CRC for
Water Sensitive Cities

BLIGH TANNER

Retrofit of stormwater harvesting scheme in highly urbanised area

The South Bank Rain Bank:

Urban stormwater irrigating Brisbane's iconic parkland

Improving irrigation reliability and sustainability for high profile parkland

Case Study

Prepared by Cooperative Research Centre for Water Sensitive Cities, May 2018.

Photo credits: South Bank Parklands, Bligh Tanner, CRCWSC

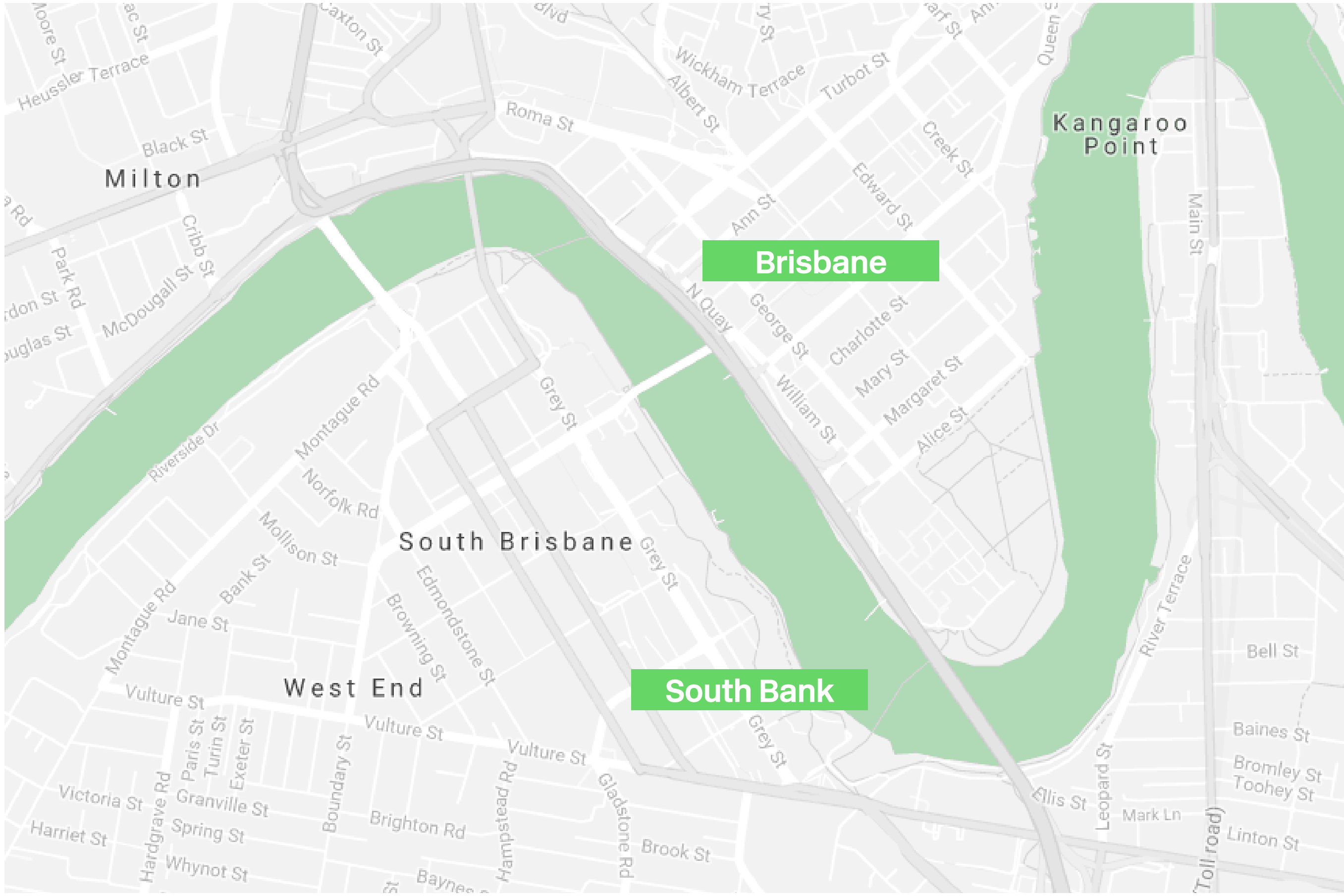
Australian Government
Department of Industry, Innovation and Science

Business
Cooperative Research Centres Programme

The context

Project location

Rain Bank is located within the South Bank Parklands. These parklands are located on the southern banks of the Brisbane River, opposite the CBD. The Queensland Government contracts Brisbane City Council to maintain the green spaces within the parklands, including horticultural and water operation services.



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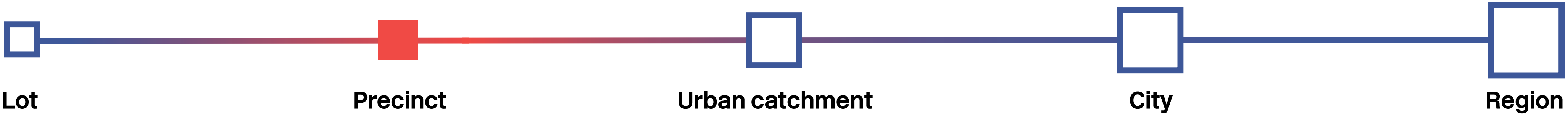
Project scale

The South Bank Parklands is a 17.5ha public parkland within the broader South Bank Precinct which is open 365 days a year and is visited by around 11 million people each year. The parklands feature 20 landscaped spaces, water features, swimming and water play areas, rainforest walks, picnic and barbeque areas.

The parklands use approximately 120ML/year of potable water and 60ML/yr of on-site treated water (both harvested stormwater and treated backwash). High quality potable water is required for human consumption and swimming top-up and filter backwash; non-potable demands include irrigation and toilet flushing.

The main South Bank sub-precincts (Source: Business South Bank) →



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Project site

Rain Bank is a stormwater harvesting system within the South Bank Parklands which diverts and treats stormwater runoff generated from a highly urbanised 30 hectare catchment in West End / South Brisbane. The land uses in this catchment include commercial, major road and rail infrastructure, residential and parklands.

Rain Bank is located in the northern section of the South Bank Parklands between the ABC building and the rainforest walk areas. While a lot of the infrastructure is underground, there is a viewing area that allows visitors to see the treatment process.

Rain bank location and catchment

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Collaborators and their roles

South Bank Corporation	South Bank Corporation was set up as the development and management authority for the South Bank Parklands. They controlled the design, construction and ongoing operation of the Rain Bank scheme. In 2013 the Corporation contracted Brisbane City Council to undertake the management and marketing of the parkland's green spaces.
Local Council	Brisbane City Council (BCC) are the owners of the stormwater pipes which are used in the Rain Bank scheme and therefore had to provide approval for the design of the interception system and extraction of water. BCC now also manage the parklands.
State and Federal Governments	State Government, Federal Government and South Bank Corporation jointly funded the delivery of this project. The Federal Government contributed $3.3 million funding from the Water for the Future program, the Queensland Government committed $4.7 million and South Bank Corporation dedicated significant funding to make Rain Bank possible.
Additional Project Advisors	Queensland Health – water quality control and management Queensland Water Commission – design principles and policies

Lead design consultants	Bligh Tanner were engaged as the consultants for the design of the Rain Bank scheme. This included the feasibility studies, HACCP analysis and detailed design.
Water Treatment Plant Contractor	Stornoway was commissioned to design, manufacture and install the water treatment plant for Rain Bank.
Other contractors and consultants	Stirloch Constructions Pty Ltd – Principal Contractors McLachlan Lister Pty Ltd – Project Manager Gamble McKinnon Green Pty Ltd – Landscape Architects Turner & Townsend – Quantity Surveyors Webb Australia Group – Electrical/Mechanical Engineers Edwards Irrigation Consultants – Irrigation Consultants WBM - Catchment water quality monitoring

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Timeline and milestones

2004

Drought conditions facing SEQ. South Bank Corporation starts to brainstorm ideas for alternative irrigation water supply and implement initiatives to reduce water used for irrigation and non-potable demands.

2006

Water restrictions require potable water supply for South Bank Parklands irrigation to be turned off. As a temporary solution South Bank Corporation install 6 x 50,000L above ground water tanks and fill them with treated plant room backwash water as well as imported recycled water supplied by tanker to irrigate high priority landscapes in the parklands. Water play areas are closed and low priority gardens are converted to reduce water demand.

2007

Long term non-potable water solutions investigated and Bligh Tanner engaged to assist in the process. Concept designs, water balance modelling and water quality testing undertaken for Rain Bank stormwater harvesting scheme.

2008

Catchment flows and water quality are monitored in the pipe for 6 months to better understand catchment runoff and characterise the runoff quality.

2008

Rain Bank concept finalised and receives South Bank Corporation board sign-off and Brisbane City Council licence to modify stormwater network. Completion was delayed for several months and re-design of Rain Bank was required to accommodate the new ABC building at South Bank.

2009

Detailed design completed and tenders called for the partial design and construction of Rain Bank. Documentation included a functional specification for the water treatment plant.

2010

Feb

Contract for construction awarded, including Stornoway engaged to design and construct water treatment plant.

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Timeline and milestones (cont.)

2010

Mar
Demolition of existing building and testing of soils and groundwater undertaken.

Apr
Construction of pipelines and storages for the Rain Bank system begins.

2011

Jan
Brisbane River floods inundate large areas of South Bank Parklands.

Mar
Rain Bank construction completed.

Jun
Practical completion of Rain Bank following testing and commissioning of Rain Bank.

Oct
Rain Bank officially opened by Her Majesty Queen Elizabeth II.

2012

Tidal flap gate added to stormwater outlet pipe to address higher than expected tide levels.

2017

Trough added to tidal flap gate to reduce tidal inflows associated with CityCat ferry wake.

The drivers

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1. Keeping an iconic parkland green in a drought

The South Bank Parklands were created for people and the environment. The lush sub-tropical landscape and water features throughout the South Bank Parklands are a key draw card for visitors all year round and therefore maintaining these landscapes through all climate conditions is critical. Due to the scale of the site, and also the high use of the landscape areas by visitors each year, the water demand for irrigation is quite high.

Since 2004, drought conditions have reduced the availability of potable water for use by the parklands for irrigation. Therefore to keep the premier Queensland parkland green in these times of drought, a substantial new source of alternative water was required.

"At 62 people/m2/year, estimates place the Parklands sub-precinct as the most intensively used public space in the world."[1]

- **CRCWSC**

Irrigated green spaces within South Bank Parklands

[1] CRC for Water Sensitive Cities (2016), Ideas for South Bank. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.

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2. Find a cheaper source of water

As drought-related water restrictions were put into place for the South Bank Parklands, alternative irrigation water was required. As an interim measure, South Bank Corporation installed 6 x 50,000L above ground rainwater tanks which were connected to existing swimming pool plant room pipes and irrigation infrastructure. These tanks were used to store treated backwash water from the pools as well as imported Class A+ recycled water which was trucked to the parklands. This was an expensive option as imported water cost almost $20/kl to truck compared to the typical cost of $2-3/kl for potable water.

To minimise the water demand of the parklands, low priority landscapes were converted to low/no irrigation demand landscapes and some water features were turned off. Despite this water saving, the interim measures were not enough to meet the irrigation requirements of the high quality and highly used landscapes and resulted in significant loss of low level and under storey planting.

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Rain Bank

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3. Ensure all options are considered

A long term solution was required to ensure that the South Bank Parklands had access to an alternative water source for irrigation which was sustainable in terms of yield, cost, public safety and environmental impacts.

During the drought, South Bank Corporation was approached by a number of suppliers with solutions. To ensure they had considered everything carefully before making a large investment, all options were put on the table by the team and local consultants Bligh Tanner were engaged to assist in the option analysis.

This option analysis included sewer mining, bore water, roofwater harvesting, desalination of Brisbane River water and stormwater harvesting. Stormwater harvesting became the preferred solution due to practicality, cost and yield, as well as providing the opportunity for interpretation and community education to be included in the design.

Rain Bank - Big Weather, Big Ideas
https://youtu.be/u75z8dgdtGg

The innovations

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1. Digging deep and making use of existing infrastructure

To understand the feasibility of retrofitting a stormwater harvesting solution at the South Bank Parklands, the existing stormwater network needed to be identified. Although mapping of the network exists, additional digging through old records and word of mouth identified that this mapping may not be accurate.

> "We were told 'there's a pipe here and we don't know what it does'. It was a 1200mm diameter pipe which was bone dry, not connected at either end and had acrow props lying in it. We didn't end up using this pipe but it is interesting what you find when you dig around."
> - **Chris Tanner, CRCWSC (former Director, Bligh Tanner)**

The detailed investigations identified that the stormwater pipe network along Glenelg Street, which connects Musgrave Park to South Bank past the Brisbane Convention and Exhibition Centre, consisted of two large parallel pipes which discharge into the Brisbane River. One of these pipes (1950mm) was the main stormwater drain for the catchment, whereas the other (1800mm) was an overflow relief pipe connected to the main pipe via a weir at its upstream end. This existing configuration meant that a weir could be constructed over the 1950mm pipe without causing any upstream flooding issues.

The new stormwater harvesting system also needed to connect with the existing irrigation system which lies across the parklands. This required a new pipeline to be installed to connect the treated water in Rain Bank back to the other end of the parklands. Fortunately the underground carpark runs for the majority of this length so limited new excavation was required to install the new pipework. The other key consideration was to ensure that the pump rates from the treated water tank through the pipes was the same as the original potable rate to ensure that the irrigation system would not be impacted.

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TECHNOLOGY FOCUS:
SHIP (Stormwater Harvesting Interception Pit)

What is it?

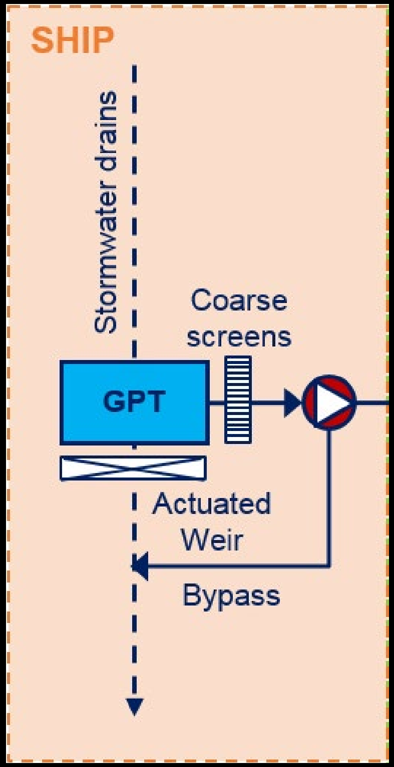
The Stormwater Harvesting Interception Pit (SHIP) was constructed over the existing 1950mm and 1800 mm diameter stormwater pipes that convey flow from a heavily urbanised catchment to the Brisbane River, beneath the South Bank Piazza within the parklands. The invert levels of these pipes sits approximately 200mm above the Low Tide mark, so, with a tidal range of more than 2m the pipes are subject to tidal inundation.

The weir within the SHIP is designed to stop tidal river water from entering the system and to intercept and hold stormwater flowing from the upstream catchment in the pipes so it can be pumped to the main storage tank. Therefore it was critical that the weir design could balance the pipe hydraulics, stormwater harvesting yield as well as tidal heights. The weir is a mechanical actuated weir which can be raised up above of the pipe during high storm flow events to prevent upstream surcharging and flooding. If the weir fails to open, water is able to flow over the weir, also without causing upstream flooding.

The SHIP also contains water quality instrumentation to test the incoming water quality, a **GPT** (screen) to separate coarse pollutants from the stormwater and a stormwater harvesting pump to transfer flows to the storage tank when acceptable water levels and water quality are met. If the water quality is not within the required levels the system bypasses and keeps testing until it comes into the limits that have been set.

The construction of the SHIP required careful consideration as it was being installed over large 'live' stormwater pipes. To minimise risk, the contractor, Stirloch, constructed the **SHIP** chamber in layers above the ground in a large watertight retaining structure (or caisson) which sat over the existing pipe. The pit was progressively formed and lowered into the ground by excavating within the caisson. This approach allowed the stormwater pipes to be left intact for as long as possible while most of the **SHIP** structure was being constructed in-situ above them. Once ready, the section of the pipes within the caisson was removed and a temporary baffle plate was placed on the downstream stormwater pipes while work was being undertaken to reduce tidal impact.

Following construction, it was identified that the tidal variation at South Bank was significantly greater than expected (+/- 200-300mm) and therefore saltwater was entering the system over the weir. To address this backflow, a hinged tidal gate was installed at the end of the stormwater pipe which was being harvested from.



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SHIP schematic diagram

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What did it cost?

Approximately $1.5M (Capex cost for collection)

What are the benefits?

- **Cost savings** – Installing the **SHIP** into the existing stormwater infrastructure provided significant cost and time savings for South Bank as it would have been difficult to construct a new set of pipes underground to provide the flood relief system in this heavily developed area.
- **Interception of spills** - A further benefit as a result of the weir installation **(SHIP)** is the potential to capture accidental spills that may occur in the catchment upstream instead of discharging into the Brisbane River.
- **Reduced river water ingress into stormwater networks** – The installation of the tidal gate at the end of the stormwater pipe reduces the risk of saline water impacting the harvested water quality as well as potentially providing flood benefits by reducing river water ingress into the pipe during flood events.

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SHIP flow schematic and image of the SHIP structure (image courtesy of David Hamlyn-Harris, Bligh Tanner)

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2. Balancing the site

The stormwater pipe in which the SHIP was installed captures flows from a 30ha developed urban catchment. Since water was going to be harvested directly from the pipe network, a combination of water balance and stormwater network modelling was required to assess the expected yield and viability of the project and to ensure that the hydraulics and hydrology of the pipes was understood to identify any potential impacts on local flooding.

A non-potable demand of 90ML/yr was assumed for use in irrigation, water features and toilet flushing. Catchment modelling estimated the likely annual stormwater runoff volume which could be captured in the stormwater pipe to be 77ML/yr. Approximately 32ML/yr of pool backwash water was also assumed to be available as an inflow to the system. Combined modelling of the stormwater pipe network and water balance showed that a significant amount of storage existed in the current infrastructure, more than what was required to meet the non-potable demand.

"We were able to save a lot of money by finding storage in existing infrastructure rather than having to build it somewhere else."

– Chris Tanner, CRCWSC (former Director, Bligh Tanner)

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Construction of water storage tank

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The size of the storage tank underwent considerable debate and review and ranged from 1ML to 5ML. A water balance assessment identified that a 2ML storage tank was suitable to store and supply 77ML/yr which would meet up to 85% of the site's non-potable water requirements. Analysis of all options, benefits and costs determined that increasing the size of the storage tanks above this would be costly and would provide limited improvement in the estimated reliability of water supply. The 2ML below ground concrete reservoir is split into 1.75ML for raw water storage and 0.25ML to store treated water. Having this provision for treated water storage allowed pump rates to be balanced between an ideal treatment rate of 6-7L/sec and a much higher rate taken out of the tank for irrigation.

"The cost of installing a bigger tank would only provide a marginal increase in volume and was therefore not considered worth it."

- David Hamlyn-Harris, Principal Consultant, Bligh Tanner.

Since its construction, the scheme is able to provide approximately 10 days' worth of irrigation at a time, resulting in an irrigation reliability between 60-85%. Irrigation is the primary focus for the use of the water and any 'surplus' is used for top-up of water features and for flushing of new toilets which have dual pipes provided.

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Timelapse of Rain Bank, South Bank's innovative, sustainable water source
https://youtu.be/R7HelkPW7ng

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TECHNOLOGY FOCUS: Water balance and stormwater network modelling

What is it?

Rain Bank was assessed in detail throughout its planning and design using a combination of excel and **XP-SWMM** models to understand:

- Hydraulics and hydrology of the pipes and proposed weir to understand flooding implications
- Water balance requirements for the project (demand vs supply)
- Yield and storage volume relationship to determine optimal tank volume
- Optimal pumping rate to maximise stormwater harvesting yield

Bligh Tanner had a number of calibrated combined excel and XP-SWMM models from previous projects which could be used to simulate continuous stormwater events to provide a high level of confidence in the water balance model for the site. However, for this project they wanted to combine this water balance model with an assessment of pipe hydraulics and hydrology to also understand the implications of putting a weir into the pipe. The use of the combined model in this way hadn't been done before in Australia and the team contacted colleagues in the USA to get advice. Once the model had been developed and tested, it provided the design team with a good understanding of the current conditions in the stormwater network and how it might operate under the design operations.

What are the benefits?

- **Cost savings** – Having a good understanding of the stormwater pipe network hydrology and hydraulics identified excess volume which was available for stormwater harvesting and storage reducing the amount of new infrastructure required for the design.
- **Confidence in design** – The detailed modelling provided confidence in the results and assured Brisbane City Council that the weir would not cause upstream flooding.

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3. Understanding the catchment

Rain Bank captures and treats stormwater from a highly developed urban catchment in the heart of Brisbane which is a mix of commercial, industrial and residential land uses. It was therefore important to understand the potential water quality generated in the catchment and the risk of using this water for irrigation at South Bank. A Hazard Analysis and Critical Control point (HACCP) process was undertaken in consultation with Queensland Health and other stakeholders to identify key risks and define required control systems to manage this risk. The key areas of risk identified in the assessment included:

- pollutants from roads,
- traffic accidents or fires,
- sewage overflows / leakage, and
- saline river water entry.

To inform the HACCP process, catchment water quality monitoring was undertaken for 6 months to obtain catchment specific baseline data. This data was used to inform the development of a suitable treatment process based on the likely incoming water quality (of both the stormwater runoff and pool backwash water) and the treated water quality objectives set for the project. These objectives were based on the most relevant guidelines available at the time which were:

- Australian Guidelines for Water Recycling: Stormwater Harvesting and Reuse – Draft for Public Comment (Phase 2) (EPHC, NHMRC, & NRMMC 2008b)
- Queensland Water Recycling Guidelines (EPA 2005)
- Australian and New Zealand Guidelines for Fresh and Marine Water (ANZECC & ARMCANZ 2000)
- Australian Guidelines for Water Recycling (Phase 1) (NRMMC, EPHC & AHMC 2006)

The catchment water quality monitoring also identified that Electrical Conductivity (EC) and pH were 2 critical water quality parameters which needed to be included in a long-term monitoring strategy for the system. A probe is located in the SHIP to monitor the water level as well as the quality of water at the weir. If the acceptable water quality parameters are not met, the pump is turned off so water does not enter the raw water storage tank. These water quality monitoring requirements and rules for treatment plant operations are set out in the Rain Bank Operations Manual. Since the installation of Rain Bank, there has only been one instance where catchment water quality was a major issue and this was thought to be a sewerage spill issue. The only other times the harvesting pumps have turned off has been due to unacceptable salinity levels in the water when River water enters the system or the pH has been out of range (usually the first flush after a dry spell).

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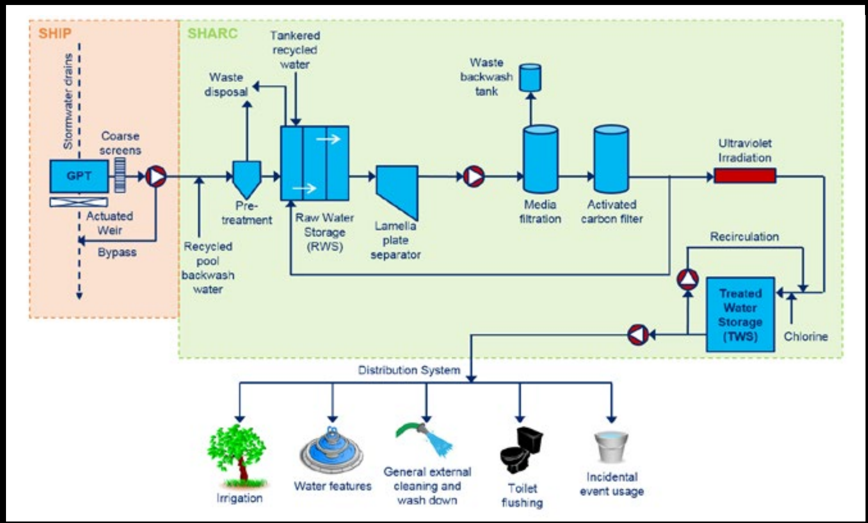
Technology focus: Rain bank treatment system

What is it?

The Rain Bank treatment plant was designed, manufactured and installed by Stornoway based on an understanding of the likely inflow quality and the required treated water quality objectives. Based on the site conditions, the treatment plant uses a multiple barrier treatment approach which includes the following:

- If water levels and water quality are acceptable in the SHIP, water is pumped to the raw water tank (as long as there is storage capacity available in the tank). Acceptable water quality levels for pH are between 6 and 8.5 and conductivity is less than 1600μS/cm.
- **GPT** – A screen within the SHIP chamber provides pre-treatment by removing gross pollutants to prevent following treatment elements becoming overloaded.
- **Coagulant dosing and mixing** –Water is pumped from the raw water storage to the treatment plant where a coagulant is added and mixed with the stormwater to cause fine particles to coagulate, making them easier to separate from the water during the clarification process. This step is rarely required due to the low turbidity of the raw water.
- **Removal of solids** – A Lamella Plate Clarifier is used to settle and remove solids from the water using gravity.
- **Media filtration** – Water is then passed through primary sand filtration where smaller particles are removed from the stormwater and turbidity is reduced prior to disinfection.
- **Activated carbon filter** - Activated carbon filtration is then used to remove any volatile organic compounds that may be present in the stormwater.
- **UV disinfection** – Water is passed through Ultraviolet (UV) irradiation to provide the primary disinfection of bacteria, viruses and protozoa that may have passed through the upstream treatment system.
- **Chlorination residual** – The last treatment process is a dose of liquid chlorine (sodium hypochlorite) to provide secondary disinfection and maintain a free chlorine residual in the treated water storage and distribution system.

Automatic samplers have been installed within the treated water distribution system to regularly test the water quality at the different stages of the process.



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Rain bank treatment process

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What did it cost?

Capex cost for storage $2.8M
Capex cost for treatment $0.8M

What are the benefits?

- **Converting waste into resource** – The Rain Bank treatment system is able to treat 500kL/day of untreated catchment stormwater flows and recycled pool backwash water so it can be safe to use for irrigation, water features and toilet flushing.
- **Fit-for-purpose treatment** – Establishing a good understanding at the start of the project of the likely quality of the inflows and the required treated water quality objectives ensured that the treatment process was suitable for the site conditions. The treatment process required at Rain Bank is fairly standard in the industry and didn't require costly or unknown infrastructure.

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Rain bank plant room (image courtesy of David Hamlyn-Harris, Bligh Tanner)

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Rain Bank's Treatment Plant Process - Part 1
https://youtu.be/eUA0wvB1Vq8

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Rain Bank's Treatment Plant Process - Part 2
https://youtu.be/XXqhl6JfH0E

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Rain Bank's Treatment Plant Process - Part 3
https://youtu.be/4ehwTuEnSB4

4. Best use of water

The initial objective of the Rain Bank project was to provide a new source of water which could replace potable water and tankered imported water to improve drought security and sustain the parklands important vegetation. Since its installation, the Rain Bank system has proven successful in supporting the lush sub-tropical landscape across the South Bank Parklands. The irrigation program run times are based on a weather station which can measure local evapotranspiration (ET) factors and ensures that irrigation is only provided when it is needed (between 40% and 160% ET).

To make the most of the treated water in times of rain, City Parklands also look for other alternative water use options, including providing additional irrigation in areas such as the nearby rainforest to build up soil storage which can improve the resilience of these areas when there is limited water available.

> "Ideally the optimisation of Rain Bank would be to increase demand. Reliability will drop, but the annual yield will increase."
>
> **- Chris Tanner, CRCWSC (former Director, Bligh Tanner)**

Treated water is also used to top-up water features and provides water for toilet flushing. At the moment the treated water is only available to a small number of new toilets which were installed with dual pipe systems. The demand for toilet flushing will increase as dual water reticulation is installed progressively into the toilets across the parklands.

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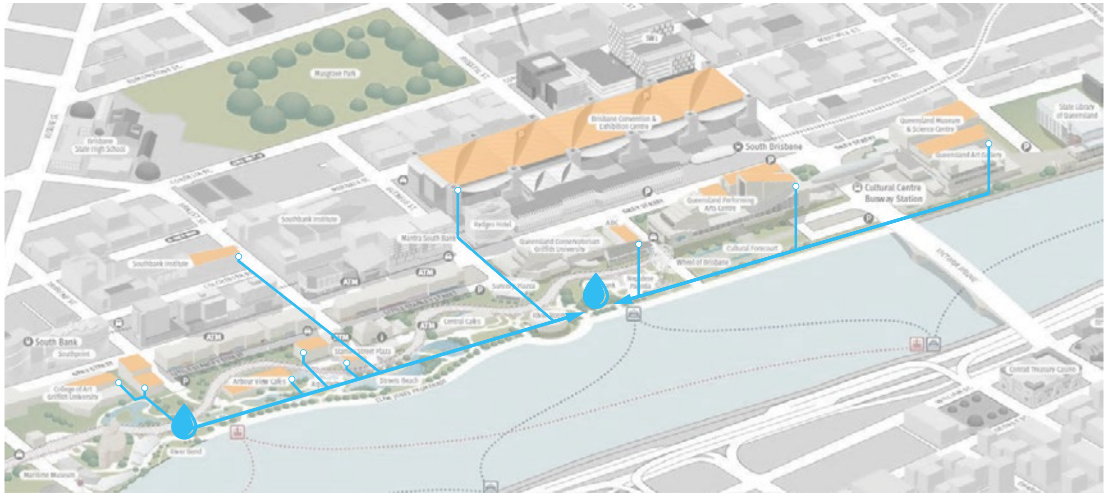
A CRCWSC research synthesis workshop with stakeholders in 2016 identified a range of ideas for water and energy initiatives aimed at improving the sustainability of the South Bank precinct. This was driven by Business Southbank who have a goal for South Bank to be Australia's most sustainable business precinct. One of the key ideas generated was the development of a Precinct-scale water network which could expand/duplicate Rain Bank to include additional rainwater capture from the roof catchments across South Bank and provide additional water storage as a distributed network.



Invest now

Undertake a feasibility assessment to map existing and new water storage and end use demands.

For example, the potential for Arts QLD and others to "share" roof water with South Bank Parklands.

Promising Project

Develop a master plan for precinct-scale water harvesting.

Where possible, **invest** in new local storages and harvesting.

Future Possibility

Create a water network to link storages across the South Bank precinct.

Expand the initiative to other areas: Kurilpa and beyond.

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Graphic from ideas for Southbank – https://watersensitivecities.org.au/ideas-south-bank/

The outcomes

1. Safe use of harvested stormwater in a highly used parkland

The South Bank Parklands are a busy, 24 hour public parkland which required water of suitable quality to ensure there are no public health and safety risks. This water quality also needs to be suitable to sustain healthy plants across the parklands. Rain Bank meets Class A+ standards and maintenance plans are in place and adhered to. Ongoing monitoring of the Rain Bank water quality has demonstrated that the water meets the objectives set for the treatment system and is safe for use in irrigation, water features and toilet flushing.

2. Demonstration and education

A key requirement for the design of Rain Bank was to utilise the popularity of the parklands and encourage visitor interaction to explain the Rain Bank system and the importance of water conservation and stormwater harvesting in general. A large window into the treatment plant allows visitors to view and learn about the treatment process. Infographics are also used to help communicate the importance of the Rain Bank system in providing an important alternative water source for the parklands. A seating area in front of the window also allows tour groups to come and learn about the Rain Bank system.

Rain Bank was officially opened by her Majesty Queen Elizabeth II and attracted significant media and public attention. Since this time, Rain Bank has continued to interest the community with tours regularly being delivered for groups such as schools, universities, engineering and other interest groups both from Australia and internationally.

> "Visiting Rain Bank for a site tour was eye-opening for the high school girls and inspired them about the role they could play as engineers in managing the impacts of urbanisation in our cities"
>
> - **Stephanie Brown, volunteer presenter for Power of Engineering high school site tour**

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Queen Elizabeth II opening Rain Bank

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Rain Bank viewing area

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3. Reliable alternative water source

Modelling estimated that Rain Bank could supply 77ML of water each year (6.4ML/month) based on historical daily rainfall data for the highly impervious catchment. The harvested volume of stormwater is dependent on local rainfall which can vary greatly from year to year. For example, in the first year of operation the median rainfall was lower than the long term average and therefore only 5ML/month was available on average. Over the 7 years of operation however, Rain Bank has been able to provide approximately 60ML/yr saving 420 million litres of drinking water.

"Due to highly impervious contributing catchment, only 12-15mm of rain is needed to fill the tanks."

- **Chris Tanner, CRCWSC (former Director, Bligh Tanner)**

4. Existing infrastructure can provide storage

The Rain Bank system demonstrates that detailed investigations into the existing infrastructure can provide cost savings for stormwater harvesting retrofit projects. Comprehensive modelling was critical to build project stakeholder confidence that the inclusion of a weir onto existing pipes would not impact local flooding and could also divert enough flows for a feasible stormwater harvesting solution.

"It was a surprise to find that an additional 700,000L of water storage could be achieved behind the weir due to the size and grade of the pipe."

– **David Hamlyn-Harris, Principal Consultant, Bligh Tanner**

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5. Cost effective water

It costs approximately $1.40 to $1.60/kL (operational cost) to generate treated water in the Rain Bank system which is considerably cheaper than potable water which is currently around $4.20/kl (as provided by local water utility) or $20/kl for tankered water. The cost effectiveness of the Rain Bank system should only improve in the future as potable water costs increase, especially in the next drought.

6. Integrated infrastructure creating a multi-functional landscape

It was critical that the inclusion of Rain Bank did not compromise much needed open space areas within the highly used parklands. The location and sub-ground level design of the stormwater harvesting system has resulted in a positive outcome for the parkland, allowing for a large grassed open space above the storage tanks and a public viewing area into the treatment plant in the Rainforest Walk area. The co-location of the viewing area in the shaded and intimate rainforest section also helps to promote the stormwater harvesting and irrigation story.

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Rain Bank treatment process viewed by visitors

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Summary of the outcomes

Cities as water supply catchments

- **Reduced potable water consumption** – It was estimated that 77ML/yr of non-potable would be available from Rainbank.
- **Fit-for-purpose use of water** – Non-potable water (treated stormwater and pool backwash) is used for irrigation, toilets and water features. Potable water is still currently required for high contact and human consumption uses such as the swimming pools and showers.

Cities providing ecosystem services

- **Reduced pollutant loads entering Brisbane River** – The retention and treatment of up to 77ML/yr of stormwater from a highly urbanised catchment removes a significant amount of pollutants that originally discharged directly into the Brisbane River.
- **Accidental spills capture** - Accidental spills that occur in the catchment can be captured in the pipeline upstream of the SHIP.
- **City greening and cooling** - The provision of an alternative water source has allowed the ongoing irrigation of this subtropical landscape which has cooling benefits in this heavily urbanised area.

Cities comprising water sensitive communities

- **Visitor education and demonstration** – A viewing area has been carefully incorporated into the design to allow visitors to see the water treatment area and learn about Rain Bank and maximised open public space.
- **Safe provision of water and landscapes** – The high quality and amenity of the parkland landscape is able to be maintained due to the provision of safe non-potable irrigation water.

The challenges

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1. Brisbane River influence

There were a number of delays caused by the proximity of Rain Bank to the tidal Brisbane River. This included the impact of the 2011 flood event and the ongoing tide levels.

The January 2011 flood event caused delays in the completion of the Rain Bank due to immediate clean-up required after the majority of the South Bank Parklands was inundated with muddy flood waters. Following this clean-up, the transition of the Rain Bank system from construction to operation was further impacted by the poor water quality caused by contamination of Council's stormwater system by 'toxic flood sludge' which required extensive clean-up throughout the contributing catchment.

The SHIP weir design ensured that there were no flooding issues as well as keeping out tidal inflows which cannot be treated. Following construction and the January 2011 floods, it was evident that the tidal information used to inform the design was incorrect and the tidal variation was in fact 200-300mm greater than expected. To prevent excessive backflow of tidal river water across the SHIP weir, a hinged tide gate was installed in early 2012. This was largely successful in reducing backflow events, however it was observed that wash generated from the CityCat ferries in the River was causing the gates to open occasionally, allowing the inflow of saline water. To address this new issue troughs have been recently bolted onto the gates which store water and weigh down the gate. These adaptive designs since construction have improved the operation of the treatment plant as it has limited the number of times the pumps have had to stop due to salinity levels in water behind the weir.

2. Construction in marine muds

South Bank Parklands are located on the bank of the Brisbane River and therefore the ground conditions were expected to be poor, with deep bearing depths (20-30m), high groundwater and potential acid sulphate soils. Geotechnical investigations were not possible however until the existing building was demolished which was done as a priority at the start of the project. Geotechnical investigations were then urgently undertaken to enable the foundation design (driven timber piles) to be finalised. A spear pump ring system was used to manage the groundwater which was of a suitable quality to allow disposal to Brisbane City Council drains. No acid sulphate soils were detected during the project.

←
Construction of Rain Bank

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3. Retrofit in a highly used iconic urban parkland

Retrofit can be difficult in developed urban areas due to location of existing services. Working within the South Bank Precinct added another complexity due to fact that it is a highly used space which is open 24 hours to the public.

Rain Bank is located very close to the main services corridor through the South Bank Parklands and required substantial excavation. Very detailed locational works (including frequent 'pot-holing') was therefore undertaken to ensure the design and construction of the system avoided these existing services.

Careful consideration was also required to ensure that public safety was considered throughout the construction of Rain Bank in the parklands to minimise noise, dust and impacts on pedestrian and vehicular traffic in the area. This was exacerbated by the fact that the adjacent ABC building was being constructed at the same time as the tank. Proactive management and close collaboration between the contractor and South Bank Corporation minimised any impacts on the public and tenants with little complaints received throughout the construction period. Following construction, the operation of the plant room generates minimal external noise due to the window design and glass thickness.

4. Development and commercial managers take on civil infrastructure development

South Bank Corporation was established as the development and management authority for the South Bank Precinct which includes the Parklands and surrounding cultural and commercial areas. Their key role is to develop and deliver on a long term vision for the precinct by overseeing the development and management of commercial assets. This has included land development across the brownfield site but had not included the delivery of major pieces of civil infrastructure such as stormwater.

Southbank Corporation sought advice from consultants Bligh Tanner to understand the best option to design and construct the stormwater harvesting scheme. It was decided that the best option was to develop tender documentation for definable scope of works (site demolition and preparation, landscape, water reticulation) while the SHIP structure, storage tanks and treatment plant were incorporated as design and construct elements within a lump sum tender. This option gave South Bank Corporation some control and certainty over budget but allowed the contractor's expertise to be incorporated into the main harvesting and treatment infrastructure design. Hold points throughout the design process for these elements allowed South Bank Corporation and the consultants to review and approve the developing design against performance criteria which was established at the start of the tender.

The lessons

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This project demonstrates...

- **Urban stormwater can provide a reliable irrigation supply for city parklands:** The installation of Rain Bank within the South Bank Parklands has allowed the sub-tropical landscape across the parklands to be re-established and maintained since the drought. The highly impervious nature of the contributing catchment has helped to maintain a good reliability in the alternative water supply (between 60-85%).
- **Looking below the ground can identify opportunities in existing infrastructure networks:** The retrofit of the stormwater harvesting scheme into the highly used urban parklands was made more cost effective by using existing infrastructure as part of the solution. This option was only identified as a possibility due to extensive questioning and investigations to confirm what stormwater pipes were actually located under the precinct, followed by detailed modelling to understand their capacity.
- **Be open to all ideas:** South Bank Corporation were keen to have a sustainable long term solution for irrigation across the parklands and therefore invested in an assessment of all potential solutions. These open and creative discussions within the City Parklands team has resulted in the continued improvement and optimisation of the water management strategy across the parklands.
- **Simplicity in a single management entity:** South Bank Corporation had control over the majority of the project as the owner and manager of the parklands, landscapes and on-site water management. Approval from Brisbane City Council was only required to undertake works on their main stormwater network (e.g. inclusion of weir and tidal gates). This high level control over all elements of the project allowed for a streamlined and efficient design and construction process.
- **Well-designed infrastructure can add value to high amenity parklands:** The careful design of the Rain Bank system ensured that the majority of the solution was constructed underground to allow for functional open space areas to be provided above. The large window opening into the underground treatment system however still allows visitors to understand what is happening below the grassy areas and how it is supporting the lush, green landscapes across the parklands.

Reflections and what to work on next time...

- **SHIP pit and weir design:** In hindsight, there are a few elements which could have been improved in the SHIP pit and weir design. The inclusion of tidal flaps (or an alternative solution) to address higher than expected tidal levels early in the design process would have saved time in the project delivery. Locating the water quality monitoring probe within the pit has also been problematic due to conditions in the pit and access. Innovations by Bligh Tanner for the design of later stormwater harvesting projects have led to the development of a floating weir system which would also improve the current system.

- **Allow time for planning and construction of infrastructure when dealing with 'live' stormwater network retrofits:** An experienced contractor was able to deal with the contractual risk of working on 'live' stormwater networks by developing a construction method which left the existing stormwater network intact as long as possible. This methodology worked well although the construction of the SHIP took longer than anticipated to complete.

- **Infrastructure needs to be flexible in the design stage as other built forms are likely to take precedence in urbanised areas:** Rain Bank was originally supposed to be located closer to Grey Street and Russell Street but had to change locations early in the design process as the new ABC building was proposed for this location instead. This resulted in some rework by the design team and extended the timeline of the project but did not compromise the overall intent of the stormwater harvesting project.

About us

The Cooperative Research Centre for Water Sensitive Cities (CRCWSC) was established in July 2012 to help change the way we design, build, and manage our cities and towns by valuing the contribution water makes to economic development and growth, quality of life, and the ecosystems of which cities are a part.

The CRCWSC is an Australian research centre that brings together many disciplines, world renowned subject matter experts, and industry thought leaders who want to revolutionise urban water management in Australia and overseas.

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