**BC Hydro, WAC Bennett Dam, Expert Engineering Panel, Report – Executive Summary**

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The Expert Engineering Panel (EEP) was appointed to examine the information available on the history and performance of WAC Bennett Dam and make an independent interpretation of its seepage control functions. The EEP was also asked to determine if further work is required to decide if a reactive or proactive approach should be taken to remedial work at the dam. The members of the EEP were Dr. Kaare Hoeg (Norwegian Geotechnical Institute), Emeritus Professor Robin Fell (University of New South Wales, Australia) and Mr. Rodney Bridle (Dam Safety Ltd., United Kingdom). The EEP visited BC Hydro in Vancouver on three occasions - in February and June 2011, and in February/March 2012. Both the 2011 visits included visits to the WAC Bennett Dam site to inspect the dam and meet the dam safety staff on site and become familiar with the dam and the monitoring systems. BC Hydro provided an extensive collection of information including copies (electronic and paper) of almost all the reports and papers published, copies of instrumentation records and copies of many drawings. Much additional information was passed on in formal and informal presentations and meetings and discussions with engineers working in many roles on the dam.

*This executive summary presents the key findings and recommendations, but should be taken in the context of the greater detail given in the two volumes of the main report.*

**Summary:**

1. The dam was well designed for the time it was constructed, and the extensive construction control testing indicates it was well constructed.

2. The standard of monitoring of the dam is extremely high, and those involved clearly understand the dam and its performance.

3. The dam has a good seepage and internal erosion control system consisting of the Transition, the Filter and Drain to maintain the integrity of the dam. It may allow a small amount of future erosion at the Core/Transition interface, but from the available information, will prevent on-going erosion. There are no situations where erosion after initiation could continue unchecked. The EEP has made some suggestions for future investigations by BC Hydro to further confirm this assessment.

4. The Drain has a large capacity to discharge leaks resulting from any future internal erosion and to prevent instability of the dam. However, near the crest of the dam, the drainage capacity is less as there is no Drain, and there is no Filter in the upper part, only the Transition zone.

5. Sinkhole 1 and Sinkhole 2 (remediated in 1996) are directly related to the benchmarks, the lightly compacted Core fill around the benchmark tubes, their proximity to the canyon walls, and the irregular bedrock topography. Sinkhole 1 may also be related to its proximity to Splitter Dyke 2. Those conditions do not exist elsewhere in the dam. The instrument Risers constructed on Instrument Planes 1 and 2 for construction year 1966 have similar lightly compacted Core fill surrounding them, but there is no evidence of cavity formation or sinkhole development or other changes that give reasons for concern.

**Recommendations:**

1. The Observation Wells (OWs) are important for cross-hole seismic monitoring to identify any further loosening of the lightly compacted Core fill around the Observation Wells and the Risers. The EEP recommends that the Observation Wells be sealed on the inside by grouting, but first a small diameter casing should be installed inside the well which would allow cross-hole seismic measurements to continue. The EEP concludes that it is not warranted to try to further compact the soil surrounding the OWs.

2. The EEP concludes that it is not warranted to attempt to densify the Core surrounding the Risers, and that it is sufficient to continue to monitor by cross-hole seismic measurements at annual intervals. The ability to do cross-hole seismic measurements between Cross Arm 1 and OW2 should be restored, or a new hole drilled in the Core if the blockage of Cross Arm 1 cannot be removed.

3. The cross-hole monitoring at Instrument Plane 2 (IP2) involves a long distance between source and receiver. Because of this the velocities are dominated by Core which is not affected by the lower velocity material around the Riser. It is recommended that a new casing be installed close to the Riser area to allow readings to be obtained which give the required degree of confidence that any tendency to the development of a cavity will be detected.

4. Seismic stability investigations using the new seismic hazard assessment are needed. The upper part of the dam may be vulnerable to damage during seismic events, and there is liquefaction potential of a 50-ft deep scour hole filled with sands, gravels and boulders over the upstream third of the canyon floor.

5. The EEP notes that preparations are being made to repair the rip-rap on the upper upstream slope of the dam. This upper part of the dam may also be vulnerable to internal erosion through concentrated leaks in cracks when the reservoir level is high. The EEP recommends that the three issues, rip-rap repair, seismic resistance, and vulnerability to cracking and internal erosion be considered simultaneously to produce a solution to works at the upper part of the dam that addresses all risks there, including the risks that will arise during the construction phase.

6. The EEP recommends that the following investigations be carried out to further confirm that the filter and drain system is effective:
    a. Carry out laboratory experiments on representative samples of the Core and Transition to confirm that the Transition will in all situations arrest erosion.
    b. Carry out investigations to determine whether the Transition in the upper part of the dam may hold a crack due to high fines content and possible cementation caused by a significant content of carbonate rock.
    c. Assess the drainage capacity in the upper part of the dam to assess whether there is sufficient capacity to cope with any foreseeable concentrated leak or other internal erosion scenario.

7. The following investigations and analyses are desirable to better understand the behaviour of the dam:
    a. Complete the characterization of the dam materials and the foundation and use these data as the base properties in improved seepage analyses.
    b. Further improvement in cross-hole monitoring methodology and interpretation of measurements.
    c. Further investigate the air occlusion and ex-solution theory to explain the pore pressure development in the dam since first impoundment.
    d. Complete the 2D numerical analysis of stresses and strains in the dam, especially in the vicinity of the canyon walls and shoulders.

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