Arnold Dam strengthening project

Riley is proud to support the long-term resilience of one of New Zealand's historic hydro-electric assets through the delivery of a comprehensive strengthening project designed to enhance seismic performance, improve embankment stability, and safeguard the scheme's future operation.

This project represents a major upgrade to the Arnold Hydro-Electric Power Scheme (HEPS), originally constructed between 1929 and 1932. The strengthening works were developed to modernise the dam's safety performance in line with current design standards while enabling Trustpower (now Contact Energy) to maintain generation throughout construction. The project included significant geotechnical, structural, and hydrological components, all delivered within the constraints of an operating, low-storage run-of-river scheme.

LOCATION

Arnold River, West Coast downstream of Lake Brunner

PROJECT LEAD

Paul Rivett
Project Director – Water Resources

THE CHALLENGE

The Arnold Dam exhibited several long-standing safety concerns identified through successive Comprehensive Dam Safety Reviews (CDSR). These included:

- Embankment stability risks during or after a major earthquake, particularly affecting the downstream shoulder.
- Potential for piping or internal erosion through or beneath the concrete core wall, or along interfaces with the adjacent spillway structure.
- Sensitivity to large flood events due to reliance on historic spillway gate mechanisms and uncertainty in freeboard performance.
- Complex foundation conditions comprising Blue Bottom Group rock, alluvium, and glacial outwash gravels, each with unique behavioural characteristics during seismic loading.
- Proximity to the Alpine Fault and Brunner Anticline, requiring design to withstand high-intensity ground motions.
- Limited ability to lower reservoir levels, requiring works to proceed while maintaining scheme operation.

These challenges required a carefully integrated design solution that addressed seismic performance, hydraulic safety, dam stability, and constructability.

KEY FACTS

80m long concrete-core earth embankment strengthened

Seismic design to PGA 0.34 g (OBE) and 0.62 g (SEE)

Full-height graded filter and drainage system installed

Large downstream **earthfill buttress** constructed.

Spillway retaining **structures upgraded** with new reinforced concrete walls and anchors.

Strengthening designed to allow **continued power** generation throughout construction.

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OUR APPROACH

Collaborative, multi-disciplinary design

Riley led a highly coordinated programme of geotechnical, structural, and hydrological investigations to inform a robust strengthening solution.

This work included field investigations, material characterisation, groundwater assessment, and seismic hazard review. Existing performance issues were assessed against modern dam safety requirements to refine the design objectives.

Hydrological and freeboard assessment

A complete hydrological review confirmed the required Inflow Design Flood for the scheme and assessed spillway capacity.

Recommendations were incorporated to ensure reliable freeboard performance under extreme events and to enable future improvements to spillway gate actuation systems.

Embankment and foundation strengthening

A large downstream earthfill buttress was designed to significantly improve embankment stability under both static and seismic load cases. A continuous graded filter and drainage zone extending from crest to bedrock was incorporated to eliminate piping risk and manage seepage through the dam. A rock toe was added along the interface with the spillway structure to provide additional protection.

Spillway and retaining wall upgrades

Working in partnership with specialist structural designers, Riley developed a new reinforced concrete retaining wall system to support the spillway structure and resist full design seismic loads.

The system incorporated a combination of anchored and cantilever wall types, tied back to the underlying Blue Bottom Group rock to provide resistance against sliding and overturning.

Pragmatic construction strategy

Because extensive reservoir lowering was not achievable, the strengthening works were designed to be completed while maintaining power generation.

Detailed construction staging and emergency procedures were developed to manage groundwater, foundation stability, and operational constraints during the works.

THE OUTCOME

The Arnold Dam strengthening project delivers a modern, resilient dam that meets current dam safety guidelines for a Low PIC structure. The works significantly enhance the stability of the embankment under seismic and flood loading, eliminate piping vulnerabilities, and improve the reliability of spillway and retaining structures.

By addressing all identified safety concerns and integrating long-term resilience into the scheme, the project secures the ongoing operation of the Arnold Hydro-Electric Power Scheme while preserving its historical legacy.