Topic - Flood management and stream flow – managing, designing and recovering waterways

0071 – Non Refereed Paper
Lessons learnt from Designing and Constructing a $4million Stormwater Harvesting Scheme

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1. ABSTRACT

Blacktown City Council has designed, built and commissioned a $4 million stormwater harvesting scheme that will harvest up to 200ML per year from Angus Creek. The scheme provides water for irrigation and toilet flushing at the Blacktown International Sports Park and several surrounding venues. The scheme allows for environmental flows and aims to provide benefit to the downstream aquatic ecosystem by reducing the severity and frequency of storm flows that cause erosion and stream degradation. The project has potential implications for the sustainability criteria of decentralised water supply schemes in other urban areas as well as challenging current approaches to urban waterway rehabilitation.

This paper provides a background to the Angus Creek stormwater harvesting scheme and shares the numerous lessons learnt through the design, construction and commissioning of a large scale stormwater harvesting scheme that extracts water from an urban creek in NSW. We will also discuss the licensing and regulatory requirements prevailing at the time including the need to comply with the Water Management Act and exercising of harvestable rights.

2. INTRODUCTION

2.1 SCHEME BACKGROUND

The Angus Creek Stormwater Harvesting and Reuse Scheme (the scheme) harvests stormwater from Angus Creek in Sydney, NSW. The Angus Creek catchment is 655ha in area and drains the suburbs of Rooty Hill and Minchinbury. The catchment consists of low and medium density housing with small areas of commercial development. Approximately 35% of the catchment is classified as directly connected impervious (hard surfaces such as roads, paths, roofs etc.). The catchment generates approximately 2 billion litres of stormwater in an average rainfall year and the scheme has approval to harvest 200 million litres per year, which is equivalent to 10% of the average total flow or approximately 80 Olympic sized swimming pools of water.

The main user of the harvested stormwater is the Blacktown International Sportspark (the Sportspark), which is a high profile regional sporting complex located in Rooty Hill. The Sportspark is used by Cricket NSW, AFL NSW/ACT, Western Sydney Wanderers, Softball NSW, Athletics NSW etc. The harvested stormwater will be used to irrigate the Sportspark and sounding Council sporting reserves, including Anne Aquilina, Kareela and Charlie Bali Reserves, and to supply water for the ornamental lakes at Nurringingy Reserve. The water will also be used for dual reticulation (toilet flushing) at the AFL and athletics precinct at the Sportspark. See Figure 1 for a map indicating the location of the Blacktown International Sportspark and all other reserves associated with the scheme.

The scheme was originally intended to be a Managed Aquifer Recharge scheme. The collected stormwater was to be pumped into and stored in an aquifer until it was extracted for irrigation. Intensive drilling investigations discovered that the aquifer was too deep and the flow rates were insufficient to support such a large scheme and the managed aquifer recharge scheme was abandoned. The stormwater harvesting scheme was then modified to store the stormwater in above ground storages such as ponds and wetlands.

The scheme has the following benefits for Blacktown City Council, including:
- Reducing potable water used for irrigation and toilet flushing
- Increasing the drought resistance of the sporting fields during drought periods

- Improving the quantity of water being supplied to the Sportspark
- Improving the condition of Angus Creek.

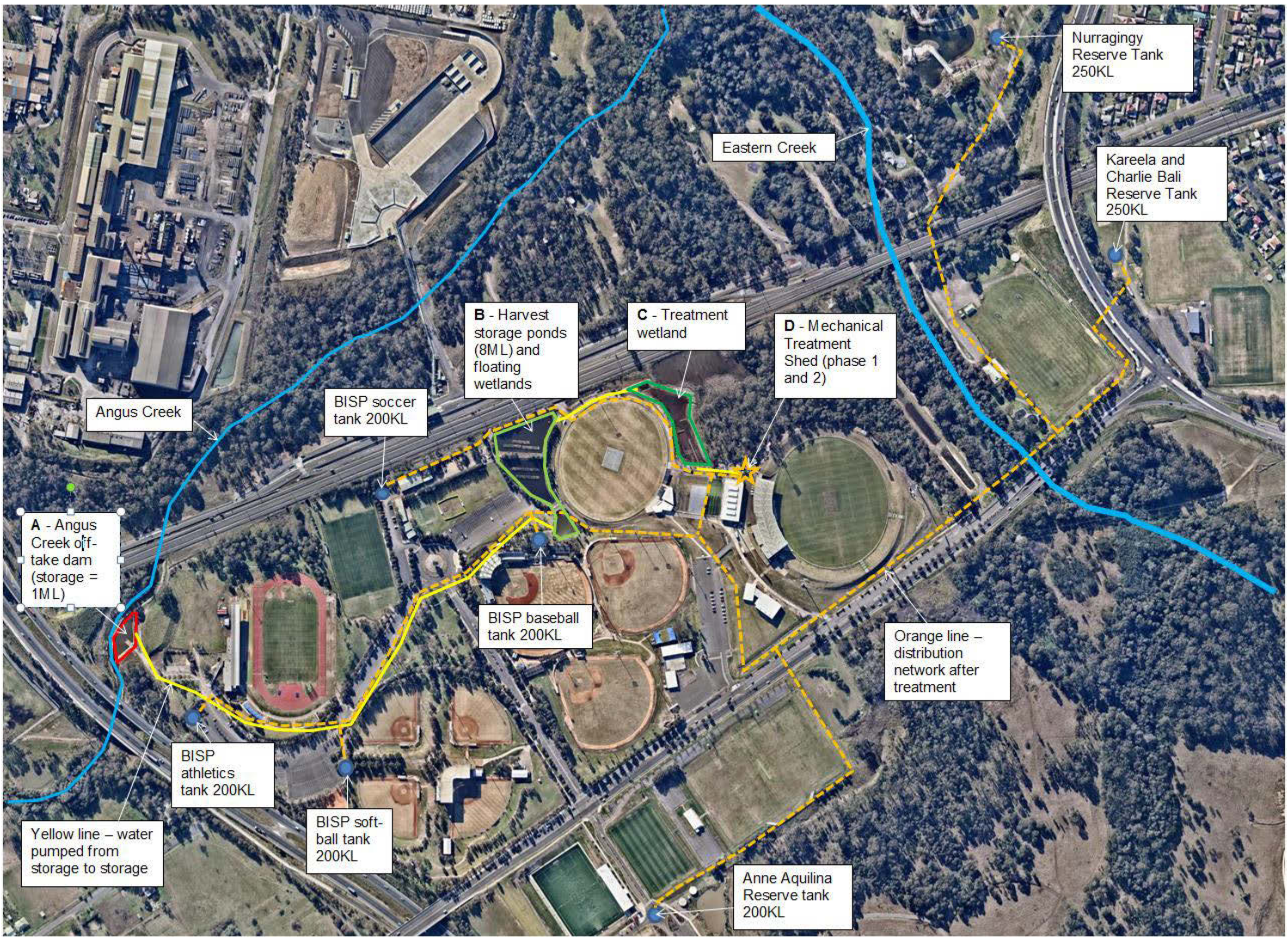


Figure 1 – location of the Angus Creek Stormwater Harvesting Scheme (Nearmap, 6/7/2015).

2.2 HOW DOES THE SCHEME WORK?

The scheme is quite complex in nature due to the need to balance competing objectives of harvesting stormwater from a creek while simultaneously allowing base flow. As a result there is a large amount of storage required to satisfy the water demand. Figure 1 and 2 provides an overview of the scheme from collection in Angus Creek to supply of water to the irrigation tanks. Figure 2 details the locations of the water quality monitoring points, both online and grab sample, the size of storages, and the treatment processes.

The section following the Figure 2 provides more detail about each component of the scheme.

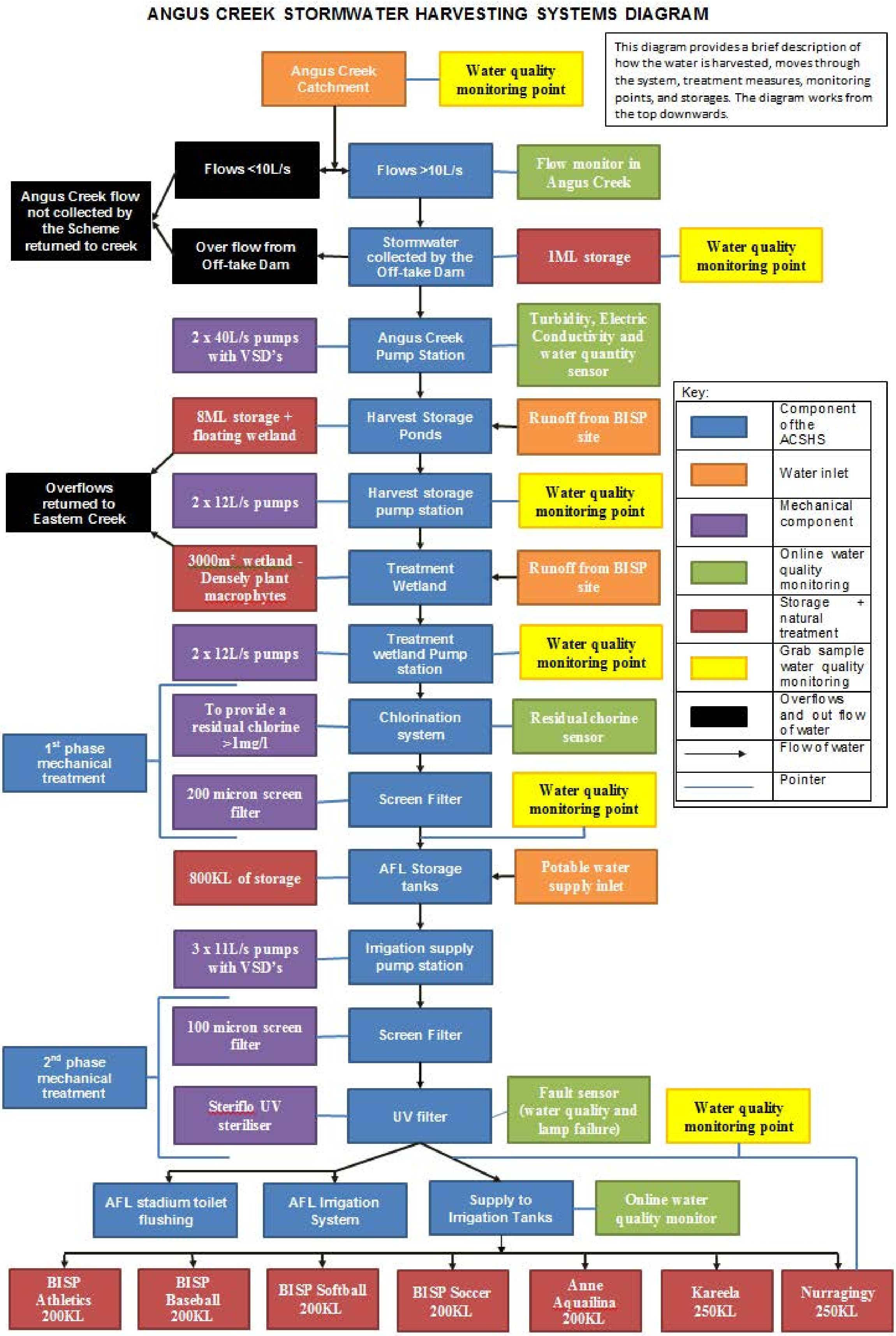


Figure 2 – Angus Creek Stormwater Harvesting Scheme Diagram

A. Angus Creek and Off-take Dam

To harvest stormwater from Angus Creek an in line weir and off line tilting weir system was installed on the creek to direct the water into a large mainly off-line off-take dam. The scheme allows all flows below 10 l/s to bypass the system maintaining an environmental flow. The off-take dam is capable of storing approximately 1 ML of stormwater, see photos 1 to 4 below.


Photo 1: Angus Creek


Photo 2: The Offtake dam (half capacity)


Photo 3: In line weir


Photo 4: Offline tilting weir with pollution deflector

The way in which water enters the offtake pool is shown in Figure 2.

The tilting weir can be adjusted to allow 10 l/s (or even more if required) downstream and all other flow to enter the off-take dam. Once the dam is full, all stormwater traveling downstream will bypass the dam. During heavy rainfall events when the flow in the creek reaches above the wall dividing the creek and the off-take dam, the water will flow into the offtake dam directly over the wall.

For the collected stormwater to be pumped to the harvest storage ponds it will need to pass through a steal mesh cage (item 5 in figure 3) excluding any debris such as litter, branches, and leaves.

The off-take pump station has a design pump rate of up to 40 l/s and uses a variable speed drive (VSD). The pump station also has a turbidity and electrical conductivity meter that indicates the quality of the stormwater being harvested. If the water quality fails to meet the correct standard the pumps are switched off until the water condition improves. This function is aimed at preventing the system from harvesting unsatisfactory water.

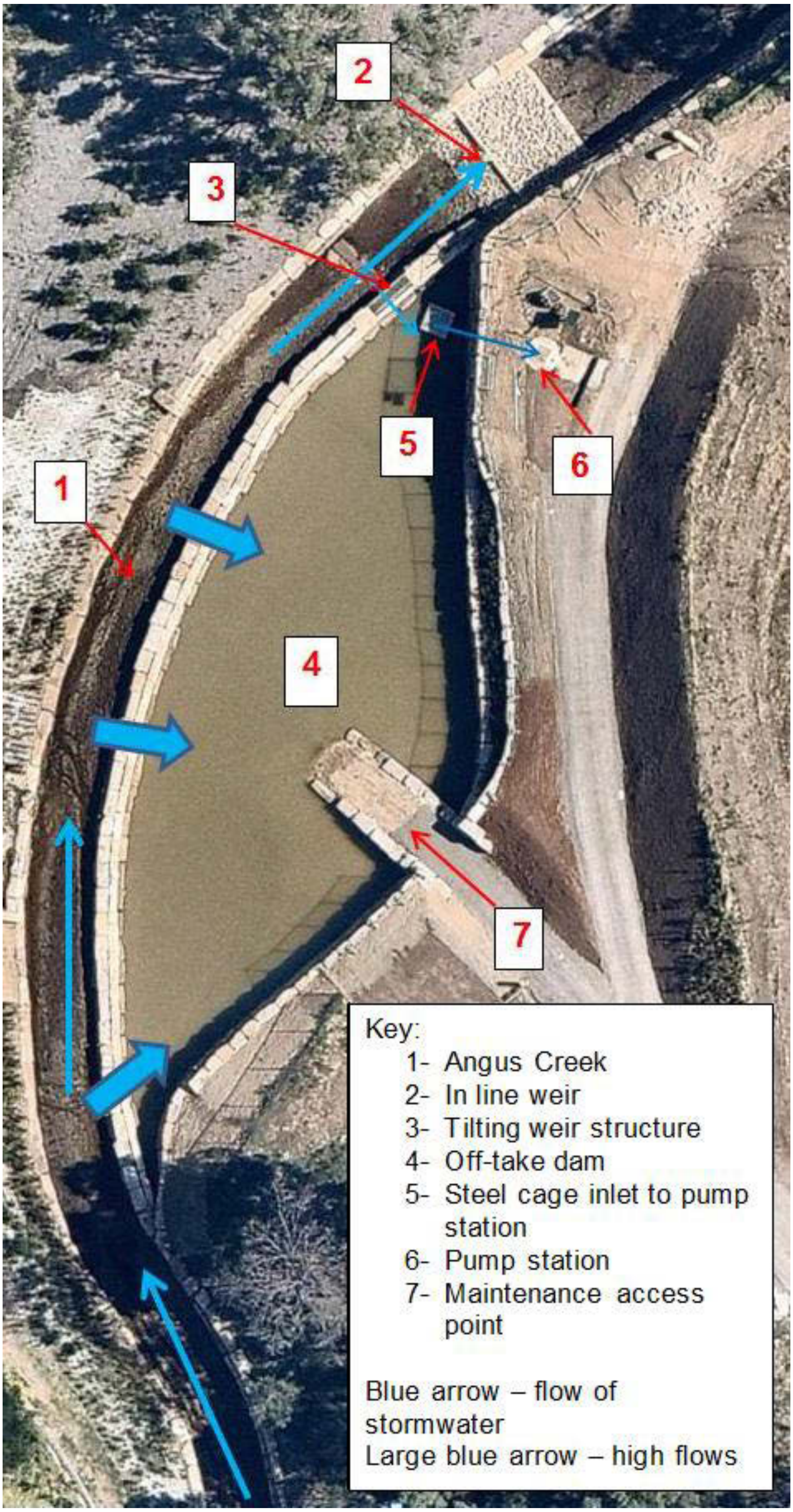


Figure 3: Aerial view of the Off-take Pool structure and an indication of how it works (Nearmap, 6/7/2015)

There is also a flow monitor in the creek downstream of the off-take point. If the flow monitor records the flow rate in the creek to be above 10 l/s the pumps will be activated; ready for pumping once the off-take dam is at the correct level. This is a further safeguard to prevent the scheme from harvesting flows of less than 10 l/s.

B. Harvest Storage Ponds

The harvest storage ponds, originally built as flood mitigation ponds, can store approximately 8ML of harvested stormwater. The water collected in the off-take dam is pumped into pond 1 (P1 in Figure 4) and the water is extracted from pond 3 (P3 in Figure 4). Separating the inlet and outlet allows contaminants in the water to settle out, improving water quality.

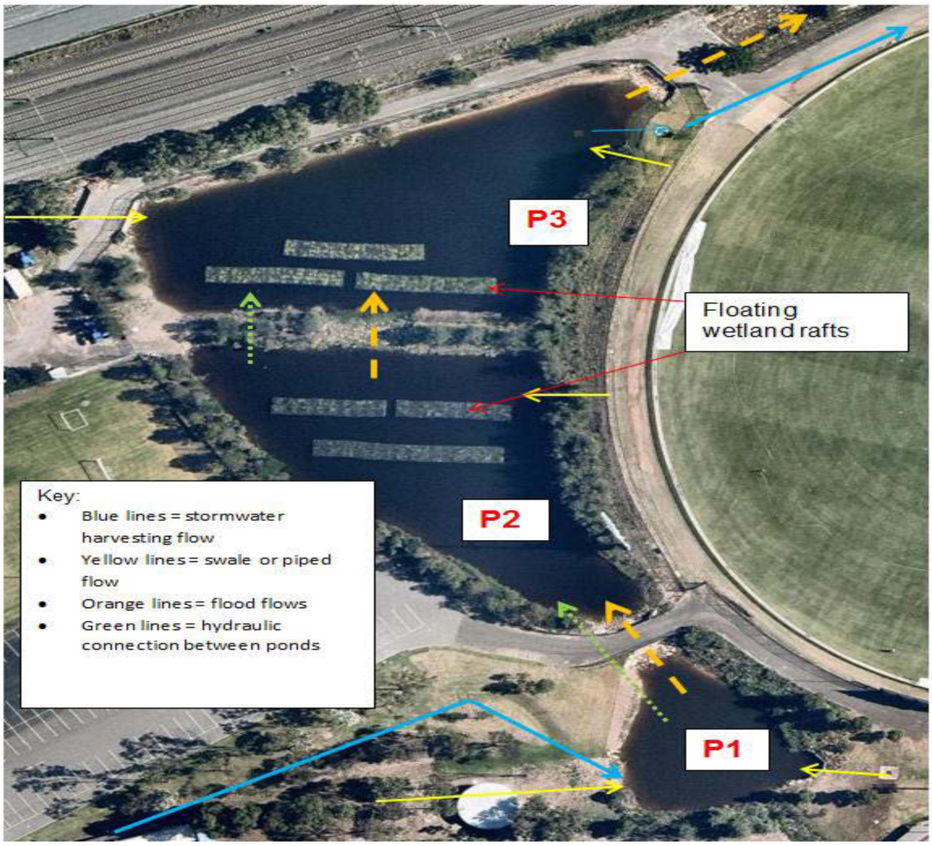


Figure 4: Aerial view of the Harvest Storage Ponds (Nearmap, 6/7/2015)

To provide additional treatment Council has installed over 400 m^2 of floating wetlands and riparian vegetation on the outer edge of the storage ponds. The floating wetlands act as a filter with their roots dangling in the water removing algae generating soluble nutrients and using it for plant growth especially in the hot summer months. The floating wetlands and bank vegetation also provide habitat for local birds, frogs, and other wildlife.

The harvest storage pump station has a design pump rate of 12 l/s. Debris and other particles above 5 mm are excluded from being pumped into the treatment wetland via a steal mess cage, similar to the Angus Creek off-take dam pump station.

Photo 5: Pond 3 with outlet cage

Photo 6: Floating wetland in pond 2

Photo 7: Floating wetland raft structure

Photo 8: Root structure of floating wetland (photo: Sean Harris)

C. Treatment Wetland

The treatment wetland is approximately 3,300m² in area and was planted out with over 50,000 aquatic/wetland plants, a density of more than 10 plants/m^2. The treatment wetland is designed to remove excess nutrients, heavy metals and hydrocarbons from the system. This treatment wetland will act as a polishing system for the water reducing the level of mechanical treatment required at later stages.

The treatment wetland features a series of level spreaders and baffles to ensure that the flow of water into the wetland is evenly distributed, to maximise hydraulic retention time and to minimize the likelihood of short circuiting.

There is also a water level control device that allows Council to control the height of the water in the wetland and to drain the wetland when maintenance is required.

Photo 9: The treatment wetland

Photo 10: The wetland inlet, pool and level spreader

The outlet structure to the wetland is a baffled pit with a shroud. This is different to the other outlets as the shroud excludes floating debris and any hydrocarbons from entering the pit as the water can only access the pit from below the surface.

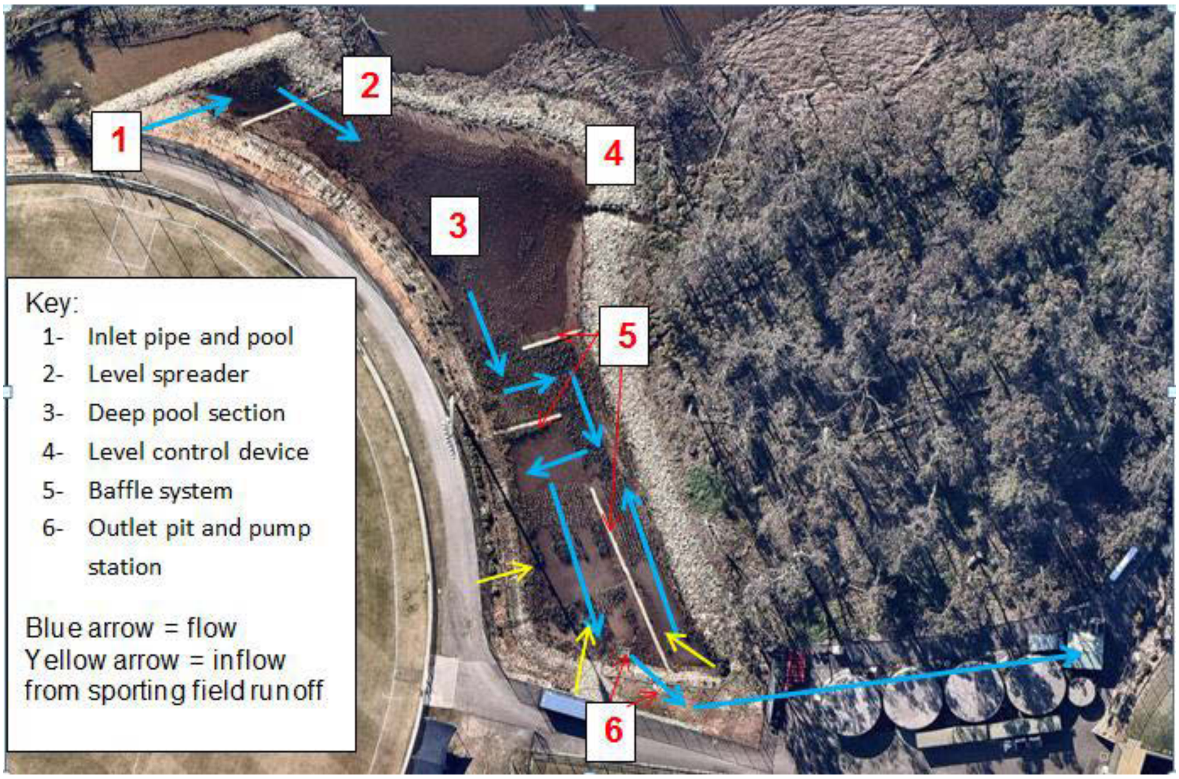


Figure 5: Aerial view of the treatment wetland (Nearmap, 6/7/2015)

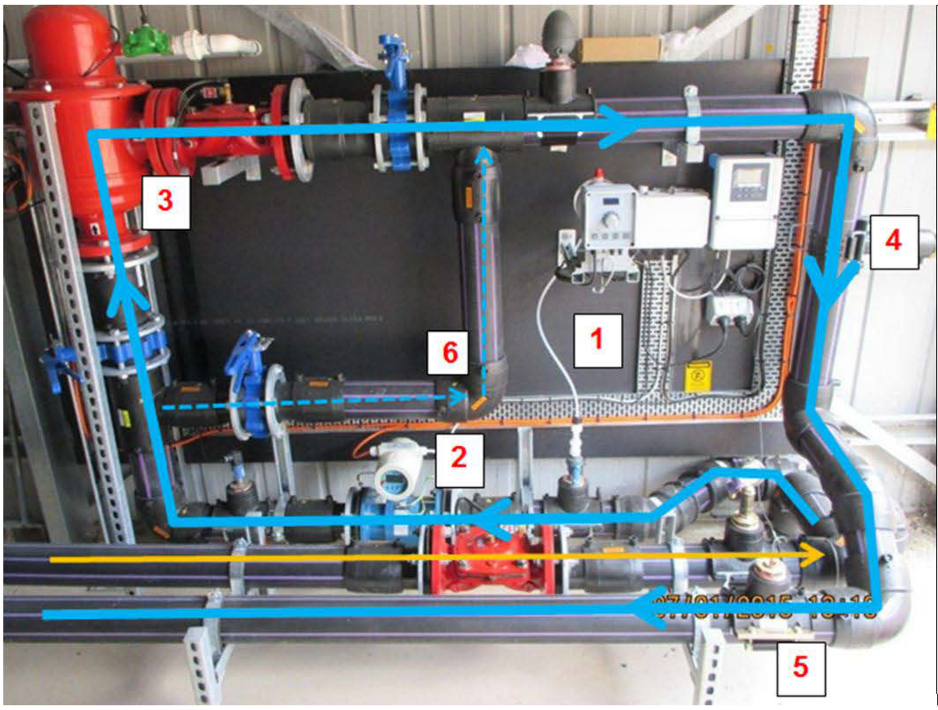
The wetland pump station has a design pump rate of 12 l/s. The water is pumped into the AFL pump shed where it will receive mechanical treatment, as described below.

D. Mechanical Treatment and Storage Tanks

Conformance to Trade Practices Legislation and relevant NSW and federal guidelines demands the water produced by the scheme to be fit for purpose. In this case fit for purpose includes irrigation (unrestricted access) and dual reticulation (toilet flushing), which is categorised as a “level 1” treatment when referring to the NSW Managing Urban Stormwater: Harvesting and Reuse Guideline, 2006. The water quality produced by the scheme will therefore be required to have low turbidity and E.coli levels. The ponds, floating wetland and treatment wetland are all critical components of the treatment train and are designed to remove a large quantity of sediment (reducing turbidity) and bacteria (E.coli) from the water before the mechanical treatment process. To ensure that the water quality is fit for purpose, Council has installed the following filters and disinfection methods:

i. First Phase Treatment

The first phase treatment system is located between the wetland pump and the AFL storage tanks. See Figure 6 below on how the water is treated before storage in the AFL tanks.



Key:
1 - Chorine dosing system
2 - Water meter that records the total volume of water harvested
3 - Screen filter 1
4 - Water quality monitoring point
5 - Residual chlorine gauge
6 - Bypass pipe section

Blue Line = flow of water between treatment wetland and AFL storage tanks

Orange Line = Flow of water to irrigation tanks after final treatment

Figure 6: The first phase treatment system.

Chlorination System

A Sodium Hypochlorite (liquid chlorine) dosing system will add chlorine to the water removing a large variety of disease causing pathogens. The chlorine also bonds to any organic matter in the water improving the effectiveness of the screen filter to remove the organic matter later in the treatment train. The dosing system will create a chlorine residual level of at least 1 mg/L residual after 30 minutes contact time. The system has a sensor that reads the free chlorine levels in the water and automatically increases or decreases dosage to achieve the desired level of residual chlorine.

Screen Filter 1

Screen Filter 1 is a screen filter that will remove particles greater than 200 microns that carry pathogens, nutrients and heavy metals. The filter has an automatic backwash system that self-cleans the filter when there is a buildup of material that reduces the performance of the filter. Figure 5 below provides an indication of how the first phase water treatment system works.

The AFL tanks have a storage capacity of 800KL and are the supply point for the Sydney Water potable supply when the stormwater harvesting scheme can’t sufficiently supply enough water.

ii. Second Treatment Phase

When there is a demand for water, either from irrigation of the AFL grounds or to fill a tank at one of the reserves, the water is gravity fed back into the pump shed where it is pumped using a series of pumps that use Variable Speed Drive’s to achieve a desired pressure. See Figure 7 for how the water is treated and distributed and the following section provides more detail about the treatment process.

Key:
1- The water enters the system from the AFL tanks via gravity to the pump station (pipe unseen)
2- The 3 distribution pumps
3- A pressure vessel
4- Screen filter 2
5- UV disinfection unit

The blue line/arrow indicates the direction of flow in the system

Figure 7: The second phase treatment system.

Screen Filter 2

Screen filter 2 removes all particles greater than 100 micron. This filter is important as any particles greater than 100 micron can block the sprinkler heads and the filter will reduce the turbidity levels of the water improving the effectiveness of the UV filter.

Ultraviolet (UV) Disinfection Unit

A UV disinfection unit is used to remove any pathogens that have survived the chlorination system.

Once the water has received its final treatment the water is either used to irrigate the AFL grounds or is stored in one of the 7 additional tanks built by the scheme. The storage tanks are located in the Sportspark (4 tanks including one each for baseball, softball, athletics, and soccer), Anne Aquilina Reserve, Kareela Reserve, and Nurragingy Reserve.

E. Control of the system

To control all components of the scheme a Supervisory Control and Data Acquisition (SCADA) system was installed. The SCADA is a computer system that gathers and analyses real time data including the pumps, monitoring equipment, disinfection units, tank/storage levels and filters. The SCADA system stores the information, sends the information to a server in Council (every 5 minutes), and can perform analysis of the information to determine faults or issues with the system. If an issue occurs it will send alerts to the officer responsible for management of the system.

The SCADA system also allows Council to remotely access the controls of the pumps and determine the water levels in the storages. This allows the officer to remotely turn pumps on and off from their office rather than having to go out to site, saving time and money. The SCADA system also collects data on the volume of water produced by the scheme and the amount of electricity used by the scheme.

F. Water Quality Management

The scheme is collecting polluted stormwater from an urban creek and runoff from the Sportspark. The main pollutant that is of particular concern to the health of the users of the sport facilities is the total pathogen content of the water. During the water quality risk assessment a number of hazards were raised and a number of solutions to these hazardous events were created and installed. To meet the required standards for unrestricted irrigation and flushing toilets set by the Australian Guidelines for Water Recycling (2009) and the NSW Managing Urban Stormwater: Harvesting and Reuse guidelines (2006) this scheme requires a log reduction of at least 6.5. The scheme is achieving the following log reductions without validation:

- Detention time in ponds of over 72 hours = 0.5 to 2 log reduction
- Detention time in wetland of over 48 hours = 2 log reduction
- Chlorine dosing = 2 to 4 log reduction
- Particle filters (improves effectiveness of UV filter)
- UV filter = 2 to 4 log reduction (NSW Department of Environment and Conservation, 2006)
- Total log reduction range = 6.5 to 14.

The level of treatment incorporated in the scheme will provide water quality that exceeds the guideline requirements. There was particular concern with the quality of water from the maintenance staff of the sporting fields as they requested to use the water for direct contact, which included using the harvested stormwater while laying turf at the same time. Even though this is 0.1% of the total water use and the water can be sourced from a nearby hydrant, Council included chlorination as a further treatment measure even though UV treatment was sufficient for 99.9% of predicted use.

3. LESSONS LEANT

The following section discusses the major triumphs and tribulations of the project from design to commissioning.

3.1 DESIGN

A. Feasibility Study

After the managed aquifer recharge scheme was dismissed as a viable option a feasibility study was completed to determine how the scheme will function using above ground storages such as dams and ponds. Once the Federal Government agreed to continue the grant funding using the modified scope Council contracted a consultant via tender to undertake the design and assist in the approval processes. It should be noted that the consultant that completed the feasibility study was the same consultant that was contracted to complete the design.

The feasibility study that was used to assist in the approvals for the federal government was also used to create the Specifications for the design tender. Unfortunately the feasibility study that was completed 18 months prior to the design tender did not represent the changes to the reserves that have occurred via the development of Master plans at both Nurragingy and Blacktown International Sportspark. These master plans significantly changed the proposed future expansion of the reserves impacting how the stormwater harvesting scheme was to function.

Once the design process commenced it was discovered that the proposed locations of the scheme components, including the harvest storage ponds and treatment wetland, could not be used as intended as the area managers highlighted significant site restrictions making these locations unfeasible. Therefore the location of the treatment wetland and harvest storage ponds were modified on several occasions until all parties could agree on a viable location. This process wasted a significant amount time and money spent discussing alternative viable locations and lead to variations of the design tender.

- Lesson 1 – Ensure the project is based on a rigorous feasibility study in which all possible stakeholders (Council, land owners, managing bodies etc.) are adequately consulted to minimise the risk of significant changes to the concept designs.

B. Steering Committee

One component of the design process that did work effectively was the establishment and use of a steering committee. Having all potential stakeholders in the one room when discussing the project and the potential design constraints is a great way of discovering unforseen issues early so that there is a minimised risk of the scheme being delayed or budgets being overspent.

A steering committee is a great way of updating the stakeholders on the progress of the design through to construction, saving time providing project updates.

- Lesson 2 – Always set up a steering committee and have regular meetings through the design process. This ensures everyone is kept informed of all current developments, minimising the likelihood of unforseen issues that arise due to poor communication. This could save significant time and funding.

C. Modelling of the Scheme

Another important component of the design that worked well was the use of an intelligent modelling program called GoldSim Pro which was linked to a MUSIC model to determine the effectiveness of the scheme.

> *GoldSim Pro "is a powerful and flexible platform for visualizing and dynamically simulating complex systems in engineering, science and business. You build a model in an intuitive manner by literally drawing a picture (an influence diagram) of your system. In a sense, GoldSim is like a "visual spreadsheet" that allows you to graphically create and manipulate data and equations… GoldSim makes it much easier for you to evaluate how systems evolve over*

time, and predict their future behaviour" (http://www.goldsim.com/Web/Products/GoldSimPro/ 23/7/15).

This program allowed the designer to insert a Council MUSIC model that synthesised creek flows and used a series of algorithms to model the volumes of water harvested from Angus Creek and to simulate how the water moved through the system to the harvest storage wetland, treatment wetland and AFL storage tanks. To generate an accurate estimate of the water harvested through to usage is quite complex due to the complexity of the scheme. The Goldsim model included details of all storage sizes, pump curves and number of pumps, and calculating the irrigation demand. See below for a screenshot of GoldSim Model that represents the Angus Creek Stormwater Harvesting Scheme.

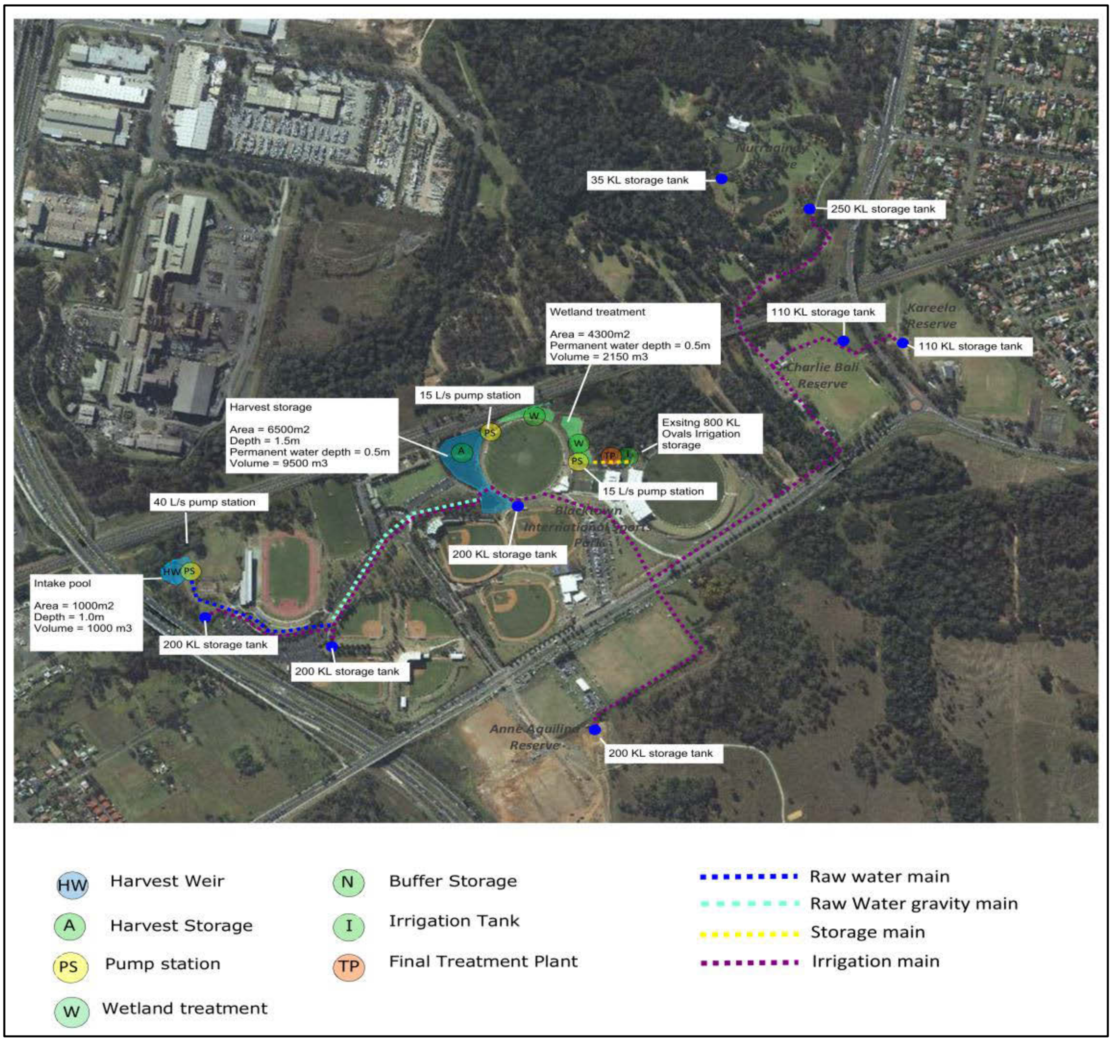


Figure 8 – Screenshot of GoldSim Model that represents the Angus Creek Stormwater Harvesting Scheme

The GoldSim model was a critical part of the design process. The model allowed the team to undertake a sensitivity analysis and to optimise the size of the storages and pumping rates. For example the design team modified the off-take pumping rate from 120 l/s to 40 l/s and the total amount of water harvested reduced by only a minimal amount. Therefore the design development was optimised, which saved Council significant funds for not only the purchase and installation of the pumps and electricity supply but for maintenance and running costs as well.

- Lesson 3 – using an intelligent modelling program to simulate the stormwater harvesting scheme could save significant sums of money by optimising the storage size and pumping rates before the scheme is built. It could provide information about reducing the size of the storage volumes and pumping rates if they have been over designed or save money on retrofitting if the original design is inadequate for the required output. This modelling was also beneficial for understanding other elements such as energy consumption, as it can generate hours of pumping, and the amount of potable water required to meet the remaining irrigation demand.

D. Contractual Agreements

It is important during the tender process that both parties (the designer and client) agree on exactly where the contractual agreements begin and end. This issue related to the designer ending their works from a design perspective prior to the supply of water to the irrigation tanks. The design tender should have finished with the delivery of water to the storage tanks, including the supply network design to the tanks, but instead finished at the AFL tanks making the completion of the design difficult.

- Lesson 4 – Be very clear in the tender or contract where the design of the scheme is to begin and where it finishes. Although it might seem logical to finish a Contract at the end of the supply line that might not be practical.

During the design of the scheme there was also an issue with the works not being performed by the people nominated in the tender. Half way through the design of the scheme the consultant went through a restructure, in which the majority of AutoCAD operators that were working on the project were dismissed causing a delay to the design. The final drawings required substantial modification by Council and interpretation by Council's Construction Engineers. There were a number of omissions on the design drawings relating to waterproofing of various structures which now has to be rectified by Council.

3.2. OFFICE OF WATER APPROVAL PROCESS

The scheme required water supply works and water use approvals from the former NSW Office of Water (NOW), currently NSW Department of Primary Industries Water prior to completion of works. It also required the purchase of water unit shares.

A. Water Supply Works and Water Use Approvals

The application and approval process for the water supply works and water use approvals was fairly straight forward, however lengthy delays of approximately 7 months were experienced prior to approval. This delayed some construction components of the scheme.

A. Purchase of Water Unit Shares

In the purchase of water unit shares NOW originally required Council to purchase the full 200ML prior to harvesting stormwater from the creek. Unit shares are the volume of water that can be harvested within each water extraction licence, i.e. 1 unit share equals 1ML. This scheme is situated within the Lower South Creek Management Zone in the NSW Water Sharing Plan. Council already owns an extraction licence permitting 25ML to be extracted from the creek, therefore 175ML's (or 175 unit shares) was required to be purchased from another licence within this management zone.

To purchase these remaining unit shares Council developed and used a tender process. A tender was required as the predicted value per unit share is between $1,000 to $1,500 meaning that the total cost, although unlikely to come from one source, is above the tender threshold of $150,000. Council is obliged to adhere to tender requirements under its procurement policy and as such called for tenders however, no tender submissions were received. This may have occurred for a number of reasons, including no one with unit shares saw the tender or they saw the tender but were not willing to sell their unit shares. In undertaking this process Council expended funds on an officer to develop the tender, hired a consultant to assist Council to purchase the unit shares, and approximately $5,000 on additional advertising above the tender requirements in an effort to attract submissions.

After the tender failed, Council contacted the NOW to seek guidance on how the unit shares can be found and purchased. But due to their privacy policies NOW were unable to provide Council with names and addresses of those with licences; therefore Council needed to find another option.

Council then wrote to NOW to articulate that requiring Council to purchase unit shares for an urban stormwater harvesting scheme should not be needed (and contravenes the intentions of the Water Management Act). The following reasons were stated in the letter:

- The scheme is predicted to have beneficial impact on the health of the creek. The scheme will reduce the likelihood of stormwater causing erosion of the bed and banks of Angus Creek while still allowing an environmental flow.

- Forcing a Council or other authority to spend between $1,000 to $1,500 (at least) per ML would impact the economic feasibility of most stormwater harvesting schemes. If fewer schemes are built the environmental benefits would be reduced and more pressure/reliance placed on the potable water supply.
- The urbanisation of the Angus Creek catchment will increase over the next 20 years increasing the volume of water generated and potentially harvested. This is the same for the whole Lower South Creek Management zone as the North West Growth Centre is located within the zone. Therefore the Water Sharing Plan for this zone should be reviewed and modified to reflect this increase in water availability. The current Water Sharing Plans are heavy based on agricultural areas west of the Great Diving Range and neglect urban areas and the issues that relate to creeks and rivers with an abundance of water.
- Council's should have been able to exercise its harvestable rights. Using GIS it was estimated that Council owns 171ha of land within the Angus Creek Catchment with a right to harvest 10% of the average annual volume of runoff. However harvestable rights can only be exercised west of the diving range.

After all of these points were considered and that it was shown Council had made an effort to purchase the unit share,s NOW provided an exemption to Council for the need to purchase unit shares. This whole process occurred over a 12 month period and expended considerable time, money and resources.

- Lesson 6 – When applying for a licence or approvals budget plenty of time. If the proposed scheme is within an urban area be prepared to liaise considerably with DPI Water and use existing precedents to hasten the process and time involved. Purchasing unit shares will potentially impact the triple bottom line of stormwater harvesting and many projects will be abandoned even if they have a beneficial impact on the environment.

It should be noted that DPI Water are working on a policy for urban stormwater harvesting and updating the water sharing plans but no timeframes are stated on when this legislation is to come into effect.

3.3. CONSTRUCTION

Construction of the scheme lasted approximately 12 months, which was 6 months over the estimated construction timeframe. The main components requiring construction were the following:

- Off-take dam and creek works – These works coincided with bed and bank stabilisation of Angus Creek. Therefore only the dam structure and in line weir structure required construction. The construction period was a very wet period that postponed the competition of the works.
- Deepening of the harvest storage dams – The harvest storage ponds already existed but required deepening. This component also suffered extensive delays as the ponds are part of the Sportsparks flood mitigation controls and all of the swales and drainage pipes drain into the ponds. Therefore every small rainfall event required the ponds to be pumped dry before the clay could be excavated.
- Construction of the treatment wetland – There were approval issues with a major high pressure gas supply line that runs underneath the wetland. Although Council was raising the wetland surface above its original level the approval processes added another 3 months.
- Installation of pump stations – this component relied on the completion of the large storage areas before they could be completed.
- Mechanical and Electrical installation – this component relied on the completion of the pump stations to be installed before these works could be completed.
- Pipeworks – pipes connect the large storage areas and from final treatment to the irrigation tanks. Both concrete and HDPE pipes were used. All up over a kilometre of pipe was laid for this project.
- Concrete tanks – The scheme installed 6 tanks ranging from 200KL (four tanks) to 250KL (two tanks).

To construct these elements Council used 2 main Civil Contractors from the Blacktown City Council Civil Construction Schedule of Rates. This was one of the main issues. As the Contractors had several other major projects with Blacktown City Council, and other clients, this project only received minimal attention (financially it was one of the smallest projects) which delayed the completion of construction by at least 6 months. If a design and construct tender was used Council it could have established liquidated damages and held the Contractor liable for missing deadlines.

Also during construction of the scheme certain components were not built according to the design. This was due to poor design (mainly not considering site constraints and a lack of detail), the Contractor using creative licence, and shortcuts to keep the project on budget and to complete as soon as possible. This led to elements having to be rebuilt or modified after completion of the contract. The designer of the scheme was to conduct site inspections during construction but due to construction being delayed the designer moved onto other projects that required attention, therefore site visits were every few months and after key components were already built.

- Lesson 7 – a design and construct (D&C) contract should have been used for the Angus Creek Stormwater Harvesting Scheme. Because the scheme was grant funded and the funding was tied into specific timelines it was critical that scheme was built on time or Council risked losing some of its funding. A D&C approach would have enabled the builder to call on the designer directly to ask relevant questions such as how do I waterproof this structure etc.

One of the largest costs for construction of the scheme was removal of material from the site. The off-take structure, deepening of the harvest storage ponds, and underground tanks all required large quantities of material being removed from site. A nearby site required fill and therefore tipping cost were kept to a minimum saving Council almost $500,000.

- Lesson 8 – before starting a project that requires extensive excavation find a suitable location that will receive the fill at a minimal cost. This saves funding that can be reallocated to other important components such as maintenance, monitoring, or upgrading equipment.

4. DISCUSSION

Harvesting stormwater from an urban creek in NSW is not as easy as it sounds. There are a number of reasons for this and they include:

- The approval process from the DPI Water is lengthy and bureaucratic
- The current legislation does not consider stormwater harvesting from urban areas, which adds to the burden of gaining approval
- The design of the scheme, in particular how the water is extracted and stored, can be complex and expensive especially if environmental flow is a requirement
- Catchment management of the creek is a large component of the management framework and needs extensive consideration, especially management of upstream water quality treatment devices – if they aren't managed effectively the trickle-down effect can be very costly.
- The water quality of the harvested stormwater varies from each storm event. Extensive commissioning and validation of the scheme is required to prove the scheme is capable of handling such fluctuations.
- Sediment removal is a major cost and requires good design to minimise collection.

Although there are many environmental benefits to harvesting stormwater from an urban creek the current legislation and policy requirements do not make it easy or cheap. Requiring Councils, or other authorities, to purchase unit shares is economically unviable. Most authorities use a cost benefit analysis to determine which projects receive funding and if this legislation doesn't change than the environmental benefits achieved by stormwater harvesting schemes will not be achieved. DPI Water needs to re-evaluate the legislation in light of these issues in consultation with relevant parties that may harvest from creeks in the future, like Blacktown City Council.

5. CONCLUSION

Blacktown City Council has undertaken its first large scale stormwater Harvesting scheme in which the stormwater is collected from a modified urban creek. The process from design, approvals, and construction was difficult due to the complexity of the scheme and there were issues with the Design Consultant and Construction Contractor. Additionally, the way in which NSW legislation and regulations is being administered lacks an appreciation of how stormwater harvesting from an urban creek has great potential for improving downstream environments.

This process, although not ideal, provided some lessons on how the process could be modified or changed for the future. In summary, the main lessons include:

- Develop a rigorous feasibility study and a solid concept design before undertaking detailed design
- Set up and use a steering committee from the start of the project
- Use an intelligent modelling program to simulate how the scheme is to perform and to optimise it
- Be careful when creating a design contract to ensure the specifications reflect the total works required and don't assume items will be completed
- Use a design and construct contract rather than a schedule of rates contract
- Allow for plenty of time when applying for approvals
- Before the project begins find a suitable location to store the fill removed for the scheme.

6. REFERENCES

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