CoastAdapt

Case Study

Brisbane water and wastewater supply climate-flood resilience

Summary

The major floods that occurred in Queensland in January 2011 are a reminder of the vulnerability to extreme events of many Queensland cities and regional centres. Climate projections suggest that such events will continue to occur in future decades. Queensland Urban Utilities, the provider of water and wastewater services to Brisbane, suffered extensive outages during the January 2011 event. In response, the organisation undertook a substantial climate-flood resilience and adaptation initiative that included a major risk assessment study, and subsequent capital works program that is presently being delivered. This represents one of the largest climate adaptation program in Queensland.

Background and context

Queensland Urban Utilities is a statutory authority in South-East Queensland that is responsible for the delivery of water supply and wastewater services for the city of Brisbane and surrounds. The organisation has assets in five local government areas that span a combined catchment area of 14,384 km^2.

Queensland Urban Utilities delivers 136,000 ML (Mega litres) of water and treats 107,000 ML of wastewater annually. The organisation operates and maintains water infrastructure valued at $1.869 M and wastewater infrastructure valued at $2.888 M. Water is delivered to 532,000 residential properties and 37,000 non-residential properties through a distribution network consisting of 9,113 km of water mains, boosted by 57 pumping stations and 90 water boosters. Wastewater is collected through a distributed network of 9,306 km of sewerage mains and 339 sewage pumping stations that supply 27 wastewater treatment plants.

In January 2011, Brisbane experienced a flood event that inundated multiple suburbs in Brisbane and resulted in loss of life at several locations in the greater catchment. The event also resulted in service disruptions and substantial asset damage to water assets and facilities. At the peak of the flood event 14,100 properties in Brisbane were flood-impacted and 1,203 houses were inundated.

The flood damage was a result of an intense rainfall event in the upper catchment of the Brisbane River, which, in itself, was preceded by many months of sustained rainfall. The second half of 2010 was the wettest period in Australia on record and this was associated with strong La Niña event which resulted in persistent monsoonal rainfalls across northern Australia. During the January flood event, the upper catchment rainfall, specifically in the Lockyer Creek and Bremer River which drain into the Brisbane River, led to flash flooding in upper catchment communities including Grantham, Toowoomba and Lockyer. As the rainfall continued, the flood storage capacity of the Wivenhoe Dam was reached which led to the need to spill flood waters from the dam. The spilled water from the dam inundated several Brisbane suburbs upstream of, and including, the central business district. Across Queensland, flood events during this period led to an estimated 56,200 insurance claims covering an insured value of $2.55 b (Insurance Council of Australia 2011).

The January 2011 flood event was deemed to have an average return period of 120 years (with the Wivenhoe and Somerset dams in place), or a return period of around 100 years if the dams were not in place (WMAwater 2011). In other words, while the 2011 flood event could be viewed as an extreme weather event, it was by no means the largest flood event that is likely to have occurred in the catchment. A previous flood event was larger; in 1974 the peak at the Port Office was 5.45 m AHD[1] in comparison to the 2011 peak of 4.27 m AHD.

Climate projections suggest little change to the long-term average annual rainfall in the catchment, which is consistent with analysis of the existing 100-year record. However, it is possible that within-year rainfall patterns will change with more intense, but shorter, rainfall events; these are the type of events that produce catchment flooding. Therefore, while the Brisbane city catchment has experienced flood events in the past, it is likely that these events will increase in intensity and/or frequency over the coming century.

Description of risk to be managed

During the January 2011 flood, substantial damage occurred to Queensland Urban Utilities assets which led to service disruptions and substantial re-instatement costs.

Wastewater treatment plants were inundated and suffered loss of power including Oxley Creek, Fairfield, Karana Downs, Bundamba, Goodna, Rosewood, Esk, Fernvale and Lowood. Across the greater catchment, 89 wastewater pumping stations were inundated and numerous trunk and reticulation lines were broken.

The Oxley Creek treatment plant services around 250,000 EP (equivalent persons) residing in the south-western suburbs of Brisbane. During the 2011 event much of the plant was completely inundated (Figure 1). This resulted in the switch room, inlet pump station, bioreactors, sludge processing stream, UV and chlorine disinfection and odour control units being completely submerged for several days. Although the plant was operational within weeks of the event occurring, full service was not regained until many months afterwards.

The widespread loss of service during the flood event, and recognition that Queensland Urban Utilities' long-lived infrastrucutre will be exposed to many more such events, led the organisation to commission a flood resilience and adaption program. This program included an initial risk-based prioritisation study and a comprehensive capital works program.

[1] Australian Height Datum or mean sea level.

Figure 1: Oxley Creek Sewage Treatment Plant before and after the 2011 flood event. Source: AECOM 2011.

Adaptation approach

The first task was to commission the development of a flood adaption and resilience strategy. The aim of the strategy was to develop knowledge to help Queensland Urban Utilities understand what actions would reduce the overall risk to service levels during events such as occurred in January 2011, and to which assets, and at what cost. The analysis had to be ISO compliant, risk-based and consider social, economic, and environmental risks.

The study assessed environmental impacts by considering the impacts of uncontrolled discharges to waterways that occur when major assets are out of service and flows need to be re-directed into waterways. The study therefore considered both the volume and nature of discharges, and the ecological ability of the receiving waterways to accommodate these discharges.

Direct costs for damages and benefits used in the study were primarily based on market values for infrastructure and consideration was given to outage costs to customers. Social and customer impacts were primarily derived from the number of EP cumulatively relying on each asset under consideration.

A key outcome from the risk analysis was the risk abatement curve, shown in Figure 2.

The graph in Figure 2 shows the relationship between how much of the overall social, economic and environment risk during major flood events can be mitigated and the cost of mitigating this risk. Risk reduction options are represented by the circles. The size of the circles show the capital works costs for each option.

Figure 2 reveals that the first 50% of the flood risk can be mitigated through the active management approach of protecting the sewage treatment plants (STPs). This would involve raising/protecting key components such as switch rooms and developing emergency procedures that allow some continuation of core functions (for example screening). It also means accepting that some parts of the plant would still be inundated and require some remedial clean-up activities following the event.

A further 18% of the risk could be mitigated through protecting the twenty priority pumping stations, either through raising/flood proofing key components or deploying permanent or temporary bunds of levels around the whole station.

The risk-resilience distribution shown in Figure 2 is common in risk assessments and these graphs often feature a 'knee' or point of reflection in the distribution at the point beyond which the risk-return diminishes. In this case, the return on investment diminishes once the minor works to STPs and the priority pumping stations have been completed, which mitigates around 75% of the risk. For example, a larger investment would be required to mitigate just under a further 7% of the risk through protecting the remaining pump stations impacted during the January 2011 event. A further 10% of the risk could be mitigated by redirecting flows from the Bundamba STP and key pumping stations. A much larger

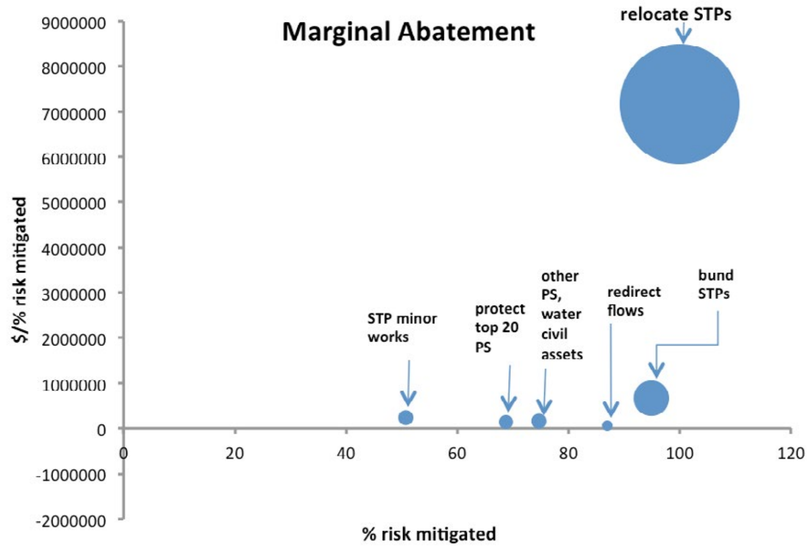

Figure 2: *Risk abatement curve. Risk reduction options are represented by the circles. The size of the circles show the capital works costs for each option. PS = pumping stations, STP = sewage treatment plant. Source: Developed by the author with information from QUU Flood Resilience Study (AECOM 2011).*

investment would be required to mitigate most of the remaining risk by constructing permanent bunds around the STPs. Similarly, the last remaining 5% of the residual risk could be potentially fully mitigated by relocating the STPs to more flood resilient sites if available. However, the cost would be substantial and would only result in a very slight increase in protection and risk reduction.

A key result from Figure 2 is that much of the future flood risk can be mitigated through protecting/ elevating key components in the STPs, top 20 pumping stations and selected other key water assets. However, there are often multiple ways of achieving the same result; for example, permanent elevation of critical equipment, waterproofing critical equipment, or the deployment of temporary barriers.

Implementation of adaptation response

Following the outcome of the flood adaption and resilience strategy, Queensland Urban Utilities further developed the program, particularly focusing on scope, risk (operational, environmental and reputational) and value for money outcomes, both from a capital and recovery perspective. This planning task initially focused on the five main impacted sewage treatment plant sites — Oxley Creek, Fairfield, Karana Downs, Bundamba, and Esk — as identified in the risk assessment.

The outcome of this detailed planning study was to implement a capital works program (flood resilience program) that aimed to reduce the:

- amount of refurbishment expenditure required after future floods
- environmental impact of potential future floods
- community impact of potential future floods.

The Flood Resilience Program also aligned with the following corporate strategies:

- Operational excellence – The program represents an innovative method of achieving lowest long-term cost to the community, with the solution representing the lowest net present value of the options considered when insurance premium increases are taken into account.
- Define and deploy operational excellence by developing and deploying robust practices to ensure Queensland Urban Utilities can effectively respond and recover from natural disasters such as the floods of 2011 and 2013.
- Consistently deliver on shareholder expectations by minimising service disruption and environmental harm caused by natural disasters.

The scope of works for the STP component of the program was to provide climate-flood resilience, by raising, or otherwise flood-proofing, assets in Areas 1-5 of the specific facilities (based on the Queensland Urban Utilities Asset Recovery Hierarchy defined below):

- Area 1 – Inlet works and preliminary treatment
- Area 2 – Biological treatment
- Area 3 – Dewatering and sludge treatment
- Area 4 – Disinfection, dosing and services
- Area 5 – Sludge treatment and Co-Gen (Oxley Creek only).

This broadly encompasses all mechanical and electrical equipment required to convey and treat sewage, but excludes recycled water provision and advanced nutrient removal/polishing.

Table 2 shows the exposure in terms of expected recovery costs with and without the implementation of the Flood Resilience Program. This illustrates the substantial reduction in recovery costs from a future flood that is expected from the implementation of the program.

In addition to the reduced recovery times and costs, the Flood Resilience Program is also expected to result in a substantial reduction in insurance premiums.

Program Delivery

This project was the first of its kind for both Queensland Urban Utilities and the Australian water industry. Therefore Queensland Urban Utilities were conservative in the delivery mechanism: they decided to first undertake a detailed design with a consultant and then move to a construct-only contract. This approach meant they could identify all the unknown risks in the design phase and provide a robust design to the construct partner.

The main scope of works within the detailed design included:

- design and construction of raised platforms to elevate switchboards
- raise blowers and building modifications as required
- design and construction of raised platforms to elevate transformers
- design and construction of a raised platform to elevate co-generation plant, including the reconfiguration of pipework and power supply infrastructure.

Table 1: Current and projected recovery times with and without project implementation. Source: Queensland Urban Utilities.

STP	Status Quo – Based on January 2011 Event		Post Program Implementation Estimate	
	Time to preliminary treatment (Area 1)	Time to full reinstatement (Areas 2, 3, 4, & 5)	Time to preliminary treatment (Area 1	Time to full reinstatement (Areas 2, 3, 4, & 5)
Oxley	6 weeks	6 to 7 months	As soon as power is available	2 months
Bundamba	1 week	6 to 7 months	As soon as power is available	1 to 2 months
Fairfield	1 to 2 weeks	3 months	As soon as power is available	1 to 2 months
Esk	2 weeks	4 weeks	1 week	1 week
Karan Downs	2 months	6 months	2 weeks	1 to 2 months

Table 2: Current and Post Program recovery costs. Source: Queensland Urban Utilities.

STP	Status Quo – Based on January 2011 Event		Post Program Implementation Estimate	
	Capital Cost	Post Flood Capital Cost	Capital Cost	Post Flood Capital Cost
Oxley	0	$25.7M	$14.7M	$9.8M
Bundamba	0	$5.1M	$4.1M	$1.6M
Fairfield	0	$1.0M	$2.8M	$0.1M
Esk	0	$0.5M	$0.3M	$0.4M
Karan Downs	0	$0.8M	$1.1M	$0.4M
Total	0	$33.1M	$23.0M	$12.3M

Considerations during the design included:

- developing a design that could be constructed without impacting the operation of the plant
- maintaining safe operation and maintenance activities
- ensuring consideration is given to both visual amenity and condition of the current assets.

Works are scheduled to be completed on the Oxley Creek site in July 2016, and design process for the Bundamba site is scheduled to commence in January 2017. Following this, works to other assets as identified in the strategy will be investigated and undertaken.

In delivering this program Queensland Urban Utilities has gained substantial knowledge in the design and construction activities associated with building a climate-flood resilient water network.

References

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