



24 January 2017

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Dear John

PEER REVIEW REPORT ON AKARANA DAM PRELIMINARY DESIGN

1.0 Introduction

This peer review has been conducted in line with the requirements of the New Zealand Society on Large Dams (NZSOLD) Dam Safety Guidelines (NZSOLD, 2015) and as requested by Environment Canterbury (ECan) in a letter dated 9th December 2016, Item 1d).

2.0 Scope of review

The scope of the review covered the review of the following:

- ✧ BCI Akarana Pond – Preliminary Design Issue 3 dated 11 August 2016, Prepared for Joint Venture between Barrhill Chertsey Irrigation Limited and Electricity Ashburton Limited by Damwatch Engineering which includes:
 - BCI Akarana Pond – Potential Impact Classification Issue 3 dated 5 August 2016, Prepared for Joint Venture between Barrhill Chertsey Irrigation Limited and Electricity Ashburton Limited by Damwatch Engineering.
 - Barrhill Chertsey Irrigation Storage Pond Geotechnical Investigation Report Issue 2 dated 4 April 2016, Prepared for Joint Venture between Barrhill Chertsey Irrigation Limited and Electricity Ashburton Limited by Damwatch Engineering.
- ✧ ECan Letter – Request for Further Information dated 8 December 2016.
- ✧ Barrhill Chertsey Irrigation Limited – Request for Further Information – Draft Letter from Damwatch Engineering dated 17 January 2017 to BCI Limited.

3.0 Assessment

The assessment had as its main objectives the following:

- ✧ Check for completeness and reliability.
- ✧ Identify any shortfalls or lack of necessary information regarding the design.
- ✧ Check the suitability of the Potential Impact Classification (PIC) for the pond.

The assessment has not included review of any modelling (stability, hydraulic or flooding) done for the preliminary design.

3.1 Issues

The assessment of the reports reviewed has identified the following issues that in our opinion require further discussion or explanation. These are discussed in the following sections.

3.1.1 Emergency Spillway

There is an inconsistency regarding the method of protection of the embankment at the emergency spillway with the preliminary design indicating HDPE lining and the Damwatch draft response to ECan's request for further information noting a reinforced grass system. It is considered prudent to select one option or the other to allow review comments to be made. Review comments relating to both options are given below:

- ✧ Issues associated with having HDPE protection at the emergency spillway relate to protection of the HDPE liner from exposure, stock and vandalism would need to be addressed in the preliminary design.
- ✧ Having a reinforced grass slope protection system would require the preliminary design to provide indicative flow and velocity parameters to review the sustainability and suitability of such a system.

A further issue that is not addressed in the preliminary design is how flow from the emergency spillway is channelled or directed as the flood assessments indicate flow against the toe of the embankment in the area of the emergency spillway. Basic details of how the embankment will be protected against erosion would need to be addressed in the preliminary design. This is covered in item 2a) of the ECan letter which is partially addressed with the Damwatch draft response to ECan's request for further information.

3.1.2 Dam Safety Management Plan

NZSOLD Dam Safety Guidelines (DSG) (NZSOLD, 2015) notes that, the dam safety management system *"should be fit for purpose and commensurate with the consequences of dam failure and the required dam performance under all loading conditions"*. The preliminary design report and appendices do not provide any information relating to the proposed dam safety management system other than noting that a dam safety management plan (DSMP) will be developed during construction. The DSMP is considered to be an integral part of the design of a dam and therefore a draft should be produced at the preliminary design stage for Medium and High PIC dams.

As noted in the DSG, *"an effective dam safety management system should adapt dynamically to change and seek to continuously improve"* and *"for new dams the dam safety management system should reflect the results of the completed investigation, design, construction and commissioning processes"*. Thus a DSMP can be expanded and updated as the detailed design is done, followed by construction, commissioning and finally operation.

It is understood from the Damwatch draft response to ECan's request for further information that a draft set of plans covering the DSMP, an emergency action plan and an emergency evacuation plan is currently being prepared but which have not yet been reviewed. In addition these plans cover the methodology for the lowering and emptying of the pond during emergency situations. The methodology proposed and summarised in the letter is considered to provide sufficient detail for resource consent evaluation and should be included in the DSMP.

3.1.3 Dam Breach Outflow Hydrographs and Flood Routing

The PIC report (Appendix B of the preliminary design report) provides Dam breach outflow hydrographs consistent with the potential dam break scenarios. The four scenarios modelled are considered to represent the range of possible breach failures and the combined flood extent defines a locus of areas that could possibly be affected by a dam breach around the perimeter of the pond.

The Damwatch draft response to ECan's request for further information has provided the depth velocity (DV) maps which clarify and visually display the information contained in Tables C.1 and C.2.

The embankment breach parameters were reviewed for the breach at the location with the greatest embankment height (location 1B). Damwatch has estimated a peak breach discharge of $588 \text{ m}^3/\text{s}$ at this location. The likely range of the breach development time and final breach base width in Table 4.2 of the Damwatch report was estimated to be 0.5 - 1.0 hours and 12-30 metres respectively. These values are based on the mid-range estimates using a range of empirical formulae. A spot check using the empirical formulae in Froehlich (2008) indicate a breach development time of 0.83 hours and a breach base width of around 21 metres which is in the middle of likely range reported by Damwatch.

Damwatch have subsequently adopted conservative values for the breach development time and final breach base width to simulate breach outflow hydrograph in Mike 11. In other words they have adopted a breach development time and breach base width that would result in the greatest peak discharge from the pond. Although the MIKE11 model has not been reviewed the resulting peak breach outflow appears realistic. Using the Froehlich (1995a) formula to estimate the peak breach outflow results in a peak breach discharge of $458 \text{ m}^3/\text{s}$. This compares to a peak breach flow of $588 \text{ m}^3/\text{s}$ as estimated by Damwatch using MIKE11. As expected the peak breach flow from Damwatch is greater than the estimate using Froehlich (1995 a) as conservative values have been adopted in their MIKE11 simulation.

To show a range of possible outflow hydrographs at location 1B Damwatch performed sensitivity testing using a range of credible breach development times and breach base widths. As noted in the S92 request from ECan the difference in peak breach discharge between the 1B base case scenario (breach development time of 0.5 hrs and breach base width of 30 metres) and 1B-S03 (sensitivity testing scenario 3) is small, $588 \text{ m}^3/\text{s}$ compared to $641 \text{ m}^3/\text{s}$. The main reason for this is that in scenario 1B-S03 the adopted breach development time remains unchanged at 0.5 hrs and the breach base width is only slightly increased from 30 to 35 metres. Although sensitivity testing is generally undertaken using a greater difference in breach base width (resulting in a greater difference in peak discharge), in this case adopting 35 metres as the upper limit for the breach base width is considered appropriate for sensitivity testing as the breach base width adopted for the 1B base case (used for flood routing) is already at the upper end of the likely range using a range of empirical formulae. The modelled peak discharges for base case 1B ($588 \text{ m}^3/\text{s}$) and sensitivity scenario 1B –S03 ($641 \text{ m}^3/\text{s}$) for a hypothetical dam breach at location 1B appear to be conservative.

3.2 Sufficient detail

Other than those areas or issues raised in the previous section the preliminary design report and appendices and the draft response from Damwatch to the request for further information, the available information is considered to contain sufficient detail in relation to the following:

- ✧ Dam type and layout
- ✧ Natural hazards – including floods, seismicity and wind and wave
- ✧ Potential failure modes
- ✧ Design considerations – including embankment details and geometry, stability assessment, freeboard, lining/seepage, embankment penetrations.

- ✧ Construction considerations
- ✧ Operation, maintenance and surveillance (portions of which would be part of the DSMP) including emergency planning and safety in design
- ✧ Potential Impact Classification
- ✧ Investigations

There are further aspects that require design however these are considered to be part of the detailed design stage of the project. These are noted in the preliminary design report and cover the following:

- ✧ Intake
- ✧ Outlet
- ✧ Control system
- ✧ Discharge measurement
- ✧ Emergency overflow spillway
- ✧ Safety in design.

4.0 Summary & Conclusions

Overall the preliminary design report and Damwatch draft response to ECan's request for further information is considered to provide sufficient information subject to the issues covered under section 3.1 of this report being satisfactorily addressed.

Subject to the identified issues being satisfactorily addressed it is the opinion of the undersigned that the information provided can be considered suitable as a preliminary design for the purposes of resource consent application.

Yours faithfully

PATTLE DELAMORE PARTNERS LIMITED

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Limitations

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This review has been conducted as a desktop review and the site has not been visited as part of the review.