

Paradise Dam

Fact Sheet: Hydrology and Hydraulic Studies

April 2021

Background

Strengthening and stabilising work is required as part of the long-term remediation of Paradise Dam. The options to achieve this include large post-tensioned anchors, or, alternatively, mass concrete buttressing (widening the base of the dam and increasing the wall thickness by mass concrete) or a combination of the two approaches, amongst other improvement works.

These options require design development, an options assessment, and then several years of construction to implement.

A detailed understanding of rainfall and flooding in the Burnett River catchment is important to help in planning for and designing the improvement works at Paradise Dam.

A range of **hydrology** and **hydraulic** studies are being undertaken to ensure that we have the best information available.

In addition to the studies outlined in this fact sheet, other hydrology studies are underway to confirm water storage yields and compliance with regulatory requirements. This fact sheet is focussed on the studies that will specifically aid dam remediation design.

What is hydrology?

Hydrology is the branch of science concerned with the properties of the earth's water, and especially its movement in relation to land. For Paradise Dam, the focus of the hydrology assessment is to understand the amount of rainfall that is converted to surface runoff.

Sunwater is currently undertaking a detailed hydrology assessment to improve our understanding of the likelihood of a flood event that may lead to spillway overtopping and potentially, a sliding/overturning failure of Paradise Dam.

Advances in scientific techniques since the dam was first built means that we can plan for the remediation of Paradise Dam with greater confidence.

What hydrology studies are being undertaken for Paradise Dam?

Estimating the likelihood of extreme rainfall events:

- This work helps to reduce the uncertainty in estimating the probability of the dam overtopping, which in turn provides more confidence in design decisions for the next phase of work at Paradise Dam.

- The study uses two independent methods to ultimately determine the catchment averaged rainfall frequency curves for the Paradise Dam catchment.
- This study is being undertaken by Hydrology and Risk Consulting (HARC) with support from Melbourne University. A peer review will be conducted by leading national and international statistical hydrologists and authorities on the theory and application of statistical methods in hydrology and water resources. The peer reviewers are overseeing the process to ensure the approach adopted is based on sound reasoning and analysis.

Palaeoflood study:

- A palaeoflood study looks for evidence of flood events that occurred before written records were kept using information about deposited flood sediments. Understanding the flood history of the Burnett is critical to designing and planning dam infrastructure within the catchment and deciding how it should be managed during an emergency event.
- The palaeoflood activities and reporting have been undertaken by Water Technology and have been peer reviewed by geomorphology and hydrology experts from James Cook University.

Hydrology modelling and flood frequency review:

- Rainfall frequency curves from the previous work to estimate the likelihood of extreme rainfall events (described above) are used as inputs into a hydrologic model representative of the Paradise Dam catchment.
- This hydrologic model is calibrated to a number of historic flood events (1971, 2010 and 2013) and replicates observed flood behaviour in the catchment.
- The hydrologic model is then assessed using the latest Australian Rainfall and Runoff guidelines to estimate flood frequencies for Paradise Dam.
- These estimated flood frequencies are compared to observed flood frequencies throughout the Paradise Dam catchment, including the observed floods obtained from the palaeoflood study. The hydrologic model replicates observed flood frequencies within the Paradise Dam catchment.
- This study is being undertaken by HARC and peer reviewed.

What is hydraulics?

Hydraulics is the study of the motion of liquids in relation to disciplines such as fluid mechanics and fluid dynamics. Hydraulic analyses are performed to determine the depth of flow, flow velocity, and forces from flowing water on a surface, for example, a lake created by a dam wall.

What hydraulic studies are being undertaken for Paradise Dam?

Computational Fluid Dynamics modelling:

- Computational Fluid Dynamics (CFD) modelling involves taking estimated flood flows from a hydrology model and using the modelled data to simulate flow conditions at a structure or location, such as a dam. This modelling is used to either understand water flow or flood conditions or for the design of structures.
- CFD modelling allows optimisation of the size and nature of structures, which can reduce construction and maintenance costs, and helps quantify at what size flood event structures may fail.

- Understanding the flood flow dynamics and how a structure will perform under a range of conditions is an important part of the design process.
- This modelling exercise is being undertaken by GHD. CFD modelling has been peer reviewed by the Paradise Dam Technical Review Panel (TRP), with national and international subject matter experts.

Downstream consequence assessment:

- The hydraulic modelling required for the downstream consequence assessment simulates a range of dam failure and natural flooding scenarios and routes these flows from Paradise Dam through the downstream floodplain.
- The dam failure scenarios have been determined by GHD's dam engineers in the first instance and have been verified as appropriate for design development by the project TRP.
- The consequence assessment hydraulic model is a two-dimensional model that covers the area from Paradise Dam down to Burnett Heads (approximately 1,500 km²).
- This hydraulic modelling involves taking estimated flood flows (of dam failure and natural flooding) to simulate flow conditions throughout the entire downstream floodplain.
- The gridded results from this hydraulic modelling are inputs into the consequence assessment, which is used to estimate variables such as the Population at Risk. These are key inputs to the Paradise Dam risk assessment.
- The design for the long-term remediation of Paradise Dam aims to reduce the risk of dam failure to as low as reasonably practical, known as ALARP.

Physical hydraulic modelling:

- Developing a physical hydraulic model is considered best practice before undertaking a major hydraulic engineering project.
- The study of physical hydraulic models and the output data they provide plays a vital role in the planning and designing of almost all hydraulic and hydrologic structures.
- The physical model of the dam is built to a defined scale ratio having an identical geometric shape (only differing in size) to the real-life structure. It includes all infrastructure elements such as stilling basins, spillways, training walls, etc. (an example is provided in Figure 1).
- By simulating various catchment inflow and flooding scenarios, the modelling outputs enable the dam engineers to predict likely performance of the proposed design and highlights the hydraulic performance of each of the infrastructure elements to enable further evaluation, refinement and, if required, improvement of the proposed design and infrastructure configuration.
- Because of the importance and value of undertaking physical hydraulic modelling to aid design development, Sunwater has its own physical hydraulic modelling research laboratory at Rocklea in Brisbane.
- Once a long-term Paradise Dam improvement solution has been endorsed by Government, Sunwater plans to construct a physical hydraulic model as part of the design development process. A dedicated team of Sunwater model building experts will assist with this process.
- Upon completion of the modelled hydraulic runs, output data will be peer reviewed to confirm the validity of the process and model outputs.

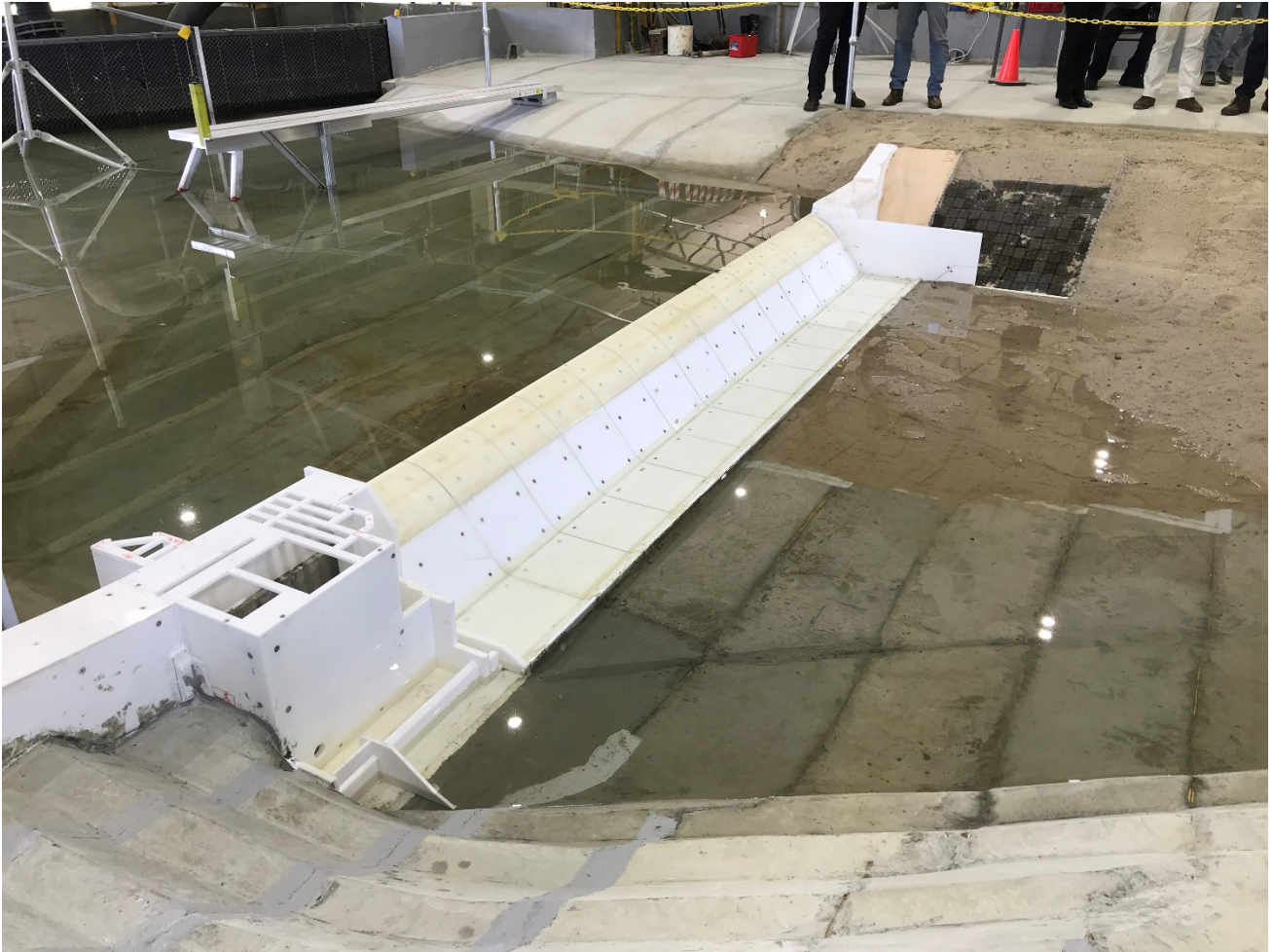


Figure 1 – Example of a physical hydraulic model

Stakeholder engagement

Sunwater is committed to ongoing engagement with the community to ensure transparency during the works at Paradise Dam. We will continue to share updates as the work progresses with a dedicated Community Reference Group and Paradise Dam Industry Forum that include representatives from local government, peak bodies, customers, and downstream residents. Information is also regularly shared on Sunwater's Paradise Dam Facebook page and the project webpages on the Sunwater website.

Questions?

Please contact us on 3120 0270 or paradise.dam@sunwater.com.au with any questions.