Managing dams

What is the purpose of the Callide Dam?

The Callide Dam was designed and constructed by the Irrigation and Water Supply Commission.[1] Callide Dam Stage One was constructed in 1965 to supply water to the Calcap Power Station on the Callide open cut coalfield, and to supply water to irrigators, industry and the township of Biloela.[2]

With the completion of Callide Dam Stage Two in 1988 (addition of radial gates), the storage capacity of the dam was more than doubled to 136,300 megalitres (ML).[3] For comparison, Wivenhoe Dam's main water storage capacity is 1,165,238 ML,[4] with capacity for flood mitigation storage of an additional 1,967,000 ML.[5]

The Callide Dam is the largest part of the Callide Valley Water Supply Scheme,[6] owned and operated by SunWater.[7] The Callide Weir and Kroombit Dam are the other main parts of this scheme.[8] The dam is filled by the natural inflow from Callide Creek and by Awoonga Dam through the Awoonga-Callide Pipeline, Stag Creek, and the Stag Creek pipeline.[9] Water is delivered from Awoonga Dam at a rate proportionate to the water used by the power stations.[10] The balance of Awoonga water in Callide Dam at the end of January 2015 was 3,778ML or around 3% of the dam.[11]

Callide Dam facts

The Callide Dam is managed under legislation as a 'referable dam' with a Category 2 failure impact rating, meaning more than 100 people are at risk if the dam fails.

As a water supply dam, there are constraints on removing water from the Callide Dam, as water security for end users needs to be maintained.

How does SunWater operate?

> *'SunWater is a bulk water infrastructure developer and manager owning and managing around $7 billion in water infrastructure assets and supplying approximately 40 percent of all water used commercially in Queensland.'*[12]

> *'SunWater was established as a statutory Government Owned Corporation (GOC) in 2000 under the Government Owned Corporations Act 1993.'*[13]

In 2008, SunWater transitioned to a Company GOC under the *Corporations Act 2001* (Cth) and is registered as SunWater Limited ACN 131 034 985.[14] The Treasurer and the Minister for Energy and Water Supply are Shareholding Ministers of SunWater on behalf of Queensland.[15] Ministers are responsible to Parliament[16] for the operation of all Government Boards and agencies within their portfolios. An *'important performance target for GOCs is to maximise the commercial return to the owners of the business – the Queensland community.'* [17]

SunWater has different water pricing arrangements for different user groups.[18] The Queensland Government decides the prices that SunWater can charge its irrigation customers.[19] The prices are recommended independently by the Queensland Competition Authority.[20]

Each local government individually agrees on its water prices with SunWater.[21] Industrial customers, such as mining companies, similarly agree on water prices with SunWater on an individual basis.[22]

How do the gates on the Callide Dam work?

Callide is an earthfill dam with radial gates.[23] The spillway is fitted with gates that are designed to open automatically using a float system.[24] That is, when the storage reaches 0.159m above the full supply level (FSL) of 216.1 metres, the gates begin to open by being pulled up.[25] The gates continue to open as the storage continues to rise.[26] The gates lower as the inflows reduce.[27] The system is designed to pass the flows from upstream through the dam.[28] The gates operate this way to protect the integrity of the dam structure from water rising above the FSL.[29] The gates minimise the risk of 'overtopping' the dam.

The gates can be opened manually. This is a multi-step process that must be operated from the spillway bridge above the gates.[30] The gates must be constantly monitored through manual operations.[31] Incremental adjustments are made at the direction of a technical specialist who would generally not be onsite.[32] The gate opening rates are currently designed to operate the dam in the same manner as automatic opening.[33] That is, manual gate openings aim to match the outflow to the inflow, in order to maintain the lake level and protect the integrity of the dam, thereby minimising the risk to residents from dam failure.

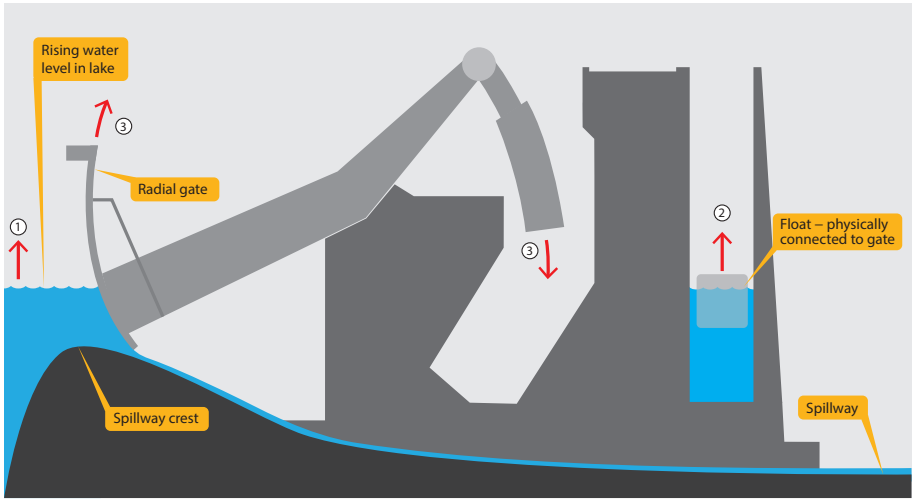
Full Supply Level

The Full Supply Level or FSL is the maximum operating water surface level of a reservoir when not affected by floods.

The regular FSL for the Callide Dam is 216.1 metres and 136,300ML of water.

The Callide Dam is currently operating under a reduced FSL due to works being carried out on the embankment.

The reduced maximum operating level was adjusted in January 2015 from a reduced FSL of 215.1m to 215.5m.



Right: Schematic diagram of the operation of the Callide Dam gates.
SunWater

Figure showing simplified schematic of radial gates

The Callide spillway gates are configured to respond to rising storage levels. The gates have a series of chambers and counter weights that are connected to the water in the storage. Once the water level in the storage rises above the FSL the gates will begin to open.

If the water level continues to rise (1) the gates will continue to progressively open (2 & 3) until the discharge matches inflows and the storage level stabilises. The rate of gate opening is a function of the rate of rise of the storage. The gates do not rely on any computer or electrical control equipment to function.

Can the Callide Dam be operated differently?

> *'...you can decide that a dam like the Callide dam will become a dual-purpose dam and in that case its capacity for supplying irrigation water will be substantially reduced and the prosperity of the area will reduce accordingly and that's the price that people would pay for having less storage compared to the risk they take of getting flooded from time to time.'* [34]

The question of whether the Callide Dam can be operated differently, to include any effective flood mitigation potential, is one that needs to be definitively answered through proper analysis. The Callide Dam is part of the way in which water is managed according to the sustainability requirements for the whole Fitzroy Basin.[35] Legislated sustainable management of water recognises, and attempts to balance, the many competing interests for the resource.[36]

There are also several practical considerations for releasing water from Callide Dam, including:

- The potential exacerbation of flooding downstream as flows meet other watercourses, or rainfall occurs downstream coinciding with released water.[37] As one resident said:

  > *'I believe it would have put more water down my end. We live right on the bottom end of Callide Creek, there are seven major creeks that feed the water that comes past our place and a bit further down there are two other major rivers from Mt Morgan way. If Callide Creek is pre-charged that's just going to back water up and add to the water. Releasing water from the dam is just going to add to the problem down the line. If they let water out early the creeks down around us will all peak at the same time.'* [38]

- The ability to predict the impact of released water, which in the case of Callide Dam, is limited by:

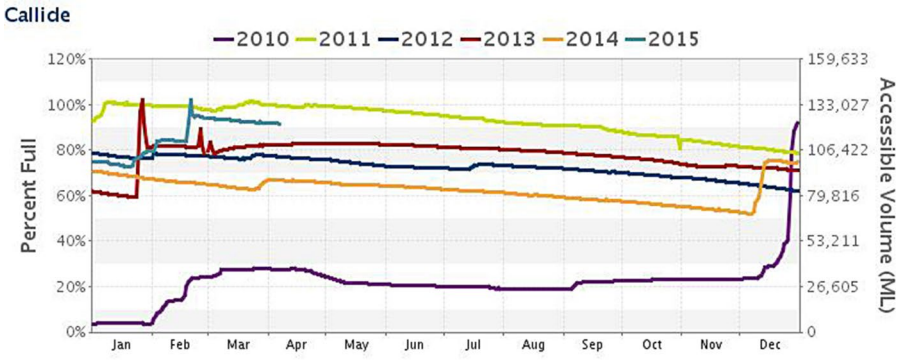
  > the uncertainty of rainfall forecasts and the temporal and spatial (when, where and how much) variability of the rainfall, both upstream and downstream of the dam.[39] The Department of Energy and Water Supply (DEWS) points out that *'even after many years of research and model development, rainfall forecasts are still not regarded as being reliable enough to confidently allow pre-emptive releases from Queensland's three, statutorily-declared, flood mitigation dams.'* [40] (refer also Operational Information and Intelligence: Bureau of Meteorology)

  > the absence of a calibrated, finalised model for Callide Dam[41] (see Hydrology Report)

  > insufficient flood mapping for downstream areas[42] (refer also Planning: Banana Shire Council)

  > too few gauges in the catchment to monitor rainfall and creek levels to assist forecasting/modelling[43] (refer to: Operational Information and Intelligence: Bureau of Meteorology).

- The variable nature of rainfall and periods of drought. As the DEWS notes, *'[the] Callide Valley is a catchment that has a long history of low rainfall (noting Callide Dam did not fill until 2011 and Kroombit Dam ran dry) broken by floods caused by tropical cyclones, whether or not it is a wetter than normal season.'* [44]



Left: Callide Dam storage levels, 2010–2015.

Bureau of Meteorology Water storage Callide Dam

Rules for releasing water

The operation of the Callide Dam must consider the sustainable management of the wider Fitzroy Basin, in accordance with the *Water Act 2000* (Qld) and the *Fitzroy Basin Resource Operations Plan* (September 2014). The dam operator is bound by legislation to ensure it can deliver water allocations to end users, such as irrigators, industry and the community.[45] The sustainable management of the Fitzroy Basin takes into account ecological factors, as well as broader economic and social factors. The competing demands for water for industry, drinking water, the environment, irrigation, cultural uses, and recreation, among others, must be balanced using the rules set down by legislation.[46]

The competing interests for the Callide Dam water were highlighted in the *Review of the Callide Dam Gate Operations in the January 2013 Flood Event*, which was completed by Water Solutions.[47] The report stated that any changes to incorporate an active flood mitigation purpose to the dam would need to carefully consider several competing and complex issues, one of which is the performance of water allocations to the Callide Valley.[48]

SunWater responded in a letter to the DEWS:

> *'... it is noted that the report explores a number of actions that could be taken to enable Callide Dam to provide more active flood mitigation. Callide Dam is a water supply dam only. It is also noted that the Banana Shire Council does not have any flood mapping or flood damage curves. Without such base information it would not be possible to assess the benefits (if any) of flood mitigation. SunWater does not intend to undertake any studies for flood mitigation.'* [49]

At the time, the Banana Shire Council (the Council) was supportive of the dam being used for water storage to its maximum capacity. On 7 June 2013, the Council Mayor wrote to SunWater seeking:

> *'repairs to the water leak at Callide Dam as a matter of urgency to allow the dam to retain 100% water capacity ... for too long Biloela and district has suffered from the Callide Dam having insufficient water ...'* [50]

SunWater responded to the Council by outlining that the reduced FSL was purely for the purpose of ensuring dam safety and would be regularly assessed.[51] Dam safety is yet another vital consideration for the sustainability of the resource, and the protection of the downstream community.[52]

Since the 20 February 2015 flood event, SunWater's CEO has said that to *'... change those rules would require ... significant consultation and I imagine that will be something which we will be looking at closely after this event.'* [53]

Increasing flood mitigation potential

Water supply dams can be modified, either structurally or through management practices, to support flood mitigation.[54] Structural modifications, such as raising the walls, require extensive modelling, consultation and capital expenditure.[55] Management practices include 'fixed' or 'variable airspace management'. This involves release of certain amounts of water from a dam before a wet season or a rainfall event based on modelling and weather predictions.

The amount of flood mitigation a dam can provide depends on a number of factors including:

- the size of the flood event
- the catchment size
- the level of water in the dam at the beginning of the event
- the capacity of the reservoir to store floodwaters above its FSL
- the area of uncontrolled catchment downstream of the dam
- the discharge capacity of the spillway.[56]

Variable airspace management

'Variable airspace management' is used by authorities within South Australia and New South Wales on water supply dams, such as the Dartmouth, Blowering and Burrinjuck.[57] Queensland uses a type of variable airspace management for the three flood mitigation dams: Wivenhoe, Somerset and North Pine.[58] State Governments, in conjunction with advice from the Bureau of Meteorology, make decisions to pre-release water from the dams under conditions to ensure the security and continuity of water supply for end users is maintained. In New South Wales, one condition of mitigating floods through variable airspace management is that the water entering the dam from the event or season must replace the amount released.[59] This has not always worked well.[60] If water supply conditions cannot be met, State Governments can be required to compensate end users for changes to water allocations.

In Queensland, the statutory process for temporarily lowering a flood mitigation dam allows the Minister to make decisions to respond to seasonal rainfall forecasts.[61] This process does not apply to water supply dams. According to the DEWS, the process takes about six to eight weeks including consultation and preparation of advice to the Minister, making it unsuited to lowering dam levels for imminent rainfall forecasts.[62]

As part of this process, approval needs to be sought from the Department of Natural Resources and Mines (DNRM) for departure from normal operating protocols by submitting an 'interim program' to the Chief Executive of DNRM.[63] This may be done at short notice by the DNRM, and SunWater has experience in preparing interim programs for approval.[64] In the past, interim programs have been used for temporarily lowering Wivenhoe Dam, and to address periods of water shortage in the Fitzroy Basin.[65] Approval still requires evidence to support that the benefits of releasing water are likely to outweigh the risks. As the DNRM told us:

> *'It would be unusual and potentially risky to be making ad hoc decisions to pre-emptively release water from a dam at short notice without doing significant pre-assessment on the risks (both in terms of downstream flooding and to water supply reliability). Proactive communication with potentially affected parties, and consideration of the potential implications for such parties, would ordinarily be prerequisite to any decision by DNRM's Chief Executive to approve an interim program.'* [66]

There are also a number of legal steps that need to be undertaken by SunWater, with the discretion of their Shareholding Ministers, which adds significant time to the process before SunWater can submit an interim program.[67]

Considering the options

Considerations for changing the purpose of the Callide Dam to include active flood mitigation are complex, which means decisions must be informed by comprehensive data collection and analysis. Attempting to balance the conflicting interests of stakeholders also requires extensive consultation and study. The DEWS estimates that the process for the Callide Dam to be considered as a flood mitigation dam under the *Water Supply (Safety and Reliability) Act 2008* (Qld) could *'take over three years'*.[68] According to the DEWS, the first stage is a comprehensive analysis of the costs and benefits of making Callide Dam a flood mitigation dam, which could take approximately one year. As an example, optimising the existing operations of Wivenhoe Dam took more than two years to complete.[69] If the Government decided that Callide Dam should be a flood mitigation dam, then a range of activities would need to be undertaken to improve the effectiveness of flood mitigation operations. This may involve significant structural changes to the dam, which could take two to three years to complete, depending on the magnitude and complexity of those changes.

Finding 1

There is currently insufficient information available to allow a fully informed decision on the use of Callide Dam to provide more active flood mitigation than its original design.

Recommendation 1

The Department of Energy and Water Supply and SunWater undertake the necessary studies to determine whether or not it is feasible to operate Callide Dam as a flood mitigation dam. Such studies should include matters in relation to, but not limited to:

- The effect on the Callide Valley Water Supply
- Dam safety issues
- Actual mitigation outcomes
- Cost-benefit analysis of alternative strategies
- Alternative means of effecting improved community outcomes.

The results of this work should be made public to enhance public knowledge and provide confidence regarding dam operations.

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