

**CONFIDENTIAL MINUTES**  
**COLLIERY DAMS TECHNICAL COMMITTEE**  
**TUESDAY, 2014-JAN-21 AT 10:30 A.M.**  
**BOARD ROOM, SERVICE & RESOURCE CENTRE, 411 DUNSMUIR STREET**

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**PRESENT:**

*Golder Associates:*

Herb Hawson, Director of Special Projects  
Bruce Downing, Principal  
Dr. Bill Roberds, Principal, Decision & Risk Analysis

*City of Nanaimo:*

Toby Seward, Director, Social & Protective Services  
Holly Pirozzini, Recording Secretary

*(Provincial) Dam Safety Section:*

Glen Davidson, Director, Water Management Branch  
Scott Morgan, Head, Dam Safety Section  
Bruce O'Neill, Senior Dam Safety Engineer, Dam Safety Section

*Executive Committee:*

Paul Silvey, Snuneymuxw First Nation  
Ted Swabey, City of Nanaimo (left meeting at noon. Returned for recommendations portion)

Katherine Gordon, Facilitator

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1. Call to Order

The meeting was called to order at 10:30 a.m.

The facilitator asked all present to introduce themselves.

The agenda was reviewed and approved.

CDPPS requested a discussion on external communication and expressed concerns about the message the community is receiving from the City, which may be confusing and making people unnecessarily fearful. The credibility of the process is being questioned. The Technical Committee needs to put out the message to the community that there are measures being taken, Golder Associates (GA) is involved and there is collaboration to reach a successful outcome.

Facilitator – The Committee has heard that CDPPS believes the community may have concerns about the credibility of the Technical Committee's process (spending time on working towards remediation, but not spending time on getting the information out about what we are doing). It was suggested that this issue be deferred to the communications portion of the agenda to be discussed at tomorrow's meeting.

**Agreed: To defer the discussion on communication to the Jan. 22 meeting.**

**Agreed: To review/Approve draft Minutes (2014-Jan-09) at the Jan. 22 meeting.**

**Agreed: To allow Colliery Dam Park Preservation Society (CDPPS) to record Dr. Bill Roberds' risk assessment presentation provided it remain confidential to the Committee.**

2. Golder Presentation and Q & A from Committee

GA provided a ppt presentation on their findings to date and stated that this is a progress update that will not include conclusions [**a copy of this presentation has been provided to the Committee**]. The information presented represents GA's current understanding and is possibly subject to review and change. The presentation included: data review findings; data gaps and design unknowns; and the dam system. It was noted that no as-built drawings for the dams exist.

- Update on review of documents/information provided

Reviewed Middle Dam findings:

Comment: A concern was raised about disturbing the current fill and the potential downstream effects.

Question: There is material in left and right abutment and there appears to be bedrock on both sides upstream, but at which point does the material protrude to the left side? GA responded that the material was left to support the spillway walls. For many years there was no fill on either side; just a wall. It is unknown when the wall was constructed and when the fill was added on either side. Geophysics will help us determine the bedrock and till foundations.

Question: Does the wall appear to be thickening towards the base? GA responded that this is unknown because no construction report has been received from the engineer.

Question: Was seepage reduced dramatically over the past 10 years due to improvements such as seepage monitoring and installation of pipes, therefore decreasing the flow? GA responded "yes" in the last 10 years, but there was a general increase in flow up to 1993.

GA stated that they were unable to confirm that the Lower Level Outlet (LLO) pipe at the base was black cast iron in the Middle Dam as proposed in 2013 anecdotal information (email from Solomon Hunter 2014-Jan-05).

Reviewed Lower Dam findings:

GA stated that it would be useful to receive samples of core reinforcement.

Question: What is the logic behind placing loose fill in 1918? GA responded that the purpose was for construction of a railway over the dam and to have an adequate surface for the tracks.

GA compared performance of the concrete dam core for both dams and stated that there are much smaller deformations, a thicker concrete wall, and a higher buttress on

the Lower Dam, than on the Middle Dam. Toppling or shearing in the Middle Dam is more likely during a seismic event. Cracking of the concrete core for both dams requires further study. The most important question is how the concrete was structurally engineered.

GA identified data gaps, design unknowns and dam core issues for both the Middle and Lower Dams.

Question: Will excavation impact the downstream and fisheries habitat / ecology? GA stated that this will be answered later when conceptual design options for stabilization are discussed in today's presentation.

GA stated that it has reviewed the Hydrology Study, conducted by Water Management Consultants in 2002, and noticed inconsistencies in curve numbers, lag times and baseflows. These will need to be refined, as well as accounting for upstream hydraulic structures/storage and verification of basin delineations (Powerline Dam). GA recommended further study of spillway hydraulics to verify rating curves for the Middle and Lower Dams, as well as verification of the Lower Dam's hydraulic jump caused by convergence and the consequences of the jump on the Lower Dam. Spillways may be undersized, but not to the extent first thought which translates to overtopping and breaching predictions.

Question: What is a hydraulic jump? GA responded that it is a wave at the channel that could jump right over a wall.

Question: Are flows accurate from previous analysis? GA responded that an answer can be provided in two weeks when the soil has been studied.

GA stated that no further hydrologist study has occurred since 2002. It is unknown whether a hydraulic jump has been observed in the field in the Lower Dam spillway.

Question: What is the timeline for the further hydrology and spillway hydraulics (H&H) studies? GA responded that a hydrology study will occur in the next two weeks and then a spillway hydraulics study will begin in the next four weeks. The studies will be done within the February timeframe and conducted in-house. GA recommended a formal incremental damage assessment be done using updated H&H information and revised breach parameters.

- Update on additional site investigations

GA continued the ppt presentation respecting the dam system and design issues.

CDPPS advised that a study respecting Lower Dam failure was done by Associated Engineers (AE).

GA stated that the two dams act as a system. If the Middle Dam fails = Lower Dam may fail. It is known that the Middle Dam is not as robust as the Lower Dam, but it is unknown whether the Lower Dam will crack, but may not actually rupture. The biggest flood that will affect the community is an earthquake. The dams have been classified as extreme if a seismic event occurred (not based on a flood event). The reports prepared by AE indicated that classification was given due to a seismic event.

Question: Is the classification for the dams based on a seismic event? DSS responded that classification is based on the worst case scenario and in this particular case, seismic is the worst case scenario. The classification is based on consequence of worst case scenario. A risk assessment can be considered, but this may not change the classification if the worst case scenario still exists.

GA stated that both dams need to be looked at as a system; not independently. If one dam ruptures and we are able to prove that under that time-dependent release, the flood is passed safely downstream and there is no effect to the community, then there is a possibility that the dams could be placed in a lower category. We are concerned now with the interaction of the two dams.

Questions: A flood or earthquake event will affect all five dams in this system, so why were only these two dams considered in a worst case scenario for classification? Why isolate these two dams? Fundamentally, if the DSS classification of the dams is purely based on consequence, wouldn't it be more accurate to look at all five dams? Can the classification be decreased by fixing a dam upstream, so it won't affect the lower dam? DSS responded that the Lower Dam could attenuate or moderate the effect if the Middle Dam fails. There could be different classifications given to dams that are near each other. The Middle Dam consequence classification will not change because the geometry of the dam is the same. The dams cannot be put into a deterministic classification.

GA stated that the culvert underneath the Parkway is a big moderator and should be considered. CDPPS stated that the Middle and Lower Dams are both classified as extreme.

Question: If the Lower Dam can pass the flood with just a trickle and doesn't flood downstream, haven't we reduced the risk? Shouldn't the Lower Dam have a lower classification?

Question: Can the dams remain in an extreme category, with the Order removed (*"That the City of Nanaimo address the high risk imposed on the community by the existing two Colliery Dams"* 2013-May-13 Council Report). DSS responded that the dams can still remain in the extreme category even though the probability of a flood or seismic event has been lowered. Ways to change an extreme classification are to remove what is downstream or to debate the mode of failure and what factors caused the extreme rating.

Facilitator – focus of this meeting is to hear about risk assessment and remediation. With more information the Committee can have a more productive discussion on the DSS classification and the merits of seeking to have it lowered. Not enough information to determine this at the moment – could satisfy DSS requirements without changing classification because worst case scenario this remains the same.

GA advised that the classification will also not drive the risk assessment. It will drive what's acceptable. We are not taking a deterministic approach. CDPPS stated that the classification is very important to the community; if it can be reduced this will be helpful.

Facilitator – There are two issues: (1) Work of committee to come up with remediation options; and (2) Discussion about the classification. Recommend discuss risk assessment information today in order to move forward. **Agreed.**

- Presentation of risk assessment findings

GA (Dr. Bill Roberds) provided a ppt presentation respecting risk assessment findings **[a copy of this presentation has been provided to the Committee]**. The process is to conduct risk assessment to appropriately evaluate potential performance (rather than worst-case scenario) of any plan, as per recent Dam Safety Guidelines. The risk assessment is a performance model that translates inputs into outputs, taking into consideration uncertainties, then quantifying the uncertainty in terms of probability and finally assessing the probability objectively or subjectively. Ten risk inputs were discussed, as well as various hypothetical example outputs. The risk model will use outcomes to do a probabilistic analysis to run simulation sequences.

Each of the following risk inputs need to be assessed:

- Precipitation/hydrology/reservoir inflow
- Seismic load
- Dam failure/breach/overtopping of either or both Middle and Lower Dams
- Middle and / or Lower Dam release
- Downstream inundation and consequences

Thousands of scenarios need to be run to determine a cumulative distribution for the number of casualties. Begin with a status quo and then change the inputs. Some outcomes will be acceptable, but will have a cost benefit question. Regulators have to determine if the outcomes are reasonable or require adjustment one way or the other. The risk assessment will consider seismic events and all factors and their uncertainties.

Question: Where do the numbers used for a deterministic approach appear on the probability distribution graph [Societal Safety Criteria (ref. CDA, 2013)]? GA responded that they land in the “unacceptable” portion (above the blue line), but that is a very conservative approach and doesn’t consider all factors.

GA stated that the risk assessment approach allows you to measure options that give you value for your money when designing. Some of the key ways to reduce the risk is to reduce the inundation consequence (remove people) or reduce the release from the Lower Dam. The goal is to reduce the risk to get to the acceptable level between the red and blue lines on the graph. We will begin with a subjective assessment using existing data and some uncertainty to produce an initial risk assessment. We will present the current status quo using current data and use collective judgement/consensus (among those with knowledge on this issue) to come up with options.

Question: Can the dam be maintained to a certain level or height of the existing bedrock? GA responded “yes” this is an option, but every option will affect another factor and then this changes the risk.

CDPPS stated that the biggest concern about the inundation study is that it is very subjective (not based on a lot of data to qualify it), so a risk assessment model will be more acceptable.

Question: What are the risk assessment timelines and where will GA be in the process by the end of February? GA responded that they hope to have some risk assessment data on the status quo and options by the end of February, depending on subjective input after holding an in-house technical risk assessment workshop.

CoN stated that the goal is Feb. 28 to determine options to allow some of the work to be done this year within the fisheries window. GA responded that it is unclear where the inundation model runs will be by that date.

Question: Can the work be done this year if the dams are designed to fit as low a level as is reasonably practical (just below the blue line on the graph)? GA responded that they will have a better idea after the risk assessment and the hydrology study are completed.

**Agreed: GA to put Associated Eng (AE) on notice that their services will be required to conduct a hydrology study.**

GA stated that tables of outputs will be required from AE.

Question: Who owns the model and is it two dimensional? CoN will inquire about access/ownership and report back to the Committee.

SFN expressed concern that the risk assessment is only addressing downstream damage to people and properties, and that fisheries is a significant item that needs to be included. GA stated that the previous analysis focussed on the number of casualties and financial impacts, but fisheries and the environment will be included in their assessment. DSS stated that consideration of impacts to environmental and fisheries are included in their regulations and that if these aren't addressed the consequence rating may not change even if public safety issues are addressed.

Question: Should the perceived contaminated soil be removed now or later because it will be affected by overtopping in flooding? GA responded that this will be addressed in the next portion of the presentation.

- Presentation of potential remediation options

GA continued the ppt presentation respecting initial conceptual ideas – increase flood routing capacity options.

GA discussed various options for allowing overtopping of the dam and reinforcement of the downstream face, as well as increasing the spillway capacity. The Allu mass stabilization method was discussed, which improves soft soils, remediates contaminated soils and improves/utilizes clean and contaminated soft sediments. The binder (cement, lime, etc.) is mixed to the treated soil using an Allu PMX power mixer attached to an excavator. The result is to significantly improve the strength and deformation properties. Geocells and concrete blocks are laid with grass on top for aesthetics. The Allu “blender” method has become more common in recent years.

GA discussed other stabilization options for the Middle and Lower Dams by adding buttresses upstream or installing additional barriers (liner); however installing a liner

will create disturbance/sludge in the dams. There may be three or four solutions where cost vs risk. The focus has been primarily on the Lower Dam.

Question: Should Alliance Engineering be contacted to do any work, as they are located on Vancouver Island? CDPPS were asked to consider this company and whether their services may be needed.

Facilitator – Reminded the Committee that it had determined that a permanent solution needs to be identified in 2014, if possible. Any short term measures need to be mindful of the permanent option to ensure they are consistent and cost-effective.

Next Steps - Additional Information:

GA continued the ppt presentation and stated that existing information has been collected and re-evaluated. They have completed the geophysical survey on the surface of the downstream and cores of both dams. They are assessing the need for any additional geotechnical information.

Question: Has the information been received? GA responded “yes” we have received concrete values from Lewkowich Eng., which have been passed onto Herold Eng.

Question: Will borehole investigations on the Middle Dam determine whether any work needs to be done on the Middle Dam? GA responded that the main focus has been on the Lower Dam and that boreholes can be done on the Middle Dam at a later date, which will confirm whether any work is required. Geopenetrating Radar (GPR) and geophysics surveys have been carried out on the Middle Dam.

Question: Who will be participating in the initial GA risk assessment workshop? GA responded that Herold Eng, AE, and GA technical authorities and that the workshop will be held in Vancouver. CoN suggested including DSS in this workshop. CDPPS suggested that members of the Committee may want to attend for information.

GA stated that risk modelling could be discussed by the end of February.

Question: Will it be possible to report to Council by the end of February? GA asked if they are expected to do a presentation to Council by the end of February. CoN responded that GA is not required to do a presentation to Council. The Committee will make recommendations to the Executive Committee.

It was noted that there are a number of other things that need to be considered in due course, such as regulatory bodies, permits, and DFO involvement.

**Agreed: To discuss this issue at tomorrow’s meeting.**

Question: When the cascade is eliminated, will each body of water be assessed individually? DSS responded that there is no relationship; each dam is reviewed in isolation.

Questions: If we can deal with the cascade on the Lower Dam then will the Lower Dam determine the classification? If we make the Lower Dam safe from any form of failure then its failure will be the one that has the greatest affect on the inundation area. If the Middle Dam fails, then the Lower Dam can contain some of the water and

mitigate the effect of it or pass it, so the Lower Dam is the dam that needs to be designed to handle it. DSS responded that they can't say there is no relationship between the two dams. Also need to consider simultaneous failure of both the Middle and Lower Dams.

CoN stated that we could improve only the design for the Lower Dam so that both dams would not fail simultaneously because the Lower Dam will be stronger.

DSS stated that the possibility of cascading failure can't be eliminated because we need to look at the consequences of a failure and how the Lower Dam will respond if the Middle Dam fails.

Question: Would DSS be receptive to GA's approach of addressing the Lower Dam first and then the Middle Dam, if required? DSS responded "yes" this is an acceptable approach.

Question: Is there anything we are missing that hasn't been discussed today with DSS? DSS responded that today's presentation is going in the right direction. This is the first time discussing a risk assessment approach, but they are receptive to the Committee having this discussion.

Questions: Is DSS aware of other situations whereby sirens and signs have been used as they are in Nanaimo? How does the City's emergency preparedness plan for the dams affect how many deaths would occur? DSS responded that there are no clear guidelines on the number of signs or sirens required. The City has done several things to reduce the number of potential fatalities, but the consequence has not changed.

Question: DSS responded that there are many communities in BC with dams that have extreme classification with thousands of people residing downstream, but the risk has been lowered because of improvements made to dam structures over the years.

### Recommendations for next steps

GA recommended the following:

- further studies be conducted for hydrology and spillway hydraulics;
- evaluation of dam breach characteristics;
- seismic analysis;
- evaluation of other failure modes;
- updated inundation modeling;
- updated damage assessment;
- risk assessment; and
- develop design (dam remediation) options.

### 3. Agenda for 2014-Jan-22 – Objectives/Additions

The agenda for tomorrow's meeting was reviewed and the following item was added:

- External communication



4. Conclusion:

The meeting concluded at 4:20 p.m.