward, A/General Manager, Social & Protective Services, City of Nanaimo
Scott Morgan, Head, Dam Safety Section, Water Management Branch, FLNR, Victoria
John Baldwin, Dam Safety Officer, Regional Operations, FLNR, Nanaimo

Attachments:

1. Flood and Earthquake Hazards, Standards-Based Assessments. Table 6-1B, Dam Safety Guidelines 2007 (2013 Edition), Canadian Dam Association, page 64.

Table 6-1B: Flood and Earthquake Hazards, Standards-Based Assessments
(Target Levels for Initial Consideration and Consultation between Owner and Regulator)

2013
Revision

Dam Class [note 1]	Annual Exceedance Probability Floods [note 2]	Annual Exceedance Probability Earthquakes [note 3]
Low	1/100	1/100
Significant	Between 1/100 and 1/1000 [note 4]	Between 1/100 and 1/1000
High	1/3 between 1/1000 and PMF [note 5]	1/2475 [note 6]
Very High	2/3 between 1/1000 and PMF [note 5]	1/2 between 1/2475 [note 6] and 1/10,000 or MCE [note 5]
Extreme	PMF [note 5]	1/10,000 or MCE [note 5]
<p>This table addresses two major natural hazards only, and does not consider the many other types of hazard that must be considered in dam safety assessments.</p>		
<p>Acronyms: PMF, probable maximum flood; AEP, annual exceedance probability; MCE, maximum credible earthquake</p>		
<p>Note 1. As defined in Table 2-1, Dam Classification (Section 2.5.4)</p>		
<p>Note 2. Simple extrapolation of flood statistics beyond 10^{-3} AEP is not acceptable.</p>		
<p>Note 3. Mean values of the estimated range in AEP levels for earthquakes should be used. The earthquake(s) with the AEP as defined in Table 6-1B is then input as the contributory earthquake(s) to develop the Earthquake Design Ground Motion (EDGM) parameters as described in Section 6.5 of these guidelines.</p>		
<p>Note 4. Selected on basis of incremental flood analysis, exposure, and consequences of failure</p>		
<p>Note 5. PMF and MCE have no associated AEP.</p>		
<p>Note 6. This level has been selected for consistency with seismic design levels given in the National Building Code of Canada.</p>		