Åtgärder på läckande dammar i Australien

SwedCOLD

[1]

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Rohan Sutton
WSP Vattenbyggnad

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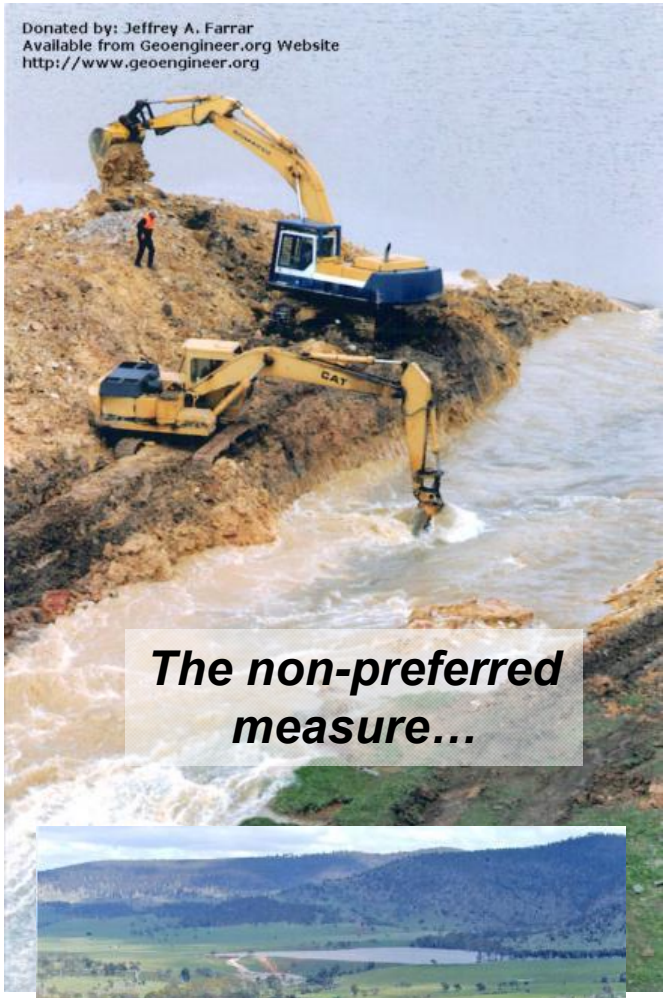
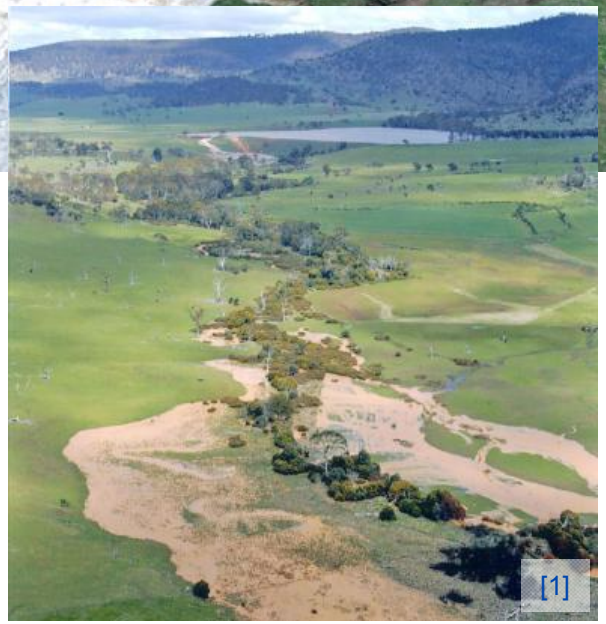




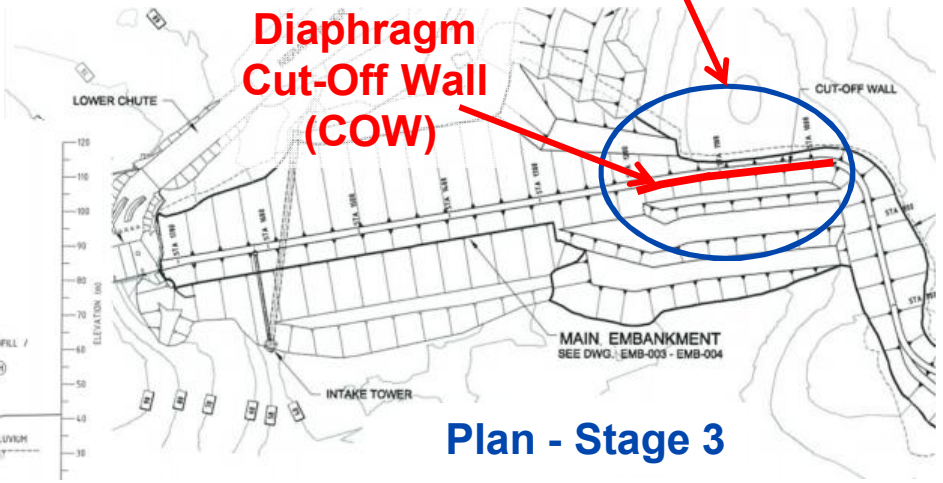
Diaphragm walls – Hinze Dam

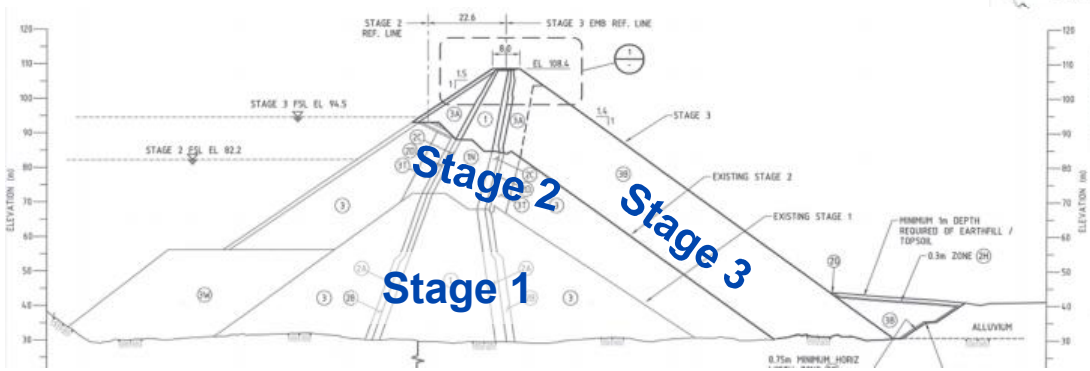
→ **Dam details**

- Zoned earth and rockfill embankment, 80m high, 1700m long, built 1976, raised 1989 (Stage 2) and again raised in 2010 (Stage 3) by 15m

→ **Major defect & failure mode**

- Complex geology on right abutment; deep weathering up to 40m deep and highly permeable
- High risk of internal erosion and piping in the right abutment foundation
- Foundation piezometric pressures impacting embankment stability

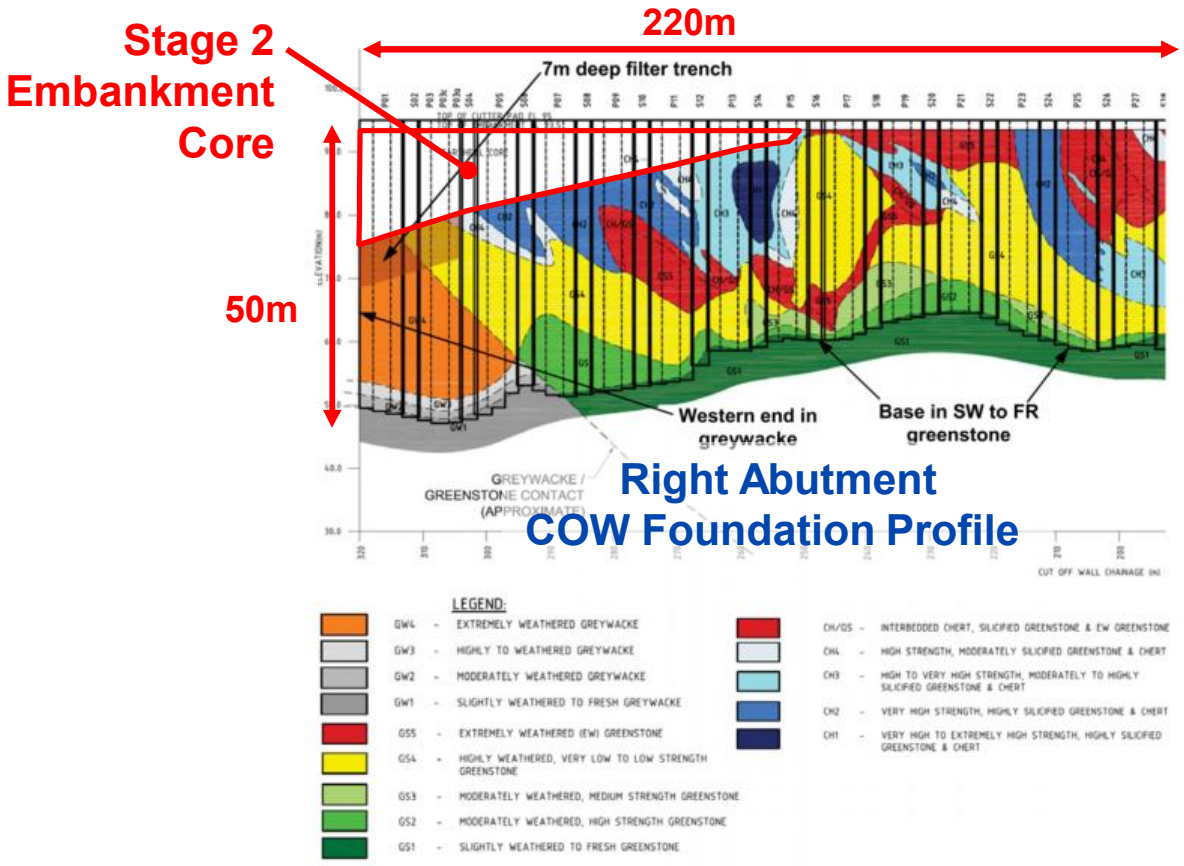




Diaphragm walls – Hinze Dam (cont.)

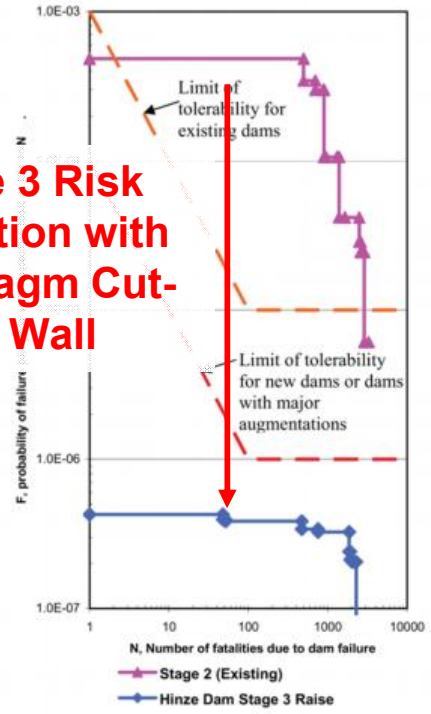
→ **Right Abutment Foundation**

- Extensive foundation grouting performed during Stage 2; does not provide an effective cut-off to seepage
- Highly varied weathering and strength (UCS up to 160MPa)
- Direct seepage connection to the reservoir through the foundation



Right Abutment COW Foundation Profile

Stage 3 Risk Reduction with Diaphragm Cut-Off Wall



Risk Assessment

Diaphragm walls – Hinze Dam (cont.)

→ **Upgrade Measure**

- 220m long and up to 53m deep Cut-Off Wall into Foundation and partly Stage 2 Embankment Core
- Cut-Off Wall Design – Plastic Concrete
  - 47 panels, 0.8m thick wall, constructed in alternating sequence of primary (7m wide) and secondary panels (2.8m wide, overcut)
- Technical requirements for plastic concrete
  - Strength between 2MPa and 4MPa
  - Ductile stress-strain properties to accommodate differential stresses and deformation without cracking
  - Low permeability (<1*10^{-9} m/s)
- Cement and bentonite concrete mix, typically 6-8hours to pour a primary panel

Tremie concrete placement

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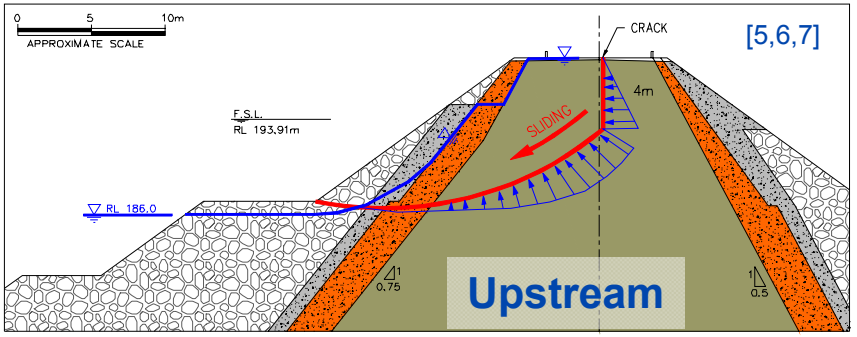
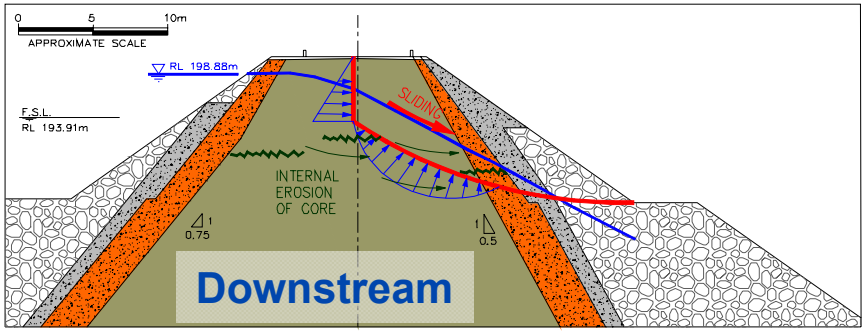
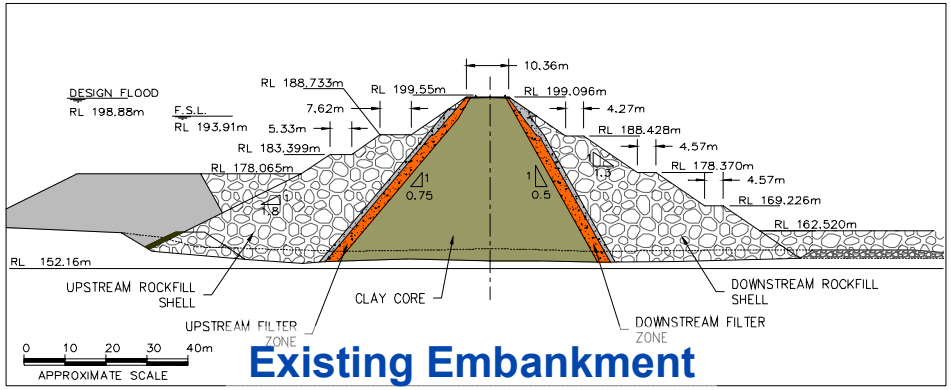
Filter Buttresses - Crest

- **Dam details**
  - Central core earth- and rockfill, 47m high, 700m long, built 1962
- **Major defect & failure mode**
  - Large differential settlement between the core and the rockfill shoulders; longitudinal cracking, water infiltration/softening of core
  - Upstream – instability
  - Downstream - instability and piping (dirty, cohesive filters)



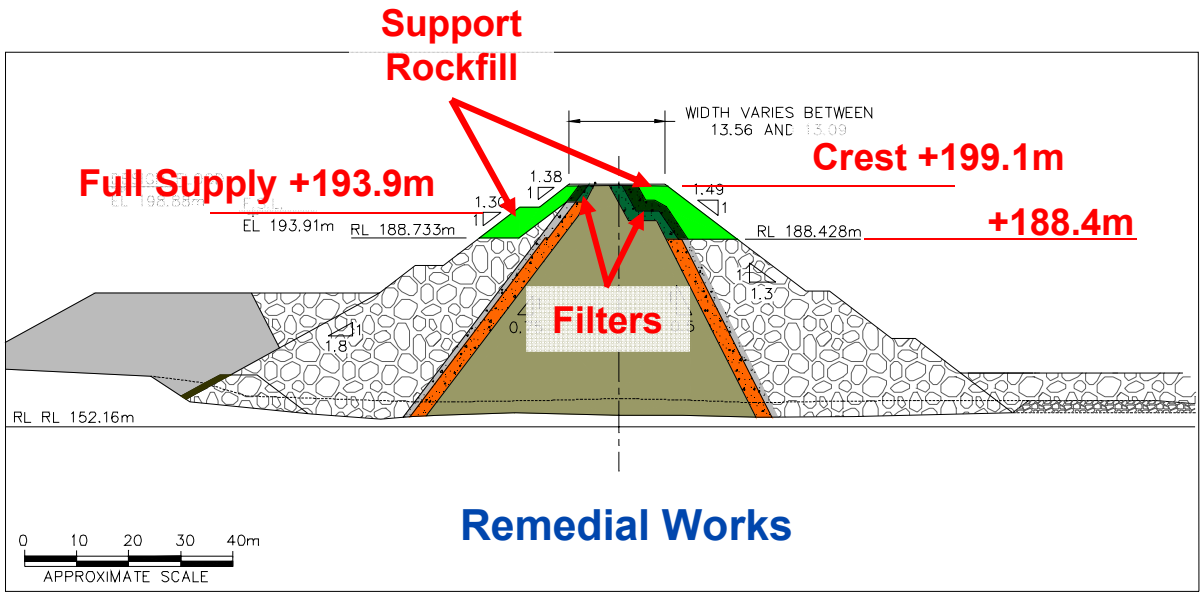




Filter Buttresses - Crest (cont.)

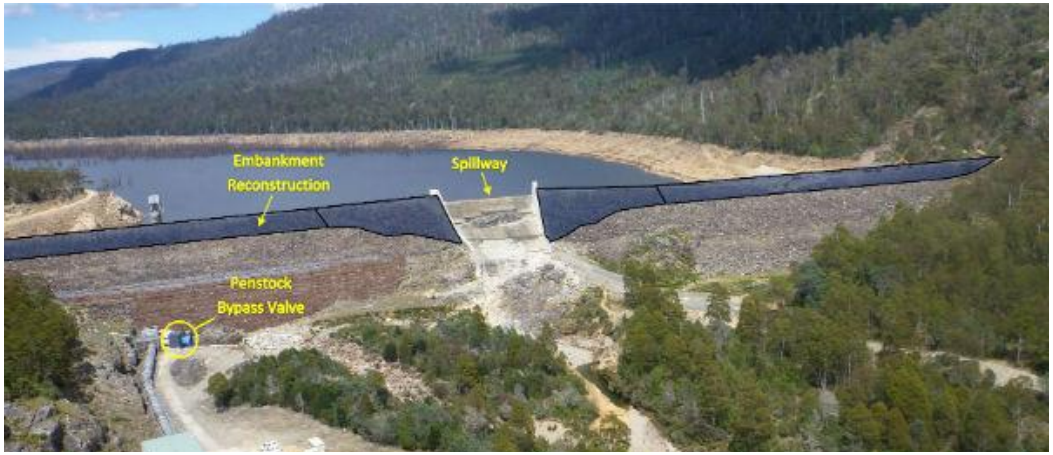
→ **Upgrade Measure**

- Re-construction of upstream and downstream upper rockfill shoulders, including new filters

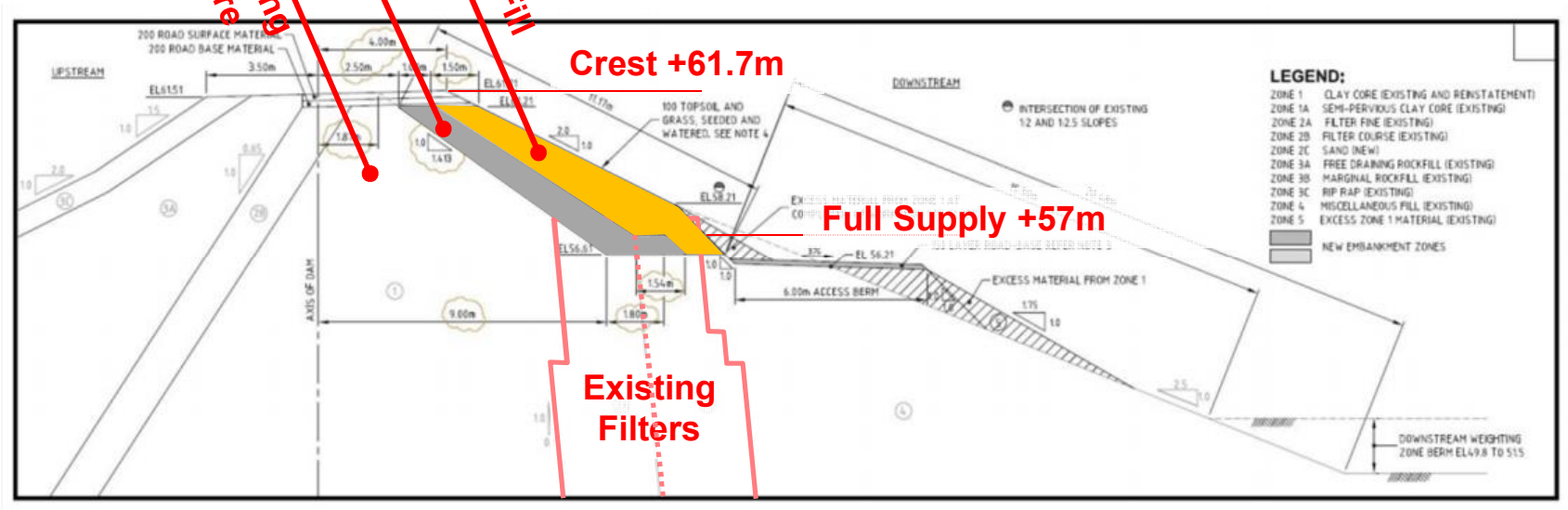


Embankment Reconstruction

- **Dam details**
  - Central core earth- and rockfill, 43m high, built 1967
- **Major defect & failure mode**
  - Piping incident in glacial fill against spillway wall (1968); poor filters
- **Upgrade Measure**
  - Removal and rebuilding of the upper 7m of the embankment
  - Reconstructing the embankment from crest to foundation adjacent to the central spillway walls



Filter Trenches & Extensions



Deep-Soil Mixing (DSM)

- **Dam details**
  - Zoned earthfill, 17m high, 450m long, built 1911, raised 1986
- **Major defect & failure mode**
  - 10m deep alluvial soils foundation
  - Sands susceptible to liquefaction under earthquake loading
- **Upgrade Measure (*seismic*)**
  - Deep-soil mixing to strengthen foundation; grout cement and bentonite mix

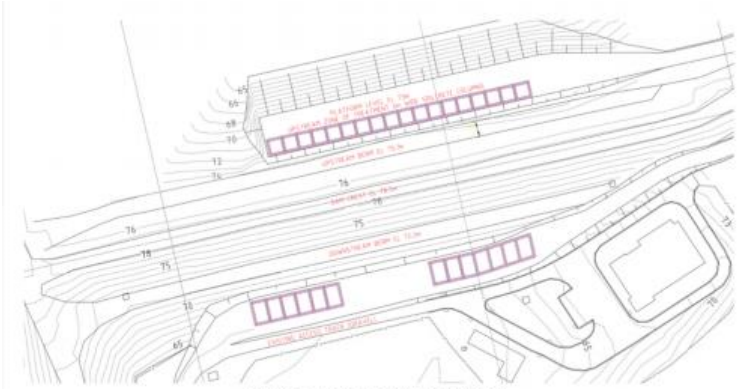
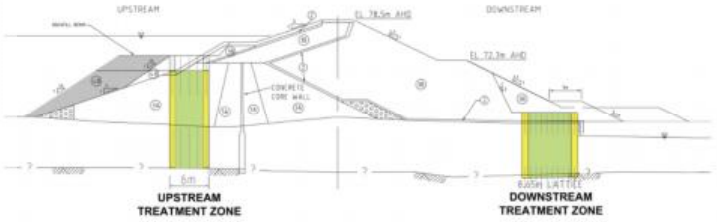
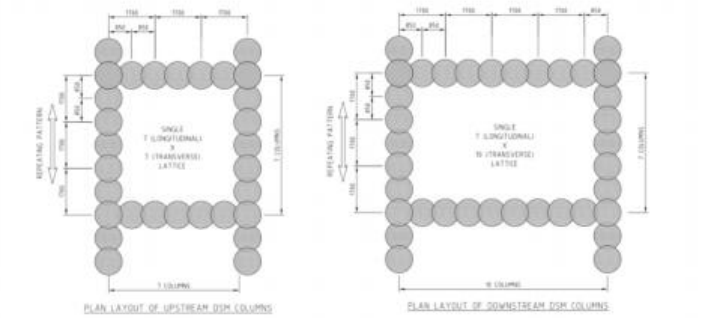


Figure 5. Project general arrangement





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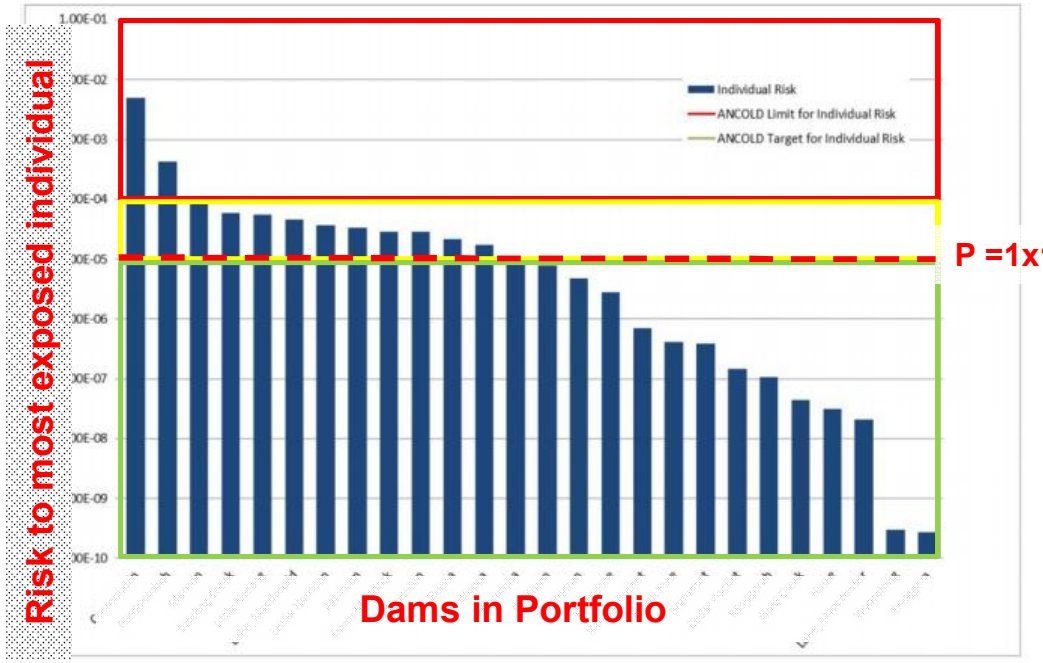
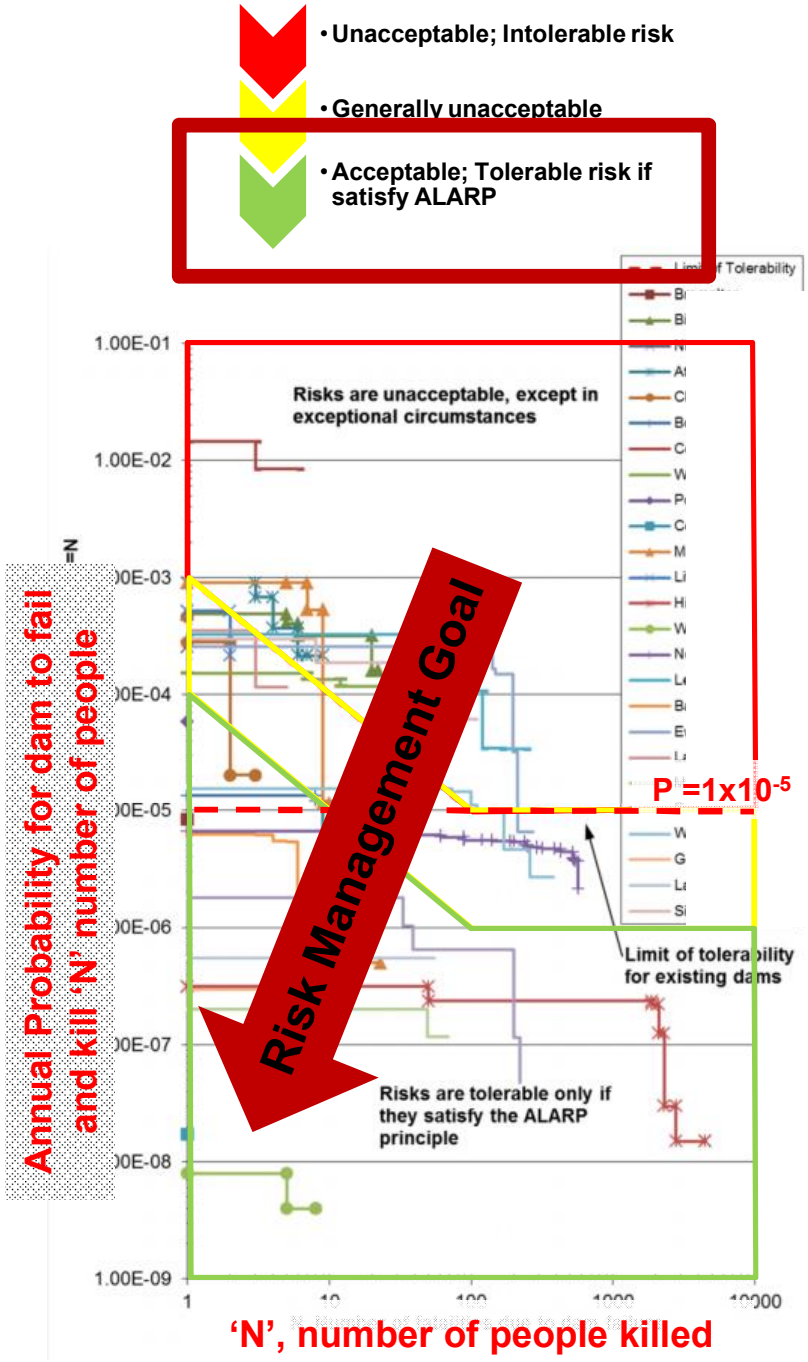
How are decisions made?

→ **Quantitative risk assessment**

- Priority and urgency through portfolio risk assessment
- Review safety of individual existing dams
- Assess public risk during dam construction
- Determine the need for individual dam safety improvement projects






Tack!
Frågor?

References

[1] Piping and Internal Erosion Failure, Tunbridge Dam, Tasmania, Australia, Geoengineer.org, 11/28/08
[2] Hunter, Chamberlain and Foster, 2009, *Innovative solution to foundation piping risk at Hinze Dam*, ANCOLD 2009.
[3] O'Brien, Dann, Hunter and Schwermer, 2009, *Construction of the Plastic Concrete Cut-off Wall at Hinze Dam*, ANCOLD 2009.
[4] Bauer Foundations, *Hinze Dam*, http://www.baueraustralia.com.au/en/references/cut_off_walls/; http://www.bauer.de/bst/references/bauer-projectreference/Hinze-Dam/
[5] Davidson, Vreugdenhil and Foster 2000, *The Dam Safety Upgrade at Lake Eppalock*, ANCOLD 2000.
[6] Hunter and Fell, 2003, *Deformation behaviour of embankment dams*, UNICIV Report No. R-416.
[7] AECOM 2015, *Ritschard Dam Evaluation Update and 2015 Plan*, 2015.
[8] Southcott and Harman, *TAS – ANCOLD Study Tour to Rowallan Dam*, ANCOLD, http://www.ancold.org.au/?s=Rowallan
[9] International Water Power & Dam Construction, 2016, *Repairs at Rowallan Dam*, 8 March 2016
[10] Ryan 2013, *Kinchant Dam, design and construction of upgrade works* ANCOLD 2013.
[11] Toose, Hunter and Watkins 2007, *Design and construction of the Lance Creek Reservoir seismic upgrade*, ANCOLD 2007.
[12] Avopiling, *Turbojet – Deep Soil Mixing*, www.avopiling.com.au
[13] Barker 2011, *Australian risk approach for assessment of dams*, USSD 2011.
[14] URS 2014, *Dams and Weirs Capital Works Program, Seqwater* http://www.qca.org.au/getattachment/f9f78774-e51b-427c-a6db-5a97a5bd57bb/Seqwater-submission-Appendix-F.aspx
[15] Thiess, *Hinze Dam Stage 3*, https://www.thiess.com/projects/hinze-dam-stage-3/detail