THE SOUTH BANK SHARC
AN ICONIC PROJECT FOR AN ICON OF BRISBANE

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ABSTRACT
This paper provides an overview of the challenges that have been faced in developing a more secure and drought-resistant water supply for the South Bank Parklands. In particular it outlines the background to the development of the project, the design challenges overcome and the risk assessment process that was undertaken to confirm water quality and treatment requirements. A description of the project is provided, including how it is expected to be configured and perform.

INTRODUCTION
South Bank Parklands is an iconic recreational area of unparalleled importance to the City of Brisbane. It is the focus for much of the cultural and recreational life of Brisbane. It is home to Australia's only city-centre beach and attracts local and international visitors alike. Water is fundamental to the Parklands, used for the numerous pools and water features as well as being crucial for maintaining the sub-tropical landscaping that is central to the character of the precinct.

Bligh Tanner is working with South Bank Corporation to provide a more secure water supply system for the South Bank Parklands in the long-term. Water sources that have previously been evaluated include sewer mining, desalinating water from the Brisbane River, harvesting rainwater from the large roof areas within South Bank, collecting stormwater runoff from local catchments, tankering imported recycled water, recycling swimming pool backwash and groundwater.

Following a lengthy feasibility and evaluation process, South Bank Corporation is now proceeding to construction of the South Bank Stormwater Harvesting and Recycling Centre (SHARC) project. The SHARC will be an iconic water management project because it will be possibly the largest stormwater harvesting project in Australia, it will harvest water from a highly urbanised catchment, and it will provide a great learning opportunity for future similar projects.

The SHARC will harvest stormwater runoff from a 30 ha urban catchment extending from South Bank into West End. Water will be extracted from a diversion pit located near the Suncorp Piazza and pumped into a 2 to 3 ML off-line storage tank. The water will be pre-treated going into the storage and polished and disinfected for reuse before distribution. The water will initially be distributed for landscape irrigation and for water features, but it may later also be used for toilet flushing and pool backwash, if this is acceptable.

In addition to harvested stormwater, the SHARC system will also use waste pool backwash water from the swimming pools and may also on occasions receive tankered imported water from off-site.

The SHARC Project is being undertaken by South Bank Corporation with funding support from the Queensland Government. The project is being actively supported and monitored by a range of agencies, including Queensland Water Commission, Brisbane City Council, SEQ Healthy Waterways Partnership, SEQ Urban Water Security Research Alliance and Queensland Health.

Construction of the South Bank SHARC is expected to commence in September.

OBJECTIVES

The objective of the SHARC Project is to develop a substantial new source of water to substitute for potable water and tankered imported water and to improve the drought security of the Parklands.

THE IMPORTANCE OF WATER TO SOUTH BANK PARKLANDS

South Bank depends heavily on a reliable source of water to maintain the sub-tropical environment that has been created and to protect the substantial investment in landscaping and public facilities.

South Bank currently uses potable water for swimming pool top-up and backwash and for toilet flushing in the various public facilities. It also uses recycled waste backwash water from the pools and tankered imported recycled water from Caboolture for irrigation of landscaping and for the water features. Under Level 6 restrictions, potable water was not able to be used for irrigation or water features and its use in the pools was limited, ie active water features such as the recently completed Aquativity system could not be used.

The drought has affected the South Bank Parklands substantially, as illustrated in the following figure showing water usage before, during and after drought restrictions. The availability of water for landscape irrigation dropped from over 250 kL/day to around 50 kL/day, all of which has been supplied from either backwash recycling or imported tankered water. The figure also illustrates the reductions in water use for the pools achieved as a result of resealing the pool systems and an extensive pipe testing and repair program. Projected future water use is shown in Table 1.

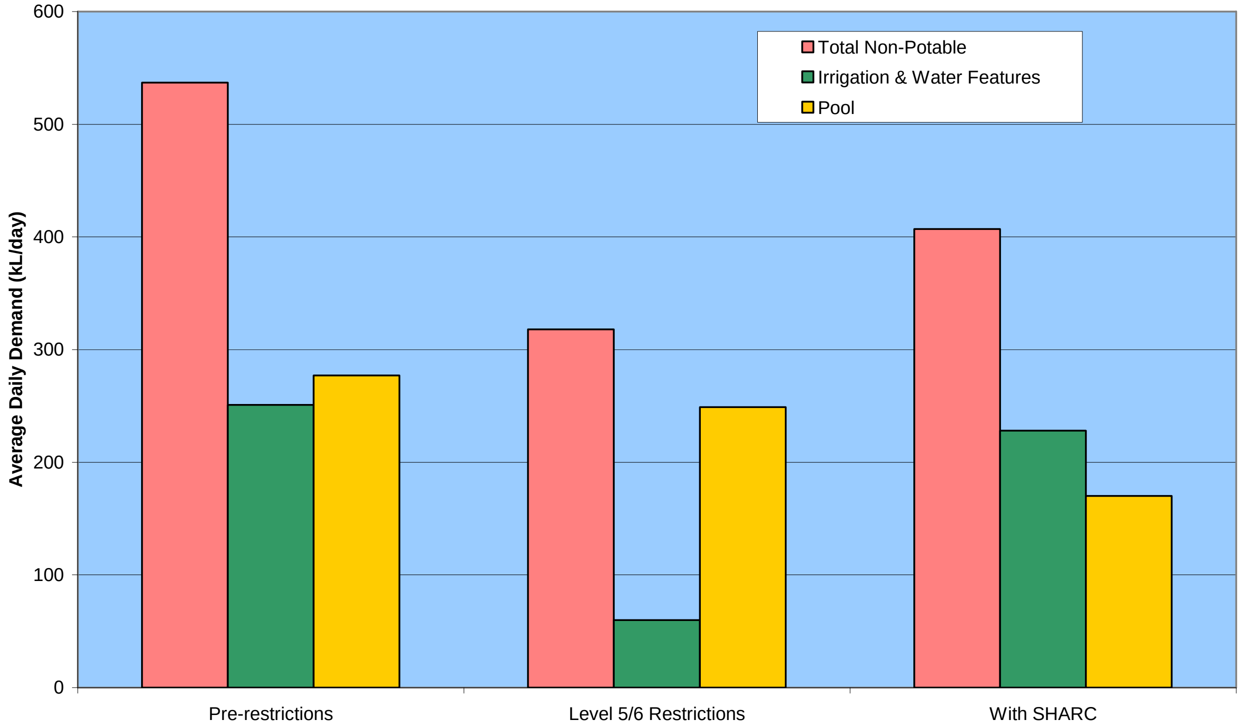

Figure 1 South Bank Parklands Water Use

Table 1 Projected Water Demands

Use	Average Water Demand
Irrigation of parklands	205 kL/day
Refilling water features	23 kL/day
General external washdown and cleaning	1 kL/day
Public toilet flushing	8 kL/day
Pool backwashing	85 kL/day
Pool top-up	85 kL/day
Total	**407 kL/day** **149 ML/yr**

PROJECT SCOPE

The main components of the SHARC will include:

- A 30 ha highly urbanised catchment including residential, parkland, commercial, business and recreational development as well as major roads and transport infrastructure (refer to Figure 3);
- The Stormwater Harvesting Interception Pit (SHIP) to be constructed on an existing 1950 mm diameter stormwater drain between the Piazza and the Riverside Restaurants. The SHIP will incorporate a weir to exclude tidal river water and to hold back the stormwater runoff, a harvesting pump and gross pollutant trap. (refer to Figures 3 and 4);
- A 2 or 3 ML below-ground reinforced concrete storage tank (the SHARC tank) to be constructed under Russell St Green; the SHARC Tank will be subdivided into Raw Water Storage (RWS) and Treated Water Storage (TWS) tanks;
- A below-ground plant room to house the treatment facilities constructed as an integral part of the SHARC Tank;
- The Stormwater Treatment Plant (SWTP) to provide a high standard of filtration and disinfection of the water for use;
- Raw water harvesting and treated water distribution pipelines.

The schematic flow diagram for the SHARC is illustrated in Figure 2 and the general layout of the system is shown in Figures 3 and 4.

ANTICIPATED SYSTEM YIELD

The estimated yield from the SHARC is summarised below.

Table 2 Estimated SHARC Water Yield

Uses	Yield	
	ML/yr	**% demand**
Irrigation and water features	73	87%
Irrigation, water features and swimming pools	102	69%

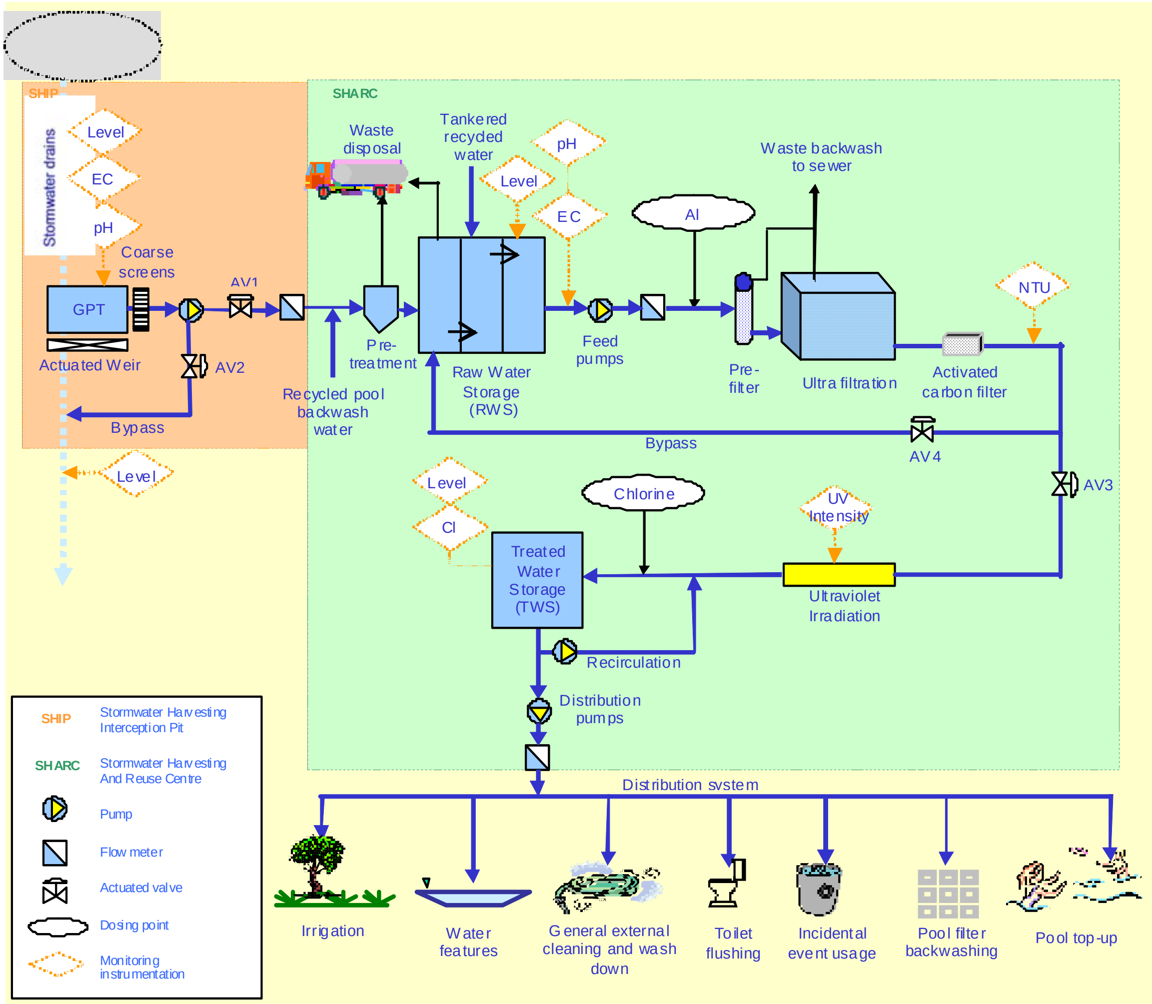

Figure 2 South Bank SHARC Flow Schematic

Figure 3 South Bank SHARC Catchment

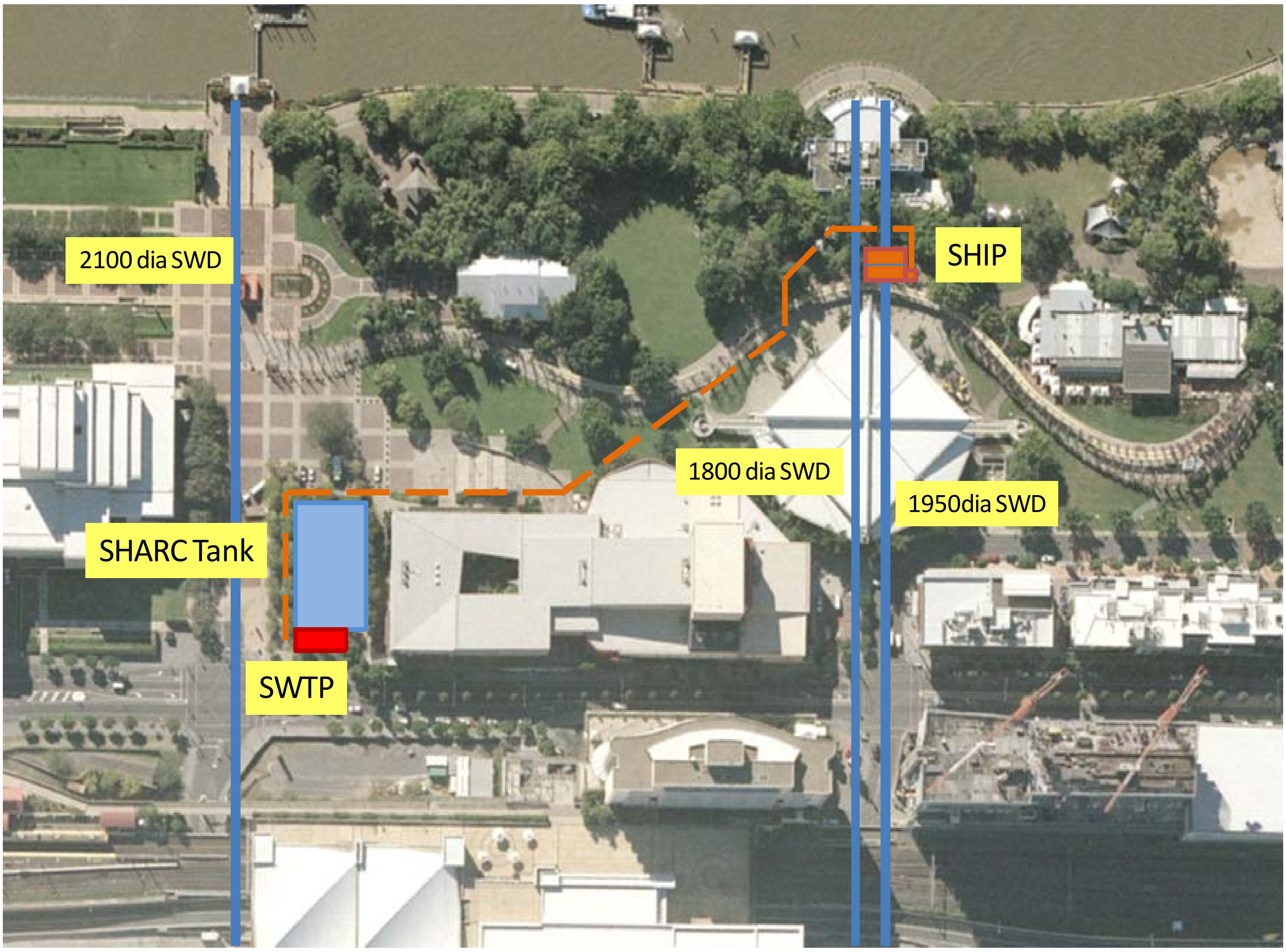

Figure 4 South Bank SHARC Overview

THE CHALLENGES FACED

The experience of this project has been that there are substantial challenges to be overcome in defining the requirements for and designing a stormwater harvesting system, including:

- System sizing
- Understanding the existing drainage system
- Ownership of the drainage system
- Tide levels & river salinity
- Catchment runoff & flooding
- Catchment modelling
- Water quality & treatment
- Risk assessment
- System siting
- Construction in Parklands
- Underground construction
- Geotechnical conditions
- ASS
- Existing services
- Procurement

SYSTEM SIZING

Challenges: The yield from any rain or stormwater harvesting scheme will be limited by either the local rainfall, the available catchment area, the rate at which water can be diverted to the storage or the volume of storage available. Optimisation of these parameters to achieve the most cost-effective system is therefore very important to the success of the project.

Solutions: The relationship between storage volume and yield was investigated using a daily time step water balance model, taking into account seasonal variations in water demand. The effect of storage on average system yield (ie the average volume of stormwater supplied annually as a percentage of the total annual stormwater demand) is illustrated in Figure 5.

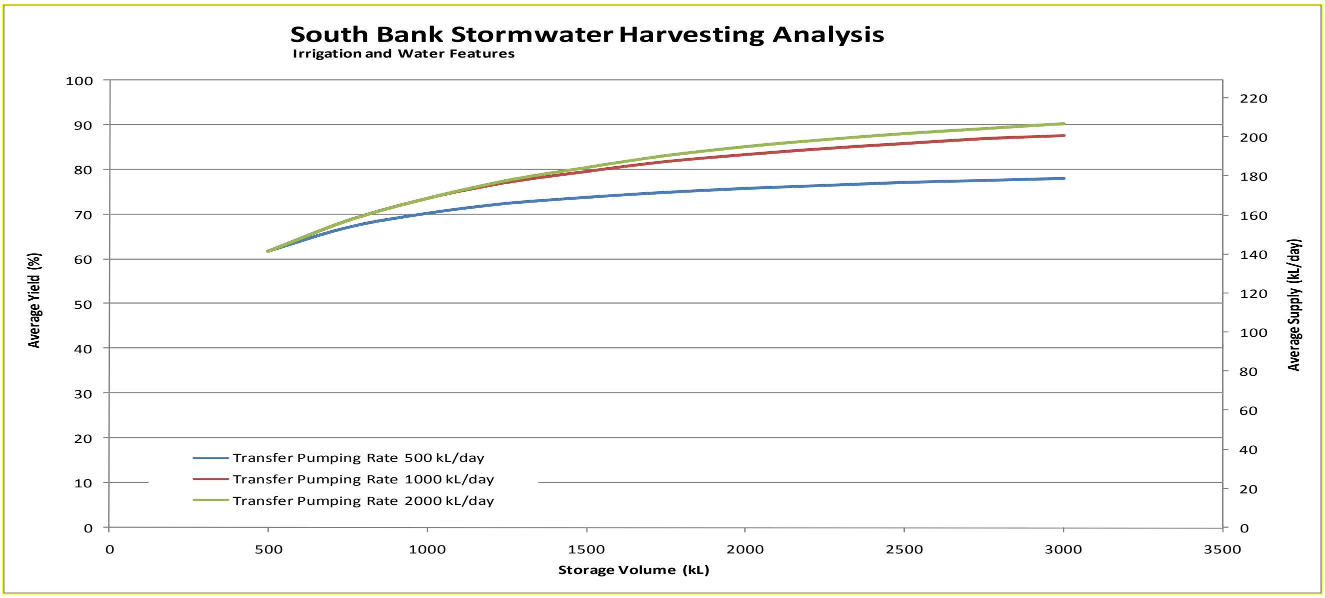

Figure 5 Water Balance Results - Average Yield vs Storage Volume

The analysis concluded that a storage volume of between 2 and 3 ML could yield up to 90% of the demand for irrigation and water features. The modelling also concluded that the stormwater harvesting transfer rate should be no less then 2000 kL/day to ensure efficient use of the available runoff.

The daily model was, however, unable to determine the pumping rate required to achieve the minimum daily transfer. This was assessed using the catchment model discussed below.

UNDERSTANDING THE EXISTING DRAINAGE SYSTEM

Challenges: The existing stormwater drainage system in the South Bank / West End area is an old system, developed in various stages over a period of around 80 years. The available as-constructed record is somewhat unclear and inconsistent. It is essential to understand the existing systems for system design and for accurate catchment modelling to be undertaken, especially with regard to the potential for the harvesting system to impact catchment flooding.

Solutions: A detailed review of Council's records was undertaken with the detail verified on-site through visual inspections. Extensive investigations were completed to confirm the location of the main stormwater drainage system in the catchment. Major pipes were accessed and photographed and key dimensions checked. The results of this work are reflected extensively in the conceptual design of the SHIP and in the catchment modelling. Ground truthing also included visual verification of inlet gullies and manholes.

OWNERSHIP OF THE DRAINAGE SYSTEM

Challenges: The works proposed for the SHARC are wholly located within the South Bank Parklands on land that is owned and operated by South Bank Corporation. However, the stormwater drainage pipeline on which the SHIP will be constructed is owned and maintained by Brisbane City Council (BCC). Access to this system for construction and operation of the SHIP requires BCC approval and will be subject to a formal access agreement.

Solutions: The project has been developed in close consultation with BCC to ensure that Council is able to accept the proposed infrastructure confident that the system will have the appropriate controls and that it will not result in any adverse catchment impacts, including flooding.

TIDE LEVELS & RIVER SALINITY

Challenges: The SHIP is to be constructed on a 1950 mm diameter stormwater drain that is subject to tidal inundation. The invert level of the pipe is at approximately -0.7mAHD with the obvert at 1.25mAHD. The Brisbane River at this point has a TDS of approximately 27,000 mg/L and is unsuitable for recycling without desalination.

Solutions: Hourly tide level data from the Brisbane Port Office were obtained to accurately characterise the expected tidal range for design. At the SHIP the pipe can range from empty to full over a normal range of tides (refer to Figure 6). It is also noted that, while the normal high tides range between 0.98 mAHD (MHWS) and 1.55 mAHD (HAT), the maximum recorded tide in the river at this location is 2.1 mAHD.

An electrically actuated undershot weir gate will be provided across the pipe in the SHIP to keep the highly saline river water from the stormwater harvesting system. The weir will be normally closed and is designed to open in the event of high storm flow to prevent upstream surcharging. The tidal variation is of critical importance in setting the weir level because it needs to be high enough to exclude most tides yet not too high that it causes upstream flooding if the weir is overtopped. The weir level has been set at RL +1.2m. At that level it will be overtopped by the tide for 2% of the time, ie 98% of the time the tide will be below the weir crest. Also, with the weir at that level, if the weir fails to open during a storm event, the upstream surcharging will not be high enough to cause flooding.

Salinity monitoring instrumentation in the SHIP will prevent the transfer of salty water to the SHARC if the weir is overtopped by the tide.

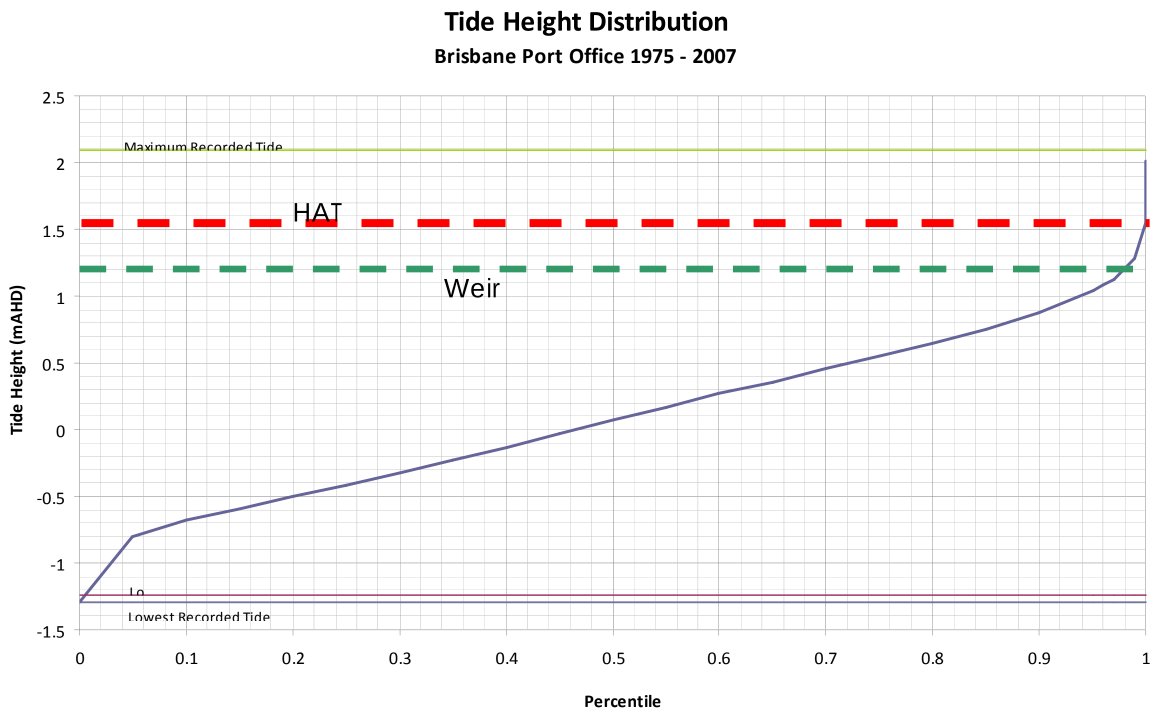

Figure 6 Percentile Analysis of Tidal Variation

CATCHMENT MODELLING

Challenges: Detailed modelling of the stormwater catchment was required to assess the implications of the proposed SHIP weir on catchment drainage in the event that it fails to open during a storm event and to determine the optimum harvesting pump rate. The anticipated impacts of climate change (ie 30% more intense storm events and a 200 mm rise in sea levels) were also assessed.

Solutions: Detailed modelling of the stormwater catchment was completed using the XP-SWMM model.

The model was tested for storm events with a range of recurrence intervals (ARI 1 to 100 yrs) for a range of rainfall durations (15 to 120 minutes). A 60 min rainfall event was found to be critical for design. Based on this modelling a SHIP weir crest level of RL 1.2 m and an overall weir crest length of 3.0 m was selected. The analysis of catchment drainage under design storm events with and without the SHIP weir indicates that, if the weir fails to open, the upstream HGL level will increase though stormwater will be contained within the underground drainage system.

A long-term simulation of stormwater harvesting yields using the SWMM model assessed the optimum stormwater harvesting pumping rate to be 40 L/s. This maximises the potential stormwater yield over the range of expected water demands. Catchment runoff rates for many storm events are significantly higher than this pumping rate (15% of all events exceed 40 L/s), however, the ability to harvest water is limited by the volume of storage available and how quickly it fills during an event.

The assessment of the impact of climate change indicates that a significant increase in peak runoff flows reaching the weir will increase water levels upstream of the weir but will not result in any surcharge at any point in the drainage system. In addition, the expected increase in seawater level will not have any significant effect on upstream water levels.

WATER QUALITY

Challenges: Stormwater runoff quality, especially from an urbanised catchment such as this one is expected to be relatively poor and highly variable. In addition, there was no existing catchment specific water quality data available. An understanding of the likely runoff water quality and the appropriate objectives for the treated water was essential to provide a starting point for planning and design of stormwater treatment systems as well as the long-term monitoring program.

Solutions: Water quality issues were investigated in detail to inform both the system design and risk assessment processes. Research was undertaken to determine the likely quality of untreated stormwater and to define stormwater runoff quality parameters to be adopted for the design of treatment systems. In addition, a review of available guidelines was undertaken to determine appropriate water treatment objectives to protect the environment and human health.

A limited catchment water quality monitoring program was initiated to obtain catchment specific data and to help develop a long-term monitoring strategy.

RISK ASSESSMENT

Challenges: In accordance with the requirements of the Draft Australian Guidelines for Stormwater Harvesting and Reuse – Phase 2, (EPHC, NHMRC & NRMMC 2008) it was necessary and appropriate to undertake a health risk analysis in order to determine the minimum water quality requirements for the proposed water uses and the treatment train required to achieve that quality. There are few, if any, precedents for a risk analysis for this application.

Solutions: A detailed risk assessment was undertaken to identify the key risks associated with the project, the control systems required to manage the risks and the key points in the system at which the risks should be managed. A Hazard Analysis and Critical Control Point (HACCP) process was used, consistent with the management frameworks recommended for the development of water supply systems in Australia, including in the Draft Stormwater Harvesting Guidelines and the Australian Drinking Water Guidelines (2004).

From a water quality perspective, the key areas of risk identified in the assessment included:

- The level of sediments / suspended solids / turbidity in the stormwater runoff;
- Hydrocarbons and other pollutants from road runoff (major roads cross the catchment);
- The potential for traffic accidents or fires to cause significant pollutant spills;
- The potential for sewage overflows / leakage to affect runoff quality;
- The potential for saline river water to enter the system;
- The need to provide effective disinfection to remove pathogens;
- Potential failure of the treatment systems to achieve the required quality, especially with respect to disinfection standards;
- The inability of water quality monitoring systems to identify treatment problems in real time;
- Deliberate vandalism or sabotage introducing contaminants.

The outcome is a series of critical control points and other supporting programs identified for the scheme. These include:

- A treatment train that aims to address each of the identified water quality concerns;
- A multiple barrier approach to treatment;
- Comprehensive monitoring programs of the raw and treated waters;
- A design that allows for pollutant spills to be captured in-pipe before diversion to the storage, providing the opportunity for interception and disposal;
- Automatic monitoring and bypass of saline river water;
- Proposed protocols with Council and Emergency Services in the event of an accident or fire.

TREATMENT

Challenges: As discussed above, the water quality review and risk assessment highlighted a range of contaminants of concern, all of which must be effectively removed by the treatment processes.

Solutions: The objective of stormwater treatment system is to reduce the concentration of constituents in urban stormwater runoff that are likely to occur at concentrations that may be hazardous to human health or the environment. The broad treatment objectives are:

- Exclusion of coarse sediment and litter;
- Removal of settleable solids;
- Removal of hydrocarbons;
- Filtration to remove suspended solids and reduce turbidity;
- Activated carbon filtration to reduce organic chemicals;
- Disinfection to denature/kill pathogens; and
- Residual chlorination.

The preferred treatment train includes media filtration, ultrafiltration, activated carbon filtration, UV disinfection, and residual chlorination using hypochlorite (refer to Figure 2). This will address the issues raised in the risk assessment particularly if water is to be used for pool back-wash and top up. It is recognised that media filtration could be sufficient where water is to be used for irrigation and toilet flushing purposes and that the decision to move to a higher level of treatment needs to be supported by financial analysis considering the additional plant cost, reduced service life and increased operational and maintenance costs.

SITING

Challenges: A project such as this can only proceed if there is a clearly identifiable catchment, a suitable location from which to divert stormwater flows and somewhere to build a substantial water storage.

Solutions: A number of surface catchments drain through the Parklands. The catchment upstream of Glenelg St provides a substantial area and a well defined and accessible stormwater drainage system from which to harvest.

Secondly, SBC was able to identify a location where a large underground storage tank and plant room could be constructed. The SHARC Tank and plant room will be constructed beneath the area known as Russell Street Green between the Queensland Conservatorium and the Performing Arts Centre.

CONSTRUCTION IN PARKLANDS

Challenges: South Bank has seen a diverse range of uses in the 170 years since Brisbane was first settled. For many years it was a port and industrial area, transformed in the 1980's into the EXPO 88 site and then subsequently reborn as South Bank. The Parklands is one of the busiest public precincts in Brisbane. Open 24 hrs a day every day of the year, it combines high use recreational facilities, public entertainment, educational facilities, restaurants, retail and commercial businesses and residential uses. It also hosts the city's major events such as River Fire and New Years Eve. Construction in this area will be challenging and will need to overcome issues of poor ground conditions, the buried remnants of past site uses, high public usage, the need to avoid disruption to businesses and residents, a myriad of services and a very congested site.

Solutions: The strategy adopted to address these issues is based on below-ground construction of facilities to minimise the long-term impacts, and well controlled construction activities both in terms of confined work sites and short construction periods. Other approaches to be adopted include the use of sacrificial sheet piling as the outer formwork for buried concrete structures to reduce the extent of excavation, directional drilling of services to reduce general disruption and the installation of some pipework suspended within the underground carpark to avoid trenching.

UNDERGROUND CONSTRUCTION

Challenges: It is a requirement of South Bank Corporation for works to be below ground to minimise the physical and aesthetic impact on the Parklands.

Solutions: As noted above, all works will be buried. Following completion, the facilities will be invisible to the general public and will have no adverse impact on the activities if the Parklands.

GEOTECHNICAL CONDITIONS

Challenges: South Bank and the proposed stormwater harvesting facilities are located very close to the Brisbane River and geotechnical conditions are characterised by alluvial sediments over a variable rock level. In addition, the previous land uses introduce a degree of uncertainty regarding what may be buried below the surface. The SHARC Tank site is underlain by rock varying from approximately 6 m to 12 m depth. The material above the rock varies but is known to include old building rubble and foundations near the surface; there is evidence of old concrete slabs. Groundwater is relatively shallow at around 2.5 m. The SHIP site is closer to the river and on approximately 20 m of alluvium above rock.

Solutions: Extensive geotechnical investigations were completed at South Bank for EXPO 88 and the subsequent site redevelopment. These investigations provided some information regarding geotechnical conditions at the SHIP and SHARC sites. Additional drilling has been undertaken during 2008.

Geotechnical conditions have been carefully addressed in determining the most appropriate construction methodology. The SHARC tank will be founded on bored concrete piles, designed as tension piles to help resist uplift. The SHIP will be founded on driven piles.

ACID SULPHATE SOILS

Challenges: Geotechnical investigations identified the presence of potential acid sulphate soils (ASS) in the undisturbed alluvial layers at the lower levels of excavation.

Solutions: Excavated acid sulphate soils will be lime treated prior to removal from site. If necessary, dewatered groundwater that has come into contact with ASS will be treated for pH correction before discharge.

SERVICES

Challenges: As noted before, the history of the site use and the congested nature of the Parklands, gives a site with many buried services that need to be protected in construction.

Solutions: A detailed survey of services and surface features was necessary to provide accurate information for design and tendering purposes. Survey included remote location of all services, vacuum potholing and detailed survey and levelling. The results of the survey have been used to provide base plans for the design drawings.

PROJECT PROCUREMENT PROCESS

Challenges: What is the best means of delivering a complex project such as this in such a difficult and publicly visible precinct?

Solutions: The project procurement approach adopted has been one of inviting Expressions of Interest from suitable contractors and specialist suppliers. The objective is to take advantage of the skills and expertise of the contractors / suppliers in finalising the designs and to agree firm contract prices. At the time of writing, we are getting close to being able to award a civil works contract. Submissions are also being sought from suppliers of water treatment systems for the stormwater treatment plant.

COMMUNICATIONS

The South Bank Corporation recognises the importance of investing in public information and communication to help improve the quality of runoff from the stormwater catchment area through better catchment management and to further educate the public on the importance of water projects such as this as part of a diversified water supply strategy for the city. A comprehensive communications strategy will be implemented in conjunction with the construction of the SHARC, targeting the residents and occupants within the catchment and the general public using the Parklands.

DESIGN SUMMARY

The key design parameters for the SHARC are summarised below.

Table 4 Key SHARC Design Parameters

Component	**Design Parameters**
SHIP:	
Weir level	RL 1.2 m AHD
Weir height above pipe invert	2.0 m
Weir crest length	3 m
Actuated weir gate length	Approx 2 m
Diversion pump rate	40 L/s

Component	Design Parameters
SHARC Tank:	
Total storage volume	2 to 3 ML
Raw Water Storage volume	1.7 to 2.7 ML
Treated Water Storage volume	0.3 ML
Tank depth (internal)	4.8 m
Tank depth (below ground level)	Approx. 5.7 m to invert
Full water depth	4.3 m
SWTP:	
Design treatment rate	600 kL/day (7.5 L/s over 22 hours)
UV dose	240 mJ/cm^2
Chlorine residual dose	1-2 mg/L
Distribution System:	
Distribution pumping rate	0 to 22 L/s
Design pumping head at pump	60.5 m @ 22 L/s
Distribution pipe diameter at pumps	160 mm MDPE

CONCLUSIONS

The South Bank SHARC is a highly ambitious project given the scale of the proposed facilities, its location within one of the most built-up parts of Brisbane and because there are so few precedents to follow. As such it has been a very interesting and challenging project to develop, throwing up a diverse range of issues, some anticipated, some unexpected, that have needed to be overcome. Nevertheless, thanks to the on-going commitment of South Bank Corporation to the project, effective solutions have been identified and the project is moving forward. At the time of presenting this paper, construction of the stormwater diversion and storage tank are about to commence. Completion of construction and installation of treatment equipment is expected by around April 2009. All we need then is for it to rain to allow the system to be commissioned. By the second half of 2009 we hope to have an operational stormwater harvesting system up and running.

REFERENCES

Environmental Protection and Heritage Council (EPHC), National Health and Medical Research Council (NHMRC) and Natural Resource Management Ministerial Council (NRMMC) 2008b, *Australian Guidelines for Water Recycling: Stormwater Harvesting and Reuse - Draft for Public Comment (Phase 2)*, Biotext, Canberra.